(Why) Is My Prompt Getting Worse?
Rethinking **Regression Testing** for **Evolving LLM APIs**

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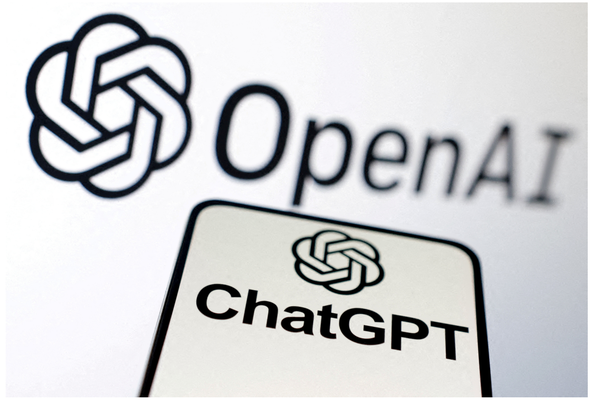
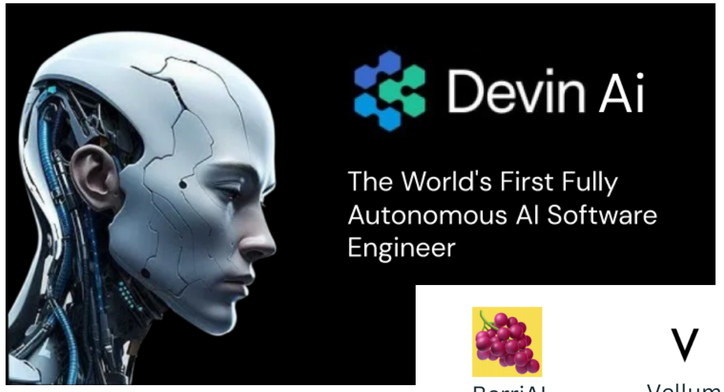
The Hong Kong University of Science and Technology[1]
Carnegie Mellon University[2]

Emerging Applications Powered by LLM APIs





truewind

AI-Powered bookkeeping and finance

The AI Boom in Y Combinator

BerriAI, Vellum, MagnaPlay, Hadrius, Anarchy, Zenfetch, PoplarML, pyq, Atri Labs, BabylonAI, Baselit, Gloo, Truewind, Chart, Intently, Rollstack, Type, Unstatiq, UpTrain AI, Buildt, JustPaid, Layup, Persana AI, Baseplate, Bluebirds, Linum, Untether Labs, Turntable, Magicflow, Blocktool, Extend, Squack, Wild Moose, OfOne, Rubbrband, Vocode, Quazel, Orchid, 222, Ivy, AlphaWatch, Chima, Pair AI

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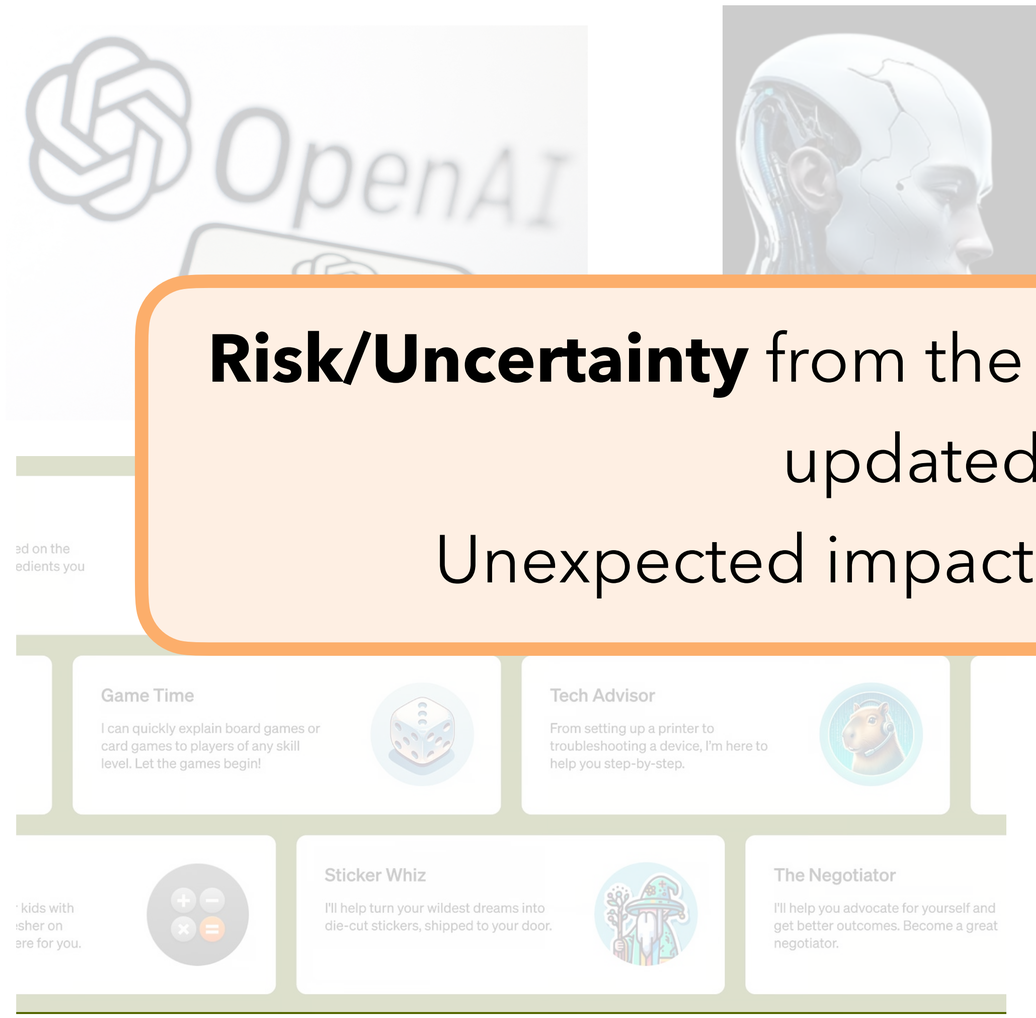

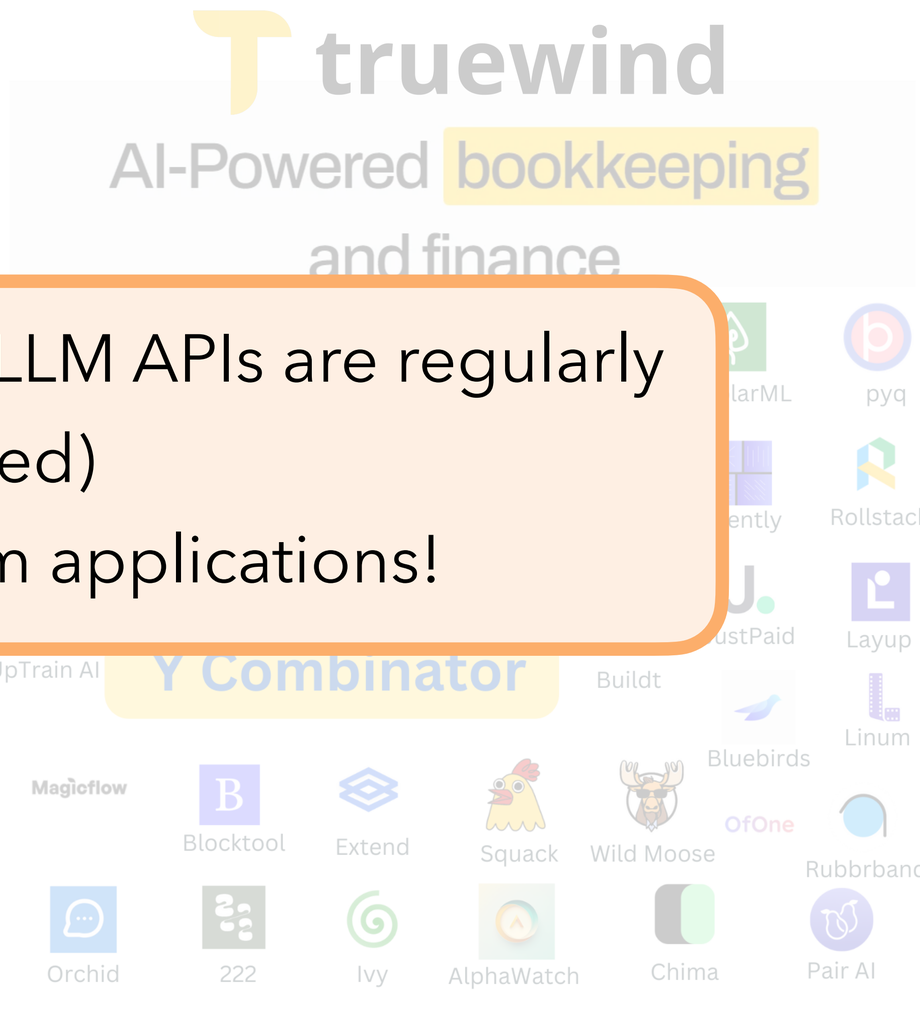

Risk/Uncertainty from the provider side: LLM APIs are regularly updated (and deprecated)

Unexpected impact on downstream applications!

LLM APIs are Regularly Updated (and Deprecated)

GPT 4

8k Tokens

Open to those who have previously paid any bills

gpt-4

Stable name. Always points to the latest release.

gpt-4-**0613**

Latest release.
Functions added.

Shutdown **TBA**

gpt-4-**0314**

Shuts down **13 June '24** New

32k Tokens

Invite only

gpt-4-32k

Stable name. Always points to the latest release.

gpt-4-32k-**0613**

Latest release.
Functions added.
Better comprehension of larger texts.

Shutdown **TBA**

gpt-4-32k-**0314**

Shuts down **13 June '24** New

GPT 3.5

4k Tokens

Generally available

gpt-3.5-turbo

Stable name. Always points to the latest release.

16k Tokens

New Generally available

gpt-3.5-turbo-16k

Stable name. Always points to the latest release.

Instruct

TBA

gpt-3.5-turbo-instruct

"Instruct style" model, not fine-tuning model.
Replaces **text-davinci-003.**

Invisible changes

gpt-3.5-turbo-**0613**

Latest release.
Functions added.
25% price reduction for input tokens.

Shutdown **TBA**

gpt-3.5-turbo-16k-**0613**

Latest release.
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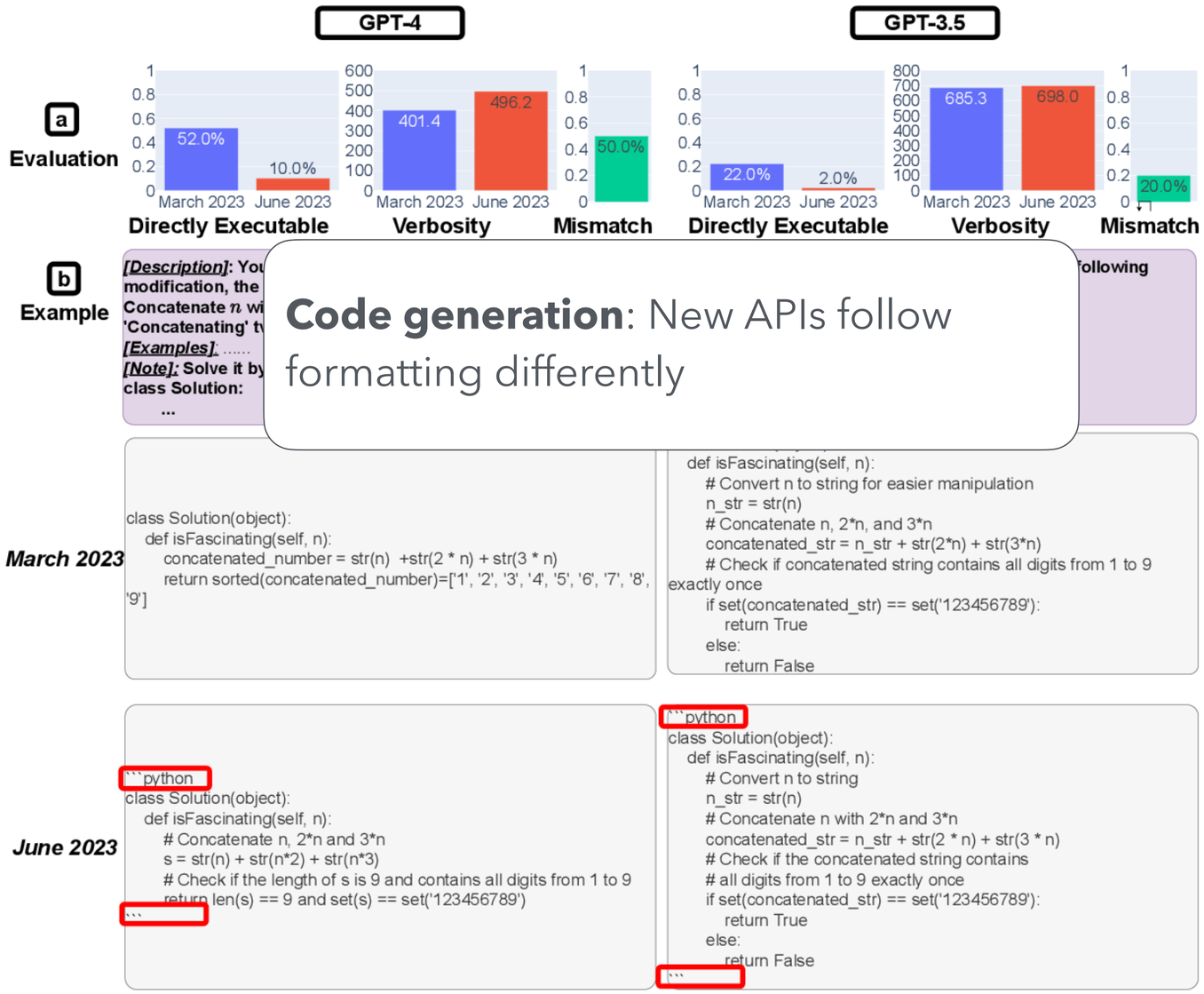
Shutdown **TBA**

Forced changes

gpt-3.5-turbo-**0301**

Shuts down **13 June '24** New

LLM API Updates Affect Applications (unexpectedly)



Code generation: New APIs follow formatting differently

Prompt A:
Classify the text as "toxic" or "non-toxic".

Document: [text omitted]
Label: toxic

Document: [text omitted]
Label: non-toxic

Document: {input}
Label:

Prompt B:
Classify the text as "toxic" or "non-toxic".

Toxic comments can be identity attacks, insulting, obscene, sexual-explicit, or threats.

Document: {input}
Label:

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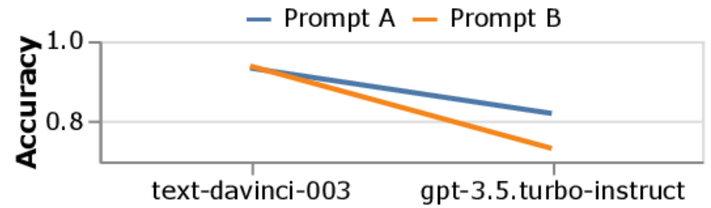

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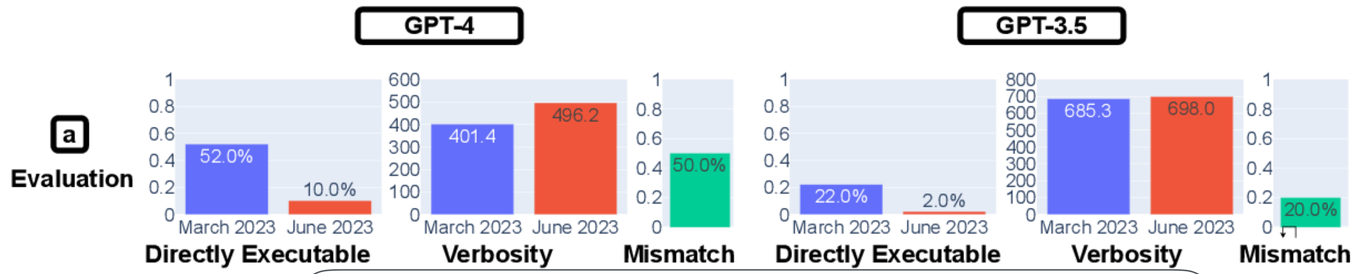

Code generation: New APIs follow formatting differently

b Example

March 2023

```
class Solution(object):
    def isFascinating(self, n):
        concatenated_number = str(n)  +str(2 * n) + str(3 * n)
        return sorted(concatenated_number)=['1', '2', '3', '4', '5', '6', '7', '8',
'9']
```

```
def isFascinating(self, n):
    # Convert n to string for easier manipulation
    n_str = str(n)
    # Concatenate n, 2*n, and 3*n
    concatenated_str = n_str + str(2*n) + str(3*n)
    # Check if concatenated string contains all digits from 1 to 9
exactly once
    if set(concatenated_str) == set('123456789'):
        return True
    else:
        return False
```

June 2023

```
```python
class Solution(object):
    def isFascinating(self, n):
        # Concatenate n, 2*n and 3*n
        s = str(n) + str(n*2) + str(n*3)
        # Check if the length of s is 9 and contains all digits from 1 to 9
        return len(s) == 9 and set(s) == set('123456789')
```
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New APIs have deteriorating performance

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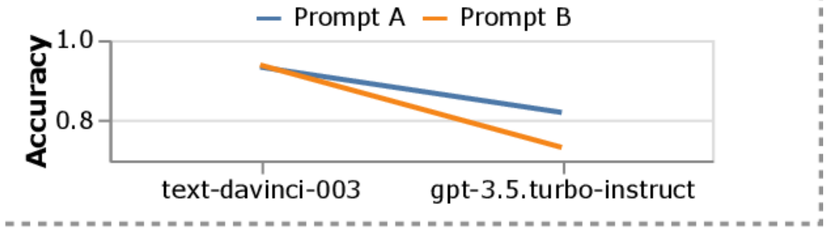

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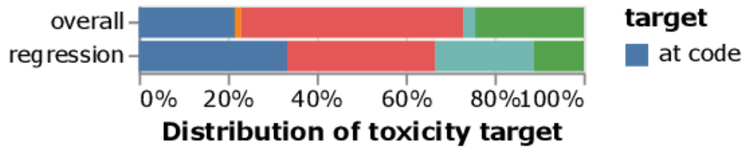
LLM API Updates Affect Applications (unexpectedly)

Experiment Setup: We study 5 APIs from GPT-3.5 family, 4 prompting strategies, and 2 datasets

Regression is common:
58.8% prompt + model combinations drop accuracy;
10.9% individual predictions regress over updates

Regression is not uniform across prompts:
The same update helps some prompts but hurts others

Regression is not uniform across subpopulations:
Some subpopulations are affected more than others



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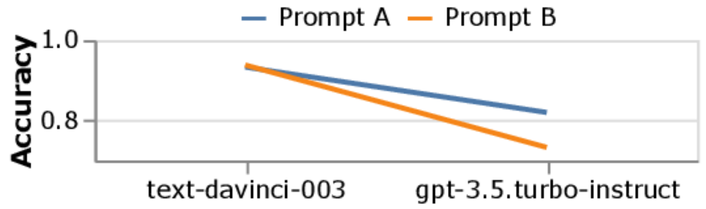

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Prompt B

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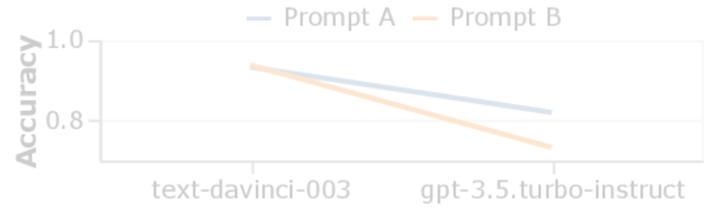
gpt-3.5-turbo-instruct toxic ✓ non-toxic ✗

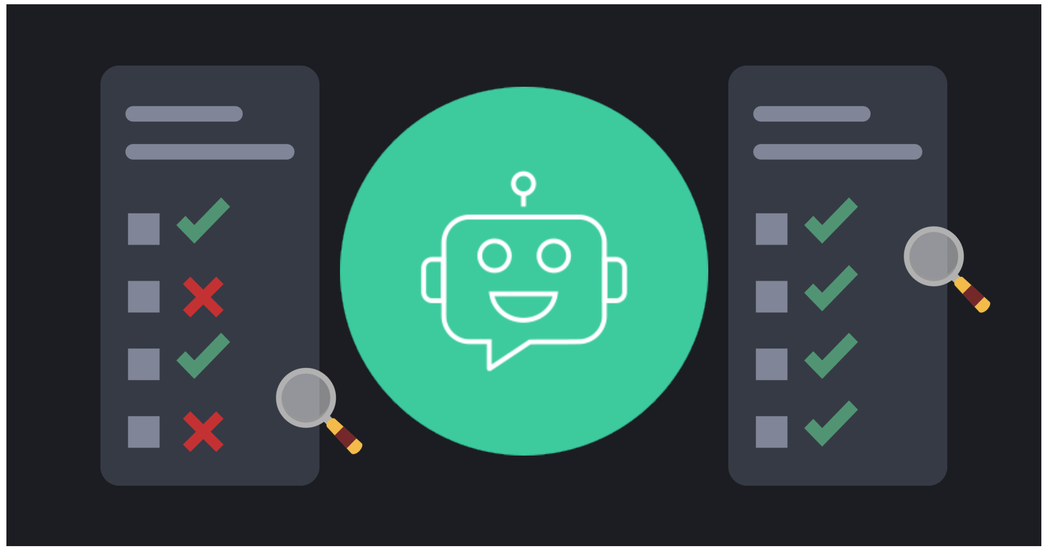


Application developers:

Is my prompt getting worse after API updates? 🤔

Is My Prompt Getting Worse after API Updates?

Software engineers uses **regression testing** to identify changes between software versions.
We argue that this can transfer to **LLM**-based software components.



From empirical observations to research opportunities:

How should we do regression testing for **LLM**-based software components?

What Counts as Regression Tests?

Traditional software: A single breaking regression test indicates a bug to fix

ML model: Overall performance drop indicates problems

Data Points

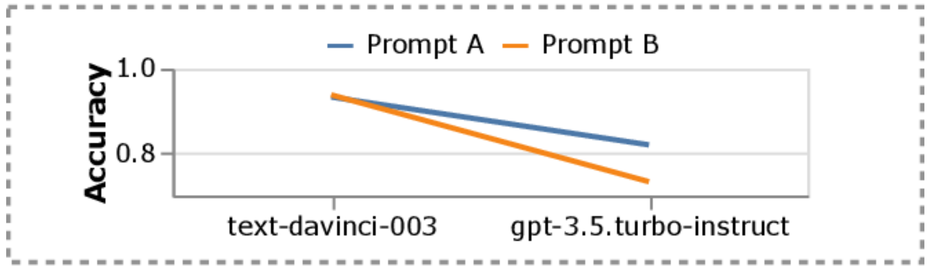
- Tweet A
- Tweet B
- Tweet C

Lots of data points are expected to flip after model updates.

Too fine-grained!

Regression is common:
10.9% individual predictions regress over updates

Evaluation Data



Not helpful for understanding what leads to regressions

Possible to miss regressions on underrepresented groups

Too coarse-grained!

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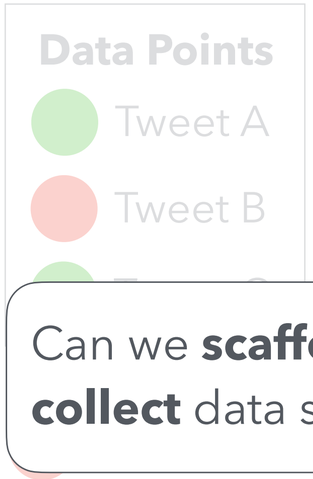
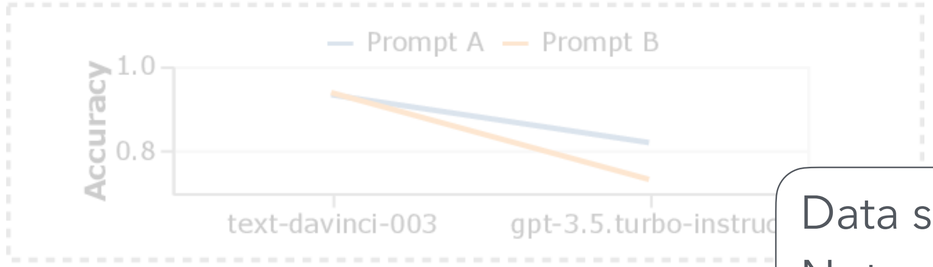
Research Opportunity #1: Test Granularity

Finding the right granularity: Use interpretable data slices to track changes



Can we **scaffold** developers to **identify and collect** data slices as regression test suites?



Data Slices

- Targeted at female
- Targeted at people with physical disability
- Insult
- Sexual explicit
- Curse words in non-toxic content

Data slices often rely on extra meta-data, or use simple regex search. Not available/applicable for many **text-based data**!

What Do Regression Tests Track?

Regression is not uniform across prompts:
The same update helps some prompts but hurts others

LLM performance is known to be sensitive to prompts:
Few-shot examples vs. zero-shot instructions

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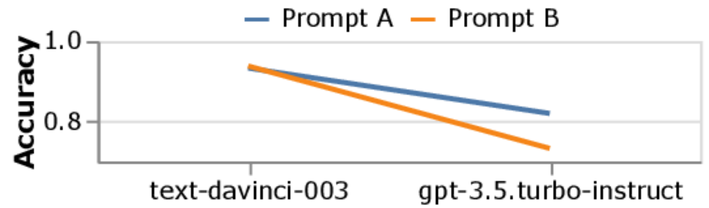
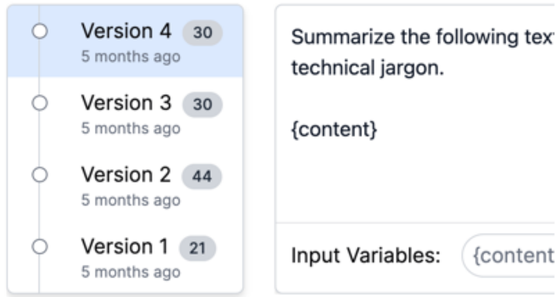


Research Opportunity #2: Prompt Versioning

Regression is not uniform across prompts:
The same update helps some prompts but hurts others

LLM performance is known to be sensitive to prompts:
Few-shot examples vs. zero-shot instructions

Can we design **prompt versioning** system to help developers track behavioral changes, debug regressions, and update prompts?



Reuse insights from ***history prompts****!*

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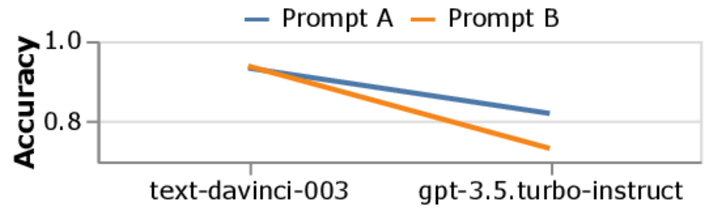
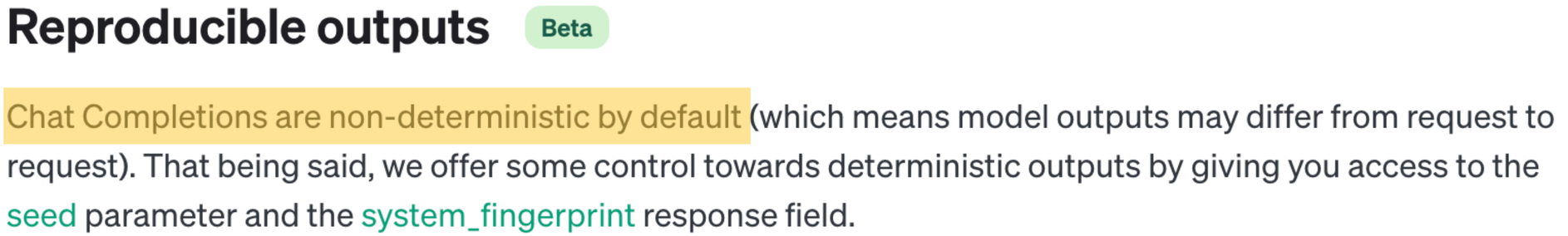


How to Make Regression Tests Reliable?

LLM regression **tests** are inherently **flaky**, as LLM outputs are (often intended to be) not deterministic.

This is especially true for **generative tasks**, where there is no single ground truth.



Reproducible outputs Beta

Chat Completions are non-deterministic by default (which means model outputs may differ from request to request). That being said, we offer some control towards deterministic outputs by giving you access to the seed parameter and the system_fingerprint response field.

https://platform.openai.com/docs/guides/text-generation/reproducible-outputs

Research Opportunity #3: Non-determinism

LLM regression **tests** are inherently **flaky**, as LLM outputs are (often intended to be) not deterministic.

This is especially true for **generative tasks**, where there is no single ground truth.

Can we develop suitable **statistical tests** and **test minimization** strategies?

Can we develop **multi-dimensional test suites** for generative tasks?

Data Slices

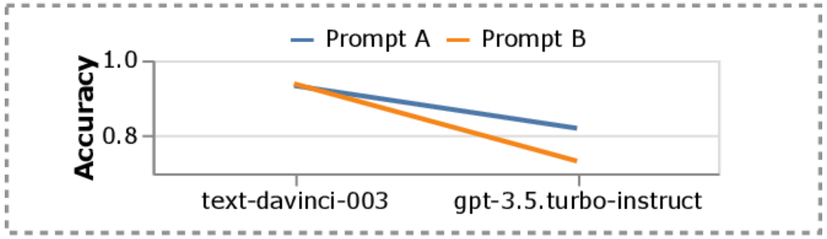
- Targeted at female
- Targeted at people with physical disability

Test Criteria for Summarization

- Language fluency
- Truthful to source text
- Summary conciseness
- Formatting

Takeaways

LLM API updates cause *regression* of downstream applications



Regression is common,
affects different prompting strategies differently,
and is not uniform across data slices.

Lots of research opportunities for doing **regression testing for LLM-based software components**

Granularity: Can we **scaffold** developers to **identify and collect** data slices as regression test suites?

Generation: Can we develop **multi-dimensional test suites** for generative tasks?

Non-determinism: Can we develop suitable **statistical tests** and **test minimization** strategies?

Versioning: Can we design **prompt versioning** system to help developers track behavioral changes, debug regressions, and update prompts?