

**The
Alan Turing
Institute**

Bringing AI into Air Traffic Control

Challenges and Opportunities

Dr Evelina Gabasova





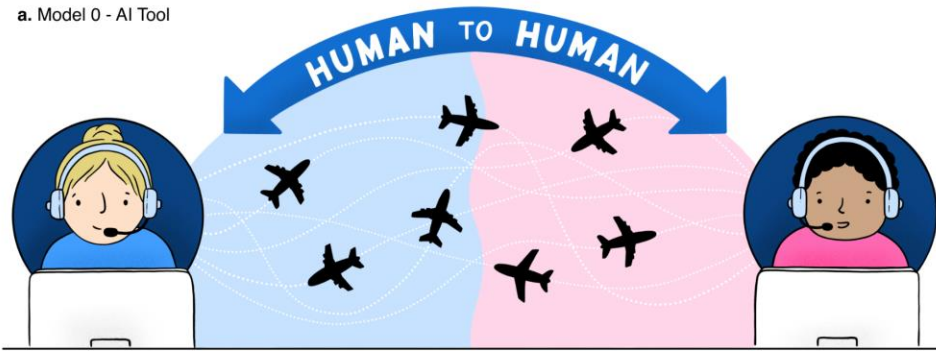
Source: DALL-E, prompt: "artificial intelligence is performing air traffic control, digital art"

NATS

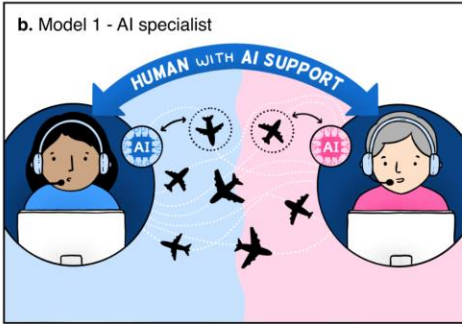


Science Museum,
London

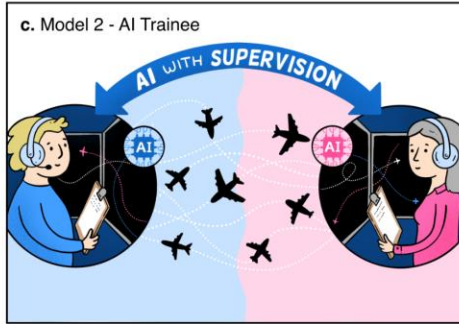
a. Model 0 - AI Tool



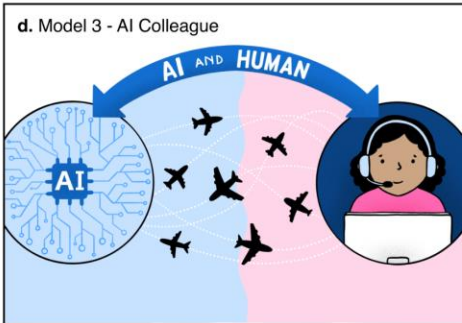
b. Model 1 - AI specialist



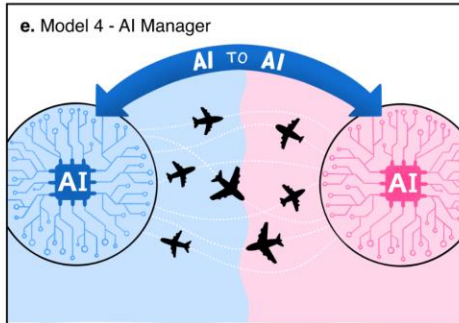
c. Model 2 - AI Trainee



d. Model 3 - AI Colleague



e. Model 4 - AI Manager



Models of interaction

14:32

Catalyst LE



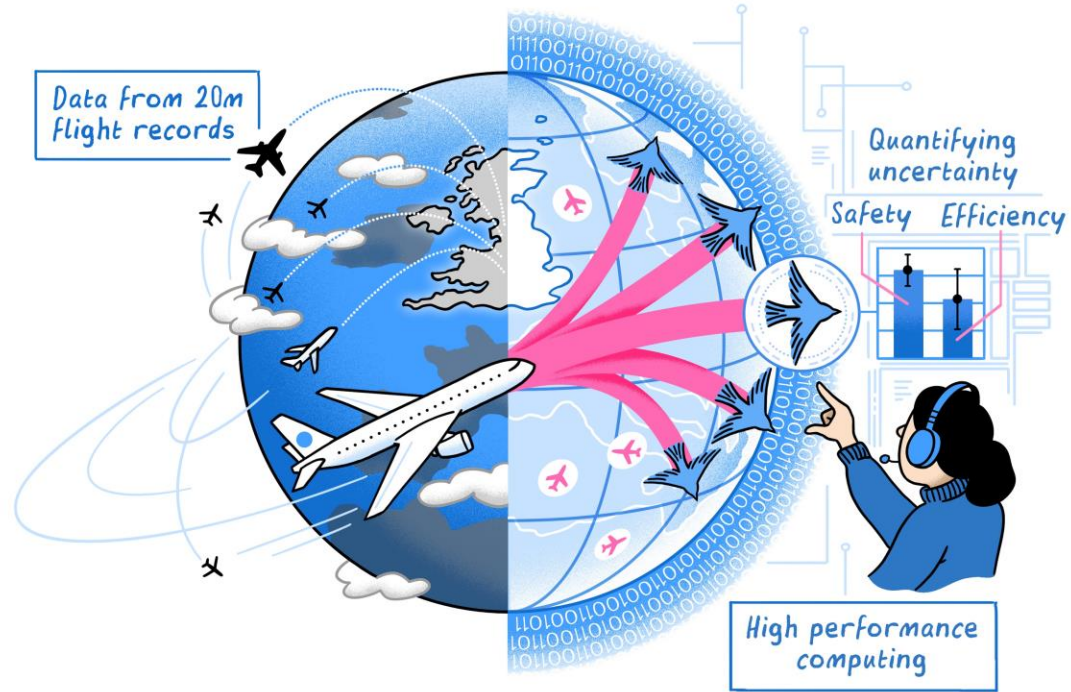
AlphaStar		177 /200	945 +2015	758 +873	64	113	940	 2 
		SUPPLY	MINERALS	GAS	WORKERS	ARMY	APM	PRODUCTION
LiquidTLO		147 /172	335 +1595	442 +1030	61	86	1377	 2  2

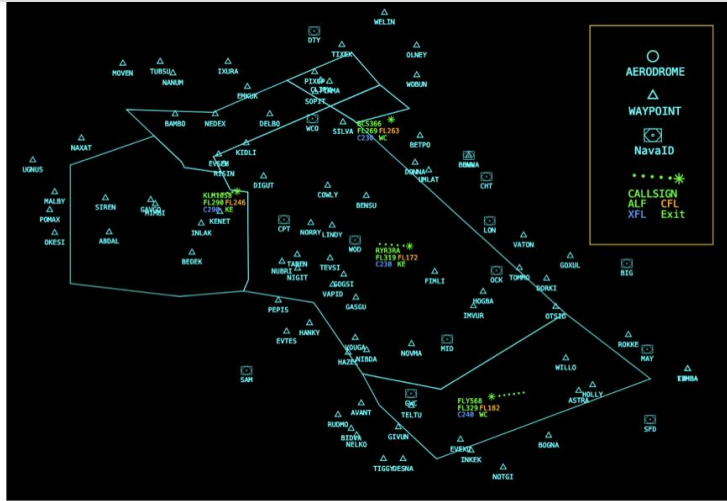
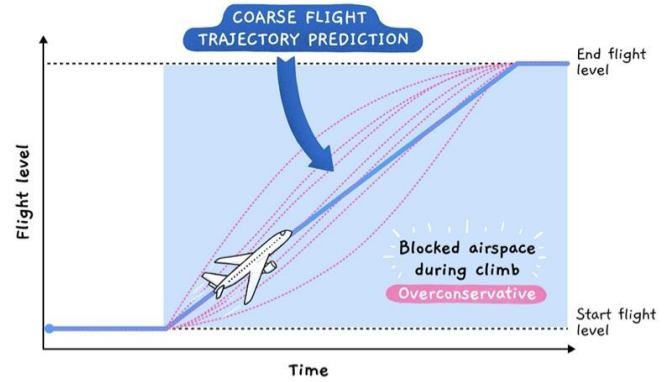
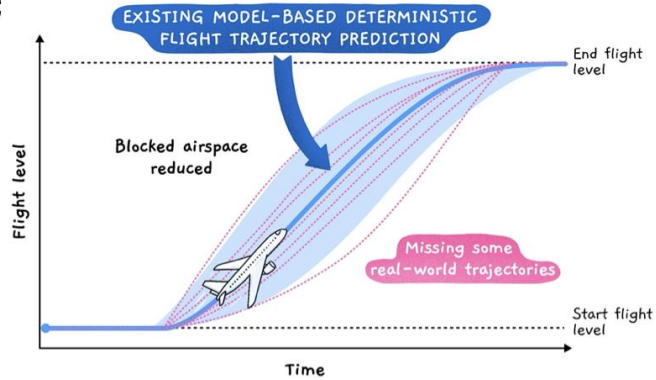
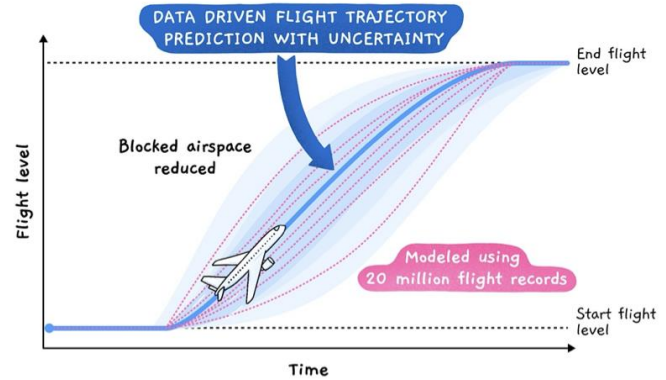


Prerequisites

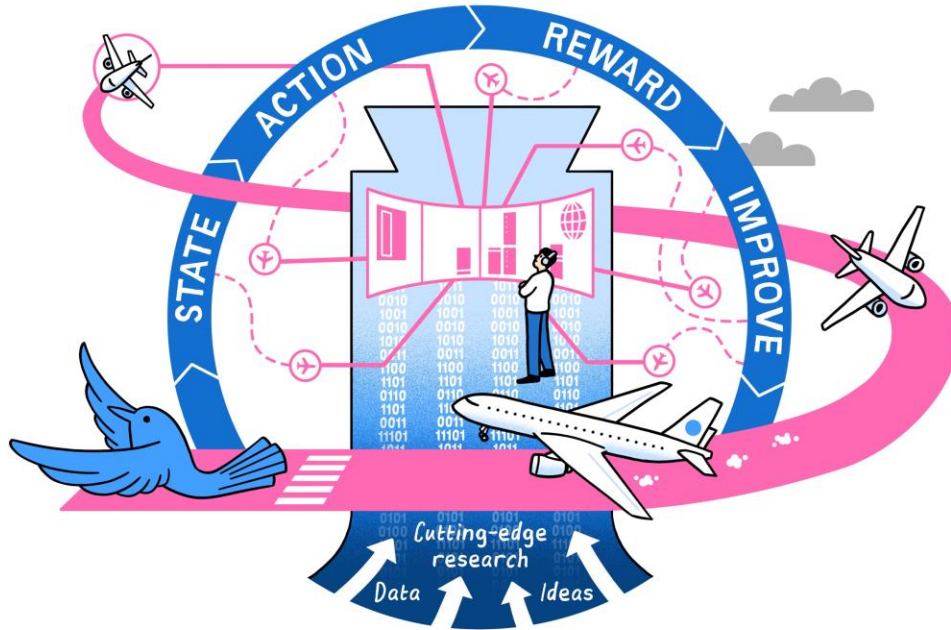
- Environment
- Agent research
- Safety
- Domain knowledge

PROBABLISTIC DIGITAL TWIN

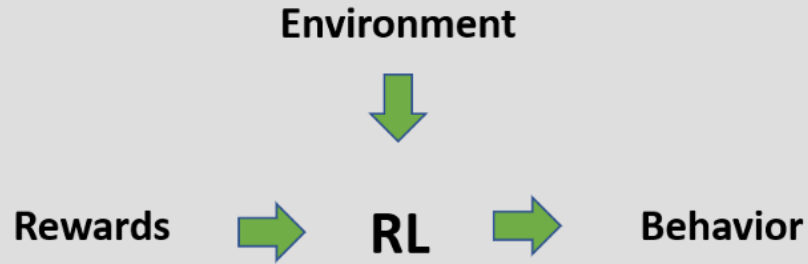


a**b****c****d**

MACHINE LEARNING CONTROL

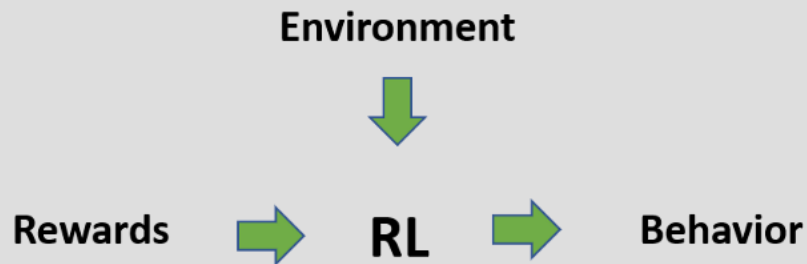


Reinforcement learning

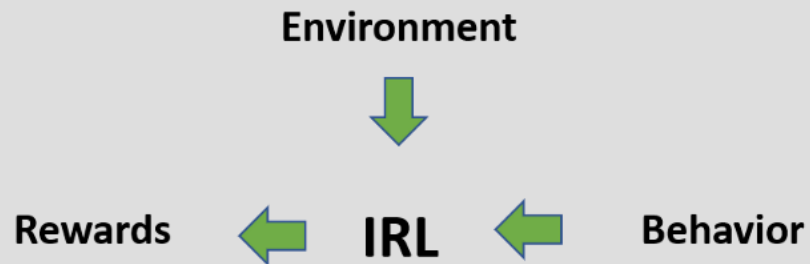


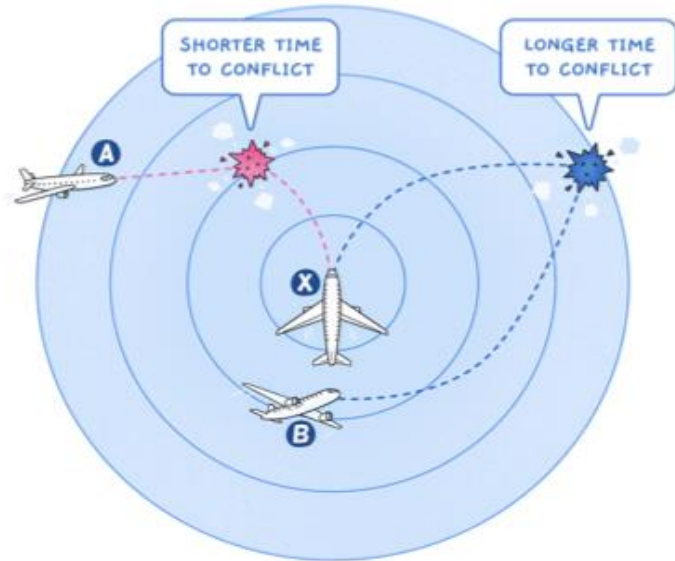
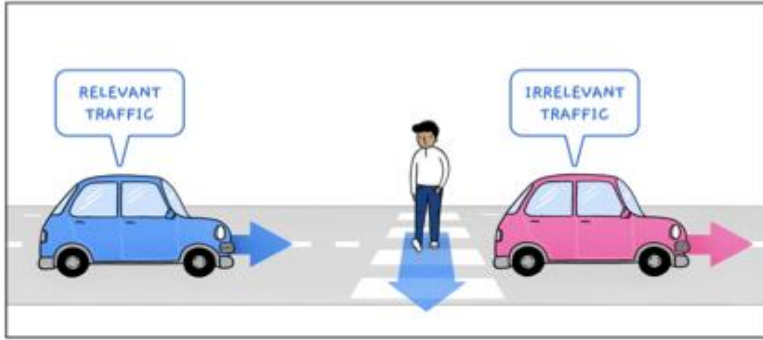
Evaluation and rewards

Reinforcement Learning



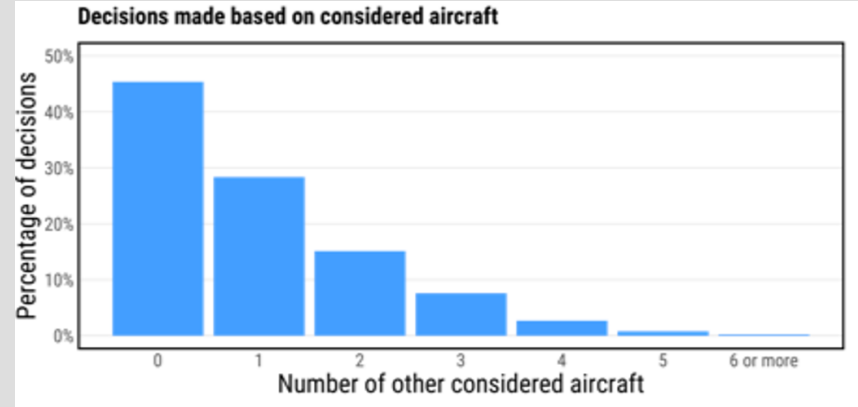
Inverse Reinforcement Learning



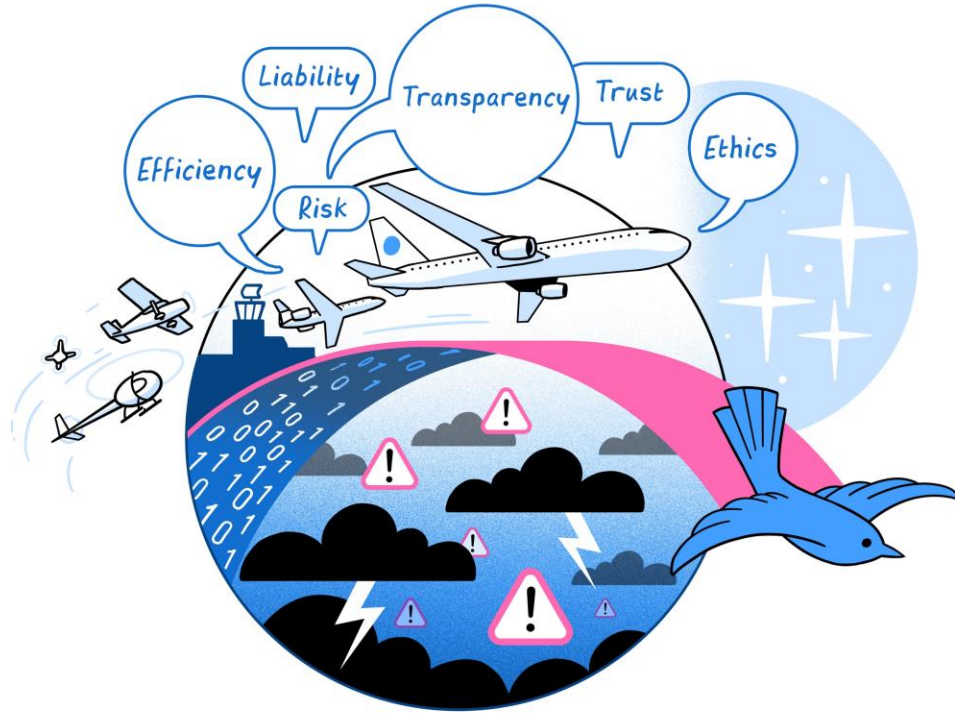


Focus and attention

- Quantifying relevant traffic



SAFETY & TRUSTWORTHINESS



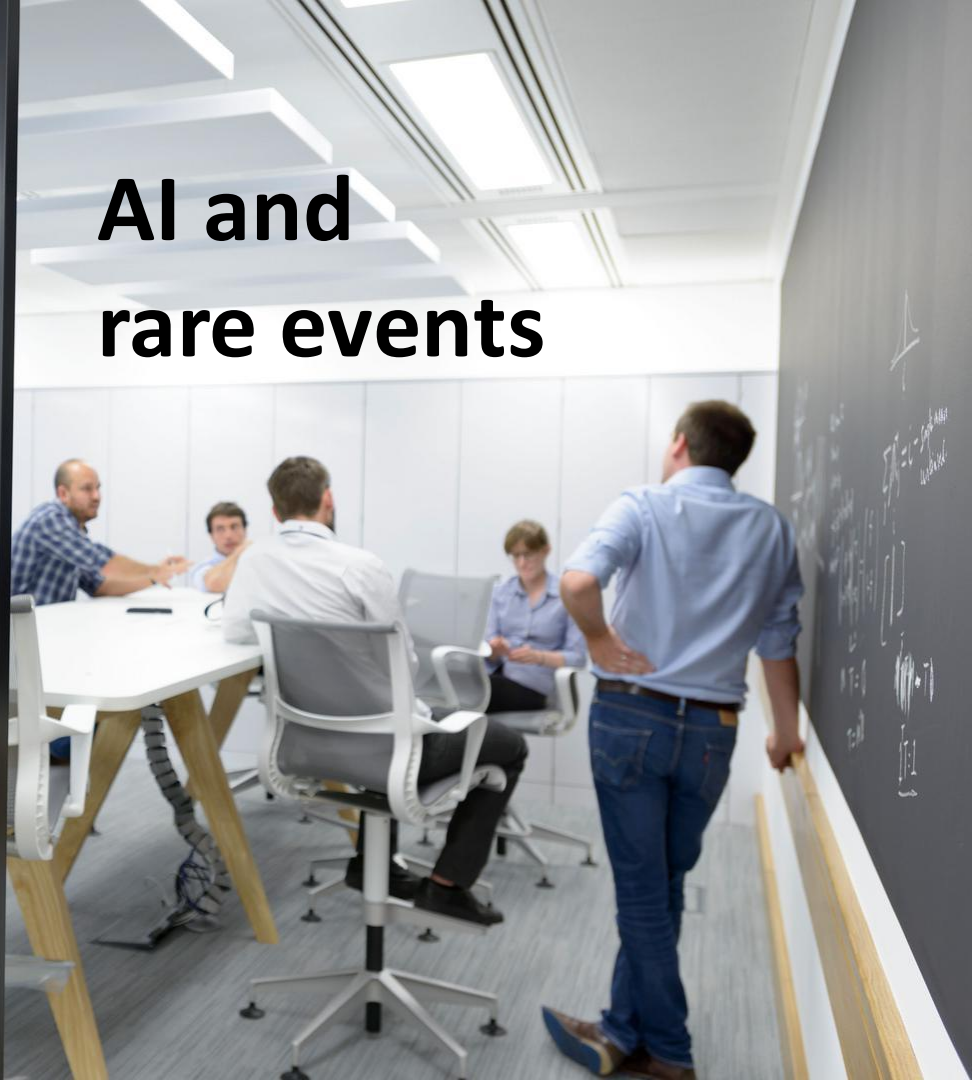
AI and rare events

$$P_{\theta}(x) = \frac{1}{c_{\theta}} h_{\theta}(x)$$

$$\frac{c_{\theta}}{c_{\psi}} = \int \frac{h_{\theta}(x)}{h_{\psi}(x)} P_{\psi}(x) dx$$

$$\hat{r} = \frac{1}{n} \sum \frac{h_{\theta}(x_i)}{h_{\psi}(x_i)}$$

$$\frac{c_{\theta}}{c_{\psi}}$$



a man standing in a room

indoor: 0.982

whiteboard: 0.968

floor: 0.960

computer: 0.959

office building: 0.949

furniture: 0.949

table: 0.933

chair: 0.928

person: 0.923

desk: 0.921

ceiling: 0.839

design: 0.825

clothing: 0.766

text: 0.760

laptop: 0.617

$$P_{\theta}(x) = \frac{1}{C_{\theta}} h_{\theta}(x)$$

$$\frac{C_{\theta}}{C_{\psi}} = \int \frac{h_{\theta}(x)}{h_{\psi}(x)} P_{\psi}(x) dx$$

$$\hat{r} = \frac{1}{n} \sum \frac{h_{\theta}(x_i)}{h_{\psi}(x_i)}$$

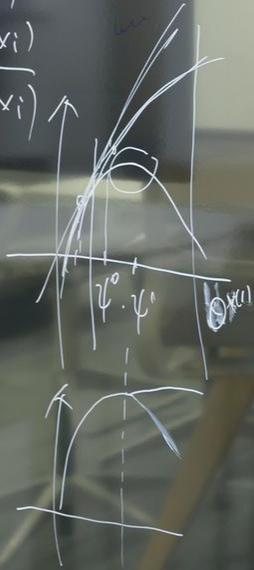
$$\frac{h_{\theta}}{h_{\psi}}$$

$$P_0(x) = \frac{1}{c_0} h_0(x)$$

$$\frac{c_0}{c_\psi} = \int \frac{h_0(x)}{h_\psi(x)} P_\psi(x) dx$$

$$\hat{r} = \frac{1}{n} \sum \frac{h_0(x_i)}{h_\psi(x_i)}$$

$$\frac{c_0}{c_\psi}$$



$$P_{\theta}(x) = \frac{1}{C_{\theta}} h_{\theta}(x)$$

$$\frac{C_{\theta}}{C_{\psi}} = \int \frac{h_{\theta}(x)}{h_{\psi}(x)}$$

$$\hat{r} = \frac{1}{n} \sum \frac{h_{\theta}(x_i)}{h_{\psi}(x_i)}$$

$$\frac{C_{\theta}}{C_{\psi}}$$

a couple of people that are standing in a room

----- whiteboard: 0.900

furniture: 0.865

chair: 0.799

computer: 0.776

table: 0.718

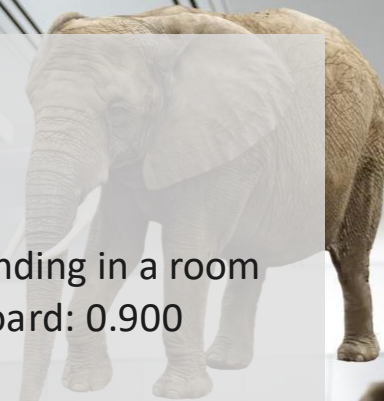
clothing: 0.710

text: 0.672

person: 0.590

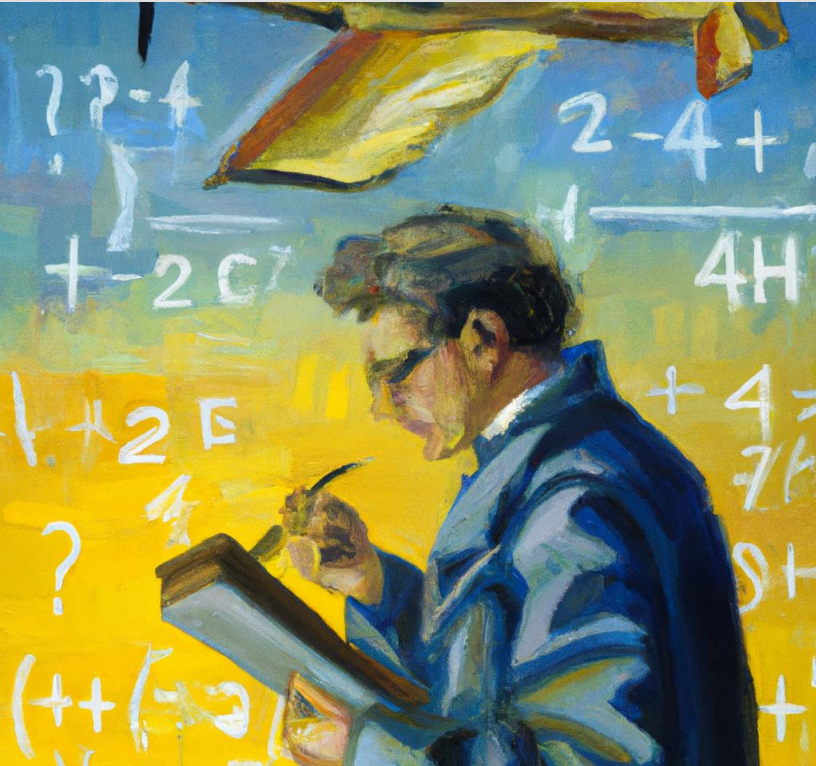
design: 0.532

desk: 0.532





AI and rare events



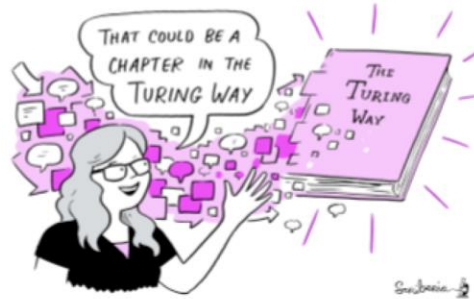
Enabling AI Research

- Environment/Data +
Common task +
Common evaluation

*Common Task Framework (50 Years of
Data Science, David Donoho)*



A Book



A Community



An Open Source Project



A Culture of Collaboration

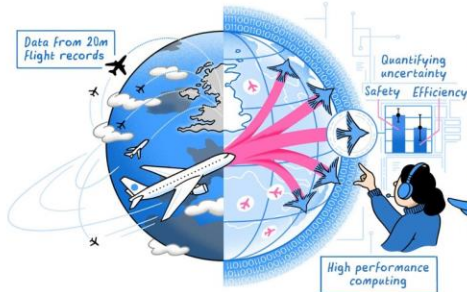


The Turing Way: Handbook for reproducible, ethical and collaborative data science



Source: DALL-E, prompt: "artificial intelligence is controlling aircraft flying in the air, digital art"

PROBABLISTIC DIGITAL TWIN



MACHINE LEARNING CONTROL



SAFETY & TRUSTWORTHINESS



NATS

BlueBird

The Alan Turing Institute

Safe AI for Air Traffic Control



Project Bluebird

NATS

The Alan Turing
Institute



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of Exeter

Prof. Tim Dodwell
Dr. Richard Cannon

Dr. Edmond Awad
Benjamin Carvell
Dr. George De Ath
Dr. Helen Duncan
Prof. Richard Everson

Dr. Evelina Gabasova
Prof. Mark Girolami
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Dr. Radka Jersakova
Dr. Matthew Johns
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Kamalaruban

Simon Kirby
John Korna
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Dr. Greg Mingas
Louise O'Brien
Dr. Enrico Olivier
Andrew Pace
Katrina Payne

Dr. Nick Pepper
Dr. Jan Povala
Annie Robinson
Amy Stamp
Dr. Mark Thomas
Prof. Adrian Weller
Dr. Freddy Wordingham
Dr. Teresa Yu Bi

