

AI University Education

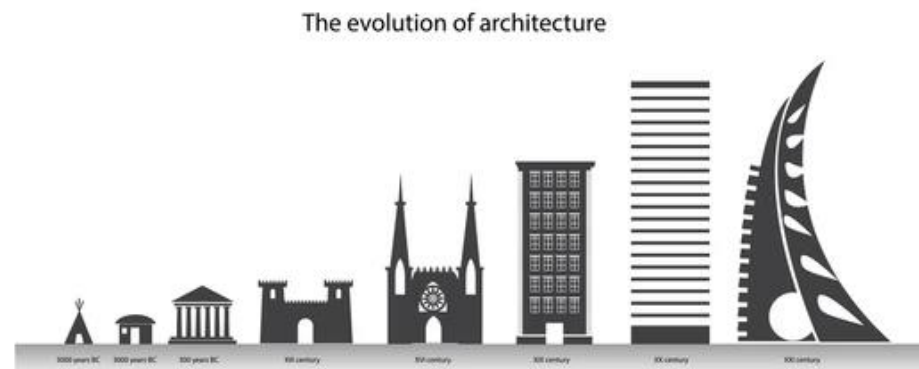
Prof. Ioannis Pitas
Aristotle University of Thessaloniki
pitass@csd.auth.gr
www.aiia.csd.auth.gr
Version 5.1

AI University Education

- **Complex world**
- What is AI?
- Citizen Morphosis
- AI Science and Engineering
- AI and University Education
- ChatGPT in Education
- LLMs and AI in Education

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**.



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!!!*

AI University Education

- Complex world
- **What is AI?**
- Citizen Morphosis
- AI Science and Engineering
- AI and University Education
- ChatGPT in Education
- LLMs and AI in Education

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)

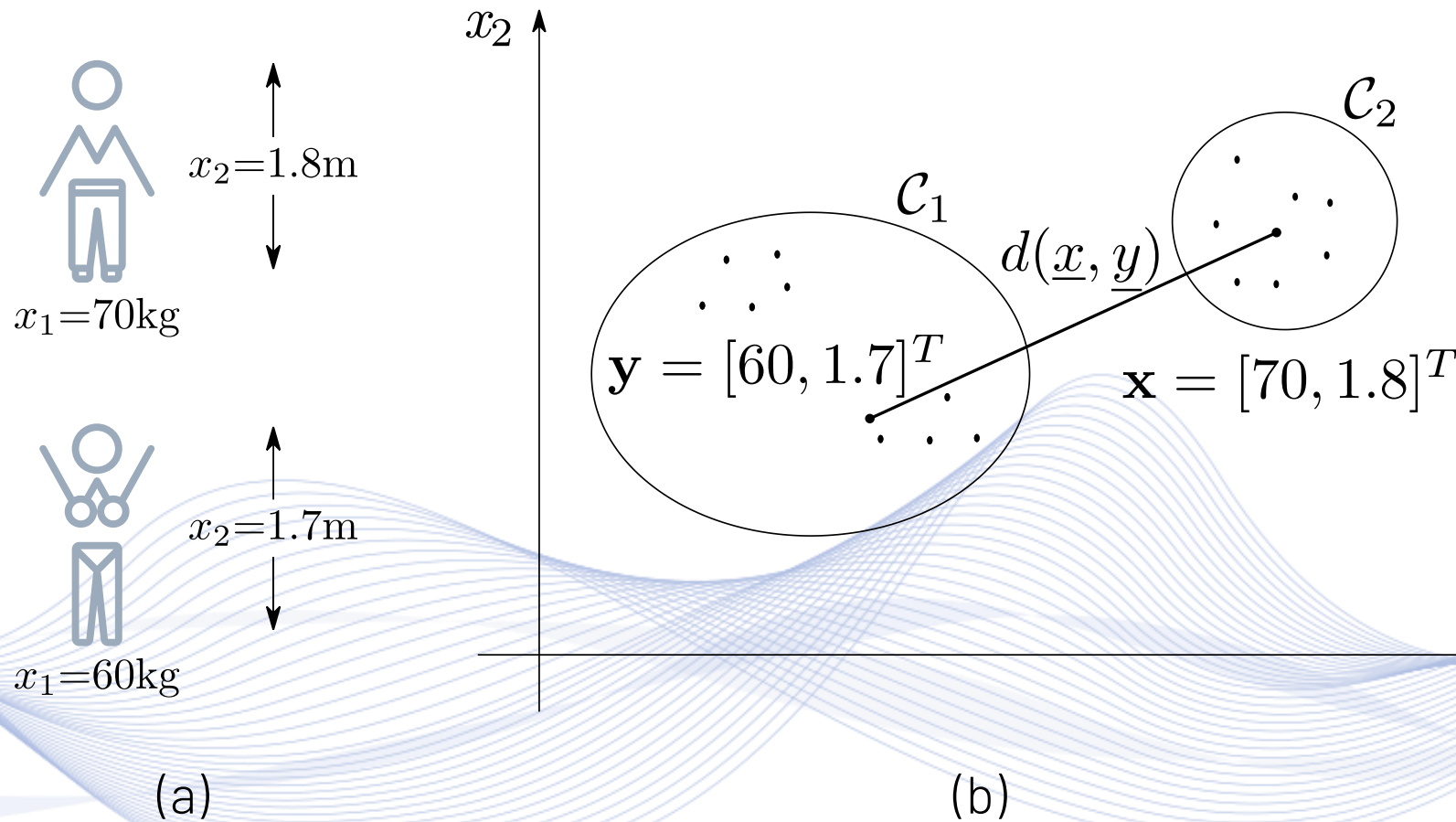
What is AI?

- 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?

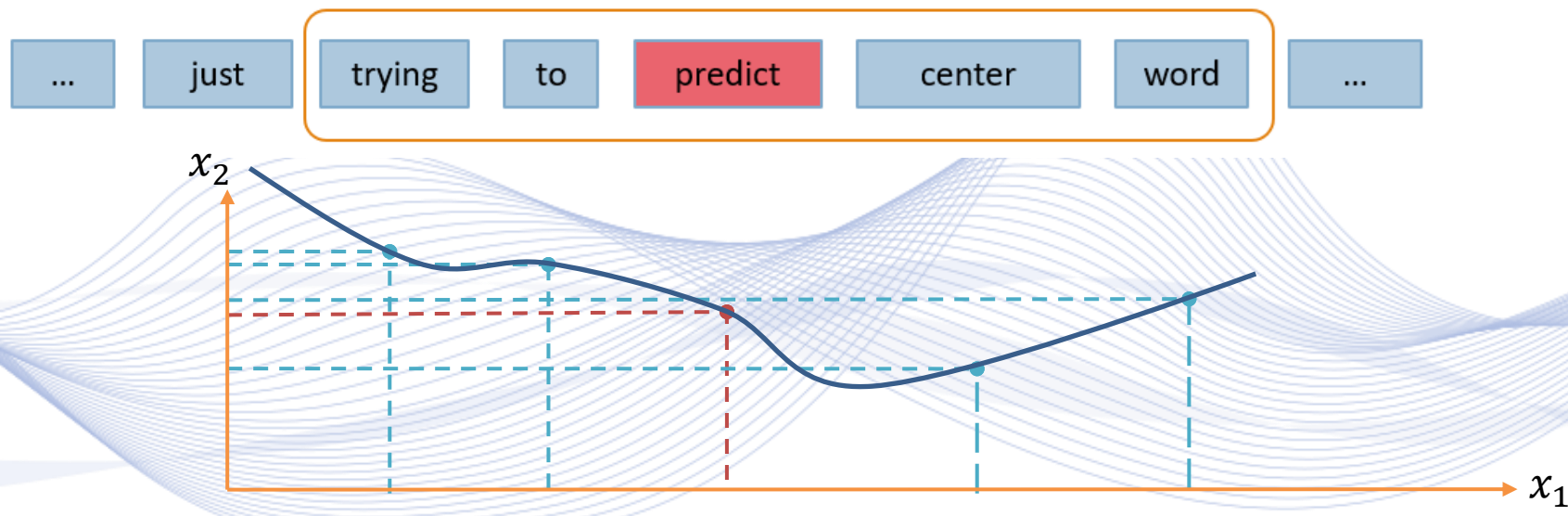


Machine Learning and data: Measuring humans and producing their weight and height vectors.

What is AI?

Natural Language Processing: Word embedding transforms words into vectors (numbers).

- A sentence can be visualized as a curve in the vectorial space over time.



Word trajectory in a 2D vectorial space $[x_1, x_2]$.

What is AI?

- Mapping of the world on data (numbers/vectors) affects all sciences.
- **It leads to a mathematization of all scientific disciplines to varying degrees.**
- It can lead to a revolutionary scientific paradigm shift in certain disciplines.
 - E.g., linguistic studies can complement grammar/syntax/etymology analysis with word/concept correlation and co-occurrence analysis.
- **Is Language all we need?**
 - **Indeed language and texts encompass a large part of human knowledge.**

AI University Education

- Complex world
- What is AI?
- **Citizen Morphosis**
- AI Science and Engineering
- AI and University Education
- ChatGPT in Education
- LLMs and AI in Education

Citizen Morphosis

Major overhaul of education at all levels to master knowledge development and uptaking needs.

- The need for such education permeates all levels of education and all social strata.
- A ***1/3-2/3 society***, where 1/3 of the population understands and benefits from scientific progress, while the remaining 2/3 lags, being impoverished and technophobic, is simply not sustainable.
- Need to educate women, minorities and Global South to improve the global education level.

Citizen Morphosis

The **basic AI and IT concepts** are simple and can be taught at all educational levels:

- Data clustering, similarity, classification etc.
- Educational readjustment for their teaching by **rearranging the curriculum of Mathematics and Informatics**.
- A (partial) mathematization of education is inevitable.
- **Aim: Mathematical and algorithmic thinking.**
- It is not certain that it is feasible, given the traditional separation of the sciences and the humanities.

Citizen Morphosis

- ***Classical studies*** are also an ideal tool for developing critical thinking and precision.
- They provide a solid basis for ***Ethics, Legal and Social Implications*** (ELSI) knowledge.

AI University Education

- Complex world
- What is AI?
- Citizen Morphosis
- **AI Science and Engineering**
- AI and University Education
- ChatGPT in Education
- LLMs and AI in Education

AI Science and Engineering: A new scientific discipline?

- **Computer Science** is the study of computation and information.
- **Computer Engineering** is a branch of Engineering that integrates several CSE fields that are required to develop computer hardware and software.
- Traditionally, AI and ML were CSE disciplines.
- Do AI and ML have own scientific methodology?

AI Science and Engineering: A new scientific discipline?

- ***AISE Interdisciplinarity?***
 - AI and Brain/mind studies
 - AI and social studies/engineering.
- **Mature AISE Interdisciplinarity?**
 - **Not there yet!**
- Risks: ***depth vs shallowness.***

AI Science and Engineering: A new scientific discipline?

CSE spawning new disciplines *through specialization*:

- Web science
- Data science
- AI Science and Engineering.
- New scientific methodologies are not **necessarily** essential.
- Poor terminology?
- Past experience: **Physics spawning Engineering disciplines**
 - Electrical Engineering, Mechanical Engineering.

AI Science and Engineering: A new scientific discipline?

AISE background

Lots of mathematics:

- **Analysis/calculus, Optimization**
- Geometry
- Linear Algebra
- Graph Theory
- **Probability theory and statistics**
- Mathematical Logic.

AI Science and Engineering: A new scientific discipline?

AISE background

Classical studies at University and high school level

- Philosophy, ethics, logic
- Linguistic competences.

- Physics?, Biology?

- ***Do we prescribe universal AI scientists?***
- **What about commoners?**

AI and University Education

Changes will be drastic and will come very soon.

Schools of 'Information Science and Engineering' with departments of:

- Computer Science/Informatics,
- Mathematics
- Computer Engineering
- Artificial Intelligence Science and Engineering
- Internet/Web Science.

AI University Education

- Complex world
- What is AI?
- Citizen Morphosis
- AI Science and Engineering
- **AI and University Education**
- ChatGPT in Education
- LLMs and AI in Education

AI and University Education

- Currently, the Humanities face the greatest pressure from LLMs and AI.
- The **mathematization of classical subjects** (e.g., Linguistics, Sociology) has advanced significantly.
- Alternative? Creation of departments for '**Philological/Linguistic Engineering**' or '**Social Engineering**' in Science/Engineering Schools.

AI and University Education

Is the combination of Liberal studies and AI doable?

- The distinction between Humanities and Natural Sciences/Engineering persists in most countries.
- Women prefer Humanities than Natural Sciences/Engineering.
 - Only 25-30% of engineers are women.

AI and University Education

The distinction between Humanities and Natural Sciences/Engineering has deep historical roots.

- Humanities were meant to be for the gentry (ruling class) [BER1946].
- They are very old disciplines.
- Emphasis on character rather than knowledge:
 - ‘καλός κ’ αγαθός’ (in Ancient Greece)
 - Liberal education of ‘Piano and French’ style.

AI and University Education

The distinction between Humanities and Natural Sciences/Engineering has deep historical roots.

- Natural Sciences/Engineering are much younger (16-19th centuries).
- They facilitated the industrial revolution.
- They are much closer to profit making and bourgeois ideology.

AI and University Education

Does the distinction between Humanities and Natural Sciences/Engineering have biological roots?

Contrasting arguments:

- There is no evidence that women are worse than men in mathematics.
- Women tend to have inclination to humanities, even if they do well in Mathematics (D. Kimura).
- Most people do not perform well in both linguistic and mathematical tests.

Exception: Few people are excellent in all disciplines.

AI and University Education

New Language Theory and Linguistic Methodologies

- **Understanding of LLM performance.**
- Development of new methodologies in Linguistic studies
 - Complement grammar, syntax, etymology etc.
- Teaching of this new theory and methodology.
- ***We are just at the start!***

AI and University Education

Past experience: from Humanities to Mathematics

- Transition from Aristotelian Logic to Mathematical Logic
 - Boolean Algebra and (19th century)
 - Foundations of Computers (mid 20th century)
- Mathematical Logic is essential tool in Symbolic AI (1960-1980)
- **Too bad Symbolic AI failed to deliver so far.**

AI and University Education

Creation of Departments for '*Mind and Social Science and Engineering*' in Schools of Arts and Humanities.

- Groundbreaking proposal.
- *Departments of Digital Humanities* is another good solution.
- The exact name or form is not important, as long as it serves the transfer of mathematical and programming skills to arts and humanities students.

AI and University Education

Alternatives:

- Introduction of 2-3 obligatory Mathematics and Computer Science courses in each Liberal Discipline.
- ***Double BSc/MSc degrees 'X+AI'***
 - X: any Liberal Discipline (major).
 - AI minor

AI and University Education

Essential CS courses for AI education (minor in Liberal Studies):

- Mathematical Analysis
- Linear Algebra
- Probabilities and Statistics
- Signals and Systems
- Programming
- Machine Learning/Pattern Recognition
- Neural Networks
- Natural Language Processing.

AI and University Education

Creation of departments for '***Bio-Science and Engineering***' in Schools of Health Sciences, including:

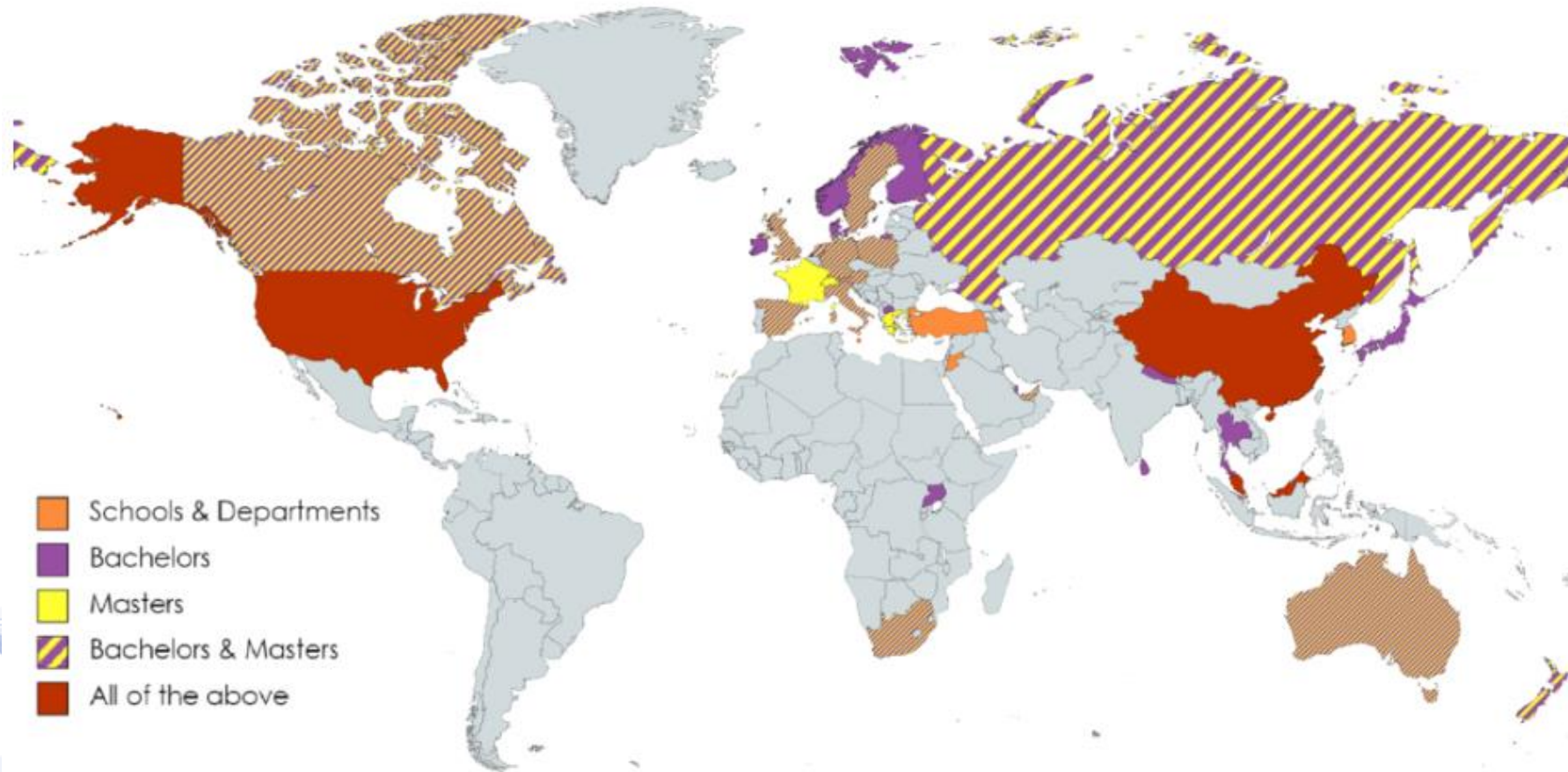
- Biomedical Engineering, Genetic Engineering and Systems Biology.

Mandatory inclusion of Mathematics and Computer Science courses in all disciplines without exception.

- Simply, one (poor) course in Statistics does not meet the current needs.
- Mandatory courses on AI ***Ethics, Legal and Social Implications*** (ELSI) in all ECE, EE, CS and CSE Curricula.

- It is already partly underway.

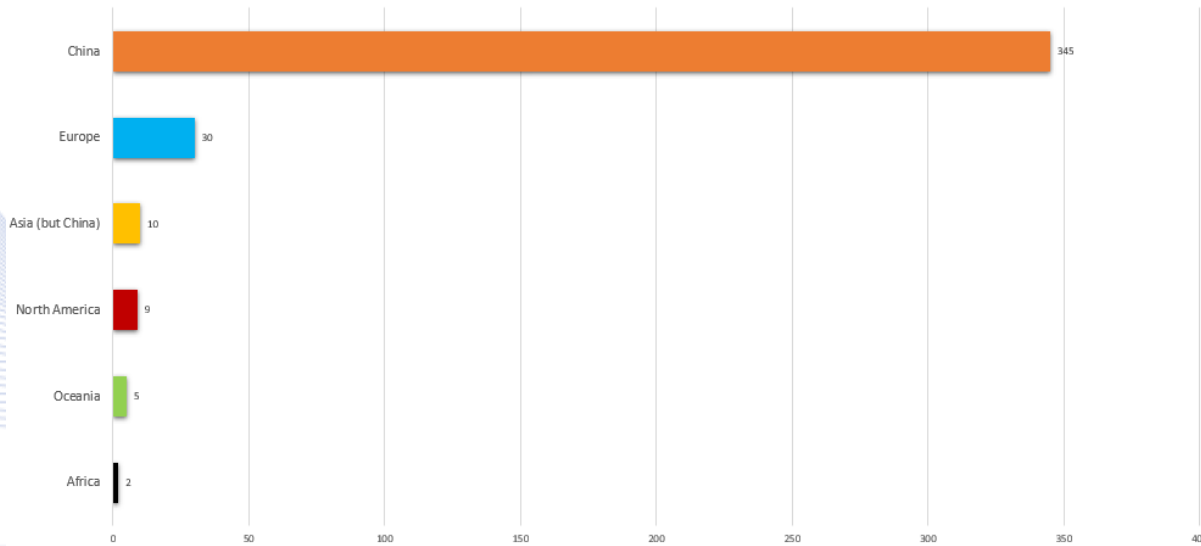
University Education on AI



Countries that offer AI studies.

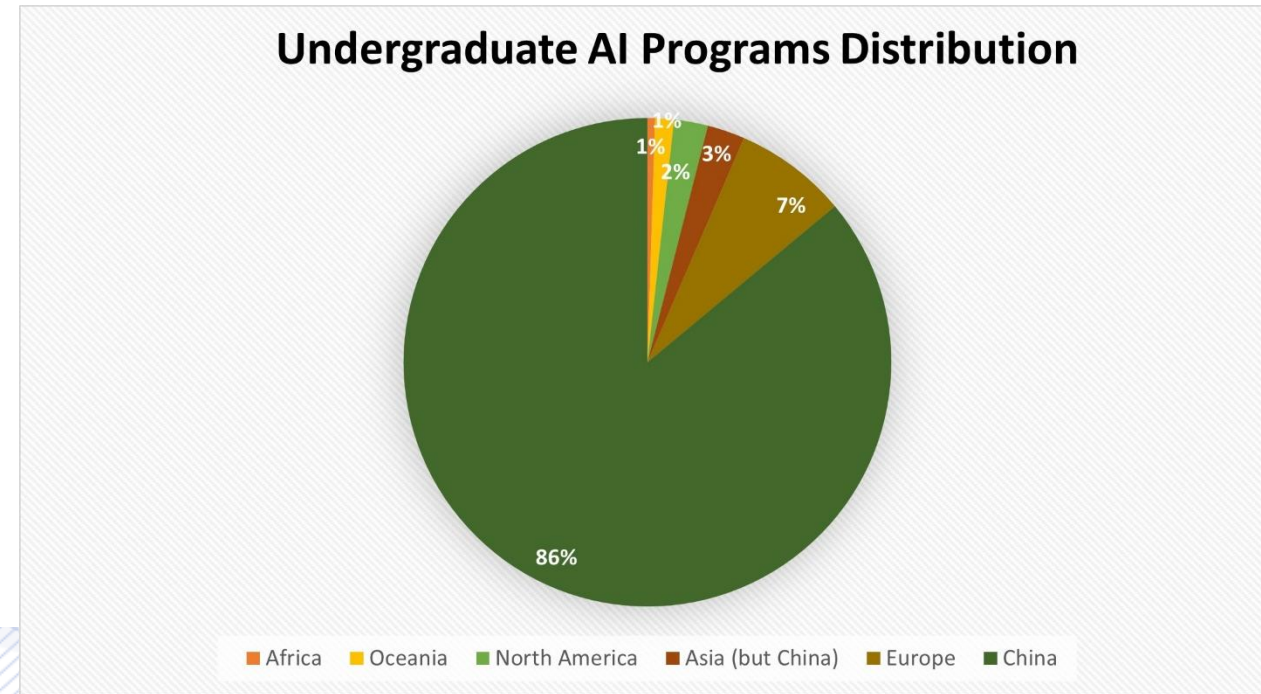
University Education on AI

Undergraduate AI Programs Distribution



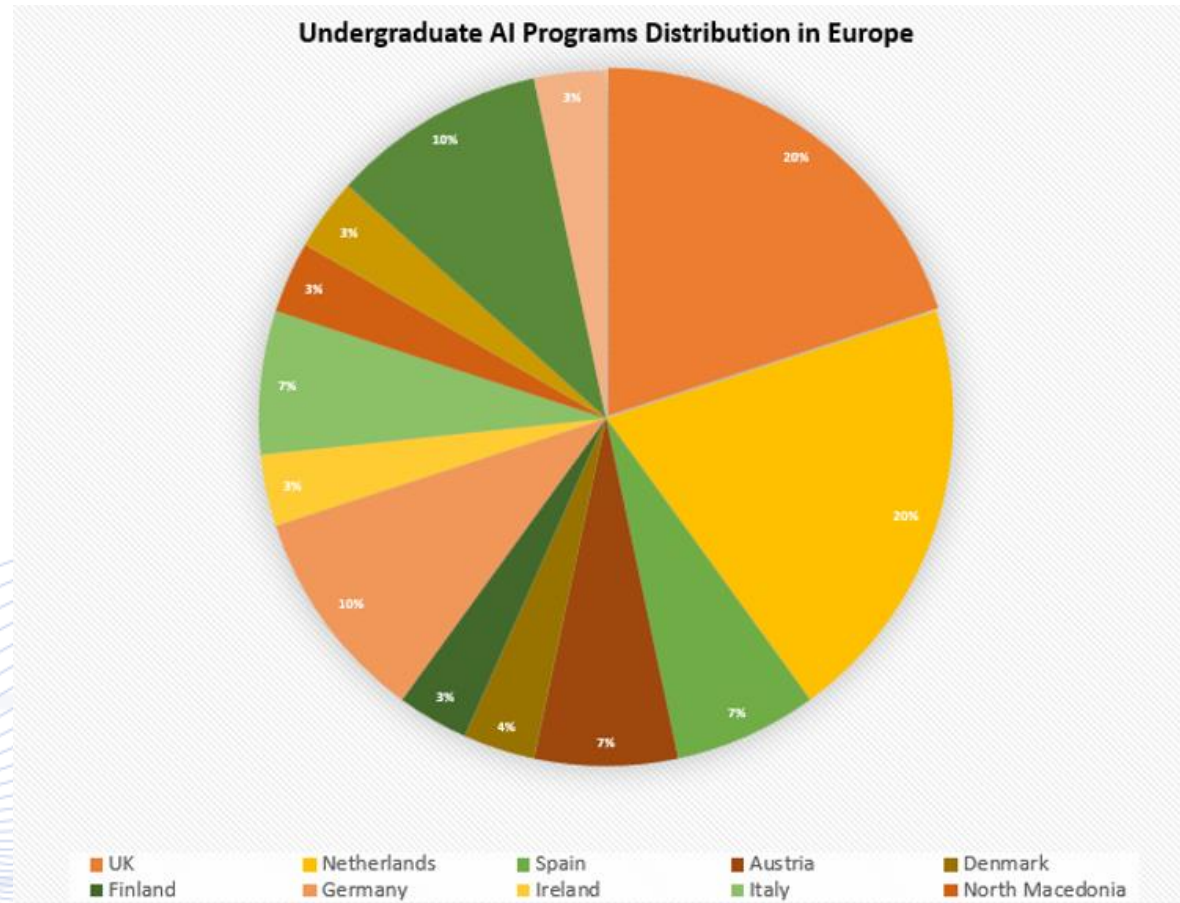
Number of undergraduate AI programs worldwide.

Undergraduate AI Programs Distribution



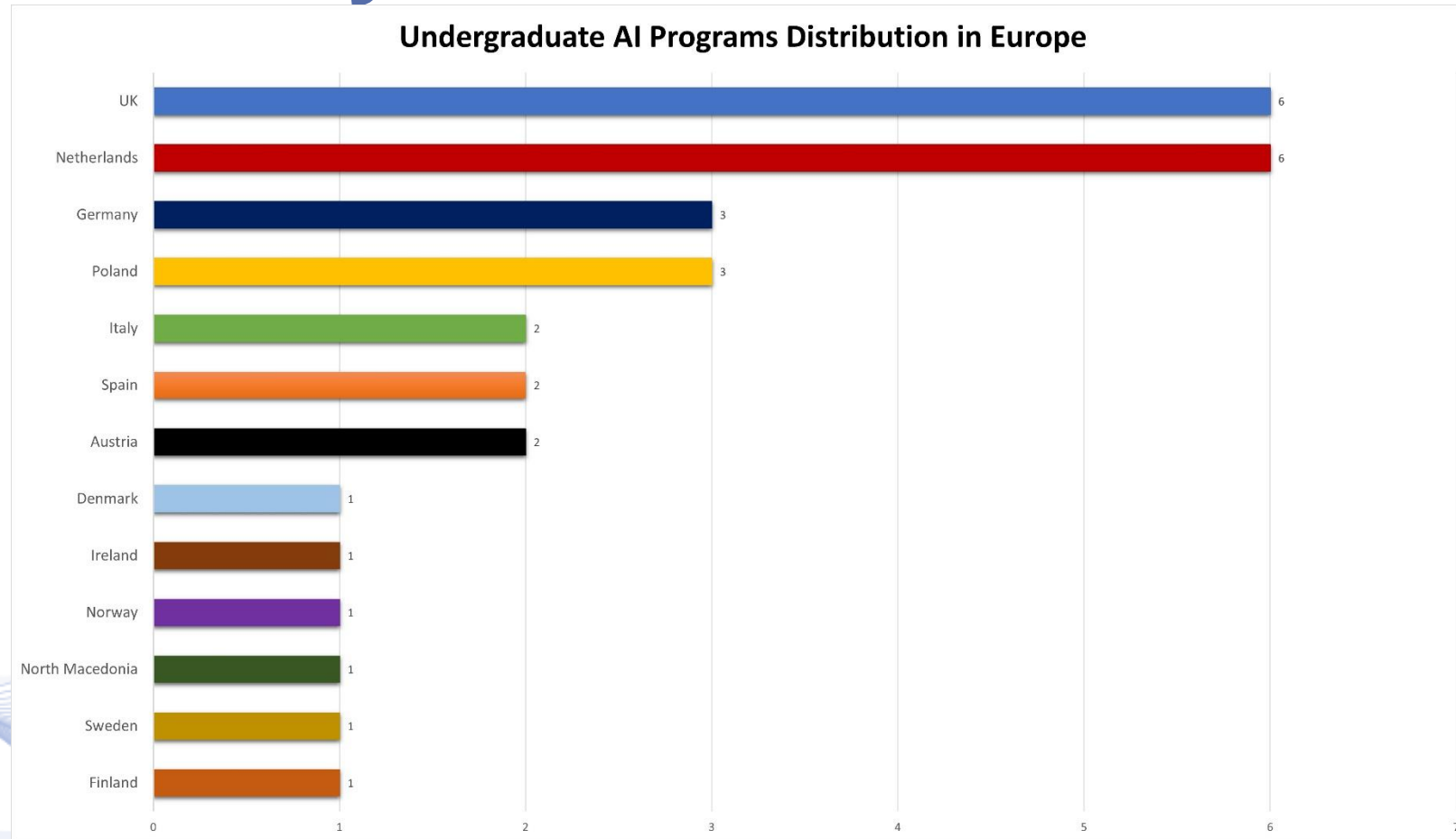
Global distribution of undergraduate AI studies.

University Education on AI



Distribution of undergraduate AI programs in Europe.

University Education on AI



Geographical distribution of AI undergraduate programs in Europe.

AI University Education

- Complex world
- What is AI?
- Citizen Morphosis
- AI Science and Engineering
- AI and University Education
- **ChatGPT in Education**
- LLMs and AI in Education

ChatGPT in Education

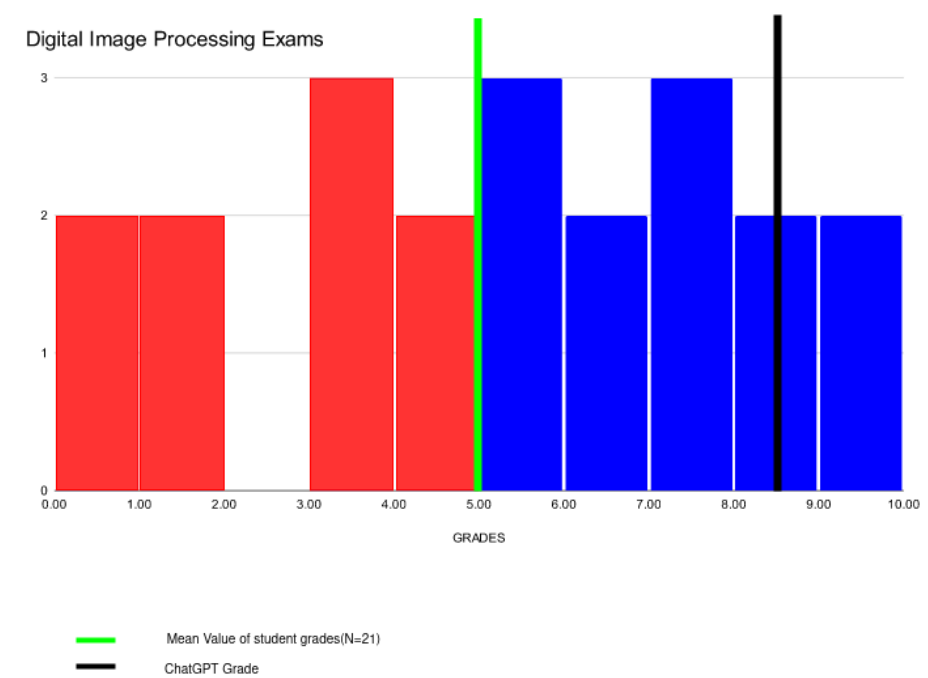
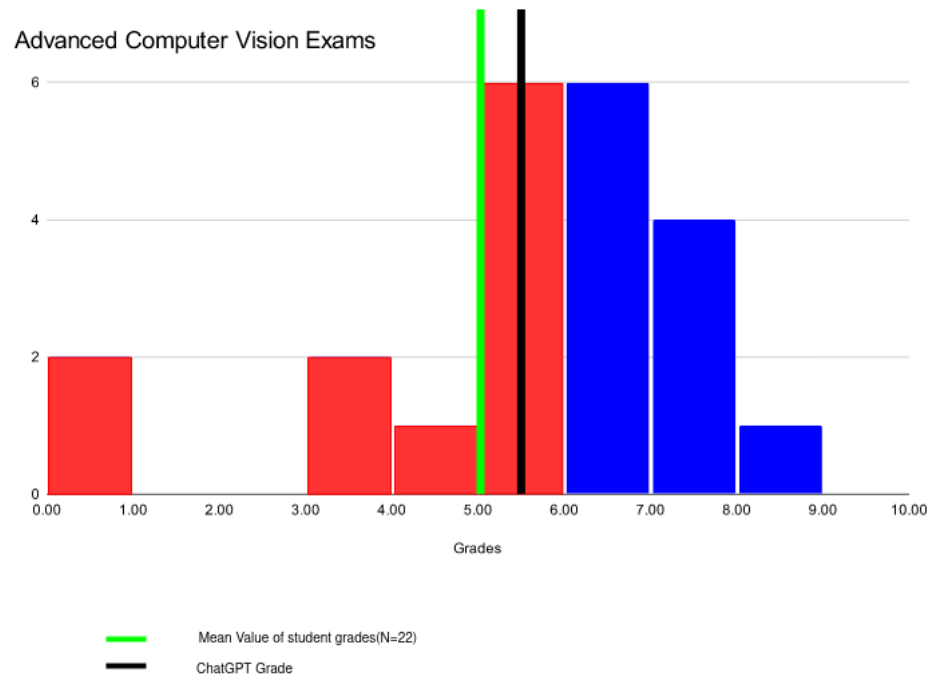
- ChatGPT can change the way we search and retrieve information.
- It has the capacity to help students reply to scientific questions.
- ChatGPT changes:
 - student project execution and examination.
 - educational exams.

ChatGPT in Education

‘Scientific’ capacity of ChatGPT:

- Good at replying factual questions on known topics.
- It has certain capacity to reply mathematical questions.
- It can solve programming exercises very well (e.g., in Python).
- Currently, it can neither process nor output diagrams and figures.

ChatGPT in Education



ChatGPT in CS/ECE exams: very good score in mathematical questions.

ChatGPT in Education

ChatGPT and Mathematics:

- It can solve mathematical questions.
 - Complex numbers, Z/Fourier transform properties.
- Replies tend to be verbose.
- It fails on some simple mathematical questions
 - It cannot always handle well reasoning with negative numbers.

Question: He asked me to give 2 Euros. I gave him 3; how much I owe him?

ChatGPT: You owe him 1 Euro.

ChatGPT in Education

- ChatGPT in CS/ECE programming exercises: excellent scores (10/10).

ChatGPT programming: arithmetic mean and 1D moving average filter routines in Python.

Here is a Python code that implements the functionality you specified:

```
python
import random

def find_mean(numbers):
    """Finds the mean value of a list of numbers"""
    return sum(numbers) / len(numbers)

def moving_average(signal, window_size):
    """Applies the moving average filter of size 'window_size' on a signal"""
    filtered_signal = []
    for i in range(len(signal) - window_size + 1):
        filtered_signal.append(find_mean(signal[i:i+window_size]))
    return filtered_signal

# Test the code
numbers = [random.randint(1, 100) for i in range(3)]
print("Random numbers:", numbers)
print("Mean value of the numbers is:", find_mean(numbers))

signal = [random.randint(1, 100) for i in range(10)]
print("Random signal:", signal)
print("Filtered signal with window size 3:", moving_average(signal, 3))
```

AI University Education

- Complex world
- What is AI?
- Citizen Morphosis
- AI Science and Engineering
- AI and University Education
- ChatGPT in Education
- **LLMs and AI in Education**

LLMs and AI in Education

ChatGPT opportunities.

- LLMs can be used as a new education tool with massive impact in education.
- We have to research how to best use it.
- Its interaction with other teaching modes must be researched.
- Can it be used to trigger creative thinking, while speeding up tedious processes?

LLMs and AI in Education

IT and AI opportunities in education.

- What is the impact of IT and AI in teaching Mathematics?
- What is the impact of LLMs in teaching languages?
- What is the impact of Deep Arts in Arts Schools?
- What is the ***long-term impact of IT and AI*** in human memory?
- Will brain be 'restructured' to be, e.g., devoted more to thinking tasks than to memory?
- Can we observe such findings from historical records?

LLMs and AI in Education

UNESCO guidelines [MIA2023].

- Promote inclusion, equity, linguistic and cultural diversity.
- Protect human agency.
- Monitor and validate GenAI systems for education.
- ***Develop AI competencies including GenAI-related skills for learners.***
- Build capacity for teachers and researchers to make proper use of GenAI.
- Promote plural opinions and plural expressions of ideas.
- Test locally relevant application models and build a cumulative evidence base.
- Review long-term implications in intersectoral and interdisciplinary manner.

- ***Less than 10% of 450 schools/universities had policies on GenAI (2023).***

LLMs and AI in Education

Restrictive/regulated use of LLMs in education.

- Plagiarism tools to detect LLM-produced documents.
- Extreme caution when examining student projects
 - ***Very effort-intensive on Professors and students.***
- Extra caution in distance learning environments.
 - ***Return to old close student-Professor relations.***
- Imposition of minimal age to use LLM tools.

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

Bibliography



[PIT2023a] Ioannis Pitas, CVML short course, “AI Science and Engineering and its Impact on the Society”, <https://icarus.csd.auth.gr/introduction-to-ai-science-and-engineering-and-its-impact-on-the-society-and-the-environment/>

[PIT2022] Ioannis Pitas, “AI Science and Engineering: A new scientific discipline?”, <https://icarus.csd.auth.gr/chatgtp-in-education/>

[PIT2023b] Ioannis Pitas, “ChatGPT in education”, <http://icarus.csd.auth.gr/ai-science-and-engineering-a-new-scientific-discipline/>

[PIT2023c] I. Pitas, “Artificial intelligence is not the new Tower of Babel. We must beware of technophobia instead”, Euronews, 8/5/2023, <https://www.euronews.com/2023/05/08/artificial-intelligence-is-not-the-new-tower-of-babel-we-should-beware-of-technophobia-ins>

[CHO2023] N. Chomsky, I. Roberts, J. Watumull, “The false promise of ChatGPT”, The New York Times, 8th March 2023.

[FUT2023] “Pause Giant AI Experiments: An Open Letter”, <https://futureoflife.org/open-letter/pause-giant-ai-experiments/>, 2023.

[NYT2023] The Godfather of A.I.’ Leaves Google and Warns of Danger Ahead, The NY Times, <https://www.nytimes.com/2023/05/01/technology/ai-google-chatbot-engineer-quits-hinton.html>

Bibliography



[OPE2023] OpenAI. "CHATGPT: Optimizing Language Models for Dialogue." OpenAI, 2 Feb. 2023, <https://openai.com/blog/chatgpt/>.

[OP2023] OpenAI. "GPT-4 Technical Report." OpenAI, 15 March 2023

[VAS2017] Vaswani, Ashish, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin. "Attention is all you need." Advances in neural information processing systems 30 (2017).

[RAD2018] Radford, Alec, Karthik Narasimhan, Tim Salimans, and Ilya Sutskever. "Improving language understanding by generative pre-training." (2018).

[RAD2019] Radford, Alec, Jeffrey Wu, Rewon Child, David Luan, Dario Amodei, and Ilya Sutskever. "Language models are unsupervised multitask learners." OpenAI blog 1, no. 8 (2019): 9.

[BRO2020] Brown, Tom, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared D. Kaplan, Prafulla Dhariwal, Arvind Neelakantan et al. "Language models are few-shot learners." Advances in neural information processing systems 33 (2020): 1877-1901.

Bibliography



[BAN2023] Bang, Yejin, Samuel Cahyawijaya, Nayeon Lee, Wenliang Dai, Dan Su, Bryan Wilie, Holy Lovenia et al. "A Multitask, Multilingual, Multimodal Evaluation of ChatGPT on Reasoning, Hallucination, and Interactivity." arXiv preprint arXiv:2302.04023 (2023).

[ZHU2015] Y. Zhu et al., "Aligning Books and Movies: Towards Story-Like Visual Explanations by Watching Movies and Reading Books," 2015 IEEE International Conference on Computer Vision (ICCV), Santiago, Chile, 2015, pp. 19-27, doi: 10.1109/ICCV.2015.11.

[FOU] The Common Crawl Foundation. Common crawl. URL <http://commoncrawl.org>.

[ALE2019] Alec Radford, Jeffrey Wu, Rewon Child, David Luan, Dario Amodei, and Ilya Sutskever. Language models are unsupervised multitask learners, 2019.

[JAR2020] Yukun Zhu, Ryan Kiros, Rich Zemel, Ruslan Salakhutdinov, Raquel Urtasun, Antonio Torralba, and Sanja Fidler. Aligning books and movies: Towards story-like visual explanations by watching movies and reading books. 2015 IEEE International Conference on Computer Vision (ICCV), Dec 2015. doi:10.1109/iccv.2015.11.

Bibliography



[CFTE] CHATGPT outperforms 85% of the 4 million programmers assessed on python on linkedin (2022) CFTE. Available at: <https://courses.cfte.education/chatgpt-outperforms-4mprogrammers/#:~:text=Some%20of%20its%20abilities%20include,large%20portion%20of%20our%20work>

[SCA2022] Scao, T.L., Fan, A., Akiki, C., Pavlick, E., Ilić, S., Hesslow, D., Castagné, R., Luccioni, A.S., Yvon, F., Gallé, M. and Tow, J., 2022. Bloom: A 176b-parameter open-access multilingual language model. arXiv preprint arXiv:2211.05100.

[CAH2022] Cahyawijaya, S., Lovenia, H., Aji, A.F., Winata, G.I., Wilie, B., Mahendra, R., Wibisono, C., Romadhony, A., Vincentio, K., Koto, F. and Santoso, J., 2022. NusaCrowd: Open Source Initiative for Indonesian NLP Resources. arXiv preprint arXiv:2212.09648.

[MIA2023] F. Miao, W. Holmes, “Guidance for generative AI in education and research”, UNESCO 2023.

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**