

Education and generative artificial intelligence. Open challenges, opportunities, and risks in higher education

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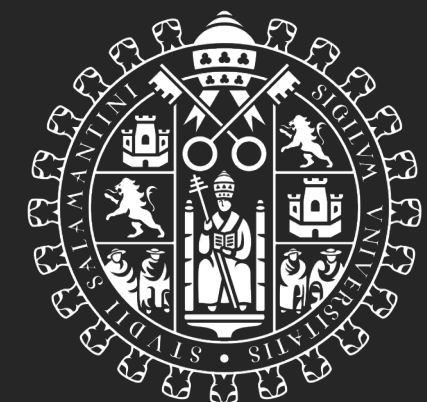
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Social perception of the Artificial Intelligence (AI)

Before November 30, 2022

- The smart devices are common in citizen's homes
- “Soft intelligent” services appear in many domains but is mostly understood as a market label
- Surprising and worries for some AI applications, such as deep fakes
- Discussions about AI “future” issues in jobs, education, ethics, etc.
- Influence of the AI Collective Imagination
- **There was a mix of soft smart apps, devices, and a perception of future problems**

After November 30, 2022

- **Artificial Intelligence is perceived as a reality in every domain**
- Thousands of apps quickly and continuously appear
- Potential benefits coexist with fears
- Discussions about AI “current” problems in jobs, education, ethics, etc.
- Much more misunderstandings about AI
- Fears due to the AI Collective Imagination

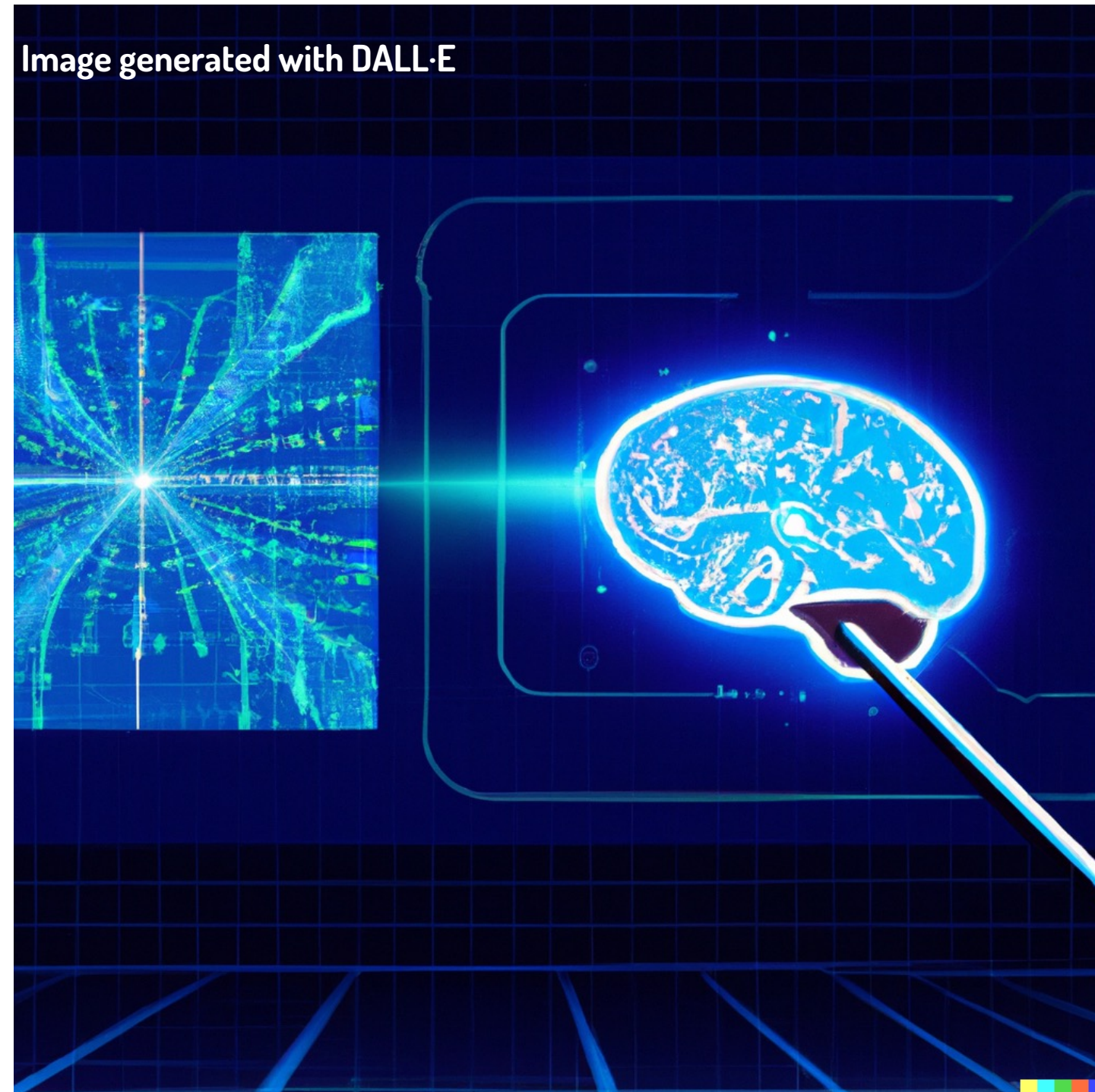


What happened on 30 November 2022?

ChatGPT

- 30 November 2022 OpenAI's ChatGPT (<https://chat.openai.com>) based on GPT 3.5 is publicly released. [1]
 - On 14 March 2023, version 4.0 is released with the ability to understand images, handle 25,000 words at once, pass the bar exam with a score in the top 10%, show advanced reasoning skills, etc.
 - A major upgrade in May 2023 includes a real-time connection to the Internet
 - OpenAI introduced voice and image capabilities in ChatGPT in September 2023. The new features will soon be rolled out to Plus
- It is a chatbot capable of **generating text** in response to a user's request expressed in natural language and made through a **simple interface**
- At first glance, the results of the queries are surprising in their quality and similarity to a human expert's response
- For many, it is a big step towards AGI (Artificial General Intelligence) [2, 3], and there is already talk of superintelligence [4]

What is AI?



- Defining AI is extremely difficult because there are different paradigms or approaches to its development [5]
- According to John McCarthy, one of the fathers of Artificial Intelligence, it can be defined as **“It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable”** [6]

Types of AI [7]

Artificial Intelligence

Enables machines to mimic human cognition, e.g., learning

Machine Learning

A subset of AI that allows machines to learn from examples (training data)

The logic of learning is often based on statistics

Some of the most common algorithms are linear regression and decision trees

It needs less data, less computing power, but more human intervention

Deep Learning

Sub-set of machine learning

The logic of learning is based on neural networks

The neural network is a complex structure of algorithms, which are inspired by biological neural networks

Needs less human intervention, but more data and more computing power

AI does not mean understanding or reasoning



- The terms “Artificial Intelligence” or “Machine Learning” can be misleading for those unfamiliar with the subject, as there is actually no thinking involved
- In this context, learning means the ability to recognise patterns in data (such as a high correlation between frequency and complexity) and make predictions about new data

Disruption in AI realm [8]



Image generated with Deep Dream Generator



Generative Artificial Intelligence [10]

Disruptive moment: when the digitised product or service outperforms the analogue product or service in terms of efficiency or cost [9]

Generative Artificial Intelligence aims to generate digital content [11]

Production of previously unseen synthetic content, in any form and to support any task, through generative modelling [12]

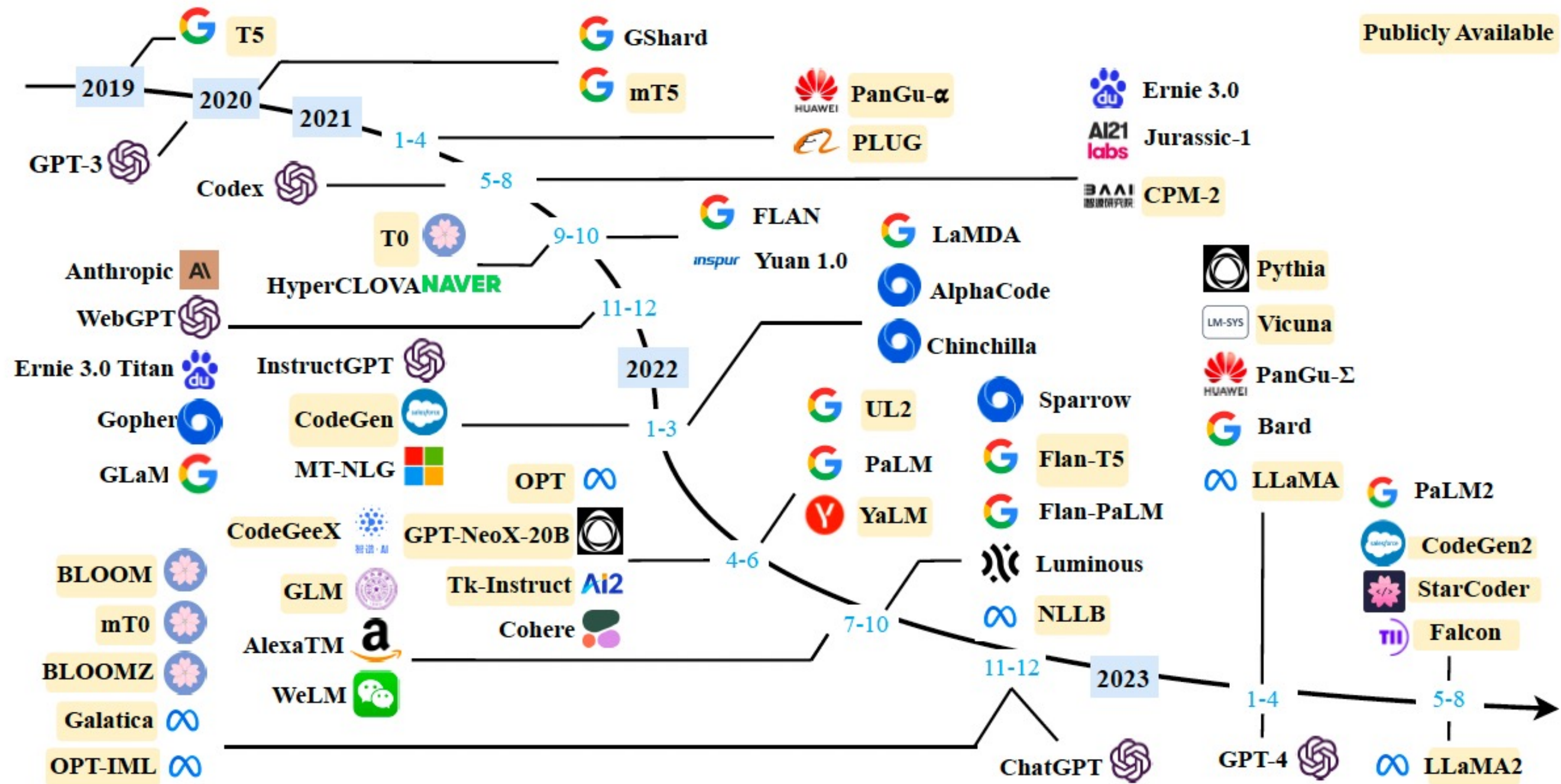
Large Language Model, LLM [13]

- A statistical language model assigns a probability to a sequence of m tokens $P(\mathbf{w}_1, \dots, \mathbf{w}_m)$ using a probability distribution, i.e., predicting the next token from the previous ones (autoregressive models)
 - Having a way to estimate the likelihood of different sentences is useful in many Natural Language Processing (NLP) applications
- Language modelling is used in speech recognition, machine translation, speech tagging, parsing, handwriting recognition, information retrieval, etc.
- Large linguistic models learn from large volumes of data
 - The definition of "big" grows along with AI
 - Today, datasets large enough to include almost everything written on the Internet over a long time are often trained on

Different kinds of language models

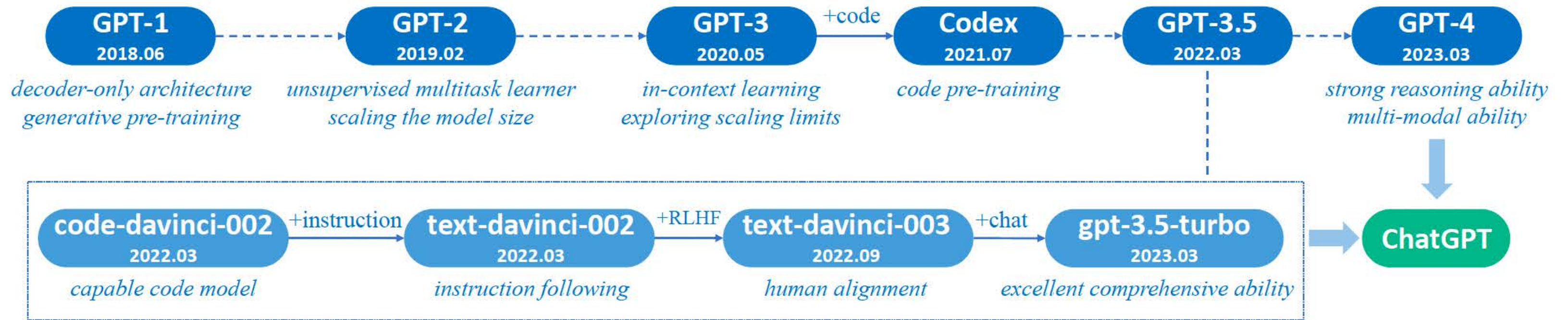
- **Statistical Language Models (SLM) [14]**
 - They build on statistical learning methods that emerged in the 1990s
The basic idea is to build the word prediction model based on the Markov assumption, i.e., predict the next word based on the most recent context
 - SLMs with a fixed context length n are called n -gram linguistic models, e.g., bigram and trigram linguistic models
 - They often have a dimensionality problem: it is difficult to estimate high-order linguistic models since an exponential number of transition probabilities must be estimated
- **Neural Language Models (NLM) [15]**
 - They characterise the probability of word sequences using neural networks, e.g., Recurrent Neural Networks (RNN)
 - These models initiate the use of linguistic models for learning representations (beyond the modelling of word sequences), which impacts natural language processing
- **Pre-trained Language Models (PLM) [16]**
 - They seek to capture context representations by pre-training networks, e.g., a bidirectional Long Short-Term Memory (biLSTM) (instead of learning fixed representations)
 - These pre-trained context-dependent word representations are very effective as general-purpose semantic features and have boosted the performance of PLN tasks. This has inspired subsequent work, establishing the "pre-training and fine-tuning" learning paradigm. This paradigm usually requires fine-tuning of the PLM to adapt it to different downstream tasks
- **Large Language Models (LLM) [17]**
 - Scaling the PLM (e.g., model size or data size) often improves the model's capability in downstream tasks
 - These large PLMs exhibit different behaviours from smaller PLMs, displaying surprising capabilities (called emergent capabilities) in solving a range of complex tasks
 - The research community, therefore, coined the term "large linguistic models (LLMs)" for these large PLMs

LLMs' timeline



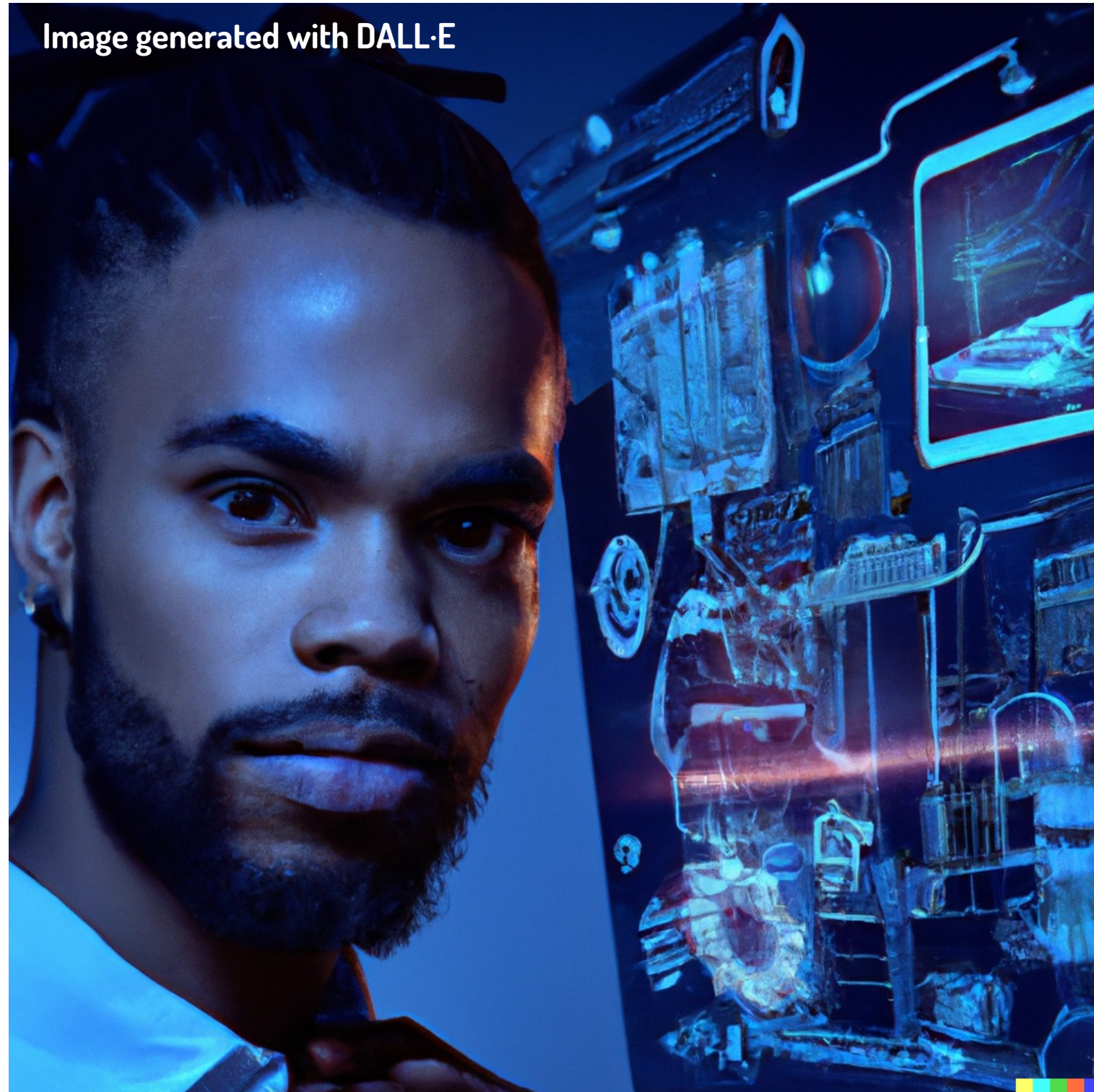
A timeline of existing large language models (having a size larger than 10B) in recent years (open source LLMs are marked in yellow). Source: [18]

Evolution of GPT-series models



Solid lines denote that there exists explicit evidence (e.g., the official statement that a new model is developed based on a base model) on the evolution path between two models, while dashed lines denote a relatively weaker evolution relation. Source: [18]

Challenges of LLMs [19]



- Scaling up and maintaining LLMs can be difficult and expensive
- Creating an LLM often requires months of training and a lot of financial investment
- As LLMs require a significant amount of training data, developers and companies may find it difficult to access sufficiently large datasets

It is not just ChatGPT

The supply of “smart” applications is growing daily

Visit, for example, Futurepedia (<https://www.futurepedia.io/>) or All Things AI (<https://allthingsai.com/>)

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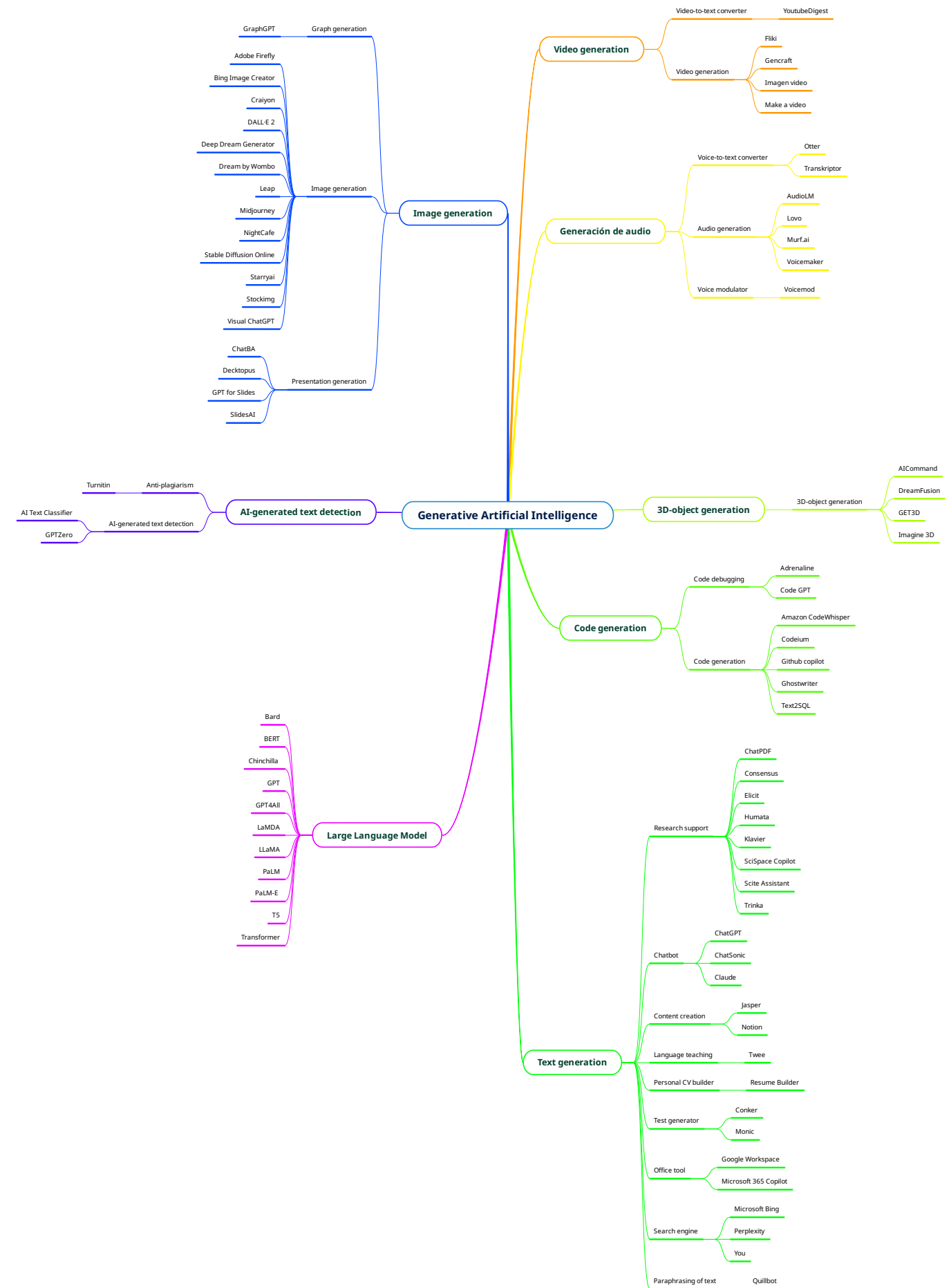


Image generated with DALL-E



Whenever a promisingly disruptive technology emerges, it is accompanied by both technophile and technophobe discourses and positions [20]

Reactions



Generative Artificial Intelligence “undermine our scientific pursuits and compromise our moral principles by integrating a fundamentally erroneous understanding of language and knowledge” N. Chomsky, I. Roberts & J. Watumull [21]

“Rather than reject these machines, and rather than replacing ourselves with them, we should reflect on what they can teach us about ourselves. They are, after all, images of humanity as reflected through the Internet” E. Lee [22]

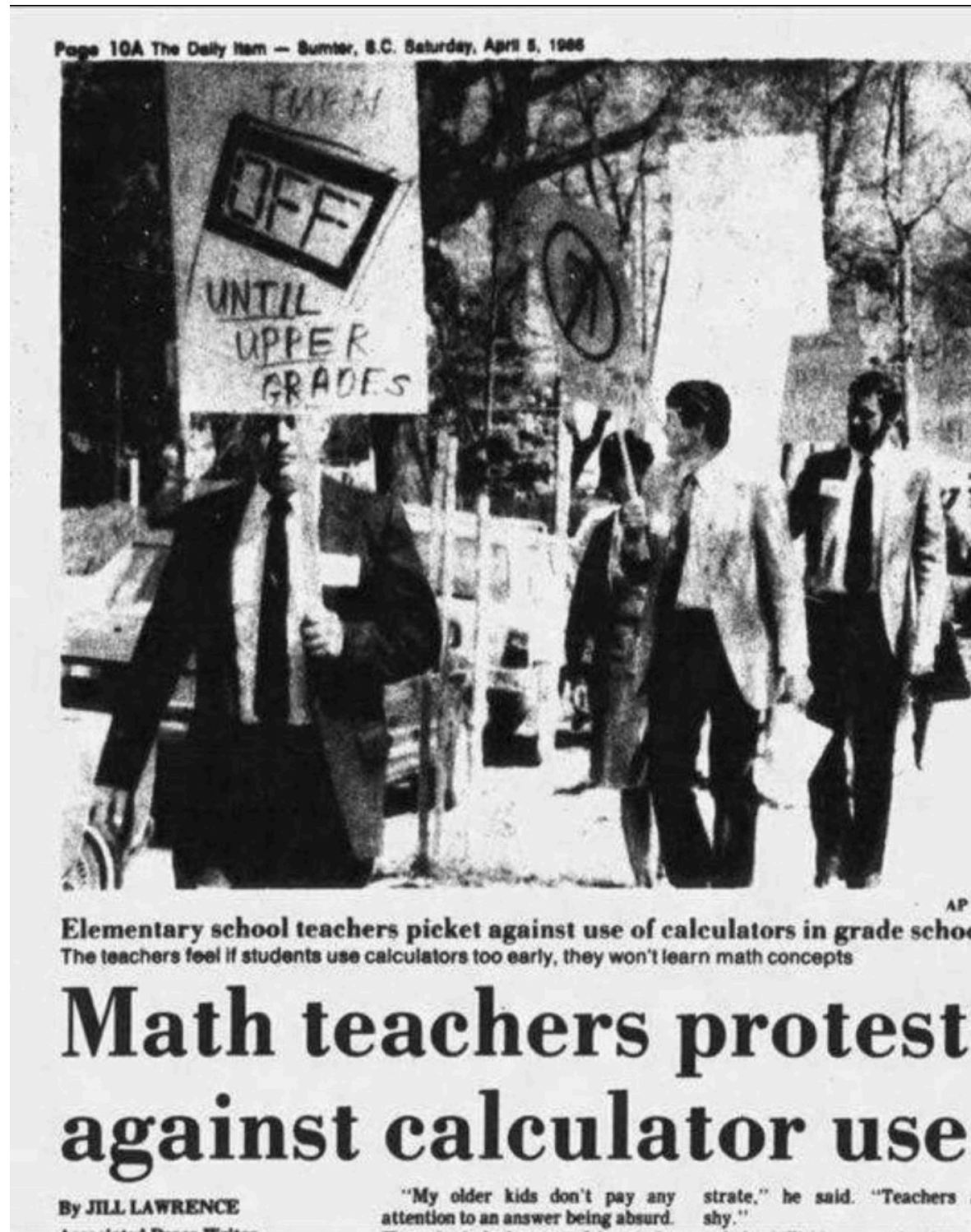
Reactions



“The development of AI is as fundamental as the creation of the microprocessor, the personal computer, the Internet, and the mobile phone. It will change the way people work, learn, travel, get health care, and communicate with each other. Entire industries will reorient around it. Businesses will distinguish themselves by how well they use it. [...] The world needs to make sure that everyone—and not just people who are well-off—benefits from artificial intelligence. Governments and philanthropy will need to play a major role in ensuring that it reduces inequity and doesn't contribute to it” B. Gates [23]

<https://unsplash.com/es/fotos/FUY5mg1f7c8>

Reactions in education



- The arrival of generative AI in the classroom has been compared to the advent of the calculator [24]
- A transformative technology so profoundly changes the capabilities of the workplace and the culture at large that the goals within the classroom must change
- With the ubiquitous power of precise calculation, it made little sense for mathematics classrooms to emphasise gross calculation as a learning outcome. However, that has not stopped people from learning to do mathematical operations
- As history has shown, prohibitions are often not as effective as intended



Reactions



The most widespread position is a mixture of enthusiasm and apprehension [25], avoiding the extremes of **naïve technophiles**, who defend technology without analysing the risks it entails, and **recalcitrant technophobes**, who reject technology simply because it is technology, without stopping to think about its benefits [26]

AI and Education

- Three directions in the relationship between AI and Education [27]
 - Learning from AI
 - Learning about AI
 - Learning with AI

AI in Education

- Intelligent tutoring systems [28, 29]
- Learning analytics [30, 31]
- Personalised or adaptive learning [32, 33]
- Robotics and intelligent environments [34, 35]
- Educational content generation [36, 37]



Education in the age of AI

- Reflect on the role of education in preparing people for a changing world in which interaction with intelligent technologies will be commonplace in all aspects of life
- Reflect on how AI applications influence teaching/learning/assessment processes
- Reflect on new knowledge, skills, competencies and values for life and work in the age of AI



<https://bit.ly/3mlr1s>



Opportunities and benefits of generative AI in Education [38]

- Access to a large amount of relevant information in real-time to later process, summarise, and present as if it were a human
- Generation of extensive sets of educational content
- Supportive tools for learning new concepts compared to traditional media, including the ability to summarise or explain complex concepts
- Understanding context, enabling interaction (dialogue) with these tools
- Enhancing critical thinking and creativity by allowing students to receive feedback on their assignments and question their beliefs
- Supporting students in repetitive tasks, allowing them to focus on the essence of the tasks and be more critical in their learning



Opportunities and benefits of generative AI in education [38]

- Facilitating the initial development of ideas and reflection upon them
- Allowing for personalised learning
- Helping students with writing difficulties and, in general, anyone to have more control over their writing skills
- Becoming virtual learning assistants
- Serving as tools for continuous and informal learning
- Facilitating the development of language skills
- Improving teachers' productivity by reducing the time spent answering the same student questions, grading written assignments, etc., allowing them to focus on higher-level tasks, such as providing feedback and support to students
- Supporting automated assessment and other innovations in evaluation



Potential risks of generative AI in education [38]

- Rapid and superficial learning
- Hindering students from developing critical and independent thinking skills, which could have long-term repercussions
- Hindrance to the development of creativity
- Providing incomplete information, leading to the misinterpretation of a concept
- Offering seemingly plausible but incoherent answers, often producing “fabricated” results known as hallucinations
- In many cases, no information is provided about the authorship or the source of evidence supporting the obtained results, which also constitutes a violation of copyright
- Possible adverse effects on developing interpersonal skills, such as communication and interaction between students and teachers and among peers being compromised



Potential risks of generative AI in education [38]

- Dishonest use of these tools, which occurs when the output generated is used without proper attribution, which can be considered plagiarism
- The differential access and usage of these tools, particularly premium paid versions, between individuals who can afford them and those who cannot, which is a potential cause of equity issues
- The invasion of data privacy and confidentiality
- An increase in racial and socio-economic prejudices due to data biases in the training of these applications
- Potential negative environmental impact due to the high processing power required to obtain the results

Generative AI open challenges in education [38]

- Adaptation of all actors involved to the digital ecosystem derived from generative AI, which is continuously evolving
- Teacher training in generative AI competencies
- Communities of practice generation to share experiences on the educational use of AI
- Development of students' competencies in generative AI, with an emphasis on fostering critical thinking skills to understand its potential and limitations and to make ethical use of these technologies
- Reviewing, updating, and innovating curriculum content and teaching methods that may have become outdated, along with addressing the resistance to change, opening up more opportunities for students' reflection

Generative AI open challenges in education [38]

- Exploration of alternatives and/or complementarities in assessment methods, such as incorporating oral assessments as a complement to written assignments, utilising open-ended evaluations to encourage originality and creativity, providing visual diagrams or graphics, and emphasising the importance of the learning process rather than solely focusing on the final product
- Development of ethical codes and the establishment of general guidelines regarding generative AI, ensuring responsible and ethical practices in its implementation

The question should not be how to prevent students from cheating us by using these technological tools, but how we should use them [39]

New scenarios of using generative AI tools in education and communication strategies [40, 41]



Possibility engine

Socratic opponent

**Collaboration
coach**

Guide on the side

Personal tutor

Co-designer

Exploratorium

Study buddy

Motivator

Dynamic assessor

Reflections

Students at all levels of education are already using generative artificial intelligence tools (ChatGPT and others) [42]



Reflections

- The extensive and widespread use of AI applications leads to the need to consider **an ethical AI** [43] and/or **eXplainable AI (XIA)** [44]
- **Generative AI** can be unsettling and, in some cases, frightening. It has its **strengths and limitations**, but it is crucial to remember that **it will improve over time**, and many of its limitations may disappear in the very short term [45]

Reflections



- **One cannot dismiss, resist, deny the presence of, or prohibit these types of technologies** [46]
- In the face of the temptation to prohibit the use of these tools in educational contexts, **there must be an emphasis on understanding what these tools can contribute to teaching/learning processes**, such as critical analysis, comparison of sources, or the selection and formulation of appropriate questions [47]

Reflections

- AI applied to education has much to **contribute towards a digital disruption of the educational system**, which seems imminent in a widespread context of **digital transformation of educational institutions** [48] and society, although it has not yet occurred [49]
- There will be a need to **train both teachers and students for the proper use of AI**, with ethics and emphasis on critical thinking so that their maximum potential is achieved in the teaching/learning processes [50]



2022/2023

Creating a collection of creative ideas to use AI in education

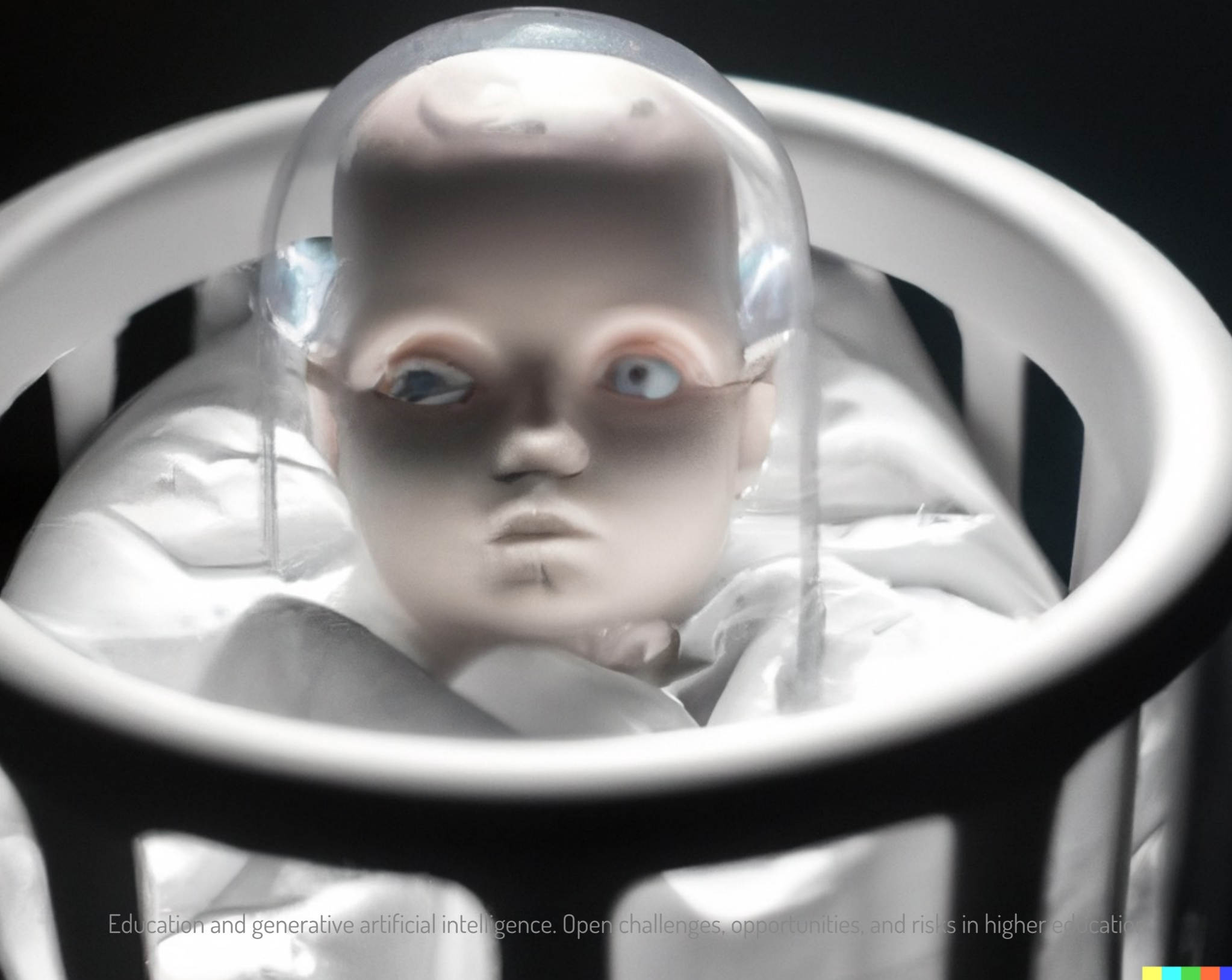
Posted by CHRISSI NERANTZI *on* FEBRUARY 2, 2023

[51]

<http://bit.ly/3KSUkWF>



Many of the problems and dangers identified in the educational context do not arise from the appearance of ChatGPT or other similar applications. They already existed, have been addressed from many perspectives, and remained unresolved. However, the potential of these technologies and the effect of their rapid penetration are magnifying some of them more than ever before



Generative Artificial Intelligence applications, like ChatGPT, are capable of doing astonishing things, but **they are just in their infancy!**

They will continue to evolve, growing in their capabilities and in their “intelligence”, with the help of users who provide feedback on the responses they generate [52]



AI, especially with the capability to **create content indistinguishable from human production** and to **interact with users using natural language**, represents one of the **most disruptive technological means** at the social level of our time. We are still just beginning to imagine the possibilities, risks, and challenges opened by this technology. However, **it must be noted that the future we can build upon this foundation should not, and must not, be in the hands of technologists alone.** There must be spaces for **inter- and trans-disciplinary co-creation** [53] to ensure the **ethical, safe, and inclusive development** of a technology we would have deemed science fiction not so long ago

Thank you

<http://bit.ly/4lhPGGz>



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Questions



Referencias

Referencias



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Education and generative artificial intelligence. Open challenges, opportunities, and risks in higher education

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