Machine Learning INF2008

Lecture 00: Technological Trends

Donny Soh

Singapore Institute of Technology

ASSOCIATE PROFESSOR DONNY SOH

PROGRAMME LEADER, APPLIED ARTIFICIAL INTELLIGENCE (AAI)

INFOCOMM CLUSTER (ICT)

SINGAPORE INSTITUTE OF TECHNOLOGY (SIT)

PROFESSIONAL WITH A PROVEN TRACK RECORD OF CONSISTENTLY VALUE ADDING TO HIS INDUSTRIAL PARTNERS.

Donny Soh is the Principal Investigator of multiple machine learning projects with the industry. His success has been guided by his key philosophy of value adding to clients by solving their key pain points.

Donny Soh was the lead in creating the Applied Artificial Intelligence (AAI) undergraduate program at SIT. He is also currently serving as the Programme Leader of the AAI Undergraduate Degree Programme at SIT.

EDUCATION

- Imperial College London - PhD in Computer Science, Department of Computing
- Singapore MIT (Massachusetts Institute of Technology) Alliance (SMA) – Masters of Science in Computing Science
- National University of Singapore – First Class Honours in Computer Engineering

Singapore Institute of Technology

Programme Leader, Applied Artificial Intelligence @ SIT

- Principal Investigator of industry project with Singapore Power. Designed, developed and deployed machine learning project which saw a tenfold increase in productivity by enhancing network reliability at power substations. (https://www.singaporetech.edu.sg/digitalnewsroom/machine-learning-platform-enhances-network-reliability-at-sp-group-substations/).
- Principal Investigator of industry project with Hitachi Asia. Designed, developed and deployed machine learning project in image processing during COVID to improve operational processes with video analytics.
- Co-Principal Investigator of healthcare project with SingHealth. Using travel patterns to determine how it affects the level of dementia in patients.
- Private consultant to vendor of Singapore's Public Utility Board (PUB) on water management.

Multiple Startups

Served in multiple positions: Co-founder, CTO, Vice President in Software Engineering

- Technical lead of a team of eight engineers / data scientists and within three months, successfully developed and completed a successful Artificial Intelligence product launch with JTC. Solution launched reduced manpower by > 50% with costs savings of > 70%.
- Technical lead of a team of six engineers / data scientists, managing the entire product life cycle from conceptualization, prototyping, manufacturing, launch to distribution.
- Built and deployed nation-wide LPG ordering system built for ExxonMobil, managing a transactional revenue worth of more than 20 million every month.

Institute for Infocomm Research (I2R)

Data Scientist II

- Leading a team of three data scientists, pitched and won projects with VISA (fraud detection) and OneEmpower (Customer Analytics).

Product Awards

1. DISTREE EMEA Fresh, Winner (International)
2. ASEAN Ricebowl Product of the Year, Winner (ASEAN)
3. NUS Suzhou Global Startup Challenge (International)
4. UK Sports Technology, Finalist (International)
5. German Good Design Award, Winner (International)
6. ISPO Digital Finalist (International)

Personal Awards

1. Best Paper Presentation at Conference (ICCCA2022)
2. Tan Kah Kee Young Inventor's Bronze Award
3. Outstanding Mentor Award 18th Youth Science Conference
4. NJC Partner Award
5. I2R Role Model Award (institutional)
6. A-STAR Overseas Scholarship (Imperial College)

Five most recent publications

1. Donny Cheng Lock Soh, Indriyati Atmosukarto. The Impact of Tweets, Mandates, Hesitancy and Partisanship on Vaccination Rates. Accepted to HCI International 2022 Conference. (May 2022. Citation yet to be released).
2. Donny Cheng Lock Soh, Indriyati Atmosukarto, Arthur Wee Yeong Loo, Thirunneepan Selvakulasingam, Toshiki Ishii, Rishabh Ranjan, Shuyang Dou, Junichi Hirayama. Improving Operational Processes for COVID-19 Ready Smart Campus. Accepted to Journal of Advances in Information Technology (Citation yet to be released).
3. Donny Soh, Indriyati Atmosukarto. Integrating Industry-based problems in Performance Testing and Optimization Course: an Experience Report. Applied Learning Conference (Jan 2022) https://doi.org/10.25447/sit.19210746
4. Soh, D.; Krishnan, S.B.; Abraham, J.; Xian, L.K.; Jet, T.K.; Yongyi, J.F. Partial Discharge Diagnostics: Data Cleaning and Feature Extraction. Energies 2022, 15, 508. https://doi.org/10.3390/en15020508
5. Nandha Kumar Kandasamy, Nurul Jannah Binte Mohamed, Jiang Hao, Soh Chew Beng, Donny Soh Cheng Lock, Feng Wei, Sivaneasan Balakrishnan and Tan KuanTak. Preemptive Identification of End-of-Life for Stationary Battery Systems. Second IEEE International Conference on Smart Technologies for Power, Energy and Control, STPEC 2021 (Dec 2021). https://doi.org/10.1109/STPEC52385.2021.9718641

Patents Applications

1. DEFECT DETECTION SYSTEM USING A CAMERA EQUIPPED UAV FOR BUILDING FACADES ON COMPLEX ASSET GEOMETRY WITH OPTIMAL AUTOMATIC OBSTACLE DECONFLICTED FLIGHTPATH. Publication number: 20210266461. Jul 2, 2019
2. METHOD AND SYSTEM FOR CHARACTERIZING SPORTING ACTIVITIY. Publication number: 20160073961. Apr 28, 2014

What would you rather have?

- A million dollars OR

- A penny on day one, doubled every day until day 30?

What would you rather have?

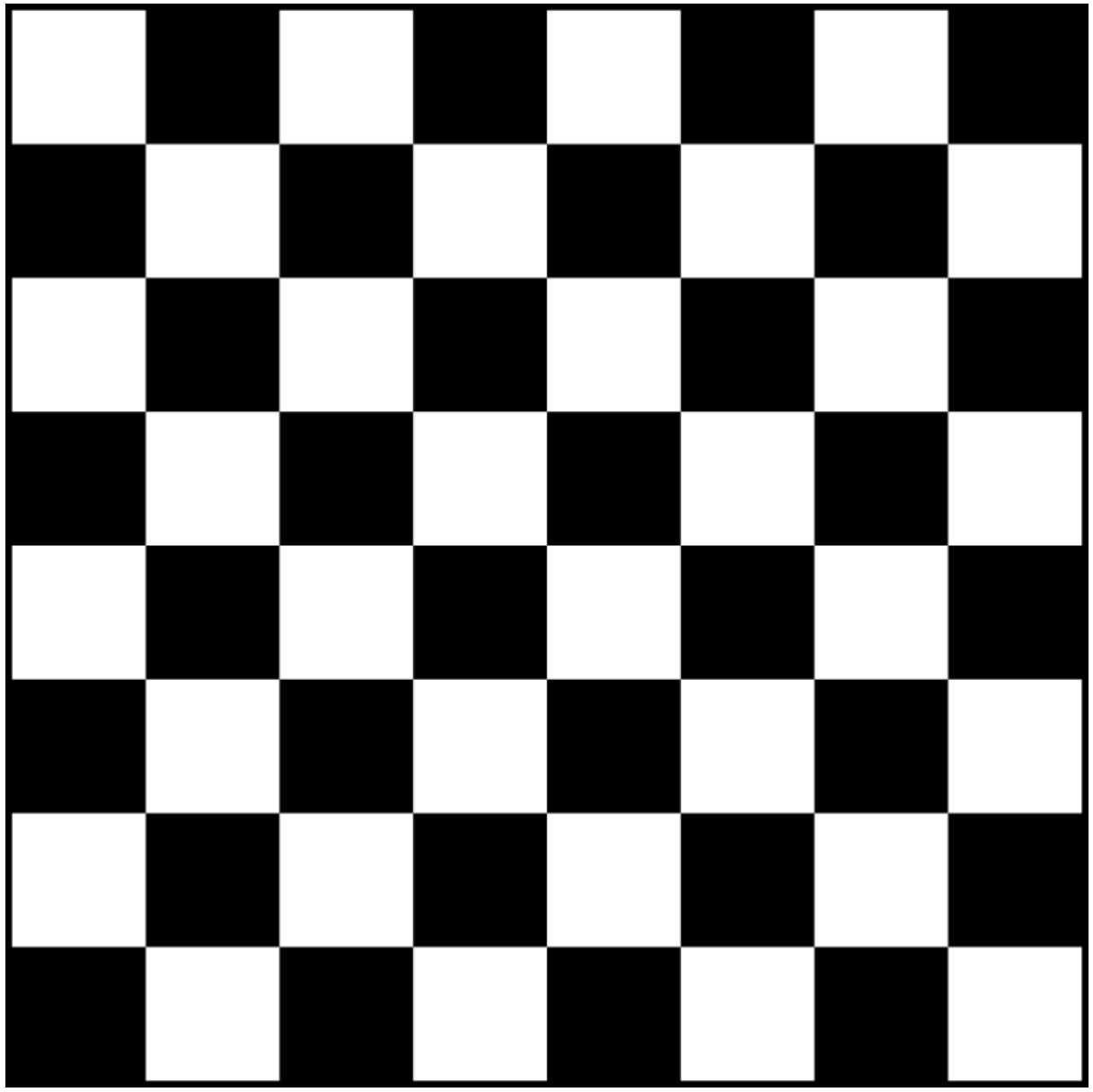
- A million dollars OR

- A penny on day one, doubled every day until day 30?

1	2	4	8	16	32	64	128	256	512
10.24	20.58	40.96	81.92	163.84	327.68	655.36	1,310.72	2,621.44	5,242.88
10,485.76	20,971.52	41,943.04	83,886.08	167,772.16	335,544.32	671,088.64	1,342,177.28	2,684,354.56	5,368,709.12

- $10,737,418.23

How much grain is this?



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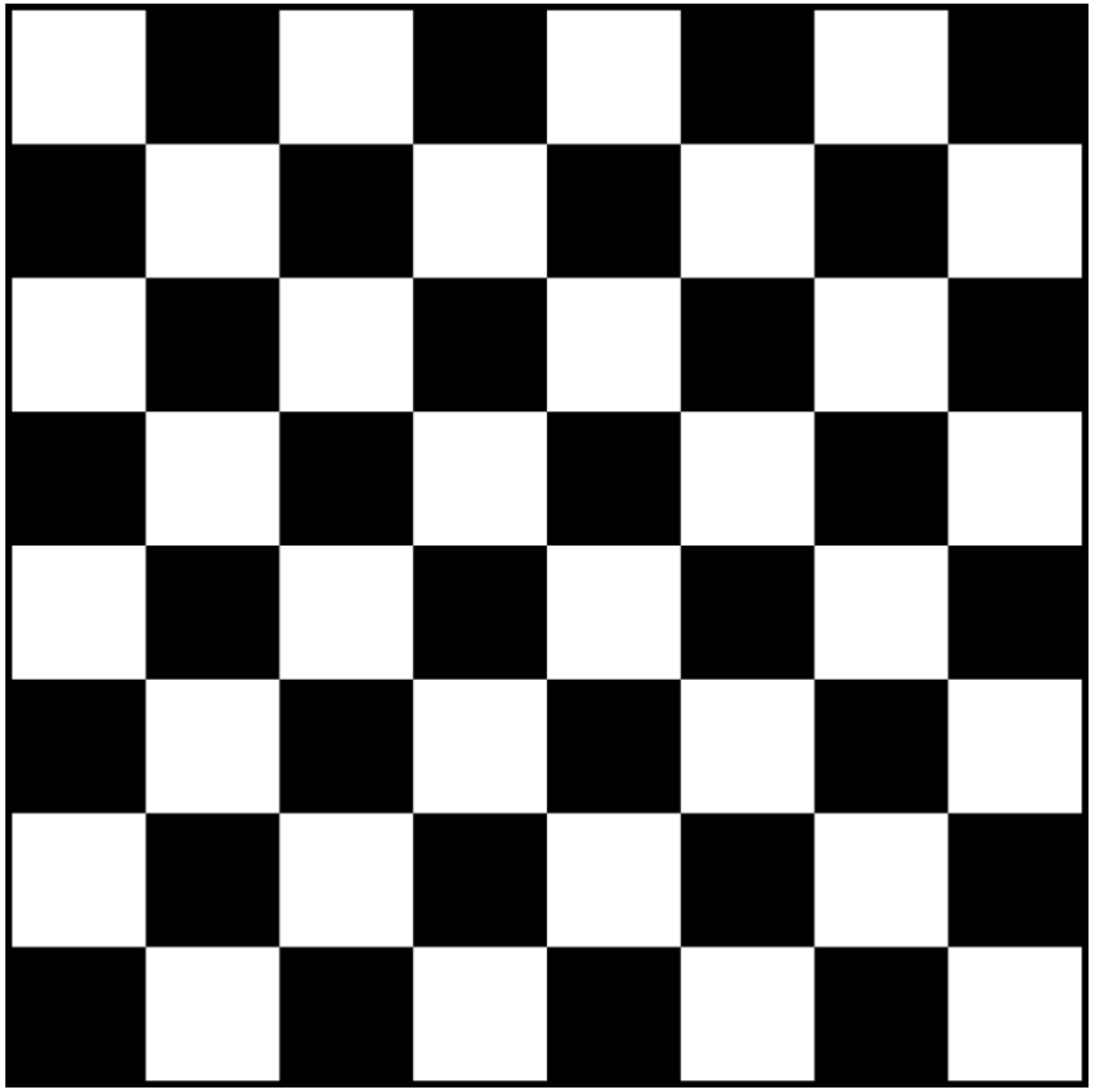
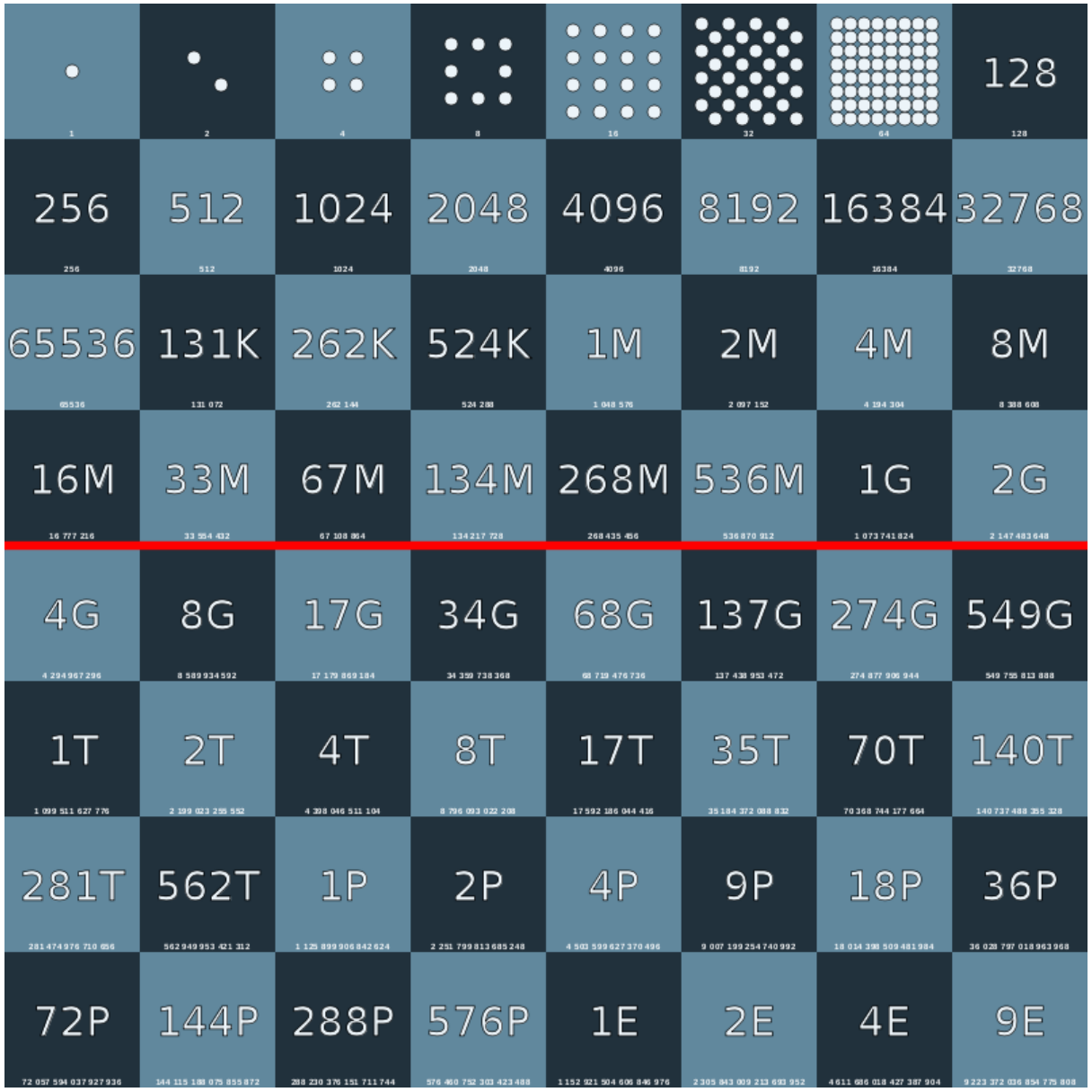


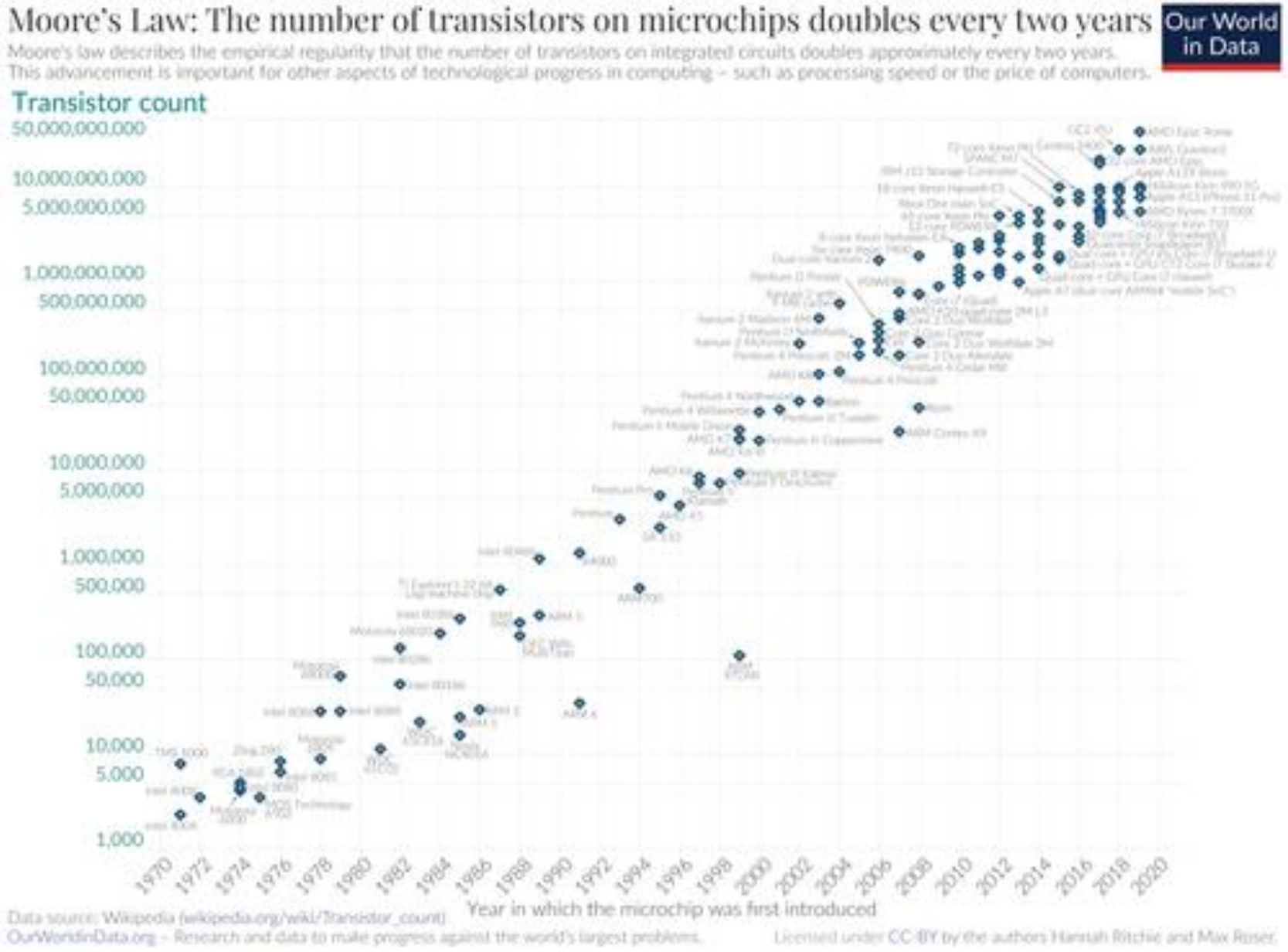


1.4 trillion metric tons: 2,000 times annual world production

Three Exponential Technological Trends

1. Computation Speed

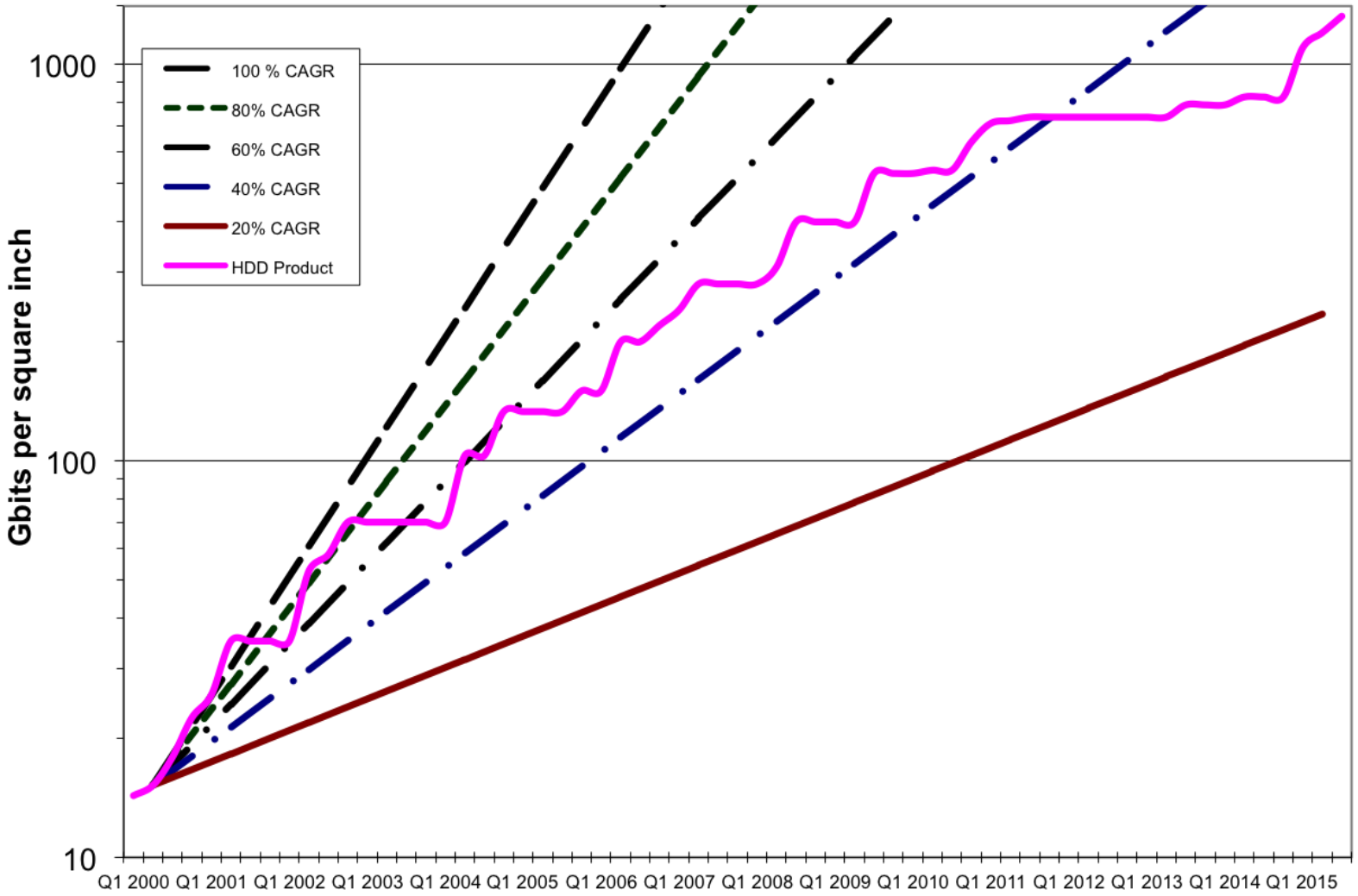
- Moore's Law
  - the number of transistors in a dense integrated circuit (IC) doubles about every two years.



Three Exponential Technological Trends

2. Hard-Disk Storage

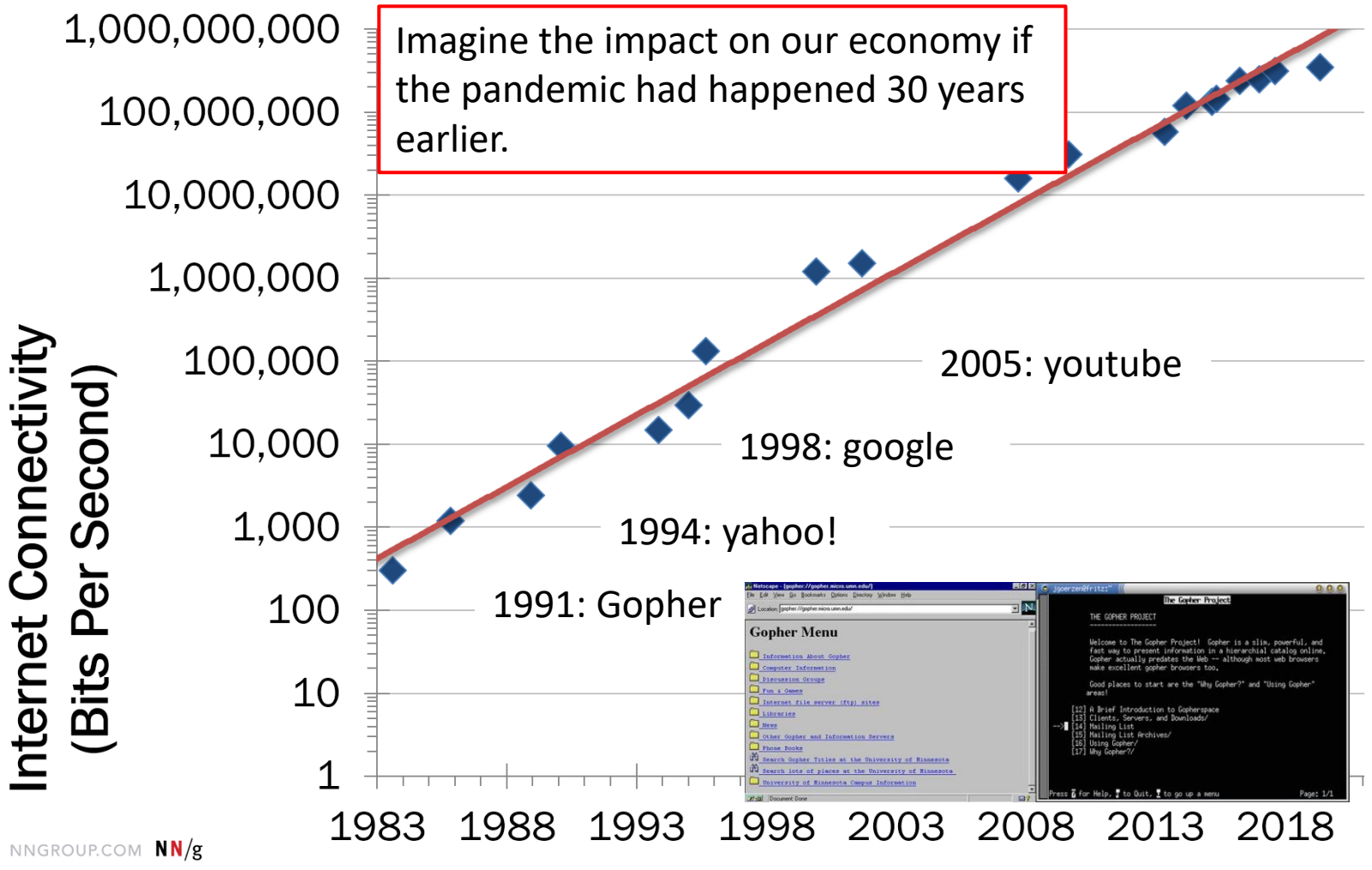
- Kryder’s Law
  - magnetic disk areal storage density was then increasing at a rate exceeding Moore's Law.



Three Exponential Technological Trends

3. Network Connectivity

- Edholm's Law
  - the bandwidth of telecommunication networks (including the Internet) is doubling every 18 months.
- Nielsen's Law
  - High--end user's connection speed grows by 50% per year / doubles roughly every 21 months.



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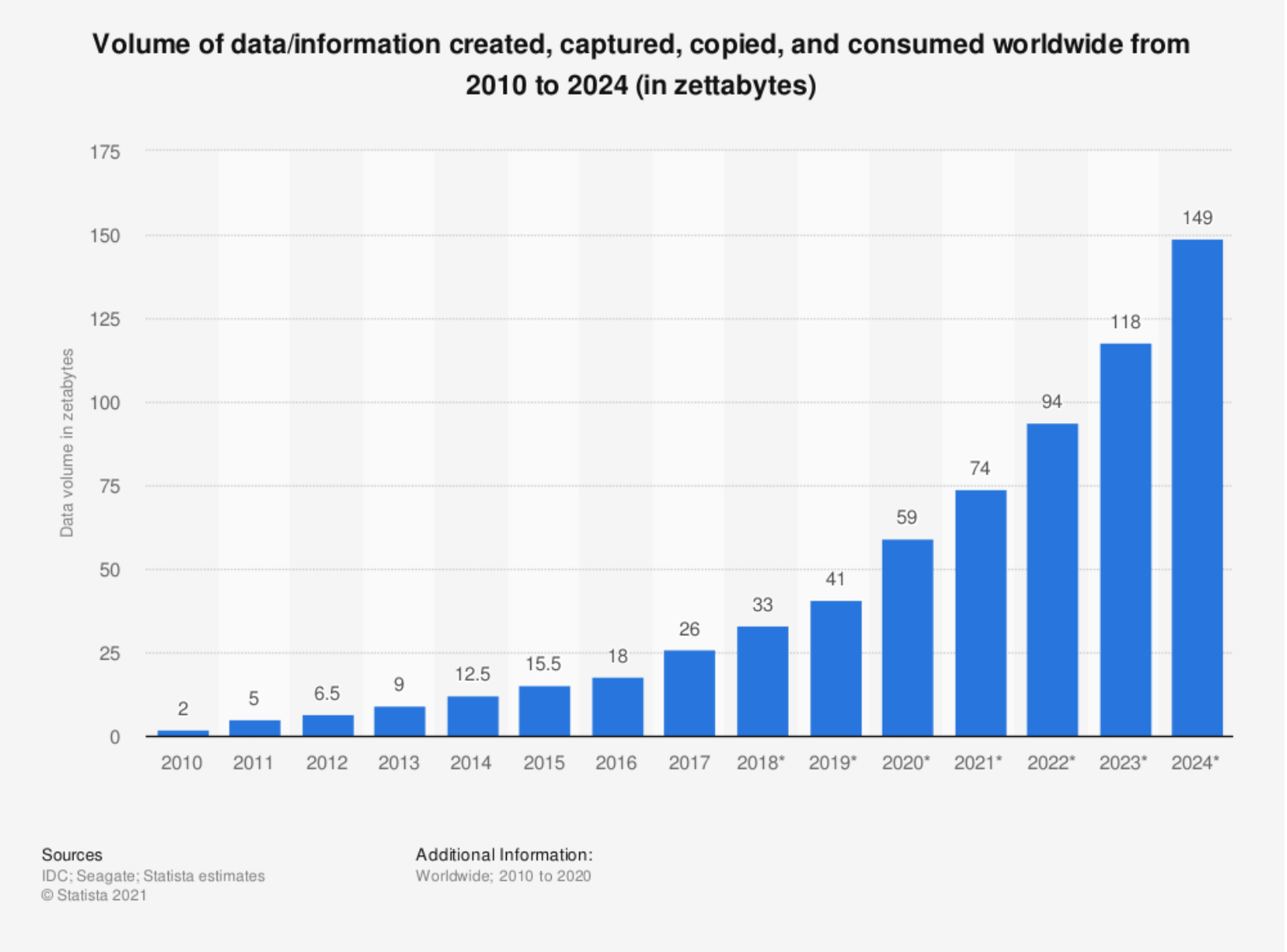
3. Network Connectivity

- Edholm's Law
  - the bandwidth of telecommunication networks (including the Internet) is doubling every 18 months.
- Butters' Law
  - the amount of data coming out of an optical fiber is doubling every nine months.



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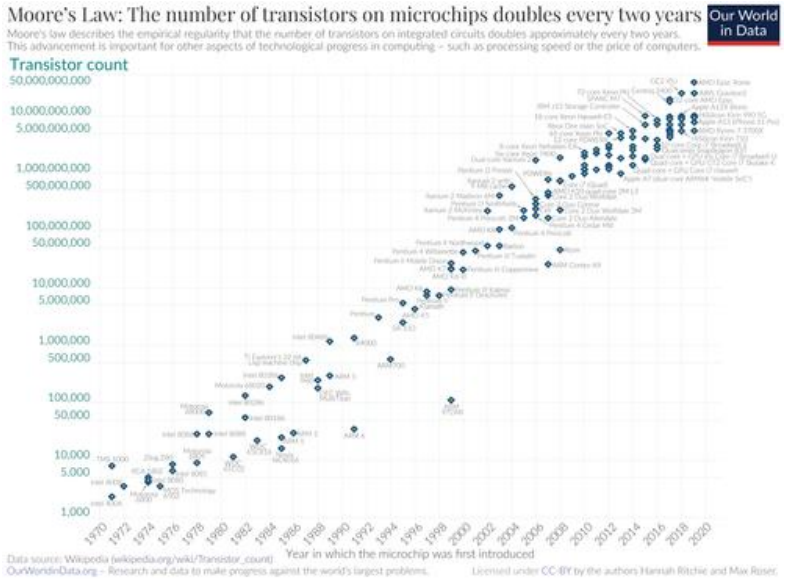

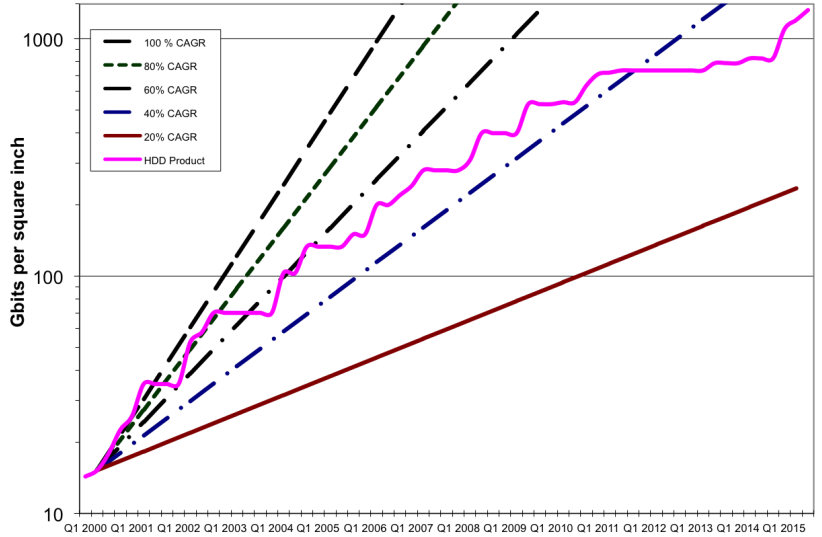

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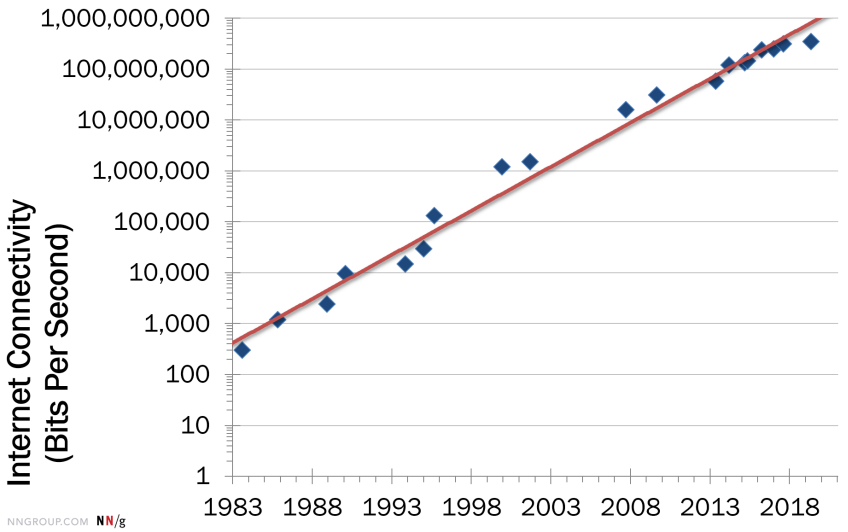

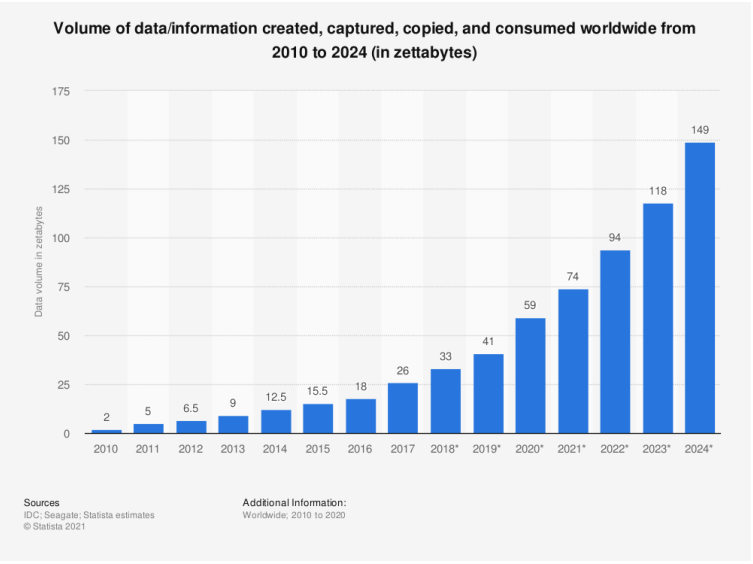

Technological Trends of 2021

Bain & Co
Edge AI transplants brains to factory tools and machinery.
5G factory revolutionizes manufacturing.
Smartphone data powers usage-based auto insurance while improving driver safety.
Automated and explainable AI makes financial organizations smarter.
In cybersecurity, authentication rights and network access get their due.
Workforce technologies boost agility and profitability.
Health data is gold.
In HR, cognitive science and gamification win the war for talent.
Shifting from selling to renting becomes the green way of doing business.
Technology works toward zero food waste.

Gartner	
People Centricity	**Internet of Behaviours**
	Total experience Strategy
	Privacy enhancing computing
Location independence	**Distributed cloud**
	Anywhere operations
	Cybersecurity mesh
Resilient delivery	Intelligent composable business
	AI engineering
	Hyperautomation

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	Total experience Strategy
	Privacy enhancing computing
Location independence	**Distributed cloud**
	Anywhere operations
	Cybersecurity mesh
Resilient delivery	Intelligent composable business
	AI engineering
	Hyperautomation

1. Big Data

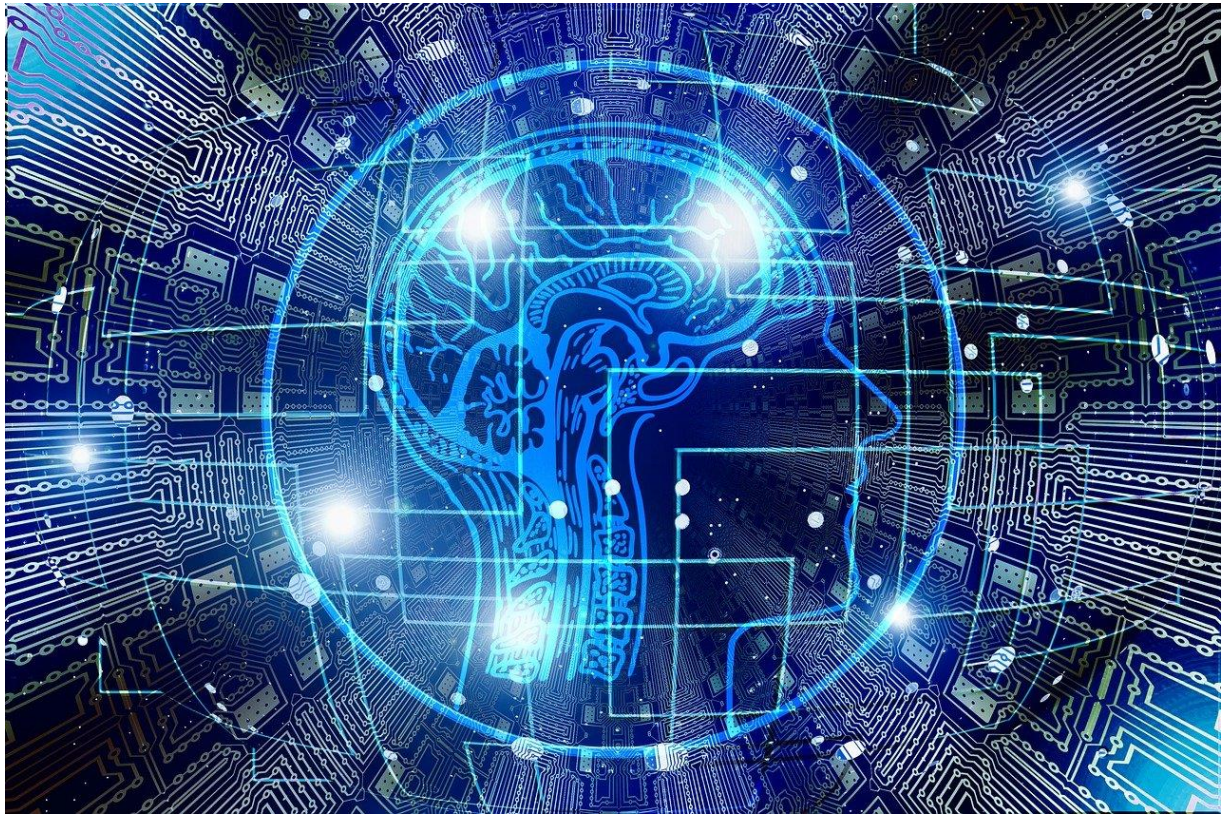
2. Cloud

3. Artificial Intelligence

What then is Artificial Intelligence?

What does the term Artificial Intelligence mean?

General A.I. and Narrow A.I.



J.A.R.V.I.S.

Terminator

C-3PO

Chess (Alpha Go)

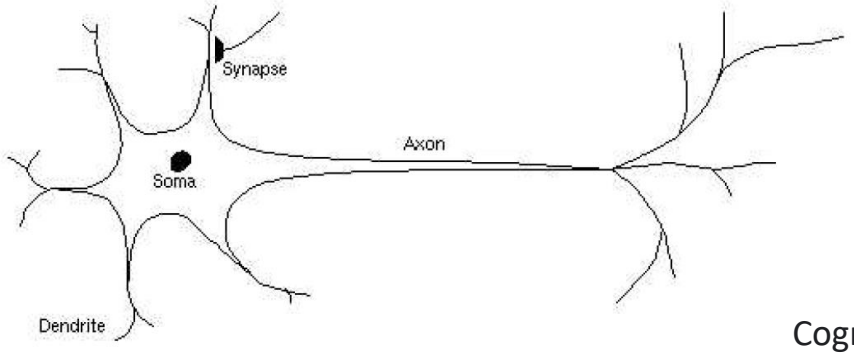
Spam Filters

Siri (Digital Assistants)

Narrow Artificial Intelligence

Four definitions of Narrow A.I.

Thinking Humanly



Cognitive Modeling

Source: https://cs.stanford.edu/people/eroberts/courses/soco/projects/neural-networks

Thinking Rationally

1. Modus ponens (MP)
$p \supset q$
p
q

2. Modus tollens (MT)
$p \supset q$
$\sim q$
$\sim p$

3. Hypothetical syllogism (HS)
$p \supset q$
$q \supset r$
$p \supset r$

4. Disjunctive syllogism (DS)
$p \vee q$
$\sim p$
q

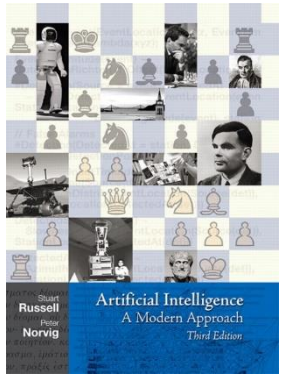
5. Constructive dilemma (CD)
$(p \supset q) \cdot (r \supset s)$
$p \vee r$
$q \vee s$

6. Simplification (Simp)
$p \cdot q$
p

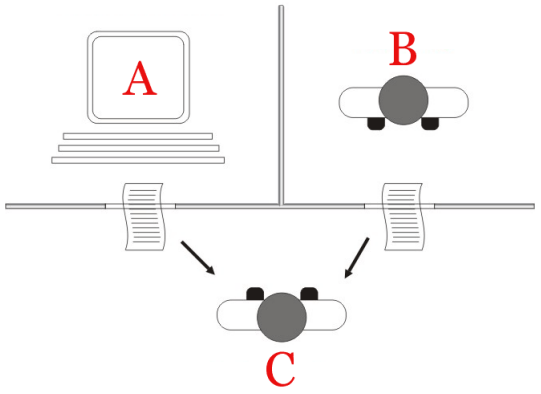
7. Conjunction (Conj)
p
q
$p \cdot q$

8. Addition (Add)
p
$p \vee q$

First order logic



Acting Humanly



https://images.app.goo.gl/ssgfNsmVjTGKhuvs8

Turing Test Approach

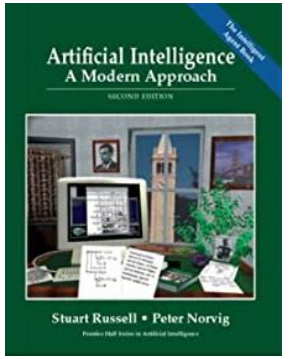
Acting Rationally

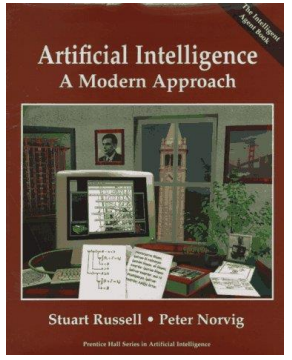
Rational agents: agents that maximize the expected value of their performance measure given what they currently know.

Expert systems

Machine Learning

Rational Agents



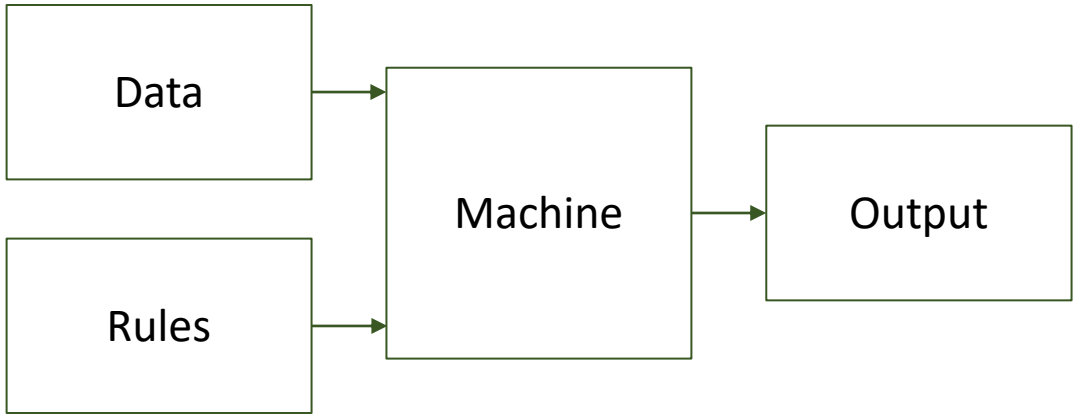


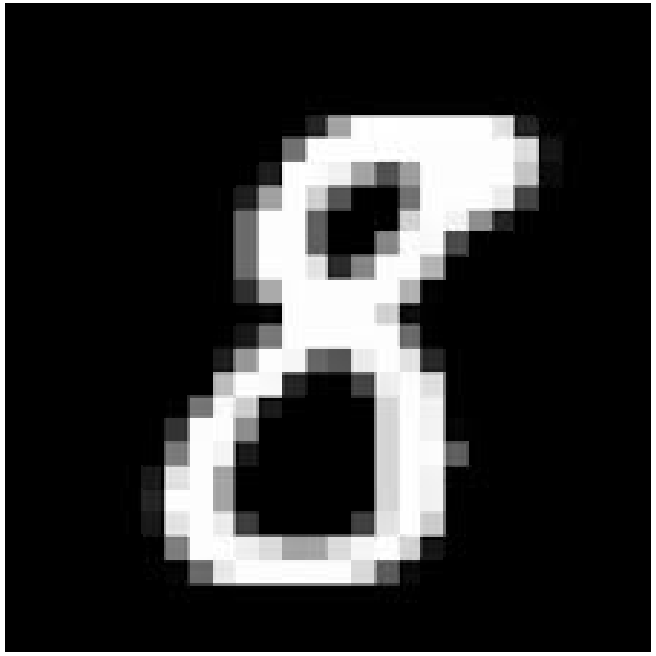
from Artificial Intelligence: A Modern Approach by Russell & Norvig, the authoritative AI reference (first published in 1994)

Machine Learning is different from Expert Systems

Expert Systems use rules to generate the output but Machine Learning uses output to generate rules

Expert Systems





Step 1:
Split image into top and bottom halves

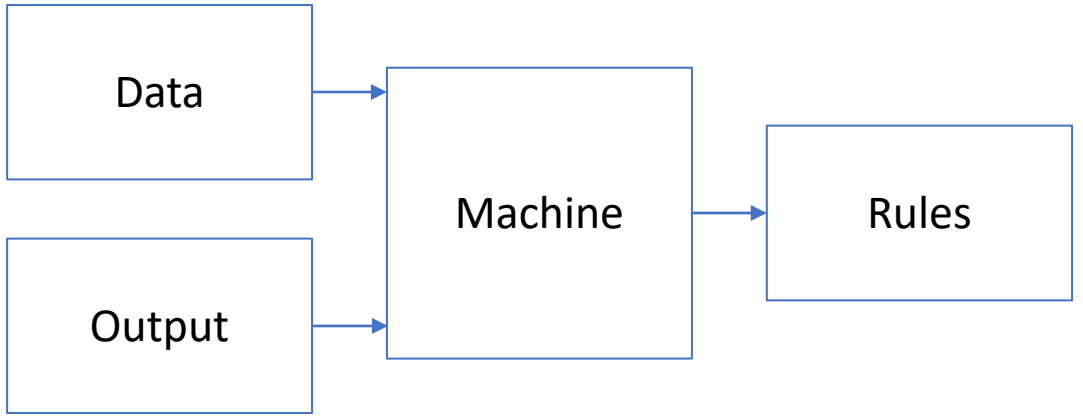
Step 2:
if (circle_is_present (top_of_image))

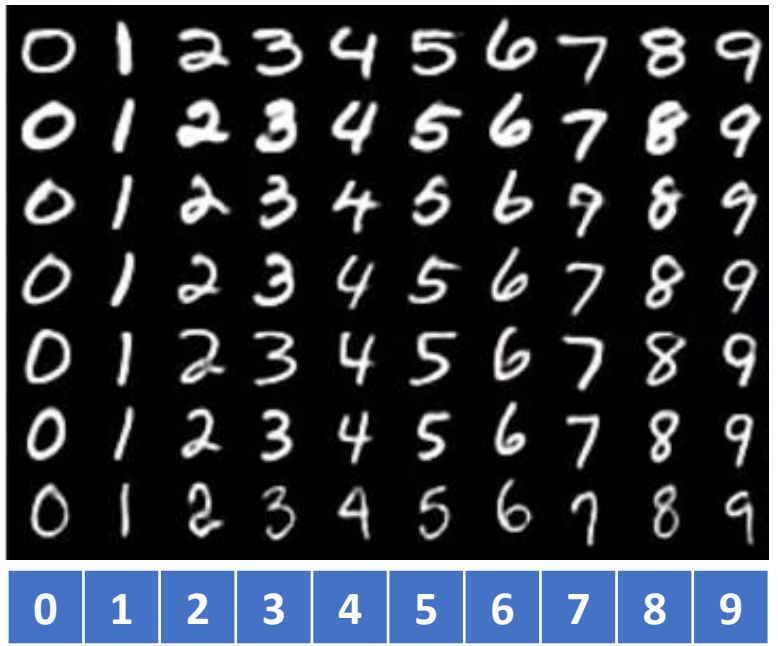
AND

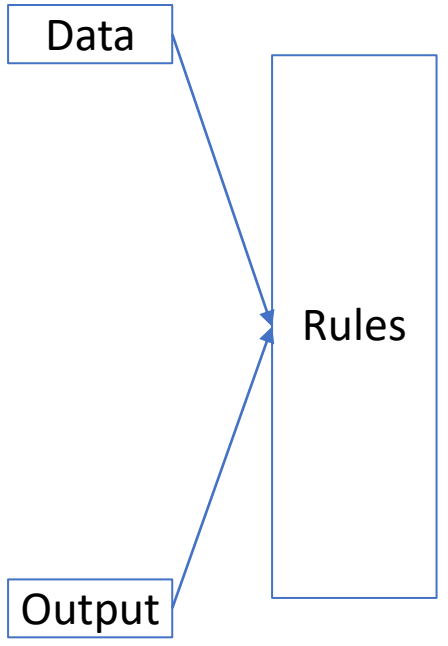
if (circle_is_present (bottom_of_image)):

Step 3:
return number_eight_found

Machine Learning (Supervised Learning)







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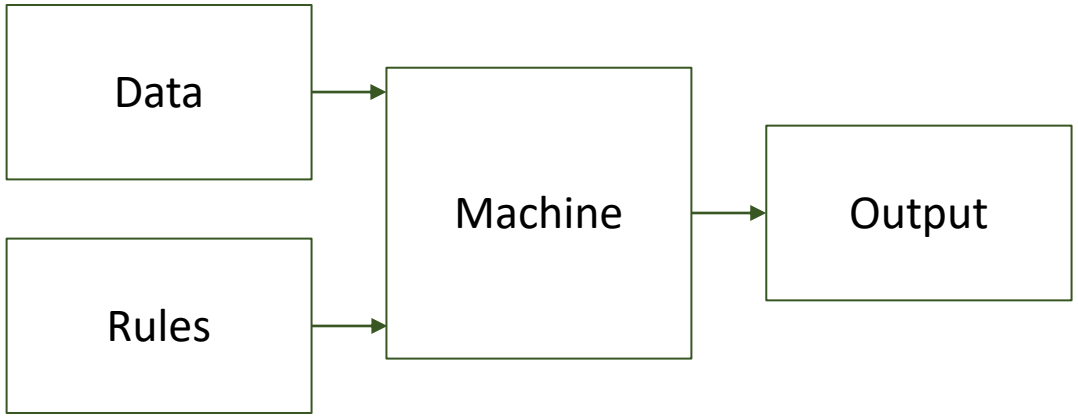
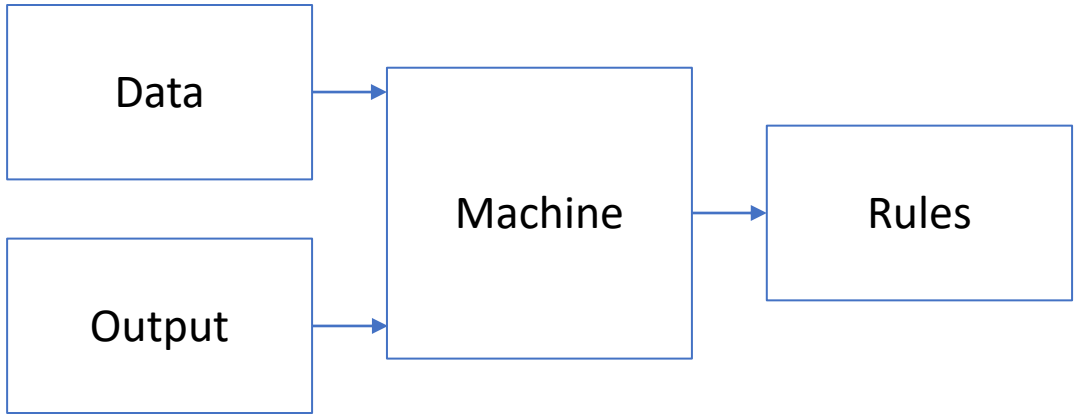
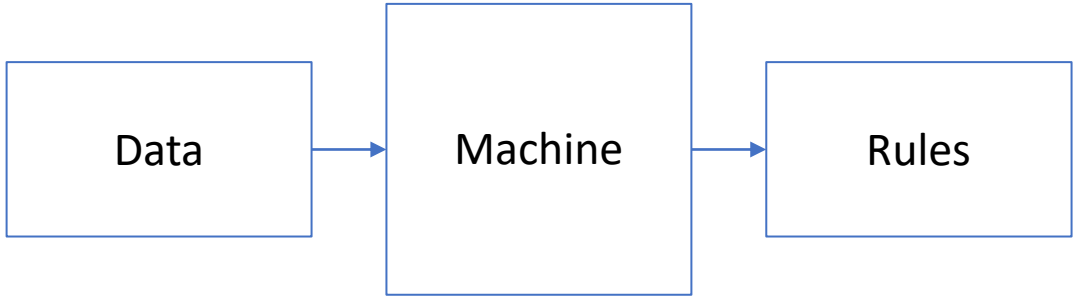


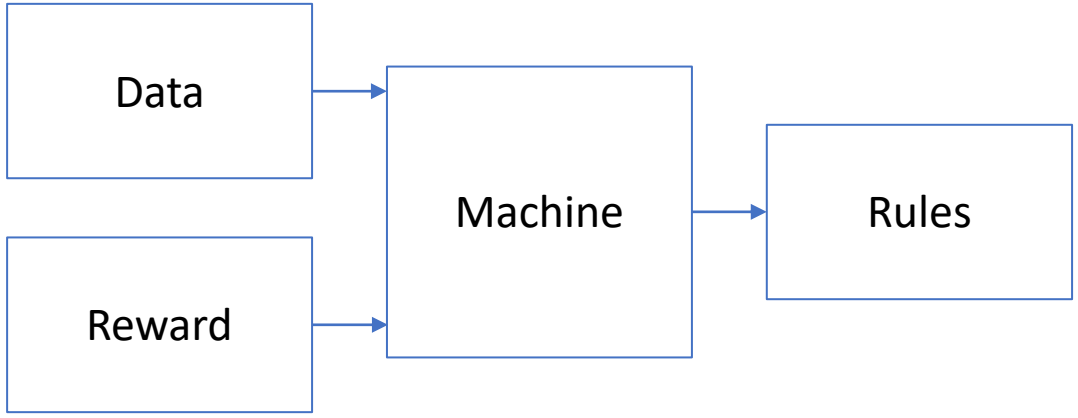
Machine Learning (Supervised Learning)

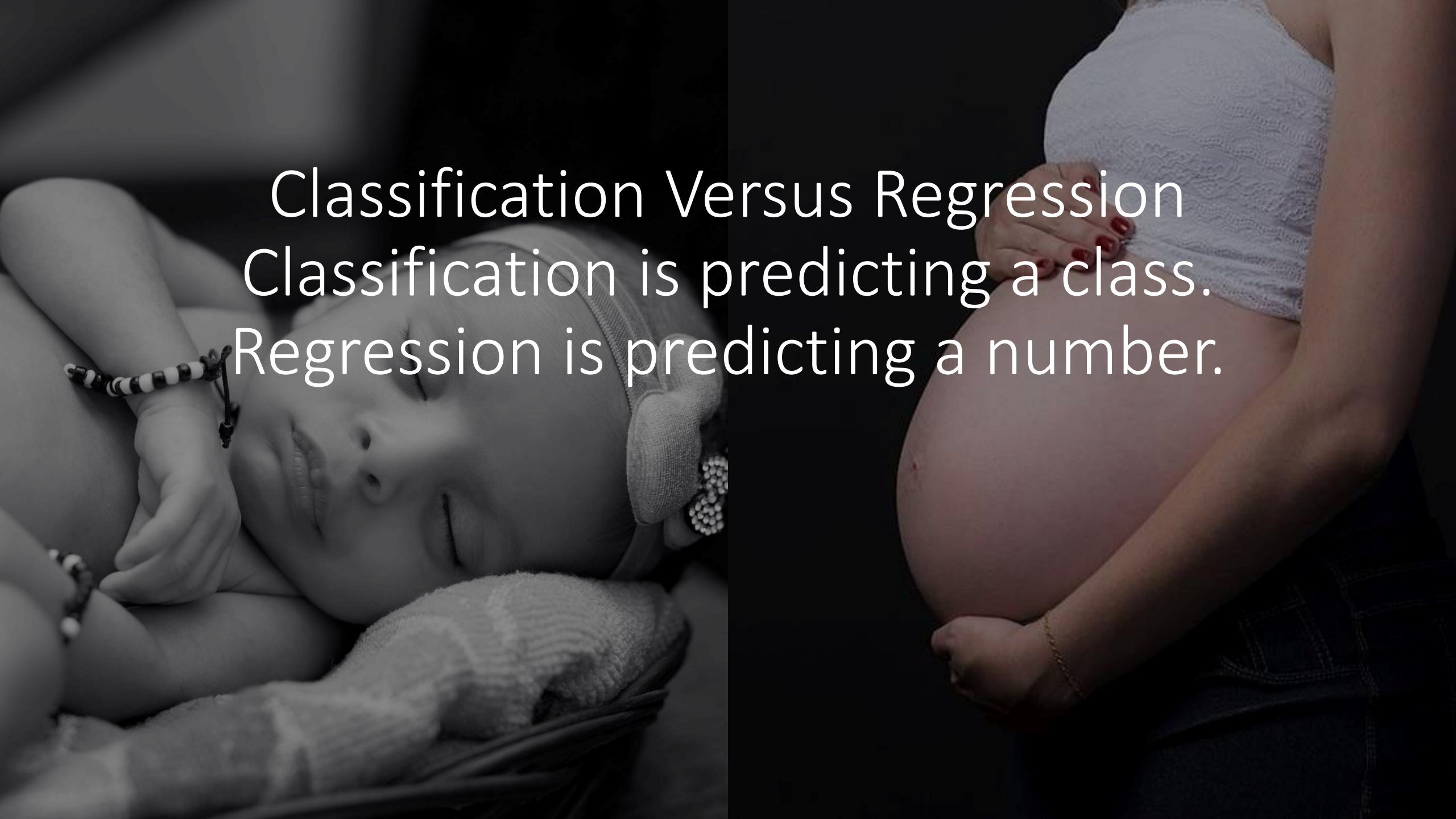


Machine Learning (Unsupervised Learning)



Machine Learning (Reinforcement Learning)





Classification Versus Regression

Classification is predicting a class.

Regression is predicting a number.

What then is Artificial Intelligence?