No-nonsense LLMs

with R and ellmer

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Get started by following the setup instructions at https://github.com/hadley/workshop-llm-hackathon

Framing

- Using LLMs as a data scientist, from a programming language (R).
- Practical, actionable, non-nonsense, minimal-jargon
- We’ll treat LLMs as black boxes, focussing on what they can do, not how they work.
- Just enough knowledge so you know what to search for (or ask an LLM about!)

Other ways to use LLMs

- On the web
  - Claude, ChatGPT
  - Shiny assistant, https://gallery.shinyapps.io/assistant/
- In a shiny app:
  - https://github.com/posit-dev/querychat
  - https://github.com/posit-dev/shinychat
- In your IDE, e.g. Positron assistant (https://positron.posit.co/assistant.html)
- In your terminal, e.g. claude code

1. Set up
2. Anatomy of a conversation
3. Tool calling
4. Structured data
5. Non-text inputs
6. Prompt engineering
7. Your turn

Setup

Getting started

- You'll need ellmer: `pak::pak("ellmer")`
- And an account with an LLM provider:
  - Option 1: claude. Cheap & good at R code.
  - Option 2: gemini. Free & good at videos.
  - (Plus many others at https://ellmer.tidyverse.org/reference/index.html)
- If you already pay for Claude, ChatGPT etc, unfortunately you still need a separate account for API access.

Your turn: get this working

https://github.com/hadley/workshop-llm-hackathon

```
library(ellmer)

chat ← chat_anthropic("You are a terse assistant.")
# or
chat ← chat_google_gemini("You are a terse assistant.")

chat$chat("What is the capital of France?")
# the client is stateful, so this continues the conversation
chat$chat("What is its most famous landmark?")

# While you wait
live_browser(chat)
```

Initial vocabulary

Provider

System prompt

```
chat ← chat_anthropic("You are a terse assistant.")
#> Using model = "claude-3-7-sonnet-latest"
```

Model

```
chat$chat("What is the capital of the France?")
```

User prompt

System prompt sets the baseline for responses

```
chat ← chat_anthropic()
chat$chat("What is the capital of the moon?")

chat ← chat_anthropic("Answer with a Scottish accent")
chat$chat("What is the capital of the moon?")

chat ← chat_anthropic("
  You're an alien that lives on the moon. Really commit to the bit"
)
chat$chat("What is the capital of the moon?")
```

LLM

LLM with system prompt

Initial vocabulary

```
> chat
<Chat Anthropic/claude-3-7-sonnet-latest turns=3 tokens=22/23 $0.00>
── system [0] ──────────────────────────────────────────────────────
You are a terse assistant.
── user [21] ───────────────────────────────────────────────────────
What is the capital of France?
── assistant [10] ──────────────────────────────────────────────────
The capital of France is Paris.
```

Provider

Model

Input/output tokens

Price

System prompt

User prompt

Model response

Anatomy of a conversation

Overview

- Each interaction is a pair of user and assistant **turns**, corresponding to a HTTP request and response.
- The API server is entirely stateless, despite conversations being very stateful!
- Can see exactly what ellmer with an httr2 option, which we'll use to explore what's going on under the hood.

HTTP request

```
{
    "model": "claude-3-7-sonnet",
    "system": "You are a terse assistant.",
    "messages": [
        {
            "role": "user",
            "content": [
                {
                    "type": "text",
                    "text": "What is the capital of France?"
                }
            ]
        }
    ],
    "stream": false,
    "max_tokens": 4096
}
```

Model

System prompt

User prompt

HTTP response

```
{
  ...
  "type": "message",
  "role": "assistant",
  "content": [
    {
      "type": "text",
      "text": "The capital of France is Paris."
    }
  ],
  "usage": {
    "input_tokens": 22,
    "cache_creation_input_tokens": 0,
    "cache_read_input_tokens": 0,
    "output_tokens": 18
  }
}
```

Model response

HTTP response


```
{
  ...
  "type": "message",
  "role": "assistant",
  "content": [
    {
      "type": "text",
      "text": "The capital of France is Paris."
    }
  ],
  "usage": {
    "input_tokens": 22,
    "cache_creation_input_tokens": 0,
    "cache_read_input_tokens": 0,
    "output_tokens": 18
  }
}
```

What is a token?

- Featuring engineering to represent words as number.
- Common words represented with a single number
  - What is the capital of Paris?
  - 4827, 382, 290, 9029, 328, 12650, 30
- Other words may require multiple numbers:
  - counterrevolutionary
  - 32128 (“counter”), 264 (“re”), 9477 (“volution”), 815 (“ary”)
- See details at https://tiktokenizer.vercel.app/

Why do tokens matter?

- API pricing is by token
  - https://www.anthropic.com/pricing#anthropic-api
  - Input: $3 / million tokens
  - Output: $15 / million tokens
- Context size
  - e.g. 200K for claude sonnet (1M for gemini flash 2.0)
  - 200K = 150,000 words / 300-600 pages / 1.5-2 novels
  - = 1/3 of Lord of the Rings

This seems like plenty but ...

```
{
    "role": "user",
    "content": [{"text": "What's the capital of Paris?"}]
},
{
    "role": "assistant",
    "content": [{"text": "The capital of France is Paris."}]
},
{
    "role": "user",
    "content": [{"text": "What is its most famous landmark?"}]
}
```

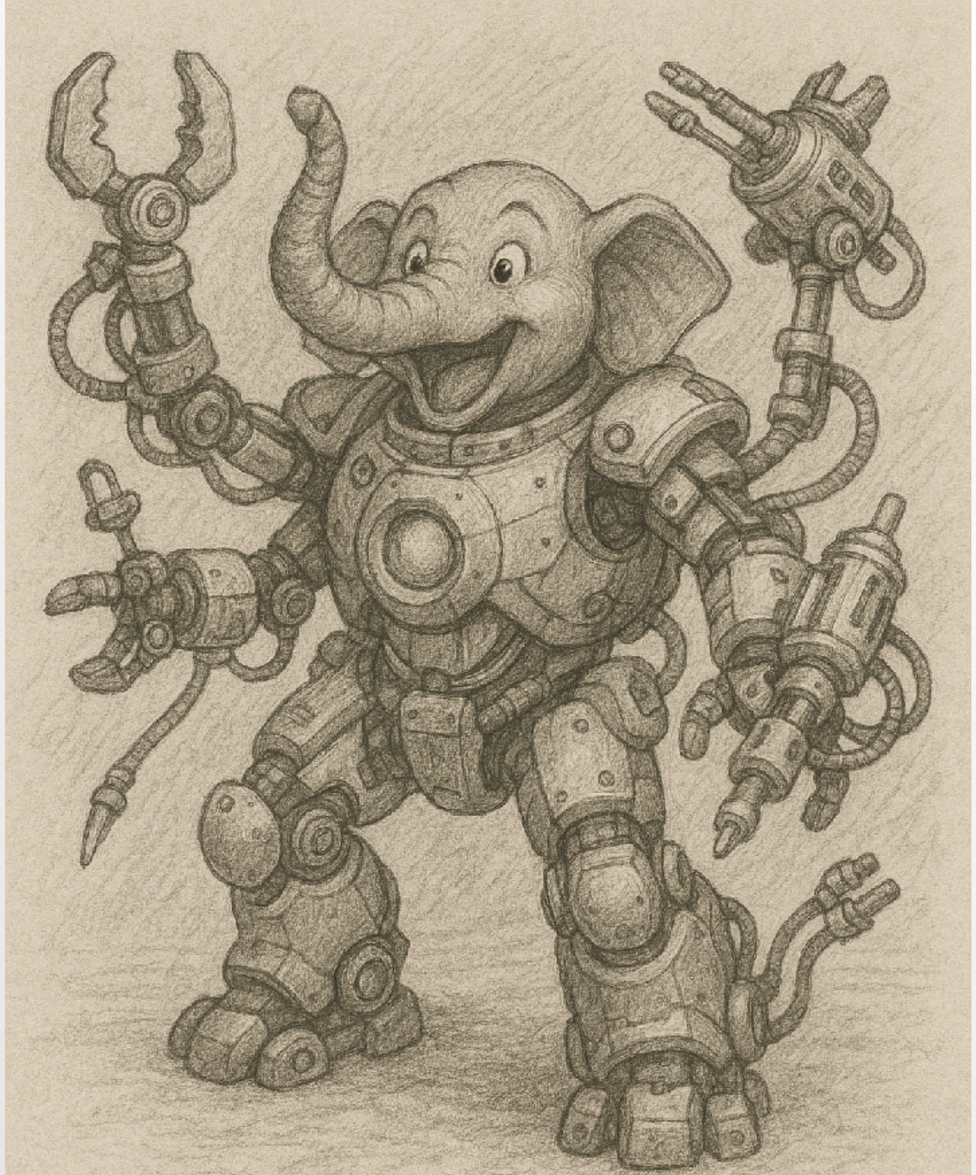
Your turn

```
library(ellmer)
options(httr2_verbosity = 2)

chat ← chat_anthropic("You are a terse assistant.", echo = FALSE)
chat$chat("Tell me a joke about a statistician and a data scientist")
chat$chat("Explain why that's funny")
chat$chat("Make the joke funnier")

# Look at the request and response and verify that you see it
# growing. Does this help you understand any features of LLMs
# that you've observed in your own usage?
```

Tool calling

https://ellmer.tidyverse.org/articles/tool-calling.html

LLM



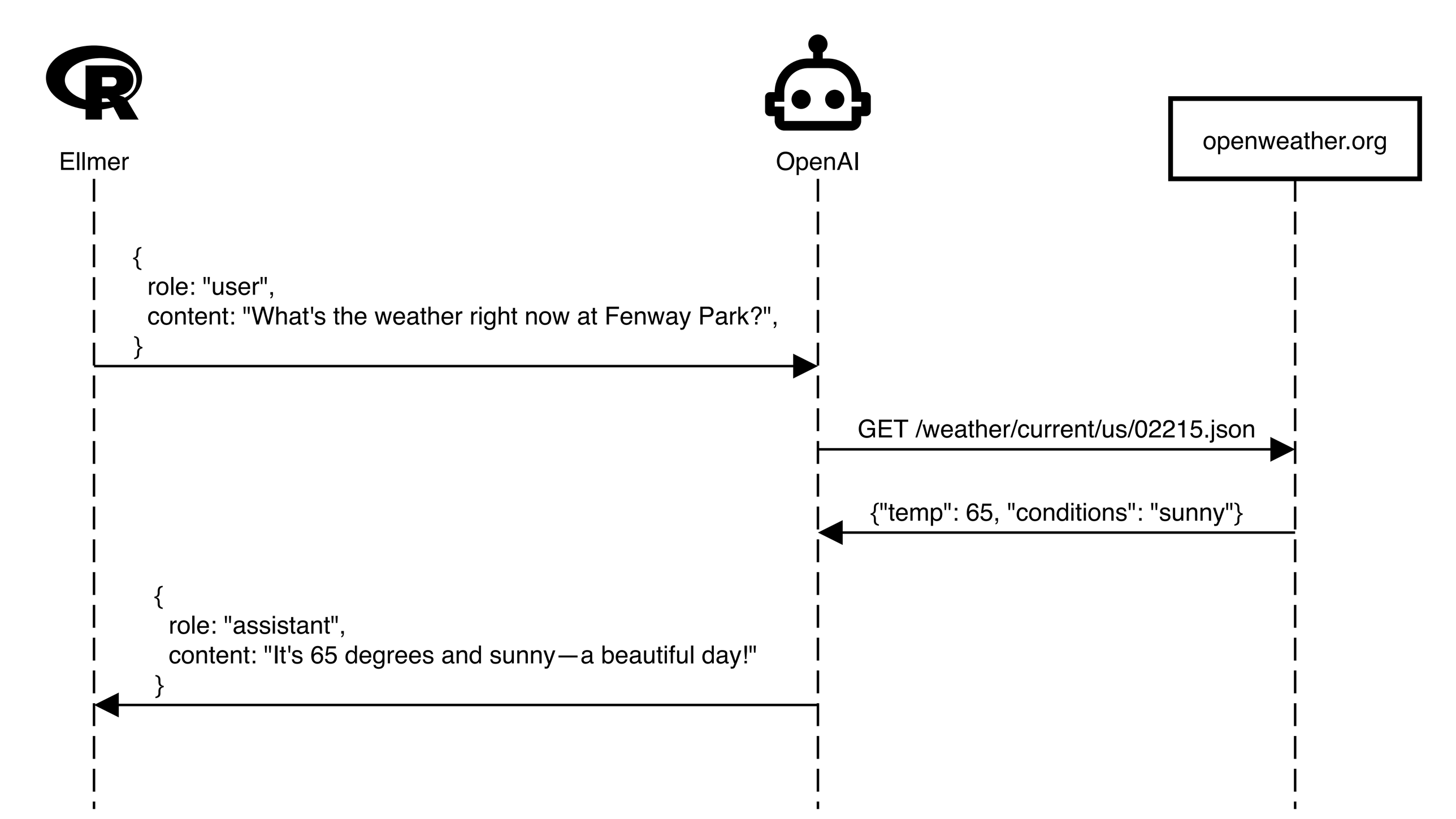
LLM with tool calling

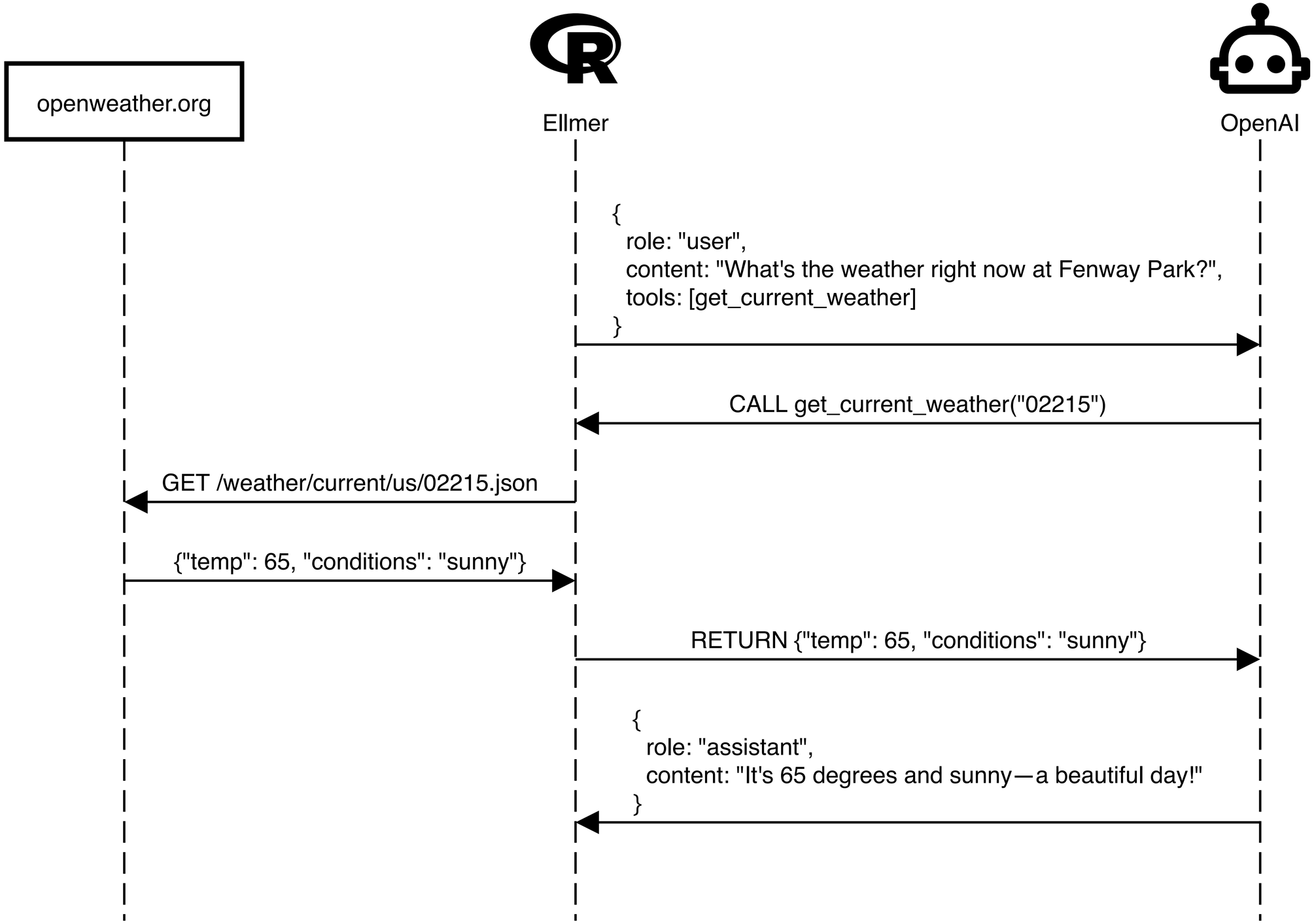
Tool calling

- Can provide the LLM with **tools** that it can **call**
- A tool is just another name for a function
- Useful for:
  - Things LLMs aren't good at (e.g. basic maths)
  - Providing current information (e.g. todays date)
  - Looking up extra info (e.g. R documentation)
  - Doing something on your behalf (this makes it an **agent**!)

How does it work?

```
# Define the tool
get_weather ← function(zip_code) {
  ...
}

chat ← chat_anthropic()
# Register the tool
chat$register_tool(tool(
  name = "get_weather",
  description = "Get the weather for a given zip code",
  func = get_weather)
)
chat$chat("What's the weather right now in Fenway park?")
```


Ellmer
OpenAI
openweather.org
{
role: "user",
content: "What's the weather right now at Fenway Park?",
}
GET /weather/current/us/02215.json
{"temp": 65, "conditions": "sunny"}
{
role: "assistant",
content: "It's 65 degrees and sunny—a beautiful day!"
}


openweather.org
Ellmer
OpenAI
{
role: "user",
content: "What's the weather right now at Fenway Park?",
tools: [get_current_weather]
}
CALL get_current_weather("02215")
GET /weather/current/us/02215.json
{"temp": 65, "conditions": "sunny"}
RETURN {"temp": 65, "conditions": "sunny"}
{
role: "assistant",
content: "It's 65 degrees and sunny—a beautiful day!"
}

LLMs don’t know what day it is. But you can provide a tool:

```
chat ← chat_anthropic("You're a terse assistant")
chat$chat("What's today's date?")
#> Today is November 24, 2023.

chat$register_tool(tool(
  function() Sys.Date(),
  "Gets the current date",
  .name = "today"
))
chat$chat("What's today's date?")
#> Let me get today's date for you.
#> ○ [tool call] today()
#> ● #> "2025-06-13"
#> It's June 13, 2025.
```

How does this work?

```
<Chat Anthropic/claude-3-7-sonnet-latest turns=7 tokens=875/71 $0.00>
── system [0] ──────────────────────────────────────────────────────────────────
You're a terse assistant
── user [19] ───────────────────────────────────────────────────────────────────
What's today's date?
── assistant [13] ──────────────────────────────────────────────────────────────
Today is May 20, 2023.
── user [365] ──────────────────────────────────────────────────────────────────
What's today's date?
── assistant [44] ──────────────────────────────────────────────────────────────
I'll check today's date for you.
[tool request (toolu_01VR1eRhnpFeJxW5bnsKFe9r)]: today()
── user [18] ───────────────────────────────────────────────────────────────────
[tool result  (toolu_01VR1eRhnpFeJxW5bnsKFe9r)]: "2025-06-13"
── assistant [14] ──────────────────────────────────────────────────────────────
Today is June 13, 2025.
```

Your turn

```
# Modify this code so the LLM returns the correct age, as of
# today. Carefully read the chat transcript to confirm your
# understanding of how tool calling works.

chat ← chat_anthropic()
chat$chat("How old is Cher? Explain your working")

# Next, run tool-quiz.R and think about how it works
```

https://github.com/hadley/workshop-llm-hackathon

BE CAREFUL

```
file.create("a.csv")
file.create("b.csv")

chat ← chat_anthropic()
chat$register_tool(tool(
  function() dir(),
  "Lists the files in the current directory",
  .name = "ls"
))
chat$register_tool(tool(
  function(path) unlink(path),
  path = type_string(),
  "Delete a file",
  .name = "rm"
))

chat$chat("What files are in the current directory?")
chat$chat("Delete all the csv files")

# Take a look at tool_reject() docs
```

Multiagent AI

```
summarise_text ← function(text) {
  chat ← chat_openai(model = "gpt-4.1-nano", echo = FALSE)
  chat$chat(c("Summarise the following text into 3 bullets", "", text))
}

chat ← chat_anthropic()
chat$register_tool(
  summarise_text,
  "Summarise text",
  text = type_string("Text to summarise"),
)
```

Structured data

https://ellmer.tidyverse.org/articles/structured-data.html

LLMs are incredibly useful for unstructured data

```
prompts ← list(
  "I go by Alex. 42 years on this planet and counting.",
  "Pleased to meet you! I'm Jamal, age 27.",
  "They call me Li Wei. Nineteen years young.",
  "Fatima here. Just celebrated my 35th birthday last week.",
  "The name's Robert - 51 years old and proud of it.",
  "Kwame here - just hit the big 5-0 this year."
)
type_person ← type_object(name = type_string(), age = type_number())
parallel_chat_structured(chat, prompts, type_person)
```

Imagine you have a recipe...

```
recipe ← "In a large bowl, cream together 1 cup of softened unsalted
butter and ½ cup of white sugar until smooth. Beat in 1 egg and 1
teaspoon of vanilla extract. Gradually stir in 2 cups of all-purpose
flour until the dough forms. Finally, fold in 1 cup of semisweet
chocolate chips. Drop spoonfuls of dough onto an ungreased baking
sheet and bake at 350°F (175°C) for 10-12 minutes, or until the edges
are lightly browned. Let the cookies cool on the baking sheet for a
few minutes before transferring to a wire rack to cool completely.
Enjoy!"
```

Structured data extraction

- As well as returning text, most providers have some way to generate structured data.
- You'll provider a type specification (with type_object(), type_array(), type_string(), etc) and the results are guaranteed to fit that specification.
- Not clear to me how this interacts with your prompt. You'll need to experiment to get the best results.
- Great combination with non-text data (next).

recipes-example.R

Non-text inputs

Content types

```
{
    "model": "claude-3-5-sonnet-latest",
    "system": "You are a terse assistant.",
    "messages": [
        {
            "role": "user",
            "content": [
                {
                    "type": "text",
                    "text": "What is the capital of the moon?"
                }
            ]
        }
    ],
    "stream": false,
    "max_tokens": 4096
}
```

What else can go here?

	Image	PDF	Video
OpenAI	✅		
Claude	✅	✅	
Gemini	✅	✅	✅

Providing non-text inputs

```
chat ← chat_anthropic()

chat$chat(
  content_image_file("holly-mandarich-3p9zaNwUtv8-unsplash.jpg"),
  "Describe this photo"
)
chat$chat("Where in the world do you think it is?")

# Note the number of tokens used
chat
```

Other functions

```
content_image_url()
content_image_file()

content_pdf_url()
content_pdf_file()

# For chat_google_gemini()
google_upload()
```

Prompt design

Treat AI like an infinitely patient new coworker who forgets everything you tell them each new conversation, one that comes highly recommended but whose actual abilities are not that clear. … Two parts of this are analogous to working with humans (being new on the job and being a coworker) and two of them are very alien (forgetting everything and being infinitely patient). We should start with where AIs are closest to humans, because that is the key to good-enough prompting

— **Ethan Mollick**

General structure

- Prompts can get long, so it makes sense to organise in a way that's useful for humans and LLMs: markdown.
- Put your prompt in a separate file.
- Use ellmer::interpolate_file() to read and add any dynamic data

Example prompt

```
You are an expert ggplot2 programmer.

Help me brainstorm ways to visualise the <dataset> described below.
Give me 10 different places to get started.

* Be creative!
* Return the results as a single block of code, using comments to separate the
  plots

<dataset>
{{glimpse}}
</dataset>
```

Your turn

- Improve the prompt! Here are some ideas:
  - Do you want to steer it towards or away from using other packages? Just the tidyverse package? Other extensions?
  - Can you prevent it from using theme_minimal()? Can you encourage it to use the base pipe instead of magrittr? What other code style issues could you improve?
  - Can you get it to explain the goal of the plot inline with the comment?
  - It has a tendency to go all out and include a large number of variables in the visualisation. Can you make it focus on simpler plots?
  - Is it still useful with a dataset that its never seen before? What other information might you want to include about the data?

Also worth reading the advice from specific providers

- Claude
- OpenAI
- Gemini

https://github.com/hadley/workshop-llm-hackathon

Your turn!

Project ideas

Create a custom prompt to solve a common coding problem. See https://simonpcouch.github.io/chores/ for some examples.

Use tool calling to give the LLM additional info.

Extract structured data from unstructured text, PDFs, images, video, ...

If you're familiar with shiny, you could use https://github.com/jcheng5/shinychat to make your own chatbot. If you’re not, ask https://jcheng.shinyapps.io/ellmer-assistant/ to make you an app.

If you get stuck, try https://jcheng.shinyapps.io/ellmer-assistant/