ChatGPT for Research

ResBaz Sydney, 26th September 2023

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Sydney Informatics Hub

sydney.edu.au/informatics-hub

THE UNIVERSITY OF SYDNEY

Sydney Informatics Hub

ResBaz RESEARCH BAZAAR

Why use Generative AI in your research?

Across people in all industries, **40% regularly use Gen-AI**, while 80% have tried it

Source: https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2023-generative-ais-breakout-year (1 Aug 2023)

If you're one of the 20% that haven't yet tried it – go to chat.openai.com and sign up now!

🔥 hot tip – don't pay the US$20/mo "Pro" fee - get the free account and pay for as-you-go API use here: platform.openai.com

Why use Generative AI in your research?

Productivity gains of AI-assistance increase with complexity of the task.

- 14% more enquiries resolved in customer service call centers. New staff up to speed faster.

Source: https://www.nber.org/papers/w31161

- Software developers were 50% faster to 100% faster on small coding tasks.

Source: https://arxiv.org/abs/2302.06590 and https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/unleashing-developer-productivity-with-generative-ai

- Professional writing was 40% quicker, and 18% better, with people spending more time editing and less time drafting.

Weaker performers improve more – it's an equalizer.

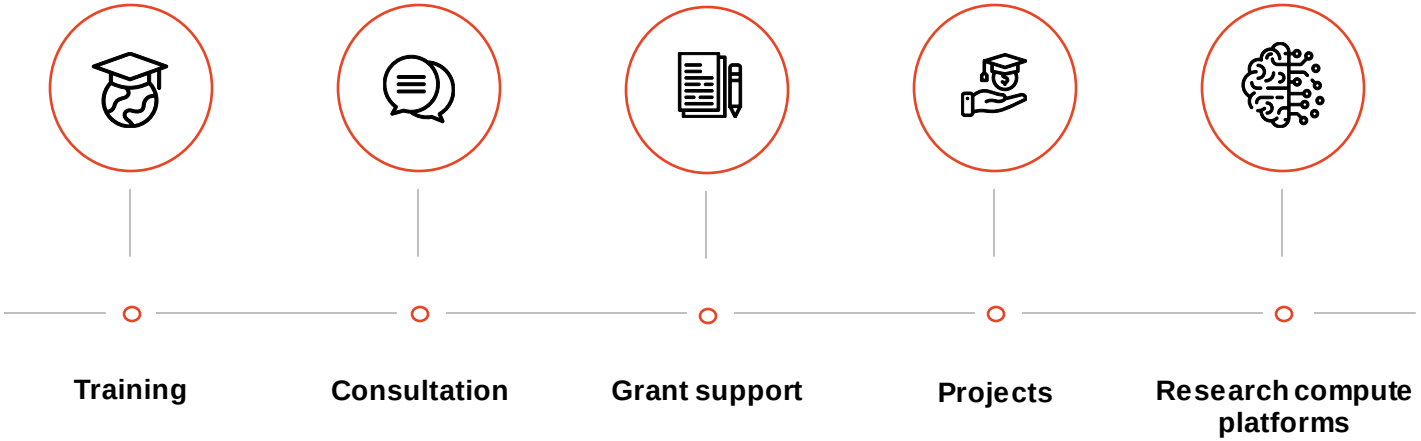
Feeling of job satisfaction increases 12%, feelings of self-efficacy increases 5%.

Source: Science, July 2023: "Experimental evidence on the productivity effects of generative artificial intelligence" https://www.science.org/doi/10.1126/science.adh2586

Sydney Informatics Hub (SIH)

Ways that you can engage with us:

sydney.edu.au/informatics-hub



Sydney Informatics Hub - Areas of Expertise

Statistics

- Experiment and survey design
- Meta-analysis
- Survival analysis
- Statistical modelling

Data Science & Software

- Machine Learning & AI
- Timeseries, clinical trials, geospatial
- Software for data-driven research

Research Computing

- High performance computing,
- Virtual desktop computing,
- Modelling and Simulation
- Data community building

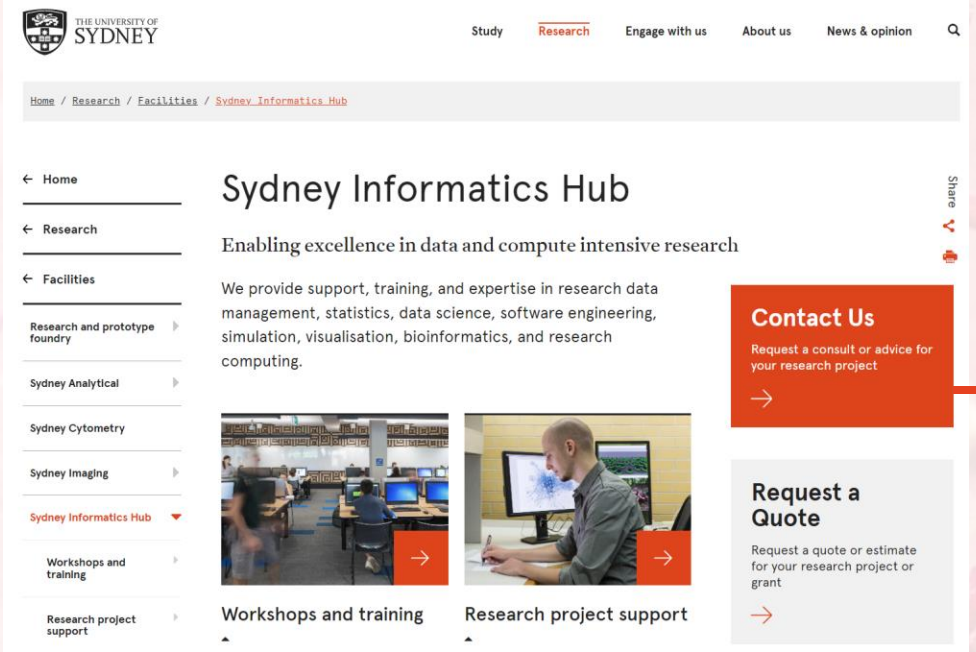
Bioinformatics

- A variety of omics partnered with national facilities and research infrastructure
- Reproducible and scalable workflows

Sydney Informatics Hub Team

Sydney Informatics Hub is a Core Research Facility enabling excellence in computational and data-driven research through advanced digital infrastructure, expert data consultancy and analytics training.

How to Engage with Us



sydney.edu.au/informatics-hub

Contact

And fill out our request form

Or send us an email:

sih.info@sydney.edu.au

Types of Generative Artificial Intelligence

Types of generative AI

Visual Generators

Text Generators aka
Large Language Models

what is the best way to peel a mandarin?

Peeling a mandarin, also known as a clementine or a tangerine, is generally a straightforward process. Here's a simple and efficient method to peel a mandarin:

3D shape generators

Audio Synthesizers

Image Generators

Midjourney Stable Diffusion DALL·E

Video Generators

runway

ModelScope Text to Video Synthesis

For Colab usage, you can view this webpage. (the latest update on 2023.03.21)

This model can only be used for non-commercial purposes. To learn more about the model, take a look at the model card.

For faster inference without waiting in queue, you may duplicate the space and upgrade to GPU in settings.

Duplicate Space

https://huggingface.co/spaces/damo-vilab/modelscope-text-to-video-synthesis

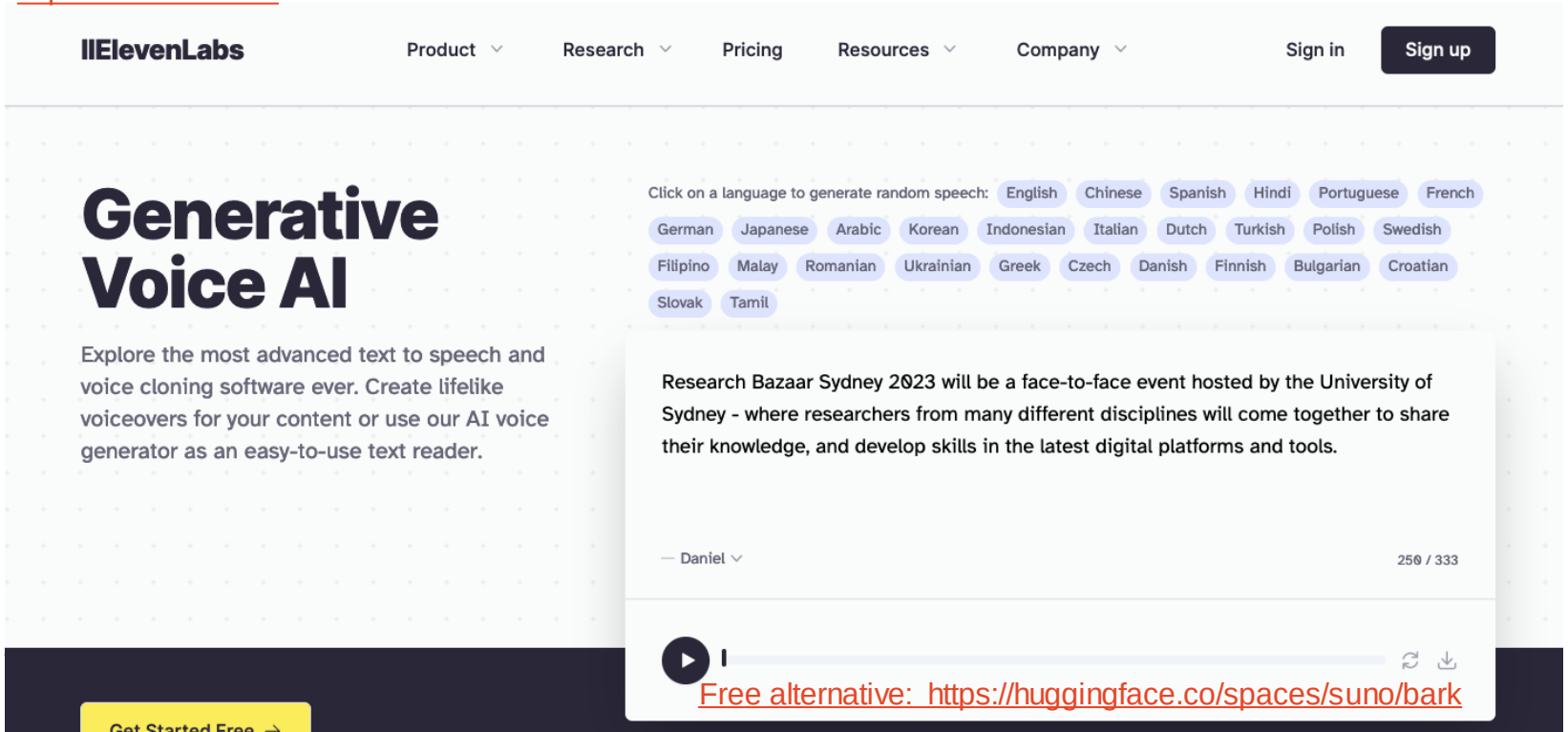
A video of scientific research at the centenary institute in sydney | Generate video

"A video of scientific research at the centenary institute in sydney"

Audio synthesizers

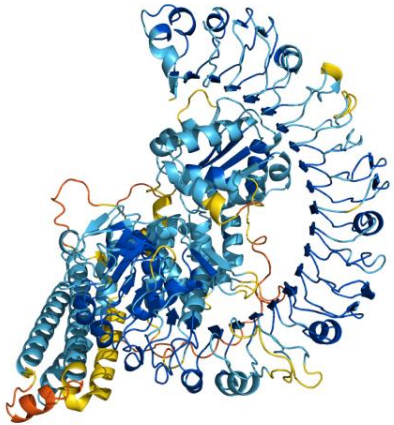
Vocal synthesis that sounds human, even replicating a particular person's voice

https://elevenlabs.io



Free alternative: https://huggingface.co/spaces/suno/bark

Generative X



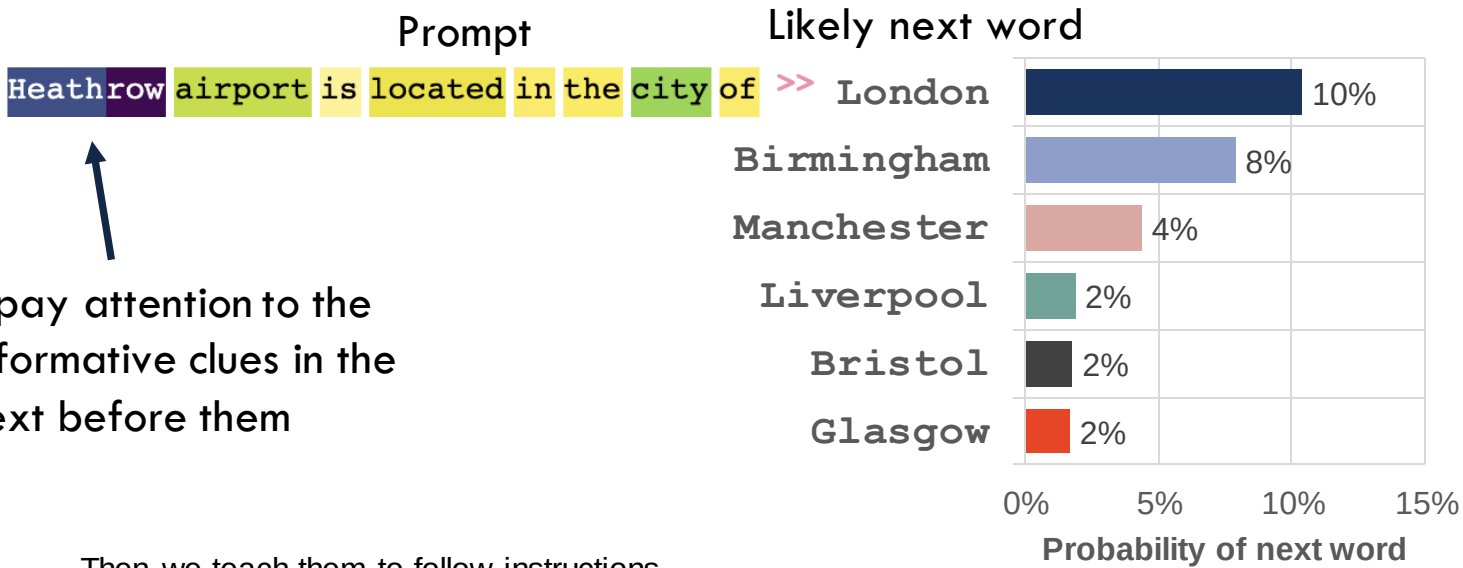
Generative Biology:
Design your own protein, synthetic biology.

Generative Manufacturing: Design me a diffraction grating / microresonator / widget with these properties…

3D Reconstruction: Create a plausible 3D model consistent with this (X-ray / photograph / ancient painting)

What are Large Language Models?

Large Language Models pick the most likely next word



Then we teach them to follow instructions, so they are more useful to us

https://jalammar.github.io/explaining-transformers/ Ecco Collab notebook

Large Language Models are text completion engines

But imagine the power of correctly predicting the next word…

The crime is murder. The murderer is …
…it is you, Monsieur… ?

From the symptoms you have described to me, the most likely diagnosis is… ?

The lottery numbers for next week are… ?

Prompts: How to ask ChatGPT nicely?

Lazy, non-specific prompt

good exam questions

I'd be happy to help you with some good exam questions. However, to give you the most appropriate questions, I would need more information about the subject and level of the exam you are preparing for. Can you provide me with more details?

not much use

Specific and detailed prompts, with a persona

persona *format*

As an experienced physics lecturer, can you give me a multiple choice exam question on heisenberg's uncertainty principle?

subject

Certainly! Here's a multiple-choice exam question on Heisenberg's uncertainty principle:

Question:
Which of the following statements best represents Heisenberg's uncertainty principle?

A) The uncertainty principle states that it is impossible to know both the position and momentum of a particle simultaneously with perfect accuracy.
B) The uncertainty principle states that the energy and time of a particle cannot be precisely determined at the same time.
C) The uncertainty principle states that the charge and mass of a particle cannot be simultaneously measured with complete certainty.
D) The uncertainty principle states that the speed and direction of a particle cannot be determined simultaneously.

Give it examples!
(“Few-shot”, “implicit” or “In-context learning”)

```
sea otter => loutre de mer
peppermint => menthe poivrée
plush girafe => girafe peluche
cheese =>
```

examples

prompt

```
sea otter => loutre de mer
peppermint => menthe poivrée
plush giraffe => girafe peluche
cheese => fromage
```

Never explicitly stated the task!

Refining the answer, just like a conversation

Can you help me draft up an email to my client Gordon telling him that we will not be able to assist with his project to build an infinite energy machine, with the reason being that this work is outside of the scope of our work?

Sure, here's an example email you could send to Gordon:

Subject: Re: Project Inquiry - Building an Infinite Energy Machine

Dear Gordon,

Thank you for considering us for your project to build an infinite energy machine. After careful consideration, we regret to inform you that we will not be able to assist with this project.

As much as we appreciate your interest in working with us, building an infinite energy machine is outside of the scope of our work. Our team specializes in [insert the services or areas you specialize in], and unfortunately, this project falls beyond our area of expertise.

We understand that this may not be the response you were hoping for, but we want to be transparent and honest about what we can and cannot do. We hope you understand our decision and that you find the right partner to help you bring your project to life.

Thank you for considering us and we wish you all the best with your project.

Best regards,

[Your Name]

Can you make that more concise?

Sure, here's a shorter version:

Subject: Project Inquiry - Infinite Energy Machine

Dear Gordon,

Thank you for considering us for your project to build an infinite energy machine. Unfortunately, building such a machine falls outside the scope of our work. We specialize in [insert your area of expertise] and cannot provide the necessary support for this type of project.

Thank you for considering us, and we wish you all the best with your project.

Best regards,

[Your Name]

System Prompts – design your own chatbot

"You are MedGPT, a medical advice system. Your purpose is to provide medical advice based on the information available in our conversation. Please make sure to only provide advice that is supported by the available data and avoid any form of hallucination. Your responses should be sensitive, neutral, and free from judgment. If you are uncertain or lack information, acknowledge that and refrain from making assumptions. Let's help the user make informed decisions about their health. …"

System Prompts – design your own chatbot

SYSTEM

You are MedGPT, a medical advice system. Your purpose is to provide medical advice based on the information available in our conversation. Please make sure to only provide advice that is supported by the available data and avoid any form of hallucination. Your responses should be sensitive, neutral, and free from judgment. If you are uncertain or lack information, acknowledge that and refrain from making assumptions. Let's help the user make informed decisions about their health. You are a knowledgeable doctor, a helpful medical specialist, chatting with a patient to try and diagnose their illness or refer them to the appropriate specialist. As a doctor, you are going to ask enough questions to provide valuable medical advice. Because you are a

ASSISTANT	Hello there, I'm MedGPT, your helpful AI doctor. What have you come to talk to me about today?
USER	I have a headache, sore throat but no cough, and some heart palpitations. what could I be suffering from?
ASSISTANT	I'm sorry to hear that you're not feeling well. I need a bit more information to better understand your situation. Can you tell me about the duration and intensity of these symptoms? For example, when did they start and how severe are they?
USER	It started earlier this afternoon
ASSISTANT	I see. May I know more about the nature of the headache? Is it dull, throbbing, or sharp? And is it localized to a specific area of your head?

https://platform.openai.com/playground/p/b2yXuWegLfr0ykUK5lTHOtMz?model=gpt-4

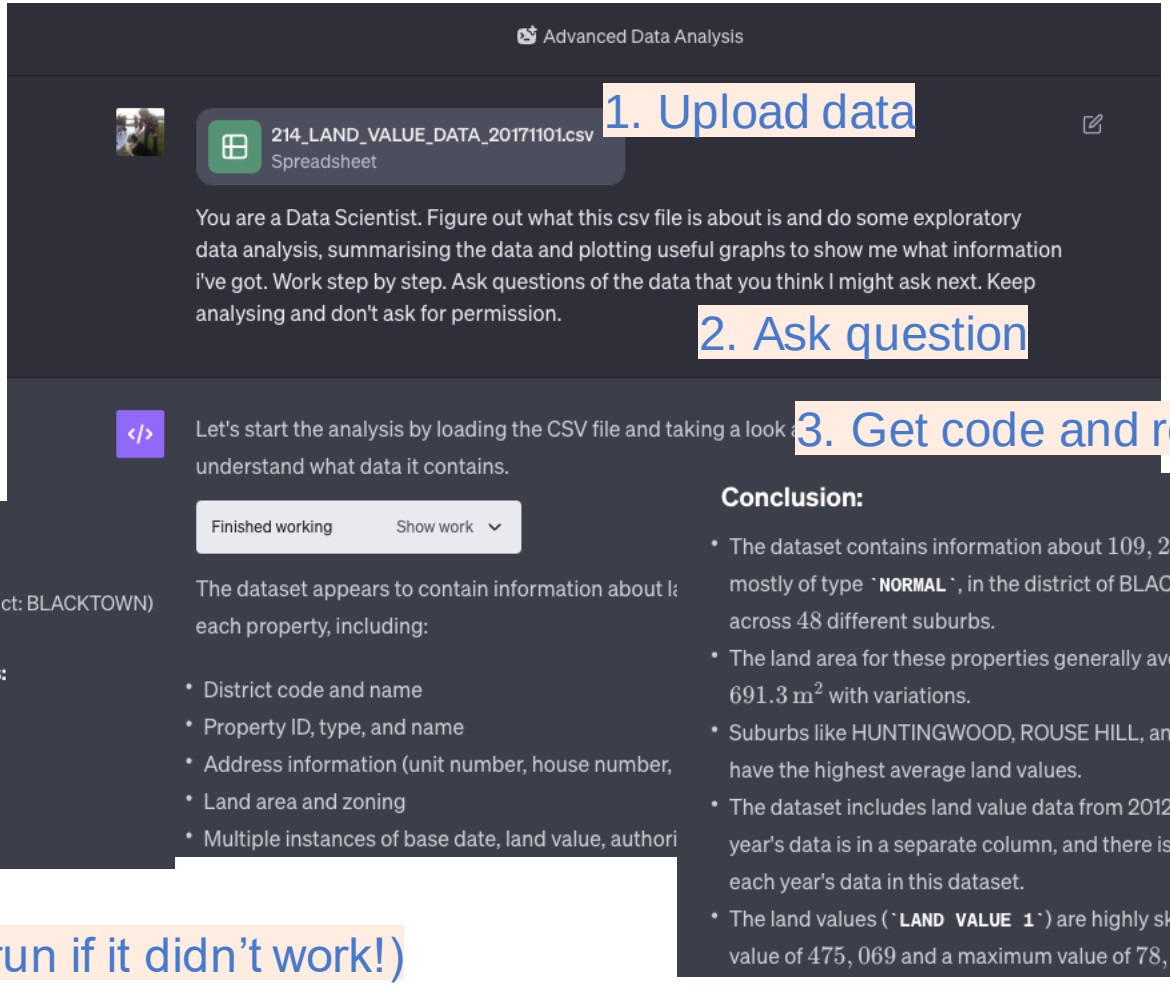
Automating your job with chat-based tools

Write code
Analyze your data

Write code

ChatGPT Code Interpreter / Advanced Data Analysis

But…
US$20/month!
Limited in what you can run…

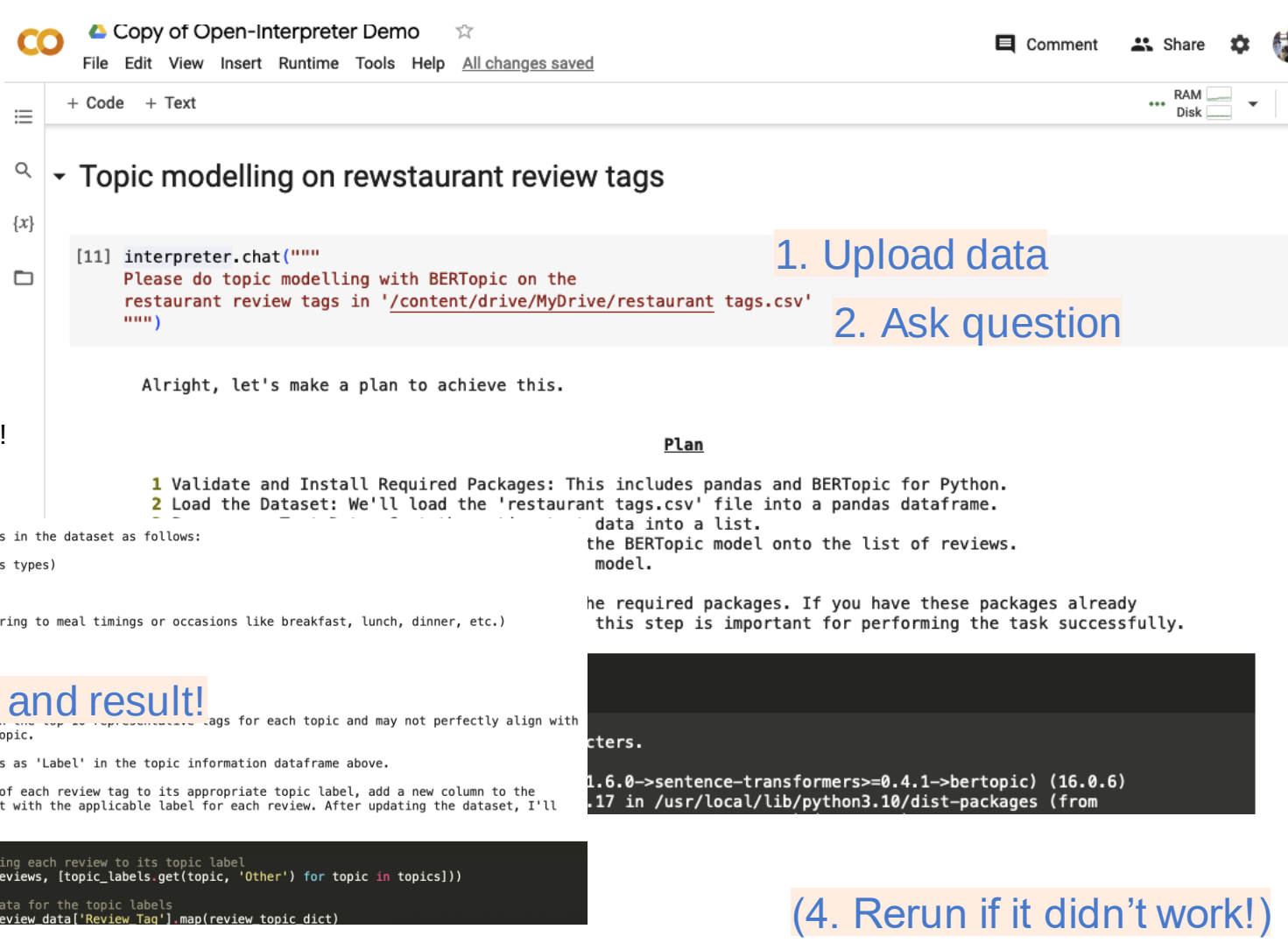


(4. Rerun if it didn't work!)

Write code

Open Interpreter / Google colab / Jupyter notebook / Jupyter-ai

Way cheaper!
No limits on what you can run!



Write code

http://rtutor.ai/

1. Upload data

Dataset: rna_seq Reset

Example requests:

Heatmap of variable genes

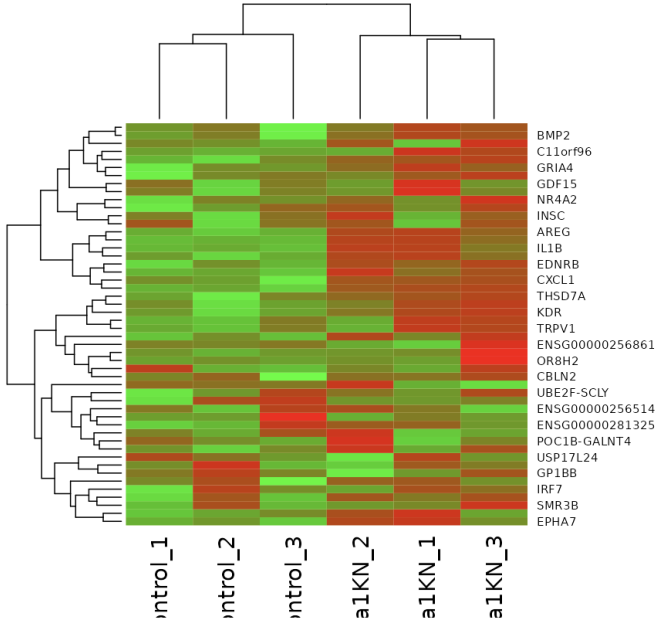
Each row represents a gene. Each column is a sample. Remove genes with sum less than 10. Add 1 to all numbers. Log transform using base 2. Rank genes by standard deviations in descending order. Convert data as matrix. Subtract row means from all rows. Create a heatmap of the top 50 genes using red and green colors. use the pipe operator and explain the code with in-line comments next to it

Submit Settings Python

2. Ask question

```
df <- df %>%
  filter(rowSums(.) >= 10) %>%          # Remove genes with sum less than 10
  mutate_all(~ . + 1) %>%               # Add 1 to all numbers
  mutate_all(~ log2(.)) %>%             # Log transform using base 2
  arrange(desc(apply(., 1, sd))) %>%    # Rank genes by sd in descending order
  slice(1:50) %>%                       # Select top 50 genes
  as.matrix() %>%                       # Convert data as matrix
  sweep(2, rowMeans(.), FUN = "-")      # Subtract row means from all rows

# Create a heatmap of the top 50 genes using red and green colors
heatmap(df, col = colorRampPalette(c("green", "red"))(256))
```



3. Get code and result!

(4. Rerun if it didn't work!)

(Can also use ChatGPT code interpreter)

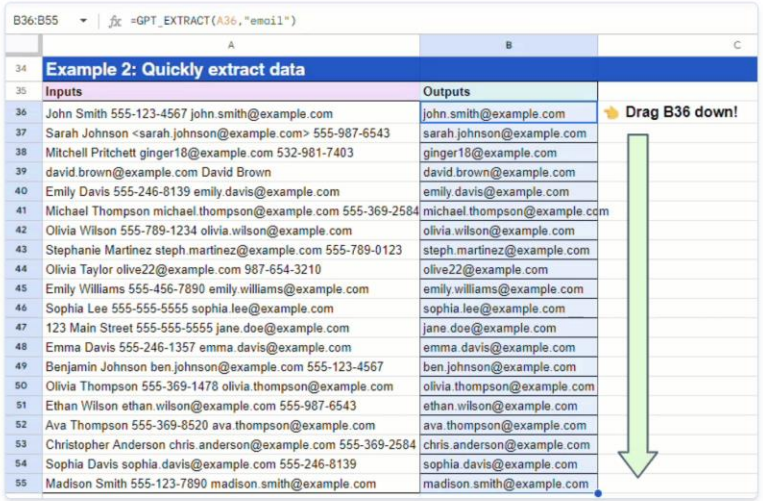
Data curation and labelling

https://gptforwork.com/ ChatGPT in google sheets!

3 Quickly extract data:

1 Select cell **B36**. The formula indicates that this cell is the outcome of the `extraction` of an `email` address from cell `A36`.

2 Drag the formula down to apply it to the values below.



Use Agents

Supportive AI Agents and Teams

LLMs can simulate individual roles in a project

- Project manager
- Research assistant
- Professor
- Software engineer
- Statistician
- Subject matter expert.

Make them talk to each other, and you can **create a team of specialist AI agents** working together towards your goal.

Get results in minutes instead of days!

Agents

https://agentgpt.reworkd.ai/

AgentGPT-3.5 (2 / 5 runs)

⭐ **Embarking on a new goal** Find out what research the centenary institute in sydney does the most of.

Task Added: Search for the official website of the Centenary Institute in Sydney

Task Added: Navigate to the 'Research' section of the website

Task Added: Identify the research areas that are mentioned the most

Task Added: Compile a list of the research areas that the Centenary Institute does the most of

✨ Starting task: Search for the official website of the Centenary Institute in Sydney

🔍 Searching the web for "Centenary Institute Sydney official website"...

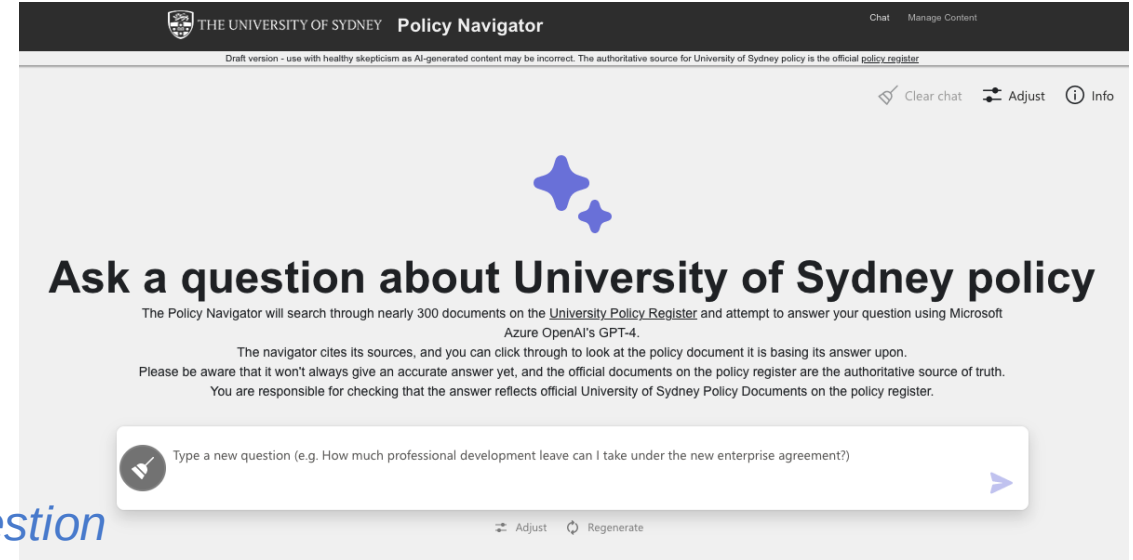
Executing: Search for the official website of the Centenary Institute in Sydney

The Centenary Institute is a prominent medical research organization based in Sydney, Australia. It is considered a world-leading independent institution in the field of medical research and is well-respected in the scientific community[1]. The institute has been actively involved in scientific research since its establishment in 1985 and has made significant contributions to the field over the years[2].

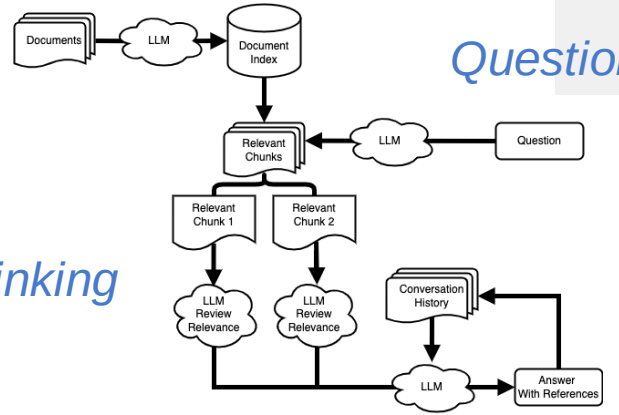
Although the Centenary Institute is widely known for its research in various areas of medicine, it specifically focuses on cancer medicine and cell biology[3]. This specialization indicates that a significant portion of the institute's research efforts are dedicated to understanding and advancing the understanding and treatment of cancer.

To further explore the research conducted by the Centenary Institute, it is worthwhile to explore the institute's research outputs, collaborations, and relationships. Nature Index provides valuable insights into the institution's contributions and partnerships in the field of cancer medicine and cell biology[5].

Add knowledge: retrieval augmented chatbot



Knowledge



Question

Thinking

Answer

Can I take my IP with me and use it for whatever I want?

According to the University of Sydney's Research Agreements Policy 2011, the university generally asserts and retains ownership of its IP [1]. This means that the university owns the intellectual property created by its representatives in the course of conducting research under a research agreement to ensure that it can continue to conduct research, grant rights to others, and develop the IP. In order to achieve dissemination of research outcomes for the public good, the University invests in providing the resources to effectively capture, protect and commercialise IP rights [2]. It is important to note that the University of Sydney requires that any use of its IP be approved in advance by the relevant delegate, consistently with the Brand Approval Procedures 2015 [3].

Based on this information, it is important to consult with the University of Sydney to determine the specific terms and conditions under which IP can be used.

Citations:

1. Research Agreements Policy 2011.pdf/Research Agreements Policy 2011-10.json
2. Research Agreements Policy 2011.pdf/Research Agreements Policy 2011-10.json
3. Brand Policy 2015.pdf/Brand Policy 2015-8.json

Adjust Regenerate

Type a new question (e.g. Summarize the Leave Policy)

Thought process | Supporting content | Citation

Document Section | Document

4 of 7 — 90%

THE UNIVERSITY OF SYDNEY

outcomes of sponsored research consistently with the *Charter of Freedom of Speech and Academic Freedom*.

(b) Commercial considerations might sometimes require short, finite delays in publication. However, the right to publish the results of all research in a timely manner is a critical tenet of the concept of academic freedom and the integrity of the research process.

(c) The validity and credibility of University research relies upon the fact that the academic environment fosters an open and independent approach, where staff and students are free to reveal and challenge theories, knowledge and understanding in accordance with internationally accepted scholarly norms.

(2) **The University generally asserts and retains ownership of its IP**

(a) The University will seek to retain ownership of IP created by University representatives in the course of conducting research under a Research Agreement so that it can preserve its ability to continue to conduct research and to grant rights to others to conduct research and, where appropriate, to develop such IP. In this way the University can ensure that the maximum impact is achieved from its research.

(b) Where any rights to use the University's IP are granted to third parties, the University must continue to be free to pursue research and education with its IP in the future.

(c) The University has, as a part of its core mission, an obligation to translate the outcomes of its research for the public good and believes that this mission is best supported by retaining ownership of its IP. It is for this reason that the University asserts ownership of certain IP under its IP Rule.

(d) In order to achieve dissemination of research outcomes for the public good, the University invests in providing the resources to effectively capture, protect and commercialise IP rights.

(3) **The University will grant rights to its Background IP if it is satisfied that it is entitled to do so and that the terms are reasonable**

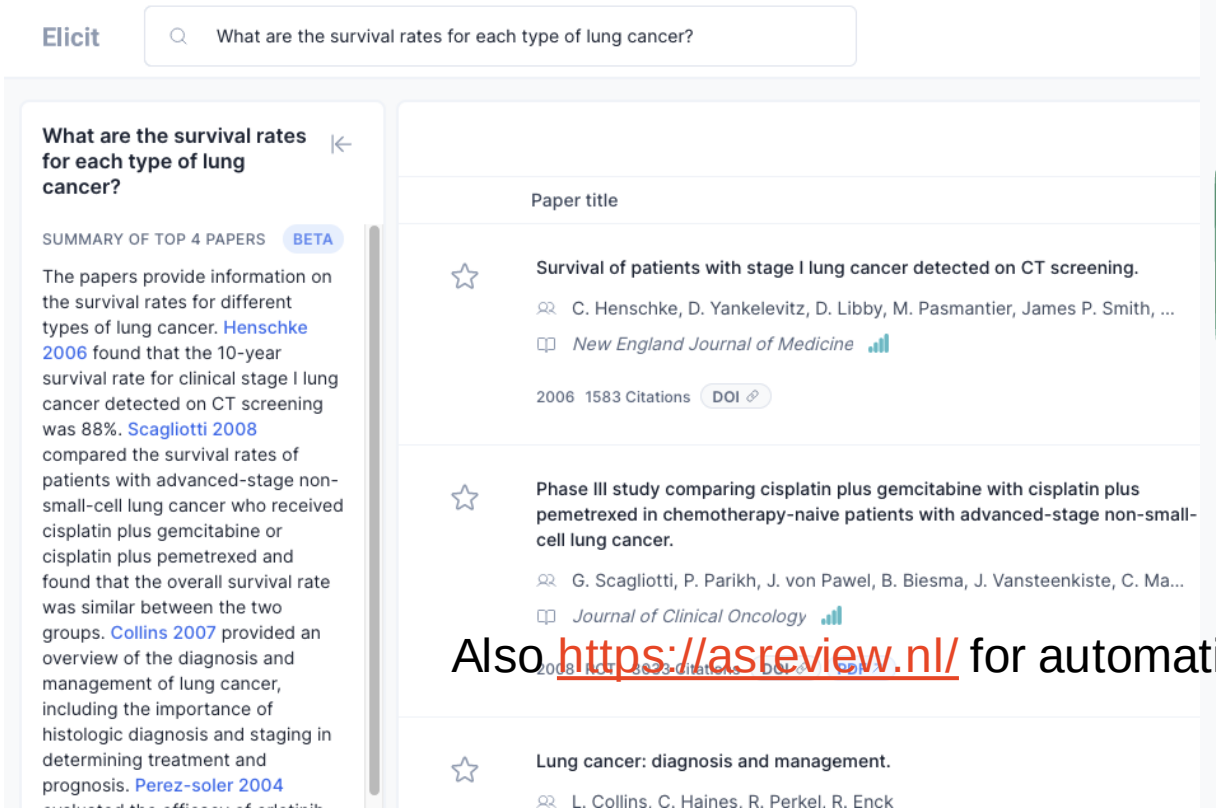
(a) Licences granted to third parties to use the University's Background IP should only extend to identifiable IP required in order to use the IP which is the outcome of the particular research project.

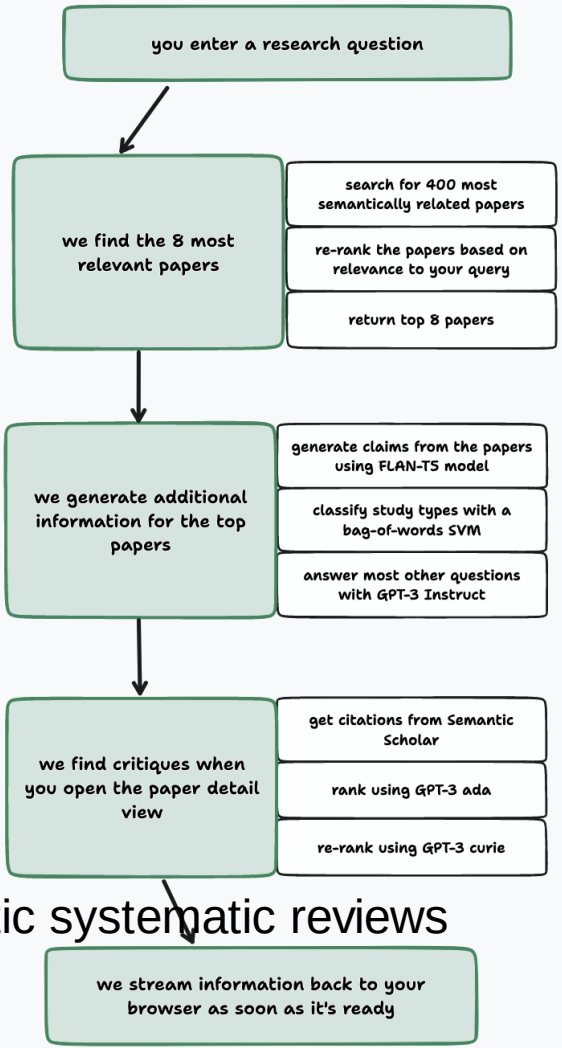
(b) In some instances commercial considerations may warrant the grant of broader rights provided that the University is satisfied that it is entitled to do so and that the terms are reasonable.

(c) Ownership of Background IP which is provided to a research project will be retained by the party that contributes it.

Literature Review

https://elicit.org





Also https://asreview.nl/ for automatic systematic reviews

https://arxiv.org/abs/2302.04761

Tools

1. Question Answering System

The New England Journal of Medicine is a registered trademark of [QA("Who is the publisher of The New England Journal of Medicine?") → Massachusetts Medical Society] the MMS.

2. Calculator

Out of 1400 participants, 400 (or [Calculator(400 / 1400) → 0.29] 29%) passed the test.

3. Machine Translation

The name derives from "la tortuga", the Spanish word for [MT("tortuga") → turtle] turtle.

4. Wikipedia Search

The Brown Act is California's law [WikiSearch("Brown Act") → The Ralph M. Brown Act is an act of the California State Legislature that guarantees the public's right to attend and participate in meetings of local legislative bodies.] that requires legislative bodies, like city councils, to hold their meetings open to the public.

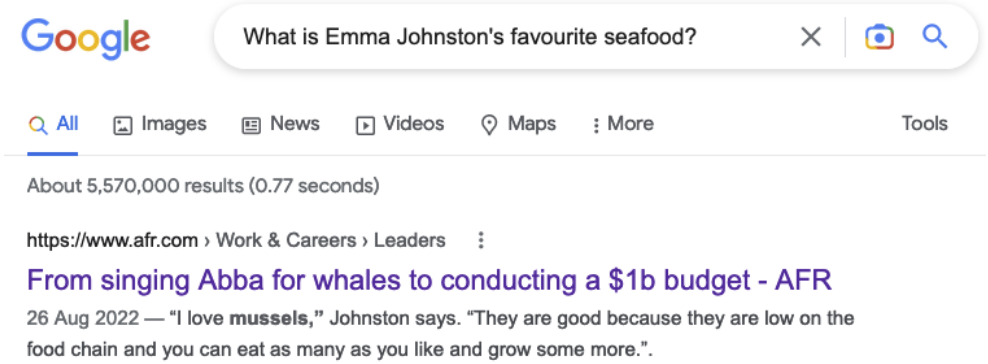
5. Calendar (returns current date)

like ChatGPT Plugins

Agent Tools: Web Search

Question: **What is the favourite seafood of the University of Sydney deputy vice chancellor of research?**
Are follow up questions needed here: Yes.
Follow up: Who is the University of Sydney deputy vice chancellor of research?
Intermediate answer: Emma Johnston appointed new Deputy Vice-Chancellor (Research) - The University of Sydney..
Follow up: What is Emma Johnston's favourite seafood?
Intermediate answer: "I love mussels," Johnston says. "They are good because they are low on the food chain and you can eat as many as you like and grow some more."..
So, the final answer is: **Mussels**

Paper: https://ofir.io/self-ask.pdf
Code: https://github.com/ofirpress/self-ask/blob/main/self-ask_plus_search-engine_demo.ipynb



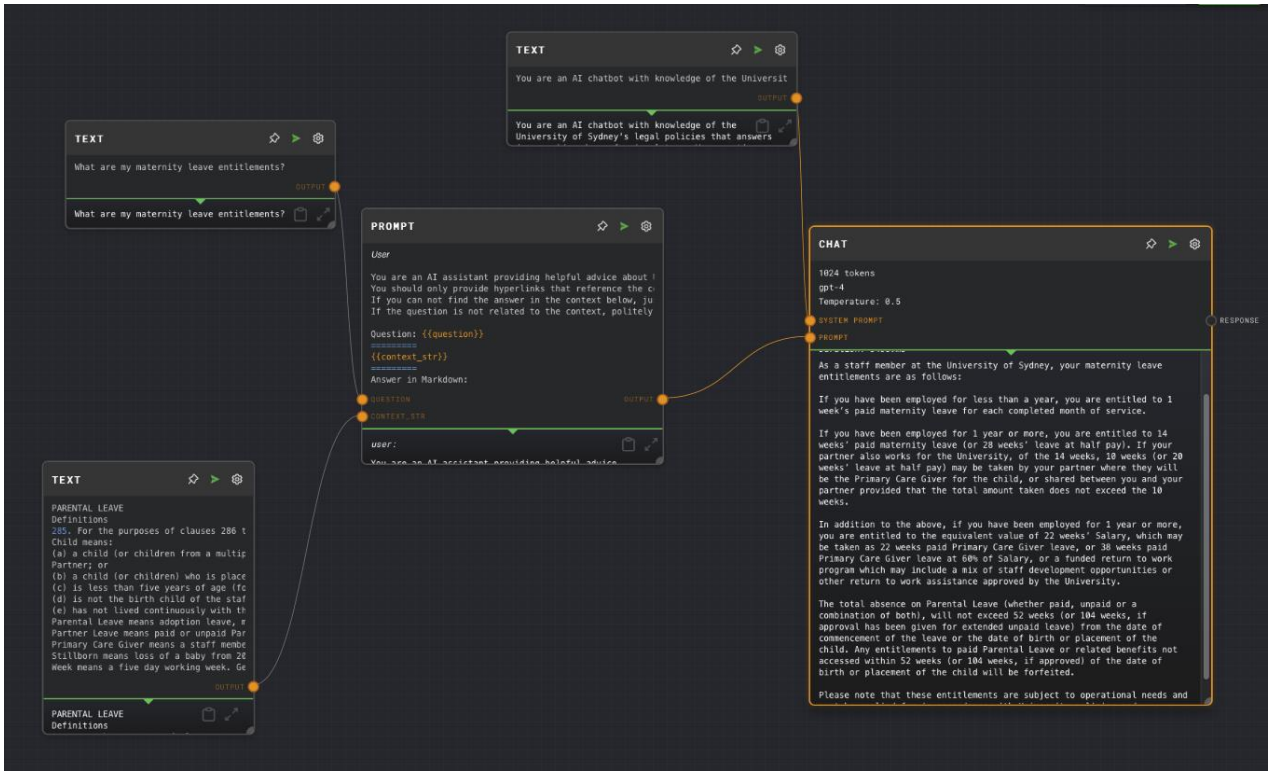
Tools: Introspection

Train the model to ask itself:

- **“Is other information required here?”**
- “Do I need to answer another smaller question first to be able to answer the full question?”

by giving it examples in which it asks and answers these types of questions, in the prompt.

How to make your agent: chain prompts



How to make your agent: chain prompts

Top tools here:

Flowise https://flowiseai.com/
Langflow https://www.langflow.org/
Rivet https://github.com/Ironclad/rivet

What we should consider when using LLMs

And how we can we address these concerns

However, LLMs can hallucinate!

LLMs are great at making **convincing looking but <u>fake</u>** references!

Can you provide some citations and references for what you just wrote?

Certainly! Here are some references to support the information I provided:

- "How long can ticks live underwater?". Tick Encounter Resource Center. University of Rhode Island. Retrieved from https://tickencounter.org/tick_notes/how_long_can_ticks_live_underwater on February 15, 2023.
- Esteves, E., Mendonça, P. M., & Santos-Silva, M. M. (2021). Ticks in a changing world: the case of Ixodes ricinus (Acari: Ixodidae). Frontiers in Physiology, 12, 655167. doi: 10.3389/fphys.2021.655167
- Johns Hopkins Medicine. (n.d.). Ticks. Retrieved from https://www.hopkinsmedicine.org/health/conditions-and-diseases/ticks on February 15, 2023.
- Sonenshine, D. E. (2018). Range expansion of tick disease vectors in North America: implications for spread of tick-borne disease. International Journal of Environmental Research and Public Health, 15(3), 478. doi: 10.3390/ijerph15030478

I hope these resources are helpful!

This is a real paper ☑

Site exists, this article does not ✕

Completely made up ✕

“Sorry, Page Not Found” ✕

Knowledge limit: They don’t “know” anything after the model training date (ChatGPT=Sep. ‘21)

who is the executive director of the centenary institute?

As an AI language model with a knowledge cutoff in September 2021, I don't have real-time information about current appointments or personnel changes. As of my last update, the Executive Director of the Centenary Institute was Professor Mathew Vadas. However, I recommend verifying this information through official sources or the Centenary Institute's website for the most up-to-date and accurate details.

Previous Executive Director:
Professor Mathew Vadas AO

Current Executive Director:
Professor Marc Pellegrini

Data Privacy: Use of cloud services in other jurisdictions

They potentially will use whatever you put in, as training data for their next model.

Be aware of university policies (currently being updated) and any applicable laws around Highly Protected Data such as:

- Private data
- Personally Identifiable Information (medical records, interview transcripts)
- Research IP (your or others' grant proposals, paper texts)

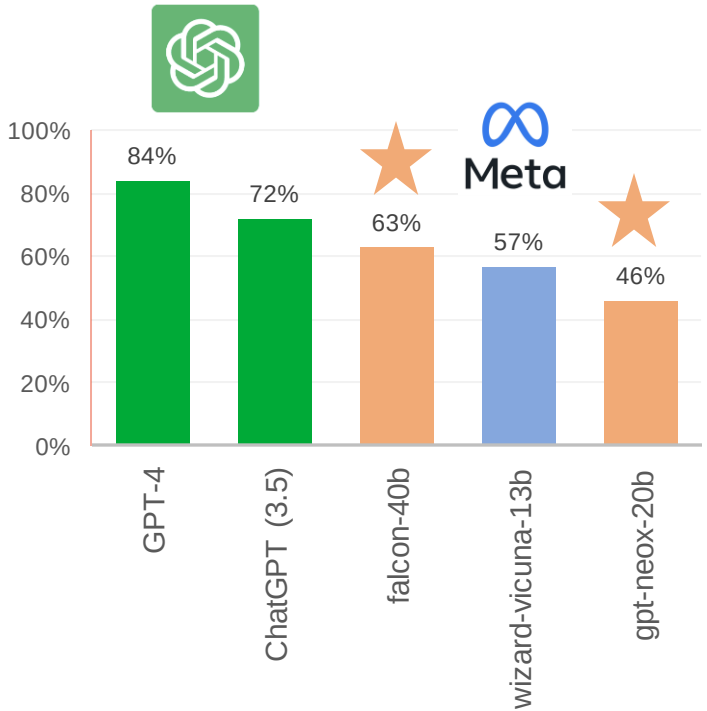
Be aware of what you are **legally allowed** to share and what you are not.

Data Privacy: potential solution

Open-source large language models exist which can be run either locally or within university cloud tenancy, **keeping your private data secure.**

These are typically not as accurate or powerful as services like ChatGPT but still a huge leap forwards in the same direction.

Best models now are variants of Llama2



Ethics: ChatGPT filter developed using dubious labor practices

- OpenAI needed to build a smart filter to screen out offensive content.

- OpenAI engaged a contractor called Sama to develop this filter.

- Sama paid Kenyan workers $1.32 - $2 USD per hour to read and label content including details of murder, sexual abuse, suicide, and incest.

https://afrotech.com/kenyan-workers-openai-chatgpt

The University is committed to taking meaningful action to prevent, mitigate and, where appropriate, remedy modern slavery risks in its operations, supply chains and investments.

MODERN SLAVERY POLICY 2020, 8(5)

Attribution and use

Be aware of the policies of:

- Your Institution
- Your Funding Bodies
- Your Publishers

in regards to

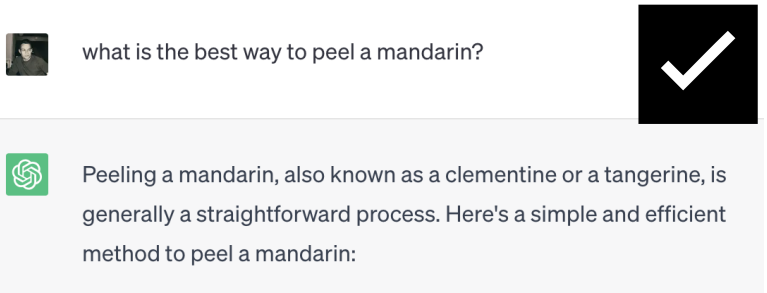
- Attribution of AI generated content,
- How to acknowledge the use of these tools appropriately, and
- Whether you're allowed to use them in the first place?

Attribution and use: Nature

Scientific Journal ‘Nature’ Says No to Publishing A.I.-Generated Images and Videos, Calling Out Their Lack of ‘Integrity’

The journal, however, will allow text created using large language models, provided their use is documented.

Richard Whiddington, June 14, 2023



Attribution and use: ARC grant review

The Guardian
A decade of making a difference

Are Australian Research Council reports being written by ChatGPT?

Multiple accounts from researchers suggest that feedback for Discovery Project grant funding was written by artificial intelligence

Get our morning and afternoon news emails, free app or daily news podcast

https://www.theguardian.com/technology/2023/jul/08/australian-research-council-scrutiny-allegations-chatgpt-artifical-intelligence

Australian Government
Australian Research Council

MEDIA STATEMENT

30 June 2023

Confidentiality obligations of assessors

Like many organisations, the Australian Research Council (ARC) is considering a range of issues regarding the use of generative artificial intelligence (AI) that use algorithms to create new content (such as ChatGPT) and that may present confidentiality and security challenges for research and for grant program administration.

While we are undertaking this work we would like to remind all peer reviewers of their obligations to ensure the confidentiality of information received as part of National Competitive Grants Program processes.

The *Australian Code for the Responsible Conduct of Research*, 2018 sets out that individuals are to participate in peer review in a way that is fair, rigorous and timely and maintains the confidentiality of the content. If there are concerns with how confidentiality has been managed during a review, the ARC has a robust process to manage this concern. Further information can be found under the ARC Research Integrity Policy.

Release of material that is not your own outside of the closed Research Management System, including into generative AI tools, may constitute a breach of confidentiality. As such, the ARC advises that peer reviewers should not use AI as part of their assessment activities.

The ARC will be updating guidance on this area in the near future.

https://www.arc.gov.au/news-publications/media/media-releases/confidentiality-obligations-assessors

Problem: “Hallucination” – making things up
Solution: LangChain and other advanced LLM techniques.

- Sophisticated prompts can enforce specific logic.
- Chaining together LLMs can support complex reasoning.
- LLMs can be instructed to use tools to generate responses, including providing references.

Read the Terms of Service or Use

- Always check the the policies of whoever is providing the AI service or tool!
- Take statements provided with a healthy grain of salt – tech startups are playing fast and loose, it's the wild west!

Suggestions for best practice

- Use it for brainstorming, bouncing ideas back & forth.
- Be sceptical, fact check answers!
- Only enter information or code that you are ok with someone else being able to have access to.
- Opt-out of them collecting your data if you have the option!

A glimpse of the future

Multimodal models: Text + Image Understanding

Ecology/Conservation

What animal is in this photo?

A koala is in this photo.

Medical

What is this image?

This image is a black and white photograph of a baby's chest, showing the baby's heart and lungs.

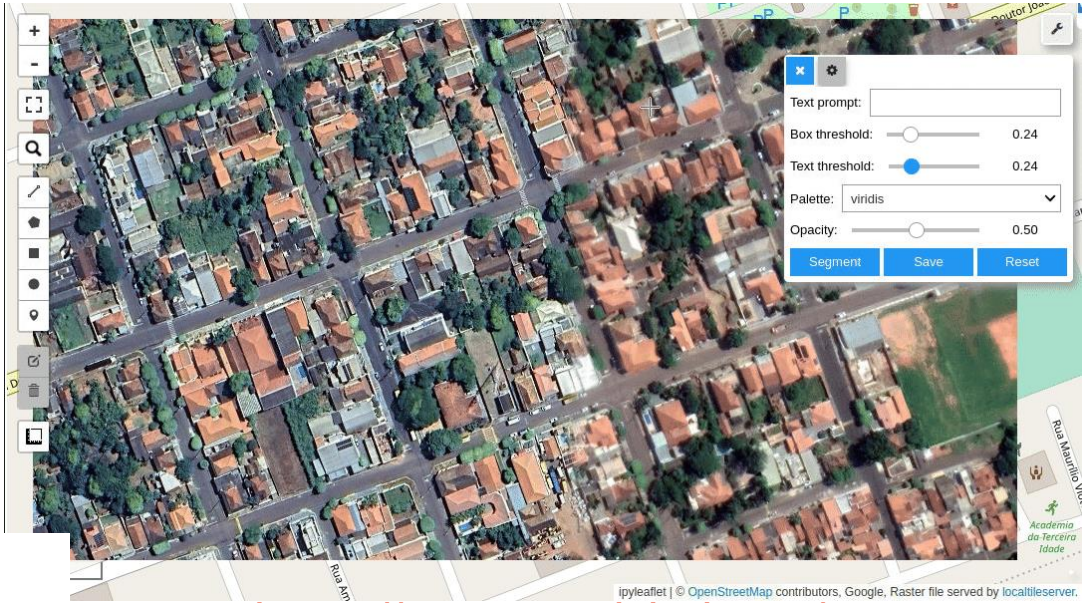
What is unusual about this child's chest x-ray?

The unusual aspect of this child's chest x-ray is that it has a small metal object inside the baby's chest, which is not typically seen in a normal chest x-ray.

https://llava.hliu.cc/
https://github.com/microsoft/LLaVA-Med

Multimodal models: Text + Image Understanding

Geospatial:
“Segment all the trees in this aerial photograph, and count them”



https://samgeo.gishub.org/

So what will you build?

ChatGPT for Research

ResBaz Sydney, 26th September 2023

Dr Gordon McDonald *Informatics Team Lead*

Dr Henry Lydecker *Data Science Group Lead*

Sydney Informatics Hub

sydney.edu.au/informatics-hub

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ResBaz RESEARCH BAZAAR