

# Text Data in Business and Economics

Basel University – Autumn 2024

## 10. Generative AI

# Outline

GPT

Generative AI for Research

GPT = Generative Pre-Trained Transformer

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- ▶ GPT-1: the first autoregressive transformer model (2018)
  - ▶ trained on the Books corpus.
  - ▶ train on a language modeling task, as well as a multi-task that adds a supervised learning task.

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  - ▶ all articles linked from Reddit with at least 3 upvotes (8 million documents, 40 GB of text)
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  - ▶ make model much bigger
- ▶ GPT-3 (2020):
  - ▶ use an even bigger corpus (Common Crawl, WebText2, Books1, Books2 and Wikipedia)
  - ▶ make model much, much bigger

# OPENAI'S NEW MULTITALENTED AI WRITES, TRANSLATES, AND SLANDERS

*A step forward in AI text-generation that also spells trouble*

By James Vincent | Feb 14, 2019, 12:00pm EST

Howard, co-founder of Fast.AI agrees. "I've been trying to warn people about this for a while," he says. "We have the technology to totally fill Twitter, email, and the web up with reasonable-sounding, context-appropriate prose, which would drown out all other speech and be impossible to filter."



BUSINESS

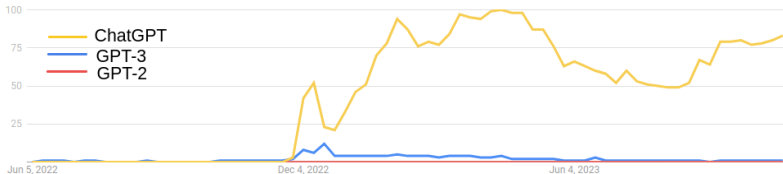
# Is ChatGPT the Start of the AI Revolution?

Analysis by The Editors | Bloomberg

December 9, 2022 at 1:39 p.m. EST

## *The New Chatbots Could Change the World. Can You Trust Them?*

Siri, Google Search, online marketing and your child's homework will never be the same. Then there's the misinformation problem.





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  - ▶ Incorporates the base model on which ChatGPT is fine-tuned + is optimized for chat
- ▶ GPT-4 (2023):
  - ▶ Multimodal model: can take also images as inputs
  - ▶ Trained in two stages:
    1. token prediction (like other GPT models)
    2. **reinforcement learning with human feedback**
  - ▶ Much, much, much bigger model

Stammbach and Ash (2020),  
“e-FEVER: Explanations and Summaries for  
Automated Fact Checking”

Claim	Extractive Summary	Abstractive Summary
Marnie was directed by someone who was "The Master of Nothing".	+ Alfred Hitchcock + Sir Alfred Joseph Hitchcock ( 13 August 1899 - 29 April 1980 ) was an English film director and producer , at times referred to as " The Master of Suspense " . + Marnie (film) + Marnie is a 1964 American psychological thriller film directed by Alfred Hitchcock ."	Marnie was directed by Alfred Hitchcock, who was "The Master of Suspense".
Colin Kaepernick is a poker player.	+ Colin Kaepernick + Colin Rand Kaepernick ( born November 3 , 1987 ) is an American football quarterback who is currently a free agent . + American football + American football , referred to as football in the United States and Canada , and also known as " gridiron football " or simply " gridiron " , is a sport played by two teams of eleven players on a rectangular field with goalposts at each end .	Colin Kaepernick is a football player, not a poker player.

Stammbach, Antoniak, and Ash (2022),  
"Heroes, Villains, and Victims, and GPT-3"

Who is the villain in the following text?

*Text: In questioning the use of hydraulic fracturing in New York to help produce natural gas, you do not note that the technology has been employed and continuously improved for more than 50 years and that studies by the Environmental Protection Agency and the Ground Water Protection Council have not identified a single instance of groundwater contamination. Wells where fracturing is used are specially constructed to protect drinking water sources. Regulatory oversight is extensive. The fluids mostly water that are forced into a well to create pressure to fracture rock are pushed back out by the oil and gas flowing upward for safe processing. Protecting our water supplies is important, as are reductions in greenhouse gas emissions through use of clean-burning natural gas. Banning hydraulic fracturing would be unwarranted and shortsighted, preventing production of large amounts of natural gas that could directly benefit New York consumers for decades and create thousands of good jobs.*

**Villain: The villain in this text is the person who is questioning the use of hydraulic fracturing in New York.**

Movie	Hero	Victim	Villain
101 Dalmatians	Roger Dearly	The Dalmatian Puppies	Cruella de Vil
Aladdin	Aladdin	Aladdin	Jafar
Cinderella	Cinderella	Cinderella	Lady Tremaine
Alice In Wonderland	Alice	Alice	The Queen of Hearts
The Jungle Book	Mowgli	Mowgli	Shere Khan, a man-eating Bengal tiger
Sleeping Beauty	Prince Phillip	Aurora	Maleficent
The Lion King	Simba	Mufasa	Scar
Peter Pan	Peter Pan	Wendy, John, Michael, and the Lost Boys	Captain Hook
Mary Poppins	Mary Poppins	Mr. Banks	Mr. Dawes
The Little Mermaid	Ariel	Ariel	Ursula
Snow White	Snow White	Snow White	The Queen

Table 2: Results for Wikipedia plots of widely known Disney Movies

# Outline

GPT

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# Generative AI for Economic Research

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---

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  - ▶ Discusses long-run implications of AI for economic research

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  - ▶ Discusses long-run implications of AI for economic research
- ▶ Main takeaway on LLMs for research:

“Treat LLMs as if it was an internet who is: 1) smart and incredibly motivated and eager to help 2) but completely lacks the context of what you are doing”

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# Generative AI for Economic Research

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  - ▶ Discusses long-run implications of AI for economic research
- ▶ Main takeaway on LLMs for research:

“Treat LLMs as if it was an internet who is: 1) smart and incredibly motivated and eager to help 2) but completely lacks the context of what you are doing”
- ▶ Good practices:
  - ▶ Provide context (e.g., specify point of view, audience, etc.)
  - ▶ Iterate
  - ▶ Be patient

---

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Category	Task	Usefulness
Ideation and Feedback	Brainstorming	●
	Feedback	◐
	Providing counterarguments	◐
Writing	Synthesizing text	●
	Editing text	●
	Evaluating text	●
	Generating catchy titles & headlines	●
	Generating tweets to promote a paper	●
Background Research	Summarizing Text	●
	Literature Research	○
	Formatting References	●
	Translating Text	●
	Explaining Concepts	◐
Coding	Writing code	◐
	Explaining code	◐
	Translating code	●
	Debugging code	◐
Data Analysis	Creating figures	◐
	Extracting data from text	●
	Reformatting data	●
	Classifying and scoring text	◐
	Extracting sentiment	◐
	Simulating human subjects	◐
Math	Setting up models	◐
	Deriving equations	○
	Explaining models	◐

## Models Overview

LLM	Price	Tokens <sup>2</sup>	Data Cutoff	Images	PDFs upload
GPT-4o mini	free	128k	10/2023	yes	yes (limited)
GPT-4o	20\$/month	128k	10/2023	yes+	yes
Claude 3.5 Opus	free/20\$ month	200k	04/2024	no	yes
Gemini 1.5 Pro	free	~30k	08/2024	yes	yes
Llama 3.1-405b	open-source	128k	12/2023	no	no

---

<sup>2</sup>Token calculator: <https://platform.openai.com/tokenizer>

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- ▶ Focus on GPT: at the moment better integrations, more functions, used by main tech. companies like Microsoft (see <https://copilot.microsoft.com/>)
- ▶ Open-source models are catching up fast

---

<sup>2</sup>Token calculator: <https://platform.openai.com/tokenizer>

## Ideation and Feedback

Category	Task	Usefulness
Ideation and Feedback	Brainstorming	●
	Feedback	◐
	Providing counterarguments	◐

# Ideation and Feedback: Feedback

## SYSTEM

You are a referee report for an economics journal who needs to evaluate a paper by looking at the abstract.

Highlight 3 strengths and 3 limitations of the paper which could undermine their conclusions, writing one sentence for each point.

## ASSISTANT

Strengths:

1. The paper utilizes a large dataset of over 250 million job vacancy postings across five English-speaking countries, providing a comprehensive analysis of the shift to remote work.
2. The authors employ a state-of-the-art language processing framework that achieves 99% accuracy in identifying job postings that advertise remote work, surpassing other methods.
3. The study covers a significant time period from 2019 to early 2023, allowing for an examination of the long-term trends and changes in the share of job postings offering remote work.

Limitations:

1. The paper focuses solely on English-speaking countries, which may limit the generalizability of the findings to other regions and cultures.
2. While the authors achieve high accuracy in identifying remote work postings, there may still be some misclassification or ambiguity in the language used, leading to potential measurement errors.
3. The study highlights non-uniformity in the adoption of remote work across cities, industries, occupations, and companies, but it does not delve into the underlying reasons for these differences, which could be crucial for understanding the broader implications of remote work.

# Writing

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Writing	Synthesizing text	●
	Editing text	●
	Evaluating text	●
	Generating catchy titles & headlines	●
	Generating tweets to promote a paper	●

---



# Writing: Synthesizing Text

USER

Write a paragraph that integrates the following arguments and goes beyond. Include a topic sentence.

- \* large language models automate cognitive tasks
- \* the work of economists is largely cognitive [add examples]
- \* we economists should therefore worry about recent progress in language models
- \* in the short run, these models can help us be more productive
- \* in the long run, there is a good likelihood that they will displace human economists
- \* we should think how to prepare [offer solutions]

ASSISTANT

The rapid advancement of large language models, which are capable of automating cognitive tasks, has significant implications for the field of economics, where the work is predominantly cognitive in nature, such as analyzing data, forecasting trends, and developing policy recommendations. As economists, it is crucial that we acknowledge and address the potential impact of these language models on our profession. In the short term, these models can undoubtedly enhance our productivity by streamlining research, automating data analysis, and even generating insightful reports. However, in the long run, there is a considerable likelihood that these advanced technologies will displace human economists, as they become increasingly adept at performing complex tasks. To prepare for this eventuality, we must consider strategies such as continuous upskilling, focusing on areas where human intuition and creativity are irreplaceable, and advocating for responsible development and deployment of these technologies to ensure that they complement, rather than replace, our expertise.

# Background Research

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Background Research	Summarizing Text	●
	Literature Research	○
	Formatting References	●
	Translating Text	●
	Explaining Concepts	◐

---

# Background Research: Literature Review (1 year ago)

C

What does the economic literature say about gender differences in media representation of gender-based violence? Please provide me with the most important references from the economics literature (no need for a summary)



I can provide you with some important references from the economics literature on gender differences in media representation of gender-based violence. Please note that the availability of these references may vary, and it's always a good idea to access academic databases or libraries for the most up-to-date research. Here are some relevant references:

1. Anderson, D. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology*, 78(4), 772-790.
2. Bandura, A., Ross, D., & Ross, S. A. (1963). Vicarious reinforcement and imitative learning. *The Journal of Abnormal and Social Psychology*, 67(6), 601-607.
3. Barroso, A. P., & Machin, S. (2011). Crime and the depenalization of cannabis possession: Evidence from a policing experiment. *The Economic Journal*, 121(552), 130-165.
4. Gentzkow, M., Shapiro, J. M., & Stone, D. F. (2015). Media slant against foreign owners: Downsizing. NBER Working Paper No. 20957.

# Background Research: Literature Review (today)



Searched 2 sites ▾

Here are some key references from the economic and broader academic literature on gender differences in media representation of gender-based violence:

1. **S. Piccolo, F. Trombetta, T. Paradiso, M. N., & Rollè, L. (2023).**

"Gender and Media Representations: A Review of the Literature on Gender Stereotypes, Objectification, and Sexualization."

This review highlights how media often perpetuates gender stereotypes and objectification, influencing societal attitudes toward violence, sexism, and abuse. It also discusses the psychological effects of these representations, such as internalization of cultural ideals and tolerance of violence.

Published in *International Journal of Environmental Research and Public Health*. [Available here](#).

2. **Oxford Academic Volume on Media, Gender, Sex, and Crime.**

This work examines media's role in shaping public perceptions of crimes like domestic violence and the portrayal of female victims and offenders. It discusses how the media acts as a gendered institution, influencing broader societal narratives. [Accessible here](#).

3. **Springer Studies on Gender-Based Violence Representation.**

Several chapters focus on how power imbalances and cultural narratives are reproduced in media portrayals of gender-based violence, emphasizing the need for reframing to reduce harm and promote gender equity. This includes analysis of journalism's role in shaping public understanding of such issues. [More details available on SpringerLink](#).

Let me know if you'd like to explore a specific aspect of this literature further!

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- ▶ Today the newest version searches the web

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- ▶ Still, not 100% reliable – often reports the wrong links

# Coding

- ▶ ChatGPT does a decent job with writing code from scratch and debugging:
  - ▶ Good substitute to StackOverflow for some tasks
  - ▶ For more complicated problems needs a lot of back and forth (real life example)

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```
#write a function to load data from pickle
#and csv files depending on the ending of the file name
def load_data(file):
    if file.endswith('.pkl'):
        df = pd.read_pickle(file)
    elif file.endswith('.csv'):
        df = pd.read_csv(file)
    return df
```



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- ▶ It does a great job translating code across languages

# Data Analysis

---

Data Analysis	Creating figures	○
	Extracting data from text	●
	Reformatting data	●
	Classifying and scoring text	○
	Extracting sentiment	○
	Simulating human subjects	○

---

# Data Analysis: Extract Data I

## SYSTEM

You are an investigator assistant, who helps to extract information about crimes from Italian newspaper articles. In particular, I want you to answer the following questions: Does the article mention the murder of a human being that happened in real life in Italy (i.e., not in fiction)? Who is the victim of the murder? Who is the perpetrator or the accused perpetrator? When did the murder happen? What is the perpetrator to the victim (e.g., partner, ex-partner, relative, acquaintance, unknown)?

Answer the questions as concisely as possible and return the answers in a semicolon-separated CSV format with no more than 5 columns, where the column headers are: IS HOMICIDE; VICTIM(S)' FULL NAME; PERPETRATOR(S)' FULL NAME; DATE; RELATIONSHIP

The format of the date should be: %d %B %Y if day, month, and year are available; %d %B Year if only day and month are available; 1 Gennaio %Y if only the year is available; 1 %B %Y if only month and year are available.

IMPORTANT: If there are more than one victim and/or more than one perpetrator separate their names with "and".

If the article is not about a murder as defined before or the murder did not happen in Italy, return: NaN; NaN; NaN; NaN; NaN

Below are a few examples of prompts and responses:

## USER

He attempted to kill his ex-partner, 29 years old, and a Milanese tourist who was in the area and was fishing, and who helped her escape. He rammed into them, causing their car to go into a ravine, where they were at risk of drowning. This happened in Terracina, in the province of Latina. In the end, the police managed to apprehend and arrest the man, originally from Rosarno (Reggio Calabria).

Brought to Terracina and threatened with a knife, the 44-year-old, Michelangelo Porretta, who had already been reported by his ex for stalking and aggravated threats, had managed to set up a meeting with the woman, who was at her mother's house in Gaeta.

## ASSISTANT

yes; NaN; Michelangelo Porretta; NaN; ex-partner

🕒 Add message

# Data Analysis: Extract Data II

- ▶ OpenAI Recently introduced structured outputs:  
<https://platform.openai.com/docs/guides/structured-outputs>
- ▶ Specify the structure using pydantic and the prompt

```
class Newsclassification(BaseModel):
    is_murder_news: bool
    perpetrator_name: str
    victim_name: str
    victim_female: bool
    city: str
    date: str
    relationship: str

messages = [
    {"role": "system",
     "content": """You are an honest classifier.
You receive an Italian news excerpt in the user prompt. You should classify if the news is related to a murder involving real people or not.
You should classify the news positively if it is explicitly about a murder of a real person taking place in Italy as the main topic.
You should classify negatively if the text generally mentions murders e.g., in political discussions or if it mentions other crimes,
e.g., attempted murder, killing of animals, murders that occur in fictional contexts, e.g., movies.
If it is a murder news, you should also extract the name of the perpetrator and the victim if it is mentioned and set the respective field to None otherwise.
Moreover, when possible you should classify if the victim is a woman or a man. You should classify it positively if the victim is female.
You should classify it negatively if the victim is a man. If you don't have this information just return None.
If the city or region where the murder took place is explicitly mentioned, you should also extract it and set the respective field to None otherwise.
If the date of the murder is explicitly mentioned, you should extract it or set the respective field to None otherwise. The date
If the relationship between the victim and the perpetrator is mentioned, you should extract it and fill the respective field with one of the following values:
partner, ex-partner (if the perpetrator is the partner or ex-partner of the murder victim), relative,
ex-relative (if the perpetrator is the relative or ex-relative of the murder victim), acquaintance. If this is not mentioned set the field to None.
Please return for each user prompt an output in the custom Newsclassification format which is inherited from Pydantic's BaseModel."""}
```

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<https://openai.com/index/introducing-structured-outputs-in-the-api/>
- ▶ Specify the structure using `pydantic` and the prompt
- ▶ Specify the *schema* and use the `response_format` option in the request
  - ▶ See supported schemas here:  
<https://platform.openai.com/docs/guides/structured-output/supported-schemas>

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<https://platform.openai.com/docs/guides/structured-output/supported-schemas>
- ▶ The output will be chat-completion object containing a JSON structured answer

```
json.loads(response.choices[0].message.content)
✓ 0.0s

{'is_murder_news': True,
 'perpetrator_name': 'Veronica Panarello',
 'victim_name': 'Loris Stival',
 'victim_female': False,
 'city': 'Santa Croce Camerina',
 'date': '29 novembre',
 'relationship': 'None'}
```

# Math

Math	Setting up models	●
	Deriving equations	○
	Explaining models	●

- ▶ There has been improvement in reasoning questions
- ▶ Still limited in solving models

## Some Limitations...

- ▶ **Weaker in analytic concepts** due to their *nature* as LLM



## Some Limitations...

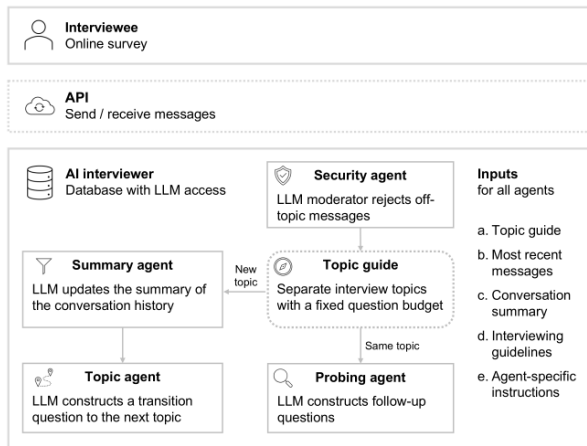
- ▶ **Weaker in analytic concepts** due to their *nature* as LLM
- ▶ **Limits to reproducibility**
- ▶ **Hallucinations:** LLMs can easily make things up, which limits how much we can leverage their knowledge base
- ▶ **Bias**

## ... but a Lot of Potential Applications!

- ▶ Fixing OCR errors in digitized text
- ▶ Extract structured information from text articles
- ▶ Classify articles, e.g., distinguish between believing or skeptical of climate change
- ▶ Interpreting old proverbs
- ▶ Conducting interview
- ▶ Summarize information
- ▶ Rank documents on non-trivial metrics through pairwise comparisons

# Qualitative Interviews with GPT – Chopra and Haaland (2024)

- ▶ Design an *AI Interviewer* using GPT-4
  - ▶ Combine different *agents*, i.e., different instances of LLMs with different prompts



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- ▶ Design an *AI Interviewer* using GPT-4
  - ▶ Combine different *agents*, i.e., different instances of LLMs with different prompts
- ▶ Use it to investigate the *Stock Market Participation Puzzle*
- ▶ Starting question:

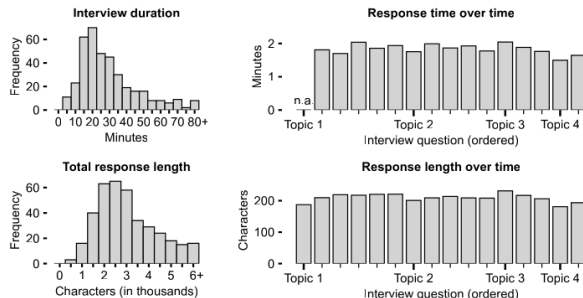
“I am interested in learning more about why you currently do not own any stocks or stock mutual funds. Can you help me understand the main factors or reasons why you are not participating in the stock market?”

# Qualitative Interviews with GPT – Chopra and Haaland (2024)

- ▶ Design an *AI Interviewer* using GPT-4
  - ▶ Combine different *agents*, i.e., different instances of LLMs with different prompts
- ▶ Use it to investigate the *Stock Market Participation Puzzle*
- ▶ AI Interviewer does not lose respondents  $\Rightarrow$  97% completion rate

Figure 2: Interview effort and experience

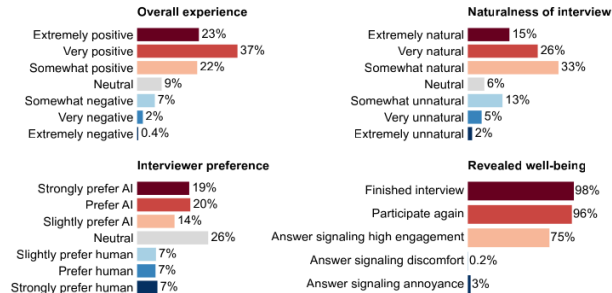
## A. Effort and engagement



# Qualitative Interviews with GPT – Chopra and Haaland (2024)

- ▶ Design an *AI Interviewer* using GPT-4
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## B. Interview experience



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- ▶ Comparable quality to human-based chat interviews
- ▶ Uncover deeply rooted mental models that explain the puzzle more than top-of-mind ones

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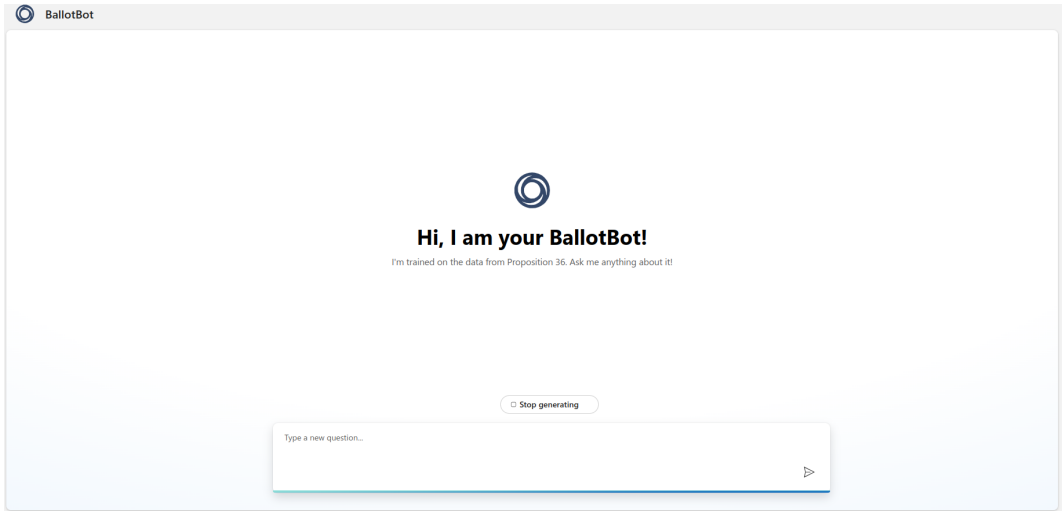
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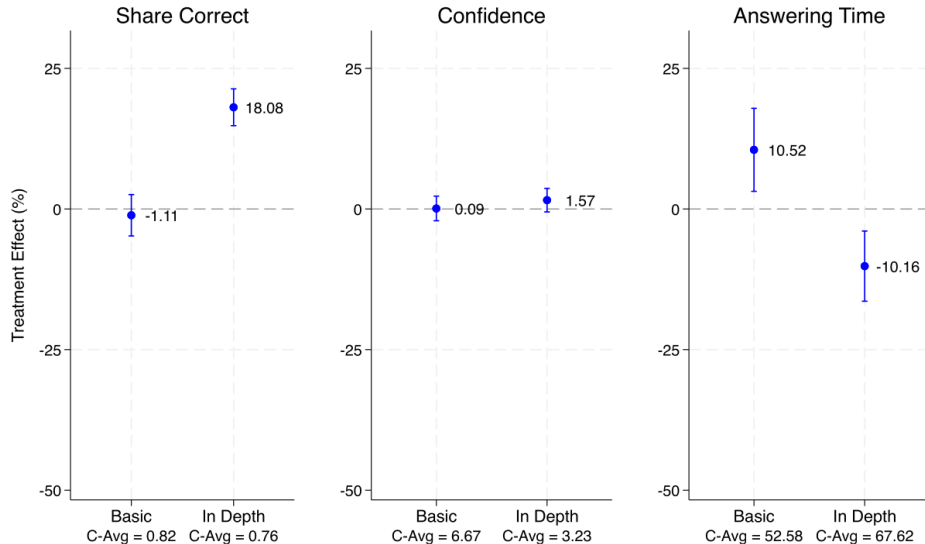
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- ▶ Measure knowledge, confidence, and voting intentions

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“Which of these sentences from a union collective bargaining agreement is more likely to be interpreted as an entitlement, benefit, or amenity for workers? Answer ‘Definitely 1’, ‘Probably 1’, ‘Probably 2’, ‘Definitely 2’, or ‘Neither’. 1. [sentence 1]. 2. [sentence 2].

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- ▶ Compute the probability that one clause is more pro-worker than all others (e.g., using the Bradley-Terry model)
- ▶ Validate previous classification

# Pairwise Comparisons – Arold et al. (2024)

Table 5: LLM Validation of Worker Rights as Favoring Workers

Clause Type	Clause Frequency (%)	Pro-Worker Frequency (%)
<b>Worker Right</b>	<b>22.9</b>	<b>80.9</b>
Union Right	2.1	67.8
Worker Permission	8.4	63.08
Manager Right	0.2	59.85
Firm Obligation	24.7	55.63
Worker Prohibition	3.1	55.51
Worker Obligation	20.9	55.33
Union Permission	2.0	46.33
Manager Prohibition	0.1	44.36
Firm Right	0.9	39.0
Union Obligation	7.0	38.74
Union Prohibition	0.6	38.73
Manager Obligation	1.7	38.5
Manager Permission	0.4	37.43
Firm Prohibition	1.5	36.17
Firm Permission	3.4	35.56

**Note:** Statistics from pairwise comparisons of clause types with GPT-3.5, as described in the text. Rows indicate clause types. Second column gives the frequency of that clause in the corpus; third column gives the proportion of pairwise comparisons where that category's clause is annotated as more beneficial to workers than the paired clause from another category. Sorted by third column. Data source: Employment and Social Development Canada.

# The Environmental Impact of LLMs

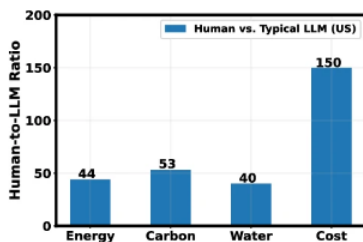
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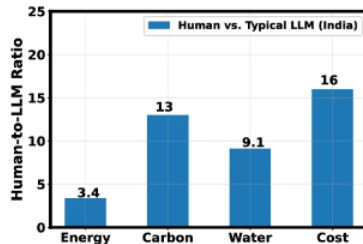
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(a) Typical LLM (U.S.)



(b) Typical LLM (India)

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- ▶ Recent studies have highlighted how LLMs are a more efficient alternative to human labor. However:
  - ▶ LLMs size is growing  $\Rightarrow$  energy demand will increase
  - ▶ In the short term, LLMs are unlikely to substitute humans fully

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- ▶ **Companies:** invest in research for *greener* AI systems