آموزش ریاضی در عصر هوش مصنوعی

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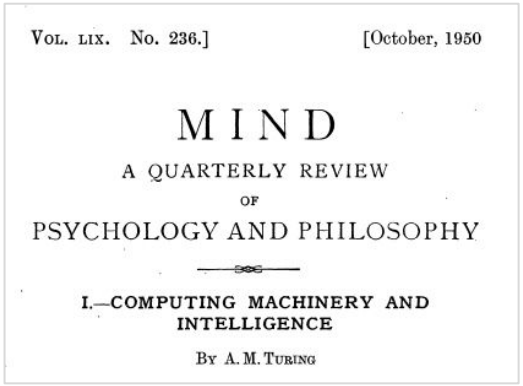
Age of Artificial Intelligence

- AI is the new electricity, 100 years ago electricity became a ubiquitous utility that transformed various aspects of life, from powering homes and industries to enabling new inventions and technologies.
- AI is on a similar trajectory, with its applications expanding across multiple domains, including education, healthcare, transportation, finance, entertainment, and more.
- AI is indeed considered a general-purpose technology, and it has the potential to bring about significant and wide-ranging transformations across various sectors.

Birth of AI



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MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

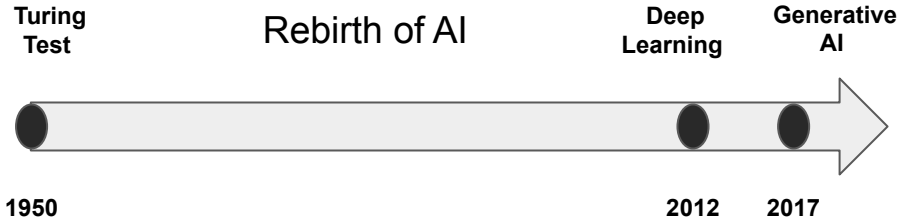
Birth of Artificial Intelligence - Alan Turing 1950

"Can a machine think?"

"Turing Test"

McCarthy-Minsky - 1956

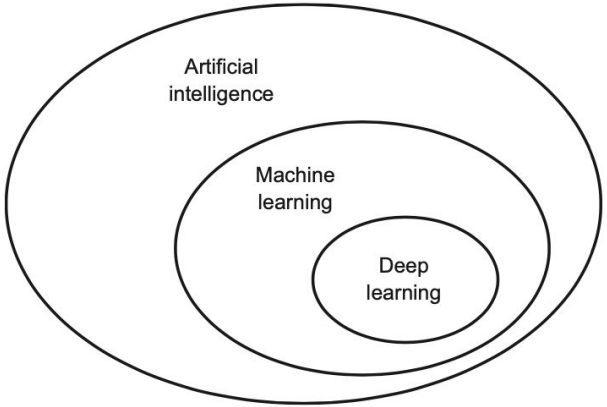
Dartmouth Summer Research Project on Artificial Intelligence



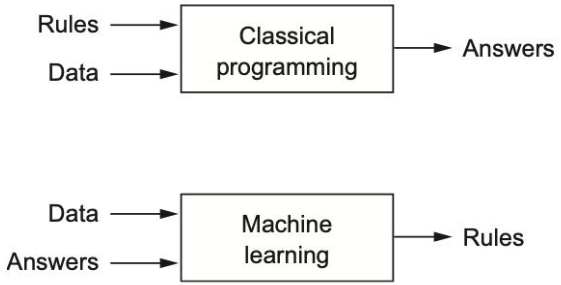
'AI Winter'

During the '80s and '90s, AI was too inflexible to pass the Turing test. Because the applications of such brittle systems were limited, R&D funding declined, and progress slowed.

AI Paradigm



Deep Learning is in the core



Machine Learning as a new programming paradigm

Attention Is All You Need

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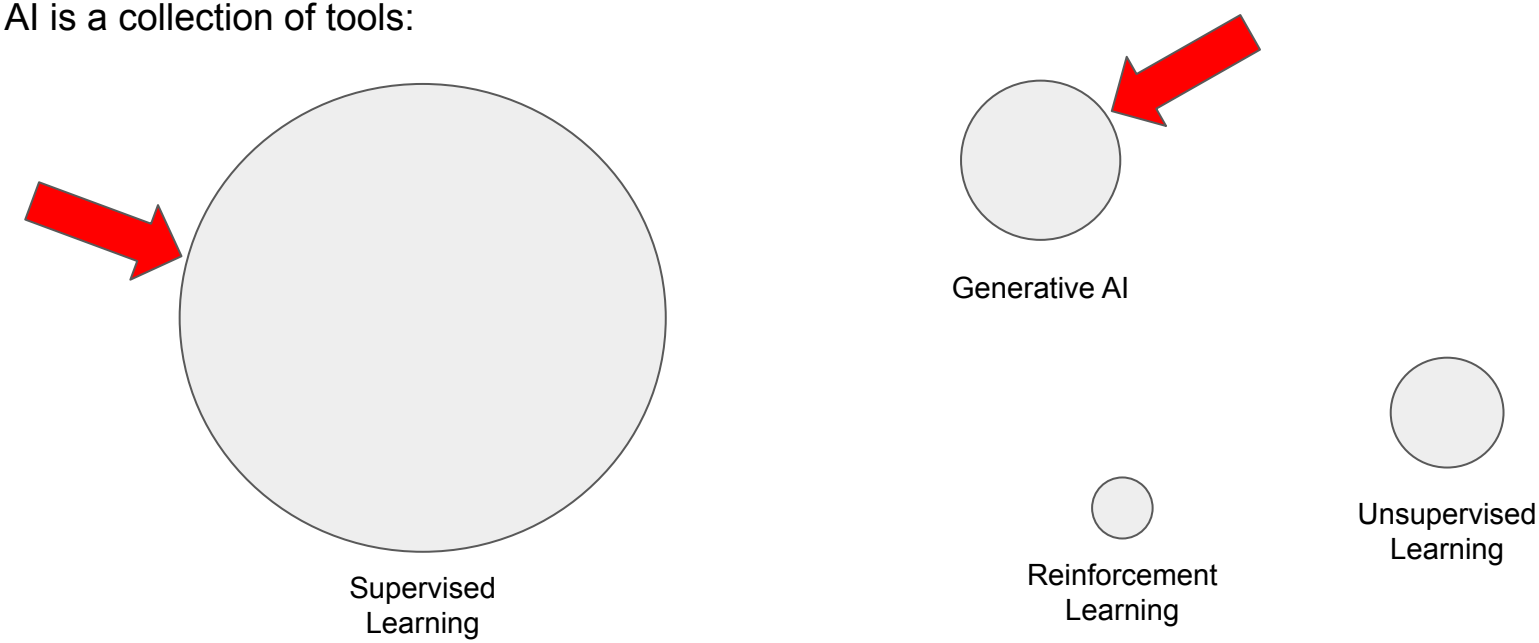
Abstract

The dominant sequence transduction models are based on complex recurrent or convolutional neural networks that include an encoder and a decoder. The best performing models also connect the encoder and decoder through an attention mechanism. We propose a new simple network architecture, the Transformer, based solely on attention mechanisms, dispensing with recurrence and convolutions entirely. Experiments on two machine translation tasks show these models to be superior in quality while being more parallelizable and requiring significantly less time to train. Our model achieves 28.4 BLEU on the WMT 2014 English-to-German translation task, improving over the existing best results, including ensembles, by over 2 BLEU. On the WMT 2014 English-to-French translation task, our model establishes a new single-model state-of-the-art BLEU score of 41.0 after training for 3.5 days on eight GPUs, a small fraction of the training costs of the best models from the literature.

AI Landscape

AI is a collection of tools:



Trends

- Last decade, 2010 - 2020
  - Large scale supervised learning
    - Small AI Models
    - Large AI Models
- Current decade, 2020 - 2030
  - Supervised learning
  - Generative AI, Large Language Models

- Large language models are a type of artificial intelligence (AI) technology that has been developed to understand and generate human language.

LLM Key Characteristics

- **Scale:** Large language models are extremely large in terms of the number of parameters in their neural networks. They can have tens or even hundreds of billions of parameters. This scale allows them to capture and generate complex patterns in language.
- **Pretrained on Massive Text Corpora:** Before they are fine-tuned for specific tasks, large language models are pretrained on massive text corpora from the internet. During this phase, the model learns grammar, syntax, world knowledge, and many other aspects of language.
- **Fine-Tuning:** After the initial pretraining, these models can be fine-tuned on smaller, domain-specific datasets for a wide range of natural language processing (NLP) tasks. This fine-tuning process makes them adaptable to various applications, including language translation, text generation, question-answering, and more.
- **Natural Language Understanding and Generation:** Large language models are capable of understanding and generating human language in a way that is contextually coherent and semantically meaningful. They can generate text, answer questions, complete sentences, and perform other language-related tasks.
- **Applications:** These models have found applications in a wide range of fields, including chatbots, virtual assistants, content generation, language translation, sentiment analysis, and even scientific research.

AI Opportunities

- Value from AI technologies: Today ⟶ 3 years
  - Millions of developers building supervised learning applications: Double in three years
  - Generative AI: Much more than double in the next three years
    - More interest by developers
    - More interest by investors
    - Exploring more applications
- AI technologies are general purpose technologies
  - Supervised learning applications will continue in the next decade as well
  - Same kicking off for generative AI

General Purpose Technologies

- General purpose technologies are useful for many tasks
  - Massive value remains to be created using supervised learning
  - Generative AI is another major tool, creating even more opportunities
- There will be fads along the way
  - Focus on long term businesses creating sustainable value
  - AI and generative AI tools for really deep, really hard applications that create very long term value
  - Opportunity is to find very diverse use cases and to build them

Enabler Technology

- The enabler technology broadly is data-centric AI:
    - Prompting, text or visual prompting
    - Large Language Models and similar tools
- Key part is taking the value of AI
    - So far very concentrated in the tech and consumer software industries
    - Pushing this out to all industries, much bigger economy than tech world

Math Education-1

Artificial Intelligence (AI) and Generative AI can offer several ways to enhance the learning of mathematics:

- **Personalized Learning Paths:** AI can analyze a student's strengths and weaknesses, learning pace, and preferences to create a customized learning path. This ensures that students are focusing on the areas where they need the most help.
- **Adaptive Learning:** AI systems can adapt to the difficulty of math problems in real time based on a student's performance. This keeps students challenged without overwhelming them.
- **Immediate Feedback:** AI can provide instant feedback on math exercises, helping students correct mistakes and understand concepts more thoroughly. This speeds up the learning process.
- **Visualizations and Simulations:** Generative AI can create interactive visualizations and simulations to make abstract math concepts more tangible. For example, it can help students understand geometric transformations or calculus concepts through interactive graphics.

Math Education-2

- **Conversational Agents:** AI-powered chatbots and virtual tutors can answer students' questions and engage in interactive math conversations. They can explain concepts, solve problems, and provide assistance whenever needed.
- **Gamification:** AI can introduce gamification elements to math learning, making it more engaging and fun. Math games and challenges can motivate students to practice and learn math concepts in an enjoyable way.
- **Content Generation:** AI can generate math problems, worksheets, and exercises, ensuring a constant supply of practice material. This is useful for both students and teachers who want a variety of problems for practice.
- **Data-Driven Insights:** AI can analyze data on students' performance to identify patterns and trends. Educators can use this data to make data-driven decisions, offer targeted interventions, and refine teaching strategies.

Math Education-3

- **Accessibility:** AI can provide accessibility features such as text-to-speech and speech-to-text to support students with disabilities or language barriers in learning mathematics.
- **Exploration and Experimentation:** Generative AI can assist students in exploring mathematical concepts by generating hypotheses, conducting simulations, and exploring mathematical relationships.
- **Research Assistance:** AI can help researchers and advanced students in mathematical research by generating conjectures, and proofs, and exploring mathematical theories.
- **Real-World Applications:** AI can generate math problems and scenarios based on real-world applications, helping students see the practical relevance of mathematics in various fields like physics, engineering, economics, and more.
- **24/7 Availability:** AI-powered learning platforms are available 24/7, allowing students to learn at their own pace and schedule, which can be especially beneficial for remote or asynchronous learning.

Creativity-1

Artificial intelligence (AI) and generative AI have the potential to enhance creativity in K-12 education in several ways:

Personalized Learning: AI can analyze students' learning patterns, strengths, and weaknesses to tailor educational content and activities to their individual needs. This personalization allows students to explore topics they are passionate about, fostering creativity and self-directed learning.

Creative Content Generation: Generative AI can help students generate creative content such as stories, poems, or artwork. For instance, AI-powered writing assistants can suggest ideas, sentence structures, and vocabulary, encouraging students to experiment and refine their writing skills.

Adaptive Feedback: AI-driven assessment tools can provide immediate feedback on assignments and projects, helping students understand where they can improve their creative work. This feedback loop can promote iterative thinking and the development of creative problem-solving skills.

Creativity-2

Collaboration and Communication: AI-powered chatbots and virtual assistants can facilitate collaboration among students by helping them schedule meetings, share resources, or brainstorm ideas. These tools can also improve communication skills by providing language correction and suggestions.

Exploration of Diverse Perspectives: AI can recommend a wide range of learning materials and resources, introducing students to diverse perspectives, cultures, and ideas. Exposure to different viewpoints can stimulate creativity by broadening students' horizons.

Data-Driven Insights: AI can analyze data from various sources, including student assessments and engagement metrics, to identify trends and patterns. Teachers can use these insights to tailor their teaching methods and strategies to better nurture creativity in their students.

Augmented Reality (AR) and Virtual Reality (VR): AR and VR technologies, driven by AI, can immerse students in creative and interactive learning environments. These technologies enable students to explore historical settings, simulate scientific experiments, and engage in hands-on, creative activities.

Creativity-3

Natural Language Processing (NLP): NLP technologies can facilitate creative writing exercises by providing students with prompts, suggesting synonyms and antonyms, and offering grammar and style recommendations. This can boost students' confidence and fluency in expressing their ideas.

Problem Solving and Critical Thinking: AI can be integrated into the curriculum to present students with real-world problems that require creative solutions. Machine learning algorithms can simulate complex scenarios, encouraging students to think critically and creatively to solve these challenges.

Professional Development for Educators: AI can support educators by offering insights into teaching methods that encourage creativity and adapt to students' needs. Continuous professional development through AI-driven tools can help teachers stay innovative in their approaches.

Accessibility and Inclusivity: AI-driven accessibility tools can assist students with disabilities, making it easier for them to participate in creative activities. This inclusivity can unlock the creative potential of a wider range of students.

AI in Education

Incorporating AI and Generative AI into math education can create a more personalized, engaging, and effective learning experience. It can help students grasp complex concepts, practice math skills, receive timely feedback, and ultimately develop a deeper understanding of mathematics. Moreover, AI can assist educators in providing individualized support and continuously improving their teaching methods.

However, it's important to approach the integration of AI in K-12 education thoughtfully. Educators and policymakers should consider ethical, privacy, and security concerns, as well as ensure that the technology enhances, rather than replaces, the role of teachers in fostering creativity and critical thinking in students. Balancing technology with the human touch is crucial for a successful creative educational experience.

Outlook

Projects:

- AI in math education
- AI to support creativity
- Learning AI

References:

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