History of innovation

Quantititive Methods

Dr. Philippe J.S. De Brouwer
Honorary Consul of Belgium in Kraków
guest professor at the UJ, AGH, UEK and UW
board member of AGH and ISK
SVP at HSBC in Kraków

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AGH University of Krakow

History of Banking: a subjective selection

Mesopotamia 2,000 BCE

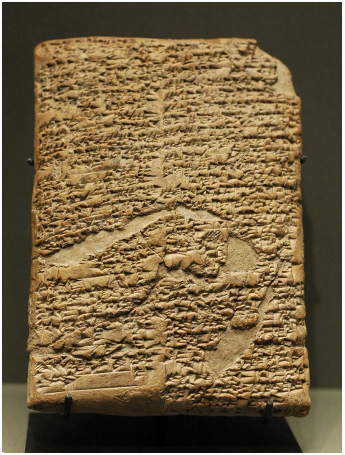


Figure 1: The Hammurabi Code (Law 100) describes interest-bearing loans. Comissioned by Hammurabi, the king of Babylon (ca. 1792–1750 BCE) – source: `wikimedia.org`

Jesus of Nazareth flips over tables and whips money changers and merchants

Figure 2: Christ driving the money changers from the temple by Jan Sanders van Hemessen. – source wikimedia.org

Liber Abaci: progress from mathematics

Figure 3: "Liber Abaci" (1202) by Leonardo di Pisa (posthumously Fibonacci) introduces the Modus Indorum the Hindu–Arabic numeral system (base-10 notations) in section 1. In section 2 the advantages for business problems: currency conversions, profit and interest calculations - foto

First Bankers: The Knights Templar

Figure 4: The Knights Templar: from poverty and devotion to military elite, richness and international banking (1120 – 1307)

The Medici

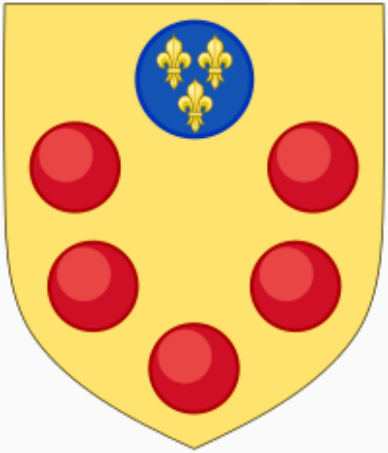


Figure 5: The Medici Dynasty power and influence beyond comparison through local in Italy - bank created by Giovanni de Medici in the 15th century.

Shares and stock exchange

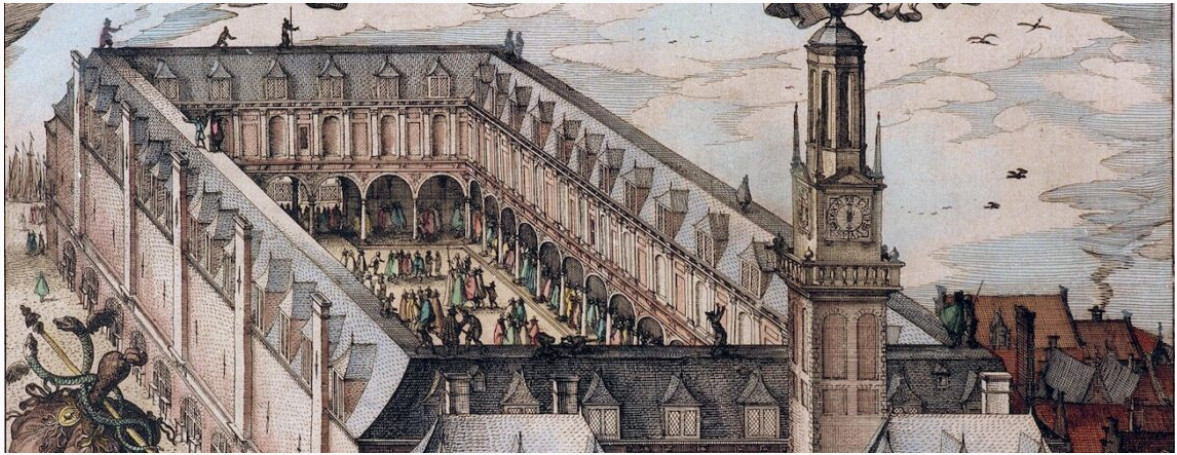


Figure 6: The Amsterdam Stock Exchange: 1602.

Shakespeare's Merchant of Venice

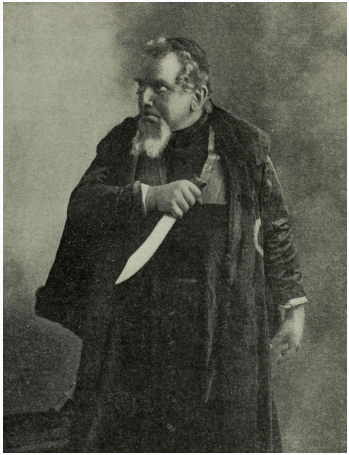


Figure 7: Ernst von Posart as Shylock in Shakespeare's play "The Merchant of Venice" (ca. 1600). — image.wikimedia.org

Mayer Amschel Rotschild

Figure 8: Mayer Amschel Rothschild re-invents international banking – The Internationalisation of the bank ca. 1770

The last piece of the puzzle

Figure 9: The last piece of the puzzle: energy rich food with the potato. From the end the 16th century (via Spain around 1570, and via the British Isles between 1588 and 1593).

The Motor: the Scientific Method

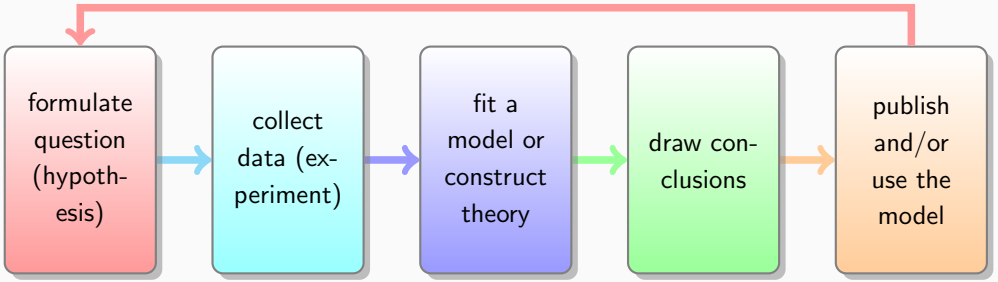


Figure 10: The steps in the scientific method for the data scientist as commonly in use from the 19th century, long after the work of Ibn al-Haytham (aka Alhazen — 965–1039, Iraq).

Cycles of Capitalism

The steam engine provides power for factories and fuelled unprecedented economic growth

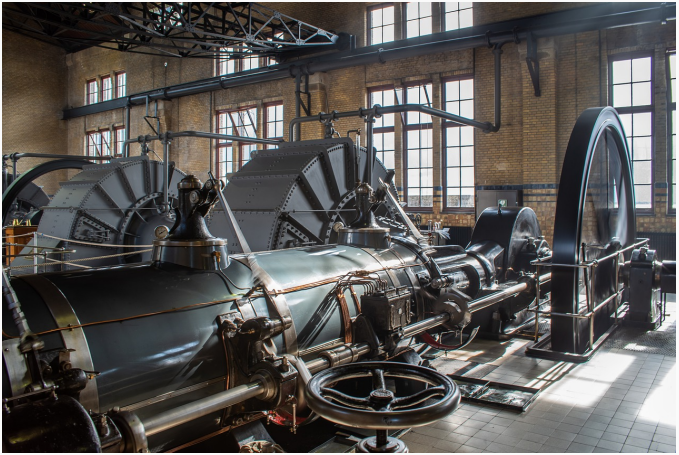


Figure 11: Steam Engine in factory — image by Kobus van Leer from pixabay.com

The Steam Engine

- Taqi al-Din in 1551 and Giovanni Branca in 1629 describe a steam engine
- Thomas Savery (1698) invents steam pump and in 1712 Thomas Newcomen invents the first practical steam engine
- invention of the steam engine with separate condenser by James Watt in 1765
- Ivan Polzunov (1766) builds the first two-cylinder steam engine
- explosive economic growth since the early 1800s
- The "Panic of 1857", 1866, and "The Panic of 1873", that initiated the "Long Depression"
- Karl Marx writes "Das Kapital" in 1867

The Train

Figure 12: The Train provided reliable mass transport — image Image by Erich Westendarp from pixabay.com

The Train

- 1804: first train (it pulled 25 tonnes of iron material and 70 people over the distance of 10 miles)
- First commercial steam train (Stephenson's "The Rocket") managed to reach speed of 96 km/h.
- about 40% of the world's cargo go still by train (ecological and efficient)
- end: "The Panic of 1901" and ultimately WWI

The Internal Combustion Engine

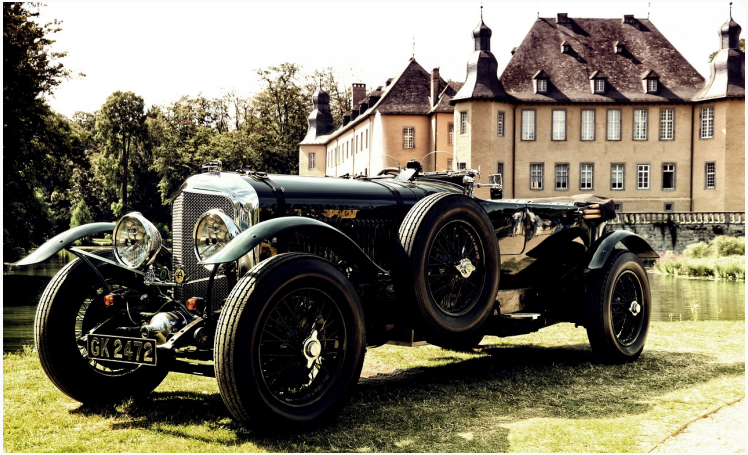


Figure 13: The internal combustion engine gave rise to reliable individual transport — image by S. Hermann & F. Richter from `pixabay.com`

Electricity and Magnetism

Figure 14: Electricity and Magnetism provided lightbulbs, radio, and all kinds of powered appliances — image by PublicDomainPictures from `pixabay.com`

The Internal Combustion Engine, Electricity and Magnetism

- 1805 Humphry Davy invets the "carbon ark" (electric light)
- 1832: first DC electro-motor (William Sturgeon); 1837
- 1885: first practical gasoline automobile by Karl Benz
- Ford T (since 1908)
- Automation both at home and in the factory due to electricity and magnetism
- end: "Wall Street Crash of 1929", that initiated the "Great Depression" and ultimately WWII.

Automobiles and the Petro-Chemical Industry

Figure 15: The petro-chemical industry — image by Frauke Feind from `pixabay.com`

Automobiles and the Petro-Chemical Industry

- Technological improvements on cars and their production
- First oil wells in USA (1846), Poland (1853), Romania (1857)
- First modern oil well (1854) and first oil refinery (1856) by Ignacy Łukasiewicz
- 1600 BCE: Mesoamericans used natural rubber for balls, bands, and figurines
- 1856: first man-made plastic by Alexander Parkes
- 1872: invention of polyvinyl chloride (PVC)
- 1923: Durite Plastics Inc. produced phenol-furfural resins
- 1930s: production of polystyrene (PS) and PVC by BASF
- 1933: polyethylene discovered by Imperial Chemical Industries (ICI) – Reginald Gibson and Eric Fawcett.
- 1941: polyethylene terephthalate (PET) discovered by Calico Printers' Association (a replacement for glass in many applications)
- 1954: polypropylene by Giulio Natta
- 1957: production of polypropylene
- 1954: expanded polystyrene (building insulation, packaging, and cups) invented by Dow Chemical.
- end: 1973–74 stock market crashes

The Electronic Computer

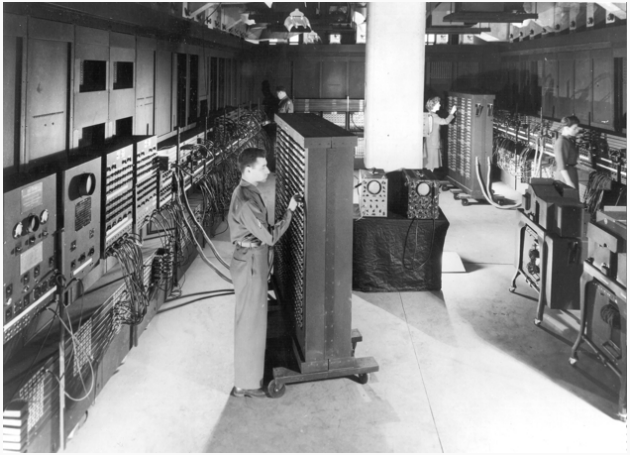


Figure 16: The ENIAC (Electronic Numerical Integrator and Computer) — image by Unidentified U.S. Army photographer - Public Domain

Moore's Law

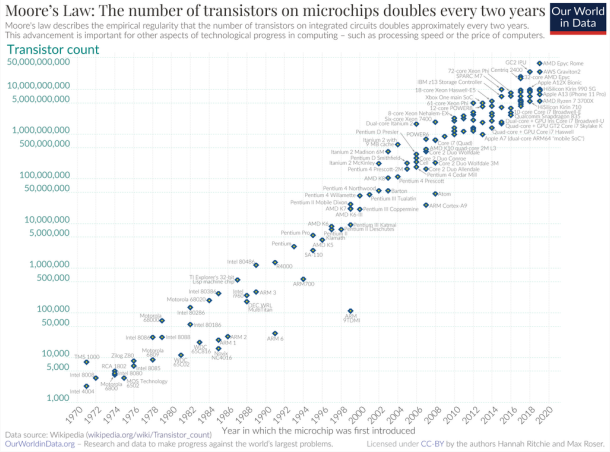


Figure 17: Moore's Law — image Wikimedia Commons `wikipedia.org`

The Computer: Key Dates

- Charles Babbage's Analytical Engine (1930s) and Ada Lovelace's code for it in 1843
- first computers: ABC in 1942, Collossus 1943
- 1946: ENIAC, first programmable general purpose computer
- 1952: IBM sells first mainframe
- 1953: Hard-disk
- 1959: metal–oxide–semiconductor field-effect transistor (MOSFET), invented by Mohamed Atalla and Dawon Kahng
- 1968: Network of Networks (UCLA) with Telnet, FTP, messaging and email — The ARPA-net in 1977 (now "the Internet")
- 1973: C (by Dennis Ritchie in the Bell Labs)
- 1980: DOS
- 1989: WWW is developed and used in CERN
- 1993: IBM Simon (first smart-phone)
- 2000: Nokia 3310
- end: Dot-Com Bubble of 2000 and the 2008 Global Meltdown

The Future

Kondratiev (1935)

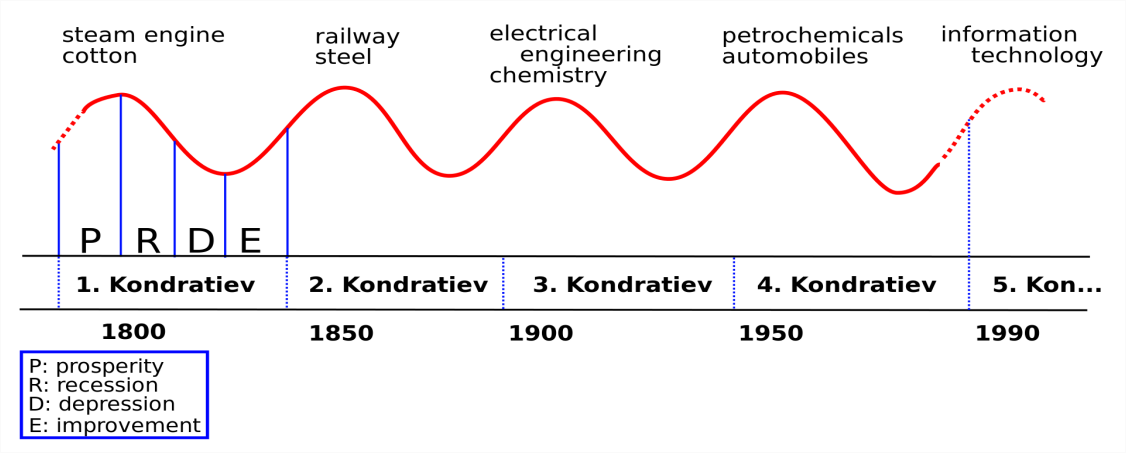


Figure 18: Kondratiev waves — image By Rursus - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=7833300.

The Next Large Trend Candidates

1. artificial intelligence, machine learning, big data, and robotic process automation;
2. nano technology
3. biotechnology, and
4. quantum computing;

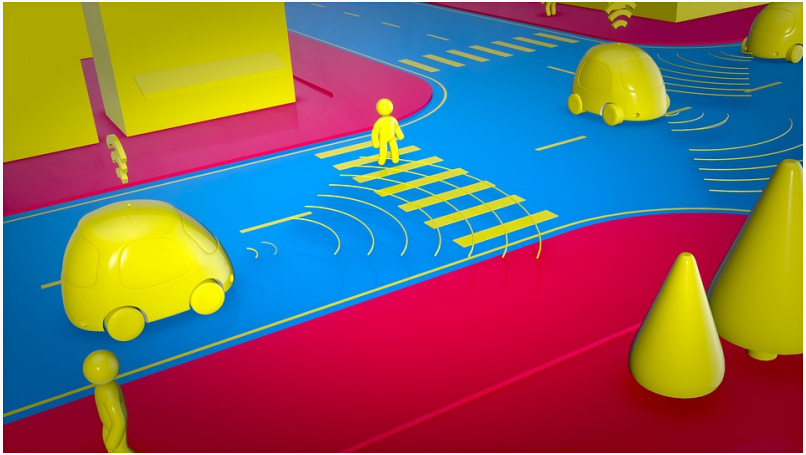


Figure 19: Self driving cars will become commonplace — image by Julien Tromeur from pixabay.com

The Singularity

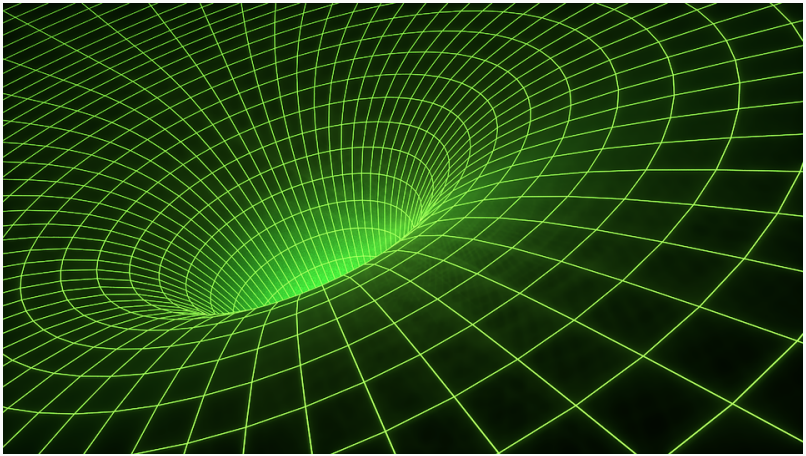


Figure 20: The singularity occurs when a machine will be able to improve on itself faster and faster — image by Johnson Martin from pixabay.com.

AI and ML – Face recognition is possible even when people are maksed

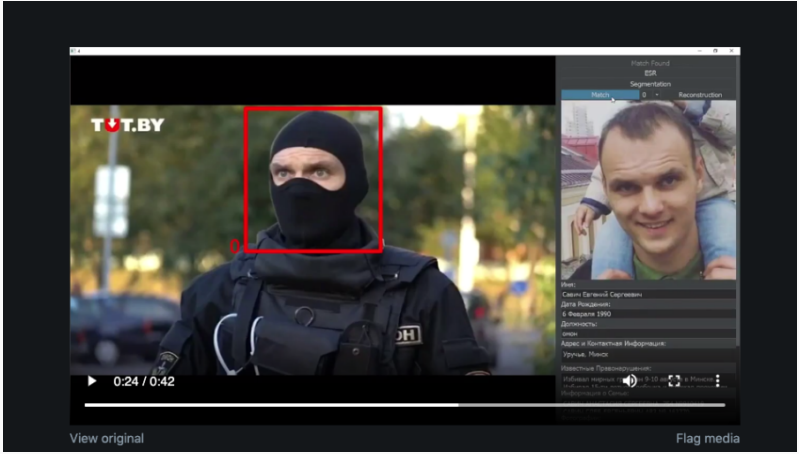


Figure 21: Police brutality under scrutiny: masked OMON police unmasked by AI.

AIML: Dall-e

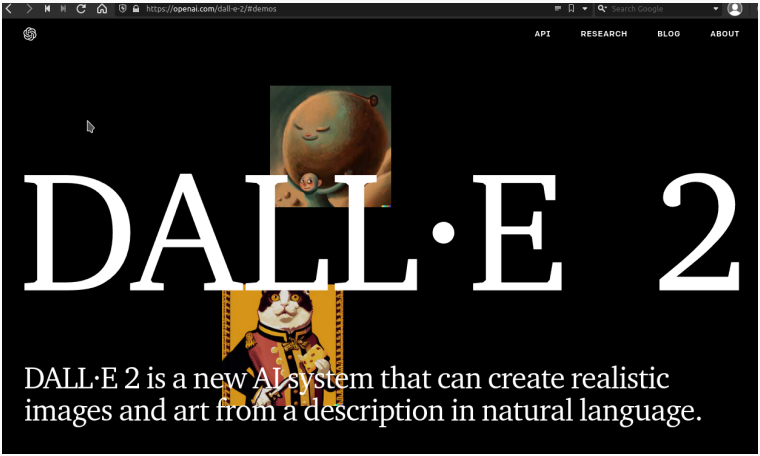
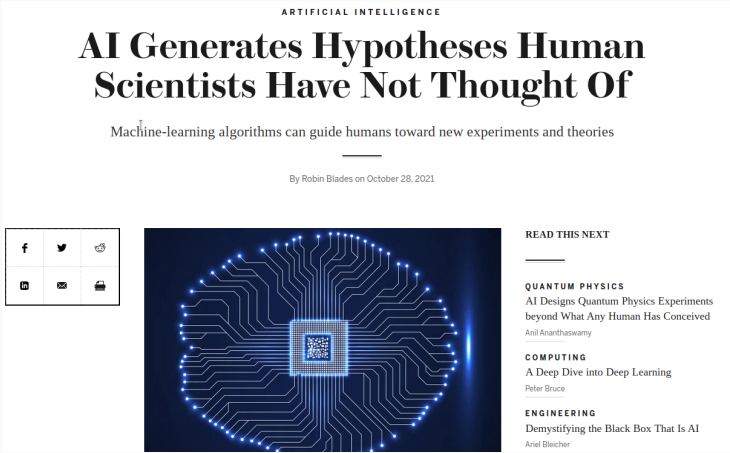


Figure 22: `https://openai.com`

AIML: Hypotheses



ARTIFICIAL INTELLIGENCE

AI Generates Hypotheses Human Scientists Have Not Thought Of

Machine-learning algorithms can guide humans toward new experiments and theories

By Robin Blades on October 28, 2021

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Anil Ananthaswamy

COMPUTING
A Deep Dive into Deep Learning
Peter Bruce

ENGINEERING
Demystifying the Black Box That Is AI
Ariel Bleicher

Figure 23: https://www.scientificamerican.com/article/ai-generates-hypotheses-human-scientists-have-not-thought-of/

AIML: Design and Creativity

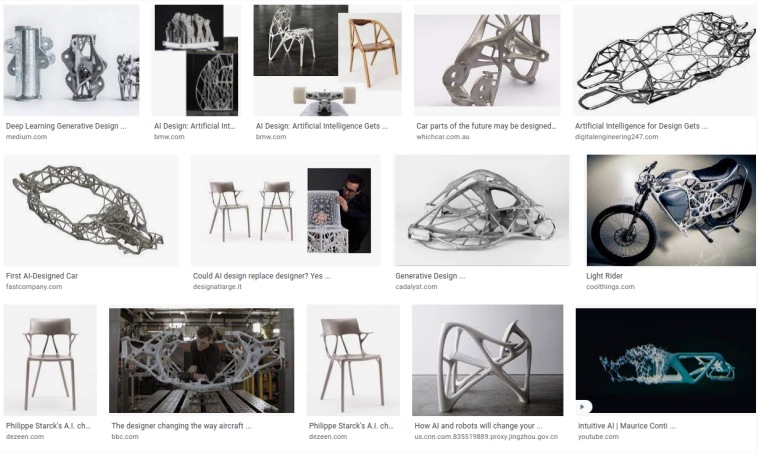
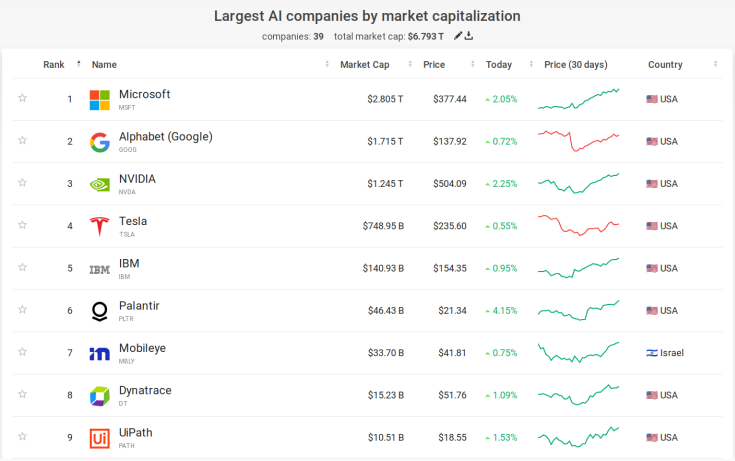


Figure 24: search on `www.google.com` "AI designed"

AIML: Transformational

The success of:

1. Netflix
2. Google: search engine, digital assistant, etc.
3. Uber
4. openAI
5. Amazon
6. Nvidia
7. etc.



Largest AI companies by market capitalization

companies: 39 total market cap: $6.793 T

Rank	Name	Market Cap	Price	Today	Price (30 days)	Country
1	Microsoft MSFT	$2.805 T	$377.44	2.05%		USA
2	Alphabet (Google) GOOG	$1.715 T	$137.92	0.72%		USA
3	NVIDIA NVDA	$1.245 T	$504.09	2.25%		USA
4	Tesla TSLA	$748.95 B	$235.60	0.55%		USA
5	IBM IBM	$140.93 B	$154.35	0.95%		USA
6	Palantir PLTR	$46.43 B	$21.34	4.15%		USA
7	Mobileye MBLY	$33.70 B	$41.81	0.75%		Israel
8	Dynatrace DT	$15.23 B	$51.76	1.09%		USA
9	UiPath PATH	$10.51 B	$18.55	1.53%		USA

Figure 25: source: `https://companiesmarketcap.com/artificial-intelligence/largest-ai-companies-by-marketcap/` on 2023-11-20

Figure 26: Vanta Black and similar coatings use nano technology – source: https://www.coating.co.uk/vantablack-coating.

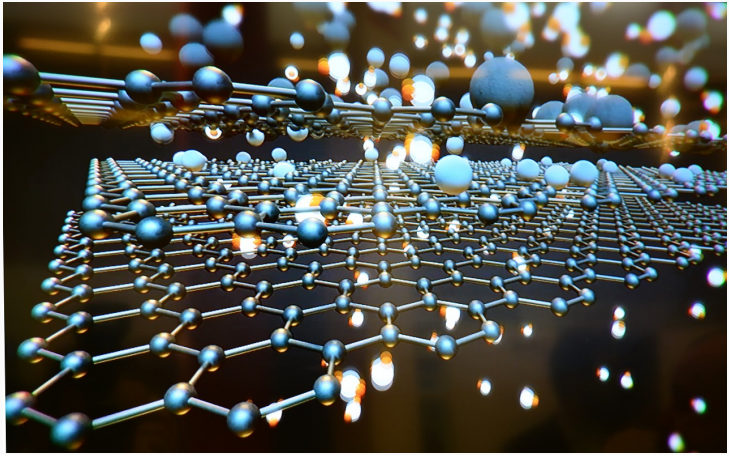


Figure 27: Graphene — image: Image by seagul from pixabay.com.

Nano Technology

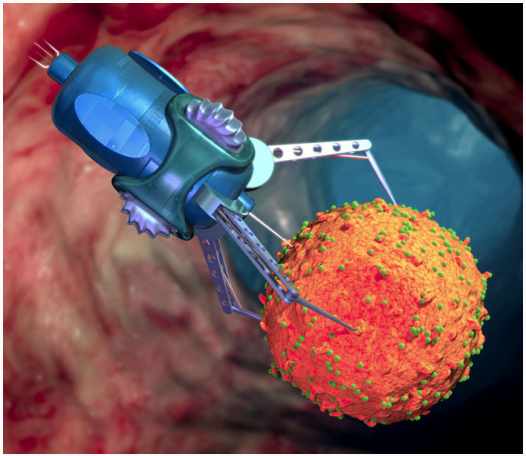


Figure 28: Nano robots — source: https://www.vaabot.com/23051/nano-robots-medicine-miniscule-wonders/.

Biotechnology and genetic manipulation is as old as farming: more than 10,000 years

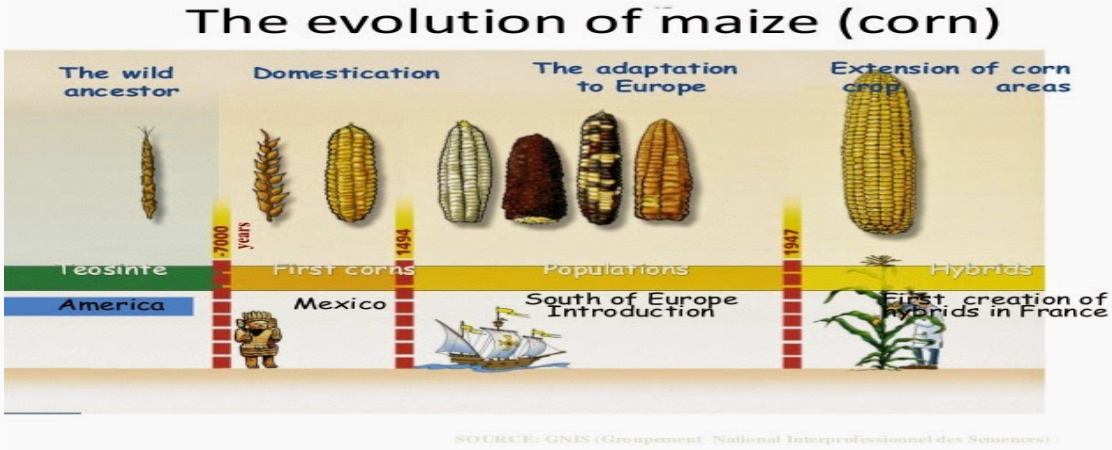


 Figure 29: the guided evolution of corn — source: unknown.

Biotech

What

- Recombinant DNA
- Cloning
- Stem Cell Therapy
- Designer Drugs
- Genomics & genetic engineering

Why

- less pesticides, $C0_2$, etc.
- better and more crops
- better plant and animal health
- better human health

The Holy Grail

Figure 30: The holy grail of Biotechnology — source: unknown.

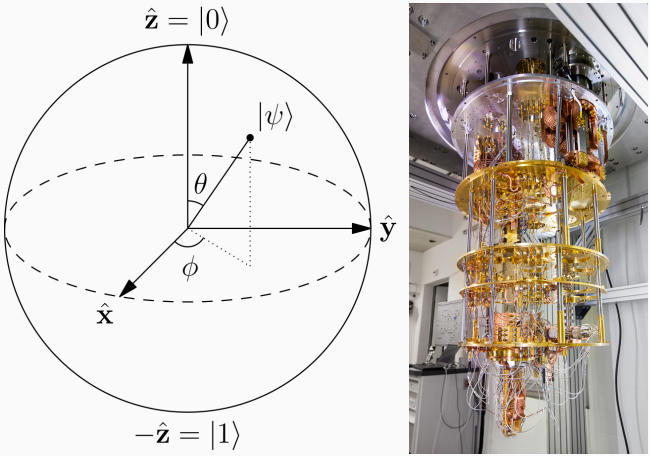


Figure 31: Quantum Computers. – Source: Wikimedia

Potential of Quantum Computers

- Adiabatic Optimization (D-Wave)
  - optimizations
  - ... but there is also the Quantum Monte-Carlo (QMC) technique for classical computers
- Shor's Alogorithm (1994): factor numbers
  - break most of today's encryption
  - ... including today's blockchain technology
- Lov Grover's (1996): invert functions without prior knowledge of the function
  - searching in unstructured data
- Solve large linear systems
  - solve ODE and PDE systems
  - regressions
  - machine learning

Conclusions

Conclusions

1. The next wave of exponential growth is taking off, and
2. while mathematics always was an enabler, for the first time it **is** mathematics (AI) that propels this growth.
3. Therefore we should consider:
   - 3.1 contributing to the development of AI,
   - 3.2 the applications of AI, but also
   - 3.3 invest even more in understanding and controlling AI, learning from AI, malevolent AI, ethics, societal organisation and purpose of humans, the future of humanity and a post-human era, etc.
4. Prepare for the next wave: of quantum computing with a focus on error correction, optimization methods, quantum robust encryption, QKD, etc.

Nomenclature i

BASF	Badische Anilin und Soda Fabrik
BCE	before common era
$C0_2$	carbon dioxide
DOS	disc operating system
ENIAC	Electronic Numerical Integrator and Computer
FTP	file transfer protocol
IBM	International Business Machines Corporation
MOSFET	metal–oxide–semiconductor field-effect transistor
OMON	Special Purpose Mobile Unit – Russian and Belarusian police force
PS	polystyrene
PVC	polyvinyl chloride
UCLA	The University of California, Los Angeles

Nomenclature ii

WWI	World War I
WWW	world wide web