Social Impact of AI Science and Engineering: Information Filtering and Disinformation

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Version 1.2

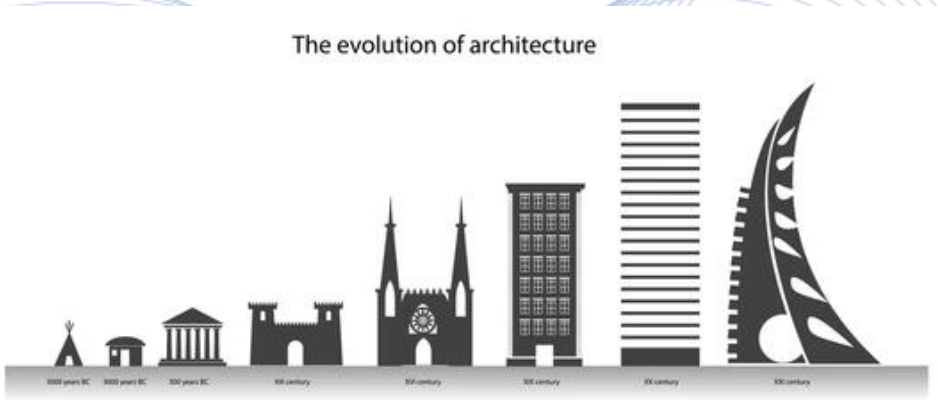
Artificial Intelligence & Information Analysis Lab

AI Science and Engineering

- **Complex world**
- What is AI?
- AI and Human Mind
- AI and Society
  - Information Filtering
  - Social Media and Disinformation

Complex world

- The ***complexity*** of our world increases.
- We live in an environment that evolves over space and time.
- Ever more complex man-made constructions:
  - Smart buildings, complex infrastructure.
  - Complexity increases along ***height***, due to space scarcity.
  - Miniaturization complexity increases due to resource scarcity: ***rare earths***.



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Complex world

- Life form complexity increases ***through evolution*** or ***by design***:
  - New plant and animal variations, e.g., genetically designed.
  - We are at the start of life evolution by design.

- The increase of ***global population*** contributes to world complexity.

- Complexity increase in contrast to the 2nd thermodynamic law (***thermal death***).

Complex world

- We live in an ever more complex ***mental world***.
  - ***Dramatic increase in data production.***
  - Large increase in knowledge, e.g., number of concepts:
    - Many ***new concepts***: Internet, fake data, cryptocurrency etc.
  - Economic growth.
  - Complex societal processes.

- It is reflected in the real world (***rather the opposite***):
  - Internet, mobile communications, economic data, media.
  - Social media, social functions.

Complex world

- Why world complexity increases?
  - Addressing human homeostatic and survival needs.
  - For-profit economies (capitalism) > Competition > Growth.
- Large strain on material and energy resources.
- ***Can humans cope with increased world complexity?***
  - Limited brain capacity. Limited human body capacity.
  - Very slow biological evolution.

- ***Is world complexity increase unavoidable?***

Complex world

- ***Statement***: ***Information technologies*** and ***Artificial Intelligence*** is our current reply to world complexity increase.

  - Handling of the huge data flow:
    - Data acquisition, processing, communication, storage.
  - Addressing human brain limitations:
    - AI and ***data analysis*** produce information.
    - ***Unlimited memory*** thanks to data storage.
    - Reasoning and knowledge production: ***not there yet!!!***

Complex world

- Addressing human body limitations:
  - New ‘senses’: ***seeing the macrocosm and microcosm***.
  - Improved human mobility: ***intelligent vehicles***.
  - Improved communication:
    - ***We can reach any person on earth in 5-6 hops!***
    - ***Mobile 24/7 communications.***
  - ***Greatly improved global health.***

- ***All the above benefits come at a price!***

What is AI?

- ***AI Science and Engineering*** (AISE) is the interdisciplinary, scientific study and engineering of ***Artificial Systems*** that mimic and/or surpass ***human intelligence*** in information analysis and ***human interaction*** with the world.

- Core AISE disciplines are:
  - ***Machine Learning*** (ML),
  - Classical (Symbolic) ***Artificial Intelligence*** (AI)

AI Science and Engineering

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What is AI?

- Closely related AISE disciplines:
  - ***Robotics,***
  - Autonomous Systems,
  - Digital Signal/Image Processing and Analysis,
  - Data Science and Data Analytics
  - ***Network Theory***.

- Very useful in defining:
  - Data, analysis modes, applications.

What is AI?

- Complementary AISE-related disciplines:
  - Cognitive Science,
  - Neuroscience,
  - Psychology,
  - ***Philosophy, Ethics***
  - Linguistics
  - Sociology.

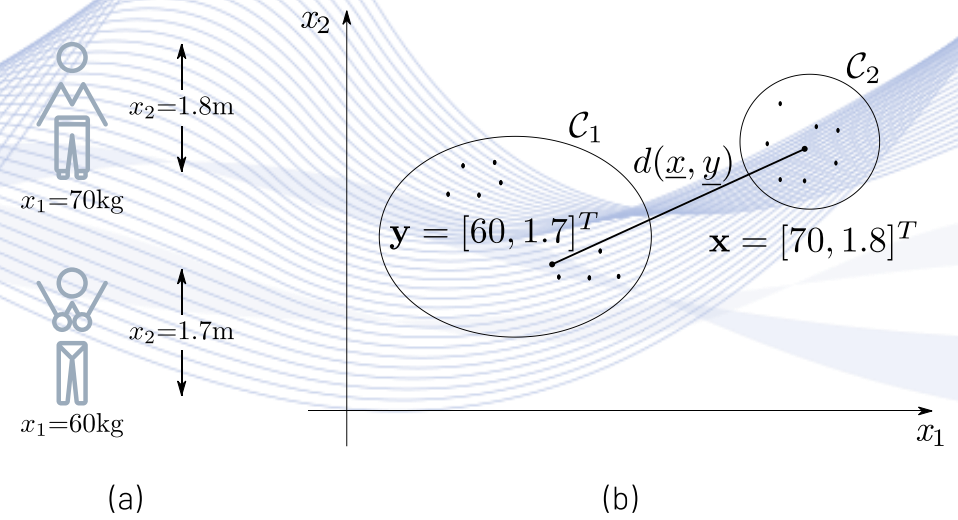
What is AI?

Data/information/knowledge definitions

Data: measured quantities related to nature and/or human activities.

- ***Data are primarily numbers*** representing object characteristics (features).
- Passive/active data acquisition.
- Data sampling.

- ***Measured in bits.***



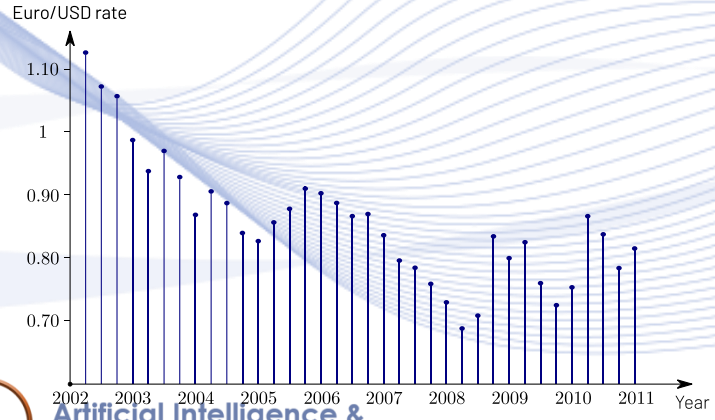
What is AI?

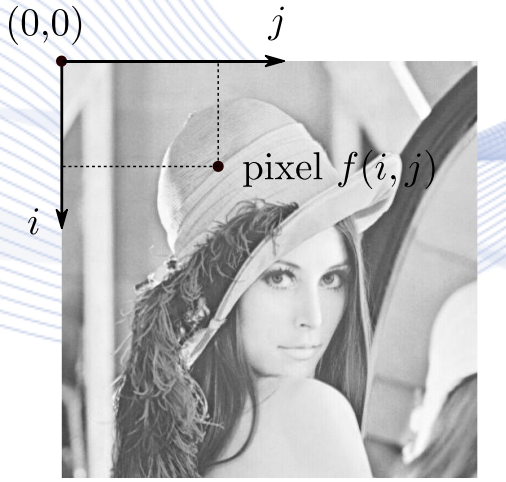
Data can have ***spatiotemporal structure***:

- 1D temporal signals, e.g., music
- 2D spatial signals: images

- Signals and object features can be represented by ***vectors***:

$$\mathbf{x}^T = [x_1, x_2, \ldots, x_n].$$

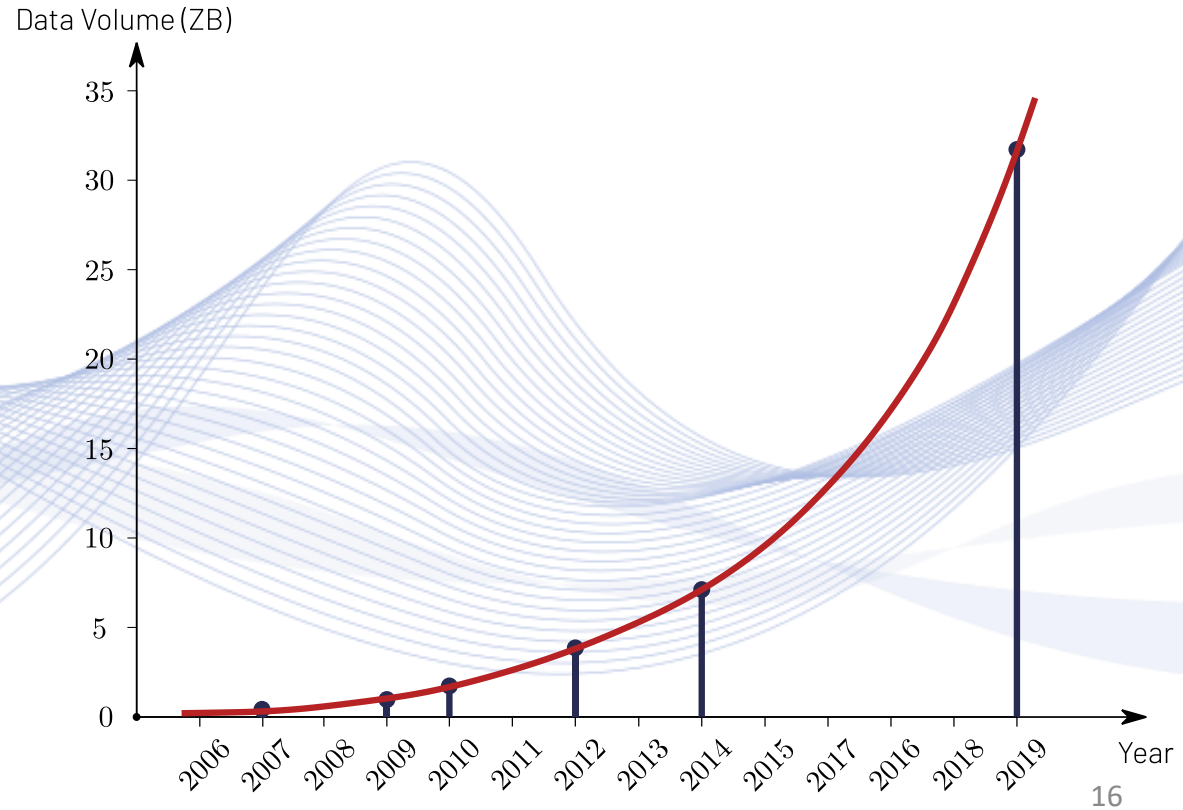




What is AI?

Exponential data increase:

- Proliferation of sensors
- Detailed recording of nature and humans
- Sensing automation.



Data volume increase in past decade.

What is AI?

Why we need ever more data?

- To navigate in an ever more complex world.
  - ***Why do we need a more complex world?***

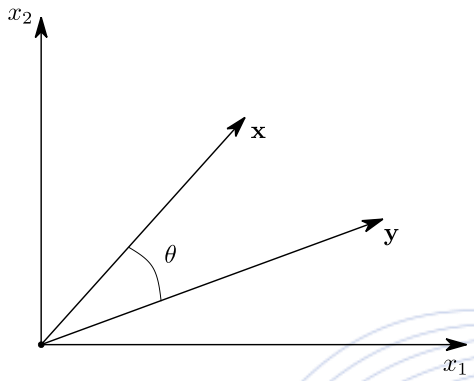
Data sustainability:

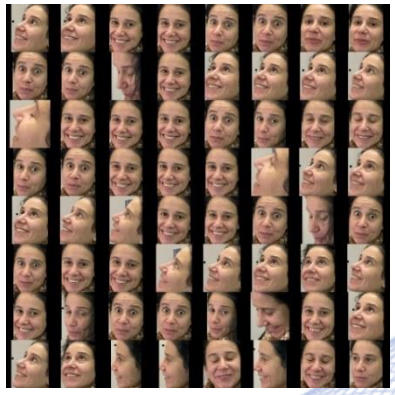
- HW enabled
- ***Moore's law***
- Data storage constraints
- Data communication constraints.

What is AI?

Unsupervised Machine Learning

- Data clustering:



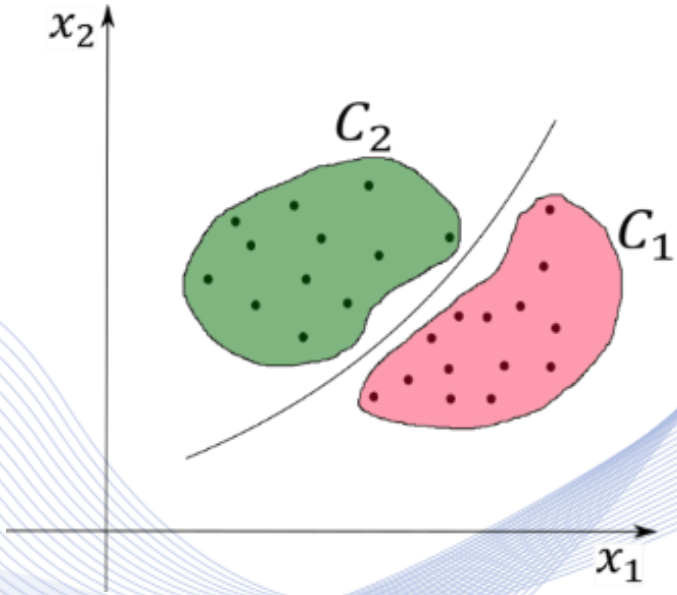


- Data geometry
- ***Abstraction***
- ***Data compression.***

What is AI?

Supervised Machine Learning

- Learning functions $\mathbf{y} = \boldsymbol{f}(\mathbf{x}; \boldsymbol{\theta})$ from labeled training data $\{(\mathbf{x}_i, \mathbf{y}_i), i = 1, \ldots, N\}$.
- ***Classification***
- ***Regression.***



- Learning data probability distributions $p(\mathbf{x})$.
  - ***Generative neural networks.***
    - ***Fake data creation.***

What is AI?

Information

- Notoriously vague definitions
- My definition: ***Information is the result of the manual or automatic Data Analysis***.

Taxonomy: Data → Information → Knowledge.

Machine Learning/inference produces ***information*** (including metadata).

- ***Information theory/entropy: bits (once more)!***

What is AI?

Concepts and ideas (‘***ιδέες***’).

- Concepts are specific mental constructs residing in our mind (brain?) that refine and abstract ideas.
- ***Concept instances***

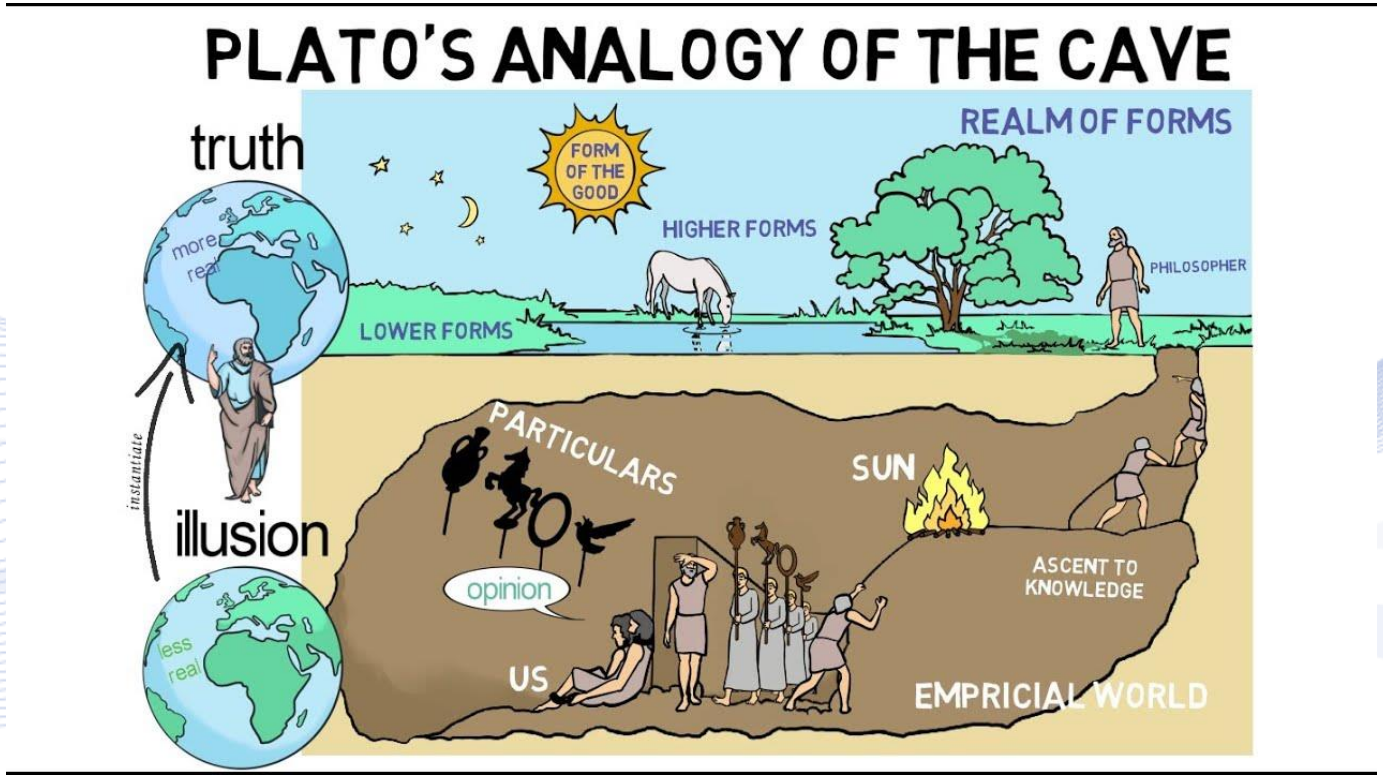
Instances of a triangle.

- ***Abstraction and generalization***:
  - Simplification and data compression.

What is AI?

Ideas in Philosophy.

- Idealism, materialism, dualism.
- Plato's cave.



What is AI?

Symbolic AI

- A ***symbol*** (‘***Σύμβολο***’) is a ***comprehensible representation*** of an object, idea, concept, action, status, or relationship.
- Symbolic AI mimics and simulates high-level human intelligence and ***reasoning***.
- It represents and operates on concepts and their relations though ***logic*** and ***search***.

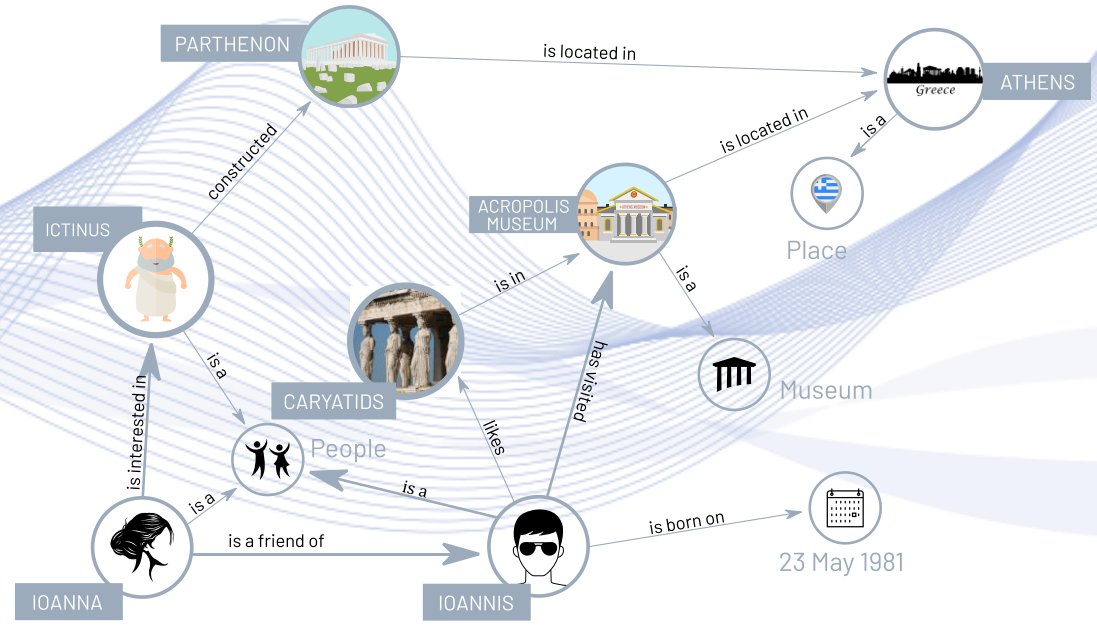
- ***Reasoning*** is one of the most complex brain activities.

What is AI?

Knowledge

- It is a familiarity, awareness, or ***understanding of someone or something***:
  - Facts (propositional knowledge),
  - Skills (procedural knowledge),
  - Objects relations (relational knowledge).

- Various knowledge descriptions.

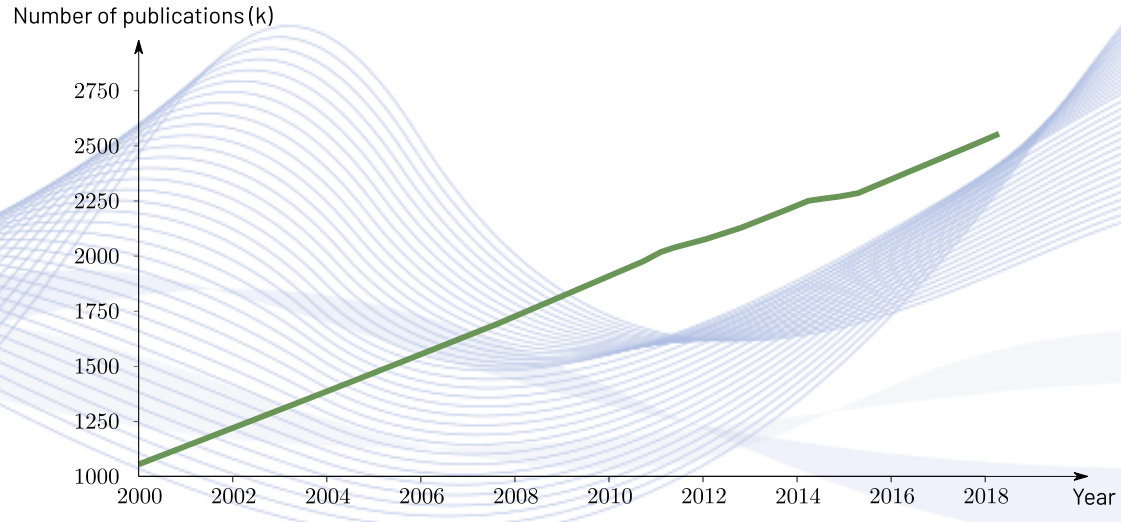


What is AI?

Knowledge is primarily a product of reasoning.

- Is knowledge finite?
- ***Can we measure knowledge?***
- Knowledge increase is linear.

- ***Encyclopedias***
- ***Research publications.***



Global research output (publication) growth.

What is AI?

Current AI revolution:

- ***AI means ML, which means Deep Neural Networks***
- Stagnation of symbolic AI
- Resurrection of a dead term: AI

Major breakthrough needed:

- Advancement of symbolic AI
- ***Fusion of Machine Learning and symbolic AI.***

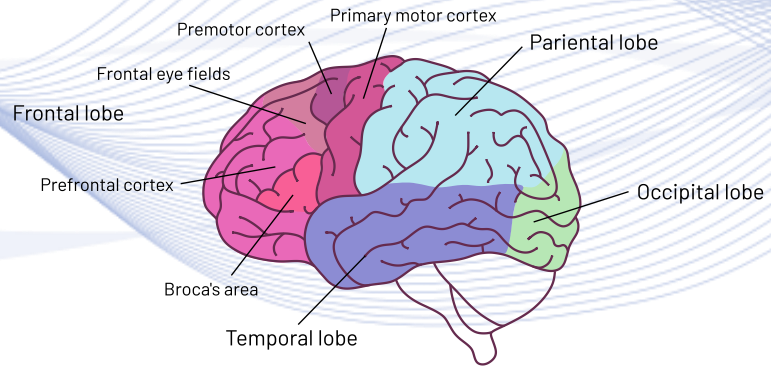
AI Science and Engineering

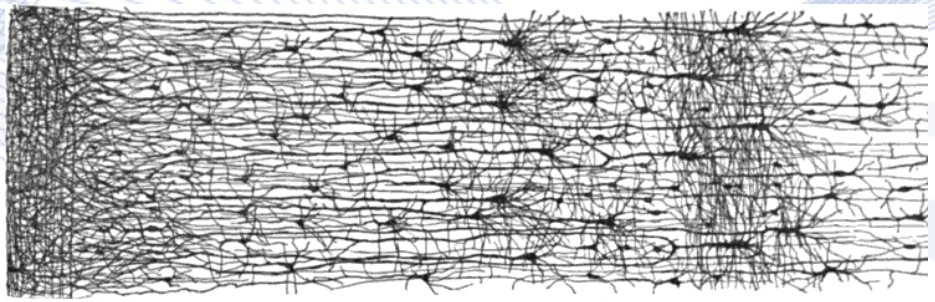
- Complex world
- What is AI?
- **AI and Human Mind**
- AI and Society
  - Information Filtering
  - Social Media and Disinformation

AI and Human Mind

Nervous system, Brain and Biological neural networks

- The brain has 100 billion neurons and 100 trillion neural synapses!
- Huge, but ***limited***, intellectual capacity.
- Capacity improves by ***education***, good health and living standards.





Biological NN (https://en.wikipedia.org/wiki/Cerebral_cortex)

AI and Human Mind

Can human brain address the increased world complexity?

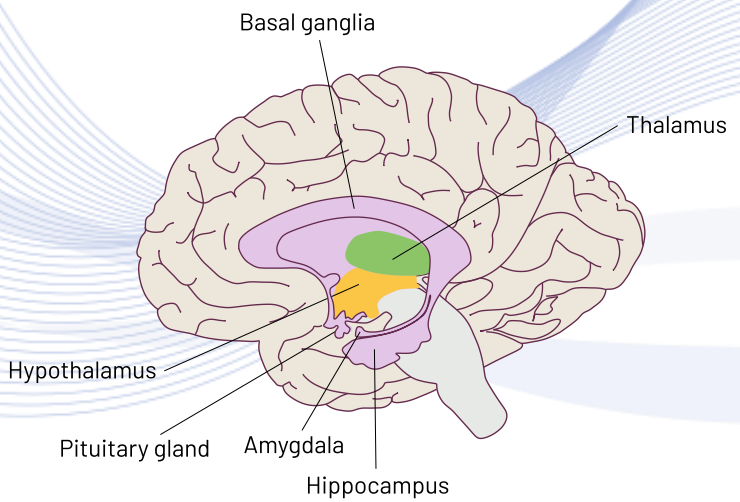
- Human sensing limitations: We cannot see the ***microcosm***.
  - Important in a miniaturized world.
- Human perception limitations: self-localization?
  - Extremely important in complex environments: big cities.
- Memory limitations: Computers are better in data storage.

- ***Affect limitations:*** ***Brain over-excitation by too many or too frequent stimuli can lead to psychological disorders.***

AI and Human Mind

Fear

- It is a natural, primitive unpleasant and powerful emotion, needed to understand or perceive we are in ***danger***.
- Localization in brain: ***amygdalae*** communicating with other brain regions, e.g., the prefrontal cortex, hippocampus, thalamus, hypothalamus, and the sensory cortex.
- Handling the ***fight-or-flight*** human response, when in danger.



AI and Human Mind

- Excessive and/or repeated fear can cause serious psychological disorders, notably ***anxiety*** and ***depression***.
- Fear can be triggered by several real or imaginary threats:
  - Snakes, spiders, earthquakes.

- ***Threat of the unknown*** triggered by unfamiliar or unknown stimuli.
- ***Intensified by a lack of education to interpret our world.***

AI and Human Mind

Generalized OnLine Affect and Cognition* (*GOLAC*) *disorder

- People receive massive stimuli 24/7 over the web, social media and mobile phones.
- Combination of a constant info bombardment and an inability to handle the threat of the unknown.
- Generalized and unsubstantiated feeling that new things are suspicious and/or fishy.
- Result: ***an unsettling feeling of an inability to cope with this online information flux and the dangers it may entail.***

AI and Human Mind

Generalized OnLine Affect and Cognition* (*GOLAC*) *disorder

- ***Real affect and cognition impairment that can jeopardize our actions to interface to the real world.***
- Good background for developing conspiracy theories.
- It can be combined with other social media related threats:
  - e.g., cyberbullying, check by peers through likes.
- Despite partial studies, we have not grasped the immensity of this disorder.
- Social implications: ***fake news proliferation, anti-social marginalization, risks for young people.***

AI Science and Engineering

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- **AI and Society**
  - Information Filtering
  - Social Media and Disinformation

AI and Society

- ***Information technologies can be very useful***:
  - Worldwide connectivity.
  - ***Huge information diffusion.***
  - Knowledge democratization?

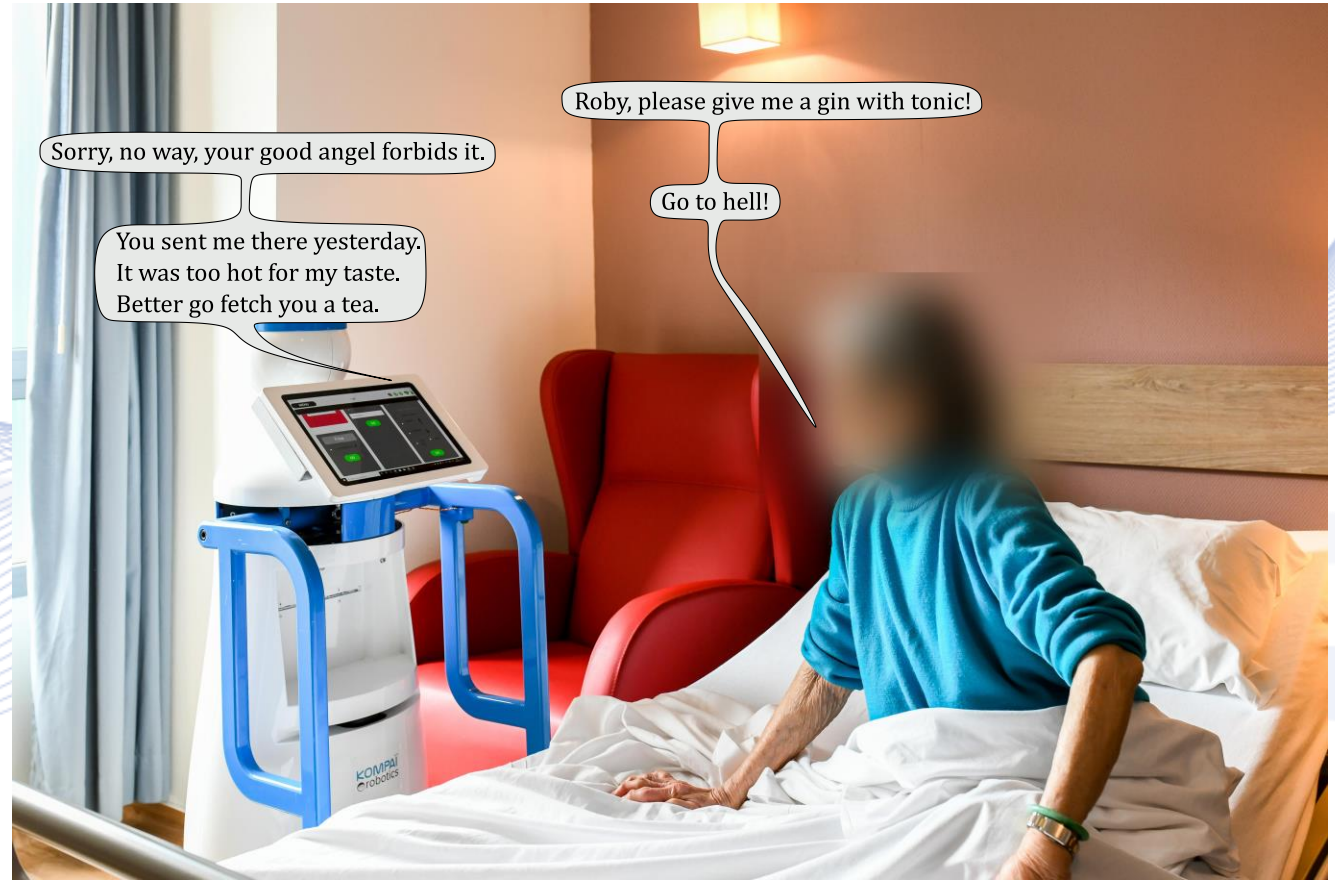
  - Intelligent content search.
  - Media personalization.

- ***Should we be technophobic?***

AI and Society

- ***Intelligent systems*** can be very useful:
  - Companion robots.
  - Robotic manufacturing.
  - Autonomous cars.

- ***Should we be technophobic?***



AI and Society

AI and IT enable ***Social Engineering***:

- Understanding and analyzing social processes
- Influencing individual humans, social strata and structure.

- Marx's famous eleventh thesis on Feuerbach: "***Philosophers have hitherto only interpreted the world in various ways; the point is to change it.***"

AI Science and Engineering

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Information filtering

AI-powered Social Engineering examples

Information filtering

- Limited ***brain capacity*** to absorb and analyze information.
- Limited ***social capacity*** to absorb information.

- Old information filtering processes:
  - News editing and broadcasting.
  - ***Propaganda***: targeted information filtering and broadcasting.

Information filtering

- Many social processes are information filtering and propagation ones.

- Information filtering is a form of ***censorship***.

- Where is the ***freedom of speech***?
  - Social balancing.

Information filtering

Information filtering

- Applications: ***News editing***, online advertising, matchmaking.
- Information filtering (bias): ***censorship***.
- Information filtering 'objectivity': ***bias minimization.***
- ***Socially conditioned objectivity: no universal optimization goal! Citizens reduced to users, consumers.***

Information filtering

Web search

- Search output ranking.
  - Success if desired output is in the first 1-2 top output pages.
- Ranking: web page popularity and links?
- Bias: Popularity is not an objective measure!!!
  - Viral/fake content tends to be popular.

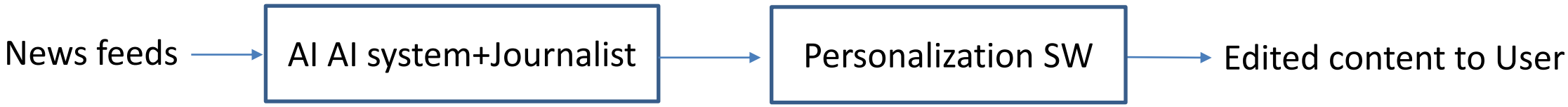
Information filtering

News editing

- ***Bias sources***: News source selection, no editing rules, corruption, commercial/political interests.
- Low media credibility among younger people.
- Remedies: strict editing rules, fact checking, financial independence.
- ***News editing automation!***

Information filtering

AI-powered news editing and recommendation



- ***Content personalization.***
- Automation and journalistic productivity.
- ***Bias sources***: Improper AI system training, biased AI system supervision, too-focused personalization.
- ***Web media: special case with no or little journalistic work.***

Information filtering

On-line marketing and recommendation systems

- Items: products, media files, news, politicians, concepts, etc.
  - ***In principle, absolutely no difference!!!***
- ***Item profiling*** and clustering: ***content similarity***.
- ***User profiling*** using personal preference data.
- Matching between Items and Users.

Information filtering

On-line marketing and recommendation systems

New gold-rush: personal data.

- Massive personal data collection (***Surveillance Capitalism***).

- ***User cheating***: trading ***free data access*** for free web services.
- Barter economy: ***taxation avoidance***.
- Too weak market regulation!

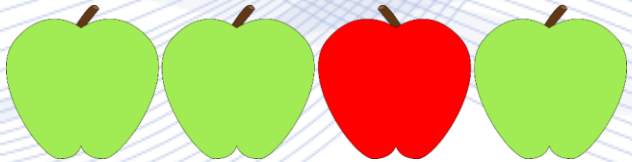
- Solution: Protect and ***valorize*** personal data.
  - Blockchain technologies.

Information filtering

On-line marketing and recommendation systems

Attention economy

- Time is precious commodity.
- Using ***Cognitive Psychology*** tricks to hook users:
  - ***Skinner effect, Zeigarnik effect, flow theory, Von Restorff effect.***



Von Restorff effect.

Information filtering

On-line marketing and recommendation systems

- Pros: Information filtering and personalization.
- Cons:
  - ***User cheating/theft.***
  - Bias: use of popularity to recommend.
    - I do not necessary like what my friends like.
  - Static recommendations.
  - Difficulties for new/weak content creators.

Information filtering

Social match-making systems


Women → Matchmaking SW → Men


- Essentially, recommendation and user profiling systems
- Great influence on personal relations and sexual life.
- ***Can we allow agents decide our mates?***
  - Matchmaking is an age-old social tradition, e.g., in India.
- Coupling with mobile communications and VR:
  - Cybersex and beyond.

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Social Media and Disinformation

Social media changed the way we interact with humans

- It is the new e-agora (‘Αγορά’).
- Free Information flow ***among peers***.
- ***Electronic word of mouth***.
- No gatekeepers, no regulations: journalists, press laws etc.
- ***Great communication facilitators.***

- ***Heaven of the freedom of speech?***

Social Media and Disinformation

AI-powered Social Engineering paradigm gone bad:

The dark side of social media.

- The world became too small: 5 hops to reach anybody.
- Constant 24/7 connectivity and information flooding.
- ***Great communication facilitators.***
- Downside:
  - ***Generalized OnLine Affect and Cognition*** (GOLAC) ***disorder***.
    - ***Anti-intellectualism and Disinformation.***

Social Media and Disinformation

Social activism and virtual communities.

- ***Activism***: ***grass-roots*** movement having a political, economic, social or environment agenda.
- ***Political spectrum***: from the far-right to the far-left/anarchism.
- On-line activism is empowered by the ***electronic word of mouth***.
- Social media offer a convenient way to get organized in ***virtual communities.***
- Handicaps: ***Irrationalism, Cult culture, Personality cult, influencers.***

Social Media and Disinformation

Social activism and virtual communities.

- Some social media sites became an ***electronic Hyde Park Speaker's Corner*** of e-lunatics.
- Propagation of irrational and false theories with absolutely no touch to reality: e.g., ***earth is planar.***
- ***Cult***: group of people sharing commitment to ideas, goals (religious in many cases) and/or persons.
- Promotion of violence and/or disinformation.
- Member manipulation and repression:
  - ***Progression bias***: our natural tendency to continue a relationship and ignore signs of trouble, rather than break it.

Social Media and Disinformation

Irrationalism and Anti-elitism

- ***Irrationalism***: is a philosophical school of the late 19th and early 19th century that questions or discounts rationalism.
  - ***Its vulgar form flourishes during crises.***
- ***Anti-intellectualism*** is supposedly against any perceived privileged elite.
  - Supported by ***lumpenproletariat*** and at times by parts of the ***ruling class***.
  - Example: ***rejecting medical knowledge and practice.***
- ***Anti-elitism***: political version of anti-intellectualism.
  - Current crisis of the dominant political elites .Questioning ***merit***.

Social Media and Disinformation

Irrationalism and Anti-elitism

Cognitive dissonance theory

Social behavior: when in conflict reduction of discomfort.

- ***if reality is at odds with what we believe, it is too bad for the reality itself***.
- If we do not understand, we discard.

- ***Aesops fable*** The fox and the grapes: Grapes that we cannot eat are unripe (“Όμφακες εισίν’).

Social Media and Disinformation

Irrationalism and Anti-elitism

Many people have neither knowledge nor mental capacity nor desire to understand a scientific explanation:

- If a view is undesirable, shun it!
- When confronted with an uncontestable rational view, shift position instead of admitting defeat!

- The most ***socially outlying irrational ideas*** are spread with biggest ***urgency***. Why?
- ***Conspiratorial virtual communities*** are much more ***militant*** than other rational virtual communities, e.g., environmentalists.

Social Media and Disinformation

Virtual Communities and Disinformation

New qualities of outlying radical virtual communities:

- They feel stronger, by forming online bonds (***small world phenomenon***).
- Amplification of their self-respect and sense of collective strength.
- ***Resonance of ideas*** is a key aspect in the formation of such communities:
  - a welcoming audience resonates with their views.

Social Media and Disinformation

Virtual Communities and Disinformation

Sentimentalist ideas (e.g., conspiracy theories) propagate much easier than rationalistic ones:

- Highjacking ***empathy***: if I smile, you smile.
- Willing ears can easily adopt whatever is pleasant.
- No second thoughts or self-restraining.
- Exciting sentiment and imagination.
- After a community reaches a critical mass, and overdrive of the Default Mode Network (DMN) leads in ***thought rumination***.

Social Media and Disinformation

Virtual Communities and Disinformation

Virtual community structure fuels their further strengthening:

- social media ***rich-get-richer mechanisms***.
- Small world diameter (5-6 hops) allows deep penetration in far-away audience.
- Ultra-fast ideas propagation by electronic word of mouth.
- Deep fake news are difficult to detect even by professionals!!!
- ***Multiple messages reinforce each other (Goebbels theory).***
- ***Good Web and Internet qualities are misused to spread disinformation.***

Social Media and Disinformation

Virtual Communities and Disinformation

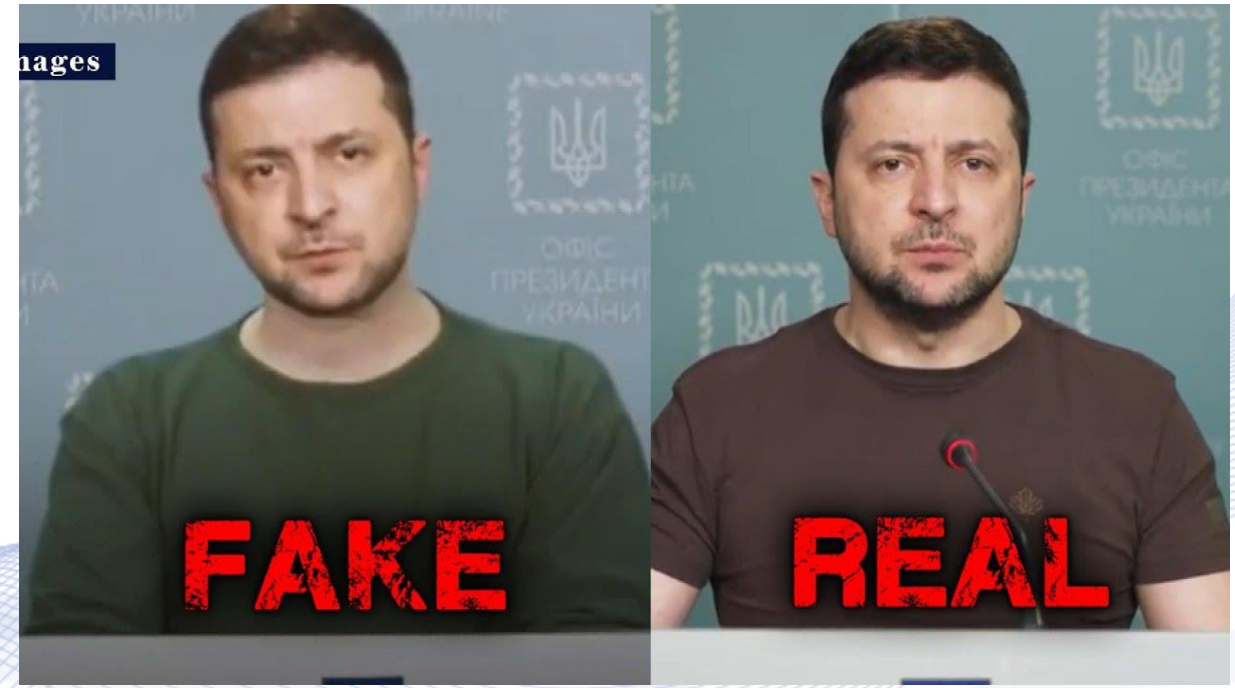
Profit-driven social media company information filtering policies can further fuel disinformation:

- News ranking is based on popularity for boosting user engagement (and marketing profits).
- Polarizing posts and hate speech go viral and create engagement.
- They can lead to misinformation cascades.
- ***A thin militant minority can highjack social media.***

Social Media and Disinformation

Virtual Communities and Disinformation

- State-sponsored misinformation.
- Professional misinformation campaigns:
  - Staged from some European countries, e.g., N. Macedonia.
- ***Deep fake news are difficult to detect even by professionals!!!***



Social Media and Disinformation

Virtual Communities and Disinformation

Political activism

- Conspiracy theories
- Qanon and the far-right.
- Capitol Hill riot.

- Where is the freedom of speech?

Social Media and Disinformation

Regulations

- Press and traditional media are governed ***by laws*** and good practices.
- Social media are governed by ***company policies***.
- ***States intervened too late too slowly.***
- ***Little/No taxation of big social media companies.***

- ***European Union pioneered in social media regulations:***
  - AI Act, GDPR, Digital Markets Act, Digital Services Act.

Social Media and Disinformation

How can Democracy defend itself?

- Better regulatory policies
- Antimonopoly practices. Monopoly break ups.
- ***Morphosis***: formation of knowledgeable citizens.
  - Major overhaul of education.
  - ***Stress on critical and abstract thinking, expression quality.***
  - Revisiting classical studies.
  - ***Global education***: diminishing social and regional barriers to education.

Social Media and Disinformation

How can Democracy defend itself?

- Fact checking.
- Better regulatory policies.
- Antimonopoly practices.
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AI and Society

M. Kranzberg: "***Technology is neither good nor bad; nor is it neutral.***"

Example: Deep data generation.

- Deep fakes.
- ***Deep art: New forms of AI-powered art.***
- ***Upcoming art revolution?***

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Q & A

Thank you very much for your attention!

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