USE OF AI IN SCIENTIFIC WRITING

by Nuno S. Osório | nosorio@med.uminho.pt

Use of AI in Scientific Writing

Learning Objectives:

1. Analyze AI's Societal Impact: Analyze how Artificial Intelligence is influencing societal norms and practices, evaluating potential implications for future development based on diverse perspectives (including those of thought leaders like Bill Gates).

2. Evaluate Ethical Integration: Critically evaluate the ethical considerations of integrating AI writing tools into scientific and academic work, determining appropriate conditions for their use.

3. Evaluate Human-AI Writing Frameworks: Explore theoretical frameworks for hybrid human-AI writing, particularly those addressing the post-plagiarism era (such as perspectives from Sarah Eaton).

4. Apply Prompt Engineering Techniques: Apply effective prompt engineering techniques to optimize outputs from large language models for specific scientific and academic writing tasks.

5. Assess AI Writing Tools: Assess the effectiveness of different prompt structures and the suitability of various large language models for scientific and academic writing based on human preference.

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Use of AI in Scientific Writing

Questions that will be addressed:

1. Where is AI's societal impact going, and do we support its current and future roles?
2. Is it ethical to use AI for writing in academic and scientific contexts, and under what conditions should it be integrated?
3. What are the theoretical frameworks behind hybrid human–AI writing?
4. What are the best practices in prompt engineering, and how do they enhance AI-driven scientific writing?
5. What is the "best" prompt structure, and which large language model demonstrates superior performance in this domain?

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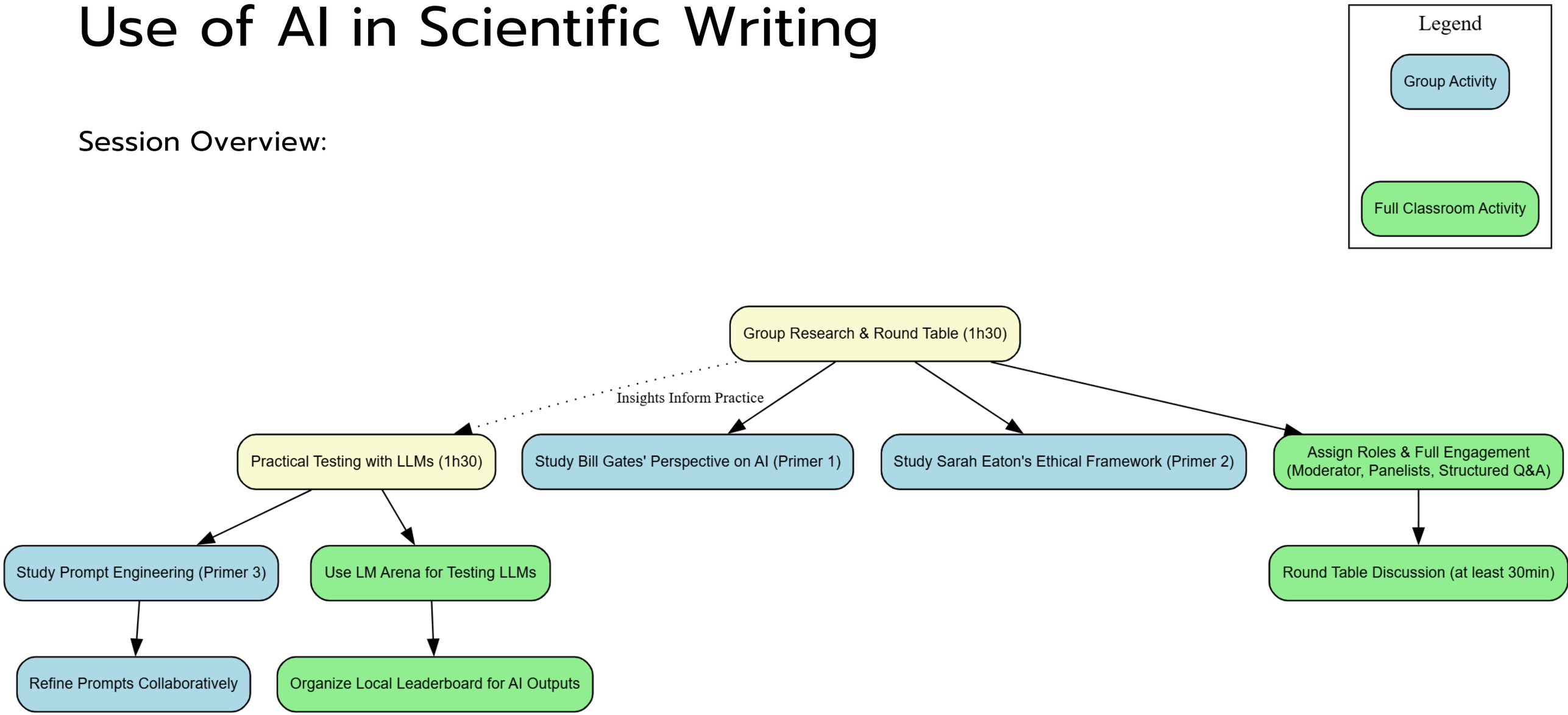
Use of AI in Scientific Writing

Session Overview:



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PRIMER 1

Bill Gates' Perspective on Artificial Intelligence

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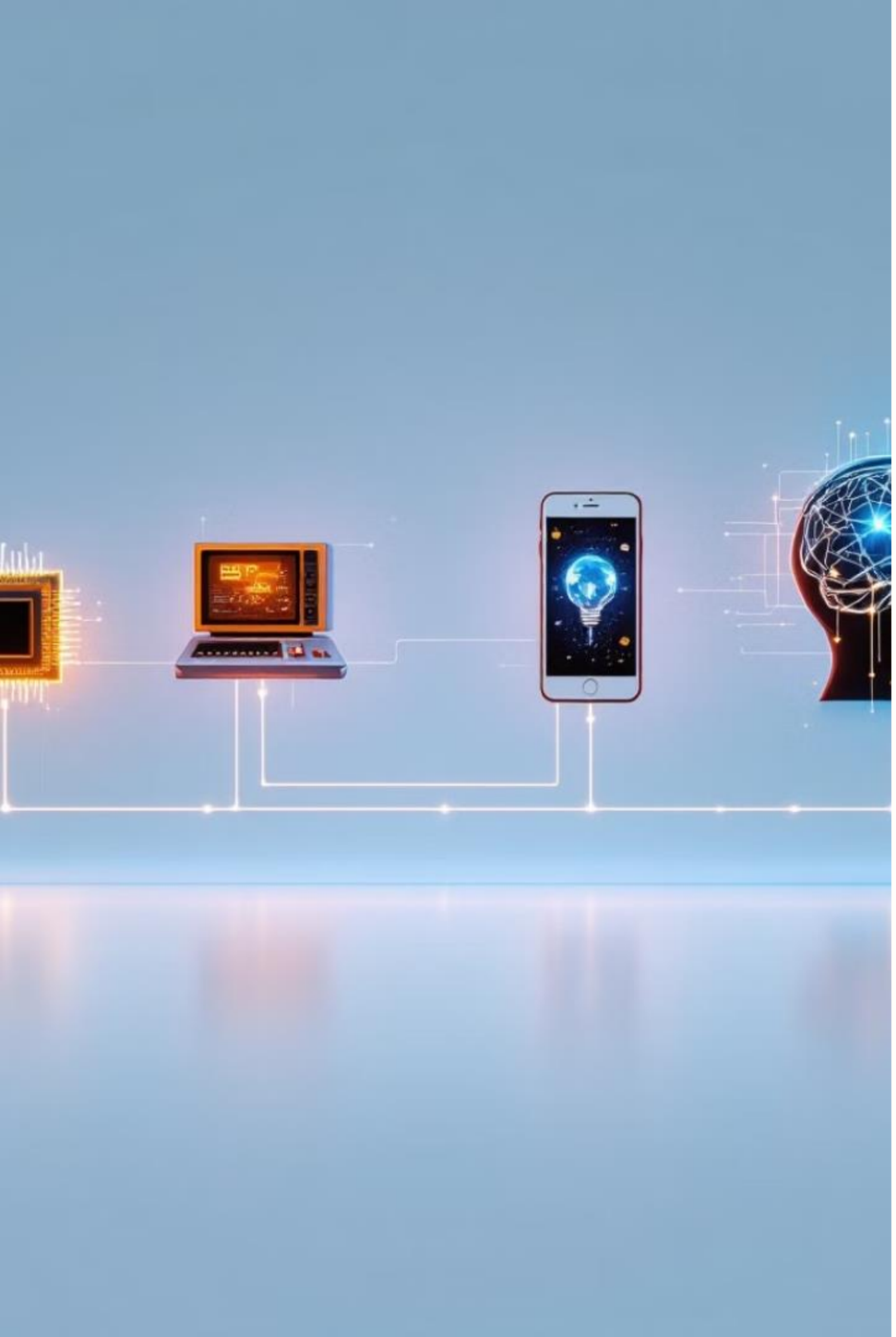

The Dawn of the AI Revolution

Technological Significance

Gates places AI alongside the microprocessor, PC, internet, and mobile phone in transformative impact.

Historical Context

AI represents an "extension of the digital revolution" but with unique capabilities.

Key Distinction

Unlike PCs that amplified human capabilities, AI can directly replace them in many tasks.

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Transforming Healthcare

Expert-Level Diagnostics

AI can provide "great medical advice" and make diagnostics more accessible and affordable.

Medical Research

AI accelerates drug discovery for diseases like AIDS, TB, and malaria.

Global Access

AI-powered tools empower healthcare workers in underserved areas with minimal training.

Health Equity

AI transcends geographical limitations to achieve greater equity in medical care.

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Revolutionizing Education

Personalized Learning

AI adapts to individual student needs, interests, and learning styles.

Human Connection

AI enhances rather than replaces the crucial role of human teachers.

AI Tutors

Virtual tutors provide real-time feedback and support to students.

Teacher Assistance

AI handles administrative tasks, freeing teachers for direct student interaction.

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Driving Global Development

Local Ownership

Gates emphasizes AI solutions must be locally driven, incorporating cultural contexts.

Foundation Investment

Gates Foundation funds "dozens of applications of AI for global health and development."

African AI Platform

$30 million committed to create an AI platform for Africa's specific needs.

Digital Infrastructure

Promoting Digital Public Infrastructure as a framework for essential services.

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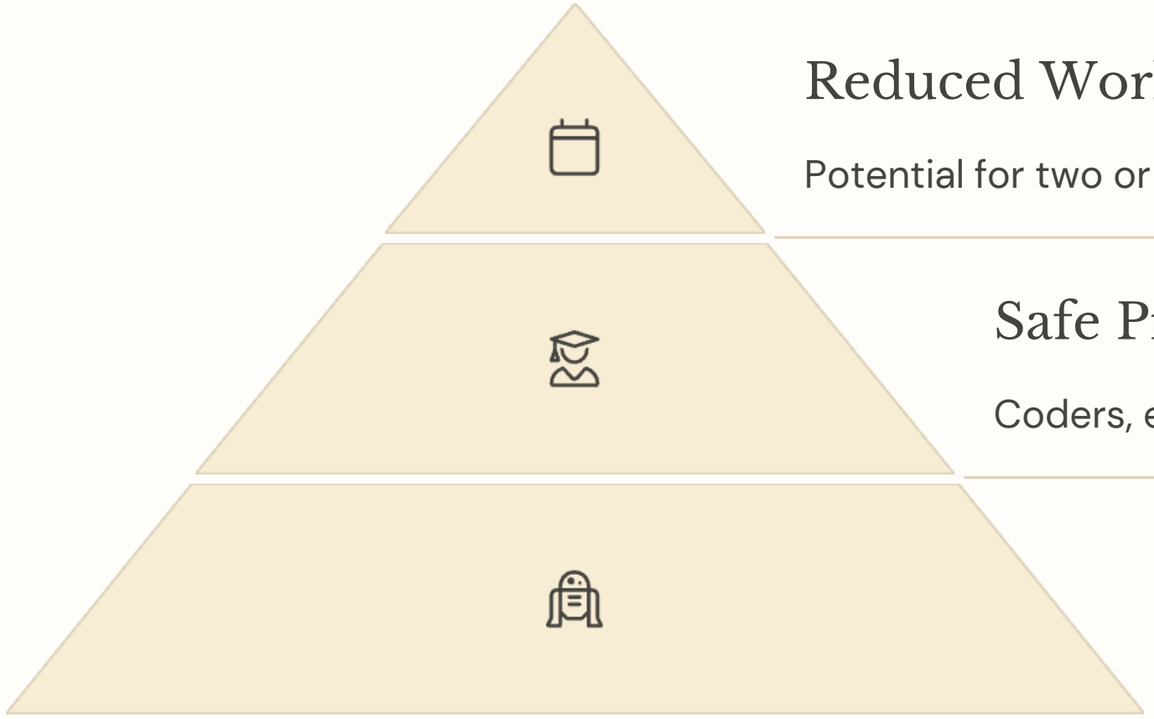
The Future of Work



Reduced Workweek

Potential for two or three-day workweeks due to automation.

Safe Professions

Coders, energy experts, and biologists may resist AI displacement.

Widespread Displacement

AI will replace humans "for most things" within a decade.

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Ethical Dilemmas and Challenges

System Fallibility

Current AI systems make factual mistakes and experience "hallucinations."

Bias Concerns

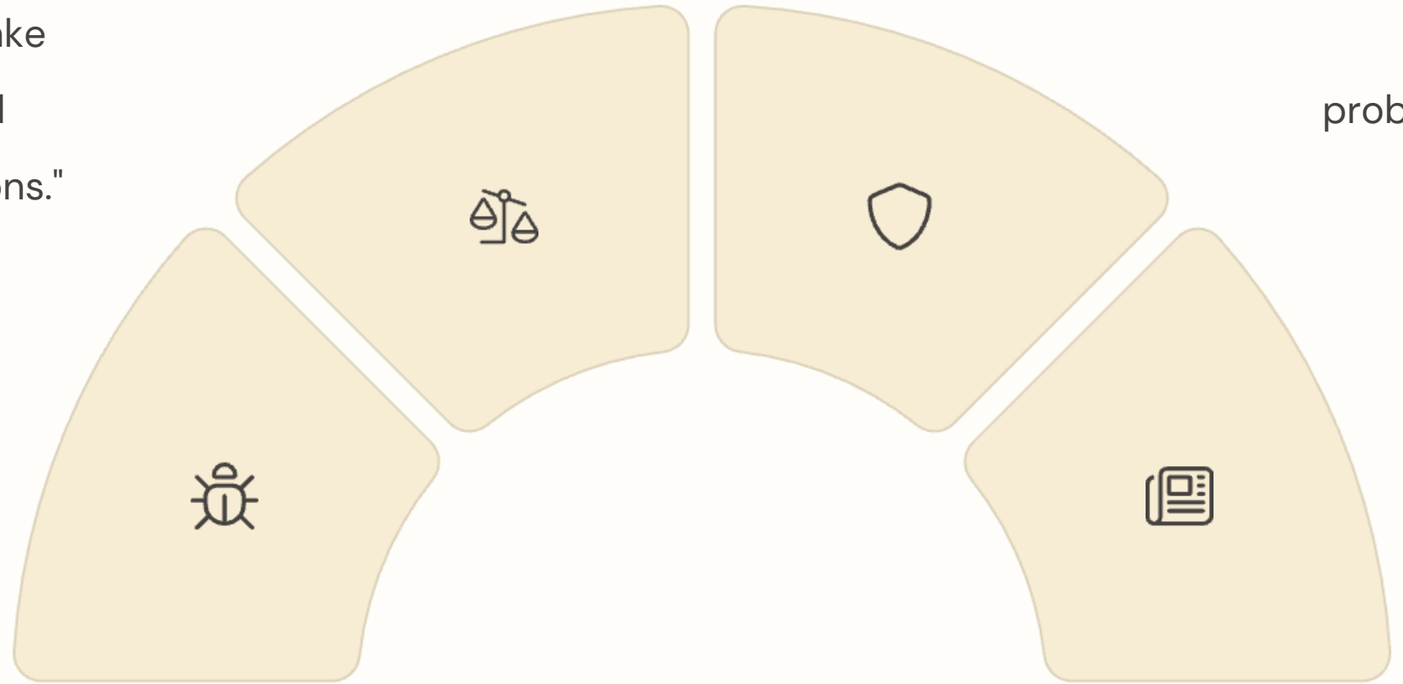
AI may reinforce existing societal biases in its decisions.

Misuse Potential

Risk of malicious actors using AI for cybercrime and bioterrorism.

Misinformation

AI could exacerbate problems by generating false narratives online.



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The Path to Responsible AI

Government Role

Ensuring benefits are shared broadly and equitably.

Global Approach

International cooperation based on safety, ethics, and accountability.

Ongoing Discussions

Establishing clear boundaries between human and AI roles.

Corporate Accountability

Companies should be responsible for discriminatory outcomes or incorrect advice.

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Additional Resources

- Interview & Opinion Articles from 2023:
  - https://www.weforum.org/stories/2023/03/heres-what-the-age-of-ai-means-for-the-world-according-to-bill-gates/
  - https://www.freevacy.com/news/gatesnotes/bill-gates-hails-development-of-ai-as-revolutionary/3517
  - https://www.gatesnotes.com/meet-bill/meet-bill-home-topic/reader/ai-agents
  - https://www.gatesfoundation.org/ideas/media-center/press-releases/2023/10/grand-challenges-ai-equity-womens-health
- Interview & Opinion Articles from 2024:
  - https://www.cnet.com/tech/services-and-software/bill-gates-chats-with-us-about-ai-misinformation-and-climate-change/
  - https://www.gatesfoundation.org/ideas/media-center/press-releases/2023/10/grand-challenges-ai-equity-womens-health
- Interview & Opinion Articles from 2025:
  - https://www.harvardmagazine.com/2025/02/harvard-bill-gates-ai-and-innovation
  - https://www.pcmag.com/news/gates-says-humans-wont-be-needed-for-most-things-in-the-ai-age
  - https://www.livemint.com/news/bill-gates-on-ai-s-future-these-3-professions-are-safe-for-now-11743074711167.html
- Other relevant links:
  - https://www.gatesfoundation.org/ideas/science-innovation-technology/artificial-intelligence
  - https://www.gatesfoundation.org/our-work/programs/global-growth-and-opportunity/digital-public-infrastructure

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PRIMER 2

Ethical Conduct in the Age of AI: Sarah Eaton's Framework

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The Postplagiarism Era

Hybrid Human-AI Writing

Collaboration between humans and AI in writing will become commonplace, blurring traditional authorship lines.

Enhanced Creativity

AI can inspire and augment human creative abilities rather than threaten them.

Disappearing Language Barriers

AI-powered translation tools will facilitate communication across languages.

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Core Tenets of Postplagiarism

Human Responsibility

Humans can delegate tasks to AI but remain accountable for integrity and ethics.

Attribution Remains Important

Acknowledging sources and AI contributions remains fundamental.

Evolving Definitions

Historical definitions of plagiarism no longer apply to AI-generated content.

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Ethical Guidelines for AI in Research

Clear Guidelines

Provide explicit instructions on appropriate AI tool usage in scientific work.

Ethical Education

Educate researchers on AI biases, transparency needs, and human accountability.

Verification

Emphasize researcher responsibility to fact-check and verify AI-generated content.

Transparency

Document and attribute AI tool usage in research methodologies and publications.

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Redefining Plagiarism

Traditional Definitions

Focused on unacknowledged copying of human-authored text

AI Challenges

AI generates seemingly original content, challenging authorship concepts

Policy Adaptation

Institutions must update integrity policies for AI-specific challenges

Eaton emphasizes that traditional plagiarism definitions are inadequate for addressing AI-generated content.

A broader focus on ethical conduct is needed.

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Human Agency in AI-Assisted Research

Human Oversight

Researchers must critically evaluate AI-generated content.

Verification Responsibility

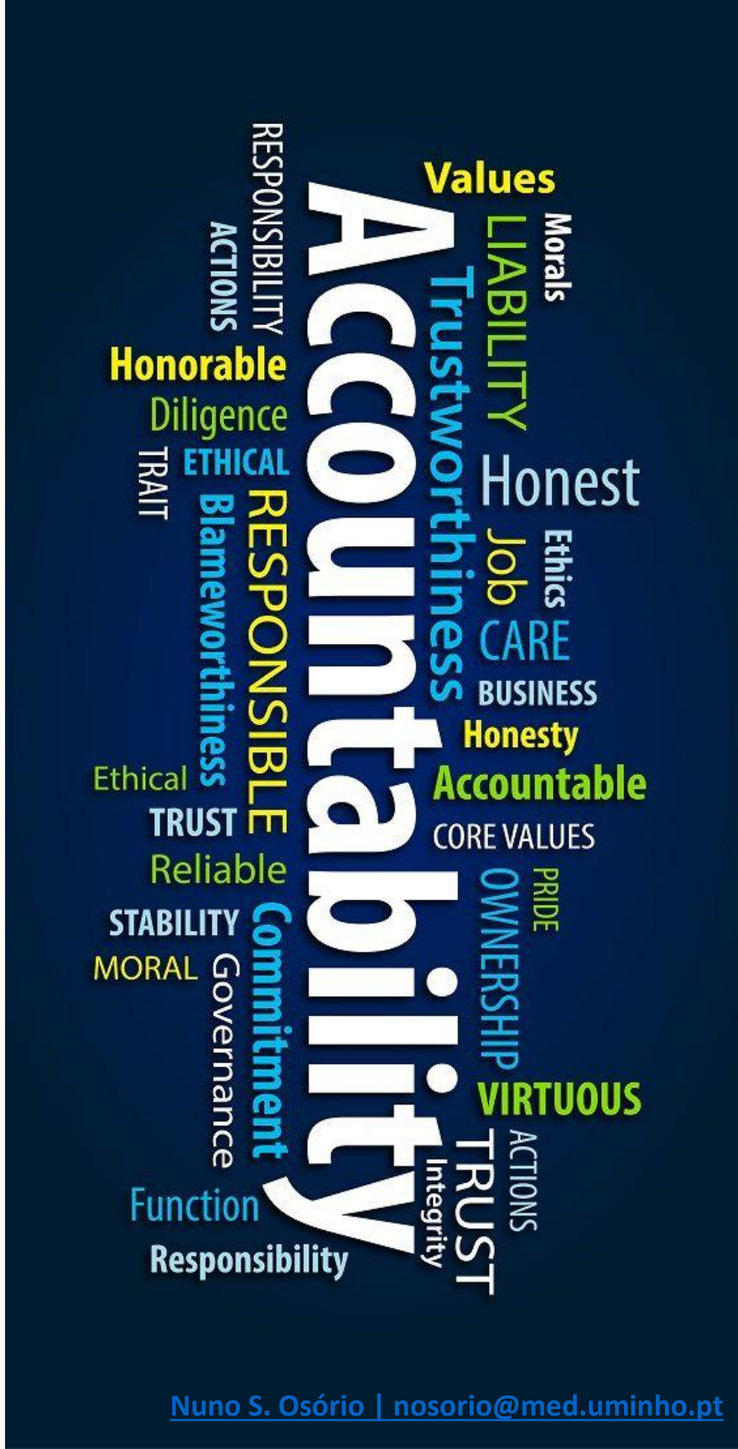
Researchers remain responsible for accuracy and integrity.

Attribution Practice

Properly identify which AI tools were used and how.

Human Authorship

Humans remain primary authors accountable for intellectual content.



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Promoting Integrity in the AI Era

1

Education & Training

Provide robust training on ethical AI use, bias awareness, and data privacy.

2

Assessment Design

Create tasks requiring critical thinking and creativity that AI cannot replicate.

3

Culture Building

Foster environments valuing honesty, trust, fairness, and respect.

4

Policy Development

Establish clear guidelines and regularly update them as technology evolves.

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Future of Ethical AI in Scientific Integrity

Key Shifts

Moving from detection to education, transparency, and ethical consciousness.

Central Priority

Human responsibility remains the cornerstone of research integrity.

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Additional Resources

- **Blog Posts:**
  - Sarah’s Thoughts: Artificial Intelligence and Academic Integrity
  - Embracing AI as a Teaching Tool: Practical Approaches for the Post-Plagiarism Classroom
  - Future-Proofing Integrity in the Age of Artificial Intelligence and Neurotechnology
  - 10 Recommendations for Academic Integrity Action: An AI-Assisted Experiment
- **Academic Profile & Events:**
  - Sarah Eaton’s Profile at UCalgary
  - Research in Progress: Artificial Intelligence and Academic Integrity at UCalgary
  - PostPlagiarism Webinar: Helping Students Maintain Academic Integrity in the Age of AI
- **Publications & Research Outputs:**
  - PostPlagiarism: Transdisciplinary Ethics and Integrity in the Age of AI and Neurotechnology (ResearchGate)
  - Article on AI, Ethics, and Integrity (Taylor & Francis Online)
  - CJLT Journal Article
- **Quality Assurance & Broader Ethical Considerations:**
  - QAA: Ethical Considerations for Using Generative AI in Higher Education

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PRIMER 3
LLMs and Prompt Engineering

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Introduction to LLMs in Scientific Writing

Scientific Applications

LLMs assist with text generation, literature reviews, and data analysis code development.

Workflow Enhancement

Models support editing, proofreading, brainstorming ideas, and synthesizing information.

Limitations

LLMs can produce inaccuracies (hallucinations) or reflect biases from training data.

Prompt Engineering

The quality of the prompt is critical for effective results. Context is key!

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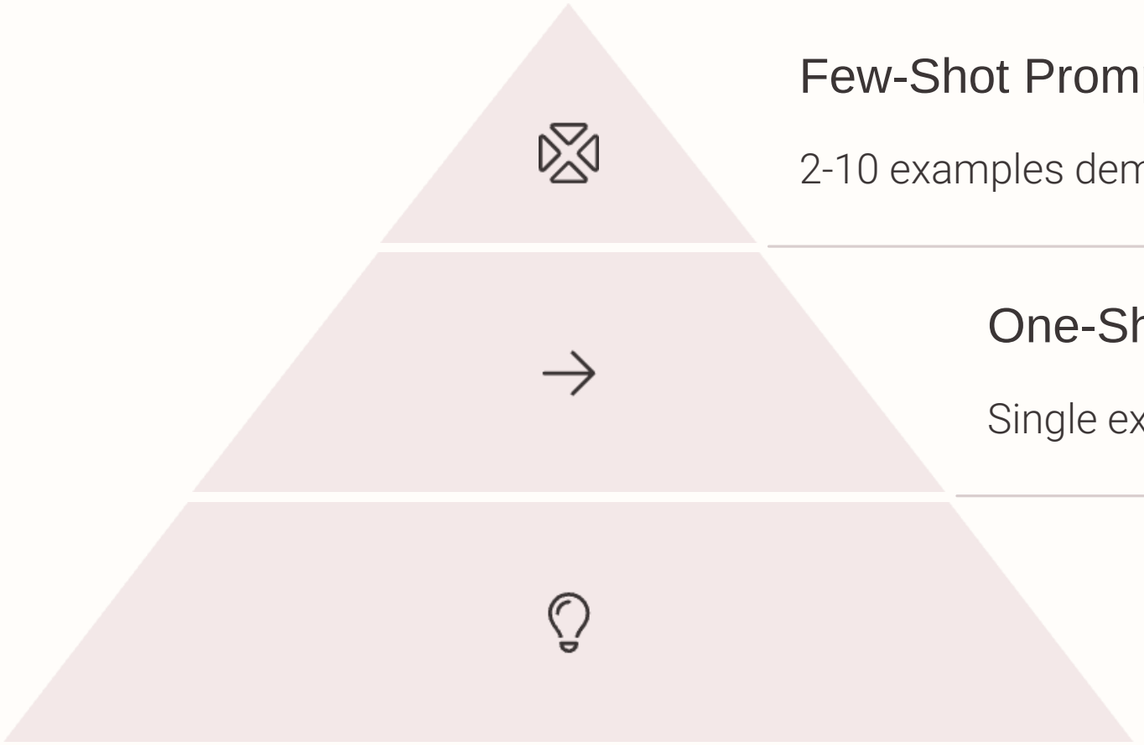
Prompt Engineering: Few-Shot Prompting



Few-Shot Prompting

2-10 examples demonstrating desired output format, structure, and style

One-Shot Prompting

Single example providing context for expected output

Zero-Shot Prompting

Direct instruction without examples

Few-shot prompting leverages in-context learning, where models learn from gold standard examples.

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Prompting Examples

Crafting the perfect title and abstract for your future paper using Hybrid Human-AI Writing

Human Abstract Draft:

Treating Glioblastoma (GBM) is really hard. A big reason is the tumor cells are all different antigen-wise, and the tumor microenvironment (TME) stops immune cells from working right. This is bad for CAR-T cells and other cell types. Regular CAR-T cells that only go after one antigen usually don't work long-term because the tumor cells just stop showing that antigen (antigen escape). So, we made some new CAR-T cells. These ones target two antigens found on GBM cells, EGFRvIII and also B7-H3. We didn't stop there, we also 'armored' them. This means they constantly pump out IL-12, which is supposed to make the TME better for T cells and make the CAR-T cells work harder. We tested this in mice with GBM tumors in their brains. The CAR-T cells that targeted both antigens and made IL-12 worked way better. They controlled the tumors much more and the mice lived longer compared to CAR-Ts targeting only one thing or the ones that didn't make IL-12. We looked inside the tumors and saw more T cells got in, there were fewer bad immune cells, and our CAR-T cells stuck around longer. We checked for side effects too, and it looks pretty safe, manageable toxicity. Overall, this seems like a good way to beat the problems GBM has with resisting treatment. We think these multi-target, armored CAR-Ts should be tried in people with solid tumors.

Zero-shot prompting example

Improve and copyedit the provided abstract to make it suitable for publication (concise, clear, formal tone), and then generate a concise, high-impact title for it suitable for Nature Medicine.

Abstract Draft:

Treating Glioblastoma (GBM) is really hard. A big reason is the tumor cells are all different antigen-wise, and the tumor microenvironment (TME) stops immune cells from working right. This is bad for CAR-T cells and other cell types. Regular CAR-T cells that only go after one antigen usually don't work long-term because the tumor cells just stop showing that antigen (antigen escape). So, we made some new CAR-T cells. These ones target two antigens found on GBM cells, EGFRvIII and also B7-H3. We didn't stop there, we also 'armored' them. This means they constantly pump out IL-12, which is supposed to make the TME better for T cells and make the CAR-T cells work harder. We tested this in mice with GBM tumors in their brains. The CAR-T cells that targeted both antigens and made IL-12 worked way better. They controlled the tumors much more and the mice lived longer compared to CAR-Ts targeting only one thing or the ones that didn't make IL-12. We looked inside the tumors and saw more T cells got in, there were fewer bad immune cells, and our CAR-T cells stuck around longer. We checked for side effects too, and it looks pretty safe, manageable toxicity. Overall, this seems like a good way to beat the problems GBM has with resisting treatment. We think these multi-target, armored CAR-Ts should be tried in people with solid tumors.

Improved Abstract:

[Space for model to write improved abstract]

Proposed Title:

[Space for model to write proposed title]

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One-shot prompting example

Curate a list of your favorite or highly cited papers from that journal and use them.

Improve and copyedit the provided abstract to make it suitable for publication (concise, clear, formal tone), and then generate a concise, high-impact title for it suitable for Nature Medicine. Here is one example of a final abstract/summary and its corresponding Nature Medicine title to guide the style:

Example:

Abstract: Recurrent glioblastoma (rGBM) remains a major unmet medical need, with a median overall survival of less than 1 year. Here we report the first six patients with rGBM treated in a phase 1 trial of intrathecally delivered bivalent chimeric antigen receptor (CAR) T cells targeting epidermal growth factor receptor (EGFR) and interleukin-13 receptor alpha 2 (IL13Rα2). The study's primary endpoints were safety and determination of the maximum tolerated dose. Secondary endpoints reported in this interim analysis include the frequency of manufacturing failures and objective radiographic response (ORR) according to modified Response Assessment in Neuro-Oncology criteria. All six patients had progressive, multifocal disease at the time of treatment. In both dose level 1 (1 ×107 cells; n = 3) and dose level 2 (2.5 × 107 cells; n = 3), administration of CART-EGFR-IL13Rα2 cells was associated with early-onset neurotoxicity, most consistent with immune effector cell-associated neurotoxicity syndrome (ICANS), and managed with high-dose dexamethasone and anakinra (anti-IL1R). One patient in dose level 2 experienced a dose-limiting toxicity (grade 3 anorexia, generalized muscle weakness and fatigue). Reductions in enhancement and tumor size at early magnetic resonance imaging timepoints were observed in all six patients; however, none met criteria for ORR. In exploratory endpoint analyses, substantial CAR T cell abundance and cytokine release in the cerebrospinal fluid were detected in all six patients. Taken together, these first-in-human data demonstrate the preliminary safety and bioactivity of CART-EGFR-IL13Rα2 cells in rGBM. An encouraging early efficacy signal was also detected and requires confirmation with additional patients and longer follow-up time. ClinicalTrials.gov identifier: NCT05168423.

Title: Intrathecal bivalent CAR T cells targeting EGFR and IL13Rα2 in recurrent glioblastoma: phase 1 trial interim results

Now, copyedit and improve the following abstract, and then generate a title:

Abstract Draft: Treating Glioblastoma (GBM) is really hard. A big reason is the tumor cells are all different antigen-wise, and the tumor microenvironment (TME) stops immune cells from working right. This is bad for things like CAR-T cells. Regular CAR-T cells that only go after one antigen usually don't work long-term because the tumor cells just stop showing that antigen (antigen escape). So, we made some new CAR-T cells. These ones target two antigens found on GBM cells, EGFRvIII and also B7-H3. We didn't stop there, we also 'armored' them. This means they constantly pump out IL-12, which is supposed to make the TME better for T cells and make the CAR-T cells work harder. We tested this in mice with GBM tumors in their brains. The CAR-T cells that targeted both antigens and made IL-12 worked way better. They controlled the tumors much more and the mice lived longer compared to CAR-Ts targeting only one thing or the ones that didn't make IL-12. We looked inside the tumors and saw more T cells got in, there were fewer bad immune cells, and our CAR-T cells stuck around longer. We checked for side effects too, and it looks pretty safe, manageable toxicity. Overall, this seems like a good way to beat the problems GBM has with resisting treatment. We think these multi-target, armored CAR-Ts should be tried in people with solid tumors.

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Proposed Title:

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Few-shot prompting example

Curate a list of your favorite or highly cited papers from that journal and use them.

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Example 1:

Abstract: Recurrent glioblastoma (rGBM) remains a major unmet medical need, with a median overall survival of less than 1 year. Here we report the first six patients with rGBM treated in a phase 1 trial of intrathecally delivered bivalent chimeric antigen receptor (CAR) T cells targeting epidermal growth factor receptor (EGFR) and interleukin-13 receptor alpha 2 (IL13Rα2). The study's primary endpoints were safety and determination of the maximum tolerated dose. Secondary endpoints reported in this interim analysis include the frequency of manufacturing failures and objective radiographic response (ORR) according to modified Response Assessment in Neuro-Oncology criteria. All six patients had progressive, multifocal disease at the time of treatment. In both dose level 1 (1 ×107 cells; n = 3) and dose level 2 (2.5 × 107 cells; n = 3), administration of CART-EGFR-IL13Rα2 cells was associated with early-onset neurotoxicity, most consistent with immune effector cell-associated neurotoxicity syndrome (ICANS), and managed with high-dose dexamethasone and anakinra (anti-IL1R). One patient in dose level 2 experienced a dose-limiting toxicity (grade 3 anorexia, generalized muscle weakness and fatigue). Reductions in enhancement and tumor size at early magnetic resonance imaging timepoints were observed in all six patients; however, none met criteria for ORR. In exploratory endpoint analyses, substantial CAR T cell abundance and cytokine release in the cerebrospinal fluid were detected in all six patients. Taken together, these first-in-human data demonstrate the preliminary safety and bioactivity of CART-EGFR-IL13Rα2 cells in rGBM. An encouraging early efficacy signal was also detected and requires confirmation with additional patients and longer follow-up time. ClinicalTrials.gov identifier: NCT05168423.

Title: Intrathecal bivalent CAR T cells targeting EGFR and IL13Rα2 in recurrent glioblastoma: phase 1 trial interim results

Example 2:

(…)

Now, copyedit and improve the following abstract, and then generate a title:

Abstract Draft: Treating Glioblastoma (GBM) is really hard. A big reason is the tumor cells are all different antigen-wise, and the tumor microenvironment (TME) stops immune cells from working right. This is bad for things like CAR-T cells. Regular CAR-T cells that only go after one antigen usually don't work long-term because the tumor cells just stop showing that antigen (antigen escape). So, we made some new CAR-T cells. These ones target two antigens found on GBM cells, EGFRvIII and also B7-H3. We didn't stop there, we also 'armored' them. This means they constantly pump out IL-12, which is supposed to make the TME better for T cells and make the CAR-T cells work harder. We tested this in mice with GBM tumors in their brains. The CAR-T cells that targeted both antigens and made IL-12 worked way better. They controlled the tumors much more and the mice lived longer compared to CAR-Ts targeting only one thing or the ones that didn't make IL-12. We looked inside the tumors and saw more T cells got in, there were fewer bad immune cells, and our CAR-T cells stuck around longer. We checked for side effects too, and it looks pretty safe, manageable toxicity. Overall, this seems like a good way to beat the problems GBM has with resisting treatment. We think these multi-target, armored CAR-Ts should be tried in people with solid tumors.

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Proposed Title:

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Few-Shot Prompting & LLM Limits: The Balancing Act

Test various prompts by changing the number and type of examples included.

- All Large Language Models (LLMs) have a maximum amount of text they can process at once.
- This limit is measured in "tokens" (pieces of words) and is called the Context Window.
- Good News: Modern models like GPT-4o, Gemini 2.5 Pro, etc., have massively increased context windows (100k+ tokens!).
- BUT... The limit, however large, is still finite

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Evaluating Large Language Models

Benchmark Datasets

Standardized tests like GLUE, MMLU, and TruthfulQA assess performance across various tasks.

Human Evaluation

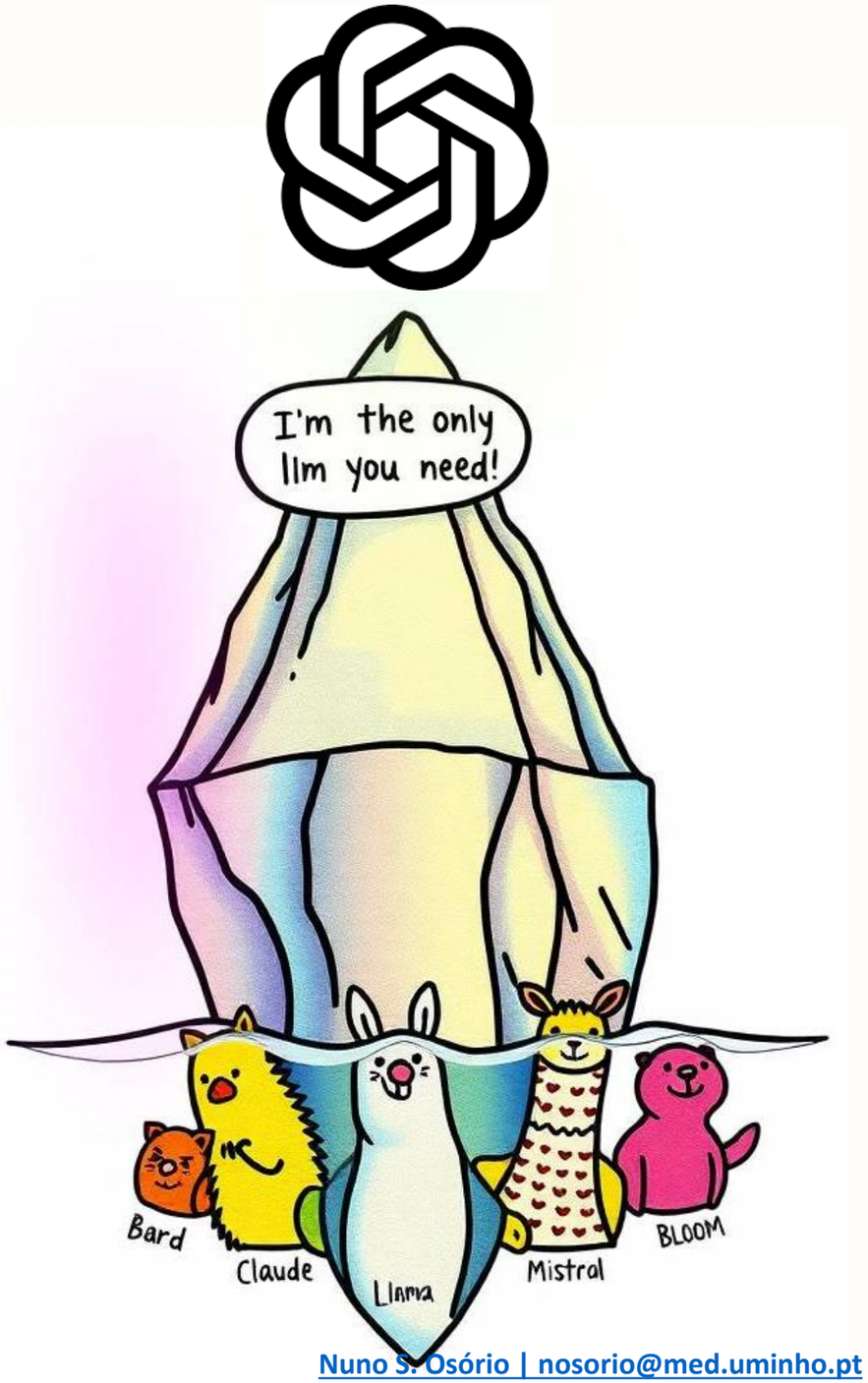
Feedback from human judges using Likert scales, A/B testing, and expert reviews.

Automated Metrics

Perplexity, BLEU, ROUGE, and BERTScore measure text quality against references.

Limitations

Aggregated metrics mask prompt-specific performance variations crucial for scientific writing.



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Prompt-to-Leaderboard (P2L) Method

Input Prompt

Natural language prompt is provided to the P2L model

P2L Processing

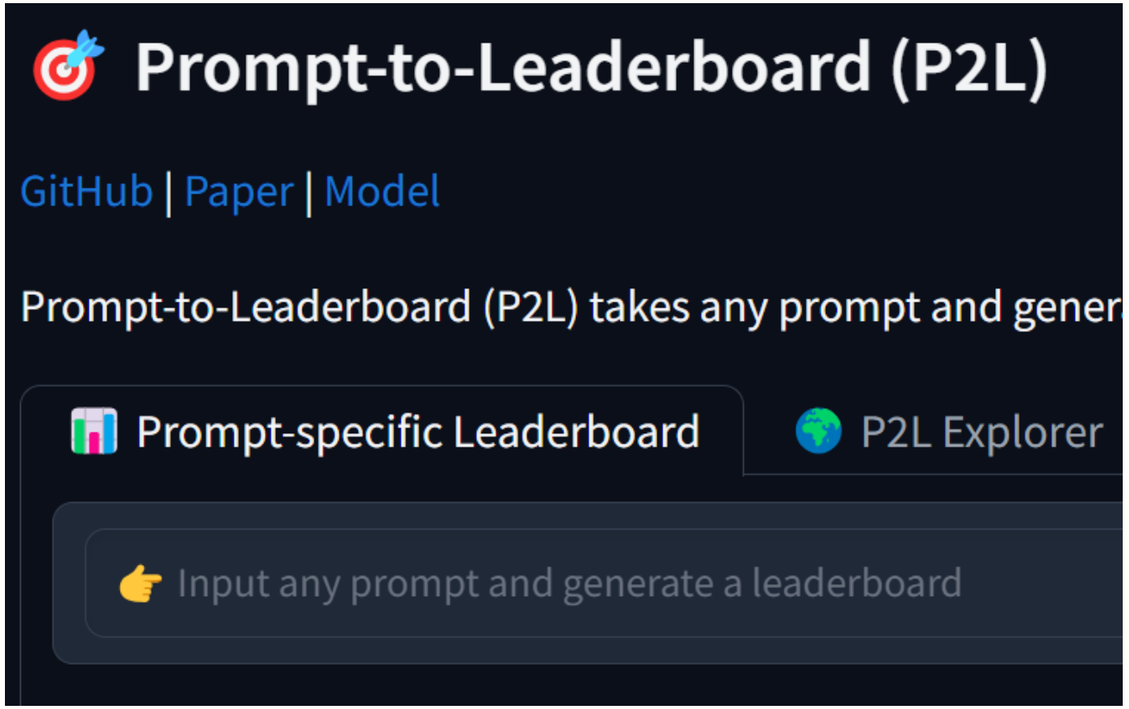
Model outputs Bradley-Terry coefficients for different LLMs

Prompt-Specific Ranking

Coefficients predict human preferences for that particular prompt

Optimal Model Selection

System routes query to best-performing LLM for the specific task



https://lmarena.ai/

P2L leverages human preference data from platforms like Chatbot Arena to create prompt-specific evaluations, enabling unsupervised task-specific model selection.

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Thank you!

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