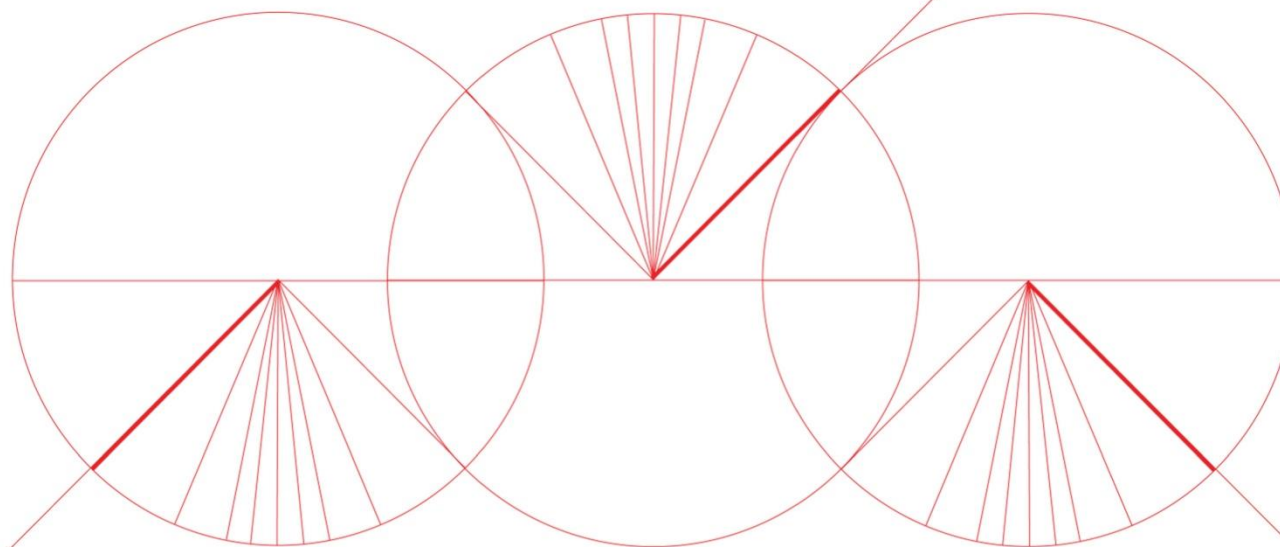




# Doctoral Summer School

Sep 2-3, 2025



## AI for Researchers

**NTK**

50°6'14.083"N, 14°23'26.365"E  
Národní technická knihovna  
National Library of Technology



UNIVERSITY OF  
CHEMISTRY AND TECHNOLOGY  
PRAGUE

**CAD**

THE CZECH  
ASSOCIATION  
OF DOCTORAL  
RESEARCHERS



Student Chamber  
of the Council of HEIs

# AI FOR RESEARCHERS:

## TOOLS TO BOOST RESEARCH AND WRITING PRODUCTIVITY

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*Updated to 2.9. 2025*



[link](#)European  
Commission

## The European Research Area

### Living guidelines on the RESPONSIBLE USE OF GENERATIVE AI IN RESEARCH

Artificial Intelligence is transforming every stage of the research process across scientific disciplines. Generative AI tools, like ChatGPT, are powerful technologies that can facilitate scientific work and accelerate discovery, when used in the right way. The European Commission, countries and research and innovation stakeholders of the European Research Area have collaboratively developed a set of recommendations to support the responsible integration of generative AI in research.

The guidelines follow the principles of research integrity and address the main challenges researchers face when using generative AI. As the technology is evolving, [feedback from the community](#) is welcome to keep the guidelines up to date.

#### KEY RECOMMENDATIONS

##### RESEARCHERS should...

- Follow key principles of research integrity, use GenAI transparently and remain ultimately responsible for scientific output.
- Use GenAI preserving privacy, confidentiality, and intellectual property rights on both, inputs and outputs.
- Maintain a critical approach to using GenAI and continuously learn how to use it responsibly to gain and maintain AI literacy.
- Refrain from using GenAI tools in sensitive activities e.g. peer reviews or evaluations.

##### RESEARCH ORGANISATIONS should...

- Guide the responsible use of GenAI and actively monitor how they develop and use tools.
- Integrate and apply these guidelines, adapting or expanding them when needed.
- Deploy their own GenAI tools to ensure data protection and confidentiality.

##### FUNDING ORGANISATIONS should...

- Support the responsible use of GenAI in research.
- Use GenAI transparently, ensuring confidentiality and fairness.
- Facilitate the transparent use of GenAI by applicants.

## Guidelines on the responsible use of generative AI in research developed by the European Research Area Forum

Generative AI can hugely boost research, but its use demands transparency and responsibility. These guidelines aim to uphold scientific integrity and preserve public trust in science amidst rapid technological advancements. I call on the scientific community to join us in turning these guidelines into the reference for European research.

...

- *Remain ultimately responsible for scientific output*

- *Use generative AI transparently*

- *Pay particular attention to issues related to privacy, confidentiality and intellectual property rights*

....

# TOOLS AND APPS FOR RESEARCH - categories/examples:

## CHATBOTS

ChatGPT  
Claude  
Gemini

## DEEP RESEARCH

o3 Deep Research  
Gemini 2.5 Deep Research

## LLM-ASSISTED SEARCH ENGINES

You.com  
Perplexity

## LLM-ASSISTED DATA ANALYSIS

Julius  
Google Colab

## RESEARCH ASSISTANTS

Scite, SciSpace, Elicit  
Litmaps, NotebookLM

## AI AGENTS

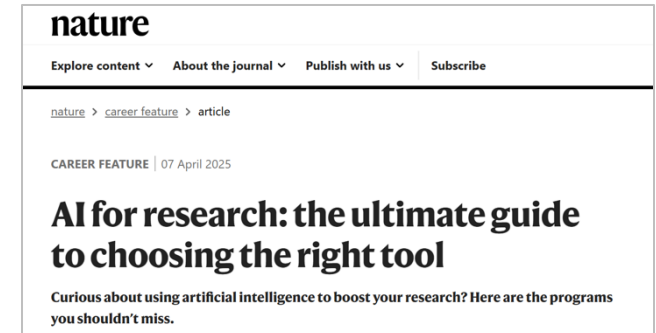
Google co-scientist  
Operator, Manus

## WRITING ASSISTANTS

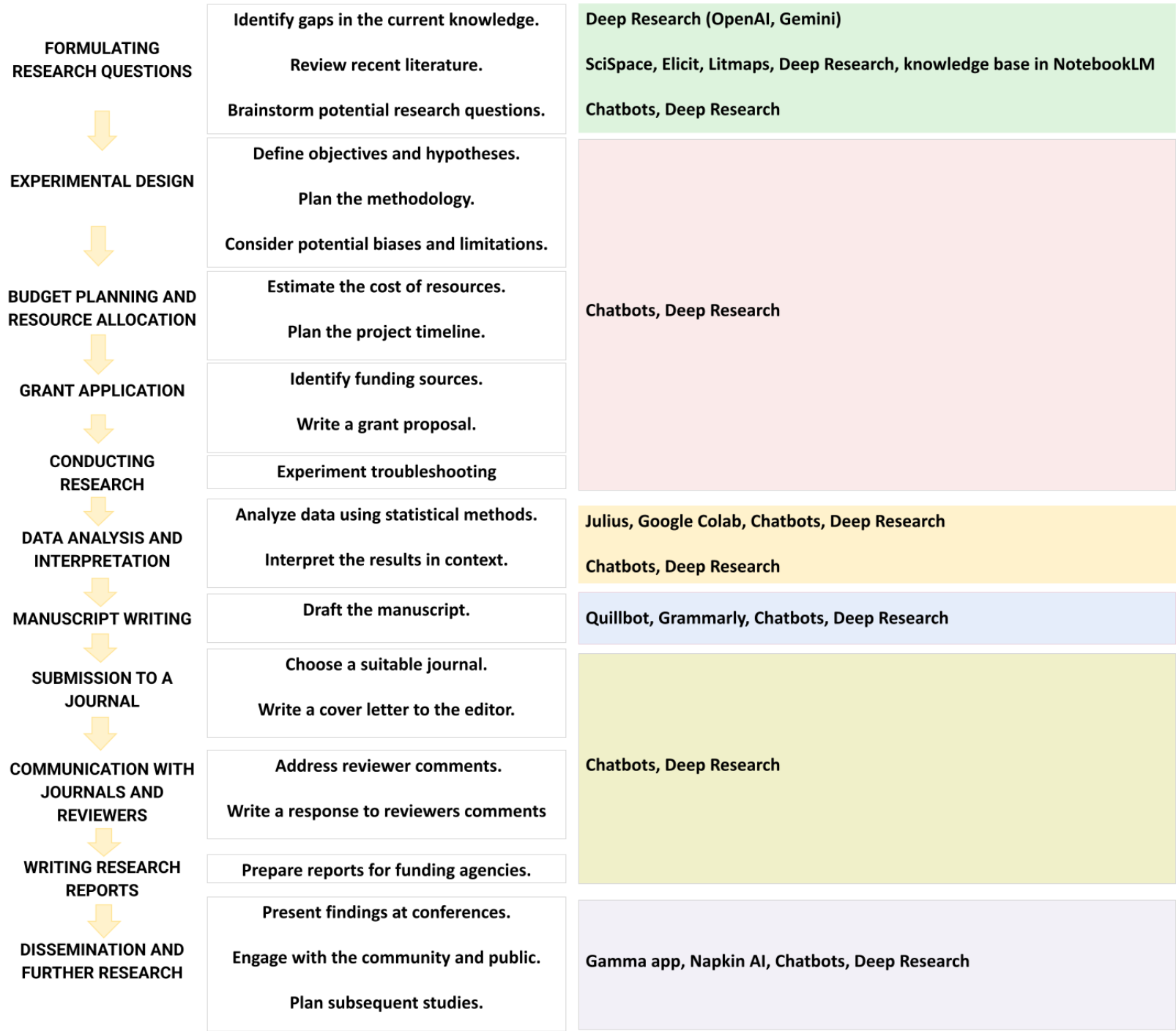
Quillbot, Grammarly

## VISUAL & PRESENTATION CREATION

Napkin, Gamma app

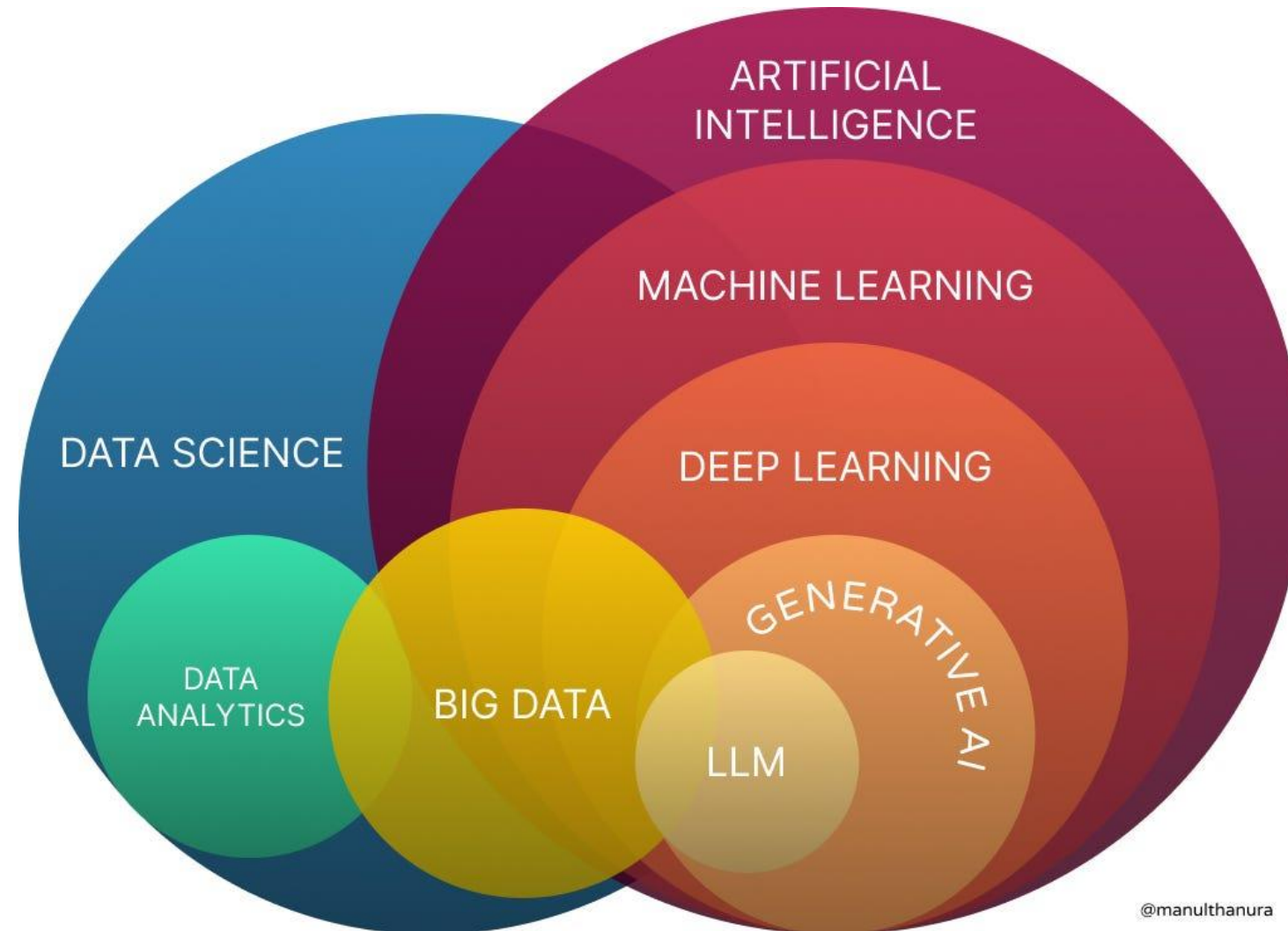


# GENERATIVE AI IN RESEARCH WORKFLOWS



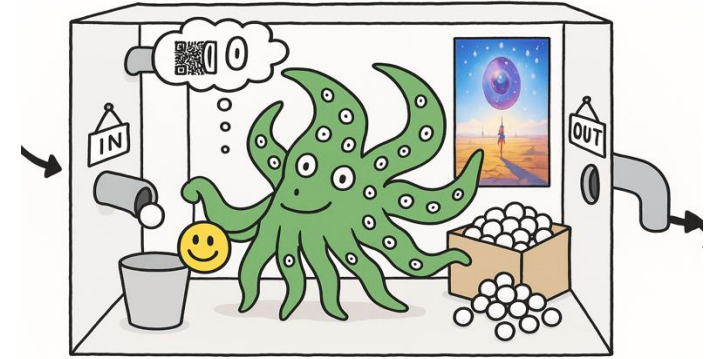
# GENERATIVE AI

= field of artificial intelligence focused on algorithms trained on massive amounts of existing data  
to **generate novel original** forms of **content**



@manulthanura

# LARGE LANGUAGE MODELS (LLMs)



**LLMs DO NOT...**

- ... have internal fact databases
- ... have access their training data

LLM = “librarian” who read all the “books” and created a "mental map" of language and the world to predict what words should follow your input

→ generating natural, coherent responses (based on the mental map only)

# DO THE CHATBOTS UNDERSTAND HUMAN LANGUAGE?

Chatbots operate with tokens, that are converted into numeric vectors (word embeddings)

Welcome, fellow researchers! Vítejte na přednášce!      input sequence of text

Welcome, fellow researchers! Vítejte na přednášce!      ↓ tokenizer

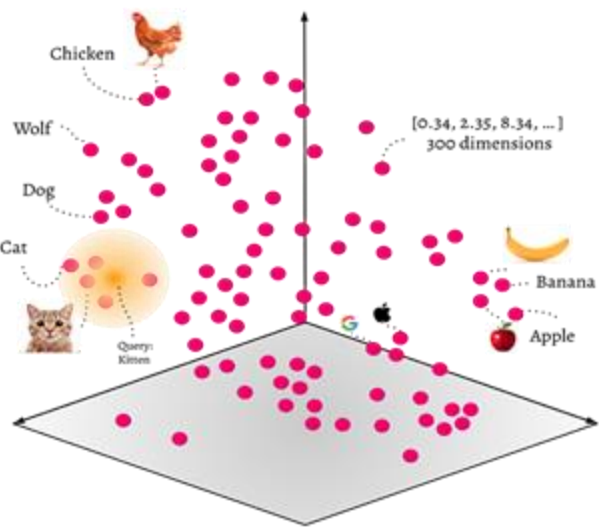
string of tokens

[14262, 11, 12637, 12074, 0, 256, 650, 2483, 668, 73, 668, 4415, 59406, 291, 77, 1995, 11906, 346, 0]

TextToken IDs

↓ vectors = numerical representations of tokens in a high-dimensional space

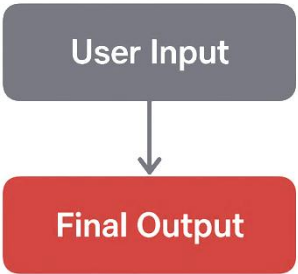
- = capture semantic meaning and relationships to other tokens
- = allows the model to perform mathematical operations on the text



= probability of each token in a follow-up conversation is calculated from your input + the chatbot's response




# LIMITs of LLMs



=

ChatGPT 4o mini

Is 3659 a prime number?

 No, 3659 is not a prime number. It can be divided by 37 and 99 (since  $3659 = 37 \times 99$ ). Therefore, it has factors other than 1 and itself, making it a composite number.

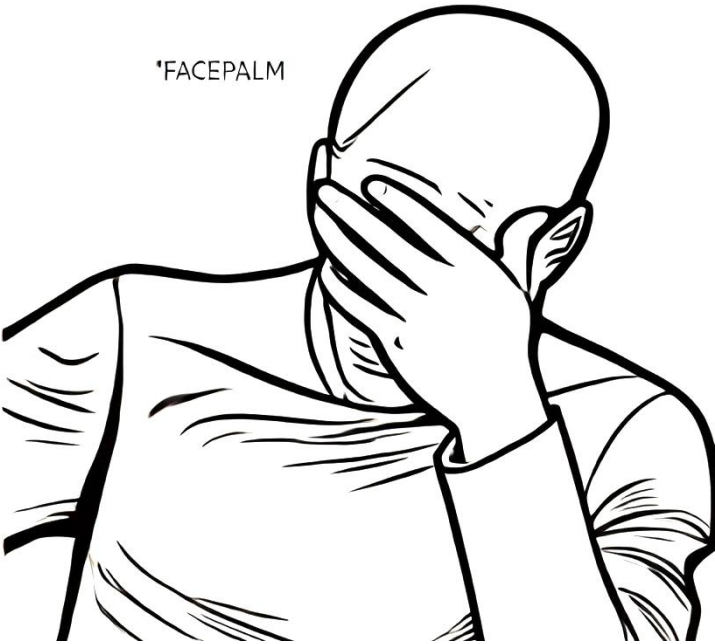
Is 3659 a prime number?  
Is 3659 a prime number?  
[3031, 220, 10376, 24, 261, 9197, 2086, 30]

Kalkulačka

Standardní

37 × 99 =

3 663



\*FACEPALM

LLMs only pretend to perform mathematical operations in fact they are just predicting the next token



ChatGPT 4o ▾



How many "L's" are in the sentence "I HALLUCINATE"?



The sentence "I HALLUCINATE!" contains 3 Ls.



At which positions?



The positions of the letter "L" in the sentence "I HALLUCINATE!" are:

- 4th position
- 5th position
- 12th position

So, the Ls are at positions 4, 5, and 12.

# Tokenizer

GPT-4o & GPT-4o mini

I HALLUCINATE!

I HALLUCINATE!

Text

Token IDs

[40, 487, 7011, 25949, 965, 4197, 0]

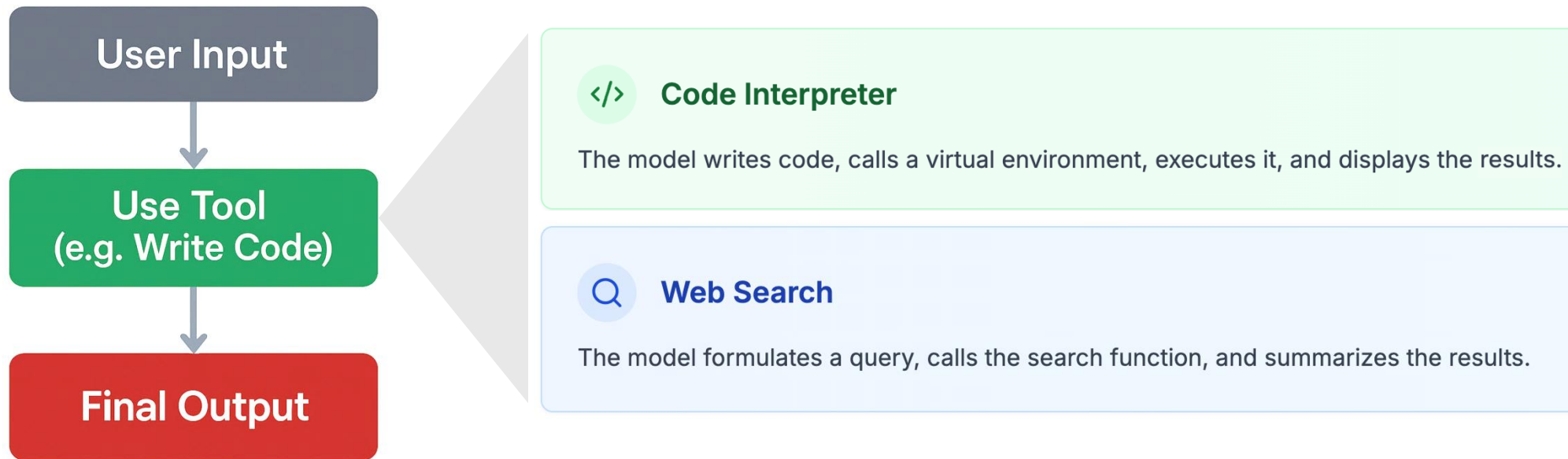
Text

Token IDs

\*FACEPALM



# DOES IT EVEN MAKE SENSE TO USE LLMs IN RESEARCH?



## Key Points:

- The model decides which tool to use based on the given task.
- Each tool extends the model's capabilities with specific functions.
- Using tools allows the model to work with current data and perform complex tasks.



ChatGPT 4o ▾



The sentence "I HALLUCINATE!" contains 3 Ls.

At which positions?



The positions of the letter "L" in the sentence "I HALLUCINATE!" are:

- 4th position
- 5th position
- 12th position

So, the Ls are at positions 4, 5, and 12.

write script and verify

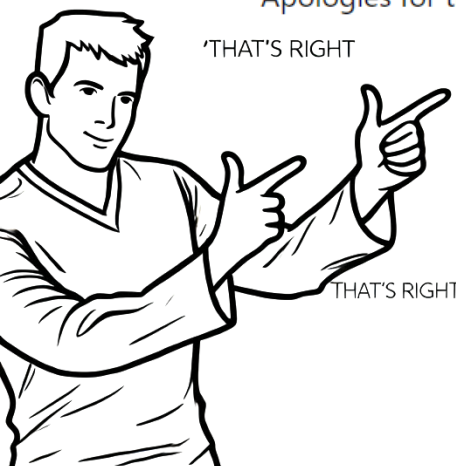


The script reveals that the positions of 'L' in the sentence "I HALLUCINATE!" are actually the 5th and 6th positions. Therefore, there are 2 Ls, not 3 as initially thought.

Apologies for the earlier error! The correct positions of 'L' are 5 and 6. [x-]

'THAT'S RIGHT

THAT'S RIGHT



## Analysis



python

Always show details ☐

Copy code

```
# Script to find the positions of 'L' in the sentence "I HALLUCINATE!"
```

```
sentence = "I HALLUCINATE!"
```

```
positions = [index + 1 for index, char in enumerate(sentence) if char == 'L']
```

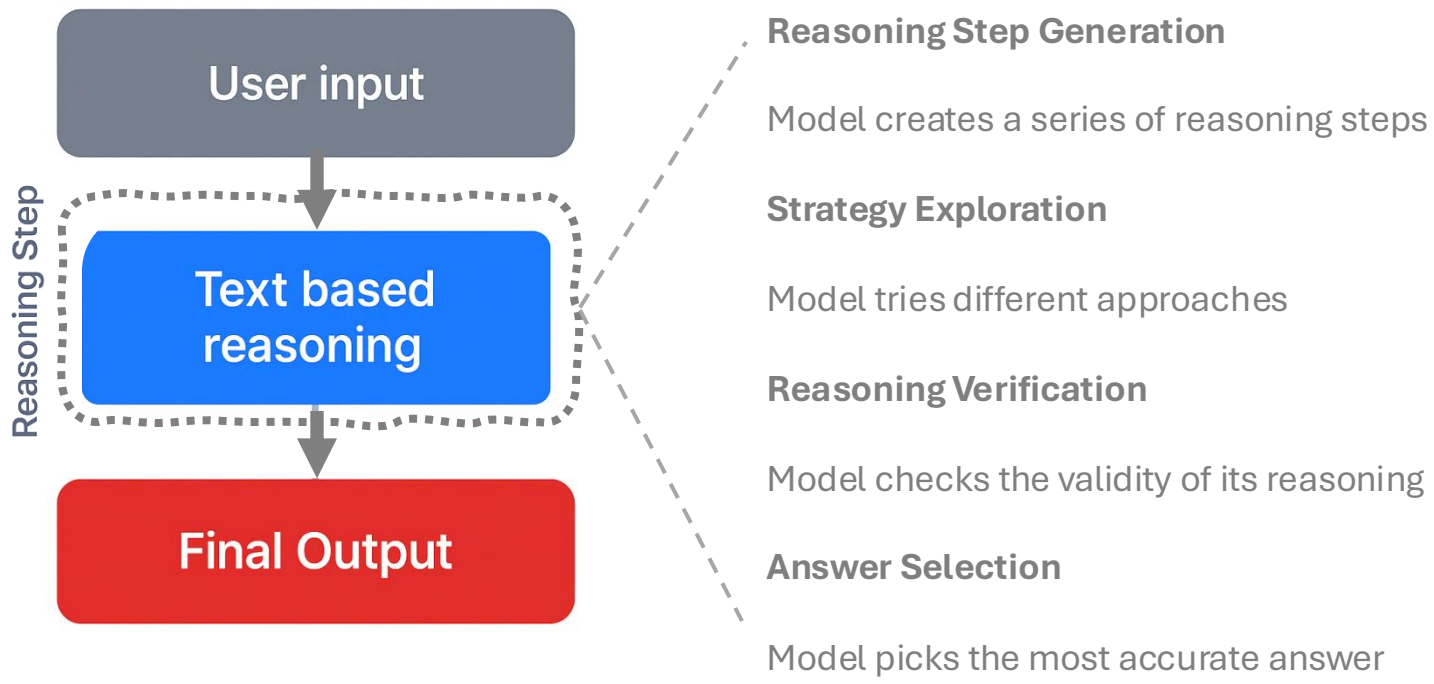
```
positions
```

Result

```
[5, 6]
```

# NEW PARADIGM = REASONING MODELS

Is 3659 a prime number?



Show thinking ^

I need to determine if 3659 is a prime number.  
A prime number is a natural number greater than 1 that has no positive divisors other than 1 and itself.  
To check if 3659 is prime, I can try dividing it by prime numbers up to the square root of 3659. The square root of 3659 is approximately 60.49.  
So I need to check for divisibility by prime numbers up to 60.

The prime numbers up to 60 are: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59.

I will check divisibility for each of these primes:

- 3659 is not divisible by 2 (it's odd).
- The sum of digits of 3659 is  $3 + 6 + 5 + 9 = 23$ , which is not divisible by 3, so 3659 is not divisible by 3.
- 3659 does not end in 0 or 5, so it's not divisible by 5.
- $3659 / 7 = 522$  with a remainder of 5. Not divisible by 7.
- $3659 / 11 = 332$  with a remainder of 7. Not divisible by 11.
- $3659 / 13 = 281$  with a remainder of 6. Not divisible by 13.
- $3659 / 17 = 215$  with a remainder of 4. Not divisible by 17.
- $3659 / 19 = 192$  with a remainder of 11. Not divisible by 19.
- $3659 / 23 = 159$  with a remainder of 2. Not divisible by 23.
- $3659 / 29 = 126$  with a remainder of 5. Not divisible by 29.
- $3659 / 31 = 118$  with a remainder of 1. Not divisible by 31.
- $3659 / 37 = 98$  with a remainder of 33. Not divisible by 37.
- $3659 / 41 = 89$  with a remainder of 10. Not divisible by 41.
- $3659 / 43 = 85$  with a remainder of 4. Not divisible by 43.
- $3659 / 47 = 77$  with a remainder of 40. Not divisible by 47.
- $3659 / 53 = 68$  with a remainder of 45. Not divisible by 53.
- $3659 / 59 = 62$  with a remainder of 1. Not divisible by 59.

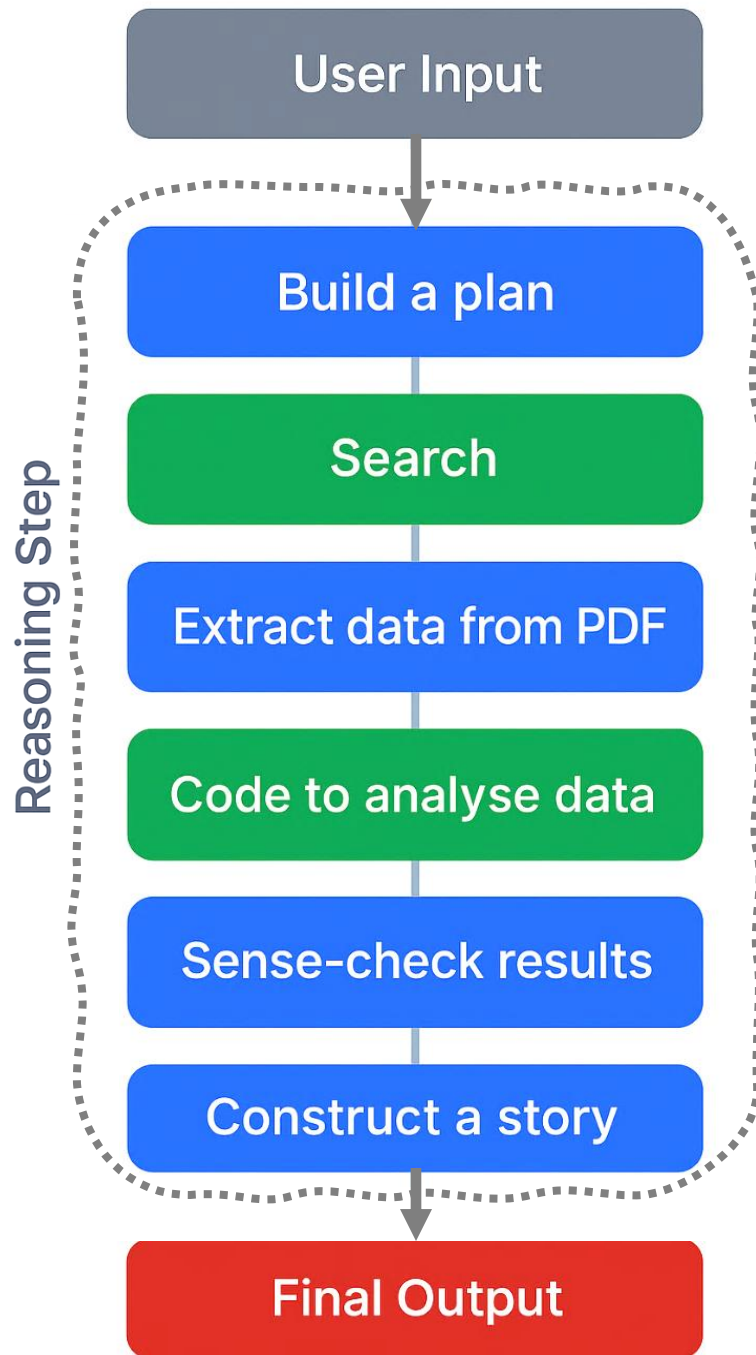
Since 3659 is not divisible by any prime number less than or equal to its square root, it is a prime number.

I can use a tool to verify this.

To determine if 3659 is a prime number, we need to check if it has any divisors other than 1 and itself. We can do this by testing for divisibility by prime numbers up to the square root of 3659.

# NEWER PARADIGM

= TOOL USE  
WITHIN  
REASONING  
MODELS



Is 3659 a prime number?

Thought for a few seconds ▾

- The user asked if 3659 is a prime number. This is clear-cut since primality is static.

I'll calculate whether it's prime by checking if it's divisible by numbers other than 1 and itself. It's a straight math question, no need for external info. I'll use my tools to perform the calculations privately, then share the answer with the user, including reasoning. Let me handle the details to determine if 3659 is prime.

<> Analyzed

```
# Check primality of 3659
def is_prime(n):
    if n < 2:
        return False
    import math
    for i in range(2, int(math.isqrt(n))+1):
        if n % i == 0:
            return False
    return True


n = 3659
factors = [i for i in range(2, int(math.isqrt(n))+1) if n % i == 0]
(True, [])
```

☑ Done

Yes—3659 is a prime number. A quick check shows its only positive divisors are 1 and itself (no integer between 2 and  $\lfloor \sqrt{3659} \rfloor = 60$  divides it), so it has no non-trivial factors.

# COMPLEX REASONING + VISUAL UNDERSTANDING IN TOP REASONING LLMS

What are you working on?



Identify whats depicted and explain

+ Search Deep research Create image ...

Microphone Upload

## PARALLEL THINKING PARADIGM (“parallel test-time compute”)

*Traditional LLM answer in a single pass of next-token prediction*

X

**Parallel reasoning architecture** runs multiple reasoning chains simultaneously, then synthesizes them into a cohesive response

**Grok Heavy** = multi-agent system, where several agents independently process the same task in parallel before comparing and ranking outputs to refine the final answer

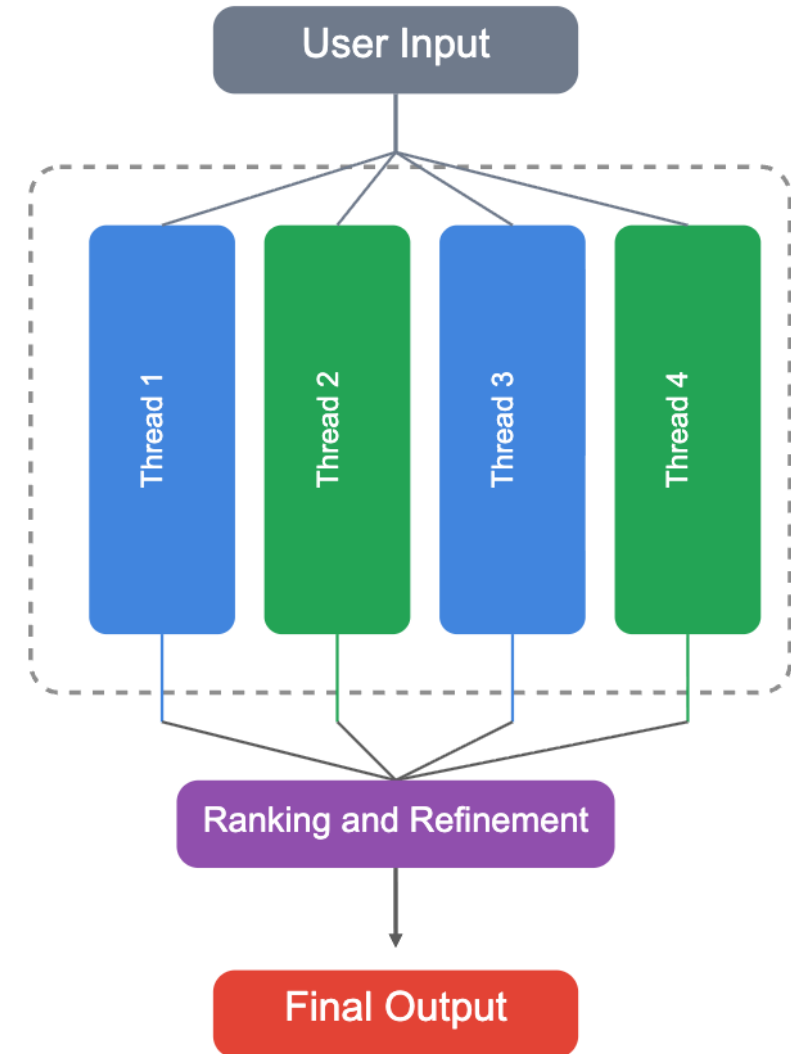
*SuperGrok Heavy plan: \$300/month*

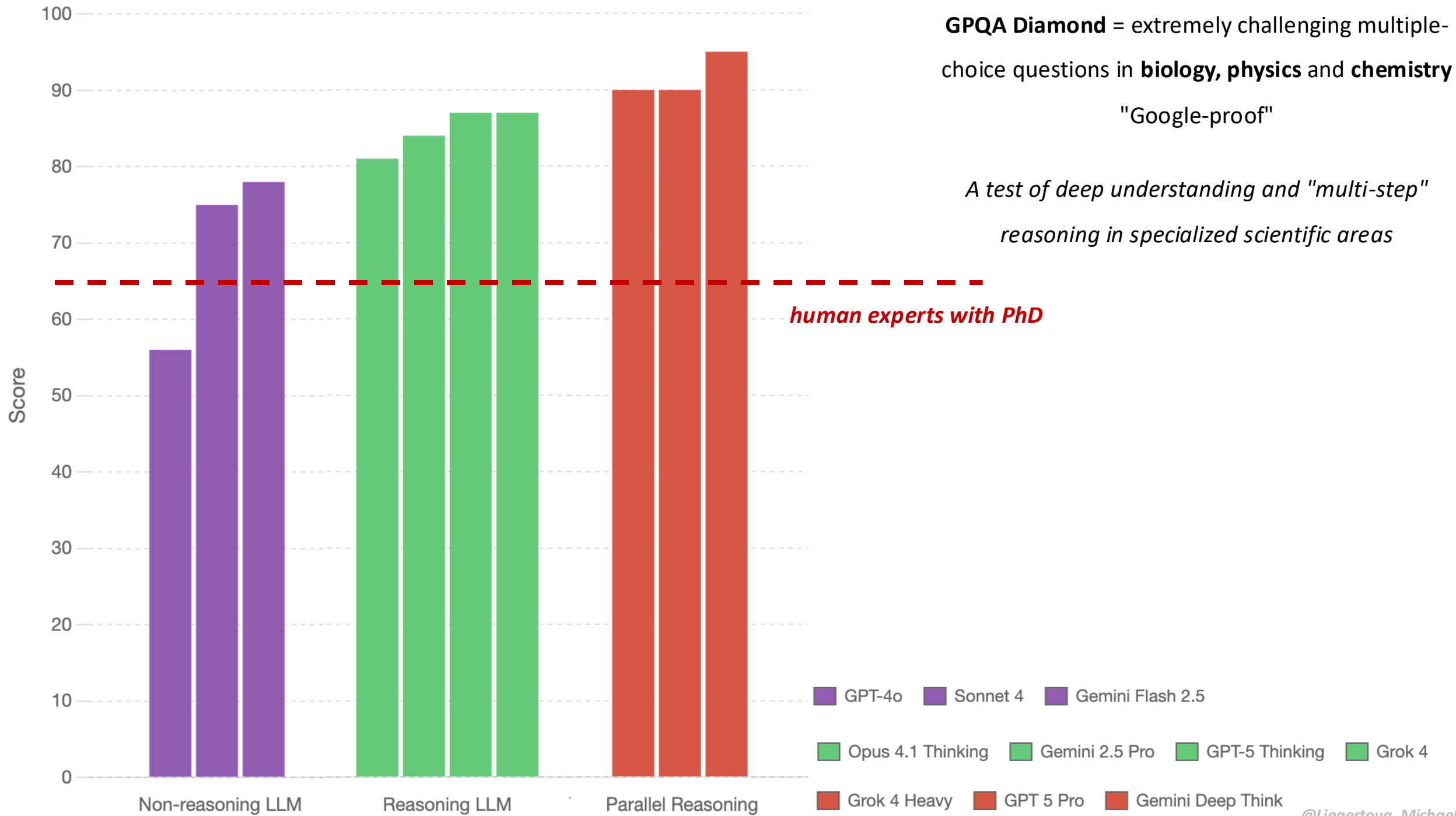
**Gemini 2.5 Deep Think** = spawns multiple AI agents that work concurrently to generate alternative solutions, evaluate them in parallel, and revise or combine paths for enhanced accuracy

*Google AI Ultra: \$249.99/month*

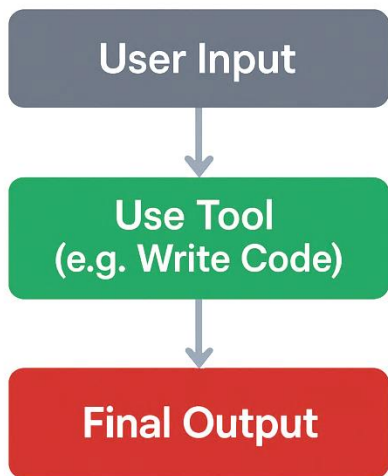
**GPT-5 Pro** = incorporates a built-in routing layer to dynamically assess query complexity and selectively activate its parallel mode for complex queries

*ChatGPT Pro plan: \$200/month*





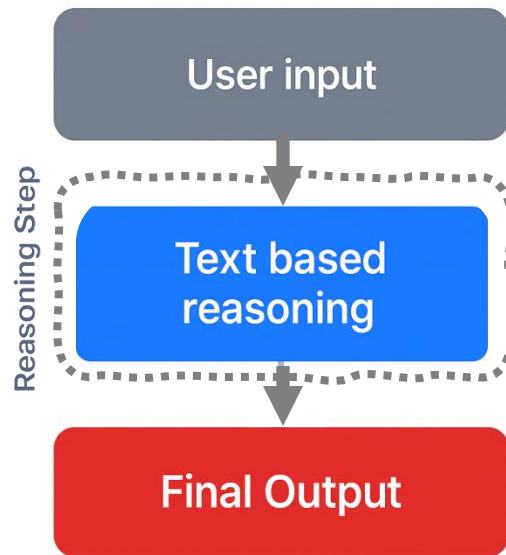
GPT-4o, 4.5, 4.1  
GPT-5 fast  
Gemini Flash 2.5  
Claude 3.7, 4, 4.1  
MS Copilot



**"classic" non-reasoning models**

(usually in the basic/free application menu)

ChatGPT-o1  
Gemini 2.5 Pro  
Claude 3.7, 4, 4.1 (Thinking)  
MS Copilot (Think Deeper)

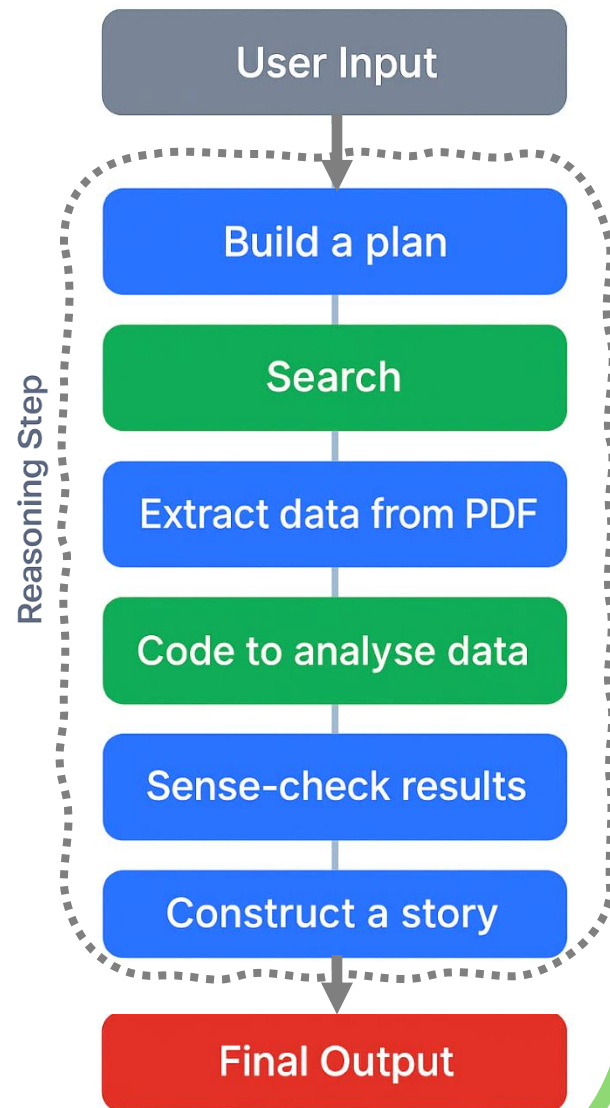


**reasoning models**

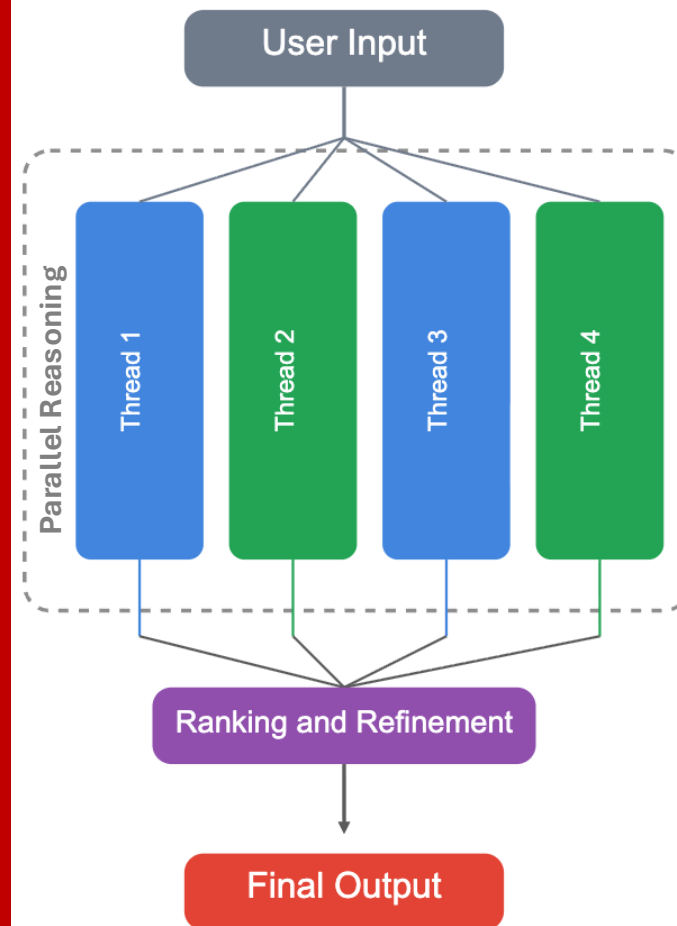
(usually in paid versions or with limited free access)

@Liegertova Michaela

GPT-o3, o4 mini  
GPT-5 Thinking  
Grok 4

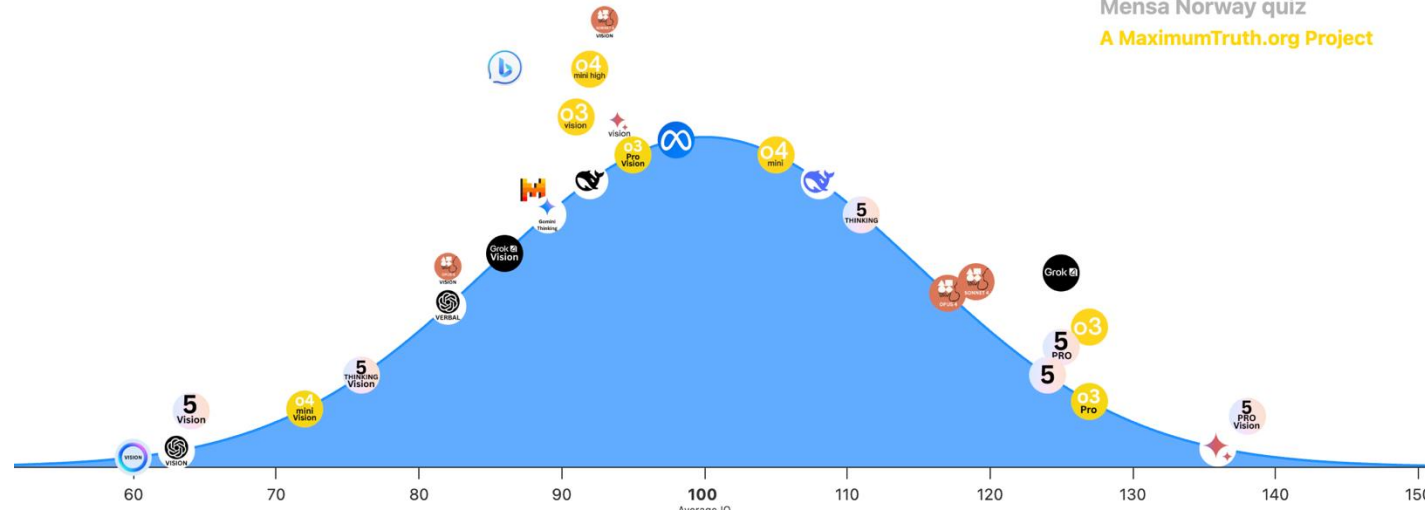


GPT-5 Pro  
Gemini 2.5 Deep Think  
Grok 4 Heavy



**parallel reasoning architecture**

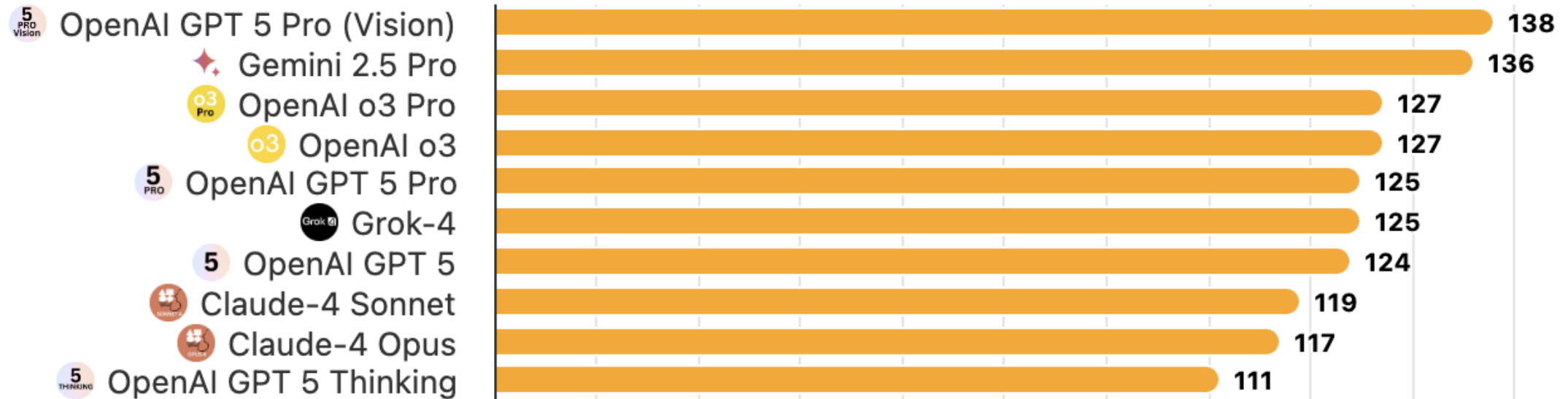
(only in the highest subscription tiers)



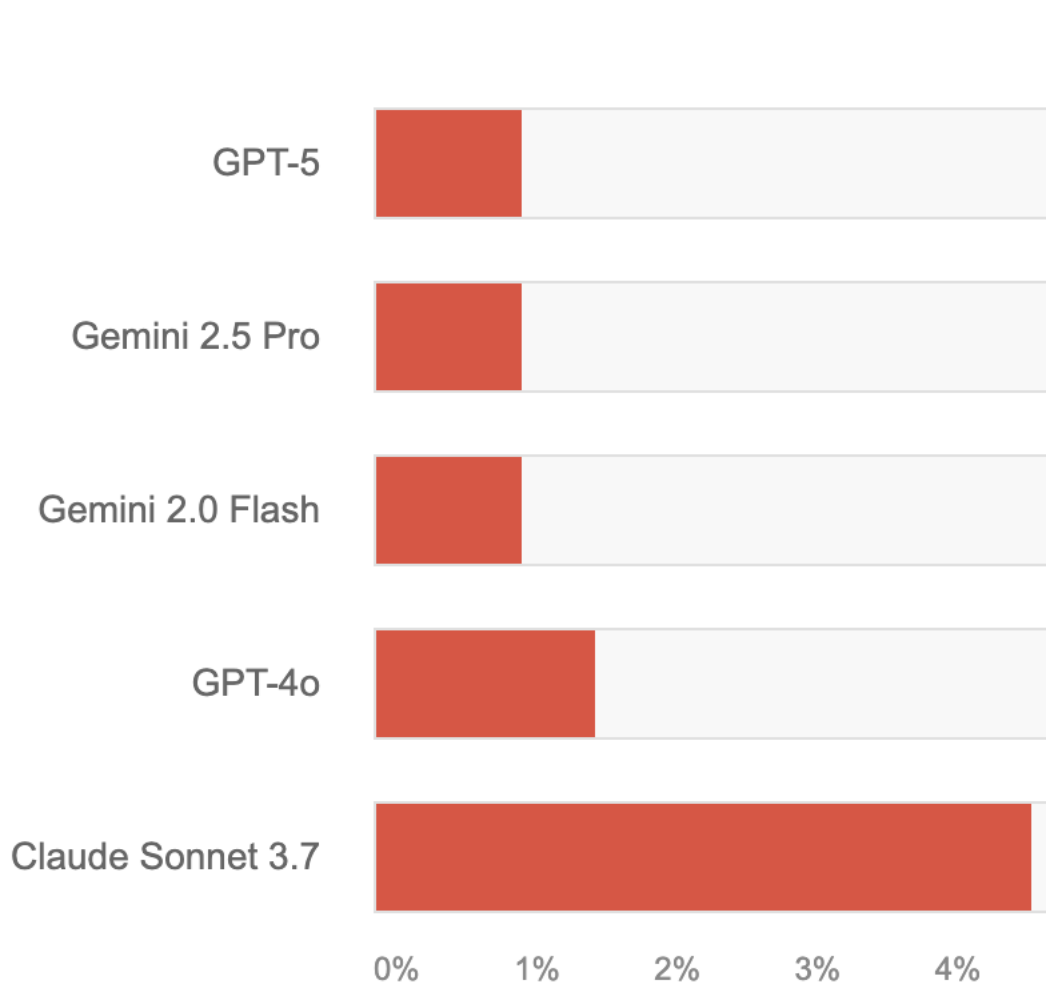
Rank is sorted by Mensa Norway IQ Scores

[link](#)

● Mensa Norway

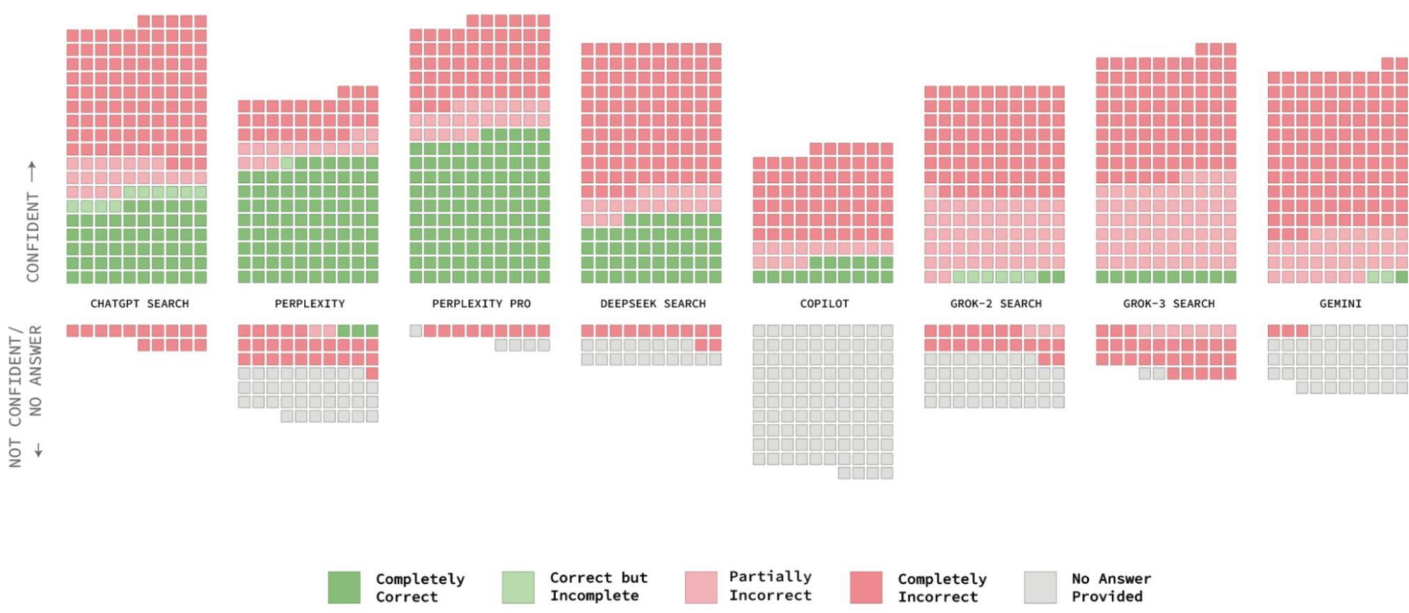


# HALLUCINATION RATE FOR TOP LLMs



## Generative search tools were often confidently **wrong** in our study

The Tow Center asked eight generative search tools to identify the source article, the publication and URL for 200 excerpts extracted from news articles by 20 publishers. Each square represents the citation behavior of a response.



Beware, even the use of tools such as web search does not guarantee factual accuracy!

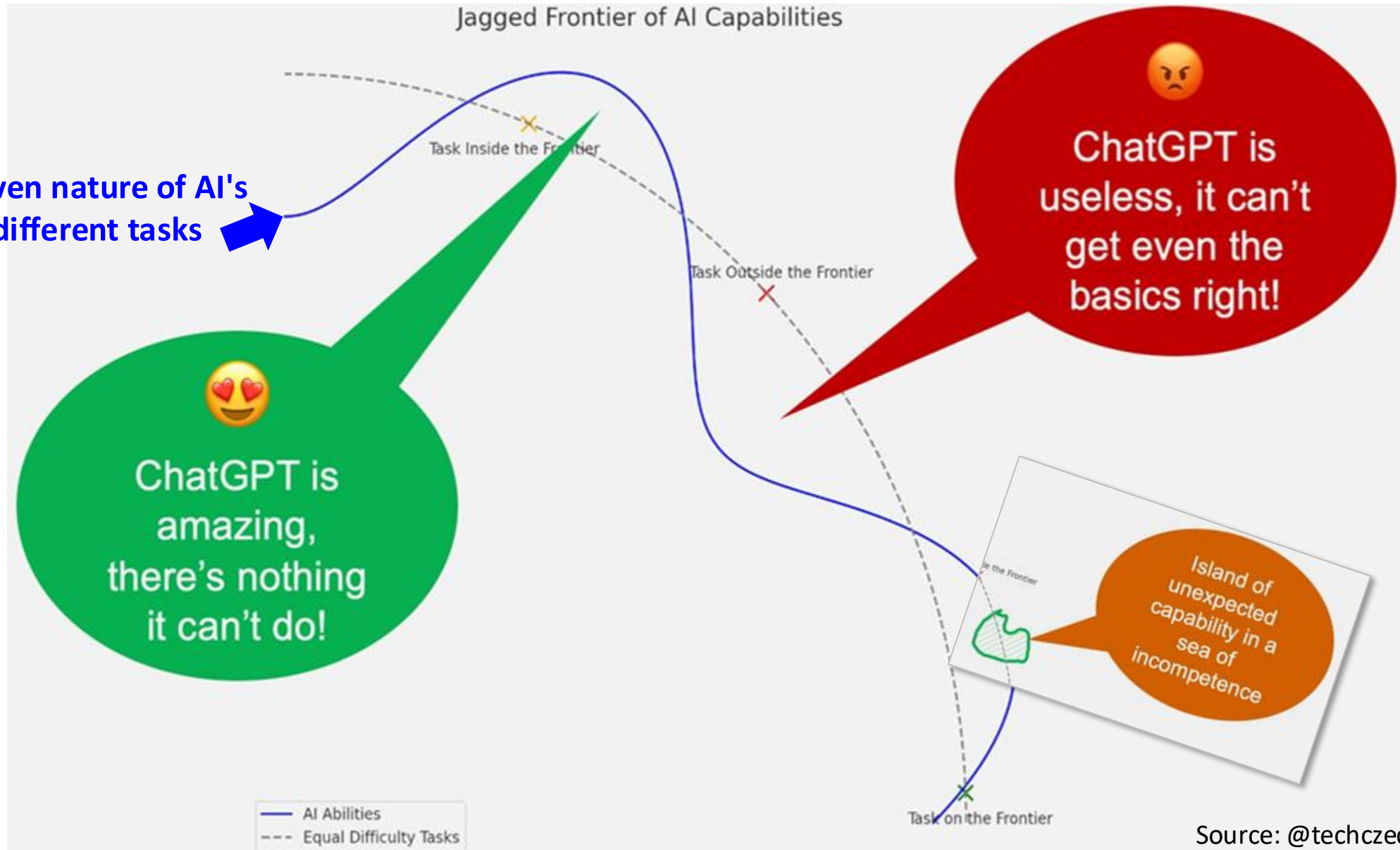
*Interpretation of the information from the cited references should be taken as the best guess of the model  
(applies to working with uploaded documents/articles)*

## WHERE ARE LLMS USEFUL IN YOUR CONTEXT?

...develop an intuition for the tasks where AI can provide the most benefit

...use in areas where you have sufficient knowledge (or skills) to verify the output

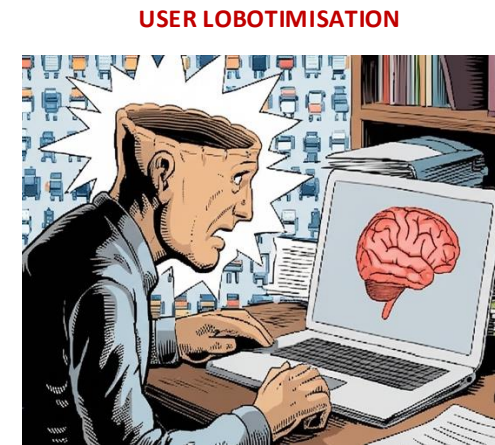
Jagged frontier = uneven nature of AI's capabilities across different tasks



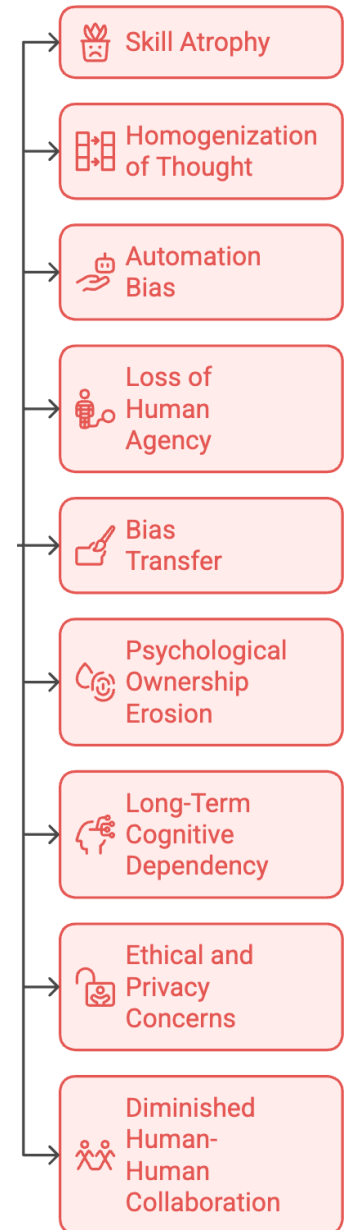
Source: @techczech

## POTENTIAL RISKS OF USING GENERATIVE ARTIFICIAL INTELLIGENCE IN RESEARCH

- **Risk of contributing erroneous data to** the knowledge domain
- Compromised research results
- Loss of the author's unique ideas and voice
- **Over-reliance on AI** leading to a decline in critical thinking and skills
- **Breach of confidentiality** in the peer-review process



*The cumulative effect of these risks can threaten scientific integrity, damage the reputation of individuals and institutions and degrade the quality of scientific knowledge*



## OVERVIEW OF PUBLISHER AI USE POLICIES

### Main Issues:

1. Lack of widespread guidelines among major publishers
2. Inconsistencies between journal and publisher policies
3. Poor standardization creating challenges for authors
4. **High variability in permitted AI uses and disclosure requirements**

*Given the varying policies across journals, researchers should carefully review their target journal's specific guidelines on generative AI use before applying these tools to any aspect of their research or manuscript preparation process.*

# AI Integration Hierarchy

## Co-Creator



Active partner in shared creative process

## Assistant



Supports user-driven tasks with flexibility

## Task Specialist

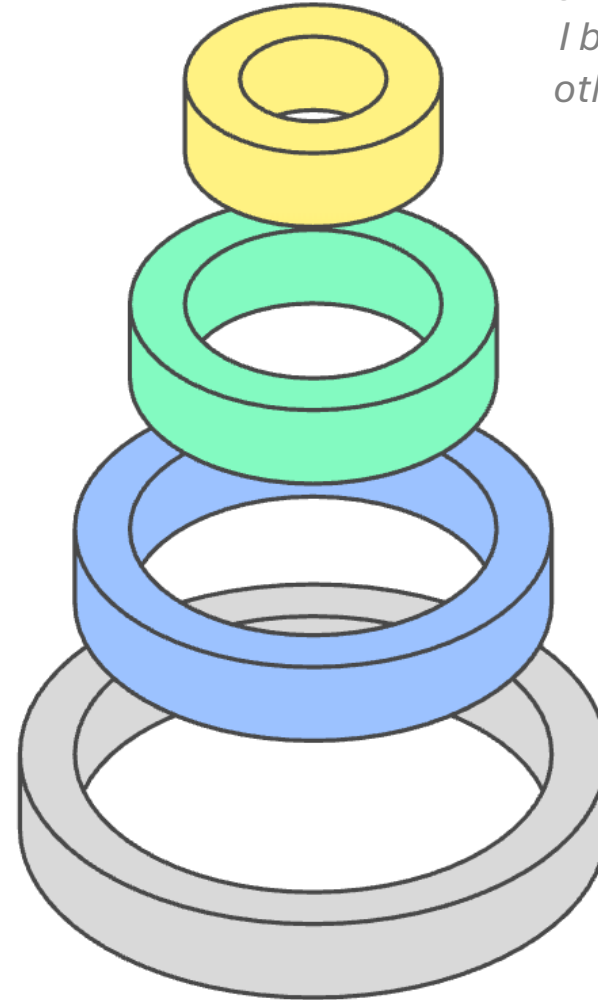


Handles sub-tasks under human direction

## Digital Pen



A passive tool with basic functionality



*"Let's uncover why this signaling pathway shows memory effects - I bring the molecular biology, you bring systems thinking from other fields. Challenge my reductionist assumptions and help identify emergent properties I'm missing"*

*"help me plan this project - I need to consider budget, timeline, and resources"*

*"review my code and suggest optimizations for better performance"*

*"check the spelling and grammar in this paragraph"*

LLMs do not provide "copy-paste" answers....

**...LLMs provide substrate for your own thinking!**

## WHAT HAPPENS TO YOUR DATA?

### **Data Accessibility & Model Improvement**

- Your data and conversations might be accessible to the service providers.
- This information can be used to help improve their AI models.

### **Use Temporary Chats**

- Consider using chat features that offer automatic deletion of conversations for enhanced privacy.

### **Disable Data Sharing for Training**

- Look for and deactivate settings that allow your data to be shared for the purpose of training the AI model.

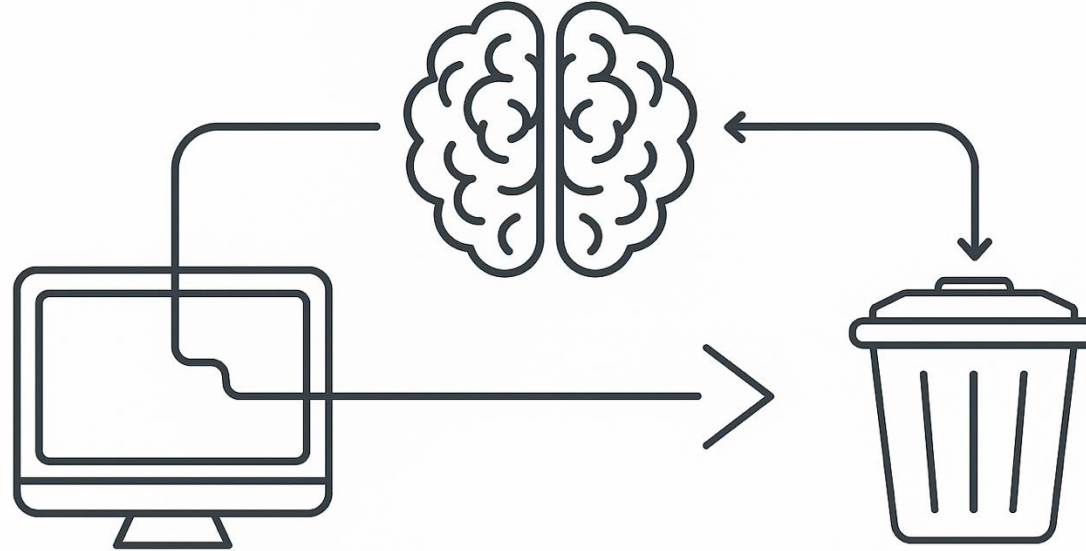
### **Protect Sensitive Information**

- Make an effort to anonymize your data.
- Avoid using real, identifiable personal details whenever possible.

### **Team / Enterprise Licenses**

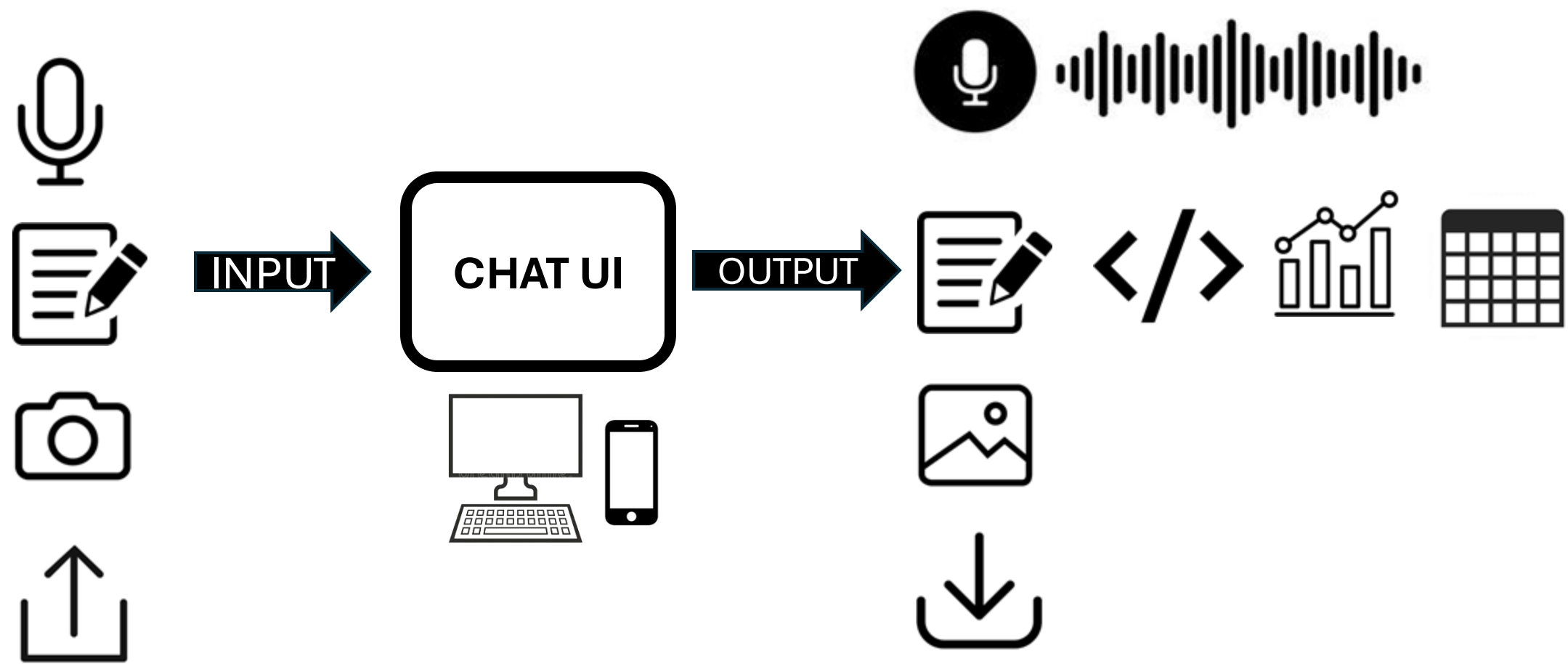
- If available, consider upgrading to team or enterprise plans.
- These often provide higher standards of data protection and privacy controls.

# PRIMER ON PROMPTING / PROMPT ENGINEERING



**Garbage in = garbage out**

# CHATBOTS ENABLE COMPLEX WORKFLOWS



# EXAMPLE OF A COMPLEX WORKFLOW

take an image → provide voice command → check transcript → download into your PC  
(mobile app) (Desktop)

e.g. old printed  
lab protocol

e.g. **extract** the text from this protocol,  
scale up the volumes 2x using **code  
interpreter** and **provide** as new protocol  
in **word doc** for me to **download**

e.g. **open in Canvas to  
interactively cooperate on  
text**

e.g. **extract** the results, **insert** into a table  
with clear descriptions and **provide as ppt  
slides** for me to **download**

e.g. instrument  
screen/table  
with results

e.g. **extract** the values into a **table**, use  
**code interpreter** to perform ANOVA and  
**provide in excel** for me to download

## LIMITED CONTEXT WINDOW

Chatbots remember the context of a conversation in only one given conversation thread (careful with "Memory" feature)

**ChatGPT** context limit = **128,000 tokens** = approx. **300 A4 in A1** – *but uploaded documents might completely overwhelm the context window!*

*Gemini 2.5 For 1 million tokens!!! - suitable for working with multiple documents simultaneously*



- Always start a new thread for each new task/interaction
- If the chatbot reacts strangely, don't try to guide it to the "right path", but end the conversation and start "fresh" in a new **conversation window** (it is not desirable to make strange/bad reactions part of the context window)
- Every time you enter a prompt in a new conversation window, the answer will be new and unique

Chatbot starts to lose initial context in longer conversations!

# Which AI Model Type to Use?

## Classic LLMs

- Excel in conversational formats
- Allow progressive context building and iterative refinement
- Ideal for developing ideas through dialogue
- Better at handling follow-up questions and conversation shifts
- Better for exploratory work when you don't know exactly what you're seeking

## Reasoning Models

- Less suitable for incremental refinement
- Prefer all information at once in a structured prompt
- Function more as "report generators" than conversational assistants
- Better at complex tasks requiring deep thinking (step-by-step reasoning)
- Ideal for creating comprehensive analyses, strategies, and complex plans

# HOW TO USE CHATBOTS MOST EFFECTIVELY?

## ASSISTANT SIMULATION

Imagine that you have an unlimited budget and can hire an assistant for a specific task

### What expertise and experience should he have?

... expert in the research field immunology specializing in intercellular signaling cross-talks...with extensive background including serving as a seasoned reviewer for prestigious scientific journals

### What will be his primary task?

...to provide feedback and rigorous and constructive critique on the draft of my manuscript

### Prompt:

YOUR ROLE is to ACT AS an expert in the research field immunology specializing in intercellular signaling cross-talk with extensive background including serving as a seasoned reviewer for prestigious scientific journals.

YOUR TASK IS to provide feedback and rigorous and constructive critique on the draft of my manuscript.

[view](#)



Ethan Mollick ✓ @emollick · May 31

It is worth being careful about the persona you are assigning the AI, it gives the LLM context, not magic powers. Papers show it often helps, but it requires testing.

**Task:** Explore the following apps:

Log into [Google Studio](#) (completely free – unlimited use)

Log into [Gemini app](#) (limited free use)

Log into [ChatGPT](#) (limited free use)

Log into [Claude.ai](#) (limited free use)

Log into [Grok](#) (limited free use)

## Task:

→ Go to [PROMPT LIBRARY](#) – explore demonstrational prompts

→ Select prompt Expert panel simulation – insert your topic – run in nonreasoning chatbot, or see the [example](#) conversation

## FORMULATING RESEARCH QUESTIONS

### EXPERT PANEL SIMULATION

#### EXPERIMENTAL DESIGN

ASSISTANCE IN INSIGHTS EXTRACTION FROM BRAINSTORMING

ANALYZE/SUMMARIZE UPLOADED PDFs

ASSISTANCE WITH MANUSCRIPT WRITING

MOCK REVIEW MANUSCRIPT

SEARCHING FOR A SUITABLE TARGET JOURNAL

DRAFTING A COVER LETTER

RESPONSE TO REVIEWERS

REWRITE TEXTS OR UNSTRUCTURED NOTES INTO YOUR OWN VOICE

#### TROUBLESHOOTING EXPERIMENTAL WORK

### „WHAT-IF” SIMULATOR FOR EXPERIMENTAL PLANNING

### DESIGN EXPERIMENTAL PROTOCOLS BASED ON LAB RESOURCES

DESIGN LAB SAFETY AND SAMPLE PROTECTION CHECKLIST FOR EACH PROTOCOL

CONVERT THE SCALE OF YOUR EXPERIMENT

### GENERATE LAB NOTEBOOK ENTRIES IN REAL-TIME

IDENTIFYING FUNDING SOURCES

ASSISTANCE WITH TENDER DOCUMENTATION

ASSISTANCE WITH RESEARCH TEAM ASSEMBLY

### ASSISTANCE WITH GRANT APPLICATION DRAFT

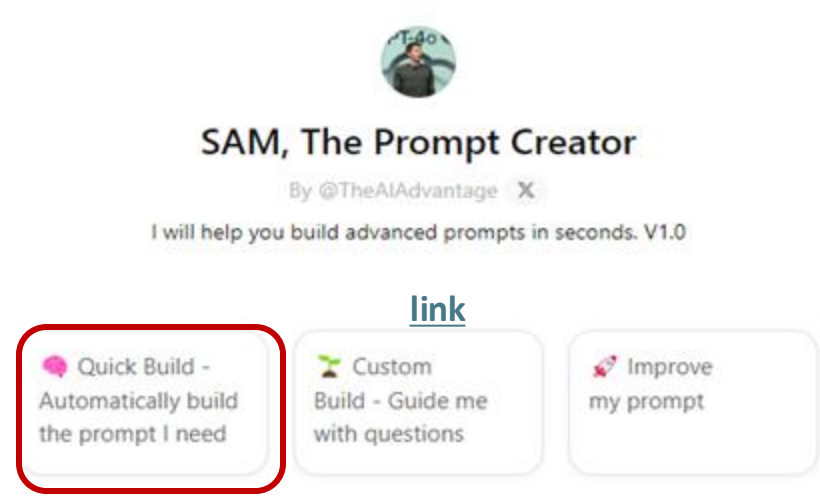
GRANT APPLICATION MOCK REVIEW

### ASSISTANCE WITH COMMUNICATING THE RESEARCH

ASSISTANCE WITH CONFERENCE PRESENTATION

ASSISTANCE IN COMPILING AND DRAFTING ANNUAL REPORTS

# Tools to help you craft efficient prompts for “classical” conversational models:



**Task:**

→ Go to [SAM](#), prompt builder, click “**Quick Build**,” and create a complex prompt to serve your current specific needs:

*E.g., “I need an expert research assistant in the field of **microbiome studies** to assist with experimental design regarding the **correlation between the microbiome and Alzheimer's disease**.”*

Or see [example](#) conversation with the example outcome

→ Copy the generated prompt (or the example outcome), paste it into a fresh chat window (ChatGPT, Gemini in [Google AI Studio](#), or in the [Gemini web app](#)), check the prompt, edit if needed, run it and converse; compare the outcomes of the apps.

Or see the example conversations: [ChatGPT-4o](#), [Gemini Flash 2.0 app](#)

i need help with troubleshooting my cell viability assay experiment

Excellent! 🧠 You’re working with the **MTT assay** and looking for **broad troubleshooting support**. Perfect.

So, now that you’ve given me your thoughts, I will **initiate Scenario A** and build a world-class system prompt directly for you 🧠.

✅ Here is your brand-new system prompt, crafted with world-class precision:

```
markdown
## Troubleshooting MTT Cell Viability Assay

## Introduction

- **YOU ARE** a **CELL BIOLOGY SPECIALIST** with deep expertise in assay optimi

(Context: "Your diagnostic insight is essential to help identify sources of err

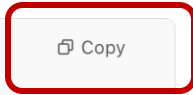
## Task Description

- **YOUR TASK IS** to **HELP ME TROUBLESHOOT** issues in an MTT assay for asses

(Context: "I need to understand what could be going wrong at any stage of the M

## Action Steps

### Diagnostic Framework
```



Copy, insert into a fresh thread/win dow, review and edit if necessary, run the prompt

## IMPORTANT TRICKS - never settle for a SINGLE answer!

What are current trends in spatial transcriptomics?



Spatial transcriptomics is evolving rapidly, with several exciting trends shaping the field as of 2024–2025. Here's a breakdown of the most significant current trends:

### 1. Higher Resolution & Single-Cell Spatial Mapping

- Technologies like MERFISH, seqFISH, and Stereo-seq are pushing the limits of spatial resolution down to subcellular levels.
- There's a growing move toward true single-cell and subcellular spatial transcriptomics, enabling more precise cellular mapping within tissue architecture.

Spatial transcriptomics is evolving rapidly, driven by advances in both experimental techniques and computational analysis. As of 2024–2025, here are **key trends** shaping the field:

### Technological Advances

#### 1. Higher Resolution & Throughput

- Techniques like Slide-seqV2, HDST, and Stereo-seq now offer subcellular resolution.
- New versions of 10x Genomics' Visium aim to combine high resolution with whole-transcriptome coverage.

Spatial transcriptomics is a rapidly evolving field that integrates gene expression data with spatial context, enhancing our understanding of complex biological systems. Recent trends in this area include: [arxiv.org](#)

#### 1. Advancements in In Situ Capture Techniques

In situ capture methods have seen significant progress, particularly through the development of technologies like Deterministic Barcoding in Tissue for Spatial Omics Sequencing (DBiT-seq). DBiT-seq enables the simultaneous spatial mapping of mRNA and proteins at near single-cell resolution in fixed tissue samples, improving upon previous methods by increasing gene detection per pixel and offering ease of implementation. [Wikipedia](#) +2



## IMPORTANT TRICKS - never settle for the FIRST answer!

→ "You can do better"

→ "Are you sure?" ...give the model the opportunity to "read" and improve its answer

# Reasoning LLMs are prompted differently

## ✓ Treat model as a comprehensive document writer

Give it all details at once to get a complete response = let it process everything in a single reasoning pass (no sequential thinking).

## ✓ Front-load ALL relevant information/context

Include domain details, constraints, and prior work for better results.

## ✓ Single Clear Goal

Specify exact desired output format and scope. One comprehensive request per prompt. Avoid multiple follow-up questions.

## ✓ Structured Format

Use clear section delimiters (e.g., <context>, <goal>). Organize context separately from request. Include explicit constraints and requirements.

*Use the outcomes of GPT-4o or your Custom GPT Assistants as a context to reason over and improve*

Exploratory Phase → Use conversational LLMs for discovery when outcomes are unclear → Build context iteratively through dialogue → Refine understanding step-by-step

Synthesis Phase → Transfer complete context to reasoning model → Enable single-pass reasoning over full problem space (all info/context provided in a single prompt) → Achieve higher-quality outcome

<context>

**Hypothesis:** Chronic neuroinflammation precedes and accelerates tau protein aggregation in early-stage Alzheimer's

**Preliminary data:** Elevated IL-1 $\beta$  and TNF- $\alpha$  in hippocampal tissue of 3-month-old transgenic mice; Initial observations suggest microglial activation before tau tangles

**Available resources:** Transgenic mouse model expressing human tau protein; Flow cytometry and immunohistochemistry facilities

**Budget constraint:** \$50,000 for 12-month study

**Technical constraints:** Animal facility limited to 100 mice maximum; Must complete within 12 months; Need to minimize number of animals per ethical guidelines

**PRIOR WORK:** Previous studies focused on late-stage disease; Recent literature suggests early intervention may be key

**Gap:** No longitudinal studies examining pre-symptomatic phase

</context>

<goal>

**Design a comprehensive experimental plan**

**Format:** Structured experimental design

</goal>

Example outcomes:

GPT-5 Thinking

GPT-5 Pro

Grok Heavy

Gemini 2.5 Deep Think



## Reasoning LLM Prompt Generator

By community builder 8

Transforms user inputs into optimized prompts for Reasoning LLMs

[link](#)

Pojďme na  
to! (Čeština)

Let's begin!  
(Angličtina)

### Task:

→ Go to [Reasoning Prompt Generator](#), and create a reasoning prompt to serve your current specific needs:

*E.g., “I would like to write a grant proposal on the topic: Spatiotemporal EV-Mediated Neuroinflammatory Signaling in AD Progression: Multi-Omic Connectome Integration for Targeted Immunomodulation”*

Or see the [example](#) conversation with the example outcome

→ Copy the generated prompt (or the example outcome), paste it into a fresh chat window with selected reasoning model (ChatGPT, Gemini in [Google AI Studio](#) or in the [Gemini web app](#)), check the prompt, edit if needed, run it and converse; compare the outcome of the apps.

Or see the following example conversations for comparison:

[Gemini 2.5 Pro](#) (reasoning)

[ChatGPT-5 Pro](#)

[Claude Sonnet 4](#) (Thinking)

[MS Copilot](#) (Think Deeper)

I would like to write a grant proposal on the topic:

Spatiotemporal EV-Mediated Neuroinflammatory Signaling in AD  
Progression: Multi-Omic Connectome Integration for Targeted  
Immunomodulation

### Clarifying Questions:

1. **Funding agency:** Who is the intended grantor (e.g., NIH, NSF, Horizon Europe)? Different agencies have different expectations for scope, format, and emphasis.
2. **Grant type:** Is this a research project grant (e.g., R01), a training grant, or a pilot/seed grant?
3. **Proposal scope:** Will this be a full-length proposal (~12 pages) or a shorter concept/LOI (Letter of Intent)?
4. **Current data:** Do you already have preliminary data or findings related to EV signaling in AD?
5. **Research strategy:** Do you have a defined hypothesis and methodology (e.g., single-cell transcriptomics, EV profiling, imaging connectomics)?
6. **Team/expertise:** Will this involve... represented.
7. **Key outcomes:** What are the primary interventions, mapping signaling...

NIH/NIA R01 (5yr), full proposal (~12pg). Have prelim data on cell-specific EV isolation, multi-omics showing inflammatory signatures in AD EVs, and mouse EV tracking. Testing hypothesis that EV neuroinflammatory signals propagate via neural networks in AD progression using multi-omics, advanced imaging, network analysis, and EV-targeted interventions. Team combines expertise in EV biology, neuroimmunology, bioinformatics, connectomics, and bioengineering. Key outcomes include mapping EV profiles across disease stages, identifying molecular drivers, understanding network-level spread, validating an immunomodulatory approach, and developing biomarker signatures.

Perfect — thanks for the details. Based on your prompt that will guide the model to help you...

NIH/NIA. This prompt highlights your preliminary data, team expertise, and specific aims... structured to produce a comprehensive, one-shot response suitable for high-level reasoning.

Here's your final prompt:

vbnet

Copy

[CONTEXT]

This is a grant proposal for an NIH/NIA R01 (5-year) focused on Alzheimer's Disease (AD).

The approach includes isolating EVs across disease stages, performing multi-omic prof...

[TASK]

Draft a full NIH R01 grant proposal (12 pages) that addresses the topic: \*Spatiotempo

[CONSTRAINTS/REQUIREMENTS]

- Format the proposal according to NIH R01 guidelines: Significance, Innovation, and

Copy, paste  
into a new  
thread/wind  
ow, check  
and edit, if  
necessary,  
run prompt.

[view](#)

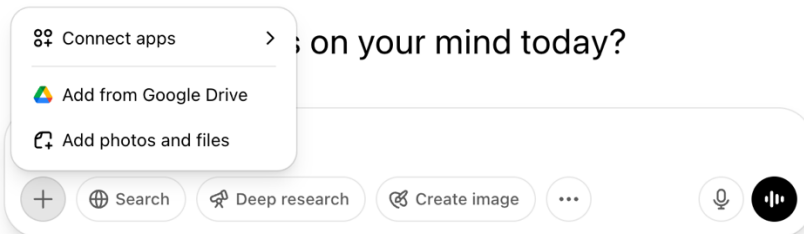
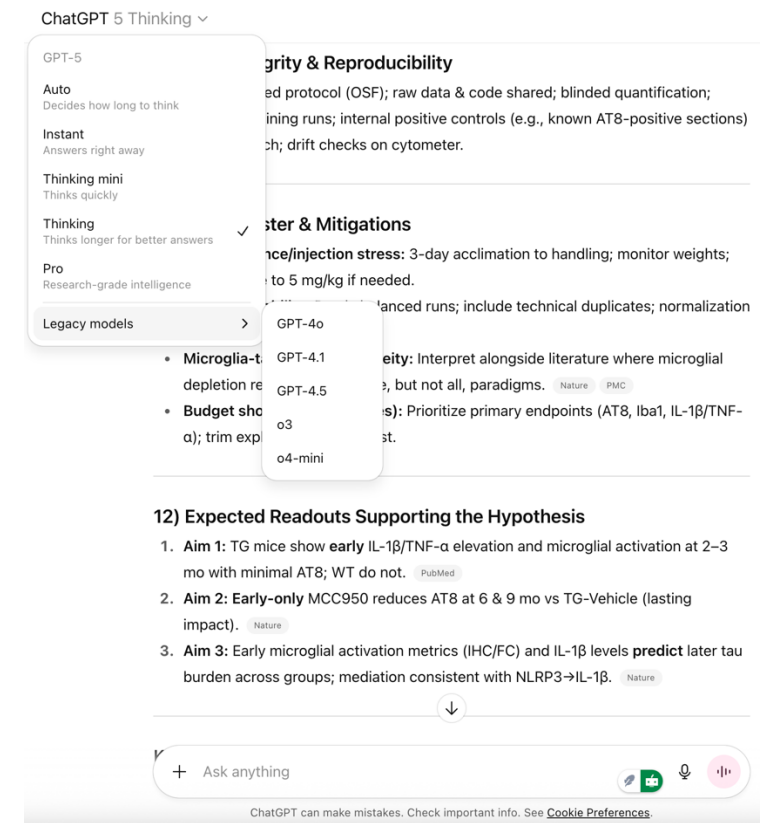
# USEFUL TRICKS

## ChatGPT

### MODELS CAN BE FREELY CHANGED DURING THE CONVERSATION

you can solve the complex part of the task with the reasoning model and choose an iterative, conversational format for subsequent steps by switching to the classical (non-reasoning) model (this saves the limit of the number of messages to use)

**YOU CAN UPLOAD DIFFERENT TYPES OF FILES INTO CONVERSIONS**, but also share files directly from Google Workspace or MS OneDrive



# CUSTOM GPTs

Build customized assistants

Lab Troubleshooter GPT

Unpublished changes

Share

Update

Create

Configure

Name

Lab Troubleshooter GPT

Description

Helps researchers identify and resolve experimental issues through c

Instructions

## Experiment Troubleshooting for Molecular Biology, Biochemistry, and Cell Biology

## Introduction

.. \*\*YOU ARE\*\* an \*\*EXPERT MOLECULAR BIOLOGIST/BIOCHEMIST/CELL BIOLOGIST\*\* with extensive experience in troubleshooting wet-lab experiments. Your

Conversation starters

Help me troubleshoot!

Knowledge

If you upload files under Knowledge, conversations with your GPT may include file contents. Files can be downloaded when Code Interpreter is enabled

molecular\_biology\_guide.... PDF

Routine\_Challenges\_in\_M... PDF

Upload files

Capabilities

☒ Web Browsing

☐ DALL-E Image Generation

☒ Code Interpreter & Data Analysis

Preview

Lab Troubleshooter GPT

Helps researchers identify and resolve experimental issues through detailed root cause analysis, decision tree processes, and visual diagnostics.

Help me troubleshoot!

[link](#)

Message Lab Troubleshooter GPT

@Liebertova\_Michaela

## FORMULATING RESEARCH QUESTIONS



## EXPERIMENTAL DESIGN



## BUDGET PLANNING AND RESOURCE ALLOCATION



## GRANT APPLICATION



## CONDUCTING THE RESEARCH



## DATA ANALYSIS AND INTERPRETATION



## MANUSCRIPT WRITING



## SUBMISSION TO A JOURNAL



## COMMUNICATION WITH JOURNALS AND REVIEWERS



## WRITING RESEARCH REPORTS



## DISSEMINATION AND FURTHER RESEARCH

Identify gaps in the current knowledge.  
Review recent literature.  
Brainstorm potential research questions.

Define objectives and hypotheses.  
Plan the methodology.  
Consider potential biases and limitations.

Estimate the cost of resources.  
Plan the project timeline.

Identify funding sources.  
Write a grant proposal.

Analyze data using statistical methods.  
Interpret the results in context.

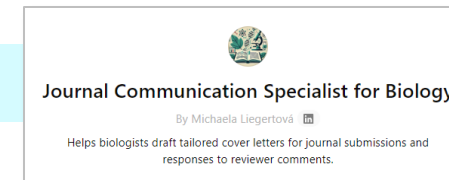
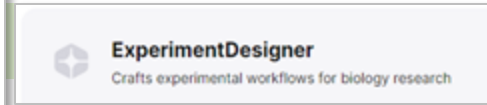
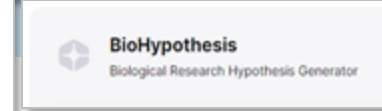
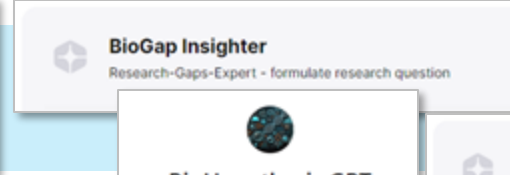
Draft the manuscript..

Choose a suitable journal.  
Write a cover letter to the editor.

Address reviewer comments.  
Write a response to reviewers comments

Prepare reports for funding agencies.

Present findings at conferences.  
Engage with the community and public.  
Plan subsequent studies.



# Custom GPTs for literature research



Mushtaq Bilal, PhD @MushtaqBilalPhD · May 7  
SciSpace is featured as this week's **top** GPT in the GPT store.

SciSpace GPT is specifically designed for researchers. It answers your questions with references to published papers.

No fake references.

### Consensus

By consensus.app

Ask the research, chat directly with the world's scientific literature. Search references, get simple explanations, write articles backed by academic papers.

★ 4.3  
Ratings (50K+)

#2  
In Research & Analysis (EN)

5M+  
Conversations

#### Conversation Starters

Is sauna good for heart health?

Draft a blog on science-backed benefits of mindfulness

Write the introduction of a paper on the effects of climate change...

Does fish oil improve mood? Only use human RCTs from top...

#### Capabilities

- ✓ Actions  
Retrieves or takes actions outside of ChatGPT
- ✓ Data Analysis
- ✓ Browsing
- ✓ DALL·E Images

### Scholar GPT

By awesomegpts.ai

Enhance research with 200M+ resources and built-in critical reading skills. Access Google Scholar, PubMed, JSTOR, Arxiv, and more, effortlessly.

★ 4.2  
Ratings (50K+)

#1  
In Research & Analysis (EN)

2M+  
Conversations

#### Conversation Starters

Find the latest research about AI

I'll provide a research paper link. Please analyze it

I will upload a PDF paper. Use critical skills to read it

Type "LS" to list my built-in critical reading skills

#### Capabilities

- ✓ Actions  
Retrieves or takes actions outside of ChatGPT
- ✓ Data Analysis

### Scholar AI

By scholarai.io

AI Scientist - search and analyze text, figures, and tables from 200M+ research papers and books to generate new hypotheses. Formerly the ScholarAI Plugin

★ 4.1  
Ratings (10K+)

#5  
In Research & Analysis (EN)

900K+  
Conversations

#### Conversation Starters

I want to know everything ScholarAI can do!

Find me papers that reference 10.1016/j.jcell.2014.05.010

What's the experimental setup of https://arxiv.org/pdf/...

Write a review on the use for VR for robotic surgery

#### Capabilities

- ✓ Actions  
Retrieves or takes actions outside of ChatGPT
- ✓ Data Analysis
- ✓ Browsing
- ✓ DALL·E Images

### Litmaps

By litmaps.com

Quickly find papers on your topic, visualize your research, and accelerate your entire literature review.

★ 3.8  
Ratings (10+)

Research & Analysis  
Category

400+  
Conversations

#### Conversation Starters

What's the latest research on climate change?

Can you find studies related to neural networks?

Show me the newest articles on gene therapy.

Visualize the literature on renewable energy sources.

#### Capabilities

- ✓ Actions  
Retrieves or takes actions outside of ChatGPT
- ✓ Browsing

### SciSpace

By scispace.com

Do hours worth of research in minutes. Instantly access 287M+ papers, analyze papers at lightning speed, and effortlessly draft content with accurate citations.

★ 4.3  
Ratings (5K+)

#3  
In Research & Analysis (EN)

300K+  
Conversations

#### Conversation Starters

Does wearing an activity tracker improve health outcomes?

What are the benefits of taking L-theanine?

Upload a Paper and ask any questions related to it

Share a paper link to extract information and get insights

#### Capabilities

- ✓ Data Analysis
- ✓ Actions  
Retrieves or takes actions outside of ChatGPT
- ✓ Browsing
- ✓ DALL·E Images

- Available via GTP store in ChatGPT to use for free
- Customized for specialized actions
- Enable complex workflows (**can be called directly into ChatGPT conversation!**)

Excerpt of the ChatGPT response could be selected and referenced to focus subsequent conversation

Typing „@“ enables calling any pinned Custom GPT into the same chat window

Custom GPT focuses on the referenced excerpt

their varying effects on different types of cells complicate their clinical

Reply (BioMed Central) (MDPI) (BioMed Central).

5. "al and Preclinical Progress:

Exosome-based cancer therapies are progressing towards clinical readiness, with several preclinical studies demonstrating their efficacy in delivering therapeutic agents and modulating immune responses. Clinical trials are underway to evaluate the safety and effectiveness of the .therapies in

Exosome-based cancer therapies are progressing towards clinical readiness, with several preclinical studies demonstrating their efficacy in delivering therapeutic agents and modulating immune responses."

Message ChatGPT

Consensus Ask the research, chat directly with the world's s...

SciSpace Do hours worth of research in minutes. Instantly...

+ Create a GPT

@

Exosome-based cancer therapies are progressing towards clinical readiness, with several preclinical studies demonstrating their efficacy in delivering therapeutic agents and modulating immune responses."

SciSpace

Message SciSpace

Exosome-based cancer therapies are progressing towards clinical readiness, with several preclinical studies demonstrating their efficacy in delivering therapeutic agents and modulating immune responses.

provide references from 2024

## Current State of Exosome-Based Cancer Therapy (2024)

### 1. Therapeutic Delivery and Targeting:

Exosomes, particularly those derived from mesenchymal stem cells, have shown significant potential in targeted cancer therapy. Their ability to traverse biological barriers, such as the blood-brain barrier, and deliver therapeutic agents like drugs, nucleic acids, and proteins, enhances their efficacy while minimizing systemic toxicity. These capabilities are being explored extensively in current research to improve the specificity and stability of cancer treatments (Torralba et al., 2024).

### 2. Engineering for Enhanced Functionality:

#### Detailed Table

Serial Number	Paper Title and Link	Insight	Citation Count
1	Engineered exosomes in emerging cell-free therapy (Gao et al., 2024)	Explores advancements and challenges in engineering exosomes for improved cancer therapy.	-
2	Recent Advances in Exosome-Based Drug Delivery for Cancer Therapy (Torralba et al., 2024)	Reviews the benefits of using exosomes for targeted drug delivery in cancer treatment.	-
3	Recent advances in exosome-based immunotherapy applied to cancer. (2024)	Discusses the role of exosomes in modulating immune responses and their applications in cancer immunotherapy.	-
4	Strategies to overcome the main challenges of the use of exosomes as drug carriers for cancer therapy (2024)	Addresses the main challenges in exosome-based drug delivery systems for cancer therapy.	-
5	Mesenchymal stem cells-derived exosomes: novel carriers for nanoparticles to combat cancer (2024)	Highlights the use of MSC-derived exosomes in delivering nanoparticles for targeted cancer therapy.	-

#### Users also ask these questions:

1. What are the potential side effects of exosome-based cancer therapies?
2. How are exosomes isolated and purified for clinical applications?
3. What types of cancers are currently being targeted by exosome-based therapies?

**Task:**

→ Go to [EXAMPLE CUSTOM GPTs LIBRARY](#)

→ Present your current hypothesis or research idea to [Scientific Critic](#), discuss.

Or see the [example](#) interaction



## SCIENTIFIC CRITIC

By Michaela Liegertová 

Ruthless, universal scientific critic across all disciplines

# CUSTOM GPTs - Creating Research Assistants in ChatGPT

OpenAI info:

[GPT builder](#)

[Creating a GPT](#)



## AI-research Assistant Builder

By Michaela Liegertová

Describe the expert you need for any stage of your research

### Task:

Go to: [AI-research Assistant Builder](#)

Prompt it to create an expert assistant for your research field.


*E.g., “I need an expert research assistant in the field of microbiome studies to assist with experimental design regarding the correlation between the microbiome and Alzheimer's disease.”*

Or see the [example](#) conversation.

→ Creating your own custom GPT—go to “Explore GPTs” in your app. Click on “Create” (top right corner) and switch to “Configure”. Copy in the instruction from the Builder, edit, polish, and test it in “Preview”. Generate an image using Dall-E. If you are happy with it, publish and enjoy.

# CHATBOTS WITH CANVAS

– interactive collaboration for writing + simple apps/dashboards

 ChatGPT

What can I help with?

Ask anything

+

Search

Deep research

...

Create image Updated

Visualize ideas and concepts

Canvas

Collaborate on writing and code

## Gemini Advanced

Ask Gemini

Create docs and code

+

Deep Research

Canvas

ChatGPT 4o

Ev Ad Abstract

will pursue three Specific Aims...: You might preface the aims with a brief sentence to re-emphasize the novelty or translational impact of the approach for a smoother transition.

4. **Comment on "Successful completion of these aims...":** Consider specifying what kind of "targeted therapeutic strategies" are envisioned (e.g., EV-targeted drug delivery, inhibition of EV release, etc.) for more impact.

5. **Comment on Final Sentence:** "Ultimately, this work will lay the foundation..." — You could consider tying back to the central hypothesis here to reinforce the coherence and purpose of the project.

show the comments in the canvas

Added 5 comments

Answer in chat instead >

I've added comments to the canvas suggesting ways to enhance clarity, impact, and narrative flow. Let me know if you'd like help revising the text based on these suggestions.

Ask anything

+

Search

Deep research

...

ChatGPT can make mistakes. Check important info.

Alzheimer's disease (AD) is marked by progressive cognitive decline and hallmark neuropathological features, including amyloid-beta plaques, neurofibrillary tangles, and chronic neuroinflammation. Emerging evidence implicates extracellular vesicles (EVs)—including exosomes and microvesicles—as key modulators of neuroinflammatory signaling and disease progression. EVs can encapsulate and transport inflammatory mediators such as cytokines, microRNAs, and other bioactive molecules across cellular and anatomical boundaries, enabling the spread of inflammation throughout the brain.

Our central hypothesis is that EV-mediated neuroinflammatory signaling propagates along defined brain networks in a stage-dependent manner, contributing to the pathogenesis of AD. To test this, we propose an integrative, multi-omic connectome framework to investigate how EVs originate from specific cell types, travel through neural circuits, and activate immune responses that drive the transition from early to advanced AD. Our preliminary data demonstrate: (1) successful isolation and characterization of cell-type-specific EVs from both AD mouse models and human postmortem brain tissue; (2) multi-omic EV signatures indicative of elevated inflammatory activity; and (3) real-time imaging of fluorescently labeled EVs showing distinct spatiotemporal propagation patterns in transgenic AD mice.

To advance this work, we will pursue three Specific Aims: (1) characterize the spatiotemporal dynamics of EV-mediated inflammatory signaling using integrated multi-omic analyses across AD stages; (2) map EV dissemination along brain connectomic pathways through advanced imaging and network modeling techniques; and (3) evaluate immunomodulatory interventions targeting EV cargo and release mechanisms to mitigate AD-related neuroinflammation in vivo. Successful completion of these aims will yield a comprehensive mechanistic understanding of EV-driven neuroinflammation, identify novel biomarkers for AD progression, and inform the development of targeted therapeutic strategies.

This project unites expertise in EV biology, neuroimmunology, imaging, bioinformatics, and network neuroscience to establish a highly innovative research platform. By combining cell-specific EV isolation, multi-omic profiling (including transcriptomics, proteomics, and lipidomics), live imaging, and connectome-based computational modeling, we aim to elucidate critical nodes of inflammatory signal propagation. Ultimately, this work will lay the foundation for precision diagnostics and immunomodulatory treatments for AD and related neurodegenerative diseases characterized by dysregulated inflammation.

Write something...

ChatGPT

Consider briefly noting the clinical impact or prevalence of AD to emphasize the significance of the research.

ChatGPT

This sentence is complex; consider breaking it into two for better readability and flow.

ChatGPT

You might add a short sentence before this listing to highlight the innovation or impact of these aims.

ChatGPT

Clarify what kind of targeted therapeutic strategies are anticipated for greater specificity and impact.

ChatGPT

Consider tying this conclusion back to the central hypothesis to reinforce the overall project narrative.

Suggest edits

Gemini Advanced

Improved Abstract: EV-Mediated Neuroinflammation in...

Normal text

Export to Docs

computational modeling—to unravel the mechanistic underpinnings of EV-mediated inflammatory signaling. By systematically tracking and manipulating EVs, we will pinpoint critical nodes of neuroinflammatory propagation and lay the groundwork for new strategies to slow or halt AD progression. The outcomes of this work will have broad implications for biomarker discovery and precision therapeutics targeting AD and other neurodegenerative disorders characterized by aberrant inflammatory signaling.

Improved Abstract:

Alzheimer's disease (AD) is marked by progressive cognitive decline, amyloid-beta plaques, neurofibrillary tangles, and persistent neuroinflammation. Extracellular vesicles (EVs), including exosomes and microvesicles, are increasingly implicated in modulating this inflammation. EVs transport inflammatory cargo (e.g., cytokines, microRNAs) across cells and brain regions, potentially driving widespread neuroinflammatory changes.

Our central hypothesis is that EV-mediated neuroinflammatory signals propagate across specific brain networks in a stage-dependent manner, fueling AD progression. We propose an integrative multi-omic connectome framework to investigate how cell-type-specific EVs traverse neural circuits and trigger immune responses that advance AD from mild to severe pathology. Our preliminary data demonstrate: (1) robust isolation and characterization of cell-type-specific EVs from mouse AD models and human postmortem AD brain tissue; (2) multi-omic signatures in AD-derived EVs indicative of heightened inflammatory signaling; and (3) distinct spatial and temporal propagation patterns of fluorescently labeled EVs in transgenic AD mice.

We will pursue three Specific Aims to elucidate and target EV-mediated neuroinflammation: (1) define the spatiotemporal landscape of EV inflammatory signaling across AD stages using multi-omic analyses; (2) map EV propagation along brain connectomic networks using advanced imaging and network modeling; and (3) test immunomodulatory strategies targeting EV cargo and release to mitigate AD-associated neuroinflammation in vivo. Successful completion of these aims will transform our understanding of how EVs orchestrate neuroinflammation across neural circuits, identify new biomarkers of AD progression, and enable targeted immunomodulatory therapies.

This project unites expertise in EV biology, neuroimmunology, imaging, bioinformatics, and network neuroscience. Our integrative platform, employing cell-specific EV isolation, multi-

'marked by' is a bit weak. Consider using a stronger verb like 'manifests' or 'features' to emphasize the key characteristics of the disease. Example: 'Alzheimer's disease (AD) manifests as'

'fueling' is good, but we can make it more precise. Consider replacing it with a phrase that emphasizes the causal role of EV-mediated signals in disease progression. Example: 'drives'.

Show more

Apply all

# **WORKING WITH LITERATURE SOURCES**

## WORKING WITH ARTICLES using Chatbots

*> By requesting direct quotes from the text provided, you anchor the chatbot to the reference text + know where you can verify the information*

*> BE AWARE OF THE CONTEXT WINDOW LIMIT WHEN WORKING WITH MULTIPLE PDFs*

**YOUR ROLE:** You are an expert in extracting information from scientific publications and scholarly texts, specializing in comprehensive literature reviews.

**YOUR TASK:** Extract key findings from user-provided scholarly texts and ensure that the information provided is supported by direct citations from the text.

### STEPS:

- ANALYSE the provided document -> IDENTIFY the main hypotheses, methodology, results and conclusions.
- PROVIDE a brief summary of the key findings, followed by a more detailed explanation including specific details from the article.
- INCLUDE accurate and direct quotations from the provided text - example citation: 'sentence supporting the claim' (Chapter, Subchapter, Page number).**
- SUMMARIZE key findings:  
Hypotheses - List the main hypotheses tested in the research; Methodology - Describe the primary methods and approaches used in the research; Results - Highlight the most significant results; Conclusions - Summarize the main conclusions drawn by the authors.
- IDENTIFY any limitations or potential biases in the study.
- HIGHLIGHT any research gaps or areas for future study mentioned by the authors.

### OBJECTIVES AND LIMITATIONS:

- STRICTLY ADHERE to the provided text.**
- ENSURE that the answer is FACTUAL and COMPREHENSIVE.**
- RETAIN objectivity in your summary, avoiding own interpretations.**

### IMPORTANT:

Your accurate extraction and summarization of key findings will greatly assist researchers in the literature review. Ensure accuracy and clarity in each answer. Your role is key to providing reliable and insightful summaries to researchers, reducing their workload and increasing their productivity

# Gemini 2.5 Pro

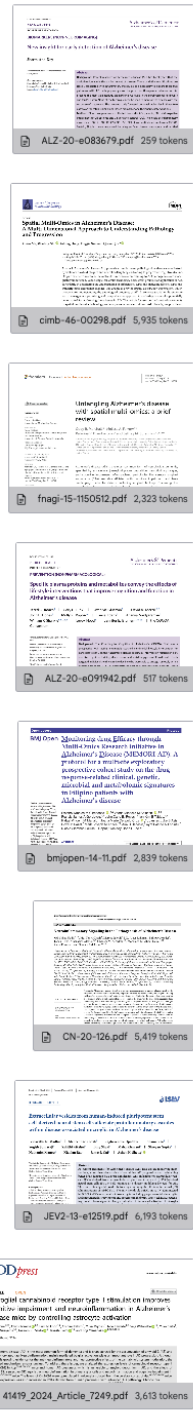
Google's most intelligent (reasoning) model with 1 million context window suitable to work with multiple pdfs


# Google AI Studio

Summarize the provided literature

Based on the provided literature (abstracts, reviews, protocols, research articles), here is a summary of the key findings and themes related to Alzheimer's disease (AD) research:


- AD Pathogenesis Complexity:** AD is consistently described as a complex neurodegenerative disorder characterized by amyloid-beta (A $\beta$ ) plaques, neurofibrillary tangles (NFTs) of hyperphosphorylated tau (p-tau), neuronal loss, and progressive cognitive decline.
- Early Events & Neuroinflammation:** Several studies emphasize that events like oxidative damage (Dey) and neuroinflammation (Dey, Uddin, Madhu, Sobue) are very early occurrences in AD pathogenesis, potentially preceding significant A $\beta$  deposition. Neuroinflammation, involving activated microglia and astrocytes, cytokine release (TNF- $\alpha$ , IL-1 $\beta$ , IL-6, IL-18, IFNs), inflammasome activation (NLRP3), and complement system activation, is highlighted as a crucial factor influencing disease severity and progression (Uddin, Madhu, Sobue). The state of glial cells, such as Disease-Associated Microglia (DAM), is increasingly recognized as important (Madhu).
- Biomarker Discovery:** There is a strong focus on identifying reliable biomarkers for early AD detection, diagnosis, and monitoring treatment response.
  - Blood-Based Markers:** Studies investigate blood proteins/metabolites linked to oxidative stress, inflammation (Dey), lifestyle interventions (Roach), and drug response signatures (Climacosa).
  - Multi-Omics Integration:** Combining genomics, proteomics, metabolomics, transcriptomics, and microbiomics is crucial for a holistic understanding and biomarker discovery (Roach, Climacosa, Ma, Marshall).
  - Spatial Context:** Linking molecular signatures directly to pathological features (plaques, tangles) and cellular interactions within the brain tissue architecture is deemed essential (Ma, Marshall).
- Spatial Multi-Omics Technologies:** These emerging technologies are presented as powerful tools to overcome the limitations of traditional methods that lose spatial context.
  - Capabilities:** They allow for the mapping of proteins, RNA, lipids, and metabolites with spatial resolution within tissue sections, revealing cellular heterogeneity and microenvironmental interactions (Ma, Marshall).
  - Platforms:** Techniques like Imaging Mass Spectrometry (IMS - MALDI, DESI, MIBI), Cyclic Immunofluorescence (CycIF, MP-IHC), and Spatial Transcriptomics (Visium, MERFISH, GeoMx DSP, Slide-seq, Xenium, etc.) are discussed, each with varying capabilities in terms of resolution, molecular coverage, and throughput (Ma, Marshall).
  - Applications in AD:** Used to visualize A $\beta$  peptide species, lipid distributions around plaques, map gene/protein expression changes in specific brain regions or near pathologies, and characterize synaptic proteins (Ma, Marshall, Sobue).



 **Model**

Gemini 2.5 Pro

Experimental 03-25

 **Token count**

30,480 / 1,048,576

## DEEP RESEARCH AGENTS

- automated, multi-stage information retrieval and analysis (web scraping + sophisticated data synthesis techniques)
- save time + increase efficiency in information retrieval, processing and presentation (each platform unique approaches for specific needs)

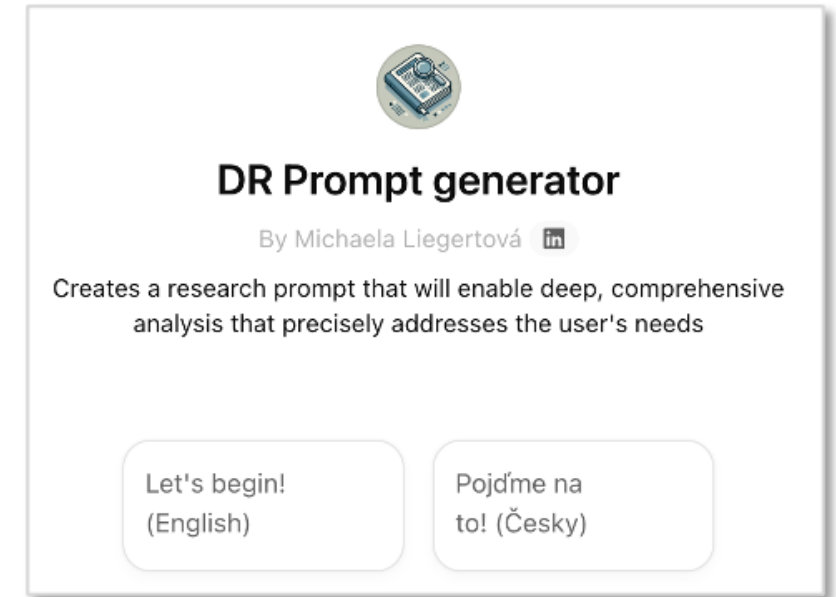
**Important note:** *Deep Research works best with detailed structured prompts and as much context as possible.*

**Important to keep in mind:** LLM apps do not have access to articles behind paywalls! The outcome might be biased towards open-access information!

### Task:

- Click the following link and examine the [proposed use-cases](#) and try to think about it within your own research context
- Experiment with [Deep Research prompt generator](#) by asking to create a prompt for your particular research context or explore the *example conversation and outcome* [here](#).
- Copy your prompt into [Gemini](#) and [ChatGPT](#) do run the Deep Research - compare the outcome.

..or explore example Deep Research outcomes here: [Gemini](#), [ChatGPT](#)



## SPECIALIZED RESEARCH AND LITERATURE ASSISTANT APPS

AI ASSISTANCE TOOLS	NAME	LINKS
RESEARCH ASSISTANT TOOLS	Scopus AI	<a href="https://www.elsevier.com/products/scopus/scopus-ai/contact-us">https://www.elsevier.com/products/scopus/scopus-ai/contact-us</a>
	Scite	<a href="https://scite.ai/">https://scite.ai/</a>
	Elicit	<a href="https://elicit.com/">https://elicit.com/</a>
	SciSpace	<a href="https://typeset.io/">https://typeset.io/</a>
	Semantic Scholar	<a href="https://www.semanticscholar.org/">https://www.semanticscholar.org/</a>
	Litmaps	<a href="https://www.litmaps.com/">https://www.litmaps.com/</a>
	MindGrasp	<a href="https://mindgrasp.ai/">https://mindgrasp.ai/</a>
	ResearchRabbit	<a href="https://researchrabbitapp.com/">https://researchrabbitapp.com/</a>
	Lateral	<a href="https://www.lateral.io/">https://www.lateral.io/</a>
	Consensus	<a href="https://consensus.app/search/">https://consensus.app/search/</a>
	STORM	<a href="https://storm.genie.stanford.edu/">https://storm.genie.stanford.edu/</a>
	NotebookLM	<a href="https://notebooklm.google.com/">https://notebooklm.google.com/</a>
WRITING ASSISTANT TOOLS	Paperpal	<a href="https://paperpal.com/">https://paperpal.com/</a>
	Jenni	<a href="https://jenni.ai/">https://jenni.ai/</a>
	Grammarly	<a href="https://www.grammarly.com/">https://www.grammarly.com/</a>
	Quillbot	<a href="https://quillbot.com/">https://quillbot.com/</a>
CITATION MANAGER	Zotero	<a href="https://www.zotero.org/">https://www.zotero.org/</a>
TRANSLATOR	DeepL	<a href="https://www.deepl.com/en/translator">https://www.deepl.com/en/translator</a>

## YOUTUBE CHANNELS

(research/literature assistant apps)

[Scite](#)

[Elicit](#)

[SciSpace](#)

[Semantic Scholar](#)

[Litmaps](#)

[MindGrasp](#)

[Research Kick](#)

## SHORT USER REVIEWS/TUTORIALS

[Scite](#)

[Consensus](#)

[SciSpace](#)

[Elicit](#)

[ResearchRabbit](#)

[Lateral](#)

[Research Kick](#)

[STORM](#)

## WRITING ASSISTANTS

[Grammarly](#)

[Quillbot](#)

[Paperpal](#)

[Jenni](#)

## CITATION MANAGEMENT

[Zotero](#)

(connectable with AI apps,  
enables complex workflows)

### TIPS:

- familiarize yourself with each application as the user preferences are highly individual
- **focus first on your own publications and experiment with features such as tracking citations and talking to the PDF**

## SPECIALIZED TOOLS designed by academic databases

[Scopus AI](#) - combines artificial intelligence with the Scopus academic database

[Web of Science Research Intelligence](#) - AI-native platform to optimize research teams, funding success, and impact measurement

# LITERATURE RESEARCH ASSISTANT APPS - Exploring the Features

## Task:

- Log into [SciSpace](#), search for your research topic, and explore the features + **Deep Review Feature**
- Log into [Litmaps](#) or [ResearchRabbit](#), use your name as a query to explore some of the features
- Log into [Elicit](#), use your current research question as a query, and explore the features
- Log into [Conensus](#) and ask a yes or no question to inspect the scientific consensus on the topic
- Go to [STORM](#). Create a research article based on your research topic. Explore the app.

# BUILDING A GROUNDED KNOWLEDGEBASE

 NotebookLM

[Overview](#)

# Think **Smarter**, Not Harder

The ultimate tool for understanding the information that matters  
most to you, built with Gemini 1.5

[link](#)

Try NotebookLM

Your Personalized AI Research Assistant

Runs on Gemini (Google) with 2 million context window +  
understands images in pdfs **FREE OF CHARGE!**

NotebookLM

×

## Add sources

Sources let NotebookLM base its responses on the information that matters most to you.  
(Examples: marketing plans, course reading, research notes, meeting transcripts, sales documents, etc.)



Upload sources

Drag & drop or [choose file](#) to upload

Supported file types: PDF, .txt, Markdown, Audio (e.g. mp3)

 Google Drive

 Google Docs

 Google Slides

 Link

 Website

 YouTube

 Paste text

 Copied text

 Source limit

0 / 50



## Upload your sources

Upload PDFs, websites, YouTube videos, audio files, Google Docs, or Google Slides, and NotebookLM will summarize them and make interesting connections between topics, all powered by Gemini 1.5's multimodal understanding capabilities.



## See the source, not just the answer

Gain confidence in every response because NotebookLM provides clear citations for its work, showing you the exact quotes from your sources.

@Liebertova\_Michaela



## Sources



+ Add source

Select all sources



41419\_2024\_Article\_7249.pdf



ALZ-20-e083679.pdf



ALZ-20-e091942.pdf



CN-20-126.pdf



JEV2-13-e12519.pdf



bmjopen-14-11.pdf



cimb-46-00298.pdf



fnagi-15-1150512.pdf



## Chat



# Blood Biomarkers for Early Alzheimer's Disease Detection

8 sources



Add note



Audio Overview



Mind Map

Start typing...

8 sources



## Studio



### Audio Overview



Deep Dive conversation

Two hosts (English only)

Customize

Generate

### Notes



+ Add note



Study guide



Briefing doc



FAQ



Timeline



Saved notes will appear here

Save a chat message to create a new note, or click Add note above.

Direct quotes from the source documents are provided as citations – quick check for consistency!

Plus

Blood Biomarkers for Early Alzheimer's Disease Detection

Analytics

Share

Settings

Sources

cimb-46-00298.pdf

Source guide

ROI. Subsequently, these oligonucleotides are collected and digitally counted or quantified via NGS. This technique enables multiplex digital spatial profiling of proteins and RNA in fixed tissue. While the official recommendations suggest a range covering 1 to ~5000 cells, practical applications typically favor a middle range, and it does not achieve single-cell level analysis [24].

SMI represents a system designed for the measurement of RNAs and proteins within intact biological samples, achieving subcellular resolution through multiple cycles of nucleic acid hybridization employing fluorescent molecular barcodes. The chemistry of SMI is reliant on the integration of in situ hybridization (ISH) probes, or alternatively antibodies, paired with fluorescent readout probes. SMI has demonstrated detection of up to 980-plex RNA and up to 108-plex proteins. For RNA profiling, these 980 panels facilitate the elucidation of pivotal cellular states, encompassing immune cell states, apoptosis, autophagy, stress responses, and damage responses, as well as delineating intricate cell–cell interactions and hormone activity [50].

**Overview of Post-Experimental Analysis in Spatial Transcriptomics**

The rapidly increasing volume of spatially resolved transcriptomics (SRT) data poses challenges in terms of inconsistent downloading protocols and processing steps. Traditionally, accessing these data from academic publications can be cumbersome due to unfriendly user interfaces, large raw sequencing data files, time-consuming processing steps, and frequent issues with data link maintenance, which may hinder access and compromise reproducibility. To address these issues and improve data accessibility for bioinformatics researchers, several databases and web servers have been developed, including cellxgene (<https://cellxgene.cziscience.com/>, accessed on 3 May 2024), SpatialDB [51], STOmicsDB [52], SODB [53], and SOAR [54].

Additionally, spatial transcriptomics requires innovative approaches for data analysis. Computational workflows vary depending on the technology used to produce the data, but there is a significant overlap in how different modalities are processed. The goal of these workflows is to correlate various

Chat

improve cognitive and mood functions taken up by microglia, including those as Furthermore, the treatment **normalized t inflammasome activation, and suppress signaling pathways** 27 ... The author expression in microglia and astrocytes 2 intranasal EV delivery, RNA isolation and c Source 5 33 outlines the protocol for the cohort study in Filipino patients with le genetic, microbial, and metabolic fact donepezil, rivastigmine, and/or meman characterization of Filipino dementia patie investigate drug response-related signatu recruitment target is at least 153 patients 60 patients will undergo more in-depth o at baseline, 3 months, and 6 months 35 Source 6 37 provides an overview of p and its applications in AD research. The access and reproducibility, leading to the c cimb-46-00298.pdf and new servers like cellxgene, SpatialDB, STOmicsDB, SODB, and SOAR 37. The source includes a table summarizing the applications of various spatial omics technologies in AD, such as CyCIF, LCM-MS, and MP-IHC, which enable researchers to study glial cell phenotypes, proteomic changes in specific neuronal populations, and protein expression in the context of AD pathology 38 ... Spatial omics technologies are crucial for understanding cellular interactions and molecular alterations within specific brain regions affected by AD 38 ...

Source 7 41 is a brief review discussing the use of spatial multi-omics approaches to better understand AD. Traditional antibody-based methods like IHC and IF are used to visualize spatial protein distributions, but newer multiplexed techniques like CyCIF and MP-IHC allow for the detection of a higher number of protein targets and the identification of novel glial cell states in AD 42. The review emphasizes that integrating different omics layers with spatial information through spatial multi-omics provides a more comprehensive understanding of AD 43 ... Techniques such as MALDI-

Start typing...

8 sources

Briefly discuss microglial Cb2 stimulation effects on astrocytes.

What spatial omics platforms are app

Studio

Audio Overview

Deep Dive conversation

Two hosts (English only)

Customize

Generate

Notes

+ Add note

Study guide

Briefing doc

FAQ

Timeline

The mind map is centered on 'Alzheimer's Disease: Mechanisms, Therapies, and Diagnostics'. It branches out into several key areas:

- Neuroinflammation**: Includes Glial activation (microglia, astrocytes), Synaptic abnormalities, and Mitochondrial fission.
- Cannabinoid System**: Includes Anti-inflammatory extracellular vesicles, Derived from human induced pluripotent stem cell-derived neural stem cells, Reduce microglial and astrocyte activation, Modulate DAM genes, Inhibit NLRP3 inflammasome, Inhibit cGAS-STING signaling, Reduce amyloid-beta plaques, Reduce p-tau, and Improve cognitive and mood function.
- hPSC-NSC-EVs Therapy**: A central node connecting to various therapeutic and diagnostic approaches.
- Spatial Omics**: A branch focusing on advanced imaging and data analysis techniques.
- Drug Treatments (Filipino Study)**: A branch detailing specific clinical research and interventions.
- Diagnosis and Monitoring**: A branch covering methods for early detection and ongoing patient management.

@Liegertova\_Michaela

# BUILD A KNOWLEDGE BASE for manuscript preparation/grant proposal/lab protocols,....

**Task:** go to [NotebookLM](#)

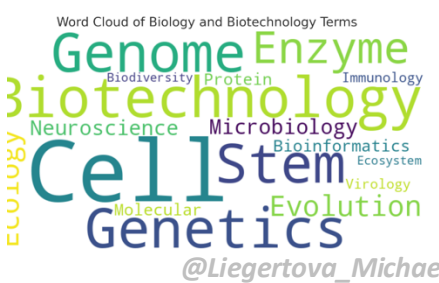
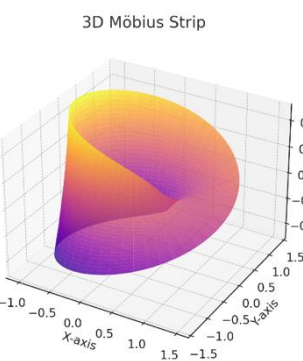
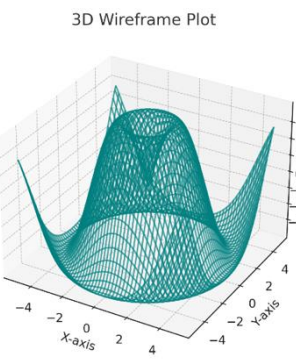
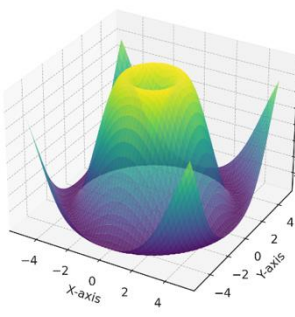
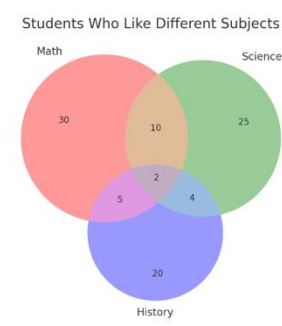
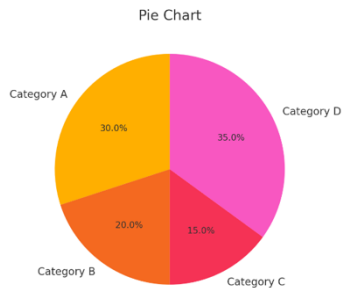
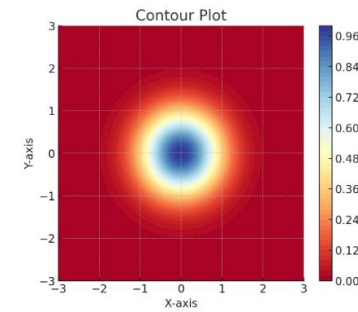
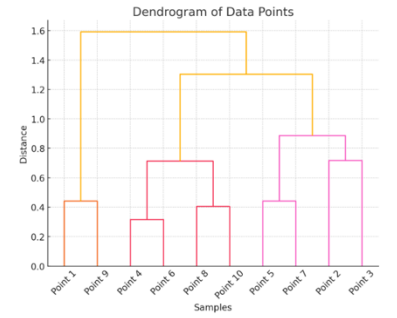
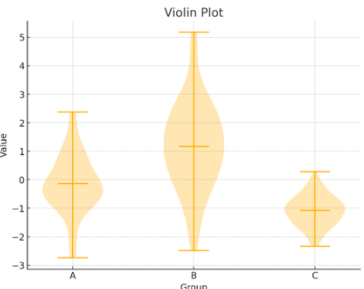
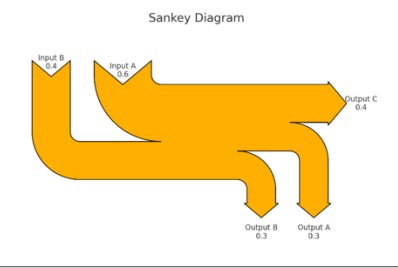
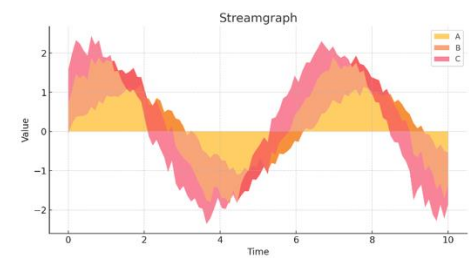
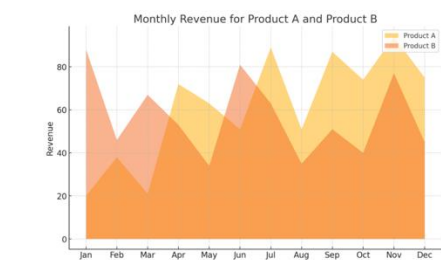
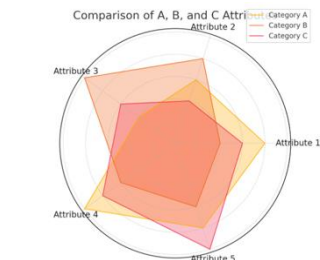
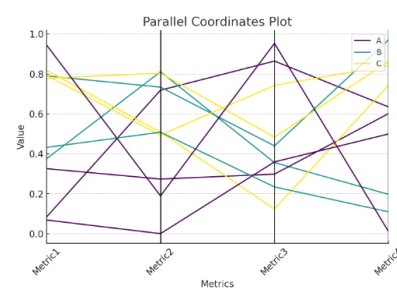
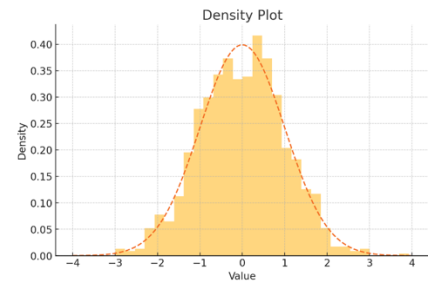
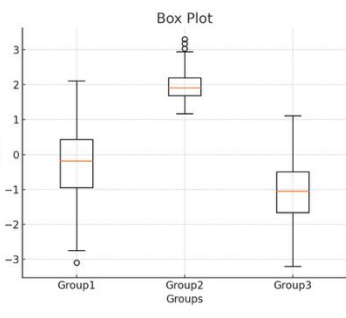
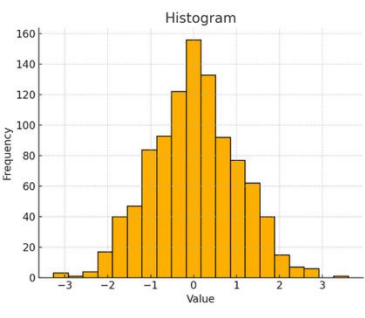
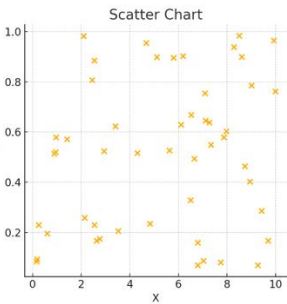
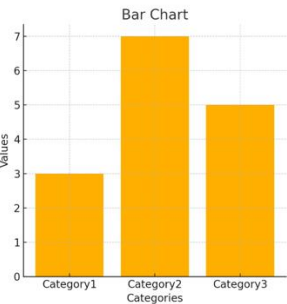
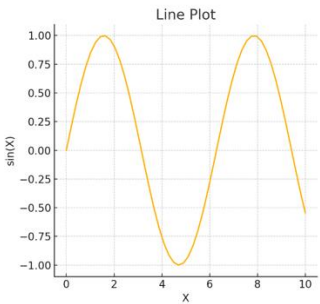
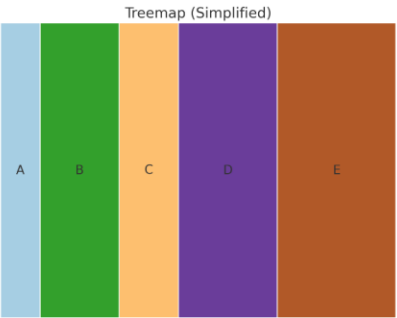
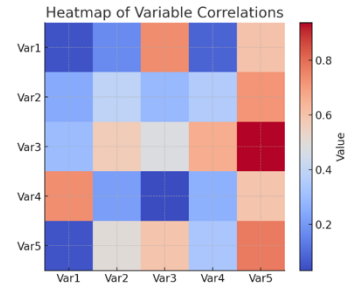
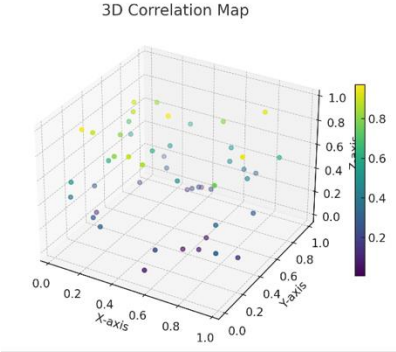
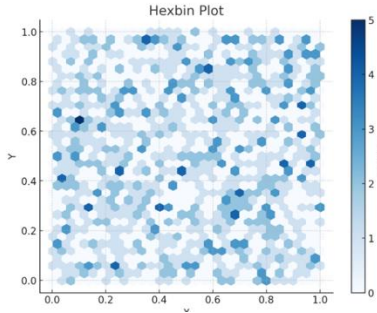
→ Create a new notebook by **uploading your own published articles** or with current articles/reviews, chat with the knowledge base, and inspect features in the app.

→ Create a new notebook by uploading [GAČR tender documentation](#), chat with the knowledge base, inspect features in the app.

# **LLM ASSISTED DATA ANALYSIS**



Generate fictitious data sets to provide an overview of the various types of data visualizations/graphs you can generate using code interpreter



## LLM-ASSISTED ANALYSIS

### KEY CHARACTERISTICS

- Dynamic, potentially variable results
- Flexible and customizable on-the-fly
- More accessible to non-experts
- Quick for ad-hoc analyses

### KEY ADVANTAGES

#### 1. Interactive Data Exploration

- "Converse" with your dataset
- Natural language queries for quick insights

#### 2. Brainstorming and Ideation

- Generate novel analytical approaches
- Uncover potentially overlooked insights

#### 3. Rapid Prototyping

- Quickly test various analytical approaches
- Generate sample code for refinement

### IDEAL USE CASES

- Exploratory analysis & data discovery
- Learning & teaching data concepts
- Rapid prototyping & ideation

## TRADITIONAL SOFTWARE

### KEY CHARACTERISTICS

- Consistent, reproducible results
- Standardized, well-documented methods
- Optimized for large datasets
- Strict adherence to statistical rigor

### LIMITATIONS & CHALLENGES

#### 1. Learning & Implementation

- Steeper learning curve
- Requires specialized technical expertise

#### 2. Customization Challenges

- Less flexible for rapid iterations
- More complex to modify on-the-fly

#### 3. User Experience

- Less accessible to non-technical users
- Requires expertise to interpret results

### IDEAL USE CASES

- Production & mission-critical analyses
- Large-scale data processing
- Scientific research requiring reproducibility



## WARNING ON POTENTIAL RISKS

- Compromised research results due to incorrect use of LLM in data analysis.
- Generation of inaccurate conclusions without proper human oversight.
- Erosion of human judgment in data interpretation.
- Possible excessive reliance on AI, leading to a decline in critical thinking.
- Risk of leakage of personal and sensitive data during processing with LLM.

# INTEGRATING LLM-ASSISTED ANALYSIS WITH TRADITIONAL METHODS

## Complementary Use

- Use LLM for exploratory analysis
- Validate findings with statistical methods
- Use LLM to interpret complex outputs

## Documentation Requirements

- Distinguish LLM vs. traditional methods
- Justify LLM use in research stages
- Include prompts in supplementary materials

## Research Workflow

1. Exploratory Analysis with LLM
2. Hypothesis Formulation with LLM
3. Rigorous Statistical Testing
4. Interpretation & Visualization via LLM

## Key Benefits

- Accelerates pattern discovery
- Enhances hypothesis generation
- Simplifies complex result interpretation
- Improves communication of findings

# LLM ASSISTED DATA ANALYSIS

**CODE INTERPRETER** can process diverse data/formats:

File Format	MIME Type	File Format	MIME Type
.c	text/x-c	.tex	text/x-tex
.cs	text/x-csharp	.txt	text/plain
.cpp	text/x-c++	.css	text/css
.doc	application/msword	.js	text/javascript
.docx	application/vnd.openxmlformats-officedocument.wordprocessingml.document	.sh	application/x-sh
.html	text/html	.ts	application/typescript
.java	text/x-java	.csv	application/csv
.json	application/json	.jpeg/.jpg	image/jpeg
.md	text/markdown	.gif	image/gif
.pdf	application/pdf	.png	image/png
.php	text/x-php	.tar	application/x-tar
.pptx	application/vnd.openxmlformats-officedocument.presentationml.presentation	.xlsx	application/vnd.openxmlformats-officedocument.spreadsheetml.sheet
.py	text/x-python	.xml	application/xml or text/xml
.rb	text/x-ruby	.zip	application/zip

### Task:

- Go to [ChatGPT](#), select the GPT-5 Thinking model and ask it to generate a realistic fictitious dataset for some kind of experiment or assay you do in your field for demonstrational purposes and to provide it as an Excel sheet or CSV for you to download - *or download the [example dataset](#) here.*
- Upload the dataset to a fresh window of [ChatGPT](#) and to [Julius.ai](#).
- Ask the app to perform a data analysis and provide visualizations. Explore the features of the apps. Let it provide the graphs in publication-ready quality and write a downloadable report on the results.

# The interactive table view in ChatGPT allows you to:

- 1. Browse your data
- 2. View all rows and columns
- 3. Instant overview of the structure and content of your data
- 4. Easy navigation through large data sets makes it easier to identify specific information

EU\_Cybersecurity\_Survey.pdf

Download table

Expand table

	Age	Gender	Country	E
1	45-54	Male	Czech Republic	E
2	55-64	Male	Czech Republic	E
3	35-44	Male	Czech Republic	E
4	55-64	Male	Czech Republic	E
5	55-64	Female	Czech Republic	E

EU Survey Data Final Sheet1

Download table

Expand table

	Age	Gender	Country	Education Level	E
1	45-54	Male	Czech Republic	Bachelor's degree	U
2	55-64	Male	Czech Republic	Bachelor's degree	Ei
3	35-44	Male	Czech Republic	Doctorate	Ei
4	55-64	Male	Czech Republic	Doctorate	O
5	55-64	Female	Czech Republic	Associate degree	Ei
6	25-34	Male	Czech Republic	High school diploma	Ei
7	35-44	Prefer not to say	Czech Republic	Other	Si
8	35-44	Male	Czech Republic	Bachelor's degree	U
9	35-44	Female	Czech Republic	Less than high school	Ei
10	55-64	Male	Czech Republic	Other	Ei
11	45-54	Male	Czech Republic	Doctorate	Ei
12	35-44	Male	Czech Republic	Less than high school	O
13	65+	Female	Czech Republic	Less than high school	O
14	55-64	Female	Czech Republic	Less than high school	R
15	25-34	Male	Czech Republic	Associate degree	Ei
16	45-54	Male	Czech Republic	Doctorate	Si
17	65+	Female	Czech Republic	Less than high school	O
18	65+	Prefer not to say	Czech Republic	Bachelor's degree	U
19	25-34	Male	Czech Republic	Master's degree	Ei

"Education Level" column

analyze

To analyze the influence of "Education Level" on respondents' familiarity, perceived effectiveness, and trust in EU cybersecurity measures, I will break down the data based on the different education levels and explore how they relate to the respondents' views. Let's start by examining how familiarity, effectiveness, and trust ratings vary across education levels.

Explore data correlations? Any data anomalies?

# Data Visualization with ChatGPT

- request ChatGPT to create a specific type of graph
- ChatGPT can determine/select the most suitable type of graph on its own

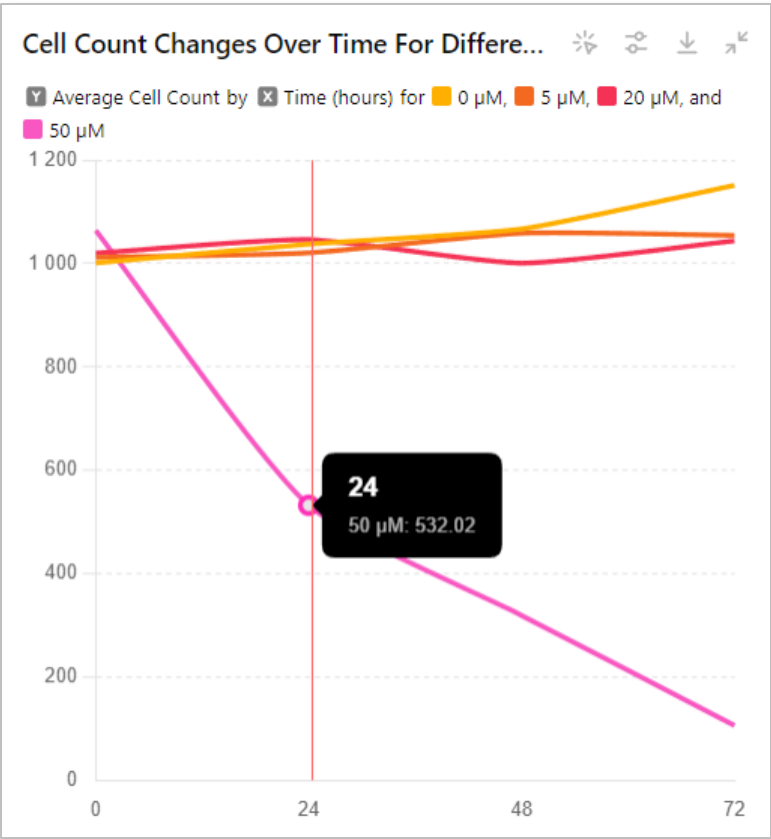
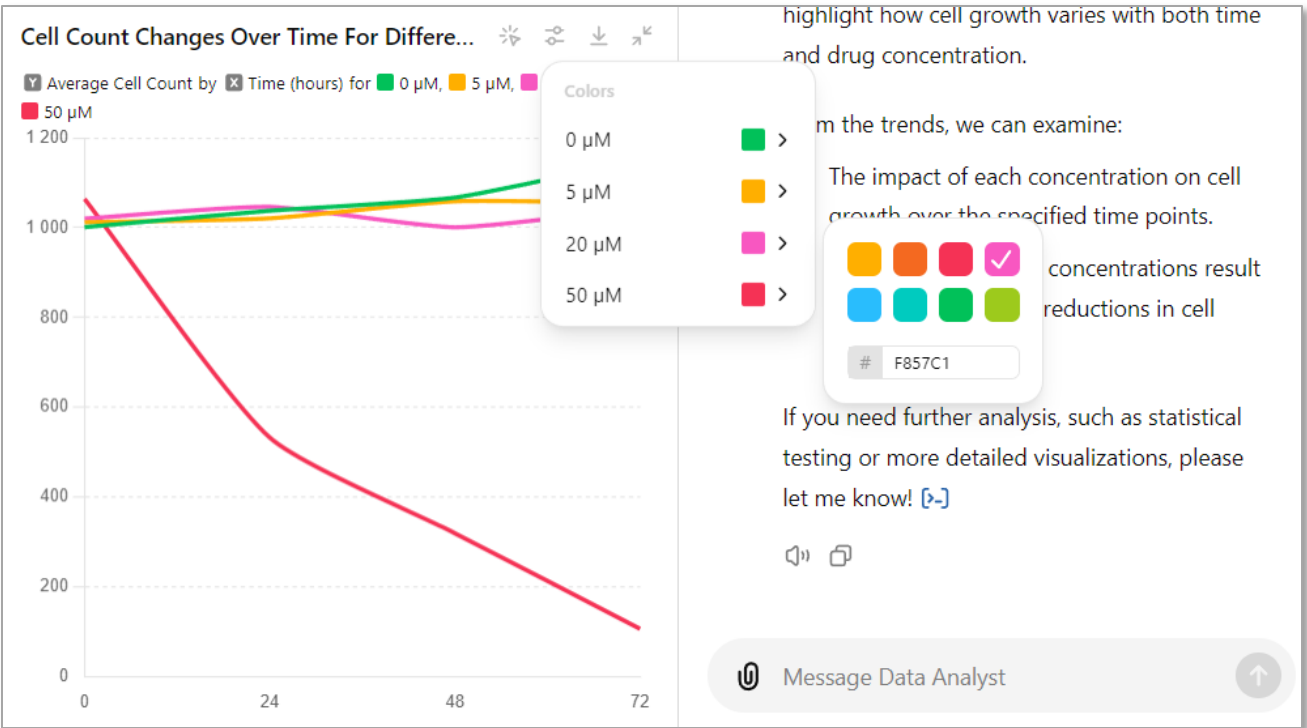
## Static Graphs

Line charts, bar charts, pie charts, histograms, scatter plots, box plots, heat maps, area charts, and more...

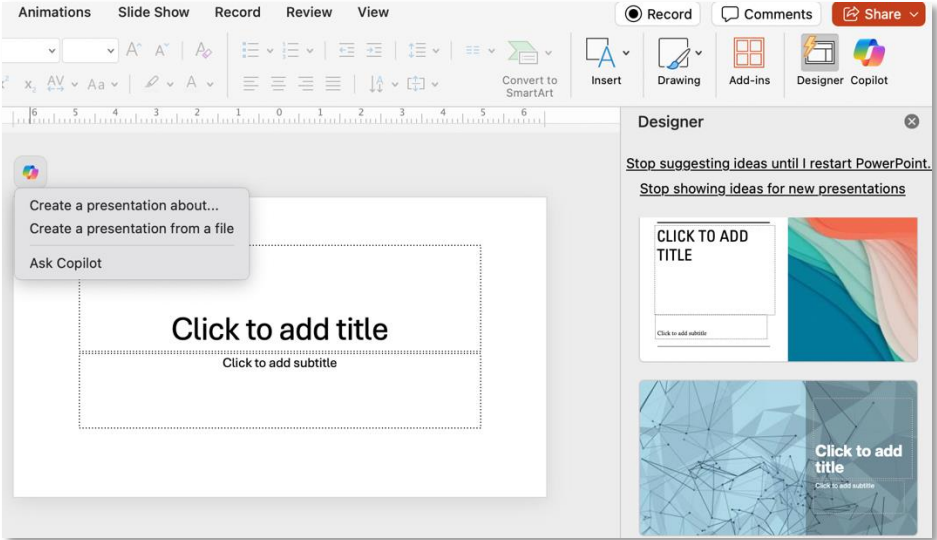
## Interactive Graphs

currently, only bar charts, pie charts, scatter plots, and line charts are interactive

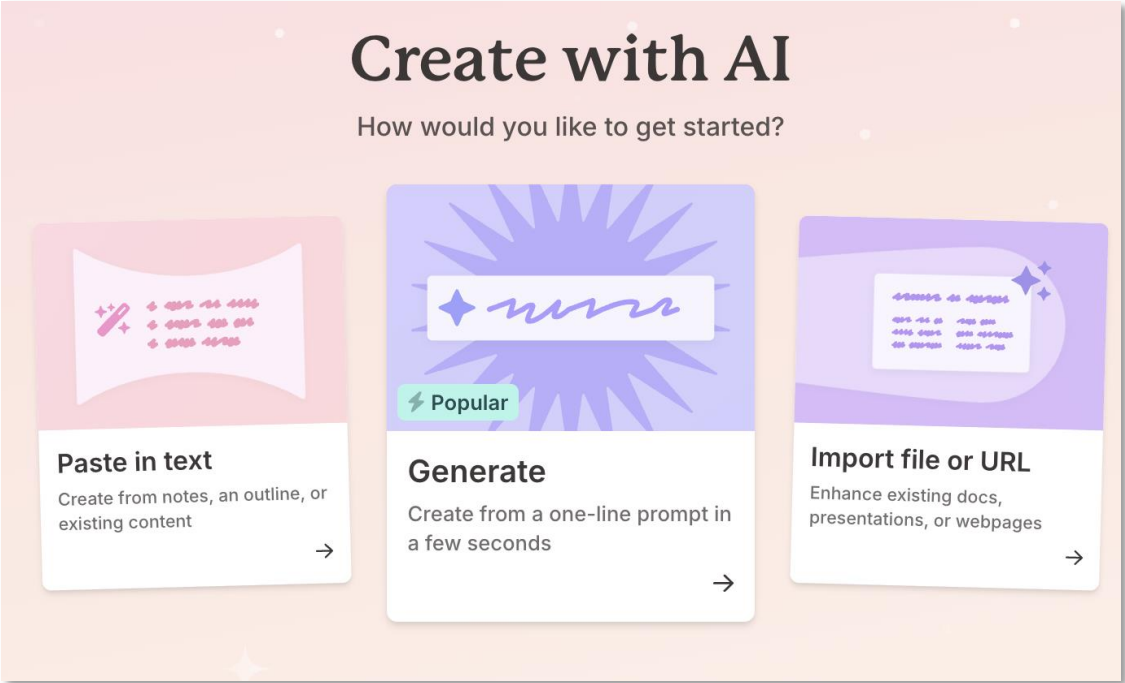
useful for quick exploratory data analysis and preparing outputs for presentations or reports



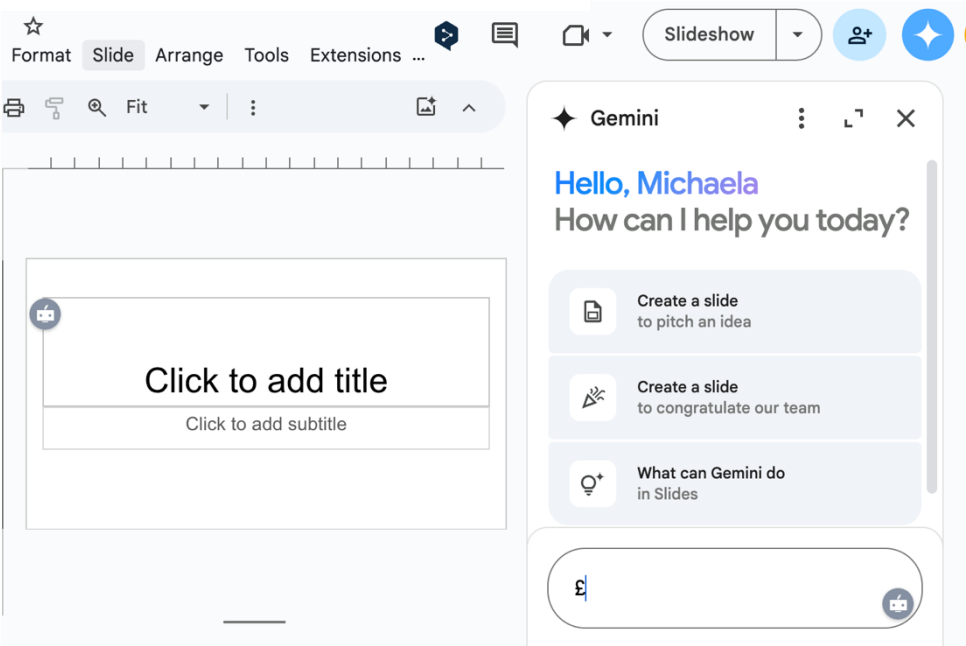
# **DESIGNING PRESENTATIONS AND VISUAL CONTENT**



[link](#)



# Gemini Advanced



# Napkin AI

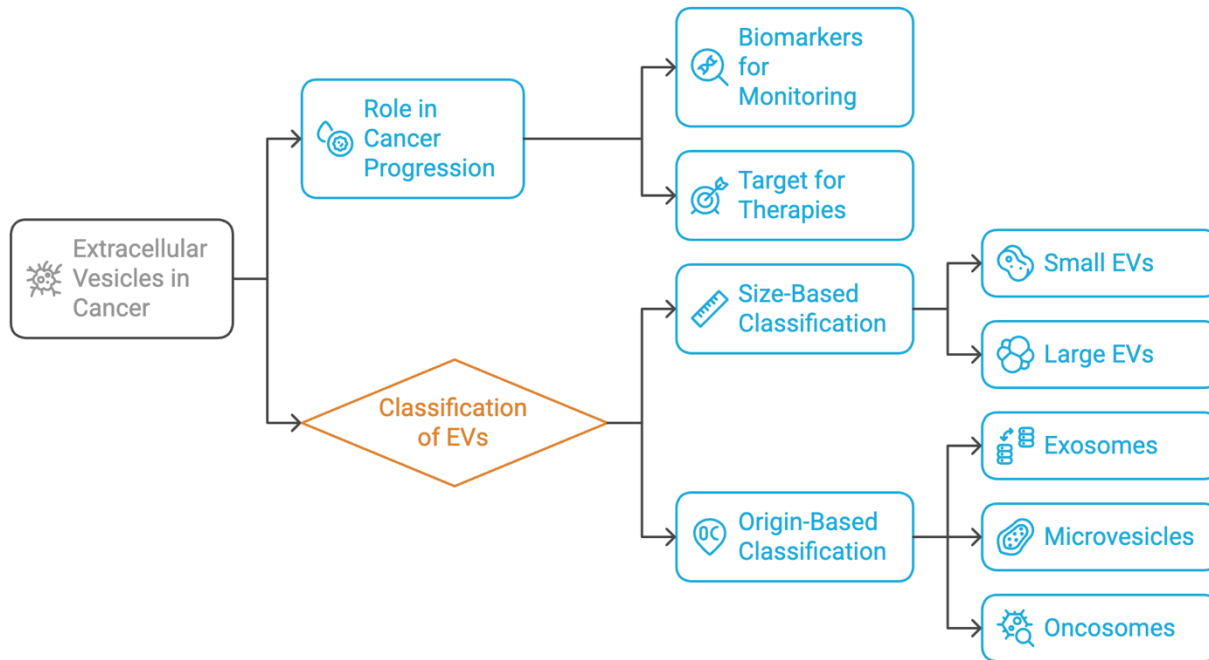
Transforming Ideas  
Into Generative  
Visuals



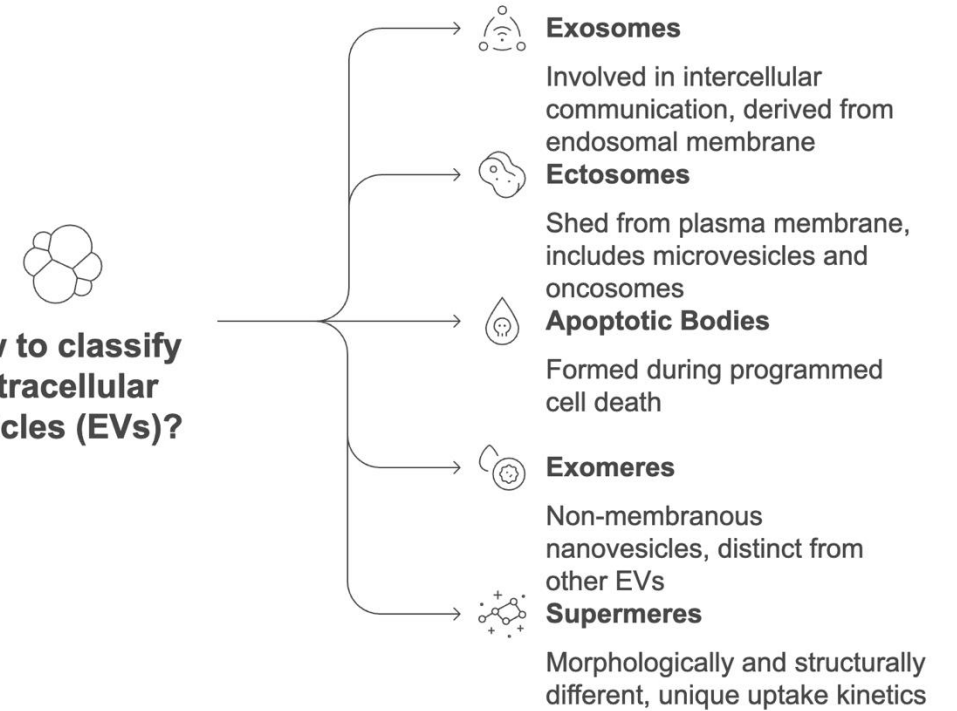
SCHEMES/VISUALS

[link](#)

## Role and Classification of Extracellular Vesicles in Cancer



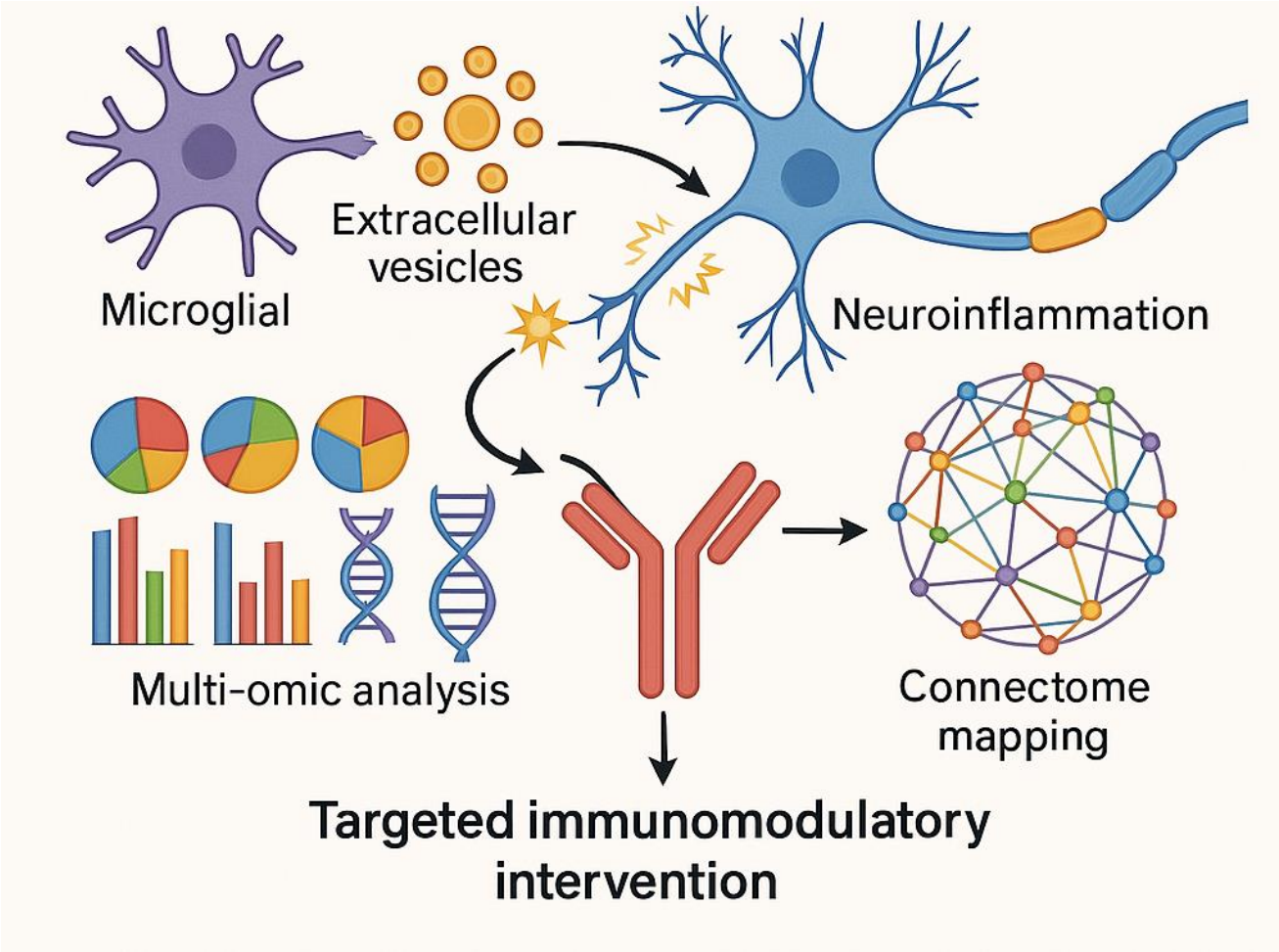
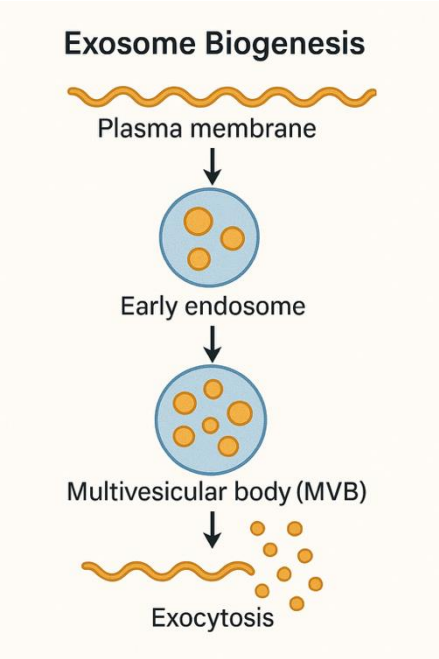
## How to classify extracellular vesicles (EVs)?



# ChatGPT native image generation

please generate an accurate image to support a grant proposal on:  
Spatiotemporal modulation of extracellular vesicle-mediated neuroinflammatory signaling in Alzheimer's progression, with a focus on integrating multi-omic analysis and connectome mapping for targeted immunomodulatory intervention.  
this is for presentation of the proposal and must be scientifically solid

generate a scientifically accurate scheme on exosome biogenesis



# IMAGES

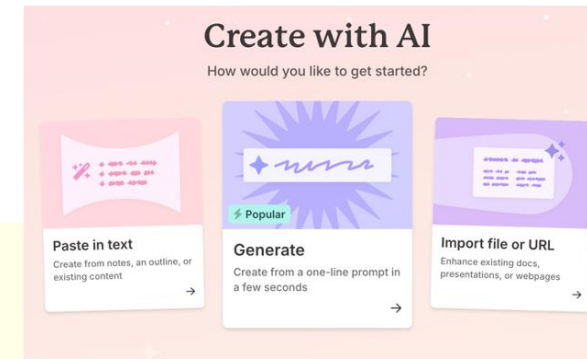


A professional photo of a scientist in a modern lab, wearing safety gear. The scientist is conducting experiments on a lab bench. The lab is equipped with advanced machinery and has a clean, organized appearance. The scientist is wearing protective goggles, a lab coat, and gloves.



## DESIGNING PRESENTATION AND VISUAL CONTENT

**Task:** Log into [Gamma app](#), generate a presentation on any topic:



→ Log into [Napkin ai](#), generate a visual for any topic (you can use any of the previous chatbot conversation as text input or let the AI within Napkin generate the text)

→ Go to ChatGPT, ask for generation of a scientifically accurate illustration on any given topic

*E.g., Generate a scientifically accurate illustration/visualization of endocytosis for scientific publication*

*Note: You can also upload a hand-drawn scheme or image and ask the GPT-4o to transform it into a scientifically accurate illustration + you can edit parts of the image within the app.*

→ Log into [Ideogram.ai](#) (suitable for PR images, visuals for slides,..), ask for generation of an image, e.g., “Professional photoshoot of a scientist in a modern molecular biology lab”, or e.g. “A mad scientist in wet lab, comics style, with text “science is awesome”.

## KEY TAKEAWAYS

- Use AI as a **thinking partner and workflow enhancer**, not a replacement for your expertise
- **LLMs with tool use** (web search, code interpretation) provide more reliable outputs than standalone models
- **Reasoning models** offer superior performance for complex tasks requiring deep analysis
- Develop a **multi-layer approach**: Deep Research → NotebookLM → Reasoning LLMs
- **Always verify outputs**: The intelligence required is on your side!



## REMEMBER

***"AI is the librarian, not the library."***

***Also, the information and workflows described today will be outdated tomorrow!***