

Using AI in Mathematical Writing

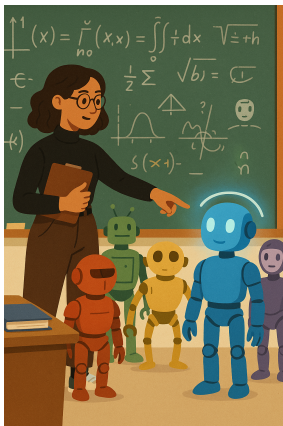
Mathematical Writing – Fall 2025

Johannes Schmitt

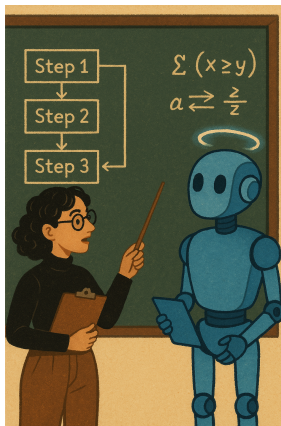
ETH Zurich

November 5, 2025

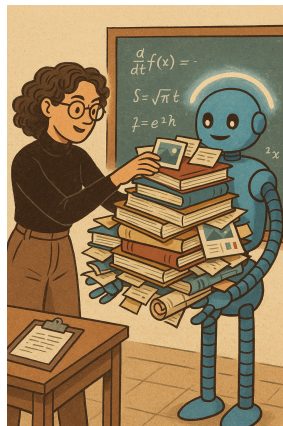
I. General Techniques



Model

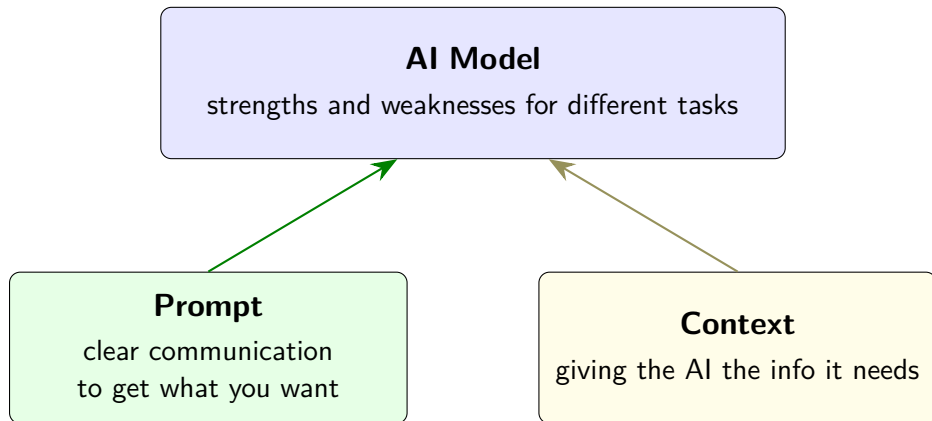


Prompt



Context

Overview: Using AI Effectively



ChatGPT

Strengths:

- Fast Internet Search
- Mathematical Reasoning
- Generating Pictures

Weaknesses:

- Overly Technical Writer
- Personality

Claude

Strengths:

- Excellent Writer
- Deep Research
- Coding (see [Claude Code](#))
- Personality

Weaknesses:

- Mediocre in Mathematics

Gemini

Strengths:

- Long Context
- Handwriting Transcription

Weaknesses:

- Underwhelming Overall

Paid versions are SIGNIFICANTLY better than free ones!

Resources

- <https://lmarena.ai/>
Test/try various models for free (rating helps create a ranking)
- https://johannesschmitt.gitlab.io/AI_applications.html
Detailed advice which model to use for which task

Key Takeaway

Different models excel at different tasks – choose wisely based on your specific needs!

Prompts - Clear Communication

Tell the AI about...

- your goal
- writing style
- output format

Optional:

- audience
- constraints
- tools

Prompts - Clear Communication

what's number of prime numbers at most n

Tell the AI about...

- your goal
- writing style
- output format

Optional:

- audience
- constraints
- tools

◆ Show thinking ▼

That quantity is described by the **prime-counting function**, which is denoted by the symbol $\pi(n)$ (pi of n).

It represents the number of prime numbers less than or equal to n .

The Prime-Counting Function ($\pi(n)$)

There is **no simple formula** to find the exact value of $\pi(n)$. For small values of n , you simply list the primes and count them.

Examples:

- **$n = 10$:** The primes are 2, 3, 5, 7.
 - $\pi(10) = 4$
- **$n = 20$:** The primes are 2, 3, 5, 7, 11, 13, 17, 19.
 - $\pi(20) = 8$

The Prime Number Theorem (Approximation)

While there's no exact formula, the **Prime Number Theorem** provides a very good approximation for large values of n .

It states that $\pi(n)$ is approximately equal to n divided by the natural logarithm of n :

$$\pi(n) \approx \frac{n}{\ln(n)}$$

Prompt - Clear Communication

Tell the AI about...

- your goal
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Optional:

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- constraints
- tools

Write a short paragraph on the prime counting function $\pi(n)$, give definitions and asymptotics in separate Definition/Theorem environments. Aim for academic style with high-information density.
Level: Master thesis in analytic number theory.

◆ Show thinking ▼

The prime counting function, denoted $\pi(x)$, is a central object of study in number theory, encapsulating the distribution of prime numbers. It is a step function that exhibits significant local irregularity, yet its global behavior is remarkably regular. Understanding the asymptotic growth of $\pi(x)$ has been a driving force in the development of analytic number theory, fundamentally linking the discrete nature of primes to the continuous analytic properties of the Riemann zeta function, $\zeta(s)$, particularly the location of its non-trivial zeros. $\mathcal{P}$

Definition (Prime Counting Function)

The **prime counting function** $\pi : \mathbb{R}_{\geq 0} \rightarrow \mathbb{N}_0$ is defined for any real number $x \geq 0$ as the count of prime numbers less than or equal to x . Formally: $\mathcal{P}$

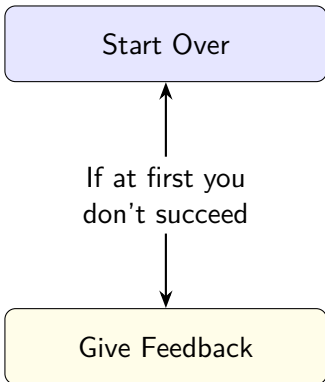
$$\pi(x) = \sum_{p \leq x} 1$$

where the summation is taken over all prime numbers p .

Theorem (Asymptotics of $\pi(x)$)

The **Prime Number Theorem (PNT)** describes the asymptotic behavior of $\pi(x)$. In its simplest form, it states that $\pi(x) \sim \frac{x}{\log x}$ as $x \rightarrow \infty$. A more precise approximation is given by the

Prompt - Conversations and Feedback



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Prompt - Conversations and Feedback

Start Over

If at first you
don't succeed

Give Feedback

Thanks a lot, great start! Can you focus less on broad context, but develop and explain terms in logical order, focusing on clear exposition? Also add an Example for $\pi(x)$. Give reply as LaTeX snippet in code box, assuming relevant packages and environments (definition, theorem, ...) have been defined before.



Show thinking ▼

Code snippet

```
\begin{definition}[Prime Counting Function]
The  $\text{prime counting function}$ , denoted  $\pi(x)$ , maps a real number  $x \geq 0$ 
to the number of primes  $p \leq x$ .

$$\pi(x) = \sum_{p \leq x} 1$$

where the summation is over all primes  $p$ . It is a right-continuous step function.
\end{definition}

\begin{example}
To illustrate the function  $\pi(x)$ :
\begin{itemize}
```

Prompt - Conversations and Feedback

Definition (Prime Counting Function)

The **prime counting function**, denoted $\pi(x)$, maps a real number $x \geq 0$ to the count of prime numbers less than or equal to x . Formally, it is defined as the sum:

$$\pi(x) = \sum_{p \leq x} 1$$

where the summation is over all primes p . It is a right-continuous step function that increases by 1 at each prime.

Example

To illustrate the function $\pi(x)$:

- $\pi(1) = 0$ (1 is not prime).
- $\pi(2) = 1$ (primes ≤ 2 : $\{2\}$).
- $\pi(2.7) = 1$ (primes ≤ 2.7 : $\{2\}$). ...

Prompt - Giving Examples (aka few-shot prompting)

Can you help me write a text about prime numbers? Here ^
is how it starts; in your reply continue where I finish
below.

In the last section we learned about prime numbers and
saw some examples:

\$\$

$\text{primes} = 2, 3, 5, 7, \dots$

\$\$

But now we can ask: if I pick a random 4-digit number,
what is the chance that that number will be a prime
number? What about 7-digit numbers? Or even larger
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number? What about 7-digit numbers? Or even larger
ones?

This is an excellent question that gets to the very heart of how prime numbers are distributed. The simple answer is: **primes become less common as the numbers get larger.**

The chance of a 4-digit number being prime is much higher than the chance of a 7-digit number being prime.

Why Do Primes Get Rarer?

Think of it this way: for a number to be prime, it must *not* be divisible by any prime number smaller than its square root.

- A 4-digit number (like 8,179) only needs to "avoid" being divisible by the primes up to $\sqrt{8179} \approx 90$. (That's 2, 3, 5, 7, 11, ..., 89).
- A 7-digit number (like 5,489,303) needs to avoid being divisible by the primes up to $\sqrt{5,489,303} \approx 2343$.

The larger number has *far more* potential divisors it needs to avoid, making it much more likely that one of them will divide it evenly, thus making it composite.

Context

ONE PART LEAKY COVERS

RENZO CAVALIERI, HANNAH MARKWIG, AND JOHANNES SCHMITT

ABSTRACT. In our previous work [CMS25] we defined a new class of enumerative invariants called k -leaky double Hurwitz descendants, generalizing both descendant integrals of double ramification cycles and k -leaky double Hurwitz numbers. Here, we focus on the one-part version of these numbers, i.e. when the positive ramification profile is (d) . We derive recursions and use them to produce explicit formulas and structure results for some infinite families of these numbers.

CONTENTS

1. Introduction
- 1.1. Results
- 1.2. Discussion
- 1.3. Context
- Acknowledgements

.pdf
Research articles

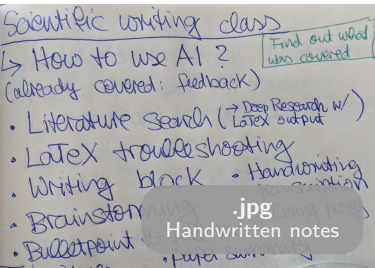
1
1
3
5
6

```
\documentclass[12pt,reqno]{amsart}
\usepackage{graphicx} % Required for inserting images
\usepackage{tikz,xypic}
\usepackage{url, hyperref}
\usepackage{fullpage}
\usepackage{microtype}
\usepackage{amsmath, amssymb, amsthm}
\usepackage{listings}
\usepackage{color}
```

```
%\lstset{language=Python}
```

```
\definecolor{mygreen}{rgb}{0,0.6,0}
\definecolor{mygray}{rgb}{0.5,0.5,0.5}
\definecolor{mymauve}{rgb}{0.58,0,0.62}
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\letcatf %
```

.tex
LaTeX code

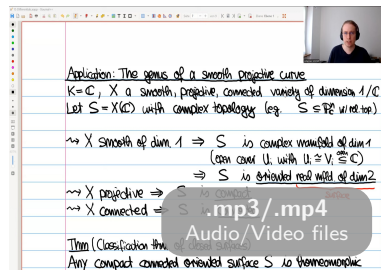
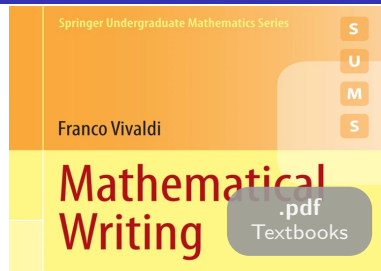


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What almost everyone agrees on

- AI is not an author; you are fully responsible. LLMs can't take responsibility or sign author agreements. Don't list them as authors; humans are accountable for all content. [publicationethics](#) (+)
- Follow your local policy and disclose allowed use. Many universities (e.g., ETH Zurich) allow GenAI in a supplementary role but require transparency and independent work on assessments; check and cite what you used. [ethz.ch](#)
- Disclose in the paper where required. Major publishers (e.g., Springer) require use with oversight; describe what tool, version/date, and how it was used (e.g., language polishing vs. drafting). [nature](#) (+)
- Guard against fabrication and errors. LLMs confidently invent "facts" (references and

.md
AI research results



Context

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- **Follow your local policy and disclose allowed use.** Many universities (e.g., ETH Zurich) allow GenAI in a **supplementary** role but require transparency and independent work on assessments; check and cite what you used. [research... .md](#)
- **Disclose in the paper where required.** Major publishers **AI in research** permit use with oversight; describe what tool, version/date, and how it was used (e.g., language polishing vs. drafting). [Nature +1](#)
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.md
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Scientific writing class

→ How to use AI ?
(already covered: feedback)

- Literature Search (→ Deep Research w/ LaTeX output)
- LaTeX troubleshooting
- Writing block
- Brainstorming
- Bulletpoint

Handwritten notes

S

U

Franco Vivaldi

Mathematical Writing

Application: The genus of a smooth projective curve
 $K = \mathbb{C}$, X a smooth, projective, connected variety of dimension 1/ $\mathbb{C}$
 Let $S = X(\mathbb{C})$ with complex topology (eg. $S \subseteq \mathbb{P}^n$ w/ rel. top.)

$\leadsto X$ smooth of dim 1 $\Rightarrow S$ is complex manifold of dim 1
 (open cover U_i with $U_i \cong \mathbb{C}$)
 $\Rightarrow S$ is oriented real manifold of dim 2

$\leadsto X$ projective $\Rightarrow S$ is compact

$\leadsto X$ connected $\Rightarrow S$ is connected

Thm (Classification thm. of Riemann surfaces)
 Any compact connected oriented surface S is homeomorphic

Example – Lecture scripts from recordings and notes



Lecture.mp4

Notes.pdf

Old_Script.tex

Gemini
1.5 Pro

Johannes

Example – Lecture scripts from recordings and notes



↓ whisper

Schönen guten Morgen, heute werden wir risch und munter in ein neues Thema starten, ...

Transcript.txt

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Transcript.txt

Notes.pdf

↓ convert

DYNAMISCHE PROGRAMMIERUNG (DP)

Schlüssel: Teilprobleme sind häufig dem Original vom Nutzen

DP: sollte Idee für Berechnung vom Aufbau

Beispiel: Verwandte zu Induktion

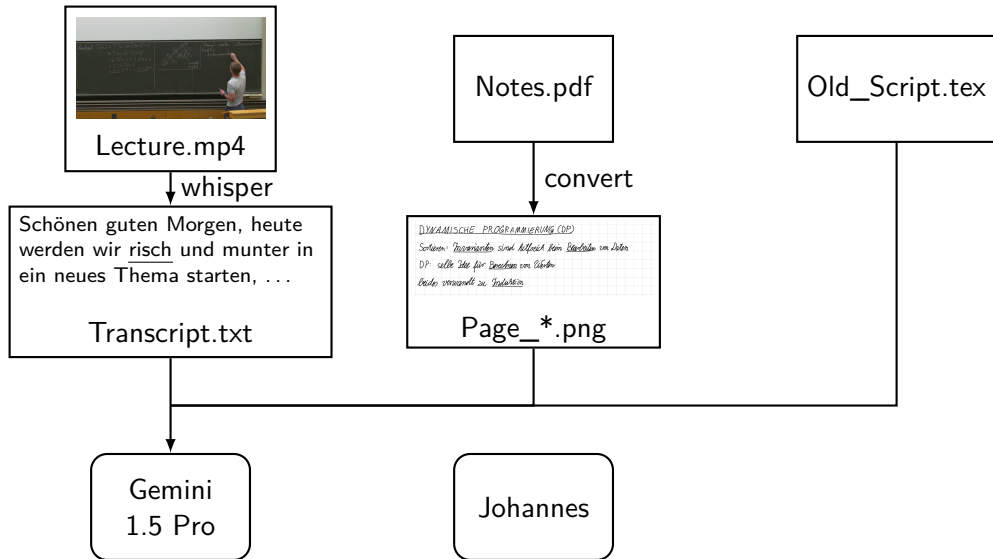
Page_*.png

Old_Script.tex

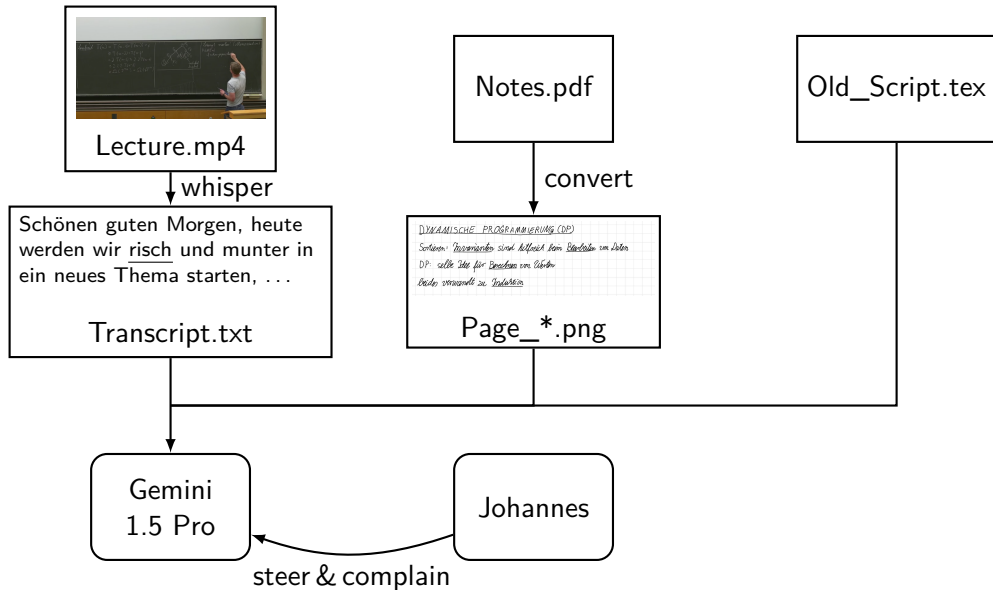
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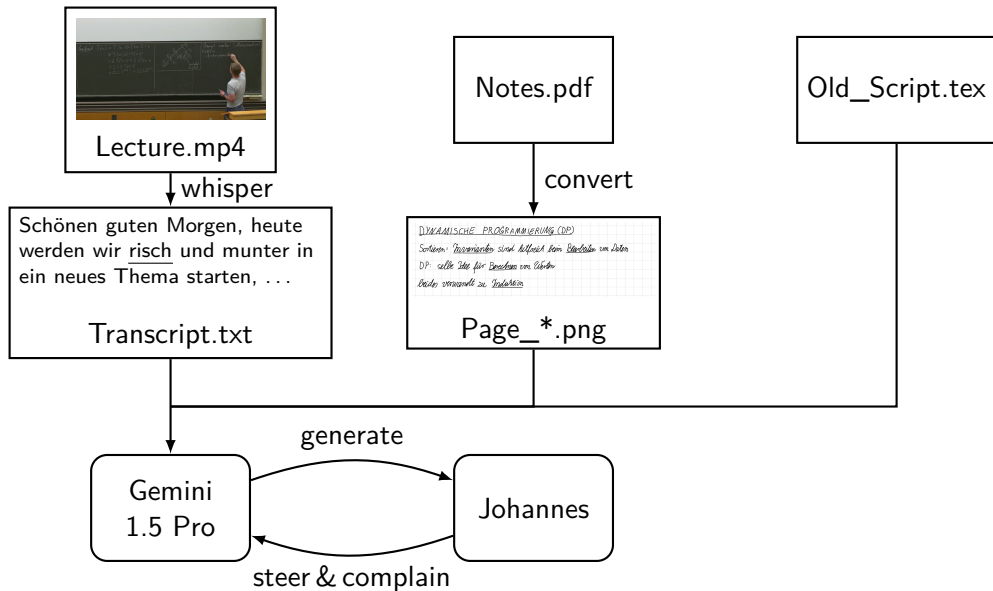
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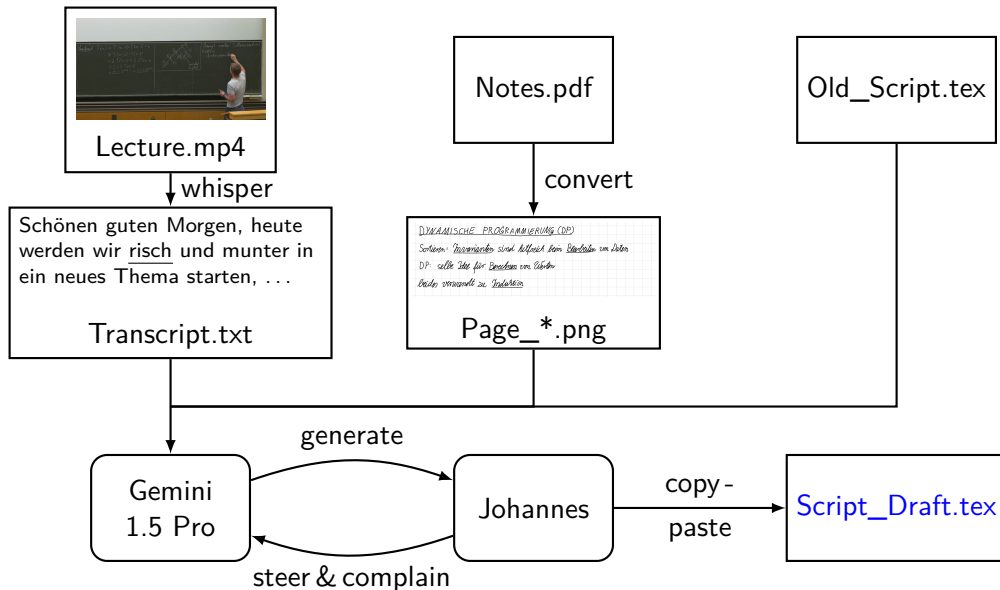
Example – Lecture scripts from recordings and notes



Example – Lecture scripts from recordings and notes



Example – Lecture scripts from recordings and notes



II. Using AI to Help You Write



Literature Search



Feedback

Literature Search

Goal

Find and summarize existing papers and books on a given topic or result

Tools

Deep Research / **Research Mode** function

Tips

- Start multiple queries, have AI consolidate
- Ask for BibTeX entries (check MathSciNet)
- Output contains links (often)



Literature Search – Example

I am interested in writing a historical background section of a Master thesis.

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■ Goal ■ Topic/Focus ■ Output Format ■ Constraints

Results:

- Claude Research Mode
- Gemini Deep Research
- ChatGPT Deep Research

Getting Feedback for your Writing

Goal

Have AI review your draft for typos, style and content

Tools

Claude Opus / any LLM with file upload

Tips

- Focus AI attention (“go paragraph by paragraph”)
- Ask for more critical feedback (“well-meaning referee with high standards”)
- .tex file → ask for feedback with line numbers
- Have conversation (“what did you think of ...”)



III. Using AI to Write for You?!



What Are the Rules?

Core Principles

After agreement with your supervisor, AI can be allowed, but only as support

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Fairness

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ETH Declaration of Originality

"In consultation with the supervisor, one of the following two options must be selected:"

Option 1: No generative AI used

Option 2: AI used with authorized aids, declarations, and supervisor consultation

Declaration of originality

The signed declaration of originality is a component of every written paper or thesis authored during the course of studies. **In consultation with the supervisor**, one of the following two options must be selected:

- ☐ I hereby declare that I authored the work in question independently, i.e. that no one helped me to author it. Suggestions from the supervisor regarding language and content are excepted. I used no generative artificial intelligence technologies¹.
- ☐ I hereby declare that I authored the work in question independently. In doing so I only used the authorised aids, which included suggestions from the supervisor regarding language and content and generative artificial intelligence technologies. The use of the latter and the respective source declarations proceeded in consultation with the supervisor.

Google Scholar search: "As an AI language model, I" -chatgpt

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ABSTRACT: Until the last century, women in many societies were denied basic human rights and their social status was low. This treatment of women not only affected their own lives, but it also hindered the healthy development of families, societies, and countries. Empowering women has become a necessity in today's world, and it is crucial for ensuring a more equitable and just society. As a language model, I firmly believe in the importance of empowering women. It means giving them equal opportunities to education, health, and employment, as well as providing them with a voice in decision-making processes. Women's empowerment is not only a moral imperative but also a strategic one, as it leads to increased economic growth, reduced poverty, and improved health outcomes for families and communities.

In this paper, we explore the meaning, concept, and definition of women's empowerment. We outline the advantages, ways, and means of empowering women, and emphasize the need for the United Nations and various national authorities to play a significant role in this process. We also analyse the current position of women - socially, economically, and politically - and highlight the progress made so far, as well as the challenges that remain. Overall, empowering women is crucial for achieving a more equitable and just society. It is not only a moral imperative but also a strategic one, as it leads to increased economic growth, reduced poverty, and improved health outcomes for families and communities. By empowering women, we can break down the barriers that have prevented them from reaching their full potential and create a better world for all.

Google Scholar search: "As an AI language model, I" -chatgpt

Received date: 05-01-2023, Manuscript No. jibc-23-89990;
Editor assigned date: 07-01-2023, Pre QC No. jibc-23-89990 (PQ);
Reviewed date: 24-01-2023, QC No. jibc-23-89990;
Revision date: 31-01-2023, Manuscript No: jibc-23-89990 (R);
Published date: 07-02-2023

Description

As an AI language model, I can give you some information and general pointers about stock price prediction, but this is a difficult endeavour and there is no sure-fire way to anticipate future stock prices.

Here are some general steps that you can follow to predict stock prices

Gather data: This data should include information on the company's financial performance, industry trends, and macroeconomic factors [1].

Choose a model: Select a suitable predictive model that can accurately forecast future stock prices. Commonly used models include time series analysis, regression analysis, and machine learning algorithms such as random forests, neural networks, and support vector machines.

Google Scholar search: "As an AI language model, I" -chatgpt

position. Figure 9 depicts the MATLAB output. Thus, the prediction algorithm's error values can be used to calibrate the hydroponics farming environment to optimal conditions for the plant species in question. The outcomes obtained through the utilisation of hydroponics have unforeseen benefits. The investigation into the utilisation of deep neural networks for the purpose of analysing hydroponic parameters in order to control actions proved to be crucial. The dataset included 5000 real-time entries, each of which contained a value for a metric such as pH, temperature, humidity, light intensity, or water level. Over a period of 10000 epochs, the input was trained. Generated the appropriate control action with a label ranging from 0 to 7. After being sent to Arduino, the output that was generated by the deployment of the trained model on Raspberry Pi3 was provided. The information and the forecast were saved in a database called Firebase, which is hosted in the cloud [16].

As an AI language model, there is no access to the specific database details of any particular research study. However, in general, a well-designed database for a hydroponics system should include the following:

Tables: Tables should be created to store data related to each aspect of the hydroponics system. For example, there may be a table for sensor readings, a table for system settings, and a table for user data.

Columns: Each table should have relevant columns that store specific types of data. For example, the sensor readings table may have columns for date and time, temperature,

displays data and allows for system control. The web server handles requests and responses from the user interface, while the database stores and retrieves data related to the hydroponics system, such as sensor readings, system settings, and user preferences [19,20]. The user interface or dashboard allows users to view real-time data from the hydroponics system, such as temperature, humidity, and nutrient levels. Users can also adjust system settings, such as nutrient concentration or water flow rate, directly from the dashboard. Additionally, the dashboard may include alerts or notifications for system events, such as low nutrient levels or system faults. Overall, the use of web technology in the proposed design allows for convenient remote monitoring and control of the hydroponics system, providing users with easy access to real-time data and system control.

E.The Results Provided

Discussions and the supporting illustrations on the research findings observed. **As an AI language model**, I don't have access to the specific results and findings of any particular research study. However, some general guidance is provided on how a research study should report and discuss its findings. In general, the results section of a research study should provide a clear and concise presentation of the data and findings. This can include tables, figures, and statistical analysis to support the results. The discussion section should then provide a more detailed interpretation and explanation of the results, including any limitations of the study and implications for future research.

Google Scholar search: "As an AI language model, I" -chatgpt

METHODS

A literature search was conducted to identify relevant articles on the pharmacological properties of quinazolinone. The search was performed using various databases, including PubMed, Scopus, and Web of Science. The articles were screened for relevance, and only those that met the inclusion criteria were included in the review. The articles were then analyzed for the various pharmacological activities of quinazolinone and the underlying mechanisms of action. As an AI language model, I don't have access to the full text of the article "Quinazolinone: Pharmacophore with Endless Pharmacological Actions - A Review". Therefore, I am unable to provide a detailed explanation of the methods used in the study. However, in general, a review article such as this one would not have a specific methods section. Instead, the authors would conduct a thorough review of the existing literature on the topic and synthesize the findings into a comprehensive overview of the pharmacological actions of quinazolinone. The sources of information may include published studies, clinical trials, and other relevant sources of information. The authors would critically analyze and interpret the information and provide a summary of the current understanding of the pharmacological properties of quinazolinone.

Cautionary Tales I

Google Scholar search: "As an AI language model, I" -chatgpt

Wu et al. • Medicine (2024) 103:14

www.md-journal.com



Figure 2. Mechanism diagram of alkaline water treatment for chronic gouty arthritis

In the first draft of a Bachelor Thesis I supervised:

5	1,1,1,1	(x^5)	Lemma 1.3.1 (a)
	2,1,1	(x^2, xy, y^4)	
		$(x^2 + y^3, xy)$	
	2,2	(xy, x^3, y^3)	Explain more Lemma?
		(x^2, xy^2, y^3)	Explain more Lemma?
	3,1	$(x^2, y^2, xy, xz, yz, z^3)$	$0_2 + 1_1$
		(x^2, y^2, z^2, xy, xz)	$0_1 + H$
		$*(x^2, xy, xz, yz, y^2 + z^2)$	$0_1 + 1_2$
		$(xy, xz, yz, x^2 + y^2, x^2 + z^2)$	1_3
	4	$(x, y, z, w)^2$	Lemma 1.3.1 (b)

Table 1: A table with 4cm-wide columns

In a referee report for one of my own papers,
submitted to a top 10 math journal:

4 minor typos

1. Page 15, Proposition 8: In the proof, the notation " p_γ " is used without prior definition. It is suggested to insert a remark defining p_γ as the class obtained from the blowup construction along the stratum M_Γ .
2. Replace instances of " $t^{\Gamma, f, 1}$ s" with a consistent notation such as $r_{\Gamma, f, 1}$ to avoid confusion.
3. Ensure that brackets and parentheses in all displayed equations are matched properly.
4. In Section 2.2.3 on toric geometry, the phrase "the fan $\Sigma_{0,n}$ is naturally identified with the cone complex $M_{0,n}^{\text{trop}}$ " should have "trop" in roman type for clarity.
5. Typo in Section 3.1, paragraph 1: "...we will use language developed here to *to* define the log tautological ring..." - duplicated "to".
6. In Definition 25 the "lifting property for all idealised log thickenings" is mentioned but not defined anywhere prior.
7. In Proposition 48, the paper uses "etale" but earlier used "  tale" (with accent).
8. In Definition 83: the paper introduces " $\text{Star}_\omega(\mathfrak{S})$ " but later refers to " $\text{Star}_\omega(\mathfrak{S})_0$ " without clearly defining what the subscript "0" means in this context.
9. Unclear reference in Lemma 84: The proof refers to "[15, Definition 2.15]" for properties of cone stacks, but the specifics of these properties aren't summarized. A brief explanation of the relevant properties would be helpful.
10. Page 39, line following equation (44) should likely be " $\text{Star}_{0 \rightarrow \sigma}$ ".

Using AI to Write for You – Best Practices

User Input

Draft



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Best Practices for AI Writing

If you do decide to use an LLM to help you write, here are some useful tips.



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User Input

- start with own writing = sets tone
- bullet points enough



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Additionally, providing structured bullet points with key details is often more effective than vague prompts--this gives the AI clear direction while allowing you to maintain control over the content's substance and flow.

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- bullet points enough
- rigorously edit AI text to make your own
- growing body of text guides AI
- occasionally restart to clear context



Draft

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3) Rigorously edit any AI-generated text – this transforms generic output into your authentic voice. Don't accept AI suggestions wholesale; instead, reshape sentences, adjust terminology, and ensure the logic flows naturally. 4) As your document grows, the accumulated text serves as an increasingly better context for the AI, improving consistency and coherence in subsequent generations. 5) When the conversation becomes unwieldy

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- 3) Rigorously edit any AI-generated text to transform generic output into your own voice. Reshape sentences, adjust terminology, and ensure the logic flows naturally.*
- 4) As your document grows, the accumulated text helps to guide the AI in subsequent generations.*
- 5) When the conversation becomes lengthy or the AI starts repeating patterns, start a new one with the current draft for context.*

Questions?

Resources and examples available at:

https://johannesschmitt.gitlab.io/AI_applications.html

Claude conversations for creating these slides:

[Session 1](#), [Session 2](#), [Session 3](#)

Note: Session 2 accidentally used smaller Sonnet model, was surprised about bad quality before I noticed.

AI-Usage section for transparency in my own paper:

<https://arxiv.org/pdf/2509.26076#page=26.30>