The Role of AI in Learning and Education: Challenges and Opportunities

استفاده از هوش مصنوعی برای بهبود کیفیت آموزش: فرصتها و چالشها

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Some slides are taken from a relevant symposium in Soran University, Soran, Iraq, 2024.

Opening Quotes

بیسوادان قرن ۲۱ کسانی نیستند که نمی توانند بخوانند و بنویسند، بلکه کسانی هستند که نمی توانند آموخته های کهنه را دور بریزند و دوباره بیاموزند...!

آلوین تافلر

Opening Quotes

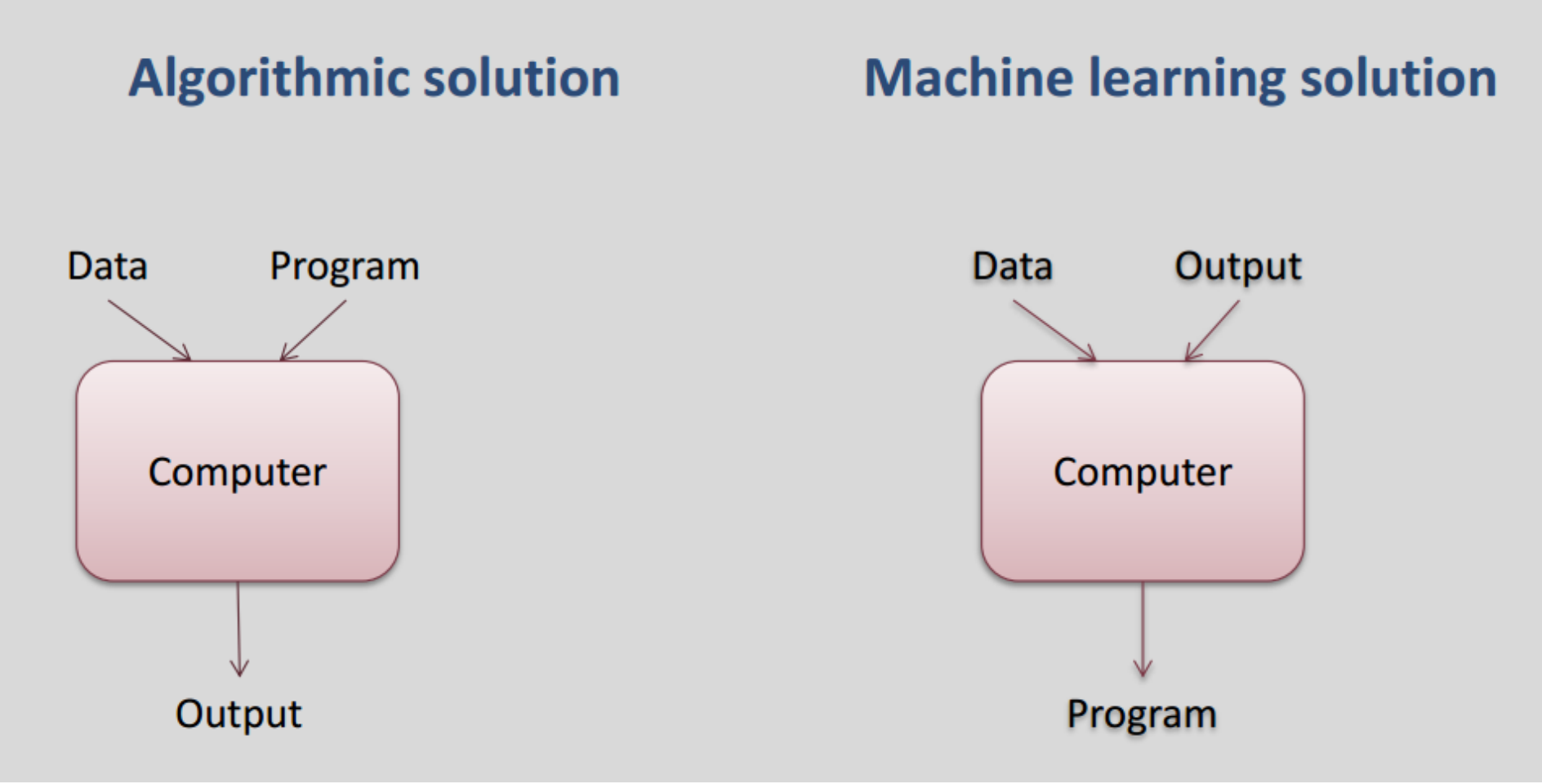
- Artificial Intelligence will not replace great teachers, but AI in the hands of great teachers can be transformational." - George Couros

- "Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime." – Chinese Proverb

Outline

- Introduction to Generative AI and LLMs
- Statistics on AI usages
- How AI can improve education performance?
- AI Literacy
- Conclusion

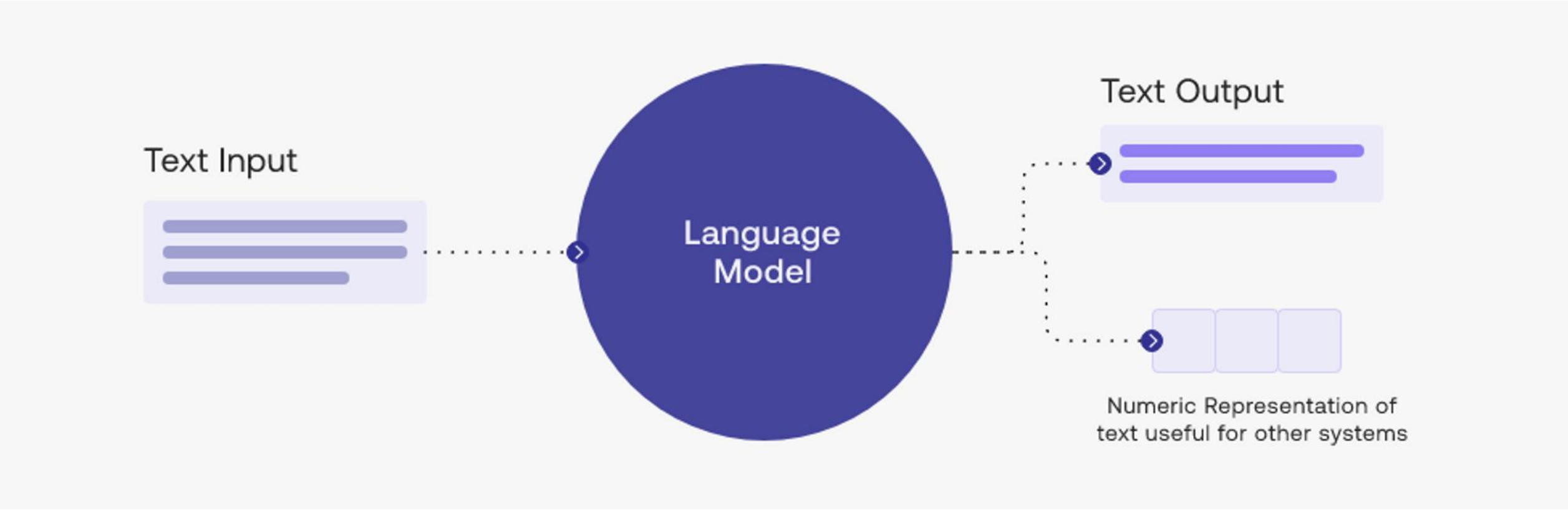
ML vs Algorithmic solutions



Generative AI and LLMs

- GAI refers to a type of AI that is based on **machine learning** models, **pre-trained** on certain datasets that can generate new content such as **text**, **images** and **sound**
- **Large Language Models (LLMs)** are a type of artificial neural network (based on transformers) created to process and generate natural language text

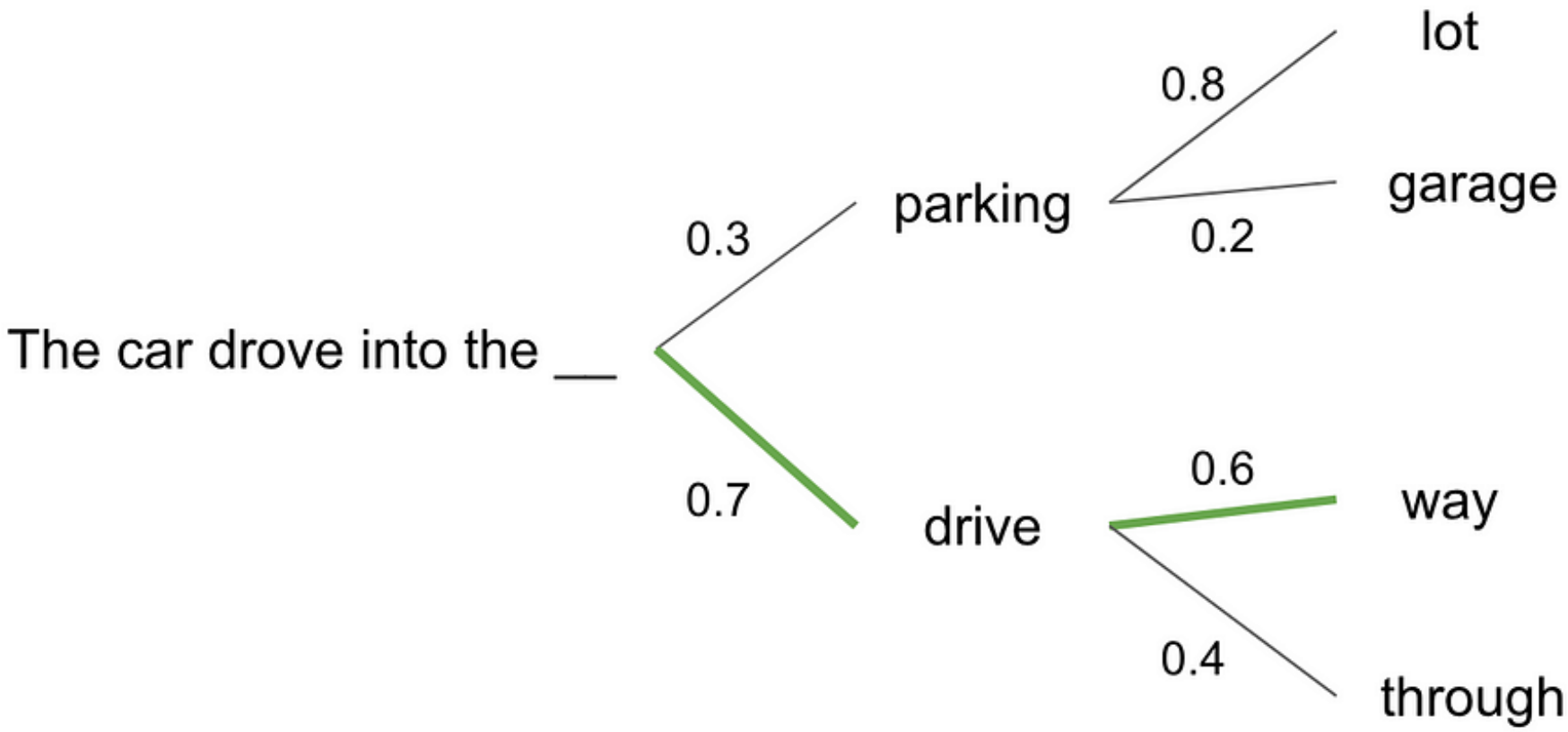
Language Models



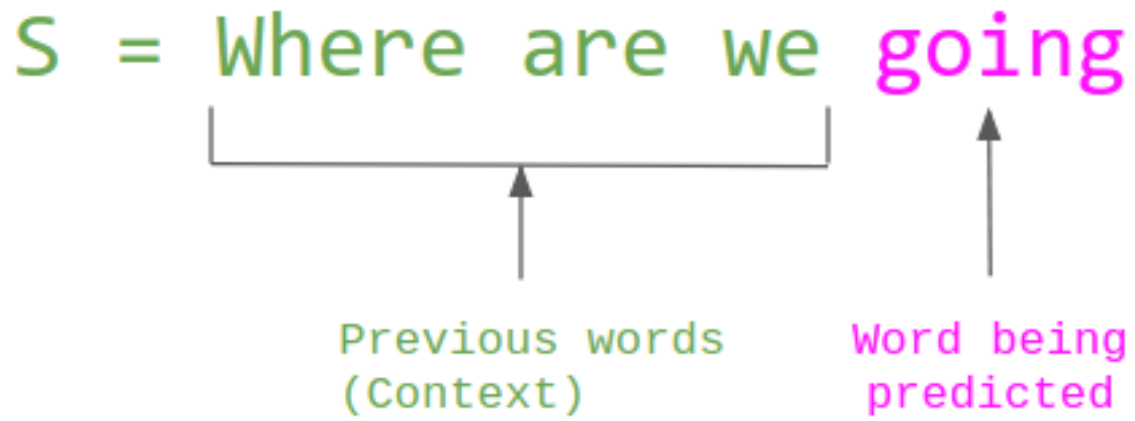
Language Models (cont.)

- Language models are probabilistic models that attempt to map the probability of a sequence of words (a phrase, sentence, etc.) occurring (i.e. how likely is it for a sentence to occur). They are trained on a collection of texts and derive probability distributions from there. The key differences between LLMs and common language models are that LLMs are trained on MASSIVELY greater amounts of texts with exponentially more compute.

Language Models (cont.)

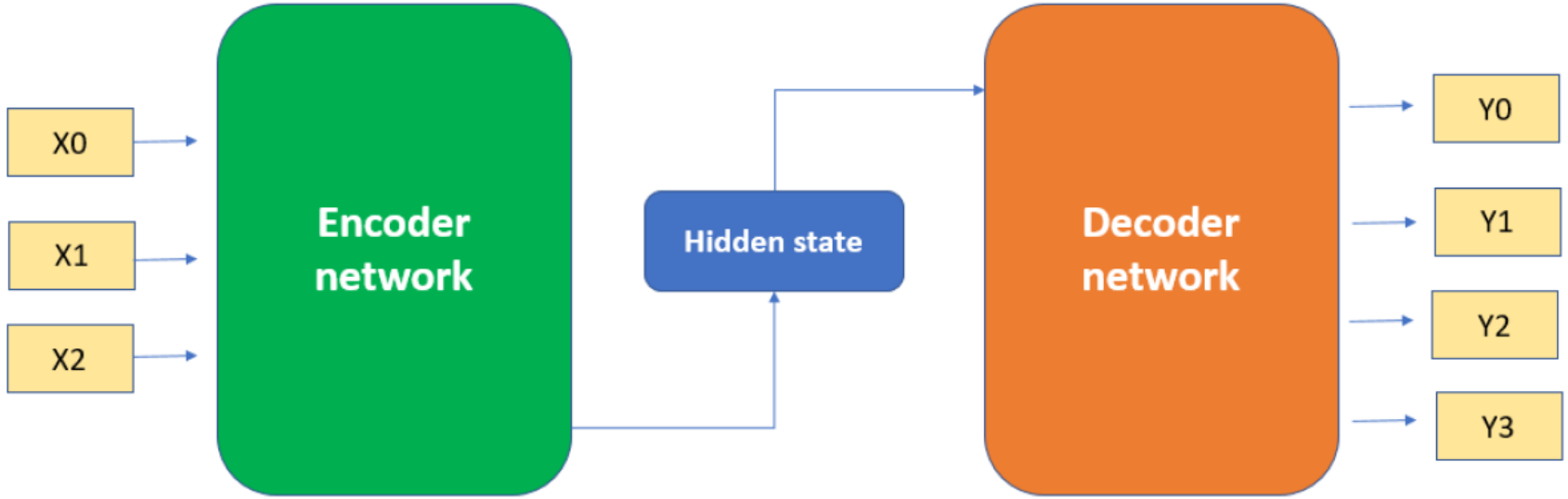


Language Model (cont.)

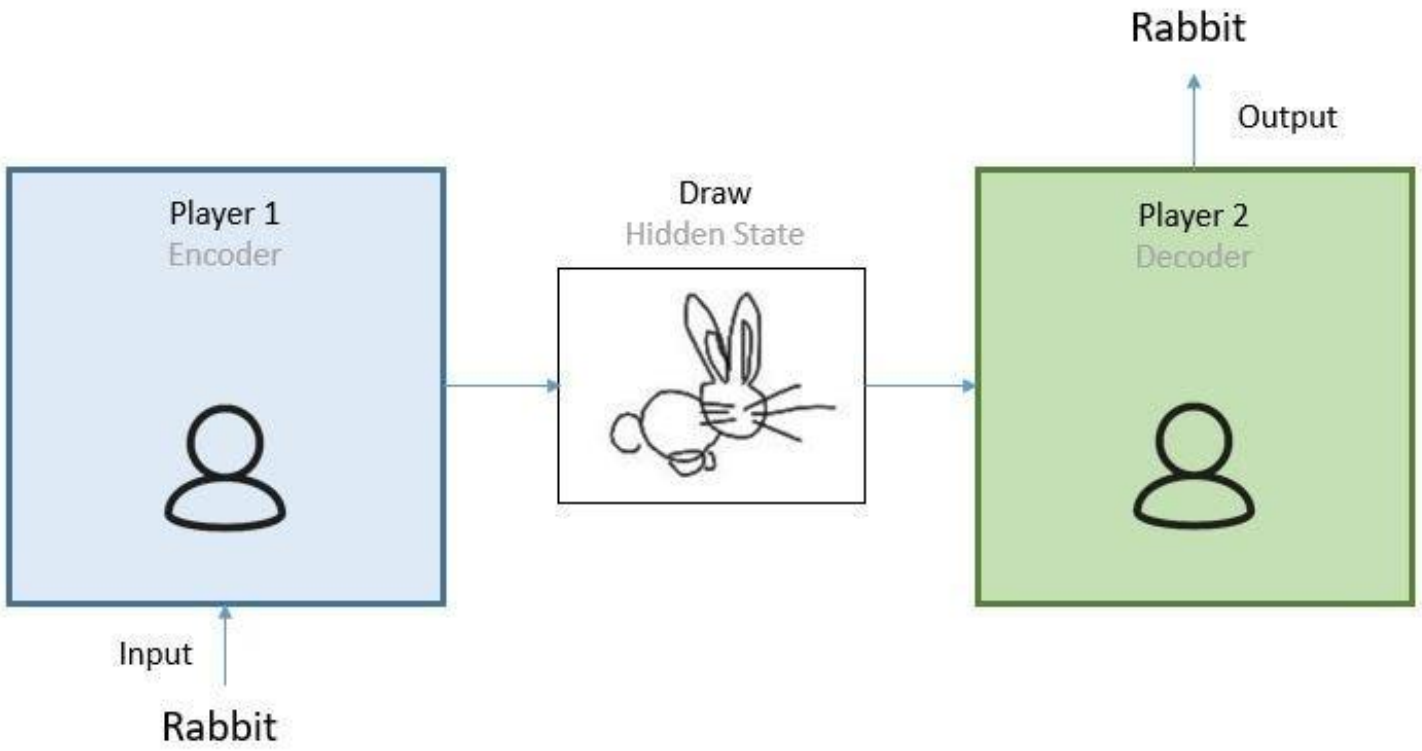


$$P(S) = P(\text{Where}) \times P(\text{are} \mid \text{Where}) \times P(\text{we} \mid \text{Where are}) \times P(\text{going} \mid \text{Where are we})$$

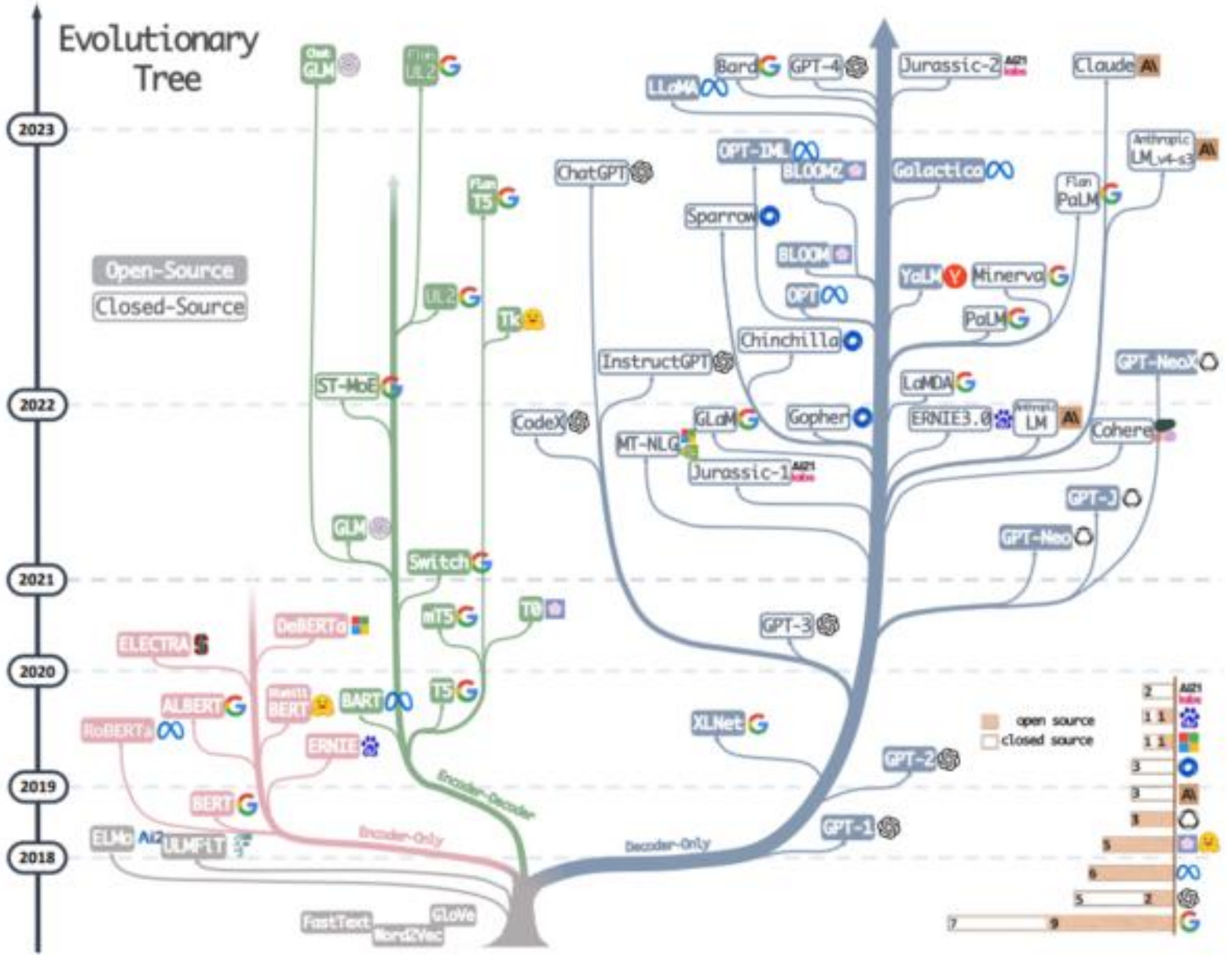
Decoder-Encoder Architecture



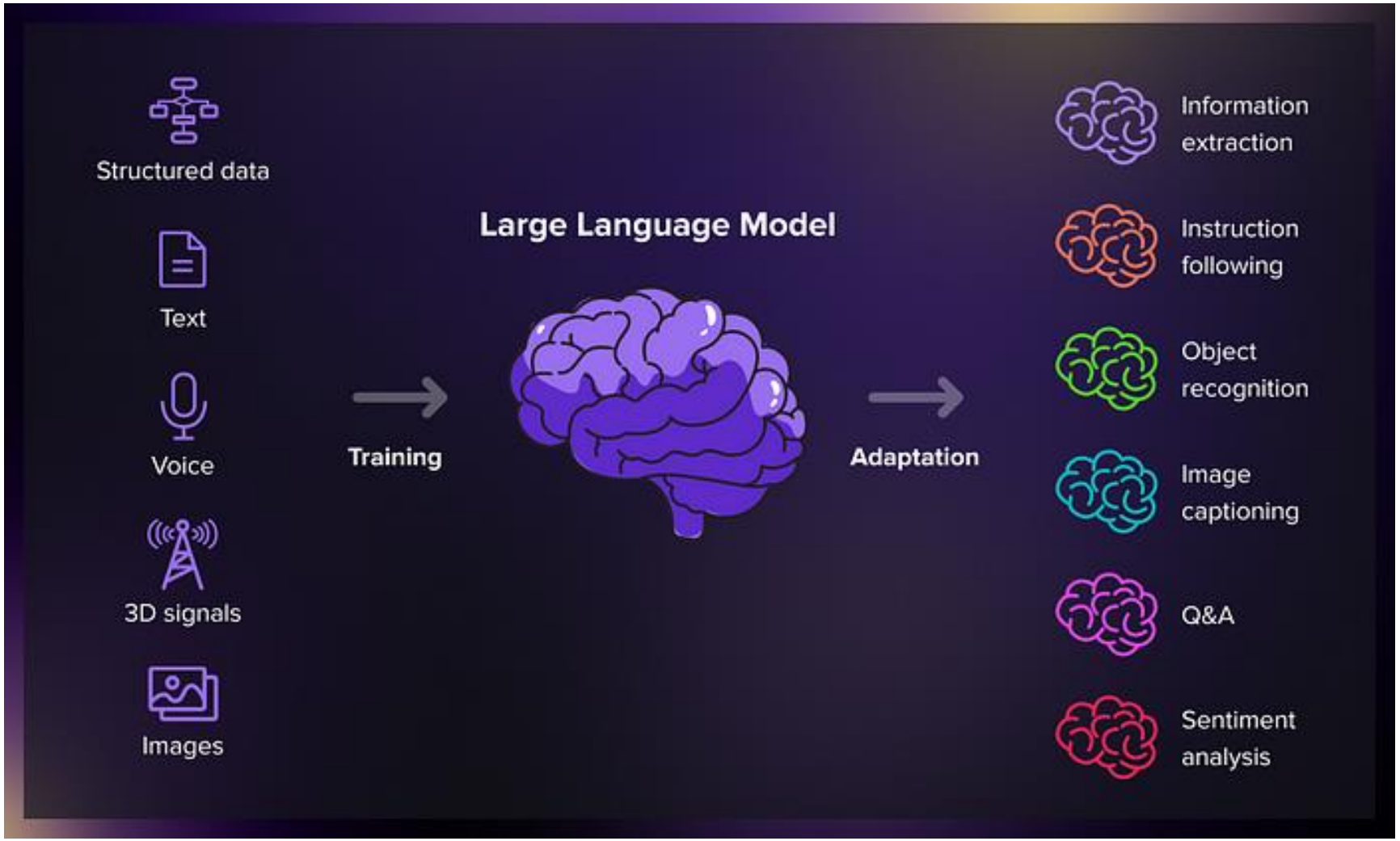
Decoder-Encoder Architecture (cont.)



Evolutionary Tree of LLMs



LLMs


Structured data
Text
Voice
3D signals
Images
Training
Large Language Model
Adaptation
Information extraction
Instruction following
Object recognition
Image captioning
Q&A
Sentiment analysis

Scaling Laws

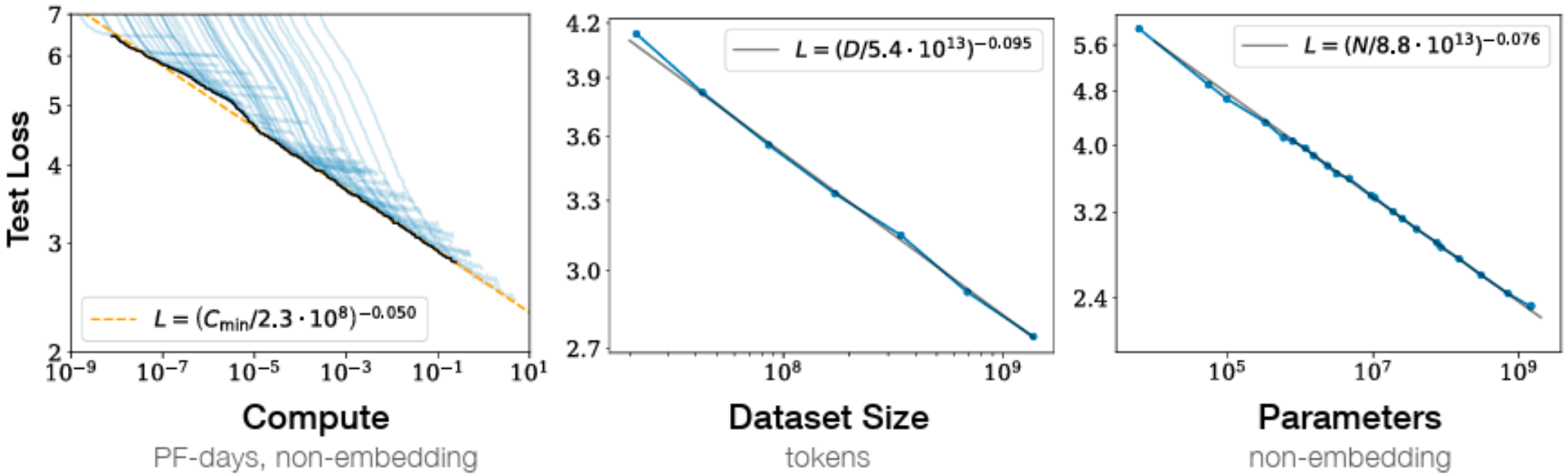
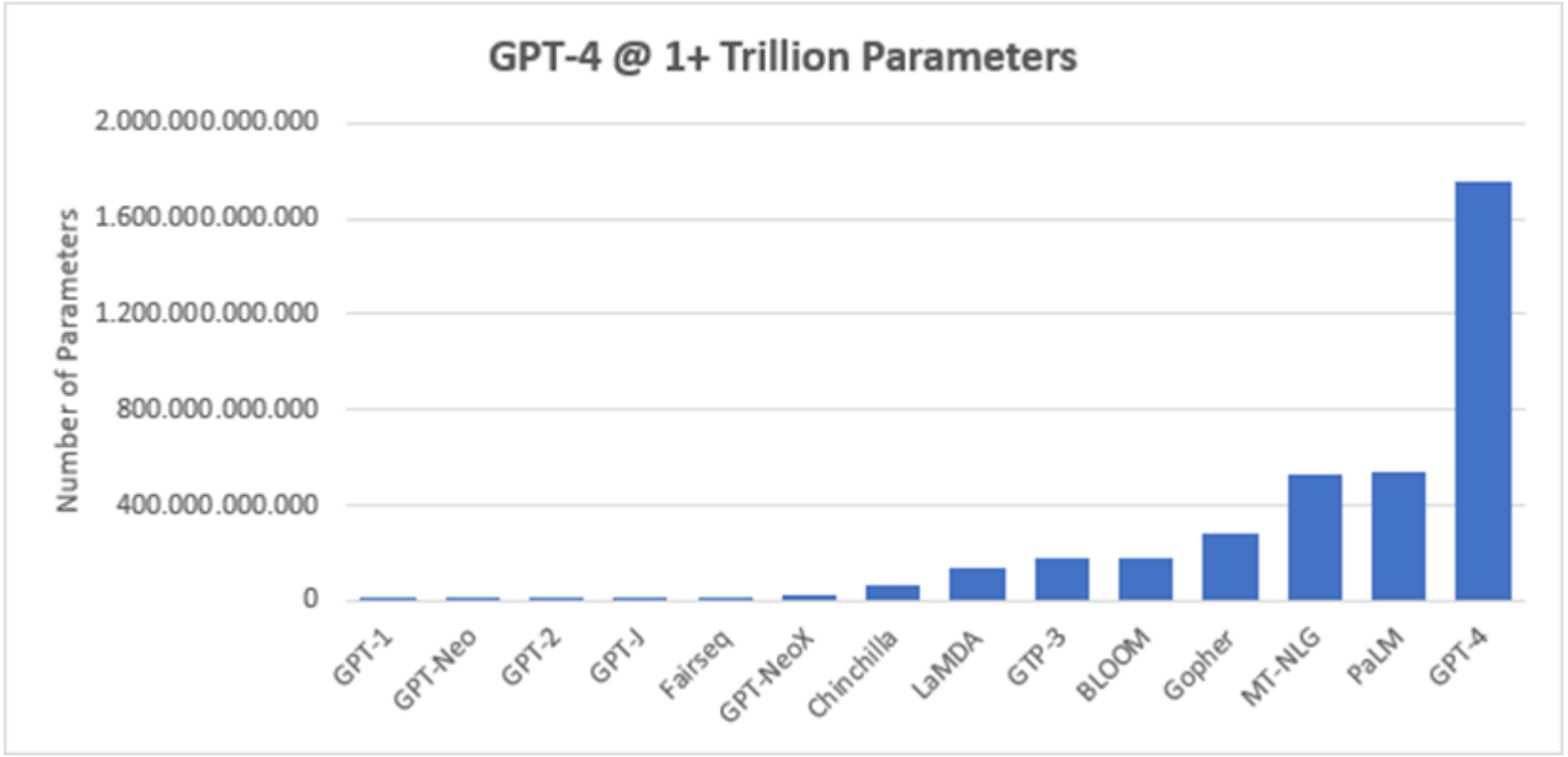


Figure 1 Language modeling performance improves smoothly as we increase the model size, datasetset size, and amount of compute[2] used for training. For optimal performance all three factors must be scaled up in tandem. Empirical performance has a power-law relationship with each individual factor when not bottlenecked by the other two.

Size Of LLMs


GPT-4 @ 1+ Trillion Parameters
Number of Parameters
2.000.000.000.000
1.600.000.000.000
1.200.000.000.000
800.000.000.000
400.000.000.000
0
GPT-1
GPT-Neo
GPT-2
GPT-J
Fairseq
GPT-NeoX
Chinchilla
LaMDA
GTP-3
BLOOM
Gopher
MT-NLG
PaLM
GPT-4

Emergent Behavior in complex systems

- ***Emergent behavior refers to the phenomenon in which a higher-level system or property emerges as a result of the interactions and organization of its lower-level components or subsystems.***

  - **Emergent behavior is often unpredictable.** This is because it is not possible to predict the behavior of a complex system simply by knowing the behavior of its individual parts.
  - **Emergent behavior is a fundamental property of complex systems.** This means that it is not something that is added to a system from the outside, but rather something that arises from the interactions of the parts of the system.
  - **Emergent properties are collective:** In the sense that they are properties of the system as a whole. This means that the emergent property cannot be attributed to any individual part of the system.

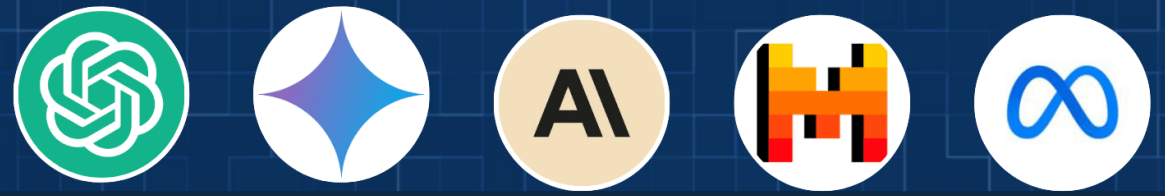
Emergent Behavior of LLMs

- Solving Complex Problems
- Handling Tasks Across Domains
- Unexpected Reasoning Capabilities
- Emergence of Creativity

- Challenges with Hallucinations and Bias

Different LLMs

FUTURE SKILLS | TOP LARGE LANGUAGE MODELS & THIER FEATURES



CRITERIA	ChatGPT	Gemini	Claude	Mistral	LlaMA
DEVELOPER	OpenAI	Google	Anthropic	Mistral AI	Meta
RELEASE DATE	Nov. 2022	Dec. 2023	Mar. 2023	Sept. 2023	Feb. 2023
LANGUAGE MODEL	GPT 4o	Gemini 1.5 Pro	Claude 3 Opus	Mixtral 8x22B	Llama 3 (8B)
OUTPUT TOKEN PRICE	$15.00 per 1M Tokens	$21 per 1M Tokens	$75.00 per 1M Tokens	$1 per 1M Tokens	$0.1 per 1M Tokens
SPEED	74 Tokens per Second	55 Tokens per Second	32 Tokens per Second	82 Tokens per Second	866 Tokens per Second
QUALITY INDEX	100	88	94	63	65
KEY FEATURE	Generates human-like response in real time based on user-input.	Understand different types of information, including text, images, audio video & code.	Generates various forms of text content like summary, creative works & code.	It can grasp the nuances of language, context, and even emotions.	It has advanced NLP capabilities that can handle complex queries easily.

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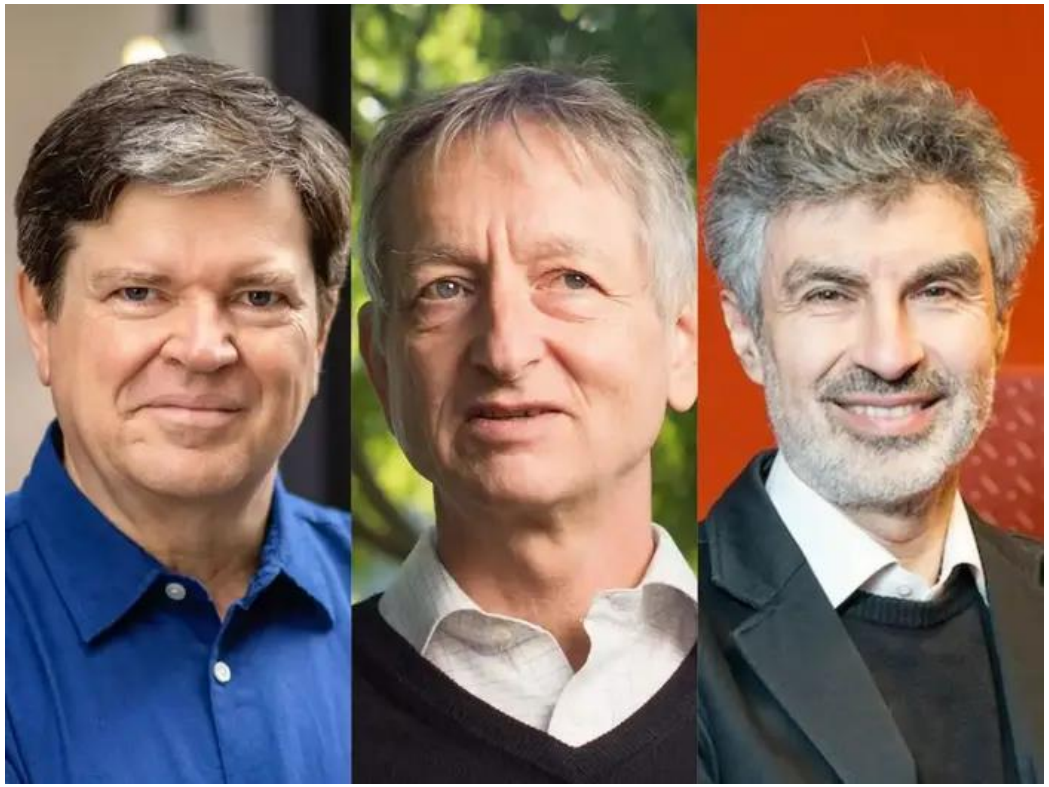
Future of AI

Humanity faces a 'catastrophic' future if we don’t regulate AI, 'Godfather of AI' Yoshua Bengio says

Geoffrey Hinton says there is 10% to 20% chance AI will lead to human extinction in three decades, as change moves fast

“flavor of AI” that we have at the moment — that is, generative AI and large language models (LLMs) — isn’t really up to all that much. It’s useful, sure, but falls short on many fronts,
Yaan LeCun



Artificial general intelligence (AGI)

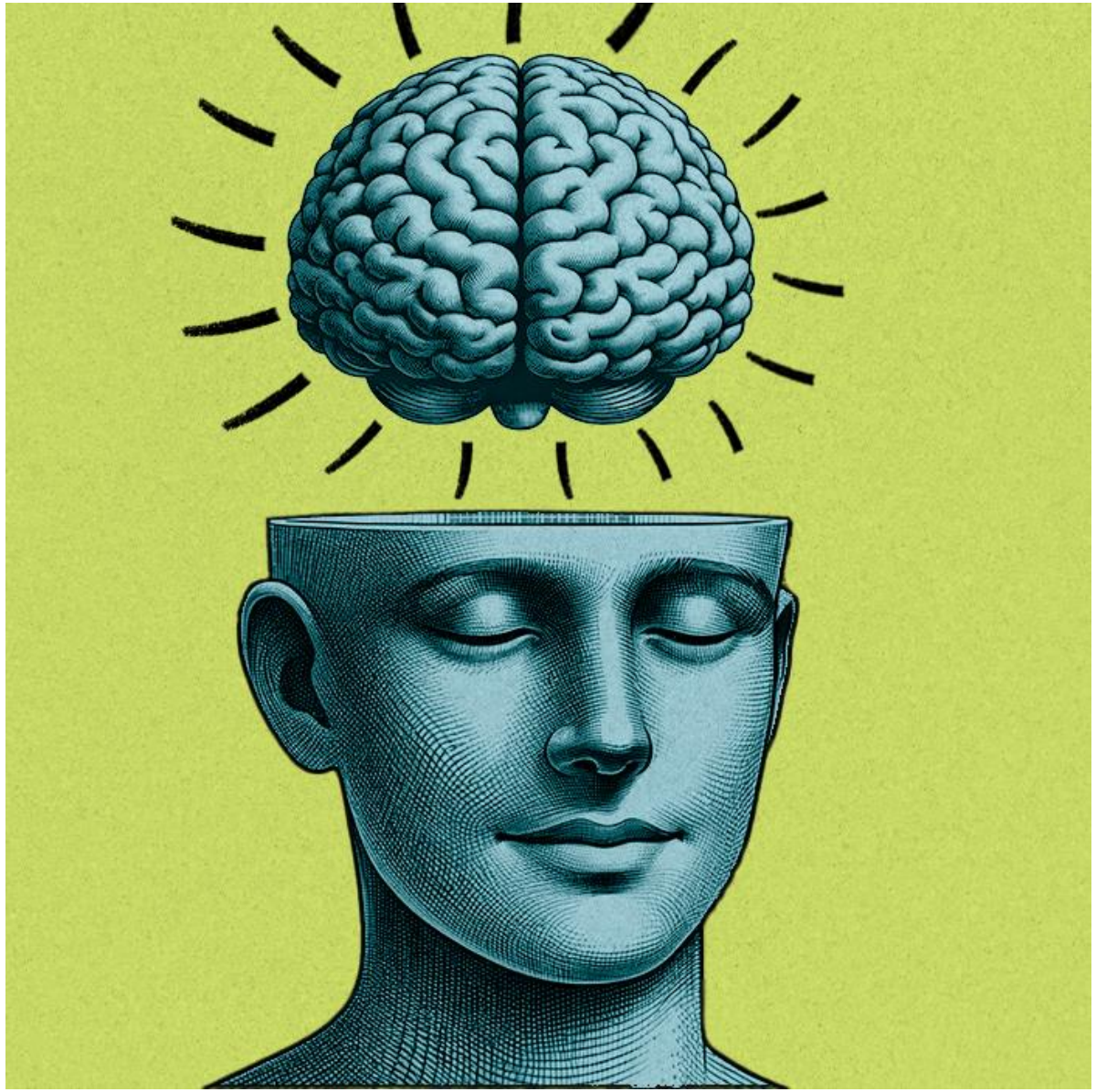
- A theoretical concept that describes a machine's ability to match or exceed human intelligence

- LeCun: LLMs Limitations:
  - a lack of understanding of the physical world;
  - a lack of persistent memory;
  - a lack of reasoning;
  - a lack of complex planning capabilities.

World Models

- LeCUn's opinion
  - We need a paradigm shift in AI models
    - World Models that promise to help machines understand the dynamics of the real world. This includes
    - having a memory
    - common sense
    - intuition
    - reasoning capabilities
  - Traits far beyond that of current systems, which are mostly about pattern recognition.
    - **The decade of robotics**

ChatGPT and the Future of the Human Mind?



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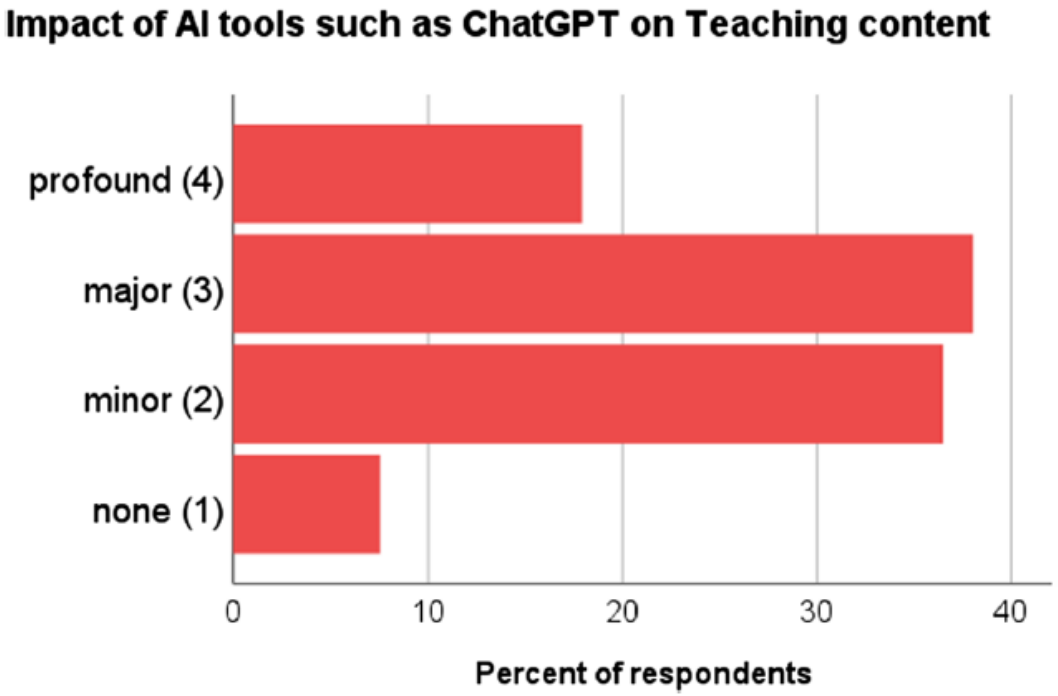
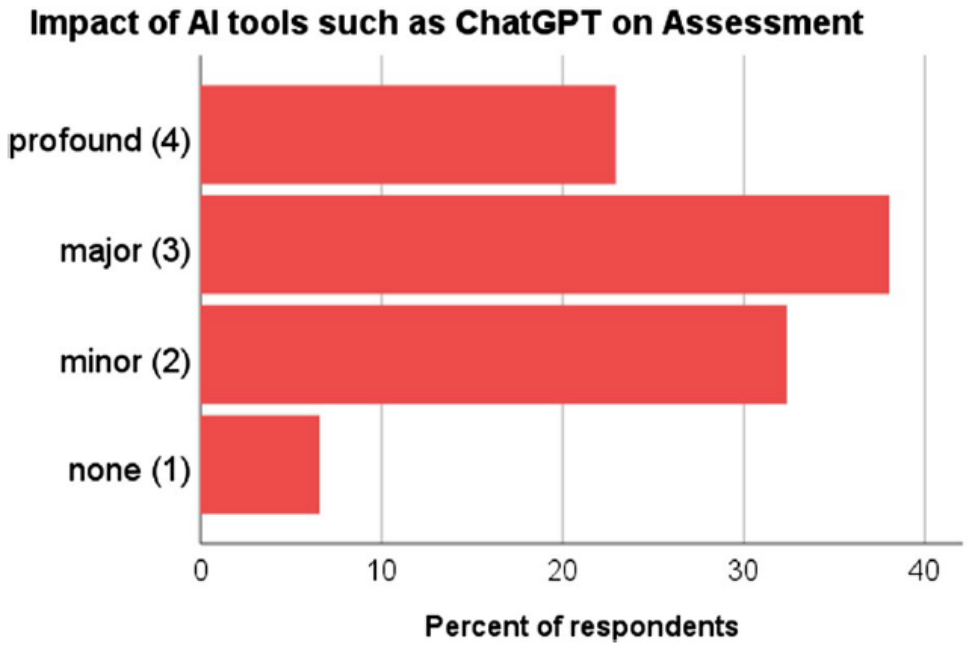
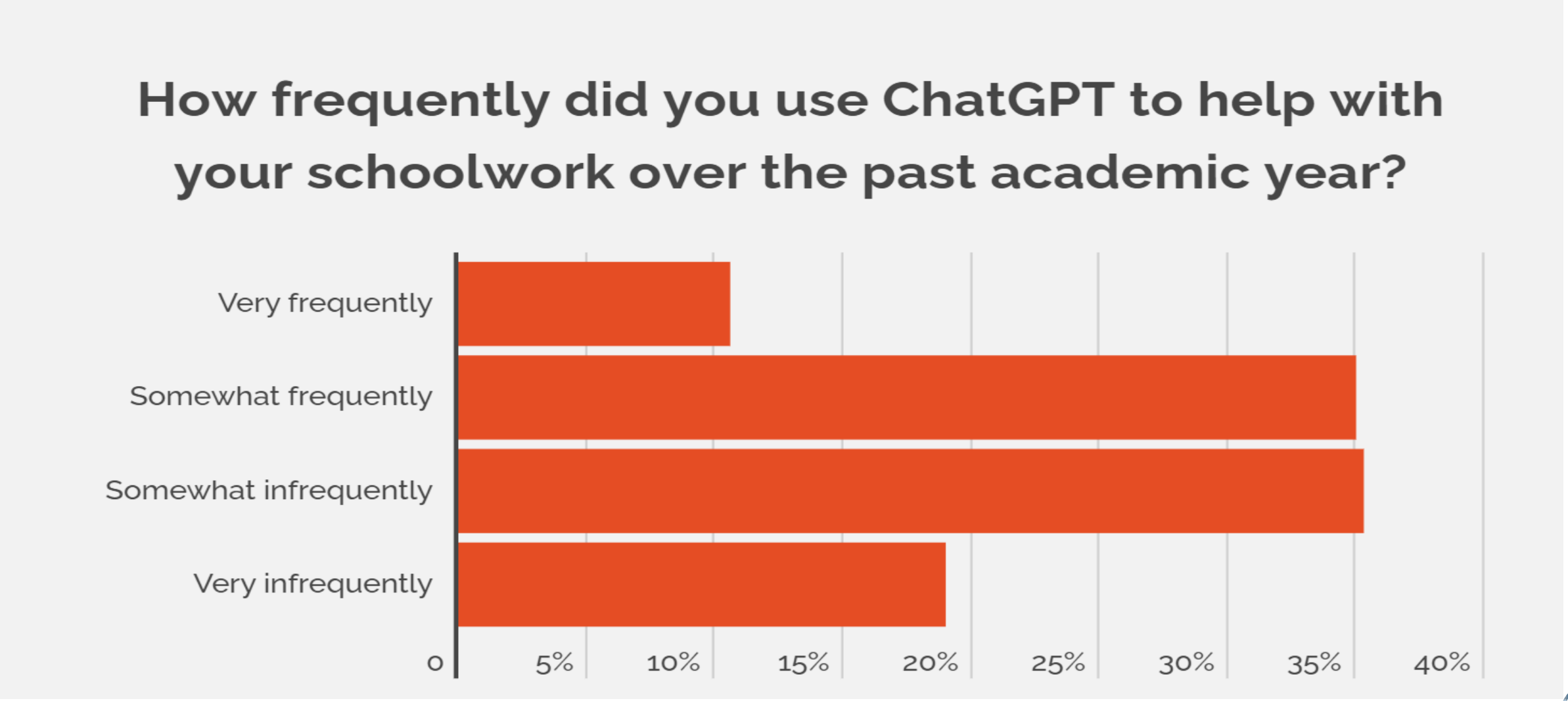
Impact of AI chatbots on teaching and assessment



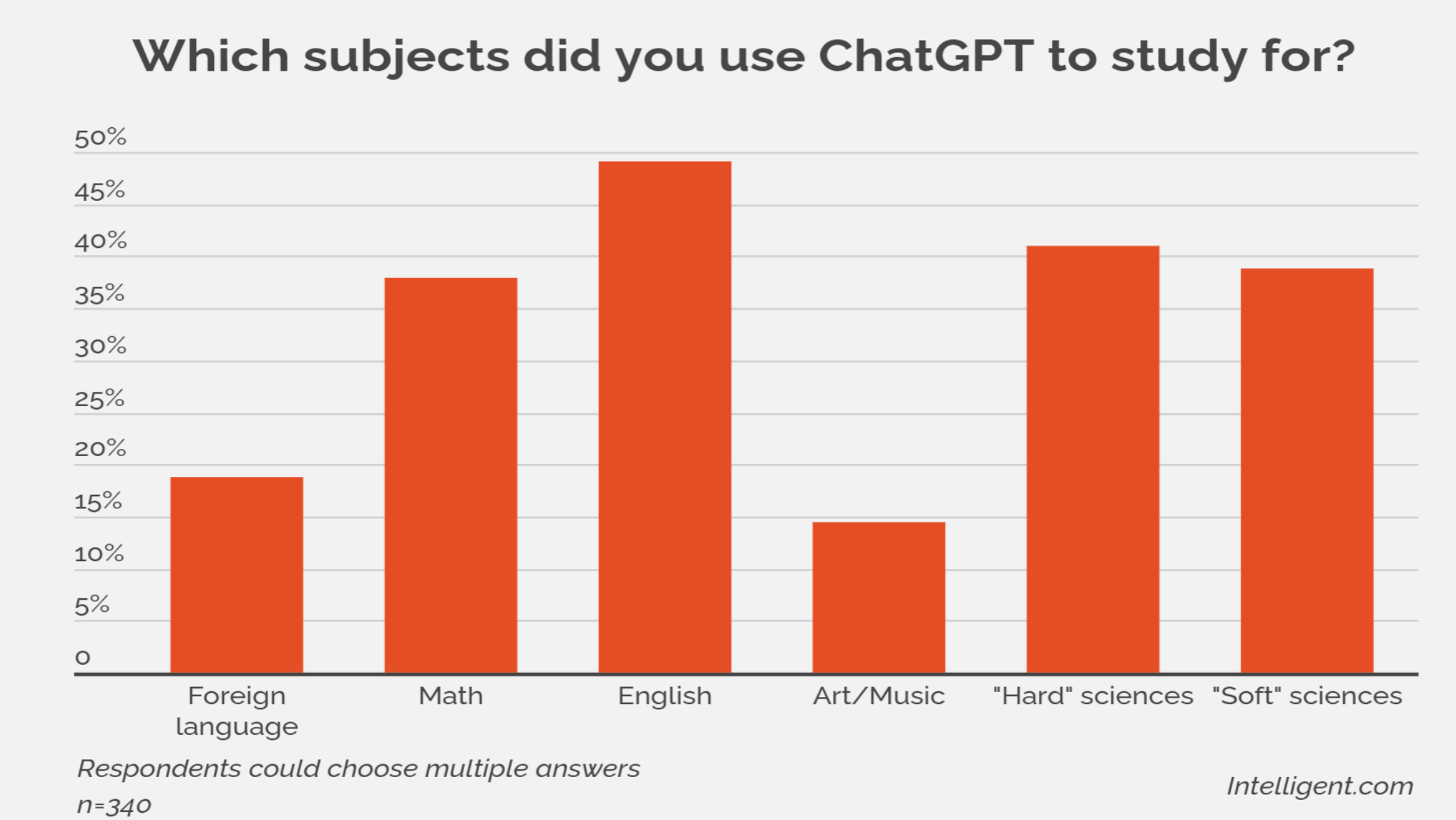


M.Bower et al. “How should we change teaching and assessment in response to increasingly powerful generative Artificial Intelligence? Outcomes of the ChatGPT teacher survey”, Springer journal of Education and Information Technologies, 2024, https://doi.org/10.1007/s10639-023-12405-0

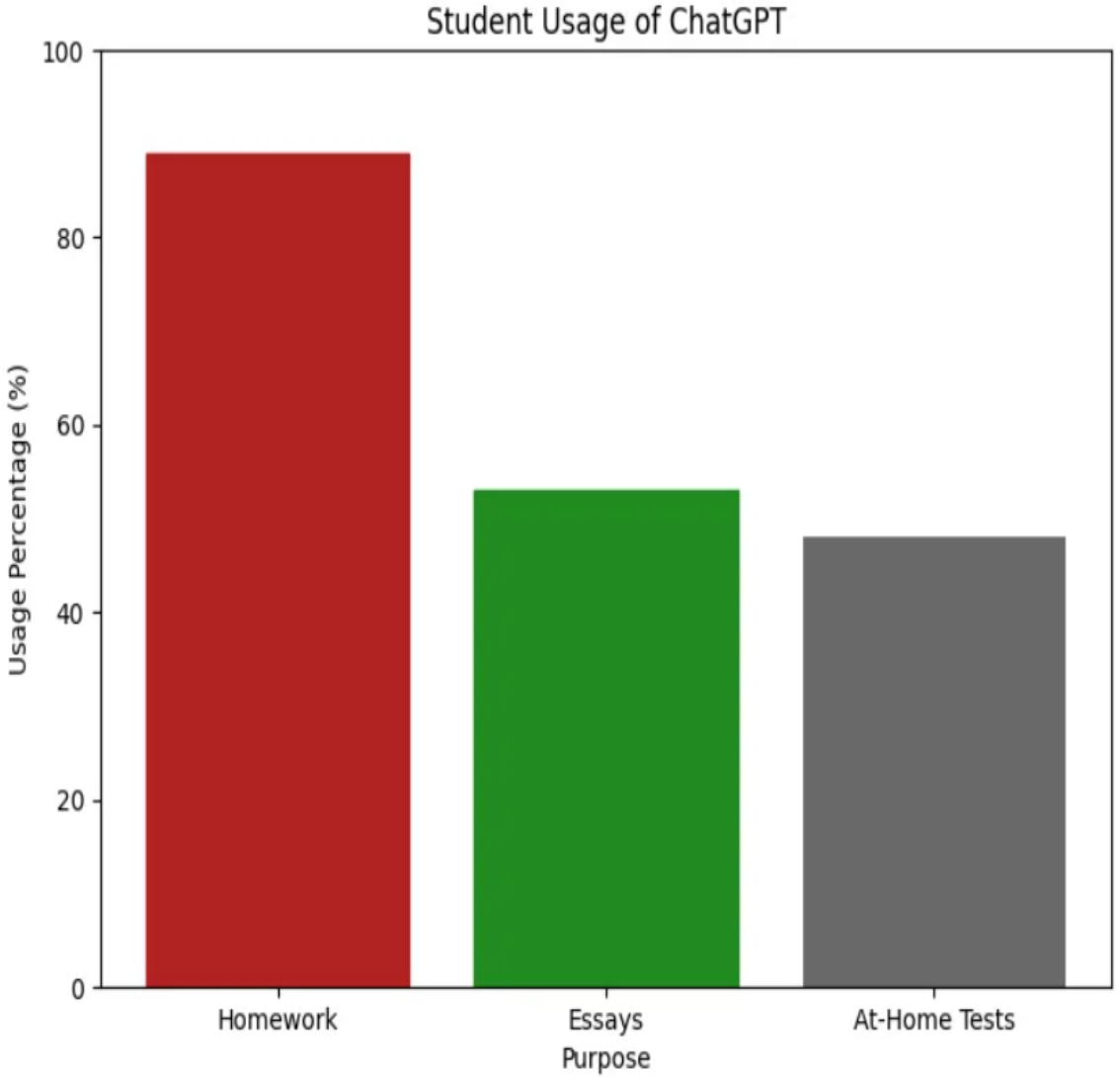
ChatGPT Cheating Statistics & Impact on Education (2024)



Which filed are used more?

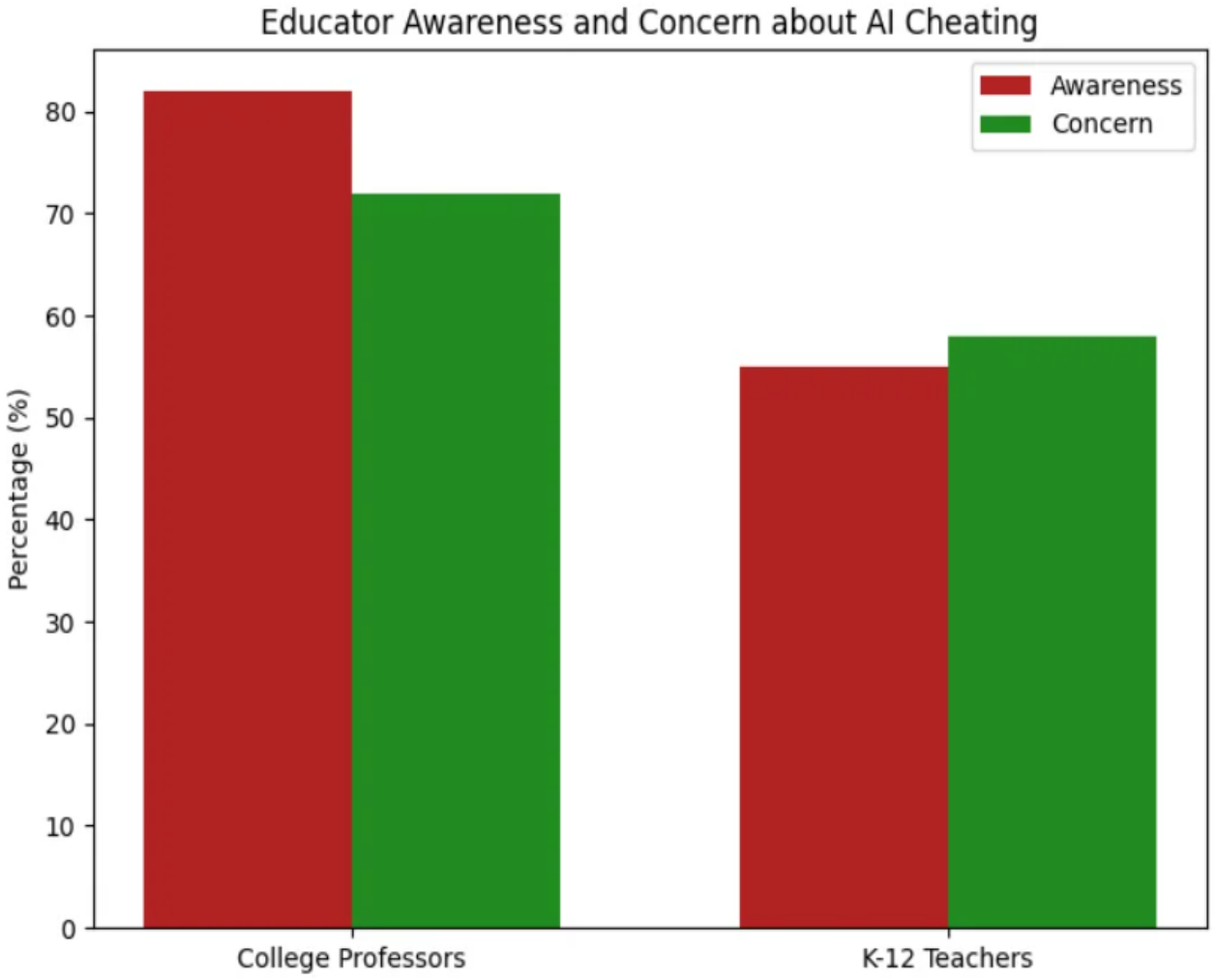


Usage Pattern?



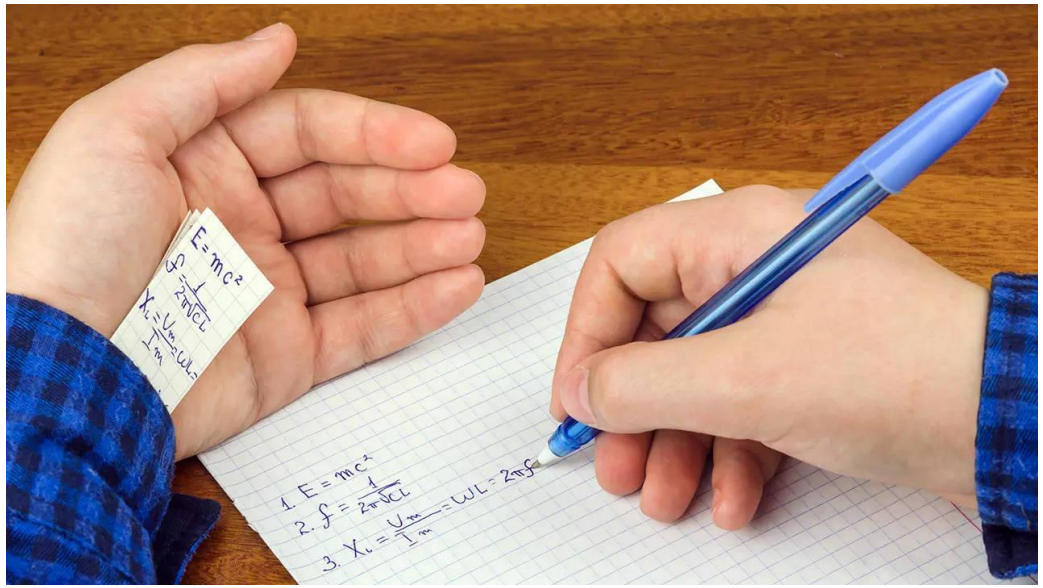
- **43%** of college students have used ChatGPT or similar AI tools.
- Of these, **89%** used it for homework, 53% for essays, and **48%** for at-home tests.
- 26% of K-12 teachers have caught a student cheating with ChatGPT.
- **50%** of teachers knew at least one student who was punished or faced negative consequences for using ChatGPT to do their assignments.

How Many Teachers Are Using ChatGPT?



- 82% of college professors are aware of ChatGPT, compared to only **55% of K-12 teachers.**
- **72% of** college professors and 58% of K-12 teachers express concern about AI's role in cheating.

Is Using ChatGPT Considered Cheating?



- **51%** of students think using ChatGPT is cheating, but **22%** still do it. (BestColleges)
- ScienceDirect suggests using ChatGPT could violate university academic dishonesty policies.
- Scribbr labels passing off AI-generated content as your work as academically dishonest.

How Many Universities Have Banned ChatGPT?

- Very few universities such a Sciences Polytechnic in Paris and RV University in Bengaluru have officially banned ChatGPT.

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Debate

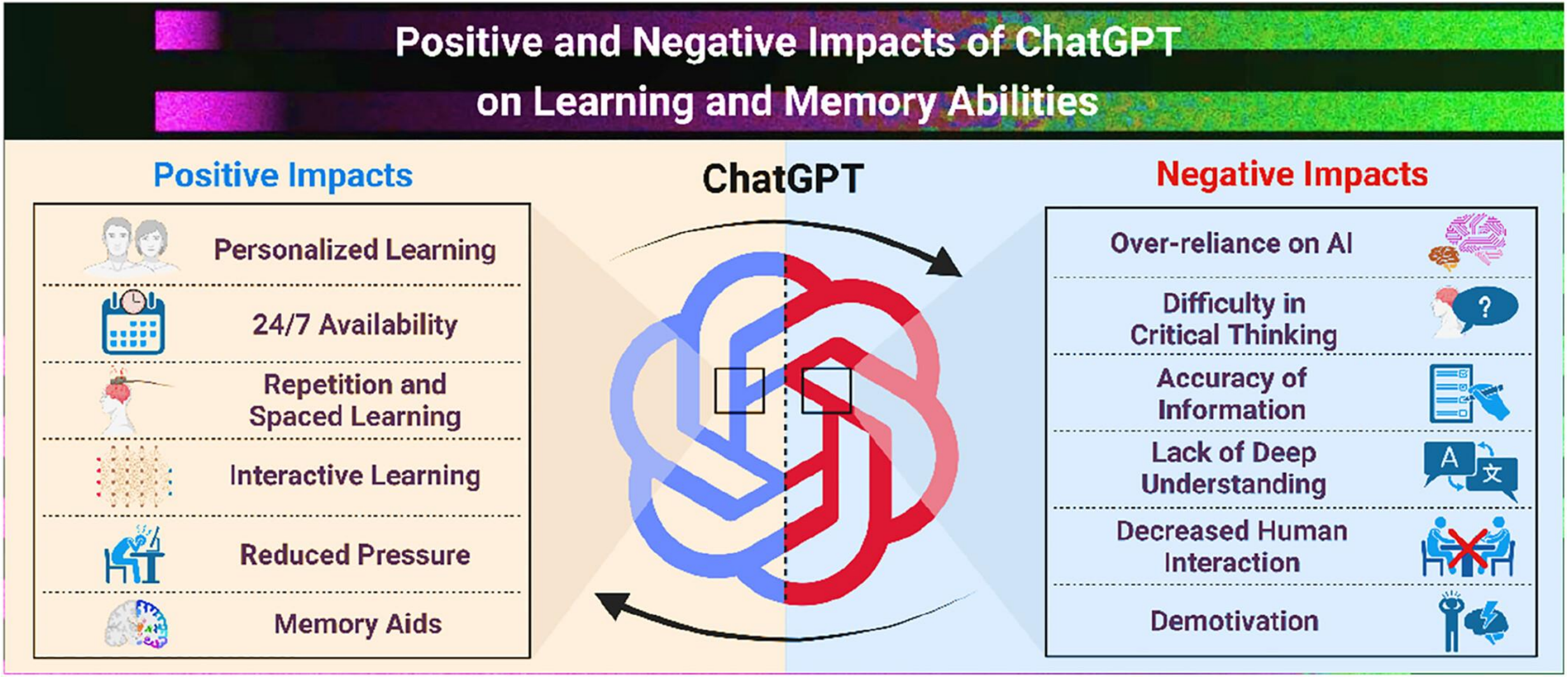
- Pessimistic view: it is dangerous and spoils education
- Optimistic view: Just relax, use and hope for the best (optimistic view)

- An important Decision:
- If we say it is bad and dangerous
  - Rule followers slow down but rule breakers speed up
    - Dystopian state : the good actor has a worse AI than bad actor

Out mission should be…

- We should work towards positive use cases
- Artificial Intelligence (AI) can be used to enhance HI (Human Intelligence), Human potential and human purpose
  - For Every Students: a personal AI tutor
  - For Every Teacher: a personal AI Teacher Assistance
  - For everyone in society: a Guidance Counselor, Academic Coach, Career Coach, Life Coach
- Enhance regulations
- Enhance AI Literacy
  - Lean how to learn with AI

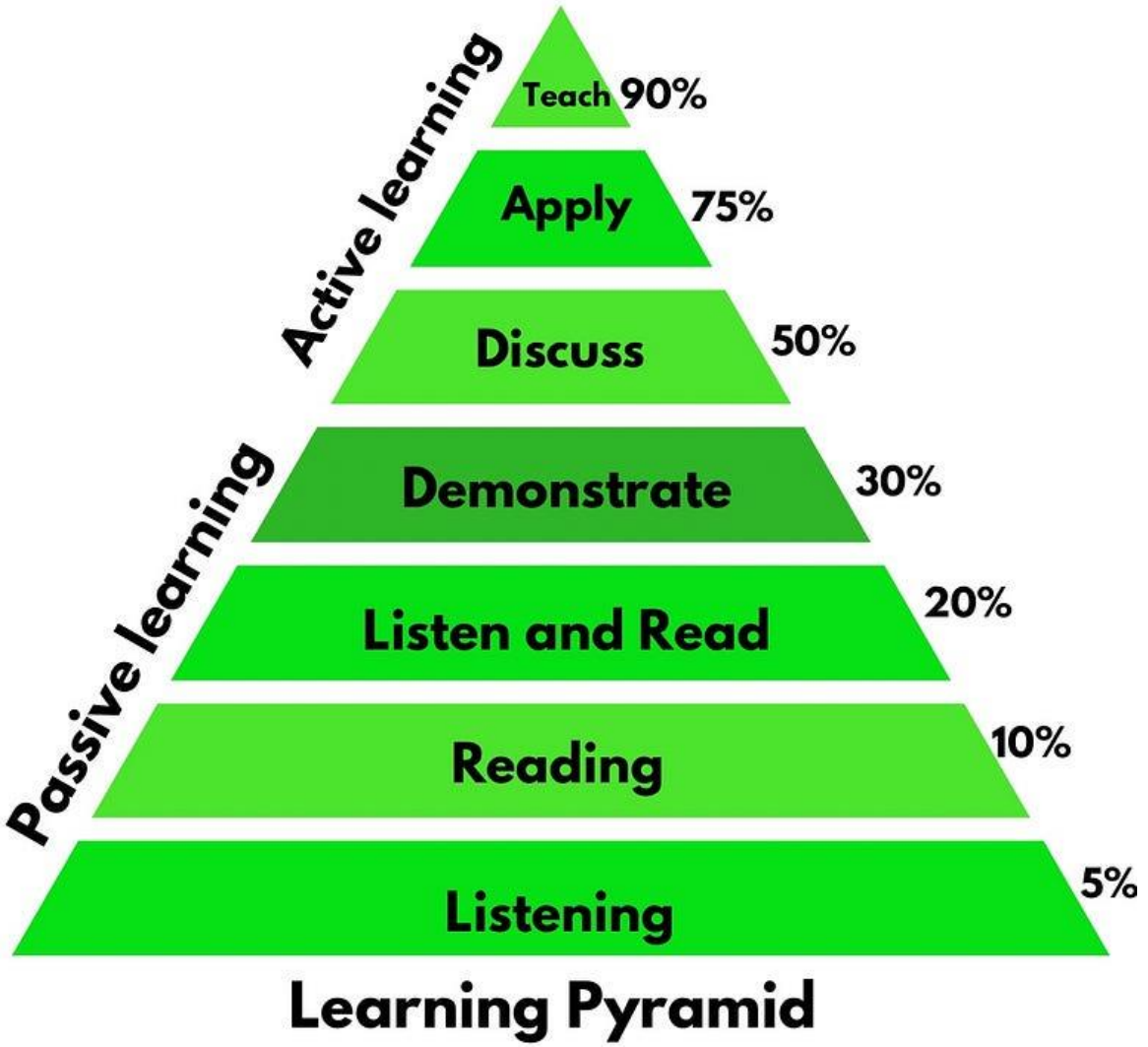
Pros and Cons



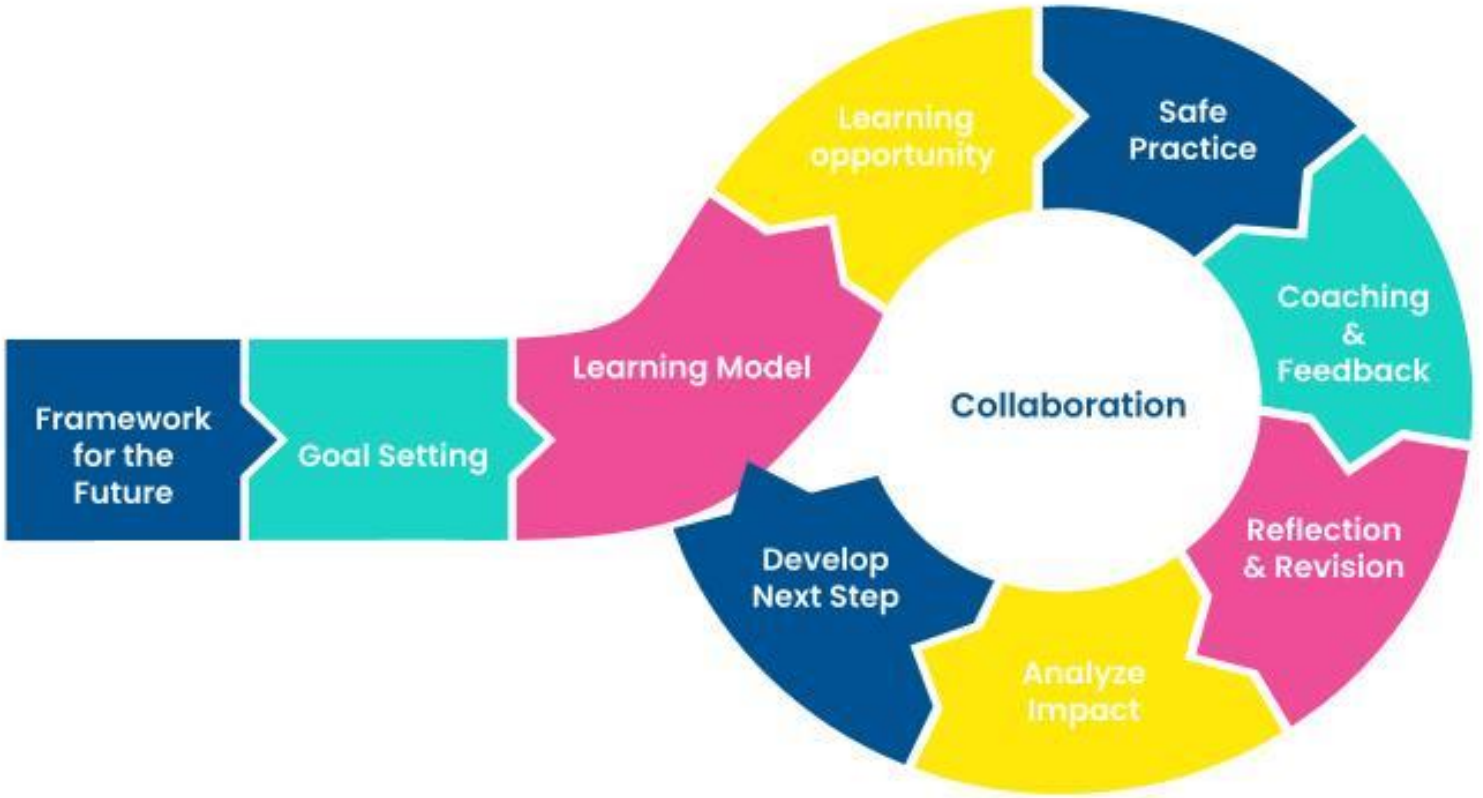
Learning Pyramid

"The mind is not a
vessel to be filled,
but a fire to be kindled"

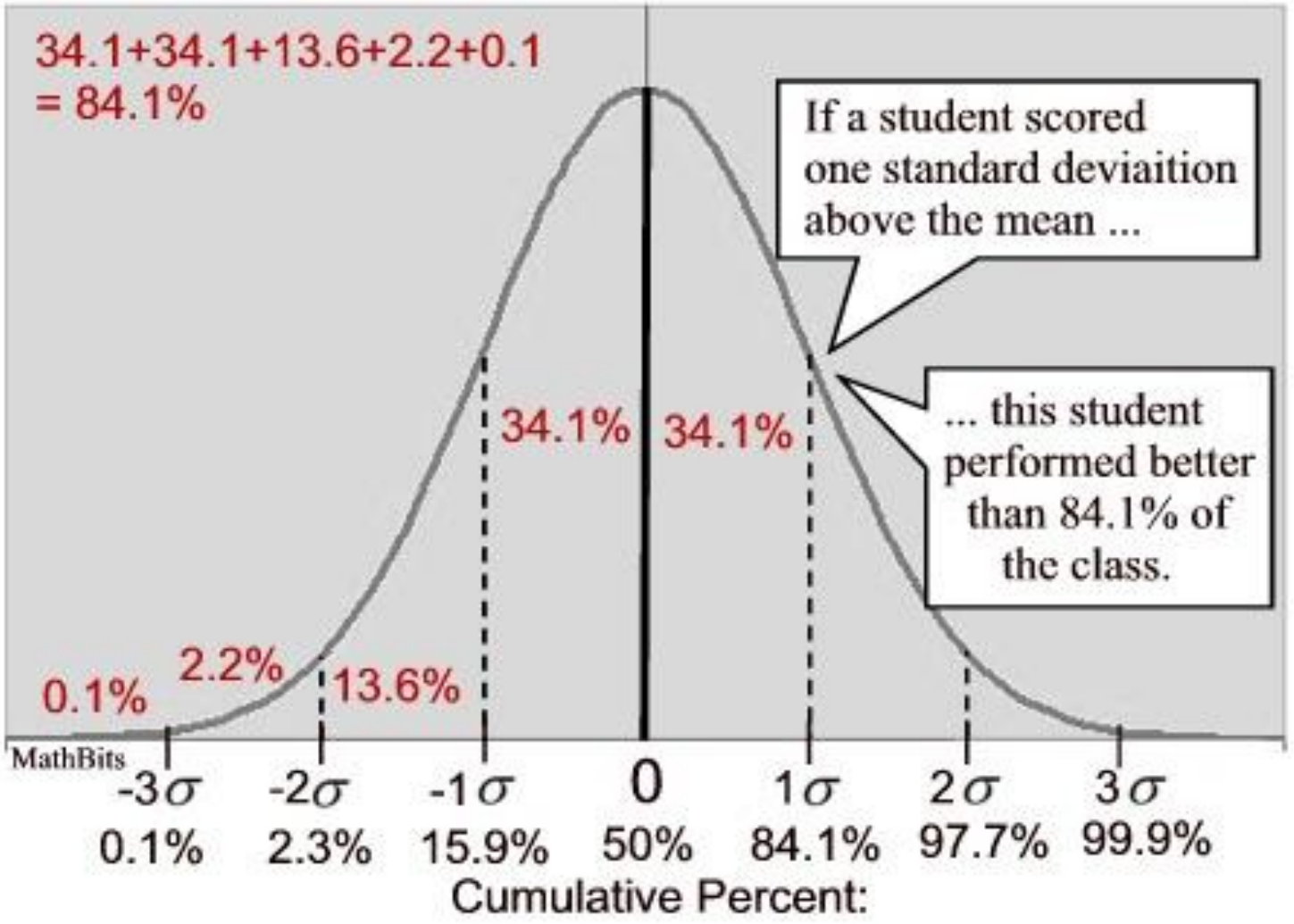
– Plutarch



Learning is a process, not an event



Percentiles and the Normal Curve



Bloom's 2 Sigma Problem

Bloom's 2 Sigma Problem (Cont.)

- **Traditional Classroom**: The peak of the curve is at the 50th percentile.
- **1 Sigma Shift**: The peak of the curve moves to the 84th percentile.
- **2 Sigma Shift**: The peak of the curve moves to the 98th percentile.

Bloom's 2 Sigma Problem

- Research by Benjamin Bloom showed that students tutored one-on-one performed two standard deviations (2 sigma) better than those in conventional classrooms.

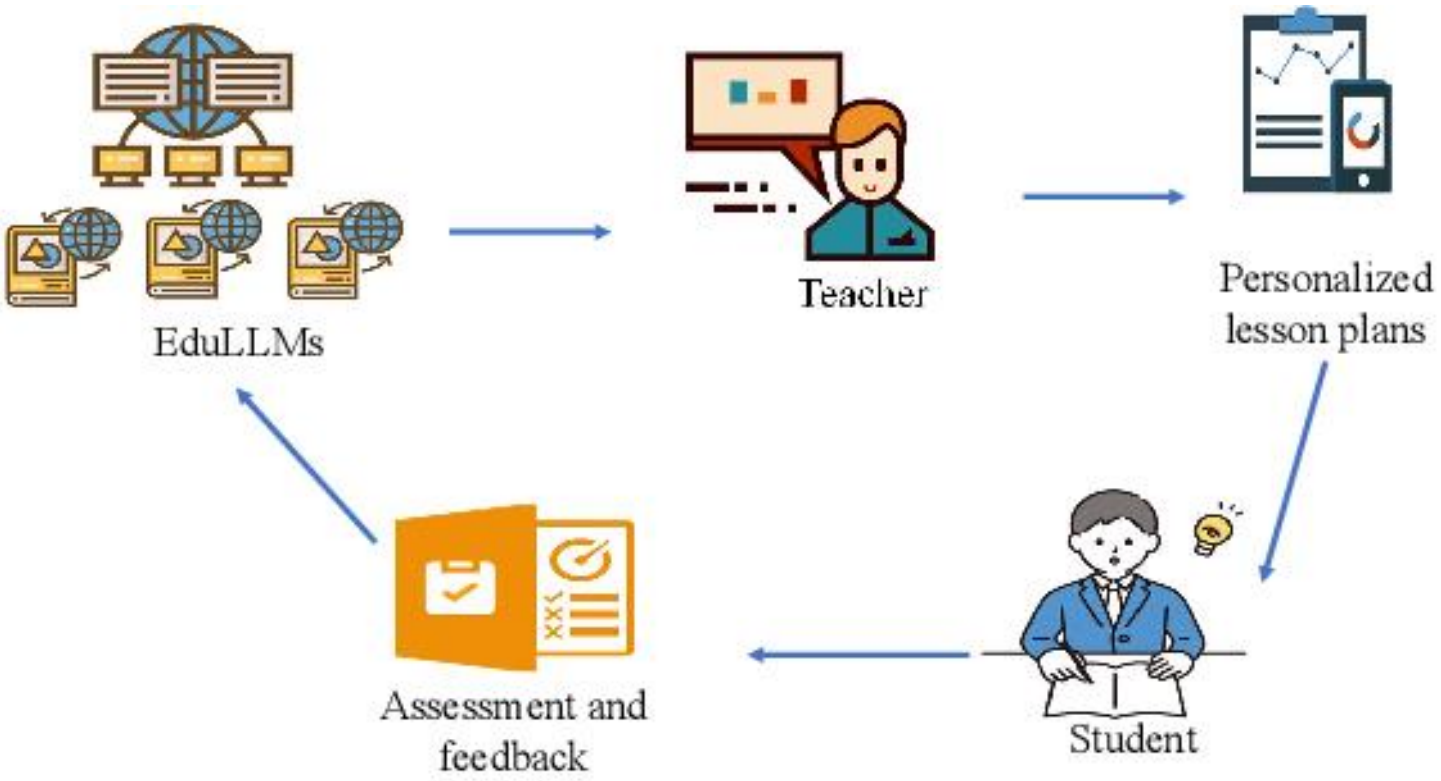
- Achieving this '2 Sigma Effect' for all students is impractical using traditional methods due to cost and scalability.

- Key Idea: AI-powered tutors can emulate personalized learning at scale, narrowing the gap between average and top-performing students.

Bloom's 2 Sigma Problem

- 1-to-1 Tutor:
  - Turn a below-average student to an above-average student
  - Turns an average student to and exceptional student
- So far, this has not been possible to do it in an economic way
  - Technology tries to make it cheaper and more fusible
  - AI and particularly Generative AI is the key enabler

LLMs for Education



AI for the students

- Don’t write for the student
  - Write with the student (e.g., each one two sentence making turns)
- Don’t solve problems for the student
  - Ask questions and give feedback and help the student to go through the process of learning
- AI intervention in the learning process not in the generating results

AI for Teachers

- Problem Solver Assistant
- Help about how to teach a content
- Design Lesson plan
- Give grades quickly
- Provide personalized feedback for homework and assessment

AI in education

Task	Best Fit	Why?	Commercial Applications
Automated grading of handwritten assignments or diagrams	CNNs	Faster and more efficient for image tasks.	**Gradescope**: Automates grading of handwritten answers.
Adaptive learning systems	RNNs	Analyzes sequential data for personalized learning.	**DreamBox Learning**: Provides adaptive math tutoring.
Speech-to-text applications	RNNs/LLMs	Handles audio transcription effectively.	**Otter.ai**: Transcribes classroom lectures and meetings.

AI in education

Creating synthetic datasets	GANs	Generates realistic datasets for research.	**Synthesis AI:** Creates synthetic data for simulations.
Gamified educational content	GANs	Adapts visuals dynamically for engagement.	**Kahoot!**: Uses AI for interactive learning games.
Detecting anomalies in performance	Autoencoders	Identifies students needing extra support.	**Civitas Learning:** Flags at-risk students for educators.

AI in education

Compressing large datasets	Autoencoders	Efficient data storage and processing.	Internal use by e-learning platforms (e.g., Coursera).
Classroom engagement tracking	Vision Transformers	Analyzes student focus from video data.	**Merlyn Mind:** AI assistant tracking student engagement.
Intelligent tutoring systems	DRL	Adjusts dynamically based on performance.	**ALEKS:** Provides adaptive math and science tutoring.
Optimizing schedules for teachers	DRL	Efficient resource allocation in schools.	**Edval Timetables:** Uses AI to optimize school schedules.

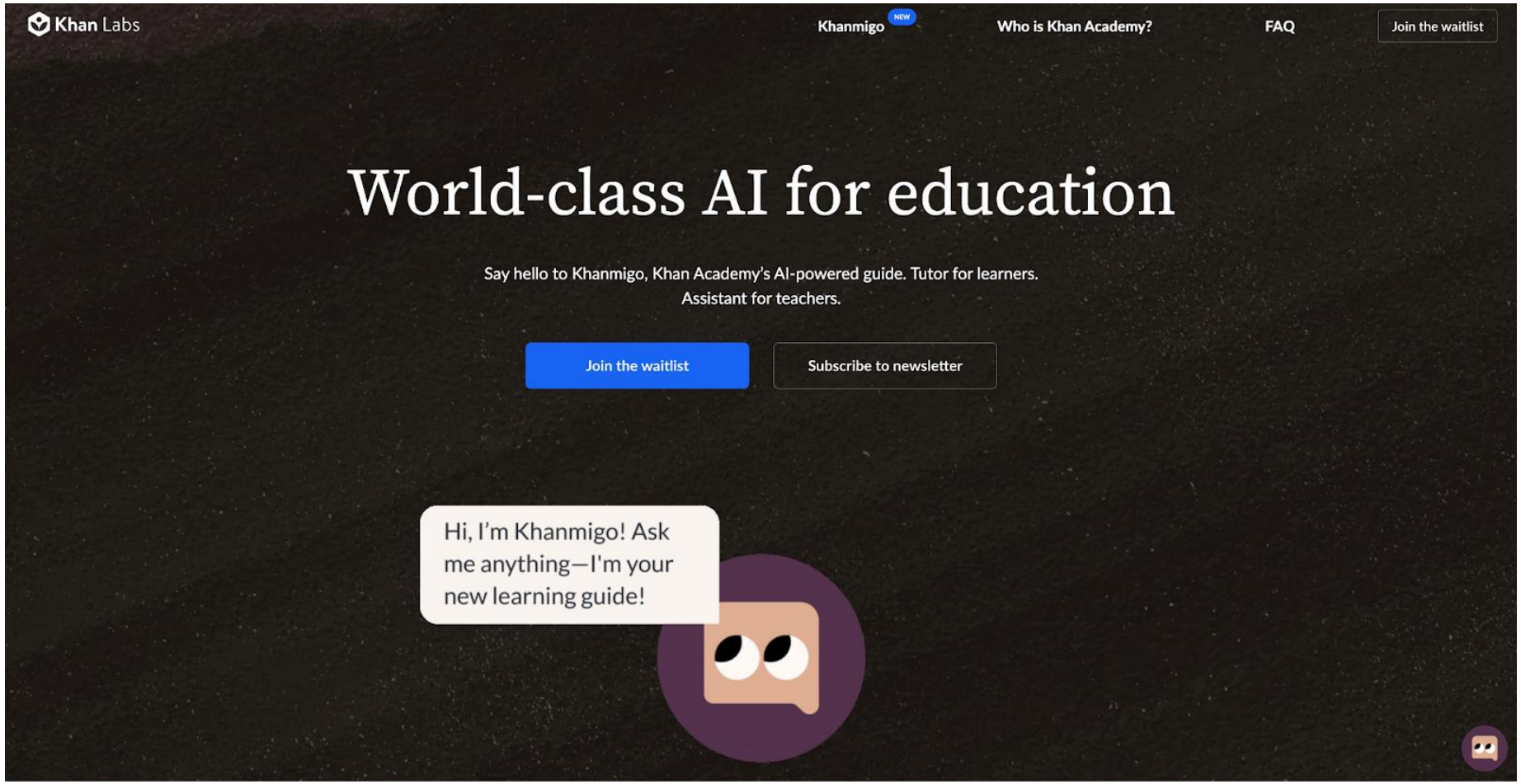
AI in education

Recommendation systems for resources	GNNs	Maps relationships to suggest content.	**Coursera:** Suggests relevant courses based on learning paths.
Mapping knowledge gaps	GNNs	Builds and analyzes student knowledge graphs.	**Knewton:** Recommends personalized next learning steps.
Verifying student identities	Siamese Networks	Compares and matches for identity validation.	**Proctorio:** Verifies student identity during exams.
Identifying plagiarized content	Siamese Networks	Detects content similarity in assignments.	**Turnitin:** Compares essays to detect plagiarism.

LLMs or other ML models

Task	Best Fit	Why?
Essay grading and feedback	LLMs	Natural language understanding is their strength.
Personalized learning paths	LLMs + DRL	LLMs for content generation, DRL for adaptation.
Handwritten text recognition	CNNs	Faster and more efficient for image tasks.
Accessibility (speech-to-text)	RNNs/LLMs	Both can work; RNNs may be simpler for this task.
Interactive AR/VR content	CNNs + GANs	Specialized for generating and processing visuals.
Student performance prediction	RNNs/GNNs	Time-series and graph relationships are key.
Classroom engagement tracking	CNNs/Transformers	Video analysis benefits from CNN efficiency.

Khanmigo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AI-Driven Assessment

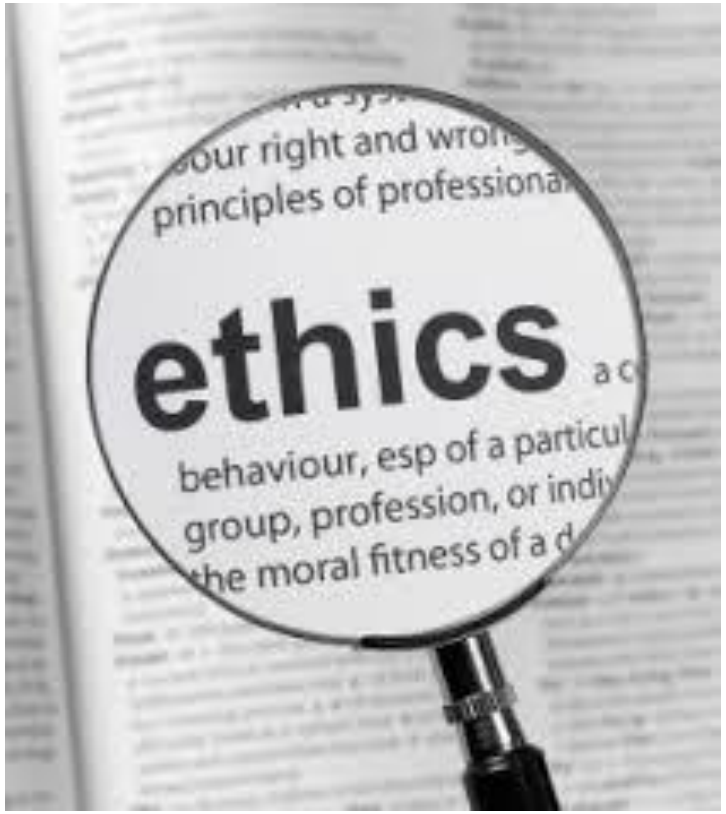
- These AI-driven approaches can enhance the reliability, efficiency, and fairness of assessments in education.
- Automated Grading:
  - AI can grade objective-type questions like multiple-choice or true/false instantly, allowing for quicker results.
- Adaptive Testing:
  - AI can adjust the difficulty of questions in real-time based on the student's performance, making tests more personalized and fair.
- Fraud Detection:
  - AI algorithms can monitor test-taking patterns to detect and prevent cheating or plagiarism.

AI-Driven Assessment (Cont.)

- Data Analysis:
  - AI can analyze test results to identify trends, helping educators understand which areas students struggle with and tailor their teaching accordingly.
- Language Support:
  - For language exams, AI can evaluate speaking and writing more consistently than human graders, providing unbiased assessments.
- Simulation-Based Assessment:
  - AI can create realistic simulations or virtual environments for students to interact with, providing a more practical assessment of skills.

Ethics

- Using AI or ani-plagiarism tools to hide plagiarism (Circumvention)!



Ethics (Cont.)

- Amalgam of hard and soft techniques/incentives
- Education and Awareness:
  - Educate students about the ethical use of AI and the importance of academic integrity. This includes understanding the consequences of unethical behavior.
- Ethical AI Design:
  - Develop AI tools with built-in ethical guidelines and features that discourage misuse. For example, AI systems can be designed to flag potential unethical behavior.
- Policy Frameworks:
  - Implement strong policy frameworks that clearly outline acceptable uses of AI in education. This includes defining what constitutes ethical and unethical use of AI tools.

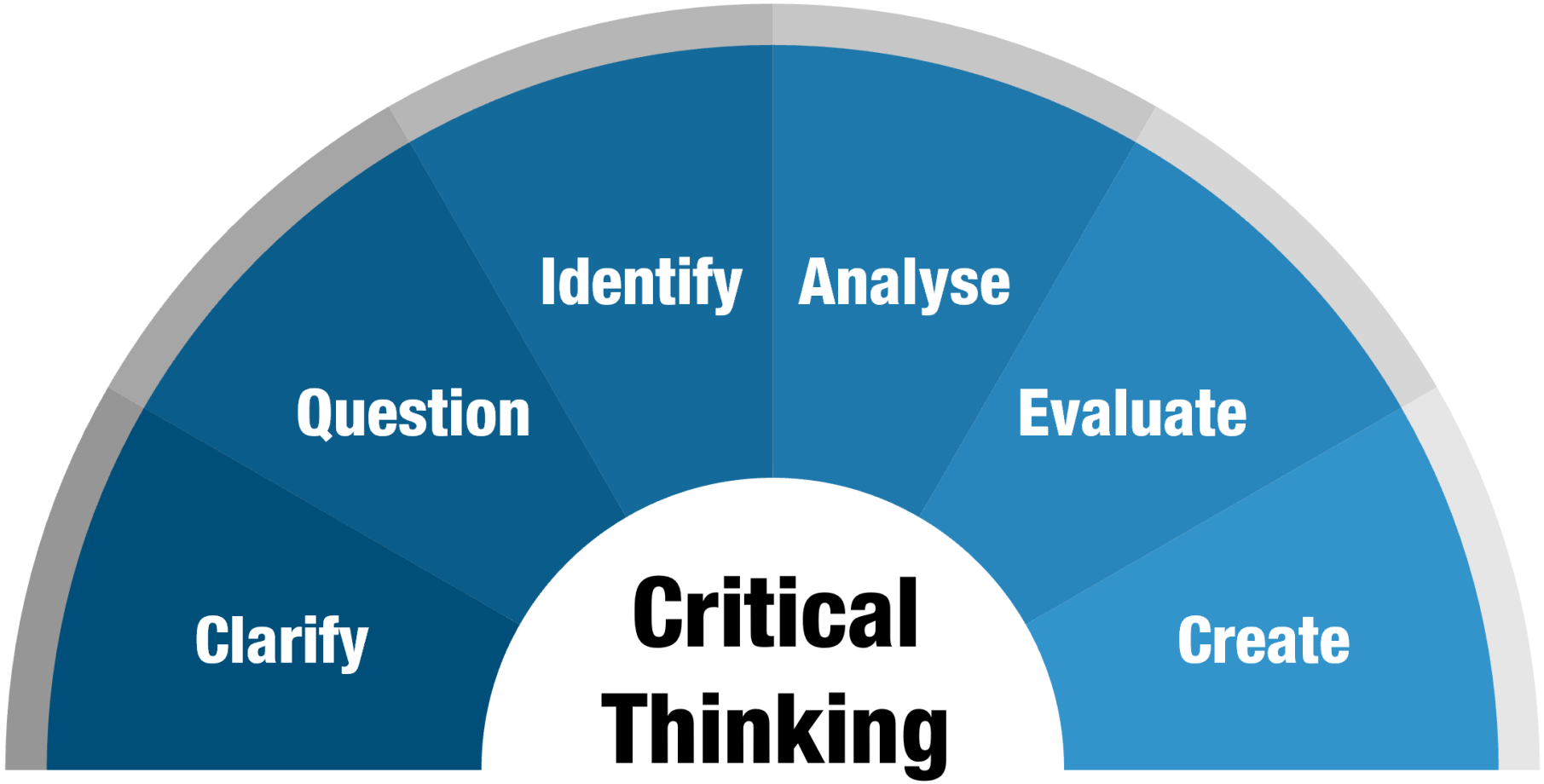
Challenges and Ethical Concerns

- Over-Reliance: Risk of skipping foundational learning.
- Bias in Recommendations: Narrow topic suggestions.
- Privacy Concerns: Sensitive data risks.
- Inequity: Limited access to AI tools in under-resourced areas.

Responsible Use of AI

- Combine AI with human oversight to foster critical thinking.
- Example: Use ChatGPT for guidance but validate solutions independently.
- **AI must complement effort, not replace it.**
- While AI can approximate the 2 Sigma Effect, it requires active participation from students and educators.
- Pairing AI with teacher oversight ensures deeper understanding and accountability.

LLMs and Critical Thinking?



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It is an important issue

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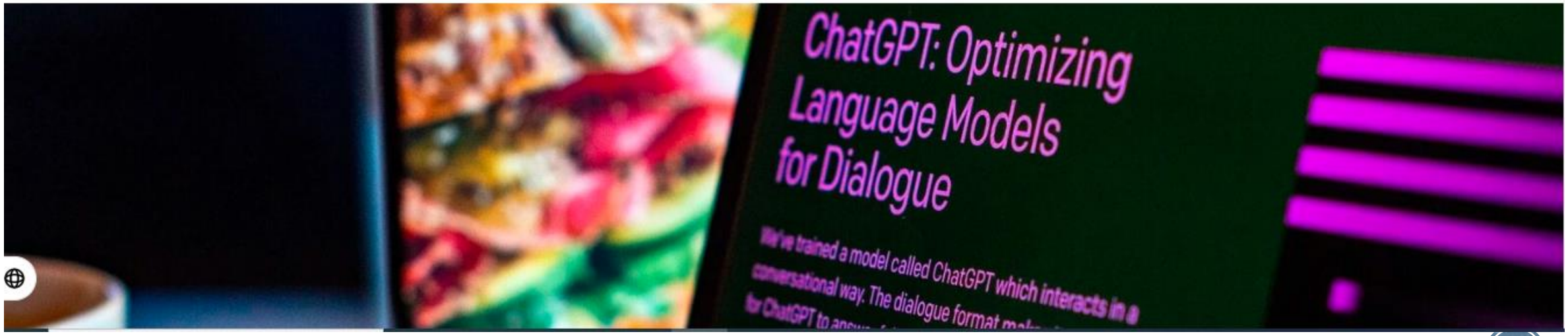
EDUCATION AND SKILLS

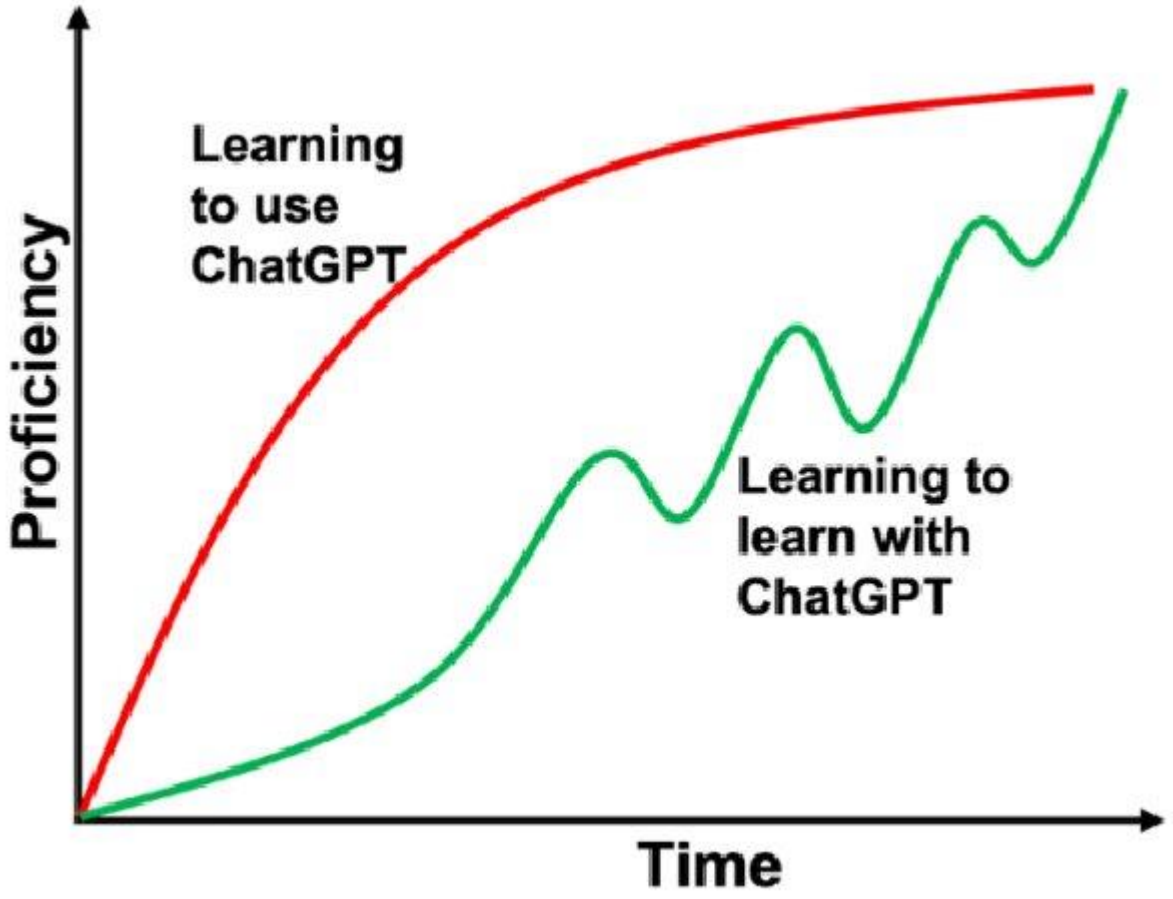
AI and education: Kids need AI guidance in school. But who guides the schools?

Jan 18, 2024

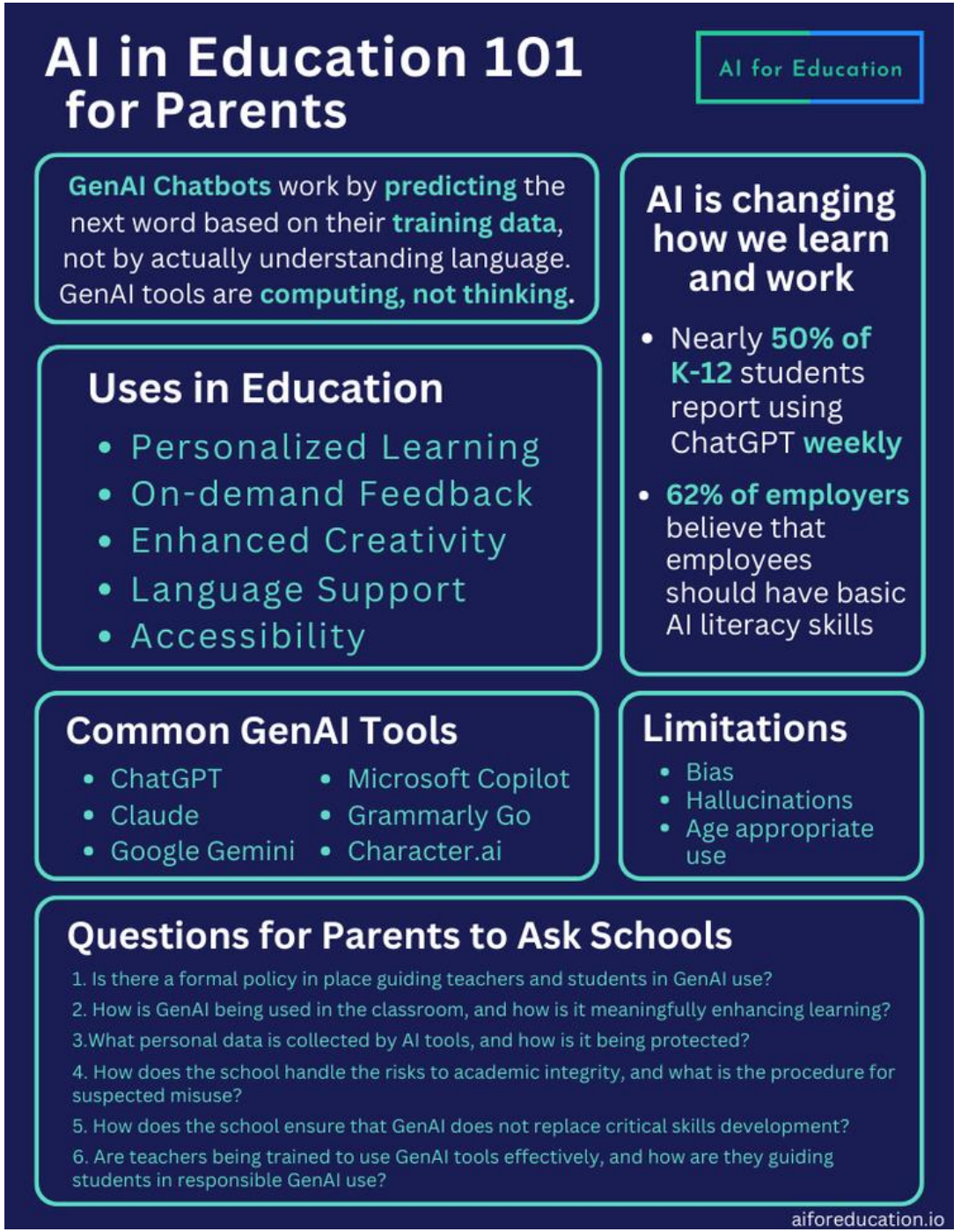


Learning to Learn with AI

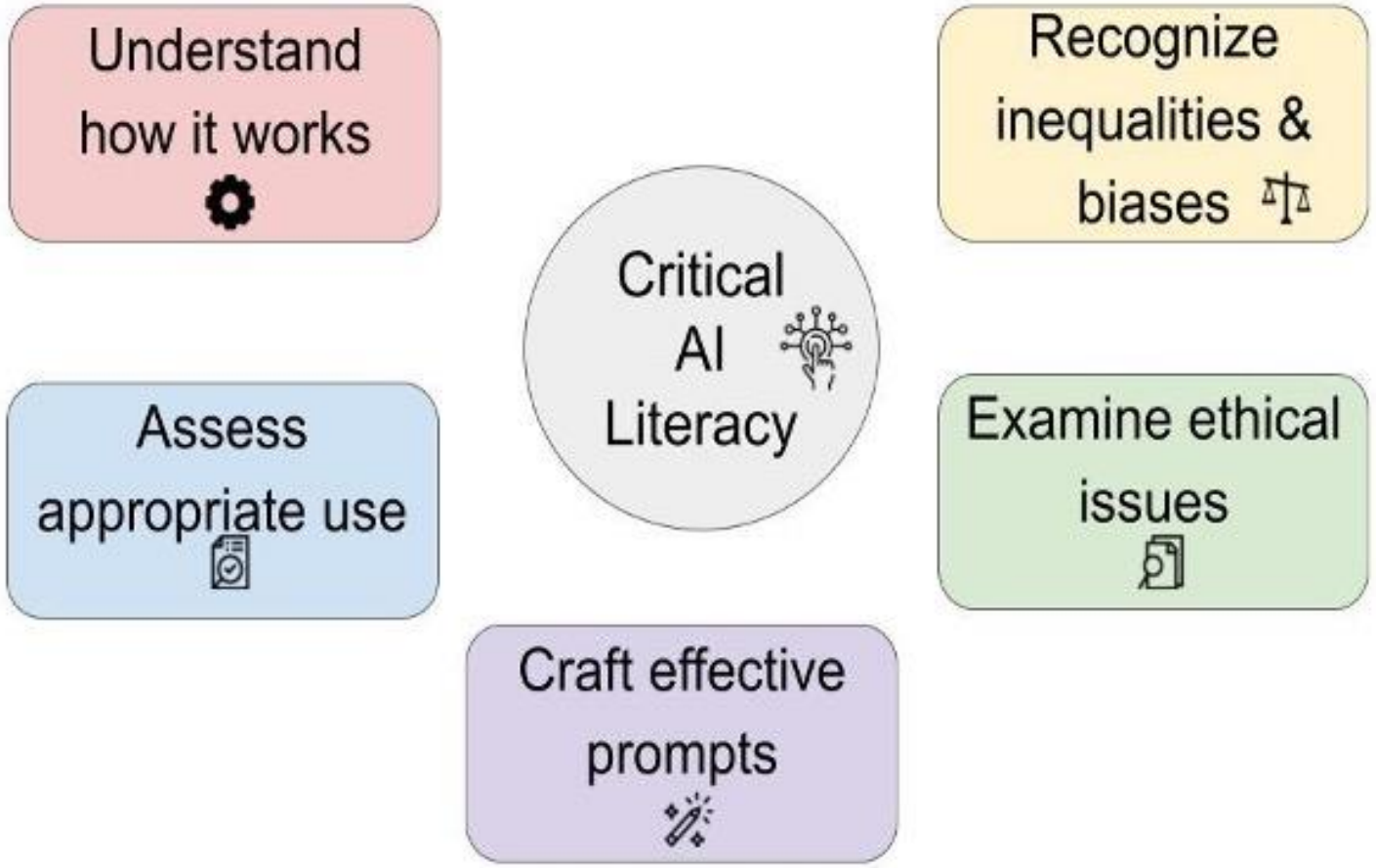
How to use AI as a personal tutor



Awareness


AI in Education 101 for Parents
AI for Education
GenAI Chatbots work by predicting the next word based on their training data, not by actually understanding language. GenAI tools are computing, not thinking.
Uses in Education
Personalized Learning
On-demand Feedback
Enhanced Creativity
Language Support
Accessibility
AI is changing how we learn and work
Nearly 50% of K-12 students report using ChatGPT weekly
62% of employers believe that employees should have basic AI literacy skills
Common GenAI Tools
ChatGPT
Claude
Google Gemini
Microsoft Copilot
Grammarly Go
Character.ai
Limitations
Bias
Hallucinations
Age appropriate use
Questions for Parents to Ask Schools
1. Is there a formal policy in place guiding teachers and students in GenAI use?
2. How is GenAI being used in the classroom, and how is it meaningfully enhancing learning?
3.What personal data is collected by AI tools, and how is it being protected?
4. How does the school handle the risks to academic integrity, and what is the procedure for suspected misuse?
5. How does the school ensure that GenAI does not replace critical skills development?
6. Are teachers being trained to use GenAI tools effectively, and how are they guiding students in responsible GenAI use?
aiforeducation.io

AI Literacy


Understand how it works
Recognize inequalities & biases
Critical AI Literacy
Assess appropriate use
Examine ethical issues
Craft effective prompts

Outline

- Introduction to Generative AI and LLMs
- statistics on AI usages
- How AI can improve education performance?
- AI Literacy
- Conclusion

Conclusion

- AI, when used responsibly, can guide students to master concepts independently.
- Focus on understanding and critical thinking, not just finding answers.
- Empower lifelong learners with the right balance of AI and effort.
  - For Every Students: a personal AI tutor
  - For Every Teacher: a personal AI Teacher Assistance
  - For everyone in society: a Guidance Counselor, Academic Coach, Career Coach, Life Coach
- Government and education sector should promote awareness about how to use AI in different aspects of life

یاد گرفتن چگونگی استفاده از هوش مصنوعی برای تحصیل خود نیاز به آموزش دارد