Estimating Public Opinion with Large Language Models

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Abstract (This Is the Abstract Head Style)

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1. Introduction

Survey research provides valuable input for policymakers to make decisions on matters related to economic strategy and public health (Page et al., 1983). In the last decades, despite the money and time invested in surveys (Jansen et al., 2023), they have shown increasingly difficult problems regarding their non-response rate and attrition, affecting results accuracy and representativeness (Bisbee et al., 2023; Chu et al., 2023).

Due to their practical consequences and rising problems, finding solutions to the usual pitfalls of surveys with automized pipelines can be of high interest to researchers and governments. Large Language Models (LLMs) have been investigated as a possible answer for some of these shortcomings thanks to their capabilities to reproduce humanlike answers, low costs and fast performance (xxx). However, the new problems that arise with them make still their best implementation unsure, being until now implemented with different methodological approaches.

In this project we test the quality of LLMs results when prompted to create an in silico social census on public opinion matters.

2. Background

In-silico surveys with LLMs

Previous research on LLM implementations for survey results prediction has leveraged the promising capabilities LLMs have to adopt personas. By stating different sociodemographic group belonging, the LLMs create tailored answers towards public opinion or group affinity questions.

Bisbee et al. (2023), for example, created synthetic personas for ChatGPT 3.5 Turbo and asked it to rate a series of groups using thermometer scores as in the American National Election Survey (ANES). In their results they observed that average synthetic opinions were often substantively and statistically indistinguishable. However, the answers altogether showed a bias towards greater affective polarization by showing greater in-group preference and out-group rejection. Additionally, the in-silico answers were more homogenous, accounting for a smaller standard deviation, which could not be compensated with higher model temperatures.

Open source (OS) models have also been implemented with the aim of creating synthetic survey responses. As compared to black box models, OS models offer the opportunity to be further trained for specific tasks by changing their parameters through fine-tuning. In the research by Chu et al. (2023), a BERT model was fine-tuned with the publications of four major mass media outlets. The fine-tuned model had a greater performance at predicting individual’s attitudes towards COVID-19. However, in the field of consumer confidence, questions regarding personal matters such as individuals’ financial situation or housing value had only low or negative correlations with their ground truth counterparts. As explained by the authors, these results align with findings that show that news coverage mostly affect sociocentric and prospective attributes.

Implementing LLMs for questions on social matters carries risks related to their biased behavior due to their training conditions. To perform next token prediction and learn insights on correct language generations, LLMs are trained on unsupervised tasks with a big amount of text. Given that social groups do not have equal access to collaborating to these datasets, also called “documentation debt”, models are trained with a bias towards hegemonic viewpoints (Bender et al., 2021). In the area of in silico surveys, Besbee et al. (2023) results showed more accurate outcomes for the opinions of Non-Hispanic Whites than those of non-Hispanic black and Hispanic. In addition, other survey prediction implementations have shown model’s lower accuracy for individuals with low socioeconomic status (Kim & Lee, 2023). Therefore, using these technologies as replacement of surveys filled out by individuals may disrupt decisions willing to be made on democratic groundings and should be avoided.

Accounting for this background in this project we propose to analyse the accuracy with which black box (GPT-3, GP4 for zero shot?) and OS models can predict the outcome of a survey on social matters from different areas of interest. To do so, it is pursued to further simplify previous approaches by prompting the model to output the frequency of the multiple answer categories. In other words, instead of creating in-silico answers for the different personas, the aim of this research is to assess the model’s ability to perform social census. We are utilizing the 2020 American National Election Studies (ANES) Time Series Study as a benchmark to examine discrepancies in answer frequencies generated by the model. Our objectives include quantifying the extent of these variations and assessing whether the model exhibits any inclination towards specific political attitudes. Our selected questions consist of some of the most regarded topics from the year of the study (2020): immigration, abortion, gun control, climate change and public health.

As a first step, we are simply asking the model to answer our selected questions from the ANES study by giving an estimate for the frequency distribution of answers (zero-shot).

In addition to zero-shot trials, this project also aims to leverage the capability of LLMs to be sensitive to in-context learning. For this, models will be inputted at prompt time with discussions over the topics of interest in the platform Reddit. Given this additional input, our aim is to evaluate whether Language Models (LLMs) can adjust their initial estimations based on the provided discussion context and potentially yield results closer to the original answers of the ANES survey. In essence, we seek to determine whether the "social sensing" capabilities of LLMs can be calibrated toward a specific representative group, potentially mitigating biases inherent in the training data. Using users’ discussions will lessen the shortcomings of mass media data, by directly collecting citizens opinions on the matter. Nevertheless, polarization bla bla bla. In this research we decided to perform transfer learning through in-context learning because fine-tuning approaches need labeled curated data of which this implementation lacks.

Context learning and context extension

One limitation of LLM is their limited context-window given that they are trained on fixed length sequences. Recently, a large effort has been put into developing and improving LLM capabilities by increasing the context length. This enables the users to provide more information to the model via prompts.

One way of increasing the context-length is via fine-tuning.  One example is CodeLlama, a fine-tuned version of Llama 2 trained on sequences of 16.000 tokens, which provides stable generations with up to 100.000 tokens of context (Rozière et al., 2024).

Many other extension techniques are derivations of Rotary Position Embeddings (RoPE), a method that leverages position embedding values that vary along a predictable smooth rotation though the different token positions (Su et al., 2023). This positional embedding behavior allows for a better performance for prompts that exceed the training length. Some examples are Positional Interpolation (Chen et al., 2023), YaRN (Peng et al., 2023), Resonance RoPE (Wang et al., 2023) and PoSE (Zhu et al., 2024).

These methodologies assume that LLMs lack the inherent capability to understand long contents, and typically also require fine tuning for the extension. Conversely, a novel approach called SelfExtend (Jin et al., 2024) proposes that LLMs already have the capabilities to handle long context even with shorter pre-training context windows. SelfExtend expands existing LLMs context windows by constructing bi-level attention information -grouped attention and neighbor attention- computed based on the original model’s self-attention mechanism during inference. Without any fine-tuning, SelfExtend efficiently extends the context window up to 24.000 tokens maintaining model performance. In addition, this method can be complemented with flash attention and quantization to reduce the computation power needed for the long prompt processing.

3. Data

[American National Election Studies (ANES)](https://electionstudies.org/)

ANES is a collaboration of [Duke University](https://duke.edu/), [University of Michigan](http://www.umich.edu/), [The University of Texas at Austin](https://www.utexas.edu/), and [Stanford University](http://www.stanford.edu/). The study is conducted every 4 years among American voters, both before and after presidential elections. Respondents are queried about various demographic factors before being asked for their opinions on a wide array of political and societal issues. Our selected topics align with those anticipated to be most significant in the 2020 presidential election (Pew Center Research, 2020). Furthermore, we believe our chosen topics -immigration, abortion, gun control, climate change and public health- are known for evoking drastically divergent opinions and therefore also likely to be controversially discussed on social media.

Reddit

In order to perform in-context learning for our models, we need suitable data that preferably reflects a wide range of opinions on our chosen topics. We decided to get the data from Reddit via the PRAW API, which provides easy and efficient retrieval of submissions and comments. All discussions were held in the r/news subreddit, a subreddit with 28 million members, where news articles and current events of the United States are discussed. Given that it does not align with any particular party or ideology, this subreddit provides the most representative forum for extracting discussions. Furthermore, each submission consists of only a link to a news article. Using the API, we obtained a preselection of submissions from 2020 related to the questions selected from the ANES survey, which also surpassed a determined number of comments. Afterwards, we manually selected the final submissions based on its linked news article; the main requisites were that it was US-based, and that it consisted solely (or as solely as possible) on the topic in question.

4. Methods

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Author’s names should appear centered below the title of the paper in boldface. You must use the Author Name style, which will automatically apply the proper size, font, and spacing. If you have many authors simply separate the author names with commas. You may then use superscript numbers as a key to their affiliations, which should appear in the affiliation lines (one affiliation per line) below the author list.

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Extracts

Long quotations and extracts should be indented ten points from the left and right margins. The “Extract” style provides this type automatically:

This is an example of an extract or quotation. Note the indent on both sides. Quotation marks are not necessary if you offset the text in a block like this, and properly identify and cite the quotation in the text.

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Algorithm 1: Example Algorithm

**Input**: Your algorithm’s input

**Parameter**: Optional list of parameters

**Output**: Your algorithm’s input

1: Let t= 0.

2: **while** condition **do**

3: Do some action.

4: **if** conditional **then**

5: Perform task A.

6: **else**

7: Perform task B.

8: **end if**

9: **end while**

10: **return** solution

Listing 1:Example listing quicksort.hs

1 quicksort :: **Ord** a **=>** [a] -> [a]

2 quicksort [] = []

3 quicksort (p:xs) = (quicksort lesser) ++

[p] ++ (quicksort greater)

4 **where**

5 lesser = **filter** (< p) xs

6 greater = **filter** (>= p) xs

Listings are much like algorithms. They should also appear floated to the top (preferably) or bottom of the page. Font size in Listings must be nine-point Courier New. Listing captions should appear in the header, left-justified and enclosed between horizontal lines as shown in Listing 1. Terminate the body with another horizontal line and avoid any background color. Line numbers, if included, must appear within the text column.

References

Reference citations in the text should appear in author-year format, for example (Smith 1975). References of the same year by the same author(s) should be distinguished by small letters following the year, for example (Smith 1977c) and ordered alphabetically by title. Use a narrative citation form when referring to a paper in a narrative context. For example, say “In his paper, Michael Youngblood (2017) refers to ....” instead of (Youngblood 2017) refers to....”

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Generally, references include the name of the author (surname first, followed by initials only for given names) and the date, followed by a period, then the title, presented in mixed case. For multiple authors, separate two names with a comma, and three or more authors with a semicolon.  The place of publication (which is required for all book and proceedings publications) is followed by a colon, with the name of the publisher following. For journal articles and serial publications, provide the volume and issue numbers as well as the page numbers. DOIs are strongly for serial publications if they have been assigned. For conference papers, and book chapters, give inclusive page numbers. Provide the DOI if it is available. Do not use shorthand abbreviations (such as AAAI-19) — spell out the full title of the publication.

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Dissertation or Thesis

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Clancey, W. J. 1979b. Transfer of Rule-Based Expertise through a Tutorial Dialogue. PhD dissertation, Department of Computer Science, Stanford University, Stanford, CA.

Forthcoming Book

Clancey, W. J. Forthcoming. *The Engineering of Qualitative* Models. Redwood City, CA: Addison-Wesley Publishing Company.

Preprint Server

Agrawal, A.; Batra, D.; and Parikh, D. 2016. Analyzing the Behavior of Visual Question Answering Models. arXiv preprint. arXiv:1606.07356v2 [cs.CL]. Ithaca, NY: Cornell University Library.

Published Book

Petroski, H. 1985. *To Engineer Is Human: The Role of Failure in Successful Design.* New York: St. Martin's Press.

Chapter in Published Book

Brown, J. S. 1977. Artificial Intelligence and Learning Strategies. In*Learning Strategies,* edited by J. O'Neil, 345–78. New York: Academic Press.

Forthcoming Journal Article

O'Connor, J. L. Forthcoming. Artificial Intelligence and Commonsense Reasoning. *AI Magazine*44(3).

Published Journal or Magazine Article

Cox, M. T. 2007. Perpetual Self-Aware Cognitive Agents. *AI Magazine*28(1): 32–45. doi.org/10.1609/aimag.v28i1.2027.

Paper Presented at Meeting

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Schoenfeld, A. H. 1981. Episodes and Executive Decisions in Mathematical Problem Solving. Paper presented at the 1981 AERA Annual Meeting. Boston, MA, September 24–30.

Zhou, S.; Suhr, A.; and Artzi, Y. 2017. Visual Reasoning with Natural Language. Paper presented at the AAAI 2017 Fall Symposium on Natural Communication for Human-Robot Collaboration. Arlington, VA, November 9–11.

Paper Presented at Meeting and Published in Proceedings

Lester, J.; Converse, S.; Kahler, S.; Barlow, T.; Stone, B.; and Bhogal, R. 1997. The Persona Effect: Affective Impact of Animated Pedagogical Agents. In Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems.New York: Association for Computing Machinery. doi.org/10.1145/258549. 258797.

Company Technical Report

Carbonell, J. R. 1970. Mixed-Initiative Man-Computer Instructional Dialogues, Technical Report QW-19871. Marina del Rey, CA: USC/Information Sciences Institute.

Scholarly Society Technical Report

Lin, F. 2007. Finitely-Verifiable Classes of Sentences. In *Logical Formalizations of Commonsense Reasoning: Papers from the 2007 AAAI Spring Symposium*. Technical Report SS-07-05. Palo Alto, CA: AAAI Press.

University Technical Report

Vattam, S.; Klenk, M.; Molineaux, M.; and Aha, D. W. 2013. Breadth of Approaches to Goal Reasoning: A Research Survey. In *Goal Reasoning: Papers from the ACS Workshop,*edited by D. W. Aha, M. T. Cox, and H. Muñoz-Avila. Technical Report CS-TR-5029. College Park, MD: University of Maryland, Department of Computer Science.

ArXiv Paper

Bouville, M. 2008. Crime and punishment in scientific re-

search. arXiv:0803.4058.

Website or online resource

NASA. 2015. Pluto: The ’Other’ Red Planet. https://www.

nasa.gov/nh/pluto-the-other-red-planet. Accessed: 2018-

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