

AI Artificial Intelligence +

Wolfgang Karl Härdle
Xiaorui ZUO

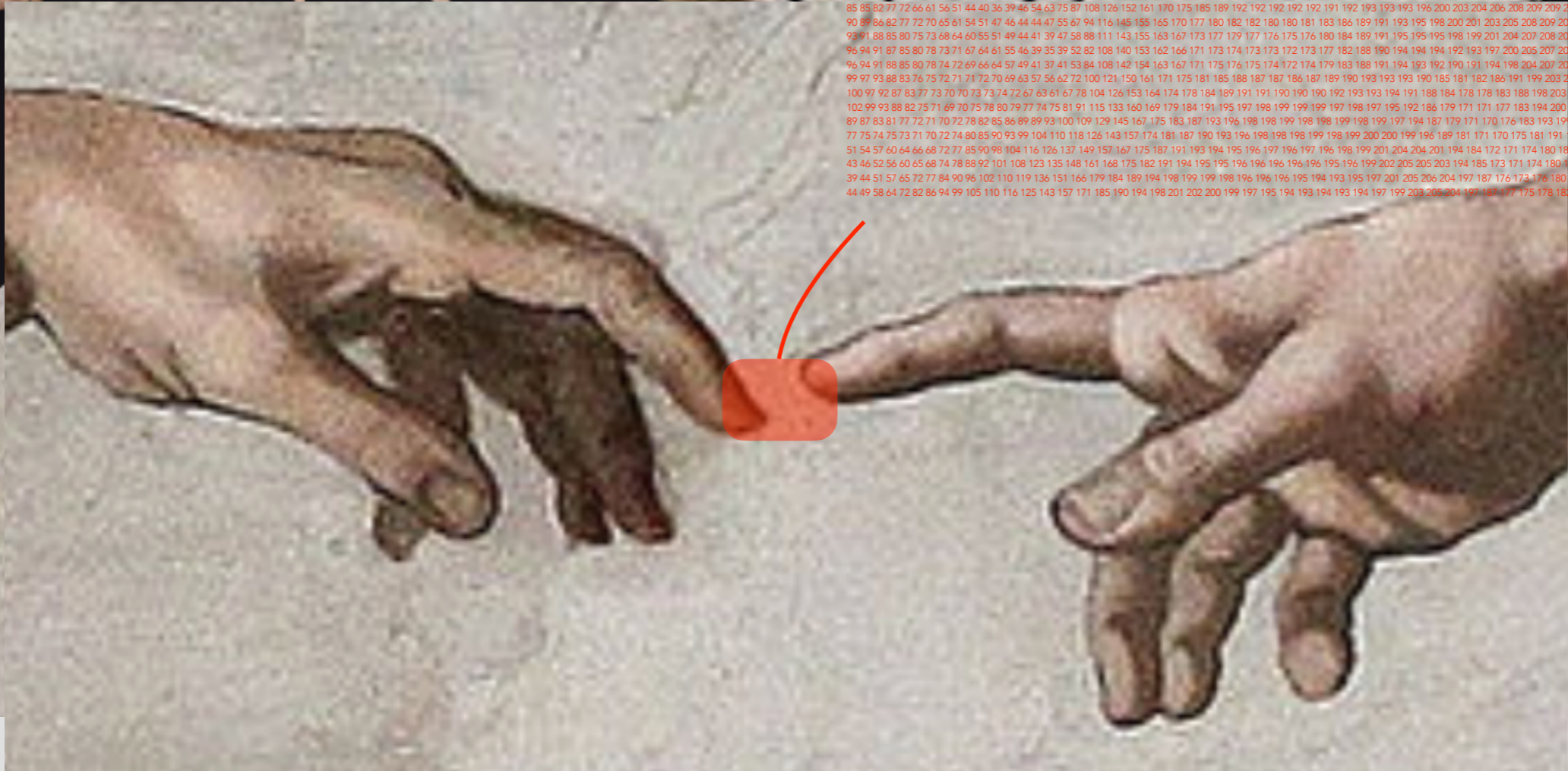
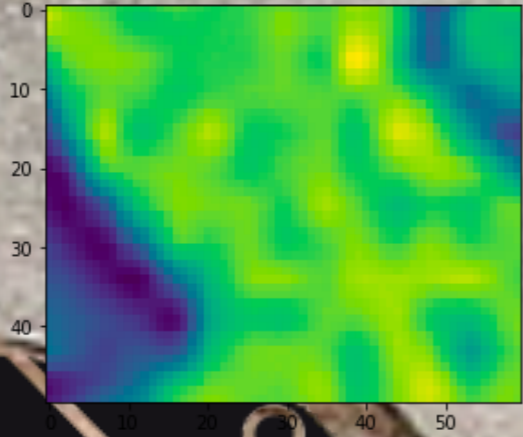
Ladislaus von Bortkiewicz Professor of Statistics
Humboldt-Universität zu Berlin
blockchain-research-center.com



ASE, Charles U, SKBI SMU, ACI NUS, NYCU 玉山學者

AI, AI+, AI++, ...

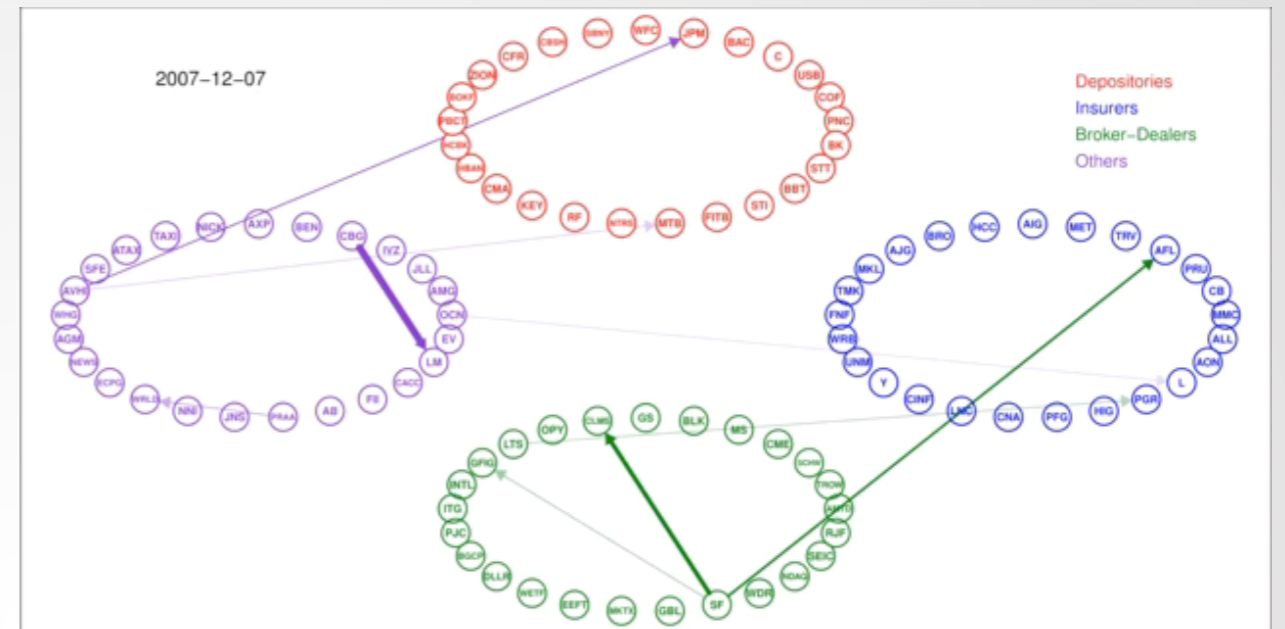
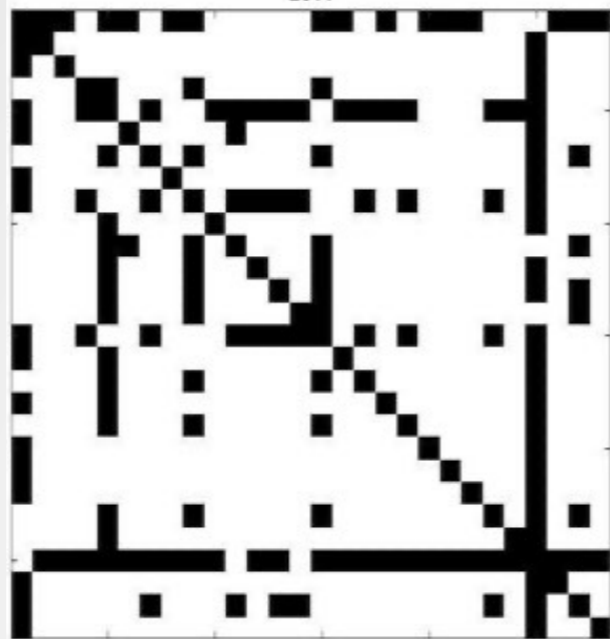
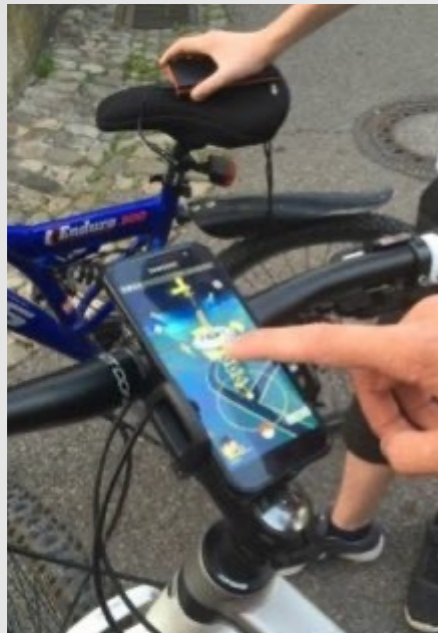
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AI in daily life



Micro to Macro to Math

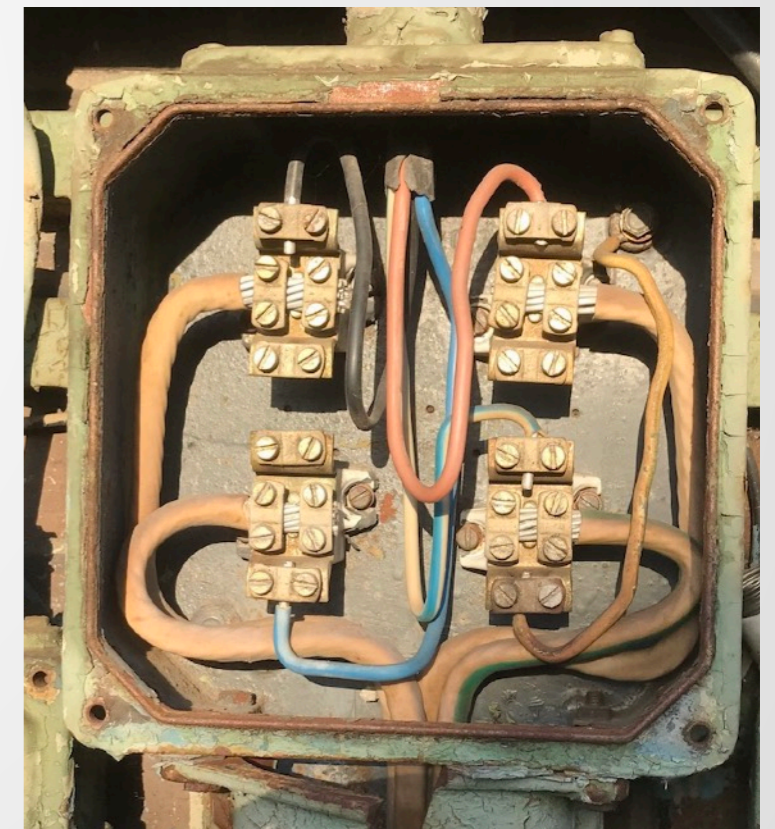


- AI connects, empowers and exposes individuals
- Dynamic interactions ask for smart data science
- Digital society creates new business relations



Basic element of Artificial Intelligence

...is a buzzer or a switch!



Combined with other switches ...

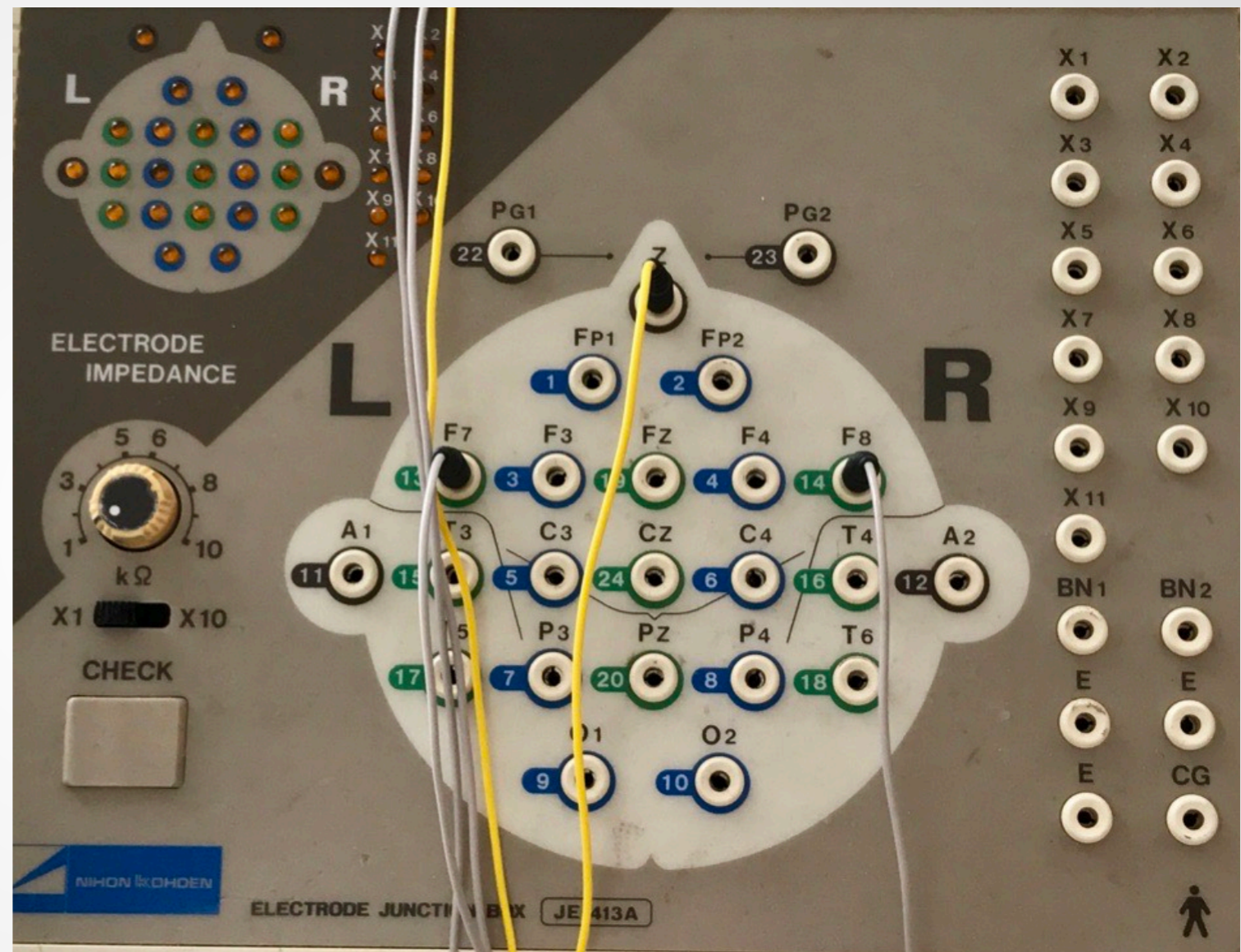


Basic elements combined

...it can do complex stuff!

...like recording an EEG

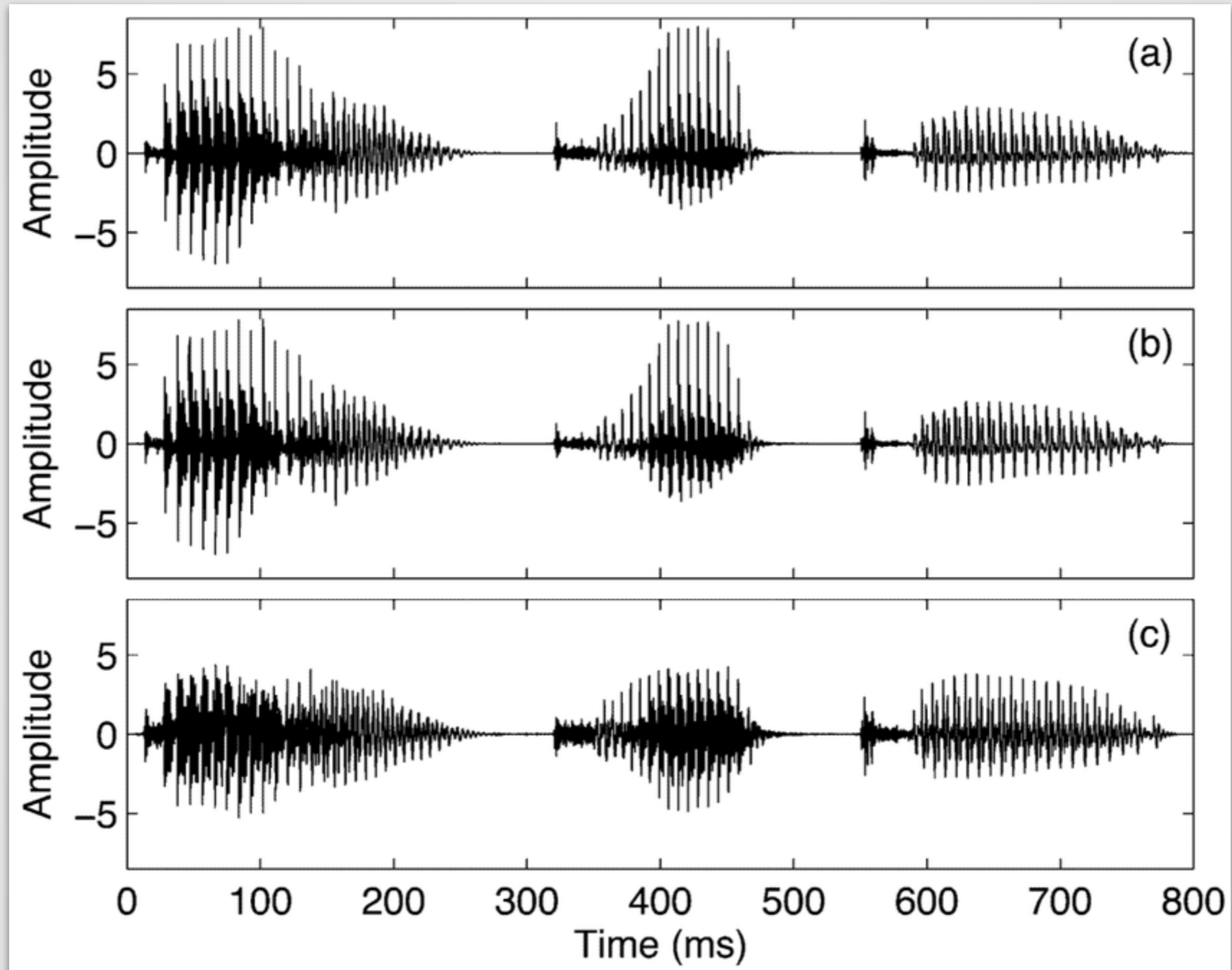
...classifying it



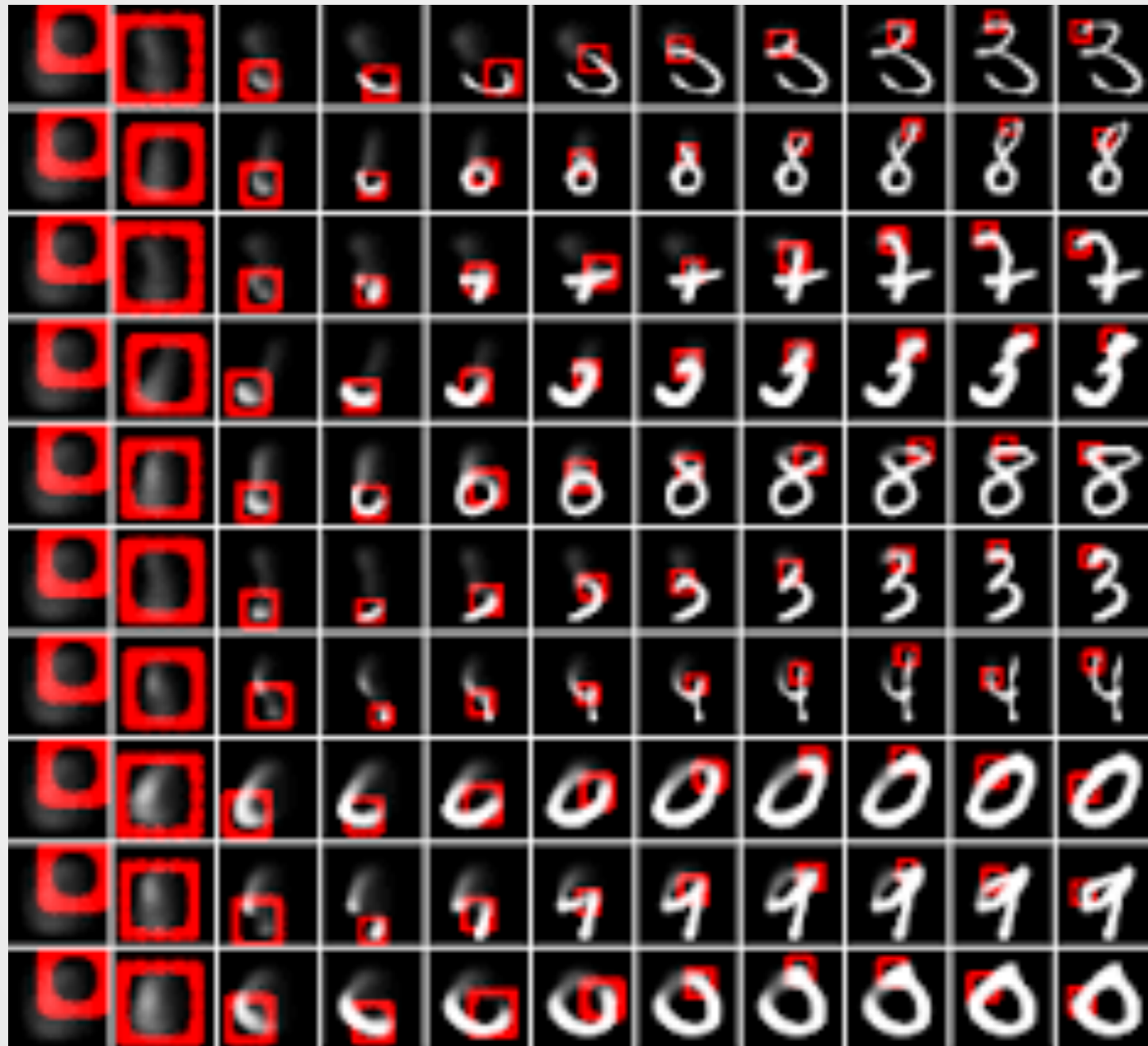
...and propose diagnostic follow ups!



AI is good at: EEG, speech, handwriting, ...



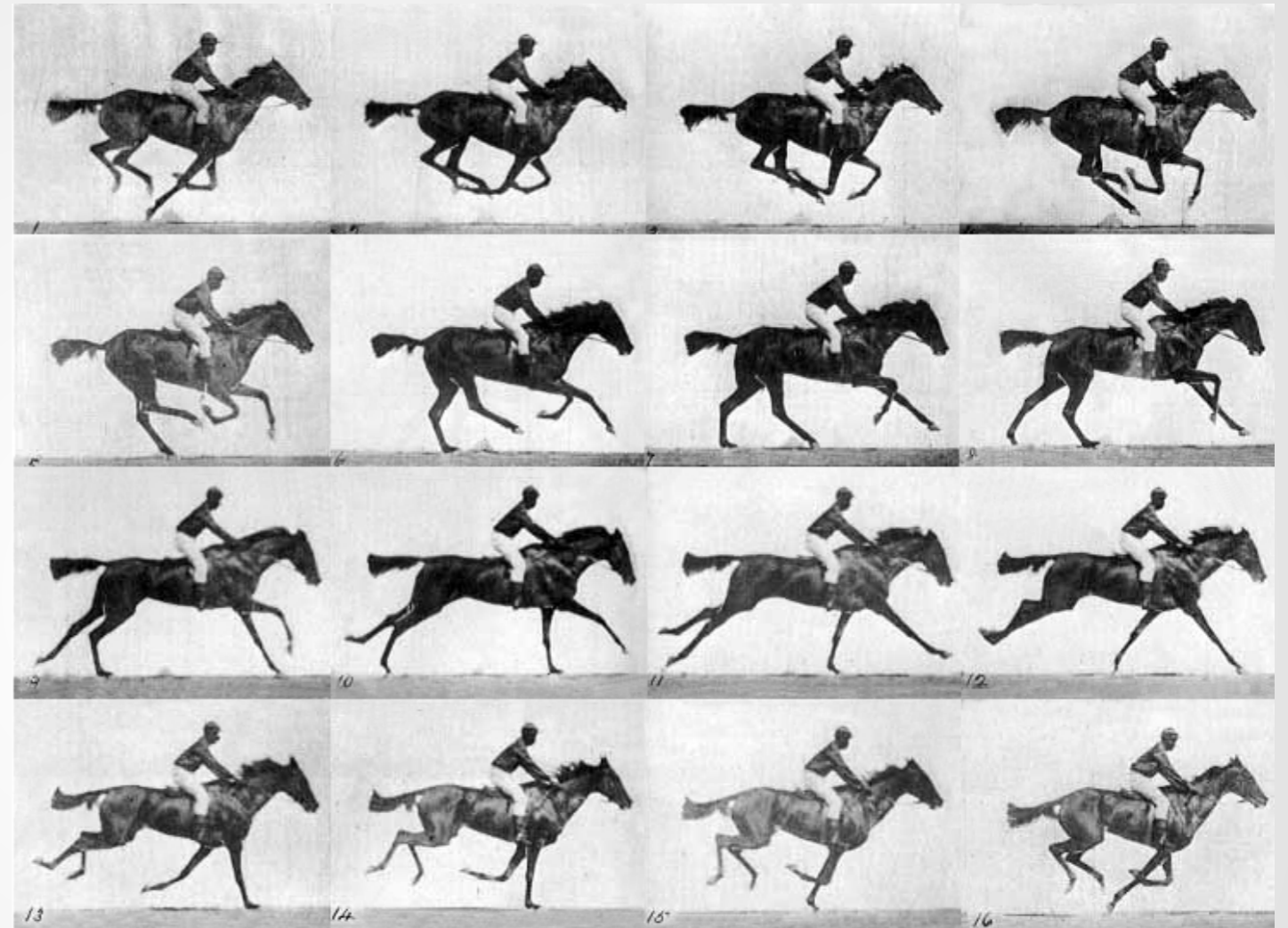
AI is good at: speech, handwriting, movies, ...



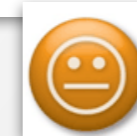
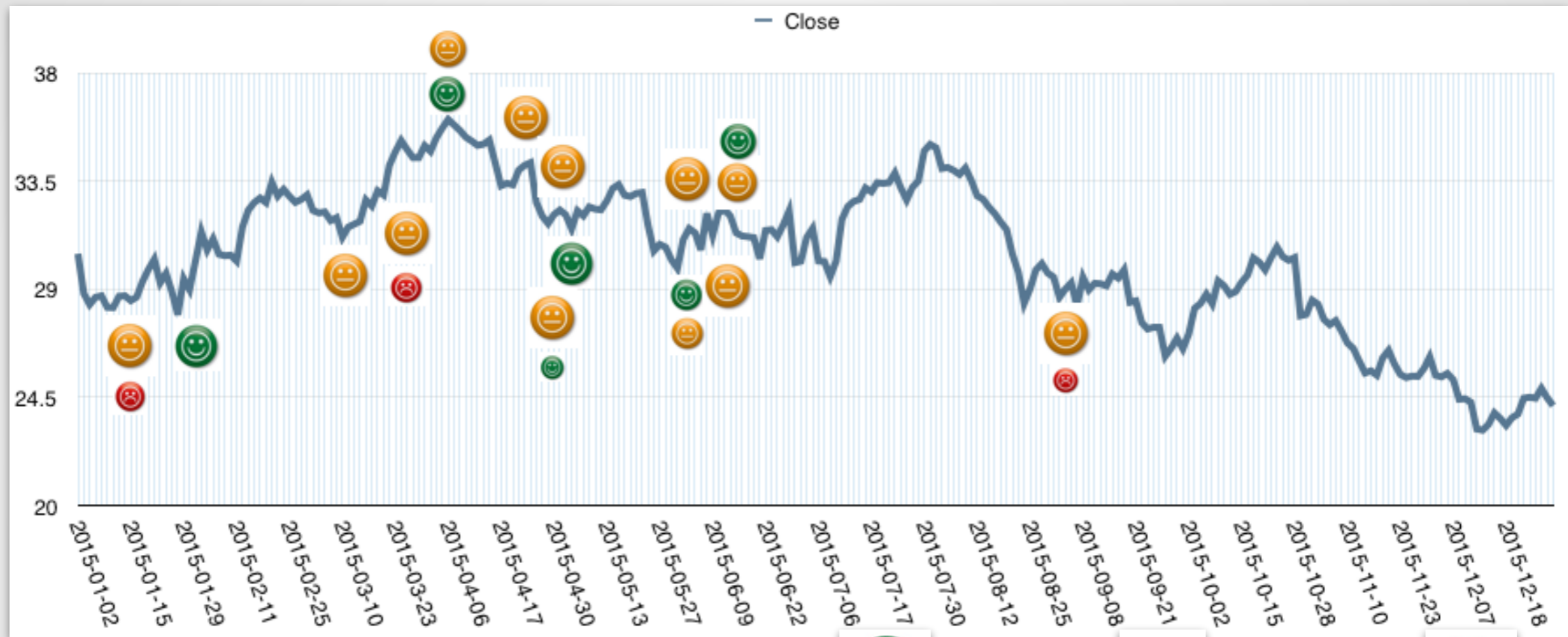
A trained DRAW network generating MNIST digits:
Each row shows successive stages in the generation of a single digit



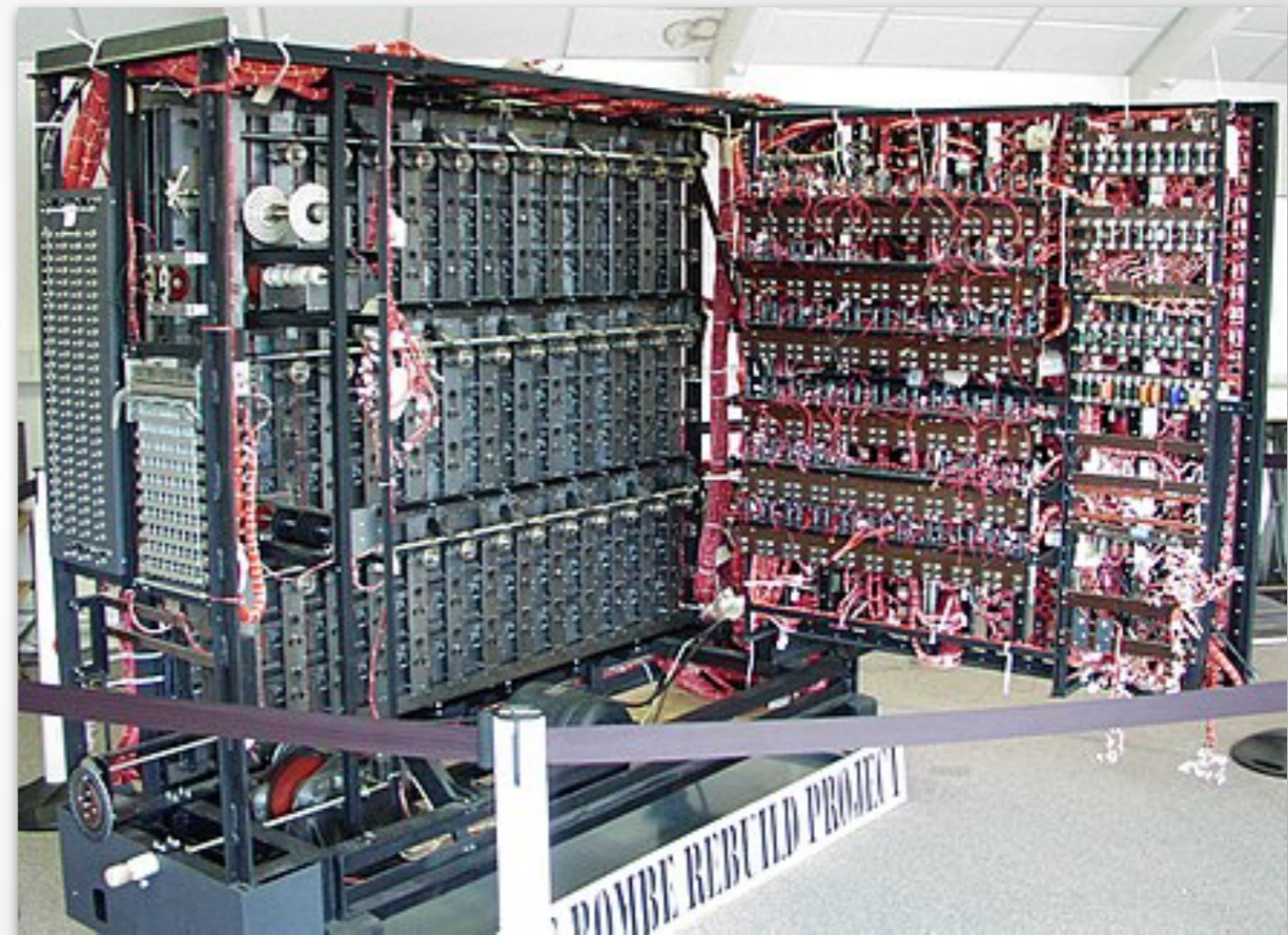
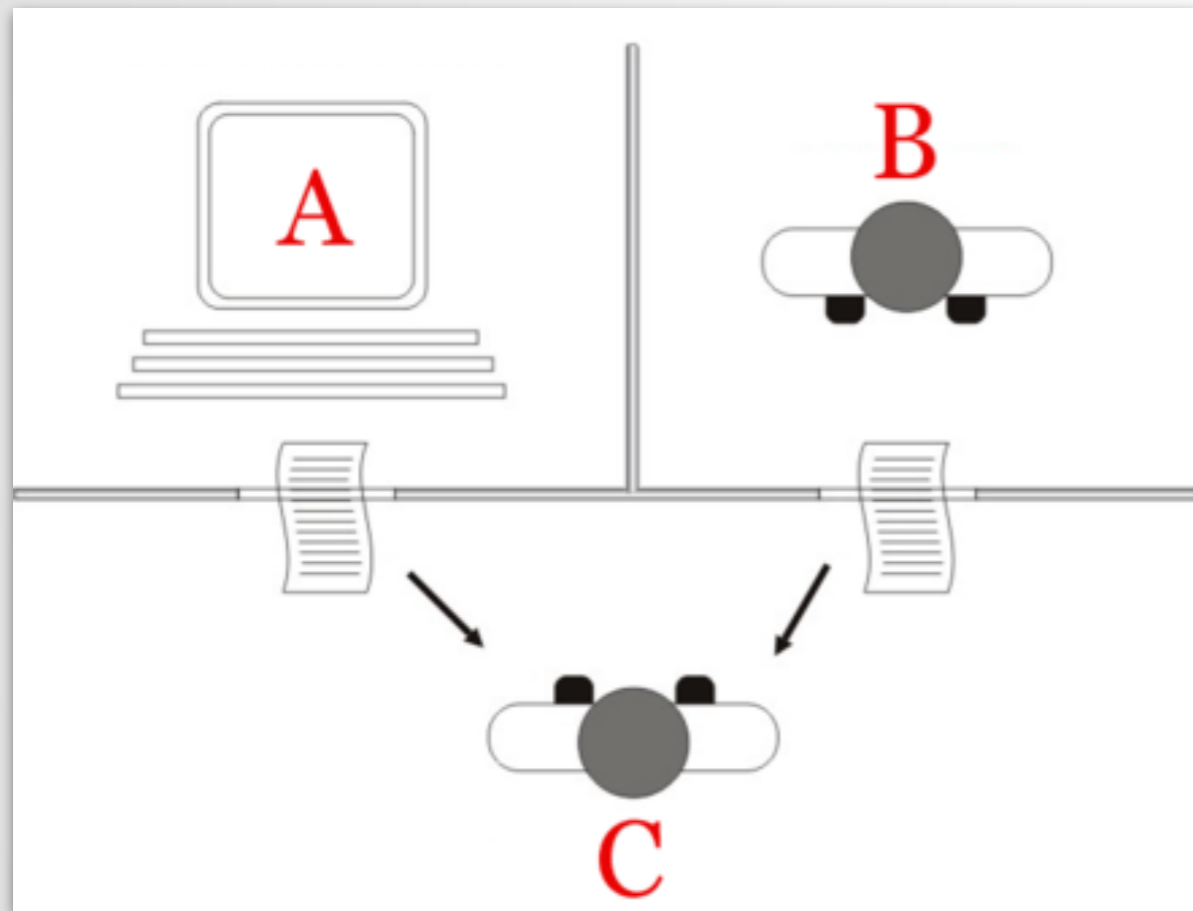
AI is good at: movies, x-rays, faces, ...



AI is good at: x-rays, face values, circuits, ...



AI is not human: Turing Test



Outline

1. Motivation ✓
2. AI applications
3. AI Details
4. AI -> ?
5. References



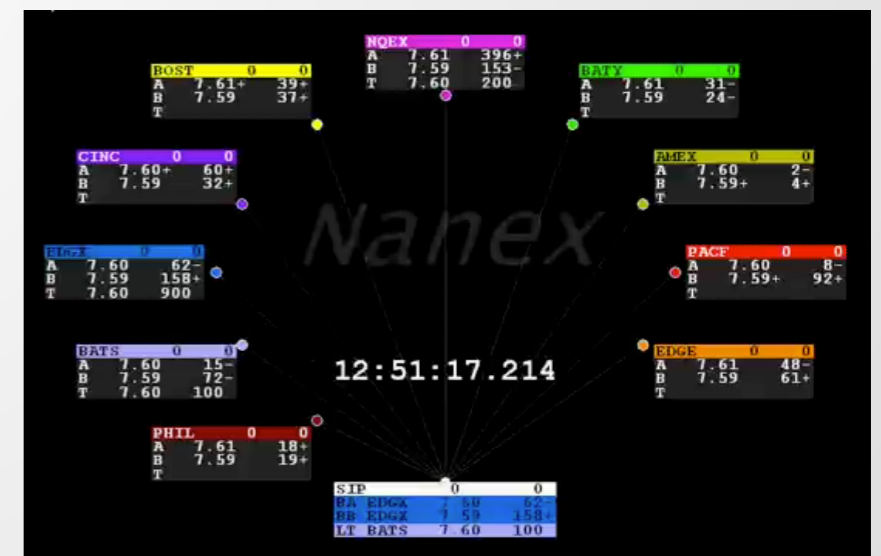
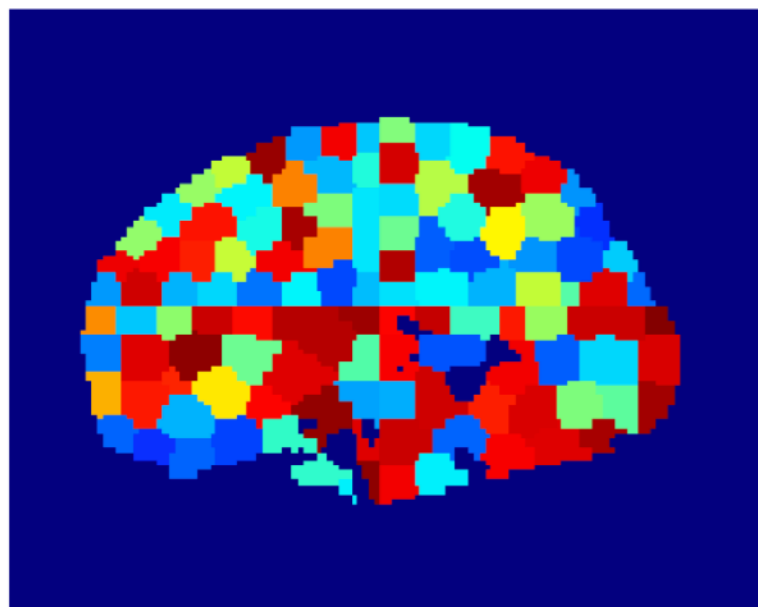
Risk Perception

Chen Y, Härdle WK, Qiang H, Majer, P (2018) Risk Related Brain Regions Detected with 3D Image FPCA

- MRI brain records 1M data points per 2 sec
- MRI on RPID tasks correlates with RP
- Stationary inputs, AI copies your RP!



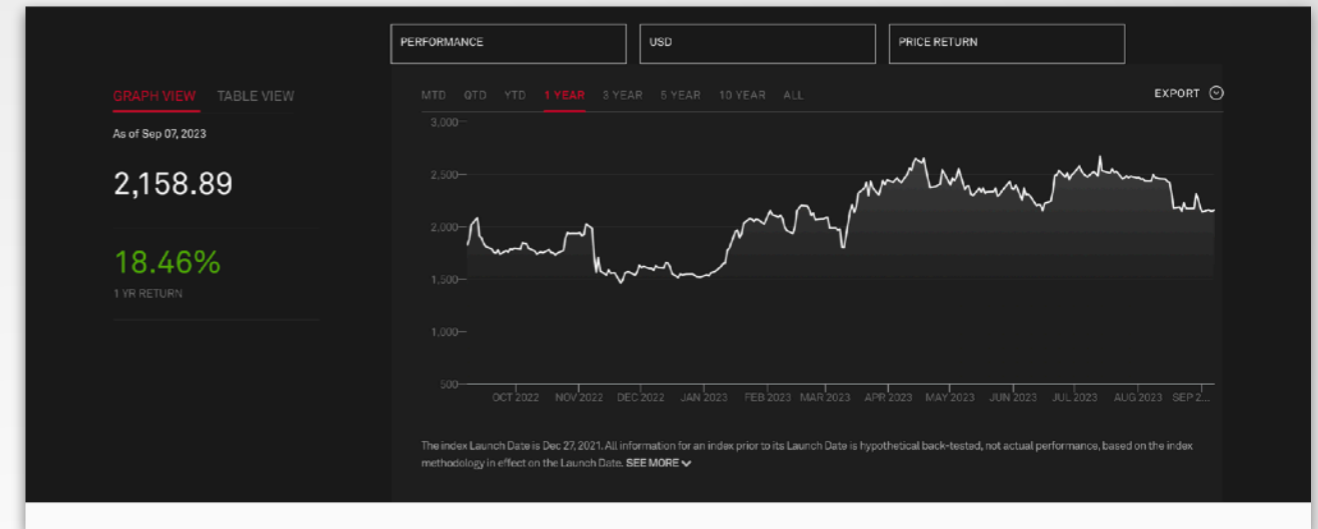
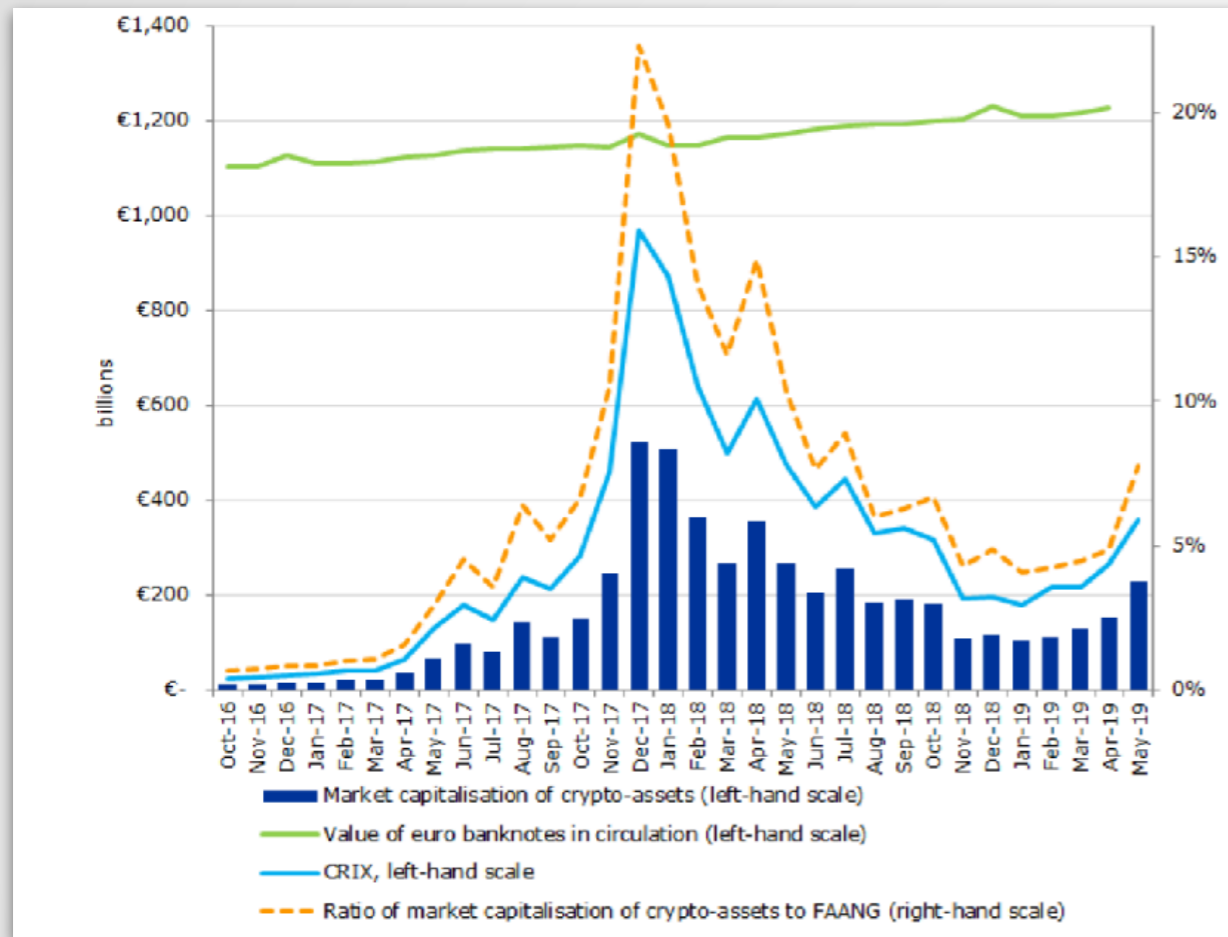
bullish?



https://www.youtube.com/watch?v=NRUCWlosL_k



Portfolio Optimisation



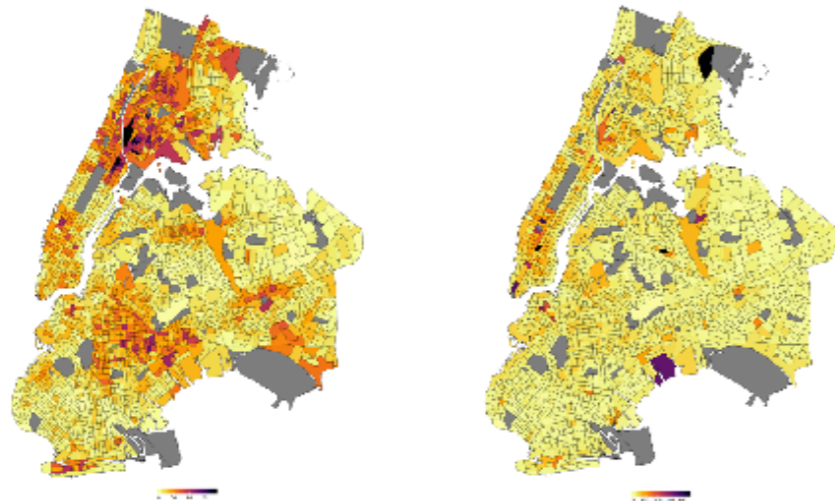
Royalton Partners



- CRYPTOCURRENCY INDEX / CRIX
- An ECB benchmark index
- Used by ETFs and Investment funds



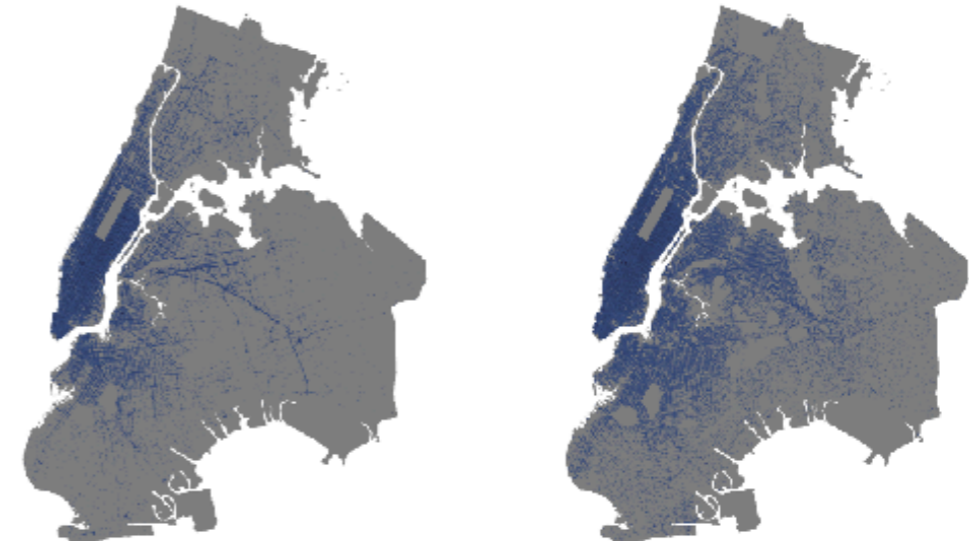
Smart City Predictive Policing



(a) Violent Crime

(b) Property Crime

Figure 1: Number of crime incidents between June and November 2015. In the property crime map, the area around Penn Station (largest outlier with 2002 incidents) is excluded for more consistent colour scaling.



(a) Pickups

(b) Dropoffs

Figure 2: Coordinates of complete taxi trips in New York City in week 46 in 2015.

- ▣ Taxi, Twitter (X) data
- ▣ Property crime
- ▣ Prediction accuracy improves by 19%

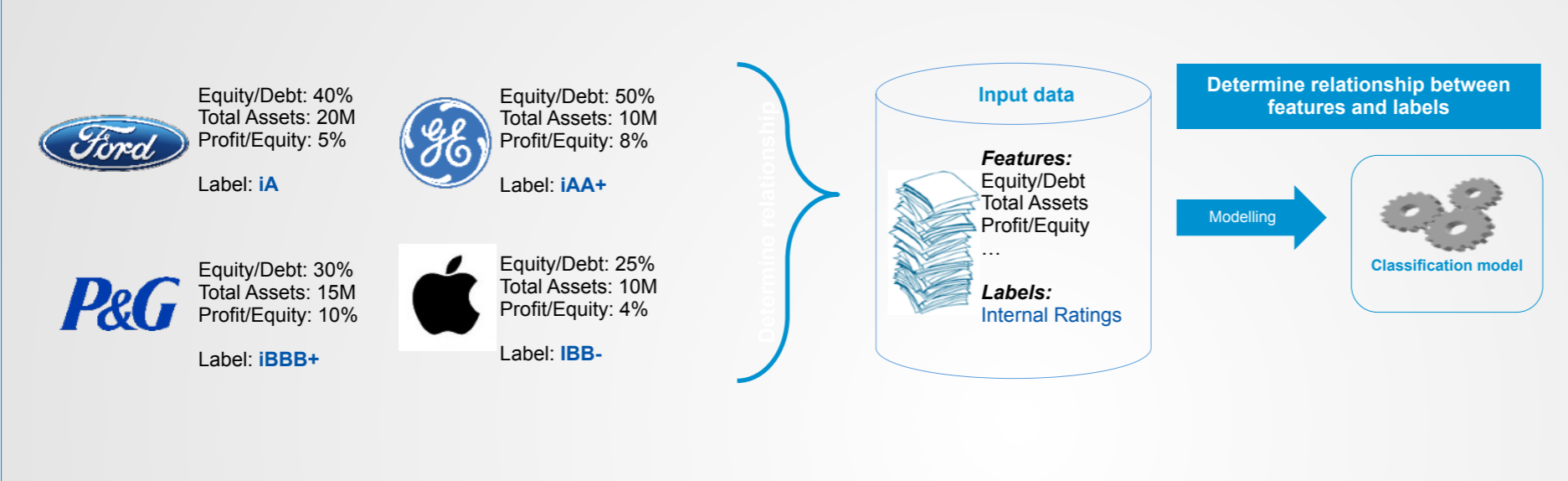


Corporate Credit Rating

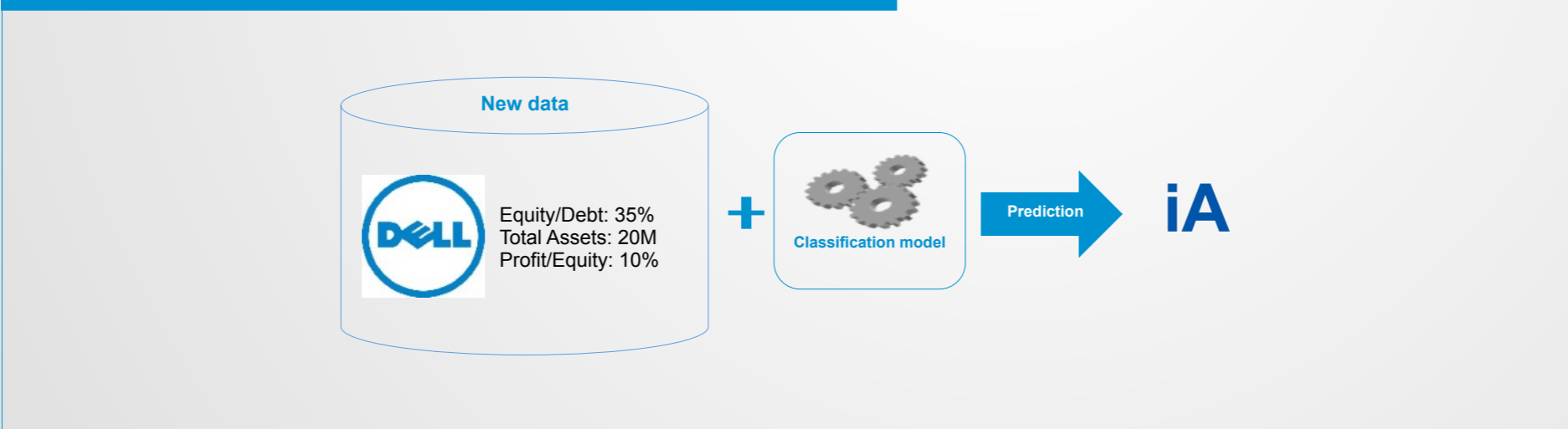
... as a Supervised Learning Problem



Use labeled data points to train the model¹



Use trained model to predict the label of new data points¹

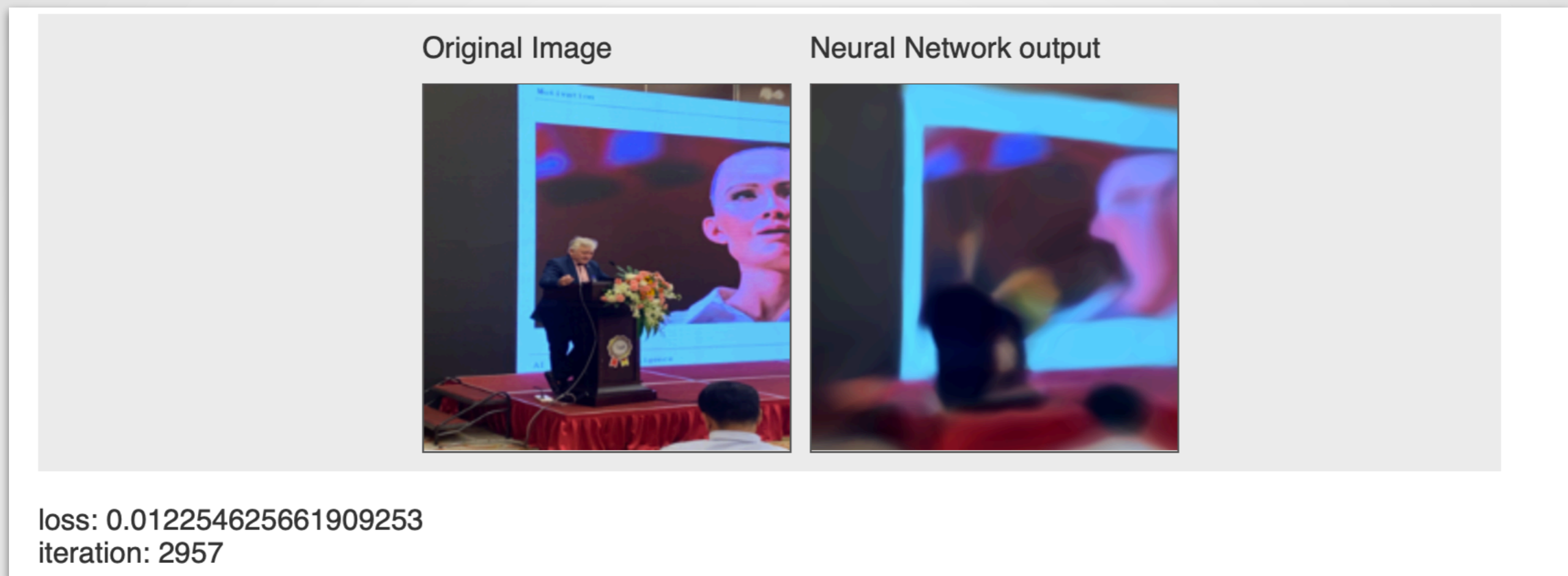


Internal DB Rating	Assigned PD in %
iAAA	> 0.00, ≤ 0.01
iAA+	> 0.01, ≤ 0.02
iAA	> 0.02, ≤ 0.03
iAA-	> 0.03, ≤ 0.04
iA+	> 0.04, ≤ 0.05
iA	> 0.05, ≤ 0.07
iA-	> 0.07, ≤ 0.11
iBBB+	> 0.11, ≤ 0.18
iBBB	> 0.18, ≤ 0.30
iBBB-	> 0.30, ≤ 0.50
iBB+	> 0.50, ≤ 0.83
iBB	> 0.83, ≤ 1.37
iBB-	> 1.37, ≤ 2.27
iB+	> 2.27, ≤ 3.75
iB	> 3.75, ≤ 6.19
iB-	> 6.19, ≤ 10.22
iCCC+	> 10.22, ≤ 16.87
iCCC	> 16.87, ≤ 27.84
iCCC-	> 27.84, ≤ 99.99

¹Depicted company characteristics and internal ratings were set arbitrarily and do not reflect real data.



AI draws pictures

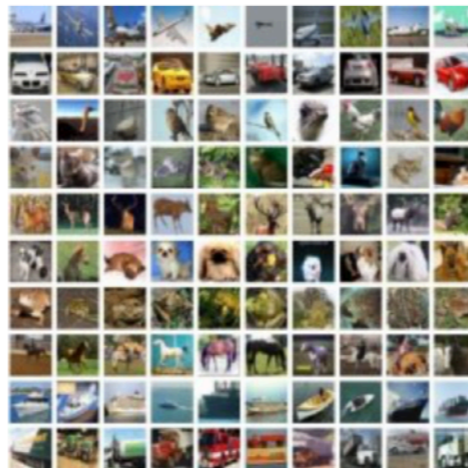


<https://cs.stanford.edu/people/karpathy/convnetjs/>

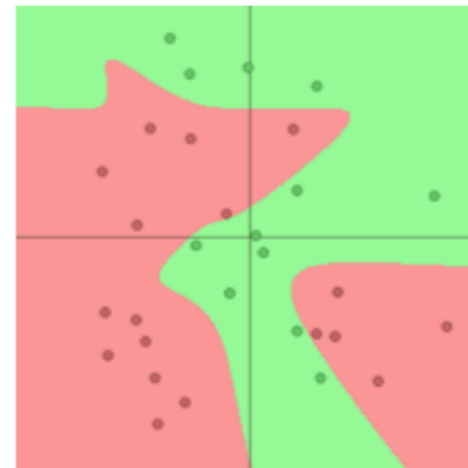
[Classify MNIST digits with a Convolutional Neural Network](#)



[Classify CIFAR-10 with Convolutional Neural Network](#)

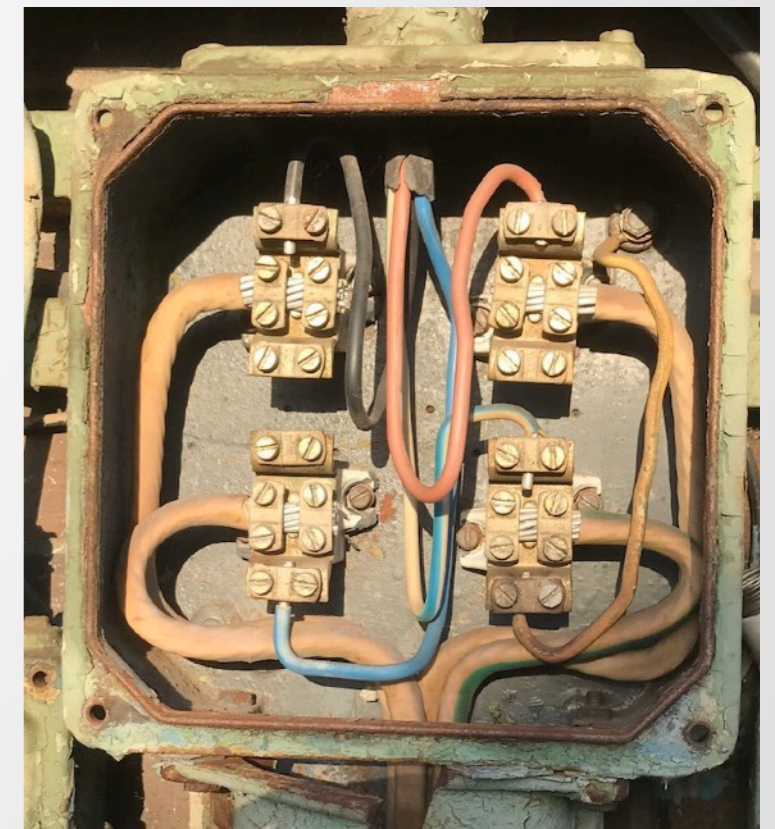


[Interactively classify toy 2-D data with a Neural Network](#)



Basic element of Artificial Intelligence

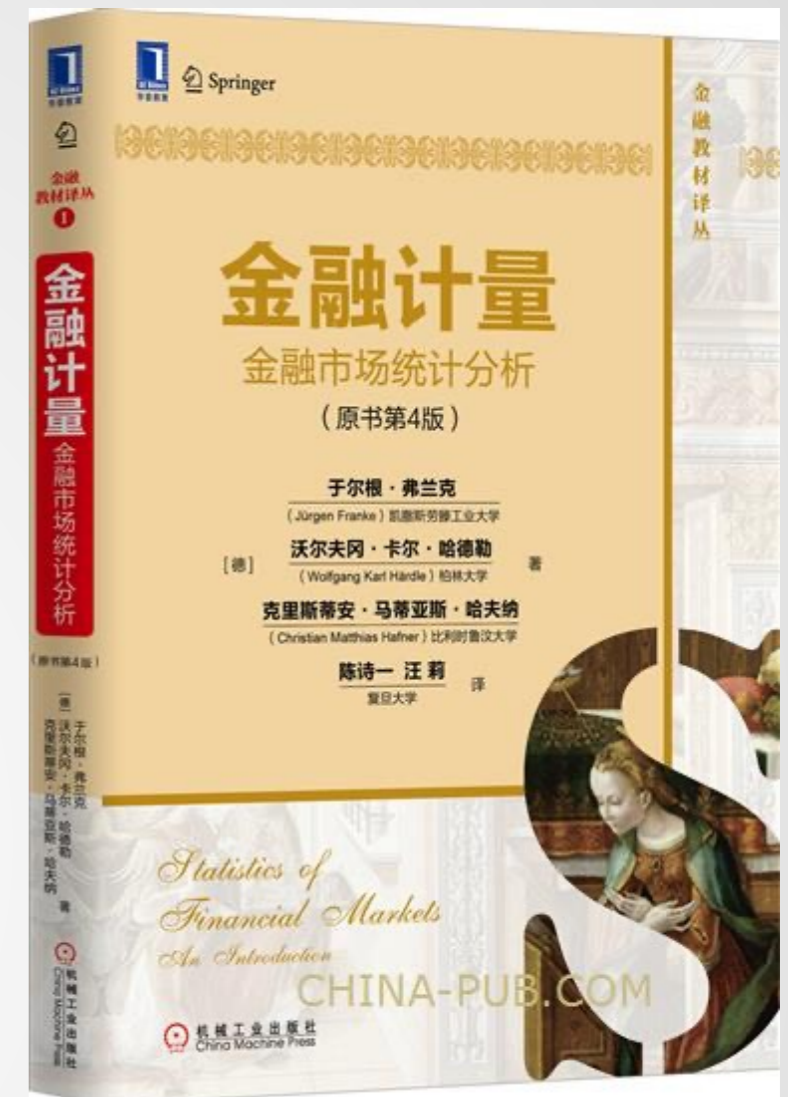
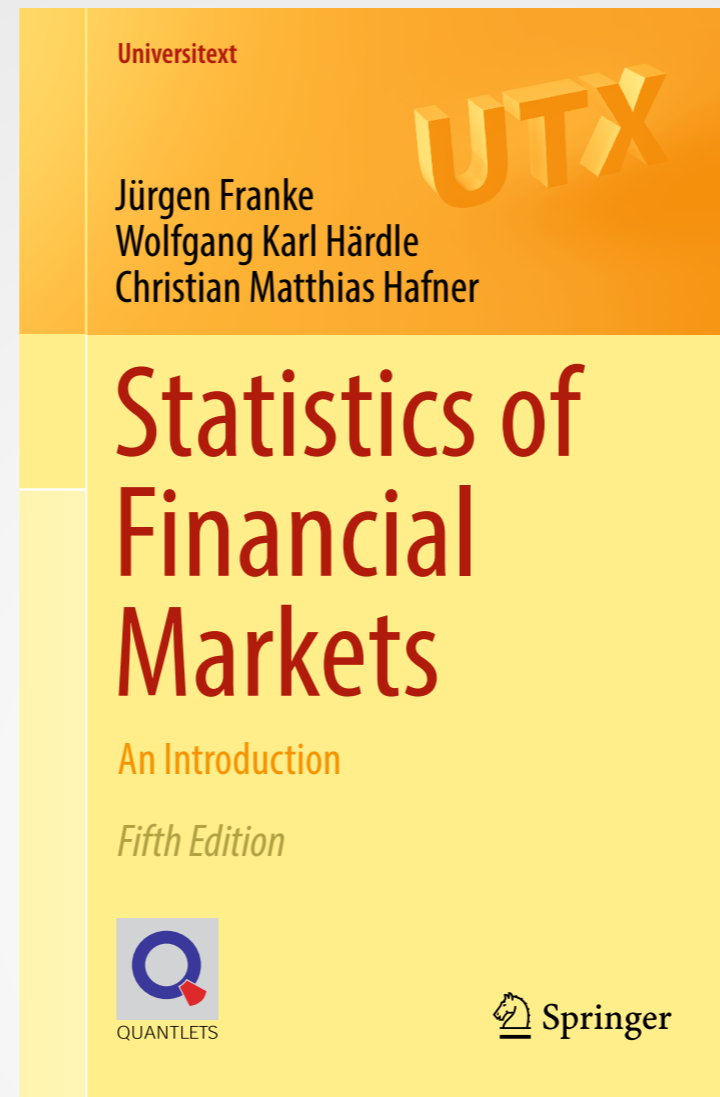
...is a buzzer or a switch!



Combined with other switches ...



The perceptron



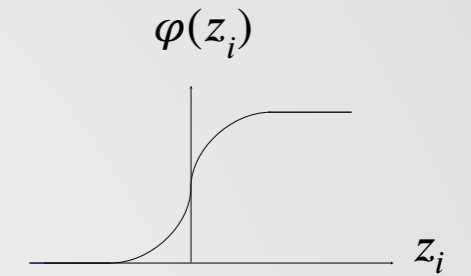
- Mimic human biological neurons
- Apply linear threshold operations
- The output is the perceptron



Neural Network

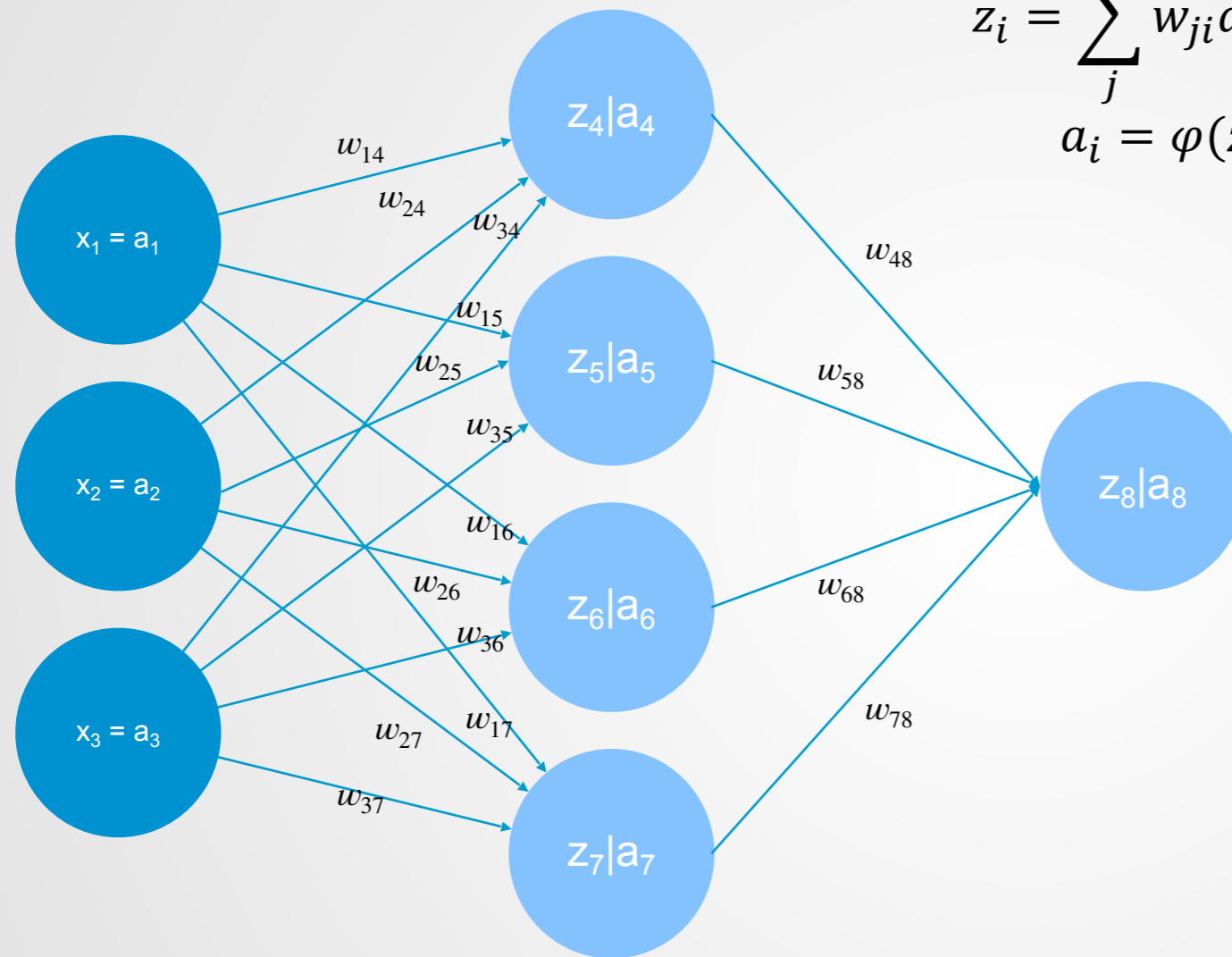
Example: 2-Layer Feed-Forward NN for Binary Classification

Activation function : e.g. sigmoid



$$z_i = \sum_j w_{ji} a_j + b_i$$

$$a_i = \varphi(z_i)$$



Input Layer

Hidden Layer

Output Layer

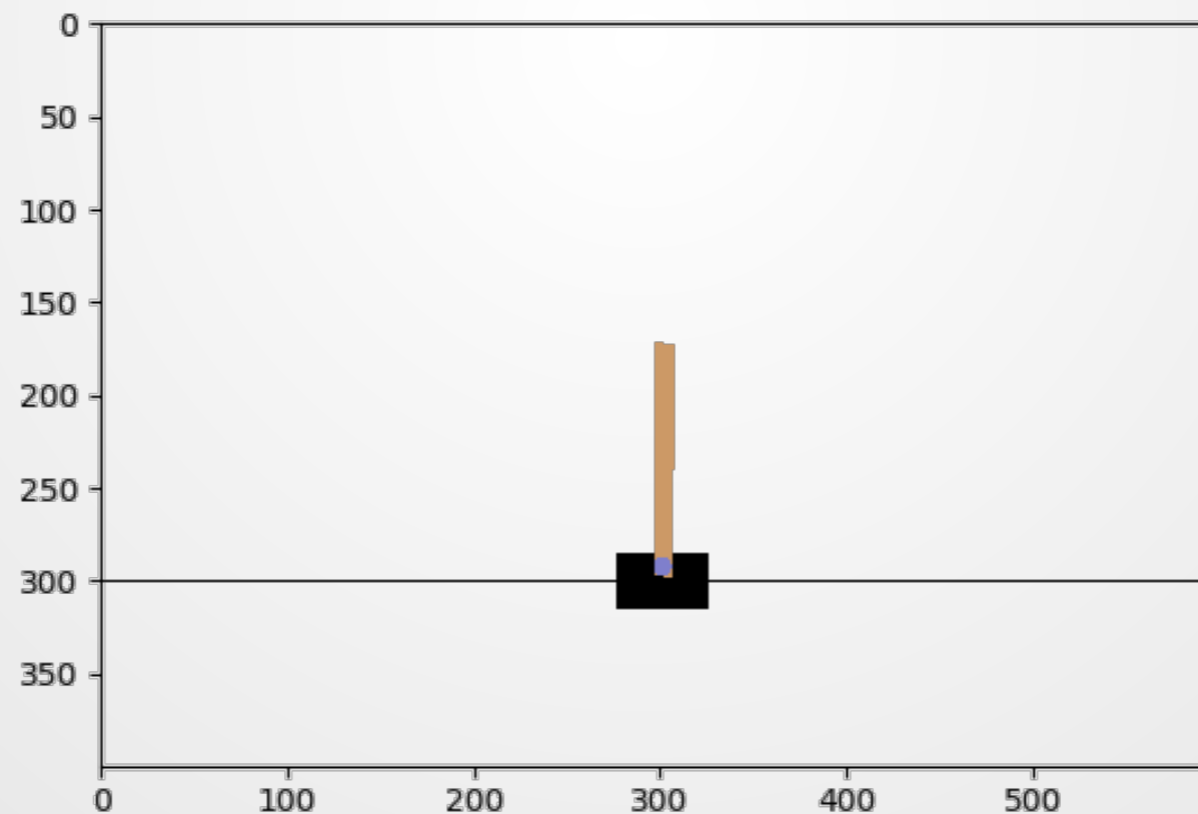
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iAA	> 0.02, ≤ 0.03
iAA-	> 0.03, ≤ 0.04
iA+	> 0.04, ≤ 0.05
iA	> 0.05, ≤ 0.07
iA-	> 0.07, ≤ 0.11
iBBB+	> 0.11, ≤ 0.18
iBBB	> 0.18, ≤ 0.30
iBBB-	> 0.30, ≤ 0.50
iBB+	> 0.50, ≤ 0.83
iBB	> 0.83, ≤ 1.37
iBB-	> 1.37, ≤ 2.27
iB+	> 2.27, ≤ 3.75
iB	> 3.75, ≤ 6.19
iB-	> 6.19, ≤ 10.22
iCCC+	> 10.22, ≤ 16.87
iCCC	> 16.87, ≤ 27.84
iCCC-	> 27.84, ≤ 99.99



Example: Cartpole

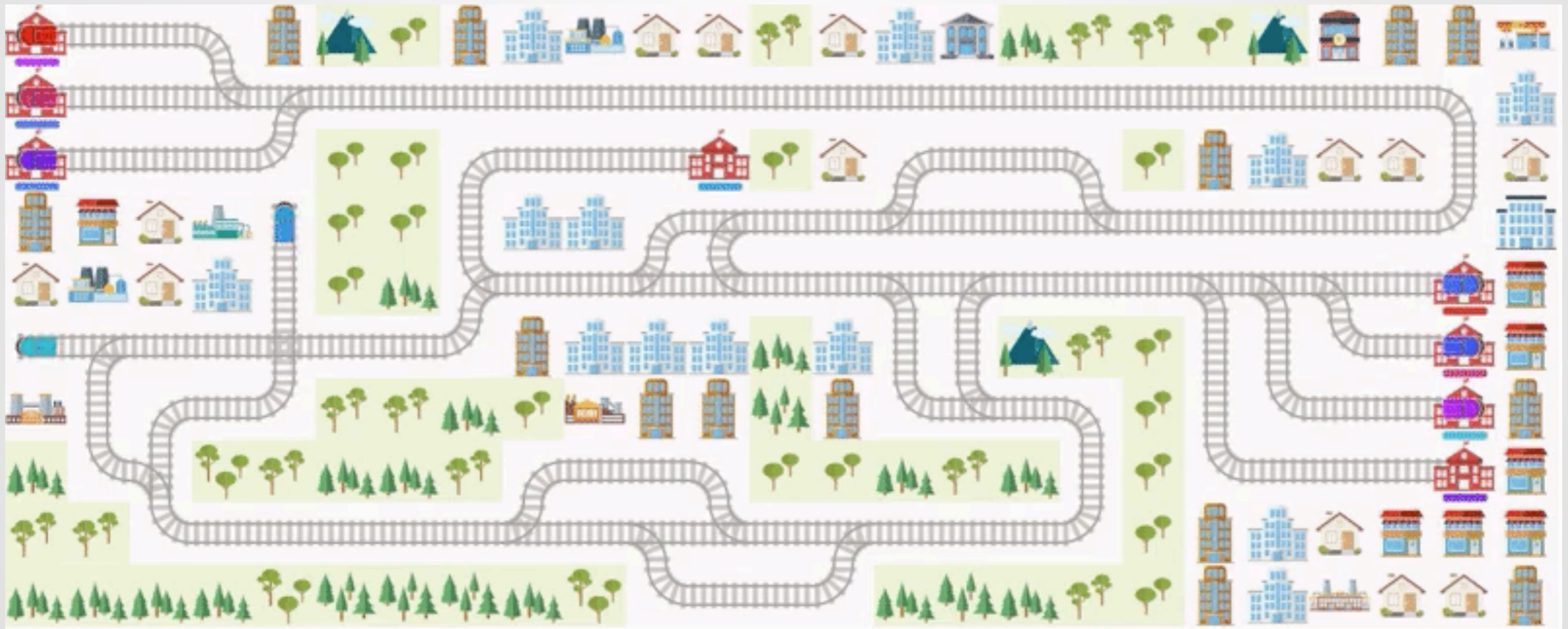
- Balance the stick, so it won't fall over
- Reward of 1 for every frame the stick is being balanced
- Only two possible actions: move left or right

Episode 438 frame 0



Reinforcement Learning

- Example: Railway simulation
 - ▶ Optimize transport for denser schedules and higher capacity
 - ▶ All trains need to reach their destinations as fast as possible



Rise of the machines



Cost per GB storage p/m

- 1981 - \$300,000
- 1987 - \$50,000
- 1990 - \$10,000
- 1994 - \$1,000
- 1997 - \$100
- 2000 - \$10
- 2004 - \$1
- 2010 - \$0.10
- 2017 - \$0.01
- 2018 - \$0.004
- 2023 - \$0.00099

<https://bnn.de/mittelbaden/buehl/das-buehler-rathaus-soll-moeglichst-schnell-papierlos-werden>



Blockchain

- ▣ Computers
- ▣ Digital Economy
- ▣ New Models.DE



```
> library(digest)
> digest("blockchain", "sha256")
[1] "b960c3a766e37e8eaa76574f7bfd031b5d1fa63bfba8dc5004fa4d0a9eccbee1"
> digest("digital economy", "sha256")
[1] "7204ecd0b6c2d9f463822e081f54d9773ff53fbdc1752841f5d68d7e2a301127"
> digest("newmodels.DE", "sha256")
[1] "ae46ede37d5c0148f0327e67015ee63b797eb1d84258bff636ff4347793c62f9"
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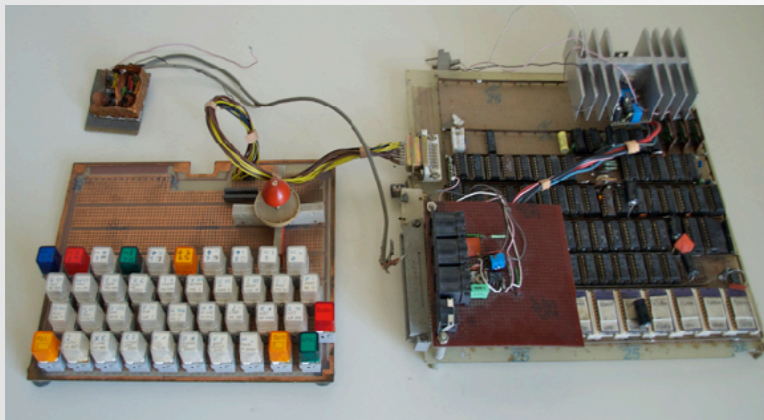


Rise of the machines

Mechanical calculator MADAS
H.W. Egli S.A., Zurich, 1965



VEB Röhrenwerk Mühlhausen, 1975
8 digits

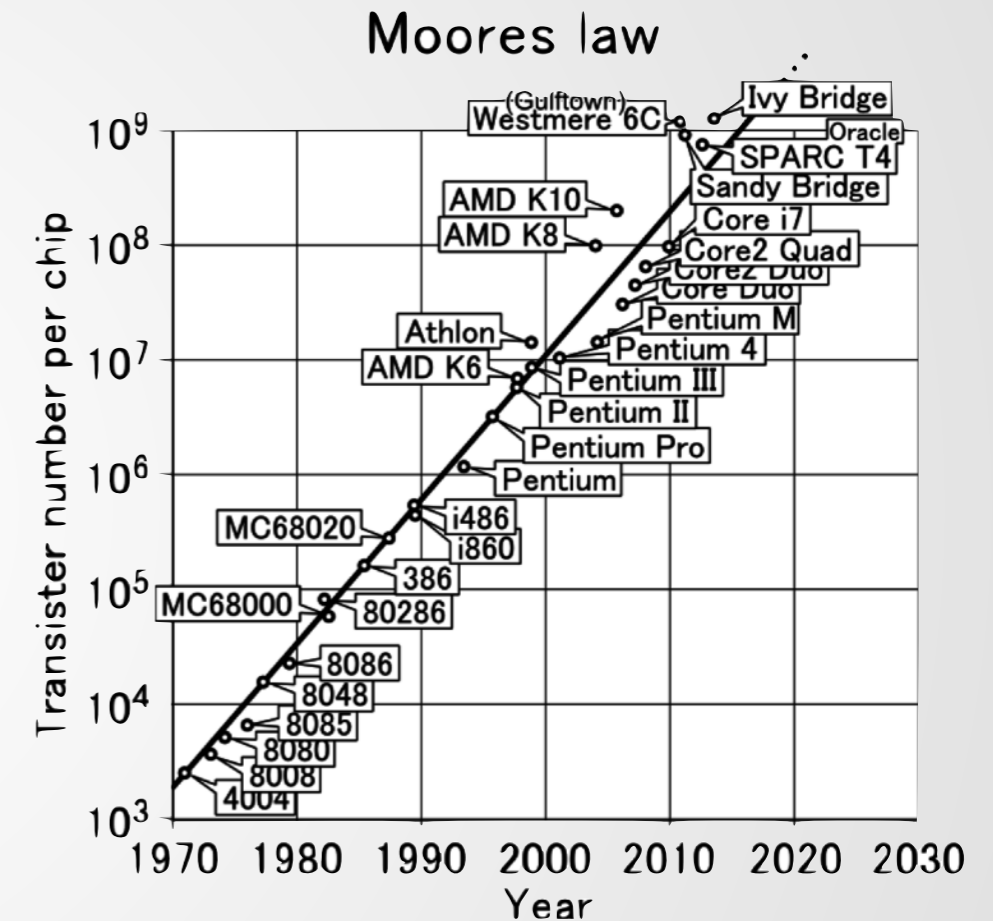


ZX Spectrum East / West 1982



<https://phys.org/news/2015-08-silicon-limits-power-electronics-revolution.html>

▣ <http://computermuseum.wiwi.hu-berlin.de>



Rise of the machines

- ▣ Cray 2: world's fastest supercomputer: 1985-1990
- ▣ 1.9 GFLOPs*
- ▣ 5,500 pounds
- ▣ \$32 million (current \$)
- ▣ 舞 锡市 太湖之光,
(wu3xi1 shi4tai4hu2zhi1 guang1)

95 PFLOPS**

- ▣ 1.102 ExaFLOPS ***

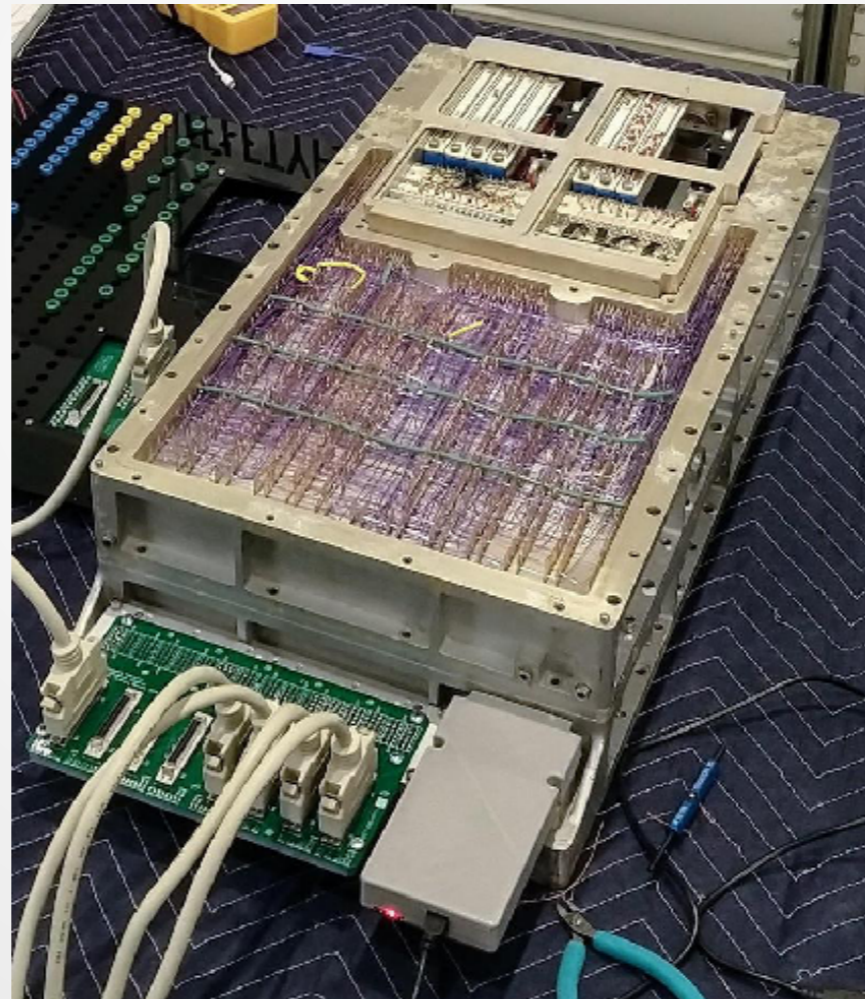
Frontier 1.1 exaFLOPS
Fugaku 0.442 exaFLOPS
Summit 0.2 exaFLOPS
Sierra 0.125 exaFLOPS

* 10^9 Floating point Operations/Sec ** 10^{15} FLOPS/sec *** 10^{18} FLOPS/sec



Rise of the machines

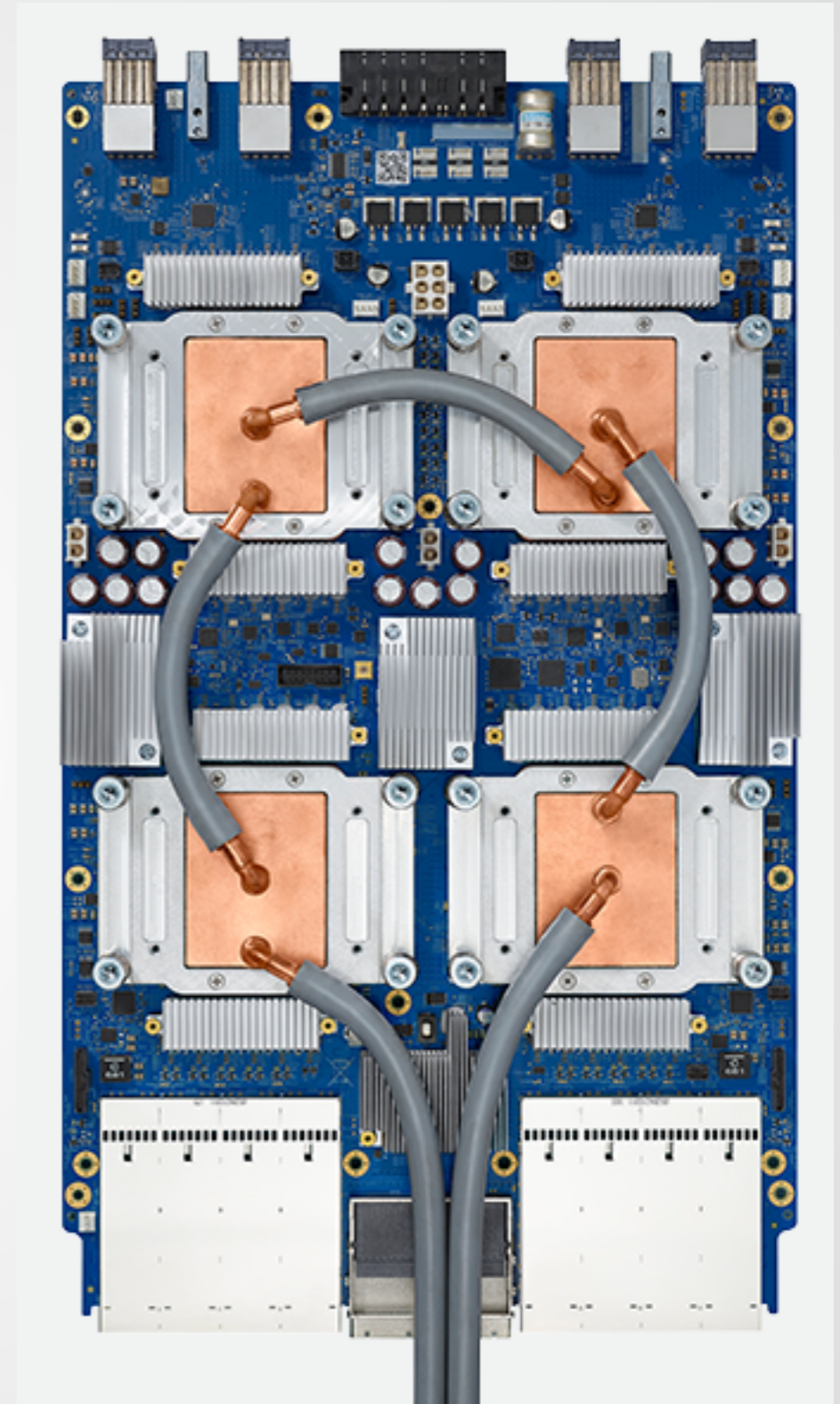
- ▣ 2016 iPhone 7, 178 GFLOPs
- ▣ 2021 iPhone 13 , 1200 GFLOPs
- ▣ 2024 iPhone 15, 1789.4 GFLOPs
- ▣ 171 g
- ▣ 945 EUR



Rise of the machines

- ▣ 2017 Nvidia Titan V
- ▣ 110 TFLOPs, 16 GB
- ▣ 1.1 K USD
- ▣ ASICs, Antminer
- ▣ Google's Tensor Processing Unit (TPUv2)
- ▣ 180 TFLOPs, 64GB per TPU
- ▣ TPUs important for MLE*

*MLE = „Maximum Likelihood Estimation“ (age \geq 45)
MLE = „Machine Learning in Economics“ (age \leq 45)



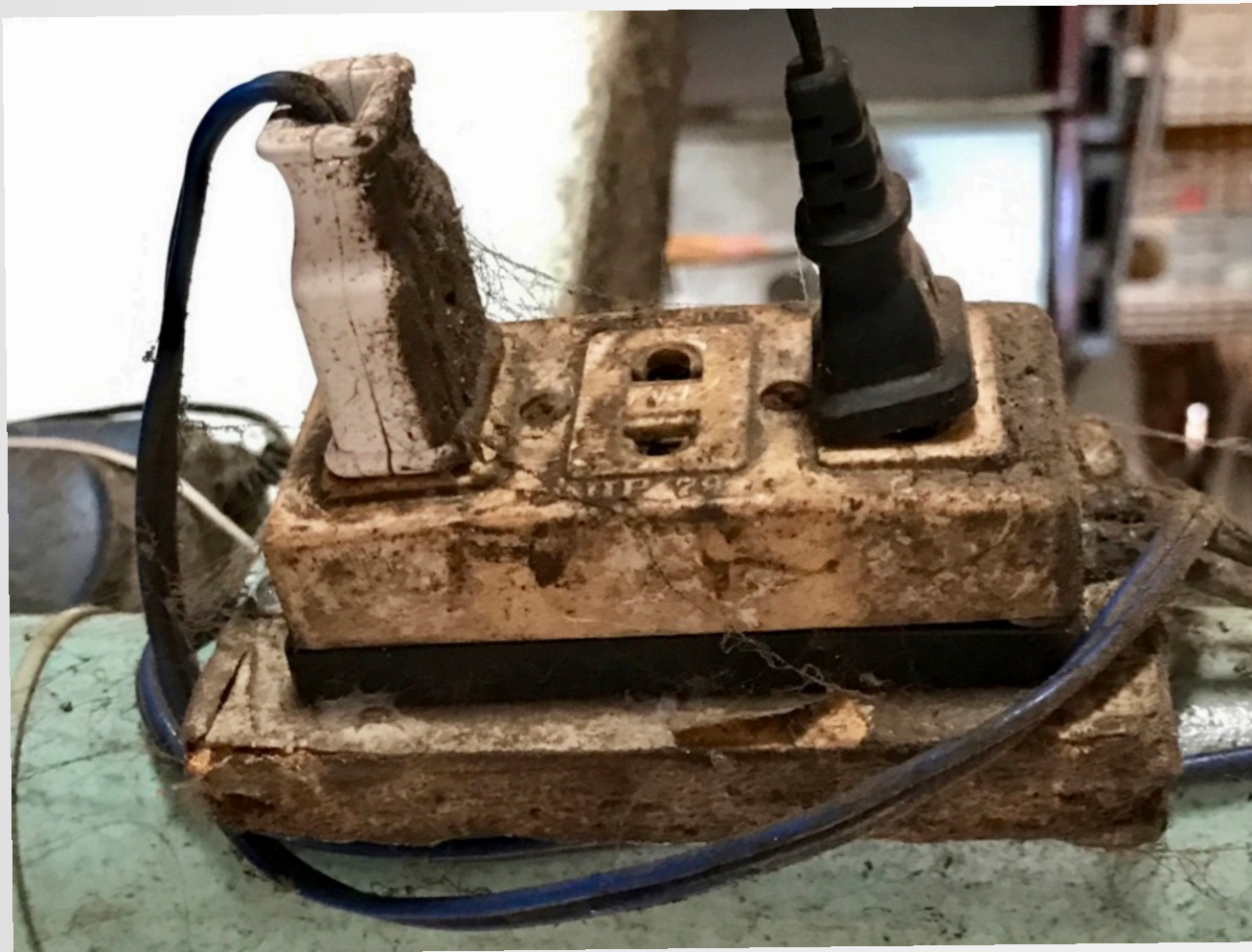
Infrastructure

- ▣ badly maintained switch
- ▣ corrupted node sequence
- ▣ biased training sample



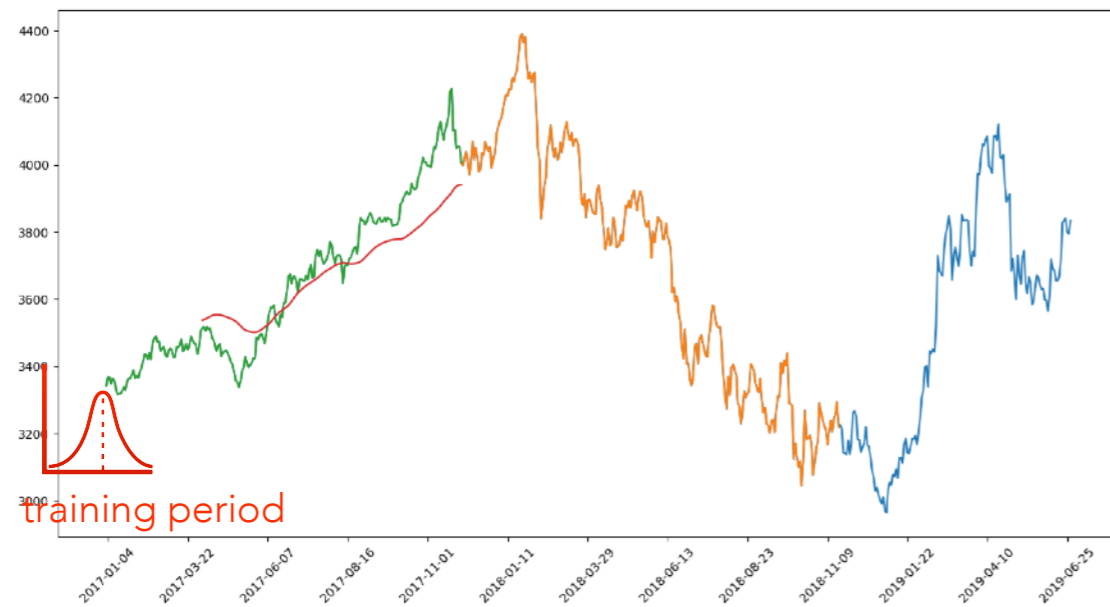
Maintenance

- ❑ do not overweigh your switch
- ❑ keep the electricity running
- ❑ invest in human brains



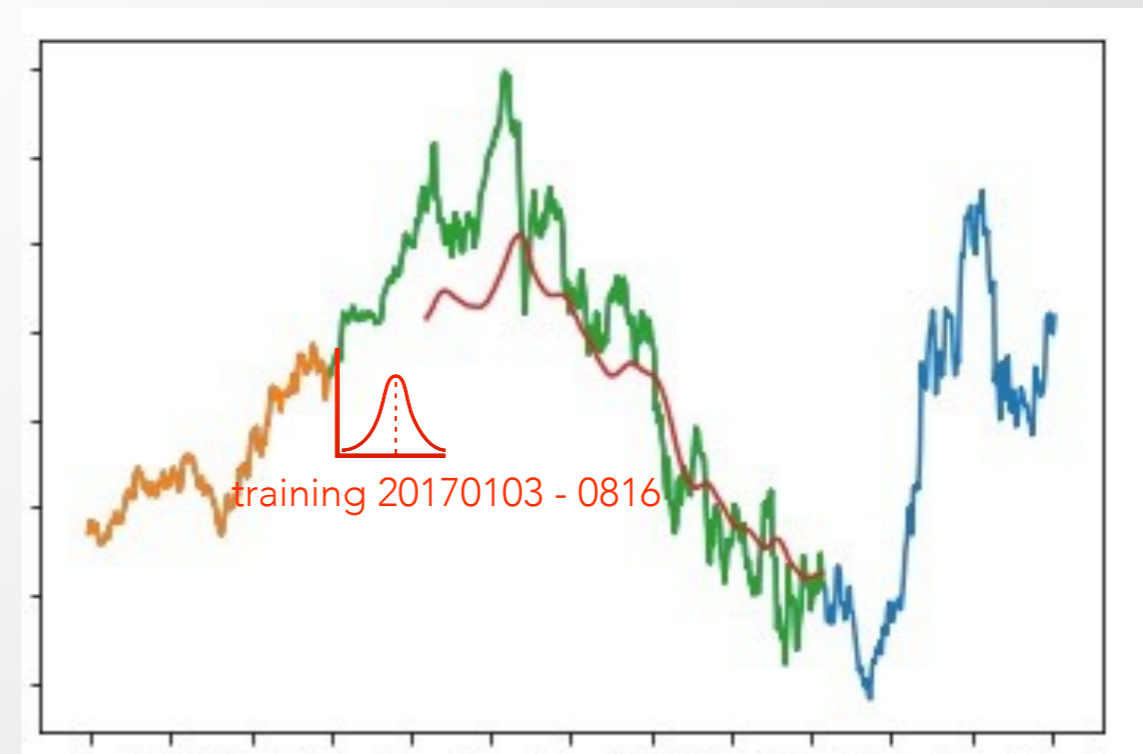
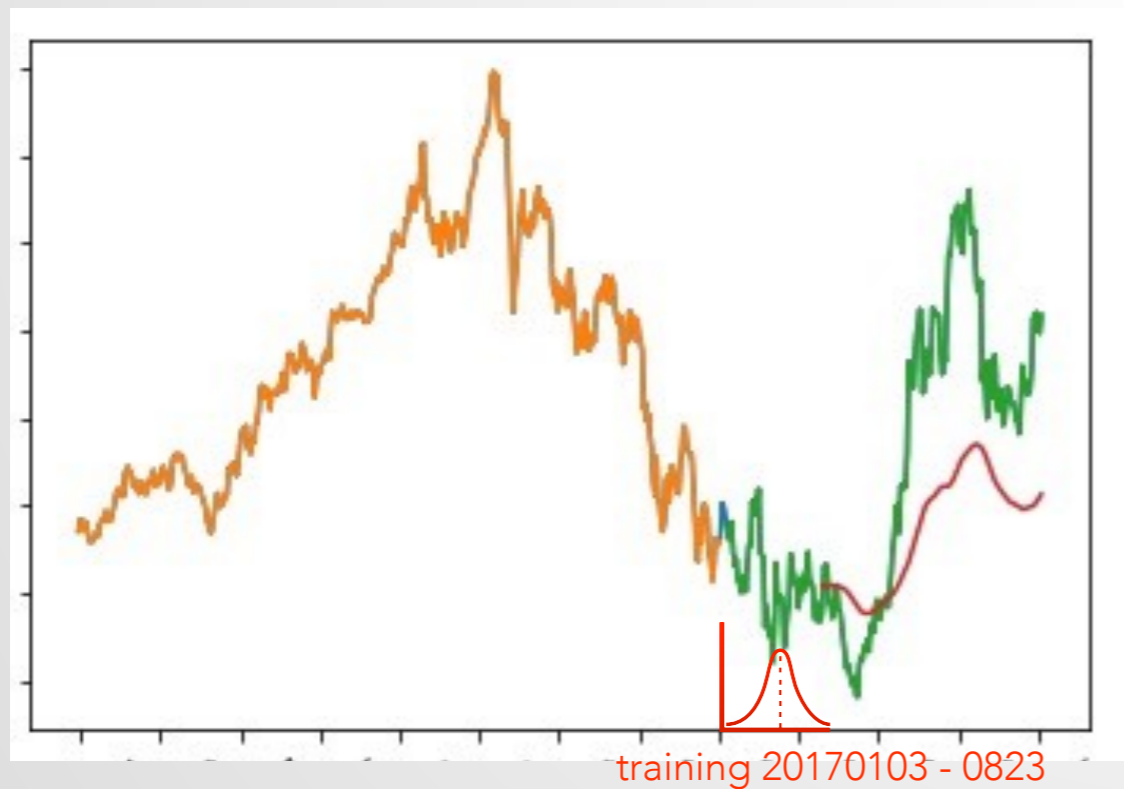
ML on Time Series

- ▣ quantlet.com 
- ▣ predict price
- ▣ train on different time periods

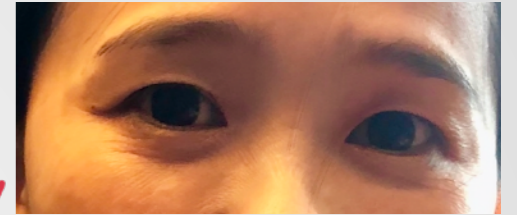


ML on Time Series

- ▣ quantlet.com
- ▣ predict price
- ▣ train on different time periods



Will AI classify this correctly?



Danish FSA muffin



Will AI classify this correctly?



Stift Melk, AU

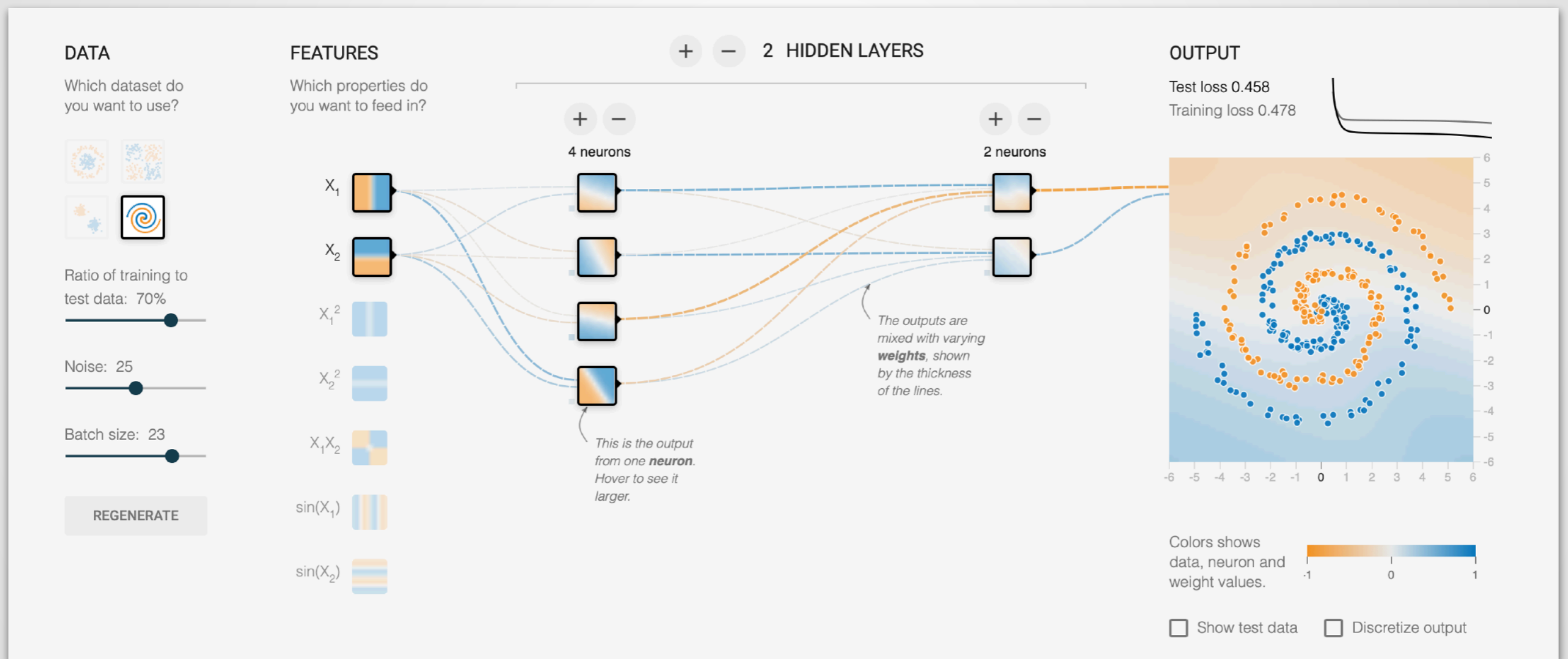


Centro storico Palermo, I



The difficulty of getting it right

Neural Network Tensorflow Playground



The difficulty of getting it right



who is wolfgang härdle



As of my last knowledge update in September 2021, Wolfgang Härdle is a German economist and statistician known for his work in the fields of econometrics, statistics, and finance. He was born on November 4, 1953, in Germany. Wolfgang Härdle has had a distinguished academic career and has made significant contributions to the areas of statistical modeling and quantitative finance.

He is a Professor of Statistics at the Humboldt-University of Berlin and is also a member of the Center for Applied Statistics and Economics (C.A.S.E.). He has authored or co-authored numerous research papers and books, including "Multivariate Statistical Analysis" and "Applied Nonparametric Regression". His research involves the application of statistical methods to solve real-world problems.

Please keep in mind that details about individuals can change over time, so I recommend consulting more recent sources for the latest information on his contributions to the field of statistics and economics.



who is wolfgang Härdle



As of my last knowledge update in September 2021, Wolfgang Härdle is a prominent German economist and statistician. He is known for his contributions to the fields of econometrics, statistics, and finance. Härdle was born on November 24, 1953, in East Germany. He has held various academic positions and has made significant research contributions, particularly in the area of nonparametric statistics and computational statistics.

One of his notable achievements is co-authoring the book "Applied Nonparametric Regression," which is widely used in the field of statistics and econometrics. He has also worked on topics such as financial econometrics and computational statistics.

Please note that information about individuals can change over time, so I recommend verifying this information with more recent sources to ensure its accuracy and to learn about any updates or changes in Wolfgang Härdle's career or contributions since my last update in September 2021.

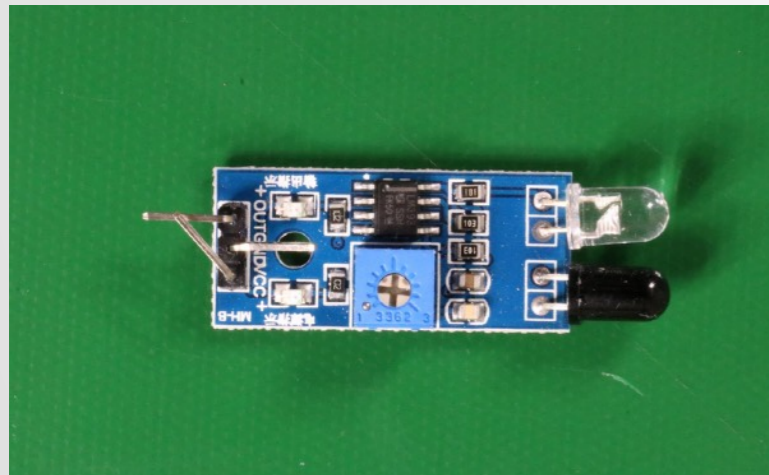
ChatGPT within 2 min



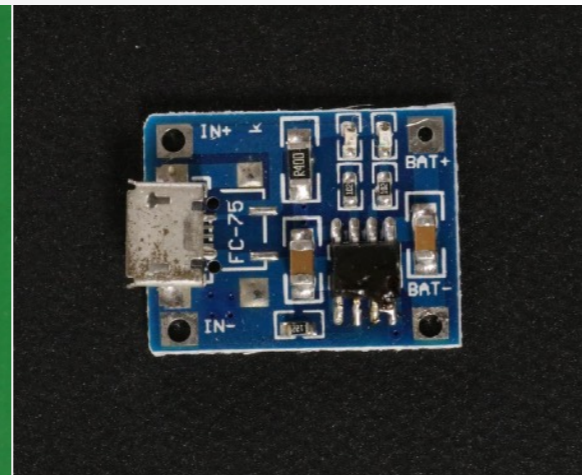
Different Electronic Boards

- VisA dataset (Visual Anomaly)
- [aws s3 cp s3://amazon-visual-anomaly/VisA_20220922.tar ./](https://aws.s3.amazonaws.com/amazon-visual-anomaly/VisA_20220922.tar)
[VisA_20220922.tar --no-sign-request](https://aws.s3.amazonaws.com/amazon-visual-anomaly/VisA_20220922.tar)
- 1,200 anomaly pictures

2



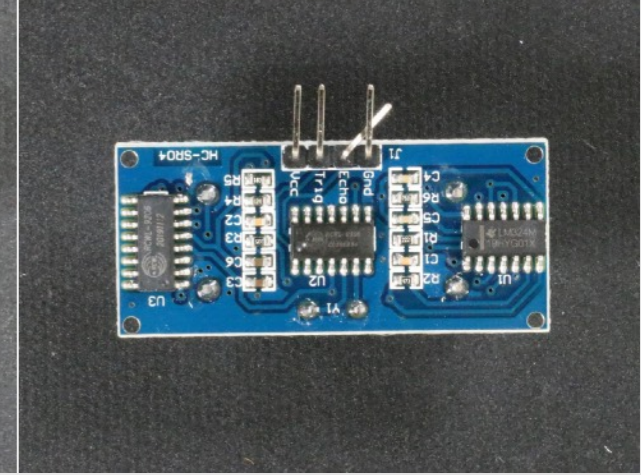
3



0



1



Select the board!

- Sorting for the assembly line
 - ▶ Different devices require different types of circuit boards.
- Process Automation
 - ▶ Automated classification systems streamline production lines
- Recycling and Disposal
 - ▶ Classification allows environmentally friendly recycling practices



Check Courselets



PLATOGRAPH

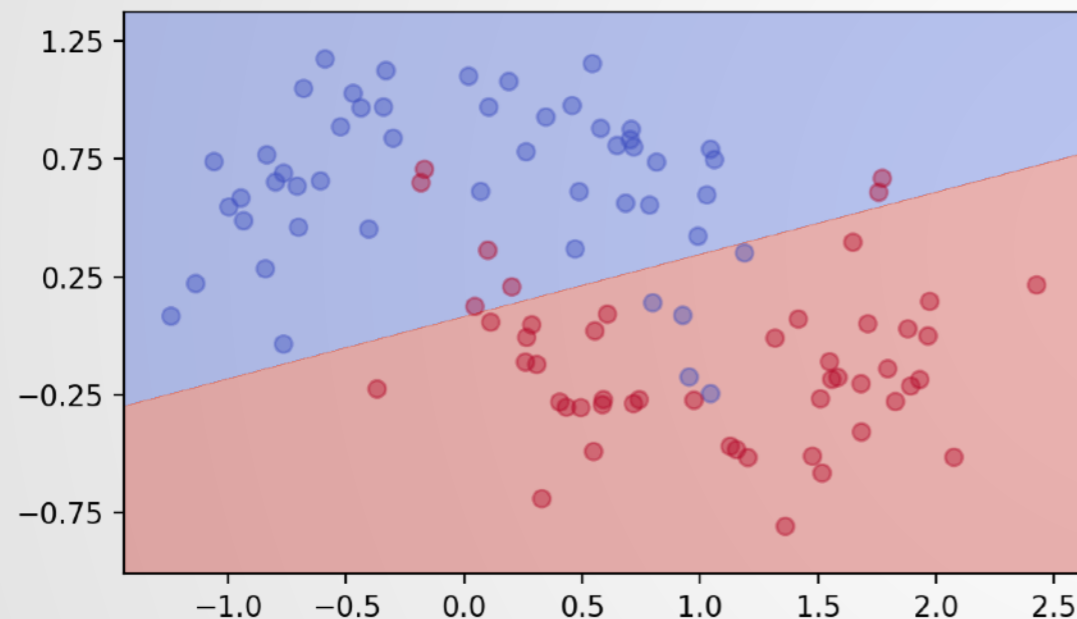


Simulation: Linearly Non-Separable Data

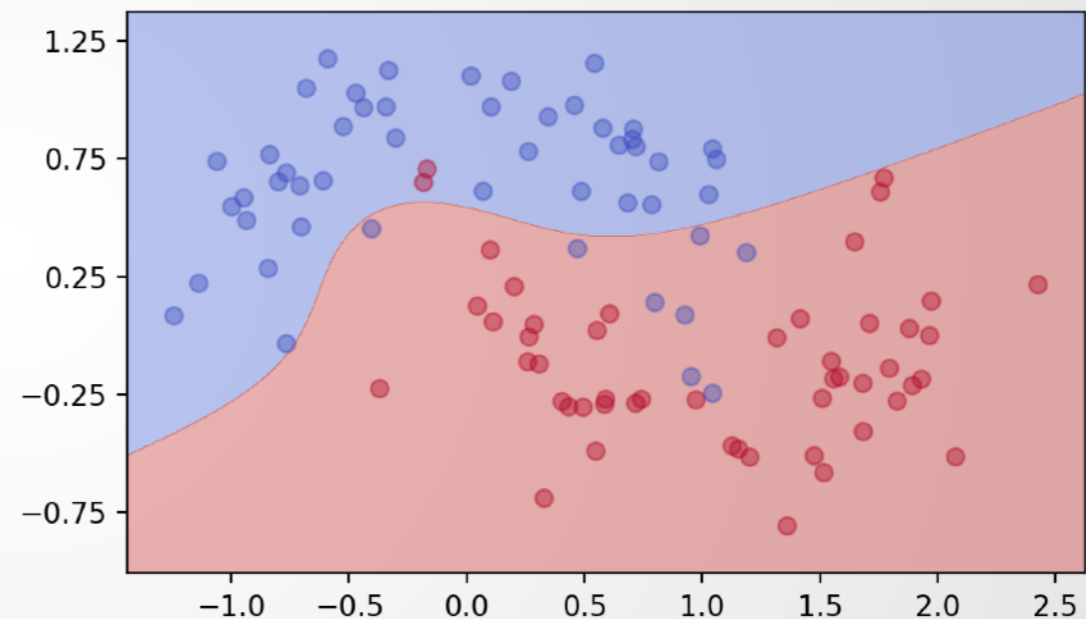
Linear kernel vs. polynomial kernel

Linear decision boundary in higher-dimensional feature space implies a non-linear decision boundary in the original data space

Try $C = 10000$
what do you expect to see?

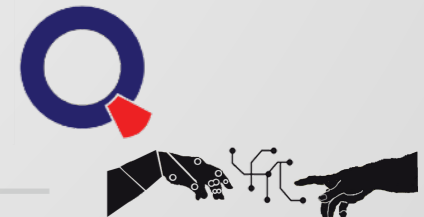


Linear kernel with $C=1$



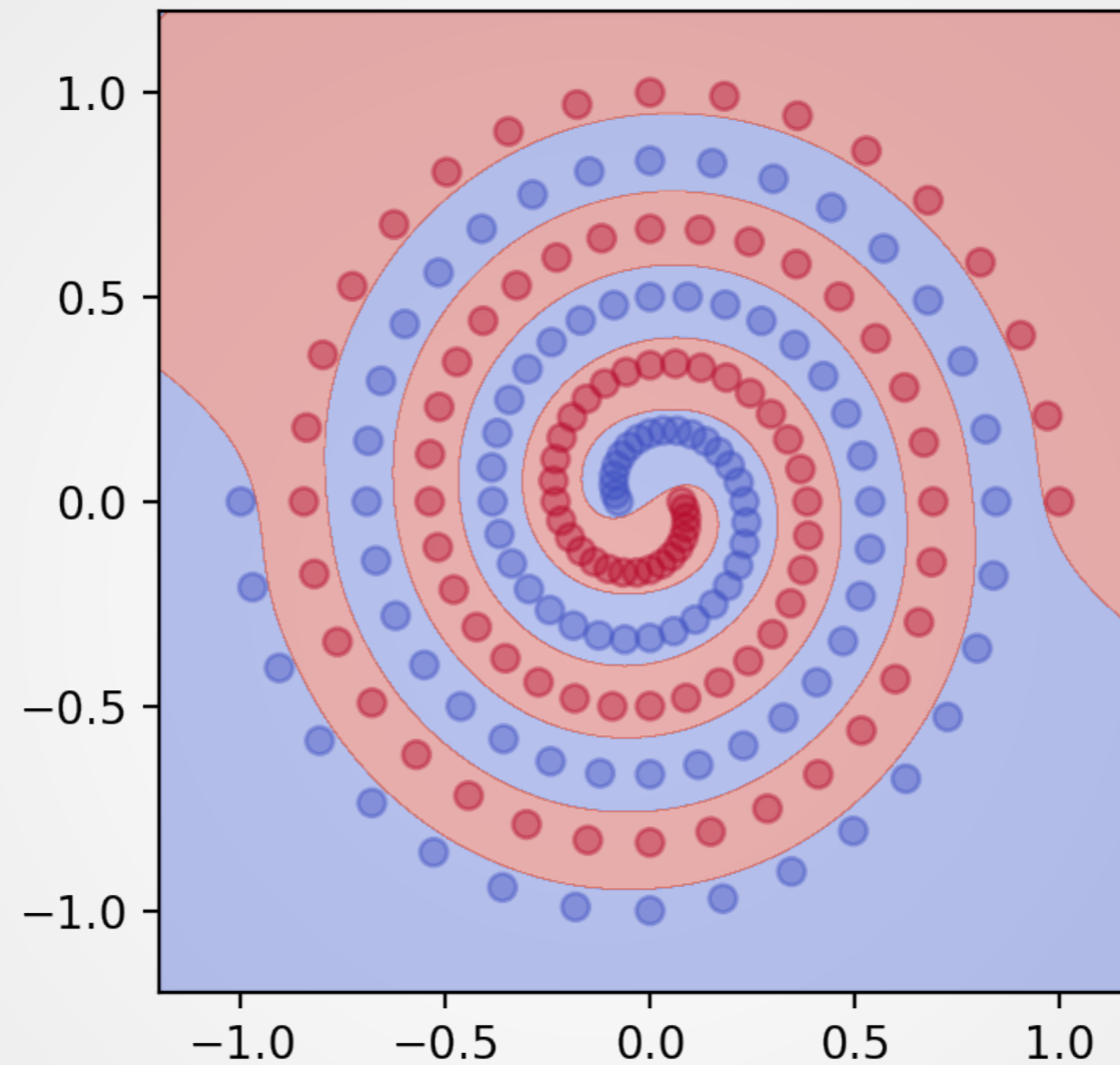
Polynomial kernel of order 3,
 $C=100$

DEDA_SVM_Nonlinear



Simulation: Spiral Data

- ▣ Nonlinear classification



RBF kernel with $C=100$ and $\gamma=20$

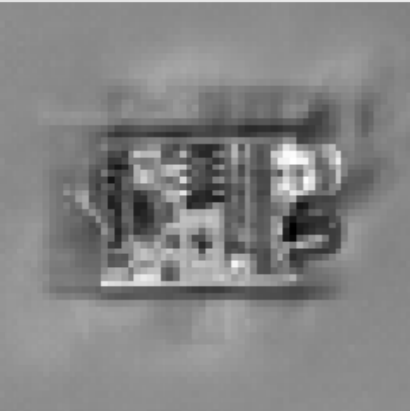
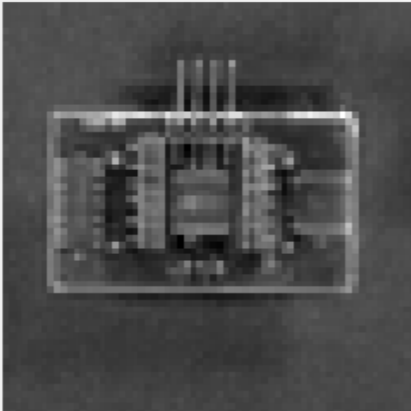
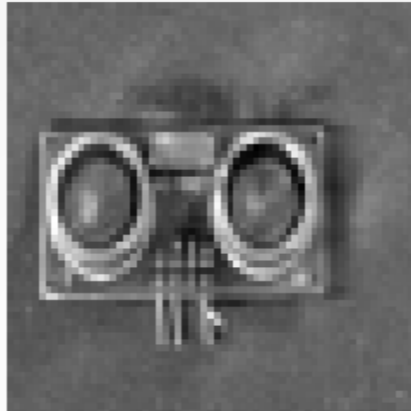
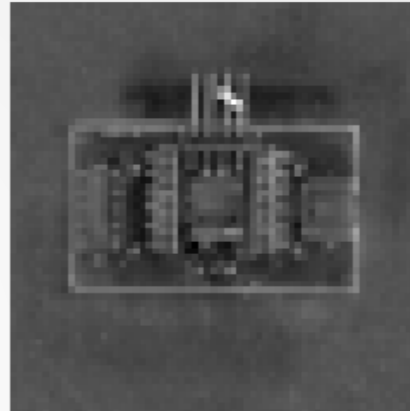
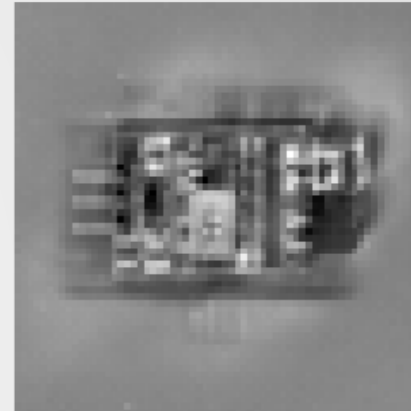
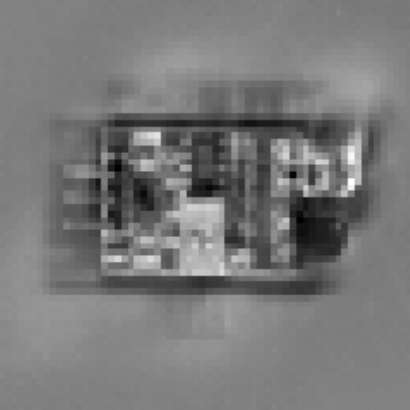
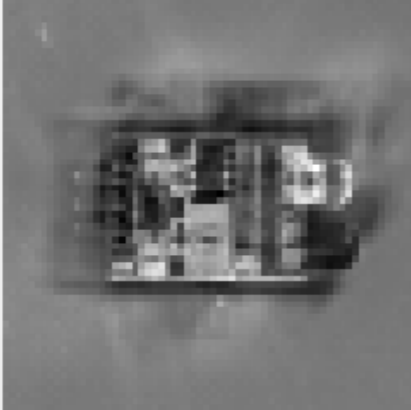
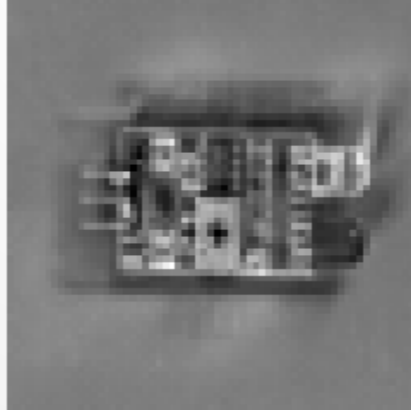
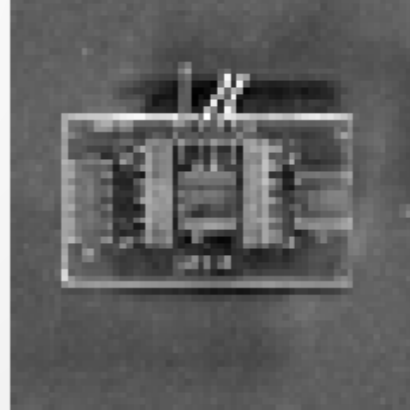
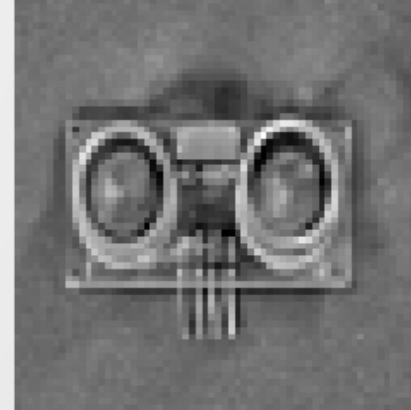
Recall: Tensorflow Playground

DEDA_SVM_Spiral



Classifications

[acc train: 1.0; acc test: 1.0]

<p>Pred: 2 True: 2</p> 	<p>Pred: 1 True: 1</p> 	<p>Pred: 0 True: 0</p> 	<p>Pred: 1 True: 1</p> 	<p>Pred: 2 True: 2</p> 
<p>Pred: 2 True: 2</p> 	<p>Pred: 2 True: 2</p> 	<p>Pred: 2 True: 2</p> 	<p>Pred: 1 True: 1</p> 	<p>Pred: 0 True: 0</p> 



Knowledge Proliferation

SDA Smart Data Analytics



(Specific, Measurable, Achievable, Relevant, Timely) Data Analytics



PLATOGRAPH



Ethics guidelines for trustworthy AI – European Union

- ▣ Lawful
 - ▶ Respecting all applicable laws and regulations
- ▣ Ethical
 - ▶ Respecting ethical principles and values
- ▣ Robust
 - ▶ Both from a technical perspective while taking into account its social environment

<https://digital-strategy.ec.europa.eu/en/library>



AI guidelines

- ▣ Human agency and oversight
 - ▶ AI should empower human beings, allowing them to make informed decisions and fostering their fundamental rights. Proper oversight mechanisms need to be ensured, which can be achieved through human-in-the-loop, human-on-the-loop, and human-in-command approaches
- ▣ Technical Robustness and safety
 - ▶ AI needs to be resilient and secure. It needs to be safe, ensuring a fall back plan in case something goes wrong, as well as being accurate, reliable and reproducible.
- ▣ Privacy and data governance
 - ▶ Besides ensuring full respect for privacy and data protection, adequate data governance mechanisms must also be ensured, taking into account the quality and integrity of the data, and ensuring legitimised access to data.



The 7 AI principles

- AI has to be useful for the society
- AI must be safe
- AI has to avoid bias
- AI should be made castigatable
- AI must respect individual privacy
- AI has to follow highest scientific standards
- AI should only be employed if the above are fulfilled



[https://en.wikipedia.org/wiki/The_Creator_\(2023_film\)](https://en.wikipedia.org/wiki/The_Creator_(2023_film))



Future

Should we wait: **NO**, go for it!

Will you take a standard air plane on long distance that is flown by an AI robot pilot? You do it already.

But...

Will you take a standard air plane on long distance that is flown by an AI robot, knowing that there is no additional human pilot?



Questions

- ▣ How do we make AI ethical ?
- ▣ How do we react to AI „colleagues“ ?
- ▣ Can an AI robot be happy ?
- ▣ What must politics and business do ?
- ▣ How long is human intelligence superior to AI ?



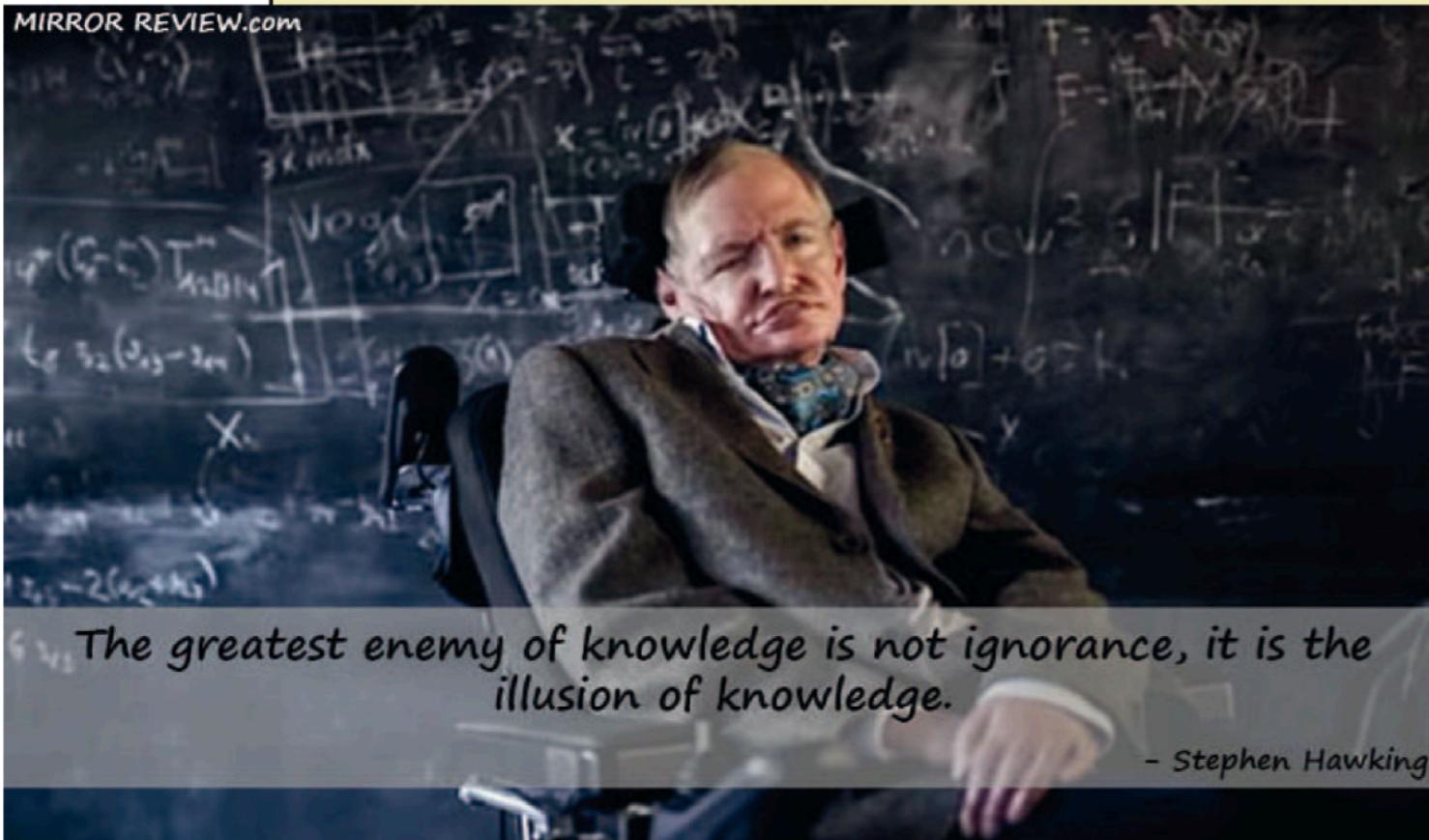
Human vs AI



„Ali Rahimi, a researcher in artificial intelligence (AI) at Google in San Francisco, California, took a swipe at his field last December—and received a 40-second ovation for it. Speaking at an AI conference, Rahimi charged that machine learning algorithms, in which computers learn through trial and error, have become a form of „alchemy.“ Researchers, he said, do not know why some algorithms work and others don't, nor do they have rigorous criteria for choosing one AI architecture over another...”

Science, May 2018

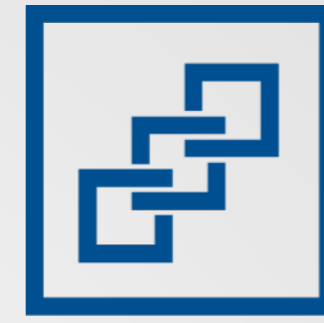
MIRROR REVIEW.com



The greatest enemy of knowledge is not ignorance, it is the illusion of knowledge.

- Stephen Hawking





AI Artificial Intelligence +

Wolfgang Karl Härdle
Xiaorui ZUO



Ladislaus von Bortkiewicz Professor of Statistics
Humboldt-Universität zu Berlin
blockchain-research-center.com



ASE, Charles U, SKBI SMU, ACI NUS, NYCU 玉山學者

Talk history

- ▣ 20181020 HKG Banker's Club WALEX Diamond Class event
- ▣ 20190919 HBF Jinan QiLu conference
- ▣ 20190921 HBF Beijing
- ▣ 20200207 Danish FSA, Copenhagen
- ▣ 20200210 Bundesbank Frankfurt
- ▣ 20210324 ML FINTECH Class, NUS, Singapore
- ▣ 20230909 Taipei Tech, 台北, TW
- ▣ 20230911 City Hall, 台中, TW
- ▣ 20230929 Bern U Applied Sciences, CH
- ▣ 20231117 Asia U, 台中, TW
- ▣ 20240309 Taipei Tech, 台北, TW

