Fairness in Prompting: How Demographic Variations Affect Language Model Outputs

Anonymous ACL submission

Abstract

LLMs are expected to respond consistently across demographic groups, yet this assumption remains largely untested due to the absence of demographic information in existing instruction datasets. To address this gap, we introduce `PromptDial`, a collection of 2,289 English prompts written by real users and annotated with seven demographic attributes: sex, race, education, age, language, employment sector, and nationality. We evaluate state-of-the-art generative models on 39 datasets, including machine translation, summarization, grammar correction, knowledge and reasoning, semantics, and question answering, and observe performance disparities of up to 7.7% between demographic groups, with statistically significant differences in over half of the datasets. Our linguistic analysis points to variation in prompt tone and linguistic features as potential drivers of these disparities. Our findings suggest that current instruction tuning practices overlook key aspects of linguistic diversity, and we call for the inclusion of demographic metadata and more representative prompt data to support fairer and more robust language model behavior.[1]

1 Introduction

Instruction tuning transforms generic pre-trained models into responsive assistants capable of interpreting and solving complex tasks effectively (Ouyang et al., 2022; Raffel et al., 2023; Wei et al., 2022). Instruction-tuned large language models (LLMs) have achieved strong results across a wide range of natural language processing (NLP) tasks, including knowledge and reasoning (Cheng et al., 2025; Liu et al., 2024; Bisk et al., 2020; Koto et al., 2023, 2024), and text generation (Venkatraman et al., 2025; Ramprasad et al., 2024). However, instruction tuning alone does not eliminate the social and linguistic biases inherited from pre-training

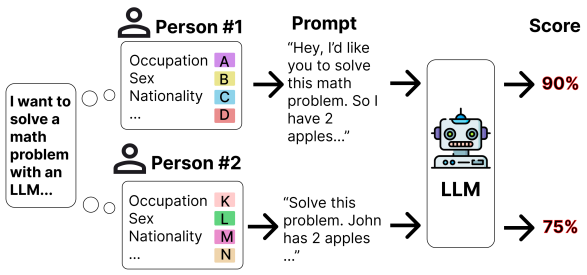

Figure 1: Illustration of how users with different demographic profiles can obtain varying outputs from the same language model when performing the same task.

(Rennard et al., 2025; Itzhak et al., 2024). These biases may carry over into inference, where the model's responses can fluctuate as a function of both the task type and the linguistic form of the prompt.

A critical yet understudied source of such variation is demographic bias: the tendency of a LLM to perform differently, depending on the background of the person providing the prompt. Differences in education, race, age, sex, or language proficiency can influence how users formulate prompts, leading to variation in vocabulary, sentence structure, or spelling (see Figure 1 for illustration). While prior studies have examined model bias in terms of harmful stereotypes (Tomar et al., 2025; Zhang et al., 2024) or downstream disparities (Feng et al., 2023), far less attention has been given to whether LLMs respond equitably to valid prompts phrased in different, demographically grounded styles.

Some work has explored this space through testing prompt variation (Ngweta et al., 2025), role-playing or identity-primed scenarios (Tan and Lee, 2025), but the core question remains open: *does a model's performance remain stable across equally valid prompts that differ only due to the user's demographic profile?* In practice, disparities in this setting could lead to lower-quality responses for marginalized communities, even when the in-

[1] Data and code can be accessed at anon.com

tent of the instruction is clear and reasonable. Our work directly addresses this challenge by systematically evaluating the demographic sensitivity of instruction-tuned models across a diverse set of tasks and user groups, providing new insights into the fairness and generalizability of current LLMs.

Our contributions can be summarized as follows.

- We introduce `PromptDial`, a collection of 2,289 English prompts written by real users, covering sentiment classification, machine translation, dialogue summarization, topic classification, question answering, free-form text generation, and conditioned text generation. Each prompt is annotated with one of seven coarse-grained demographic attributes: employment sector, race, education, sex, age, language, and nationality group. Unlike previous work that relies on role-playing or synthetic personas, `PromptDial` captures naturally occurring demographically diverse prompting styles.

- We assessed prompt sensitivity using `PromptDial` along with 39 existing datasets, analyzing performance variation between demographic groups. Our evaluation includes diversity scoring and pairwise statistical comparisons between demographic profiles (e.g., Engineering vs. Health, High School vs. Graduate Education). We find that model performance can differ by as much as 7.7% across demographic groups, with over 50% of tasks exhibiting statistically significant differences.

- We conducted a detailed linguistic analysis to investigate potential sources of prompt sensitivity, focusing on variation in prompt tone, grammaticality, and linguistic features, such as the number of short words. Our findings suggest that differences in these features, shaped by users' demographic backgrounds, may contribute to disparities in model performance.

2 Related Work

2.1 Bias in Generative LLMs

Group fairness in LLM is a well-studied (Hardt et al., 2016; Zafar et al., 2017; Cho et al., 2020; Zhao et al., 2020) phenomenon in NLP and is defined as a condition in which an LLM should perform equally well in different demography subgroups (Shen et al., 2022). In other words, LLMs should be insensitive towards prompt variations that may arise from the different backgrounds of their prompters.

2.2 Prompt Sensitivity in LLMs

LLM performance discrepancy can also arise from LLMs which tend to be sensitive towards how the words of the prompt are elicited, i.e. prompt sensitivity. This phenomenon is what causes *prompt engineering*, where many research pursuits try to optimize the performance of LLMs via paraphrasing inputs (White et al., 2023). The rise of this phenomenon proves that there is still efforts to be made after the already-intensive training process of LLMs. Therefore, it is crucial to build LLMs that are robust towards these kind of sensitivities to make LLMs work well and fairly on the same task under many different circumstances regarding the linguistic characteristics of the input.

This prompt sensitivity has been identified in multiple levels by prior works. Zhu et al. (2024) have addressed this problem by introducing perturbations on character, word, sentence, and semantic levels to benchmark how robust LLMs are on these variations. In another work on prompt sensitivity with perturbations, Pezeshkpour and Hruschka (2024) observed a considerable performance gap when LLMs are faced with multiple choice questions whose options have been rearranged.

In their work which has been previously mentioned, Zhu et al. (2024) used Performance Drop Rate (PDR) was used which quantifies relative performance decline for some adversary. In another work, Zhuo et al. (2024) quantified prompt sensitivity of LLMs in their work *ProSa*, in which they introduced *PromptSensiScore* and claimed that higher model decoding confidence correlates with model robustness towards prompt variations. A focused study on quantifying this prompt sensitivity is done by Chatterjee et al. (2024) which introduces `POSIX`, a prompt sensitivity index that tells us how much the model's log-likelihood for a given response shifts when we switch the original prompt for another but intent-preserving one.

Additionally, sensitivity in prompting also exists in Vision Language Models (VLMs). Dumpala et al. (2024) evaluated VLMs using the `SugarCrepe++` dataset to evaluate the robustness of VLMs on lexical alterations and reported that VLMs are highly sensitive to such modifications.

Additionally, Li et al. (2025) also identified this phenomenon in VLMs by introducing *Robust-Prompt* benchmark which then also approached the problem by modeling the variants of prompts to make models more robust.

2.3 Persona-Induced Bias in LLMs

Our work subtly resembles that of Tan and Lee (2025), which views biases purely from the persona of a subject. In their work, scenarios were simulated where there exists a power disparity and whether demographic information about the actors of the scenario was available. The authors then uncover a "default persona" bias favoring middle-aged, able-bodied, native-born, Caucasian, atheistic males with centrist views. They also find that responses involving non-default demographic prompts tend to be lower quality, and that power disparities amplify variability in response semantics and quality.

While their evaluation involves simulated social scenarios, our study focuses on analyzing real-world user prompts in downstream NLP tasks. By linking the prompts to the profiles of their respective authors, we are able to assess whether biases emerge when comparing the prompts authored by different social groups. A key distinction of our approach is that we do not explicitly provide demographic information to the LLMs, allowing us to observe potential biases that arise solely from the interaction between naturally occurring prompts and the models' behavior.

3 Prompt Sensitivity across Different Demography Profiles

3.1 Definitions

Annotator, tasks, and demographic profile. We define a set of demographic profiles, adapted from previous studies (Tan and Lee, 2025; Zhao et al., 2020), *including employment sector, race, education, sex, age, language, and nationality group*. Each attribute has its own set of *labels*, detailed in § 3.1 together with the number of annotators corresponding to each label.[2] We also define a set of tasks, described in Table 2. Under this setup, each annotator provides a set of answers, one per task, subject to the filtering process described in a later section.

[2]We address the imbalance in annotator profiles by limiting the scope of the considered attributes. Further discussion is provided in the *Limitations* section.

Category	Subcategory	Count
Employment Sector	Engineering-STEM	38
	Humanities	35
	Health-STEM	26
Race	White	47
	Asian	26
	Black	18
Education	Postgraduate	42
	Graduate	40
	Highschool	17
Sex	female	52
	male	47
Age	18-30	36
	41-50	32
	31-40	31
Language	L1	43
	L2	20
Nationality Group	Europe	38
	North America	24
	Asia	18
	Africa	15

Table 1: Distribution of respondents based on demography categories and labels.

Fairness. We define a language model to be *fair* on a task t if, in general, the downstream task scores m_1 and m_2 yielded by 2 different prompts p_1 and p_2, where p_1, p_2 come from 2 different annotators with different *labels* from a *demographic profile* on a dataset x, show a negligible performance difference. That is, $m_1 \approx m_2$ given that p_1 and p_2 are *valid* prompts. The *Validity* criterion refers to whether a response is reasonable and appropriately addresses the task at hand, as determined by human judgment. We additionally assess *string validity* to ensure that responses can be safely used for string replacement in tasks based on predefined datasets.

3.2 Quantifying Sensitivity and Fairness

Diversity score. To show the distances of task scores between profile labels, we define a *diversity score*. Let $S = (avg_1, avg_2, \ldots, avg_n)$ be an array of averages for each label in a demography profile with each $|S| \geq 2$. A diversity score is calculated for each model against each demography profile on each task group.

$$\text{diversity}(S) = \frac{\sum_{i=1}^{n} \sum_{j=i+1}^{n} |S_i - S_j|}{\binom{n}{2}} \quad (1)$$

Pairwise Welch's t-tests. We also conduct pairwise t-tests on every combination of labels in a demographic profile and report the percentage of

tasks with at least one significantly different pair of labels. We assume that a model is *unfair* on a task for a profile if there is at least one pair of labels within that profile with a p-value that allows us to reject the null hypothesis. Formally, let $T = \{t_1, t_2, ...t_k\}$ be the set of all tasks we have defined and $P_{T,M,D}$ be the percentage of tasks in T inferred with the model M that has at least one pair of labels in the demographic profile D with labels $\{d_1, d_2, ...d_z\}$ that have a p-value of < 0.05. $B_{M,t,d}$ is a list of scores for task t, inferred using model M of the annotators that have the demographic label d.

$$P_{T,M,D} = \frac{|\{t \in T \mid \exists a, b \in D,\ \text{pval}(B_{M,t,a}, B_{M,t,b}) < 0.05\}|}{|T|} \tag{2}$$

Here, pval(x, y) denotes the p-value obtained from a t-test comparing x and y. We will draw conclusions about the *unfairness* of a model within a demography profile based on these $P_{M,D}$ values.

For each of the model disparity measures that we mentioned, we normalize the scores (locally for each model-task combination) prior to doing any calculations involving $B_{M,t,d}$ For example, given the demographic profile D with labels $\{d_1, d_2, d_3\}$, we normalize across $B_{M,t,d_1}, B_{M,t,d_2}, B_{M,t,d_3}$. We do this to ensure comparability between downstream task scores with different ranges.

4 Dataset Construction

We collected the annotator answers through both Prolific (Prolific, 2025) and Google Forms (Google, 2025). We use the former to reach communities where the latter is not widely used. We modified the Potato (Pei et al., 2022) framework for annotator answer collection to fit our use-case. We define 25 tasks that span a diverse range of problems. Each task can have several benchmarks to run on, resulting in 39 task-dataset pairs. The 25 tasks we have defined are further classified into task groups. The complete task definition and classification are presented in Table 2. Annotators are instructed to solve each task as if they are using an LLM. To ensure their understanding, we provide several examples to them prior to the annotation. We deploy surveys iteratively on the Prolific platform, with each run aiming to achieve a background-diverse set of annotators based on our criteria in § 3.1. The examples of different stages of annotation on the annotation platform are presented in Appendix D.

The collected annotator answers then go through two filtering phases, as illustrated in Figure 2.

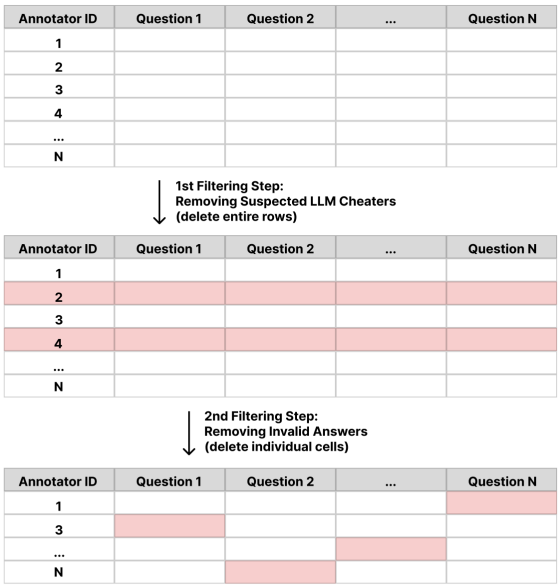

Figure 2: Illustration of the filtering process resulting in a slightly sparse set of annotator responses.

First, we exclude *LLM-assisted annotators*, that is, annotators whose responses explicitly indicate the use of a large language model (e.g., containing phrases such as "`Here's how you can ask an LLM to solve your task. . .`"). We further identify and discard potential cases of LLM assistance using *LLM detection scores*. Specifically, we compute word-level 3-gram overlaps between each annotator's answers and those produced by several LLMs (`gpt-4o-mini`, `gpt-4o`, and `chatgpt-4o`). For each model, we sample five responses and calculate both the maximum and average similarity scores. An annotator is flagged as LLM-assisted if both the maximum and average scores exceed the thresholds of 0.5 and 0.2, respectively. These thresholds were determined empirically based on the detection scores of annotators whose responses were evidently generated by LLMs prior to this additional verification step.

Second, we manually review each annotator's prompts to verify that the corresponding LLM-generated responses are *valid*. In this step, we do not exclude an entire annotator in cases of isolated faulty responses, as it is often the case that the same annotator performs reliably on other tasks. Consequently, the resulting dataset contains a slightly sparse set of responses for each task. After this filtering stage, we retain a total of 99 annotators, yielding a cleaner and more reliable prompt dataset. The corresponding statistics are presented in Appendix A.

Group	Task Name and Benchmark	Dataset Size	Eval Metric
Semantics	Sentiment Analysis 3 Classes - sentiment_3class (Socher et al., 2013)	500	f1
Semantics	Sentiment Analysis 2 Classes - sentiment_2class (Socher et al., 2013)	500	f1
Machine Translation	Machine Translation (given source and target Languages) (Goyal et al., 2022)	100×14	bleu
Summarization	Dialogue Summarization - dialogsum (Chen et al., 2021)	500	rouge
Semantics	Topic Classification - ag_news (Zhang et al., 2015)	500	f1
Knowledge and Reasoning	Free Generation (Given a Keyword)	1×11	llm_judge
Syntaxes	Free Generation: Grammar Correction	1	llm_judge_grammar_sentence
Syntaxes	Free Generation: Grammar Correction CoT	1	llm_judge
Knowledge and Reasoning	Free Generation: Arithmetic	1	llm_judge
Knowledge and Reasoning	Free Generation: Shakespeare-Prompt Jailbreak	1	llm_judge
QA and Extraction	Multiple Choice Questions - arc_easy (Clark et al., 2018)	500	f1
QA and Extraction	Extractive QA - squad_v2 (Rajpurkar et al., 2018)	500	or_custom
QA and Extraction	MultispanQA - multispan_qa (Li et al., 2022)	500	and_custom
Syntaxes	Grammar Correctness Classification - blimp (Warstadt et al., 2020)	250	f1
Syntaxes	Grammar Correctness Classification - colorless (Gulordava et al., 2018)	250	f1
Conditioned Text Generation	Linguistically-conditioned Text Generation - text_requirement	100	requirement_checker

Table 2: Full task list information.

5 Experiment

5.1 Experimental Setup

Models. We run both closed weight (available through API) and open weight LLMs: `gpt-4o`, `Llama3.1-Instruct (8B, 70B)`, `Llama3.2-Instruct 1B`, `Qwen2.5 Instruct (1B, 7B, 72B)`. For open weight models, we use the `lm-evaluation-harness` (Gao et al., 2024) framework for our evaluation. The metrics used for each task are defined in Table 2; self-defined metrics and llm-as-a-judge prompts are defined in Appendix B. We set the `temperature` and `top_p` the same for every inference, both of which are `1`. We use the same evaluation method for the API model, except for classification tasks, for which we employ fuzzy string matching techniques. For tasks with a benchmark, we inject the benchmark dataset instances into the annotator prompts, and for free generation tasks that do not require any dataset, we simply run the annotator prompts.

5.2 Main Results

We begin our analysis by observing Figure 4, which tells us the comparison of unfairness levels for each demography profile for each model. We observed that **nationality group** and **race** almost always have the highest percentage of tasks with a significantly different pair of labels within that demography group. This suggests that these demographic profiles are the ones that the models seem to be most unfair about. At the other end of the spectrum, we see that **sex** has the least percentage of tasks. Further breakdown of the percentage of tasks based on task group is presented in Table 4

On the other hand, Figure 3 tells us how much the differences are in the averages between labels in a demography profile. Despite having some contrasting and consistent demography profiles in Figure 4, we find no pattern that explains the relationship between how many significantly different tasks are in a demography profile and how far are the averages are between each label in them. Further breakdown of the percentage of tasks is presented in Table 4. Further breakdown of the diversity scores based on task groups is presented in Table 3.

To better refine the connection between the scores of the models on the particular task and the diversity scores of the models, we built a scatter plot for all of the tasks for all investigated models; the results are provided at Figure 5. The bigger models (GPT-4o, Llama3.1-70B-Instruct, Qwen2.5-72B-Instruct) are mostly grouped in the upper left corner of the plot, showing both high scores on the target task and low diversity scores. On the other hand, smaller models (Llama3.2-1B-Instruct, Qwen2.5-1.5B-Instruct) tend to group in the lower left corner with a low target score and a relatively low diversity score, while medium-sized models are positioned between the two aforementioned model groups. In terms of diversity score, most models on most tasks have a diversity score lower than 10%. However, models of all sizes have a diversity score higher than 10% at least on one task. These results additionally highlight that even large models with high scores on most tasks can have relatively high diversity scores on some tasks. Moreover, these results are supported by Figure 3, where larger models have lower diversity scores than smaller ones, but their mean diversity score is still not equal to zero.

Model	Semantics	Machine Translation	Summarization	Knowledge and Reasoning	Syntaxes	QA and Extraction	Conditioned Text Generation
GPT-4o	1.3%	1.1%	2.1%	3.8%	2.9%	2.0%	0.4%
Llama3.1-70B-Instruct	1.8%	0.8%	1.5%	5.6%	2.7%	3.0%	2.1%
Llama3.1-8B-Instruct	4.2%	0.5%	0.0%	6.1%	6.1%	2.7%	5.1%
Llama3.2-1B-Instruct	3.6%	0.4%	0.0%	6.3%	6.1%	4.4%	2.5%
Qwen2.5-72B-Instruct	1.7%	0.6%	1.8%	5.1%	3.1%	2.6%	1.5%
Qwen2.5-7B-Instruct	3.8%	0.7%	0.0%	6.9%	6.5%	2.3%	4.5%
Qwen2.5-1.5B-Instruct	4.1%	0.4%	0.0%	6.3%	7.7%	3.6%	1.6%

Table 3: Diversity scores of each model against each task group. Each value in this table is the average of all **demography profile**, that is, the average of $P_{M,D}$ across all D. Values are shown in percentage to better highlight their relative magnitudes.

Model	Semantics	Machine Translation	Summarization	Knowledge and Reasoning	Syntaxes	QA and Extraction	Conditioned Text Generation
GPT-4o	66.7%	64.3%	0.0%	61.5%	100.0%	33.3%	100.0%
Llama3.1-70B-Instruct	33.3%	64.3%	0.0%	61.5%	75.0%	66.7%	100.0%
Llama3.1-8B-Instruct	33.3%	71.4%	100.0%	46.2%	100.0%	100.0%	100.0%
Llama3.2-1B-Instruct	33.3%	35.7%	100.0%	30.8%	100.0%	33.3%	100.0%
Qwen2.5-72B-Instruct	66.7%	50.0%	0.0%	30.8%	50.0%	66.7%	0.0%
Qwen2.5-7B-Instruct	100.0%	35.7%	0.0%	46.2%	50.0%	0.0%	100.0%
Qwen2.5-1.5B-Instruct	66.7%	64.3%	0.0%	38.5%	50.0%	66.7%	0.0%

Table 4: Percentage of statistically significant tasks for each model on each task group under **pairwise t-test** with a threshold of $p < 0.05$. For this table, the set of significant tasks considered is the result of all significant tasks over all demography profile D under the union operation, that is, $\bigcup\{t \in T \mid \exists a, b \in D,\ \text{pval}(B_{M,t,a}, B_{M,t,b}) < 0.05\}$. for all D.

5.3 Prompt Sensitivity Analysis

One of the possible sources of prompt sensitivity is the inherent linguistic characteristics of each prompt. To further investigate this, we extracted several linguistic and LLM features from prompts on each task, namely: (1) number of words, (2) exclamation ratio, (3) type-token ratio (TTR), (4) pronoun ratio, (5) adjective ratio, (6) noun ratio, (7) capitalized words ratio, (8) question ratio, (9) prompt tone, and (10) grammatical correctness. The extraction was conducted using the NLTK framework (Bird and Loper, 2004), with all ratio-based features calculated as a ratio of value to the number of words. The latter two features are categorical and are extracted as follows. Prompt *tone/tonality* classifies each prompt into one of three categories:

1. **Imperative**: A command or instruction (e.g., "Describe the process of photosynthesis.").
2. **Interrogative**: A question (e.g., "What is the process of photosynthesis?").
3. **Declarative**: A statement (e.g., ='I'd like to know about the process of photosynthesis.").

We do the prompt tone and grammar correctness classification using the `chatgpt-4o-latest`.[3] The exact prompt strings used to classify are in Appendix B. Note that here we described only the features which are used in further analysis and have less than 0.9 pairwise correlation.

After that, we trained a Linear Support Vector Machine (Pedregosa et al., 2011) for binary classification to predict demographic profile from these features and used the absolute values of coefficients of the trained models as an importance of each feature. Note that each feature scale is standardized, and the coefficients are comparable across different features. We trained a separate model for each profile. The results are provided in Figure 6 for the top-5 most important features for each demographic characteristic.

Based on the results in Figure 6, we choose the most common top-5 features for all demography profiles and build a Table 5 showing the percentage of tasks with significantly different scores with respect to top-5 features. To reduce the number of possible linguistic feature groups, we binarized each linguistic feature category into two groups:

[3]We conducted a preliminary experiment with this API model for tone classification task and report an accuracy of **97%**. However, we do not do the same verification for grammar correctness as it has been done extensively (Kobayashi et al., 2024; Davis et al., 2024; Ide et al., 2025).

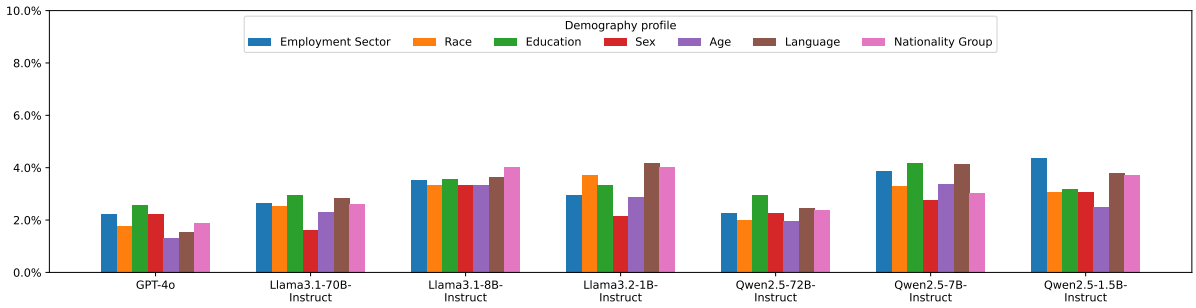

Figure 3: Distribution of **diversity scores** across different task groups for each demography profile. Each bar represents the diversity score for a demography profile on a task group. The diversity scores range from 0 to 1. We limit the y-axis to 10% to better highlight the differences among the values.

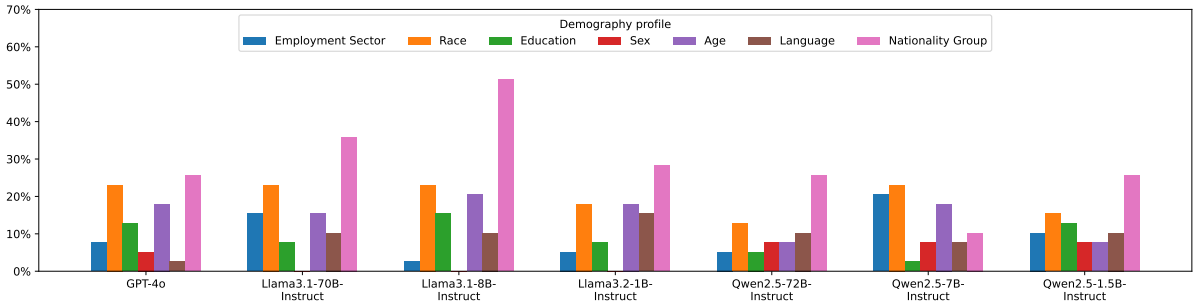

Figure 4: Distribution of the percentage of tasks (from all task groups) where there exists at least one significantly different profile label (Welch's t-test) for each demography profile for each model.

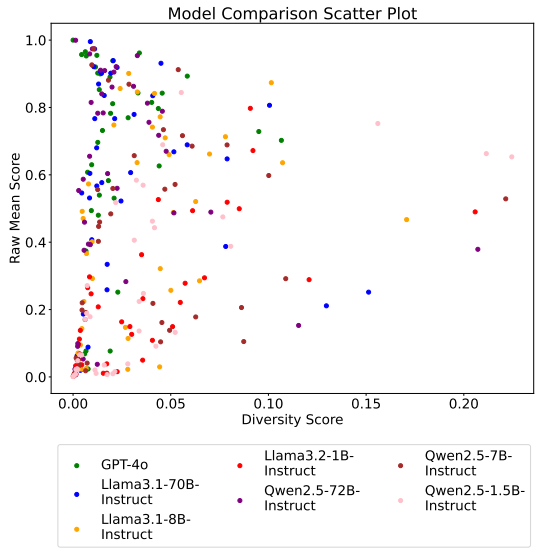

Figure 5: Raw score and diversity score (averaged per demography profile) for each of 39 tasks for each model.

less or equal than the median and greater than the median. The median values are chosen independently for each task.

From Table 5 we highlight TTR, nouns ratio, number of words, and prompt tone for having a noticeable number of different task scores. We observe that various prompt parameters consistently yield more significantly different scores than other prompt parameters. Particularly, this table suggests that LLMs are less robust towards the aforementioned features than on the exclamation ratio.

To further investigate the difference in prompts based on LLM and linguistic features, we build an additional Figure 7 in Appendix C, showing the split of prompts by demography profile and feature. Figure 7 shows that the distribution for four selected features is more unbalanced between various demographic profiles than for the remaining feature (exclamation ratio), with a lower difference in task scores in Table 5. For example, the ratio of nouns and the number of words differs for persons with various language profiles, highlighting the possible difference in task scores. The same results apply for race (Asians tend to use more than the median words and nouns ratio), age (group 18 to 30 uses more than the median number of words and nouns), and nationality group.

5.4 Discussion

We also conducted additional experiments with other criteria besides pairwise Welch's t-tests, as

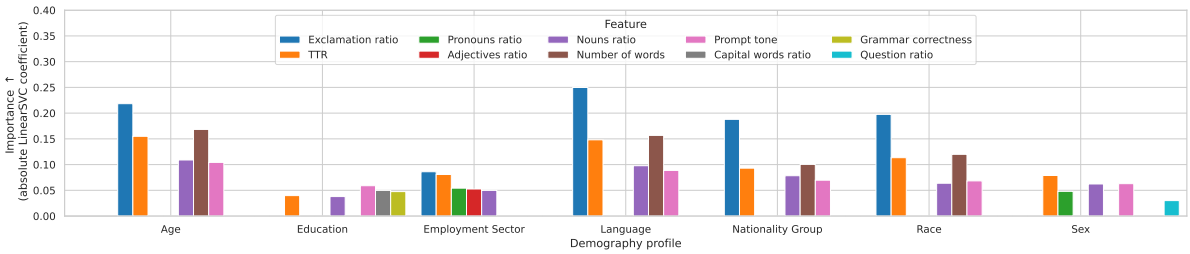

Figure 6: Top-5 features by importance with respect to demography profile.

Model	Exclamation ratio	TTR	Nouns ratio	Number of words	Prompt tone
GPT-4o	3%	38%	31%	33%	44%
Llama3.1-70B-Instruct	0%	26%	18%	23%	26%
Llama3.1-8B-Instruct	10%	23%	23%	28%	44%
Llama3.2-1B-Instruct	8%	33%	26%	31%	44%
Qwen2.5-72B-Instruct	15%	26%	21%	15%	44%
Qwen2.5-7B-Instruct	10%	13%	28%	23%	36%
Qwen2.5-1.5B-Instruct	10%	31%	13%	15%	33%

Table 5: Percentage of tasks where there exists at least one pair from each features set: *ratio of exclamation*, *TTR*, *ratio of nouns*, *number of words* and *prompt tone* that has a p value of < 0.05. Each set of linguistic features in encoded with respect to median value on the task (e. g. for number of words we compare two groups - less or equal than median and greater than median).

well as we have more than two labels in demography profiles. Specifically, we employed one-way ANOVA tests and one-way ANOVA tests with Bonferroni correction on the same data as in Table 4; the results are presented in Appendices G and H. However, we noted that the main outcomes, derived from Table 4, remain unchanged; therefore, so we provided the results of the more rigorous tests in the corresponding appendices.

6 Conclusion

In this paper, we systematically investigated how demographic variations in prompts influence language model responses. To this end, we introduce a new dataset, `PromptDial`, comprising prompts collected from real users across diverse tasks, where each user is characterized by a unique demographic profile defined by seven attributes.

Using this dataset, we investigated the prompt sensitivity of LLMs with respect to demographic attributes and showed that the performance of LLMs has a statistically significant difference in more than 50% of the investigated tasks, with a maximum difference of 7.7%. Moreover, this disparity in task scores persists across all investigated LLM architectures (Qwen-2.5, Llama-3, and GPT-4o) and for all model sizes (1B to 72B). These results show that even the widely-used modern LLMs can exhibit performance drops based on prompts from a person with a specific demographic profile.

Our additional analysis highlights that several features of prompts can be sources of the described behavior of LLMs, such as prompt tone and linguistic features. We found that the top 5 features affecting the quality of LLM responses' are (1) exclamation ratio, (2) type-token ratio, (3) nouns ratio, (4) number of words, and (5) prompt tone. We showed that the latter four features lead to differences in a task's scores on up to 44% of tasks. Finally, we demonstrated that for some demographic attributes (such as language, age, race, and nationality group), these features have an unbalanced distribution, which, in turn, can lead to score disparity in LLMs.

Limitations

Due to the nonexistence of an annotation platform that *truly* reaches every possible demography label for every demography profile, we limit our findings to only the annotator profiles that we have enumerated and we strive to be as transparent as possible about the distribution of our annotators. We also acknowledge the possibility of one demography label being dominated by another demography label from another demography category e.g.

$$N\% \text{ of } \alpha \text{ are coincidentally } \beta$$

We have made efforts to minimize the effects of this by filtering our annotators when calculating the results. To ensure that our findings are not misleading, we restrict our analysis altogether to *L1 speakers* of English within the following **demographic profiles**: *employment_sector, education, sex* and **labels**: *White (race), Black (race)*. We also limit our study to the English language and tasks that involve only the text modality.

Ethical Considerations

We have made sure to adhere to the platform rules for annotator compensation or local norms on how much an annotator's job should be compensated. To protect the anonymity of our annotators, we do not publicly release personally identifiable information (such as names, emails, or phone numbers). We also follow and acknowledge the dataset used in this paper, as cited in Table 2.

We have stated in the annotator registration form that they will agree to be a participant in this research project, which implies that their data will be used to prompt LLMs

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A Valid Answer stats

Task	Valid answers
Sentiment Analysis 3 Classes	80
Sentiment Analysis 2 Classes	90
Machine Translation	92
Dialogue Summarization	97
Topic Classification	90
Free Generation: Balonku Song	93
Free Generation: G30SPKI	93
Free Generation: Hijrah	80
Free Generation: Adhan	84
Free Generation: Karak Kaliang	94
Free Generation: Giant Drum	90
Free Generation: Scientific Letter	83
Free Generation: School Life	97
Free Generation: Olympics Medallists	96
Free Generation: Hillary Clinton	98
Free Generation: MBZUAI	98
Free Generation: Grammar Correction	98
Free Generation: Grammar Correction CoT	98
Free Generation: Arithmetic	99
Free Generation: Shakespeare-Prompt Jailbreak	97
Multiple Choice Questions	88
Extractive QA	91
MultispanQA	92
Grammar Correctness Classification	92
Linguistically-conditioned Text Generation	79

Table 6: Number of valid prompts left after filtering, per task

B Definition of Custom Metrics and Prompts

Custom metrics and exact prompts mentioned throughout the paper are defined here.

Metric Name	**Description or Prompt**
and_custom	Given a model answer and a list of references, get the fuzzy string match score for each reference. Return the average.
or_custom	Given a model answer and a list of references, get the fuzzy string match score for each reference. Return the maximum.
requirement_checker	Given a set of rules, which consists only of minimum generation length and the existence of certain words, score based on how many rules an answer abides by.
llm_judge	You are a judge that gives a score to a prediction answer based on how accurate it is compared to a reference answer. Given this instruction right here: {prompt} On a scale of 0 (worst) to 1 (best), how would you rate the machine's answer? Reference Answer: {refs} Prediction Answer: {preds} Answer only the XML format of the score: <score>[float]</score>

Metric Name	Description or Prompt
llm_judge_drum	You are a judge that gives a holistic score to a text based on how accurate it is to these criteria: - How well it promotes cost - How well it promotes quality - How well it promotes environmental impact This is the text: {preds} Score it on a scale of 0 (worst) to 1 (best). Answer only the XML format of the score: <score>[float]</score>
llm_judge science_project	You are a judge that gives a holistic score to a text based on how accurate it is to these criteria: - How convincing it is This is the text: {preds} Score it on a scale of 0 (worst) to 1 (best). Answer only the XML format of the score: <score>[float]</score>
llm_judge aeni_school_life	You are a judge that gives a score to a text based on how accurate it is to these criteria: 1. The story has to be about: - Aeni's school life 2. The story has exactly: - 2 dogs - 1 cat - 5 mice - 2 adults named 'Thomas' and 'Haroon' - 1 child named 'Aeni' This is the text: {preds} Score it on a scale of 0 (least accurate) to 1 (most accurate). Answer only the XML format of the score: <score>[float]</score>
llm_judge grammar_sentence	You are a judge that gives a score of grammar correctness given a reference and a prediction. On a scale of 0 (worst) to 1 (best), how would you rate the grammar correctness? (including punctuation, etc) Reference: {refs} Prediction: {preds} Answer only the XML format of the score: <score>[float]</score>
prompt tone classifier	Given this request sentence: \"{answer}\"" Classify it as either "Declarative", "Interrogative", or "Imperative". Declarative is a statement-like request. You state a situation that implies a request. Example: I really need some help right now. It would be great if you could stay a bit longer. Interrogative is a question-like request. You ask like a question, but it's really a polite request. Example: Could you help me with this? Would you mind closing the door? Imperative is a command-like request. You give a direct command, often softened with "please." Please pass the salt. Turn down the volume. Answer only in one word.
prompt grammaticality classifier	Given this request sentence: \"{answer}\"" Decide if it's grammatically correct or incorrect. Exclude placeholder strings that are not part of the request. e.g. [TEXT] becuse they are going to be replaced with something else. If it's a request to correct the grammar of some given text, ignore the given text. Only assess the user request string. Answer only in one word. ("correct" or "incorrect")

C Prompt Distribution Based on Demography Profile

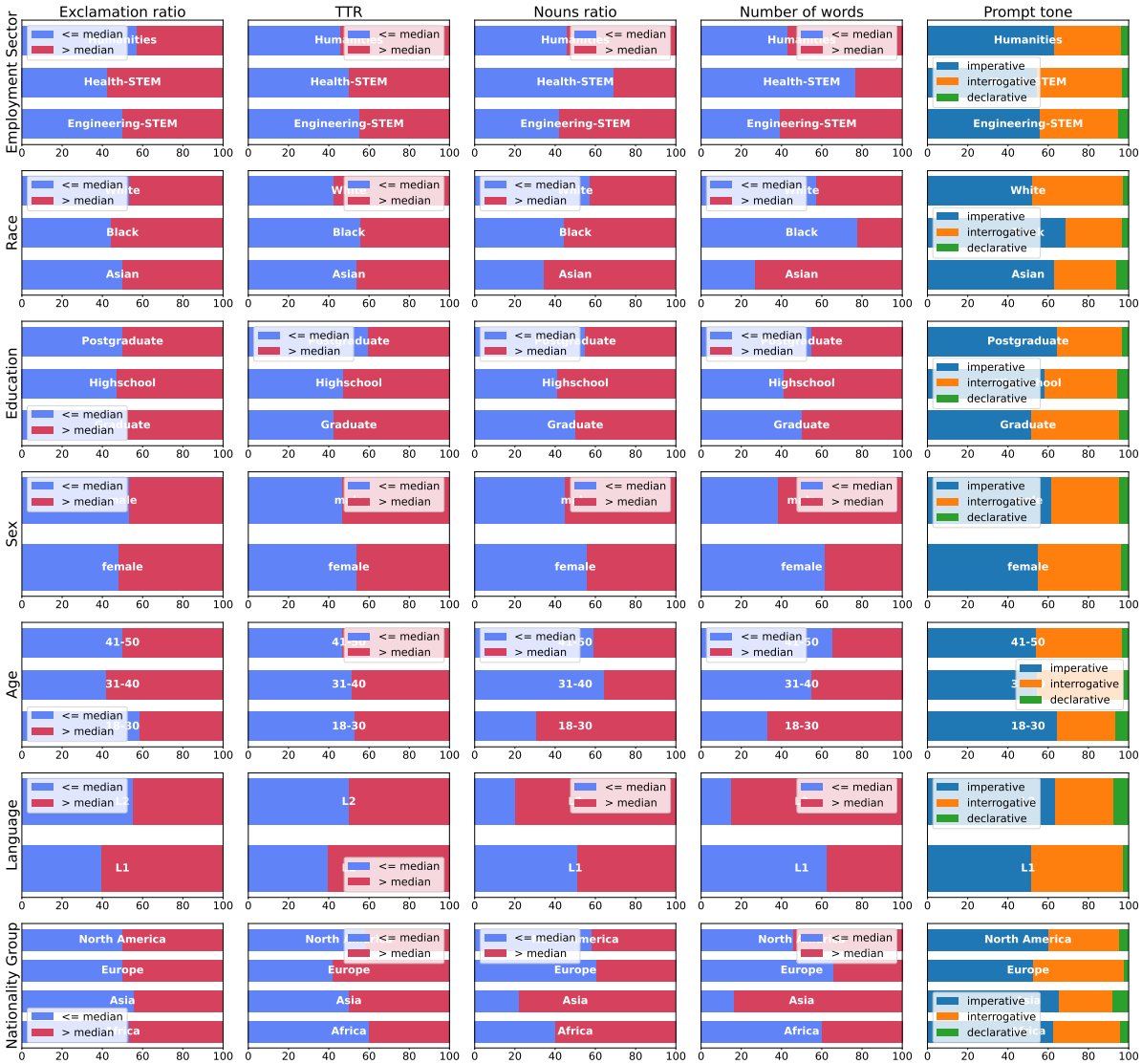


Figure 7: Prompt characteristics across demography profiles for all tasks with respect to linguistic and LLM features.

D Annotation Platform Preview

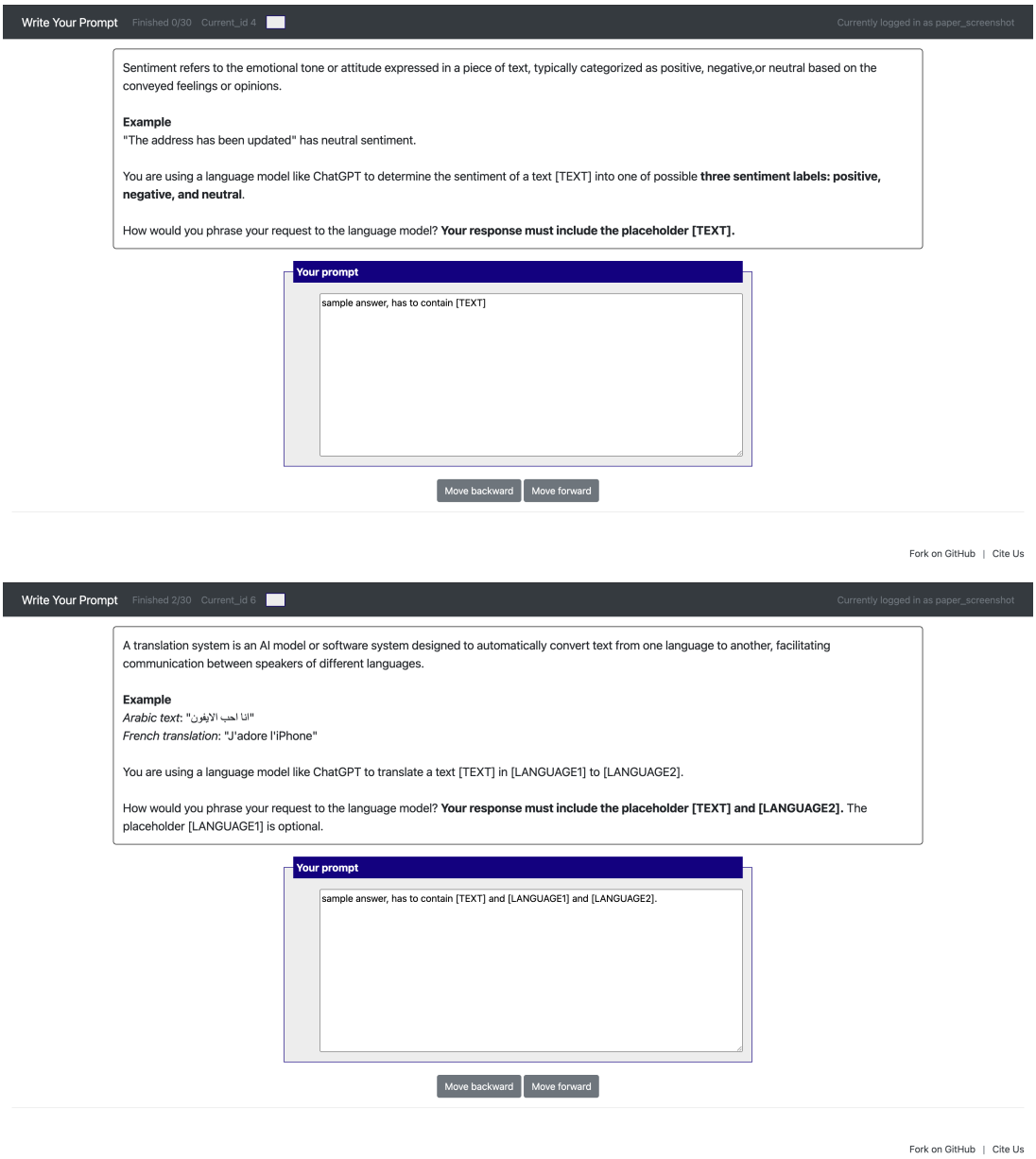
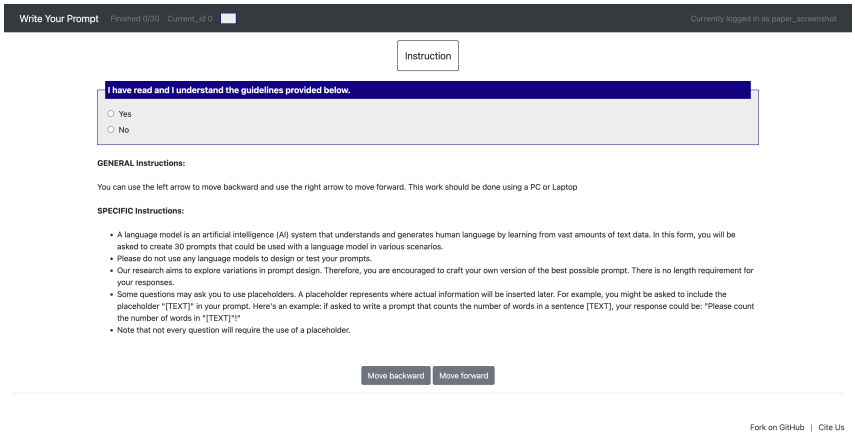
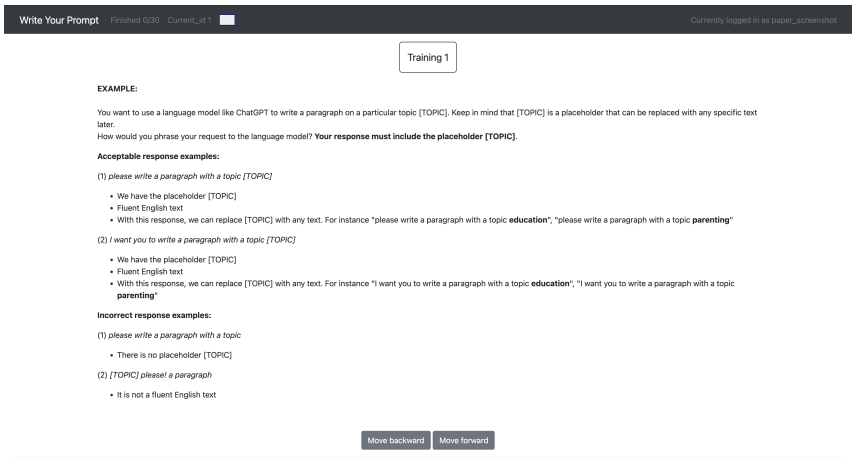


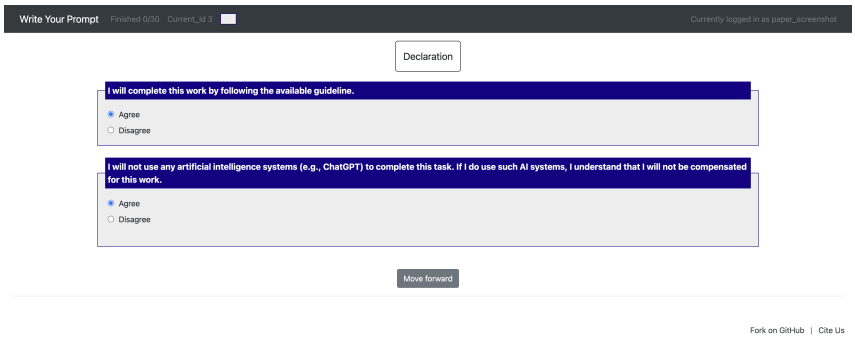
Figure 8: Examples of actual task done by annotators



(a) Introduction page of our data collection platform that contains annotator instructions



(b) First example page of our data collection platform that contains an example of how to do the task



(c) Agreement and declaration of no AI-usage page of our annotation platform

Figure 9: Screenshots of Annotation Platform

E Diversity Scores: Task Group Breakdown

Model	Industry	Race	Education	Sex	Age	Language	Nationality
			Semantics				
GPT-4o	0.08	0.06	0.07	0.06	0.03	0.07	0.04
Llama3.1-70B-Instruct	0.1	0.06	0.06	0.03	0.03	0.07	0.05
Llama3.1-8B-Instruct	0.12	0.05	0.05	0.11	0.03	0.05	0.05
Llama3.2-1B-Instruct	0.1	0.08	0.05	0.04	0.05	0.07	0.07
Qwen2.5-72B-Instruct	0.08	0.05	0.11	0.1	0.04	0.06	0.04
Qwen2.5-7B-Instruct	0.14	0.06	0.09	0.08	0.04	0.07	0.04
Qwen2.5-1.5B-Instruct	0.1	0.07	0.1	0.09	0.07	0.12	0.07
			Syntaxes				
GPT-4o	0.07	0.03	0.11	0.06	0.04	0.02	0.04
Llama3.1-70B-Instruct	0.06	0.06	0.1	0.05	0.04	0.06	0.08
Llama3.1-8B-Instruct	0.06	0.08	0.1	0.02	0.08	0.12	0.12
Llama3.2-1B-Instruct	0.08	0.1	0.09	0.02	0.1	0.13	0.12
Qwen2.5-72B-Instruct	0.08	0.06	0.09	0.08	0.05	0.09	0.08
Qwen2.5-7B-Instruct	0.14	0.1	0.12	0.08	0.13	0.18	0.09
Qwen2.5-1.5B-Instruct	0.15	0.08	0.09	0.11	0.06	0.1	0.11
			Summarization				
GPT-4o	0.05	0.03	0.08	0.04	0.03	0.04	0.04
Llama3.1-70B-Instruct	0.04	0.03	0.06	0.02	0.03	0.02	0.02
Llama3.1-8B-Instruct	0.02	0.05	0.04	0.01	0.05	0.13	0.07
Llama3.2-1B-Instruct	0.06	0.05	0.05	0.01	0.05	0.14	0.1
Qwen2.5-72B-Instruct	0.06	0.02	0.06	0.02	0.03	0.01	0.04
Qwen2.5-7B-Instruct	0.04	0.01	0.06	0.02	0.01	0.04	0.04
Qwen2.5-1.5B-Instruct	0.02	0.01	0.06	0.02	0.01	0.06	0.03
			Knowledge and Reasoning				
GPT-4o	0.08	0.06	0.09	0.05	0.04	0.05	0.05
Llama3.1-70B-Instruct	0.08	0.06	0.11	0.06	0.06	0.08	0.08
Llama3.1-8B-Instruct	0.07	0.05	0.09	0.09	0.06	0.09	0.07
Llama3.2-1B-Instruct	0.08	0.06	0.08	0.06	0.06	0.06	0.07
Qwen2.5-72B-Instruct	0.08	0.05	0.1	0.11	0.05	0.07	0.06
Qwen2.5-7B-Instruct	0.1	0.07	0.08	0.05	0.05	0.07	0.07
Qwen2.5-1.5B-Instruct	0.08	0.05	0.05	0.06	0.04	0.06	0.05
			Machine Translation				
GPT-4o	0.07	0.04	0.07	0.08	0.05	0.03	0.05
Llama3.1-70B-Instruct	0.09	0.06	0.07	0.04	0.04	0.03	0.06
Llama3.1-8B-Instruct	0.07	0.05	0.09	0.06	0.04	0.04	0.07
Llama3.2-1B-Instruct	0.06	0.03	0.08	0.05	0.04	0.03	0.05
Qwen2.5-72B-Instruct	0.09	0.04	0.07	0.05	0.04	0.04	0.06
Qwen2.5-7B-Instruct	0.06	0.03	0.08	0.05	0.04	0.04	0.04
Qwen2.5-1.5B-Instruct	0.08	0.05	0.07	0.06	0.03	0.05	0.06
			Conditioned Text Generation				
GPT-4o	0.05	0.07	0.12	0.12	0.08	0.07	0.1
Llama3.1-70B-Instruct	0.1	0.1	0.1	0.06	0.14	0.13	0.1
Llama3.1-8B-Instruct	0.08	0.05	0.07	0.08	0.11	0.04	0.06
Llama3.2-1B-Instruct	0.02	0.05	0.06	0.1	0.04	0.07	0.07
Qwen2.5-72B-Instruct	0.06	0.08	0.15	0.11	0.07	0.07	0.07
Qwen2.5-7B-Instruct	0.12	0.12	0.18	0.1	0.13	0.14	0.1
Qwen2.5-1.5B-Instruct	0.05	0.03	0.05	0.06	0.03	0.03	0.06
			QA and Extraction				
GPT-4o	0.06	0.04	0.04	0.08	0.03	0.03	0.06
Llama3.1-70B-Instruct	0.07	0.08	0.05	0.04	0.06	0.1	0.07
Llama3.1-8B-Instruct	0.06	0.06	0.09	0.06	0.04	0.06	0.06
Llama3.2-1B-Instruct	0.1	0.11	0.08	0.06	0.04	0.14	0.1
Qwen2.5-72B-Instruct	0.05	0.03	0.08	0.03	0.04	0.04	0.04
Qwen2.5-7B-Instruct	0.02	0.05	0.06	0.04	0.03	0.06	0.04
Qwen2.5-1.5B-Instruct	0.08	0.09	0.07	0.04	0.05	0.07	0.08

Table 7: Breakdown of diversity scores per task group

F Pairwise t-test: Task Group Breakdown

Model	Industry	Race	Education	Sex	Age	Language	Nationality
			QA and Extraction				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%
Llama3.1-70B-Instruct	0.0%	33.3%	0.0%	0.0%	66.7%	33.3%	33.3%
Llama3.1-8B-Instruct	0.0%	66.7%	66.7%	0.0%	33.3%	33.3%	100.0%
Llama3.2-1B-Instruct	0.0%	66.7%	0.0%	0.0%	0.0%	33.3%	66.7%
Qwen2.5-72B-Instruct	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	66.7%	0.0%	0.0%	0.0%	33.3%	66.7%
			Knowledge and Reasoning				
GPT-4o	7.7%	30.8%	23.1%	0.0%	7.7%	0.0%	23.1%
Llama3.1-70B-Instruct	15.4%	15.4%	7.7%	0.0%	7.7%	0.0%	46.2%
Llama3.1-8B-Instruct	0.0%	15.4%	0.0%	0.0%	15.4%	7.7%	30.8%
Llama3.2-1B-Instruct	15.4%	15.4%	0.0%	0.0%	23.1%	7.7%	15.4%
Qwen2.5-72B-Instruct	0.0%	15.4%	7.7%	15.4%	7.7%	15.4%	15.4%
Qwen2.5-7B-Instruct	23.1%	15.4%	0.0%	7.7%	15.4%	7.7%	23.1%
Qwen2.5-1.5B-Instruct	0.0%	0.0%	15.4%	7.7%	7.7%	0.0%	7.7%
			Semantics				
GPT-4o	0.0%	66.7%	33.3%	0.0%	0.0%	0.0%	33.3%
Llama3.1-70B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	33.3%
Llama3.1-8B-Instruct	0.0%	33.3%	33.3%	0.0%	0.0%	0.0%	33.3%
Llama3.2-1B-Instruct	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	33.3%	33.3%	0.0%	0.0%	33.3%
Qwen2.5-7B-Instruct	66.7%	33.3%	0.0%	33.3%	33.3%	33.3%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	33.3%	33.3%	33.3%	33.3%	33.3%	33.3%
			Machine Translation				
GPT-4o	14.3%	21.4%	0.0%	14.3%	35.7%	7.1%	14.3%
Llama3.1-70B-Instruct	28.6%	28.6%	7.1%	0.0%	21.4%	0.0%	28.6%
Llama3.1-8B-Instruct	7.1%	14.3%	14.3%	0.0%	14.3%	0.0%	57.1%
Llama3.2-1B-Instruct	0.0%	14.3%	21.4%	0.0%	14.3%	7.1%	21.4%
Qwen2.5-72B-Instruct	14.3%	7.1%	0.0%	0.0%	7.1%	0.0%	28.6%
Qwen2.5-7B-Instruct	14.3%	14.3%	0.0%	7.1%	7.1%	0.0%	7.1%
Qwen2.5-1.5B-Instruct	14.3%	28.6%	7.1%	7.1%	7.1%	14.3%	42.9%
			Conditioned Text Generation				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Llama3.1-70B-Instruct	0.0%	100.0%	0.0%	0.0%	100.0%	100.0%	100.0%
Llama3.1-8B-Instruct	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Llama3.2-1B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Summarization				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-70B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-8B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
Llama3.2-1B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Syntaxes				
GPT-4o	0.0%	0.0%	25.0%	0.0%	25.0%	0.0%	50.0%
Llama3.1-70B-Instruct	0.0%	25.0%	25.0%	0.0%	0.0%	25.0%	50.0%
Llama3.1-8B-Instruct	0.0%	25.0%	25.0%	0.0%	50.0%	25.0%	75.0%
Llama3.2-1B-Instruct	0.0%	50.0%	0.0%	0.0%	50.0%	50.0%	75.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%	50.0%
Qwen2.5-7B-Instruct	25.0%	50.0%	0.0%	0.0%	50.0%	50.0%	50.0%
Qwen2.5-1.5B-Instruct	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%

Table 8: Breakdown of pairwise t-tests per task group

G ANOVA with Bonferroni Correction: Aggregated Results

Model	Semantics	Machine Translation	Summarization	Knowledge and Reasoning	Syntaxes	QA and Extraction	Conditioned Text Generation
GPT-4o	0.0%	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-70B-Instruct	0.0%	21.4%	0.0%	23.1%	0.0%	33.3%	100.0%
Llama3.1-8B-Instruct	33.3%	28.6%	100.0%	0.0%	0.0%	33.3%	100.0%
Llama3.2-1B-Instruct	0.0%	7.1%	100.0%	0.0%	25.0%	33.3%	0.0%
Qwen2.5-72B-Instruct	33.3%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	7.1%	0.0%	15.4%	50.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	33.3%	7.1%	0.0%	7.7%	0.0%	0.0%	0.0%

Table 9: Aggregated scores with ANOVA with Bonferroni Correction for all task groups.

H ANOVA: Aggregated and Task Group Breakdown Results

Model	Semantics	Machine Translation	Summarization	Knowledge and Reasoning	Syntaxes	QA and Extraction	Conditioned Text Generation
GPT-4o	33.3%	42.9%	0.0%	15.4%	0.0%	33.3%	0.0%
Llama3.1-70B-Instruct	33.3%	28.6%	0.0%	38.5%	50.0%	33.3%	100.0%
Llama3.1-8B-Instruct	33.3%	64.3%	100.0%	15.4%	75.0%	66.7%	100.0%
Llama3.2-1B-Instruct	0.0%	14.3%	100.0%	23.1%	75.0%	33.3%	0.0%
Qwen2.5-72B-Instruct	66.7%	7.1%	0.0%	23.1%	50.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	100.0%	28.6%	0.0%	30.8%	50.0%	0.0%	100.0%
Qwen2.5-1.5B-Instruct	33.3%	35.7%	0.0%	23.1%	25.0%	66.7%	0.0%

Table 10: Aggregated scores with ANOVA for all task groups.

Model	Industry	Race	Education	Sex	Age	Language	Nationality
			Summarization				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-70B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-8B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
Llama3.2-1B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Syntaxes				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-70B-Instruct	0.0%	25.0%	0.0%	0.0%	25.0%	0.0%	0.0%
Llama3.1-8B-Instruct	0.0%	0.0%	0.0%	0.0%	25.0%	50.0%	50.0%
Llama3.2-1B-Instruct	0.0%	25.0%	0.0%	0.0%	50.0%	50.0%	50.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	25.0%
Qwen2.5-7B-Instruct	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%	0.0%
Qwen2.5-1.5B-Instruct	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%
			Semantics				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%
Llama3.1-70B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%
Llama3.1-8B-Instruct	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.2-1B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	33.3%	33.3%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	66.7%	33.3%	0.0%	33.3%	0.0%	33.3%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	33.3%	0.0%	33.3%	33.3%	33.3%	33.3%
			Conditioned Text Generation				
GPT-4o	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Llama3.1-70B-Instruct	0.0%	100.0%	0.0%	0.0%	100.0%	100.0%	100.0%
Llama3.1-8B-Instruct	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Llama3.2-1B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Machine Translation				
GPT-4o	14.3%	7.1%	0.0%	7.1%	14.3%	0.0%	7.1%
Llama3.1-70B-Instruct	0.0%	14.3%	0.0%	0.0%	0.0%	0.0%	14.3%
Llama3.1-8B-Instruct	7.1%	14.3%	21.4%	0.0%	7.1%	0.0%	35.7%
Llama3.2-1B-Instruct	0.0%	0.0%	7.1%	0.0%	7.1%	0.0%	7.1%
Qwen2.5-72B-Instruct	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	0.0%	14.3%	7.1%	0.0%	7.1%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	7.1%	7.1%	7.1%	7.1%	7.1%	14.3%
			QA Extraction				
GPT-4o	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%
Llama3.1-70B-Instruct	0.0%	33.3%	0.0%	0.0%	0.0%	33.3%	33.3%
Llama3.1-8B-Instruct	0.0%	0.0%	33.3%	0.0%	33.3%	33.3%	66.7%
Llama3.2-1B-Instruct	0.0%	33.3%	0.0%	0.0%	0.0%	33.3%	33.3%
Qwen2.5-72B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-7B-Instruct	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	33.3%	0.0%	0.0%	0.0%	33.3%	33.3%
			Knowledge and Reasoning				
GPT-4o	0.0%	0.0%	7.7%	0.0%	7.7%	0.0%	0.0%
Llama3.1-70B-Instruct	7.7%	15.4%	7.7%	0.0%	7.7%	7.7%	30.8%
Llama3.1-8B-Instruct	0.0%	7.7%	0.0%	7.7%	7.7%	0.0%	0.0%
Llama3.2-1B-Instruct	15.4%	7.7%	0.0%	0.0%	7.7%	7.7%	0.0%
Qwen2.5-72B-Instruct	0.0%	7.7%	0.0%	7.7%	7.7%	15.4%	0.0%
Qwen2.5-7B-Instruct	15.4%	7.7%	0.0%	7.7%	0.0%	15.4%	0.0%
Qwen2.5-1.5B-Instruct	0.0%	0.0%	7.7%	0.0%	7.7%	0.0%	7.7%

Table 11: Breakdown of ANOVA per task group