University of BRISTOL

Machine Learning

Introduction

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TARGET
$20 Off Baby Coupon

- *"My daughter got this in the mail!. She's still in high school, and you're sending her coupons for baby clothes and cribs? Are you trying to encourage her to get pregnant?"*

- *"My daughter got this in the mail!. She's still in high school, and you're sending her coupons for baby clothes and cribs? Are you trying to encourage her to get pregnant?"*
- *"I had a talk with my daughter, It turns out there's been some activities in my house I haven't been completely aware of. She's due in August. I owe you an apology"*

"artificial intelligence is our biggest existential threat"
– Elon Musk, The Guardian Oktober 2014

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"I agree with Elon Musk and some others on this and don't understand why some people are not concerned."
– Bill Gates, January 2015

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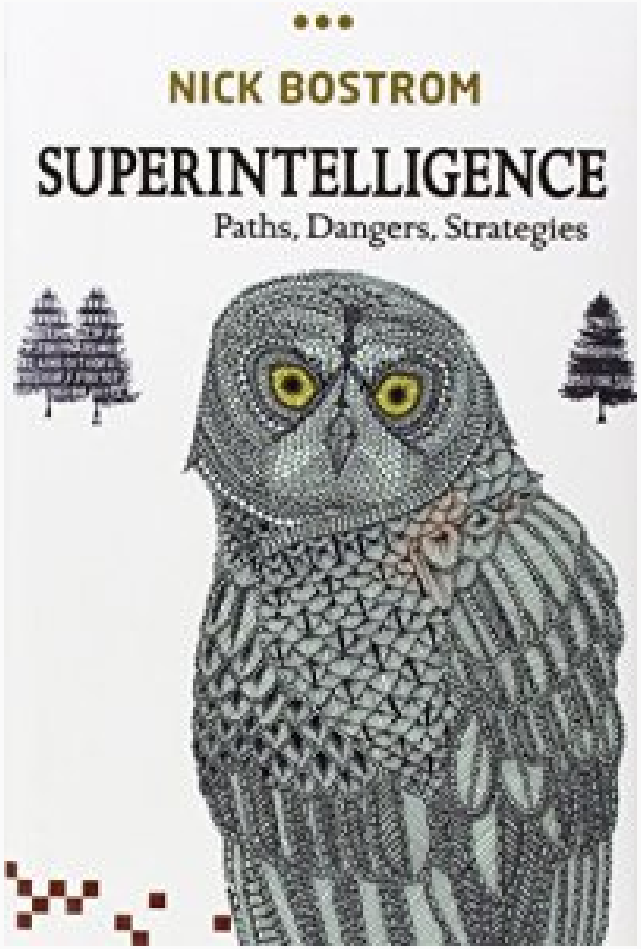
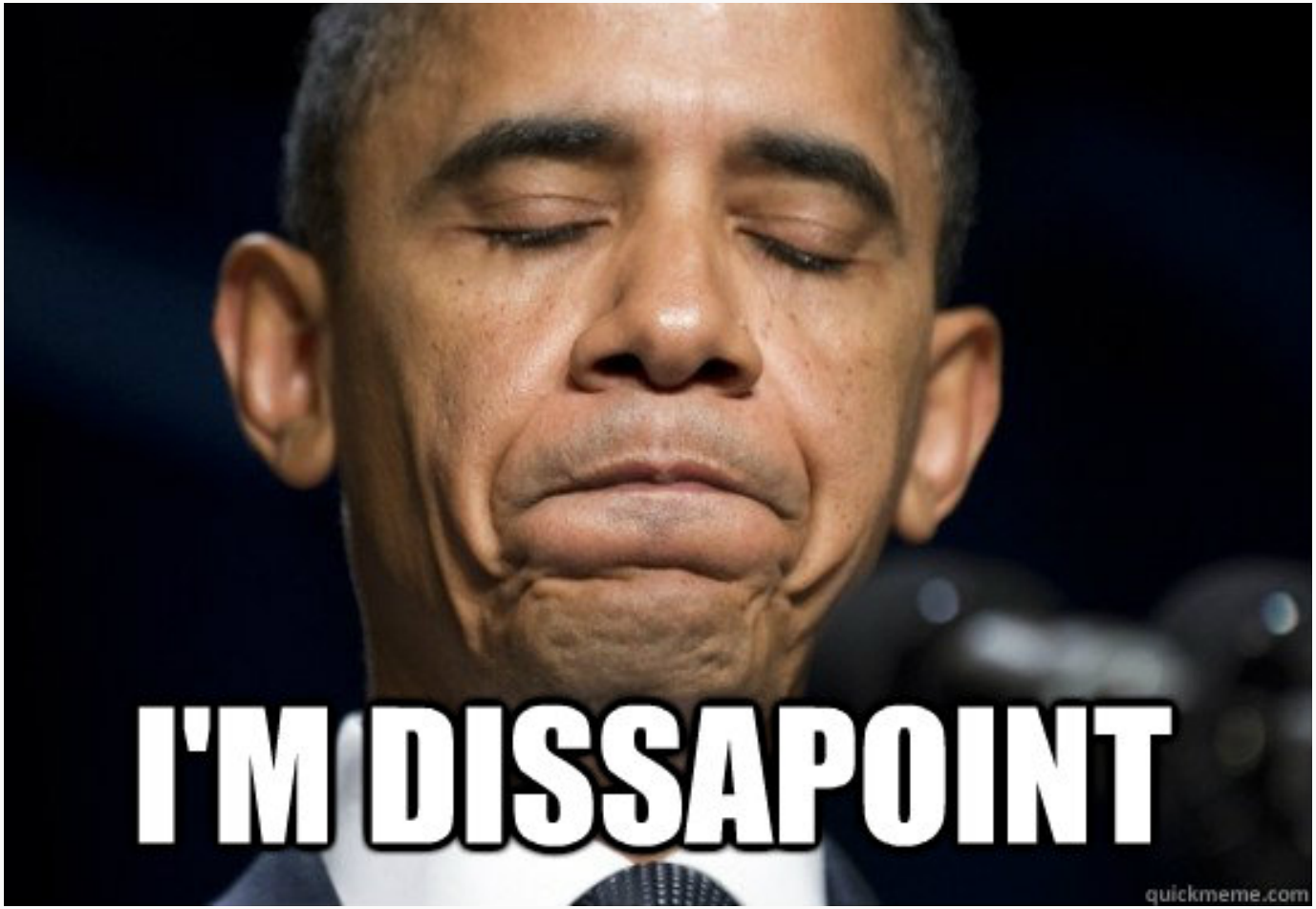
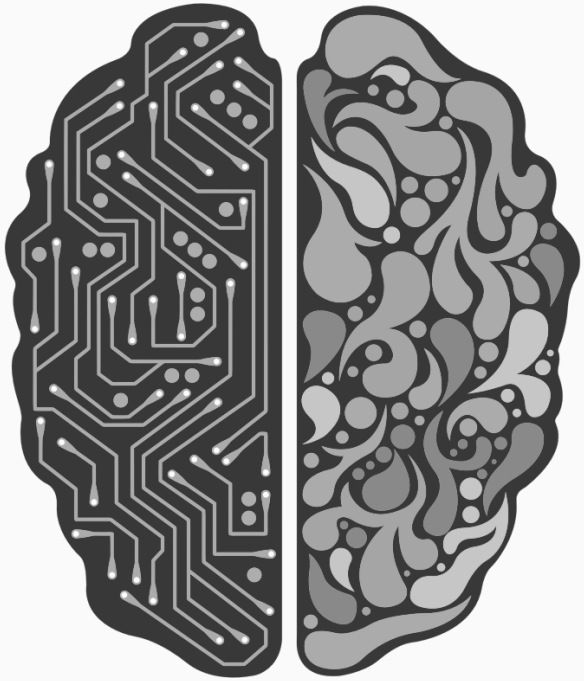
"Artificial intelligence could wipe out humanity when it gets too clever as humans will be like ants."
– Prof. Steven Hawking, The Independent, October 2015

Nick Bostrom



Nick Bostrom


I'M DISSAPOINT
quickmeme.com



Artificial Intelligence

Work

- 1990
- 36.0×10^9 USD
- 1.2 million

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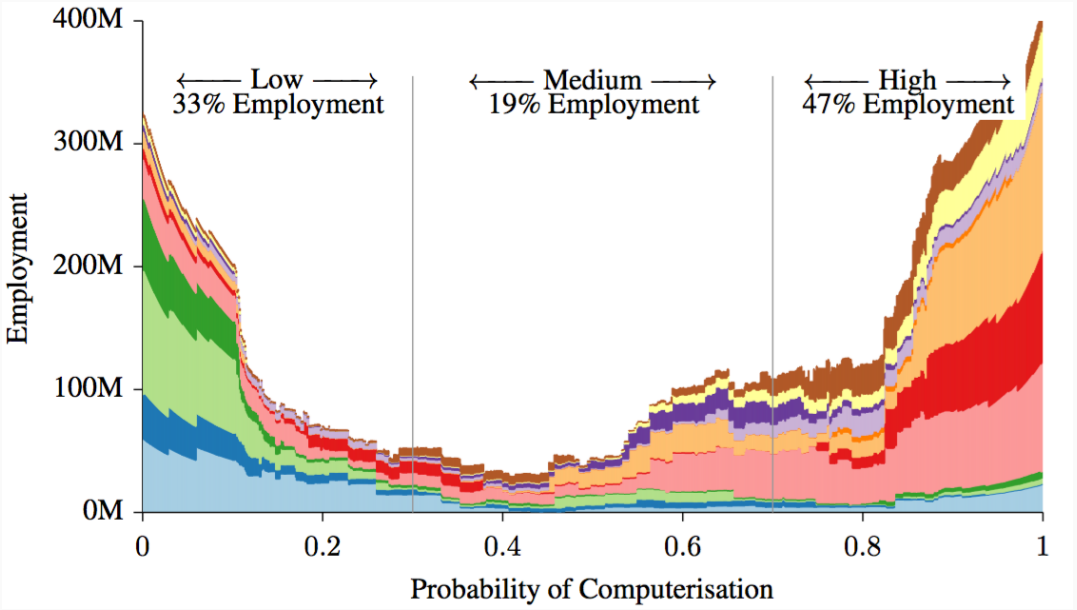
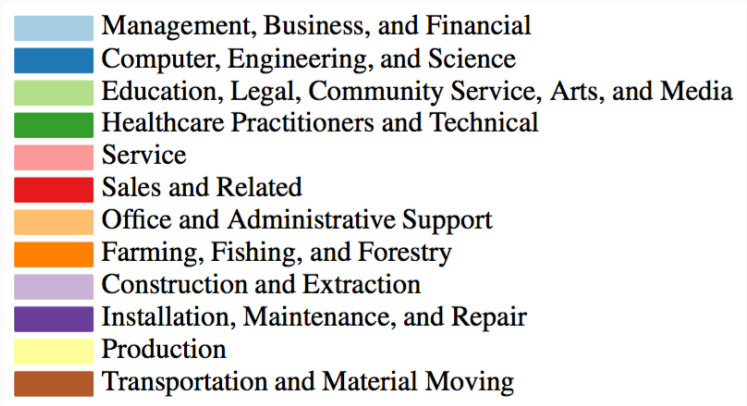
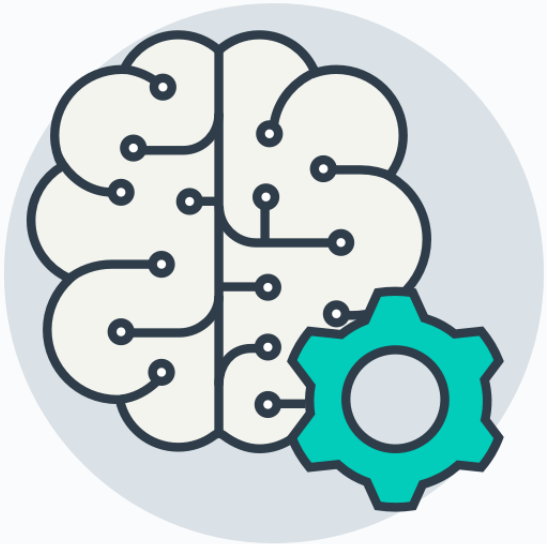
11% of the Detroit workforce is generating 30 times as much wealth in SF

Work [1]


400M
300M
200M
100M
0M
Employment
Low
33% Employment
Medium
19% Employment
High
47% Employment
0
0.2
0.4
0.6
0.8
1
Probability of Computerisation

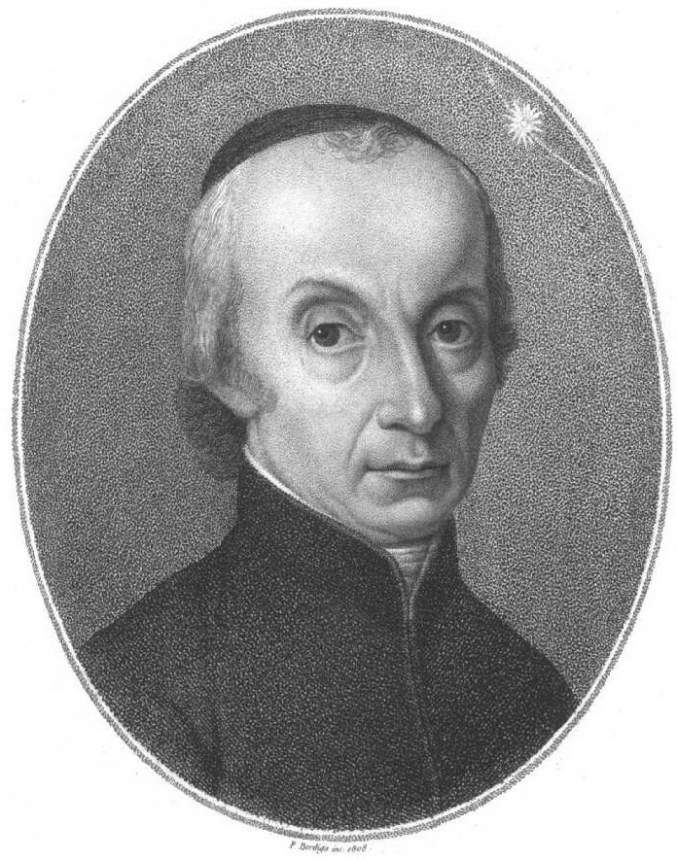

Management, Business, and Financial
Computer, Engineering, and Science
Education, Legal, Community Service, Arts, and Media
Healthcare Practitioners and Technical
Service
Sales and Related
Office and Administrative Support
Farming, Fishing, and Forestry
Construction and Extraction
Installation, Maintenance, and Repair
Production
Transportation and Material Moving

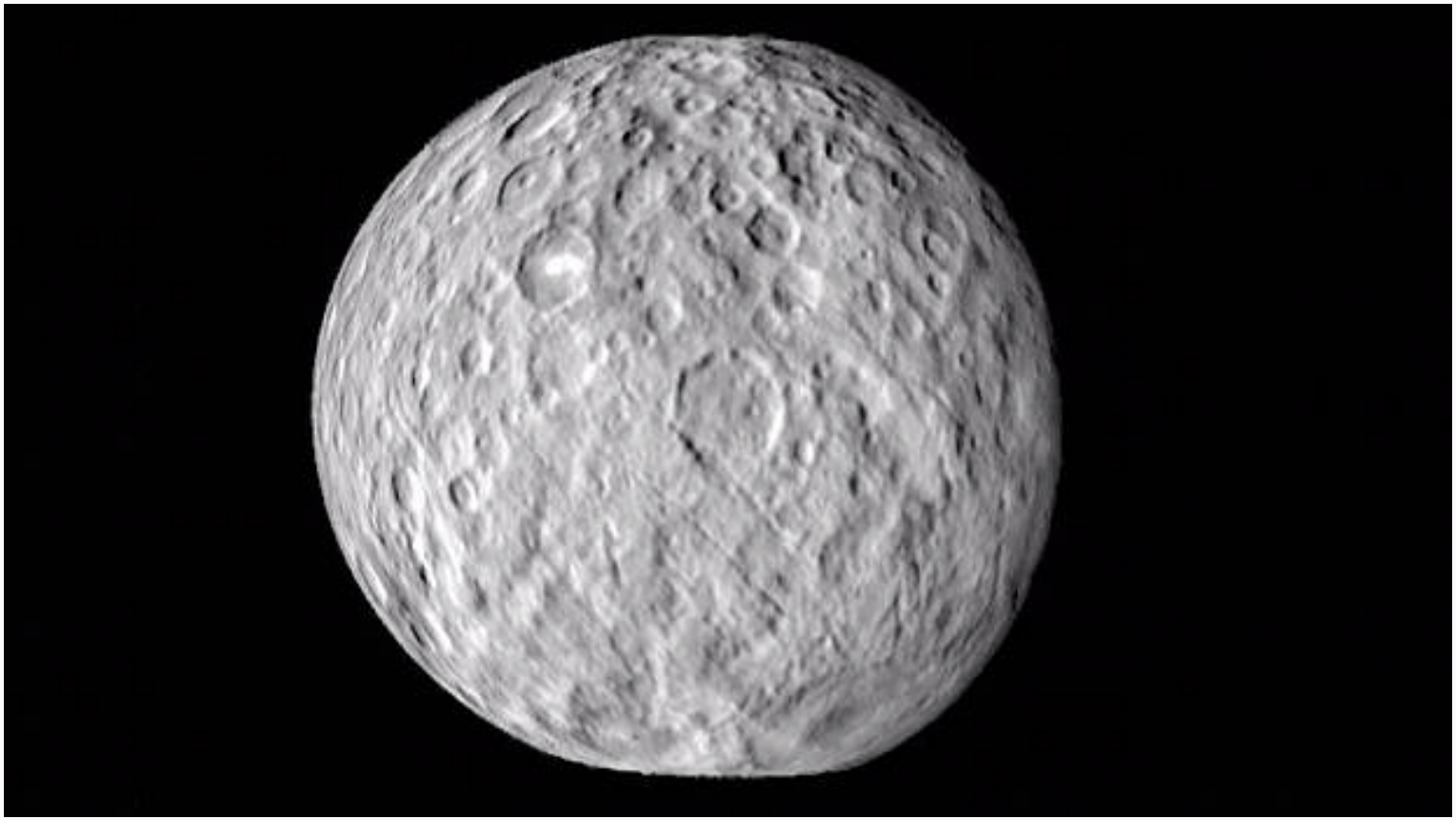


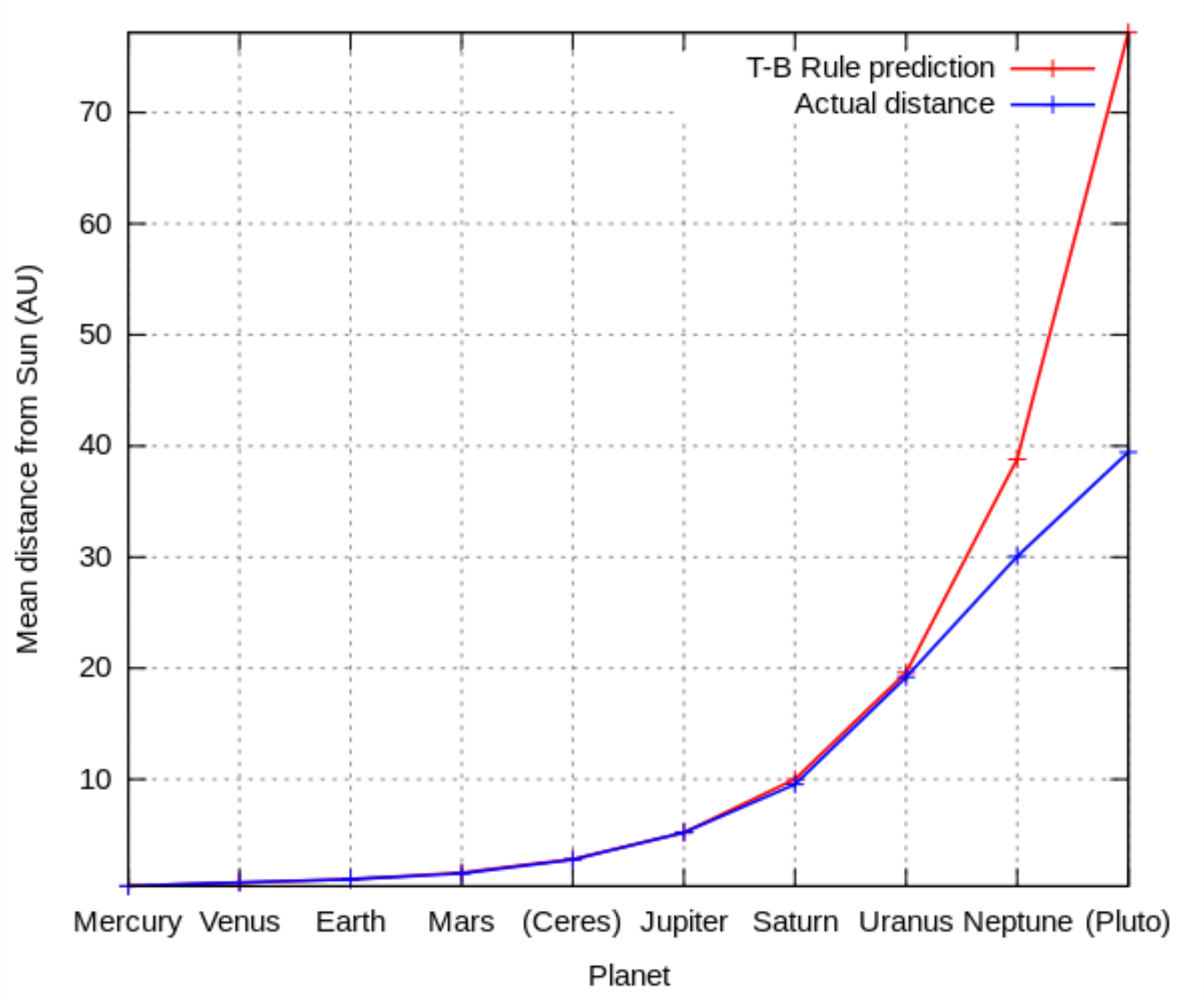
Machine Learning

Introduction

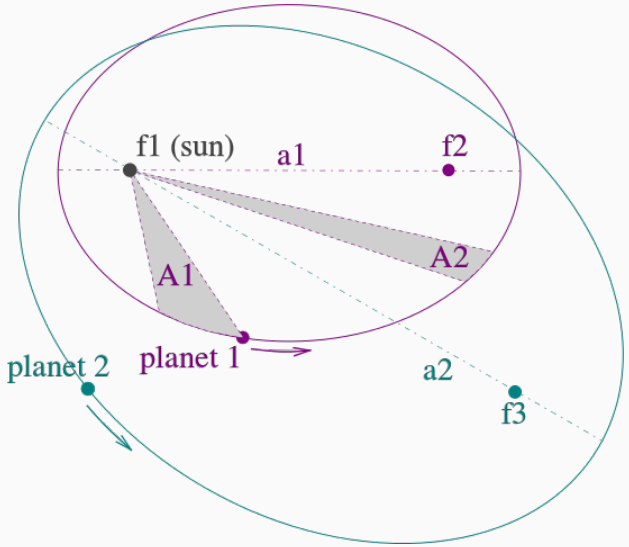
1





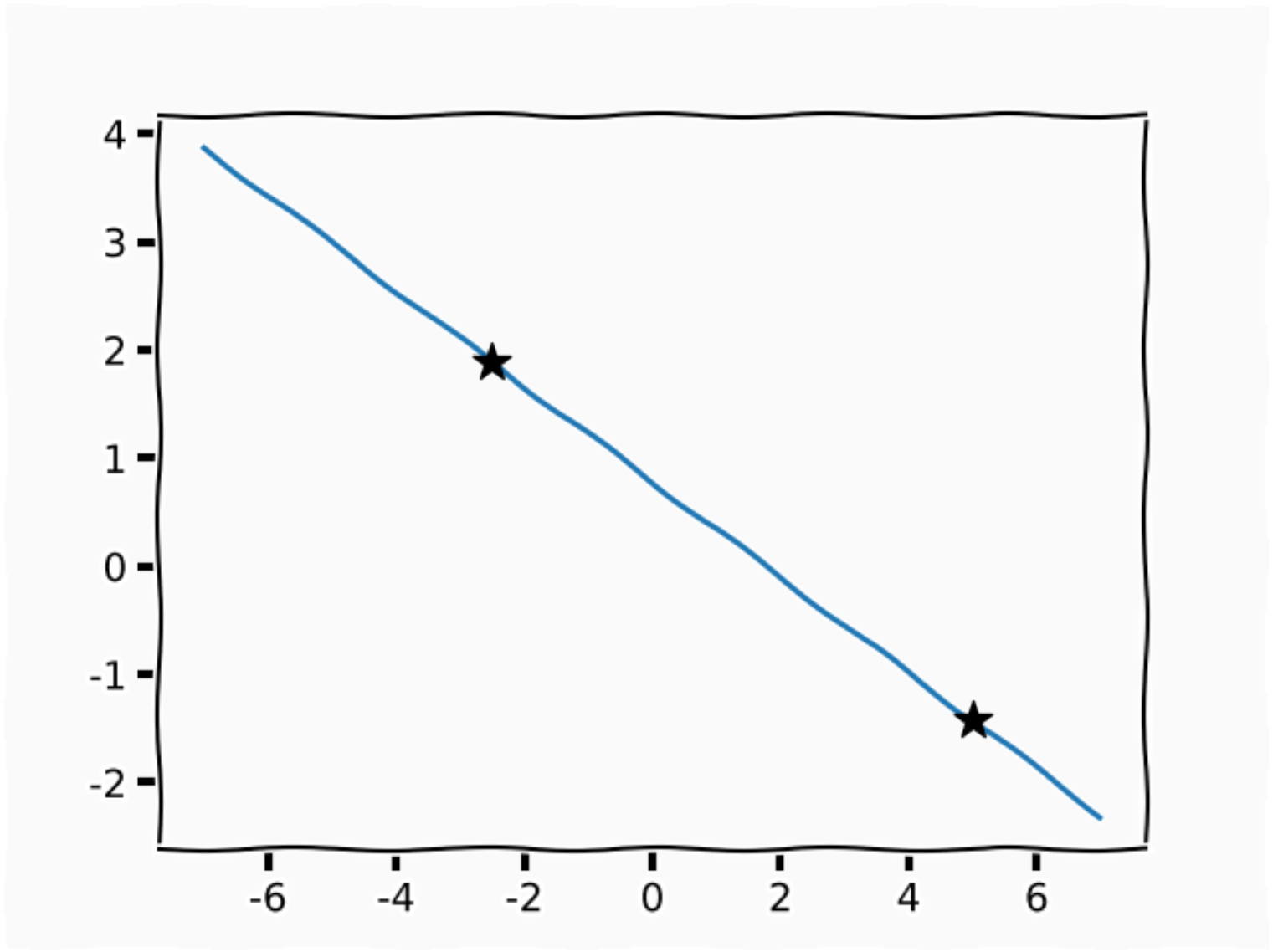

T-B Rule prediction
Actual distance
Mean distance from Sun (AU)
70
60
50
40
30
20
10
Mercury
Venus
Earth
Mars
(Ceres)
Jupiter
Saturn
Uranus
Neptune
(Pluto)
Planet

Keplers Law's

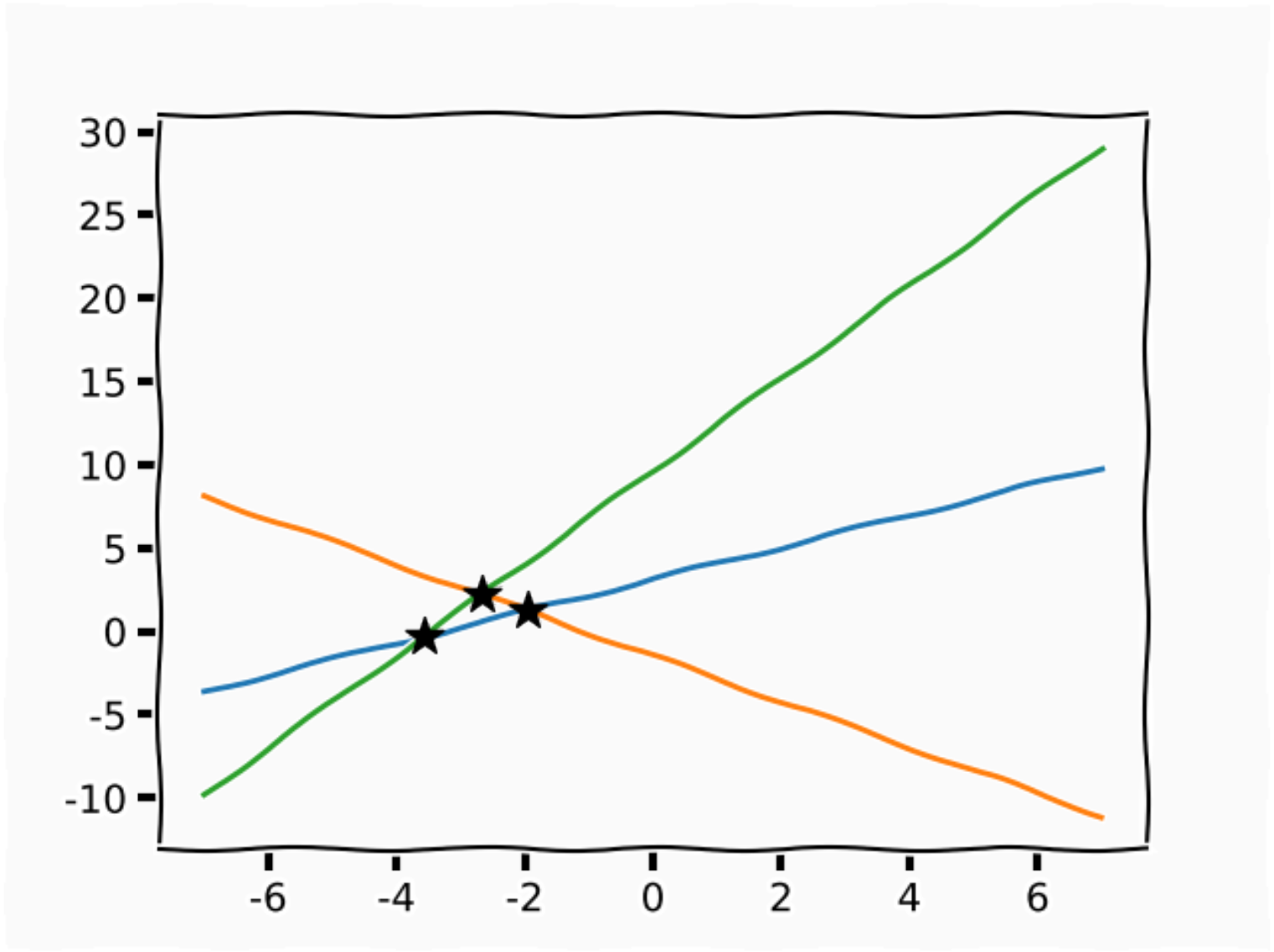


Gauss

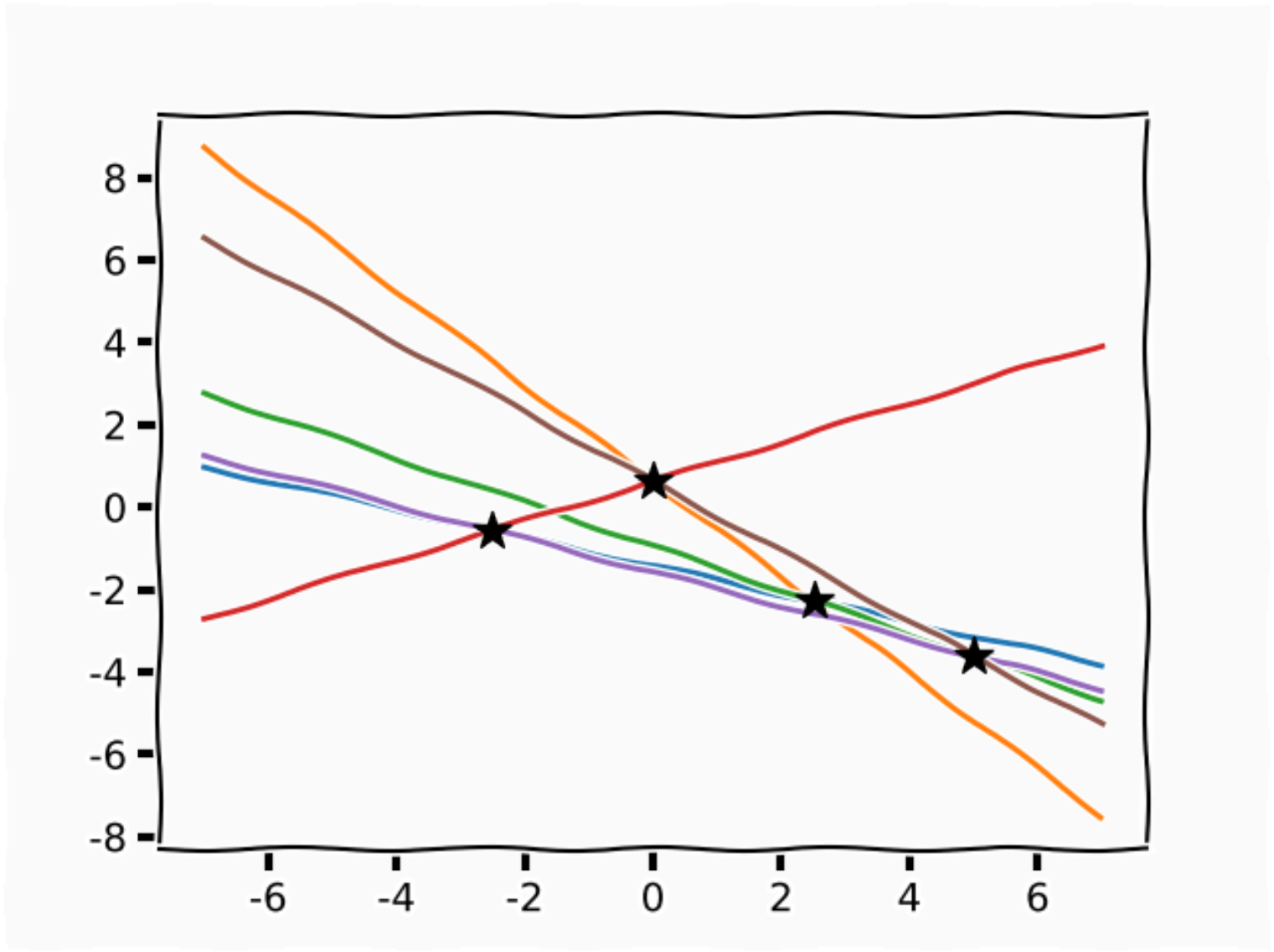
Least Square



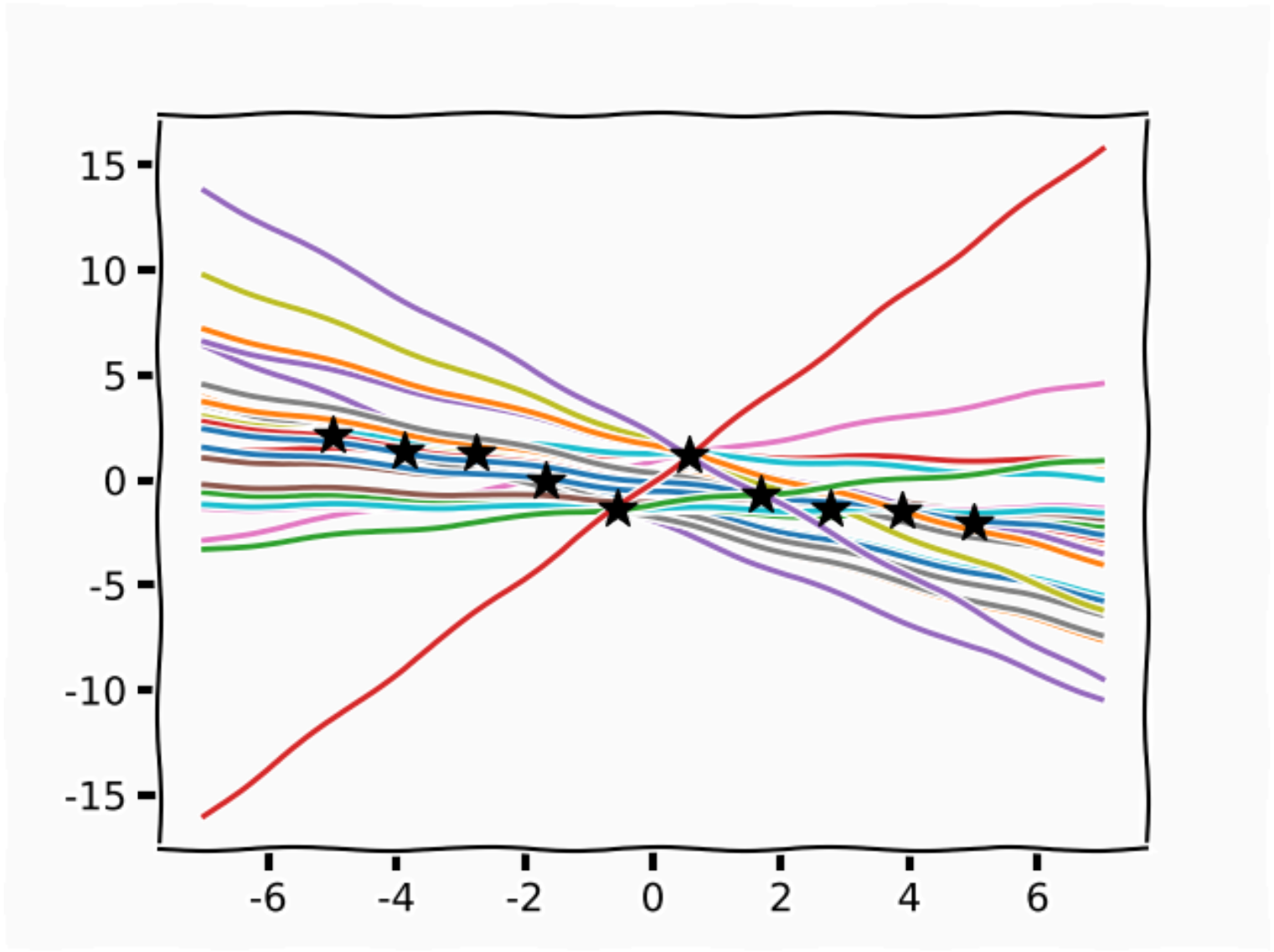
Least Square



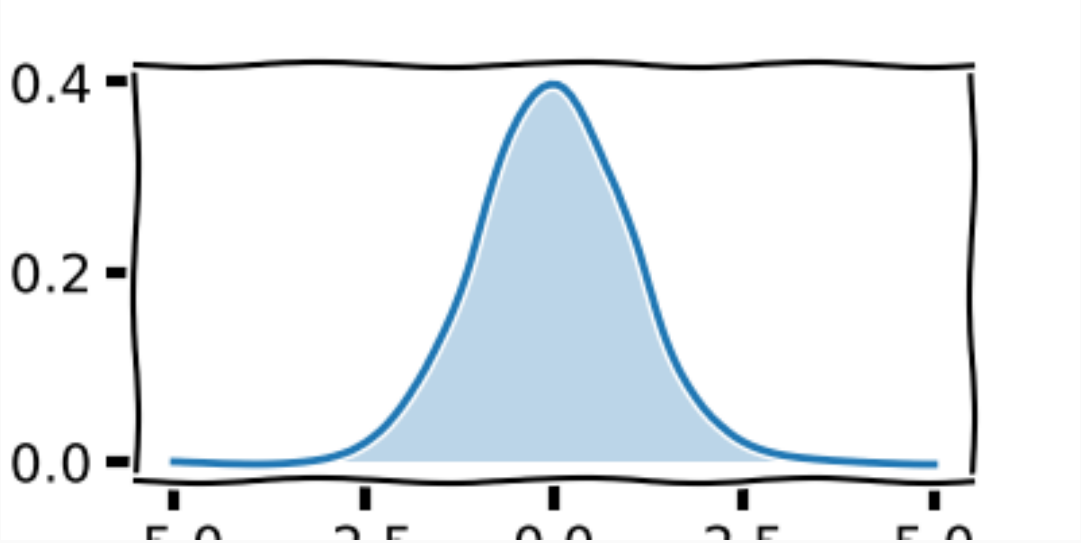
Least Square



Least Square



Least Square



$$y = f(x) + \epsilon$$

$$\epsilon \sim \mathcal{N}(0, I)$$

Laplace Demon [2]

Laplace Demon [2]

Laplace's Demon [2]

An intelligence which at a given instant knew all the forces acting in nature and the position of every object in the universe - if endowed with a brain sufficiently vast to make all necessary calculations - could describe with a single formula the motions of the largest astronomical bodies and those of the smallest atoms. To such an intelligence, nothing would be uncertain; the future, like the past, would be an open book.

Laplace Demon [2]

All these efforts in the search for truth tend to lead the mind continously towards the intelligence we have just mentioned, although it will always remain infinetly distant from this intelligence.

2

Halley's Comet

- 1531, 1607 and 1682
- In 1705 predicted 1758
- Died 1742

"Came in with Halley's Comet in 1835. It is coming again next year and I expect to go out with it."
– Mark Twain, 1909

Data

- 90% of all *stored* information was created the last two years

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Data

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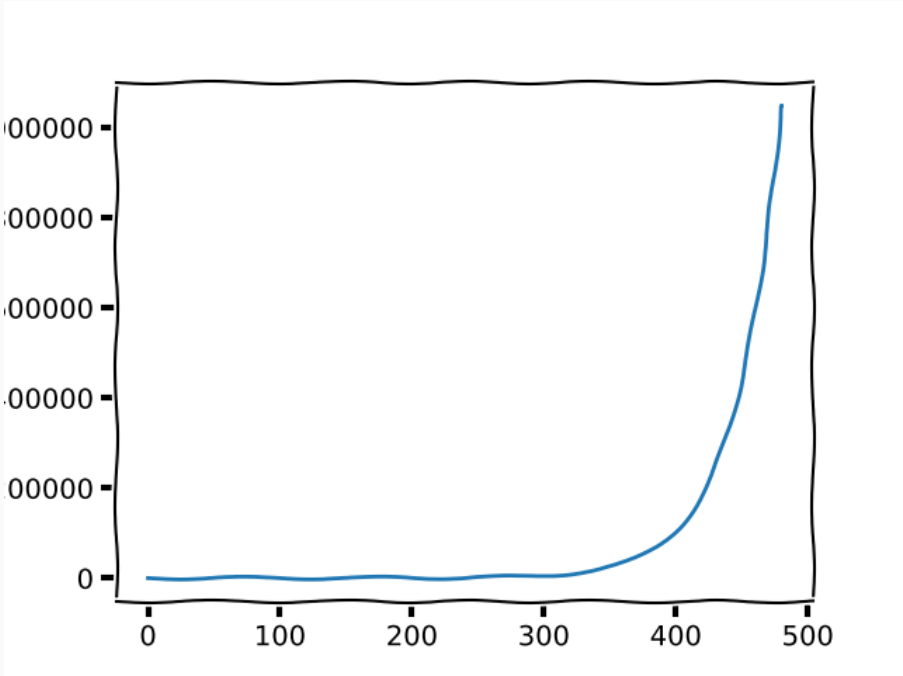
- Every other day we create as much *stored* information that was created during the whole human civilisation till the year 2003
- We create 10^{19} bytes of "data" every day
- *more facts that are beyond grasp*

3

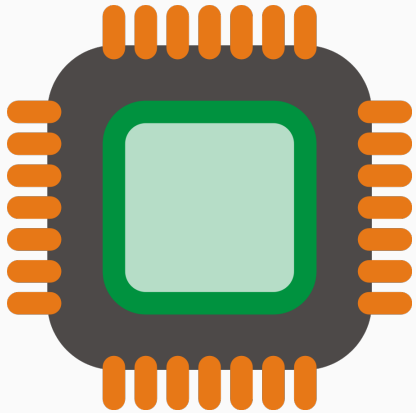
Compute



Now

$$p(\mathrm{H}|\mathcal{D}) = \frac{p(\mathcal{D}|\mathrm{H})p(\mathrm{H})}{p(\mathcal{D})}$$

1100
1010
0101



Machine Learning

SPS

Model

$$p(y|\theta)p(\theta)$$

- A statistical description of the world that you can "hallucinate"/generate data from
- An abstraction or simplification of the world

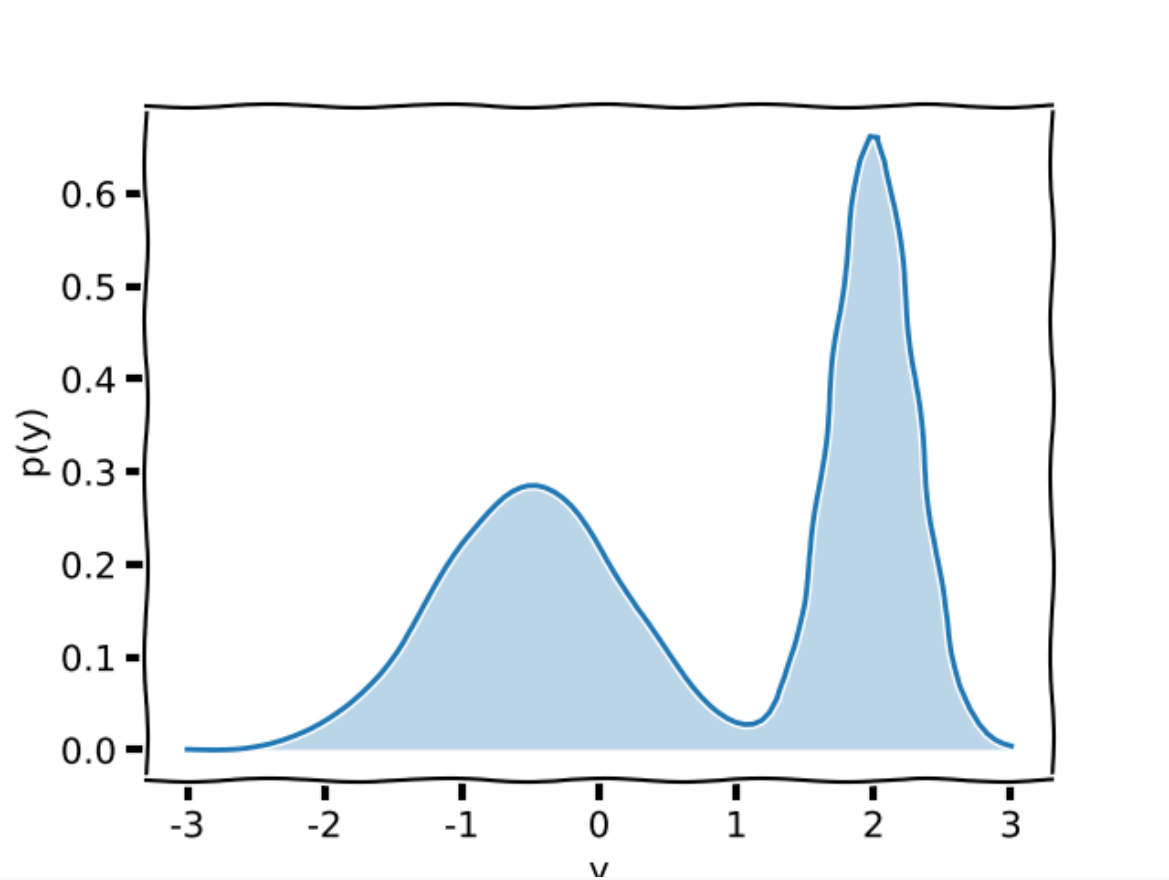
The World

Bristol City

Bristol City

$y =$ Bristol Goals $-$ Opponent Goals

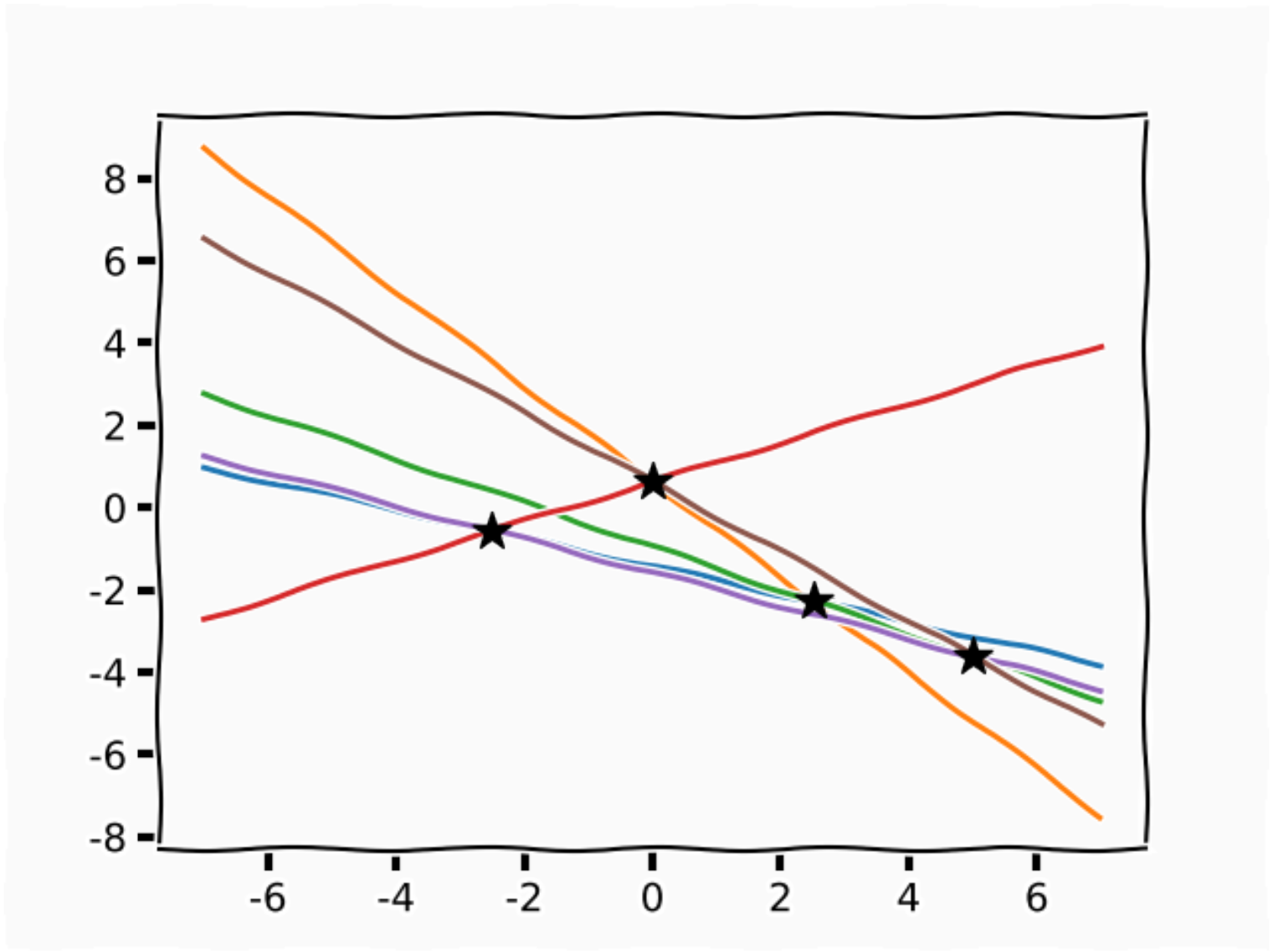
Structure



- A structure to the future under uncertainty is an assumption

Assumptions

Least Square



Machine Learning[1]

$$\text{Data} + \text{Model} \rightarrow \text{Prediction}$$

[1]

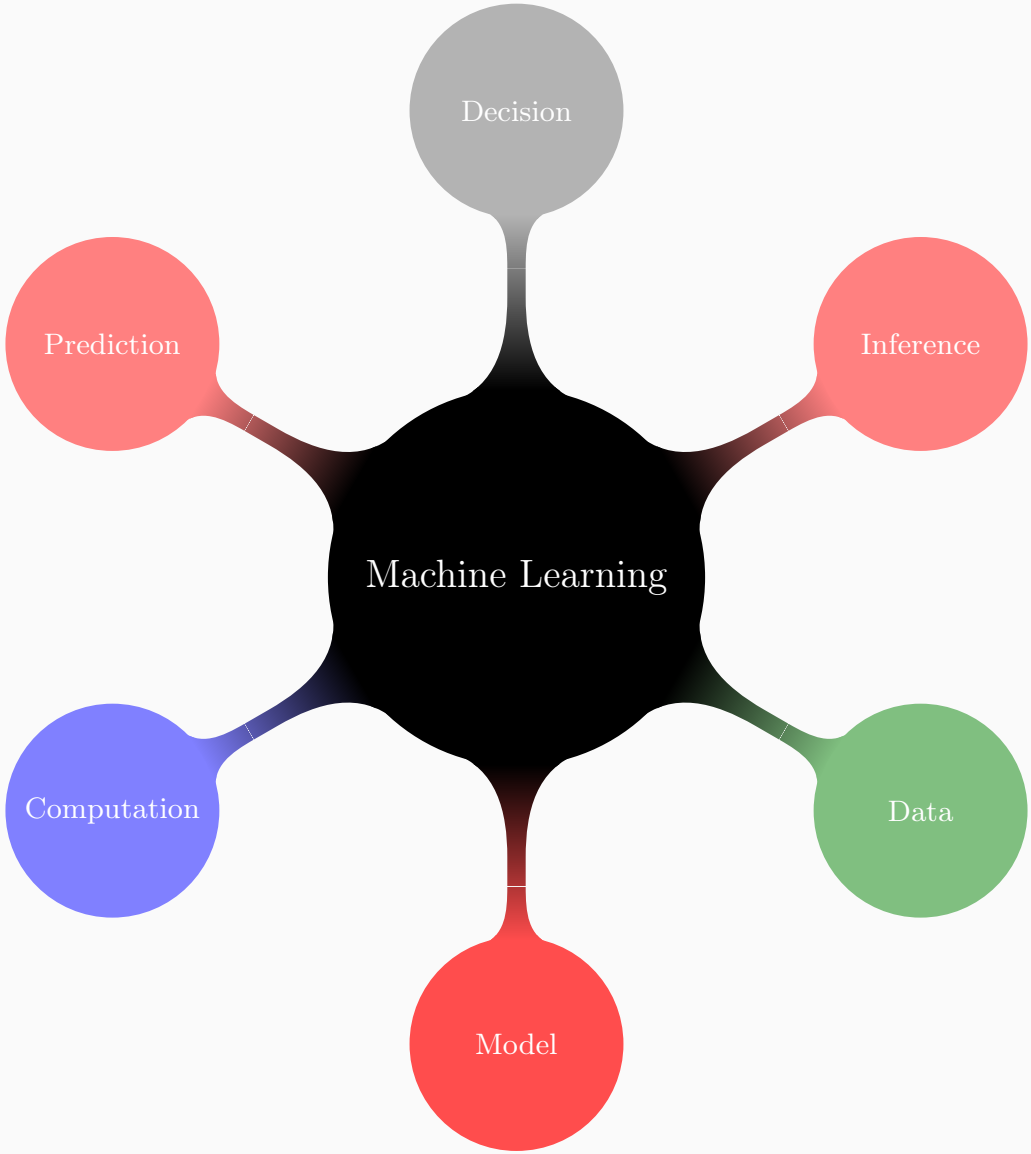
Inference

$$p(\theta|y) = \frac{p(y|\theta)p(\theta)}{p(y)}$$

- how can we update our belief/assumption in the presence of data/examples/observations

Inference

Machine Learning



COMS30007

Lectures

Part I (3 lectures)

- What is learning (SPS)
- Basic probability (SPS)

Part II (8 lectures)

- modelling
- mathematical formulation of assumptions

Lectures

Part III (3 lectures)

- Inference
- How do we fit models to data?
- Three different approaches

Part IV (5 lectures)

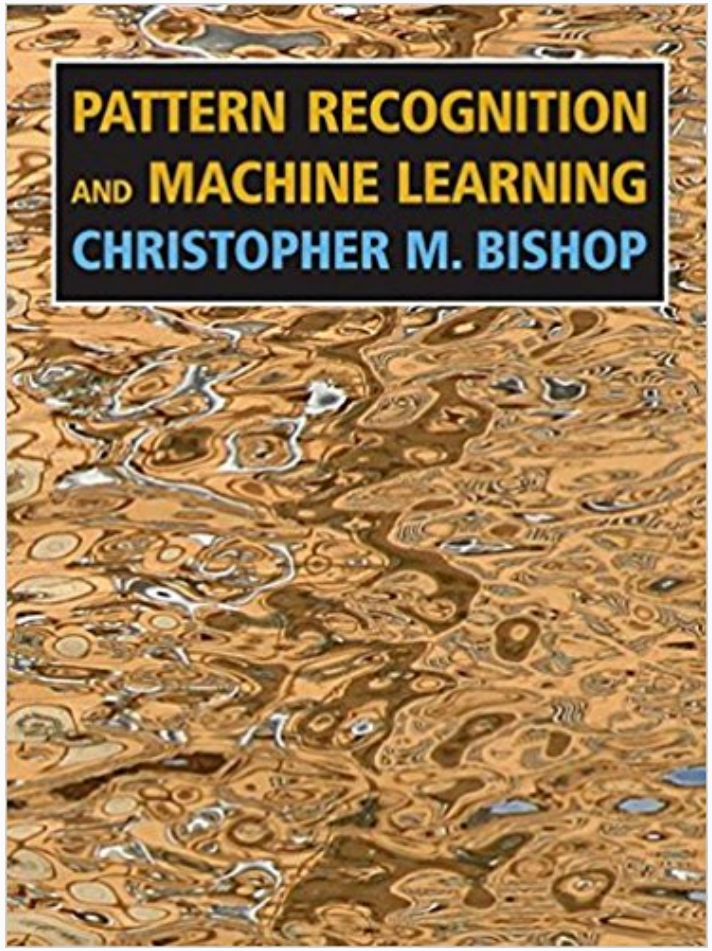
- Summary of unit
- Material outside the assessed material
- Practical machine learning

Questions

reddit

http://www.reddit.com/r/coms30007/

The Book [3]



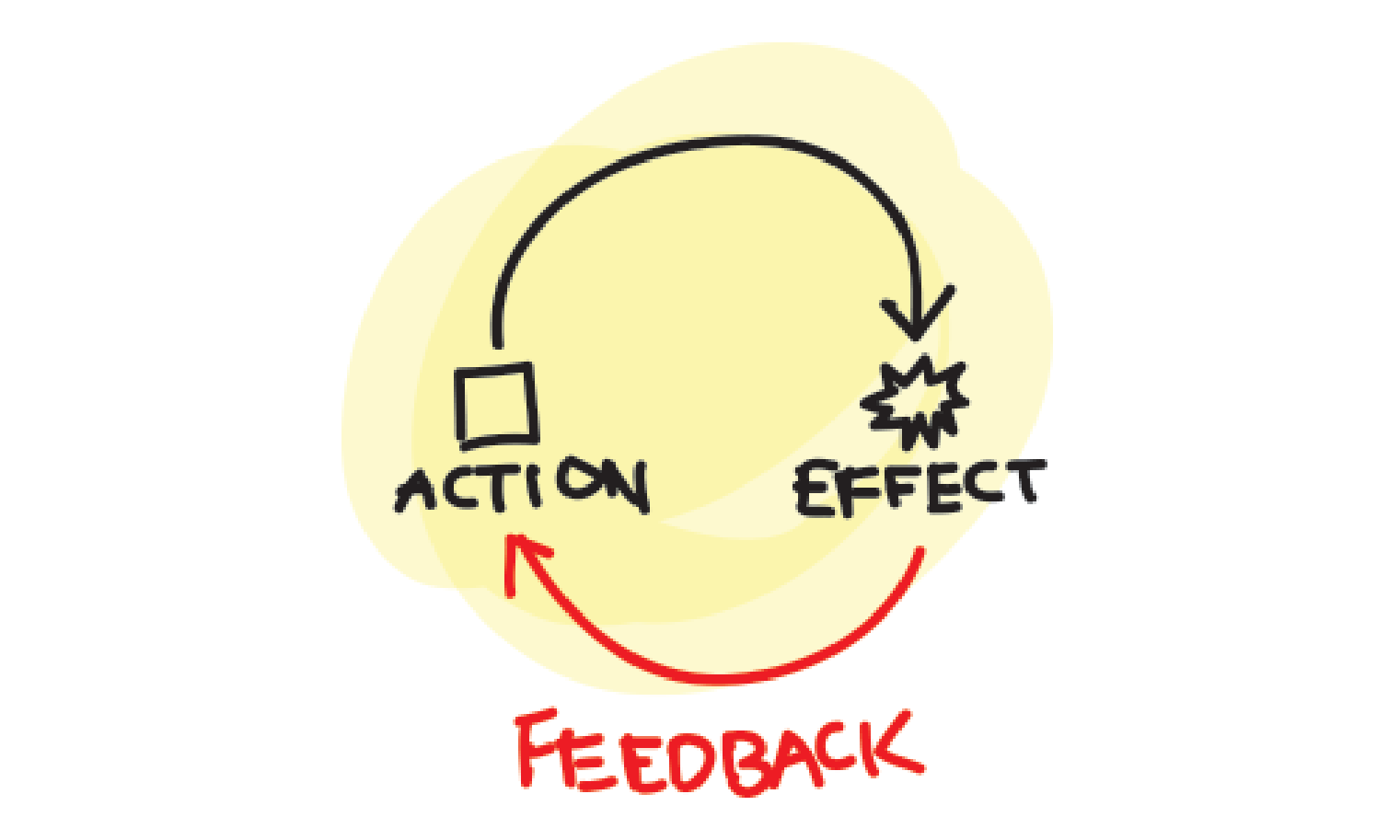
Bishop, C. M., Pattern recognition and machine learning (information science and statistics) (2006)

Assignments

- Modelling 35%
  - Linear regression
  - Non-linear & non-parametric regression
  - Unsupervised learning
  - Evidence
- Inference 15%
  - sampling/stochastic inference
  - variational inference
  - amortised inference

Labs

Feedback



Exam

- Multiple choice
- understanding
- conceptual aspects
- 50% of grade

Webpage

https://carlhenrikek.github.io/COMS30007/

Summary

Summary

- Learning can only be done by assumptions
- Machine learning is the science for making "handles" to incorporate assumptions
- We will learn mathematical formulations of assumptions
- We will learn mathematical tools for updating assumptions from data

eof

References

Carl Benedikt Frey and Michael A. Osborne.
The future of employment: How susceptible are jobs to computerisation?
Technological Forecasting and Social Change, 114:254–280, January 2017.

Pierre Simon Laplace.
A philosophical essay on probabilities, 1814.

Christopher M. Bishop.
***Pattern Recognition and Machine Learning (Information Science and Statistics)*.**
Springer-Verlag New York, Inc., Secaucus, NJ, USA, 2006.