

AI and Book Publishing

Prof. Ioannis Pitas

Aristotle University of Thessaloniki

pitas@csd.auth.gr

www.aiia.csd.auth.gr

Version 1.1

AI and Book Publishing

- **What is AI?**
- Symbolic AI
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- Generative AI
- Knowledge
- AI and books

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:
 - Classical (Symbolic) ***Artificial Intelligence*** (AI),
 - ***Machine Learning*** (ML).

What is AI?

AI and books

- Books contain data, information and knowledge.
- Book content forms:
 - Text, images, 3D graphics output.
 - Multimedia books (containing also audio, video, animations).
- ***Book content is exactly the form of data analyzed or generated by Machine Learning techniques.***

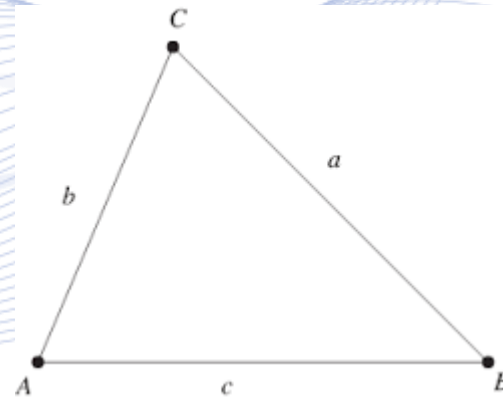
AI and Book Publishing

- What is AI?
- **Symbolic AI**
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- Generative AI
- Knowledge
- AI and books

Symbolic AI

Concepts and ideas (ιδέες).

- Concepts are specific mental constructs residing in our mind (brain?) that refine and abstract ideas.
- Examples: 'Triangle', 'Freedom', 'Love'.
- **Concept definition:** Triangle consists of three points connected by 3 straight line segments.



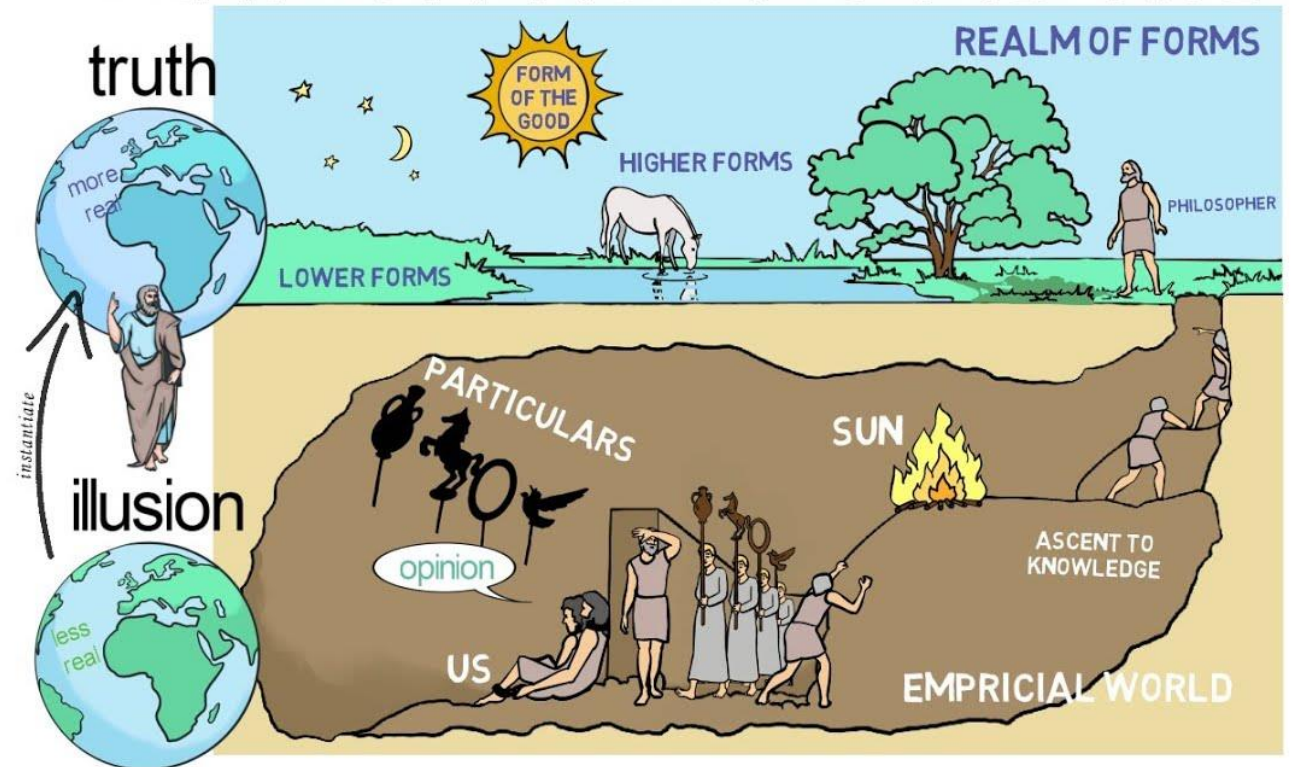
Triangle.

Symbolic AI

Ideas in Philosophy.

- Plato's cave.
- **Idealism**: reality is a reflection of ideas.
- **Materialism**: ideas are shadows of matter on itself (brain).

PLATO'S ANALOGY OF THE CAVE



Symbolic AI

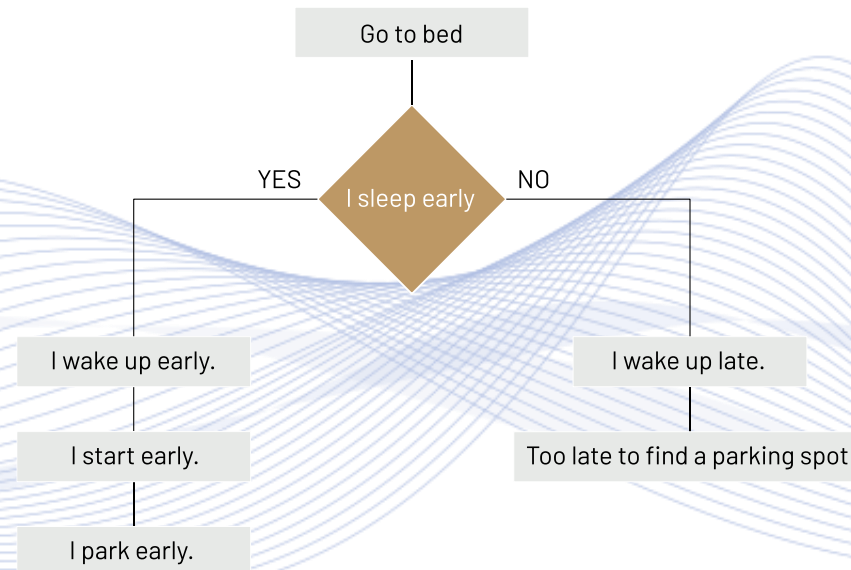
- ***Symbolic AI*** operates on concepts and their relations through ***logic*** and ***search***.
- It mimics and simulates high-level human intelligence and ***reasoning***.
- ***Reasoning*** is one of the most complex brain activities.
- ***Symbolic AI*** employs Mathematical Logic.

Symbolic AI

- Examples:

‘If somebody has high fever and coughs, she/he has flu.’

‘If I turn left, I may enter the opposite lane.’



- ***Symbolic AI failed to deliver!***

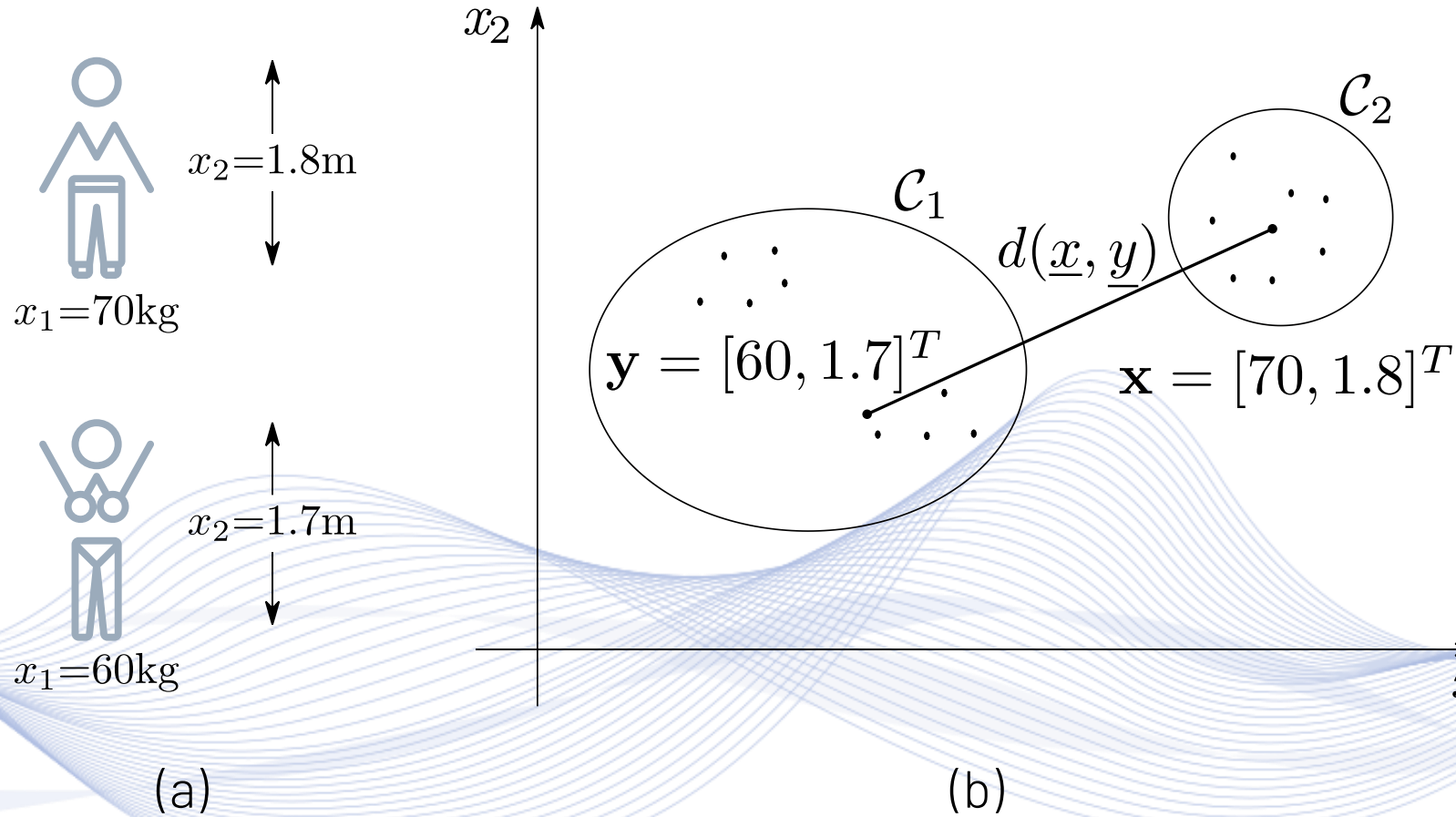
AI and Book Publishing

- What is AI?
- Symbolic AI
- **Data**
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- Generative AI
- Knowledge
- AI and books

Data

- ***Data***: measured quantities related to nature and/or human activities.
- ***Data are primarily numbers*** representing object characteristics (***features***).
- ***Measured in bits.***
- ***Data can be organized in vectors.***

Data



Measuring humans and producing their weight and height vectors.

Data

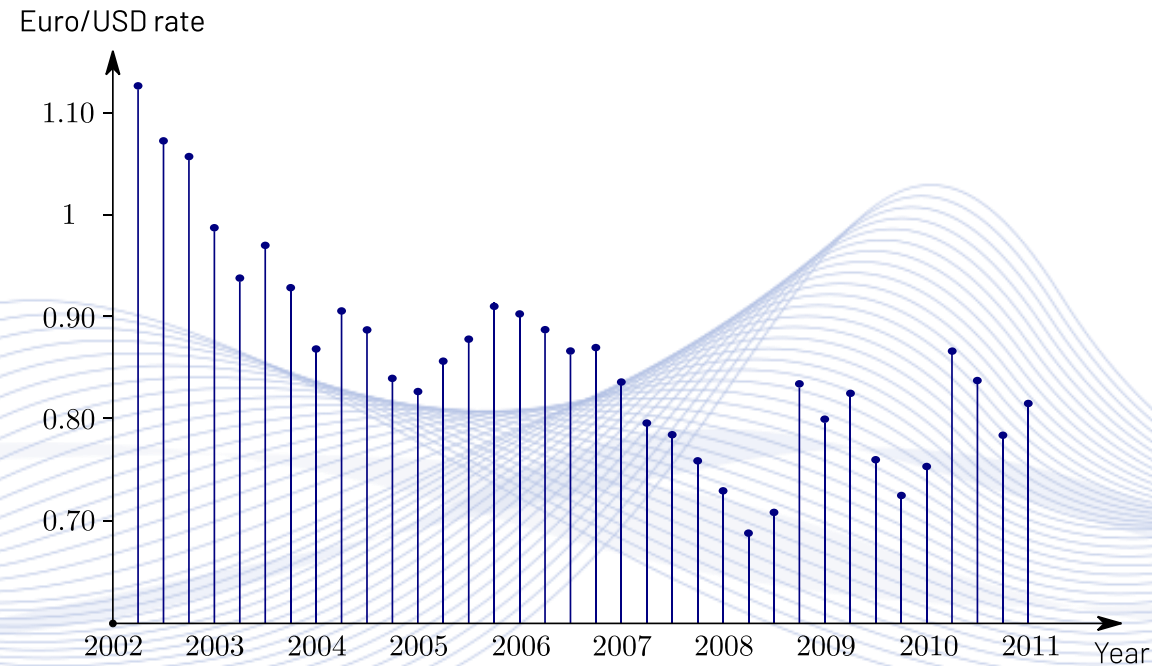
Calculating **object features**: person weight and height.



Data

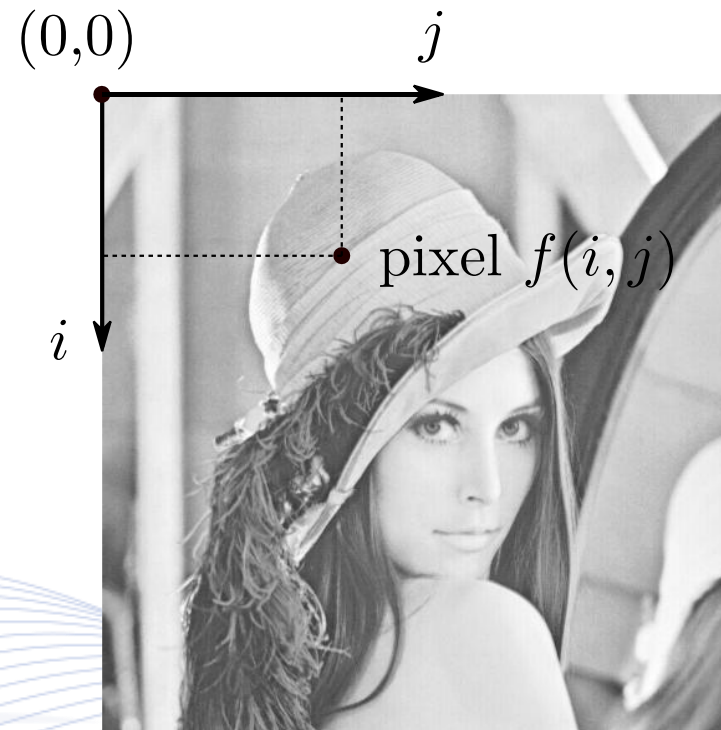
Signals $y = f(t)$: voice, financial **time series** etc.

- Also called **functions**.



Time series of Euro/USD conversion rate.

Data



Digital Images: Matrix of image dots (pixels).
 Each image can have up to 48 Mpixels or more!

Data

Once we extract the object/image/signal features (data):

- Data analysis can be performed.
- Mathematics and Computer Science are needed.
- Machine Learning is applied Statistics, Calculus and Programming.
- We can concentrate on data and forget the real world.
- ***All sciences are increasingly mathematized.***
- High impact on Liberal sciences and Medicine.

Data

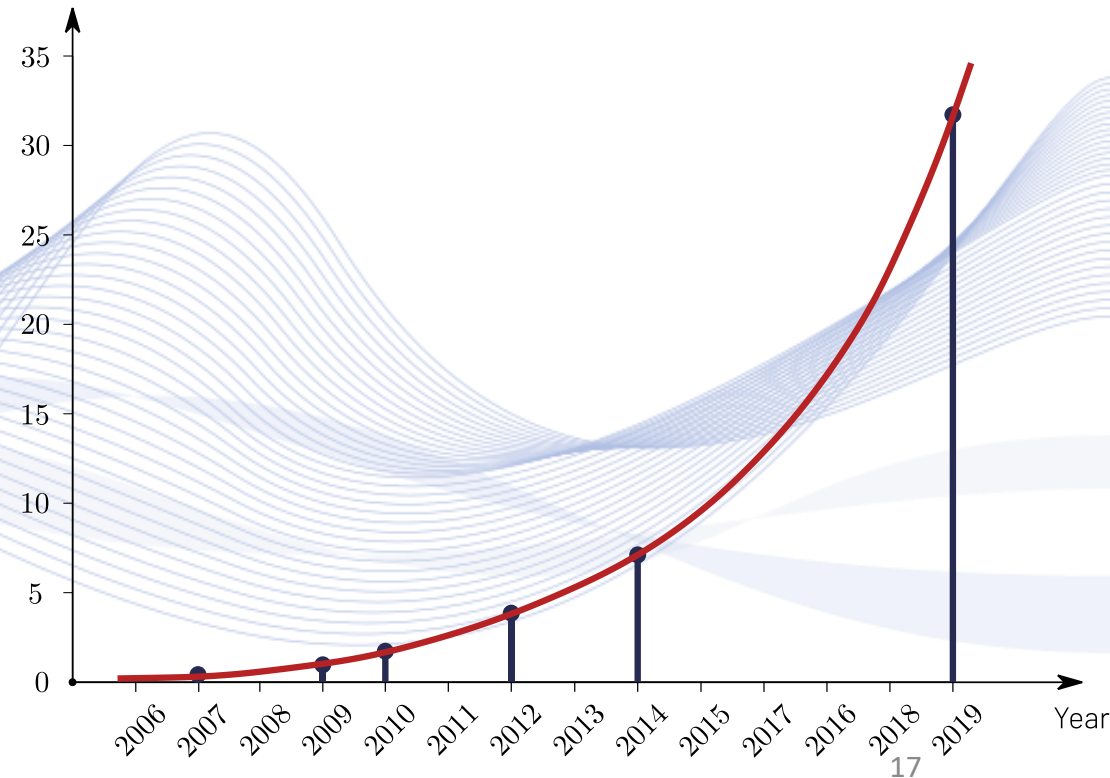
Exponential data increase:

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

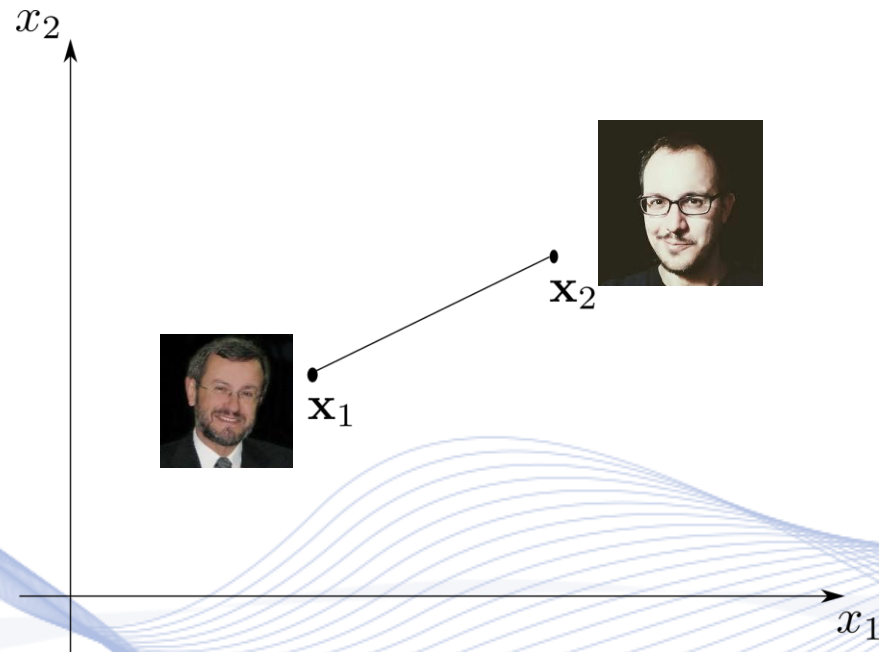
Big data analytics is only possible through Machine Learning.

Data volume increase in past decade.

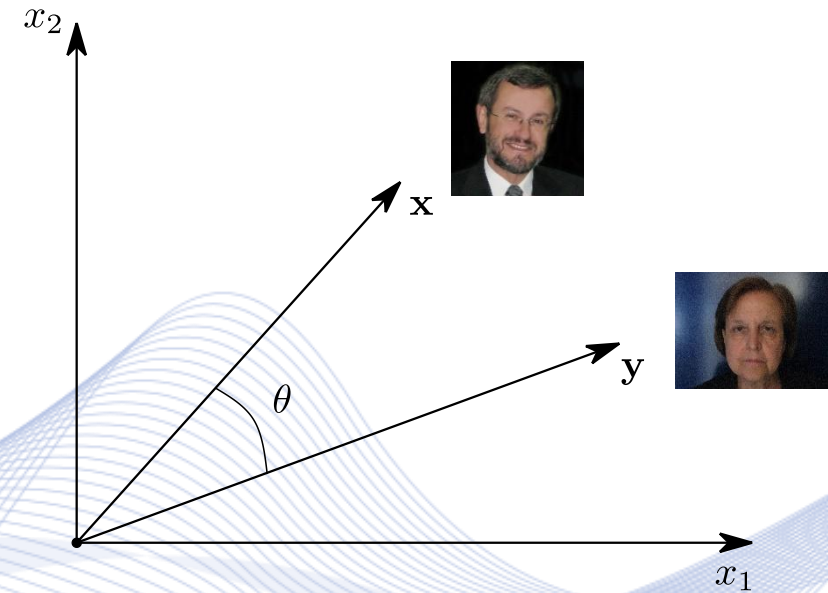
Data Volume (ZB)



Data



Distance between two person images.



Similarity between two person characters.

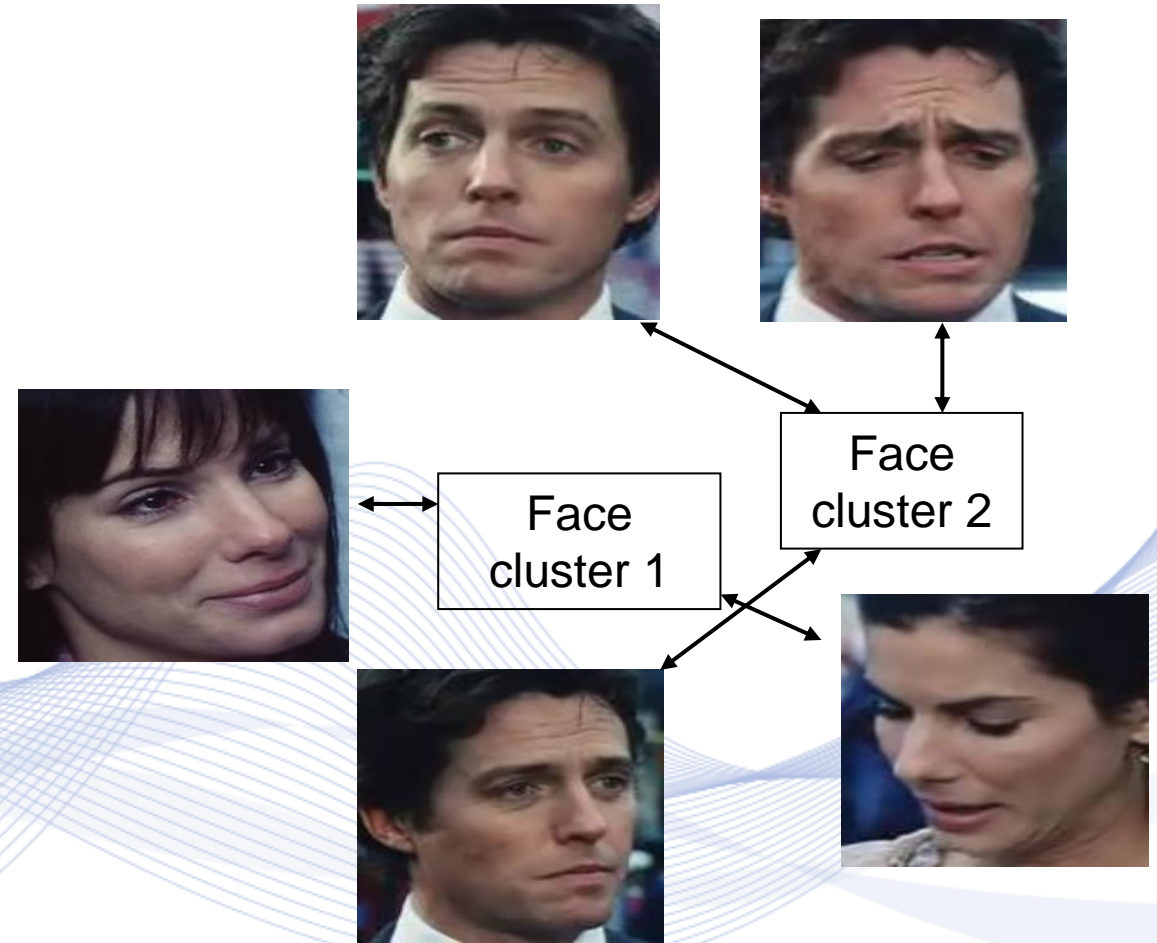
AI and Book Publishing

- What is AI?
- Symbolic AI
- Data
- **Machine Learning**
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- Generative AI
- Knowledge
- AI and books

Data clustering

Face clustering:

- **Input:** many facial ROIs
- **Output:** facial image clusters.
- **Unsupervised learning.**
- Applications:
 - Biometrics
 - Surveillance applications
 - Video analytics.



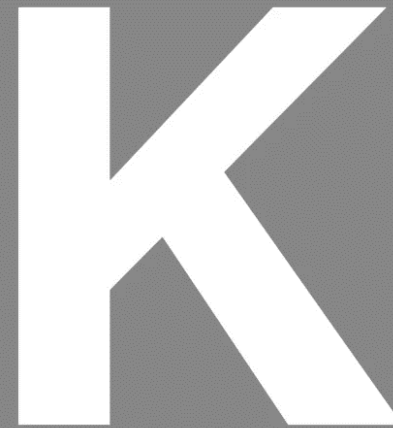
Data clustering



Set partitioning. Data clusters should: a) be homogeneous; b) distant from each other.

Data clustering

Clustering using ***K-means algorithm.***

A large, white, bold, sans-serif letter 'K' is centered on a dark gray rectangular background.

Data clustering

Data clustering offers:

- Description of data geometry.
- Data visualization.
- ***Abstraction.***
- ***Data compression.***

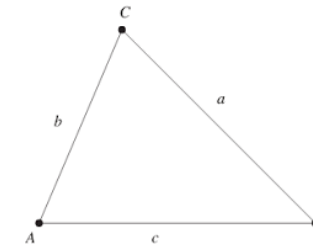


Abstraction

- ***Concept instances***



Instances of a triangle.



Concept 'triangle'.

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

Classification

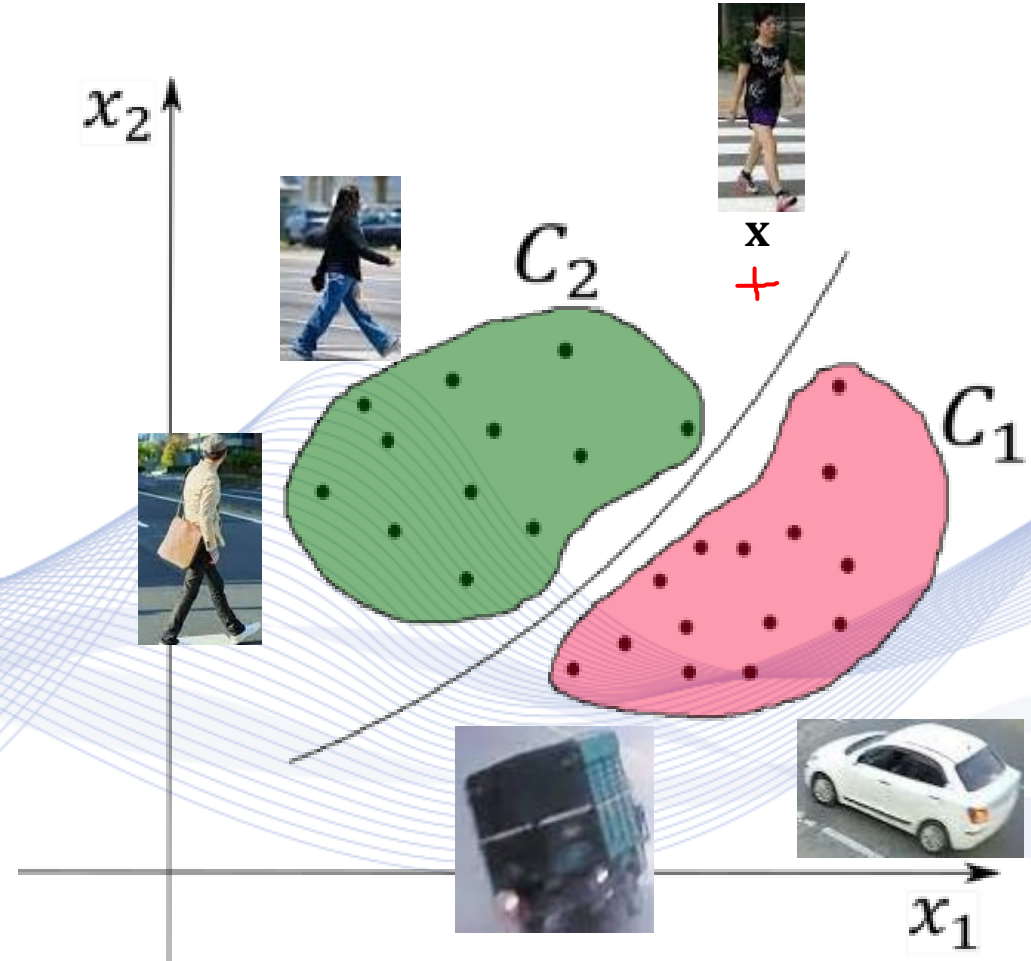
Supervised Machine Learning

Decision-making theory:

- Does object x belong to class C_1 or class C_2 ?
- E.g., 'car' or 'pedestrian'?

Examples:

- Autonomous systems.
- Medical diagnosis.



Introduction to AI Science

- Symbolic AI
- Data
- **Machine Learning**
 - Clustering
 - Classification
 - **Neural Networks**
- Computer Vision
- Natural Language Processing
- Generative AI
- Knowledge
- AI and Society
- AI, Life and the Environment

Neural Networks

- Basic computational unit of the brain.
- Main parts:

- **Dendrites**

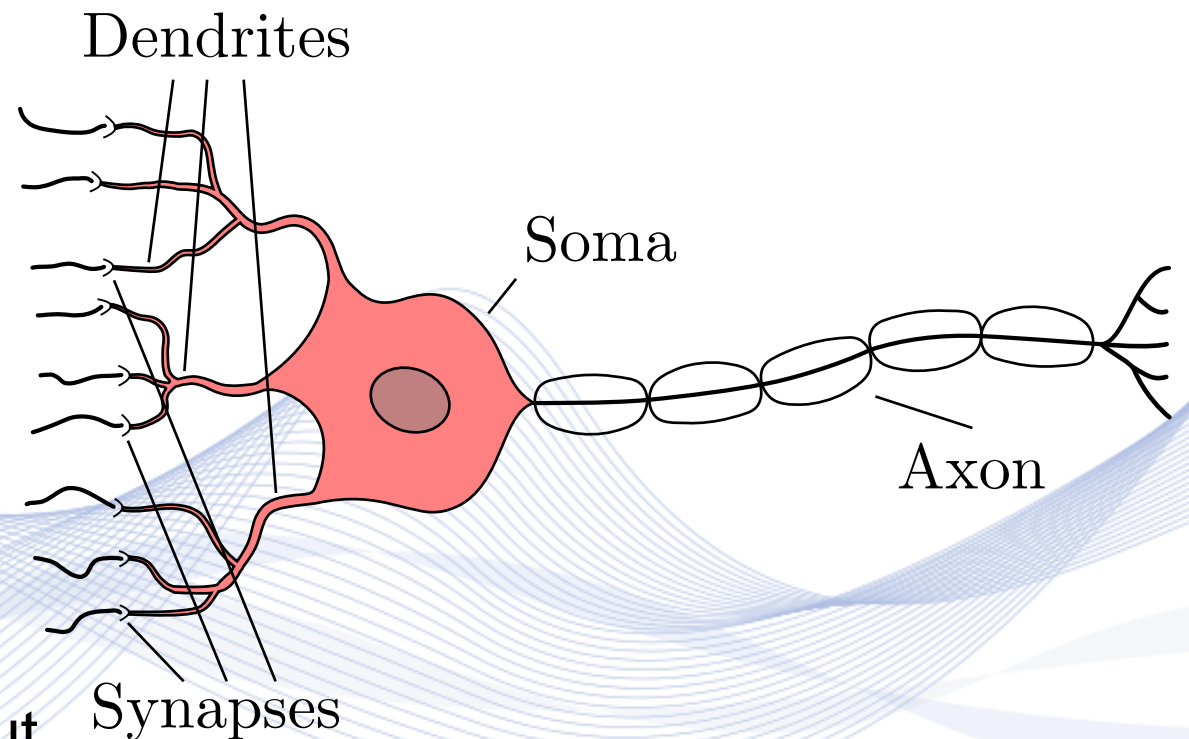
- They act as inputs.

- **Soma**

- Main body of neuron.

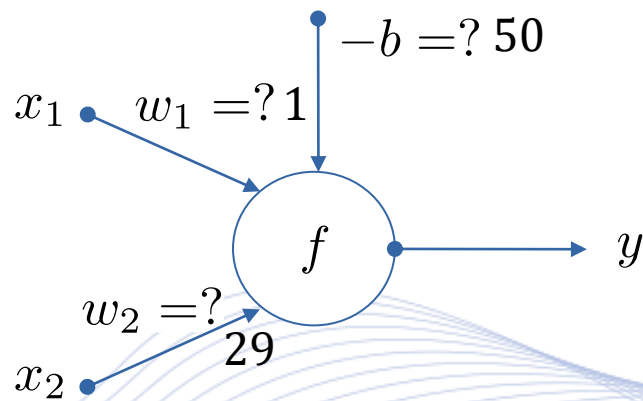
- **Axon**

- It acts as neuron output.



Neural Networks

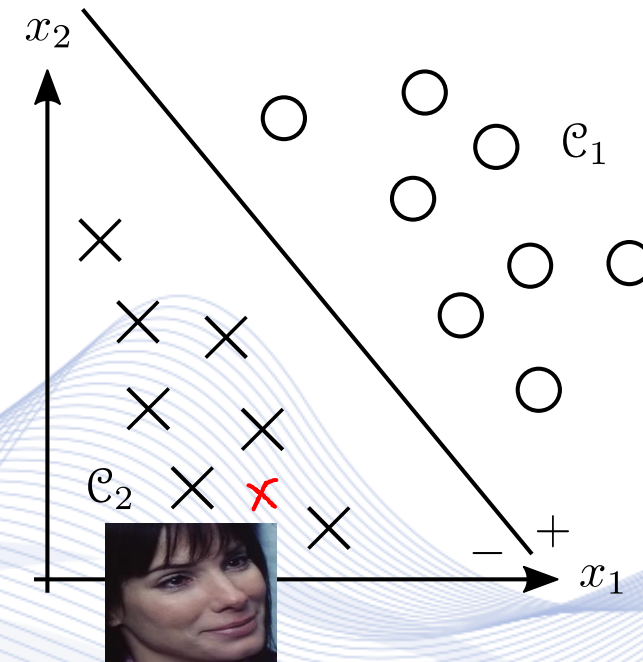
Artificial Neural Networks



2D perceptron for woman/man recognition

- x_1, x_2 : weight, height.

Separating line: $x_1 + 29x_2 - 50 > 0$.



Neural Networks



S. Terzis , Prof. Ioannis Pitas
Aristotle University of Thessaloniki
pitas@csd.auth.gr
www.aifia.csd.auth.gr
Version 1.0



Perceptron training. Minimization of classification error.

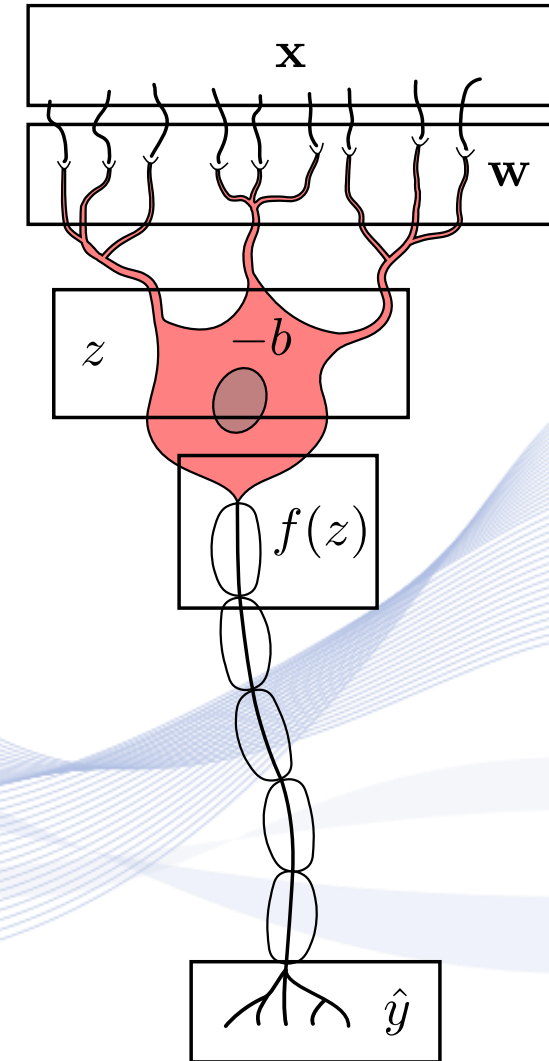
Neural Networks

Artificial neurons are mathematical models loosely inspired by their biological counterparts.

- $[x_1, x_2, \dots, x_n]$: neural input from previous neurons.
- $[w_1, w_2, \dots, w_n]$: synaptic weights

- **Synaptic integration:**

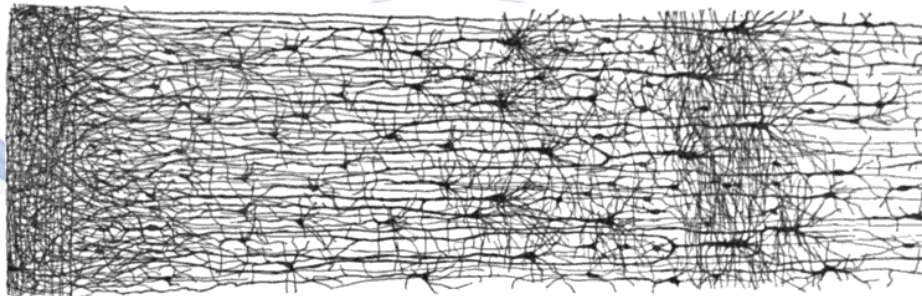
$$z = w_1x_1 + w_2x_2 + \dots + w_nx_n > b.$$



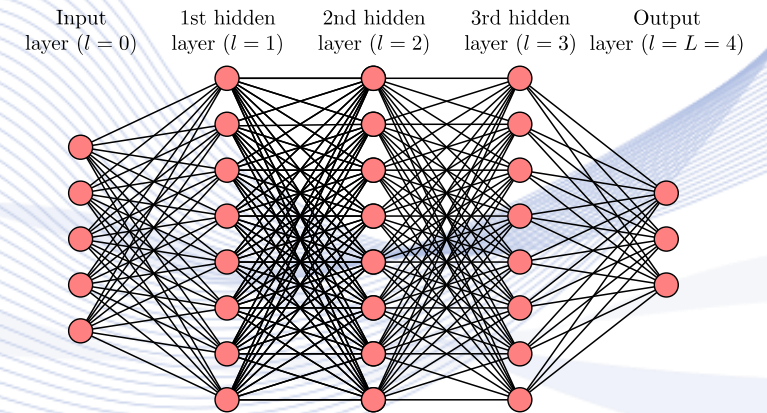
Neural Networks

Artificial and Biological Neural Networks

- Neurons can form **Artificial Neural Networks (ANNs)**.
- **Deep NNs** (DNNs) have many neuron layers.
- Is **network complexity** the basis of both the biological and artificial intelligence?



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



Deep neural Network.

Neural Networks

Classification is a binary function **prediction** (estimation):

$$y = f(\mathbf{x}, \mathbf{w}).$$

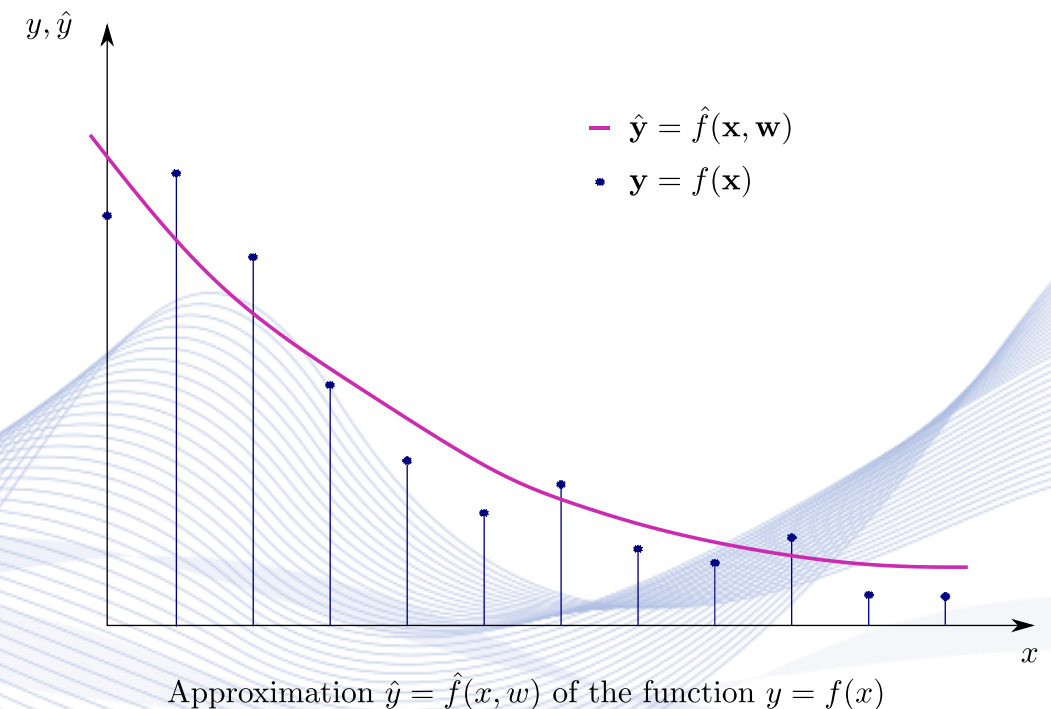
- **Input.** $\mathbf{x} = [x_1, x_2, \dots, x_n]^T$, e.g., facial 100 × 80 pixel image.
- **Trainable parameters** (NN weights): $\mathbf{w} = [w_1, w_2, \dots, w_n]^T$.
- **Output.** $\mathbf{y} = [0, 1, 0, \dots, 0]^T$.
- Only the correct facial (person) class label is 1.

Neural Networks

Neural regression provides an approximation of a function

$$y = f(t).$$

- t : **input** (time).
- \hat{y} : **output** (approximated function values).
- Very useful in **time series prediction**.
- **Applications:** financial prediction, weather forecasting.



Neural Networks

Regression example: object detection.

- **Input:** image x .
- **Trainable parameters** w .
- **Output vector** $y = [x_c, y_c, h, w]^T$.
- It describes the **bounding box** of an object (center coordinates, height, width).



Athlete detection.

Neural Networks

Advantages

- Very good decision accuracy
 - (frequently above human performance).
- Wide range of applications.
- New generative (creative) arts.

Pitfalls

- Too many data/energy needed for their training.
- Poor explainability.
- Possible decision bias.
- Creation of fake data/news.

Neural Networks

Current AI revolution:

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

Major breakthrough needed:

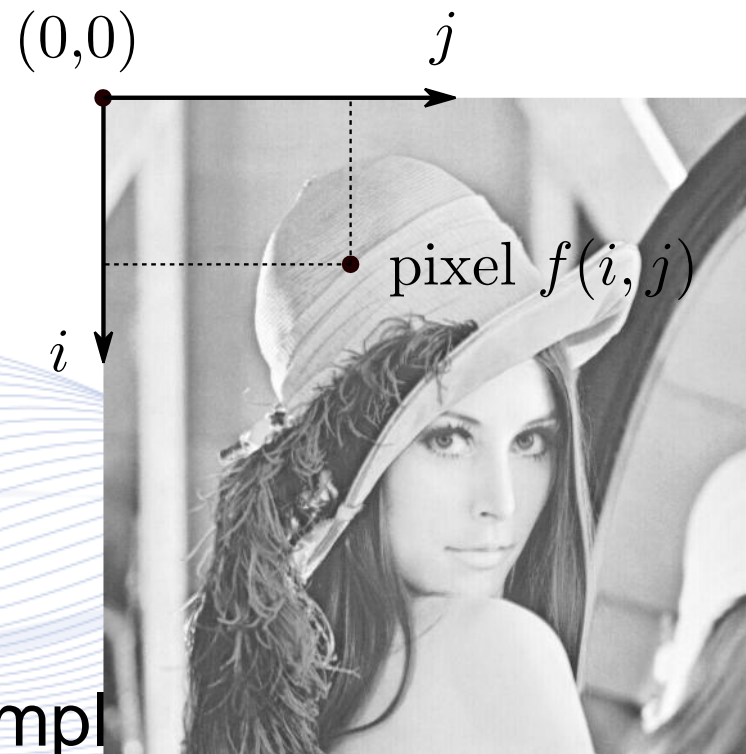
- Advancement of symbolic AI
- ***Fusion of Machine Learning and symbolic AI.***

AI and Book Publishing

- What is AI?
- Symbolic AI
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- **Computer Vision**
- Natural Language Processing
- Generative AI
- Knowledge
- AI and books

Computer Vision

Digital images consist of **pixels**.



Example image.

Computer Vision



Input image.



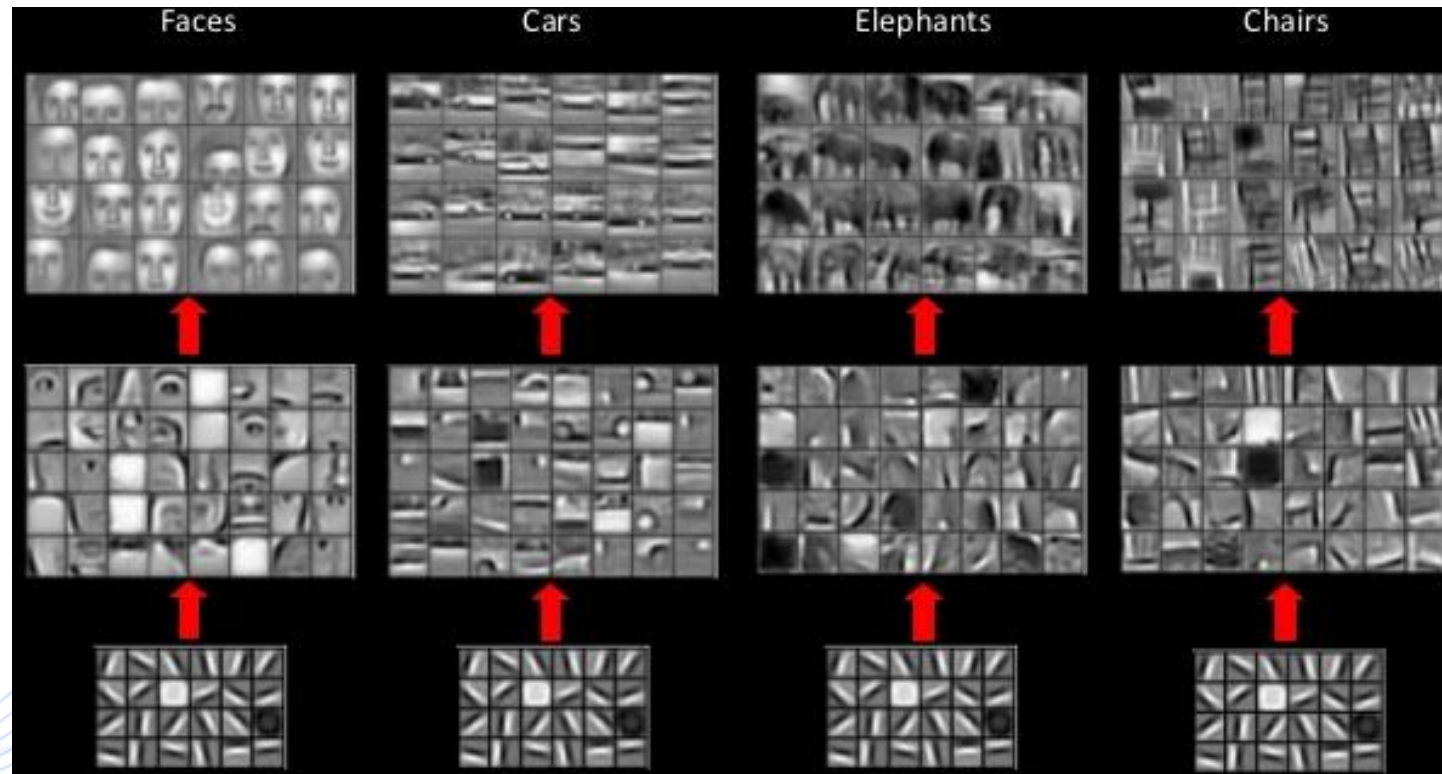
Vertical image edges.

Computer Vision



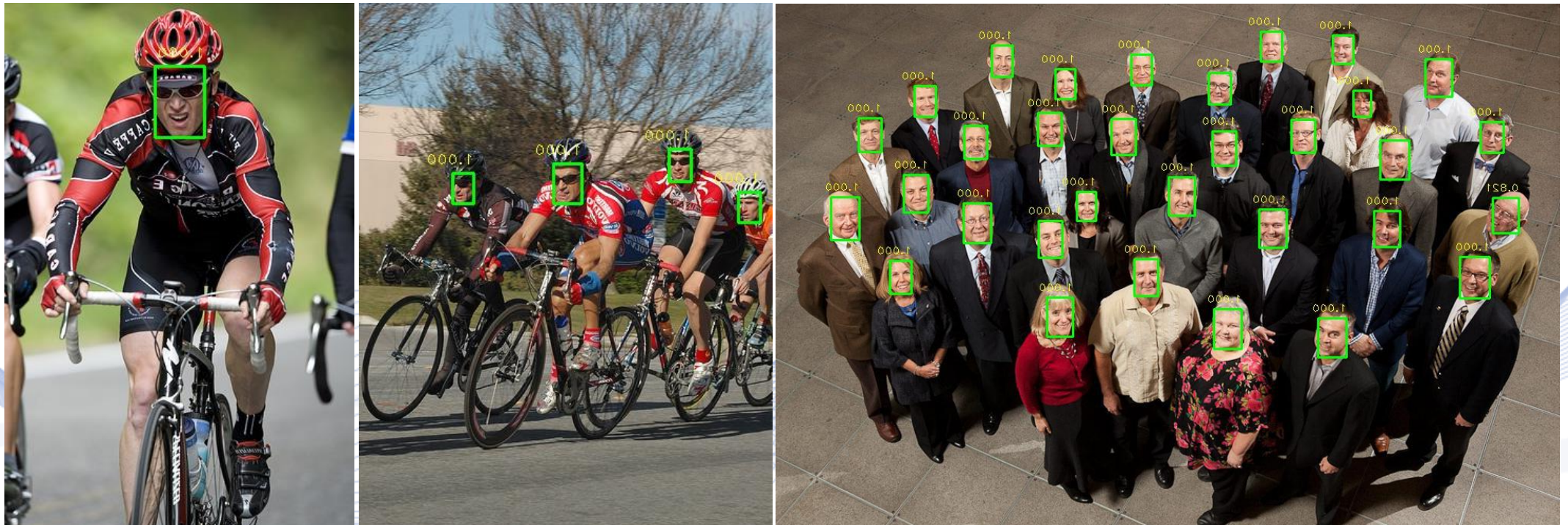
Neural Image Features.

Computer Vision



Convolutional Neural Networks: using neural image features for ML tasks.

Computer Vision



Face detection examples.

Computer Vision



Computer Vision



Region segmentation.

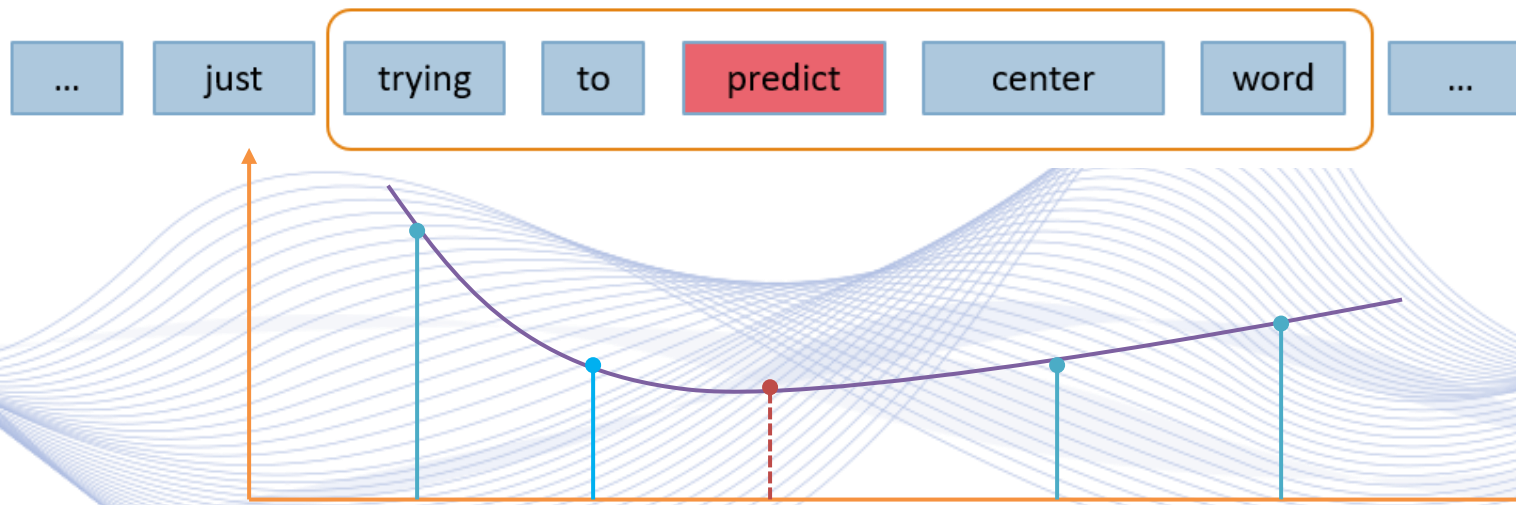
AI and Book Publishing

- What is AI?
- Symbolic AI
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- **Natural Language Processing**
- Generative AI
- Knowledge
- AI and books

Natural Language Processing

Word embeddings

- Transforming words in series of numbers (vectors).
- Predicting word order.



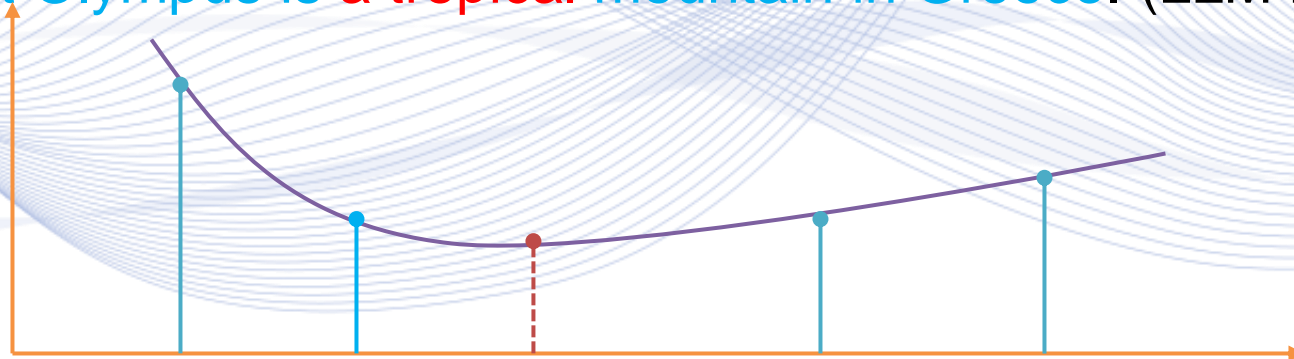
Vectors representing words 'to' and 'center' can best interpolate the 'predict' vector.

Natural Language Processing

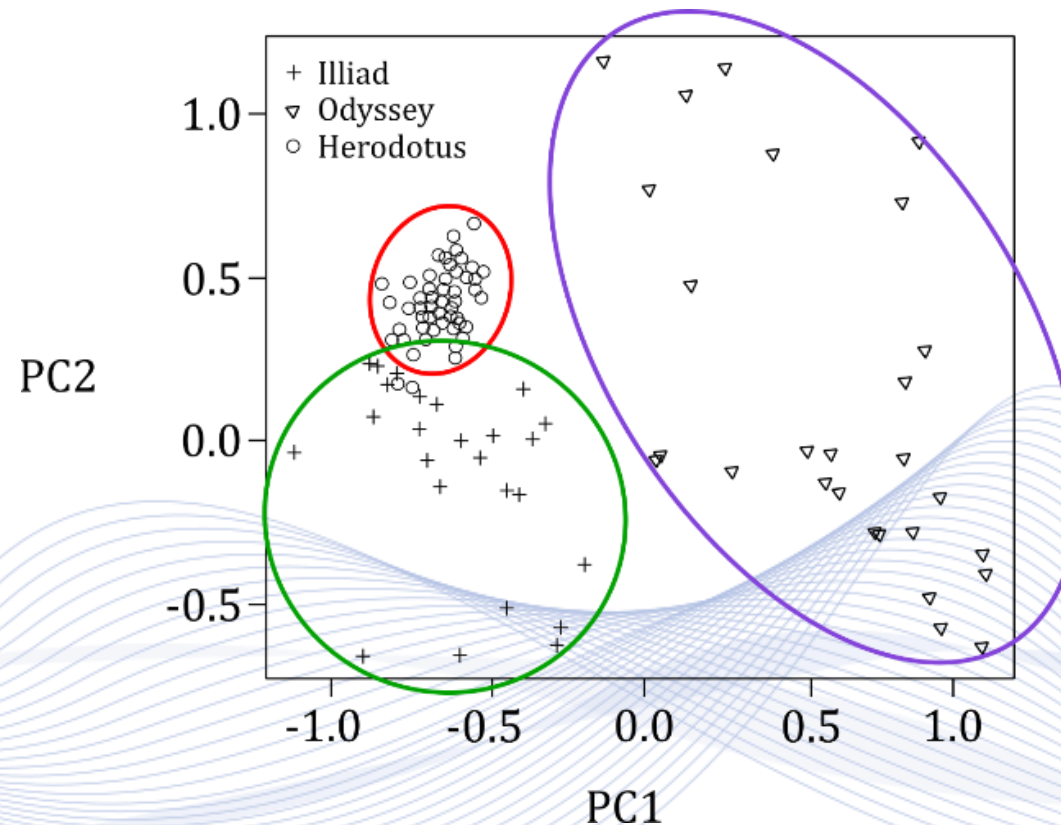


ChatGPT text production

- Question: What do you know about Mt. Olympus and Greece?
- Answer using word order prediction:
 - Mt Olympus is the highest mountain in Greece.
 - Mt Olympus is the loveliest mountain in Greece. (sentimental).
 - Mt Olympus is a tropical mountain in Greece. (LLM hallucination).



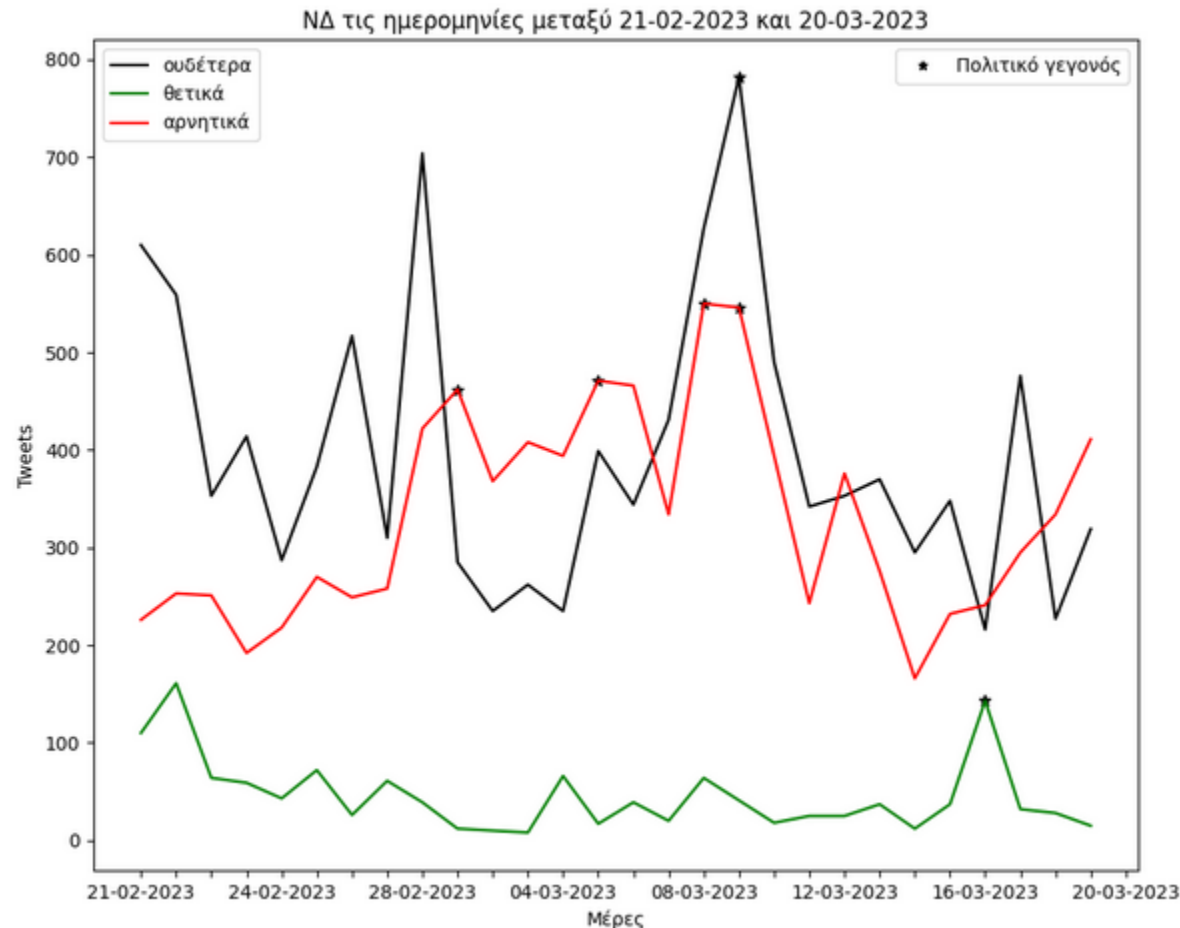
Natural Language Processing



Representing texts by vectors:

Principal component analysis of Homer's Iliad and Odyssey.

Natural Language Processing



Natural Language Processing

Large Language Models

- ChatGPT, GPT-4
- ***Mathematical Language Modeling*** (word embedding).
- Smooth text production.
- Not intended to offer inference capabilities.
- Code programming.
- Certain mathematical skills.
- Big question: ***what is its best use in education?***

AI and Book Publishing

- What is AI?
- Symbolic AI
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- **Generative AI**
- Knowledge
- AI and books

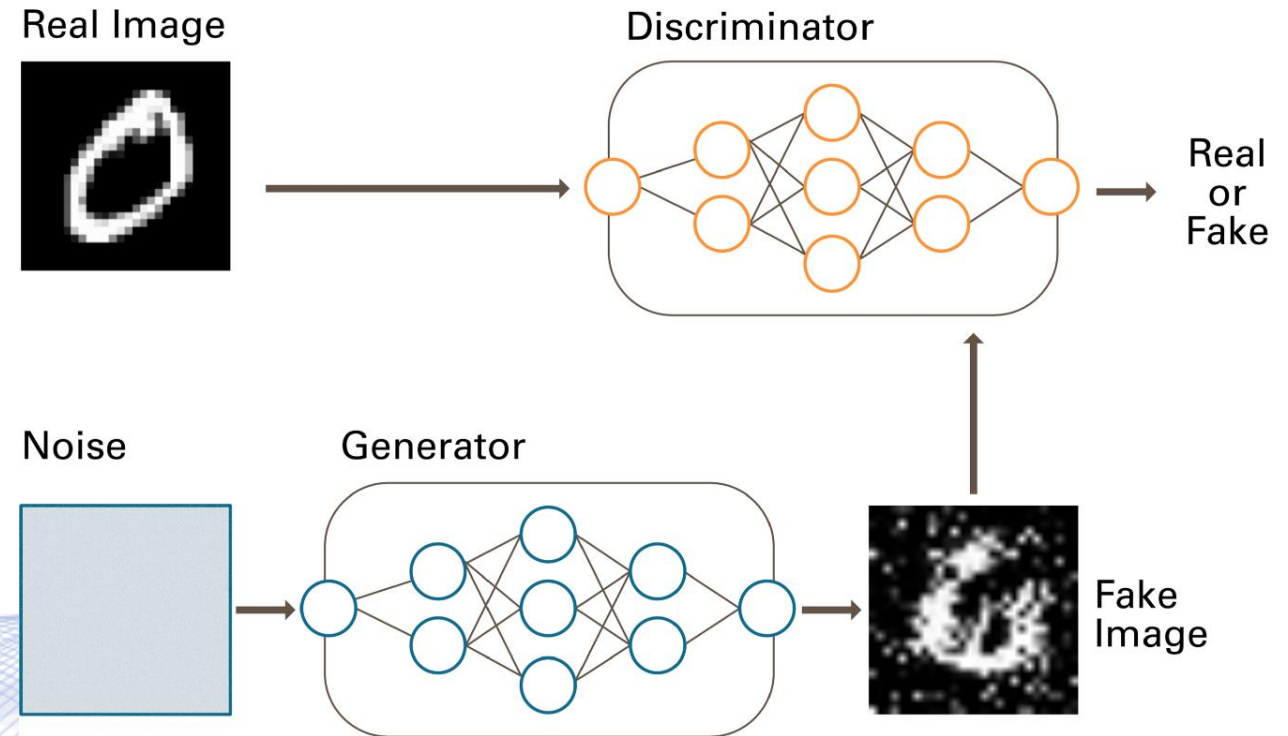
Generative AI

Generative AI creates synthetic data, e.g., images.

- They can be **fake data**.

Generative Adversarial Networks (GANs).

- The **generator** NN generates an image.
- The **discriminator** NN decides:
 - Real or fake?



Generative AI

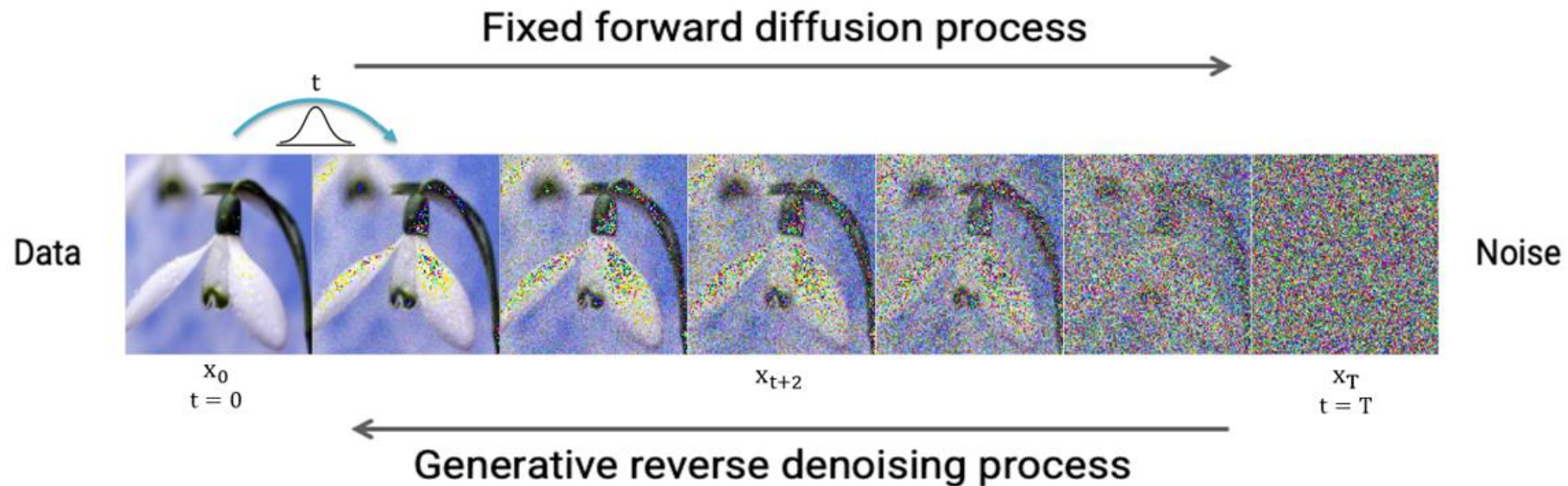
Sculpture Examples

Example image

Input poses Synthesized Input poses Synthesized

Generative AI

- **Diffusion Models (DMs)** gradually degrade the training data (images) by adding noise, while attempting to learn to reverse this process to generate new data (images).



AI and Book Publishing

- What is AI?
- Symbolic AI
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- Generative AI
- **Knowledge**
- AI and books

Knowledge

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).

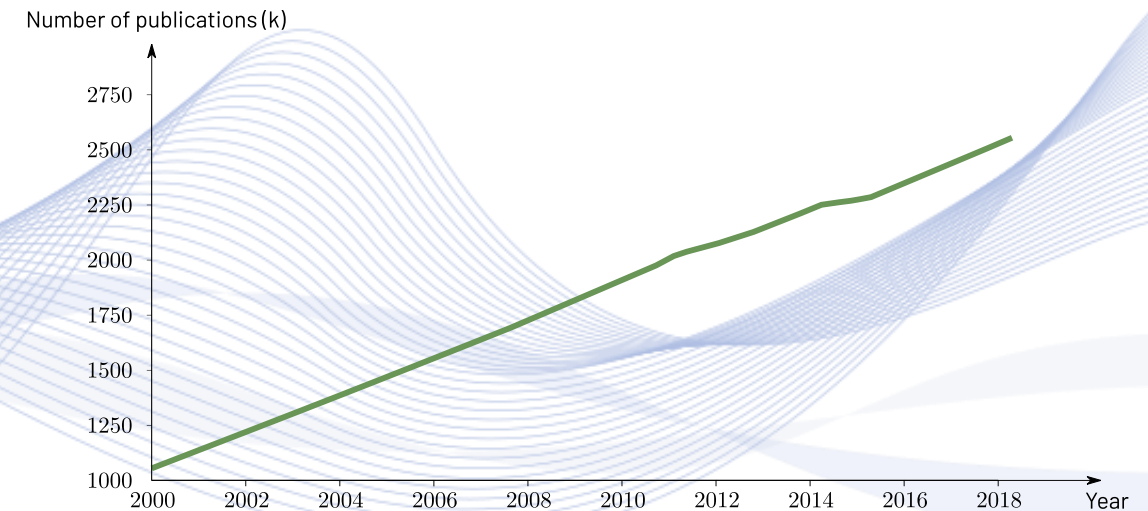
- ***Information theory/entropy: bits (once more)!***



Knowledge

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.

Knowledge

Data/Information society:

- Exponential data growth.
- Data acquisition automation.
- ***Information extraction automation through ML.***

Sustainability?

- More sensors, more processors, Moore's law.
- ***Energy-intensive data and information extraction.***

Knowledge

Knowledge society:

- Exponential knowledge growth.
- Not there yet: ***knowledge production and communication is still manual.***
- ***Real danger: inability of humanity to grow and uptake knowledge.***
- Past devastating setbacks in knowledge uptaking:
 - Dark ages (beginning of the Medieval times).

Knowledge

Sustainability of knowledge growth:

- Limitations in brain capacity.
- Solution: **social swarm intelligence**
- Example: collective memory.
- Knowledge communication through **education** is way suboptimal:
 - New education mode needed, stressing **critical thinking** and **abstraction**.
 - **Morphosis**: formation of knowledgeable citizens.
 - **Global education**: diminishing social and regional barriers to education.

AI and Book Publishing

- What is AI?
- Symbolic AI
- Data
- Machine Learning
 - Clustering
 - Classification
 - Neural Networks
- Computer Vision
- Natural Language Processing
- Generative AI
- Knowledge
- **AI and books**

Books and Journals

- **Books** are a classical form to store and communicate human knowledge.
- **Scientific journals** publish new knowledge.
- Many books and journals are fully digital.
- Some book forms have disappeared:
 - Encyclopedias, conference proceedings, several journals.
- **Collective on-line works:**
 - Wikis etc.

Book Authoring

Book authoring can be greatly sped up:

- Web-based literature search can be very fast.
- LLMs can facilitate book authoring.
 - Automatically written books and journal articles appeared.
- LLMs can greatly speed up book translation.
 - Sometimes translated book/article quality is horrific without human editing.

Book Authoring

LLM-assisted book authoring.

- Full range from LLM-assisted book authoring to automatic LLM book authoring.
- What assistance level is acceptable?
- Can automatically authored books be considered as original quality works?
- ***Soon, the number of such books can surpass human-authored books.***
- **There is no reliable way to identify LLM authored books.**
 - ***Watermarking*** is unreliable.

Book/Journal Intellectual Property

IP protection of digital assets are difficult to attain.

- **Who owns the IP of GenAI-assisted book authoring?**

Book IP theft for training LLMs

- Digital content accessibility in the web does not mean it is free to grab for profitable LLM training.
- Authors and publishers must be renumerated!
- Is author style mimicking by LLMs an IP infringement?
- Human authors 'mimick' previous works for free!

Book/Journal Intellectual Property

IP protection of digital assets are difficult to attain.

- ***Collective works*** (e.g., Wikis) IP: difficult to handle.
- NFTs cannot guarantee IP protection!
- Switching to ***open publishing*** mode (authors pay).

Digital book content integrity difficult to verify.

- Watermarking against document tampering is unreliable.

Book/Journal Publishing

Book publisher role changed dramatically.

- Book marketing rather than book publishing.
- ***Self-publishing.***

Journal publishing changed a lot.

- Information flow has sped up a lot.
- Block-chain publishing and Non-fungible tokens (NFT).
- ***Book publisher future is uncertain!***

Global Intellectual Property Market

New book/journal publishing mode.

- ***All books are freely available in the web!***
- All book readers pay an annual fee (according to their consumption).
- Book authors are paid in proportion to their book consumption.
- Block-chain technologies can be use for money flow from readers and authors.
- Book authors retain their IP.

- ***Role of publishers?***

I. Pitas, 'AI Science and Society'



4 Volume book, 1070+ pages, Amazon 2023.

Bibliography

- [1] I. Pitas, “Artificial Intelligence Science and Society Part A: Introduction to AI Science and Information Technology“, Amazon/Kindle Direct Publishing, 2022,
https://www.amazon.com/dp/9609156460?ref_=pe_3052080_397514860
- [2] I. Pitas, “Artificial Intelligence Science and Society Part B: AI Science, Mind and Humans“, Amazon/Kindle Direct Publishing, 2022,
https://www.amazon.com/dp/9609156479?ref_=pe_3052080_397514860
- [3] I. Pitas, “Artificial Intelligence Science and Society Part C: AI Science and Society“, Amazon/Kindle Direct Publishing, 2022,
https://www.amazon.com/dp/9609156487?ref_=pe_3052080_397514860
- [4] I. Pitas, “Artificial Intelligence Science and Society Part D: AI Science and the Environment“, Amazon/Kindle Direct Publishing, 2022,
https://www.amazon.com/dp/9609156495?ref_=pe_3052080_397514860

Q & A

Thank you very much for your attention!

**More material in
<http://icarus.csd.auth.gr/cvml-web-lecture-series/>**

**Contact: Prof. I. Pitas
pitass@csd.auth.gr**