

	Mental Model Description	Description Source
General Thinking Concepts	Inversion	"Otherwise known as thinking through a situation in reverse or thinking "backwards," inversion is a problem-solving technique. Often by considering what we want to avoid rather than what we want to get, we come up with better solutions. Inversion works not just in mathematics but in nearly every area of life. As the saying goes, "Just tell me where I'm going to die so I can never go there." Shane Parrish's Farnam Street Mental Model Guide
	Falsification / Confirmation Bias	What a man wishes, he also believes. Similarly, what we believe is what we choose to see. This is commonly referred to as the confirmation bias. It is a deeply ingrained mental habit, both energy-conserving and comfortable, to look for confirmations of long-held wisdom rather than violations. Yet the scientific process – including hypothesis generation, blind testing when needed, and objective statistical rigor – is designed to root out precisely the opposite, which is why it works so well when followed. The modern scientific enterprise operates under the principle of falsification: A method is termed scientific if it can be stated in such a way that a certain defined result would cause it to be proved false. Pseudo-knowledge and pseudo-science operate and propagate by being unfalsifiable – as with astrology, we are unable to prove them either correct or incorrect because the conditions under which they would be shown false are never stated. Shane Parrish's Farnam Street Mental Model Guide
	Circle of Competence	An idea introduced by Warren Buffett and Charles Munger in relation to investing, each individual tends to have an area or areas in which they really, truly know their stuff, their area of special competence. Areas not inside that circle are problematic because not only are we ignorant about them, but we may also be ignorant of our own ignorance. Thus, when we're making decisions, it becomes important to define and attend to our special circle, so as to act accordingly. Shane Parrish's Farnam Street Mental Model Guide
	The Principle of Parsimony (Occam's Razor)	Named after the friar William of Ockham, Occam's Razor is a heuristic by which we select among competing explanations. Ockham stated that we should prefer the simplest explanation with the least moving parts: it is easier to falsify (see: Falsification), easier to understand, and more likely, on average, to be correct. This principle is not an iron law but a tendency and a mindset. If all else is equal, it's more likely that the simple solution suffices. Of course, we also keep in mind Einstein's famous idea (even if apocryphal) that "an idea should be made as simple as possible, but no simpler." - Shane Parrish "Among competing hypotheses, the one with the fewest assumptions should be selected." (related: conjunction fallacy, overfitting, "when you hear hoofbeats, think of horses not zebras.") - Gabriel Weinberg Shane Parrish's Farnam Street Mental Model Guide via https://www.farnamstreetblog.com/mental-models/
	Hanlon's Razor	"Harder to trace in its origin, Hanlon's Razor states that we should not attribute to malice that which is more easily explained by stupidity. In a complex world, this principle helps us avoid extreme paranoia and ideology, often very hard to escape from, by not generally assuming that bad results are the fault of a bad actor, although they can be. More likely, a mistake has been made." - Shane Parrish "Never attribute to malice that which is adequately explained by carelessness." (related: fundamental attribution error — "the tendency for people to place an undue emphasis on internal characteristics of the agent (character or intention), rather than external factors, in explaining another person's behavior in a given situation.") - Gabriel Weinberg Shane Parrish's Farnam Street Mental Model Guide via https://www.farnamstreetblog.com/mental-models/
	Second-Order Thinking	Harder to trace in its origin, Hanlon's Razor states that we should not attribute to malice that which is more easily explained by stupidity. In a complex world, this principle helps us avoid extreme paranoia and ideology, often very hard to escape from, by not generally assuming that bad results are the fault of a bad actor, although they can be. More likely, a mistake has been made. In all human systems and most complex systems, the second layer of effects often dwarfs the first layer, yet often goes unconsidered. In other words, we must consider that effects have effects. Second-order thinking is best illustrated by the idea of standing on your tiptoes at a parade: Once one person does it, everyone will do it in order to see, thus negating the first tiptoe. Now, however, the whole parade audience suffers on their toes rather than standing firmly on their whole feet. Shane Parrish's Farnam Street Mental Model Guide
	The Map Is Not the Territory	The map of reality is not reality itself. If any map were to represent its actual territory with perfect fidelity, it would be the size of the territory itself. Thus, no need for a map! This model tells us that there will always be an imperfect relationship between reality and the models we use to represent and understand it. This imperfection is a necessity in order to simplify. It is all we can do to accept this and act accordingly. Shane Parrish's Farnam Street Mental Model Guide
	Thought Experiments	A technique popularized by Einstein, the thought experiment is a way to logically carry out a test in one's own head that would be very difficult or impossible to perform in real life. With the thought experiment as a tool, we can solve problems with intuition and logic that could not be demonstrated physically, as with Einstein imagining himself traveling on a beam of light in order to solve the problem of relativity. Shane Parrish's Farnam Street Mental Model Guide
	Mr. Market	Mr. Market was introduced by the investor Benjamin Graham in his seminal book The Intelligent Investor to represent the vicissitudes of the financial markets. As Graham explains, the markets are a bit like a moody neighbor, sometimes waking up happy and sometimes waking up sad – your job as an investor is to take advantage of him in his bad moods and sell to him in his good moods. This attitude is contrasted to an efficient-market hypothesis in which Mr. Market always wakes up in the middle of the bed, never feeling overly strong in either direction. Shane Parrish's Farnam Street Mental Model Guide
	Probabilistic Thinking (See also: Numeracy/Bayesi an Updating)	The unknowable human world is dominated by probabilistic outcomes, as distinguished from deterministic ones. Although we cannot predict the future with great certainty, we are wise to ascribe odds to more and less probable events. We do this every day unconsciously as we cross the street and ascribe low, yet not negligible, odds of being hit by a car. Shane Parrish's Farnam Street Mental Model Guide
	Default Status	The USCB ecologist/economist Garrett Hardin once said that "The scientific mind is not closed: it is merely well-guarded by a conscientious and seldom sleeping gatekeeper." The way it does that is with the concept of the default status: The "resting position" of common sense, whereby the burden of proof falls on assertions to the contrary. Given the problem of opportunity costs and limited time and energy, a default status is nearly always necessary to avoid wasting time. Examples include the laws of thermodynamics, the law of natural selection, and the incentive-caused bias. Shane Parrish's Farnam Street Mental Model Guide
	Numeracy	Permutations and Combinations
Algebraic Equivalence		The introduction of algebra allowed us to demonstrate mathematically and abstractly that two seemingly different things could be the same. By manipulating symbols, we can demonstrate equivalence or inequivalence, the use of which led humanity to unfold engineering and technical abilities. Knowing at least the basics of algebra can allow us to understand a variety of important results. Shane Parrish's Farnam Street Mental Model Guide
Randomness		Though the human brain has trouble comprehending it, much of the world is composed of random, non-sequential, non-ordered events. We are "fooled" by random effects when we attribute causality to things that are actually outside of our control. If we don't course-correct for this fooled-by-randomness effect – our faulty sense of pattern-seeking – we will tend to see things as being more predictable than they are and act accordingly. Shane Parrish's Farnam Street Mental Model Guide
Stochastic Processes (Poisson, Markov, Random Walk)		A stochastic process is a random statistical process and encompasses a wide variety of processes in which the movement of an individual variable can be impossible to predict but can be thought through probabilistically. The wide variety of stochastic methods helps us describe systems of variables through probabilities without necessarily being able to determine the position of any individual variable over time. For example, it's not possible to predict stock prices on a day-to-day basis, but we can describe the probability of various distributions of their movements over time. Obviously, it is much more likely that the stock market (a stochastic process) will be up or down 1% in a day than up or down 10%, even though we can't predict what tomorrow will bring. Shane Parrish's Farnam Street Mental Model Guide
Compounding		It's been said that Einstein called compounding a wonder of the world. He probably didn't, but it is a wonder. Compounding is the process by which we add interest to a fixed sum, which then earns interest on the previous sum and the newly added interest, and then earns interest on that amount, and so on ad infinitum. It is an exponential effect, rather than a linear, or additive, effect. Money is not the only thing that compounds; ideas and relationships do as well. In tangible realms, compounding is always subject to physical limits and diminishing returns; intangibles can compound more freely. Compounding also leads to the time value of money, which underlies all of modern finance. Shane Parrish's Farnam Street Mental Model Guide
Multiplying by Zero		Any reasonably educated person knows that any number multiplied by zero, no matter how large the number, is still zero. This is true in human systems as well as mathematical ones. In some systems, a failure in one area can negate great effort in all other areas. As simple multiplication would show, fixing the "zero" often has a much greater effect than does trying to enlarge the other areas. Shane Parrish's Farnam Street Mental Model Guide
Churn		Insurance companies and subscription services are well aware of the concept of churn – every year, a certain number of customers are lost and must be replaced. Standing still is the equivalent of losing, as seen in the model called the "Red Queen Effect." Churn is present in many business and human systems: A constant figure is periodically lost and must be replaced before any new figures are added over the top. Shane Parrish's Farnam Street Mental Model Guide
Law of Large Numbers		One of the fundamental underlying assumptions of probability is that as more instances of an event occur, the actual results will converge on the expected ones. For example, if I know that the average man is 5 feet 10 inches tall, I am far more likely to get an average of 5'10" by selecting 500 men at random than 5 men at random. The opposite of this model is the law of small numbers, which states that small samples can and should be looked at with great skepticism. Shane Parrish's Farnam Street Mental Model Guide
Bell Curve/Normal Distribution		The normal distribution is a statistical process that leads to the well-known graphical representation of a bell curve, with a meaningful central "average" and increasingly rare standard deviations from that average when correctly sampled. (The so-called "central limit" theorem.) Well-known examples include human height and weight, but it's just as important to note that many common processes, especially in non-tangible systems like social systems, do not follow the normal distribution. Shane Parrish's Farnam Street Mental Model Guide
Power Laws		One of the most common processes that does not fit the normal distribution is that of a power law, whereby one quantity varies with another's exponent rather than linearly. For example, the Richter scale describes the power of earthquakes on a power-law distribution scale: an 8 is 10x more destructive than a 7, and a 9 is 10x more destructive than an 8. The central limit theorem does not apply and there is thus no "average" earthquake. This is true of all power-law distributions. Shane Parrish's Farnam Street Mental Model Guide
Fat-Tailed Processes (Extremistan)		A process can often look like a normal distribution but have a large "tail" – meaning that seemingly outlier events are far more likely than they are in an actual normal distribution. A strategy or process may be far more risky than a normal distribution is capable of describing if the fat tail is on the negative side, or far more profitable if the fat tail is on the positive side. Much of the human social world is said to be fat-tailed rather than normally distributed. Shane Parrish's Farnam Street Mental Model Guide
Bayesian Updating		The Bayesian method is a method of thought (named for Thomas Bayes) whereby one takes into account all prior relevant probabilities and then incrementally updates them as new information arrives. This method is especially productive given the fundamentally non-deterministic world we experience: We must use prior odds and new information in combination to arrive at our best decisions. This is not necessarily our intuitive decision-making engine. Shane Parrish's Farnam Street Mental Model Guide
Regression to the Mean		In a normally distributed system, long deviations from the average will tend to return to that average with an increasing number of observations: the so-called Law of Large Numbers. We are often fooled by regression to the mean, as with a sick patient improving spontaneously around the same time they begin taking an herbal remedy, or a poorly performing sports team going on a winning streak. We must be careful not to confuse statistically likely events with causal ones. Shane Parrish's Farnam Street Mental Model Guide
Order of Magnitude		In many, perhaps most, systems, quantitative description down to a precise figure is either impossible or useless (or both). For example, estimating the distance between our galaxy and the next one over is a matter of knowing not the precise number of miles, but how many zeroes are after the 1. Is the distance about 1 million miles or about 1 billion? This thought habit can help us escape useless precision. Shane Parrish's Farnam Street Mental Model Guide
Scale		One of the most important principles of systems is that they are sensitive to scale. Properties (or behaviors) tend to change when you scale them up or down. In studying complex systems, we must always be roughly quantifying – in orders of magnitude, at least – the scale at which we are observing, analyzing, or predicting the system. Shane Parrish's Farnam Street Mental Model Guide

	Mental Model	Description	Description Source
Systems	Law of Diminishing Returns	Related to scale, most important real-world results are subject to an eventual decrease of incremental value. A good example would be a poor family: Give them enough money to thrive, and they are no longer poor. But after a certain point, additional money will not improve their lot; there is a clear diminishing return of additional dollars at some roughly quantifiable point. Often, the law of diminishing returns veers into negative territory – i.e., receiving too much money could destroy the poor family.	Shane Parrish's Farnam Street Mental Model Guide
	Pareto Principle	Named for Italian polymath Vilfredo Pareto, who noticed that 80% of Italy's land was owned by about 20% of its population, the Pareto Principle states that a small amount of some phenomenon causes a disproportionately large effect. The Pareto Principle is an example of a power-law type of statistical distribution – as distinguished from a traditional bell curve – and is demonstrated in various phenomena ranging from wealth to city populations to important human habits.	Shane Parrish's Farnam Street Mental Model Guide
	Feedback Loops (and Homeostasis)	All complex systems are subject to positive and negative feedback loops whereby A causes B, which in turn influences A (and C), and so on – with higher-order effects frequently resulting from continual movement of the loop. In a homeostatic system, a change in A is often brought back into line by an opposite change in B to maintain the balance of the system, as with the temperature of the human body or the behavior of an organizational culture. Automatic feedback loops maintain a "static" environment unless and until an outside force changes the loop. A "runaway feedback loop" describes a situation in which the output of a reaction becomes its own catalyst (auto-catalysis).	Shane Parrish's Farnam Street Mental Model Guide
	Chaos Dynamics (Sensitivity to Initial Conditions)	In a world such as ours, governed by chaos dynamics, small changes (perturbations) in initial conditions have massive downstream effects as near-infinite feedback loops occur; this phenomenon is also called the butterfly effect. This means that some aspects of physical systems (like the weather more than a few days from now) as well as social systems (the behavior of a group of human beings over a long period) are fundamentally unpredictable.	Shane Parrish's Farnam Street Mental Model Guide
	Preferential Attachment (Cumulative Advantage)	A preferential attachment situation occurs when the current leader is given more of the reward than the laggards, thereby tending to preserve or enhance the status of the leader. A strong network effect is a good example of preferential attachment; a market with 10x more buyers and sellers than the next largest market will tend to have a preferential attachment dynamic.	Shane Parrish's Farnam Street Mental Model Guide
	Emergence	Higher-level behavior tends to emerge from the interaction of lower-order components. The result is frequently not linear – not a matter of simple addition – but rather non-linear, or exponential. An important resulting property of emergent behavior is that it cannot be predicted from simply studying the component parts.	Shane Parrish's Farnam Street Mental Model Guide
	Irreducibility	We find that in most systems there are irreducible quantitative properties, such as complexity, minimums, time, and length. Below the irreducible level, the desired result simply does not occur. One cannot get several women pregnant to reduce the amount of time needed to have one child, and one cannot reduce a successfully built automobile to a single part. These results are, to a defined point, irreducible.	Shane Parrish's Farnam Street Mental Model Guide
	Tragedy of the Commons	A concept introduced by the economist and ecologist Garrett Hardin, the Tragedy of the Commons states that in a system where a common resource is shared, with no individual responsible for the wellbeing of the resource, it will tend to be depleted over time. The Tragedy is reducible to incentives: Unless people collaborate, each individual derives more personal benefit than the cost that he or she incurs, and therefore depletes the resource for fear of missing out.	Shane Parrish's Farnam Street Mental Model Guide
	Gresham's Law	Gresham's Law, named for the financier Thomas Gresham, states that in a system of circulating currency, forged currency will tend to drive out real currency, as real currency is hoarded and forged currency is spent. We see a similar result in human systems, as with bad behavior driving out good behavior in a crumbling moral system, or bad practices driving out good practices in a crumbling economic system. Generally, regulation and oversight are required to prevent results that follow Gresham's Law.	Shane Parrish's Farnam Street Mental Model Guide
	Algorithms	While hard to precisely define, an algorithm is generally an automated set of rules or a "blueprint" leading a series of steps or actions resulting in a desired outcome, and often stated in the form of a series of "If → Then" statements. Algorithms are best known for their use in modern computing, but are a feature of biological life as well. For example, human DNA contains an algorithm for building a human being.	Shane Parrish's Farnam Street Mental Model Guide
	Fragility – Robustness – Antifragility	Popularized by Nassim Taleb, the sliding scale of fragility, robustness, and antifragility refers to the responsiveness of a system to incremental negative variability. A fragile system or object is one in which additional negative variability has a disproportionately negative impact, as with a coffee cup shattering from a 6-foot fall, but receiving no damage at all (rather than 1/6th of the damage) from a 1-foot fall. A robust system or object tends to be neutral to the additional negative variability, and of course, an antifragile system benefits: If there were a cup that got stronger when dropped from 6 feet than when dropped from 1 foot, it would be termed antifragile.	Shane Parrish's Farnam Street Mental Model Guide
	Backup Systems/Redundancy	A critical model of the engineering profession is that of backup systems. A good engineer never assumes the perfect reliability of the components of the system. He or she builds in redundancy to protect the integrity of the total system. Without the application of this robustness principle, tangible and intangible systems tend to fail over time.	Shane Parrish's Farnam Street Mental Model Guide
	Margin of Safety	Similarly, engineers have also developed the habit of adding a margin for error into all calculations. In an unknown world, driving a 9,500-pound bus over a bridge built to hold precisely 9,600 pounds is rarely seen as intelligent. Thus, on the whole, few modern bridges ever fail. In practical life outside of physical engineering, we can often profitably give ourselves margins as robust as the bridge system.	Shane Parrish's Farnam Street Mental Model Guide
	Criticality	A system becomes critical when it is about to jump discretely from one phase to another. The marginal utility of the last unit before the phase change is wildly higher than any unit before it. A frequently cited example is water turning from a liquid to a vapor when heated to a specific temperature. "Critical mass" refers to the mass needed to have the critical event occur, most commonly in a nuclear system.	Shane Parrish's Farnam Street Mental Model Guide
	Network Effects	A network tends to become more valuable as nodes are added to the network: this is known as the network effect. An easy example is contrasting the development of the electricity system and the telephone system. If only one house has electricity, its inhabitants have gained immense value, but if only one house has a telephone, its inhabitants have gained nothing of use. Only with additional telephones does the phone network gain value. This network effect is widespread in the modern world and creates immense value for organizations and customers alike.	Shane Parrish's Farnam Street Mental Model Guide
	Black Swan	Also popularized by Nassim Taleb, a Black Swan is a rare and highly consequential event that is invisible to a given observer ahead of time. It is a result of applied epistemology: If you have seen only white swans, you cannot categorically state that there are no black swans, but the inverse is not true: seeing one black swan is enough for you to state that there are black swans. Black Swan events are necessarily unpredictable to the observer (as Taleb likes to say, Thanksgiving is a Black Swan for the turkey, not the butcher) and thus must be dealt with by addressing the fragility-robustness-antifragility spectrum rather than through better methods of prediction.	Shane Parrish's Farnam Street Mental Model Guide
	Via Negativa – Omission/Removal/Avoidance of Harm	In many systems, improvement is at best, or at times only, a result of removing bad elements rather than of adding good elements. This is a credo built into the modern medical profession: First, do no harm. Similarly, if one has a group of children behaving badly, removal of the instigator is often much more effective than any form of punishment meted out to the whole group.	Shane Parrish's Farnam Street Mental Model Guide
	The Lindy Effect	The Lindy Effect refers to the life expectancy of a non-perishable object or idea being related to its current lifespan. If an idea or object has lasted for X number of years, it would be expected (on average) to last another X years. Although a human being who is 90 and lives to 95 does not add 5 years to his or her life expectancy, non-perishables lengthen their life expectancy as they continually survive. A classic text is a prime example: if humanity has been reading Shakespeare's plays for 500 years, it will be expected to read them for another 500.	Shane Parrish's Farnam Street Mental Model Guide
	Renormalization Group	The renormalization group technique allows us to think about physical and social systems at different scales. An idea from physics, and a complicated one at that, the application of a renormalization group to social systems allows us to understand why a small number of stubborn individuals can have a disproportionate impact if those around them follow suit on increasingly large scales.	Shane Parrish's Farnam Street Mental Model Guide
	Spring-loading	A system is spring-loaded if it is coiled in a certain direction, positive or negative. Positively spring-loading systems and relationships is important in a fundamentally unpredictable world to help protect us against negative events. The reverse can be very destructive.	Shane Parrish's Farnam Street Mental Model Guide
Complex Adaptive Systems	A complex adaptive system, as distinguished from a complex system in general, is one that can understand itself and change based on that understanding. Complex adaptive systems are social systems. The difference is best illustrated by thinking about weather prediction contrasted to stock market prediction. The weather will not change based on an important forecaster's opinion, but the stock market might. Complex adaptive systems are thus fundamentally not predictable.	Shane Parrish's Farnam Street Mental Model Guide	
Physical World	Laws of Thermodynamics	The laws of thermodynamics describe energy in a closed system. The laws cannot be escaped and underlie the physical world. They describe a world in which useful energy is constantly being lost, and energy cannot be created or destroyed. Applying their lessons to the social world can be a profitable enterprise.	Shane Parrish's Farnam Street Mental Model Guide
	Reciprocity	If I push on a wall, physics tells me that the wall pushes back with equivalent force. In a biological system, if one individual acts on another, the action will tend to be reciprocated in kind. And of course, human beings act with intense reciprocity demonstrated as well.	Shane Parrish's Farnam Street Mental Model Guide
	Velocity	Velocity is not equivalent to speed; the two are sometimes confused. Velocity is speed plus vector: how fast something gets somewhere. An object that moves two steps forward and then two steps back has moved at a certain speed but shows no velocity. The addition of the vector, that critical distinction, is what we should consider in practical life.	Shane Parrish's Farnam Street Mental Model Guide
	Relativity	Relativity has been used in several contexts in the world of physics, but the important aspect to study is the idea that an observer cannot truly understand a system of which he himself is a part. For example, a man inside an airplane does not feel like he is experiencing movement, but an outside observer can see that movement is occurring. This form of relativity tends to affect social systems in a similar way.	Shane Parrish's Farnam Street Mental Model Guide
	Activation Energy	A fire is not much more than a combination of carbon and oxygen, but the forests and coal mines of the world are not combusting at will because such a chemical reaction requires the input of a critical level of "activation energy" in order to get a reaction started. Two combustible elements alone are not enough.	Shane Parrish's Farnam Street Mental Model Guide
	Catalysts	A catalyst either kick-starts or maintains a chemical reaction, but isn't itself a reactant. The reaction may slow or stop without the addition of catalysts. Social systems, of course, take on many similar traits, and we can view catalysts in a similar light.	Shane Parrish's Farnam Street Mental Model Guide
	Leverage	Most of the engineering marvels of the world have been accomplished with applied leverage. As famously stated by Archimedes, "Give me a lever long enough and I shall move the world." With a small amount of input force, we can make a great output force through leverage. Understanding where we can apply this model to the human world can be a source of great success.	Shane Parrish's Farnam Street Mental Model Guide
	Inertia	An object in motion with a certain vector wants to continue moving in that direction unless acted upon. This is a fundamental physical principle of motion; however, individuals, systems, and organizations display the same effect. It allows them to minimize the use of energy, but can cause them to be destroyed or eroded.	Shane Parrish's Farnam Street Mental Model Guide
	Alloying	When we combine various elements, we create new substances. This is no great surprise, but what can be surprising in the alloying process is that 2+2 can equal not 4 but 6 – the alloy can be far stronger than the simple addition of the underlying elements would lead us to believe. This process leads us to engineering great physical objects, but we understand many intangibles in the same way; a combination of the right elements in social systems or even individuals can create a 2+2=6 effect similar to alloying.	Shane Parrish's Farnam Street Mental Model Guide
	Incentives	All creatures respond to incentives to keep themselves alive. This is the basic insight of biology. Constant incentives will tend to cause a biological entity to have constant behavior, to an extent. Humans are included and are particularly great examples of the incentive-driven nature of biology; however, humans are complicated in that their incentives can be hidden or intangible. The rule of life is to repeat what works and has been rewarded.	Shane Parrish's Farnam Street Mental Model Guide
Cooperation (Including Symbiosis)	Competition tends to describe most biological systems, but cooperation at various levels is just as important a dynamic. In fact, the cooperation of a bacterium and a simple cell probably created the first complex cell and all of the life we see around us. Without cooperation, no group survives, and the cooperation of groups gives rise to even more complex versions of organization. Cooperation and competition tend to coexist at multiple levels.	Shane Parrish's Farnam Street Mental Model Guide	

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The Biological World	Tendency to Minimize Energy Output (Mental & Physical)	In a physical world governed by thermodynamics and competition for limited energy and resources, any biological organism that was wasteful with energy would be at a severe disadvantage for survival. Thus, we see in most instances that behavior is governed by a tendency to minimize energy usage when at all possible.	Shane Parrish's Farnam Street Mental Model Guide	
	Adaptation	Species tend to adapt to their surroundings in order to survive, given the combination of their genetics and their environment – an always-unavoidable combination. However, adaptations made in an individual's lifetime are not passed down genetically, as was once thought: Populations of species adapt through the process of evolution by natural selection, as the most-fit examples of the species replicate at an above-average rate.	Shane Parrish's Farnam Street Mental Model Guide	
	Evolution by Natural Selection	Evolution by natural selection was once called "the greatest idea anyone ever had." In the 19th century, Charles Darwin and Alfred Russel Wallace simultaneously realized that species evolve through random mutation and differential survival rates. If we call human intervention in animal-breeding an example of "artificial selection," we can call Mother Nature deciding the success or failure of a particular mutation "natural selection." Those best suited for survival tend to be preserved. But of course, conditions change.	Shane Parrish's Farnam Street Mental Model Guide	
	The Red Queen Effect (Co-evolutionary Arms Race)	The evolution-by-natural-selection model leads to something of an arms race among species competing for limited resources. When one species evolves an advantageous adaptation, a competing species must respond in kind or fail as a species. Standing pat can mean falling behind. This arms race is called the Red Queen Effect for the character in Alice in Wonderland who said, "Now, here, you see, it takes all the running you can do, to keep in the same place."	Shane Parrish's Farnam Street Mental Model Guide	
	Replication	A fundamental building block of diverse biological life is high-fidelity replication. The fundamental unit of replication seems to be the DNA molecule, which provides a blueprint for the offspring to be built from physical building blocks. There are a variety of replication methods, but most can be lumped into sexual and asexual.	Shane Parrish's Farnam Street Mental Model Guide	
	Hierarchical and Other Organizing Instincts	Most complex biological organisms have an innate feel for how they should organize. While not all of them end up in hierarchical structures, many do, especially in the animal kingdom. Human beings like to think they are outside of this, but they feel the hierarchical instinct as strongly as any other organism.	Shane Parrish's Farnam Street Mental Model Guide	
	Self-Preservation Instincts	Without a strong self-preservation instinct in an organism's DNA, it would tend to disappear over time, thus eliminating that DNA. While cooperation is another important model, the self-preservation instinct is strong in all organisms and can cause violent, erratic, and/or destructive behavior for those around them.	Shane Parrish's Farnam Street Mental Model Guide	
	Simple Physiological Reward-Seeking	All organisms feel pleasure and pain from simple chemical processes in their bodies which respond predictably to the outside world. Reward-seeking is an effective survival-promoting technique on average. However, those same pleasure receptors can be co-opted to cause destructive behavior, as with drug abuse.	Shane Parrish's Farnam Street Mental Model Guide	
	Exaptation	Introduced by the biologist Steven Jay Gould, an exaptation refers to a trait developed for one purpose that is later used for another purpose. This is one way to explain the development of complex biological features like an eyeball; in a more primitive form, it may have been used for something else. Once it was there, and once it developed further, 3D sight became possible.	Shane Parrish's Farnam Street Mental Model Guide	
	Extinction	The inability to survive can cause an extinction event, whereby an entire species ceases to compete and replicate effectively. Once its numbers have dwindled to a critically low level, an extinction can be unavoidable (and predictable) given the inability to effectively replicate in large enough numbers.	Shane Parrish's Farnam Street Mental Model Guide	
	Ecosystems	An ecosystem describes any group of organisms coexisting with the natural world. Most ecosystems show diverse forms of life taking on different approaches to survival, with such pressures leading to varying behavior. Social systems can be seen in the same light as the physical ecosystems and many of the same conclusions can be made.	Shane Parrish's Farnam Street Mental Model Guide	
	Niches	Most organisms find a niche: a method of competing and behaving for survival. Usually, a species will select a niche for which it is best adapted. The danger arises when multiple species begin competing for the same niche, which can cause an extinction – there can be only so many species doing the same thing before limited resources give out.	Shane Parrish's Farnam Street Mental Model Guide	
	Dunbar's Number	The primatologist Robin Dunbar observed through study that the number of individuals a primate can get to know and trust closely is related to the size of its neocortex. Extrapolating from his study of primates, Dunbar theorized that the Dunbar number for a human being is somewhere in the 100–250 range, which is supported by certain studies of human behavior and social networks.	Shane Parrish's Farnam Street Mental Model Guide	
	Trust	Fundamentally, the modern world operates on trust. Familial trust is generally a given (otherwise we'd have a hell of a time surviving), but we also choose to trust chefs, clerks, drivers, factory workers, executives, and many others. A trusting system is one that tends to work most efficiently; the rewards of trust are extremely high.	Shane Parrish's Farnam Street Mental Model Guide	
	Bias from Incentives	Highly responsive to incentives, humans have perhaps the most varied and hardest to understand set of incentives in the animal kingdom. This causes us to distort our thinking when it is in our own interest to do so. A wonderful example is a salesman truly believing that his product will improve the lives of its users. It's not merely convenient that he sells the product; the fact of his selling the product causes a very real bias in his own thinking.	Shane Parrish's Farnam Street Mental Model Guide	
	Pavlovian Mere Association	Ivan Pavlov very effectively demonstrated that animals can respond not just to direct incentives but also to associated objects; remember the famous dogs salivating at the ring of a bell. Human beings are much the same and can feel positive and negative emotion towards intangible objects, with the emotion coming from past associations rather than direct effects.	Shane Parrish's Farnam Street Mental Model Guide	
	Tendency to Feel Envy & Jealousy	Humans have a tendency to feel envious of those receiving more than they are, and a desire "get what is theirs" in due course. The tendency towards envy is strong enough to drive otherwise irrational behavior, but is as old as humanity itself. Any system ignorant of envy effects will tend to self-immolate over time.	Shane Parrish's Farnam Street Mental Model Guide	
	Human Nature & Judgment	Tendency to Distort Due to Liking/Loving or Disliking/Hating	Based on past association, stereotyping, ideology, genetic influence, or direct experience, humans have a tendency to distort their thinking in favor of people or things that they like and against people or things they dislike. This tendency leads to overrating the things we like and underrating or broadly categorizing things we dislike, often missing crucial nuances in the process.	Shane Parrish's Farnam Street Mental Model Guide
		Denial	Anyone who has been alive long enough realizes that, as the saying goes, "denial is not just a river in Africa." This is powerfully demonstrated in situations like war or drug abuse, where denial has powerful destructive effects but allows for behavioral inertia. Denying reality can be a coping mechanism, a survival mechanism, or a purposeful tactic.	Shane Parrish's Farnam Street Mental Model Guide
		Availability Heuristic	One of the most useful findings of modern psychology is what Daniel Kahneman calls the Availability Bias or Heuristic: We tend to most easily recall what is salient, important, frequent, and recent. The brain has its own energy-saving and inertial tendencies that we have little control over – the availability heuristic is likely one of them. Having a truly comprehensive memory would be debilitating. Some sub-examples of the availability heuristic include the Anchoring and Sunk Cost Tendencies.	Shane Parrish's Farnam Street Mental Model Guide
Representativeness Heuristic		The three major psychological findings that fall under Representativeness, also defined by Kahneman and his partner Tversky, are:	Shane Parrish's Farnam Street Mental Model Guide	
Failure to Account for Base Rates		An unconscious failure to look at past odds in determining current or future behavior.	Shane Parrish's Farnam Street Mental Model Guide	
Tendency to Stereotype		The tendency to broadly generalize and categorize rather than look for specific nuance. Like availability, this is generally a necessary trait for energy-saving in the brain.	Shane Parrish's Farnam Street Mental Model Guide	
Failure to See False Conjunctions		Most famously demonstrated by the Linda Test, the same two psychologists showed that students chose more vividly described individuals as more likely to fit into a predefined category than individuals with broader, more inclusive, but less vivid descriptions, even if the vivid example was a mere subset of the more inclusive set. These specific examples are seen as more representative of the category than those with the broader but vaguer descriptions, in violation of logic and probability.	Shane Parrish's Farnam Street Mental Model Guide	
Social Proof (Safety in Numbers)		Human beings are one of many social species, along with bees, ants, and chimps, among many more. We have a DNA-level instinct to seek safety in numbers and will look for social guidance on our behavior. This instinct creates a cohesive sense of cooperation and culture which would not otherwise be possible, but also leads us to do foolish things if our group is doing them as well.	Shane Parrish's Farnam Street Mental Model Guide	
Narrative Instinct		Human beings have been appropriately called "the storytelling animal" because of our instinct to construct and seek meaning in narrative. It's likely that long before we developed the ability to write or to create objects, we were telling stories and thinking in stories. Nearly all social organizations, from religious institutions to corporations to nation-states, run on constructions of the narrative instinct.	Shane Parrish's Farnam Street Mental Model Guide	
Curiosity Instinct		We like to call other species curious, but we are the most curious of all, an instinct which led us out of the savanna and led us to learn a great deal about the world around us, using that information to create the world in our collective minds. The curiosity instinct leads to unique human behavior and forms of organization like the scientific enterprise. Even before there were direct incentives to innovate, humans innovated out of curiosity.	Shane Parrish's Farnam Street Mental Model Guide	
Language Instinct		The psychologist Steven Pinker calls our DNA-level instinct to learn grammatically constructed language the Language Instinct. The idea that grammatical language is not a simple cultural artifact was first popularized by the linguist Noam Chomsky. As we saw with the narrative instinct, we use these instincts to create shared stories, as well as to gossip, solve problems, and fight, among other things. Grammatically ordered language theoretically carries infinite varying meaning.	Shane Parrish's Farnam Street Mental Model Guide	
First-Conclusion Bias		As Charlie Munger famously pointed out, the mind works a bit like a sperm and egg: the first idea gets in and then the mind shuts. Like many other tendencies, this is probably an energy-saving device. Our tendency to settle on first conclusions leads us to accept many erroneous results and cease asking questions; it can be countered with some simple and useful mental routines.	Shane Parrish's Farnam Street Mental Model Guide	
Tendency to Overgeneralize from Small Samples		It's important for human beings to generalize; we need not see every instance to understand the general rule, and this works to our advantage. With generalizing, however, comes a subset of errors when we forget about the Law of Large Numbers and act as if it does not exist. We take a small number of instances and create a general category, even if we have no statistically sound basis for the conclusion.	Shane Parrish's Farnam Street Mental Model Guide	
Relative Satisfaction/Misery Tendencies		The envy tendency is probably the most obvious manifestation of the relative satisfaction tendency, but nearly all studies of human happiness show that it is related to the state of the person relative to either their past or their peers, not absolute. These relative tendencies cause us great misery or happiness in a very wide variety of objectively different situations and make us poor predictors of our own behavior and feelings.	Shane Parrish's Farnam Street Mental Model Guide	
Commitment & Consistency Bias	As psychologists have frequently and powerfully demonstrated, humans are subject to a bias towards keeping their prior commitments and staying consistent with our prior selves when possible. This trait is necessary for social cohesion: people who often change their conclusions and habits are often distrusted. Yet our bias towards staying consistent can become, as one wag put it, a "hobgoblin of foolish minds" – when it is combined with the first-conclusion bias, we end up landing on poor answers and standing pat in the face of great evidence.	Shane Parrish's Farnam Street Mental Model Guide		
Hindsight Bias	Once we know the outcome, it's nearly impossible to turn back the clock mentally. Our narrative instinct leads us to reason that we knew it all along (whatever "it" is), when in fact we are often simply reasoning post-hoc with information not available to us before the event. The hindsight bias explains why it's wise to keep a journal of important decisions for an unaltered record and to re-examine our beliefs when we convince ourselves that we knew it all along.	Shane Parrish's Farnam Street Mental Model Guide		
Sensitivity to Fairness	Justice runs deep in our veins. In another illustration of our relative sense of well-being, we are careful arbiters of what is fair. Violations of fairness can be considered grounds for reciprocal action, or at least distrust. Yet fairness itself seems to be a moving target. What is seen as fair and just in one time and place may not be in another. Consider that slavery has been seen as perfectly natural and perfectly unnatural in alternating phases of human existence.	Shane Parrish's Farnam Street Mental Model Guide		

	Mental Model Description	Description Source	
Microeconomics & Strategy	Tendency to Overestimate Consistency of Behavior (Fundamental Attribution Error)	We tend to over-ascribe the behavior of others to their innate traits rather than to situational factors, leading us to overestimate how consistent that behavior will be in the future. In such a situation, predicting behavior seems not very difficult. Of course, in practice this assumption is consistently demonstrated to be wrong, and we are consequently surprised when others do not act in accordance with the "innate" traits we've endowed them with. The equally famous Stanford Prison Experiment and Milgram Experiments demonstrated what humans had learned practically many years before: the human bias towards being influenced by authority. In a dominance hierarchy such as ours, we tend to look to the leader for guidance on behavior, especially in situations of stress or uncertainty. Thus, authority figures have a responsibility to act well, whether they like it or not.	Shane Parrish's Farnam Street Mental Model Guide
	Influence of Authority	Stress causes both mental and physiological responses and tends to amplify the other biases. Almost all human mental biases become worse in the face of stress as the body goes into a fight-or-flight response, relying purely on instinct without the emergency brake of Daniel Kahneman's "System 2" type of reasoning. Stress causes hasty decisions, immediacy, and a fallback to habit, thus giving rise to the elite soldiers' motto: "In the thick of battle, you will not rise to the level of your expectations, but fall to the level of your training."	Shane Parrish's Farnam Street Mental Model Guide
	Influence of Stress (Including Breaking Points)	A major problem with historiography – our interpretation of the past – is that history is famously written by the victors. We do not see what Nassim Taleb calls the "silent grave" – the lottery ticket holders who did not win. Thus, we over-attribute success to things done by the successful agent rather than to randomness or luck, and we often learn false lessons by exclusively studying victors without seeing all of the accompanying losers who acted in the same way but were not lucky enough to succeed.	Shane Parrish's Farnam Street Mental Model Guide
	Survivorship Bias Tendency to Want to Do Something (Fight/Flight, Intervention, Demonstration of Value, etc.)	We might term this Boredom Syndrome: Most humans have the tendency to need to act, even when their actions are not needed. We also tend to offer solutions even when we do not enough knowledge to solve the problem.	Shane Parrish's Farnam Street Mental Model Guide
	Opportunity Costs	Doing one thing means not being able to do another. We live in a world of trade-offs, and the concept of opportunity cost rules all. Most aptly summarized as "there is no such thing as a free lunch."	Shane Parrish's Farnam Street Mental Model Guide
	Creative Destruction	Coined by economist Joseph Schumpeter, the term "creative destruction" describes the capitalistic process at work in a functioning free-market system. Motivated by personal incentives (including but not limited to financial profit), entrepreneurs will push to best one another in a never-ending game of creative one-upmanship, in the process destroying old ideas and replacing them with newer technology. Beware getting left behind.	Shane Parrish's Farnam Street Mental Model Guide
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	Comparative Advantage	The Scottish economist David Ricardo had an unusual and non-intuitive insight: Two individuals, firms, or countries could benefit from trading with one another even if one of them was better at everything. Comparative advantage is best seen as an applied opportunity cost: If it has the opportunity to trade, an entity gives up free gains in productivity by not focusing on what it does best.	Shane Parrish's Farnam Street Mental Model Guide
	Specialization (Pin Factory)	Another Scottish economist, Adam Smith, highlighted the advantages gained in a free-market system by specialization. Rather than having a group of workers each producing an entire item from start to finish, Smith explained that it's usually far more productive to have each of them specialize in one aspect of production. He also cautioned, however, that each worker might not enjoy such a life; this is a trade-off of the specialization model.	Shane Parrish's Farnam Street Mental Model Guide
	Seizing the Middle	In chess, the winning strategy is usually to seize control of the middle of the board, so as to maximize the potential moves that can be made and control the movement of the maximal number of pieces. The same strategy works profitably in business, as can be demonstrated by John D. Rockefeller's control of the refinery business in the early days of the oil trade and Microsoft's control of the operating system in the early days of the software trade.	Shane Parrish's Farnam Street Mental Model Guide
	Trademarks, Patents, and Copyrights	These three concepts, along with other related ones, protect the creative work produced by enterprising individuals, thus creating additional incentives for creativity and promoting the creative-destruction model of capitalism. Without these protections, information and creative workers have no defense against their work being freely distributed.	Shane Parrish's Farnam Street Mental Model Guide
	Double-Entry Bookkeeping	One of the marvels of modern capitalism has been the bookkeeping system introduced in Genoa in the 14th century. The double-entry system requires that every entry, such as income, also be entered into another corresponding account. Correct double-entry bookkeeping acts as a check on potential accounting errors and allows for accurate records and thus, more accurate behavior by the owner of a firm.	Shane Parrish's Farnam Street Mental Model Guide
	Utility (Marginal, Diminishing, Increasing)	The usefulness of additional units of any good tends to vary with scale. Marginal utility allows us to understand the value of one additional unit, and in most practical areas of life, that utility diminishes at some point. On the other hand, in some cases, additional units are subject to a "critical point" where the utility function jumps discretely up or down. As an example, giving water to a thirsty man has diminishing marginal utility with each additional unit, and can eventually kill him with enough units.	Shane Parrish's Farnam Street Mental Model Guide
	Bottlenecks	A bottleneck describes the place at which a flow (of a tangible or intangible) is stopped, thus holding it back from continuous movement. As with a clogged artery or a blocked drain, a bottleneck in production of any good or service can be small but have a disproportionate impact if it is in the critical path.	Shane Parrish's Farnam Street Mental Model Guide
	Prisoner's Dilemma	The Prisoner's Dilemma is a famous application of game theory in which two prisoners are both better off cooperating with each other, but if one of them cheats, the other is better off cheating. Thus the dilemma. This model shows up in economic life, in war, and in many other areas of practical human life. Though the prisoner's dilemma theoretically leads to a poor result, in the real world, cooperation is nearly always possible and must be explored.	Shane Parrish's Farnam Street Mental Model Guide
	Bribery	Often ignored in mainstream economics, the concept of bribery is central to human systems: Given the chance, it is often easier to pay a certain agent to look the other way than to follow the rules. The enforcer of the rules is then neutralized. This principle/agent problem can be seen as a form of arbitrage.	Shane Parrish's Farnam Street Mental Model Guide
	Arbitrage	Given two markets selling an identical good, an arbitrage exists if the good can profitably be bought in one market and sold at a profit in the other. This model is simple on its face, but can present itself in disguised forms: The only gas station in a 50-mile radius is also an arbitrage as it can buy gasoline and sell it at the desired profit (temporarily) without interference. Nearly all arbitrage situations eventually disappear as they are discovered and exploited.	Shane Parrish's Farnam Street Mental Model Guide
	Supply and Demand	The basic equation of biological and economic life is one of limited supply of necessary goods and competition for those goods. Just as biological entities compete for limited usable energy, so too do economic entities compete for limited customer wealth and limited demand for their products. The point at which supply and demand for a given good are equal is called an equilibrium; however, in practical life, equilibrium points tend to be dynamic and changing, never static.	Shane Parrish's Farnam Street Mental Model Guide
	Scarcity	Game theory describes situations of conflict, limited resources, and competition. Given a certain situation and a limited amount of resources and time, what decisions are competitors likely to make, and which should they make? One important note is that traditional game theory may describe humans as more rational than they really are. Game theory is theory, after all.	Shane Parrish's Farnam Street Mental Model Guide
	Military & War	Seeing the Front	One of the most valuable military tactics is the habit of "personally seeing the front" before making decisions – not always relying on advisors, maps, and reports, all of which can be either faulty or biased. The Map/Territory model illustrates the problem with not seeing the front, as does the incentive model. Leaders of any organization can generally benefit from seeing the front, as not only does it provide firsthand information, but it also tends to improve the quality of secondhand information.
Asymmetric Warfare		The asymmetry model leads to an application in warfare whereby one side seemingly "plays by different rules" than the other side due to circumstance. Generally, this model is applied by an insurgency with limited resources. Unable to out-muscle their opponents, asymmetric fighters use other tactics, as with terrorism creating fear that's disproportionate to their actual destructive ability.	Shane Parrish's Farnam Street Mental Model Guide
Two-Front War		The Second World War was a good example of a two-front war. Once Russia and Germany became enemies, Germany was forced to split its troops and send them to separate fronts, weakening their impact on either front. In practical life, opening a two-front war can often be a useful tactic, as can solving a two-front war or avoiding one, as in the example of an organization tamping down internal discord to focus on its competitors.	Shane Parrish's Farnam Street Mental Model Guide
Counterinsurgency		Though asymmetric insurgent warfare can be extremely effective, over time competitors have also developed counterinsurgency strategies. Recently and famously, General David Petraeus of the United States led the development of counterinsurgency plans that involved no additional force but substantial additional gains. Tit-for-tat warfare or competition will often lead to a feedback loop that demands insurgency and counterinsurgency.	Shane Parrish's Farnam Street Mental Model Guide
Mutually Assured Destruction		Somewhat paradoxically, the stronger two opponents become, the less likely they may be to destroy one another. This process of mutually assured destruction occurs not just in warfare, as with the development of global nuclear warheads, but also in business, as with the avoidance of destructive price wars between competitors. However, in a fat-tailed world, it is also possible that mutually assured destruction scenarios simply make destruction more severe in the event of a mistake (pushing destruction into the "tails" of the distribution).	Shane Parrish's Farnam Street Mental Model Guide
Sorting	2 - 2 - Schelling's Segregation Model	"In 1971, the American economist Thomas Schelling created an agent-based model that might help explain why segregation is so difficult to combat. His model of segregation showed that even when individuals (or "agents") didn't mind being surrounded or living by agents of a different race, they would still choose to segregate themselves from other agents over time! Although the model is quite simple, it gives a fascinating look at how individuals might self-segregate, even when they have no explicit desire to do so." - Harding University Computer Science Department	Scott Page Model Thinking MOOC Course
	2 - 4 - Peer Effects	"These sort of contagion phenomena that happened [inaudible] pure effects. That sometimes. The tail wags the dog. What do I mean by that. What I mean is that sometimes. The people at the end of distribution. The extremists. Are the ones that really drive what happens. And as a result. That means it's gonna be incredibly difficult to predict what's gonna go on." - Transcript from Scott Page Coursera [1]	Scott Page Model Thinking MOOC Course
	2 - 5 - The Standing Ovation Model	"Now this is a model that builds off the [inaudible] model it's just really an extension. But it can allow us to sort of think about threshold based models of participation and pure effects in a little more subtle ways. Why standing ovations, those are kind of a funny thing to study. Well here's why. Think about a standing ovation. When the performance ends, you don't have a lot of time to decide whether you are going to stand up or not. You gotta make sort of a fairly quick judgment. You're going to clap of course but then you gotta decide do I stand or do I not stand. And then after the standing ovation either starts or doesn't start you gotta make another decision, do I stand up, do I follow these people, or do I know stay sitting. So when you think about human behavior there's going to be different models that we play with throughout the course about how humans act. One model will be that people are optimizing, that they make rational choices in all setting. When it comes [inaudible] of a standing ovations that is probably a difficult thing to do because it is all happening so fast. So instead, what people probably do is they follow rules." - Transcript from Scott Page Coursera [2]	Scott Page Model Thinking MOOC Course
	2 - 6 - The Identification Problem - The Big Sort: Why the Clustering of Like-Minded America is Tearing Us Apart	"Synopsis of Big Sort: Bill Bishop claims that we are increasingly self-sorting ourselves into neighborhoods politically and only associating with like-minded political neighbors with all kinds of horrible consequences. Much of Bishop and Cushing's evidence about the corrosive effect comes from psycho-sociological experiments like Asch's where group pressure causes people to behave immorally (a la Lord of the Flies or the Stanford Prison Experiment), or to censor their own dissenting voice even when they originally believed those views to be correct. (Note: Fiorina has made quite a name for himself on how the political elites in America have become ever more polarized and the masses have over time sorted themselves out more reliably into political parties but the masses views' have not become any more extreme, so obviously the Big Sort doesn't square with his other research that uses ongoing surveys like the General Social Survey, the American National Election Studies, etc.) There is a wonderful cartoon that the New York Times did about the Big Sort." - Social Capital Blog	Scott Page Model Thinking MOOC Course
	3 - 2 Central Limit Theorem	"The central limit theorem (CLT) is a statistical theory that states that given a sufficiently large sample size from a population with a finite level of variance, the mean of all samples from the same population will be approximately equal to the mean of the population. Furthermore, all of the samples will follow an approximate normal distribution pattern, with all variances being approximately equal to the variance of the population divided by each sample's size." - Investopedia	Scott Page Model Thinking MOOC Course

	Mental Model	Description	Description Source
Aggregation	3.3 Six Sigma	"Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by engineers Bill Smith & Mikel J Harry while working at Motorola in 1986.[1][2] Jack Welch made it central to his business strategy at General Electric in 1995. It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits." - Wikipedia	Scott Page Model Thinking MOOC Course
	3.5 Cellular Automata	"A cellular automaton (pl. cellular automata, abbrev. CA) is a discrete model studied in computability theory, mathematics, physics, complexity science, theoretical biology and microstructure modeling. Cellular automata are also called cellular spaces, tessellation automata, homogeneous structures, cellular structures, tessellation structures, and iterative arrays." Wikipedia	Scott Page Model Thinking MOOC Course
	3.6 Preference Aggregation	"At the heart of social choice theory is the analysis of preference aggregation, understood as the aggregation of several individuals' preference rankings of two or more social alternatives into a single, collective preference ranking (or choice) over these alternatives." - Stanford Encyclopedia of Philosophy	Scott Page Model Thinking MOOC Course
Decision -Making	4.2 Multi-Criterion Decision Making	"Multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis (MCDA) is a sub-discipline of operations research that explicitly evaluates multiple conflicting criteria in decision making (both in daily life and in settings such as business, government and medicine). Conflicting criteria are typical in evaluating options: cost or price is usually one of the main criteria, and some measure of quality is typically another criterion, easily in conflict with the cost. In purchasing a car, cost, comfort, safety, and fuel economy may be some of the main criteria we consider – it is unusual that the cheapest car is the most comfortable and the safest one. In portfolio management, we are interested in getting high returns but at the same time reducing our risks, but the stocks that have the potential of bringing high returns typically also carry high risks of losing money. In a service industry, customer satisfaction and the cost of providing service are fundamental conflicting criteria" - Wikipedia	Scott Page Model Thinking MOOC Course
	4.3 Spatial Choice Thinking	"Spatial choice models originally started by thinking about geographic choice. There's a guy named Harold Hotelling who's an economist who thought about, imagine you're on a beach and there's an ice cream vendor, you know, 50 feet to your left and there's another ice cream vendor 40 feet to your right. You made decide well, you know, since the one to my right is closer what I'll do is I'll go and, you know, buy my ice cream from the one that's closer and I don't have to walk as far. Well you can take that idea and you can apply it to attributes of a good." - Transcript from Scott Page Coursera [3]	Scott Page Model Thinking MOOC Course
	4.4 Probability The Basics	"Probability is the measure of the likelihood that an event will occur.[1] Probability is quantified as a number between 0 and 1, where, loosely speaking,[2] 0 indicates impossibility and 1 indicates certainty.[3][4] The higher the probability of an event, the more likely it is that the event will occur. A simple example is the tossing of a fair (unbiased) coin. Since the coin is fair, the two outcomes ("heads" and "tails") are both equally probable; the probability of "heads" equals the probability of "tails", and since no other outcomes are possible, the probability of either "heads" or "tails" is 1/2 (which could also be written as 0.5 or 50%)." - Wikipedia	Scott Page Model Thinking MOOC Course
	4.5 Decision Trees	"A decision tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility. It is one way to display an algorithm.	
	4.6 Value of Information	Decision trees are commonly used in operations research, specifically in decision analysis, to help identify a strategy most likely to reach a goal, but are also a popular tool in machine learning." - Wikipedia	
	4.6 Value of Information	"Value of Information (VoI) is a concept from decision analysis: how much answering a question allows a decision-maker to improve its decision. Like opportunity cost, it's easy to define but often hard to internalize, and so instead of belaboring the definition let's look at some examples." -LessWrong	Scott Page Model Thinking MOOC Course
Modeling People	5.1 Thinking, Electrons Modeling People	"Modeling people is tricky. Physicist Marie Gelmont once famously said, imagine how difficult physics would be. If electrons could think [laugh] so what did he mean humor? What he meant was that you know if you take an electron or a carbon atom or even a water molecule it doesn't think it doesn't try to make sense of the world it doesn't have any goals or objectives or anything like that no beliefs so it's pretty straight forward to model how those things function when you look at people, people are much more complicated right? We're purposeful, we've got goals we've got objectives we've got things we want to do, we've got belief structures, we're messy. And because of that you just don't quite know how we're going to behave. Now on top of that we're diverse, right? We want different things. We have different goals and objectives. So this combination of sort of purposeful, thinking actors who are different means that it can be really hard to understand what they do and how they act." - Transcript from Scott Page Coursera [4]	Scott Page Model Thinking MOOC Course
	5.2 Rational Actor Models	"The rational actor model is based on rational choice theory. The model adopts the state as the primary unit of analysis, and inter-state relations (or international relations) as the context for analysis." - Wikipedia	Scott Page Model Thinking MOOC Course
	5.3 Behavioral Models-Model	"The behavioral approach to systems theory and control theory was initiated in the late-1970s by J. C. Willems as a result of resolving inconsistencies present in classical approaches based on state-space, transfer function, and convolution representations. This approach is also motivated by the aim of obtaining a general framework for system analysis and control that respects the underlying physics." - Wikipedia	Scott Page Model Thinking MOOC Course
	5.4 Rule Based Models	"Rule-based modeling is a modeling approach that uses a set of rules that indirectly specifies a mathematical model." - Wikipedia	Scott Page Model Thinking MOOC Course
	5.5 When Does Behavior Matter	"The rational behavior is a really good benchmark. But it's also important to include biases in our model. Think about, are there biases that would be relevant. And it's also important to think about what if we just write down a simple rule. And then if we compare these three things. Rational behavior, bias. Right, and then simple rule. And we see, well, how much difference do we see in the outcome. If the difference is small, then we can say you can look our results seem to be sort of varied to behavior. If the difference is big, then what you gotta do is you gotta sit back and think. Okay which of these three makes the most sense." - Transcript from Scott Page Coursera [5]	Scott Page Model Thinking MOOC Course
Bringing Models to Data	6.1 Introduction to Linear Models	"Linear models describe a continuous response variable as a function of one or more predictor variables. They can help you understand and predict the behavior of complex systems or analyze experimental, financial, and biological data. Linear regression is a statistical method used to create a linear model." - MathWorks	Scott Page Model Thinking MOOC Course
	6.2 Categorical Models	"A special case of categorical modeling is logistic regression. You have to use this model when the dependent variable is ordinal. A page devoted to this problem also comes up shortly. You could also turn simple models like these around and analyze them as ANOVAs, but you shouldn't."- Sportssci.org	Scott Page Model Thinking MOOC Course
	6.3 Linear Models	"Using the linear models, you can draw a line through data and use that line to explain some of the variation in the data. Now typically the world isn't gonna be perfectly linear. There's going to be lots of extra variation left over, but there's a question of how much of that variation did the line explain. In addition to explaining the variation, the line tells us something about the relationship between our independent variable, x and our dependent variable, y. In particular, we learn the sine on x, like does y increase in x or decrease in x, and we also learn something about the magnitude, so how much does. Each one unit increase of x increased the value of y. So what this linear model can do is help us understand something about data we see in the real world."- Transcript from Scott Page Coursera [6]	Scott Page Model Thinking MOOC Course
	6.4 Fitting Lines to Data	"How do you draw the best possible line through the data? ...it's a lot of data out there. One thing you can do is you can fit that data to linear models. What linear models will do is they'll explain some percentage of the variation. Maybe a lot, maybe a little. These linear models will also tell us the sign and magnitude of coefficients. So I'll tell us whether a variable. It's got a positive effect but it's got a negative effect. And also tell a sort of how big that effect is, and that allows us to make policy choices. You know, investing in things like teacher quality as opposed to class size because they have a larger effect. This is what I call big coefficient thinking." - Transcript from Scott Page Coursera [7]	Scott Page Model Thinking MOOC Course
	6.5 Reading Regression Output	"The R-squared of the regression is the fraction of the variation in your dependent variable that is accounted for (or predicted by) your independent variables. (In regression with a single independent variable, it is the same as the square of the correlation between your dependent and independent variable.)" - Princeton University Library	Scott Page Model Thinking MOOC Course
	6.6 From Linear to Nonlinear	"The world may be nonlinear, and we've got techniques that help us sort of understand linear functions. So here's the first thing we can do. The first thing we can do is we can just approximate our nonlinear function with a linear function so we've got this nonlinear function here right, but we're just gonna do a three linear function to approximate it. So that's the best possible approximation. And so what we can do is we can say I have a model. So in this case I may have a model that says this is my functional form, this is what should happen." - Transcript from Scott Page Coursera [8]	Scott Page Model Thinking MOOC Course
	6.7 The Big Coefficient vs The New Reality	"The big coefficient: If we have a simple linear regression model, we have some equation like $Y = a_1 x_1 + a_2 x_2 + b$, right? And x_1 and x_2 are called the independent variables, and y 's the dependant variable. So, for example, Y might be sales of a product. And x_1 might be advertising in magazines and x_2 might be advertising in television. Now we can look at these two coefficients, a_1 and a_2 and figure out which one's bigger. And what that's telling us is we get sort of more bang for the buck from advertising on magazines or from advertising on television. If it's television, if a_2 is bigger than a_1 , then that's where we spend our money. So the idea is you put your assets, you put your resources on the variables that have the bigger coefficients. So this big coefficient thinking has led to something that people like to call Evidence Based blank. So there's Evidence Based Medicine. What you do is you look at all sorts of different treatments that have been tried on patients..." - Transcript from Scott Page Coursera [9]	Scott Page Model Thinking MOOC Course
Tippling Points	7.1 Tipping Points	"The tipping point is an expression used in epidemiology that was taken by Malcolm Gladwell, a New York Times writer, and applied to other areas of life—including business—in his 2000 book "The Tipping Point". The subtitle, "How Little Things Can Make a Big Difference", explains more clearly what the whole thing is about. In epidemiology the tipping point is that moment when a small change tips the balance of a system and brings about a large change; for example, when the normal spread of influenza throughout a population suddenly turns into an epidemic. In recent years the language of epidemiology has spread (like a virus?) within business. Managers talk about viral marketing (see article), the infectious enthusiasm of their teams, and "outbreaks" of corporate greed—and even, as was reported once about JetBlue, an American low-cost airline, an "outbreak of passenger abuse". A lot of this language owes its spread to the influence of the internet, where viruses are common and where dormant information can sometimes erupt suddenly and infect us all." - Economics "Percolation theory deals with fluid flow (or any other similar process) in random media.	Scott Page Model Thinking MOOC Course
	7.2 Percolation Models	"If the medium is a set of regular lattice points, then there are two main types of percolation: A site percolation considers the lattice vertices as the relevant entities; a bond percolation considers the lattice edges as the relevant entities. These two models are examples of discrete percolation theory, an umbrella term used to describe any percolation model which takes place on a regular point lattice or any other discrete set, and while they're most certainly the most-studied of the discrete models, others such as AB percolation and mixed percolation do exist and are reasonably well-studied in their own right." - WolframWorld	Scott Page Model Thinking MOOC Course
	7.3 Contagion Models 1 Diffusion	"In the diffusion model, everybody just gets it. There's no, you know, sort of getting cured. So this thing of this is diffusion of information through a system or disease that everybody's just gonna get. Alright? So the diffusion method sorta works as follows." - Transcript from Scott Page Coursera [10]	Scott Page Model Thinking MOOC Course
	7.4 Contagion Models 2 SIS Model	"the SIS model, for "susceptible, infected and then susceptible". That is, you're susceptible to some disease, then you get infected, and then after you get infected you're cured, but then you can become susceptible again if the disease is mutated in some way, like a flu virus. There's also something called the SIR model, where after you become infected then you're recovered, then there's no chance of getting the disease again." - Transcript from Scott Page Coursera [11]	Scott Page Model Thinking MOOC Course
	7.5 Classifying Tippling Points	"There are contextual tips where the environment changes. Once the environment changes, then the system is likely to move from one state to another once somebody lights the match. There's tips within class, where you move from one equilibrium to a new equilibrium. And there's tips between class, where a system, where a system tips from an equilibrium to, you know, a much more complex state, or a periodic state. So that's a simple taxonomy of tippling points." - Transcript from Scott Page Coursera [12]	Scott Page Model Thinking MOOC Course

	Mental Model Description	Description Source
	<p>"So one way to think about tipping points in the measure we're going to introduce is gonna depend on that idea. That the uncertainty goes away. Initially, there was some uncertainty. It could go left or right, but after the tip, we know where it's gonna go. So we're gonna measure tipiness by reductions in uncertainty. So, to get there we first need a measure of uncertainty. Way to think about that is you want to think about changes in outcomes." - Transcript from Scott Page Coursera [13]</p>	<p>Scott Page Model Thinking MOOC Course</p>
Growth	<p>"One of the surprising results of that model of economic growth is going to be that there are limits, that without innovation, growth stops. So we will move from that simple model to something called a solo growth model. The solo growth model allows for there to be innovation and shows how innovation has this sort of multiplier effect on our collective well-being and why innovation is so important. And then we'll talk a little bit about some extensions, in particular we'll talk about once we've got this model how do we use it to think about why some countries. Successful in other countries are, and really what, oh, enables. Growth to continue over time." - Transcript from Scott Page Coursera [14]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"Exponential growth is exhibited when the rate of change—the change per instant or unit of time—of the value of a mathematical function is proportional to the function's current value, resulting in its value at any time being an exponential function of time, i.e., a function in which the time value is the exponent. Exponential decay occurs in the same way when the growth rate is negative. In the case of a discrete domain of definition with equal intervals, it is also called geometric growth or geometric decay, the function values forming a geometric progression. In either exponential growth or exponential decay, the ratio of the rate of change of the quantity to its current size remains constant over time." - Wikipedia</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"If we write down a Simple Model of Growth - Economic Growth that involves investing money in new machines. That there are limits to growth. That the model is going to max out at this point, when the number of machines lost to depreciation is exactly offset by the number of machines that we invested in the previous period. If we start with no machines, growth is going to happen really really fast initially, but then it's going to fall off when it reaches this equilibrium level. So to get sustained growth, that's going to require new technologies - new innovations. And that's where we are going next. We're going to construct Solow's Growth Model which includes this Innovation Parameter." - Transcript from Scott Page Coursera [15]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"We just took in a very simple growth model and in that growth model we saw that well, growth stopped, right. Once we got to 144 machines and an output of 120, we no longer got any growth. So we use that very simple model to get at. A really important fact, that without innovation, if technology stays fixed, growth will stop. Now, sure the labor supply could get bigger, we could have more workers or something like that. But holding the amount of labor fixed and holding that technology fixed, if we've got a fixed savings rate, and a fixed rate of depreciation, there's no more growth at some point. We're gonna go up, up, up, up, and then stop. Well. That hasn't been human experience right." - Transcript from Scott Page Coursera [16]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"One type of growth, what we're seeing in China now and what we saw in Japan post war. And what we saw in Europe and the United States post war, is growth that occurs through capital accumulation. Another type of growth, is what we're, which is what we see in the United States and Japan and Europe now, but not in China, occurs from technological advances, not from buildup of capital. And as you advance technology and you increase that A term, then it makes sense to. Buy more capital, but different types of capital and that's what drives growth." - Transcript from Scott Page Coursera [17]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"We also learned that absent innovation growth tails off right it just stops, so we need a constant driver of innovation. And, the we also saw [inaudible] in this last lecture that's not so easy. It'd be easy to say that all we need is innovation, well to maintain that innovation you need secure property rights. You need people who have incentives to invest in things like machines and also invest in new technologies. And so to get that you need a strong central government. But the central government can be so strong that it starts extracting stuff. But if it extracts stuff, that is essentially the same effect as lowering the technology. And at the third, and that government can't necessarily protect industry. Now sometimes it can. There's cases where it's gonna make sense to protect industries, but. One of the things that's going to drive growth to innovation is this process of creative destruction. So the model tells us that sometimes, we may have to, you know throw out our vinyl records and move to cassettes, and then throw out those cassettes and move to c.d.'s, and then throw out those c.d.'s and you just listen to digital music. There's going to be these processes of creative destruction that drive the growth and they're representative of innovation, of what makes us all better off. Okay. Thank you." - Transcript from Scott Page Coursera [18]</p>	<p>Scott Page Model Thinking MOOC Course</p>
Problem Solving	<p>"The big idea is this: I have some solution from one problem, you have a solution from a different problem, and sometimes I can take your solution and combine it with my solution, and come up with something even better. So, the thing about sophisticated products—like a house, an automobile, or even a computer—that consists of all sorts of solutions to sub-problems. And we are going to see how by recombining solutions to sub-problems we get ever better solutions, and that is really a big driver of innovation." - Transcript from Scott Page Coursera [19]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"That a perspective is going to be is it's going to be a representation of all possible solutions. So it's some encoding of the set of possible solutions to the problem. Once we have that encoding of the set of possible solutions, then we can create our landscape by just assigning a value to each one of those solutions. And that will give us a landscape picture like you saw before. Now most of us are familiar with perspectives, even though we don't know it. Let me give some examples. Remember when we took seventh grade math? We learned about how to represent a point, how to plot points. And we typically learned two ways to do it. The first way was Cartesian coordinates. So given a point, we would represent it by an X and a Y value in space." - Transcript from Scott Page Coursera [20]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"A heuristic technique (/hjuːˈrɪstɪk/; Ancient Greek: εὑρίσκω, "find" or "discover"), often called simply a heuristic, is any approach to problem solving, learning, or discovery that employs a practical method not guaranteed to be optimal or perfect, but sufficient for the immediate goals. Where finding an optimal solution is impossible or impractical, heuristic methods can be used to speed up the process of finding a satisfactory solution. Heuristics can be mental shortcuts that ease the cognitive load of making a decision. Examples of this method include using a rule of thumb, an educated guess, an intuitive judgment, guesstimate, stereotyping, profiling, or common sense." - Wikipedia</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"Recombination is incredibly powerful and if we have a few solutions. Or futuristic. We can combine those to create evermore and that may be the real driving force behind innovation in the economy, is that when we come up with a solution we can then recombine it with all sorts of other solutions and that leads to ever and ever more innovation." - Transcript from Scott Page Coursera [21]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"In probability theory, a Markov model is a stochastic model used to model randomly changing systems.[1] It is assumed that future states depend only on the current state, not on the events that occurred before it (that is, it assumes the Markov property). Generally, this assumption enables reasoning and computation with the model that would otherwise be intractable. For this reason, in the fields of predictive modelling and probabilistic forecasting, it is desirable for a given model to exhibit the Markov property." - Wikipedia</p>	<p>Scott Page Model Thinking MOOC Course</p>
Markov	<p>"For example, in the case of the alert and bored students. People are moving from alert to bored. But if I think in terms of probabilities, that probability is staying fixed. That probability is staying fixed at 5/9. People are moving around, but the probability's staying fixed. That's why this is sometimes called a statistical equilibrium, 'cause the statistic p, the probability of someone being alert, is the thing that doesn't change. Okay, pretty involved, right? What we did is, we wrote down the Markov transition matrix. And we showed how using that matrix, we could solve for an equilibrium. And we saw, at least in the simple example of alert and bored students, that the process went to an equilibrium, and it was fairly straightforward to solve for. What we want to do next is we want to do [a] slightly more sophisticated model that involves multiple states instead of just two, involves three states, and we'll see how that process also converges to an equilibrium." - Transcript from Scott Page Coursera [22]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"To explain this model its' best to give the example of countries. Countries that can be free, partly free or run by dictators (not free). Start from a 2 state democracy model -> 5% of democracies switch to dictatorship and 20% the opposite. Trend towards freedom, but only 2/3 will be free unless the transition probabilities change. You can get a line that's flat or a bar chart to compare model and actual, and they are very similar! And line chart patterns look very similar!" - Model Thinking Section 10: Markov Models [23]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"Markov convergence theorem that says the process is going to go to a unique equilibrium. If you rule out simple cycles, and just assume finite states, fixed probabilities, can get from any state to any other, then you get an equilibrium. So this is the Markov convergence theorem." - Transcript from Scott Page Coursera [24]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"Markov process is a fixed set of states, fixed transition probabilities. You can get from any one state to any other, and then you get an equilibrium. So that equilibrium doesn't depend on where you start, it doesn't depend on interventions. And it doesn't depend on history in any way. The model is really powerful. And so if you wanna argue history matters. Or if you wanna argue interventions matter. If someone gonna argue that this isn't a transition, that this isn't a Markov process. Or that you've gotta argue that you're changing the transition probabilities. Now that isn't impossible." [25]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"In the theory of ordinary differential equations (ODEs), Lyapunov functions are scalar functions that may be used to prove the stability of an equilibrium of an ODE. Named after the Russian mathematician Aleksandr Mikhailovich Lyapunov, Lyapunov functions (also called the Lyapunov's second method for stability) are important to stability theory of dynamical systems and control theory. A similar concept appears in the theory of general state space Markov chains, usually under the name Foster–Lyapunov functions." - Wikipedia</p>	<p>Scott Page Model Thinking MOOC Course</p>
Lyapunov Functions	<p>"Simple model is, there's a min, if the process moves, it goes down by some amount each time, therefore the process has to stop. We use that model to say, let's think about how a city organizes itself." - Transcript from Scott Page Coursera [26]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"We've got that, without externalities, or with only positive externalities in the case of finding a maximum, what you're gonna get is that, it's easy to construct a Lyapunov function, and boom, you get there. The system's gonna stop. But if there's these negative externalities, I'm making myself happier but I'm gonna make other people less happy, then the system could continue to churn, and we may not be able to say whether or not the system's gonna go to equilibrium or whether it's gonna be complex. But we do have some intuitions. And those intuitions suggest that markets, simple markets trading goods should go to equilibrium, should constantly improve. People choosing routes should constantly improve. But things like international alliances or coalitions within political parties, or possibly even dating, that these things may be more complex, and certainly that's how it appears out there in the real world." - Transcript from Scott Page Coursera [27]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"What we learn is that it's at least possible to put a Lyapunov function on a process and have it stop at somewhere less than the optimal point. Doesn't have to stop at the optimal point, it could stop below. That's what we're seeing here. So we've answered two important questions. The first one is: Okay, we know it goes to equilibrium, can we say how fast? And the answer is yes. And the better bound we get on k, and the better bound we get on the max, the more accurately we can put a restriction on how fast, how long it's going take. So, we can put a tighter bound on how long it's going to take, if we can estimate k accurately, and if we can estimate the maximum value accurately. We also learned that it can stop a lot faster than that, because of the fact that the process may not get to that optimum value." - Transcript from Scott Page Coursera [28]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"when you think about a model, when you think about a process like the Lyapunov process, right? Lyapunov functions. What you've got is, you can say, hey, there some cases like the case of chairs, a pure exchange market, this thing works great. And we can just say, boom, it's gonna stop, we're fine. There's other things like the office process, that unless you know a lot about the nature of the externalities, you can't tell. It could be, oh yeah this thing's gonna go right to equilibrium. Or it could be that, whoa it's gonna churn a long time." - Transcript from Scott Page Coursera [29]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"By looking at Lyapunov functions and comparing it to some of our other models, like Markov processes and the Langton model, we begin to see how having multiple models in our heads enables us to understand some of the richness we see out there in the world, and actually have deeper understandings of the processes we see. To understand, like, this process is going into equilibrium because it's a Markov process, and it's a stochastic equilibrium. And this process, an exchange market, is going to equilibrium because of the fact that it's a Lyapunov function and happiness is going up. So what you get is different processes in that equilibrium for very different reasons. And having different tools for understanding why equilibrium exists is [a] very useful thing for making sense of the world." - Transcript from Scott Page Coursera [30]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"11 - 6 - Lyapunov of Markov</p>	<p>Scott Page Model Thinking MOOC Course</p>

	<p>Mental Model Description</p>	<p>Description Source</p>
<p>Culture</p>	<p>"What do we mean by culture? Well, typically when you think about culture, you mean differences between countries, differences between groups of interacting people. So people from Japan act differently than people from Germany, and people from Germany act and believe and behave differently than people from El Salvador. So think about just differences between countries. Now in order to, for there to be differences between the people within a country or nation state or even a small group, there have to be similarities within. So it means that there have to be similar actions within a group. And that's where the coordination game is gonna enter. And in addition, when we think about cultural behavior, we think of it being "interesting". I mean, interesting sort of, [inaudible] what I mean is, is that it can be suboptimal in a way. It can be, if you sat down and efficiently said, what should these people be doing? Maybe what we're doing doesn't make sense. And that'll be true of people from every nation or group. We say, look at the behavior and think, that seems different than how I would do it, or different than what seems maybe the most efficient way to do it. So by culture behavior, we're gonna mean behavior as well that maybe doesn't look optimal from an outsider's perspective, but possibly viewed within that culture, it makes a lot of sense." - Transcript from Scott Page Coursera [31]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"The reason we care about culture, and here's a quote from Ken Arrow, who's a Nobel Prize winning economist, is when you think about how the economy works, how political systems work, how society works, it's all mediated through these social exchanges, so as Arrow says in this quote, that a lot of economic backwardness can be explained by lack of mutual confidence, so lack of trust. So one of the things that we've seen in cultures is different levels of trust. And different levels of trust have huge implications for how well political, economic, social, and religious institutions are gonna perform in terms of meeting the needs of the citizens." - Transcript from Scott Page Coursera [32]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"Pure coordination games - games in which players have identical preferences over the set of possible outcomes. Focal points, even when they arise as framing effects based on the labelling of options, are intuitively obvious choices, and experimental evidence shows that decision makers often coordinate successfully by choosing them." - Journal of Economics Strategy [33]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"what Axelrod's model gives us, which is really sort of fascinating, is, he makes this assumption that says: We've all got these traits. We look to our neighbors. If they're like us, we tend to interact with them. If they're not like us, we tend not to. And what he ends up getting is these distinct cultures with thick boundaries. And these thick boundaries means vast differences between the cultures. Now the thick boundaries emerge because of the fact that if there weren't a thick boundary, then what would happen is, I would interact with that person and would become more similar, and the boundary would disappear. So Axelrod's model shows how in a social space, we can get distinct cultures on multi dimensions, and those boundaries can be self-reinforcing. People don't interact across the boundaries, and the cultures remain disparate." - Transcript from Scott Page Coursera [34]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"There's two people, they meet, they each have this vector of actions or beliefs or attitudes, whatever you want to call them. And when the leader and follower meet, they look at the second dimension, let's say the follower says, well you're a three, I'm a one, I'll switch that to a three. That's what coordination is, you switch your action. You put the ketchup where your friends put the ketchup. What would consistency be? Well, consistency would just be this: you look at yourself, now these values, 5, 3, 1, 4, have meaning. Five is close to five, four is close to four. And you look and you think, I'm five on the first, I'm one on the second. And that doesn't make any sense, so you switch and become five on both." - Transcript from Scott Page Coursera [35]</p>	<p>Scott Page Model Thinking MOOC Course</p>
<p>Path Dependence</p>	<p>"Path dependence is the idea that decisions we are faced with depend on past knowledge trajectory and decisions made, and are thus limited by the current competence base. In other words, history matters for current decision-making situations and has a strong influence on strategic planning." -Financial Times [36]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"An urn model is either a set of probabilities that describe events within an urn problem, or it is a probability distribution, or a family of such distributions, of random variables associated with urn problems." - Wikipedia</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"One of the simplest models in probability theory. A description of an urn model is as follows: Consider some vessel — an urn — with black and white balls. One ball is drawn at random from the urn, and then it is returned to the urn together with cc balls of the same colour as the ball drawn and dd balls of the other colour. After mixing the balls in the urn, the procedure is repeated a certain number of times. It is assumed that initially the urn contains a-0a>0 white and b-0b>0 black balls. The numbers cc and dd, the parameters of the urn model, may also be negative." - Encyclopedia of Mathematics [37]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"When we talk about path dependence, what we're talking about is the sequence of previous events influencing not only outcome in this period, but possibly the long run equilibrium. So our definition of path dependence is that the outcome probabilities depend on the sequences of past outcomes. So in the case of a see even the outcome depends on it." - Transcript from Scott Page Coursera [38]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"We said that one thing that people often equate with path dependence is increasing returns and we've shown that although maybe empirically the case that a lot of path dependence does come from increasing returns, logically they're completely separate. You can have path dependence without increasing returns, you can have increasing returns and not get path dependence. We also talked about how one big cause of path dependence may be externalities. Inner dependencies between choices, especially big choices like public projects, and those externalities, whether they're positive or negative. Can create that dependence. But the negative [inaudible] may have a larger effect." - Transcript from Scott Page Coursera [39]</p>	<p>Scott Page Model Thinking MOOC Course</p>
<p>"A tipping point was a single instance in time where, where that long, long equilibrium was gonna be suddenly changed drastically. So think about path dependent. Path dependent means what happens along the way. As you move along that path, how does that effect where we're likely to end up. So each step may have a small effect, but it's the accumulation of those steps that has the difference. With tipping points, everything sort of moves along in expected ways but not getting a lot of information." - Transcript from Scott Page Coursera [40]</p>	<p>Scott Page Model Thinking MOOC Course</p>	
<p>Networks</p>	<p>"One is, the internet has allowed us to make all sorts of network connections with people, and to give us graphs of those networks. We're just more aware that networks exist. Another thing is that we get more and more data on networks. We're getting to see the importance of networks for all sorts of things. Whether it's scientific innovation, whether it's the spread of ideas, whether it's the polarization of critical thought, and whether it's the rise of. With a decrease in smoking with a rise in social trends, you can see these effects through networks using new techniques. What we want to do in this set of lectures is understand a little bit about how networks work and why they're so important. So first thing I just want to convince you the networks have become a hot topic." - Transcript from Scott Page Coursera [41]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"We can think of networks as having nodes, edges, degrees, path length, and connected in a cluster coefficient. So this is a language for describing different network structures. When you look at the graphs or network, then you look at the structure to graphs. We could measure which is on average how many nodes is another node connected to. We could talk about path length, which is how far is it from one node to another node. We could talk about connectedness, is the whole graph connected. And we can talk about clustering coefficient, which is how many triangles, of the possible triangles, how many of those are filled in. Now these are statistical measures." - Transcript from Scott Page Coursera [42]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"The network structure's gonna be something that emerges through these micro-level interactions. The first one's gonna be random connections, where each node and randomly decided to connect to other nodes. The second one is gonna be a small worlds model. And the is, is gonna work as follows. Each person is gonna have some friends that are, sort of, belong to a clique. They're sort of nearby. And then some friends that are random, that they randomly connect to. So we're gonna start out by having people connected to just people near them. And then assume that they sort of rewired, in a way, and randomly connect to some people who are further away in social space. ?Cause this is what a lot of social networks look like. And the last thing we're gonna do is we're gonna look at something called a preferential attachment network. And this has been used to describe the internet. And the world wide web. And the idea here is the following. It's that you're more likely to connect to nodes that are more connected. So, that's true certainly in the world wide web." - Transcript from Scott Page Coursera [43]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"What are the functionalities of this sort of network? Look, here's an interesting functionality. Suppose I think about random node failures. So suppose nodes on the internet are gonna fail randomly. Well most nodes are connected to very few. Most nodes are over here. So that means if you have random failure, this node is gonna be incredibly robust. So no one said, hey, let's. Make connections in such a way that makes the internet robust, but the fact that it emerges from the structure of the network. What about targeted failures? What if you want to shut down internet? What if you want to target failure, then you go after these, lots and lots of connections. So although the internet is really robust in handling failure but it's not at all robust to targeted failure. That's a functionality that emerges from the preferential [inaudible] rule. Nobody built them in. They just happened. So what have we learned? We learned that it's sort of fun to talk about networks. There's pictures but we can really unpack it in a formal way by constructing models and networks. Cause models and networks can focus on the logic. How does the network form. The structure. What are the statistical properties within networks? And then finally the functionality. What does the network do? Right. Does the network robust to random failures or is it robust to strategic failures? Does it give us six degrees of separation or 400 degrees of separation? Is it connected or non-connected? So there's all these functionalities that emerge from the network structure. And the network structure in turn is a result of. The individual logic for how people make connections, or how firms make connections, or how." - Transcript from Scott Page Coursera [44]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"A random walk is a mathematical object, known as a stochastic or random process, that describes a path that consists of a succession of random steps on some mathematical space such as the integers. An elementary example of a random walk is the random walk on the integer number line, \mathbb{Z}, which starts at 0 and at each step moves +1 or -1 with equal probability. Other examples include the path traced by a molecule as it travels in a liquid or a gas, the search path of a foraging animal, the price of a fluctuating stock and the financial status of a gambler can all be approximated by random walk models, even though they may not be truly random in reality. As illustrated by those examples, random walks have applications to many scientific fields including ecology, psychology, computer science, physics, chemistry, biology as well as economics. Random walks explain the observed behaviors of many processes in these fields, and thus serve as a fundamental model for the recorded stochastic activity. As a more mathematical application, the value of pi can be approximated by the usage of random walk in agent-based modelling environment.[1][2] The term random walk was first introduced by Karl Pearson in 1905." - Transcript from Scott Page Coursera</p>	<p>Scott Page Model Thinking MOOC Course</p>
<p>Randomness</p>	<p>"If I'm writing a model of people, I don't wanna say, I know what these people are gonna do. Instead, I might say, well, you know, they're probably gonna do this, but who knows. You know, they're people. They're crazy. They might do anything. So we put in a little bit of an error term. All sorts of reasons why things may not go as we expect. There can be noise, there can be error, there can be capriciousness, there can be uncertainty, there can be complexity in the underlying process. So when we think about these models, these random models that we're gonna study, there's all sorts of things that can come into play to make the outcome not be what we expect, but to include little error term." - Transcript from Scott Page Coursera [45]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"In some cases you can think of outcomes as being combinations of skill and luck, and you can determine how much skill and how much luck by looking at variations in outcomes. Is there a lot of flipping, or is there sort of consistent winners? We also then got from this very simple model, a paradoxical result. And a paradoxical result is, is that when you get all high skill people competing against one another, even when it's a low luck environment, luck will play a large role because of the paradoxical skill. Alright, so that's a luck and skill model, now we're going to move on to a model of random walks." - Transcript from Scott Page Coursera [46]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"We can often think of. An outcome is being a sequence of random events. And if an outcome of sequence of random events, what we're gonna expect to see, is we're gonna expect to see an expect value of zero. But we're gonna see some big winners and some big losers. And we can't then necessarily infer just because someone's been successful in the past, but fairly successful in the future. So we start with two random walkers and one who happened to go up and one who happened to go down, and then we think, right, who in heaven's sake are we gonna place our bets on. Well, this one is just as likely to go down as this one is to go up. You don't know anything. So what we really want to try and figure out in these situations is, is something a random walk? Or is it not? Is there some reason to believe that there is, that this person's going up for a reason. And this person's going down for a reason, or is the data consistent with things being purely random? And if it is, we should expect some regression in the mean, we should expect the two of them to perform about the same." - Transcript from Scott Page Coursera [47]</p>	<p>Scott Page Model Thinking MOOC Course</p>
	<p>"A Random Walk Down Wall Street, written by Burton Gorkam Malkiel, is an influential book on the subject of stock markets which popularized the random walk hypothesis. Malkiel argues that asset prices typically exhibit signs of random walk and that one cannot consistently outperform market averages. The book is frequently cited by those in favor of the efficient-market hypothesis. As of 2015, there have been eleven editions and over 1.5 million copies sold." - Wikipedia</p>	<p>Scott Page Model Thinking MOOC Course</p>
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	Mental Model	Description	Description Source
Game	15 - 6 - Finite Memory Random Walks	"Here's the idea. The idea is that our random walk model your value depended on every single shock. All the way through, in a finite memory random walk, your value only depends on the previous five shocks, the previous seven shocks. Let me show you. So, the value of something at time T instead of being all of the shocks, instead of starting at zero, and adding all that up to T just includes the previous five periods. So you think of there being a window like this and that window slides along over time. As time passes, you sort of just take the last five things that have occurred." - Transcript from Scott Page Coursera [48]	Scott Page Model Thinking MOOC Course
	16 - 1 - Colonel Blotto Game	"A Blotto game, Colonel Blotto game, or divide-a-dollar game is a type of two-person zero-sum game in which the players are tasked to simultaneously distribute limited resources over several objects (or battlefields). In the classic version of the game, the player devoting the most resources to a battlefield wins that battlefield, and the gain (or payoff) is then equal to the total number of battlefields won." - Wikipedia	Scott Page Model Thinking MOOC Course
	16 - 2 - Blotto No Best Strategy	"If you're playing a mixed strategy, if you're playing an equilibrium strategy, then there isn't any strategic ability. We can just cross this out and it's all just going to come down to luck. So against really smart players, Blotto may end up equal numbers of troops, Blotto's probably luck. We have maybe one player who is smarter than the other, or one player with more troops than the other. Then Blotto starts becoming more skilled. But again, the interesting thing about Blotto. Anything can be beaten. You don't need all your troops, and it really comes down to, Where is that other person gonna put their troops. So, what you want to do is not to be understood. You want to be confusing to the other person so you want to random off. So, it's an interesting game. Alright so, that's the basic Blotto. Where we're gonna go next is we're going to think a little bit more deeply about this idea of one side having an advantage and see what that means for the nature of competition. We're also gonna talk about why Blotto has become interesting again." - Transcript from Scott Page Coursera [49]	Scott Page Model Thinking MOOC Course
	16 - 3 - Applications of Colonel Blotto	"We've learned that Blotto, which was developed for warfare for putting troops on fronts, applies to a whole bunch of different stuff. It applies for the Electoral College, to terrorism, to trials, to sports, even hiring decisions. And we can get insights from Blotto to all those different environments. We've already seen from Blotto that any position can be beaten by somebody else. We've also seen that you don't need all your troops to win. What we're gonna do in the next lecture is see how much of an advantage it is to really have more troops. And what you should do. So, if you're at a disadvantage, if you don't have all those troops." - Transcript from Scott Page Coursera [50]	Scott Page Model Thinking MOOC Course
	16 - 4 - Blotto Troop Advantages	"The advantage of being stronger really depends on there being, you know, not as many fronts for over the troops. And then, we've seen if we go to a Multiplayer Blotto game, that we're likely to get cycles where one player beats two, two beats three, and then three can beat one or something like that, so we get these interesting cycles. We don't get sort of a consistent winner. So what Blotto does, if we have a situation, a competitive situation that looks like Blotto, we have some understanding of what the structure of winners should look like, and that's different than what we've seen in our other models." - Transcript from Scott Page Coursera [51]	Scott Page Model Thinking MOOC Course
Cooperation	16 - 5 - Blotto and Competition	"There's a sense in which the winner of the presidential election is luck, because it comes down to economic shocks going their way. And at the other extent, we can also say, look, another way to think about these presidential elections, though, is it's this elaborate game of blotto. They're each trying to figure out where to allocate their resources, where to spend their time, where to spend their money, trying to convince voters. And except not only electoral college, but to win different factions of voters. Cuz you can also make a Blotto game playing out on factions of voters. What you get from those two lenses, and of course the other two lenses, is just a much richer understanding of the nature of political competition. It's gonna make you better able to predict what's gonna happen, also better understand what's going on and better able to think about how do you design institutions to pick a president. Again, which is one of the things we wanna do modeling for." - Transcript from Scott Page Coursera [52]	Scott Page Model Thinking MOOC Course
	17 - 1 - Intro The Prisoners Dilemma and Collective Action	"Collective action refers to action taken together by a group of people whose goal is to enhance their status and achieve a common objective.[1] It is enacted by a representative of the group.[2] It is a term that has formulations and theories in many areas of the social sciences including psychology, sociology, anthropology, political science and economics." - Wikipedia	Scott Page Model Thinking MOOC Course
	17 - 2 - Seven Ways To Cooperation	"A whole bunch of ways in which we can get cooperation [inaudible] dilemma. It can be repeated, direct reciprocity, it could be reputation, indirect reciprocity. >> Yeah. It can be a network effect. It can be group selection, where groups fight against each other, and so the groups that cooperate are likely to win. There can be kin selection, where what happens is that I cooperate with people who are like me." - Transcript from Scott Page Coursera [53]	Scott Page Model Thinking MOOC Course
	17 - 3 - Collective Action and Common Pool Resource Problems	"The term 'collective action problem' describes the situation in which multiple individuals would all benefit from a certain action, but has an associated cost making it implausible that any individual can or will undertake and solve it alone." - Wikipedia	Scott Page Model Thinking MOOC Course
Mechanism Design	17 - 4 - No Panacea	"When you think about the mechanisms you need to induce in this setting you gotta focus a lot more attention on this person than you do on this person, because the person at the head of the stream has a larger influence than people downstream [inaudible]. So, again, not quite the same as just rotating cattle on the common, and also, not the same as harvesting lobster. So, the particulars matter. In each one of these cases, hence Ostrom says no panacea. So what we've seen in this simple lecture is that we can write down these mathematical models and say, here's a collective action problem, here's a common pool resource problem, here's a prisoner's dilemma. And by bringing that model to bear in a real life situation, we identify the nature of the problem. Once we've identified the nature of the problem, then we can use our expertise at a particular situation, embrace the particulars, take thicker descriptions of what's going on and then construct institutions and incentives that help us solve those problems. Overcome the collective action problem; solve the common pool resource problem, get cooperation in the prisoner's dilemma." - Transcript from Scott Page Coursera [54]	Scott Page Model Thinking MOOC Course
	18 - 1 - Mechanism Design	"Mechanism design the standard way, and the standard way is to assume that people are rational. So we're gonna sort of lay out the basics of mechanism design assuming rational agents. But after we do that we'll talk through what if people suffered from physiological biases or were slightly irrational Or what if it were the case that people just followed simple rules would our same results still follow. So we're gonna have a dialogue using mechanisms design as a framework for thinking about how we model people. Okay, so that's an outline of what we're going to do. What we're going to do first is just add some of the basics of mechanism design, talk about hidden action information, move on to options, and then conclude with some discussion of public good games." - Transcript from Scott Page Coursera [55]	Scott Page Model Thinking MOOC Course
	18 - 2 - Hidden Action and Hidden Information	"When you think about designing mechanisms in effect what we are doing, we are designing incentive structures so that we get the sort of outcomes we want. Now to get those outcomes often what we're trying to do is we're trying to induce people into taking the right kinds of effort. So, for example, if I'm an employer, what I'd like to do is I'd like to write a contract so that people actually put forth a lot of effort in their work as opposed to slacking off. Alternatively, if I'm auctioning something off, what I'd like people to do is reveal their information. I like them to reveal how much they value something. So, another feature that we want when we construct mechanisms is revelation of information. So, when I think about mechanism design, two of the core problems are dealing with these hidden actions and dealing with hidden information. So, how do we write mechanisms or incentive structures that overcome those two problems? ..." - Transcript from Scott Page Coursera [56]	Scott Page Model Thinking MOOC Course
Replicator Dynamics	18 - 3 - Auctions	"we can write down models of auctions and we can develop some really profound results saying that it doesn't matter how you auction things off provided some conditions are met. So that's really nice. It sort of frees us up to think about other things. And it frees us up to think about how are people are actually going to behave. How much information do they have? How sophisticated are they? How many of them are there? And that can then, then we can use those criteria to decide which auctions we're going to use. As opposed to spending our time thinking about, well this auction is better than this auction on purely rational grounds. So we talked about what, why do we model. But why do we assume even rational actors? Remember, I said, benchmarks are good things. Remember I said Roger Myerson says, the one who's got the revenue equivalent theorem, that, assuming rational behavior's often a very good benchmark. Well, we saw that was the case here in options, because we see. If people are rational, doesn't matter what mechanism you use. Once we relax that assumption, then the mechanism may matter. But, now we know what criteria to use to think about choosing among auction mechanisms." - Transcript from Scott Page Coursera [57]	Scott Page Model Thinking MOOC Course
	18 - 4 - Public Projects	"In this public project case, or in the auction case. We don't know people's values, so what we'd like to do is we'd like to create a mechanism where people truthfully reveal their values, and where we get outcomes that are desired outcomes. So in the case of an auction, we sell it to the person who values it the most. And in the case of a public project, we undertake the public project if it's worth doing. All right, so that's mechanism design and it's really interesting, it's a way to use models to try and design institutions so they're more efficient. Now one thing we saw now, and I wanna be very careful, is most mechanism people assume people are rational, but we talk about auctions, some [inaudible] we saw that, if we don't assume people rational, we maybe get slightly different implications of what we should do." - Transcript from Scott Page Coursera [58]	Scott Page Model Thinking MOOC Course
Prediction	19 - 1 - Replicator Dynamics	"The replicator dynamics are part of evolutionary game theory and are especially prominent in models of cultural evolution. Evolutionary game theory uses principles of interactive behavior to explain the emergence of behavioral regularities in organisms forming a population. ... An organism's offspring inherit its traits." - Encyclopedia [59]	Scott Page Model Thinking MOOC Course
	19 - 2 - The Replicator Equation	"In mathematics, the replicator equation is a deterministic monotone non-linear and non-innovative game dynamic used in evolutionary game theory. This important property allows the replicator equation to capture the essence of selection." - Wikipedia	Scott Page Model Thinking MOOC Course
	19 - 3 - Fisher's Theorem	"Fisher's fundamental theorem of natural selection is an idea about genetic variance in population genetics developed by the statistician and evolutionary biologist Ronald Fisher. It uses some mathematical notation but is not a theorem in the mathematical sense." - Wikipedia	Scott Page Model Thinking MOOC Course
	19 - 4 - Variation or Six Sigma	"by having multiple models, we can then adjudicate which models can work in which setting by looking at the assumptions of those models. If we just have opposite proverbs, we're stuck with two contradictory statements. So one of the huge advantages of becoming a many model thinker is that you can then look at the assumptions of the model, What's the assumptions in Fischer's fundamental theorem is that, that landscape that you're not at a peak. Cuz, you? re not at a peak you want to move towards it. In the Sixth Sigma setting, their presumption is that you're at the peak and therefore you want to reduce variation. So this is, I think a really nice example, Fishers Fundamental Theorem, and the contrast with Sixth Sigma of seeing how thinking with models helps us make sense of the world." - Transcript from Scott Page Coursera [60]	Scott Page Model Thinking MOOC Course
plati	20 - 1 - Prediction	"These many models are actually better than individual models, even if the many models are all equally good on their own. So, you get the wisdom of crowd's effect being the fact that the diversity of models is really powerful. That's why they call this the Diversity Prediction Theorem because diversity ends up being really valuable in crowds of people getting things right. Alright, so that's an outline of what we're gonna do. We're gonna talk about prediction at individual level and at the collective level and we'll show how having many models results in something what you call [inaudible] prediction theorem and then diverse sets of models need to more accurate collective forecast and then explains what some people call a wisdom of crowds phenomena." - Transcript from Scott Page Coursera [61]	Scott Page Model Thinking MOOC Course
	20 - 2 - Linear Models	"Linear models describe a continuous response variable as a function of one or more predictor variables. They can help you understand and predict the behavior of complex systems or analyze experimental, financial, and biological data. Linear regression is a statistical method used to create a linear model." - MathWorks [62]	Scott Page Model Thinking MOOC Course
	20 - 3 - Diversity Prediction Theorem	"Diversity prediction theorem is a draft programming task. ... Scott E. Page introduced the diversity prediction theorem: "The squared error of the collective prediction equals the average squared error minus the predictive diversity". Therefore, when the diversity in a group is large, the error of the crowd is small." - Rosetta Code [63]	Scott Page Model Thinking MOOC Course
Arguing from First Principles	20 - 4 - The Many Model Thinker	"By constructing these models they're this crutch for us, they help us clarify our thinking, we're better thinkers, we use data better, we can design and strategize better and we're just more intelligent citizens. I hope you've enjoyed taking this class. I've certainly had a lot of fun putting it together and I've learned a lot in the process and I apologize for any confusion and technological glitches and delays and things like that, but we've done the best we can do. I particularly want to thank Tom and Leia, two undergraduate, >> [inaudible] machine who have helped me throughout this whole process. They've just been absolutely fabulous, they've given me incredible support and they've helped a lot in all sorts of ways you can never imagine." - Transcript from Scott Page Coursera [64]	Scott Page Model Thinking MOOC Course
	Cognitive Biases	"Tendencies to think in certain ways that can lead to systematic deviations from a standard of rationality or good judgments." (See list of cognitive biases)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Arguing from First Principles	"A first principle is a basic, foundational, self-evident proposition or assumption that cannot be deduced from any other proposition or assumption." (related: dimensionality reduction; orthogonality; "Reasonable minds can disagree" if underlying premises differ.)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful

	Mental Model	Description	Description Source	
Modeling	Thought Experiment	"considers some hypothesis, theory, or principle for the purpose of thinking through its consequences." (related: counterfactual thinking)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Systems Thinking	"By taking the overall system as well as its parts into account systems thinking is designed to avoid potentially contributing to further development of unintended consequences." (related: causal loop diagrams; stock and flow; Le Chatelier's principle, hysteresis — "the time-based dependence of a system's output on present and past inputs."; "Can't see the forest for the trees.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Scenario Analysis	"A process of analyzing possible future events by considering alternative possible outcomes." (related: "Skate to where the puck is going."; black swan theory — "a metaphor that describes an event that comes as a surprise, and is often inappropriately rationalized after the fact with the benefit of hindsight.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Power-law	"A functional relationship between two quantities, where a relative change in one quantity results in a proportional relative change in the other quantity, independent of the initial size of those quantities; one quantity varies as a power of another." (related: Pareto distribution; Pareto principle — "for many events, roughly 80% of the effects come from 20% of the causes."; diminishing returns, premature optimization, heavy-tailed distribution, fat-tailed distribution; long tail — "the portion of the distribution having a large number of occurrences far from the "head" or central part of the distribution."; black swan theory — "a metaphor that describes an event that comes as a surprise, has a major effect, and is often inappropriately rationalized after the fact with the benefit of hindsight.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Normal Distribution	"A very common continuous probability distribution...Physical quantities that are expected to be the sum of many independent processes (such as measurement errors) often have distributions that are nearly normal." (related: central limit theorem)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Sensitivity Analysis	"The study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be apportioned to different sources of uncertainty in its inputs."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Cost-benefit Analysis	"A systematic approach to estimating the strengths and weaknesses of alternatives that satisfy transactions, activities or functional requirements for a business." (related: net present value — "a measurement of the profitability of an undertaking that is calculated by subtracting the present values of cash outflows (including initial cost) from the present values of cash inflows over a period of time."; discount rate)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Simulation	"The imitation of the operation of a real-world process or system over time." (related: Queuing theory — "the mathematical study of waiting lines, or queues.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Pareto Efficiency	"A state of allocation of resources in which it is impossible to make any one individual better off without making at least one individual worse off...A Pareto improvement is defined to be a change to a different allocation that makes at least one individual better off without making any other individual worse off, given a certain initial allocation of goods among a set of individuals."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Physics	Critical Mass	"The smallest amount of fissile material needed for a sustained nuclear chain reaction." "In social dynamics, critical mass is a sufficient number of adopters of an innovation in a social system so that the rate of adoption becomes self-sustaining and creates further growth."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Activation Energy		"The minimum energy which must be available to a chemical system with potential reactants to result in a chemical reaction."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Catalyst		"A substance which increases the rate of a chemical reaction." (related: tipping point)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Leverage		"The force amplification achieved by using a tool, mechanical device or machine system." (related: Theory of constraints — "a management paradigm that views any manageable system as being limited in achieving more of its goals by a very small number of constraints.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Inertia		"the resistance of any physical object to any change in its state of motion; this includes changes to its speed, direction or state of rest. It is the tendency of objects to keep moving in a straight line at constant velocity." (related: strategy tax — "sometimes products developed inside a company...have to accept constraints that go against competitiveness, or might displease users, in order to further the cause of another product."; flywheel — "a rotating mechanical device that is used to store rotational energy. Flywheels have an inertia called the moment of inertia and thus resist changes in rotational speed.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Half-life		"the time required for a quantity to reduce to half its initial value. The term is commonly used in nuclear physics to describe how quickly unstable atoms undergo, or how long stable atoms survive, radioactive decay." (related: viral marketing)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Heisenberg Uncertainty Principle		"A fundamental limit to the precision with which certain pairs of physical properties of a particle, known as complementary variables, such as position x and momentum p, can be known."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Lateral Thinking		"Solving problems through an indirect and creative approach, using reasoning that is not immediately obvious and involving ideas that may not be obtainable by using only traditional step-by-step logic."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Divergent Thinking vs Convergent Thinking		"Divergent thinking is a thought process or method used to generate creative ideas by exploring many possible solutions. It is often used in conjunction with its cognitive opposite, convergent thinking, which follows a particular set of logical steps to arrive at one solution, which in some cases is a 'correct' solution." (related: groupthink; Maslow's hammer — "if all you have is a hammer, everything looks like a nail.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Crowdsourcing		"The process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially an online community, rather than from employees or suppliers." (related: wisdom of the crowd — "a large group's aggregated answers to questions involving quantity estimation, general world knowledge, and spatial reasoning has generally been found to be as good as, and often better than, the answer given by any of the individuals within the group."; collective intelligence, bandwagon effect — "a phenomenon whereby the rate of uptake of beliefs, ideas, fads and trends increases the more that they have already been adopted by others."; Stone Soup)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Brainstorming	Paradigm shift	"a fundamental change in the basic concepts and experimental practices of a scientific discipline." (related: The Structure of Scientific Revolutions — "an episodic model in which periods of such conceptual continuity in normal science were interrupted by periods of revolutionary science; Planck's principle — "the view that scientific change does not occur because individual scientists change their mind, but rather that successive generations of scientists have different views."; punctuated equilibrium)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Scientific Method	"Systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses." (related: reproducibility)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Proxy	"A variable that is not in itself directly relevant, but that serves in place of an unobservable or immeasurable variable. In order for a variable to be a good proxy, it must have a close correlation, not necessarily linear, with the variable of interest." (related: revealed preference; Proxy War — "A conflict between two nations where neither country directly engages the other.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Selection Bias	"The selection of individuals, groups or data for analysis in such a way that proper randomization is not achieved, thereby ensuring that the sample obtained is not representative of the population intended to be analyzed." (related: sampling bias)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Response Bias	"A wide range of cognitive biases that influence the responses of participants away from an accurate or truthful response."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Observer Effect	"Changes that the act of observation will make on a phenomenon being observed." (related: Schrödinger's cat)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Survivorship Bias	"The logical error of concentrating on the people or things that 'survived' some process and inadvertently overlooking those that did not because of their lack of visibility."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Order of Magnitude	"An order-of-magnitude estimate of a variable whose precise value is unknown is an estimate rounded to the nearest power of ten." (related: order of approximation, back-of-the-envelope calculation, dimensional analysis, Fermi problem)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Major vs Minor Factors	Major factors explains major portions of the results, while minor factors only explain minor portions. (related: first order vs second order effects — first order effects directly follow from a cause, while second order effects follow from first order effects.)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	False Positives and False Negatives	"A false positive error, or in short false positive, commonly called a 'false alarm', is a result that indicates a given condition has been fulfilled, when it actually has not been fulfilled...A false negative error, or in short false negative, is where a test result indicates that a condition failed, while it actually was successful, i.e. erroneously no effect has been assumed."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Experimenting	Confidence Interval	"Confidence intervals consist of a range of values (interval) that act as good estimates of the unknown population parameter; however, the interval computed from a particular sample does not necessarily include the true value of the parameter." (related: error bar)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Bayes' Theorem	"Describes the probability of an event, based on conditions that might be related to the event. For example, suppose one is interested in whether a person has cancer, and knows the person's age. If cancer is related to age, then, using Bayes' theorem, information about the person's age can be used to more accurately assess the probability that they have cancer." (related: base rate fallacy)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Regression to the Mean	"The phenomenon that if a variable is extreme on its first measurement, it will tend to be closer to the average on its second measurement." (related: Pendulum swing; variance; Gambler's fallacy)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Infection Point	"A point on a curve at which the curve changes from being concave (concave downward) to convex (concave upward), or vice versa."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Simpson's Paradox	"A paradox in probability and statistics, in which a trend appears in different groups of data but disappears or reverses when these groups are combined."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Business Case	"Captures the reasoning for initiating a project or task. It is often presented in a well-structured written document, but may also sometimes come in the form of a short verbal argument or presentation." (related: why this now?)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Opportunity Cost	"The value of the best alternative forgone where, given limited resources, a choice needs to be made between several mutually exclusive alternatives. Assuming the best choice is made, it is the 'cost' incurred by not enjoying the benefit that would have been had by taking the second best available choice." (related: cost of capital)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Intuition	Personal experience coded into your personal neural network, which means your intuition is dangerous outside the bounds of your personal experience. (related: thinking fast vs thinking slow — "a dichotomy between two modes of thought: 'System 1' is fast, instinctive and emotional; 'System 2' is slower, more deliberative, and more logical.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Local vs Global Optimum	"A local optimum of an optimization problem is a solution that is optimal (either maximal or minimal) within a neighboring set of candidate solutions. This is in contrast to a global optimum, which is the optimal solution among all possible solutions, not just those in a particular neighborhood of values."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Decision Trees	"A decision support tool that uses a tree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility." (related: expected value)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Deciding	Sunk Cost	"A cost that has already been incurred and cannot be recovered." (related: "throwing good money after bad", "in for a penny, in for a pound")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Availability Bias	"People tend to heavily weigh their judgments toward more recent information, making new opinions biased toward that latest news."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Confirmation Bias	"The tendency to search for, interpret, favor, and recall information in a way that confirms one's preexisting beliefs or hypotheses, while giving disproportionately less consideration to alternative possibilities." (related: cognitive dissonance)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Loss Aversion	"People's tendency to strongly prefer avoiding losses to acquiring gains." (related: diminishing marginal utility)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Anecdotal	"Using a personal experience or an isolated example instead of a sound argument or compelling evidence."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	False Cause	"Presuming that a real or perceived relationship between things means that one is the cause of the other." (related: correlation does not imply causation, or in xkcd form)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Straw Man	"Giving the impression of refuting an opponent's argument, while actually refuting an argument that was not advanced by that opponent."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
	Plausible	Thinking that just because something is plausible means that it is true.	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
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	Mental Model	Description	Description Source
Reasoning	Likely	Thinking that just because something is possible means that it is likely.	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Appeal to Emotion</u>	"Manipulating an emotional response in place of a valid or compelling argument."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Ad Hominem</u>	"Attacking your opponent's character or personal traits in an attempt to undermine their argument."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Slippery Slope	"Asserting that if we allow A to happen, then Z will eventually happen too, therefore A should not happen." (related: broken windows theory — "maintaining and monitoring urban environments to prevent small crimes such as vandalism, public drinking, and toll-jumping helps to create an atmosphere of order and lawfulness, thereby preventing more serious crimes from happening.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Black or White</u>	"When two alternative states are presented as the only possibilities, when in fact more possibilities exist."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Negotiating	<u>Bandwagon</u>	"Appealing to popularity or the fact that many people do something as an attempted form of validation."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	The Third Story	"The Third Story is one an impartial observer, such as a mediator, would tell; it's a version of events both sides can agree on." (related: Most Respectful Interpretation)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Active Listening</u>	"Requires that the listener fully concentrates, understands, responds and then remembers what is being said."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Trade-offs</u>	"A situation that involves losing one quality or aspect of something in return for gaining another quality or aspect."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Incentives	"Something that motivates an individual to perform an action." (related: carrot and stick — "a policy of offering a combination of rewards and punishment to induce behavior.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Best Alternative to a Negotiated Agreement (BATNA)</u>	"The most advantageous alternative course of action a party can take if negotiations fail and an agreement cannot be reached."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Zero-sum vs Non-zero-sum	"A zero-sum game is a mathematical representation of a situation in which each participant's gain (or loss) of utility is exactly balanced by the losses (or gains) of the utility of the other participant(s)...In contrast, non-zero-sum describes a situation in which the interacting parties' aggregate gains and losses can be less than or more than zero." (related: win-win — "A win-win strategy is a conflict resolution process that aims to accommodate all disputants.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Alternative Dispute Resolution (ADR)	"Dispute resolution processes and techniques that act as a means for disagreeing parties to come to an agreement short of litigation." (related: mediation; arbitration; "extend an olive branch.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Prisoner's Dilemma	"A standard example of a game analyzed in game theory that shows why two completely 'rational' individuals might not cooperate, even if it appears that it is in their best interests to do so." (related: Nash equilibrium, evolutionarily stable strategy)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Mitigating	Unintended Consequences	"Outcomes that are not the ones foreseen and intended by a purposeful action." (related: collateral damage — "Deaths, injuries, or other damage inflicted on an unintended target"; "Goodhart's law — "When a measure becomes a target, it ceases to be a good measure"; Campbell's law; Streisand Effect — "The phenomenon whereby an attempt to hide, remove, or censor a piece of information has the unintended consequence of publicizing the information more widely, usually facilitated by the internet"; cobra effect — "when an attempted solution to a problem actually makes the problem worse."; "Kick a hornet's nest.")
Preserving Optionality		"A strategy of keeping options open and fluid, fighting the urge to make choices too soon, before all of the uncertainties have been resolved." (related: tyranny of small decisions — "a situation where a series of small, individually rational decisions can negatively change the context of subsequent choices, even to the point where desired alternatives are irreversibly destroyed."; boiling frog — "an anecdote describing a frog slowly being boiled alive."; path dependence; "Everybody has a plan until they get punched in the mouth."; fog of war; OODA loop)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
<u>Precautinary Principle</u>		"If an action or policy has a suspected risk of causing harm to the public, or to the environment, in the absence of scientific consensus (that the action or policy is not harmful), the burden of proof that it is not harmful falls on those taking an action that may or may not be a risk."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
<u>Short-termism</u>		"Short-termism refers to an excessive focus on short-term results at the expense of long-term interests."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
<u>Weekly 1-1s</u>		"1-1's can add a whole new level of speed and agility to your company."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Managing	<u>Forcing Function</u>	"A forcing function is any task, activity or event that forces you to take action and produce a result."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Directly Responsible Individual	A management concept, originally championed by Apple, that good things come if someone is explicitly responsible for something. (related: diffusion of responsibility — "a sociopsychological phenomenon whereby a person is less likely to take responsibility for action or inaction when others are present."; bystander effect — "a social psychological phenomenon that refers to cases in which individuals do not offer any means of help to a victim when other people are present.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Pygmalion Effect	"The phenomenon whereby higher expectations lead to an increase in performance." (related: market pull technology policy — where the government sets future standards beyond what the current market can deliver, and the market pulls that technology into existence.; Radical Candor)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Virtual Team</u>	"A group of individuals who work across time, space and organizational boundaries with links strengthened by webs of communication technology." At least in some circumstances, it is possible to have a completely virtual team. The downsides in lack of face-to-face communication can be outweighed by the upsides in sourcing from the entire world.	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Introversion vs. Extraversion</u>	"Extraversion tends to be manifested in outgoing, talkative, energetic behavior, whereas introversion is manifested in more reserved and solitary behavior. Virtually all comprehensive models of personality include these concepts in various forms."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	IQ vs EQ	"IQ is a total score derived from one of several standardized tests designed to assess human intelligence." "EQ is the capacity of individuals to recognize their own, and other people's emotions, to discriminate between different feelings and label them appropriately, and to use emotional information to guide thinking and behavior."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Growth Mindset vs. Fixed Mindset</u>	"Those with a 'fixed mindset' believe that abilities are mostly innate and interpret failure as the lack of necessary basic abilities, while those with a 'growth mindset' believe that they can acquire any given ability provided they invest effort or study."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Hindsight Bias	"The inclination, after an event has occurred, to see the event as having been predictable, despite there having been little or no objective basis for predicting it." (related: Pollyanna principle — "tendency for people to remember pleasant items more accurately than unpleasant ones")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Organizational Debt</u>	"All the people/culture compromises made to 'just get it done' in the early stages of a startup."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Generalist vs. Specialist</u>	"A generalist is a person with a wide array of knowledge, the opposite of which is a specialist." (related: hedgehog vs fox — "A fox knows many things, but a hedgehog one important thing.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Consequence vs. Conviction</u>	"Where there is low consequence and you have very low confidence in your own opinion, you should absolutely delegate. And delegate completely. Let people make mistakes and learn. On the other side, obviously where the consequences are dramatic and you have extremely high conviction that you are right, you actually can't let your junior colleague make a mistake."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>High-context vs. Low-context Culture</u>	"In a higher-context culture, many things are left unsaid, letting the culture explain. Words and word choice become very important in higher-context communication, since a few words can communicate a complex message very effectively to an in-group (but less effectively outside that group), while in a low-context culture, the communicator needs to be much more explicit and the value of a single word is less important."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Peter Principle</u>	"The selection of a candidate for a position is based on the candidate's performance in their current role, rather than on abilities relevant to the intended role. Thus, employees only stop being promoted once they can no longer perform effectively, and managers rise to the level of their incompetence."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Maslow's Hierarchy of Needs</u>	"Maslow uses the terms 'physiological', 'safety', 'belongingness' and 'love', 'esteem', 'self-actualization', and 'self-transcendence' to describe the pattern that human motivations generally move through... [though there is] little evidence for the ranking of needs that Maslow described or for the existence of a definite hierarchy at all."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Loyalists vs. Mercenaries</u>	"There are highly loyal teams that can withstand almost anything and remain steadfastly behind their leader. And there are teams that are entirely mercenary and will walk out without thinking twice about it."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
<u>Dunbar's Number</u>	"A suggested cognitive limit to the number of people with whom one can maintain stable social relationships...with a commonly used value of 150."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
<u>Zero Tolerance</u>	"Strict punishment for infractions of a stated rule, with the intention of eliminating undesirable conduct."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
<u>Commandos vs. Infantry vs. Police</u>	"Three distinct groups of people that define the lifetime of a company: Commandos, Infantry, and Police: Whether invading countries or markets, the first wave of troops to see battle are the commandos...Grouping offshore as the commandos do their work is the second wave of soldiers, the infantry...But there is still a need for a military presence in the territory they leave behind, which they have liberated. These third-wave troops hate change. They aren't troops at all but police."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	
Developing	<u>Technical Debt</u>	"A concept in programming that reflects the extra development work that arises when code that is easy to implement in the short run is used instead of applying the best overall solution."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Binary Search	"A search algorithm that finds the position of a target value within a sorted array. It compares the target value to the middle element of the array; if they are unequal, the half in which the target cannot lie is eliminated and the search continues on the remaining half until it is successful." (related: debugging)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Divide and Conquer</u>	"Recursively breaking down a problem into two or more sub-problems of the same or related type, until these become simple enough to be solved directly. The solutions to the sub-problems are then combined to give a solution to the original problem."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Design Pattern	"The re-usable form of a solution to a design problem." (related: anti-pattern — "a common response to a recurring problem that is usually ineffective and risks being highly counterproductive."; dark pattern — "user interfaces designed to trick people.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Black box	"a device, system or object which can be viewed in terms of its inputs and outputs (or transfer characteristics), without any knowledge of its internal workings. Its implementation is 'opaque' (black)."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Zawinski's Law	"Every program attempts to expand until it can read mail. Those programs which cannot so expand are replaced by ones which can." (related: Greenspun's tenth rule — "any sufficiently complicated C or Fortran program contains an ad hoc, informally-specified, bug-ridden, slow implementation of half of Common Lisp.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Metcalf's Law</u>	"The value of a telecommunications network is proportional to the square of the number of connected users of the system...Within the context of social networks, many, including Metcalfe himself, have proposed modified models using (n x log n) proportionality rather than n^2 proportionality."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	<u>Clarke's Third Law</u>	"Any sufficiently advanced technology is indistinguishable from magic."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Minimum Viable Product (MVP)	"A product with just enough features to gather validated learning about the product and its continued development." (related: perfect is the enemy of good; de-risking; Customer Development; "Get out of the building.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Product/Market Fit	"the degree to which a product satisfies a strong market demand." (related: pivot — "structured course correction designed to test a new fundamental hypothesis about the product, strategy, and engine of growth."; "rebuilding year")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Reversible vs Irreversible Decisions	For reversible decisions: "If the decision was a bad call you can unwind it in a reasonable period of time. An irreversible decision is firing an employee, launching your product, a five-year lease for an expensive new building, etc. These are usually difficult or impossible to reverse." (related: Jeff Bezos on Type 1, Type 2 decisions)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful	

	Mental Model	Description	Description Source
Business	Capital Allocation Options	"Five capital allocation choices CEOs have: 1) invest in existing operations; 2) acquire other businesses; 3) issue dividends; 4) pay down debt; 5) repurchase stock. Along with this, they have three means of generating capital: 1) internal/operational cash flow; 2) debt issuance; 3) equity issuance."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Open Platform vs Closed Platform	"A closed platform, walled garden or closed ecosystem is a software system where the carrier or service provider has control over applications, content, and media, and restricts convenient access to non-approved applications or content. This is in contrast to an open platform, where consumers generally have unrestricted access to applications, content, and much more."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Freemium	"a pricing strategy by which a product or service (typically a digital offering or application such as software, media, games or web services) is provided free of charge, but money (premium) is charged for proprietary features, functionality, or virtual goods." (related: "If you're not paying for it, you're the product."; pay to play)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Luck Surface Area	"When you do something you're excited about you will naturally pull others into your orbit. And the more people with whom you share your passion, the more who will be pulled into your orbit."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Open Platform vs Closed Platform	"A closed platform, walled garden or closed ecosystem is a software system where the carrier or service provider has control over applications, content, and media, and restricts convenient access to non-approved applications or content. This is in contrast to an open platform, where consumers generally have unrestricted access to applications, content, and much more."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Secrets	"Every one of today's most famous and familiar ideas was once unknown and unsuspected...There are many more secrets left to find, but they will yield only to relentless searchers."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Strategic Acquisition vs Financial Acquisition vs Acquire	Different motivations for an acquiring company typically have significantly different valuation models. (related: rollout — "a technique used by investors (commonly private equity firms) where multiple small companies in the same market are acquired and merged."; P/E-driven acquisitions, auction)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Influencing	Framing	"With the same information being used as a base, the 'frame' surrounding the issue can change the reader's perception without having to alter the actual facts." (related: anchoring)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Cialdini's Six Principles of Influence	Reciprocity ("People tend to return a favor."), Commitment ("If people commit...they are more likely to honor that commitment."), Social Proof ("People will do things they see other people are doing."), Authority ("People will tend to obey authority figures."), Liking ("People are easily persuaded by other people they like."), and Scarcity ("Perceived scarcity will generate demand"). (related: foot-in-the-door technique)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Paradox of Choice	"Eliminating consumer choices can greatly reduce anxiety for shoppers." (related: Hick's Law, "increasing the number of choices will increase the decision time logarithmically.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Major vs Minor Chords	"In Western music, a minor chord, in comparison, 'sounds darker than a major chord.'"	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Coda	"A term used in music primarily to designate a passage that brings a piece to an end." (related: CTA.) People psychologically expect codas, and so they can be used for influence.	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Marketing	Bullseye Framework	"With nineteen traction channels to consider, figuring out which one to focus on is tough. That's why we've created a simple framework called Bullseye that will help you find the channel that will get you traction."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Technology Adoption Lifecycle	"Describes the adoption or acceptance of a new product or innovation, according to the demographic and psychological characteristics of defined adopter groups. The process of adoption over time is typically illustrated as a classical normal distribution or "bell curve". The model indicates that the first group of people to use a new product is called 'innovators', followed by 'early adopters'. Next come the early majority and late majority, and the last group to eventually adopt a product are called 'laggards.'" (related: S-curve, Crossing the Chasm, Installation Period vs Deployment Period)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Jobs To Be Done	"Consumers usually don't go about their shopping by conforming to particular segments. Rather, they take life as it comes. And when faced with a job that needs doing, they essentially 'hire' a product to do that job."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Fear, Uncertainty, and Doubt (FUD)	"A disinformation strategy used in sales, marketing, public relations, politics and propaganda. FUD is generally a strategy to influence perception by disseminating negative and dubious or false information and a manifestation of the appeal to fear."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Competing	Supply and Demand	"An economic model of price determination in a market. It concludes that in a competitive market, the unit price for a particular good, or other traded item such as labor or liquid financial assets, will vary until it settles at a point where the quantity demanded (at the current price) will equal the quantity supplied (at the current price), resulting in an economic equilibrium for price and quantity transacted." (related: perfect competition; arbitrage — "the practice of taking advantage of a price difference between two or more markets.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Winner Take All Market	A market that tends towards one dominant player. (related: lock-in; monopoly; monopsony)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Two-sided Market	"Economic platforms having two distinct user groups that provide each other with network benefits."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Barriers to Entry	"A cost that must be incurred by a new entrant into a market that incumbents don't or haven't had to incur."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Price Elasticity	"The measurement of how responsive an economic variable is to a change in another. It gives answers to questions such as 'If I lower the price of a product, how much more will sell?'" (related: Giffen good — "a product that people consume more of as the price rises and vice versa.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Market Power	"The ability of a firm to profitably raise the market price of a good or service over marginal cost."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Conspicuous Consumption	"The spending of money on and the acquiring of luxury goods and services to publicly display economic power." (related: Veblen goods — "types of luxury goods, such as expensive wines, jewelry, fashion-designer handbags, and luxury cars, which are in demand because of the high prices asked for them.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Comparative Advantage	"An agent has a comparative advantage over another in producing a particular good if they can produce that good at a lower relative opportunity cost or autarky price, i.e. at a lower relative marginal cost prior to trade."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Creative Destruction	"Process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." (related: Software is Eating the World — "in many industries, new software ideas will result in the rise of new Silicon Valley-style start-ups that invade existing industries with impunity.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	First-mover advantage vs First-mover disadvantage	"the advantage gained by the initial ("first-moving") significant occupant of a market segment." (related: Why now?)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Strategizing	Sustainable Competitive Advantage	Structural factors that allow a firm to outcompete its rivals for many years.	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Core Competency	"A harmonized combination of multiple resources and skills that distinguish a firm in the marketplace." (related: circle of competence — "you don't have to be an expert on every company, or even many. You only have to be able to evaluate companies within your circle of competence. The size of that circle is not very important; knowing its boundaries, however, is vital.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Strategy vs Tactics	Sun Tzu: "Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Sphere of Influence	"A spatial region or concept division over which a state or organization has a level of cultural, economic, military, or political exclusivity, accommodating to the interests of powers outside the borders of the state that controls it."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Unknown Unknowns	"Known unknowns refers to 'risks you are aware of, such as cancelled flights...' Unknown unknowns are risks that 'come from situations that are so out of this world that they never occur to you.' (related: Cynefin framework)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Switching Costs	"The costs associated with switching suppliers."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Network Effect	"The effect that one user of a good or service has on the value of that product to other people. When a network effect is present, the value of a product or service is dependent on the number of others using it." "The cost advantages that enterprises obtain due to size, output, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Military	Economies of Scale	"The cost advantages that enterprises obtain due to size, output, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Guerrilla warfare	"a form of irregular warfare in which a small group of combatants such as paramilitary personnel, armed civilians, or irregulars use military tactics including ambushes, sabotage, raids, petty warfare, hit-and-run tactics, and mobility to fight a larger and less-mobile traditional military." (related: asymmetric warfare; "Punch above your weight.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Two-front War	"A war in which fighting takes place on two geographically separate fronts."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Flypaper Theory	"The idea that it is desirable to draw enemies to a single area, where it is easier to kill them and they are far from one's own vulnerabilities." (related: honeypot)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Fighting the Last War	Using strategies and tactics that worked successfully in the past, but are no longer as useful.	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Rumsfeld's Rule	"You go to war with the Army you have. They're not the Army you might want or wish to have at a later time." (related: Joy's law — "no matter who you are, most of the smartest people work for someone else."; Effectuation)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Trojan Horse	"After a fruitless 10-year siege, the Greeks constructed a huge wooden horse, and hid a select force of men inside. The Greeks pretended to sail away, and the Trojans pulled the horse into their city as a victory trophy. That night the Greek force crept out of the horse and opened the gates for the rest of the Greek army, which had sailed back under cover of night. The Greeks entered and destroyed."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Empty Fort Strategy	"Involves using reverse psychology (and luck) to deceive the enemy into thinking that an empty location is full of traps and ambushes, and therefore induce the enemy to retreat." (related: Potemkin village — "any construction (literal or figurative) built solely to deceive others into thinking that a situation is better than it really is."; vaporware — "a product, typically computer hardware or software, that is announced to the general public but is never actually manufactured nor officially cancelled.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Exit Strategy	"A means of leaving one's current situation, either after a predetermined objective has been achieved, or as a strategy to mitigate failure."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Boots on the Ground	"The belief that military success can only be achieved through the direct physical presence of troops in a conflict area."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Winning Hearts and Minds	"In which one side seeks to prevail not by the use of superior force, but by making emotional or intellectual appeals to sway supporters of the other side." "In which a full-scale use of nuclear weapons by two or more opposing sides would cause the complete annihilation of both the attacker and the defender. It is based on the theory of deterrence, which holds that the threat of using strong weapons against the enemy prevents." (related: Mexican standoff, Zugzwang)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful

	Mental Model	Description	Description Source
	Containment	"A military strategy to stop the expansion of an enemy. It is best known as the Cold War policy of the United States and its allies to prevent the spread of communism abroad."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Appeasement	"A diplomatic policy of making political or material concessions to an enemy power in order to avoid conflict." (related: Danegeld, extortion)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Winning a Battle but Losing the War	"A poor strategy that wins a lesser (or sub-) objective but overlooks and loses the true intended objective." (related: sacrifice play)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Beachhead	"A temporary line created when a military unit reaches a landing beach by sea and begins to defend the area while other reinforcements help out until a unit large enough to begin advancing has arrived."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Attrition warfare	"a military strategy in which a belligerent attempts to win a war by wearing down the enemy to the point of collapse through continuous losses in personnel and material."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Nuclear option	"a parliamentary procedure that allows the U.S. Senate to override a rule or precedent by a simple majority of 51 votes, instead of by a supermajority of 60 votes...The name is an analogy to nuclear weapons being the most extreme option in warfare."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Cargo cult	"a millenarian movement first described in Melanesia which encompasses a range of practices and occurs in the wake of contact with more technologically advanced societies. The name derives from the belief which began among Melanesians in the late 19th and early 20th century that various ritualistic acts such as the building of an airplane runway will result in the appearance of material wealth, particularly highly desirable Western goods (i.e., "cargo"), via Western airplanes."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Political Failure	Unforced Error	In tennis, an "error in a service or return shot that cannot be attributed to any factor other than poor judgement and execution by the player; contrasted with a forced error," "an error caused by an opponent's good play."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Hail Mary Pass	"A very long forward pass in American football, made in desperation with only a small chance of success... has become generalized to refer to any last-ditch effort with little chance of success."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Social vs Market Norms	"People are happy to do things occasionally when they are not paid for them. In fact there are some situations in which work output is negatively affected by payment of small amounts of money."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Information Asymmetry	"The study of decisions in transactions where one party has more or better information than the other." (related: adverse selection — "when traders with better private information about the quality of a product will selectively participate in trades which benefit them the most."; moral hazard — "when one person takes more risks because someone else bears the cost of those risks.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Externalities	"An externality is the cost or benefit that affects a party who did not choose to incur that cost or benefit." (related: tragedy of the commons — "A situation within a shared-resource system where individual users acting independently according to their own self-interest behave contrary to the common good of all users by depleting that resource through their collective action"; free rider problem — "when those who benefit from resources, goods, or services do not pay for them, which results in an under-provision of those goods or services."; Coase theorem — "if trade in an externality is possible and there are sufficiently low transaction costs, bargaining will lead to a Pareto efficient outcome regardless of the initial allocation of property."; NIMBY — "Not In My Back Yard")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Deadweight Loss	"A loss of economic efficiency that can occur when equilibrium for a good or service is not achieved or is not achievable."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Chilling Effect	"The inhibition or discouragement of the legitimate exercise of natural and legal rights by the threat of legal sanction...Outside of the legal context in common usage, any coercion or threat of coercion (or other unpleasanties) can have a chilling effect on a group of people regarding a specific behavior, and often can be statistically measured or be plainly observed."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Market Failure	Third Rail	"The third rail of a nation's politics is a metaphor for any issue so controversial that it is 'charged' and 'untouchable' to the extent that any politician or public official who dares to broach the subject will invariably suffer politically."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Regulatory Capture	"When a regulatory agency, created to act in the public interest, instead advances the commercial or political concerns of special interest groups that dominate the industry or sector it is charged with regulating." (related: Shirkly principle — "Institutions will try to preserve the problem to which they are the solution."; "Sunlight is the best disinfectant.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Duverger's Law	"A principle which states that plurality-rule elections (such as first past the post) structured within single-member districts tend to favor a two-party system, and that "the double ballot majority system and proportional representation tend to favor multipartism."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Arrow's Impossibility Theorem	"When voters have three or more distinct alternatives (options), no ranked order voting system can convert the ranked preferences of individuals into a community-wide (complete and transitive) ranking while also meeting a pre-specified set of criteria." (related: approval voting)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Fear of Missing Out (FOMO)	"A pervasive apprehension that others might be having rewarding experiences from which one is absent."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Preferred Stock vs Common Stock	"Preferred stock is a type of stock which may have any combination of features not possessed by common stock including properties of both an equity and a debt instrument, and is generally considered a hybrid instrument."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Margin of Safety	"The difference between the intrinsic value of a stock and its market price."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Investing	Investing vs. Speculation	"Typically, high-risk trades that are almost akin to gambling fall under the umbrella of speculation, whereas lower-risk investments based on fundamentals and analysis fall into the category of investing."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Compound Interest	"Interest on interest. It is the result of reinvesting interest, rather than paying it out, so that interest in the next period is then earned on the principal sum plus previously-accumulated interest."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Inflation	"A sustained increase in the general price level of goods and services in an economy over a period of time." (related: real vs nominal value, hyperinflation, deflation, debasement)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Gross Domestic Product (GDP)	"A monetary measure of the market value of all final goods and services produced in a period (quarterly or yearly)."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Efficient-Market Hypothesis	"Asset prices fully reflect all available information...Investors, including the likes of Warren Buffett, and researchers have disputed the efficient-market hypothesis both empirically and theoretically." (related: alpha)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Purchasing Power Parity	"Allows one to estimate what the exchange rate between two currencies would have to be in order for the exchange to be at par with the purchasing power of the two countries' currencies."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Insider Trading	"The trading of a public company's stock or other securities (such as bonds or stock options) by individuals with access to nonpublic information about the company."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Learning	Poison Pill	"A type of defensive tactic used by a corporation's board of directors against a takeover. Typically, such a plan gives shareholders the right to buy more shares at a discount if one shareholder buys a certain percentage or more of the company's shares." (related: proxy fight).	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Deliberate Practice	"How expert one becomes at a skill has more to do with how one practices than with merely performing a skill a large number of times."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Imposter Syndrome	"High-achieving individuals marked by an inability to internalize their accomplishments and a persistent fear of being exposed as a "fraud"."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Dunning-Kruger Effect	"Relatively unskilled persons suffer illusory superiority, mistakenly assessing their ability to be much higher than it really is...[and] highly skilled individuals may underestimate their relative competence and may erroneously assume that tasks which are easy for them are also easy for others." (related: overconfidence effect)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Spacing Effect	"The phenomenon whereby learning is greater when studying is spread out over time, as opposed to studying the same amount of time in a single session."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Focus on High-leverage Activities	"Leverage should be the central, guiding metric that helps you determine where to focus your time." (related: Eisenhower decision matrix — "what is important is seldom urgent, and what is urgent is seldom important.", "The best time to plant a tree was 20 years ago. The second best time is now.", law of triviality — "members of an organisation give disproportionate weight to trivial issues.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Makers vs Manager's Schedule	"When you're operating on the maker's schedule, meetings are a disaster." (related: Deep Work)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Productivity	Murphy's Law	"Anything that can go wrong, will." (related: Hofstadter's Law, "It always takes longer than you expect, even when you take into account Hofstadter's Law.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Parkinson's Law	"Work expands so as to fill the time available for its completion."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Gate's Law	"Most people overestimate what they can do in one year and underestimate what they can do in ten years."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Nature vs Nurture	"the relative importance of an individual's innate qualities as compared to an individual's personal experiences in causing individual differences, especially in behavioral traits."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Chain Reaction	"A sequence of reactions where a reactive product or by-product causes additional reactions to take place. In a chain reaction, positive feedback leads to a self-amplifying chain of events." (related: cascading failure, domino effect)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Filling a Vacuum	A vacuum "is space void of matter." Filling a vacuum refers to the fact that if a vacuum is put next to something with pressure, it will be quickly filled by the gas producing that pressure. (related: power vacuum)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Emergence	"Whereby larger entities, patterns, and regularities arise through interactions among smaller or simpler entities that themselves do not exhibit such properties." (related: decentralized system, spontaneous order)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Nature	Natural Selection	"The differential survival and reproduction of individuals due to differences in phenotype. It is a key mechanism of evolution, the change in heritable traits of a population over time."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Butterfly Effect	"The concept that small causes can have large effects." (related: bullwhip effect — "increasing swings in inventory in response to shifts in customer demand as you move further up the supply chain.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Sustainability	"The endurance of systems and processes."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Peak Oil	"The point in time when the maximum rate of extraction of petroleum is reached, after which it is expected to enter terminal decline."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful

	Mental Model	Description	Description Source
Philosophy	Consequentialism	"Holding that the consequences of one's conduct are the ultimate basis for any judgment about the rightness or wrongness of that conduct." (related: "ends justify the means")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Distributive Justice vs Procedural Justice	"Procedural justice concerns the fairness and the transparency of the processes by which decisions are made, and may be contrasted with distributive justice (fairness in the distribution of rights or resources), and retributive justice (fairness in the punishment of wrongs)."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Effective Altruism	"Encourages individuals to consider all causes and actions, and then act in the way that brings about the greatest positive impact, based on their values."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Utilitarianism	"Holding that the best moral action is the one that maximizes utility."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Agnosticism	"The view that the truth values of certain claims — especially metaphysical and religious claims such as whether God, the divine, or the supernatural exist — are unknown and perhaps unknowable."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Veil of Ignorance	"A method of determining the morality of a certain issue (e.g., slavery) based upon the following thought experiment: parties to the original position know nothing about the particular abilities, tastes, and positions individuals will have within a social order. When such parties are selecting the principles for distribution of rights, positions, and resources in the society in which they will live, the veil of ignorance prevents them from knowing who will receive a given distribution of rights, positions, and resources in that society."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Internet	Filter Bubble	"In which a website algorithm selectively guesses what information a user would like to see based on information about the user (such as location, past click behavior and search history) and, as a result, users become separated from information that disagrees with their viewpoints, effectively isolating them in their own cultural or ideological bubbles." (related: echo chamber)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Botnet	"A number of Internet-connected computers communicating with other similar machines in which components located on networked computers communicate and coordinate their actions by command and control (C&C) or by passing messages to one another." (related: flash mob)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Spamming	"The use of electronic messaging systems to send unsolicited messages (spam), especially advertising, as well as sending messages repeatedly on the same site." (related: phishing — "the attempt to acquire sensitive information such as usernames, passwords, and credit card details (and sometimes, indirectly, money), often for malicious reasons, by masquerading as a trustworthy entity in an electronic communication.", clickjacking, social engineering)	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Content Farm	"large amounts of textual content which is specifically designed to satisfy algorithms for maximal retrieval by automated search engines." (related: click farm — "where a large group of low-paid workers are hired to click on paid advertising links for the click fraudster.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Micropayment	"A financial transaction involving a very small sum of money and usually one that occurs online."	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
	Godwin's Law	"If an online discussion (regardless of topic or scope) goes on long enough, sooner or later someone will compare someone or something to Hitler or Nazism." (related: "Take the high road.", "Rise above the fray.", "Don't stoop down to their level.")	Gabriel Weinberg's Mental Models I Find Repeatedly Useful
Cognitive Biases	Reward & Punishment Superresponse Tendency	Want to get an individual or a team to do something? Munger says you need to answer this question correctly: "What's in it for them?"	Michael Simmons & Jan Chew
	Protect Yourself From Bad Advice.	Munger cautions us to be careful of professional advice that might be shaped by the advisor's personal interest.	Michael Simmons & Jan Chew
	Influence Yourself	By understanding what really drives you, you can drive yourself.	Michael Simmons & Jan Chew
		Munger argues that we are wired to naturally favor people we like and love to the point of irrationality. In social psychology, this tendency is known as in-group bias.	
		In order to keep liking and loving them, we do the following behaviors that we may not have done otherwise: Distort facts Ignore faults Comply with wishes Favor people, products, and actions merely associated with the object of affection. We even go to great lengths in order to keep being liked and loved by others; even people we don't know.	Michael Simmons & Jan Chew
	Liking/Loving Tendency	The opposite of the liking/loving tendency is also true. We tend to disfavor people we already dislike and hate to level of irrationality. This results in: Ignoring virtues of people we dislike.	
	Disliking/Hating Tendency	Disliking people, products, and actions merely associated with the object of our dislike. Distorting facts in order to facilitate the hatred.	Michael Simmons & Jan Chew
		The human brain has evolved to resolve open issues (i.e., cognitive dissonance) by making decisions. Part of our speedy decision making process comes at a price: we eliminate any potential doubts, which might cause us to make mistakes. What normally triggers the tendency is some combination of: Puzzlement Stress	
	Doubt/Avoidance Tendency		Michael Simmons & Jan Chew
	Inconsistency-Avoidance Tendency	We rarely do things that are inconsistent with our identity, beliefs, and habits. To save energy, we are often reluctant to change our habits, especially bad ones. Such bad habits include biased thinking patterns. These patterns lead to cognitive errors, limiting our choice of actions in life.	Michael Simmons & Jan Chew
	Curiosity Tendency	Munger argues that curiosity not only counters the negative effects of our psychological tendencies, it also lets us enjoy the process of learning and acquiring knowledge.	Michael Simmons & Jan Chew
	Kantian Fairness Tendency	Citing Kant and his categorical imperative, Munger argues that "reciprocal courtesy" is a societal norm, at least in United States. When we are not treated fairly, often we become very angry and/or frustrated. In a famous Prisoner's Dilemma experiment, when one person feels betrayed by another, that person will not act out of his/her own immediate self-interest in order to punish the other person.	Michael Simmons & Jan Chew
	Envy/Jealousy Tendency	Munger points how out our evolutionary desire to own others' possessions leads to worse situations like hatred, fights and so on. Abraham Tesser's academic research on the Self-Evaluation Model counterintuitively shows that our self-esteem suffers and therefore, feel the most jealous of other people when they're: Close to us (ie - sibling, friend) Outcompeting us in areas that are important to us	Michael Simmons & Jan Chew
		We are wired to reciprocate. If people give to us, we feel we owe the other person. Similar to the fairness tendency, if someone hurts us, we feel the need to hurt them back.	
	Reciprocation Tendency	Companies can use this approach to: Start a relationship by giving something, even if it's small. Negotiate by asking for something big and unrealistic at first, and then when the person says no, ask for something that is smaller than that is the ultimate thing you wanted anyway. In an experiment performed by Robert Cialdini, this approach was incredibly effective. Use the 'foot in the door' technique (a.k.a., Franklin Effect) by asking for something small that everyone will say yes to and then increase the sizes of the asks.	Michael Simmons & Jan Chew
		We perceive people or things differently depending on who/what they are associated with. Advertisers have long understood this. They link their products to things that will trigger the responses they want you to have. This is also known as classical conditioning.	
Influence-From-Mere-Association Tendency	Sometimes when people receive a favor when they're in pain (poor, sick, etc.), they associate the person that gave them the favor with the pain. As a result, the favor just reinforces the pain. If we link a past event where we got lucky to skill rather than luck, then we will make poor choices about the future."	Michael Simmons & Jan Chew	
Pain-Avoiding Psychological Denial	We tend to distort facts for our own psychological comfort. This psychological discomfort is known as cognitive dissonance. If we make a habit of continually avoiding information that is painful, we'll not only develop a distorted view of reality, we'll train other people not to tell us the truth.	Michael Simmons & Jan Chew	
	We are overconfident - thinking we're better than the average person. Several studies of self-perception, show that for any given trait, more than 50% of people think they're above average - from unsophisticated computer users who think they are cyber crime experts, to Harvard Business School students who think that they are better looking than everyone else. This is known as the Endowment Effect. Being overconfident can lead to many shortcomings; for example, overconfident students do significantly poorer on tests.		
Excessive Self-Regard Tendency	The result of this is overappraising things we own, decisions we make, and people like us underappraising things that challenge our self-regard.	Michael Simmons & Jan Chew	
	We tend to be foolishly optimistic without calculating the risks. In anticipation of good future outcomes - and how much control we have over them - we overestimate how much control we have over them. Neuroscientist Tali Sharot's research suggests that the optimism bias has evolved to become an integral part of the human psyche, regardless of one's race, gender and nationality.		
Over-Optimism Tendency	Two sobering examples are we are over-optimistic regarding how fast we can pay off our student debt, or how well we can use our driving skills.	Michael Simmons & Jan Chew	
Deprival-Superreaction Tendency	We tend to intensely react to any real loss or potential loss irrationally. This explains in-fighting that occurs within bureaucracies.	Michael Simmons & Jan Chew	
	We are wired to make a huge number of decisions in our life based purely on other people's actions. The effect is so strong that even if we are surrounded by a small group of people who insist that blue is green, then we'll question our own reality.		
Social-Proof Tendency	Entrepreneurs who create public social proof of their product (i.e. positive customer reviews) get more sales. Our conscious mind is limited. Therefore, we can't register every detail that we see, hear, feel, taste, and smell in every moment. Our brain unconsciously makes choices about where our attention flows. One of the ways that it makes this decision is by sudden change. If we hear a loud sound all of a sudden, our attention immediately goes there.	Michael Simmons & Jan Chew	
Contrast-Misreaction Tendency	This same principle applies to the world of value. We don't measure the value of things in a vacuum. We often notice value by contrasting it with something else. Retailers take advantage of this by attaching an artificially high price to their product and then providing a significant discount.	Michael Simmons & Jan Chew	

	Mental Model Description	Description Source
	<p>Some stress helps us focus, but too much destroys our decision making capabilities. Therefore, we must learn how to manage stress in situations, so that we make the best decisions possible.</p> <p>In ethically questionable experiments performed by Nobel Laureate, Ivan Pavlov, where he stress-induced nervous breakdowns in dogs and tried to reverse the effects, he found: "He could classify dogs so as to predict how easily a particular dog would breakdown." "The dogs hardest to break down were also the hardest to return to their pre-breakdown state." "Any dog could be broken down." "He couldn't reverse a breakdown except by reimposing stress."</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Stress-Influence Tendency</p>	<p>We tend to overemphasize information that is the most available and vivid from our surroundings and our mind. In the academic world, this is known as the Availability Bias. Unfortunately, The easiness doesn't mean that the information is the most useful one.</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Availability-Misweighing Tendency</p>	<p>This can work to people's benefit in the world of persuasion and memory. By painting a vivid picture of something, we can more effectively influence others and keep ideas in our own memories.</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Authority-Misinfluence Tendency</p>	<p>We trust and respect leaders too much, even when they make mistakes.</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Twaddle Tendency</p>	<p>We also trust leaders in areas where they are not experts. This is known as the Halo Effect.</p> <p>People tend to talk a lot about things they're not an expert in. Be very careful of these people.</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Reason-Respecting Tendency</p>	<p>Instead, try to surround yourself with people who show restraint in sharing their opinions until they're more proven or thought through.</p> <p>Before doing things, we love to have reasons. Therefore, when delegating things to other people, be sure to share the reasons why the task is important.</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Lollapalooza Tendency</p>	<p>In a famous study by researcher, Ellen Langer, she showed that when asking for a favor from a stranger, simply giving a reason for the request, even if it's artificial, greatly increases the odds of the person complying.</p> <p>Lollapalooza Tendency is the tendency to get extreme consequences from confluences of psychological tendencies acting in favor of a particular outcome. Although it is listed last here, Munger counts it as one of the most important.</p> <p>This tendency works in one of two ways:</p> <p>Effects bolster each other. In the famous Milgram experiments at Stanford, test subjects devolved into terrible behavior in just a few days as a result of six tendencies being triggered at once. In Munger's experience, when you combine two forces together, you don't get simple addition, you get a nuclear explosion.</p> <p>Effects cancel each other out. As companies grow, they get benefits (ie - economies of scale) and disadvantages (ie - beauracracy).</p>	<p>Michael Simmons & Jan Chew.</p>
<p>Common Knowledge</p>	<p>By understanding all of the biases and how they relate to each other, you will have a huge advantage in your life.</p> <p>"Common knowledge is knowledge that is known by everyone or nearly everyone, usually with reference to the community in which the term is used. Common knowledge need not concern one specific subject, e.g., science or history. Rather, common knowledge can be about a broad range of subjects, such as science, literature, history, and entertainment. Often, common knowledge does not need to be cited. Common knowledge is distinct from general knowledge. The latter has been defined by differential psychologists as referring to "culturally valued knowledge communicated by a range of non-specialist media", and is considered an aspect of ability related to intelligence. Therefore, there are substantial individual differences in general knowledge as opposed to common knowledge." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Comparative Advantage</p>	<p>"The theory of comparative advantage is an economic theory about the work gains from trade for individuals, firms, or nations that arise from differences in their factor endowments or technological progress. In an economic model, agents have a comparative advantage over others in producing a particular good if they can produce that good at a lower relative opportunity cost or autarky price, i.e. at a lower relative marginal cost prior to trade. One does not compare the monetary costs of production or even the resource costs (labor needed per unit of output) of production. Instead, one must compare the opportunity costs of producing goods across countries. The closely related law or principle of comparative advantage holds that under free trade, an agent will produce more of and consume less of a good for which they have a comparative advantage." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Diversification</p>	<p>"In finance, diversification is the process of allocating capital in a way that reduces the exposure to any one particular asset or risk. A common path towards diversification is to reduce risk or volatility by investing in a variety of assets. If asset prices do not change in perfect synchrony, a diversified portfolio will have less variance than the weighted average variance of its constituent assets, and often less volatility than the least volatile of its constituents." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Economies of Scale</p>	<p>"In microeconomics, economies of scale are the cost advantages that enterprises obtain due to size, output, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output.</p> <p>Economies of scale apply to a variety of organizational and business situations and at various levels, such as a business or manufacturing unit, plant or an entire enterprise. For example, economies of scale apply to the fixed cost to produce units of output through production and manufacturing. When average costs start falling then economies of scale are in production with fixed costs being a requirement for the equation. With no fixed costs, the average cost and average variable cost would be equal" - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Efficient Market Hypothesis</p>	<p>The efficient-market hypothesis (EMH) is a theory in financial economics that states that asset prices fully reflect all available information. A direct implication is that it is impossible to "beat the market" consistently on a risk-adjusted basis since market prices should only react to new information or changes in discount rates (the latter may be predictable or unpredictable)." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Game Theory</p>	<p>"Game theory is "the study of mathematical models of conflict and cooperation between intelligent rational decision-makers". Game theory is mainly used in economics, political science, and psychology, as well as logic, computer science and biology. Originally, it addressed zero-sum games, in which one person's gains result in losses for the other participants. Today, game theory applies to a wide range of behavioral relations, and is now an umbrella term for the science of logical decision making in humans, animals, and computers." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Incentives (Reward and Punishment)</p>	<p>"An incentive is something that motivates an individual to perform an action. The study of incentive structures is central to the study of all economic activities (both in terms of individual decision-making and in terms of co-operation and competition within a larger institutional structure). Economic analysis, then, of the differences between societies (and between different organizations within a society) largely amounts to characterizing the differences in incentive structures faced by individuals involved in these collective efforts. Ultimately, incentives aim to provide value for money and contribute to organizational success. As such the design of incentive systems is a key management activity." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Scarcity</p>	<p>"Scarcity refers to the limited availability of a commodity, which may be in demand in the market. The concept of scarcity also includes an individual capacity to buy all or some of the commodities as per the available resources with that individual" - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Supply and Demand</p>	<p>"In microeconomics, supply and demand is an economic model of price determination in a market. It postulates that in a competitive market, the unit price for a particular good, or other traded item such as labor or liquid financial assets, will vary until it settles at a point where the quantity demanded (at the current price) will equal the quantity supplied (at the current price), resulting in an economic equilibrium for price and quantity transacted." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Anchoring</p>	<p>"Anchoring or focalism is a cognitive bias that describes the common human tendency to rely too heavily on the first piece of information offered (the "anchor") when making decisions. During decision making, anchoring occurs when individuals use an initial piece of information to make subsequent judgments. Once an anchor is set, other judgments are made by adjusting away from that anchor, and there is a bias toward interpreting other information around the anchor. For example, the initial price offered for a used car sets the standard for the rest of the negotiations, so that prices lower than the initial price seem more reasonable even if they are still higher than what the car is really worth." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Classical Conditioning (Pavlov)</p>	<p>"Classical conditioning (also known as Pavlovian or respondent conditioning) refers to learning procedure in which a biologically potent stimulus (e.g. food) is paired with a previously neutral stimulus (e.g. a bell). It also refers to the learning process that results from this pairing, through which the neutral stimulus comes to elicit a response (e.g. salivation) that is usually similar to the one elicited by the potent stimulus. These basic facts, which require many qualifications (see below), were first studied in detail by Ivan Pavlov through experiments with dogs. Together with operant conditioning, classical conditioning became the foundation of behaviorism, a school of psychology which was dominant in the mid-20th century and is still an important influence on the practice of psychological therapy and the study of animal behavior. Classical conditioning is a basic learning process, and its neural substrates are now beginning to be understood." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>
<p>Commitment and Consistency Bias</p>	<p>"Even when it acts against our best interest our tendency is to be consistent with our prior commitments, ideas, thoughts, words, and actions. As a byproduct of confirmation bias, we rarely seek disconfirming evidence of what we believe. This, after all, makes it easier to maintain our positive self-image.</p> <p>Part of the reason this happens is our desire to appear and feel like we're right. We also want to show people our conviction. This shouldn't come as a surprise. Society values consistency and conviction even when it is wrong.</p> <p>We associate consistency with intellectual and personal strength, rationality, honesty, and stability. On the other hand, the person who is perceived as inconsistent is also seen as confused, two-faced, even mentally ill in certain extreme circumstances." - Farnam Street [65]</p>	<p>James Clear Mental Models Overview</p>
<p>Hyperbolic Discounting</p>	<p>"For instance, when I have agreed to wait for six days for online discounts to start, I don't mind waiting for one more day. Well, if I can wait for six, goes the rationale, waiting for seven shouldn't be a big deal!</p> <p>But when I am told that I can get something today instead of tomorrow, my temptation refuses to wait for another day. Scientists, as usual, have a name for this tendency – Hyperbolic Discounting. I am not going to explain the meaning of a hyperbolic function by drawing some fancy graphs. That's beyond the scope of this post and my abilities.</p> <p>'Discounting is hyperbolic' simply means a reward that is very close gets drastically more attractive. In other words, the closer a reward is, the higher our 'emotional interest rate' rises and the more we are willing to give up in exchange for it.</p> <p>I hope you understand that for most humans, including me and most probably you too, this behavioural quirk comes ingrained in the psyche. It's the way nature has wired us, an outcome of evolutionary process. So don't feel bad." - Safal Niveshak. [66]</p>	<p>James Clear Mental Models Overview</p>
<p>Illusion of Control</p>	<p>"The illusion of control is the tendency for people to overestimate their ability to control events; for example, it occurs when someone feels a sense of control over outcomes that they demonstrably do not influence. The effect was named by psychologist Ellen Langer and has been replicated in many different contexts. It is thought to influence gambling behavior and belief in the paranormal. Along with illusory superiority and optimism bias, the illusion of control is one of the positive illusions." - Wikipedia</p>	<p>James Clear Mental Models Overview</p>

Business - Economics

- Psychology

	Mental Model	Description	Description Source
Business -			
	Loss Aversion	"In economics and decision theory, loss aversion refers to people's tendency to prefer avoiding losses to acquiring equivalent gains: it's better to not lose \$5 than to find \$5. Some studies have suggested that losses are twice as powerful, psychologically, as gains. This leads to risk aversion when people evaluate an outcome comprising similar gains and losses; since people prefer avoiding losses to making gains." - Wikipedia	James Clear Mental Models Overview
	Maslow's Hierarchy of Needs	"Maslow's hierarchy of needs is a theory in psychology proposed by Abraham Maslow in his 1943 paper "A Theory of Human Motivation" in Psychological Review. Maslow subsequently extended the idea to include his observations of humans' innate curiosity. His theories parallel many other theories of human developmental psychology, some of which focus on describing the stages of growth in humans. Maslow used the terms "physiological", "safety", "belonging" and "love", "esteem", "self-actualization", and "self-transcendence" to describe the pattern that human motivations generally move through. The goal of Maslow's Theory is to attain the sixth level of stage: self transcendent needs." - Wikipedia	James Clear Mental Models Overview
	Mere Exposure Effect	"The mere-exposure effect is a psychological phenomenon by which people tend to develop a preference for things merely because they are familiar with them. In social psychology, this effect is sometimes called the familiarity principle. The effect has been demonstrated with many kinds of things, including words, Chinese characters, paintings, pictures of faces, geometric figures, and sounds. In studies of interpersonal attraction, the more often a person is seen by someone, the more pleasing and likeable that person appears to be." - Wikipedia	James Clear Mental Models Overview
	Operant Conditioning (Skinner)	"Operant conditioning (also called "instrumental conditioning") is a learning process through which the strength of a behavior is modified by reward or punishment. It is also a procedure that is used to bring about such learning." - Wikipedia	James Clear Mental Models Overview
	Reciprocity	"The norm of reciprocity requires that we repay in kind what another has done for us. It can be understood as the expectation that people will respond favorably to each other by returning benefits for benefits, and responding with either indifference or hostility to harms. The social norm of reciprocity often takes different forms in different areas of social life, or in different societies. All of them, however, are distinct from related ideas such as gratitude, the Golden Rule, or mutual goodwill. See reciprocity (social and political philosophy) for an analysis of the concepts involved. The norm of reciprocity mirrors the concept of reciprocal altruism in evolutionary biology. However, evolutionary theory and therefore sociobiology was not well received by mainstream psychologists. This led to the revitalisation of reciprocal altruism underneath the new social psychological concept, norm of reciprocity. Reciprocal altruism has been applied to various species, including humans, while mainstream psychologists use the norm of reciprocity to only explain humans." - Wikipedia	James Clear Mental Models Overview
	Status Quo Bias	"Status quo bias is an emotional bias; a preference for the current state of affairs. The current baseline (or status quo) is taken as a reference point, and any change from that baseline is perceived as a loss. Status quo bias should be distinguished from a rational preference for the status quo ante, as when the current state of affairs is objectively superior to the available alternatives, or when imperfect information is a significant problem. A large body of evidence, however, shows that status quo bias frequently affects human decision-making." - Wikipedia	James Clear Mental Models Overview
	Survivorship Bias	"Survivorship bias or survival bias is the logical error of concentrating on the people or things that made it past some selection process and overlooking those that did not, typically because of their lack of visibility. This can lead to false conclusions in several different ways. It is a form of selection bias." - Wikipedia	James Clear Mental Models Overview
	Tribalism	"Tribalism is the state of being organized in or an advocate for a tribe or tribes. In terms of conformity, tribalism may also refer in popular cultural terms to a way of thinking or behaving in which people are loyal to their own tribe or social group." - Wikipedia	James Clear Mental Models Overview
	Thinking	The Scientific Method	"The scientific method is a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. To be termed scientific, a method of inquiry is commonly based on empirical or measurable evidence subject to specific principles of reasoning. The Oxford Dictionaries Online defines the scientific method as "a method or procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses". Experiments need to be designed to test hypotheses. Experiments are an important tool of the scientific method." - Wikipedia
Inversion		"By imagining the worst case scenario ahead of time, they could overcome their fears of negative experiences and make better plans to prevent them. While most people were focused on how they could achieve success, the Stoics also considered how they would manage failure. This way of thinking, in which you consider the opposite of what you want, is known as inversion. Inversion is a powerful thinking tool because it puts a spotlight on errors and roadblocks that are not obvious at first glance." - James Clear	James Clear Mental Models Overview
Surfing or "Riding the Wave"		"A surfer not only is carried by the wave, but it gives an exceptional forward speed to its rider, provided the surfer can get on to the wave at the right time and not get thrown off in between. The second most important thing required to ride a wave is to recognize that the a wave is approaching. Which means 90 percent of the times you would find a surfer lying on his surfing board and paddling slowly, waiting for the right wave. So why are we talking about waves and surfers in a place reserved for discussing mental models? That's because "surfing" isn't just a sport. There are brilliant insights that can be used to analyse a business opportunity through the lens of a mental model with the same name i.e., Surfing. Charlie Munger used the surfing metaphor in his lecture on Elementary Worldly Wisdom to represent the idea of some large business force that developed, which a company was able to ride to grow itself much bigger." - safalnihvshak [67]	James Clear Mental Models Overview
Working Backward		"Backward chaining (or backward reasoning) is an inference method that can be described colloquially as working backward from the goal(s). It is used in automated theorem provers, inference engines, proof assistants and other artificial intelligence applications. In game theory, its application to (simpler) subgames in order to find a solution to the game is called backward induction. In chess, it is called retrograde analysis, and it is used to generate tablebases for chess endgames for computer chess. Backward chaining is implemented in logic programming by SLD resolution. Both rules are based on the modus ponens inference rule. It is one of the two most commonly used methods of reasoning with inference rules and logical implications – the other is forward chaining. Backward chaining systems usually employ a depth-first search strategy, e.g. Prolog"	James Clear Mental Models Overview
Science - Biology	Evolution by Natural Selection	"Natural selection is the differential survival and reproduction of individuals due to differences in phenotype. It is a key mechanism of evolution, the change in heritable traits of a population over time. Charles Darwin popularised the term "natural selection", and compared it with artificial selection. Natural selection acts on the phenotype, or the observable characteristics of an organism, but the genetic (heritable) basis of any phenotype that gives a reproductive advantage may become more common in a population. Over time, this process can result in populations that specialise for particular ecological niches (microevolution) and may eventually result in speciation (the emergence of new species, macroevolution). In other words, natural selection is a key process in the evolution of a population. Natural selection can be contrasted with artificial selection, in which humans intentionally choose specific traits, whereas in natural selection there is no intentional choice." - Wikipedia	James Clear Mental Models Overview
	Equilibrium (Homeostasis)	"Homeostasis is the property of a system within an organism in which a variable, such as the concentration of a substance in solution, is actively regulated to remain very nearly constant. Examples of homeostasis include the regulation of body temperature, the pH of extracellular fluid, or the concentrations of sodium, potassium and calcium ions, as well as that of glucose in the blood plasma, despite changes in the environment, diet, or level of activity. Each of these variables is controlled by a separate regulator or homeostatic mechanism, which, together, maintain life.	
	Heredity	The concept was described by French physiologist Claude Bernard in 1865 and the word was coined by Walter Bradford Cannon in 1926." - Wikipedia "Heredity is the passing on of traits from parents to their offspring, either through asexual reproduction or sexual reproduction; the offspring cells or organisms acquire the genetic information of their parents. Through heredity, variations between individuals can accumulate and cause species to evolve by natural selection. The study of heredity in biology is called genetics, which includes the field of epigenetics." - Wikipedia	James Clear Mental Models Overview
	Signalling	"Within evolutionary biology, signalling theory is a body of theoretical work examining communication between individuals, both within species and across species. The central question is when organisms with conflicting interests, such as in sexual selection, should be expected to provide honest signals (no presumption being made of conscious intention) rather than cheating. Mathematical models describe how signalling can contribute to an evolutionarily stable strategy." - Wikipedia	James Clear Mental Models Overview
Science - Chemistry	Activation Energy	"In chemistry, activation energy is the energy which must be available to a chemical system with potential reactants to result in a chemical reaction.[1] Activation energy may also be defined as the minimum energy required to start a chemical reaction. The activation energy of a reaction is usually denoted by Ea and given in units of kilojoules per mole (kJ/mol) or kilocalories per mole (kcal/mol). Activation energy can be thought of as the height of the potential barrier (sometimes called the energy barrier) separating two minima of potential energy (of the reactants and products of a reaction). For a chemical reaction to proceed at a reasonable rate, there should exist an appreciable number of molecules with translational energy equal to or greater than the activation energy." - Wikipedia	James Clear Mental Models Overview
	Atomic Theory	"In chemistry and physics, atomic theory is a scientific theory of the nature of matter, which states that matter is composed of discrete units called atoms. It began as a philosophical concept in ancient Greece and entered the scientific mainstream in the early 19th century when discoveries in the field of chemistry showed that matter did indeed behave as if it were made up of atoms." - Wikipedia	James Clear Mental Models Overview
	Autocatalysis	"A single chemical reaction is said to have undergone autocatalysis, or be autocatalytic, if one of the reaction products is also a reactant and therefore a catalyst in the same or a coupled reaction.[1] The reaction is called an autocatalytic reaction." - Wikipedia	James Clear Mental Models Overview
	Entropy (The Second Law of Thermodynamics)	"Entropy is a measure of disorder. And there are always far more disorderly variations than orderly ones. Here's the crucial thing about entropy: it always increases over time. It is the natural tendency of things to lose order. Left to its own devices, life will always become less structured. Sand castles get washed away. Weeds overtake gardens. Ancient ruins crumble. Cars begin to rust. People gradually age. With enough time, even mountains erode and their precise edges become rounded. The inevitable trend is that things become less organized. This is known as the Second Law of Thermodynamics. It is one of the foundational concepts of chemistry and it is one of the fundamental laws of our universe. The Second Law of Thermodynamics states that the entropy of a closed system will never decrease." - Wikipedia "Catalysis (IPA: /kəˈtælɪsɪs/) is the increase in the rate of a chemical reaction due to the participation of an additional substance called a catalyst, which is not consumed in the catalyzed reaction and can continue to act repeatedly. Often only tiny amounts of catalyst are required in principle.	James Clear Mental Models Overview
	Catalysts	In general, reactions occur faster with a catalyst because they require less activation energy. In catalyzed mechanisms, the catalyst usually reacts to form a temporary intermediate which then regenerates the original catalyst in a cyclic process." - Wikipedia	James Clear Mental Models Overview
	Critical Mass	"A critical mass is the smallest amount of fissile material needed for a sustained nuclear chain reaction. The critical mass of a fissionable material depends upon its nuclear properties (specifically, the nuclear fission cross-section), its density, its shape, its enrichment, its purity, its temperature, and its surroundings. The concept is important in nuclear weapon design." - Wikipedia	James Clear Mental Models Overview
	Relativity	"The theory of relativity usually encompasses two interrelated theories by Albert Einstein: special relativity and general relativity. Special relativity applies to elementary particles and their interactions, describing all their physical phenomena except gravity. General relativity explains the law of gravitation and its relation to other forces of nature. It applies to the cosmological and astrophysical realm, including astronomy." - Wikipedia	James Clear Mental Models Overview
Science - Physics			

	Mental Model	Description	Description Source
Scie Phy		"The velocity of an object is the rate of change of its position with respect to a frame of reference, and is a function of time. Velocity is equivalent to a specification of its speed and direction of motion (e.g. 60 km/h to the north). Velocity is an important concept in kinematics, the branch of classical mechanics that describes the motion of bodies.	
	Velocity	Velocity is a physical vector quantity; both magnitude and direction are needed to define it." - Wikipedia	James Clear Mental Models Overview
Math & Engineering	Break Points	"In software development, a breakpoint is an intentional stopping or pausing place in a program, put in place for debugging purposes. It is also sometimes simply referred to as a pause." - Wikipedia "Farnam Street give a very good explanation of the nature of break point -- Multiplicative System. What's 1,506,789 x 9,809 x 5.56 x 0? Hopefully you didn't have to whip out the old TI-84 to solve that one. It's a zero. and that zero, is our concept of break points. Break Point can be understand as Weakest Link in the multicaptive system, it could be place in the system intentionally, such as fuse in electrical circuits, or sharp pins in boat propellers." - Rational Pov [68]	James Clear Mental Models Overview
	Leverage	"Mechanical advantage is a measure of the force amplification achieved by using a tool, mechanical device or machine system. The device preserves the input power and simply trades off forces against movement to obtain a desired amplification in the output force. The model for this is the law of the lever. Machine components designed to manage forces and movement in this way are called mechanisms. An ideal mechanism transmits power without adding to or subtracting from it. This means the ideal mechanism does not include a power source, is frictionless, and is constructed from rigid bodies that do not deflect or wear. The performance of a real system relative to this ideal is expressed in terms of efficiency factors that take into account departures from the ideal." - Wikipedia	James Clear Mental Models Overview
	Margin of Safety	"This term, margin of safety, is an engineering concept used to describe the ability of a system to withstand loads that are greater than expected. There are many ways to implement a margin of safety in everyday life. The core idea is to protect yourself from unforeseen problems and challenges by building a buffer between what you expect to happen and what could happen. This idea is widely useful on a day-to-day basis because uncertainty creeps into every area of life. Let's explore a few ways we can use this concept to live better." - James Clear	James Clear Mental Models Overview
	Redundancy	"In reliability engineering, redundancy is defined as the existence of more than one means for accomplishing a given task. Thus all of these means must fail before there is a system failure. A Backup System is turning a Multiplicative System with a single break point into an additive system with two or more break points. How to use this mental model: Analyze the primary system - Is the primary system a multiplicative one or additive one? If the system is additive, by definition it doesn't need a backup system. if the primary system is a simple or complex one? If the system is a simple one, other means of increasing reliability could be more effective(margin of safety) - Designing Backup System. if the primary system is a complex and multiplicative one, adding backup system could greatly improve reliability." - [69]	James Clear Mental Models Overview
Evolution	Evolution / Making Mistakes	"Evolution is one of the central themes of this book, as of all my books, for the simple reason that it is the central, enabling process not only of life but also of knowledge and learning and understanding. If you attempt to make sense of the world of ideas and meanings, free will and morality, art and science and even philosophy itself without a sound and quite detailed knowledge of evolution, you have one hand tied behind your back." - Rational Pov	Philosopher Daniel Dennett's Book Intuition Pumps
Thinking About Free Will	A Truly Nefarious Neurosurgeon	"Neuroscientists, psychologists, and philosophers need to take seriously their moral obligation to think through the presuppositions and implications of their public pronouncements on these issues with the same care that is demanded of people who hold forth on global warming or impending asteroid strikes."	Philosopher Daniel Dennett's Book Intuition Pumps
	A Deterministic Toy: Conway's Game of Life	The breathtakingly simple model of a deterministic world created by the mathematician John Horton Conway and his graduate students in 1970. Using the Game calls Life, Conway concluded that "by the time you have built up enough pieces into something that can reproduce itself (in a two-dimensional world), it is roughly as much larger than its smallest bits as an organism is larger than its atoms. You probably can't do it with anything much less complicated, though this has not been strictly proved."	Philosopher Daniel Dennett's Book Intuition Pumps
	Rock, Paper, and Scissors	Probably every one of you knows the game of rock, paper, and scissors. Can some people play the game better than others? Yes, Perhaps by picking up subtle hints from the faces and postures of their opponents. People are notoriously bad at creating actually random series. They tend to switch too often, avoiding choosing the same move two or three times in a row, for instance (which ought to occur fairly often in a genuinely random series). Knowing that your casual effort to create a genuinely patternless series is apt to fail, you should consider a better strategy: get a table of random numbers from the library (or online).	Philosopher Daniel Dennett's Book Intuition Pumps
	Two Lotteries	If the world is determined, then we have pseudo-random number generators in us, not truly (quantum-mechanical) random randomizers. If our world is determined, all our lottery tickets were drawn at once, in effect, about fourteen billion years ago at the moment of the Big Bang, put in an envelope for us, and doled out as we needed them through life. The winner cannot properly claim it was his "destiny" to win, but whatever advantages accrue to winning are his, destiny or not, and what could be fairer than that? Fairness does not consist in everybody winning. Probably the most frequently cited reason for hoping for indeterminism is that without it, when we choose an act, "we could not have done otherwise," and surely (ding!) that is something that should be important to us. This, too, is not as obvious as it has often seemed, and in order to get a glimpse at how this familiar idea might be misleading us, consider the curious category of inert historical facts.	Philosopher Daniel Dennett's Book Intuition Pumps
	Inert Historical Facts	An inert historical fact is any fact about a perfectly ordinary arrangement of matter in the world at some point in the past that is no longer discernible, a fact that has left no footprints at all in the world today. My favorite example of an inert historical fact is this: A. Some of the gold in my teeth once belonged to Julius Caesar.	Philosopher Daniel Dennett's Book Intuition Pumps
	A Computer Chess Marathon	Suppose you install two different chess-playing programs on your computer and yoke them together with a little supervisory program that pits them against each other, game after game, in a potentially endless series. Will they play the same game, over and over, until you turn off the computer? You could set it up like that, but then you wouldn't learn anything interesting about the two programs, A and B. Suppose A beats B in this off-repeated game. You couldn't infer from this that A is a better program in general than B, or that A would beat B in a different game, and you wouldn't be able to learn anything from the exact repetition about the strengths and weaknesses of the two different programs. What does this intuition pump accomplish? It takes the familiar phrase "could have done otherwise" and shows that contrary to widespread but ill-examined opinion, a valuable version of it does not depend on indeterminism. If there is a sense of "could have done otherwise" that is both incompatible with determinism and morally important—not merely a metaphysical curiosity, you might say—this has yet to be established, and the burden of proof lies with those who think so. One more "obvious" point exposed as not so obvious after all.	Philosopher Daniel Dennett's Book Intuition Pumps
	Ultimate Responsibility	I [Daniel Dennett] think it is just as obvious that people can gradually become morally responsible during their passage from infancy to adulthood as it is that lineages of reptiles and then therapsids can gradually become a lineage of mammals over the eons. You don't have to be an absolute mammal to be a mammal, and you don't have to be absolutely responsible to be responsible, or have absolute free will to have a kind of free will worth wanting. In fact, since absolute free will would be miraculous, there really needs to be a powerful argument to show why anybody would covet such a thing.	Philosopher Daniel Dennett's Book Intuition Pumps
	Sphexishness	"Sphexishness is an important property not so much because so many whole, simple animals—insects, worms, fish—exhibit it (though they do, in varying degrees), but because it gives us a term for the limited, robotic, myopic, competences out of which we can build fancier, more versatile, comprehending minds. The building blocks in any mind model had better be sphexish! Or, as I noted earlier, the building blocks should be sorta minds, pale shadows of our minds. Sphexishness is also useful to distinguish morally competent minds from morally incompetent minds. To the extent that a human being is sphexish, because of a brain tumor or brain injury or serious imbalance of neuromodulators or mental illness or sheer ignorance or immaturity, that human being could not have done otherwise in the relevant sense."	Philosopher Daniel Dennett's Book Intuition Pumps
The Boys from Brazil: Another Boom Crutch	The film The Boys from Brazil, about Nazi scientists who raise Hitler clones (thanks to some salvaged DNA) inspired this thought experiment: Let us suppose, then, that a group of scientists has managed to create an individual—call him Mr Puppet—who, by design, engages in some criminal behavior: say, a murder done during a drug deal gone bad. [p. 1780] Here is what they say about their thought experiment: Yes, he is as rational as other criminals, and, yes, it was his desires and beliefs that produced his actions. But those beliefs and desires were rigged by external forces, and that is why, intuitively, he deserves our pity more than our moral condemnation. . . . what is the real difference between us and Mr Puppet? One obvious difference is that Mr Puppet is the victim of a diabolical plot whereas most people, we presume, are not. But does this matter? The thought that Mr Puppet is not fully responsible depends on the idea that his actions were externally determined. . . . But the fact that these forces are connected to the desires and intentions of evil scientists is irrelevant, is it not? What matters is only that these forces are beyond Mr Puppet's control, that they're not really his. [p. 1780]	Philosopher Daniel Dennett's Book Intuition Pumps	
Making Mistakes	The crowbar of rational inquiry, the great lever that enforces consistency, is reductio ad absurdum—literally, reduction (of the argument) to absurdity. You take the assertion or conjecture at issue and see if you can pry any contradictions (or just preposterous implications) out of it. If you can, that proposition has to be discarded or sent back to the shop for retooling.	Philosopher Daniel Dennett's Book Intuition Pumps	
Reductio ad Absurdum	How to compose a successful critical commentary: 1. You should attempt to re-express your target's position so clearly, vividly, and fairly that your target says, "Thanks, I wish I'd thought of putting it that way." 2. You should list any points of agreement (especially if they are not matters of general or widespread agreement). 3. You should mention anything you have learned from your target. 4. Only then are you permitted to say so much as a word of rebuttal or criticism.	Philosopher Daniel Dennett's Book Intuition Pumps	
Rapoport's Rules	One immediate effect of following these rules is that your targets will be a receptive audience for your criticism: you have already shown that you understand their positions as well as they do, and have demonstrated good judgment (you agree with them on some important matters and have even been persuaded by something they said).	Philosopher Daniel Dennett's Book Intuition Pumps	

	Mental Model Description	Description Source
General Thinking Tools	<p>"Sturgeon's Law is usually put a little less decorously: Ninety percent of everything is crap. Ninety percent of experiments in molecular biology, 90 percent of poetry, 90 percent of philosophy books, 90 percent of peer-reviewed articles in mathematics—and so forth—is crap. Is that true? Well, maybe it's an exaggeration, but let's agree that there is a lot of mediocre work done in every field...."</p>	
	<p>"Now, in order not to waste your time and try our patience, make sure you concentrate on the best stuff you can find, the flagship examples extolled by the leaders of the field, the prizewinning entries, not the dregs."</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>"Don't concoct a complicated, extravagant theory if you've got a simpler one (containing fewer ingredients, fewer entities) that handles the phenomenon just as well. If exposure to extremely cold air can account for all the symptoms of frostbite, don't postulate unobserved "snow germs" or "arctic microbes." Kepler's laws explain the orbits of the planets; we have no need to hypothesize pilots guiding the planets from control panels hidden under the surface."</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>"The process in which inconvenient facts are whisked under the rug by intellectually dishonest champions of one theory or another."</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>"In many fields—not just philosophy—there are controversies that seem never-ending and partly artifactual: people are talking past one another and not making the necessary effort to communicate effectively. When experts talk to experts, whether they are in the same discipline or not, they always err on the side of under-explaining. The reason is not far to seek: to overexplain something to a fellow expert is a very serious insult—"Do I have to spell it out for you?"—and nobody wants to insult a fellow expert.</p>	
	<p>Solution for this problem: Have all experts present their views to a small audience of curious nonexperts (here at Tufts I have the advantage of bright undergraduates) while the other experts listen in from the sidelines. They don't have to eavesdrop; this isn't a devious suggestion. On the contrary, everybody can and should be fully informed that the point of the exercise is to make it comfortable for participants to speak in terms that everybody will understand. By addressing their remarks to the undergraduates (the decoy audience), speakers need not worry at all about insulting the experts because they are not addressing the experts. (I suppose they might worry about insulting the undergraduates, but that's another matter.) When all goes well, expert A explains the issues of the controversy to the undergraduates while expert B listens. At some point B's face may light up. "So that's what you've been trying to say! Now I get it."</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>"Joothings stands for 'jumping out of the system.'" This is an important tactic not just in science and philosophy, but also in the arts. Creativity, that ardently sought but only rarely found virtue, often is a heretofore unimagined violation of the rules of the system from which it springs. It might be the system of classical harmony in music, the rules for meter and rhyme in sonnets (or limericks, even), or the "canons" of taste or good form in some genre of art. Or it might be the assumptions and principles of some theory or research program. Being creative is not just a matter of casting about for something novel—anybody can do that, since novelty can be found in any random juxtaposition of stuff—but of making the novelty jump out of some system, a system that has become somewhat established, for good reasons."</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>Rathering is a way of stiding you swiftly and gently past a false dichotomy. The general form of a rathering is "It is not the case that blahblahblah, as orthodoxy would have you believe; it is rather that suchandsuchandsuch—which is radically different." Some ratherings are just fine; you really must choose between the two alternatives on offer; in these cases, you are not being offered a false, but rather a genuine, inescapable dichotomy. But some ratherings are little more than sleight of hand, due to the fact that the word "rather" implies—without argument—that there is an important incompatibility between the claims flanking it.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>"When you're reading or skimming argumentative essays, especially by philosophers, here is a quick trick that may save you much time and effort, especially in this age of simple searching by computer: look for "surely" in the document, and check each occurrence. Not always, not even most of the time, but often the word "surely" is as good as a blinking light locating a weak point in the argument, a warning label about a likely boom crutch. Why? Because it marks the very edge of what the author is actually sure about and hopes readers will also be sure about. (If the author were really sure all the readers would agree, it wouldn't be worth mentioning.)"</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>Just as you should keep a sharp eye out for "surely," you should develop a sensitivity for rhetorical questions in any argument or polemic. Why? Because, like the use of "surely," they represent an author's eagerness to take a short cut. A rhetorical question has a question mark at the end, but it is not meant to be answered. Whenever you see a rhetorical question, try—silently, to yourself—to give it</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>A deeply is a proposition that seems both important and true—and profound—but that achieves this effect by being ambiguous. On one reading it is manifestly false, but it would be earth-shaking if it were true; on the other reading it is true but trivial. The unwary listener picks up the glimmer of truth from the second reading, and the devastating importance from the first reading, and thinks, Wow! That's a deeply. Example: Love is just a word.</p>	
	<p>"love" is an English word, but just a word, not a sentence, for example.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>What do all death threats have in common? Only their meaning. It seems. And meaning is not like radioactivity or acidity, a property readily discriminated by a well-tuned detector. The closest we have come yet to creating a generalpurpose meaning-detector is IBM's Watson, which is much better at sorting by meanings than any earlier artificial intelligence system, but notice that it is not at all simple, and would still (probably) misidentify some candidates for death threats that a child would readily get. Even small children recognize that when one laughing kid yells to another, "So help me, I'll kill you if you do that again!" this is not really a death threat. The sheer size and sophistication of Watson are at least indirect measures of how elusive the familiar property of meaning is.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>Let us suppose we are going to insert into Tom's brain the following false belief: I have an older brother living in Cleveland. Let us suppose the cognitive micro-neurosurgeon can do the requisite rewiring, as much and as delicate as you please. This rewiring will either impair Tom's basic rationality or not. Consider the two outcomes. Tom is sitting in a bar and a friend asks, "Do you have any brothers or sisters?" Tom says, "Yes, I have an older brother living in Cleveland." "What's his name?" Now what is going to happen? Tom may reply, "Name? Whose name? Oh my gosh, what was I saying? I don't have an older brother! For a moment, there, it seemed to me that I had an older brother living in Cleveland! Alternatively, he may say, "I don't know his name," and when pressed he will deny all knowledge of this brother and assert things like "I am an only child and have an older brother living in Cleveland." In neither case has our cognitive micro-neurosurgeon succeeded in wiring in a new belief. In the first case, Tom's intact rationality wipes out the (lone, unsupported) intruder as soon as it makes an appearance. An evanescent disposition to say, "I have an older brother living in Cleveland" isn't really a belief—it's more in the nature of a tic, like a manifestation of Tourette's syndrome</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>What this intuition pump shows is that nobody can have just one belief. (You can't believe a dog has four legs without believing that legs are limbs and four is greater than three, etc.) It shows other things as well, but I won't pause to enumerate them. Nor will I try to say now how one might use a variation on this very specific thinking tool for other purposes—though you are invited to turn the knobs yourself, to see what you come up with.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>A young child is asked what her father does, and she answers, "Daddy is a doctor." Does she believe what she says? Clearly her understanding of what it is to be a doctor, as well as what it is to be a father, will grow over the years, and hence her understanding of her own sentence, "Daddy is a doctor," will grow. Can we specify—in any nonarbitrary way—how much she must know in order to understand this proposition "completely"? If understanding comes in degrees, as this example shows, then belief, which depends on understanding, must come in degrees as well, even for such mundane propositions as this. She "sorta" believes her father is a doctor—which is not to say she has reservations or doubts, but that she falls short of the understanding that is an important precondition for any useful concept of belief.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
	<p>The manifest image is the world as it seems to us in everyday life, full of solid objects, colors and smells and tastes, voices and shadows, plants and animals, and people and all their stuff: not only tables and chairs, bridges and churches, dollars and contracts, but also such intangible things as songs, poems, opportunities, and free will. Think of all the puzzling questions that arise when we try to line up all those things with the things in the scientific image: molecules, atoms, electrons, and quarks and their ilk. Is anything really solid?</p>	
<p>Most of our manifest image is not genetically inherited; it is somehow inculcated in our early childhood experience. Words are a very important category of thing for us, and are the medium through which much of our manifest image is transmitted, but the capacity to categorize some events in the world as words, and our desire to speak, may well be at least partly a genetically inherited talent—like the bird's capacity to make out individual flying insects, or a wasp's desire to dig a nest.</p>	Philosopher Daniel Dennett's Book Intuition Pumps	
<p>Terms can structure and flavor our minds, enriching our personal manifest images with things—loose cannons and lip service and feedback—that are otherwise almost invisible.</p>	Philosopher Daniel Dennett's Book Intuition Pumps	
<p>Probably the most important pattern in our manifest image, because it anchors so many other categories that matter to us, is the pattern I call folk psychology. I proposed folk psychology as a term for the talent we all have for interpreting the people around us—and the animals and the robots and even the lowly thermostats—as agents with information about the world they act in (beliefs) and the goals (desires) they strive to achieve, choosing the most reasonable course of action given their beliefs and desires.</p>	Philosopher Daniel Dennett's Book Intuition Pumps	
<p>This simple theory of intentional systems is a theory about how and why we are able to make sense of the behaviors of so many complicated things by considering them as agents. It is not directly a theory of the internal mechanisms that somehow achieve the rational guidance thereby predicted. The intentional stance gives you the "specs," the job description, of an intentional system—what it should discriminate, remember, and do, for instance—and leaves the implementation of those specs to the engineers (or evolution and development, in the case of an intentional system that is an organism).</p>	Philosopher Daniel Dennett's Book Intuition Pumps	
<p>This idea, that we can divide and conquer the daunting problem of imagining how a person could be composed of (nothing but) mindless molecules, can be looked at bottom-up, or top-down, starting with the whole person and asking what smallish collection of very smart homunculi could conspire to do all the jobs that have to be done to keep a person going. Plato pioneered the topdown approach. His analysis of the soul into three agent-like parts, analogized to the Guardians, the Auxiliaries, and the Workers, or the rational, the spirited, and the appetitive, was not a very good start, for reasons well analyzed over the last two millennia. Freud's id, ego, and superego of the last century was something of an improvement, but the enterprise of breaking down a whole mind into sub-minds really began to take shape with the invention of the computer and the birth of the field of artificial intelligence (AI), which at the outset had the explicit goal of analyzing the cognitive competences of a whole (adult, conscious, language-using) person into a vast network of sub-personal specialists, such as the goal-generator, the memory-searcher, the plan-evaluator, the perception-analyzer, the sentenceparser, and so on.</p>	Philosopher Daniel Dennett's Book Intuition Pumps	
<p>In the millennia-old quest to understand the mind, theorists have often succumbed to the temptation to imagine an inner agent, a little man—homunculus, in Latin—who sits in the control room in the brain and does all the clever work.</p>		
<p>Bottom-up, neuroscientifically inspired, homuncular functionalism is looking better and better as a model of how the brain works, since the more chaotic and competitive "computational architectures" it generates are more plausible from a biological point of view: we can begin to discern the developmental processes that could build and revise these architectures, starting in the embryo and continuing into adulthood, and also see how they could have evolved from simpler nervous systems, themselves teams of less accomplished homunculi, which sorta perceive, signal, and remember.</p>	Philosopher Daniel Dennett's Book Intuition Pumps	
<p>Why indulge in this "sorta" talk? Because when we analyze—or synthesize—this stack of ever-more competent levels, we need to keep track of two facts about each level: what it is and what it does. What it is can be described in terms of the structural organization of the parts from which it is made—so long as we can assume that the parts function as they are supposed to function. What it does is some (cognitive) function that it (sorta) performs—well enough so that at the next level up, we can make the assumption that we have in our inventory a competent building block that performs just that function—sorta, good enough to use.</p>	Philosopher Daniel Dennett's Book Intuition Pumps	

	Mental Model Description	Description Source
	<p>Experimental psychology is giving us an ever-more detailed catalogue of the competences and frailties of the mind—the triumphs of perception and the embarrassments of illusion, the pace of language learning and the conditions of distraction, lust, fear, and mirth—and now, as “convinced materialists,” we need to figure out how on earth the brain does it all, without postulating wonder tissue. As our understanding grows, what counts as wonder tissue shifts. When “connectionist” and other “neural network” models burst on the scene in the mid-1980s, they demonstrated learning capabilities and pattern-recognition powers that nobody would have dared postulate in small tracts of neurons a few years earlier. We still don’t know exactly how—or even if—the brain exploits the computational powers exhibited by these semi-realistic models, but it is now okay to postulate a connectionist competence for some neural network that you can’t yet explain as long as you are upfront about it and the competence is not clearly beyond the demonstrated range of feats. The main objection to wonder tissue is that it does not give us a way of solving the problem, but a way of giving up, of assuming that it is a mystery that can never be solved.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Wonder Tissue</p>	<p>Your brain is importantly not in the same predicament you would be in, trapped in the control room. Its task is—must be—partly solved in advance by the way some inputs are “wired up” to some outputs so that there is some leverage in the brain with which to learn and refine further appropriate relationships. This is another way of dramatizing the widely recognized claim that our brains are not “blank slates” at birth (Pinker, 2002), but are already designed by natural selection to embody various preferences, anticipations, and associations. And as long as some of the appropriate connections are built in, they don’t have to be labeled. Before there can be comprehension, there has to be competence without comprehension. This is nature’s way</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Trapped in the Robot Control Room</p>	<p>SECRET 1: Competence without Comprehension: Something—e.g., a register machine—can do perfect arithmetic without having to comprehend what it is doing. SECRET 2: What a number in a register stands for depends on the program that we have composed. SECRET 3: Since a number in a register can stand for anything, this means that the register machine can, in principle, be designed to “notice” anything, to “discriminate” any pattern or feature that can be associated with a number—or a number of numbers SECRET 4: Since a number can stand for anything, a number can stand for an instruction or an address. SECRET 5: All possible programs can be given a unique number as a name, which can then be treated as a list of instructions to be executed by a Universal machine. SECRET 6: All the improvements in computers since Turing invented his imaginary paper-tape machine are simply ways of making them faster. SECRET 7: There are no more secrets!</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>The Seven Secrets of Computer Power Revealed</p>	<p>A virtual machine is what you get when you impose a particular pattern of instructions (more literally, dispositions) on a real machine that has lots of plasticity—interacting parts that can be in many different states. Since a virtual machine does informational work, it can do the same job as a computer whose “moving parts” are state-changes in hardware by making all those state-changes in representations of those moving parts. The concept of a virtual machine is one of the most useful imagination-stretchers to come out of computer science, and having proved its worth in that domain, it is ripe for importing to other areas.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Virtual Machines</p>	<p>An algorithm is a certain sort of formal process that can be counted on—logically—to yield a certain sort of result whenever it is “run” or instantiated. Algorithms are not new, and they were not new in Darwin’s day. The idea that an algorithm is a foolproof and somehow “mechanical” procedure has been present for centuries, but it was the pioneering work of Alan Turing, Kurt Gödel, and Alonzo Church in the 1930s that more or less fixed our current understanding of the term. Three key features of algorithms will be important to us, and each is somewhat difficult to define. (1) Substrate neutrality (2) Underlying mindlessness (3) Guaranteed results</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Algorithms</p>	<p>Back in the days, there were elevator operators, people whose job was to go up and down in an elevator all day, stopping at the right floors to take on and let off passengers. Now imagine what happened when it became possible for a simple computer program to take over all the control tasks of the operator. A machine has replaced one actual human being—not a figurative homunculus. And the machine follows the same rules as the human operator. Does it really? Really? Ok, it doesn’t. It sorta follows the same rules. This is a nice intermediate case between a human being who memorizes—and hence literally represents in her mind, and consults—the rules that dictate her behavior, and the planets, whose orbits are elegantly described by equations that the planets “obey.” We human beings also often occupy an intermediate level, when we have internalized or routinized through practice a set of explicit rules that we may then discard or even forget (“I before e” except after “c” or when it sounds like “a” as in “neighbor” and “weigh”).</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Automating the Elevator</p>	<p>Suppose Pat says that Mike “has a thing about redheads.” What Pat means, roughly, is that Mike has a stereotype of a redhead that is rather derogatory and influences Mike’s expectations about, and interactions with, redheads. It could turn out that Mike does have a thing, not an idea or a thought or a belief or an image or any of the other traditional things that furnish our conscious experience, but a bit of sub-personal cognitive machinery in his brain, that is about redheads in the sense that it systematically comes into play whenever the topic is redheads or a redhead, and adjusts various parameters of Mike’s cognitive machinery, making flattering hypotheses about redheads less likely to be entertained, or confirmed, making relatively aggressive behavior vis-à-vis redheads closer to implementation than otherwise it would be, and so on.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>A Thing about Redheads</p>	<p>What is the aim of this intuition pump? It is simply an attempt to suggest that the familiar refrain in support of the language of thought—“What else could it be?”—might have a good answer that would take the wind out of the sails of those who find it obvious. What is the aim of this intuition pump? It is simply an attempt to suggest that the familiar refrain in support of the language of thought—“What else could it be?”—might have a good answer that would take the wind out of the sails of those who find it obvious. I</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>The Wandering Two-Bitsler, Twin Earth, and the Giant Robot</p>	<p>Note even though all the robot’s intentional states and acts are derived from your purposes, they are beginning to become detached somewhat from your purposes. Since you designed the robot to “think for itself” to some degree, its “thinking” may escape your anticipated boundaries. For a real-world, nonfictional example of such an artifact, consider a chess-playing computer that can beat its creator at chess. It is true that the only reason we can say that the computer is currently “investigating” queen-side rook options and “deciding” not to castle is that it is an artifact designed by a human artificer to do just that sort of thing.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Radical Translation and a Quinian Crossword Puzzle</p>	<p>We are artifacts, designed over the eons as survival machines for genes that cannot act swiftly and informedly in their own interests. Our interests as we conceive of them and the “interests” of our genes may well diverge—even though were it not for our genes’ “interests,” we would not exist. Their preservation is our original raison d’être, even if we can learn to ignore that goal and devise our own summum bonum, thanks to the intelligence, the capacity to learn, that our genes have installed in us. So our intentionality is derived from the intentionality of our “selfish” genes.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Semantic Engines and Syntactic Engines</p>	<p>Ruth Millikan (for instance) is right that given the nature of design constraints, it is unlikely in the extreme that there could be different ways of skinning the cat that led to two radically different, globally indeterminate, tied-for-first-place interpretations. Indeterminacy of radical translation is truly negligible in practice. Still, the principle survives. The reason we don’t have indeterminacy of radical translation is not because, as a matter of metaphysical fact, there are “real meanings” in there, in the head (what Quine called the “museum myth” of meaning, his chief target). The reason we don’t have indeterminacy in the actual world is that with so many independent constraints to satisfy, the cryptographer’s maxim assures us that it is a vanishingly small worry. When indeterminacy threatens in the real world, it is always just more “behavioral” or “dispositional” facts—more of the same—that save the day for a determinate reading, not some mysterious “causal power” or “intrinsic semanticity.” Intentional interpretation almost always arrives in the limit at a single interpretation, but in the imaginable catastrophic case in which dual interpretations survived all tests, there would be no deeper facts to settle which was “right.” Facts do settle interpretations, but it is always “shallow” facts that do the job.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Swampman Meets a Cow-Shark</p>	<p>Brains are energetically very expensive organs, and if they can’t do the important job of distinguishing the words meaning, they aren’t earning their keep. Brains, in other words, are supposed to be semantic engines. What brains are made of is kazillions of molecular pieces that interact according to the strict laws of chemistry and physics, responding to shapes and forces; brains, in other words, are in fact only syntactic engines.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Two Black Boxes</p>	<p>A genuine semantic engine, responding directly to meanings, is like a perpetual motion machine—physically impossible. So how can brains accomplish their appointed task? By being syntactic engines that track or mimic the competence of the impossible semantic engine. But is this even possible? Some philosophers have argued that if the micro-causal story of how a brain works is complete (without any mysterious gaps), there is simply no room for meaning to make a difference</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
<p>Universal Acid</p>	<p>Suppose lightning strikes a dead tree in a swamp; I am standing nearby. My body is reduced to its elements, while entirely by coincidence (and out of different molecules) the tree is turned into my physical replica. My replica, The Swampman, moves exactly as I did. But there is a difference. My replica can’t recognize my friends; it can’t recognize anything, since it never cognized anything in the first place</p> <p>These bizarre examples attempt to prove one conceptual point or another by deliberately reducing all but one underappreciated feature of some phenomenon to zero, so that what really counts can shine through. The Twin Earth example sets internal similarity to a maximum (you are whisked off to Twin Earth without being given a chance to register this huge shift) so that external context can be demonstrated to be responsible for whatever our intuitions tell us. The Swampman intuition pump keeps both future dispositions and internal states constant and reduces “history” to zero. Thus these thought experiments mimic scientific experiments in their design, attempting to isolate a crucial interaction between variables by holding other variables constant. A problem with such experiments is that the dependent variable is intuition—they are intuition pumps—and the contribution of imagination in the generation of intuitions is harder to control than philosophers have acknowledged.</p> <p>You didn’t have to have a semantic or intentional interpretation of the boxes to see it: a caused red, and b caused green—an obvious pattern in need of explanation. In each instance of button-pressing, the scientists understood exactly how each step in the computing and transmitting process worked, but they couldn’t explain the generalization. You do need a semantic interpretation to explain why the regularity exists. In other words, the “macro-causal” level at which the explanation is expressed does not “reduce” to the “micro-causal” level.</p> <p>Universal acid is a liquid so corrosive that it will eat through anything! But what do you keep it in? It dissolves glass bottles and stainless-steel canisters as readily as paper bags. What would happen if you somehow came upon or created a dollop of universal acid? Would the whole planet eventually be destroyed? What would it leave in its wake? After everything had been transformed by its encounter with universal acid, what would the world look like? Little did I realize that in a few years I would encounter an idea Darwin’s idea—bearing an unmistakable likeness to universal acid: it eats through just about every traditional concept, and leaves in its wake a revolutionized worldview, with most of the old landmarks still recognizable, but transformed in fundamental ways. Darwin’s idea is a revolutionary idea, no doubt about it, but it does not destroy what we value in all these things; it puts them on better foundations, and unites them gracefully with the rest of knowledge. For centuries “the arts and humanities” have been considered not just separate from the sciences but somehow protected from the invasive examinations science engages in, but this traditional isolation is not the best way to preserve what we love. Trying to hide our treasures behind a veil of mystery prevents us from finding a proper anchoring for them in the physical world. It is a common-enough mistake, especially in philosophy.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>

Tools About Computers

Tools About Meaning

	Mental Model Description	Description Source
	<p>How can our personal DNA be so different and yet so similar? A good way to understand this surprising fact is by comparing DNA with the texts of books, and the Argentine writer Jorge Luis Borges (1962) has given us a little fable, "The Library of Babel," that vividly illustrates the way this difference and similarity can coexist. Borges tells of the forlorn explorations and speculations of people who find themselves living in a vast storehouse of books, structured like a honeycomb, composed of thousands (or millions or billions) of hexagonal air shafts surrounded by balconies lined with shelves.</p> <p>One of the important features of DNA is that all the permutations of sequences of adenine, cytosine, guanine, and thymine are about equally stable, chemically. All could be constructed, in principle, in the gene-splicing laboratory, and once constructed they would have an indefinite shelf life, like a book in a library. But not every such sequence in the Library of Mendel corresponds to a viable organism. Most DNA sequences—the vast majority—are gibberish, recipes for nothing living at all. All the genomes that we see, that actually exist today, are the products of billions of years of adjustment and revision, a mindless editorial process that is effective because most of the gibberish is automatically discarded, while the rest is relentlessly reused, copied kazillions of times. You have more than a trillion copies of your genome in your own body right now, one copy in each human cell, and every day, as new skin cells and bone cells and blood cells are made, new copies of your genomes are installed in them. The text that can be copied—because it resides in a going concern, a living cell—is copied. The rest dissolves. Publish or perish.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Library of Mendel: Vast and Vanishing	<p>When a person is made, or when a mouse is made, both embryologies draw upon the same dictionary of genes: the normal vocabulary of mammalian embryologies. The difference between a person and a mouse comes out of the different orders with which the genes, drawn from that shared mammalian vocabulary, are deployed, the different places in the body where this happens and its timing. All this is under the control of particular genes whose business it is to turn other genes on, in complicated and exquisitely timed cascades. But such controlling genes constitute only a minority of the genes in the genome.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Genes as Words or as Subroutines	<p>All this helps us understand why it is so easy for an expert to recognize the genome of a mammal. It has the mammal toolbox, which in addition to its specialized mammal-making tools also includes tools from the reptile toolbox, and the fish toolbox, and even the worm toolbox. The oldest tools in the kit are shared by all living things, including bacteria.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Tree of Life	<p>The genomes that exist today are connected by threads of descent to the genomes of their parents and grandparents and so on, back to the beginning of life on Earth. The Tree of Life, shows how every person is relatively closely related to every other person—sharing common human ancestors within the last hundred thousand years, and sharing ancestors with every dog and whale within the last two hundred million years, and every daisy and redwood tree within the last two billion years.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Cranes and Skyhooks, Lifting in Design Space	<p>The most amazing of all is the tenacity of living things, the thousands of ways they have of clinging to life and reproducing, eking out a living against formidable obstacles, thanks to millions of ingenious devices and arrangements, from the convoluted cascades of protein machinery within every cell, to echolocation in bats, to the elephant's trunk, to the capacity of our brains to reflect on every topic "under the sun" and many others as well. All that magnificent adjustment of means to ends requires an explanation, since it cannot be pure chance or happenstance. There are only two known possibilities: Intelligent Design or evolution by natural selection. In either case there is a tremendous amount of design work to be done, either miraculously by an Intelligent Designer or ploddingly, unforesightedly, stupidly—but non-miraculously—by natural selection.</p> <p>A convenient way to imagine the design work that needs to have been done is to think of it as lifting in Design Space. What is Design Space? Like the Library of Babel and the Library of Mendel, it can best be conceived as a multidimensional space. In fact Design Space contains both of those libraries and more, because it includes not only all the (designed, authored) books and the (designed, evolved) organisms, but all other things that are well described by the design stance (see chapter 18), such as houses, mousetraps, battleaxes, computers, and spaceships.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Competence without Comprehension	<p>MacKenzie described Darwin's idea of Absolute Ignorance being the source of "all the achievements of creative skill" as a "strange inversion of reasoning," since it turns upside down one of the most "obvious" ideas we have: comprehension is the source of competence. Why do we send our children to school, and why do we emphasize "concepts" over "rote learning"? Because we think that the best route to competence, in any sphere of activity, is comprehension. In general, the rule of thumb is hard to deny: comprehension is usually the key to (human) competence.</p> <p>Darwin really does invert that reasoning, showing, as MacKenzie so vividly put it, that Absolute Ignorance is the artificer. The process of natural selection is breathtakingly competent—think of Orgel's Second Law—but utterly mindless. Moreover, the organisms it designs get the benefits of all their exquisite equipment without needing to understand why or how they are so gifted.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Free-Floating Rationales	<p>Natural selection is an automatic reason-finder; it "discovers" and "endorse" and "focuses" reasons over many generations. The reasons tracked by evolution I have called "free-floating rationales," a term that has apparently jangled the nerves of more than a few thinkers, who suspect I am conjuring up ghosts of some sort, strange immaterial ideas that have no business appearing in a sober materialist's account of reality. Not at all. Free-floating rationales are no more ghostly or problematic than numbers or centers of gravity. There were nine planets before people invented ways of articulating arithmetic, and asteroids had centers of gravity before there were physicists to dream up the idea and calculate with it. It is a mistake to confuse numbers with the numerals (Arabic or Roman or whatever) that we use as their names. Numerals are human inventions; numbers are not. Reasons, in the sense I am using the term, are like numbers, not numerals. We should all be happy to speak of the reasons uncovered by evolution before they were ever expressed or represented by human investigators or any other minds. Consider the strikingly similar constructions in the figures facing page 240.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Do Locusts Understand Prime Numbers?	<p>Nor does it depend on the process of natural selection understanding prime numbers. The mindless, uncomprehending process of natural selection can exploit this important property of some numbers without having to understand it at all. For another example: neither bees nor Mother Nature need to understand the geometry that declares the hexagon the ideal shape for cells in a honeycomb.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
How to Explain Stotting	<p>You have probably seen video of gazelles being chased across the plain by a predator, and noticed that some of the gazelles are leaping high into the air during their attempts to escape their pursuer. This is called stotting. Why do gazelles stot? It is clearly beneficial, because gazelles that stot seldom get caught and eaten. This is a causal regularity that has been carefully observed, just like the regularity between buttons and lights. And it too can baffle. No account of the actions of all the proteins in all the cells of all the gazelles and the predators chasing them could reveal why this regularity exists. For that we need the branch of evolutionary theory known as costly signaling theory (Zahavi, 1987; FitzGibbon and Fanshawe, 1988)</p> <p>The strongest and fastest of the gazelles stot to advertise their fitness to the pursuer, signaling in effect, "Don't bother chasing me: I'm too hard to catch; concentrate on one of my cousins who isn't able to stot—a much easier meal!" and the pursuer takes this to be an honest, hard-to-fake signal and ignores the stotter. This is the free-floating rationale, and it need not be appreciated by either gazelle or predator. That is, the gazelle may be entirely oblivious to why it is a good idea to stot if it can, and the predator, say, a lion, may not understand why it finds stotting gazelles relatively unattractive prey, but if the signaling wasn't honest, costly signaling, it couldn't persist in the evolutionary arms race between predator and prey</p> <p>These explanations in terms of free-floating rationales are not reducible to explanations at lower levels, such as the molecular level, but it is important to recognize that even though the explanation of why and how stotting works is from the intentional stance (in terms of what it would be rational for a lion to conclude from the stotting of the gazelle), the individual lion or gazelle need not understand the meaning of stotting for it to work; they need only sorta understand it.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Beware of the Prime Mammal	<p>You may think you're a mammal, and that dogs and cows and whales are mammals, but really there aren't any mammals at all. There couldn't be! Here's a philosophical argument to prove it.</p> <ol style="list-style-type: none"> 1. Every mammal has a mammal for a mother. 2. If there have been any mammals at all, there have been only a finite number of mammals. 3. But if there has been even one mammal, then by (1), there have been an infinity of mammals, which contradicts (2), so there can't have been any mammals. It's a contradiction in terms. <p>The Prime Mammal must be whichever mammal in the set of mammals was the first to have all the essential mammalian features. If there is no definable essence of mammal—and evolutionary biology shows us that there are no such essences—these philosophers are in trouble. So, as a general rule, consider ignoring the philosophers' demand for an essence, a defining feature, a "truth-maker." It typically—not always—starts a wild goose chase that may be diverting but is only moderately illuminating at best.</p> <p>The insistence that there must be a Prime Mammal, even if we can never know when and where it existed, is an example of hysterical realism. It invites us to reflect that if we just knew enough, we'd see—we'd have to see—that there is a special property of mammal-hood that defines mammals once and for all. To deny this, philosophers sometimes say, is to confuse metaphysics with epistemology: the study of what there (really) is with the study of what we can know about what there is.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
When Does Speciation Occur?	<p>A curious feature of evolution by natural selection is that it depends crucially on events that "almost never" happen. For instance, speciation, the process in which a new species is generated by wandering away from its parent species, is an exceedingly rare event, but each of the millions of species that have existed on this planet got its start with an event of speciation. Every birth in every lineage is a potential speciation event, but speciation almost never happens, not once in a million births. Mutation in DNA almost never happens—not once in a trillion copyings—but evolution depends on it. Moreover, the vast majority of mutations are either deleterious or neutral; a fortuitously "good" mutation almost never happens. But evolution depends on those almost rarest of rare events.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Widowmakers, Mitochondrial Eve, and Retrospective Coronations	<p>A woman in New York City may suddenly acquire the property of being a widow by virtue of the effects that a bullet has just had on some man's brain in Dodge City, over a thousand miles away. (In the days of the Wild West, there was a revolver nicknamed the Widowmaker. Whether a particular revolver lived up to its nickname on a particular occasion might not be settled by even the most exhaustive examination of the scene of the crime.) The example gets its curious capacity to leap through space and time from the conventional nature of the relationship of marriage, in which a past historical event, a wedding, is deemed to create a permanent relation—a formal relation, not a causal relation—of interest in spite of subsequent wanderings and concrete misfortunes (the accidental loss of a ring, or the destruction of the marriage certificate, for instance).</p> <p>Mitochondrial Eve is the woman who is the most recent direct ancestor, in the female line, of every human being alive today. We all have mitochondria in our cells, and they are passed to us through the maternal line alone, so all the mitochondria in all the cells in all the people alive today are direct descendants of the mitochondria in the cells of a particular woman, named Mitochondrial Eve by Rebecca Cann, Mark Stoneking, and Allan Wilson (1987).</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Cycles	<p>Everybody knows about the familiar large-scale cycles of nature: day follows night follows day; summer-fall-winter-spring-summer-fall-winter-spring; the water cycle of evaporation and precipitation that recycles our rivers, scours our rivers, and restores the water supply of every living thing on the planet. But not everybody appreciates how cycles—at every spatial and temporal scale from the atomic to the astronomical—are quite literally the hidden spinning motors that power all the wonderful phenomena of nature.</p> <p>A good rule of thumb, then, when confronting the apparent magic of the world of life and mind is to look for the cycles that are doing all the hard work.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>

	Mental Model Description	Description Source
What Does the Frog's Eye Tell the Frog's Brain?	<p>It showed that the frog's visual system is sensitive to small moving dark spots on the retina, tiny shadows cast in almost all natural circumstances by flies flying in the vicinity. This "fly-detector" mechanism is appropriately wired to the hair trigger in the frog's tongue, which handily explains how frogs feed themselves in a cruel world and thereby help propagate their kind. Now what does the frog's eye tell the frog's brain?</p> <p>Unless there were "meaningless" or "indeterminate" variation in the triggering conditions of the various frogs' eyes, there could be no raw material (blind variation) for selection for a new purpose to act upon. The indeterminacy that Fodor (and others) see as a flaw in Darwinian accounts of the evolution of meaning is actually a precondition for any such evolution. The idea that there must be something determinate that the frog's eye really means—some possibly unknowable proposition in froggish that expresses exactly what the frog's eye is telling the frog's brain—is just essentialism applied to meaning (or function). Meaning, like function, on which it so directly depends, is not something determinate at its birth. It arises not by saltation—huge leaps in Design Space—or special creation, but by a (typically gradual) shift of circumstances.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
Leaping through Space in the Library of Babel	<p>In 1988, Otto Neugebauer, the great historian of astronomy, was sent a photograph of a fragment of Greek papyrus that had a few numbers written in a column on it. The sender, a classicist, had no clue about the meaning of this bit of papyrus and wondered if Neugebauer had any ideas. The eighty-nine-year-old scholar recomputed the line-to-line differences of the numbers, found their maximum and minimum limits, and determined that this papyrus had to be a translation of part of "Column G" of a Babylonian cuneiform tablet on which was written a Babylonian "System B" lunar ephemeris! (An ephemeris is a tabular system for computing the location of a heavenly body for every time in a particular period.) How could Neugebauer make this Sherlock Holmesian deduction? Elementary: he recognized that what was written in Greek (a sequence of sexagesimal—not decimal—numbers) was part—column G!—of a highly accurate calculation of the moon's location that had been worked out by the Babylonians. There are lots of different ways of calculating an ephemeris, and Neugebauer knew that anyone working out their own ephemeris independently, using their own system, would not have come up with exactly the same numbers, though they might have been close. The Babylonian system B was excellent, so the design had been gratefully conserved, in translation, with all its finegrained particularities (Neugebauer, 1989).</p>	Philosopher Daniel Dennett's Book Intuition Pumps
Who Is the Author of Spamlet?	<p>Suppose Dr. Frankenstein designs and constructs a monster, Spakesheare, which thereupon sits up and writes out a play, Spamlet. Who is the author of Spamlet?</p> <p>To a Darwinian, this new element in the cascade of cranes is simply the latest in a long history, and we should recognize that the boundary between authors and their artifacts should be just as penetrable as all the other boundaries in the cascade. When Richard Dawkins (1982) notes that the beaver's dam is as much a part of the beaver phenotype—its extended phenotype—as its teeth and its fur, he sets the stage for the further observation that the boundaries of a human author are exactly as amenable to extension. In fact, we have known this for centuries and have carpentered various semi-stable conventions for designating the products of Rubens, of Rubens's studio, of Rubens's various students. Wherever there can be a helping hand, we can raise the question of just who is helping whom, what is creator and what is creation.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
Noise in the Virtual Hotel	<p>In his book <i>Le Ton Beau de Marot</i>, Doug Hofstadter (1997) draws attention to the role of what he calls spontaneous intrusions into a creative process. In the real world, almost everything that happens leaves a wake, makes shadows, has an aroma, makes noise, and this provides a bounty of opportunities for spontaneous intrusions. It is also precisely what is in short supply in a virtual world. Indeed one of the chief beauties of virtual worlds, from the point of view of computer modelers, is that quietness: nothing happens except what you provide for, one way or another. This permits you to start with a clean slate and add features to your model one at a time, seeing what the minimal model is that will produce the sought-for effects. This absence of noise makes computer simulations of evolution extremely limited, since evolution by natural selection feeds on noise, turning fortuitously encountered noise into signal, junk into tools, bugs into features.</p> <p>Why? What is all this noise for? It's not for anything; it's just there so that every other process has that noise as a potential source of signal, as something that it might turn, by the alchemy of the creative algorithm, into function, into art, into meaning. Every increment of design in the universe begins with a moment of serendipity, the undesigned intersection of two trajectories yielding something that turns out, retrospectively, to be more than a mere collision. But to the extent that computer modelers follow this advice, they squander the efficiency that makes computers such great tools. So there is a sort of homeostasis here. We can see that, not for any mysterious reason, computer modeling of creativity confronts diminishing returns. In order to get closer and closer to the creativity of a human composer, the model has to become ever-more concrete; it has to model more and more of the incidental collisions that impinge on an embodied composer.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
Herb, Alice, and Hal, the Baby	<p>If there were alternate structures that preserved the information, evolution would continue unimpeded. This claim can be further examined in yet another intuition pump. Imagine that on another planet, "odd-numbered" generations used the DNA rungs A, C, G, and T, and "even-numbered" generations used a different double helix, call it XNA, with rungs made of P, Q, R, and S (some other molecules). We can suppose that the offspring's XNA molecules were made from DNA templates from their parents by a mechanism rather like messenger RNA, but "translating" between the two different biochemical languages.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
Memes	<p>As Dawkins (1976) pointed out, when he introduced the concept of the meme as a cultural item that gets itself copied, the fundamental principle of biology is that all life evolves by the differential survival of replicating entities. . . .</p> <p>Two main insights that flow from this thinking tool dramatically alter the landscape of our imaginations when we think about human culture and creativity. First, memes shatter the otherwise seductive idea that there are only two routes to good Design: it's either genes or genius. For most thinkers, until memes open their eyes, if something in human life exhibits the telltale signs of adaptation of means to ends or functional efficiency, it must be either a product of genetic natural selection or a product of deliberate, comprehending, intending human thinking—intelligent design.</p> <p>The second insight is that the price we pay for having this extra information highway, this bounteous medium of design and transmission that no other species enjoys, is that memes have their own fitness, just like all the other symbionts that thrive in our company, and their fitness is to some degree independent of our own fitness. Blindness to this idea is endemic, and is particularly evident when people discuss evolutionary accounts of religion.</p> <p>Memes are informational symbionts, and like the mutualist symbionts by the trillions that also inhabit us, we couldn't live without them, but that doesn't mean they are all our friends. Some are harmful plagues we could well do without.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
Two Counter-images	<p>Our minds don't have a single magnificent summit, consciousness. Contrary to a tradition going back at least to Descartes in the seventeenth century, conscious phenomena are neither the most "central" nor the "highest" phenomena in our minds (Jackendoff, 1987; Dennett, 1991a). A seductive bad image needs a counter-image to neutralize it, so here is a simple imagination-adjuster to start us off: recall Cole Porter's wonderful song "You're the Top" and reflect that maybe you're not the top—not the summit of the mountain, but the whole mountain, and what you know and can tell about the mountain that is you is not the view from the summit, but various views from halfway up. You might like to think of the phenomena of consciousness as rather like the fringe of hair around a bald man's pate. Bear that in mind. Consciousness is more like fame than television: fame in the brain, cerebral celebrity, a way in which some contents come to be more influential and memorable than the competition.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
The Zombic Hunch	<p>Philosophers' zombies, in contrast, can be delightful company, the life of the party, as loving and joyous and spontaneous as anybody you know. Some of your best friends might be zombies. Philosophers' zombies are (by definition) behaviorally indistinguishable from normal conscious human beings, but "there's nobody home"—they entirely lack any inner life, any conscious experience. They just appear from the outside to be conscious. If you agree with these philosophers that this is a serious issue, if you wonder—given the logical possibility of philosophers' zombies—how there could ever be a scientific, materialistic theory of consciousness, then you are gripped by the Zombic Hunch.</p> <p>I am pretty sure that a philosophers' zombie is conceptually incoherent, impossible, a bankrupt idea. But don't take my word for it. What could you do to convince yourself that you can conceive of a philosophers' zombie? Suppose you try to imagine that your friend Zeke "turns out to be" a zombie. What would convince you or even tempt you to conclude that this is so? What difference would make all the difference? Remember, nothing Zeke could do should convince you that Zeke is, or isn't, a zombie. I find that many people don't do this exercise correctly; that is, they inconveniently forget or set aside part of the definition of a philosophers' zombie when they attempt their feat of conception. It may help you see if you are making this mistake if we distinguish a special subspecies of zombies that I call zimboes (Dennett, 1991a). All zombies have nonconscious (of course) control systems that extract information from the world (via their zombie eyeballs and ears) and exploit that information to avoid walking into walls and to turn when you call, and so on. They are all intentional systems, in other words. But a zimbo is special, a zombie that is also blessed with equipment that permits it to monitor its own activities, both internal and external, so it has internal (nonconscious) higher-order informational states that are about its other internal states. Further self-monitoring allows a zimbo to have and use information about those very self-monitoring states, and so on, indefinitely. A zimbo, in other words, is equipped with recursive self-representation—unconscious recursive selfrepresentation, if that makes any sense.</p> <p>I can imagine that there might be two (or seven, or ninety-nine) different sorts of so-called consciousness, and lefties have one, and righties have another, and lobsters have yet another. But the only way I can imagine this (so far) is by imagining that they are distinguishable by the following functional differences: lefties can't do X, and righties can't do Y, and so on. But those distinguishable differences just go to show that we're not talking about philosophical zombies after all, (or (by definition) there are no distinguishable-from-the-outside differences between philosophical zombies and "genuinely conscious" people. The whole idea of a philosophical zombie is a sort of intellectual hallucination, an affliction one can outgrow.</p>	Philosopher Daniel Dennett's Book Intuition Pumps
The Curse of the Cauliflower	<p>"Qualia" is a "technical" term for something that could not be more familiar to each of us: the ways things seem to us.</p> <p>The very same food often tastes different to me at different times. For instance, my first sip of breakfast orange juice tastes much sweeter than my second sip if I interpose a bit of pancakes and maple syrup, but after a swallow or two of coffee, the orange juice goes back to tasting (roughly?) exactly? the way it did during the first sip. Surely (ding!) we want to say (or think about) such things, and surely (ding!) we are not wildly wrong when we do, so . . . surely (ding!) it is quite okay to talk of the way the juice tastes to Dennett at time t, and ask whether it is just the same as or different from the way the juice tastes to Dennett at time t', or the way the juice tastes to Jones at time t. Call these ways things can seem to us qualia.</p> <p>This "conclusion" seems innocent, but right here we have already made the big mistake. The final step presumes that we can isolate the "qualia" from everything else that is going on—at least in principle or for the sake of argument.</p> <p>The examples that seduce us are abundant in every modality. I cannot imagine, will never know, could never know, it seems, how Bach sounded to Glenn Gould. (I can barely recover in my memory the way Bach sounded to me when I was a child.) And I cannot know, it seems, what it is like to be a bat (Nagel, 1974), or whether you see what I see, color-wise, when we look up at a clear "blue" sky. These everyday cases convince us of the reality of these special properties—those subjective tastes, looks, aromas, sounds—that we then apparently isolate for definition by this act of philosophical distillation. Thus are qualia born.</p>	Philosopher Daniel Dennett's Book Intuition Pumps

	Mental Model Description	Description Source
	<p>No amount of clever engineering could endow a robot with qualia—but this is an empty victory, since there is no reason to believe such intrinsic properties exist. To see this, compare the qualia of experience to the value of money. Some naïve Americans seem to think that dollars, unlike euros and yen, have intrinsic value. The tourist in the cartoon asks, “How much is that in real money?” meaning how much is that in dollars. Every dollar, they declare, has something logically independent of the functional exchange powers it shares with all other currencies in circulation. A dollar has a certain je ne sais qui. When you contemplate it, you can detect that it has an aura of value—less than in the olden days, perhaps, but still discernible: let’s call it the dollar’s vim (from the Latin, vis, meaning power). Officially, then, vim is the non-relational, non-dispositional, intrinsic economic value of a dollar. Pounds sterling and euros and the like have no intrinsic value—they are just symbolic stand-ins; they are redeemable for dollars, and hence have derived economic value, but they don’t have vim!</p> <p>Vim is quite obviously a figment of the imagination, an artifact of the heartfelt hunches of those naïve Americans, and we can explain the artifact without honoring it.</p> <p>Vitalism—the insistence that there is some big, mysterious extra ingredient in all living things, dubbed élan vital—turns out to have been a failure of imagination.</p> <p>How do they distinguish their conviction from the mistake of the naïve Americans? (Or are the Americans right? Dollars do have vim, as anybody can just intuit!)</p>	
Vim: How Much Is That in “Real Money”?	<p>In short, although Clapgras does not complain about any problems of color vision, and indeed passes all standard color-naming and color-discriminating tests with, well, flying colors, he has undergone a profound inversion of all his emotional and attentional reactions to colors. What has happened to Clapgras, Dr. Chromaphil tells his amazed and skeptical colleagues, is simple: he’s undergone a total color qualia inversion, while leaving intact his merely high-level cognitive color talents—his ability to discriminate and name colors, for instance, the talents a color-sensitive robot could have.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Sad Case of Mr. Clapgras	<p>Here is the main weakness in the philosophical methods standardly used in these cases: philosophers tend to assume that all the competences and dispositions that normal people exhibit regarding, say, colors, form a monolithic block, invulnerable to decomposition or dissociation into independent subcompetences and sub-dispositions. This handily excuses them from addressing the question of whether qualia are to be anchored to some subset or specific disposition.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Tuned Deck	<p>“The Tuned Deck” is the trick: “This deck of cards is magically tuned [Hull holds the deck to his ear and riffles the cards, listening carefully to the buzz of the cards]. By their finely tuned vibrations, I can hear and feel the location of any card. Pick a card, any card. . . . [The deck is then fanned or otherwise offered for the audience, and a card is taken by a spectator, noted, and returned to the deck by one route or another.] Now I listen to the Tuned Deck, and what does it tell me? I hear the telltale vibrations, . . . [buzz, buzz, the cards are riffled by Hull’s ear and various manipulations and rituals are enacted, after which, with a flourish, the spectator’s card is presented].</p> <p>Like much great magic, the trick is over before you even realize it has begun. The trick, in its entirety, is in the name, “The Tuned Deck,” and more specifically, in one word—“The!” As soon as Hull had announced his new trick and given its name to his eager audience, the trick was over. Having set up his audience in this simple way, and having passed the time with some obviously phony and misdirecting chatter about vibrations and buzz-buzz-buzz, Hull would do a relatively simple and familiar card presentation trick of type A (at this point I will draw the traditional curtain of secrecy; the further mechanical details of legerdemain, as you will see, do not matter)</p> <p>Hull’s trick was introducing a single common word: “he!”—for heaven’s sake! This modest monosyllable seduced his audience of experts, paralyzing their minds, preventing them from jootsing. They found themselves stuck in a system in which they were sure that they had to find a big, new trick, so they couldn’t see that their problem(s) had not one solution but many; they failed to jump out of the system.</p> <p>What does the story about the Tuned Deck add to all the other intuition pumps about qualia? Just a real-life example of how very clever, knowledgeable experts can be induced to create a phantom problem simply by the way an issue is presented to them. It has happened. It can happen again. And this yields a novel perspective on the impasse, creating a new burden of proof: How do you know that you have found something like the Tuned Deck? I’m not suggesting that this is conclusive, but just that it ought to give those who credit the Zombic Hunch some second thoughts about how “obvious” it is.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Chinese Room	<p>In 1980, John Searle he published “Minds, Brains and Programs,” his famous Chinese Room thought experiment purporting to show that “Strong AI” was impossible. He defined Strong AI as the claim that “the appropriately programmed computer literally has cognitive states and that the programs thereby explain human cognition” (Searle, 1980, p. 417), and later clarified his definition: “the appropriately programmed digital computer with the right inputs and outputs would thereby have a mind in exactly the sense that human beings have minds”</p> <p>He invites us to imagine himself alone in a room following a computer program for responding to Chinese characters slipped under the door. Searle understands nothing of Chinese, and yet, by following the program for manipulating symbols and numerals just as a computer does, he produces appropriate strings of Chinese characters that fool those outside into thinking there is a Chinese speaker in the room. The narrow conclusion of the argument is that programming a digital computer may make it appear to understand language but does not produce real understanding. Hence the “Turing Test” is inadequate. Searle argues that the thought experiment underscores the fact that computers merely use syntactic rules to manipulate symbol strings, but have no understanding of meaning or semantics. The broader conclusion of the argument is that the theory that human minds are computer-like computational or information processing systems is refuted.</p> <p>The central processing unit in your laptop doesn’t know anything about chess, but when it is running a chess program, it can beat you at chess, and so forth, for all the magnificent competences of your laptop. What Searle describes as an ideology is at the very heart of computer science, and its soundness is demonstrated in every walk of life.</p> <p>We’ve turned the knob on Searle’s intuition pump that controls the level of description of the program being followed. There are always many levels. At the highest level, the comprehending powers of the system are not unimaginable; we even get insight into just how the system comes to understand what it does. The system’s reply no longer looks embarrassing; it looks obviously correct. That doesn’t mean that AI of the sort Searle was criticizing actually achieves a level of competence worth calling understanding, nor that those methods, extended in the ways then imagined by those AI researchers, would likely have led to such high competences, but just that Searle’s thought experiment doesn’t succeed in what it claims to accomplish: demonstrating the flatout impossibility of Strong AI.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Teleclone Fall from Mars to Earth	<p>The woman on Mars, millions of miles from home, protected from the killing, frostless cold of the red Martian desert by fragile membranes of terrestrial technology—protected but stranded, for your spaceship has broken down beyond repair. The only hope she found was the Teleclone. With nothing to lose, you set the transmitter up, flip the right switches, and step into the chamber. Five, four, three, two, one, FLASH! You open the door in front of you and step out of the Teleclone receiver chamber into the sunny, familiar atmosphere of Earth. She arrived to Earth and met her families. Later it hits her: “Am I, really, the same person who kissed this little girl good-bye three years ago? Am I this eight-year-old child’s mother or am I actually a brand new human being, only several hours old, in spite of my memories—or apparent memories—of days and years before that? Did this child’s mother recently die on Mars, dismantled and destroyed in the chamber of a Teleclone Mark IV?”</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
The Self as the Center of Narrative Gravity	<p>A song or a poem or a movie can undoubtedly be teleported. Is a self the sort of thing—a thing “made of information”—that can be teleported without loss? Is our reluctance to admit the teleportation of people a bit like the anachronistic resistance, recently overcome in most quarters, to electronically scanned legal signatures on documents?</p> <p>What is a self? I propose that it is the same kind of thing as a center of gravity, an abstraction that is, in spite of its abstractness, tightly coupled to the physical world. You, like every other material object, have a center of gravity (or more properly a center of mass, but we’ll ignore that nicely here). If you are top-heavy, your center of gravity is higher than average for people of your height, you have to work harder to stay upright, and so forth. There are many ways of locating your center of gravity, which, depending on such factors as the shoes you have on and when you last ate a meal, moves around in a smallish area in the middle of your body. It is a mathematical point, not an atom or molecule. The center of gravity of a length of steel pipe is not made of steel and indeed is not made of anything. It is a point in space, the point on the midline running through the center of the pipe that is equidistant from the ends (roughly, depending on imperfections, etc.). The concept of a center of gravity is a very useful thinking tool in its own right. In effect it averages over all the gravitational attractions between every particle of matter in a thing and every particle of matter on the planet, and tells us that we can boil all that down to two points—the center of the earth (its center of gravity) and the center of gravity of the thing—and calculate the behavior of the thing under varying conditions. For instance, if a thing’s center of gravity at any time falls outside all the points of its supporting base, it will topple.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Heterophenomenology	<p>What you are is that rolling sum of experience and talent, solemn intention and daydreaming fantasy, bound together in one brain and body and called by a given name. The idea that there is, in addition, a special indissoluble nugget of you, or ego, or spirit, or soul, is an attractive fantasy, but nothing that we need in order to make sense of people, their dreams and hopes, their heroism and their sins.</p> <p>Heterophenomenology is not an intuition pump, but another example of staging that is well worth putting in place before we tackle some difficult questions. Heterophenomenology is the study of first-person phenomena from the third-person point of view of objective science. The core of heterophenomenology: it exploits our capacity to perform and interpret speech acts, yielding a catalogue of what the subject believes to be true about his or her conscious experience. This catalogue of beliefs fleshes out the subject’s heterophenomenological world, the world according to S, the subjective world of one subject. The total set of details of heterophenomenology, plus all the data we can gather about concurrent events in the brains of subjects and in the surrounding environment, comprise the total data set a theory of human consciousness must explain. It leaves out no objective phenomena and no subjective phenomena of consciousness.</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Mary the Color Scientist: A Boom Crutch Unveiled	<p>Australian philosopher Frank Jackson’s thought experiment about Mary the color scientist, often called “the Knowledge Argument,” has been pumping philosophers’ intuitions with remarkable vigor since it first appeared in 1982. Mary is a brilliant scientist who is, for whatever reason, forced to investigate the world from a black and white room via a black and white television monitor. She specializes in the neurophysiology of vision and acquires, let us suppose, all the physical information there is to obtain about what goes on when we see ripe tomatoes, or the sky, and use terms like “red”, “blue”, and so on. She discovers, for example, just which wavelength combinations from the sky stimulate the retina, and exactly how this produces via the central nervous system the contraction of the vocal chords and expulsion of air from the lungs that results in the uttering of the sentence “The sky is blue”. What will happen when Mary is released from her black and white room or is given a color television monitor? Will she learn anything or not? It seems just obvious that she will learn something about the world and our visual experience of it. But then it is inescapable that her previous knowledge was incomplete. But she had all the physical information. Ergo there is more to have than that, and Physicalism [i.e., materialism, the denial of dualism] is false. [Jackson, 1982, p. 130]</p>	<p>Philosopher Daniel Dennett's Book Intuition Pumps</p>
Be a hyperrealist.	<p>Jackson’s intuition pump excellently exposes to the light a lot of naïve thinking about the nature of color experience and the brain that no doubt serves people well most of the time, so we might grant that he nicely draws out some of the implications of folk theory. But his aim was to refute a hypothesis about the capacity of the physical sciences to account for all color phenomena. Of course in any real-world situation, somebody in Mary’s imagined position would learn something new because however much she knew about color, there would be lots of facts about physical effects of color she didn’t know.</p> <p>Dreams + Reality + Determination = A Successful Life.</p>	<p>Ray Dalio's Book Principles</p>

	Mental Model Description	Description Source
Embrace Reality	Truth—or, more precisely, an accurate understanding of reality—is the essential foundation for any good outcome.	Ray Dalio's Book Principles
	Be radically open-minded and radically transparent.	<ol style="list-style-type: none"> 1. Radical open-mindedness and radical transparency are invaluable for rapid learning and effective change. 2. Don't let fears of what others think of you stand in your way. 3. Embracing radical truth and radical transparency will bring more meaningful work and more meaningful relationships. Ray Dalio's Book Principles
	Look to nature to learn how reality works.	<ol style="list-style-type: none"> 1. Don't get hung up on your views of how things "should" be because you will miss out on learning how they really are. 2. To be "good," something must operate consistently with the laws of reality and contribute to the evolution of the whole; that is what is most rewarded. 3. Evolution is the single greatest force in the universe; it is the only thing that is permanent and it drives everything. 4. Evolve or die. Ray Dalio's Book Principles
	Evolving is life's greatest accomplishment and its greatest reward.	<ol style="list-style-type: none"> 1. The individual's incentives must be aligned with the group's goals. 2. Reality is optimizing for the whole—not for you. 3. Adaptation through rapid trial and error is invaluable. 4. Realize that you are simultaneously everything and nothing—and decide what you want to be. 5. What you will be will depend on the perspective you have. Ray Dalio's Book Principles
	Understand nature's practical lessons.	<ol style="list-style-type: none"> 1. Maximize your evolution. 2. Remember "no pain, no gain." 3. It is a fundamental law of nature that in order to gain strength one has to push one's limits, which is painful. Ray Dalio's Book Principles
	Pain + Reflection = Progress.	<ol style="list-style-type: none"> 1. Go to the pain rather than avoid it. 2. Embrace tough love. Ray Dalio's Book Principles
	Weigh second- and third-order consequences.	Ray Dalio's Book Principles
	Own your outcomes.	Ray Dalio's Book Principles
Use the 5-Step Process to Get What You Want Out of Life	Have clear goals.	<ol style="list-style-type: none"> 1. Think of yourself as a machine operating within a machine and know that you have the ability to alter your machines to produce better outcomes. 2. By comparing your outcomes with your goals, you can determine how to modify your machine. 3. Distinguish between you as the designer of your machine and you as a worker with your machine. 4. The biggest mistake most people make is to not see themselves and others objectively, which leads them to bump into their own and others' weaknesses again and again. 5. Successful people are those who can go above themselves to see things objectively and manage those things to shape change. 6. Asking others who are strong in areas where you are weak to help you is a great skill that you should develop no matter what, as it will help you develop guardrails that will prevent you from doing what you shouldn't be doing. 7. Because it is difficult to see oneself objectively, you need to rely on the input of others and the whole body of evidence. 8. If you are open-minded enough and determined, you can get virtually anything you want. Ray Dalio's Book Principles
	Identify and don't tolerate problems.	<ol style="list-style-type: none"> 1. Prioritize: While you can have virtually anything you want, you can't have everything you want. 2. Don't confuse goals with desires. 3. Decide what you really want in life by reconciling your goals and your desires. 4. Don't mistake the trappings of success for success itself. 5. Never rule out a goal because you think it's unattainable. 6. Remember that great expectations create great capabilities. 7. Almost nothing can stop you from succeeding if you have a) flexibility and b) self-accountability. 8. Knowing how to deal well with your setbacks is as important as knowing how to move forward. Ray Dalio's Book Principles
	Diagnose problems to get at their root causes.	<ol style="list-style-type: none"> 1. View painful problems as potential improvements that are screaming at you. 2. Don't avoid confronting problems because they are rooted in harsh realities that are unpleasant to look at. 3. Be specific in identifying your problems. 4. Don't mistake a cause of a problem with the real problem. 5. Distinguish big problems from small ones. 6. Once you identify a problem, don't tolerate it. <p>"1. Focus on the "what is" before deciding "what to do about it." 2. Distinguish proximate causes from root causes. 3. Recognize that knowing what someone (including you) is like will tell you what you can expect from them." - Ray Dalio</p> <p>"A proximate cause is an event which is closest to, or immediately responsible for causing, some observed result. This exists in contrast to a higher-level ultimate cause (or distal cause) which is usually thought of as the "real" reason something occurred." (related: 5 whys — "to determine the root cause of a defect or problem by repeating the question 'Why?') - Gabriel Weinberg</p>
	Design a plan.	<ol style="list-style-type: none"> 1. Go back before you go forward. 2. Think about your problem as a set of outcomes produced by a machine. 3. Remember that there are typically many paths to achieving your goals. 4. Think of your plan as being like a movie script in that you visualize who will do what through time. 5. Write down your plan for everyone to see and to measure your progress against. 6. Recognize that it doesn't take a lot of time to design a good plan. Ray Dalio's Book Principles
	Push through to completion.	<ol style="list-style-type: none"> 1. Great planners who don't execute their plans go nowhere. 2. Good work habits are vastly underrated. 3. Establish clear metrics to make certain that you are following your plan. Ray Dalio's Book Principles
	Remember that weaknesses don't matter if you find solutions.	<ol style="list-style-type: none"> 1. Look at the patterns of your mistakes and identify at which step in the 5-Step Process you typically fail. 2. Everyone has at least one big thing that stands in the way of their success; find yours and deal with it. Ray Dalio's Book Principles
	Understand your own and others' mental maps and humility.	Ray Dalio's Book Principles
	Radically Open-Minded	Recognize your two barriers.
Practice radical open-mindedness.		<ol style="list-style-type: none"> 1. Sincerely believe that you might not know the best possible path and recognize that your ability to deal well with "not knowing" is more important than whatever it is you do know. 2. Recognize that decision making is a two-step process: First take in all the relevant information, then decide. 3. Don't worry about looking good; worry about achieving your goal. 4. Realize that you can't put out without taking in. 5. Recognize that to gain the perspective that comes from seeing things through another's eyes, you must suspend judgment for a time—only by empathizing can you properly evaluate another point of view. 6. Remember that you're looking for the best answer, not simply the best answer that you can come up with yourself. 7. Be clear on whether you are arguing or seeking to understand, and think about which is most appropriate based on your and others' believability. Ray Dalio's Book Principles
Appreciate the art of thoughtful disagreement.		Ray Dalio's Book Principles
Triangulate your view with believable people who are willing to disagree.		Plan for the worst-case scenario to make it as good as possible. Ray Dalio's Book Principles
Recognize the signs of closed-mindedness and open-mindedness that you should watch out for.	Ray Dalio's Book Principles	

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Be	Understand how you can become radically open-minded.	<ol style="list-style-type: none"> 1. Regularly use pain as your guide toward quality reflection. 2. Make being open-minded a habit. 3. Get to know your blind spots. 4. If a number of different believable people say you are doing something wrong and you are the only one who doesn't see it that way, assume that you are probably biased. 5. Meditate. 6. Be evidence-based and encourage others to be the same. 7. Do everything in your power to help others also be open-minded. h. Use evidence-based decision-making tools. i. Know when it's best to stop fighting and have faith in your decision-making process. 	Ray Dalio's Book Principles
Understand That People Are Wired Very Differently	Understand the power that comes from knowing how you and others are wired.	We are born with attributes that can both help us and hurt us, depending on their application.	Ray Dalio's Book Principles
	Meaningful work and meaningful relationships aren't just nice things we chose for ourselves—they are genetically programmed into us.		Ray Dalio's Book Principles
	Understand the great brain battles and how to control them to get what "you" want.	<ol style="list-style-type: none"> 1. Realize that the conscious mind is in a battle with the subconscious mind. 2. Know that the most constant struggle is between feeling and thinking. 3. Reconcile your feelings and your thinking. 4. Choose your habits well. 5. Train your "lower-level you" with kindness and persistence to build the right habits. 6. Understand the differences between right-brained and left-brained thinking. 7. Understand how much the brain can and cannot change. 	Ray Dalio's Book Principles
	Find out what you and others are like.	<ol style="list-style-type: none"> 1. Introversion vs. extroversion. 2. Intuiting vs. sensing. 3. Thinking vs. feeling. 4. Planning vs. perceiving. 5. Creators vs. refiners vs. advancers vs. executors vs. flexors. 6. Focusing on tasks vs. focusing on goals. 7. Workplace Personality Inventory. 8. Shapers are people who can go from visualization to actualization. 	Ray Dalio's Book Principles
Learn How to Make Decisions Effectively	Getting the right people in the right roles in support of your goal is the key to succeeding at whatever you choose to accomplish.	Manage yourself and orchestrate others to get what you want.	Ray Dalio's Book Principles
	Recognize that	<ol style="list-style-type: none"> 1) the biggest threat to good decision making is harmful emotions, and 2) decision making is a two-step process (first learning and then deciding). 	Ray Dalio's Book Principles
	Synthesize the situation at hand.	<ol style="list-style-type: none"> 1. One of the most important decisions you can make is who you ask questions of. 2. Don't believe everything you hear. 3. Everything looks bigger up close. 4. New is overvalued relative to great. 5. Don't oversqueeze dots. 	Ray Dalio's Book Principles
	Synthesize the situation through time.	<ol style="list-style-type: none"> 1. Keep in mind both the rates of change and the levels of things, and the relationships between them. 2. Be imprecise. 3. Remember the 80/20 Rule and know what the key 20 percent is. 4. Be an imperfectionist. 	Ray Dalio's Book Principles
	Navigate levels effectively.	<ol style="list-style-type: none"> 1. Use the terms "above the line" and "below the line" to establish which level a conversation is on. 2. Remember that decisions need to be made at the appropriate level, but they should also be consistent across levels. 	Ray Dalio's Book Principles
	Logic, reason, and common sense are your best tools for synthesizing reality and understanding what to do about it.		Ray Dalio's Book Principles
	Make your decisions as expected value calculations.	<ol style="list-style-type: none"> 1. Raising the probability of being right is valuable no matter what your probability of being right already is. 2. Knowing when not to bet is as important as knowing what bets are probably worth making. 3. The best choices are the ones that have more pros than cons, not those that don't have any cons at all. 	Ray Dalio's Book Principles
	Prioritize by weighing the value of additional information against the cost of not deciding.	<ol style="list-style-type: none"> 1. All of your "must-dos" must be above the bar before you do your "like-to-dos." 2. Chances are you won't have time to deal with the unimportant things, which is better than not having time to deal with the important things. 3. Don't mistake possibilities for probabilities. 	Ray Dalio's Book Principles
	Simplify!		Ray Dalio's Book Principles
	Use principles.		Ray Dalio's Book Principles
Radical Truth and Radical Transparency	Believability weight your decision making.		Ray Dalio's Book Principles
	Convert your principles into algorithms and have the computer make decisions alongside you.		Ray Dalio's Book Principles
	Be cautious about trusting AI without having deep understanding.		Ray Dalio's Book Principles
	Realize that you have nothing to fear from knowing the truth.		Ray Dalio's Book Principles
	Have integrity and demand it from others.	<ol style="list-style-type: none"> 1. Never say anything about someone that you wouldn't say to them directly and don't try people without accusing them to their faces. 2. Don't let loyalty to people stand in the way of truth and the well-being of the organization. 	Ray Dalio's Book Principles
	Create an environment in which everyone has the right to understand what makes sense and no one has the right to hold a critical opinion without speaking up.	<ol style="list-style-type: none"> 1. Speak up, own it, or get out. 2. Be extremely open. 3. Don't be naive about dishonesty. 	Ray Dalio's Book Principles
Be radically transparent.	<ol style="list-style-type: none"> 1. Use transparency to help enforce justice. 2. Share the things that are hardest to share. 3. Keep exceptions to radical transparency very rare. 4. Make sure those who are given radical transparency recognize their responsibilities to handle it well and to weigh things intelligently. 5. Provide transparency to people who handle it well and either deny it to people who don't handle it well or remove those people from the organization. 6. Don't share sensitive information with the organization's enemies. 	Ray Dalio's Book Principles	

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Trust in I	Meaningful relationships and meaningful work are mutually reinforcing, especially when supported by radical truth and radical transparency.		Ray Dalio's Book Principles
	Be loyal to the common mission and not to anyone who is not operating consistently with it.		Ray Dalio's Book Principles
Cultivate Meaningful Work and Meaningful Relationships	Be crystal clear on what the deal is.	<ol style="list-style-type: none"> 1. Make sure people give more consideration to others than they demand for themselves. 2. Make sure that people understand the difference between fairness and generosity. 3. Know where the line is and be on the far side of fair. 4. Pay for work. 	Ray Dalio's Book Principles
	Recognize that the size of the organization can pose a threat to meaningful relationships.		Ray Dalio's Book Principles
	Remember that most people will pretend to operate in your interest while operating in their own.		Ray Dalio's Book Principles
	Treasure honorable people who are capable and will treat you well even when you're not looking.		Ray Dalio's Book Principles
	Recognize that mistakes are a natural part of the evolutionary process.	<ol style="list-style-type: none"> 1. Fail well. 2. Don't feel bad about your mistakes or those of others. Love them! 	Ray Dalio's Book Principles
Create a Culture in Which It is Okay to Make Mistakes and Unacceptable Not to Learn from Them	Don't worry about looking good—worry about achieving your goals.	Get over "blame" and "credit" and get on with "accurate" and "inaccurate."	Ray Dalio's Book Principles
	Observe the patterns of mistakes to see if they are products of weaknesses.		Ray Dalio's Book Principles
	Remember to reflect when you experience pain.	<ol style="list-style-type: none"> 1. Be self-reflective and make sure your people are self-reflective. 2. Know that nobody can see themselves objectively. 3. Teach and reinforce the merits of mistake-based learning. 	Ray Dalio's Book Principles
	Know what types of mistakes are acceptable and what types are unacceptable, and don't allow the people who work for you to make the unacceptable ones.		Ray Dalio's Book Principles
	Recognize that conflicts are essential for great relationships because they are how people determine whether their principles are aligned and resolve their differences.	<ol style="list-style-type: none"> 1. Spend lavishly on the time and energy you devote to getting in sync, because it's the best investment you can make. 	Ray Dalio's Book Principles
	Know how to get in sync and disagree well.	<ol style="list-style-type: none"> 1. Surface areas of possible out-of-syncness. 2. Distinguish between idle complaints and complaints meant to lead to improvement. 3. Remember that every story has another side. 	Ray Dalio's Book Principles
	Be open-minded and assertive at the same time.	<ol style="list-style-type: none"> 1. Distinguish open-minded people from closed-minded people. 2. Don't have anything to do with closed-minded people. 3. Watch out for people who think it's embarrassing not to know. 4. Make sure that those in charge are open-minded about the questions and comments of others. 5. Recognize that getting in sync is a two-way responsibility. 6. Worry more about substance than style. 7. Be reasonable and expect others to be reasonable. 8. Making suggestions and questioning are not the same as criticizing, so don't treat them as if they are. 	Ray Dalio's Book Principles
Get and Stay in Sync	If it is your meeting to run, manage the conversation.	<ol style="list-style-type: none"> 1. Make it clear who is directing the meeting and whom it is meant to serve. 2. Be precise in what you're talking about to avoid confusion. 3. Make clear what type of communication you are going to have in light of the objectives and priorities. 4. Lead the discussion by being assertive and open-minded. 5. Navigate between the different levels of the conversation. 6. Watch out for "topic slip." 7. Enforce the logic of conversations. 8. Be careful not to lose personal responsibility via group decision making. 9. Utilize the "two-minute rule" to avoid persistent interruptions. 10. Watch out for assertive "fast talkers." 11. Achieve completion in conversations. 12. Leverage your communication. 	Ray Dalio's Book Principles
	Great collaboration feels like playing jazz.	1+1=3. b. 3 to 5 is more than 20.	Ray Dalio's Book Principles
	When you have alignment, cherish it.		Ray Dalio's Book Principles
	If you find you can't reconcile major differences—especially in values—consider whether the relationship is worth preserving.		Ray Dalio's Book Principles

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Believability Weight Your Decision Making	<p>Recognize that having an effective idea meritocracy requires that you understand the merit of each person's ideas.</p> <p>Find the most believable people possible who disagree with you and try to understand their reasoning.</p> <p>Think about whether you are playing the role of a teacher, a student, or a peer and whether you should be teaching, asking questions, or debating.</p>	<p>1. If you can't successfully do something, don't think you can tell others how it should be done. 2. Remember that everyone has opinions and they are often bad.</p> <p>Ray Dalio's Book Principles</p>
	<p>Understand how people came by their opinions.</p>	<p>1. Think about people's believability in order to assess the likelihood that their opinions are good. 2. Remember that believable opinions are most likely to come from people 1) who have successfully accomplished the thing in question at least three times, and 2) who have great explanations of the cause-effect relationships that lead them to their conclusions. 3. If someone hasn't done something but has a theory that seems logical and can be stress-tested, then by all means test it. 4. Don't pay as much attention to people's conclusions as to the reasoning that led them to their conclusions. 5. Inexperienced people can have great ideas too, sometimes far better ones than more experienced people. 6. Everyone should be up-front in expressing how confident they are in their thoughts.</p> <p>Ray Dalio's Book Principles</p>
	<p>Disagreeing must be done efficiently.</p>	<p>1. It's more important that the student understand the teacher than that the teacher understand the student, though both are important. 2. Recognize that while everyone has the right and responsibility to try to make sense of important things, they must do so with humility and radical open-mindedness.</p> <p>Ray Dalio's Book Principles</p>
	<p>Recognize that everyone has the right and responsibility to try to make sense of important things.</p> <p>Pay more attention to whether the decision-making system is fair than whether you get your way.</p>	<p>1. If you ask someone a question, they will probably give you an answer, so think through to whom you should address your questions. 2. Having everyone randomly probe everyone else is an unproductive waste of time. 3. Beware of statements that begin with "I think that . . ." 4. Assess believability by systematically capturing people's track records over time.</p> <p>Ray Dalio's Book Principles</p>
	<p>Remember: Principles can't be ignored by mutual agreement.</p> <p>Make sure people don't confuse the right to complain, give advice, and openly debate with the right to make decisions.</p> <p>Don't leave important conflicts unresolved.</p> <p>Once a decision is made, everyone should get behind it even though individuals may still disagree.</p>	<p>1. Know when to stop debating and move on to agreeing about what should be done. 2. Use believability weighting as a tool rather than a substitute for decision making by Responsible Parties. 3. Since you don't have the time to thoroughly examine everyone's thinking yourself, choose your believable people wisely. 4. When you're responsible for a decision, compare the believability-weighted decision making of the crowd to what you believe.</p> <p>Ray Dalio's Book Principles</p>
	<p>Remember that if the idea meritocracy comes into conflict with the well-being of the organization, it will inevitably suffer.</p> <p>Recognize that if the people who have the power don't want to operate by principles, the principled way of operating will fail.</p>	<p>1. Communications aimed at getting the best answer should involve the most relevant people. 2. Communication aimed at educating or boosting cohesion should involve a broader set of people than would be needed if the aim were just getting the best answer. 3. Recognize that you don't need to make judgments about everything.</p> <p>Ray Dalio's Book Principles</p>
Remember That the WHO Is More Important than the WHAT	<p>Remember: Principles can't be ignored by mutual agreement.</p> <p>Make sure people don't confuse the right to complain, give advice, and openly debate with the right to make decisions.</p> <p>Don't leave important conflicts unresolved.</p> <p>Once a decision is made, everyone should get behind it even though individuals may still disagree.</p>	<p>The same standards of behavior apply to everyone.</p> <p>Ray Dalio's Book Principles</p>
	<p>Remember that if the idea meritocracy comes into conflict with the well-being of the organization, it will inevitably suffer.</p> <p>Recognize that if the people who have the power don't want to operate by principles, the principled way of operating will fail.</p>	<p>When challenging a decision and/or a decision maker, consider the broader context.</p> <p>Ray Dalio's Book Principles</p>
	<p>Recognize that the most important decision for you to make is who you choose as your Responsible Parties.</p> <p>Know that the ultimate Responsible Party will be the person who bears the consequences of what is done.</p> <p>Remember the force behind the thing.</p>	<p>1. Don't let the little things divide you when your agreement on the big things should bind you. 2. Don't get stuck in disagreement—escalate or vote!</p> <p>Ray Dalio's Book Principles</p>
	<p>Match the person to the design.</p> <p>Remember that people are built very differently and that different ways of seeing and thinking make people suitable for different jobs.</p>	<p>1. See things from the higher level. 2. Never allow the idea meritocracy to slip into anarchy. 3. Don't allow lynch mobs or mob rule.</p> <p>Ray Dalio's Book Principles</p>
	<p>Match the person to the design.</p> <p>Remember that people are built very differently and that different ways of seeing and thinking make people suitable for different jobs.</p>	<p>1. Declare "martial law" only in rare or extreme circumstances when the principles need to be suspended. 2. Be wary of people who argue for the suspension of the idea meritocracy for the "good of the organization."</p> <p>Ray Dalio's Book Principles</p>
ong Are Huge	<p>Match the person to the design.</p> <p>Remember that people are built very differently and that different ways of seeing and thinking make people suitable for different jobs.</p>	<p>Understand that the most important RPs are those responsible for the goals, outcomes, and machines at the highest levels.</p> <p>Ray Dalio's Book Principles</p>
	<p>Match the person to the design.</p> <p>Remember that people are built very differently and that different ways of seeing and thinking make people suitable for different jobs.</p>	<p>1. Think through which values, abilities, and skills you are looking for (in that order). 2. Make finding the right people systematic and scientific. 3. Hear the click: Find the right fit between the role and the person. 4. Look for people who sparkle, not just "any of" one of those. 5. Don't use your pull to get someone a job.</p> <p>1. Understand how to use and interpret personality assessments. 2. Remember that people tend to pick people like themselves, so choose interviewers who can identify what you are looking for. 3. Look for people who are willing to look at themselves objectively. 4. Remember that people typically don't change all that much.</p> <p>Ray Dalio's Book Principles</p>

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Hire Right, Because the Penalties for Hiring Wrong	Think of your teams the way that sports managers do: No one person possesses everything required to produce success, yet everyone must excel.		Ray Dalio's Book Principles
	Pay attention to people's track records.	<ol style="list-style-type: none"> 1. Check references. 2. Recognize that performance in school doesn't tell you much about whether a person has the values and abilities you are looking for. 3. While it's best to have great conceptual thinkers, understand that great experience and a great track record also count for a lot. 4. Beware of the impractical idealist. 5. Don't assume that a person who has been successful elsewhere will be successful in the job you're giving them. 6. Make sure your people have character and are capable. 	Ray Dalio's Book Principles
	Don't hire people just to fit the first job they will do; hire people you want to share your life with.	<ol style="list-style-type: none"> 1. Look for people who have lots of great questions. 2. Show candidates your warts. 3. Play jazz with people with whom you are compatible but who will also challenge you. 	Ray Dalio's Book Principles
	When considering compensation, provide both stability and opportunity.	<ol style="list-style-type: none"> 1. Pay for the person, not the job. 2. Have performance metrics tied at least loosely to compensation. 3. Pay north of fair. d. Focus more on making the pie bigger than on exactly how to slice it so that you or anyone else gets the biggest piece. 	Ray Dalio's Book Principles
	Remember that in great partnerships, consideration and generosity are more important than money.	Be generous and expect generosity from others.	Ray Dalio's Book Principles
Constantly Train, Test, Evaluate, and Sort People	Understand that you and the people you manage will go through a process of personal evolution.	<ol style="list-style-type: none"> 1. Recognize that personal evolution should be relatively rapid and a natural consequence of discovering one's strengths and weaknesses; as a result, career paths are not planned at the outset. 2. Understand that training guides the process of personal evolution. 3. Teach your people to fish rather than give them fish, even if that means letting them make some mistakes. 4. Recognize that experience creates internalized learning that book learning can't replace. 	Ray Dalio's Book Principles
	Provide constant feedback.		Ray Dalio's Book Principles
	Evaluate accurately, not kindly.	<ol style="list-style-type: none"> 1. In the end, accuracy and kindness are the same thing. 2. Put your compliments and criticisms in perspective. 3. Think about accuracy, not implications. 4. Make accurate assessments. 5. Learn from success as well as from failure. 6. Know that most everyone thinks that what they did, and what they are doing, is much more important than it really is. 	Ray Dalio's Book Principles
	Recognize that tough love is both the hardest and the most important type of love to give (because it is so rarely welcomed).	Recognize that while most people prefer compliments, accurate criticism is more valuable.	Ray Dalio's Book Principles
	Don't hide your observations about people.	<ol style="list-style-type: none"> 1. Build your synthesis from the specifics up. 2. Squeeze the dots. 3. Don't oversqueeze a dot. 4. Use evaluation tools such as performance surveys, metrics, and formal reviews to document all aspects of a person's performance. 	Ray Dalio's Book Principles
	Make the process of learning what someone is like open, evolutionary, and iterative.	<ol style="list-style-type: none"> 1. Make your metrics clear and impartial. 2. Encourage people to be objectively reflective about their performance. 3. Look at the whole picture. 4. For performance reviews, start from specific cases, look for patterns, and get in sync with the person being reviewed by looking at the evidence together. 5. Remember that when it comes to assessing people, the two biggest mistakes you can make are being overconfident in your assessment and failing to get in sync on it. 6. Get in sync on assessments in a nonhierarchical way. 7. Learn about your people and have them learn about you through frank conversations about mistakes and their root causes. 8. Understand that making sure people are doing a good job doesn't require watching everything that everybody is doing at all times. 9. Recognize that change is difficult. 10. Help people through the pain that comes with exploring their weaknesses. 	Ray Dalio's Book Principles
	Knowing how people operate and being able to judge whether that way of operating will lead to good results is more important than knowing what they did.	<ol style="list-style-type: none"> 1. If someone is doing their job poorly, consider whether it is due to inadequate learning or inadequate ability. 2. Training and testing a poor performer to see if he or she can acquire the required skills without simultaneously trying to assess their abilities is a common mistake. 	Ray Dalio's Book Principles
	Recognize that when you are really in sync with someone about their weaknesses, the weaknesses are probably true.	<ol style="list-style-type: none"> 1. When judging people, remember that you don't have to get to the point of "beyond a shadow of a doubt." 2. It should take you no more than a year to learn what a person is like and whether they are a click for their job. 3. Continue assessing people throughout their tenure. 4. Evaluate employees with the same rigor as you evaluate job candidates. 	Ray Dalio's Book Principles
	Train, guardrail, or remove people; don't rehabilitate them.	<ol style="list-style-type: none"> 1. Don't collect people. 2. Be willing to "shoot the people you love." 3. When someone is "without a box," consider whether there is an open box that would be a better fit or whether you need to get them out of the company. 4. Be cautious about allowing people to step back to another role after failing. 	Ray Dalio's Book Principles
	Remember that the goal of a transfer is the best, highest use of the person in a way that benefits the community as a whole.	Have people "complete their swings" before moving on to new roles.	Ray Dalio's Book Principles
Don't lower the bar. TO BUILD AND EVOLVE YOUR MACHINE.		Ray Dalio's Book Principles	
	Look down on your machine and yourself within it from the higher level.	<ol style="list-style-type: none"> 1. Constantly compare your outcomes to your goals. 2. Understand that a great manager is essentially an organizational engineer. 3. Build great metrics. 4. Beware of paying too much attention to what is coming at you and not enough attention to your machine. 5. Don't get distracted by shiny objects. 	Ray Dalio's Book Principles

	Mental Model	Description Source
Manage as Someone Operating a Machine to Achieve a Goal	Remember that for every case you deal with, your approach should have two purposes: 1) to move you closer to your goal, and 2) to train and test your machine (i.e., your people and your design).	1. Everything is a case study. 2. When a problem occurs, conduct the discussion at two levels: 1) the machine level (why that outcome was produced) and 2) the case-at-hand level (what to do about it). 3. When making rules, explain the principles behind them. 4. Your policies should be natural extensions of your principles. 5. While good principles and policies almost always provide good guidance, remember that there are exceptions to every rule. Ray Dalio's Book Principles
	Understand the differences between managing, micromanaging, and not managing.	1. Managers must make sure that what they are responsible for works well. 2. Managing the people who report to you should feel like skiing together. 3. An excellent skier is probably going to be a better ski coach than a novice skier. 4. You should be able to delegate the details. Ray Dalio's Book Principles
	Know what your people are like and what makes them tick, because your people are your most important resource.	1. Regularly take the temperature of each person who is important to you and to the organization. 2. Learn how much confidence to have in your people—don't assume it. 3. Vary your involvement based on your confidence. Ray Dalio's Book Principles
	Clearly assign responsibilities.	1. Remember who has what responsibilities. 2. Watch out for "job slip." Ray Dalio's Book Principles
	Probe deep and hard to learn what you can expect from your machine. Think like an owner, and expect the people you work with to do the same.	1. Get a threshold level of understanding. 2. Avoid staying too distant. 3. Use daily updates as a tool for staying on top of what your people are doing and thinking. 4. Probe so you know whether problems are likely to occur before they actually do. 5. Probe to the level below the people who report to you. 6. Have the people who report to the people who report to you feel free to escalate their problems to you. 7. Don't assume that people's answers are correct. 8. Train your ear. 9. Make your probing transparent rather than private. 10. Welcome probing. 11. Remember that people who see things and think one way often have difficulty communicating with and relating to people who see things and think another way. 12. Pull all suspicious threads. 13. Recognize that there are many ways to skin a cat. Ray Dalio's Book Principles
	Recognize and deal with key-man risk.	1. Going on vacation doesn't mean one can neglect one's responsibilities. 2. Force yourself and the people who work for you to do difficult things. Ray Dalio's Book Principles
	Don't treat everyone the same—treat them appropriately.	1. Don't let yourself get squeezed. 2. Care about the people who work for you. Ray Dalio's Book Principles
	Know that great leadership is generally not what it's made out to be.	1. Be weak and strong at the same time. 2. Don't worry about whether or not your people like you and don't look to them to tell you what you should do. 3. Don't give orders and try to be followed; try to be understood and to understand others by getting in sync. Ray Dalio's Book Principles
	Hold yourself and your people accountable and appreciate them for holding you accountable.	1. If you've agreed with someone that something is supposed to go a certain way, make sure it goes that way—unless you get in sync about doing it differently. 2. Distinguish between a failure in which someone broke their "contract" and a failure in which there was no contract to begin with. 3. Avoid getting sucked down. 4. Watch out for people who confuse goals and tasks, because if they can't make that distinction, you can't trust them with responsibilities. 5. Watch out for the unfocused and unproductive "theoretical should." Ray Dalio's Book Principles
	Communicate the plan clearly and have clear metrics conveying whether you are progressing according to it.	Put things in perspective by going back before going forward. Ray Dalio's Book Principles
and Don't Tolerate Problems	Escalate when you can't adequately handle your responsibilities and make sure that the people who work for you are proactive about doing the same.	 Ray Dalio's Book Principles
	If you're not worried, you need to worry—and if you're worried, you don't need to worry.	 Ray Dalio's Book Principles
	Design and oversee a machine to perceive whether things are good enough or not good enough, or do it yourself.	1. Assign people the job of perceiving problems, give them time to investigate, and make sure they have independent reporting lines so that they can convey problems without any fear of recrimination. 2. Watch out for the "Frog in the Boiling Water Syndrome." 3. Beware of group-think: The fact that no one seems concerned doesn't mean nothing is wrong. 4. To perceive problems, compare how the outcomes are lining up with your goals. 5. "Taste the soup." 6. Have as many eyes looking for problems as possible. 7. "Pop the cork." 8. Realize that the people closest to certain jobs probably know them best. Ray Dalio's Book Principles
	Be very specific about problems; don't start with generalizations.	Avoid the anonymous "we" and "they," because they mask personal responsibility. Ray Dalio's Book Principles
	Don't be afraid to fix the difficult things. Diagnose Problems to Get at Their Root Causes 12.1 To diagnose well, ask the following questions: 1. Is the outcome good or bad? 2. Who is responsible for the outcome? 3. If the outcome is bad, is the Responsible Party incapable and/or is the design bad?	1. Understand that problems with good, planned solutions in place are completely different from those without such solutions. 2. Think of the problems you perceive in a machinelike way. Ray Dalio's Book Principles 1. Ask yourself: "Who should do what differently?" 2. Identify at which step in the 5-Step Process the failure occurred. 3. Identify the principles that were violated. 4. Avoid Monday morning quarterbacking. 5. Don't confuse the quality of someone's circumstances with the quality of their approach to dealing with the circumstances. 6. Identifying the fact that someone else doesn't know what to do doesn't mean that you know what to do. 7. Remember that a root cause is not an action but a reason. 8. To distinguish between a capacity issue and a capability issue, imagine how the person would perform at that particular function if they had ample capacity. 9. Keep in mind that managers usually fail or fall short of their goals for one (or more) of five reasons. Ray Dalio's Book Principles

	Mental Model	Description	Description Source
Perceive :	Maintain an emerging synthesis by diagnosing continuously.		Ray Dalio's Book Principles
	Keep in mind that diagnoses should produce outcomes.	Remember that if you have the same people doing the same things, you should expect the same results.	Ray Dalio's Book Principles
	Use the following "drill-down" technique to gain an 80/20 understanding of a department or sub-department that is having problems.		Ray Dalio's Book Principles
	Understand that diagnosis is foundational to both progress and quality relationships.		Ray Dalio's Book Principles
Design Improvements to Your Machine to Get Around Your Problems	Build your machine.		Ray Dalio's Book Principles
	Systemize your principles and how they will be implemented.	Create great decision-making machines by thinking through the criteria you are using to make decisions while you are making them.	Ray Dalio's Book Principles
	Remember that a good plan should resemble a movie script.	<ol style="list-style-type: none"> Put yourself in the position of pain for a while so that you gain a richer understanding of what you're designing for. Visualize alternative machines and their outcomes, and then choose. Consider second- and third-order consequences, not just first-order ones. Use standing meetings to help your organization run like a Swiss clock. Remember that a good machine takes into account the fact that people are imperfect. 	Ray Dalio's Book Principles
	Recognize that design is an iterative process. Between a bad "now" and a good "then" is a "working through it" period.	<p>Understand the power of the "cleansing storm."</p> <ol style="list-style-type: none"> Build your organization from the top down. Remember that everyone must be overseen by a believable person who has high standards. Make sure the people at the top of each pyramid have the skills and focus to manage their direct reports and a deep understanding of their jobs. In designing your organization, remember that the 5-Step Process is the path to success and that different people are good at different steps. Don't build the organization to fit the people. Keep scale in mind. Organize departments and sub-departments around the most logical groupings based on "gravitational pull." Make departments as self-sufficient as possible so that they have control over the resources they need to achieve their goals. Ensure that the ratios of senior managers to junior managers and of junior managers to their reports are limited to preserve quality communication and mutual understanding. Consider succession and training in your design. Don't just pay attention to your job; pay attention to how your job will be done if you are no longer around. Use "double-do" rather than "double-check" to make sure mission-critical tasks are done correctly. Use consultants wisely and watch out for consultant addiction. 	Ray Dalio's Book Principles
	Build the organization around goals rather than tasks.		Ray Dalio's Book Principles
	Create an organizational chart to look like a pyramid, with straight lines down that don't cross.	<ol style="list-style-type: none"> Involve the person who is the point of the pyramid when encountering cross-departmental or cross-sub-departmental issues. Don't do work for people in another department or grab people from another department to do work for you unless you speak to the person responsible for overseeing the other department. Watch out for "department slip." 	Ray Dalio's Book Principles
	Create guardrails when needed—and remember it's better not to guardrail at all.	<ol style="list-style-type: none"> Don't expect people to recognize and compensate for their own blind spots. Consider the clover-leaf design. 	Ray Dalio's Book Principles
	Keep your strategic vision the same while making appropriate tactical changes as circumstances dictate.	<ol style="list-style-type: none"> Don't put the expedient ahead of the strategic. Think about both the big picture and the granular details, and understand the connections between them. 	Ray Dalio's Book Principles
	Have good controls so that you are not exposed to the dishonesty of others.	<ol style="list-style-type: none"> Investigate and let people know you are going to investigate. Remember that there is no sense in having laws unless you have policemen (auditors). Beware of rubber-stamping. Recognize that people who make purchases on your behalf probably will not spend your money wisely. Use "public hangings" to deter bad behavior. 	Ray Dalio's Book Principles
	Have the clearest possible reporting lines and delineations of responsibilities.	<ol style="list-style-type: none"> Assign responsibilities based on workflow design and people's abilities, not job titles. Constantly think about how to produce leverage. Recognize that it is far better to find a few smart people and give them the best technology than to have a greater number of ordinary people who are less well equipped. Use leveragers. 	Ray Dalio's Book Principles
	Remember that almost everything will take more time and cost more money than you expect.		Ray Dalio's Book Principles
	Do What You Set Out to Do	Work for goals that you and your organization are excited about and think about how your tasks connect to those goals.	<ol style="list-style-type: none"> Be coordinated and consistent in motivating others. Don't act before thinking. Take the time to come up with a game plan. Look for creative, cut-through solutions.
Recognize that everyone has too much to do.		Don't get frustrated.	Ray Dalio's Book Principles
Use checklists.		Don't confuse checklists with personal responsibility.	Ray Dalio's Book Principles
Allow time for rest and renovation.			Ray Dalio's Book Principles
Ring the bell.			Ray Dalio's Book Principles
Use Tools and Protocols to Shape How Work is Done	Having systemized principles embedded in tools is especially valuable for an idea meritocracy.	<ol style="list-style-type: none"> To produce real behavioral change, understand that there must be internalized or habitualized learning. Use tools to collect data and process it into conclusions and actions. Foster an environment of confidence and fairness by having clearly-stated principles that are implemented in tools and protocols so that the conclusions reached can be assessed by tracking the logic and data behind them. 	Ray Dalio's Book Principles

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And for Heaven's Sake, Don't Overlook Governance!		<ol style="list-style-type: none"> 1. Even in an idea meritocracy, merit cannot be the only determining factor in assigning responsibility and authority. 2. Make sure that no one is more powerful than the system or so important that they are irreplaceable. 3. Beware of fiefdoms. 4. Make clear that the organization's structure and rules are designed to ensure that its checks-and-balances system functions well. 5. Make sure reporting lines are clear. 6. Make sure decision rights are clear. 7. Make sure that the people doing the assessing 1) have the time to be fully informed about how the person they are checking on is doing, 2) have the ability to make the assessments, and 3) are not in a conflict of interest that stands in the way of carrying out oversight effectively. 8. Recognize that decision makers must have access to the information necessary to make decisions and must be trustworthy enough to handle that information safely. 	Ray Dalio's Book Principles
		<p>To be successful, all organizations must have checks and balances.</p> <p>Remember that in an idea meritocracy a single CEO is not as good as a great group of leaders.</p>	Ray Dalio's Book Principles
		No governance system of principles, rules, and checks and balances can substitute for a great partnership.	Ray Dalio's Book Principles
Startups	Regret Minimization Framework	"I knew that when I was 80 I was not going to regret having tried this. I was not going to regret trying to participate in this thing called the Internet that I thought was going to be a really big deal. I knew that if I failed I wouldn't regret that, but I knew the one thing I might regret is not ever having tried." — Jeff Bezos (on his decision whether or not to leave his cushy job to start Amazon)	Jeff Bezos via "13 Mental Models Every Founder Should Know"
	The Idea Maze	"A good founder is capable of anticipating which turns lead to treasure and which lead to certain death. A bad founder is just running to the entrance of (say) the "movies/music/fleesharing/P2P" maze or the "photosharing" maze without any sense for the history of the industry, the players in the maze, the casualties of the past, and the technologies that are likely to move walls and change assumptions." —Balaji S. Srinivasan	Balaji S. Srinivasan via "13 Mental Models Every Founder Should Know"
	Schlep Blindness	"A company is defined by the schleps it will undertake. And schleps should be dealt with the same way you'd deal with a cold swimming pool: just jump in." —Paul Graham	Paul Graham via "13 Mental Models Every Founder Should Know"
	Jobs to be Done	If you understand the job, how to improve the product becomes just obvious.—Clayton Christensen	Clayton Christensen via "13 Mental Models Every Founder Should Know"
	Minimum Viable Product	"Minimum viable product is a process for testing assumptions and making sure theres a need for your idea. The MVP process: - What is my riskiest assumption? - What is the smallest experiment I can do to test this assumption?"	Frank Robinson via "13 Mental Models Every Founder Should Know"
	Confirmation Bias	"It is the peculiar and perpetual error of the human understanding to be more moved and excited by affirmatives than by negatives."—Francis Bacon	Thucydides via "13 Mental Models Every Founder Should Know"
	Product Market Fit	"Product market fit is when you're in a good market and the product you're working on satisfies the market. Getting to PMF is crucial because the biggest company killer is a lack of market." "Getting a 100 people to love you is far better than having a million people just sort of like you. 100 customers or users that love you will tell the world about your tiny little company and give you feedback or ideas that help you make the experience much better."	Andy Rachleff via "13 Mental Models Every Founder Should Know"
	100 People Love	"It's better to make a few people really happy than to make a lot of people semi-happy"—Paul Buchheit	Paul Graham via "13 Mental Models Every Founder Should Know"
	AARRR	AARRR or (Acquisition, Activation, Retention, Referral, Revenue) is a framework for customer lifecycle.	Dave McClure via "13 Mental Models Every Founder Should Know"
	Network Effects	"Network effects occur when a product or service becomes more valuable as more people use it. Network effects help you build better, faster-growing and more valuable products and businesses."	Robert Metcalfe via "13 Mental Models Every Founder Should Know"
	Economies Of Scale	"Economies of scale are simple economics where the costs of your product or service decreases as the volume increases. Facebook, Amazon, Apple and Google all have strong economies of scale."	Adam Smith via "13 Mental Models Every Founder Should Know"
	Disruptive Innovation	"Disruptive innovation is when your product or service starts out as a simple solution at the bottom of a market and then relentlessly moves up market, eventually displacing the established competitors and redefining the industry."	Clayton Christensen via "13 Mental Models Every Founder Should Know"
	Conjoined Triangles of Success	Now what do those two triangles make together? A box. They make a box. You can't make that shit up.—Jack Barker	Jack Barker via "13 Mental Models Every Founder Should Know"

- [1] <https://www.coursera.org/learn/model-thinking/lecture/KEboX/peer-effects>
- [2] <https://www.coursera.org/learn/model-thinking/lecture/ldA4x/the-standing-ovation-model>
- [3] <https://www.coursera.org/learn/model-thinking/lecture/l9cO7/spatial-choice-models>
- [4] <https://www.coursera.org/learn/model-thinking/lecture/8g3al/thinking-electrons-modeling-people>
- [5] <https://www.coursera.org/learn/model-thinking/lecture/gfQMW/when-does-behavior-matter>
- [6] <https://www.coursera.org/learn/model-thinking/lecture/6g7bn/linear-models>
- [7] <https://www.coursera.org/learn/model-thinking/lecture/237bX/fitting-lines-to-data>
- [8] <https://www.coursera.org/learn/model-thinking/lecture/Z97RD/from-linear-to-nonlinear>
- [9] <https://www.coursera.org/learn/model-thinking/lecture/hQ354/the-big-coefficient-vs-the-new-reality>
- [10] <https://www.coursera.org/learn/model-thinking/lecture/SV8Bo/contagion-models-1-diffusion>
- [11] <https://www.coursera.org/learn/model-thinking/lecture/SV8Bo/contagion-models-1-diffusion>
- [12] <https://www.coursera.org/learn/model-thinking/lecture/0pujC/classifying-tipping-points>
- [13] <https://www.coursera.org/learn/model-thinking/lecture/IQW8i/measuring-tips>
- [14] <https://www.coursera.org/learn/model-thinking/lecture/xvOP9/introduction-to-growth>
- [15] <https://www.coursera.org/learn/model-thinking/lecture/vhUM0/basic-growth-model>
- [16] <https://www.coursera.org/learn/model-thinking/lecture/YQv9S/solow-growth-model>
- [17] <https://www.coursera.org/learn/model-thinking/lecture/lJEr0/will-china-continue-to-grow>
- [18] <https://www.coursera.org/learn/model-thinking/lecture/aYw9z/why-do-some-countries-not-grow>
- [19] <https://www.coursera.org/learn/model-thinking/lecture/fDpeK/problem-solving-and-innovation>
- [20] <https://www.coursera.org/learn/model-thinking/lecture/NF4hG/perspectives-and-innovation>
- [21] <https://www.coursera.org/learn/model-thinking/lecture/WX7SW/recombination>
- [22] <https://www.coursera.org/learn/model-thinking/lecture/rrVvl/a-simple-markov-model>
- [23] https://s3.amazonaws.com/accreditable_card_attachments/attachments/47382/original/open-uri20140316-15266-kmxz6o
- [24] <https://www.coursera.org/learn/model-thinking/lecture/dqH1Z/markov-convergence-theorem>

- [25] <https://www.coursera.org/learn/model-thinking/lecture/2z40v/exapting-the-markov-model>
- [26] <https://www.coursera.org/learn/model-thinking/lecture/Still/the-organization-of-cities>
- [27] <https://www.coursera.org/learn/model-thinking/lecture/r3WSh/exchange-economies-and-externalities>
- [28] <https://www.coursera.org/learn/model-thinking/lecture/gYxGW/time-to-convergence-and-optimality>
- [29] <https://www.coursera.org/learn/model-thinking/lecture/FVW9R/lyapunov-fun-and-deep>
- [30] <https://www.coursera.org/learn/model-thinking/lecture/VAQaT/lyapunov-or-markov>
- [31] <https://www.coursera.org/learn/model-thinking/lecture/VRyw6/coordination-and-culture>
- [32] <https://www.coursera.org/learn/model-thinking/lecture/OJw0l/what-is-culture-and-why-do-we-care>
- [33] <https://www2.le.ac.uk/departments/npb/people/amc/articles-pdfs/salifocu.pdf>
- [34] <https://www.coursera.org/learn/model-thinking/lecture/SRx2n/emergence-of-culture>
- [35] <https://www.coursera.org/learn/model-thinking/lecture/Wi4db/coordination-and-consistency>
- [36] <http://lexicon.ft.com/Term?term=path-dependence>
- [37] https://www.encyclopediaofmath.org/index.php/Urn_model
- [38] <https://www.coursera.org/learn/model-thinking/lecture/PI0rW/path-dependence-and-chaos>
- [39] <https://www.coursera.org/learn/model-thinking/lecture/GD759/path-dependence-and-increasing-returns>
- [40] <https://www.coursera.org/learn/model-thinking/lecture/SvohB/path-dependent-or-tipping-point>
- [41] <https://www.coursera.org/learn/model-thinking/lecture/OPHaW/networks>
- [42] <https://www.coursera.org/learn/model-thinking/lecture/Er4rf/the-structure-of-networks>
- [43] <https://www.coursera.org/learn/model-thinking/lecture/LBSFT/the-logic-of-network-formation>
- [44] <https://www.coursera.org/learn/model-thinking/lecture/njMva/network-function>
- [45] <https://www.coursera.org/learn/model-thinking/lecture/8XaKV/sources-of-randomness>
- [46] <https://www.coursera.org/learn/model-thinking/lecture/UagHY/skill-and-luck>
- [47] <https://www.coursera.org/learn/model-thinking/lecture/WTw55/random-walks>
- [48] <https://www.coursera.org/learn/model-thinking/lecture/UAg3z/finite-memory-random-walks>
- [49] <https://www.coursera.org/learn/model-thinking/lecture/0fjj4/blotto-no-best-strategy>
- [50] <https://www.coursera.org/learn/model-thinking/lecture/0fjj4/blotto-no-best-strategy>
- [51] <https://www.coursera.org/learn/model-thinking/lecture/WxmBK/blotto-troop-advantages>

- [52] <https://www.coursera.org/learn/model-thinking/lecture/sJtsR/blotto-and-competition>
- [53] <https://www.coursera.org/learn/model-thinking/lecture/Oj51H/seven-ways-to-cooperation>
- [54] <https://www.coursera.org/learn/model-thinking/lecture/N7cwc/no-panacea>
- [55] <https://www.coursera.org/learn/model-thinking/lecture/CVIVC/mechanism-design>
- [56] <https://www.coursera.org/learn/model-thinking/lecture/cpnvu/hidden-action-and-hidden-information>
- [57] <https://www.coursera.org/learn/model-thinking/lecture/XcoOS/auctions>
- [58] <https://www.coursera.org/learn/model-thinking/lecture/91hJB/public-projects>
- [59] <http://www.encyclopedia.com/social-sciences/applied-and-social-sciences-magazines/replicator-dynamics>
- [60] <https://www.coursera.org/learn/model-thinking/lecture/4cDiJ/variation-or-six-sigma>
- [61] <https://www.coursera.org/learn/model-thinking/lecture/SVI8b/prediction>
- [62] <https://www.mathworks.com/discovery/linear-model.html>
- [63] https://rosettacode.org/wiki/Diversity_prediction_theorem
- [64] <https://www.coursera.org/learn/model-thinking/lecture/GvgxR/the-many-model-thinker>
- [65] <https://www.farnamstreetblog.com/2016/08/commitment-consistency-bias/>
- [66] <https://www.safalniveshak.com/latticework-mental-models-hyperbolic-discounting/>
- [67] <https://www.safalniveshak.com/latticework-of-mental-models-surfing/>
- [68] https://rationalpov.gitbooks.io/mental-model/content/discipline_engineering,break_points.html
- [69] https://rationalpov.gitbooks.io/mental-model/content/discipline_engineering,backup_systemredundancy.html