

Generative AI and Research

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The AI revolution

Three components that induced the AI revolution

- Big data (internet)
- Algorithms
- Computing power (GPU by NVIDIA)

Generative AI

A generative artificial intelligence or generative AI is a type of AI system capable of **generating text, images, or other media** in response to prompts. Generative AI systems use generative models such as **large language models** to **statistically sample** new data based on the **training data set** that was used to create them. (Wikipedia)

Based on Big Data, Trained by AI, Generates natural language

- Based on Big Data: different maturity for different language
- Continuous learning through conversation
- Misinformation and bias
- Generative, not copy

ChatGPT: Chat **G**enerative **P**re-trained **T**ransformer



<https://openai.com/blog/chatgpt>

Menu

Introducing ChatGPT

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.

[Try ChatGPT ↗](#)

[Read about ChatGPT Plus](#)



AI wants you to prove you are human!

ChatGPT page



驗證您是人類



Query



Examples

"Explain quantum computing in simple terms" →

"Got any creative ideas for a 10 year old's birthday?" →

"How do I make an HTTP request in Javascript?" →



Capabilities

Remembers what user said earlier in the conversation

Allows user to provide follow-up corrections

Trained to decline inappropriate requests



Limitations

May occasionally generate incorrect information

May occasionally produce harmful instructions or biased content

Limited knowledge of world and events after 2021

Enter your query



Query and Response

YI

我發現在TNBC細胞中，STAT磷酸化增加，要證明STAT磷酸化與癌化的關係，需要做哪些實驗？



如果您想進一步證明STAT磷酸化與TNBC的癌化有關，以下是一些可能有幫助的實驗：



1. 確定STAT的磷酸化位點：在TNBC細胞中，磷酸化的STAT可能出現在不同的位點，進一步確定磷酸化的位點可以幫助證明STAT磷酸化與TNBC癌化的關係。這可以通過質譜分析和蛋白質修飾實驗等方法進行。
2. 研究磷酸化STAT的影響：研究磷酸化STAT對TNBC細胞增殖、侵襲和轉移的影響可以進一步確定磷酸化STAT與TNBC癌化的關係。可以通過使用磷酸化缺陷的STAT蛋白來進行此類實驗。

↻ Regenerate response



Regenerate response

Send a message...



Can one distinguish AI from human work?

No !

- Tools developing, with variable success. But not 100% reliable. Cannot prove.
- I do not foresee reliable tools developed.

ChatGPT is hot!

2022.11.20 go public

ChatGPT Statistics 2024: Key Market Data

- ChatGPT boasts a user base of over 180.5 million monthly users and 100 million weekly active users, OpenAI's CEO Sam Altman announced at its first-ever developer conference.
- Within just five days of its launch, ChatGPT reached a remarkable milestone of 1 million users.
- More than 80% of Fortune 500 companies have integrated ChatGPT into their operations.
- ChatGPT owner OpenAI projects \$1 billion in revenue by 2024.

ChatGPT uses in business

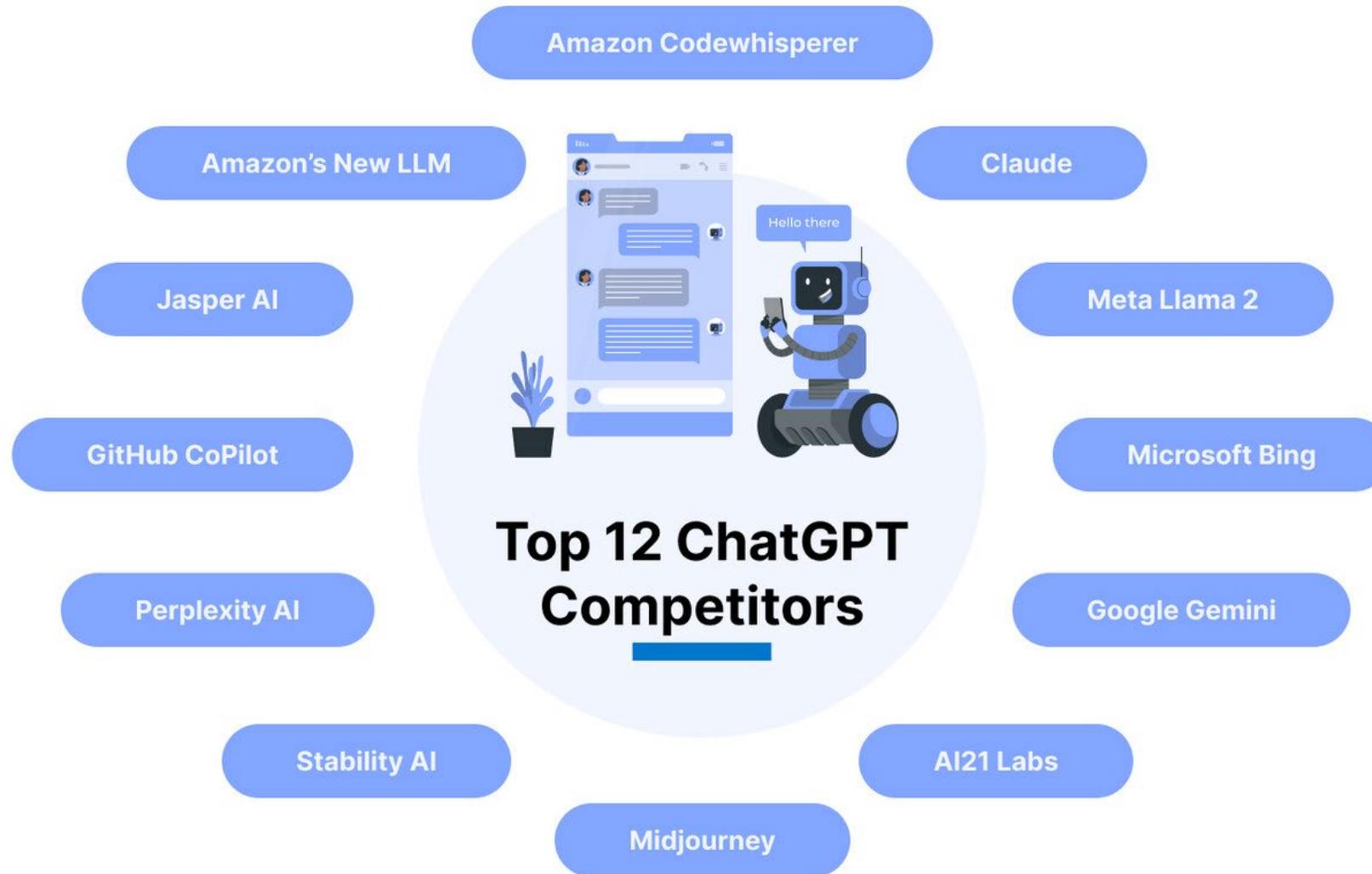
Most regularly reported generative AI use cases within function, % of respondents



¹Questions were asked of respondents who said their organizations have adopted AI in at least 1 business function. The data shown were rebased to represent all respondents.

Source: McKinsey Global Survey on AI, 1,684 participants at all levels of the organization, April 11–21, 2023

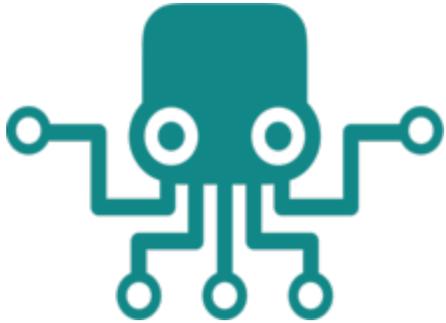
Top ChatGPT competitors



Current problems with ChatGPT

- Training database only up to 2021
 - No citation of information source
 - Not reliable. Hallucination. => **Need human verification**
 - Can be misleading/bias (training set, algorithm) (politics, existing bias, fake info)
 - AI operation is a black box (emergent property of complex system)
 - Info leakage (info in prompts goes into learning database)
 - Dominated by majority opinion. Minority opinion is suppressed.
 - Infringing on copyrighted works
 - Expected to improve soon
 - Many competitors
 - General AI + Domain-specific AI
- These problems exist before AI.**
- GPT-3.5 => GPT-4**
Web-browsing

Auto-GPT



<https://news.agpt.co/>

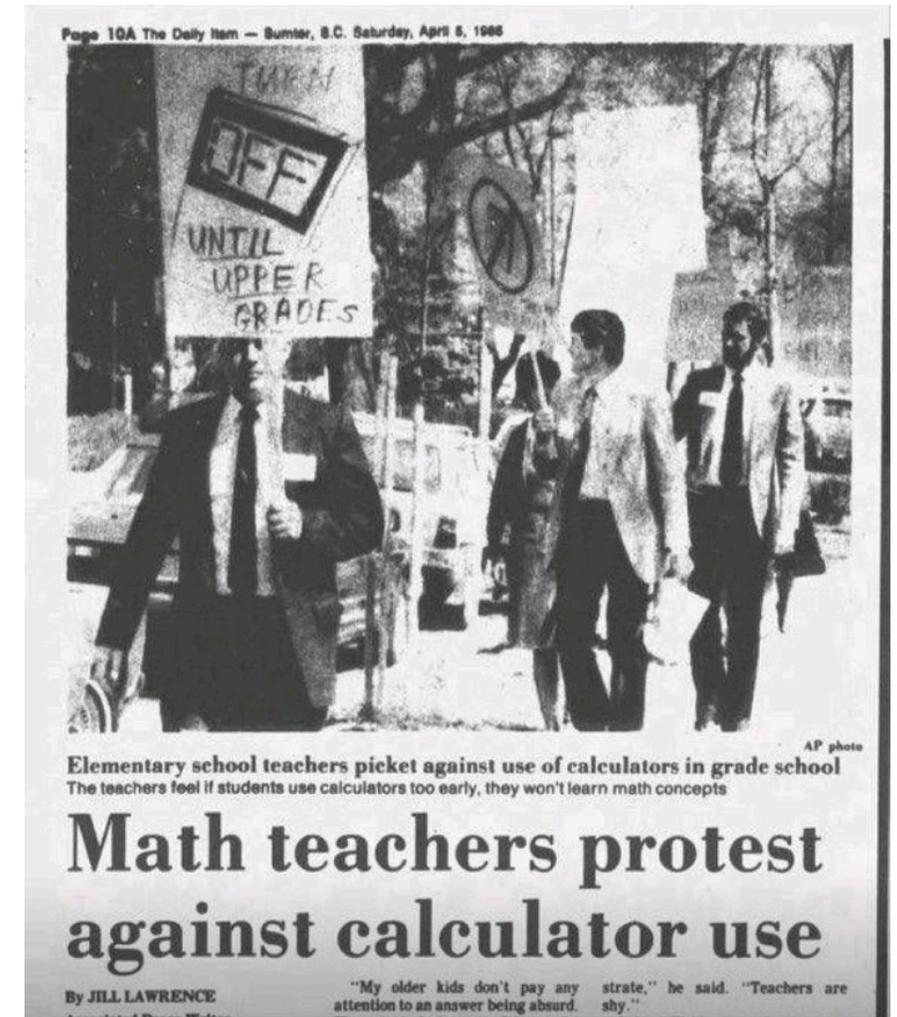
An experimental open-source Python application that attempts to make GPT-4 fully autonomous.

2023.3.30 posted on GitHub

Developed by Toran Bruce Richards, the founder of video game company Significant Gravitas Ltd.

AI is unstoppable

- Revolutionary new tool.
- Destructive innovation.
- The pros far outweighs the cons.
- Blocks and restrictions are useless.
- Outdated if you do not use the new tool.
- We have to change our own behavior.
- We must adapt and use AI.



<https://www.linkedin.com/pulse/how-adapt-knowledge-testing-professional-training-ai-world-espanet/>

Destructive Innovations

Steam engine, Electricity

Transportation (wheel, train, airplane, self-driving car)

Computer, Personal computer, Word Processing (Chinese typing, revising, spelling/grammar check, translation)

Internet, Mobile phone, Smart phone

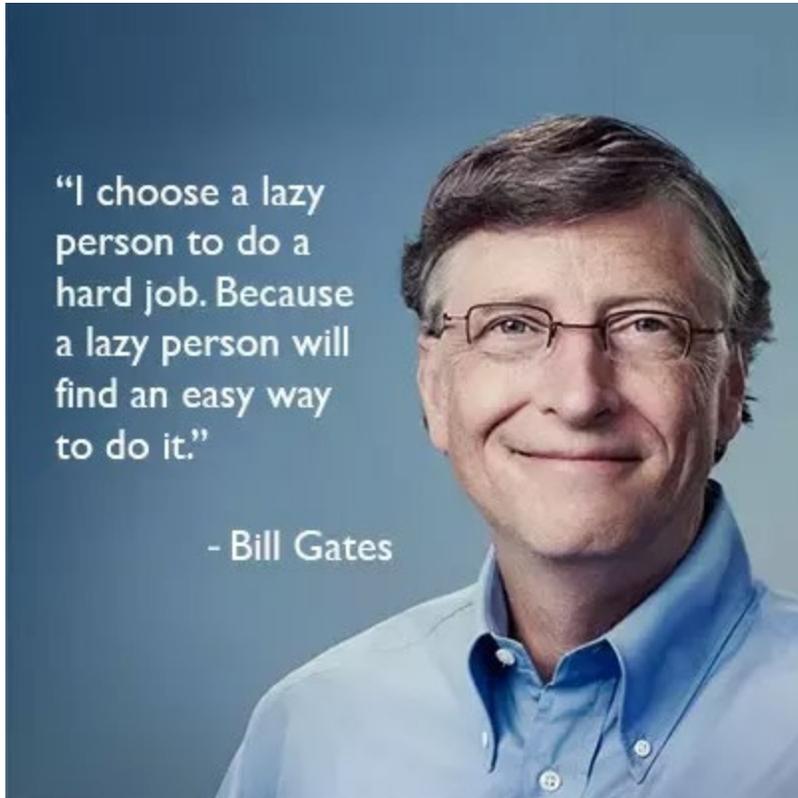
Biomedicine (Recombinant DNA, PCR, CRISPR/Cas9)

Google Search 、 Google Map

ChatGPT

- Free and open for all. => elevates baseline for everyone => equality
- **If you do not learn the new tool, you lose to everyone**

Efficiency brings progress



"good programmers are sometimes the lazy ones." !

“a competent programmer will always search for the most efficient and effective way to achieve a task, which can include finding shortcuts or automating repetitive tasks.”

Work smarter, not harder.

Governance?

AI developers

- Tool developers always act/react faster than government.
- Community self-imposed regulation/guidelines? (Recombinant DNA, Risk classification and management)

Users

- Impossible to regulate users
- Users can regulate developers by **market selection**
- **Government and Industry (info leakage)**

EU Artificial Intelligence Act

2024.3.13 approved by EU Parliament

Summarized by ChatGPT

Scope: The regulation applies to AI systems developed, sold, or used in the EU, regardless of where the developer or user is located.

Prohibited AI practices: Certain AI practices considered high-risk are prohibited, such as AI systems that manipulate human behavior, use subliminal techniques, or exploit vulnerable groups.

High-risk AI: AI systems with a high-risk of causing harm will require conformity assessments, including systems used in critical infrastructure, law enforcement, and healthcare.

Data and data governance: The regulation emphasizes the importance of data quality and governance in AI development and use, including ensuring transparency and accountability in AI systems.

Enforcement and oversight: National competent authorities will oversee the enforcement of the regulation, and a European Artificial Intelligence Board will be established to ensure consistent application across the EU.

Conformity assessment and certification: High-risk AI systems must undergo a conformity assessment before they can be placed on the market or used in the EU.

Penalties: Non-compliance with the regulation can lead to fines of up to 6% of the company's global annual turnover.

行政院及所屬機關（構）使用生成式 AI 參考指引

1. 為使行政院及所屬機關（構）使用生成式 AI 提升行政效率，並避免其可能帶來之國家安全、資訊安全、人權、隱私、倫理及法律等風險，特就各機關使用生成式 AI 應注意之事項，訂定本參考指引。
2. 生成式 AI 產出之資訊，須由業務承辦人就其風險進行客觀且專業之最終判斷，不得取代業務承辦人之自主思維、創造力及人際互動。
3. 製作機密文書應由業務承辦人親自撰寫，禁止使用生成式 AI。
前項所稱機密文書，指行政院「文書處理手冊」所定之國家機密文書及一般公務機密文書。
4. 業務承辦人不得向生成式 AI 提供涉及公務應保密、個人及未經機關（構）同意公開之資訊，亦不得向生成式 AI 詢問可能涉及機密業務或個人資料之問題。但封閉式地端部署之生成式 AI 模型，須確認系統環境安全性後，方得依機密等級分級使用。
5. 各機關不可完全信任生成式 AI 產出之資訊，亦不得以未經確認之產出內容直接作成行政行為或作為公務決策之唯一依據。
6. 各機關使用生成式 AI 作為執行業務或提供服務輔助工具時，應適當揭露。
7. 使用生成式 AI 應遵守資通安全、個人資料保護、著作權與相關資訊使用規定，並注意其侵害智慧財產權與人格權之可能性。各機關得依使用生成式 AI 之設備及業務性質，訂定使用生成式 AI 之規範或內控管理措施。
8. 各機關應就所辦採購事項，要求得標之法人、團體或個人注意本參考指引，並遵守各該機關依前點所訂定之規範或內控管理措施。
9. 公營事業機構、公立學校、行政法人及政府捐助之財團法人使用生成式 AI，得準用本參考指引。
10. 行政院及所屬機關（構）以外之機關得參照本參考指引，訂定各該機關使用生成式 AI 之規範。

Use the tools

AI is a super powerful tool. If you do not use it well, you will be competed out.

Avoid to be replaced by AI.

Well read vs. Google search

- Well read. Not only knowing the contents, but integration and synthesis.
- Google can search other people's insights.
- AI can help.

Use AI as a learning tool.

Important abilities (for education)

- Previously important abilities (memory, writing, calculation, info searching) are no longer important.
- Do not train students based on what we learned in the past.

Mastering information

- Well read, knowledgeable => Google Search 、 Wikipedia

Analyzing information

- AI can analyze, also find other people's analyses.
- **Need to distinguish correctness. Critical judgement.**

Connecting information (associations)

Problem solving: AI provides suggestions, but human makes the judgement and decision.

Innovation

Traditional testings in education need to change

Can AI be used for homework, report, exams?

- Original purpose: testing level of learning, incentive for learning, training on basic abilities

Ban the use of internet or ChatGPT?

- Honor system
- Block internet signal

Do not test human nature. Blocking is useless, but only creates troubles.

- Change the tests.
- Use AI to help => interactive
- Emphasize on important abilities (not memory and familiarity)

Applications in research

- English editing, summarize, revise, shortening
- Background information, references organization
- Write/correct software codes.
- Identify important unsolved problems
- Design experiments
- Write grants, reports and papers
- ~~Review grants and manuscripts (may leak confidential info)~~
- Summarize the past, avoid repetition, avoid mistakes and omissions.
- Reduce efforts and time.
- Based on past population experience. Approaching **mediocrity**.
- **No innovation? (linking different disciplines)**

Applications in research

Researchers :

- What are important unsolved problems in this field?
- What are known research in this field? What are relevant literatures?
- I want to study XXX. Please suggest three specific aims.
- For XX, please suggest the required experiments.
- From my experimental results, what conclusions can you derive?
- What additional control experiments do I need?
- What are the innovative points of my research?
- Based on my research results, please suggest the future directions.
- Which journal should I submit my work to?

~~Journals, funding agencies:~~

- ~~• What are the innovative points of this work? Application value?~~
- ~~• Is this novel? Are there similar researches? Does this work supersede the previous works?~~
- ~~• Do the results support its conclusions? What more experiments need to be done?~~

Q: I want to write a research grant on "temporal control of biological processes". Please suggest three specific aims.

ChatGPT: Sure, here are three possible specific aims for a research grant on "temporal control of biological processes":

1. Investigate the role of circadian rhythms in regulating biological processes: In this aim, the focus could be on understanding the molecular mechanisms that underlie the circadian clock and how it regulates various physiological processes. This could involve using techniques such as CRISPR-Cas9 gene editing to manipulate key genes involved in the circadian clock and studying the resulting changes in cellular behavior.
2. Develop new methods for controlling the timing of gene expression: In this aim, the goal could be to engineer new genetic circuits that allow for precise temporal control of gene expression. This could involve using synthetic biology techniques to design and test new genetic constructs that respond to specific stimuli (e.g., light, temperature, chemicals) in a time-dependent manner.
3. Investigate the temporal dynamics of cellular signaling pathways: In this aim, the focus could be on understanding how signaling pathways function over time and how their activity is regulated. This could involve using live-cell imaging techniques to track the activity of signaling molecules in real-time and developing computational models to analyze the resulting data. The goal would be to gain insights into the temporal regulation of signaling pathways and how they contribute to various biological processes.

Q: Please provide relevant references

ChatGPT: 以下是一些關於三陰性乳癌和EGFR的研究文獻，供您參考：

Lehmann BD, Bauer JA, Chen X, Sanders ME, Chakravarthy AB, Shyr Y, Pietenpol JA. Identification of human triple-negative breast cancer subtypes and preclinical models for selection of targeted therapies. *J Clin Invest*. 2011;121(7):2750-2767. doi:10.1172/JCI45014

Ueno NT, Zhang D, Targeting EGFR in Triple Negative Breast Cancer. *J Cancer Sci Ther* 2014; 6(6): 236-243. doi:10.4172/1948-5956.1000262

wrong

Baselga J, Albanell J. Mechanism of action of anti-HER2 monoclonal antibodies. *Ann Oncol*. 2001;12 Suppl 1:S35-S41. doi:10.1023/a:1011199018579

Yardley DA, Kaufman PA, Brufsky A, et al. Treatment patterns and clinical outcomes for patients with de novo versus recurrent HER2-positive metastatic breast cancer. *Breast Cancer Res Treat*. 2021;186(1):107-117. doi:10.1007/s10549-021-06105-5

Hynes NE, MacDonald G. ErbB receptors and signaling pathways in cancer. *Curr Opin Cell Biol*. 2009;21(2):177-184. doi:10.1016/j.ceb.2008.12.010

Moulder SL, Yakes FM, Muthuswamy SK, Bianco R, Simpson JF, Arteaga CL. Epidermal growth factor receptor (HER1) tyrosine kinase inhibitor ZD1839 (Iressa) inhibits HER2/neu (erbB2)-overexpressing breast cancer cells in vitro and in vivo. *Cancer Res*. 2001;61(24):8887-8895.

Siddiqui S, Chopra R. EGFR: A Potential Target for the Treatment of Triple-Negative Breast Cancer. *Chemotherapy*. 2017;62(3):177-184. doi:10.1159/000452984



Totally made up

Q: 請畫一個小丸子的卡通圖

GPT-3.5: I can't draw images, but I can describe how you might draw a cartoon figure of "Chibi Maruko-chan" (櫻桃小丸子):

GPT-4



How can we cope?

- Need human verification of accuracy (human inherently lazy)
- Responsibility is on human (e.g. Doctor's order)
- Expression ability (reading, searching, organizing, deduction, language, writing) will reduce.
- When AI takes over these tasks, how can humans demonstrate their value?
- Humanities emphasize on expression of ideas. How can innovation be demonstrated?
- How to show a work is created by you, not AI?
- Evaluation system need to change.

Are contents generated by ChatGPT considered plagiarized?

- ChatGPT generates text based on common language models, not direct copying.
- Use text generated text to search internet, will find similar patterned phrases, but not the same.
- Paraphrasing.
- Not plagiarism by current detection method.

AI-assisted product is still the creation of the author

Author contribution

- Tools is under the guidance of people.
- The original idea/question is from the author. The author is responsible for the accuracy, framework, logic, judgements of the contents.
- Analogy: Research Assistant helps to look up references, do experiments, and data analyses, but is often not listed as an author. Usually only acknowledged.
- Author takes the responsibility.

How to evaluate academic achievements?

- Journals and funding agency should judge the **work itself** (whether worthy of publishing or funding), not who created it.(double-blind review)
- Appointment, promotion, awards should judge **individual** contributions.
- Using tools to increase efficiency, should be a plus, not minus.
- Should look at the **results**, not the **efforts**.
- Integration (people, tools, data) is an important ability and contribution.
- Outsourcing of research is a norm.
 - Experiments A, B and C done by three collaborators, or to service providers (pay-for-service)
 - Statistics and data analyses by collaborators
 - **Original idea, design and integration are key.**

Innovations in research?

How much innovation is in our research?

- Follow the common logic, methodologies, analyses (routine)
- Research topics often follow others, follow the trend.
- Just change the key word.

Using AI can help us to find the “routines” (common research strategy, experiments need to do, required controls, questions reviewers often ask), avoid mistakes and omissions.

- Steady path, but not exciting.
- Results may be novel.

Innovation: link across disciplines

*“Progress of science depends on **new techniques**, new discoveries and new ideas, probably in that order”*

- Sydney Brenner (Nobel Laureate)

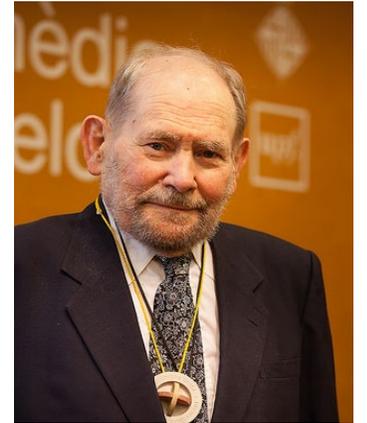
*“Breakthroughs often comes from bringing tools and concepts **from other fields** and apply to your problem”*

- Bruce Alberts (President of NAS, USA)

Inter-disciplinary cross-talks: introduce new tools, new concepts, new combination of expertise

Past: broad knowledge, wide social circle, associative power

Now: AI will connect you across disciplines.



Journals attitudes toward ChatGPT usage

- Cannot be listed as an author: cannot be accountable
- Need to disclose the use of ChatGPT (in Methods or Acknowledgment)
 - *As a tool or RA*

How to annotate the use of ChatGPT?

Quoting text created by ChatGPT

“As an artificial intelligence language model, ChatGPT does not have legal ownership or copyright over the generated text or figures it produces.” (ChatGPT, personal communication, April 21, 2023) or

¹ Text generated by ChatGPT, April 21, 2023, OpenAI, <https://chat.openai.com/chat>.

² ChatGPT.

No standard format for annotating help from ChatGPT

- The writing of this paper was helped by ChatGPT (OpenAI). (difficult to describe the degree of help)
- The Introduction section was written/revised by ChatGPT (OpenAI).
- The original idea was conceived by XX. The literature search/review was done by XX with help from ChatGPT.

Disclosing use of ChatGPT cannot be enforced

- Cannot reliably detect the use of ChatGPT
- Disclosure only indicate its usage, but the degree of usage is hard to describe.
- A rule that cannot be effectively enforced, is a meaningless rule. It only creates confusion.
- Better not require such disclosure.
- ChatGPT is a basic tool, like EXCEL 、 WORD. You do not disclose the use of WORD spelling check.

ChatGPT and Research Ethics

Use of ChatGPT

1. Just a tool. Using it for good or for bad, depends on the user. The tool is neutral.
2. Generative, not copying.
3. Accuracy of generated contents need to be checked by human. This is author's responsibility.
4. Innovation and value are not research ethics issues.
5. Journals request disclosure of ChatGPT use.
6. Should not be used for reviewing (confidentiality of review info)
7. Can be abused (plagiarism; fabricating or falsifying research results). Hard to find/prove.
8. Author takes full responsibility. Tools or assistants are responsible to authors.

Copyright of AI-generated contents?

OpenAI company? ChatGPT program? Person who wrote ChatGPT program?
Person giving prompts to ChatGPT?

ChatGPT:

The issue of the ownership of the copyright of text generated by AI is currently a matter of debate. Since AI itself is not a legal entity capable of holding copyright, it cannot enjoy copyright protection. (2023)

The copyright for the text generated by ChatGPT belongs to OpenAI, the organization behind the development of the GPT models. (2024.3.26)

Responsibility of the author

Analogy: ghost writer

- Royalty goes to the nominal author, not the ghost writer.
- **The nominal author takes full responsibility.** Accessories (AI, ghost writer, assistants) are accountable only to the author.

Future Impacts

Positive impacts

- All writings will be smoother, grammar and spelling correct.
- No need to plagiarize.
- AI can remind you not to make simple mistakes.
- Need to ask better questions to be innovative.
- Reviewers need to judge on the innovation.

Negative impacts

- Grants and papers are easy to produce. Review burden may increase.
- Content not reliable. Need to be checked (by authors and reviewers)

Using Generative AI

Use pre-trained AI

- General purpose (ChatGPT, etc.)
- Domain-specific

Train your own AI

Trends for AI development

- Reality check: more realistic expectations
- Multimodal AI
- Small(er) language models and open source advancements
- GPU shortages and cloud costs
- Model optimization is getting more accessible
- Customized local models and data pipelines
- More powerful virtual agents
- Regulation, copyright and ethical AI concerns
- Shadow AI (and corporate AI policies)

<https://www.ibm.com/blog/artificial-intelligence-trends/>

誌謝

本文中的內容，部分來自2023/3/30臺灣學術倫理教育資源中心AI線上講座觀眾所提出之問題，部分來自2023/6/19中研院[思想櫥窗－AI與未來社會：知識協力、智慧指引？]討論會，謹此誌謝！

感謝聆聽，敬請指教

