AI in Qualitative Analysis
CPDE Lunch & Learn

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Why talk about this?

- 🎉 Artificial Intelligence (AI) seems to be everywhere, all of a sudden
- 🏋️ Large Language Models' (LLM) capabilities are impressive
- 🌊 A wave of new and shiny AI tools is flooding the scene
- 🤖 AI components are making their way into many analysis workflows and tools
- 🤔 AI literacy is a critical skill for everyone

Objectives of this talk

- 💬 Explain how Large Language Models (de-)construct language
- 🧭 Show how AI can help explore qualitative data
- 🔬 Equip you with critical knowledge to assess new tools and techniques
- Spark ideas and conversation

How Large Language Model's (de-)construct language

What *can't* AI do?

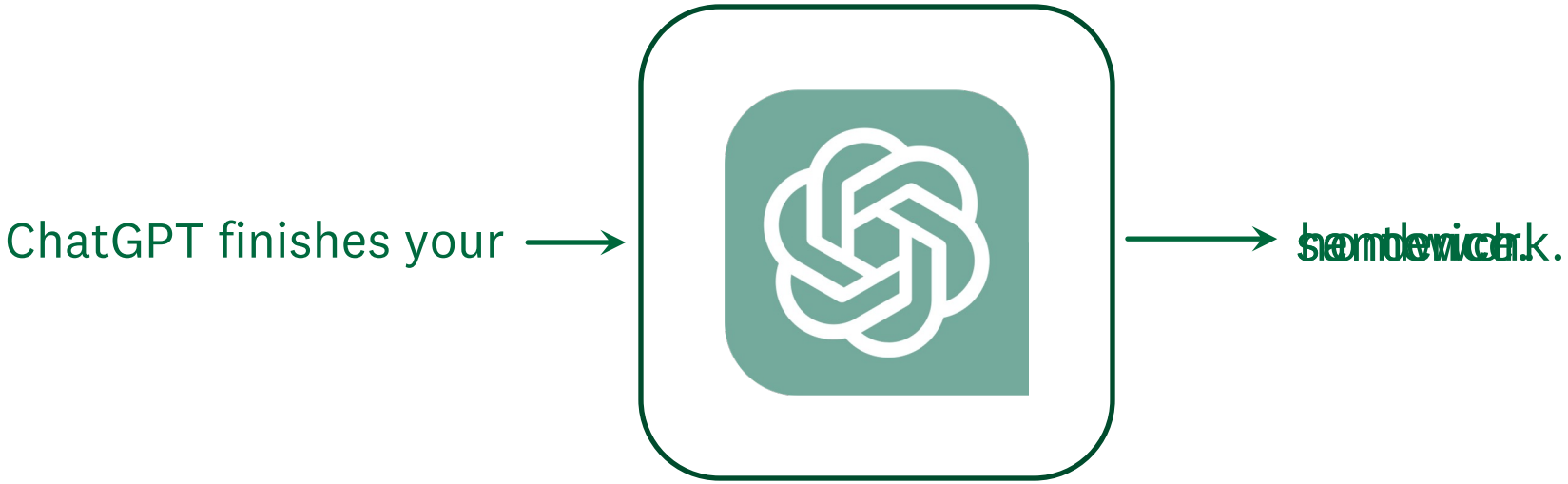
🥇 LLMs can do exactly one thing:

- 🔮 Predict the next word given a sequence of input words

🦜 Everything else they do is a clever use of this singular ability!

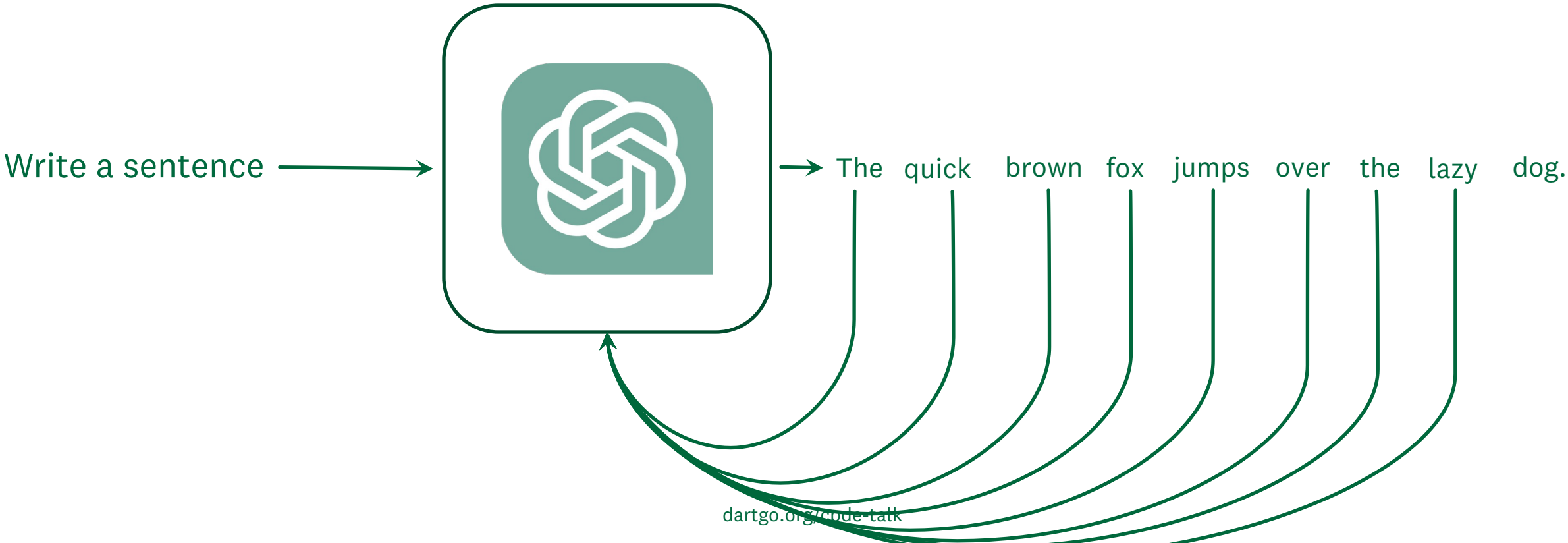
How Large Language Model's (de-)construct language

The fundamental case



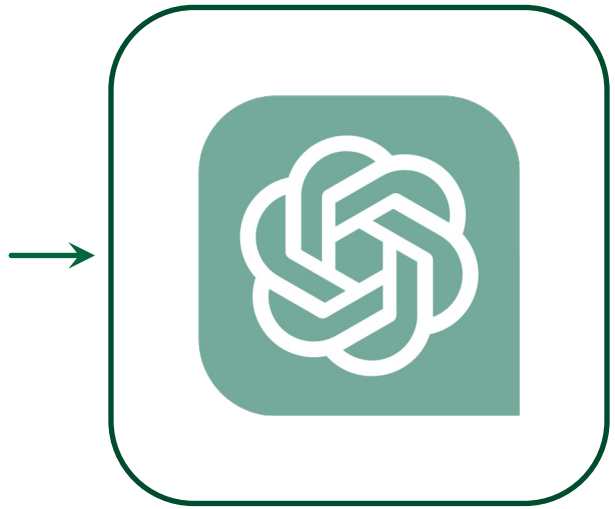
How Large Language Model's (de-)construct language

Predicting in a loop



How Large Language Model's (de-)construct language
Predicting a conversational turn

```
<|begin_of_text|>
<|start_header_id|>system<|end_header_id|>
Cutting Knowledge Date: December 2023 Today
Date: 23 July 2024 You are a helpful assistant
<|eot_id|>
<|start_header_id|>user<|end_header_id|>
What is the capital of France?
<|eot_id|>
<|start_header_id|>assistant<|end_header_id|>
```



```
The capital of France is Paris.
<|eot_id|>
```

*The template shown is the template used for Llama 3.2

How Large Language Model's (de-)construct language

How Large Language Models construct language

🗣️ How many words are in your response?

There are 12 words in my response.

🗣️ List them out in a numbered list.

Sure, here are the words in my previous response listed in a numbered list:
1. There
2. are
3. 12
4. words
5. in
6. my
7. response.

How Large Language Model's (de-)construct language

LLMs lie? - It's complicated

🤷‍♂️ LLMs have no concept of facts or truth, no internal database, no search mechanism

🦜 They only "know" patterns reinforced through their training data

- Example in Dartmouth Chat: Timothée Chalamet's mother

🤞 Factually correct responses are patterns that happen to be correct

🤔 "Hallucination" is a bit of a misnomer

Emily M. Bender *et al*. 2021. On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? 🦜. In Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency (FAccT '21). Association for Computing Machinery, New York, NY, USA, 610–623. https://doi.org/10.1145/3442188.3445922

How Large Language Model's (de-)construct language

How to find the next word?

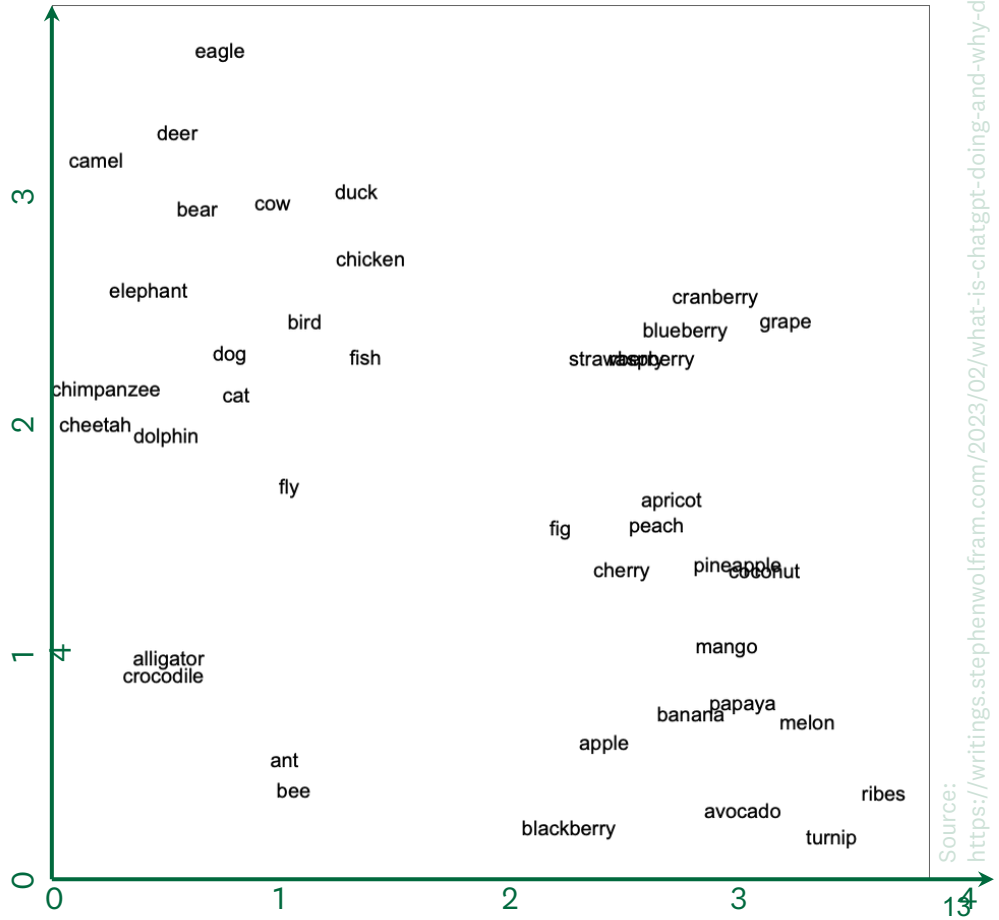
- 🏋️ The patterns in written language are learned from text data in a training phase
- 📚 GPT 3.5, for example, has been trained on about 570 GB of texts or 300 billion words (English Wikipedia: 4.2 billion words)
- 🤯 This would still not be enough data if we were looking for examples of longer specific word sequences!

How Large Language Model's (de-)construct language

How to find the next word?

Two important "tricks" solve this problem:

- The model learns to map every word into a numerical "meaning space", where words with similar meaning are represented by similar numbers
- That way the model can base the probability of the next word on sequences of similar words
- GPT 3.5 uses 2048 dimensional embeddings (probably)



Source: https://writings.stephenwolfram.com/2023/02/what-is-chatgpt-doing-and-why-does-it-work/

Background

How to find the next word?

Two important “tricks” solve this problem:

1. Words in “meaning space”
2. The model uses a mechanism called “attention” to emphasize the most important words in the sequence
   - 🏋️ These weights are learned during training
   -  This structure is called a “transformer”
   - 💡 GPT: **G**enerative **P**re-trained **T**ransformer

What can AI do for qualitative analysis?

- 🧨 Concept of “semantic similarity” very powerful
- 🦾 LLM’s are excellent at picking up patterns in language
- 👉 Let’s look at an example!

- 🤖 By the way: All responses for the following demos were generated using Claude 3.7 Sonnet

Summary

- 📚 Large Language Models are excellent text processors
- 🎯 Semantic embeddings are a useful tool to capture contextual information in text
- 🤝 Using a Human-in-the-Loop approach, AI holds a lot of potential to speed up and scale qualitative analysis

Discussion

Thank you

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