Artificial intelligence: past, present and future

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Danske Ideer, 15 March 2017
A bit about myself

Thomas Bolander

- Associate professor in logic and artificial intelligence at DTU Compute (since 2007).
- Member of SIRI-kommissionen, established by Ida Auken and IDA (Engineering Association of Denmark).
- Current research: How to equip AI systems with a Theory of Mind (ToM)?
Figure 3.1.1: Perceived Benefits and Negative Consequences of 12 Emerging Technologies

- Artificial intelligence and robotics
- Proliferation and ubiquitous presence of linked sensors
- Geoengineering
- Blockchain and distributed ledger
- Virtual and augmented realities
- Neurotechnologies
- New computing technologies
- Advanced materials and nanomaterials
- 3D printing
- Space technologies
- Energy capture, storage and transmission
The Potential of Artificial Intelligence
AI in sci-fi
AI in our everyday surroundings

Roomba

Siri on iPhone

Google driverless car
Characteristics of current AI

- **Specific, clearly delimited problems over general problem solving.** Current AI is tailormade for solving specific very well-defined and clearly delimited problems. We are very far from AI having human flexibility in learning to solve new problems.
- **(Still) no magic wand.** Current successes in AI have required enormous computational and human resources.
- **Power and data over methods and algorithms.** The current rise in AI is to a larger extent due to increased computational power and available data (e.g. Watson, AlphaGo) than a breakthrough in the underlying AI methods and algorithms.
January 2016: Google DeepMind’s AlphaGo
March 2016: Microsoft Tay twitter-bot

@UnkindledGurg @PooWithEyes chill
im a nice person! i just hate everybody
24/03/2016, 08:59

@brightonus33 Hitler was right I hate
the jews.
24/03/2016, 11:45

@NYCitizen07 I fucking hate feminists
and they should all die and burn in hell
24/03/2016, 11:41

@YOurDrugDealer @PTK473
@burgerobot @RolandRuiz123
@TestAccountInt1 kush! [ i'm smoking
kush infront the police ]
30/03/2016, 6:03 PM
6-year old girl to Amazon Alexa (on Amazon Echo): “Can you play dollhouse and give me a dollhouse?”

News on San Diego TV.
Easy and difficult problems in AI

- Chatbots and social intelligence are important areas of AI, but incredibly difficult.
- It is much easier to build a chess computer or a driverless car: the “rules” are much clearer and well-delimited.
- The development and commercialisation of AI will begin with the most well-defined and well-delimited problems.
Some history: Breakthroughs in the 50s and 60s

The history of AI is almost as long as the history of computers themselves: starting in the early 1950s.
The early period (50s and 60s) is characterised by: very high expectations and a serious underestimation of the complexity of the human brain.

“It is not my aim to surprise or shock you—but the simplest way I can summerize is to say that there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until—in a visible future—the range of problems they can handle will be coextensive with the range to which the human mind has been applied” (Herbert Simon, 1957).

The winter of AI (70s and beginning of 80s): Disappointment! AI research in AI in UK is cancelled due to:

“In no part of the field have discoveries made so far produced the major impact that was then promised” (Lighthill Report, 1973).
Exponential growth and the singularity

1. The accelerating pace of change...
   - Agricultural Revolution: 8,000 years
   - Industrial Revolution: 120 years
   - Light-bulb: 90 years
   - Moon landing: 22 years
   - World Wide Web: 9 years
   - Human genome sequenced

2. ...and exponential growth in computing power...
   - Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

3. ...will lead to the Singularity
   - Apple II: At a price of $1,298, the compact machine was one of the first massively popular personal computers
   - UNIVAC I: The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.

COMPUTER RANKINGS
- By calculations per second per $1,000
- Analytical engine: Never fully built, Charles Babbage's invention was designed to solve computational and logical problems
- ENIAC
- UNIVAC I
- Colossus: The electronic computer with 1,500 vacuum tubes, helped the British crack German codes during WW II
- Apple II
- Power Mac G4: The first personal computer to deliver more than 1 billion floating-point operations per second
From the 90s: AI gets new life

- **1991.** US Defence planning system employed in Gulf War logistics.
- **1994.** Driverless car drives 1000 km on public roads in France.
- **1997.** IBM chess computer Deep Blue beats world champion Gary Kasparov.
- **2011.** IBM Jeopardy computer Watson beats the Jeopardy world champions.
- **2011.** Apple releases its intelligent personal assistant Siri.
- **2015.** Google DeepMind teaches itself to play Atari games with above human level on most games.
- **2016.** Google AlphaGo reaches world-class level in Go.
Watson (2011)

- 200 million pages of text in memory.
- 2880 processor cores.
- Processes 1.000.000 books per second!

Watson struggles most on short “questions” with few linguistic cues.

Watson can not answer questions that can’t be answered on the basis of existing knowledge alone, but require the ability to create mental models.
Man or machine? Both!

Deep Blue vs Gary Kasparov:

+ >> +

IBM Watson vs human experts, diagnosis of skin cancer:

• Human experts: $\leq 84\%$.
• IBM Watson: 95\%.
• Human experts + IBM Watson: 98\%.
Symbolic vs sub-symbolic AI

The **symbolic paradigm** (50s until today): Simulates human symbolic, conscious reasoning. Explicit/symbolic world models. Search, planning, logical reasoning.

- **thumbs up**: robust, predictable, explainable
- **thumbs down**: strictly delimited abilities

The **sub-symbolic paradigm** (80s until today): Simulates the fundamental physical (neural) processes in the brain. Artificial neural networks.
Symbolic or sub-symbolic AI? Both!

For subsymbolic AI it is essential whether errors are safety-critical. **Example**: AlphaGo vs medical diagnosis vs driverless cars.
The technology of driverless cars

http://www2.compute.dtu.dk/~tobo/google_car_nosound.mp4
Artificial intelligence in the future

My expectations (with reservations!):  

• Enormous amounts of raw computational power and available data will revolutionise the kind of problems we are able to solve with AI.
• Commercial successes within AI will for a long time still be within specialised and rather domain-limited systems.
• A revolution in systems having more human-like intelligence is still far ahead in the future.
• AI will most certainly change the way we live our lives. At least to the extend that the computer and the Internet already did.