



# **INDTECH2018**

## **Innovative industries for smart growth**

29-31 October, 2018  
Vienna, Austria

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**PILLAR 1**

**Session 1.5**

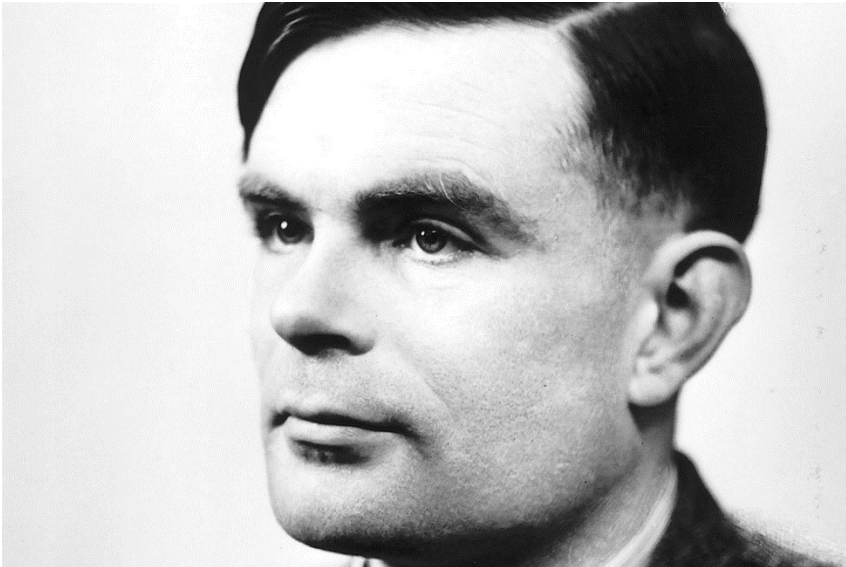
**Products and Production Systems  
of the Future  
will be Cognitive!**

**Alois Ferscha**

**Johannes Kepler University of Linz,  
Austria**

**31 October 2018**

## “Can Machines Think?”



### Computing Machinery and Intelligence

A. M. Turing

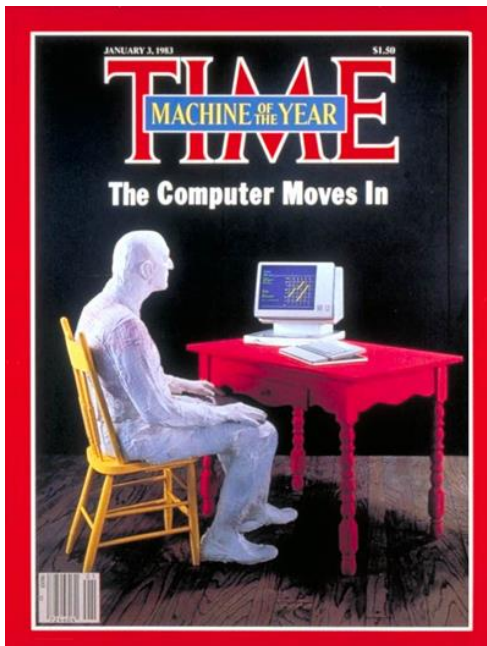
*Computing Machinery and Intelligence.*

Mind, Vol. 59, No. 236 (Oct., 1950), pp. 433-460

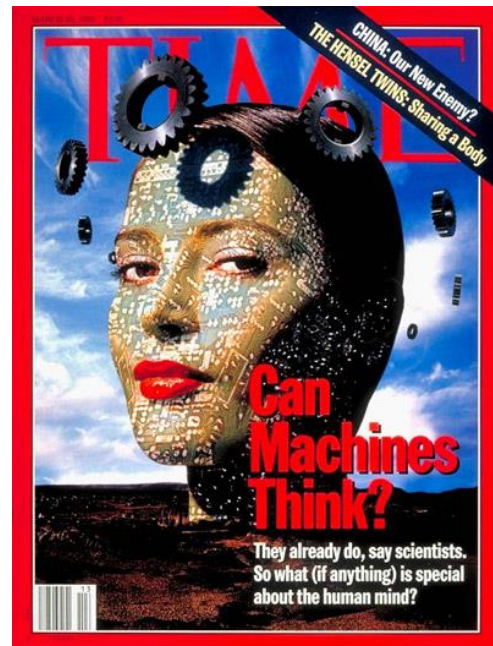
I PROPOSE to consider the question, ‘Can machines think?’ This should begin with definitions of the meaning of the terms ‘machine’ and ‘think’. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words ‘machine’ and ‘think’ are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, ‘Can machines think?’ is to be



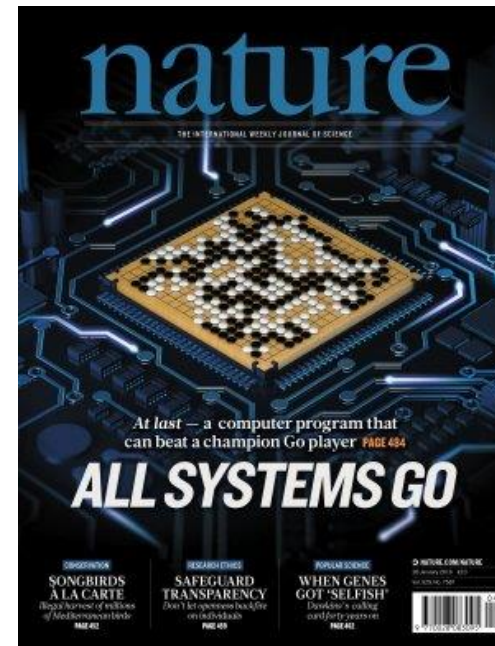
## The Dawn of the Age of “Machine Thinking”



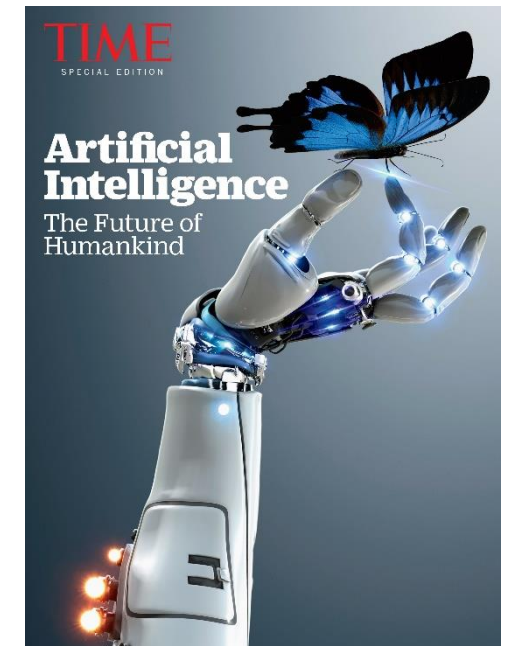
**The Computer, Machine of the Year**  
Jan. 3, 1983



**Can Machines Think?**  
Mar. 25, 1996



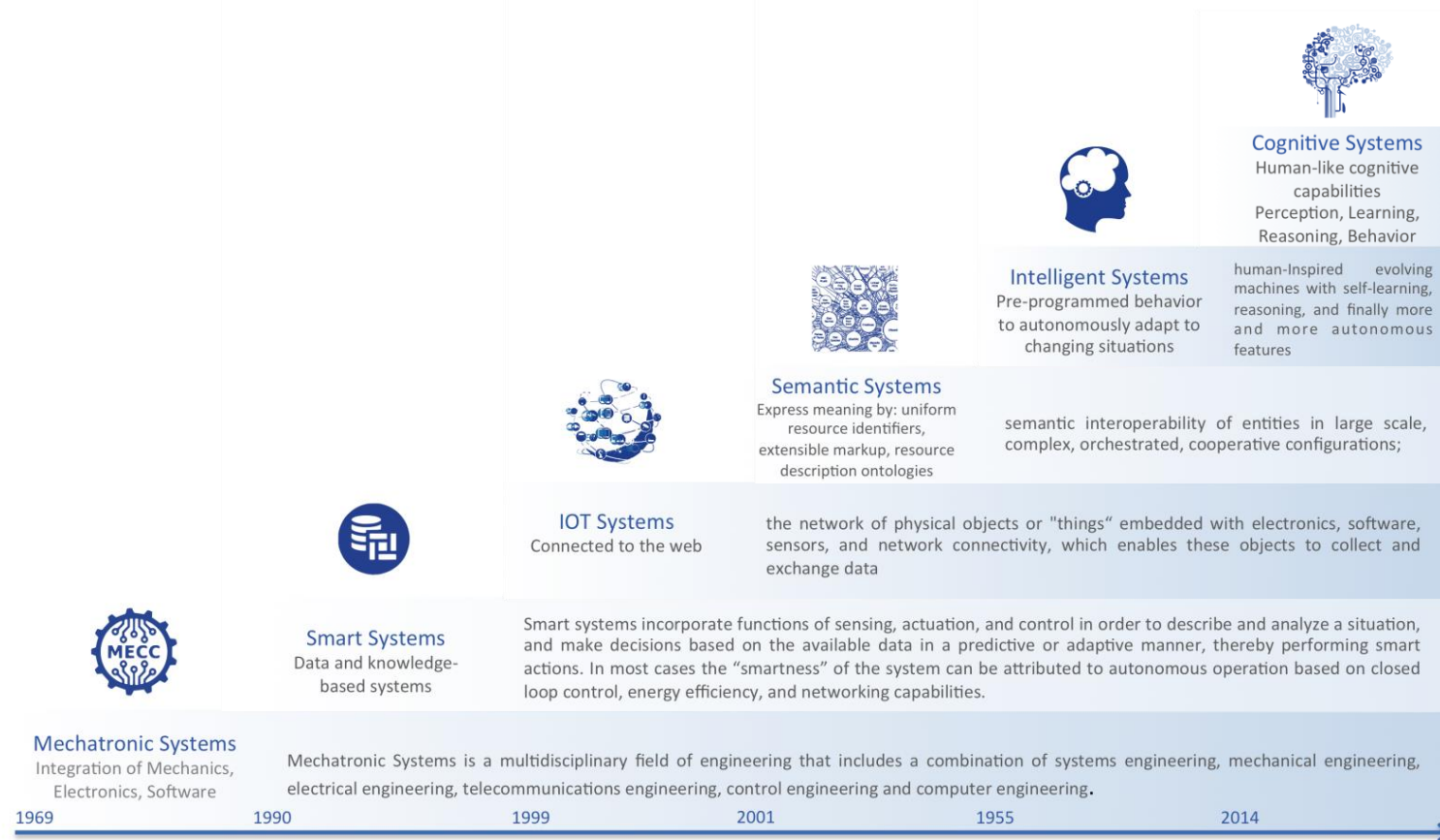
**AlphaGo**  
Jan. 28, 2016



**AI The Future of Humankind**  
Sep. 29, 2017



## Towards Cognitive Industrial Systems



Industrial Systems  
„that think“



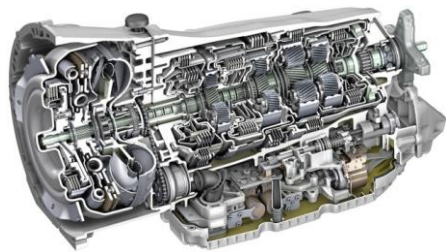




## (Yesterdays) Products of the Future



**NEST Learning Thermostat**  
The New York Times  
October 3, 2012



**9G-TRONIC**  
VDI Getriebetagung Friedrichshafen  
June 17-18, 2013



**ABB YuMi**  
Automatica Munich  
June 3, 2014



**Waymo**  
World's first fully self-driving ride on public roads  
October 20, 2015

## „Thinking“ like Humans

### Causal Models of the World

Capability to Understand and Explain Physical Forces, Causal Relationships

Understand language  
Understand others

Shared intentionality  
Selective attention

### Learning-to-Learn

Incremental/Representation/Concept Learning  
Transferability, Richness and Efficiency  
Rapidly Acquire and Generalize Knowledge from Very Sparse Data

### In-born Understanding of Core Domains

Numbers, Space, Intuitive Physics, Intuitive Psychology, Theory of Mind, Causal Reasoning, Detection of Agency, Infer Mental States, Goals, Beliefs, Reciprocal Relations

### Human Like Reinforcement Learning

Maximize Future Reward







## Products and Production Systems of the Future will be “Cognitive” !





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### Cognitive Abilities

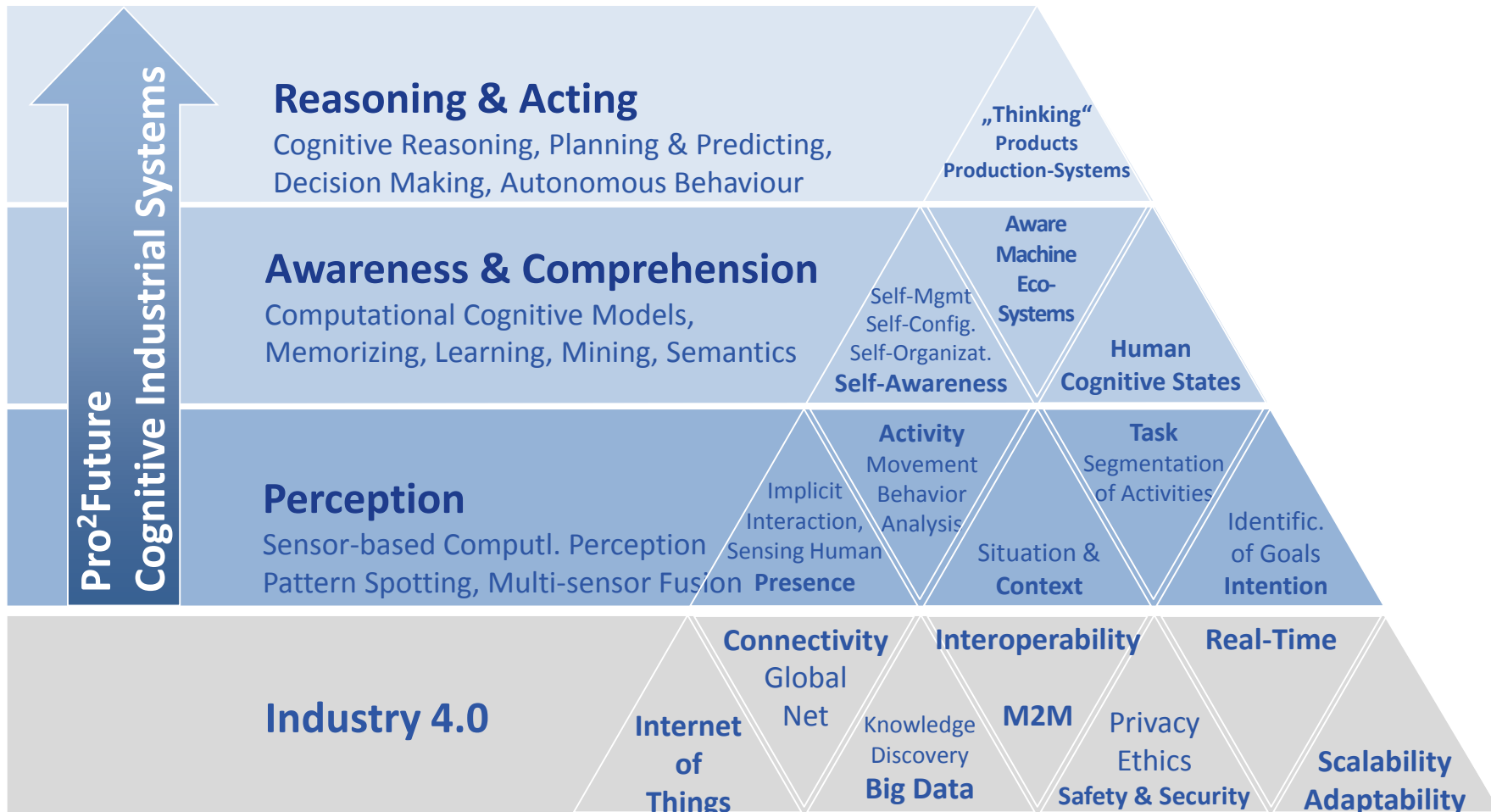
- Perception
- Comprehension
- Reasoning
- Learning
- Planning
- Prediction
- Decision Making
- Autonomous Acting







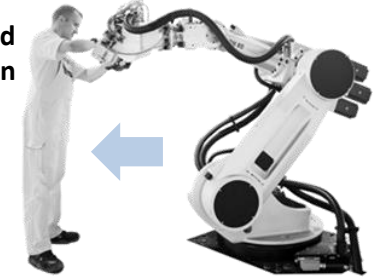
## Pro2Future :: Fostering the “Cognitive” in Industrial Systems



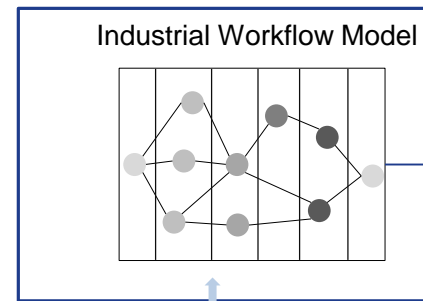
## Cognitive Man-Machine Cooperation - „Human-Aware“ Machines

- Symbiotic Man-Machine Collaboration
- Cognitive Systems - Attention Sensitive Machines
- Industrial Assistance Systems  
(Cognitive-, Motor-, Wearable-, Interaction-, Robotic Assistance)
- Guided Interaction
- Machine Learning  
(Semi-Supervised, Open Ended Learning)

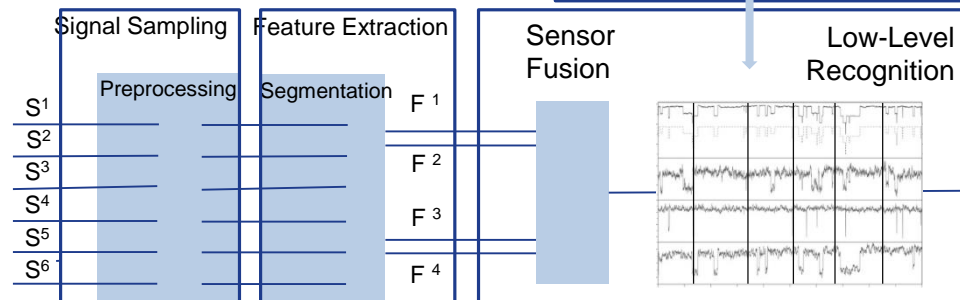
Acting :: Guided  
Man-Machine Collaboration



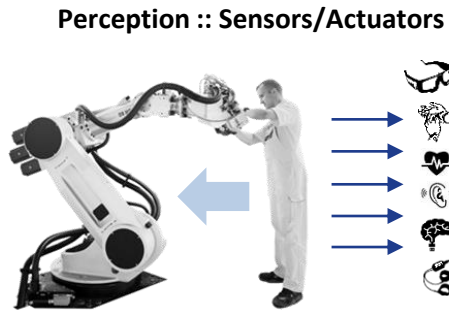
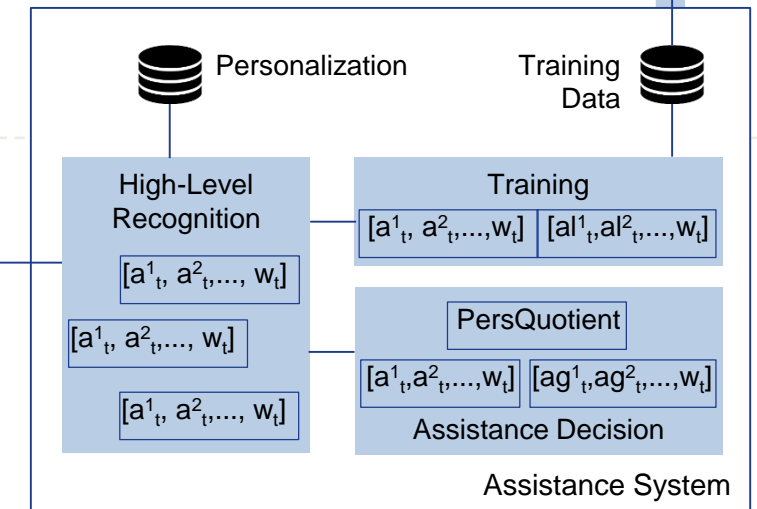
Awareness :: Relating Cognitive  
Load to Workflow



Awareness :: Activity, Cognitive Load  
Recognition



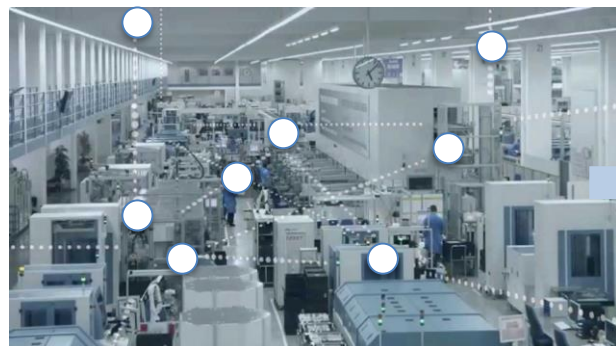
Reasoning :: Guidance Decision



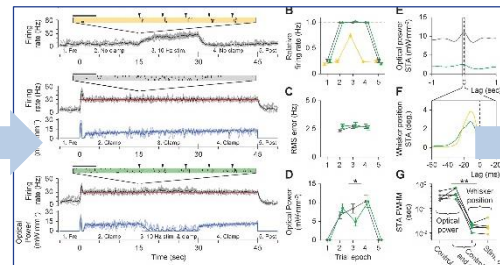


## Cognitive Systems for Smart Production - „Machines that think!“

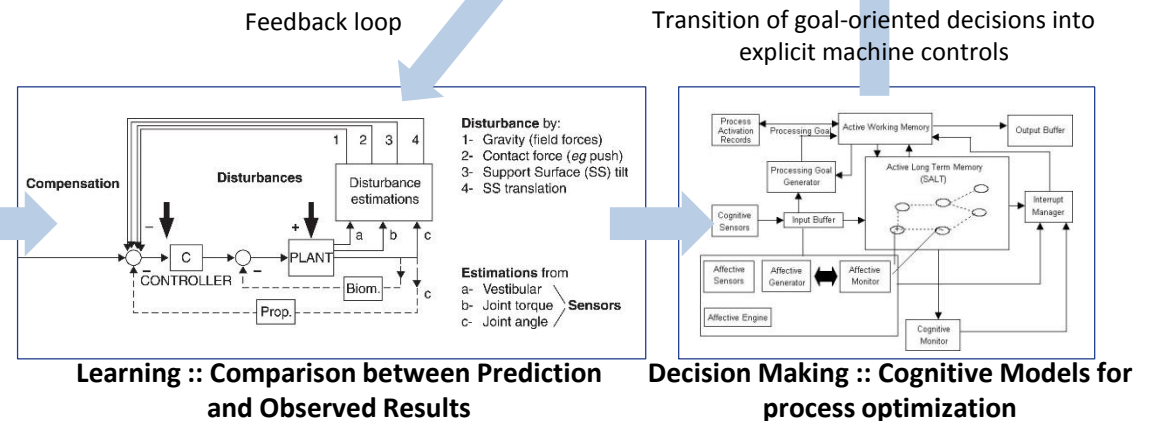
- **Collective Cognitive Awareness via Distributed, Cognitive Agent-Based Systems**
- **Handling the Overwhelming Complexity of Systems**
- **Goal-oriented / Cognitive Decision Making for Optimization** (efficiency, time & resources, product quality, flexibility, etc.)
- **„Learning“ Systems which Evolve with their Gained Experience**



**Collective Awareness :: Eco-System of Productions Systems as Social Agents**

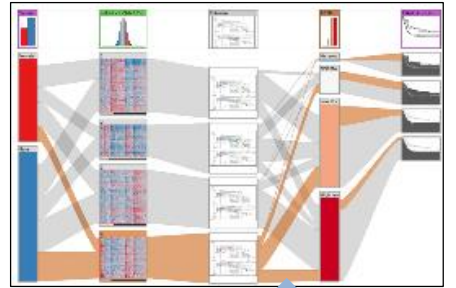


**Prediction :: Modeling under Immense Complexity**



## Cognitive Decision Making - „Informing“ Human Decisions

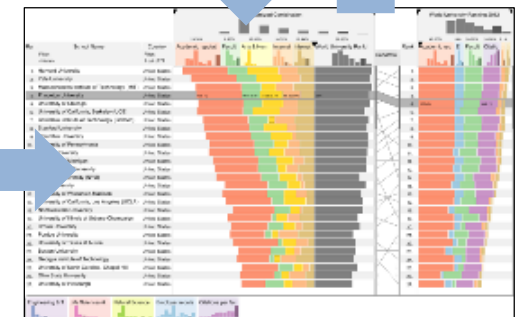
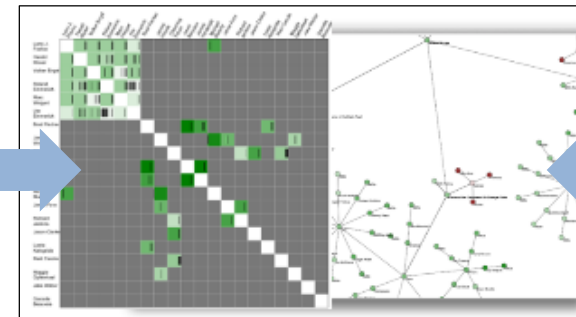
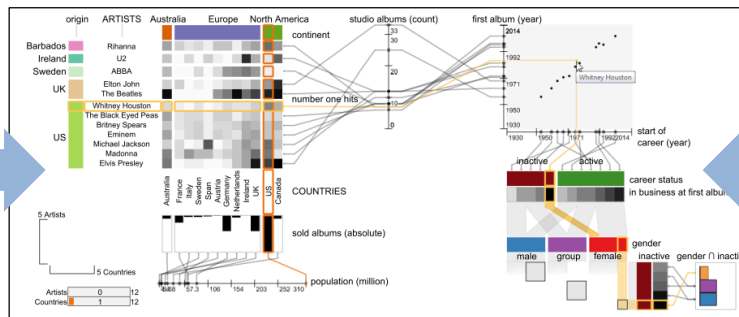
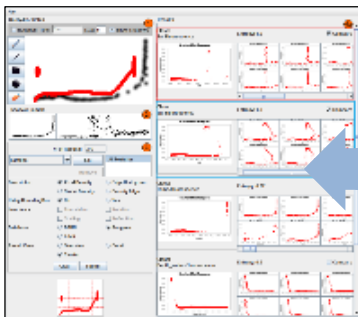
- Combination of **Data-driven Approaches** with **Configuration Management Tools**
- **Timely / Optimal Decisions** based on **Situation/Context** and **Human Cognition**
- **Creation of Data Analytics and Decision Making Methods Bases**
- **Creation of Industrial Decision Support Tools**



Filter & Rate

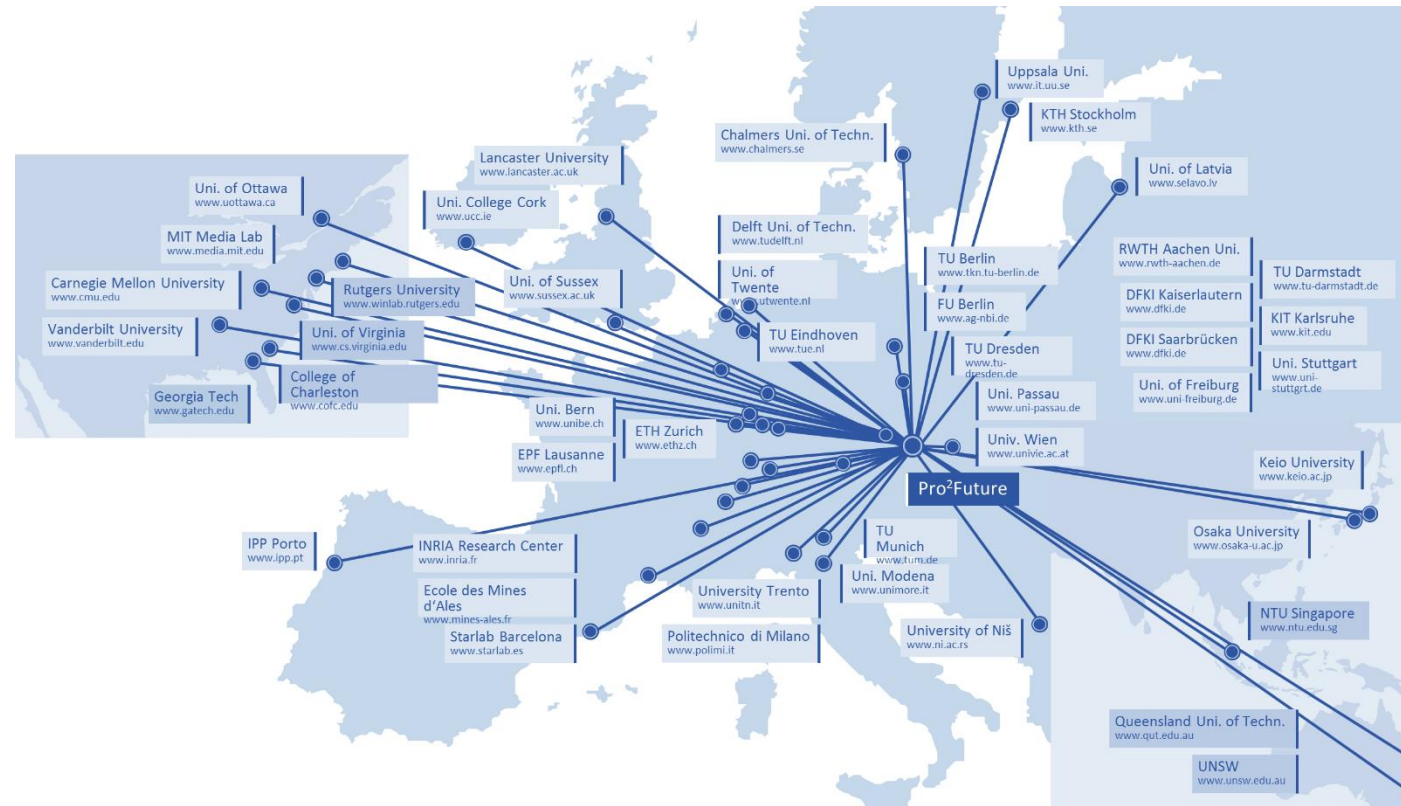
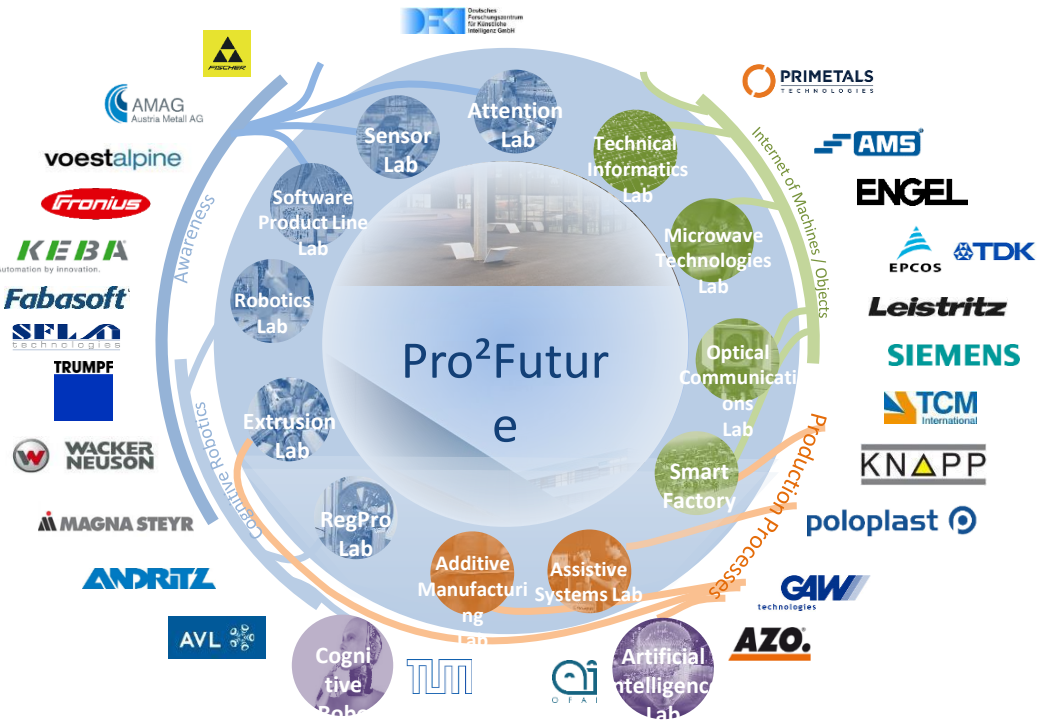
(Visual-) Interactive creation and steering of data models

(Visual-) Interactive Decision Support Systems





# The Pro<sup>2</sup>Future Competence Centre on Cognitive Industrial Systems (Linz – Steyr – Graz)





# The Entanglement of Industrial and Cognitive System Technologies

## Narrow AI (rule-based speech)

Personalisation:  
76,897 Micro-Genres



Rule-Based Decisions

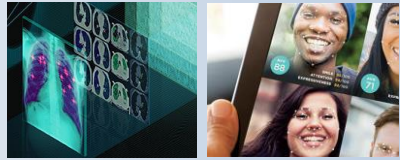


Industrial Robots



## Narrow AI – with Big Data (B-2-C, search, E-commerce)

Deep Learning – Image Processing



Handwriting & Voice Recognition



NLP & Big Data Statistical Learning



## Democratisation & Embodied AI

Data Scientist in a Box



Home & Service Robots



Self-driving Vehicles



## Collaborative AI on new AI Hardware

Man-Machine Collaboration



Neuromorphic Computing



Brain-Computer Interfaces



## Artificial General Intelligence (AGI)

Quantum Computing



Conscious & Emotional Robots



Past

90's



00's

Federal Ministry  
Republic of Austria  
Transport, Innovation  
and Technology

Now

Next 5 years

e 20  
u 18  
- a t



Next 10 years

Future

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 767162.