



FUTURE MILITARY TECHNOLOGIES: ARTIFICIAL INTELLIGENCE (AI)

- What is AI ?
- Why is AI so hot ?
- Is AI human's greatest invention ?
- Is AI the 3rd revolution in warfare ?
- AI in autonomous weapon systems
- Will AI exceed Human Intelligence ?
- Is AI dangerous ?



Henning Heiselberg, Security DTU

What is AI ?

- **Artificial** refers to computers, ie. non-biological/silicon
- **Intelligence** is not well defined – usually understood as human level
- Often called machine intelligence/learning, deep neural networks, etc.

Examples:

- Google's search machines, Google deep mind
- IBM's Watson jeopardy winner, W-chef, W-beat, Simon at ISS, ..
- Facebook social network surveillance
- Apple's Siri voice recognition
- Microsoft Hanover cancer recognition, Skype chatbots, ..
- Amazon, Netflix, Instagram, Snapchat, twitter, LinkedIn, AmEX, BP, GE Power,
- Tesla, BMW, Mercedes, Google ...



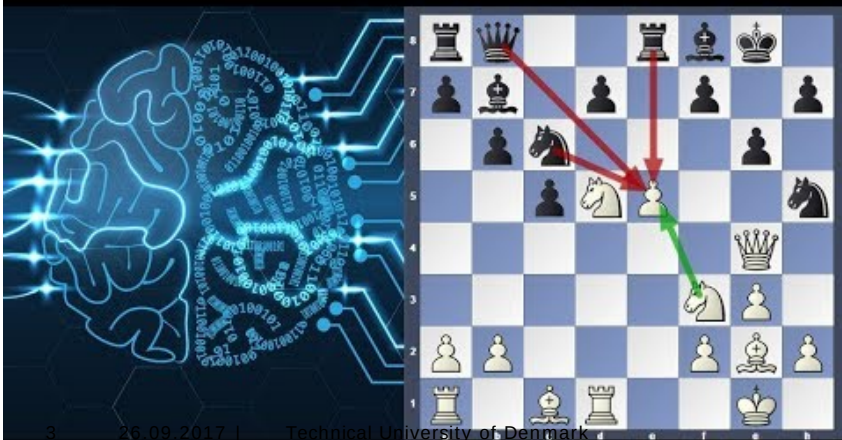
- Most modern business plans are: add AI to your product!

AI games



1977: Chess 4.6 wins first major tournament

1997: IBM Deep Blue beats world champion Gary Kasparov in chess 3,5-2,5



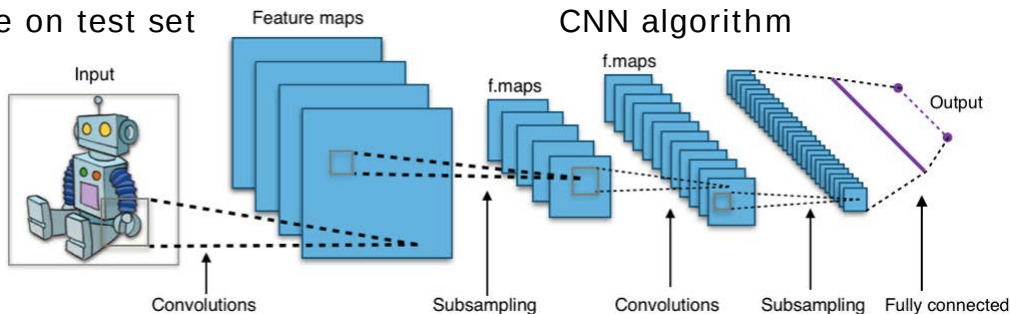
2017:

AlphaZero from Google DeepMind machine learning algorithm selftraining against world chess champion Stockfish8.

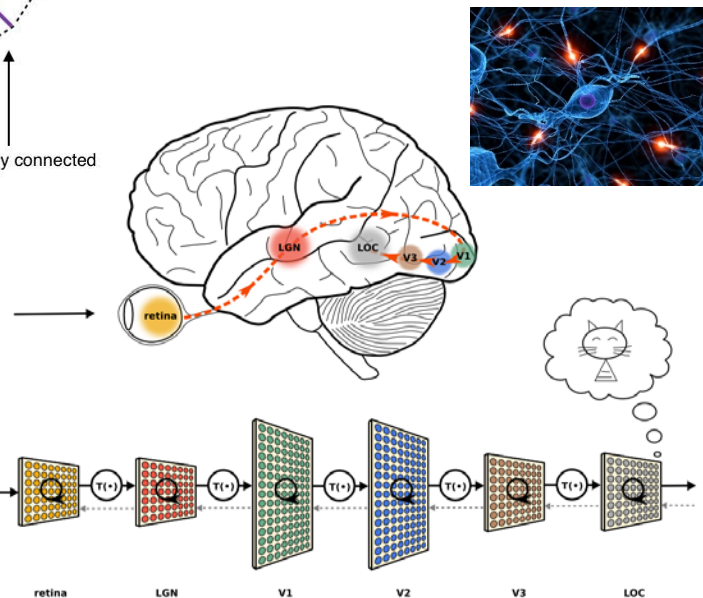
After 4hours: 100 games (28wins, 0 losses)

Machine Learning ($\approx$ AI)

- Start from a large training set, fx images of known objects
- Build/take a deep learning algorithm, eg. Convolutional Neural Network (CNN)
- Adjust (automatic – steepest descent) thousands of parameters to optimize recognition score
- Validate on test set



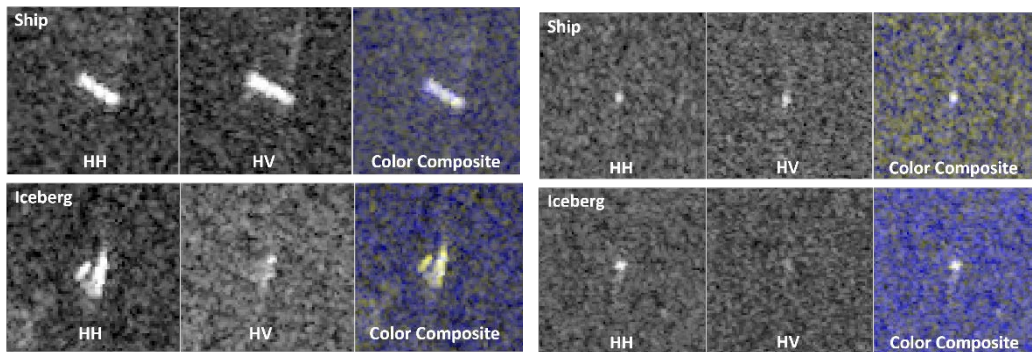
Our brain does a similar CNN recognition process
Years of learning is our training – builds memory bank
Our brain is “just” an electrochemical network of neurons



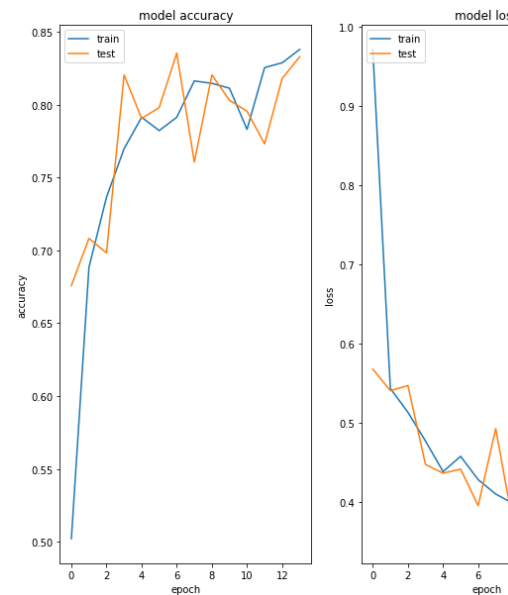
Example: Ship/Iceberg classification

Statoil 50.000\$ competition 2018:

- Large training set of 1400 images of icebergs and ships
- Build a deep learning algorithm, eg. Convolutional Neural Network (CNN)
- Adjust thousands of parameters to optimize recognition score
- Validate on test set of 4000 images -> high score
- 3400 teams competed (mostly Chinese)
- Winner found overfitting error in training set



We are running such a project for satellite images in the Arctic and in DK using Automatic Ship ID System – to find “black” ships





CYBERWAR

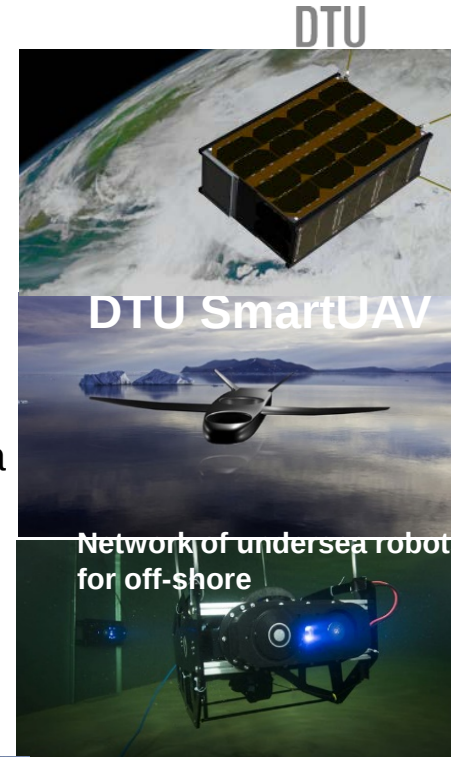
- The explosive growth of the Internet has opened new battle fields
- Cyber espionage, terror, presidential elections, hacking (MIL.DK), Maersk shipping...
- STUXNET virus from US/Israel infected Iranian centrifuges
- AI is used more and more to monitor attacks, anomaly detection, etc.
- DTU Compute Cybersecurity collaborates with Defense Intelligence
- "White-hat" hacking, "capture-the-flag" øvelser, og penetrationstests. Hacking lab!
- Huge demand for our software engineers
- What do we do about it? - DTU started bachelor in AI



AI in Autonomous Systems



- Sensor and weapons platforms
- 24/7, >9g
- Big Data analysis, ISR
- Threat databases, friend or foe?
- Rapid/automatic response required
- Advanced computers & decision systems
- AI is fast and crunch huge amounts of data
- Can control swarms
- No human errors, unbiased
- Cheaper, dispensable
- Fewer casualties (own & collateral)



AI in Autonomous Weapons Systems – "killer robots"



Aegis combat system

**IT Backbone of NATO BMD
Missile ID and defense.
Phalanx A/C def. sys.**



SGR-A1

**Intelligent watch tower
South Korean Samsung
guarding demilitarized zone.
3km ID, alarm, machine
gun/grenade launcher.
Cf. Sentry Tech at Gaza**



Sea Hunter

**Pentagon/DARPA
Submarine hunter & EW
Unmanned, ocean scan
Target detection, ID & attack**



X-47B

**Autonomous attack drone
Launch from hangar ships**

**AI is/will be 3rd revolution
In military technology !**

Ethical issues of human intelligence vs. AI



Human in the loop in all deployed weapon systems according to defense officials.

History of human vs. Technical errors:

- Oct. 27, 1963 during Cuban crisis, USS Randolph bombarded Soviet submarine B-59 in int. waters with depth charges. 3rd officer Vasili Arkhipov broke protocol by refusing to launch nuclear torpedo, thereby avoiding WW3
- Sept. 1, 1983, Korean airliner 007 stray into Soviet Union airspace and is shot down killing 269 passengers
- Sept. 9, 1983: Soviet early warning satellite system reported 5 US nuclear missiles. Officer Stanislav Petrov broke protocol by NOT retaliating due to "gut" feeling. Sun reflections off clouds was mistaken as rocket engines.
- 1988: USS Vincennes Aegis system shot down Iran Air flight 655 killing 290 passengers. Captain misread descending US patrol plane.

Human and technical errors due to limited intel and time.

Technical errors are human errors!

Human decision support heavily based on AI intel from sensor data

AI arms race is on!



V2

Dual Use and AI



Dual use is often understood as civilian technology mis-used by military (or police). Often it is the other way around:

- Aircrafts, jets, rockets, satellittes, GPS, drones, nuclear power,...
- Chips, computers, internet, cell phones, encryption
- Many radio, optical, chemical and biological sensors, detectors and electronics,...
- Radar, microwaves, lasers,...
- Penicillin,...



Me-262

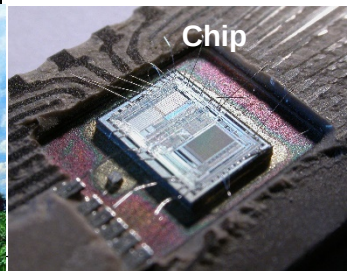


SPUTNIK 1
СЛҮТНІК 1

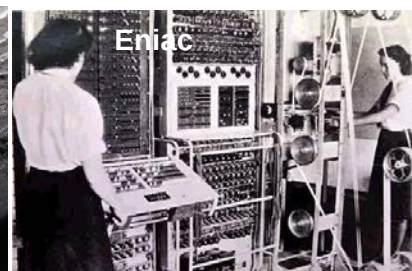
are examples of revolutionizing technologies, that require long time and enormous investments, only available from defense budgets.

Pentagon AI fiscal budget 2017 was \$15 billions

Employees stopped Google AI project Maven with Pentagon june 2018



Chip



Eniac



ABM Radar
Hawaii



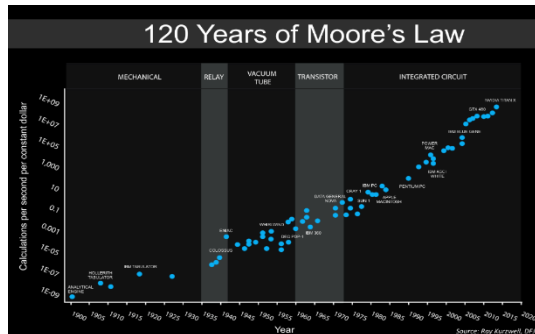
USS Ponce
High Energy Laser

The 3 stages of LIFE (Max Tegmark)



- Life = process that retains its complexity and replicate
- Life 1.0 = evolves its hardware and software (biological stage)
- Life 2.0 = evolves its hardware but designs its software (brain and learning)
 - our brains contain 100.000 times our genetic information!
- Life 3.0 = designs both its hardware and software
 - technological stage: cyborgs, AI chip and software development

Will AI exceed Human Intelligence ?

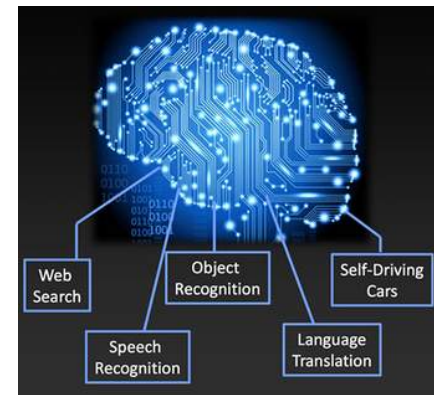


- Moore's law: transistor capacity doubles every 2-3 years
- Likewise for CPU processor power, RAM, memory, internet bw, ...
- No capacity limitations or saturation
- Processing speed 10 mio. times faster than neurons
- Still do not have same capacity for parallel processing as our brain
- No CPU volume limitations, the SkyNet is the limit!
- Quantum computers ?



Math 101:

- $dl/dt \sim l$ gives exponential growth:
interest rates, chain reactions, ...
- $dl/dt > l$ leads to a SINGULARITY -> Super AI



Calculations per second (FLOPS) per \$1000

1 The accelerating pace of change ...



2 ... and exponential growth in computing power ...

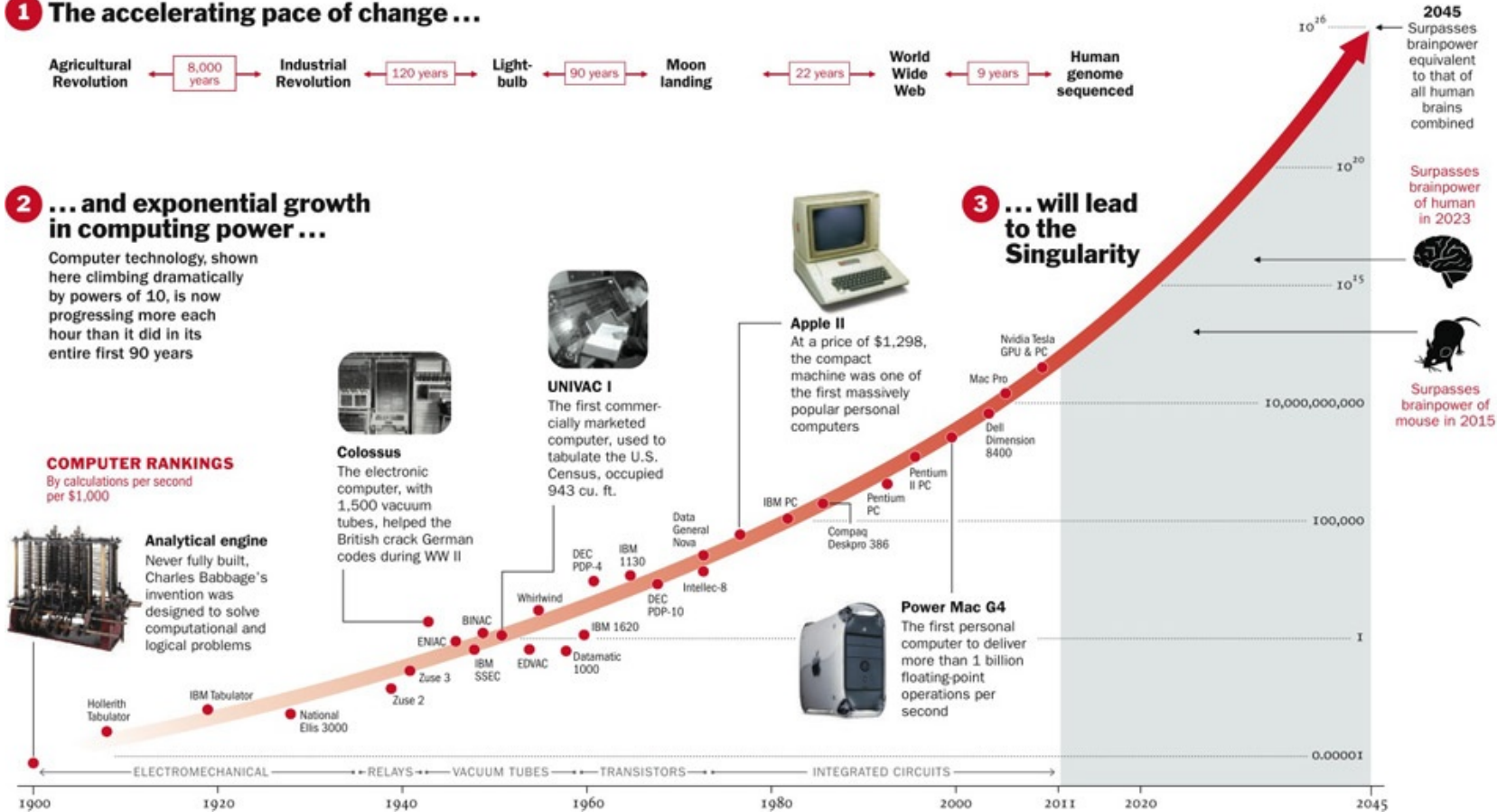
Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS

By calculations per second per \$1,000

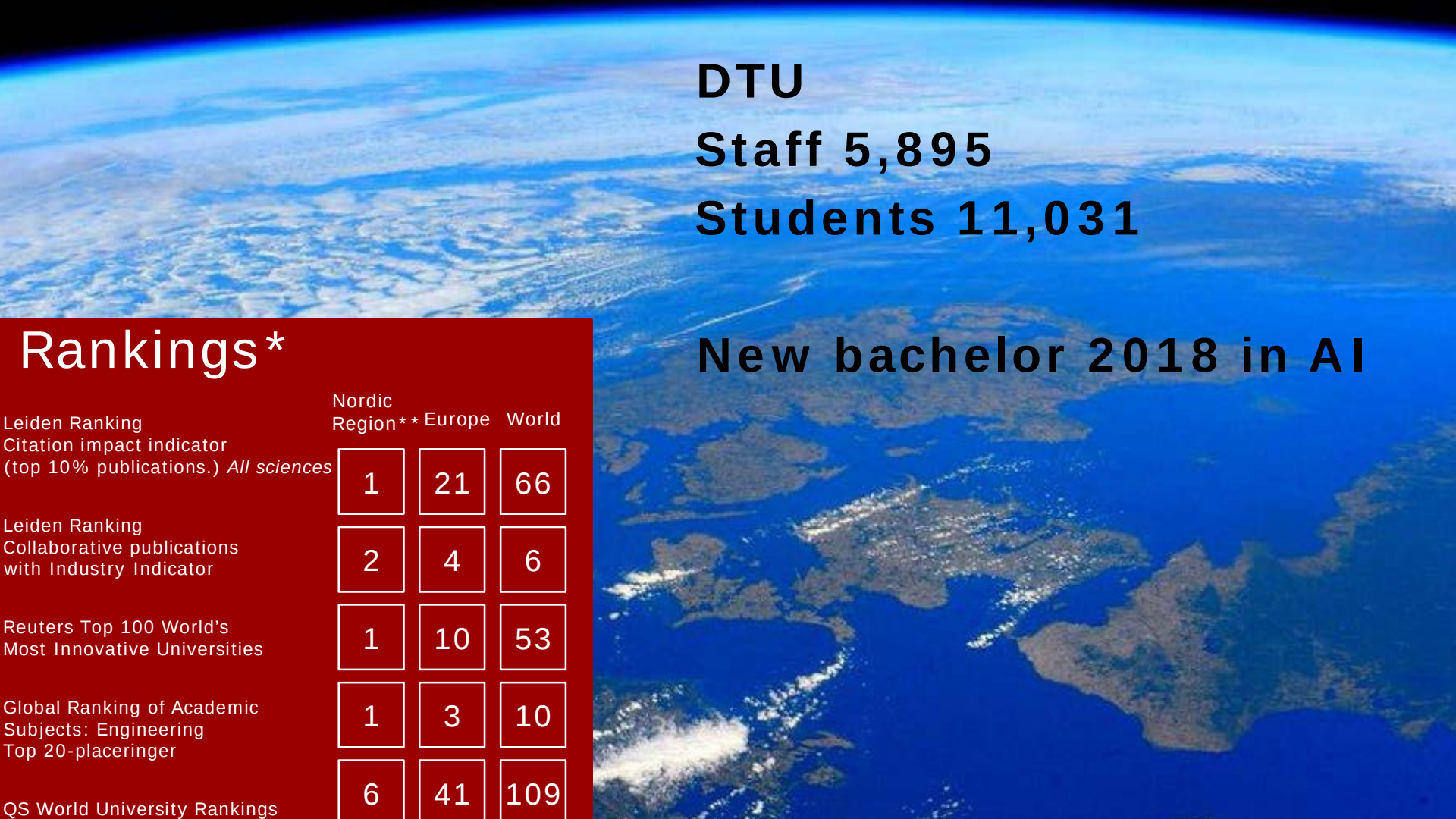


3 ... will lead to the Singularity



2045

2023

A satellite view of Earth from space, showing a blue ocean, white clouds, and brown landmasses. The horizon is visible at the top of the frame.

DTU

Staff 5,895

Students 11,031

New bachelor 2018 in AI

Rankings*

	Nordic Region**	Europe	World
Leiden Ranking Citation impact indicator (top 10% publications.) <i>All sciences</i>	1	21	66
Leiden Ranking Collaborative publications with Industry Indicator	2	4	6
Reuters Top 100 World's Most Innovative Universities	1	10	53
Global Ranking of Academic Subjects: Engineering Top 20-placeringer	1	3	10
QS World University Rankings	6	41	109

Tracking 1000 students mobile phones



DTU Campus

Lyngby

15km north

Dormitories

Auditoria

Canteens

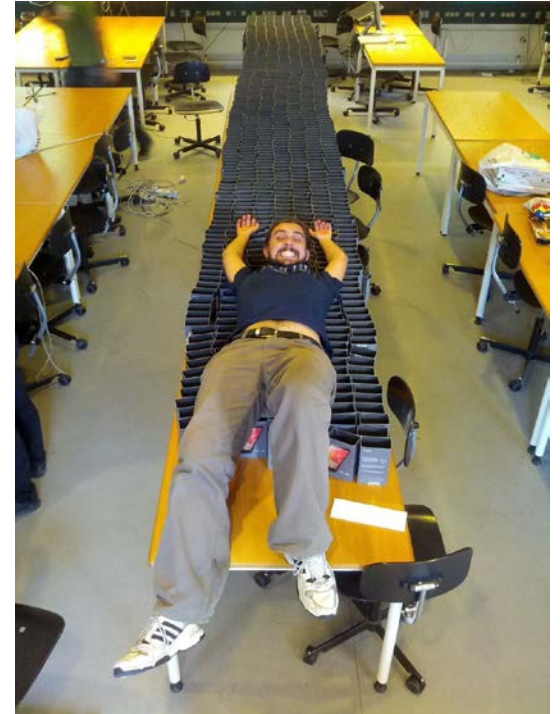
Courtesy:
Sune Lehmann
DTU Compute



Copenhagen Denmark The World



2 years, 1000 individuals

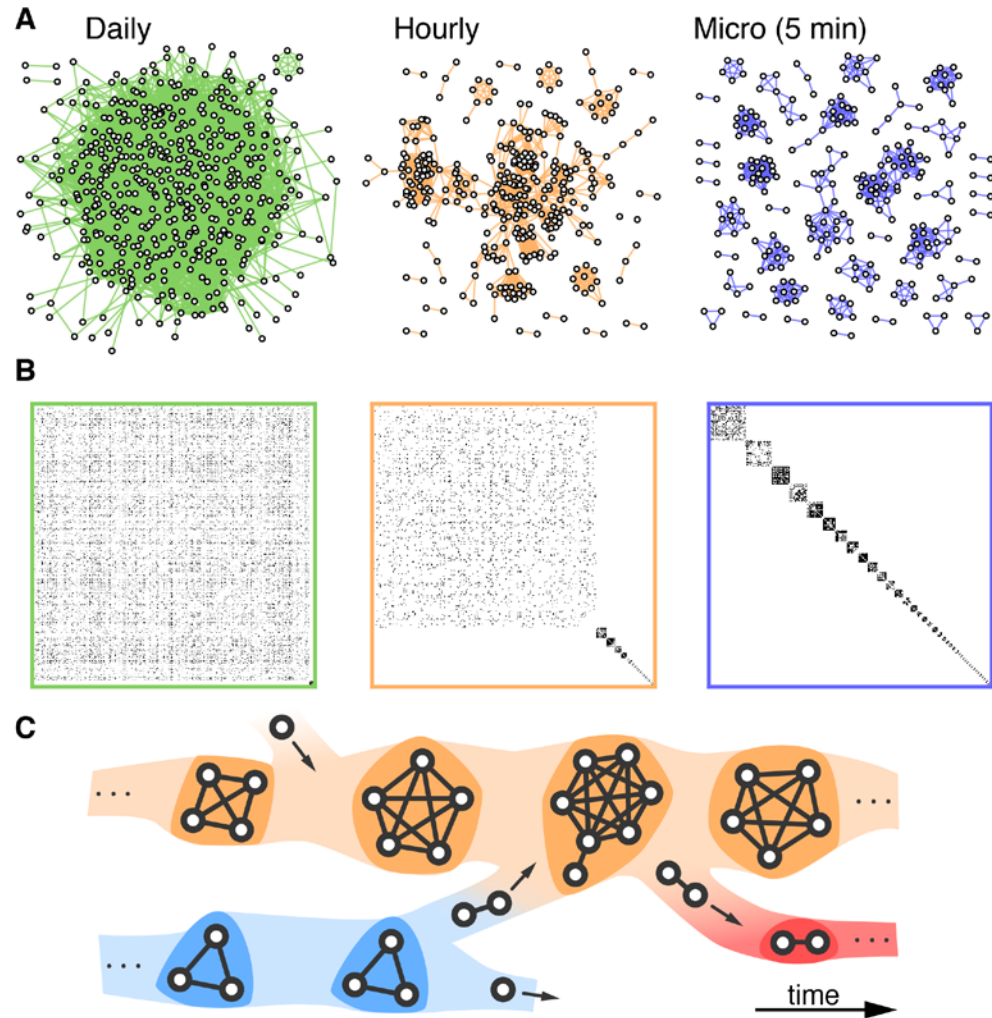


Human mobility & Social behavior
Predictive analyses
Anomaly detection
Automatic, fast, Big Data, IoT, ...

Drugdealers, trespassers, spys, etc.
would show up as smoking guns

Similar AI used by:
Google, Facebook, Amazon, IBM, Microsoft, Finance,
...

Global navigations systems (Galileo vs GPS) with
cm resolution can have many uses:
fx Las Vegas shoot out 1-10-2017, 58d, 851 inj.



Is AI dangerous?

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- Google, Microsoft, IBM, Facebook, Apple, Amazon, Netflix, Instagram, Snapchat, twitter, LinkedIn, AmEX, BP, GE, Tesla, BMW,...:
AI is our greatest invention, huge benefits and business potential, ..
My colleagues at DTU Compute have also sold their soles for mammon

- Elon Musk, Stephen Hawking, Kurzweil, Bostrom, Terminator, ...:

Super AI is near

Our brains are too limited to predict consequences

AI is uncontrollable and dangerous

The Singularity is near

