History of innovation

Quantititive Methods

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History of Banking: a subjective selection

Mesopotamia 2,000 BCE



Figure 1: The Hammurabi Code (Law 100) describes interest-bearing loans. Comissioned by Champurabis theorem 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. – @PHIffអ្នងខ្លាំងថានៅរត់ org

Liber Abaci: progress from mathematics

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Figure 3: "Liber Abaci" (1202) by Leonardo di Pisa (posthumously Fibonacci) introduces the Modus Cpedrypy Dther 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

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First Bankers: The Knights Templar



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

The Medici



Figure 5: The Medici Dynasty power and influence beyond comparison through local in Italy - bank

Shares and stock exchange



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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).

Mayer Amschel Rotschild



Figure 8: Mayer Amschel Rothschild re-invents international banking – The Internationalisation of Chrillpart Deard The Internationalisation of

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 CFARTHER (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



©Philippe **PigBrewMet:** Steam Engine in factory — image by Kobus van Leer from pixabay.com

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- 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

- 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. CHAMINAR D&BFourRichter from pixabay.com

Electricity and Magnetism



Figure 14: Electricity and Magnetism provided lightbulbs, radio, and all kinds of powered appliances

- 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 ©Philippe De Brouwer

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

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The Electronic Computer



Figure 16: The ENIAC (Electronic Numerical Integrator and Computer) — image by Unidentified

Moore's Law



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

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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

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The Future

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Kondratiev (1935)

steam engine cotton	railway steel	electrical engineering chemistry	petrochemicals automobiles	information technology
P R D	E		\frown	**
1. Kondratie	ev 2. Kondratiev	/ 3. Kondratiev	4. Kondratiev	5. Kon
1800	1850	1900	1950	1990
P: prosperity R: recession D: depression E: improvement				

Figure 18: Kondratiev waves — image By Rursus - Own work, CC BY-SA 3.0,

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

AI and ML



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

The Singularity



Figure 20: The singularity occurs when a machine will be able to improve on itself faster and faster CPhimago by Longson 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. ©Philippe De Brouwer



Figure 22: https://openai.com

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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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ENGINEERING Demystifying the Black Box That Is AI Ariel Bleicher

Figure 23: https://www.scientificamerican.com/article/

AIML: Design and Creativity

medium.com

fastcompany.com





bmw.com









Artificial Intelligence for Design Gets ... digitalengineering247.com





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Could AI design replace designer? Yes

designatiange.it

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The designer changing the way aircraft ...



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voutube.com

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

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AIML: Transformational

The success of:

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

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Figure 25: source: https:

//companiesmarketcap.com/artificial-intelligence/
largest-ai-companies-by-marketcap/ on 2023-11-20

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Nano Technology



Figure 26: Vanta Black and similar coatings use nano technology – source:

Nano Technology



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

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Nano Technology



Figure 28: Nano robots — source:

Chringse/Dergwarbot.com/23051/nano-robots-medicine-miniscule-wonders/.

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

The evolution of maize (corn) The adaptation Extension of corn The wild Domestication to Europe CEOR areas ancestor leasing Seren interaction - Weighteist FIRST CORA South of Europe t creation of America Mexico

©Philippe De Brouwer 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, C0₂, etc.
- better and more crops
- better plant and animal health
- better human health

The Holy Grail



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

Quantum Computing



Figure 31: Quantum Computers. - Source: Wikimedia

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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

- 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
- C0₂ 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

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WWI World War I

WWW world wide web