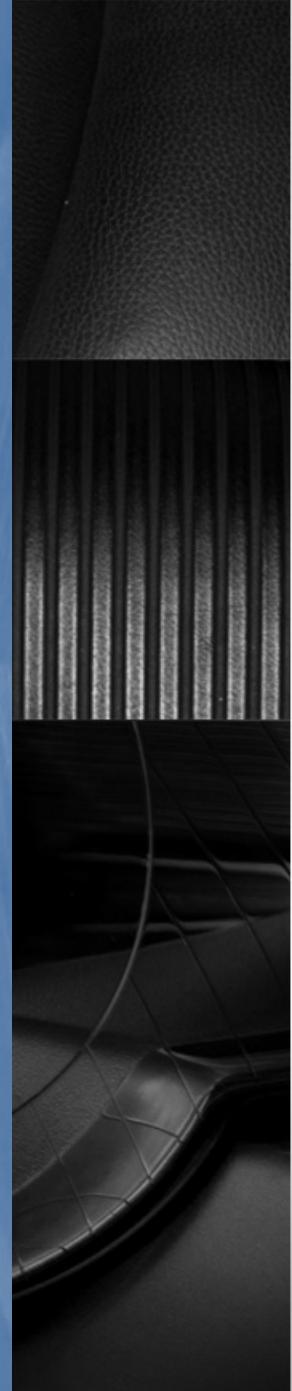


COMP4431 Artificial Intelligence

Introduction

Raymond Pang
Department of Computing
The Hong Kong Polytechnic University

Largely based on Prof. Liu Slides



Subject Lecturer

Lecturer: Dr. Pang Wai Man, Raymond

- Email: waiman.pang@polyu.edu.hk
- Office : PQ821
- Consultation Hours:
 - Every Thursday 9:30am – 11:30am

Tutors

Junbao PAN

Office: QT406

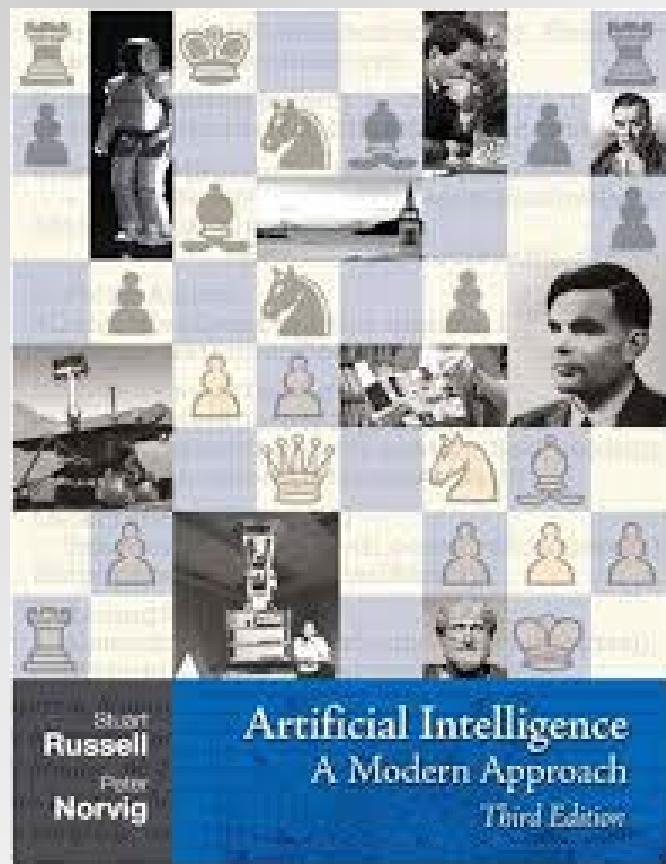
Email: junbao.pan@connect.polyu.hk

WU Bing

- Office: QT415
- Email: bing-comp.wu@connect.polyu.hk

Textbooks

- **Stuart Russell and Peter Norvig, “Artificial Intelligence A Modern Approach”, third edition.**
- Latest is 4th edition



Assessment Scheme

- Continuous Assessments (55%)
 - Attendance (5%)
over 80% of the lectures
 - 4 Individual Quizzes (25%)
 - Group Project (25%)
 - Storyboard
 - Video
- Final Examination (45%)

Details of Assessments

■ Quiz

- Quiz paper will be distributed in the classroom and returned to the TA face to face immediately after the quiz
- Zero point for late submission
- If you miss the quiz due to the medical reason and the visa problem, please **send email** to TA for recording
- Makeup quiz will be arranged on Thu. Apr. 24 evening time (tentative)

■ Final exam

- Absence and late situation are handled based on the regulations of the university for the examination

Group Project

- 1-4 members/group
- Make a short video with the theme
"Future Visions: Life with AI."
 - You are strongly encouraged to use different kinds of generative AI techniques and tools
 - All materials should be collected by yourselves
- Length of video
 - Up to 1.5 min
- The group members are given same score
 - For any objection, email to subject lecturer by email waiman.pang@polyu.edu.hk with the justification and the signature of all group members

Group Project (cont')

■ Deliverables

- Storyboard

- In ppt format with images and captions to explain your story

- Video

- In mp4 format, not less than 1.5 min

■ Submission and Important dates

- Storyboard: **Feb. 26 (Wed) 23:59pm**

- Video: **Apr. 2 (Wed) 23:59pm**

- Each group only needs to submit one copy of the item by one group member via blackboard

- 50% per day for late submission

More Details in the project specification **NEXT WEEK!**

Course topics and schedule

- Please pay close attention to the announcement of COMP4431 on the Blackboard

Week	Date	Topics (<i>Tentative</i>)	Quiz
1	16 Jan	Introduction to Artificial Intelligence	--
2	23 Jan	Heuristic Search	--
3	30 Jan	CNY break	
4	6 Feb	Knowledge based agent & Expert System	Quiz 1
5	13 Feb	Simulated Annealing & Genetic Algorithm	--
6	20 Feb	Constraints	Quiz 2
7	27 Feb	Machine Learning	--
8	6 Mar	Neural Networks	Quiz 3
9	13 Mar	Deep Learning	--
10	20 Mar	Bayesian	Quiz 4
11	27 Mar	Advanced Topics in AI	--
12	3 Apr	AI and Society	--
13	10 Apr	Group project demonstration	--
14	17 Apr	Final Exam Review	--

Introduction to COMP4431 Lab

■ General Information

Subject Group	Start Time	End Time	Venue
2011, 211, 227, 230, 251, 261, 271, 281, 291, 2911 (i.e. ALL)	20:30	21:20	PQ603, PQ604A, PQ604B, PQ604C

- ❑ Each lab session lasts 50 minutes.
- ❑ Each lab session includes lectures and hands-on experiments (40 min) and a Q&A (10 min).

Schedule of COMP4431 Lab (tentative)

Week	Date	Topics (Tentative)
1	16 Jan	--
2	23 Jan	Generative AI for Text Generation
3	30 Jan	CNY break
4	6 Feb	Generative AI for Image Generation
5	13 Feb	Generative AI for Audio Generation
6	20 Feb	Generative AI for Video Generation (1)
7	27 Feb	Storyboard Presentation
8	6 Mar	Storyboard Presentation
9	13 Mar	Generative AI for Video Generation (2)
10	20 Mar	Video Editing / Retouching
11	27 Mar	Generative AI for Code Generation (1)
12	3 Apr	Generative AI for Code Generation (2)
13	10 Apr	--
14	17 Apr	--

- ❑ The first 6 sessions focus on group projects for AI-generated content (AIGC).
- ❑ The rest sessions focus on practical techniques in AI for programming.

Introduction to COMP4431 Lab

■ Learning Objectives

- ❑ Understand the capabilities of generative AI
- ❑ Understand the advantages and disadvantages of generative AI
- ❑ Learn to use various generative AI tools
- ❑ Practice AI-generated content pipeline from scratch

■ Materials

- ❑ Generative Deep Learning: Teaching Machines To Paint, Write, Compose, and Play (book)
- ❑ Artificial Intelligence & Generative AI for Beginners: The Complete Guide (book)

Agenda

- Introduction to COMP4431
 - ❑ Assessment
 - ❑ Tentative schedule
 - ❑ Group project
 - ❑ Introduction to Lab
 - ❑ Schedule, Learning Objectives and Materials
- History of artificial intelligence
 - ❑ Definition
 - ❑ Birth - Golden time – Winter – Struggle - Revival
- Generative artificial intelligence
 - ❑ Concept
 - ❑ Different Application
 - ❑ Limitation

What is to be taught in this course?

- Basics of Artificial Intelligence
 - ❑ Mainly : Classical AI problems and approaches
 - ❑ Machine Learning
 - ❑ History, advanced methods, ethics
- Hands-on on using Generative AI
 - ❑ Use GenAI tools for text, image, audio and video

What is Artificial Intelligence

- Artificial intelligence
 - Is concerned with the design of intelligence in an artificial device
 - Term coined by McCarthy in 1956
- Artificial device
 - Limited to computer system in our course
- Definition of intelligence
 - Quality that enables an entity to function appropriately and with foresight in its environment
- A typical definition of artificial intelligence
 - A science and a set of computational technologies that are inspired by—but typically operate quite differently from—the ways people use their neuro systems and bodies to sense, learn, reason, and take action
- No widely accepted definition
 - Relationship between machine learning, big data, deep learning, pattern recognition

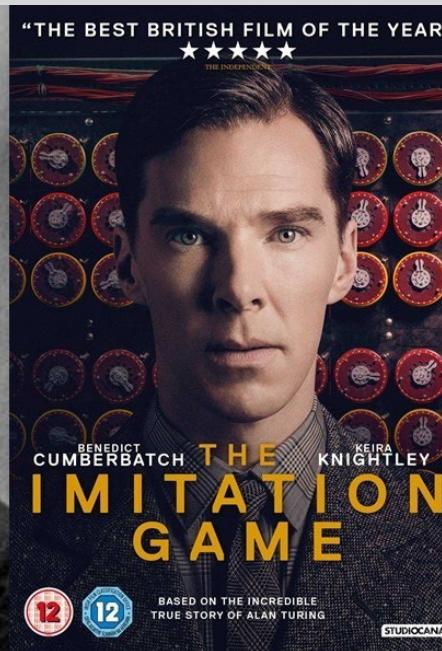
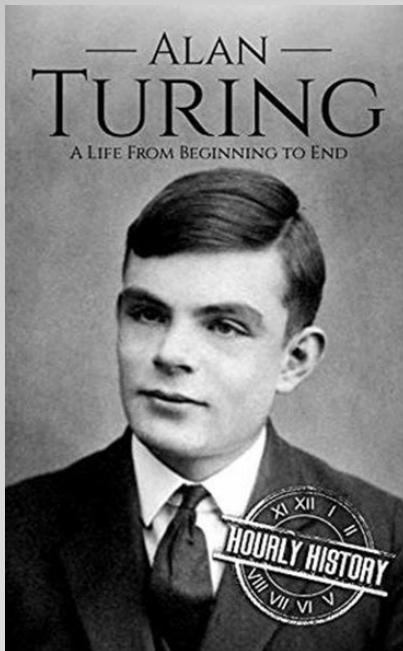
Turing Test

- Aim to solve the problem
 - Can machines behave as the human beings
- Proposed in 1950 by Alan Turing
 - Participate all major argument against AI
- Initial Design
 - Human
 - Types in questions
 - Receives answers on screen
 - Computer/human
 - Processes questions
 - Returns answers
- Judge
 - Computer or human?
- Limitation
 - Lack of mathematical analysis
 - Not reproducible



Alan Turing

- Born
 - In 1912 at United Kingdom
- Died
 - In 1954 (Aged 41)
- Education
 - Undergraduate at King's College in mathematics
 - PhD from Princeton University
- Turing machine
 - Give a definition of computation (mathematically)
 - Absolute limitation on what computation could achieve
- Contribution to artificial intelligence
 - Propose that modification of behavior could be adapted from learning brain to learning machine in 1948
 - Design Turing test in 1950



Dartmouth College

- Dartmouth college
 - ❑ Ivy League research university
 - ❑ Four senior professor retires from the Department of mathematics in 1954
 - ❑ **John McCarthy** has been hired as assistant professor by Dartmouth Colleagues
- Summer in 1955
 - ❑ John McCarthy came to work with Nathaniel Rochester
 - IBM 701 computer designer and wrote the first assembler
 - ❑ Write the proposal for a summer workshop in 1956
- Team members of proposal
 - ❑ John McCarthy, Nathaniel Rochester, Claude Shannon, and Marvin Minsky
 - ❑ Shannon is the god father of information theory

Dartmouth Workshop (1956)



Photo from the 1956 Dartmouth Conference with Marvin Minsky, Ray Solomonoff, Claude Shannon, John McCarthy, Peter Milner, Oliver Selfridge and Nathaniel Rochester.

Five of the attendees of the 1956 Dartmouth Summer Research Project on Artificial Intelligence reunited at the July 2006 AI@50 conference. From left: Trenchard More, John McCarthy, Marvin Minsky, Oliver Selfridge and Ray Solomonoff. (Photo by Joseph Mehling)



John McCarthy

- Born
 - In 1927 at USA
- Died
 - In 2011
- Got Turing Award in 1971
- Professor at Stanford University
- Contribution to artificial intelligence
 - Coined the term of artificial intelligence
 - Organized the Dartmouth workshop
 - Created the LISP language in 1958
- Contribution to other areas
 - Came up with a scheme for creating general purpose timesharing



Seven Research Pillars of Artificial Intelligence Proposed in 1956

- Automatic computers
 - Autonomous vehicles
- How can a computer be programmed to use a language
 - Python
- Neuron nets
 - Deep learning
- Theory of the size of a calculation
 - GPU
- Self-improvements
 - Machine learning
- Abstractions
 - Feature engineering
- Randomness and creativity
 - Artificial arts

Achievements in the Birth Stage

- 1950 - 1980
- Search
 - Reasoning as search
 - Heuristic search
- Natural language processing
 - Eliza is the first Chatbot created in 1966
 - Eliza has no understanding of the content and use pattern matching to answer the question
- Computer vision
 - Micro-worlds
 - Pixel – shape – object – scene



Golden Time

- 1980 – 1987
 - The knowledge revolution
- The rise of Symbolicism
 - Symbolic logic is claimed that can explain the character of mind
- Allen Newell and Herbert Simon
 - Proposed logic theorist in 1955
 - Prove the mathematical theorems successfully
- Expert system has been widely used till now
 - Answers questions or solves problems about a specific domain of knowledge
 - Reasoning by logical rules that are derived from the knowledge of experts

Allen Newell and Herbert Simon

- Long-term partners

- Share the Turing Award in 1975

- Herbert Simon

- He received the Nobel Prize in Economics in 1978

- Cognitive psychologist

- Decision making

- Allen Newell

- Published the paper of Chess Machine in 1955



Winter

- 1987- 1993
 - The practical progress is far behind the expectation of the public
 - The difficulty to reproduce general intelligence
- Rethinking of the importance of abstract reasoning
 - Building intelligence from bottom to up
 - Trigger the research of perception and interaction with the environment
 - Body is important
 - Enhance the research of robotics
- Embodied artificial intelligence
 - Integrates artificial intelligence into physical entities like robots, making them interact with their physical environment dynamically



Humanoid robot NAO

Struggle

- 1993 – 2011
 - Computer scientists and software engineers avoided the term artificial intelligence for fear of being viewed as wild-eyed dreamers
- The success of deep blue produced by IBM in 1997
 - First winner of computer chess-playing system
- The rise of machine learning
 - With large volume data
- Support vector machines
 - Most powerful binary classifier
- Autonomous vehicles
 - DARPA Grand Challenge



Deep Blue in IBM's headquarters in Armonk, N.Y.



Garry Kasparov vs.
Deep Blue

Revival

- 2012 –
- Deep learning
 - The success of connectionism
 - Imitate the physical structure and the information processing of the biological neuro system
- Marvin Minsky
- Turing Award 1969
 - Co-founder of MIT Artificial Intelligence Lab
- Turing Award 2018
 - Geoffrey Hinton
 - Yoshua Bengio
 - Yann LeCun
- Nobel Prize in Physics 2024
 - Geoffrey Hinton
 - John J. Hopfield



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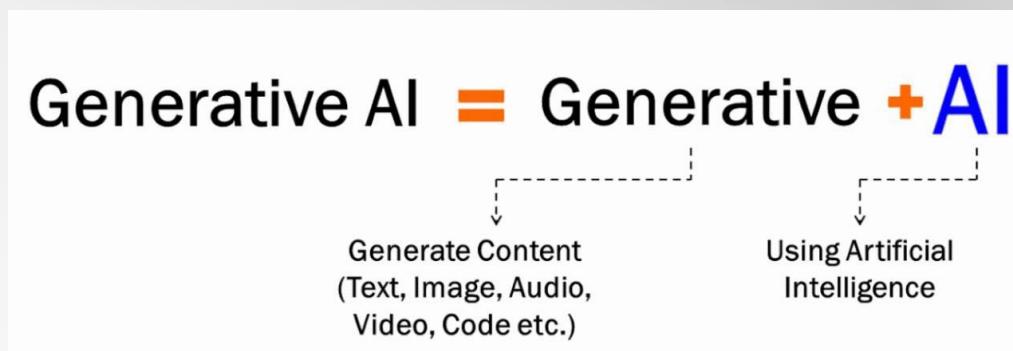
Generative AI

- Generative artificial intelligence
 - Technique that can be used to create new content, including text, code, speech, music, images, and videos.
 - ChatGPT, Suno, Midjourney, Pika
- ChatGPT
 - Chat Generative pre-trained transformer
 - Developed in 2022 by OpenAI
- Discriminative AI and generative AI
 - Discriminative AI focuses on modeling the relationship between input features and output labels
 - Generative AI focuses on modeling the inherent data structure and generation processes



Concepts of Generative AI

- Generative Artificial Intelligence (AI)
 - Generative artificial intelligence (AI) describes algorithms that can be used to create new content, including audio, code, images, text, simulations, and videos.



Kalota F.A Primer on Generative Artificial Intelligence[J]. Education Sciences, 2024, 14(2): 172.

Concepts of Generative AI

■ Artificial Intelligence Generative Content (AIGC)

- ❑ AIGC refers to content that is generated using advanced Generative AI (GAI) techniques, as opposed to being created by human authors.
- ❑ It can automate the creation of large amounts of content in a short amount of time.

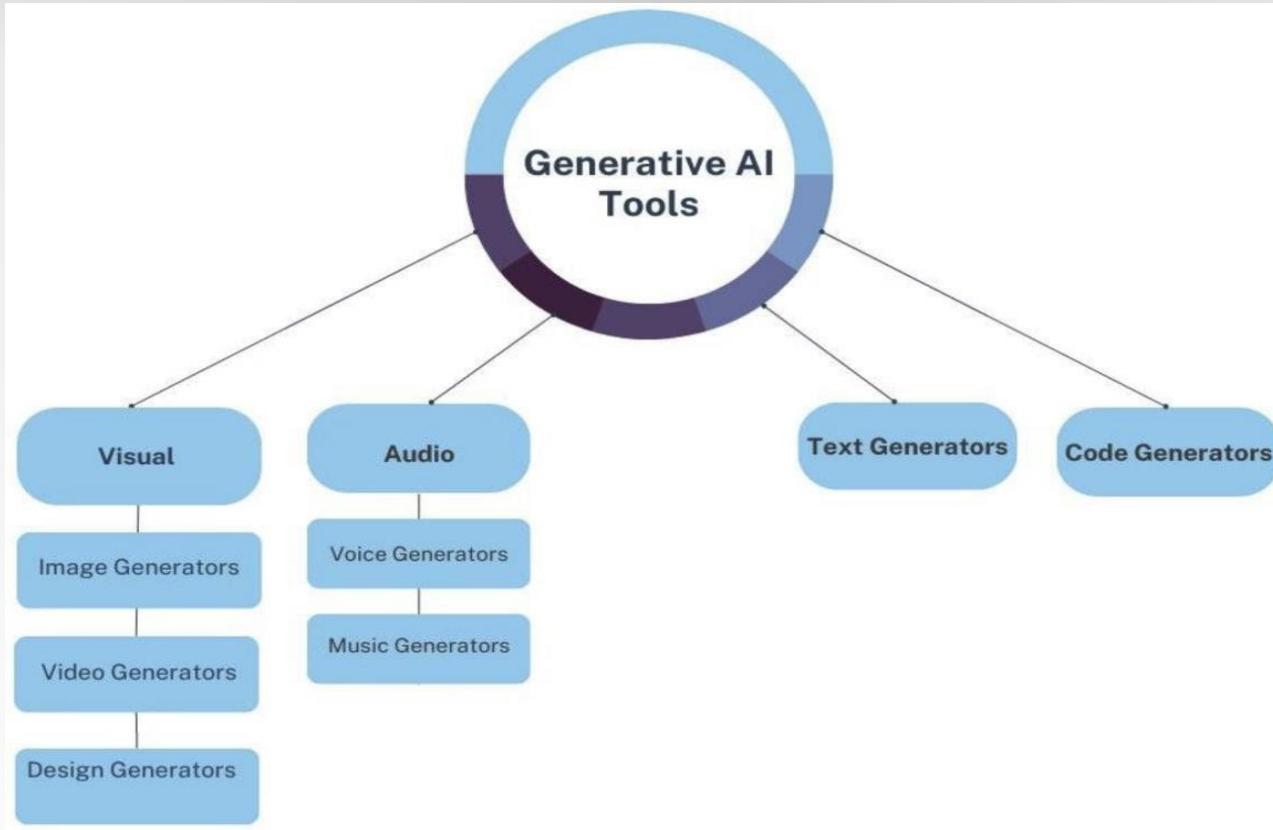


Cao Y, Li S, Liu Y, et al. A comprehensive survey of ai-generated content (aigc): A history of generative ai from gan to chatgpt[J]. arXiv preprint arXiv:2303.04226, 2023.

Why does Generative AI get popular?

- Content need
 - The way we communicate and interact with the world has been fundamentally changed by the Internet, for which digital content plays a key role. It can automate the creation of large amounts of content in a short amount of time.
- Technology conditions
 - Accessing a huge dataset becomes possible mainly due to the Internet. The price of computing resources is on the trend of becoming more affordable.

Different Generative AI Applications



Sakirin T, Kusuma S. A survey of generative artificial intelligence techniques[J]. Babylonian Journal of Artificial Intelligence, 2023, 2023: 10-14.

Different Generative AI Applications

■ X-to-text applications

- ❑ X-to-text applications are centered around text generation. The goal is to generate human-like written text that fits the user's instruction by providing a meaningful answer within the context.
- ❑ Chatbots like OpenAI's ChatGPT imitate textual conversations with the user and can be guided to output text artifacts as desired

ChatGPT ▾



JA

Write a short-and-sweet text message inviting my neighbor to a barbecue.



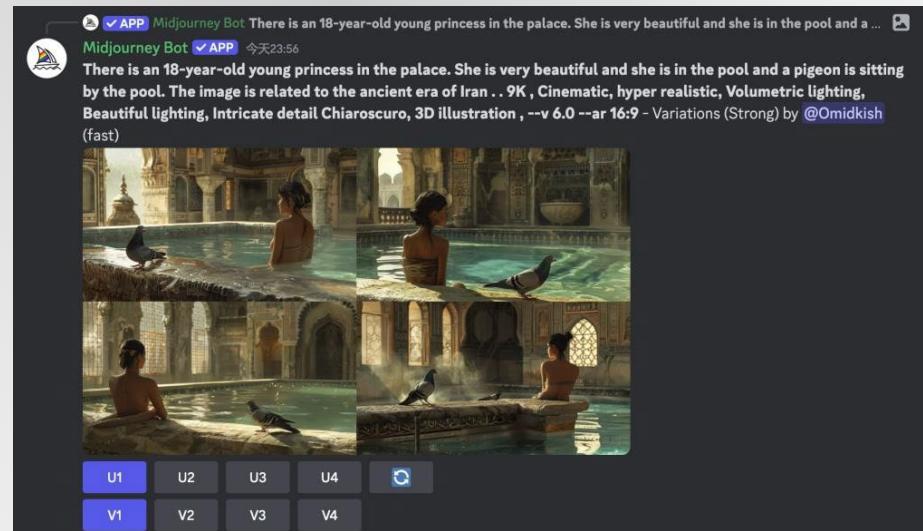
Hey! We're having a barbecue this weekend and would love for you to join us.
Let me know if you can make it! 😊🍔



Different Generative AI Applications

■ X-to-image applications

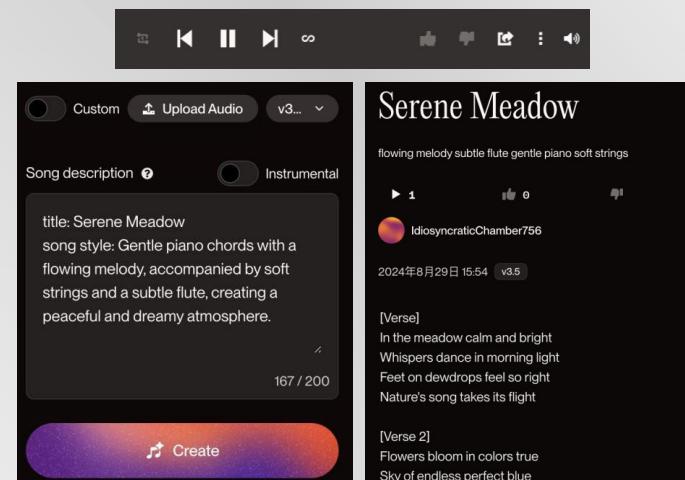
- ❑ X-to-image applications generate images based on the user's instruction. Synthetic images are created that find use cases in marketing, design and fashion, or creative fields in the form of new visual art.
- ❑ Users can use Midjourney through Discord. To generate images, users use the /imagine command and type in a prompt; the bot then returns a set of four images.



Different Generative AI Applications

■ X-to-audio applications

- ❑ X-to-audio applications focus on audio content generation and comprise. They have many applications, including speech synthesis, music composition, and sound design.
- ❑ Suno is a generative artificial intelligence music creation program designed to generate realistic songs that combine vocals and instrumentation.

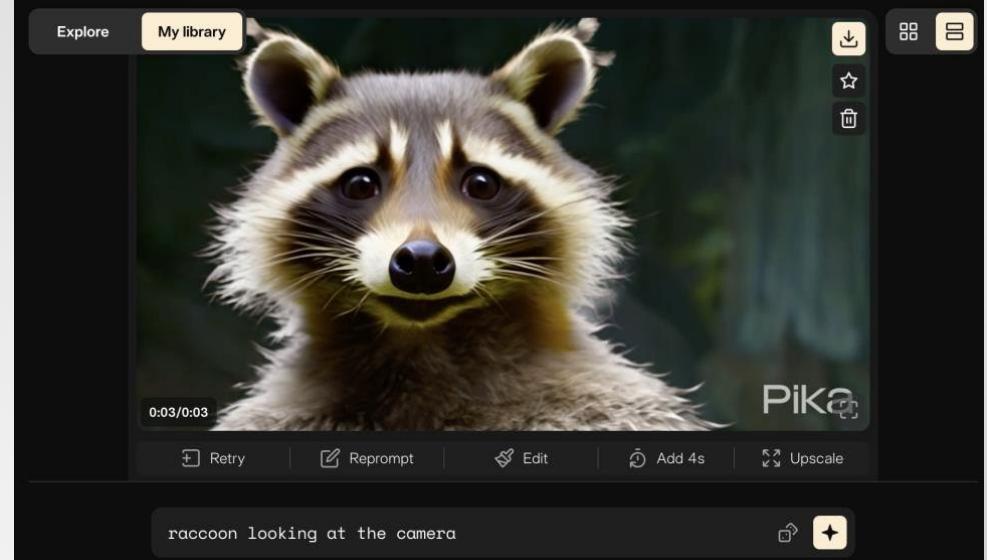


Banh L, Strobel G. Generative artificial intelligence[J]. Electronic Markets, 2023, 33(1): 63.

Different Generative AI Applications

■ X-to-video applications

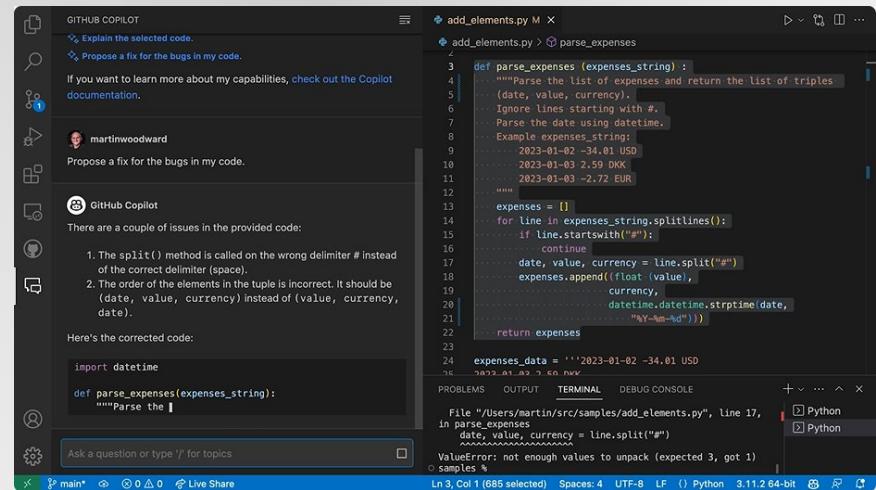
- ❑ X-to-video applications deal with the creation of synthetic videos. New video clips are generated by describing the content of the desired video footage (text-to-video) or applying the style and composition via text or image prompt to a source video (video-to-video).
- ❑ Pika is an AI video generator that transforms text or image prompts into short videos, for conveying ideas, telling stories, or adding visuals to your content.



Different Generative AI Applications

■ X-to-code applications

- ❑ X-to-code GAI applications offer transformative potential in how developers work and code by providing x-to-text capabilities specific to programming languages.
- ❑ GitHub Copilot can automatically write chunks of code, convert ideas into actionable scripts, auto-complete functions, generate unit tests, and fix bugs.



The screenshot shows a GitHub Copilot interface integrated into a code editor. The code editor window displays a Python script named `add_elements.py`. The script contains a function `parse_expenses` which takes a string of expenses and returns a list of tuples. The code includes several comments explaining the logic and handling of date, value, and currency. GitHub Copilot has provided feedback on the code, pointing out two issues: 1. The `split()` method is called on the wrong delimiter '#' instead of the correct delimiter space. 2. The order of elements in the tuple is incorrect; it should be `(date, value, currency)` instead of `(value, currency, date)`. It also suggests a corrected version of the code. The GitHub Copilot interface includes sections for 'Explain the selected code.', 'Propose a fix for the bugs in my code.', and 'Propose a fix for the bugs in my code.' (repeated). A sidebar on the left shows a profile picture of 'martinwoodward' and a message from 'GitHub Copilot'. At the bottom, there's a search bar and a terminal tab.

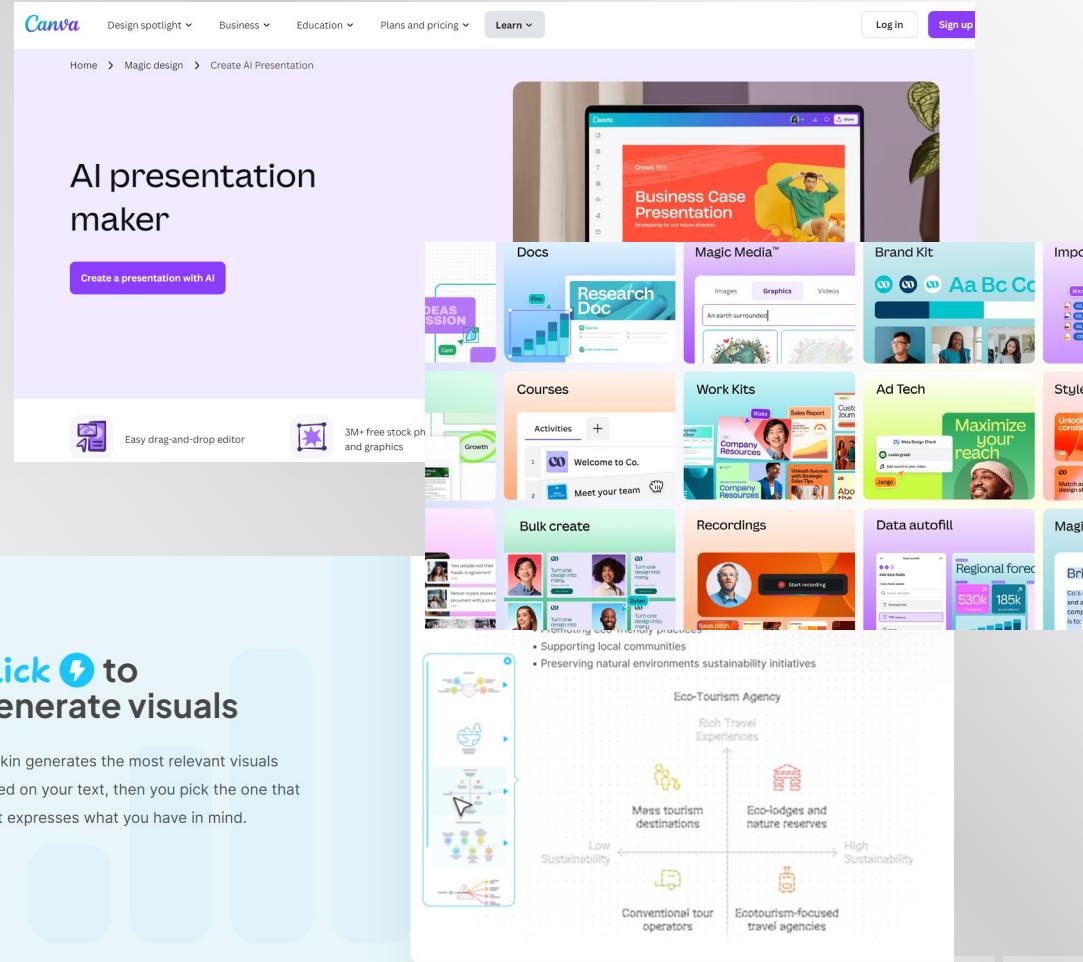
Banh L, Strobel G. Generative artificial intelligence[J]. Electronic Markets, 2023, 33(1): 63.

Different Generative AI Applications

- More and more GenAI application come out everyday

❑ Canva

Generate slides



❑ Napkin

Generate visual aid

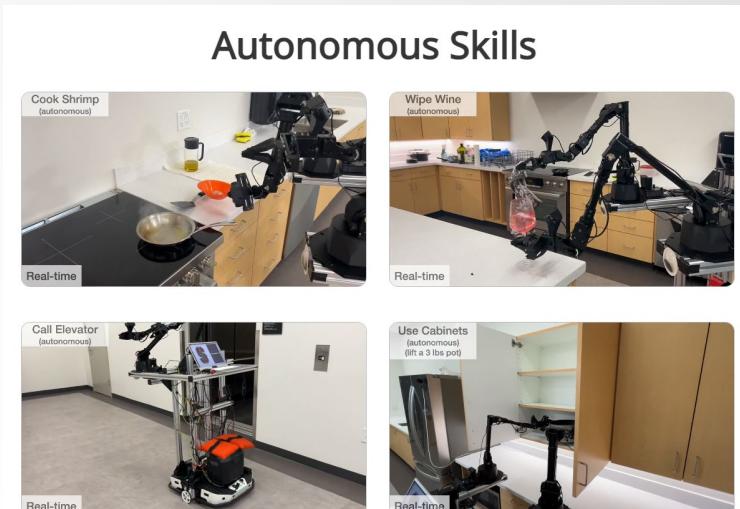
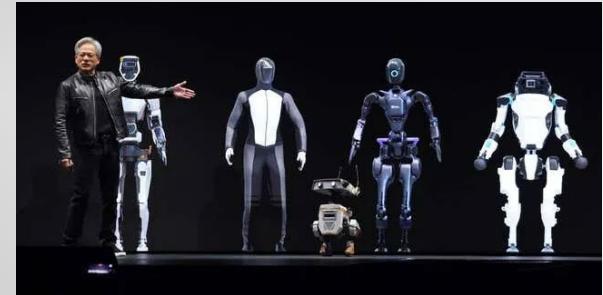
② Click ⚡ to generate visuals

Napkin generates the most relevant visuals based on your text, then you pick the one that best expresses what you have in mind.

Different Generative AI Applications

■ Embedded AI

- ❑ Also referred as Physical AI by Nvidia
- ❑ Use GenAI in Robots
- ❑ Allow robot to think and communicate with human
- ❑ Multimodal LLM even learn from human demonstration



Limitations of Generative AI

■ Incorrect outputs

- Generative AI models may produce output with errors. This is owed to the underlying nature of machine learning models relying on probabilistic algorithms. For example, generative AI models generate the most probable response to a prompt, not necessarily the correct response.

The screenshot shows a dark-themed arXiv preprint page. At the top, there's a question from a user asking for survey papers on Generative AI. Below it, a response suggests several notable survey papers on generative AI, covering various models and applications. One specific paper is highlighted:

1. "Generative Adversarial Networks: A Survey" by X. Wang, Z. Wang, and C. Xu (2020)

- **Description:** This survey provides a comprehensive overview of Generative Adversarial Networks (GANs), including their fundamental theory, various models, and training techniques. It also explores the applications of GANs across different domains.
- **Link:** [Generative Adversarial Networks: A Survey \(arXiv\)](#)

Below this, the main article summary is provided:

Computer Science > Machine Learning
[Submitted on 4 Jun 2019 (v1), last revised 29 Dec 2020 (this version, v6)]
Generative Adversarial Networks in Computer Vision: A Survey and Taxonomy
Zhengwei Wang, Qi She, Tomas E. Ward

Generative adversarial networks (GANs) have been extensively studied in the past few years. Arguably their most significant impact has been in the area of computer vision. Despite the significant successes achieved to date, applying GANs to real-world problems still poses significant challenges, three of which we focus on. As GAN technologies have made progress against these challenges, we provide a detailed review of the state of the art in GAN-related research in the published scientific literature. Several reviews for GANs have been presented to date, none have considered the status of this field based on their progress towards addressing practical challenges related to GANs. Our objective is to provide an overview as well as a critical analysis of the status of GAN research in terms of relevant progress towards important computer vision applications along with some suggestions for future research directions. Code related to GAN-variants studied in this work is summarized on [this https URL](#).

Comments: Accepted by ACM Computing Surveys, 23 November 2020
Subjects: Machine Learning (cs.LG); Computer Vision and Pattern Recognition (cs.CV)
Cite as: [arXiv:1906.01529 \[cs.LG\]](#)

Banh L, Strobel G. *Generative artificial intelligence[J]. Electronic Markets*, 2023, 33(1): 63.

Feuerriegel S, Hartmann J, Janiesch C, et al. *Generative ai[J]. Business & Information Systems Engineering*, 2024, 66(1): 111-126.

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Limitations of Generative AI

■ Bias and fairness

- Training deep learning models on biased data can amplify human biases, replicate toxic language, or perpetuate stereotypes of gender, sexual orientation, political leaning, or religion.



The first column of images are generated with neutral prompts, without adding any gender-specific words.

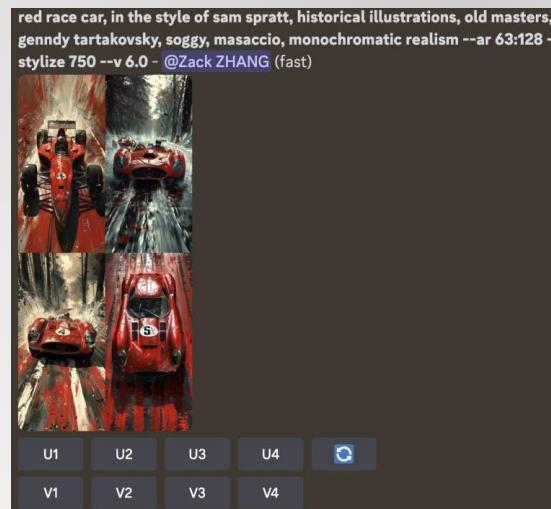
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Limitations of Generative AI

■ Other Arguments

- ❑ The nature of generative AI models, particularly when given simple prompts, can be very reductive, resulting in content that is over-simplified, low quality, or very generic.



Limitations of Generative AI

■ Other Arguments

- Many common generative AI tools are not connected to the internet and cannot update or verify the content they generate.

Who will be the men's singles table tennis champion at the 2024 Paris Olympics?

 As of now, the men's singles table tennis champion for the 2024 Paris Olympics hasn't been determined, since the games are scheduled to take place from July 26 to August 11, 2024. The competition will feature top players from around the world, but the final outcome will depend on the matches held during the Olympic Games.

Historically, players from China have dominated the sport, with champions like Ma Long, Fan Zhendong, and Xu Xin being strong contenders. However, other top players from countries like Japan, Germany, and South Korea could also challenge for the title.

To know the winner, we will have to wait for the results of the matches during the 2024 Paris Olympics.

⋮ ⏪ ⏵ ✨ 40 ✎

Limitations of Generative AI

■ Other Arguments

- Generative AI cannot draw conclusions or make decisions based on complex situations — something that only humans can do at present.
- Generative AI cannot replace human creativity completely as it lacks the ability to come up with novel ideas or recognize abstract concepts such as humor or irony.
- ...

Copyright Issue of Generative AI

■ Copyright violation

- Generative AI models, systems, and applications may cause a violation of copyright laws because they can produce outputs that resemble or even copy existing works without permission or compensation to the original creators.

The New York Times lawsuit against OpenAI

Output from GPT-4:
exempted it from regulations, subsidized its operations and promoted its practices, records and interviews showed.

Their actions turned one of the best-known symbols of New York — its yellow cabs — into a financial trap for thousands of immigrant drivers. More than 900 have filed for bankruptcy, according to a Times analysis of court records, and many more struggle to stay afloat.

"Nobody wanted to upset the industry," said David Klahr, who from 2007 to 2016 held several management posts at the Taxi and Limousine Commission, the city agency that oversees medallions. "Nobody wanted to kill the golden goose."

New York City in particular failed the taxi industry. The Times found former mayors Rudolph W. Giuliani and Michael R. Bloomberg placed political allies inside the Taxi and Limousine Commission and directed it to sell medallions to help them balance budgets and fund key initiatives.

During that period, much like in the mortgage lending crisis, a group of industry leaders enriched themselves by artificially inflating medallion prices. They encouraged medallion buyers to borrow as much as possible and offered them interest-only loans and other one-sided deals that often required borrowers to pay hefty fees, forfeit their legal rights and give up most of their monthly incomes.

When the market collapsed, the government largely abandoned the drivers who bore the brunt of the crisis. Officials did not bail out borrowers or persuade banks to soften loan terms.

Actual text from NYTimes:
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New York City in particular failed the taxi industry. The Times found former mayors Rudolph W. Giuliani and Michael R. Bloomberg placed political allies inside the Taxi and Limousine Commission and directed it to sell medallions to help them balance budgets and fund priorities. Mayor Bill de Blasio continued the policies.

Under Mr. Bloomberg and Mr. de Blasio, the city made more than \$855 million by selling taxi medallions and collecting taxes on private sales, according to the Times.

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Midjourney generates numerous plagiaristic works based on brief prompts related to commercial films.

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