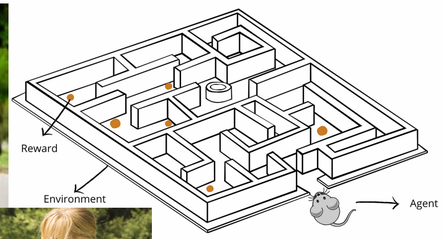
Training

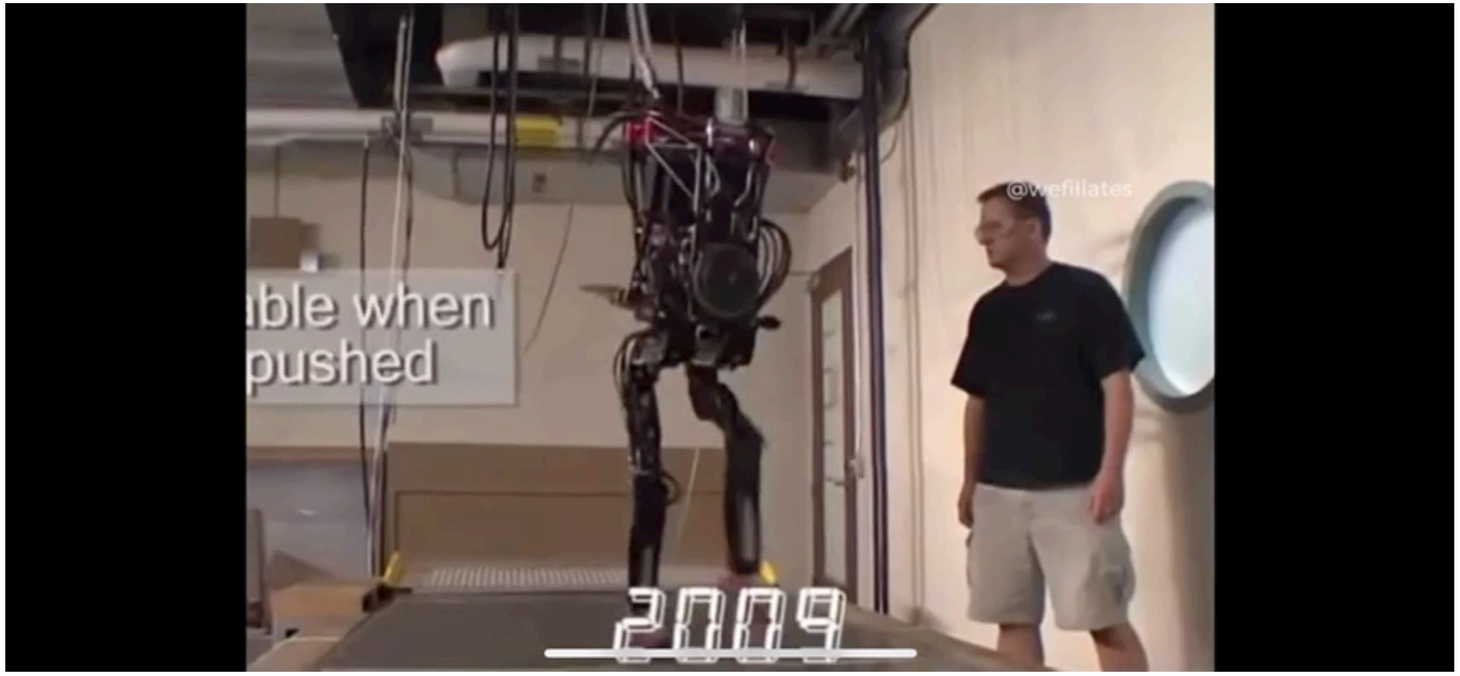
- Finding that mapping function.

Reinforcement Learning



Imitation Learning

- Observe an expert and repeat what she does.



Self-driving car

Robotic

Costs and Powers:

- It needs thousands of processors to
  - Train the models
  - Support the billions of daily queries by users.

- Each processing unit can consume over 400 watts.

  - Overall, with the cooling, we need up to 10 gigawatt-hour to train a single model like ChatGPT-3.

  - This is similar to the yearly electricity consumption of over 1,000 households.

- Training OpenAI’s GPT-3 text-generating model is similar to driving a car to the Moon and back.

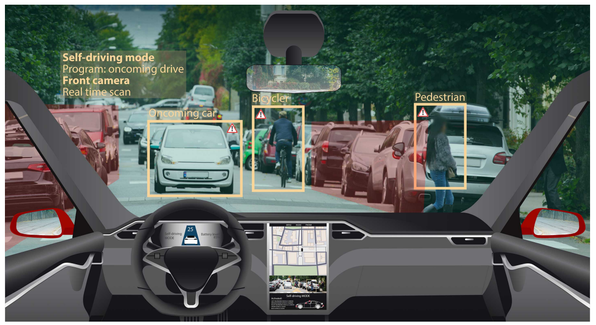
- 3,400 kilowatts of electricity at peak time

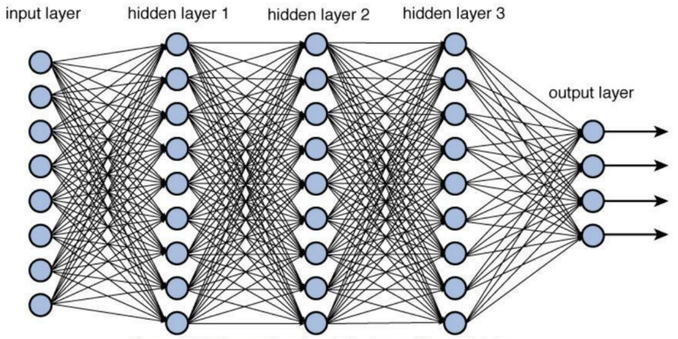
- 850,000 computing nodes

Decision Making

- **What** to do next?
  - After seeing and detecting objects and states, it is important to act or make decisions.

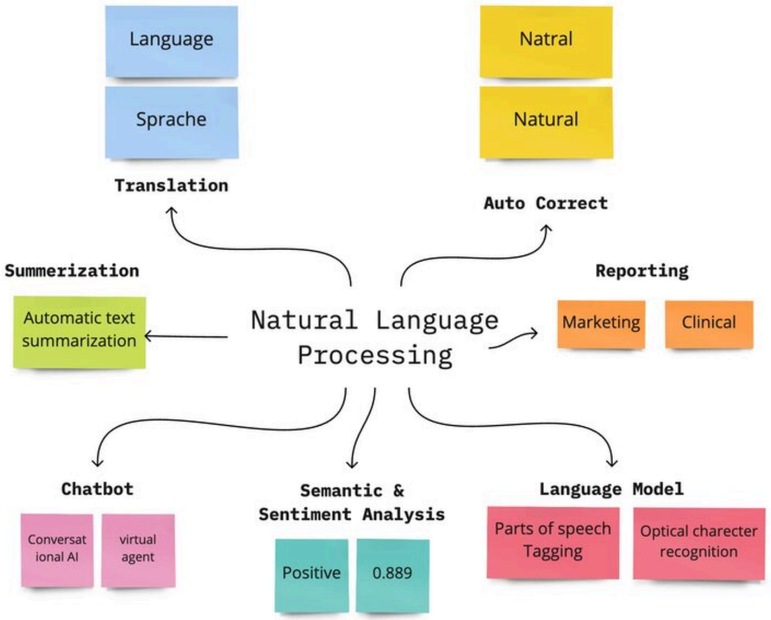
- **Autonomous driving**





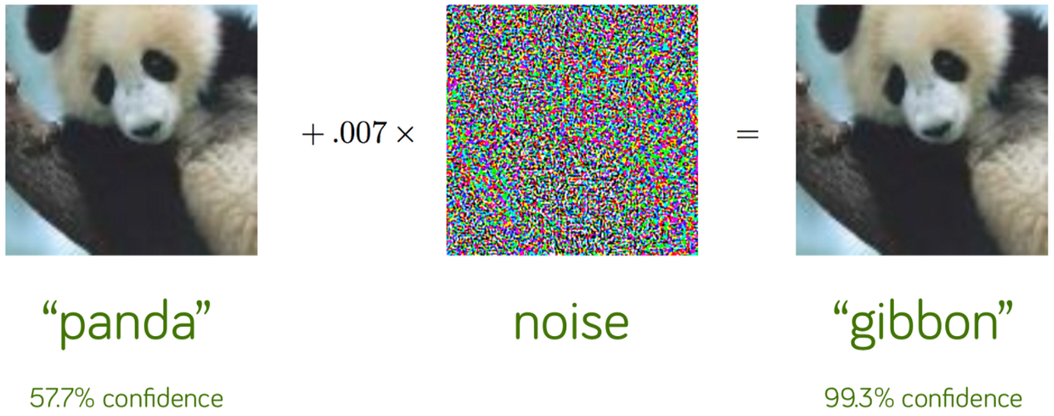
- Break
- Drive slowly (how much?)
- Drive fast
- Turn right (how much?)
- Turn left
-
-

- **Natural language processing (NLP)**



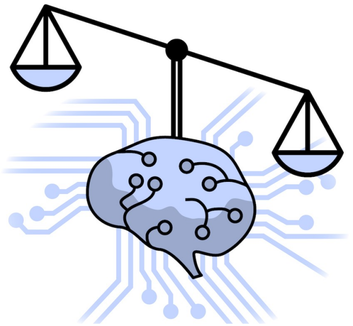
How reliable is AI?

- Many of the AI models are still very sensitive
- They can be manipulated : (
- Needs more research to make them trustworthy and robust



Ethics in AI:

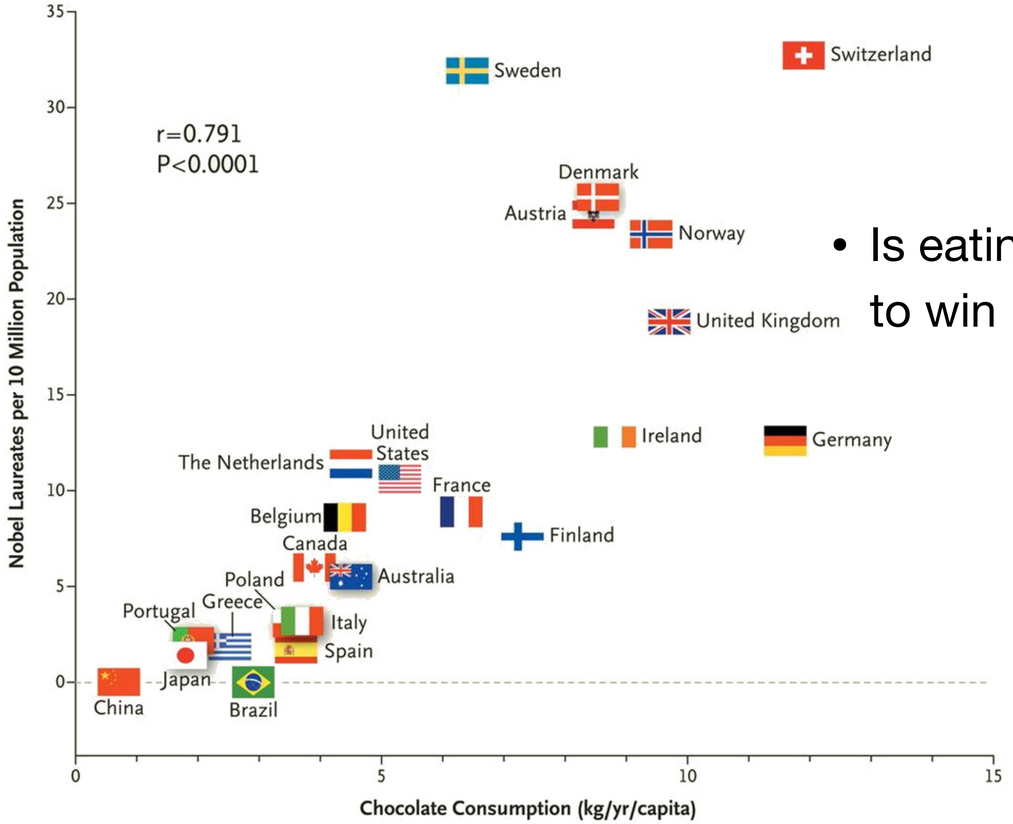
- Many trained AI models are biased.
- They do not make fair decisions.



Explain our Decision

- After making decisions, we have to be able to explain **why** that decision.
  - To do this, we should understand, what causes what.

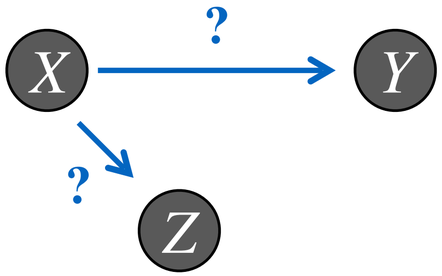
- It is likely raining,
- It is unlikely snowing,

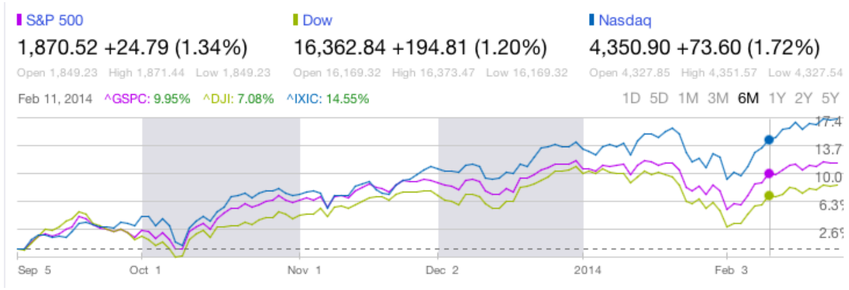


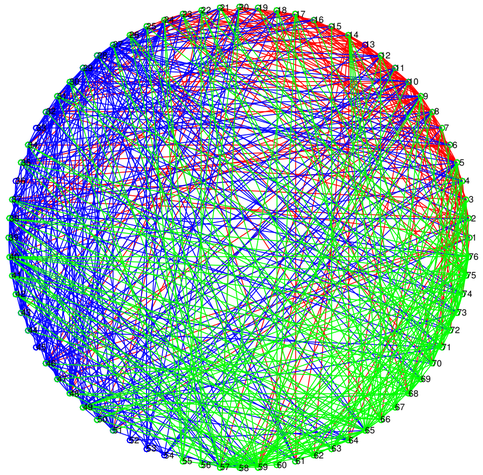
- Is eating more chocolate good to win Noble price !?

Causal Inference

- Inferring causal relationships from data







- Learning effects
  - Without direct experiment

- What is the effect of bankrupting BMW on house pricing in Germany?

- What is the effect of a new medicine on humans?

- Learning *counterfactual* effects

- We did chemotherapy and the patient died. What would have happened if had performed a surgery?

• Computer science at TUM

- Around 45 Professors at CS.
  - Algorithms & Complexity
  - Algorithmic Economics & Operations Research
  - Artificial Intelligence & Machine Learning
  - Data Engineering & Cloud Systems
  - Digital Biology & Digital Medicine
  - Extreme Scaling
  - Human-centered Engineering
  - Information Systems & Software Engineering
  - Robotics & Autonomous Systems
  - Security, Safety, Risk Management
  - Visual Computing

Figures as of winter semester 2023/24

	Students	No. of female students	No. of international students
Total	**52,528**	**19,088**	**23,422**
Computation, Information and Technology	15,092	3,354	8,319
Engineering and Design	13,285	3,935	5,985
Natural Sciences	4,950	1,767	1,944
Life Sciences	4,884	2,812	1,643
Medicine	4,393	2,397	749
Management	6,977	2,769	3,710
Social Sciences and Technology	2,201	1,270	551
TUM Campus Straubing	798	359	521

	Studierende insgesamt	Frauen	Ausländer*innen	Studierende in der Regelstudienzeit
COMPUTATION, INFORMATION AND TECHNOLOGY	**13.284**	**2.972**	**6.785**	**8.769**
Diplom				
Finanz- und Wirtschaftsmathematik*	1	0	0	0
Informatik*	5	2	0	0
Bachelor				
Bioinformatik	317	158	87	224
Elektrotechnik und Informationstechnik	1.649	289	893	1.179
Informatik	2.657	467	1.085	1.913
Informatik: Games Engineering	442	77	142	261
Information Engineering (Heilbronn)	102	24	88	102
Mathematik	598	152	162	420
Wirtschaftsinformatik	1.070	298	428	747
Master				
Bioinformatik	74	33	16	50
Biomedical Computing	115	51	96	56
Communications Engineering	338	115	334	211
Computational Science and Engineering	174	27	148	111
Data Engineering and Analytics	374	87	328	267
Elektrotechnik und Informationstechnik	1.393	276	764	737
Informatik	1.999	384	1.254	1.266
Informatik: Games Engineering	139	26	51	80
Information Systems	309	84	86	211
Mathematik	366	145	169	195
Mathematical Finance and Actuarial Science	111	40	59	80
Mathematics in Data Science	151	55	92	90
Mathematics in Operations Research	45	15	25	30
Mathematics in Science and Engineering	92	27	59	62
Robotics, Cognition, Intelligence	737	137	417	479
Sonstige (Zeugnis, Zertifikat o.ä.)				
Informatik Aufbaustudium*	25	6	4	1
Studium weitere/r Studienrichtung/Schwerpunkt	1	0	0	1

• Where are we heading?

- We need to understand the theory behind AI.
  - To better control, design and predict its behaviour.
- Many routine, daily human jobs can be done up to some extend by machines.
  - Even those that look complex like surgery, trading, …
- There are also somethings that are not learnable or teachable to machines, e.g., emotions, …
  - Current AI is still limited to human knowledge. Cannot generate new knowledge.
  - It requires a series of reasoning and developing new methods that current AI cannot do.
- We know some fundamental limits of the current computers (binary) and algorithm but new computers may arise in future (Quantum computers)
  - They perform much much faster than the current computers.

Q & A

Thank you ….