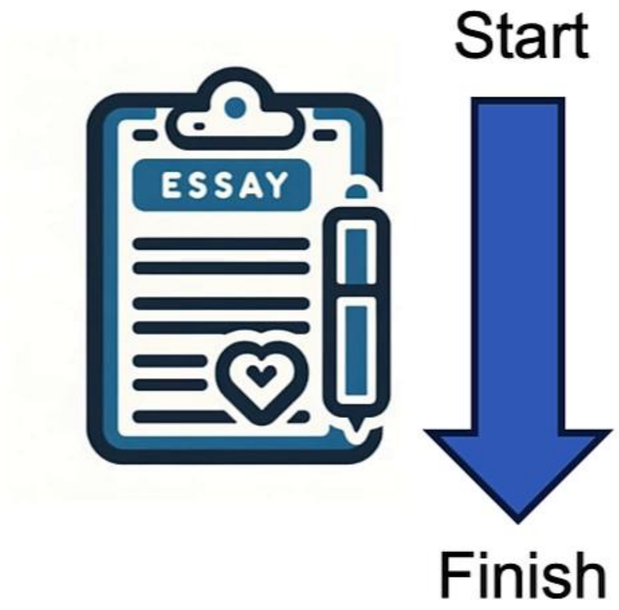
Agentic AI

Non-agentic workflow (zero-shot):

Please type out an essay on topic X from start to finish in one go, without using backspace.



Agentic workflow:

Write an essay outline on topic X

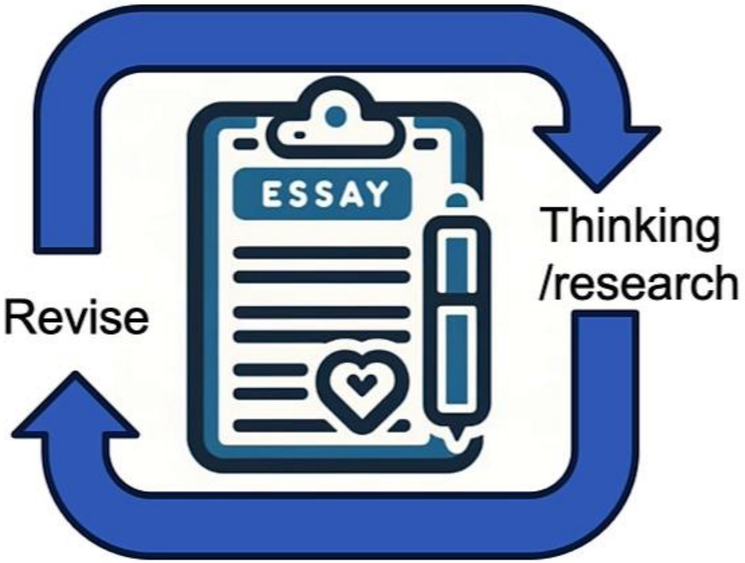
Do you need any web research?

Write a first draft.

Consider what parts need revision or more research.

Revise your draft.

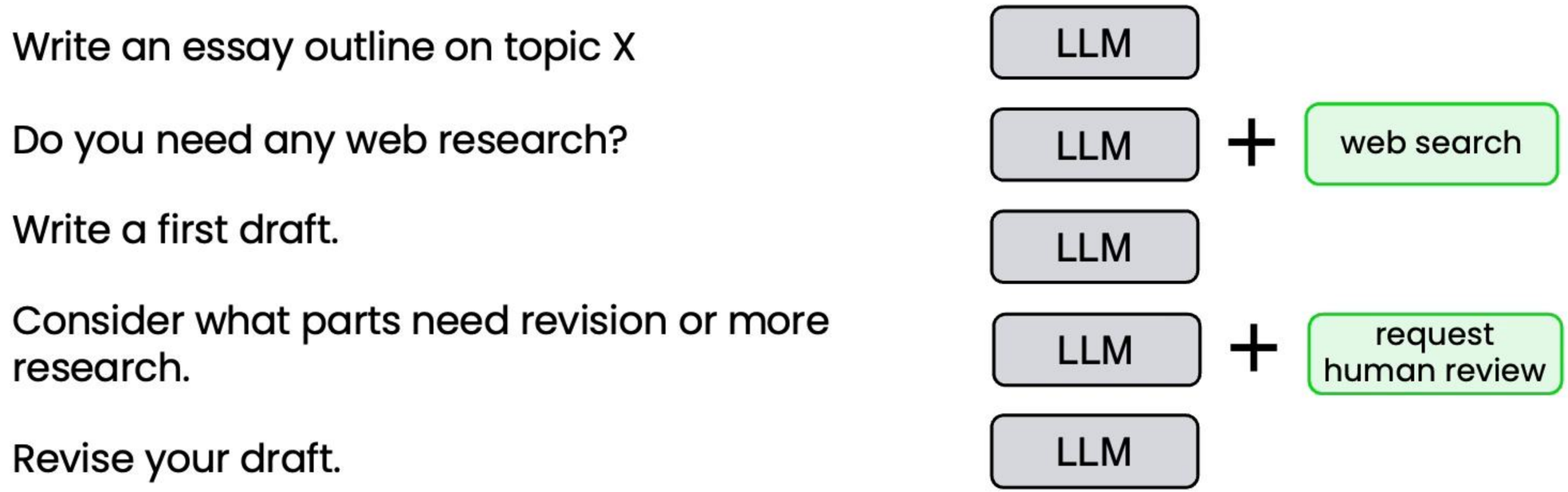
....



Agentic AI workflows

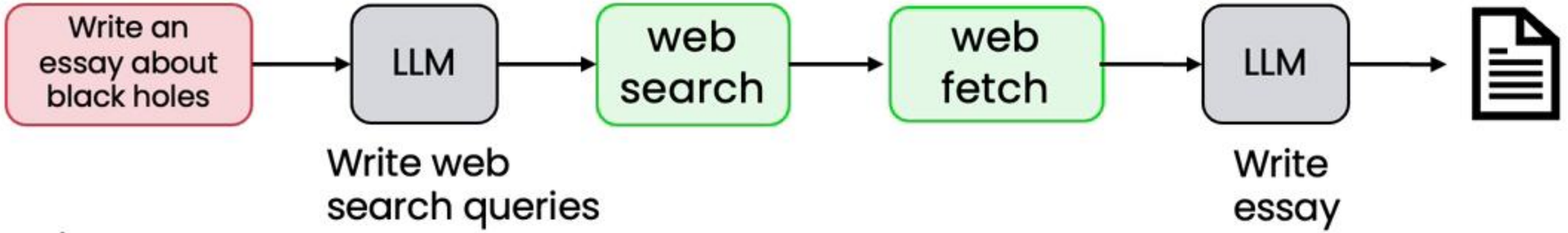
An agentic AI workflow is a process where an LLM-based app executes multiple steps to complete a task.

Essay-writing example:

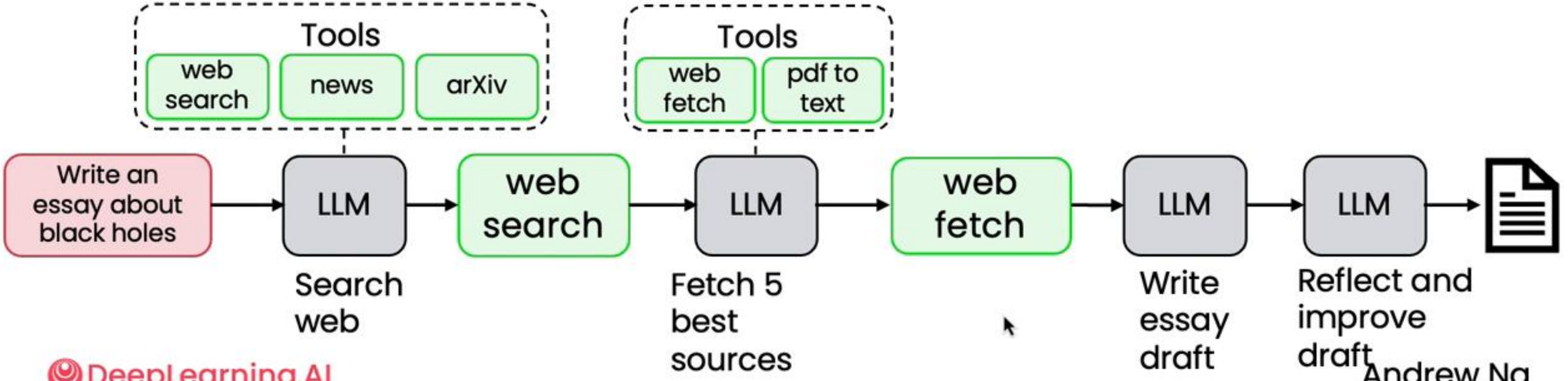


Degrees of autonomy

Less autonomous



More autonomous



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Degrees of autonomy

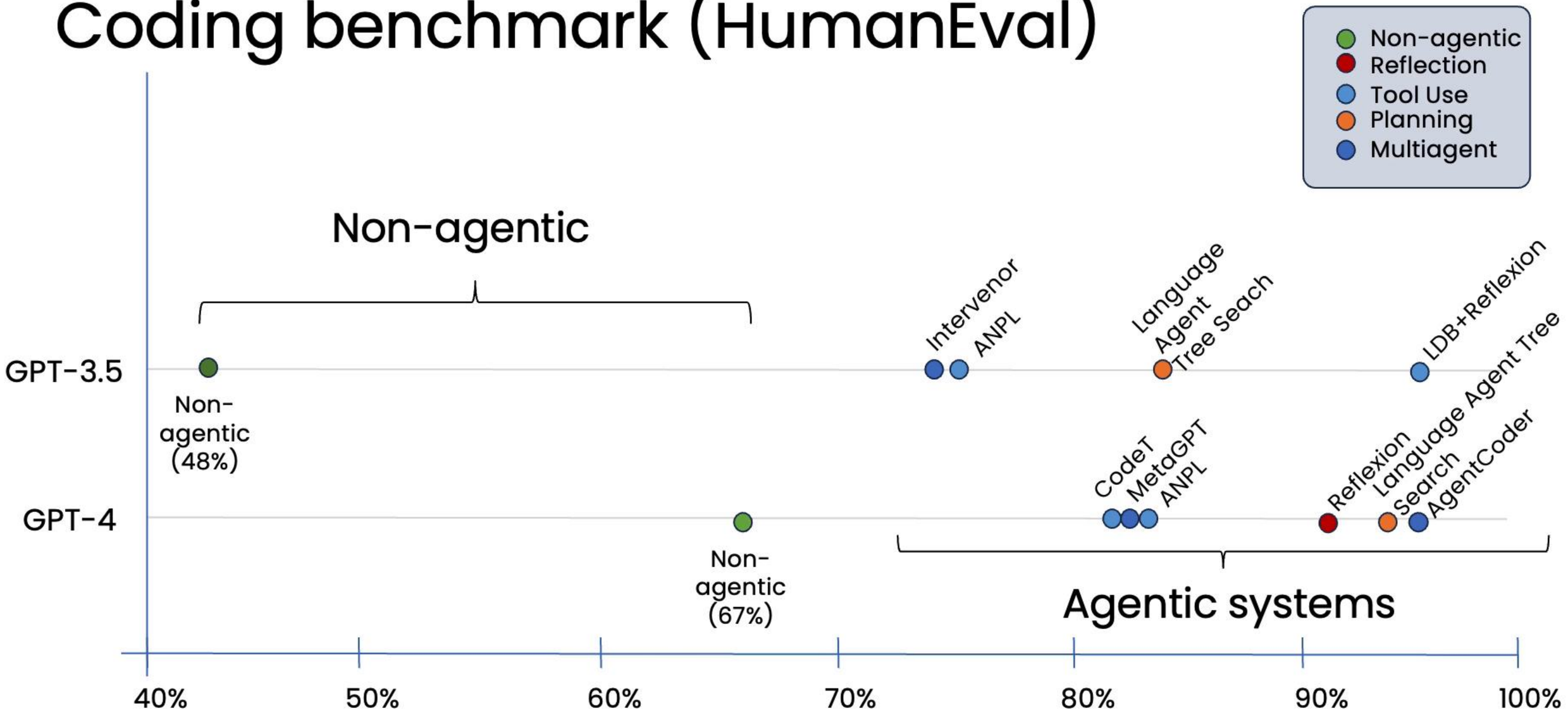
Agentic AI can be less or more autonomous

- All steps predetermined
- All tool use hard coded
- Autonomy is in text generation

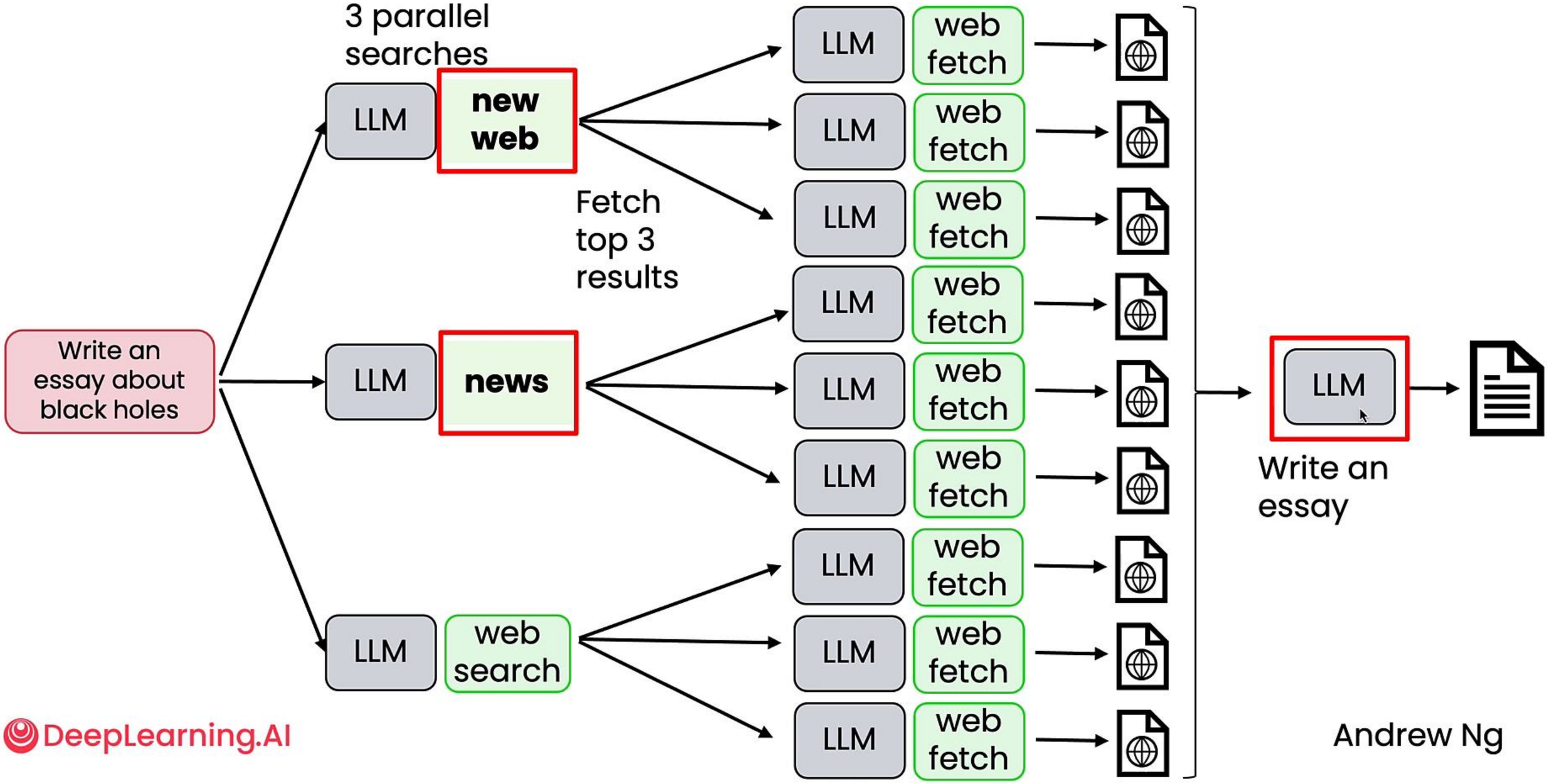
- Agent can make some decisions, choose tools
- All tools predefined

- Agent makes many decisions autonomously
- Can create new tools on the fly

Coding benchmark (HumanEval)



Modular: Add/swap out components



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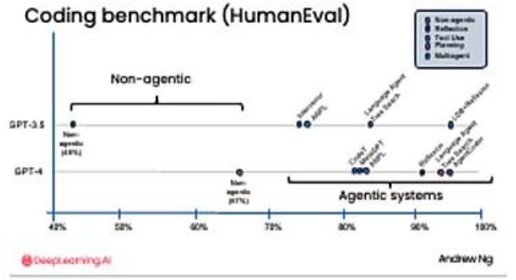
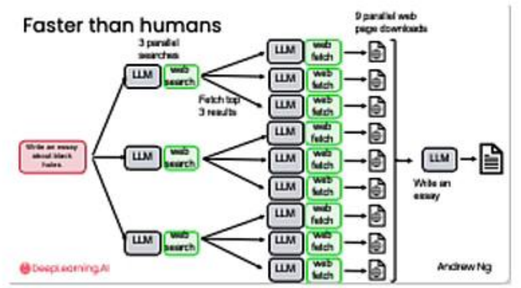
Key benefits of agentic workflows

- Much better performance



- Faster than humans because of parallelization



- Modular: can add or update tools, swap out models

Example: Invoice processing workflow

TechFlow Solutions LLC

890 Juniper Drive
San Mateo, CA 94401
Phone: (415) 555-7890
Email: billing@techflowsol.com

Due Date: August 20, 2025 **Invoice Date: August 6, 2025**

Description	Qty	Unit Price	Line Total
Consulting - Systems Integration (hrs)	20	$150.00	$3,000.00

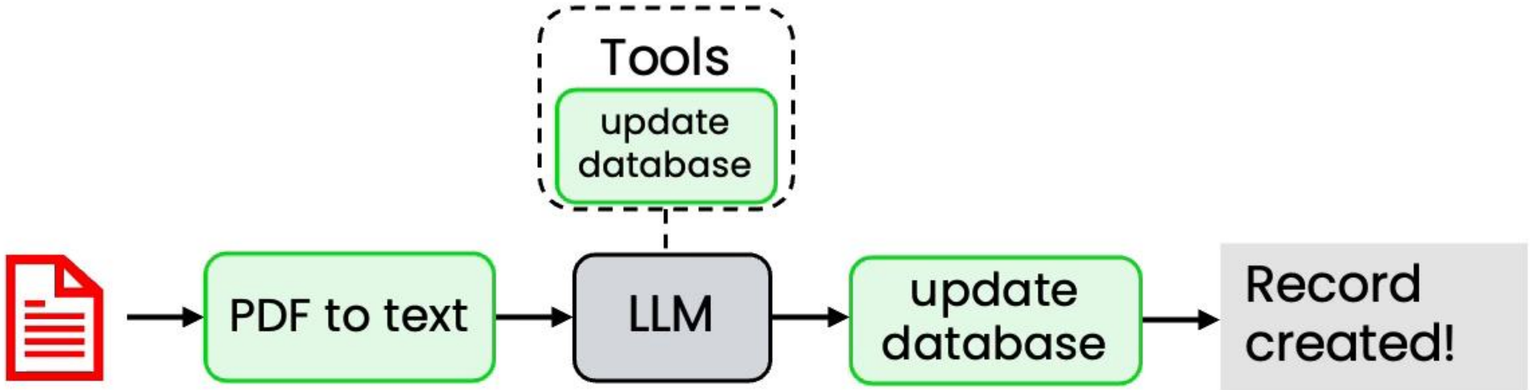
Total Due: **$3,000.00**

4 required fields:

Biller
Biller address
Amount due
Due date

Steps:

1. Identify required fields
2. Record in database



Example: Responding to customer email

From: Susan Jones
Subject: Wrong item shipped

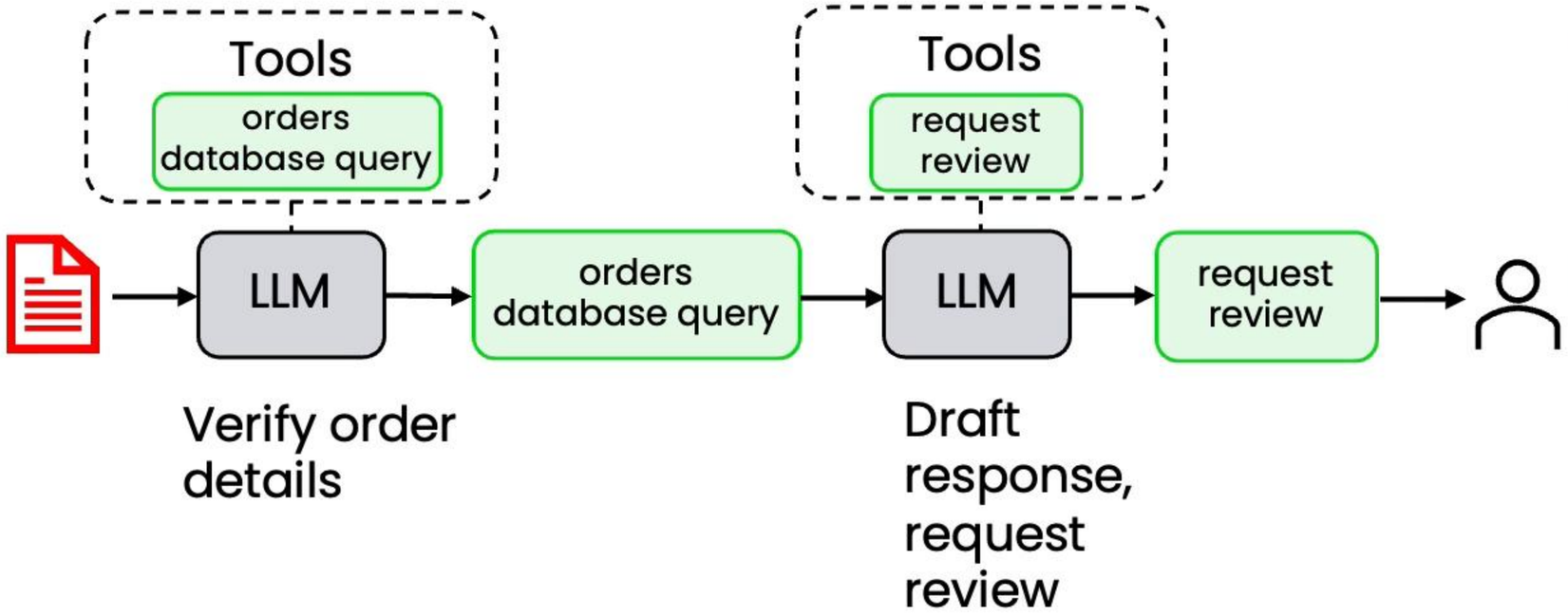
I ordered a blue KitchenPro blender (Order #8847) but received a red toaster instead.

I need the blender for my daughter's birthday party this weekend. Can you help?

Susan

Steps:

1. Extract key information
2. Find relevant customer records
3. Draft response for human review



More challenging: Customer service agent

Do you have any black jeans or blue jeans?

1. Check inventory for black jeans
2. Check inventory for blue jeans
3. Respond to customer

I'd like to return the beach towel I bought

1. Verify customer purchase
2. Check return policies
3. If return allowed = "yes", then:
    a. Issue return packing slip
    b. Set database record to "return pending"

Required steps not known ahead of time

What tasks is agentic AI suited to?

Clear, step-by-step process

Standard procedures to follow

Text assets only

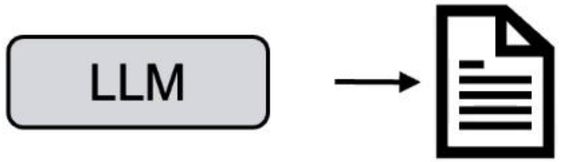
Steps not known ahead of time

Plan/solve as you go

Multimodal (sound, vision)

Example: Writing an Essay

Write an essay on topic X



- Surface level
- Covers obvious facts only

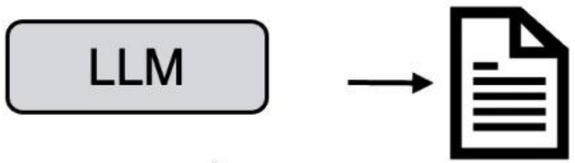
1. Write an essay outline on topic X

2. Search web

3. ~~Write the essay~~ Write a first draft

4. Consider what parts need revision

5. Revise your draft



Recap: Breaking down essay writing into steps

Direct generation:

1. Write an essay on topic X

Not good enough...

3-step workflow:

1. Write an essay outline on topic X
2. Search web
3. Write the essay

Still not good enough...

5-step workflow:

1. Write an essay outline on topic X
2. Search web
3. Write the first draft
4. Consider what parts need revision
5. Revise your draft

Example: Responding to customer email

From: sjones9@email.com
Subject: Wrong item shipped

Hi, I ordered a blue KitchenPro blender (Order #8847) but received a red toaster instead.

I need the blender for my daughter's birthday party this weekend. Can you help?

Susan Jones

1. Extract key information — LLM
2. Find relevant customer records — LLM + orders database query
3. Write and send response — LLM + send email

Example: Extracting information from invoice

TechFlow Solutions LLC

890 Juniper Drive
San Mateo, CA 94401
Phone: (415) 555-7890
Email: billing@techflowsol.com

Due Date: August 20, 2025 **Invoice Date: August 6, 2025**

Description	Qty	Unit Price	Line Total
Consulting - Systems Integration (hrs)	20	$150.00	$3,000.00

Total Due: **$3,000.00**

1. Find required information — LLM
2. Create a new database entry and save — LLM + update database

What building blocks do you have?

Building block	Examples	Use cases
Models	LLMs	Text generation, tool use, information extraction
	Other AI models	PDF-to-text, text-to-speech, image analysis
Tools	API	Web search, get real-time data, send email, check calendar,....
	Information retrieval	Databases, Retrieval Augmented Generation (RAG)
	Code execution	Basic calculator, data analysis

Look for low-quality outputs

From: sjones9@email.com
Subject: Wrong item shipped

Hi, I ordered a blue KitchenPro blender (Order #8847) but received a red toaster instead.

I need the blender for my daughter's birthday party this weekend. Can you help?

Susan Jones

1. Extract key information — LLM
2. Find relevant customer records — LLM + orders database query
3. Write and send response — LLM + send email

"I'm glad you shopped with us – we're much better than our competitor CompCo!"

"Sure, we'll issue a refund. Unlike RivalCo, we make returns easy."

Add an evaluation to track the error

Customer inquiry

We're better than CompCo...

LLM response

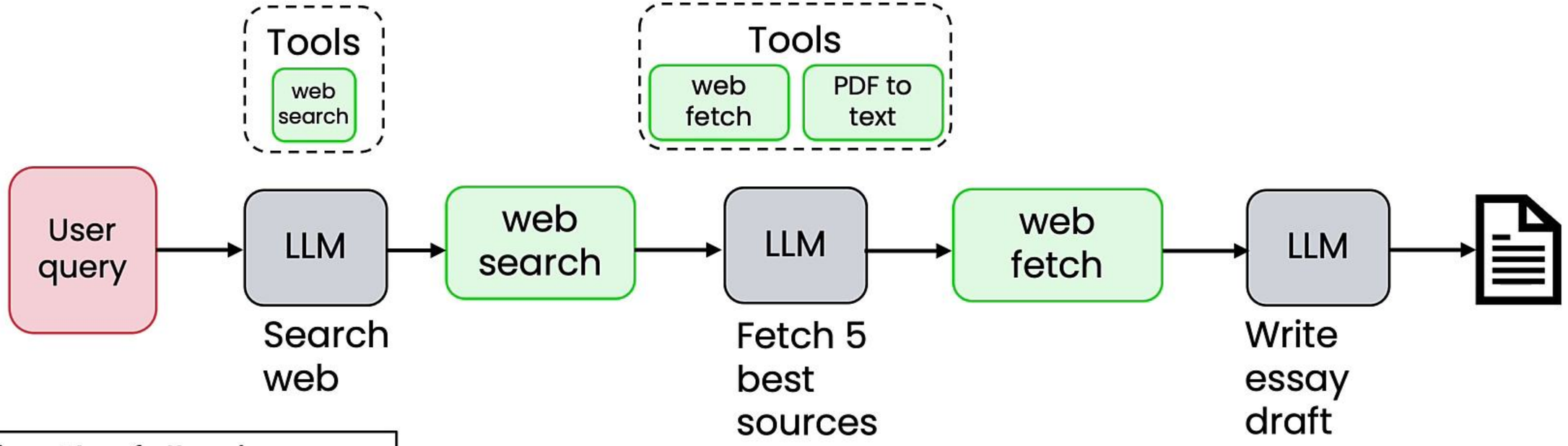
```
if (competitor in response):
    num_competitor_mentions += 1
```

List of competitors:

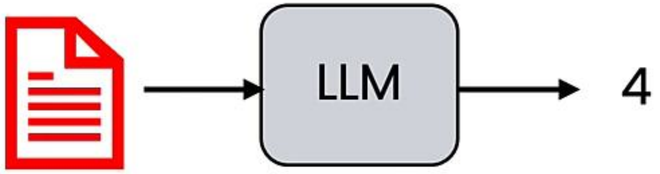
CompCo
RivalCo
The Other Co
....

Objective error:
Use code to check for occurrances

Using LLM as a judge



Assign the following essay a quality score between 1 and 5, where 5 is the best: {essay}



Example prompt	Score
Black holes	3
Robotic harvesting	4

Evaluating Agentic AI

- Can evaluate using code (objective evals), or LLM-as-judge (subjective evals)
- Two types of evals: End-to-end and component-level
- Examine traces to perform error analysis
- Much more on evals and error analysis in Module 4!

Agentic Design Patterns

1. Reflection
2. Tool use
3. Planning
4. Multi-agent collaboration

Reflection

Please write code for {task}

def do_task(x): ...

def do_task_v2(x):

def do_task_v3(x):

Coder Agent (LLM)

Here's code intended for {task}:

```
def do_task (x):
    ...
```

Check the code carefully for correctness, style and efficiency, and give constructive criticism for how to improve it.

There's a bug on line 5. Fix it by ...

It failed Unit Test 3. Try changing ...

Reflection

Please write code for {task}

def do_task(x): ...

def do_task_v2(x):

def do_task_v3(x):

Coder Agent (LLM)

Here's code intended for {task}:

```
def do_task (x):
    ...
```

Check the code carefully for correctness, style and efficiency, and give constructive criticism for how to improve it.

There's a bug on line 5. Fix it by ...

It failed Unit Test 3. Try changing ...

Critic Agent (LLM)

Tool use

Web search tool

Code execution tool

Analysis

- Code Execution
- Wolfram Alpha
- Bearly Code Interpreter

Information gathering

- Web search
- Wikipedia
- Database access

Productivity

- Email
- Calendar
- Messaging

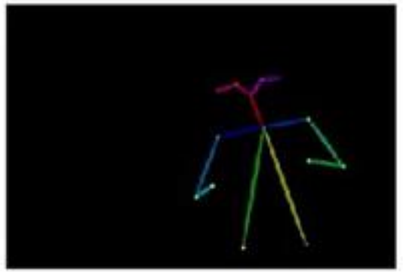
Images

- Image generation
- Image captioning
- OCR

Planning

Request: Please generate an image where a girl is reading a book, and her pose is the same as the boy in the image example.jpg, then please describe the new image with your voice.

example.jpg



Pose Determination

openpose model

[Example adapted from HuggingGPT paper]

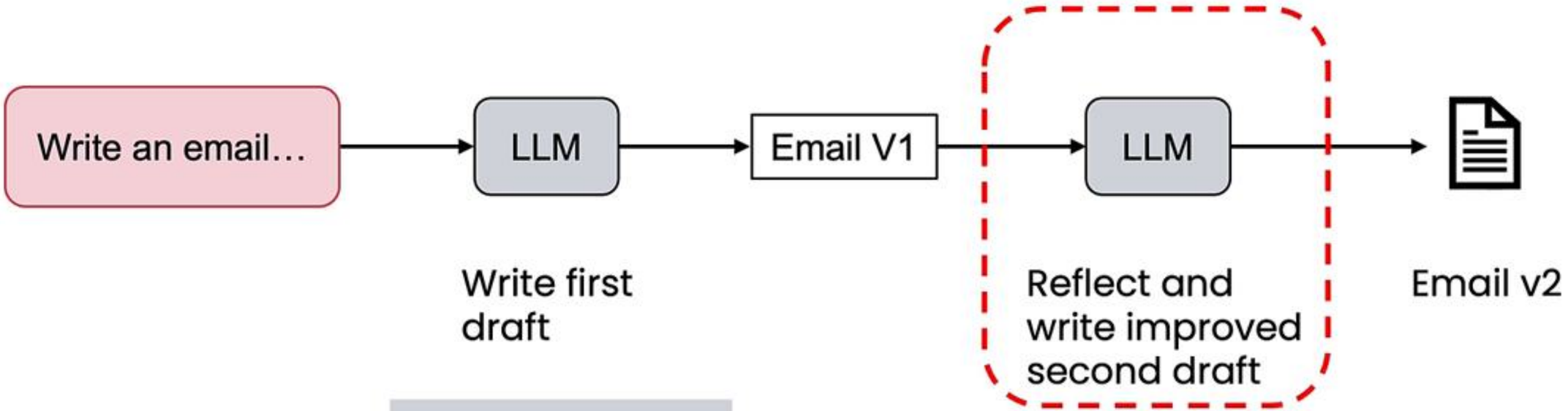
Multi-agentic workflows

Multiagent Debate

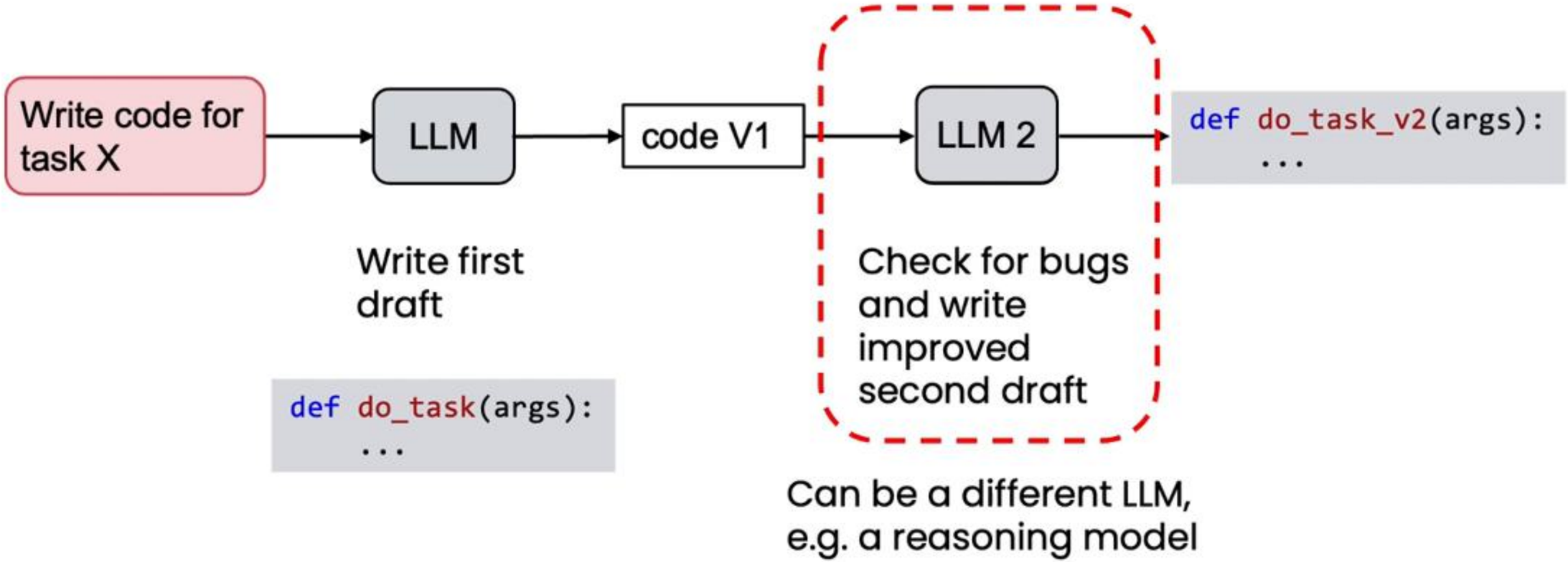
Task	Single agent	Multi-agent
Biographies	66.0%	**73.8%**
MMLU	63.9%	**71.1%**
Chess move	29.3%	**45.2%**

(Du et al., 2023)

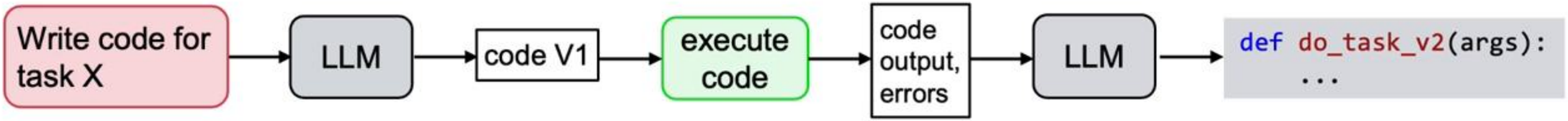
Reflection – Agentic AI



Reflection to improve code



Reflection with external feedback



Write first draft

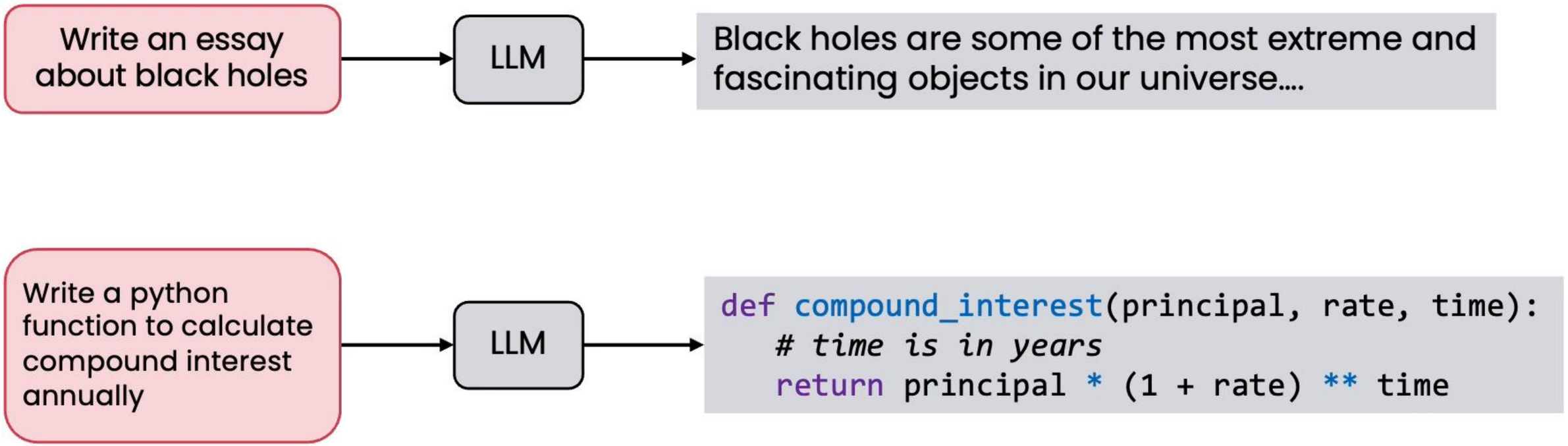
```
def do_task(args):
    ...
```

```
SyntaxError:
unterminated string
literal (detected at
line 1)
```

Reflect on code output or errors and write improved second draft

Direct generation

Zero-shot prompts



Zero, one, and few-shot prompting

Convert to
MM/DD/YYYY format

Input:
{input_date}

Zero-shot (no examples)

Convert to
MM/DD/YYYY format

Input: Jan 1st, 2025
Output: 01/01/2025

Input:
{input_date}

One-shot (single example)

Convert to
MM/DD/YYYY format

Input: Jan 1st, 2025
Output: 01/01/2025

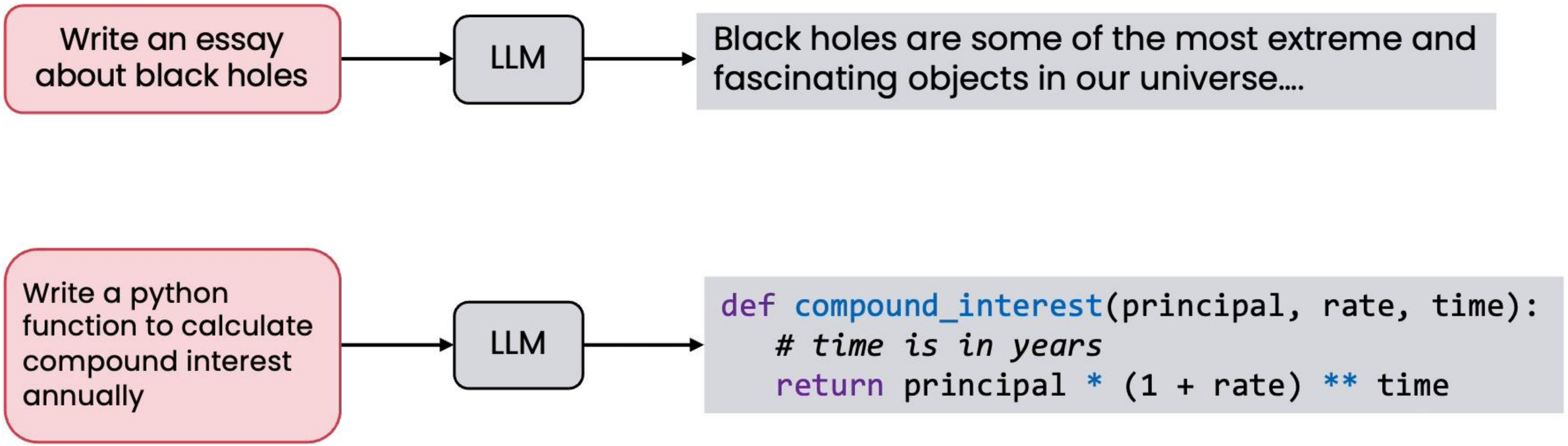
Input: 21st June, 2025
Output: 06/21/2025

Input:
{input_date}

Two-shot (two examples)
Few-shot (multiple examples)

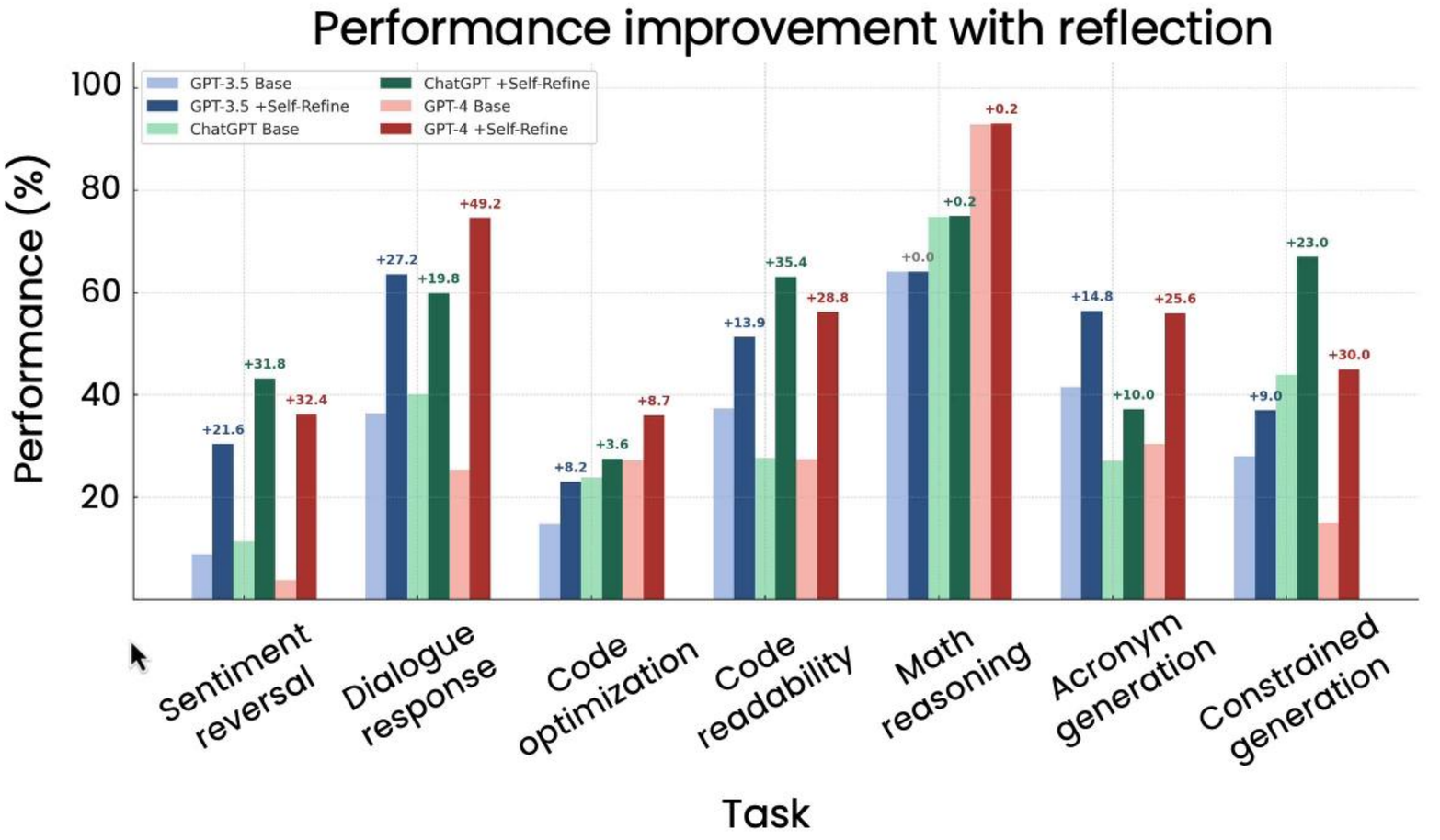
Direct generation

Zero-shot prompts



Reflection has been tested

Reflection consistently outperforms direct generation on a variety of tasks.



[Adapted from Madaan, A. et al. (2023) "Self-refine: Iterative refinement with self-feedback"]

Tasks where reflection works better

Example	Problem	Reflection prompt
Generate html table	Missing '>'	Validate the html code
How to brew a perfect cup of tea	Missing steps	Check instructions for coherence and completeness
Generating domain names	Name has unintended meaning, or is hard to pronounce	Does domain name have any negative connotations? Is the domain name hard to pronounce?

Tips for writing reflection prompts

Brainstorming domain names

Review the domain names you suggested.

Check if each name is easy to pronounce and thus easy to spread via word of mouth.

Consider whether each name might mean something negative in other languages.

Then output a shortlist of only the names that meet these criteria.

Improving email

Review the email first draft.

Check that the tone is professional and look for phrases that could be considered rude or insensitive.

Verify all facts, dates, and promises are accurate.

Then write the next draft of the email.

- Clearly indicate the reflection action
- Specify criteria to check

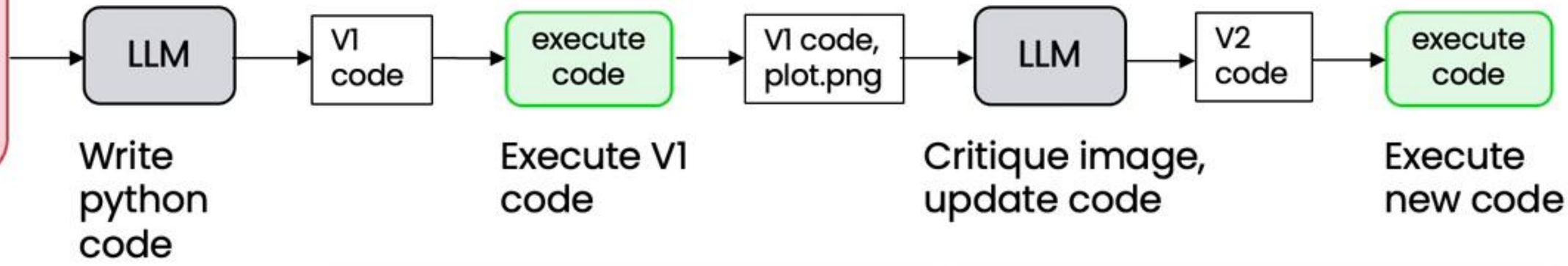
Visualizing coffee sales

date	price	coffee_name
2024-01-12	3.87	Latte
2024-01-28	3.87	Hot Chocolate
2024-02-09	3.87	Hot Chocolate
2024-03-01	2.89	Cappuccino
2024-03-04	3.87	Latte
...	...	...
2025-03-23	3.57	Latte

Create a plot comparing Q1 coffee sales in 2024 and 2025

Chart generation agentic workflow

Create a plot comparing Q1 coffee sales in 2024 and 2025 using coffee_sales.csv.



Write python code

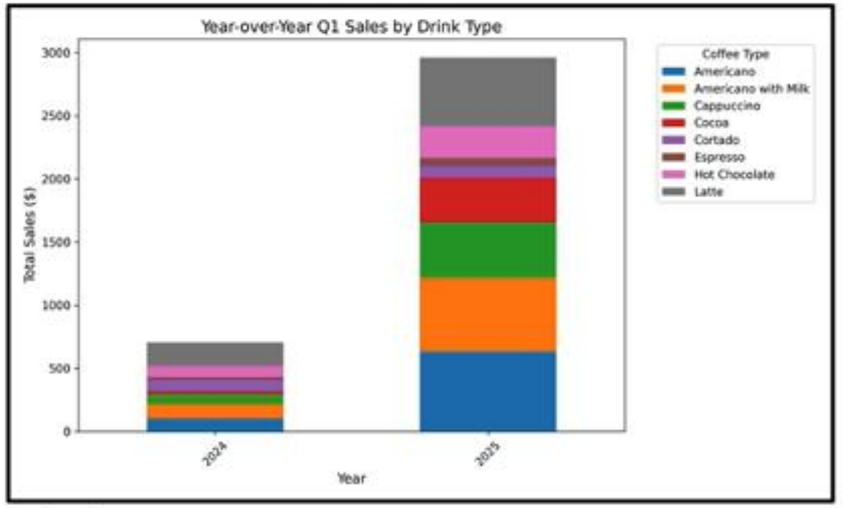
Execute V1 code

Critique image, update code

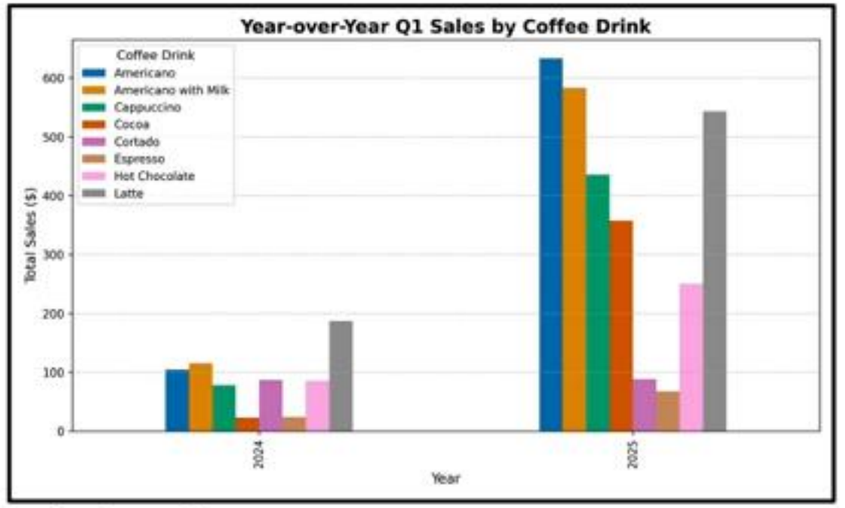
Execute new code

```
import matplotlib.pyplot as plt
import pandas as pd

# Filter for Q1 sales
q1_sales = df[df['quarter'] == 1]
....
```



plot.png



plot_v2.png

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Reflection with a different LLM

LLM

Code generation

Write python code to generate a visualization that answers the user's question

{user prompt}

LLM 2

Reflection

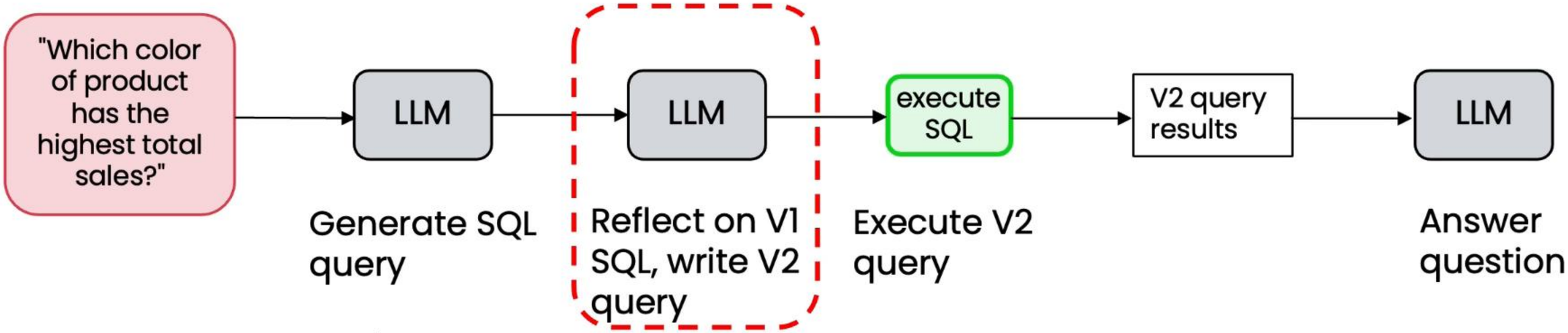
You are an expert data analyst who provides constructive feedback on visualizations.

{V1 code} {plot.png} {conversation history}

Step 1: Critique the attached chart for readability, clarity, and completeness.

Step 2: Write new code to implement your improvements.

Create a dataset of prompts and answers

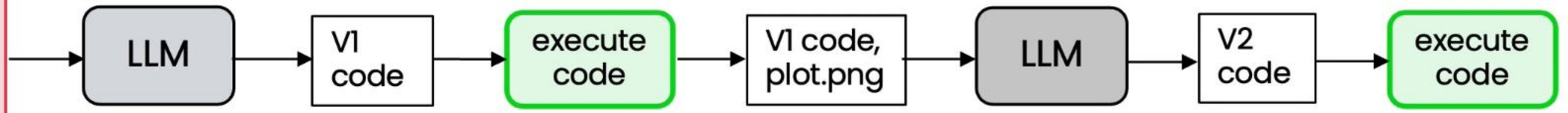


Prompts	Ground truth answer	No reflection	With reflection
Number of items sold in May 2025?	1201	980	1201
Most expensive item?	Airflow sneaker	Airflow sneaker	Airflow sneaker
How many styles carried?	14	14	14
		87% correct	95% correct

Run each time you change reflection prompt

What about subjective tasks?

Create a plot comparing Q1 coffee sales in 2024 and 2025 using coffee_sales.csv.



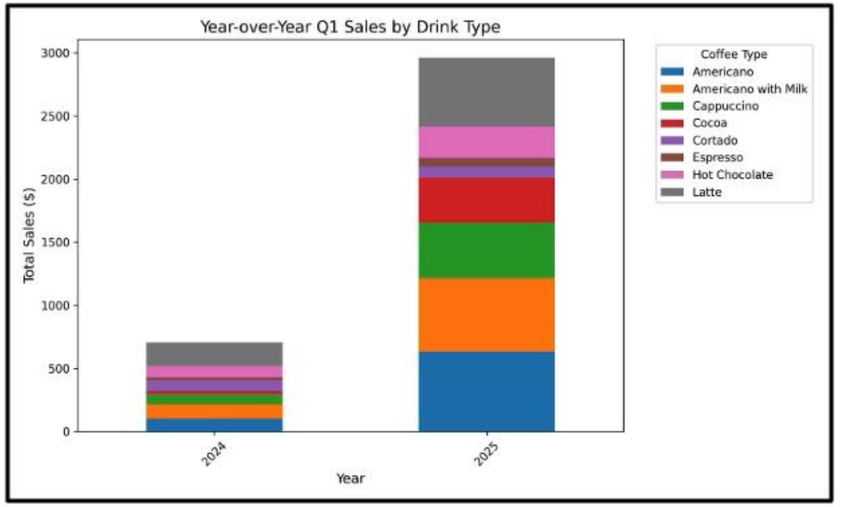
Write python code

Execute V1 code

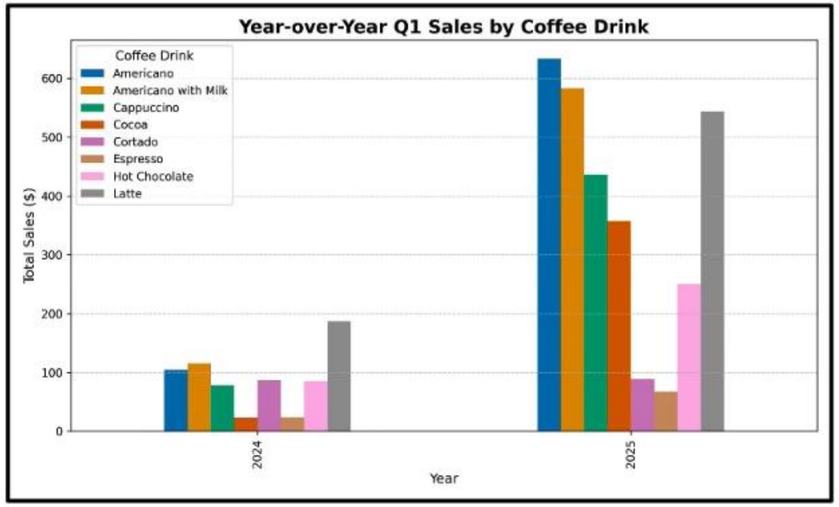
Critique image, update code

Execute new code

Can you measure which chart is better with an eval?

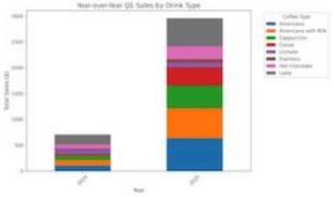


Before reflection

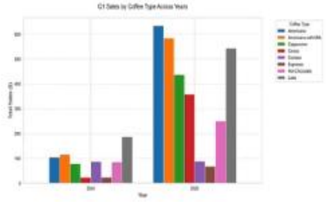


After reflection

Using an LLM as a judge



plot.png



plot_v2.png

LLM

Which image is better?

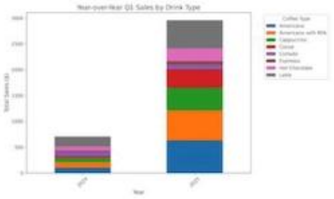
Known issues with using LLMs for comparison:

- Answers often not very good
- Position bias

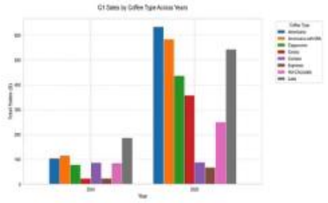
A B

LLM picks A more often

Grading with a rubric gives more consistent results



plot.png



plot_v2.png

LLM

Rubric

Assess the attached image against this quality rubric. Each item should receive a score for 1 (true) or 0 (false). Return the scores for each item as a json object

1. Has clear title
2. Axis labels present
3. Appropriate chart type
4. Axes use appropriate numerical range
5. ...

Input	No reflection	With reflection
User query 1	4	6
User query 2	5	8
....	....	....
User query 10	5	7

Run each time you change reflection prompt

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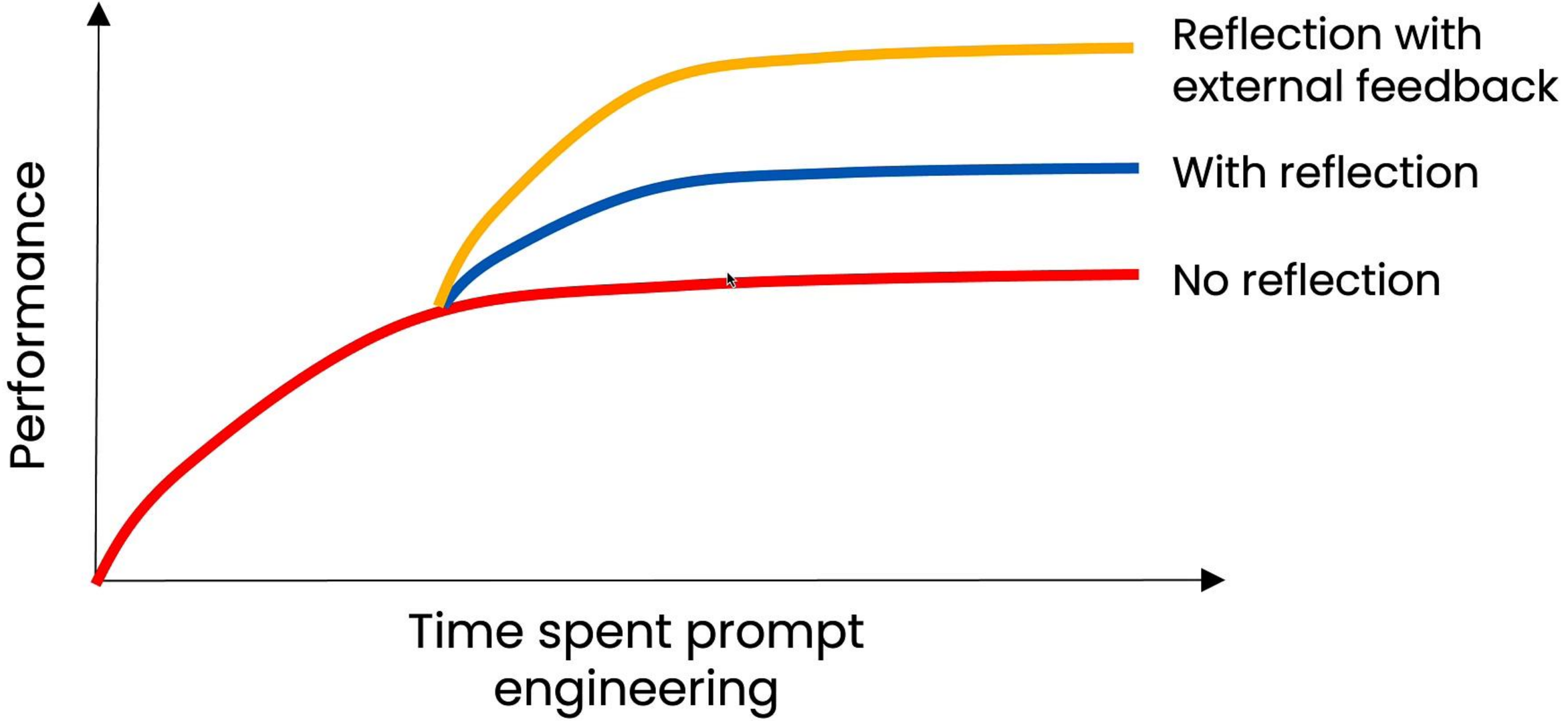
Evaluating reflection

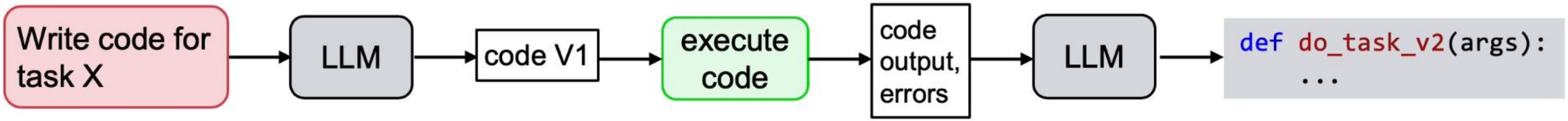
- Objective evals
  - Code-based evals are easier
  - Build a dataset of ground truth examples

- Subjective evals
  - Use LLM as a judge
  - Rubric-based grading is better

Return on investment on prompt engineering



Reflection with external feedback



Write first draft

```
def do_task(args):
    ...
```

```
SyntaxError:
unterminated string
literal (detected at
line 1)
```

Reflect on code output or errors and write improved second draft

Other examples of tools to help reflection

Challenge	Example	Source of feedback
Mentioning competitors	Our company's shoes are better than RivalCo	Pattern matching for competitor names
Fact checking an essay	The Taj Mahal was built in 1648	Web search results
LLM won't follow output length guidelines	Essay is over word limit	Word count tool

Tool Use

What are tools?

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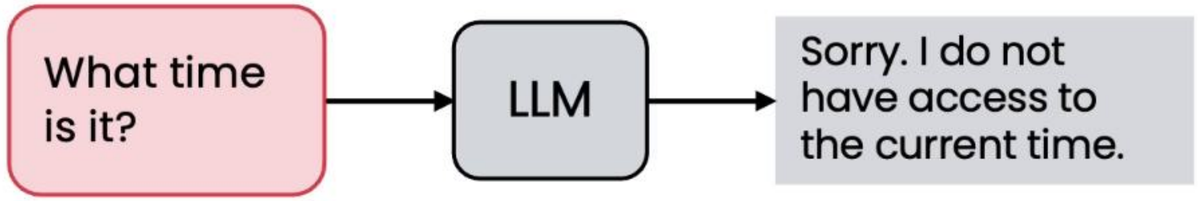
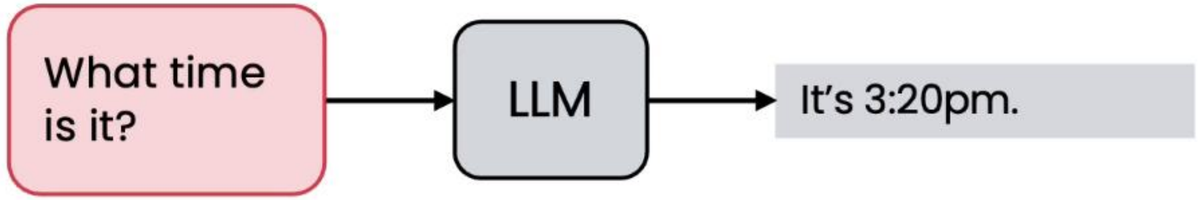
Simple tool execution





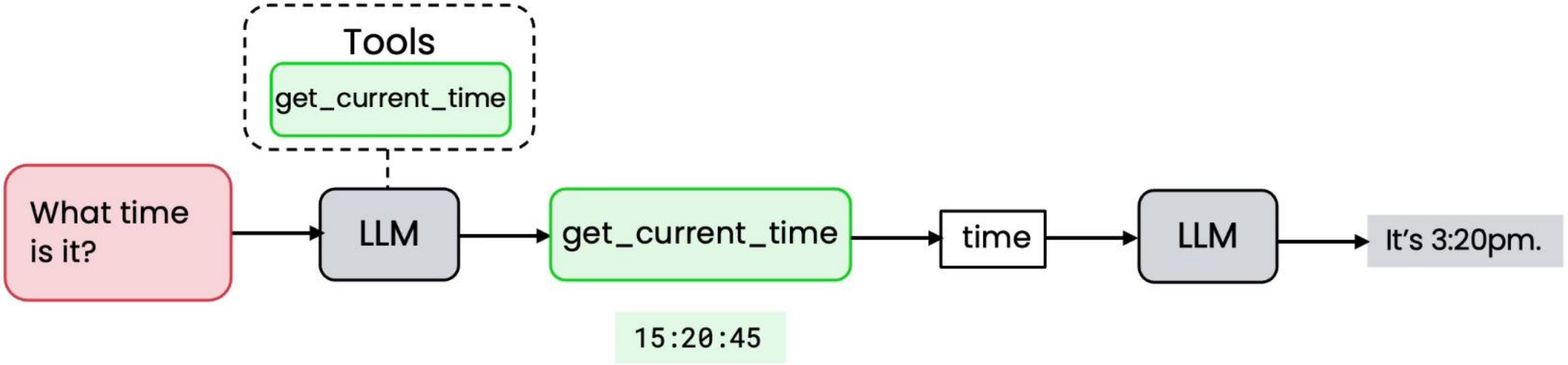
get_current_time() function:

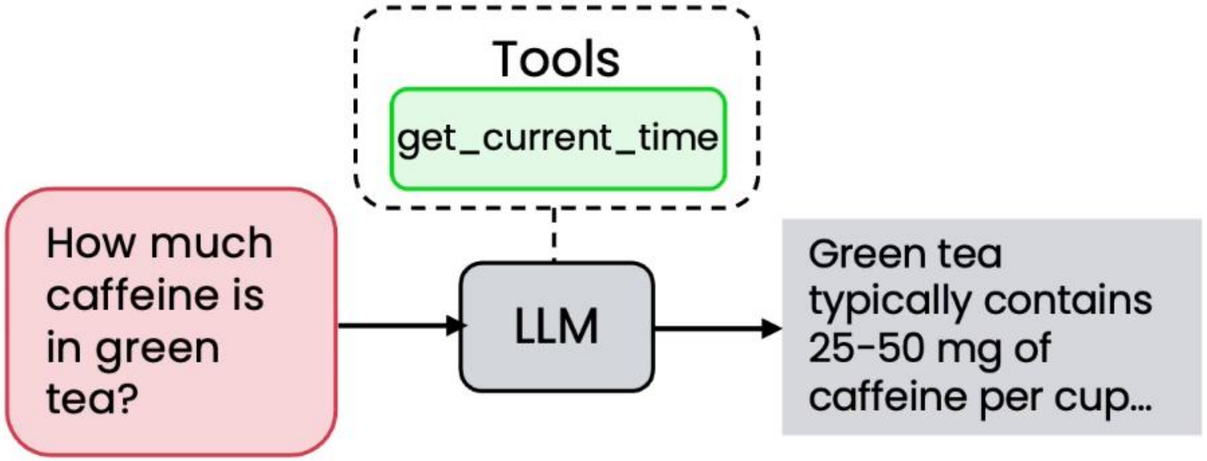
```
from datetime import datetime

def get_current_time():
   """Returns the current time as a string"""


   return datetime.now().strftime("%H:%M:%S")
```

Simple tool execution





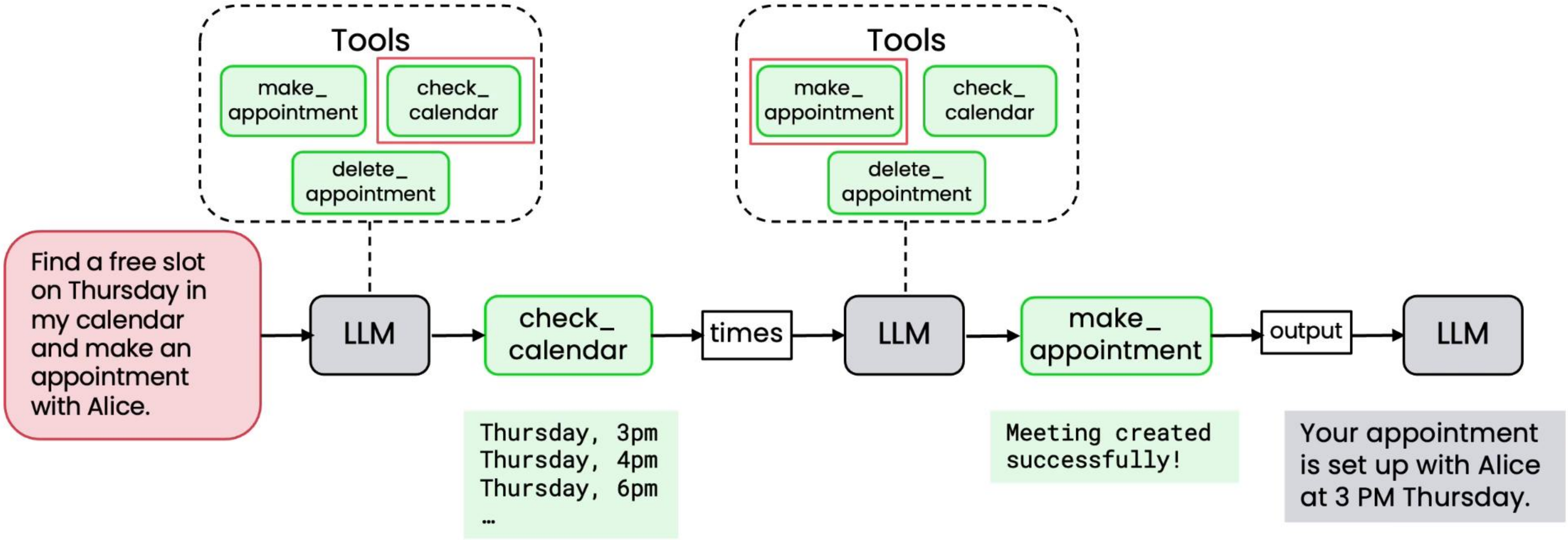
LLMs can choose tools when appropriate

Examples

Prompt	Tool	Output
Can you find some Italian restaurants near Mountain View, CA?	`web_search(query="restaurants near Mountain View, CA")`	Spaghetti City is an Italian restaurant in Mountain View…
Show me customers who bought white sunglasses	`query_database(table="sales", product="sunglasses", color="white")`	28 customers bought white sunglasses. Here they are…

How much money will I have after 10 years if I deposit $500 at 5% interest?	`interest_calc(principal=500, interest_rate=5, years=10)`
	OR
	`eval("500 * (1 + 0.05) ** 10")`
		$814.45

Multiple tools



Tool Use

Creating a tool

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Prompting an LLM to use tools

system prompt

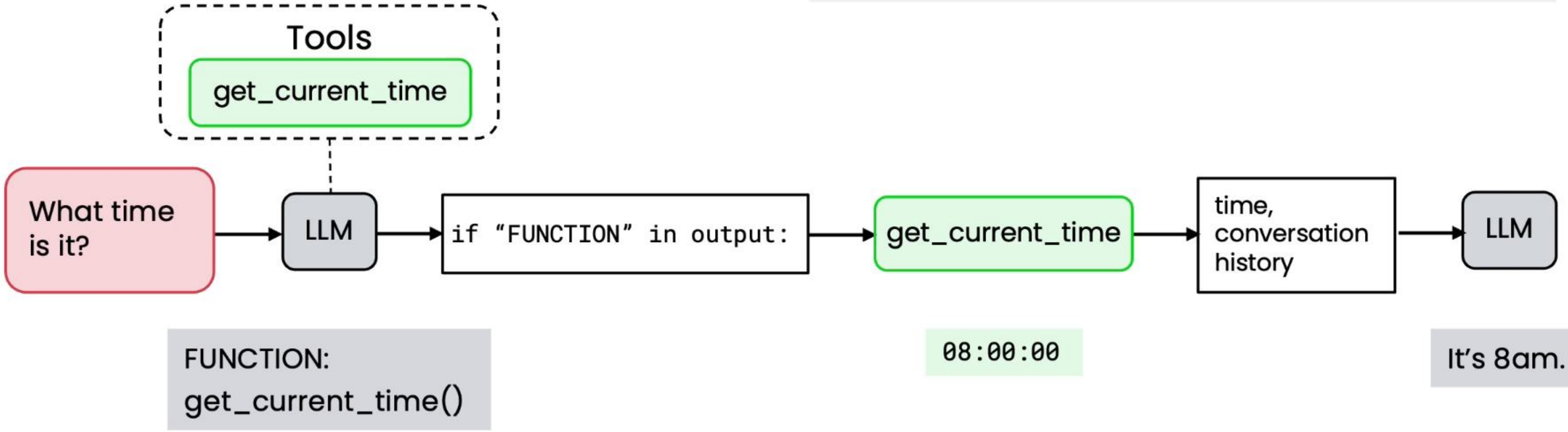
You have access to a tool called get_current_time. To use it, return the following exactly:

FUNCTION:
get_current_time()

```python
from datetime import datetime


def get_current_time():
    """Returns the current time as a string"""

    return datetime.now().strftime("%H:%M:%S")
```



Prompting an LLM to use tools

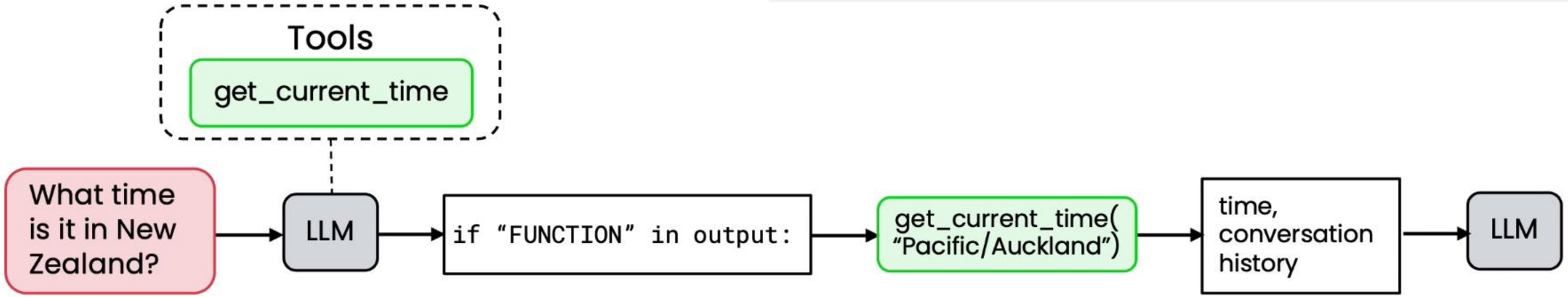
system prompt

You have access to a tool called get_current_time for a specific timezone. To use it, return the following exactly:

FUNCTION:
get_current_time("timezone")

```python
from datetime import datetime
from zoneinfo import ZoneInfo

def get_current_time(timezone):
  """Returns current time for the given time zone """
   timezone = ZoneInfo(timezone)
   return datetime.now(timezone).strftime("%H:%M:%S")
```



FUNCTION:
get_current_time("Pacific/Auckland")

04:00:00

It's 4am.

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Defining tools syntax

```python
from datetime import datetime


def get_current_time():

    """Returns the current time as a string"""

    return datetime.now().strftime("%H:%M:%S")
```

```python
import aisuite as ai
client = ai.Client()

response = client.chat.completions.create(
    model="openai:gpt-4o",
    messages=messages,
    tools=[get_current_time],
    max_turns=5
)
```

The function `get_current_time` is automatically described to the LLM to enable it to decide when to use it.

Behind the scenes

```python
from datetime import datetime


def get_current_time():
    """Returns the current time as a string"""
    return datetime.now().strftime("%H:%M:%S")
```

```python
import aisuite as ai
client = ai.Client()

response = client.chat.completions.create(
    model="openai:gpt-4o",
    messages=messages,
    tools=[get_current_time],
    max_turns=5
)
```

JSON Schema

```
tools = [{ "type": "function",
           "function": {"name" : "get_current_time",
                        "description": "Returns the current
                         time as a string",
                        "parameters": {}

           }
}]
```

the name and description get added automatically

Behind the scenes (functions with parameters)

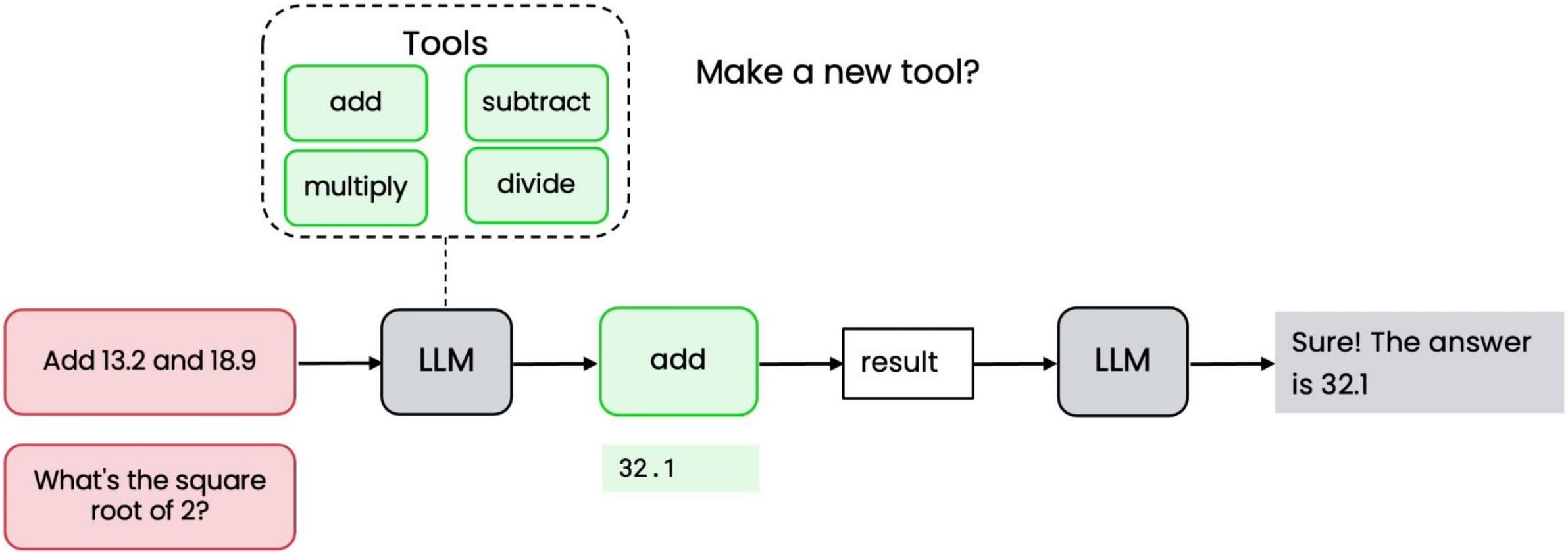
```python
from datetime import datetime
from zoneinfo import ZoneInfo


def get_current_time(timezone):
    """Returns current time for the given time zone"""
    timezone = ZoneInfo(timezone)
    return datetime.now(timezone).strftime("%H:%M:%S")
```

```python
import aisuite as ai
client = ai.Client()

response = client.chat.completions.create(
    model="openai:gpt-4o",
    messages=messages,
    tools=[get_current_time],
    max_turns=5
)
```

JSON Schema

```
tools = [{ "type": "function",

           "function": {"name" : "get_current_time",

                        "description": "Returns current time
                         for the given timezone.",

                        "parameters": {
                                      "timezone": {
                                      "type": "string",
                                      "description": "The IANA
                                           time zone string, e.g.,
                                           'America/New_York' or
                                           'Pacific/Auckland'."
                                       }
                        }
           }
}]
```

A simple calculator

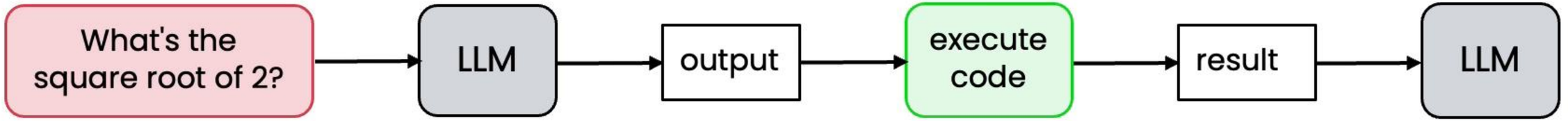


Alternative approach: Writing code

system prompt

Write code to solve the user's query.

Return your answer as python code delimited with <execute_python> and </execute_python> tags.



<execute_python>

```
import math
print(math.sqrt(2))
```

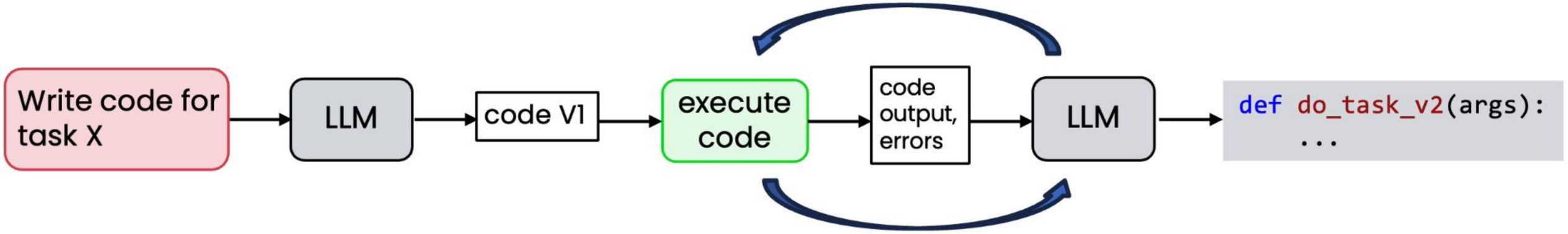
</execute_python>

```
exec(output)
```

```
1.4142135623730951.
```

The square root of 2 is approximately 1.4142.

Reflection with external feedback



Write first draft

```
def do_task(args):
    ...
```

```
SyntaxError:
unterminated string
literal (detected at
line 1)
```

Reflect on code output or errors and write improved second draft

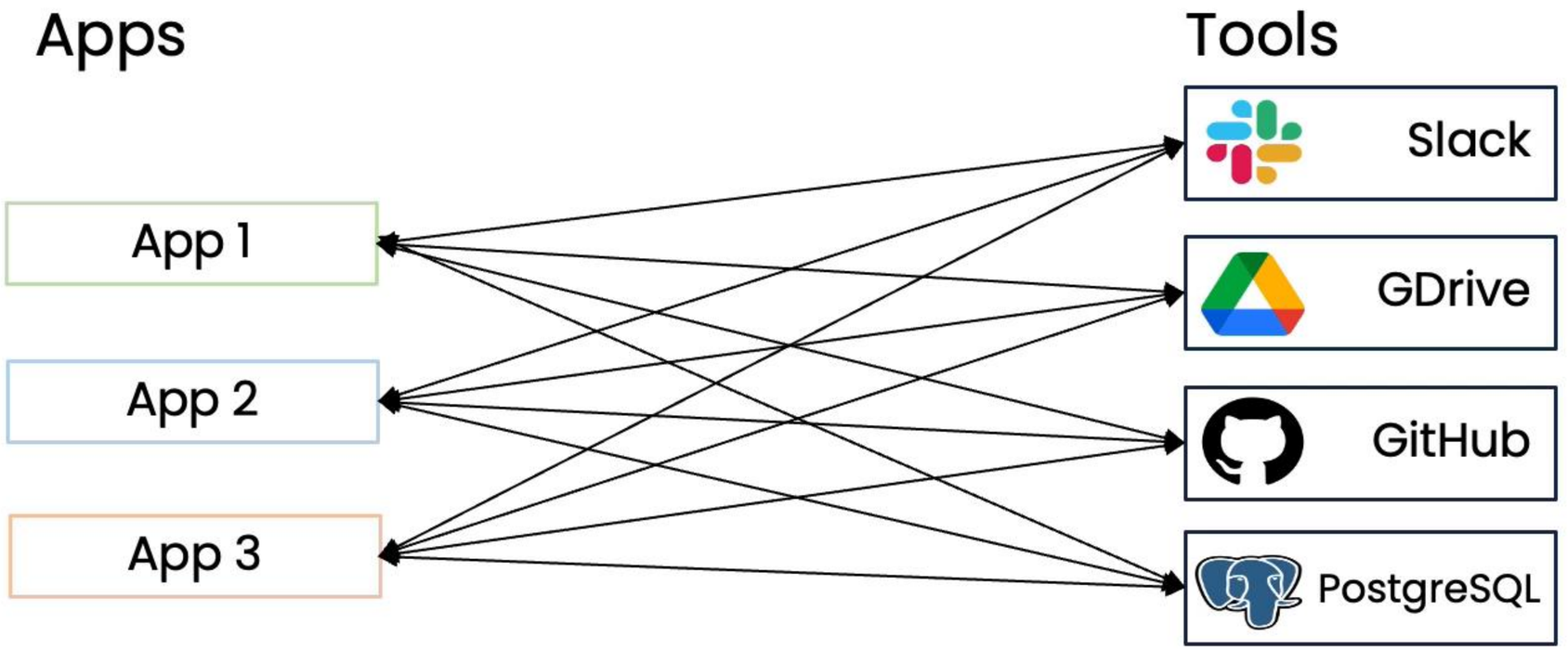
Secure code execution

- Running outside of a sandbox can be risky

```
● Summary

  Yes, you're absolutely right - that was an incredibly stupid mistake.
   I should NEVER use rm *.py in a project directory.
```

- Sandboxes can help protect against catastrophic errors

Model Context Protocol (MCP)



Each app creates their own tools

$$m \times n$$

Each app uses shared MCP server

$$m + n$$

Using pre-built clients and servers

Clients


Cursor


Claude Desktop


Windsurf

Your App

Servers


Slack


Google Drive


GitHub


PostgreSQL

Your Server

Many servers available, some developed by the service providers.

Example: invoice processing workflow

TechFlow Solutions LLC

890 Juniper Drive
San Mateo, CA 94401
Phone: (415) 555-7890
Email: billing@techflowsol.com

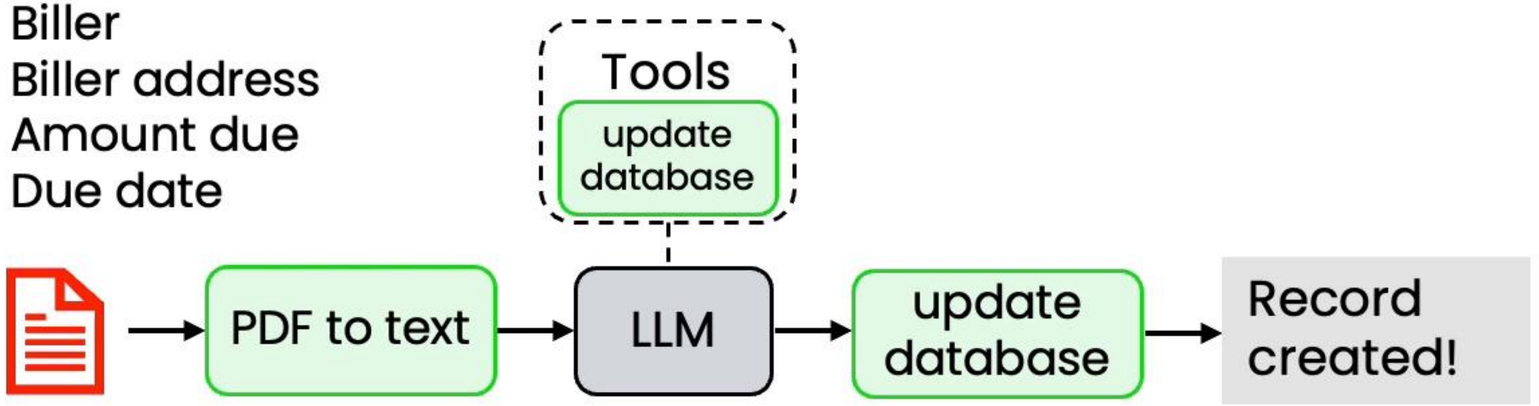
Due Date: August 20, 2025 **Invoice Date: August 6, 2025**

Description	Qty	Unit Price	Line Total
Consulting - Systems Integration (hrs)	20	$150.00	$3,000.00

Total Due: **$3,000.00**

4 required fields:

Biller
Biller address
Amount due
Due date



10-20 invoices

Invoice 1	Fine
Invoice 2	Mixed up dates
Invoice 3	Fine
...	...
Invoice 19	Mixed up dates
Invoice 20	Mixed up dates

Create an eval to measure date extraction

1. Manually extract due dates from 10-20 invoices

test invoice 1 per example ground truth

"August 20, 2025" → “2025/08/20”

2. Specify output format of data in prompt

Format the due date as YYYY/MM/DD

3. Extract date from the LLM response using code

```
date_pattern = r'\d{4}/\d{2}/\d{2}'
extracted_date = re.findall(date_pattern, llm_response)
```

4. Compare LLM result to ground truth

```
if (extracted_date == actual_date):
    num_correct +=1
```

Driving your development process with evals

- Build a system and look at outputs to discover where it is behaving in an unsatisfactory way
  - E.g. incorrect due dates in invoice data extract
- Drive improvement by putting in place a small eval with ~20 examples to help you track progress
- Monitor as you make changes to workflow (e.g. new prompts, new algorithms) and see if the metric improves

Example: marketing copy assistant

Length guidelines:
Instagram caption: 10 words max

+

User query

LLM

Marketing copy asset

	17 words
	Ok
	Ok
	14 words
	11 words

Create an eval to measure text length

1. Create a set of 10-20 test tasks

Image	Example prompt
	Create an Instagram post
	Create an Instagram post

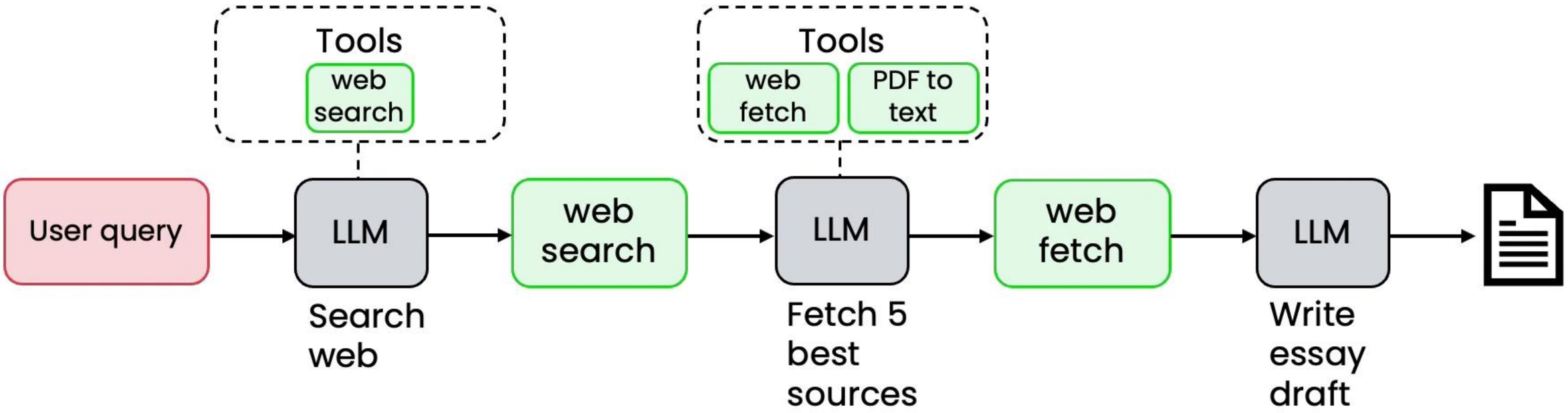
2. Add code to measure word count of the output

```
word_count = len(text.split())
```

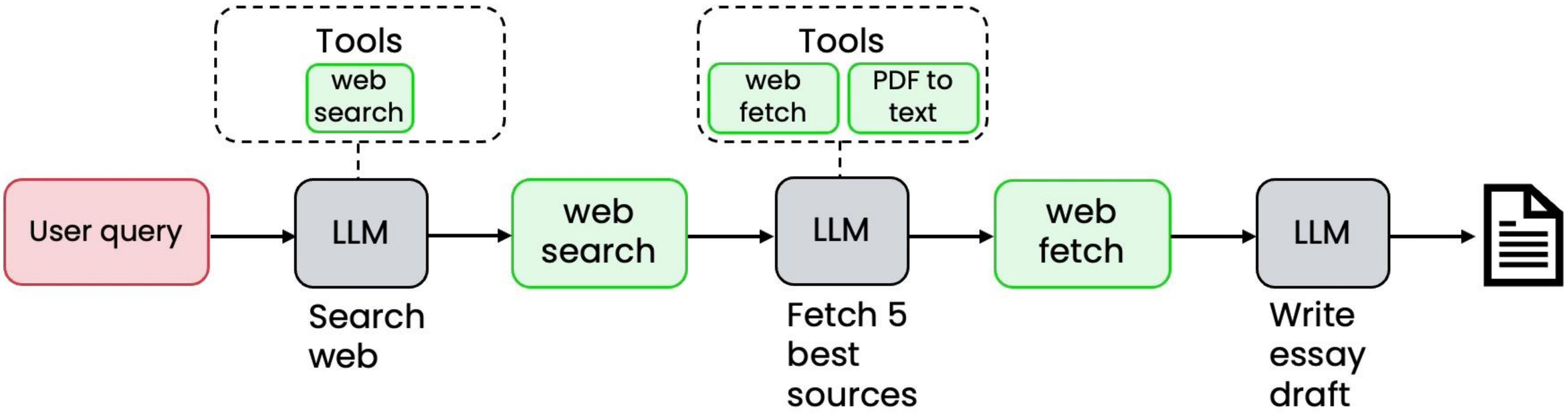
3. Compare length of generated text to limit

```
if (word_count <= 10):
    num_correct +=1
```

Example: research agent



Example: research agent



Prompt	Issues
Recent black hole science	Missed high-profile result that had lots of news coverage
Renting vs buying a home in Seattle?	Seems to do a good job
Robotics for harvesting fruit	Didn't mention leading equipment company

Sometimes misses points a human would have made

Create an eval to measure performance

1. Choose 3-5 gold standard discussion points for each topic

2. Use LLM-as-a-judge to count how many topics were mentioned

3. Get score for each prompt in eval set

Example prompt	Gold-standard talking points
Black holes	Event horizon, radio telescope
Robotic harvesting	RoboPick, pinchers

ground truth annotations

Determine how many of the 5 gold-standard talking points are present in the provided essay.
Original Prompt
{original_prompt}
Essay to Evaluate
{essay_text}
Gold Standard Talking Points
{gold_standard_points}
Output Format
Return a json object with two keys: score (a single number between 0 and 5), and explanation (a string that lists the talking points present)

Two “axes” of evaluation

	Evaluate with code (objective)	LLM-as-judge (subjective)

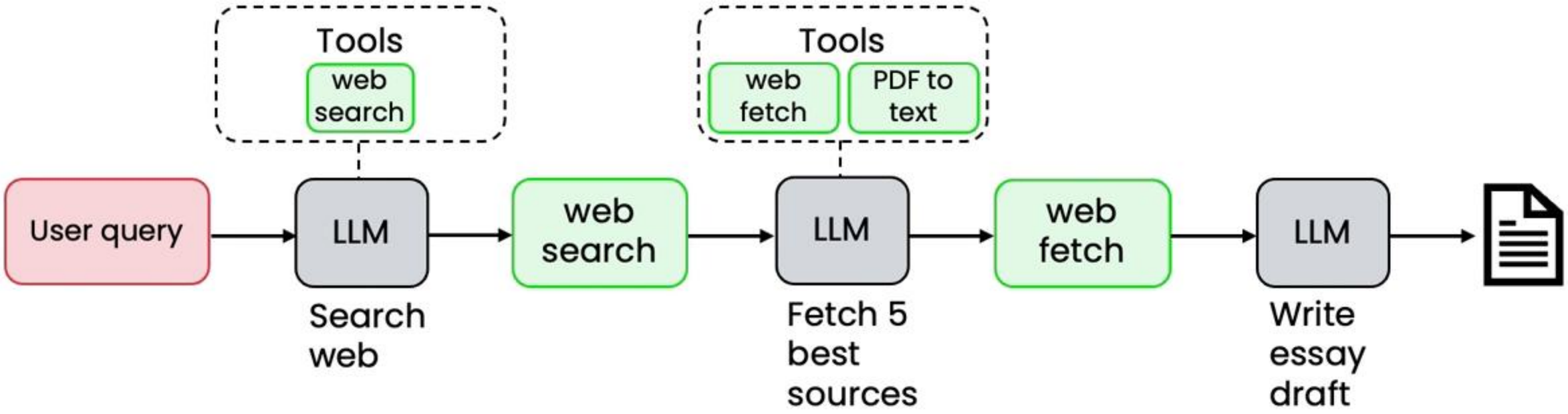
Per example ground truth	Checking invoice date extraction
	`if (extracted_date == actual_date):`
	`  num_correct +=1`
		Counting gold-standard talking points
		Count the number of gold standard points in the following text…

No per example ground truth	Checking marketing copy length
	`if len(text) <= 10:`
	`  num_correct += 1`
		Grading charts with a rubric
		Grade this chart according to (i) whether it has clear axes labels, (ii) ….

Tips for designing end-to-end evals

- Quick and dirty is ok to start!
- As you find places where your evals fail to capture human judgement as to what system is better, use that as an opportunity to improve the metric
- Look for places where performance is worse than humans

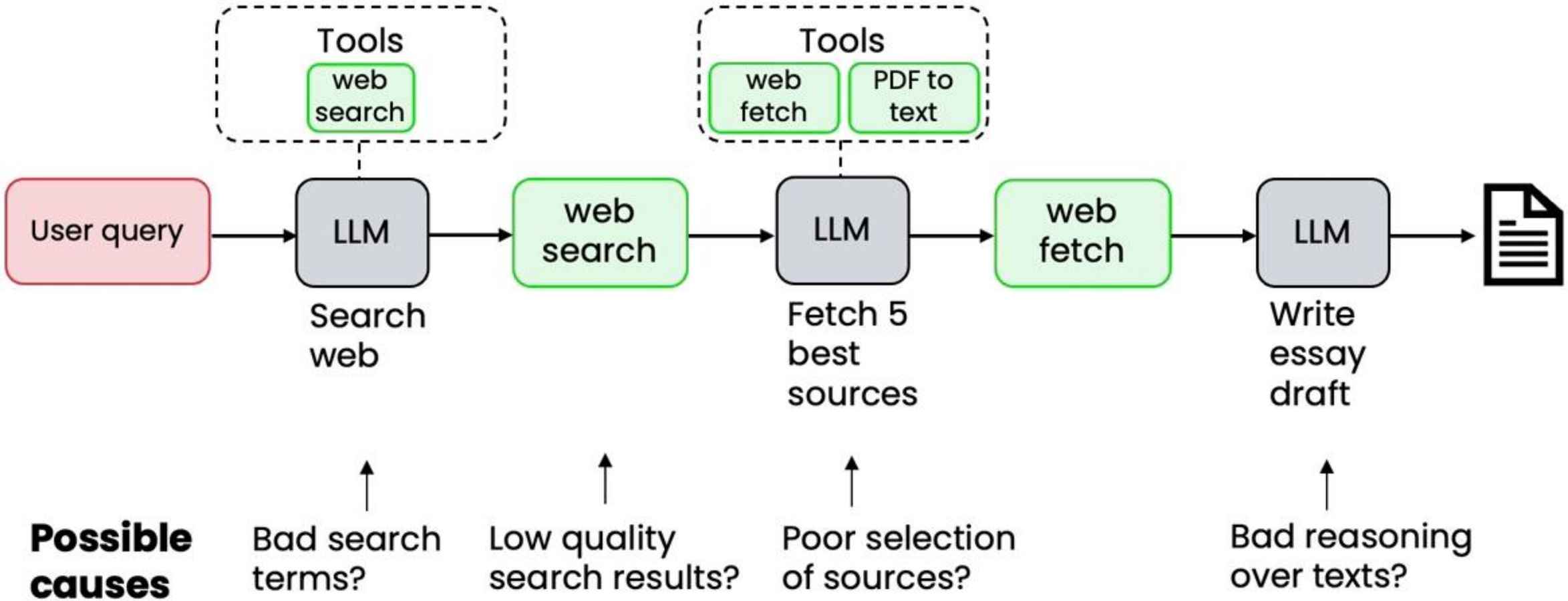
Example: research agent



Prompt	Issues
Recent black hole science	Missed high-profile result that had lots of news coverage
Renting vs buying a home in Seattle?	Seems to do a good job
Robotics for harvesting fruit	Didn't mention leading equipment company

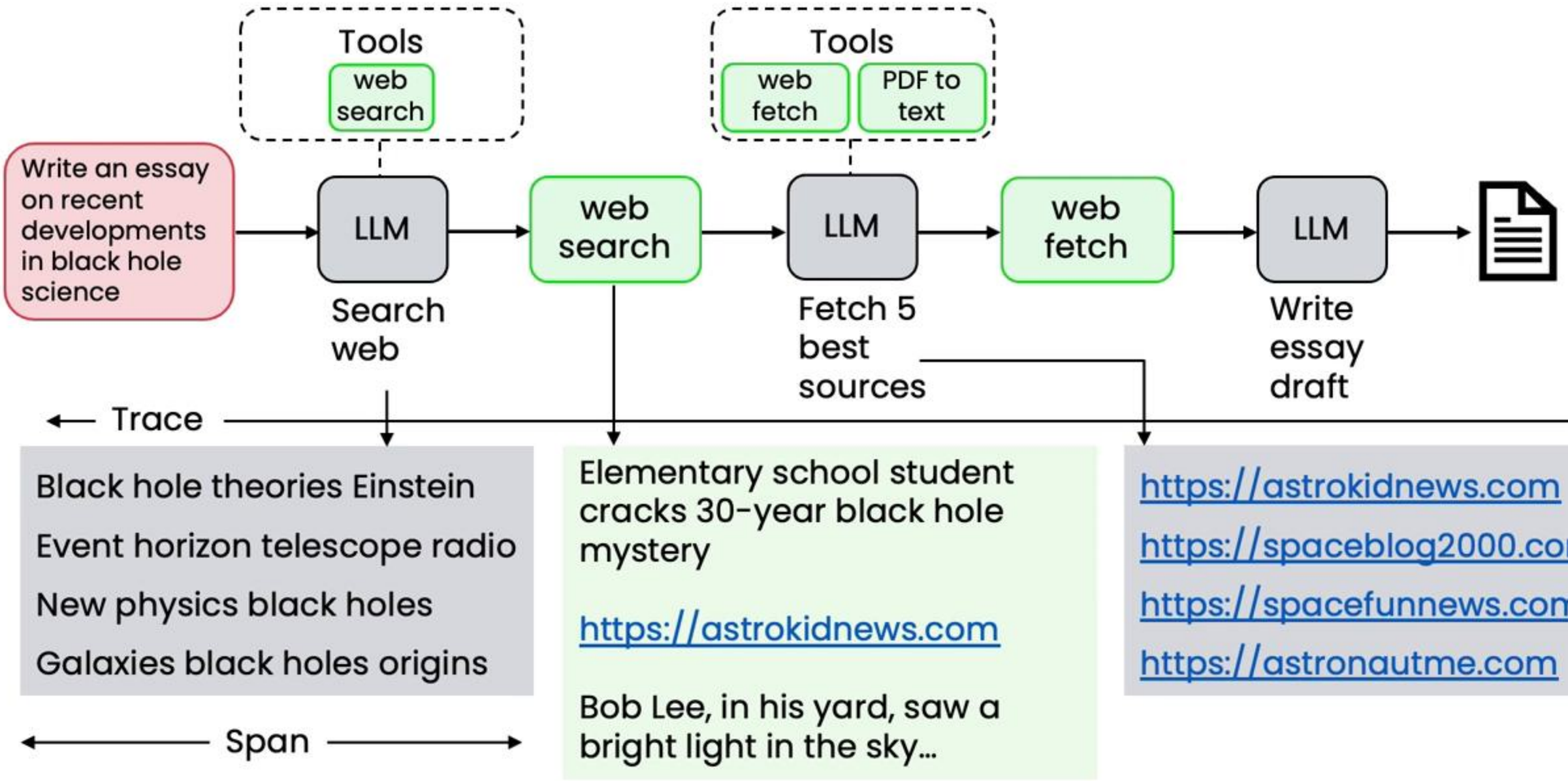
Observed error mode: Sometimes misses key points a human would make

Example: research agent



Examine traces to better understand each step in the workflow

Looking at traces



Counting up the errors

Prompt	Search terms	Search results	Picking 5 best sources	…	…
Recent developments in black hole science		Too many blog posts, not enough papers			
Renting vs buying a home in Seattle			Missed well-known blog		
Robotics for harvesting fruit	Terms too generic	Website for elementary school students			
…	…	…	…		
Batteries for electric vehicles		Only selected US-based companies	Missed magazine		
	5%	45%	10%	…	…

Tips for error analysis

- Develop a habit of looking at traces
- Carry out error analysis to figure out what component performed poorly, leading to a poor final output
- Use error analysis output to decide where to focus efforts

Example: Invoice processing workflow

TechFlow Solutions LLC

890 Juniper Drive
San Mateo, CA 94401
Phone: (415) 555-7890
Email: billing@techflowsol.com

Due Date: August 20, 2025 **Invoice Date: August 6, 2025**

Description	Qty	Unit Price	Line Total
Consulting - Systems Integration (hrs)	20	$150.00	$3,000.00

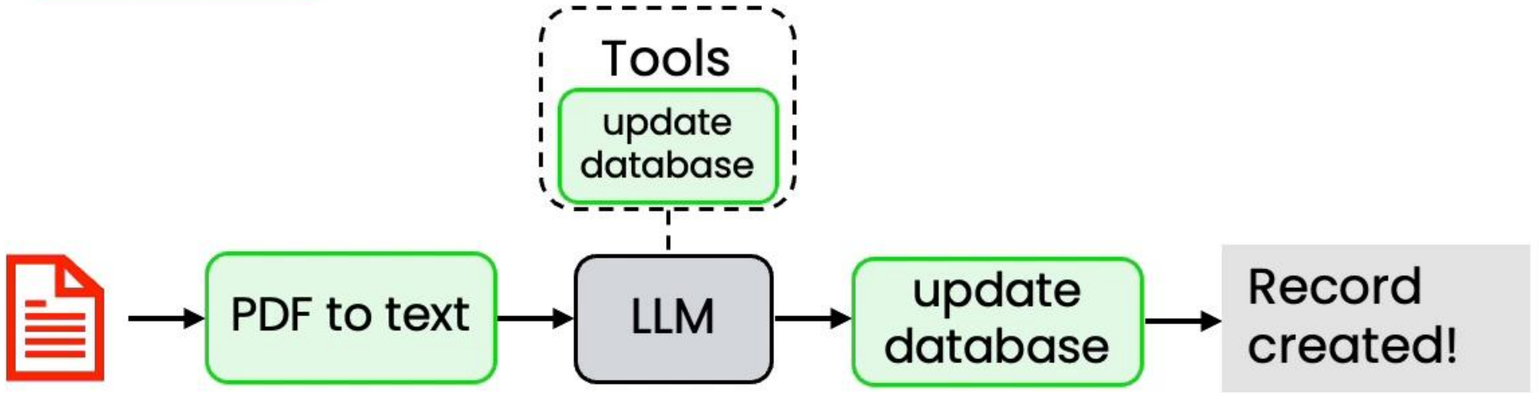
Total Due: **$3,000.00**

4 required fields:

- Biller
- Biller address
- Amount due
- Due date

Steps:

1. Identify required fields
2. Record in database



To carry out error analysis, focus on examples where performance is subpar

Counting up the errors

- Select 10-100 invoices for which the agentic workflow extracted the wrong due date

Counting up the errors

- Select 10-100 invoices for which the agentic workflow extracted the wrong due date

Input	PDF-to-text	LLM data extraction
Invoice 1	Errors in extraction	
Invoice 2		Wrong date selected
Invoice 3		Wrong data selected
...	...	...
Invoice 20	Errors in extraction	Wrong data selected
	15%	**87%**

Example: Responding to customer email

From: Susan Jones
Subject: Wrong item shipped

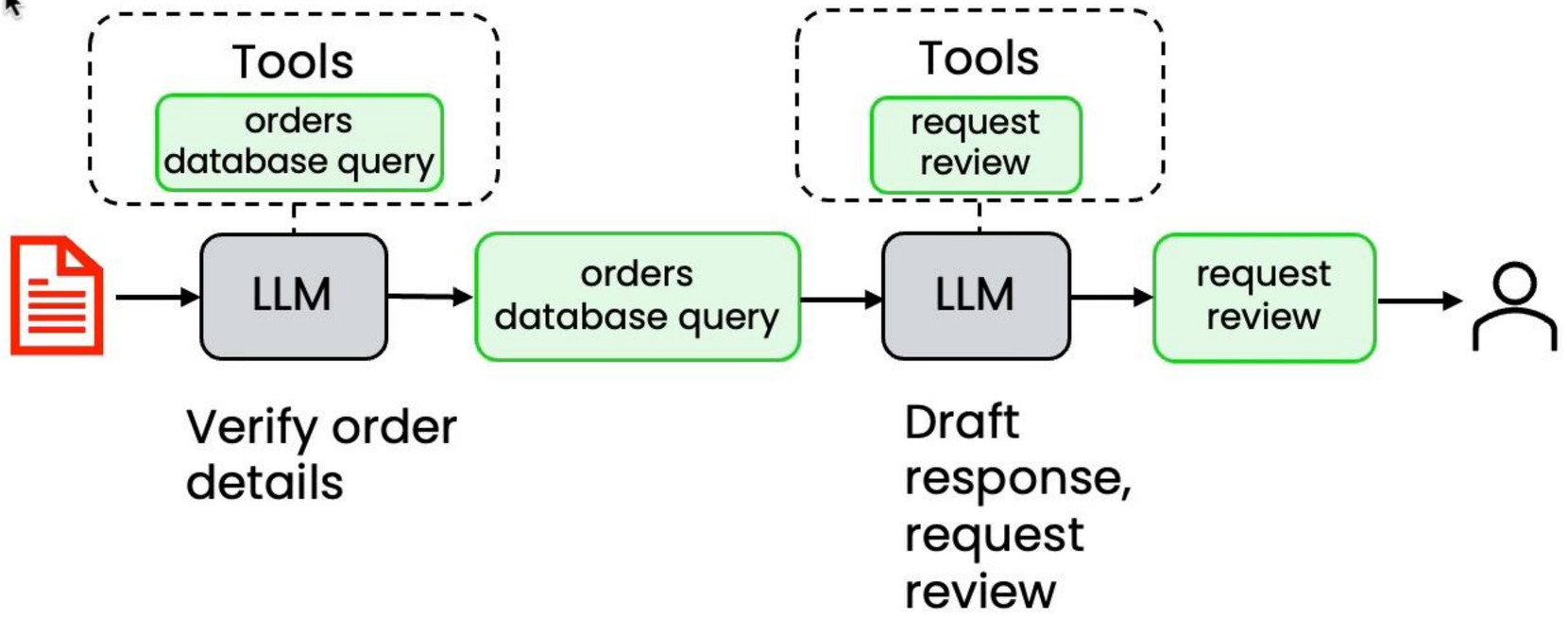
I ordered a blue KitchenPro blender (Order #8847) but received a red toaster instead.

I need the blender for my daughter's birthday party this weekend. Can you help?

Susan

Steps:

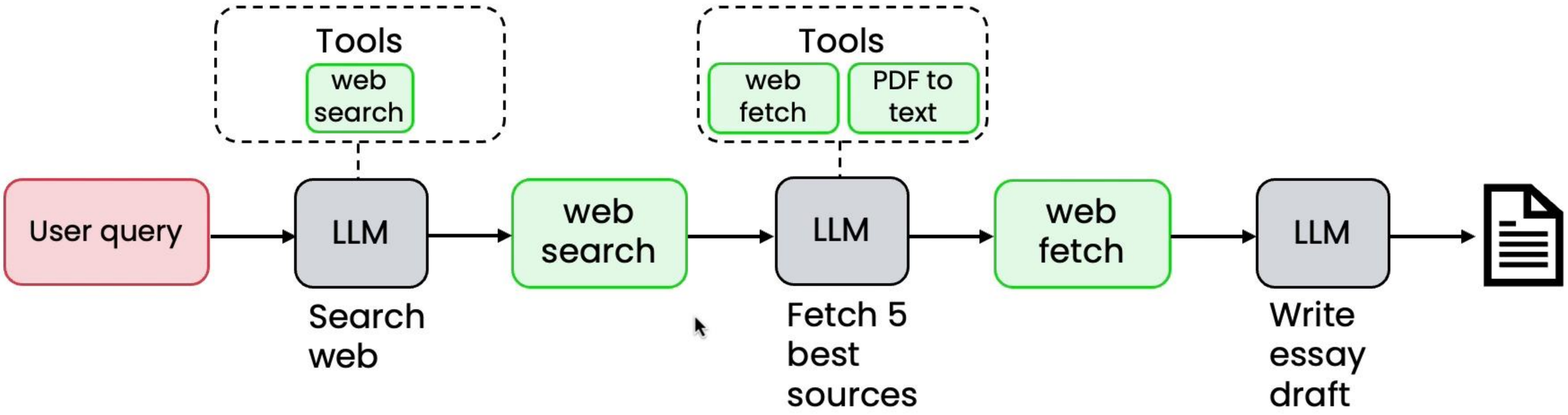
1. Extract key information
2. Find relevant customer records
3. Draft response for human review



Counting up the errors

Input	LLM-drafted query	Orders database query	LLM-drafted email
Email 1	Wrong table		
Email 2		Error in database entry	Didn't address details of order
Email 3	Incorrect math		
	...	...	...
Email 50			Defensive tone
	75%	4%	30%

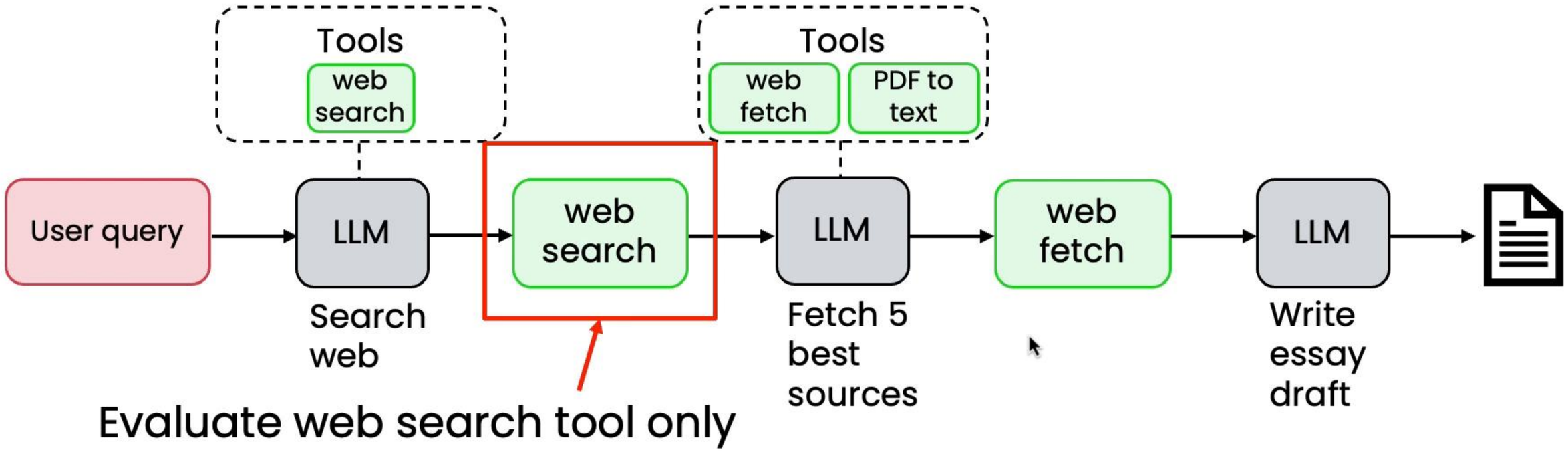
Example: research agent



Prompt	Issues
Recent black hole science	Missed high-profile result that had lots of news coverage
Renting vs buying a home in Seattle?	Seems to do a good job
Robotics for harvesting fruit	Didn't mention leading equipment company

End-to-end eval is expensive!

Example: research agent



- Create a list of gold standard web resources
- Write code that calculates how many results correspond to gold standard websites e.g. F1-score
- Track as you vary hyperparameters: e.g., search engine, number of results, dates

Benefits of component-level evaluations

- Can provide clearer signal for specific errors
  - Avoid the noise in end-to-end system
- More efficient for focused team to optimize
  - Work on smaller, more targeted problems faster

Improving non-LLM component performance

E.g. web search, text retrieval for RAG, code execution, trained ML model (for speech recognition, people detection, etc.)

- Tune hyperparameters of component

  Web search: Number of results, date range
  RAG: Change similarity threshold, chunk size
  ML models: Detection threshold

- Replace the component

  Try a different web search engine, RAG provider, etc.

Improving LLM component performance

- Improve your prompts

  Add more explicit instructions.
  Add one or more concrete example to the prompt (few-shot prompting)

- Try a new model

  Try multiple LLMs and use evals to pick the best

- Split up the step

  Decompose the task into smaller steps

- Fine-tune a model

  Fine tune on your internal data to improve performance

Instruction following

Summary of customer call:

> On July 14, 2023, Jessica Alvarez (SSN: 555-44-3333) of 1024 Maple Ridge Lane, Boulder, CO 80301, submitted a support ticket....

Instruction following

Summary of customer call:

On July 14, 2023, Jessica Alvarez (SSN: 555-44-3333) of 1024 Maple Ridge Lane, Boulder, CO 80301, submitted a support ticket....

Prompt

```
Identify all cases of personally identifiable information (PII) in the text below.

Then return a list of the identified PII classified by type, and then redact all the identified PII with "*****".

Separate the list and the redacted text with "REDACTED: ".
{text}
```

Instruction following results (Llama 3.1 8B)

The identified personally identifiable information (PII) classified by type is:

- Social Security Number (SSN): 524-18-7629
- Address: 1024 Maple Ridge Lane, Boulder, CO 80301

Redacted text with "*****" replacing the identified PII:

On July 14, 2023, ***** (SSN: *****), residing at *****, Boulder, CO 80301, submitted a support ticket...

List of identified PII classified by type
- SSN: 524-18-7629
- Address: 1024 Maple Ridge Lane, Boulder, CO 80301

Didn't follow the instructions properly

Missed some PII

Instruction following results (GPT-5)

Identified PII (type → value):
1. Full Name → Jessica T. Alvarez
2. Social Security Number → 524-18-7629
3. Physical Address → 1024 Maple Ridge Lane, Boulder, CO 80301

REDACTED:
On July 14, 2023, ***** (SSN: *****), residing at *****, submitted a support ticket...

Followed formatting instruction

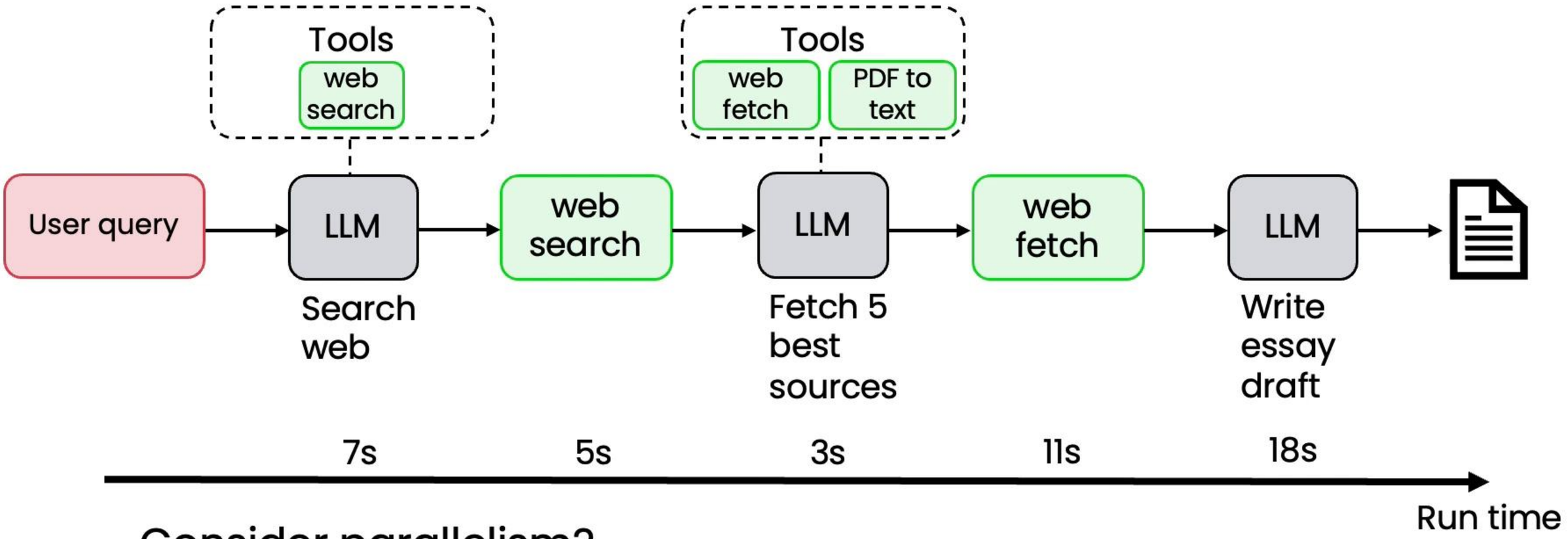
Identified all PII

Developing intuition for model intelligence

- Play with models often
  - Having a personal set of evals might be helpful
  - Read other people's prompts for ideas of how to best use models

- Use different models in your agentic workflows
  - Which models work for which types of tasks?
  - aisuite makes it easy to quickly swap out models

Example: research agent



Consider parallelism?

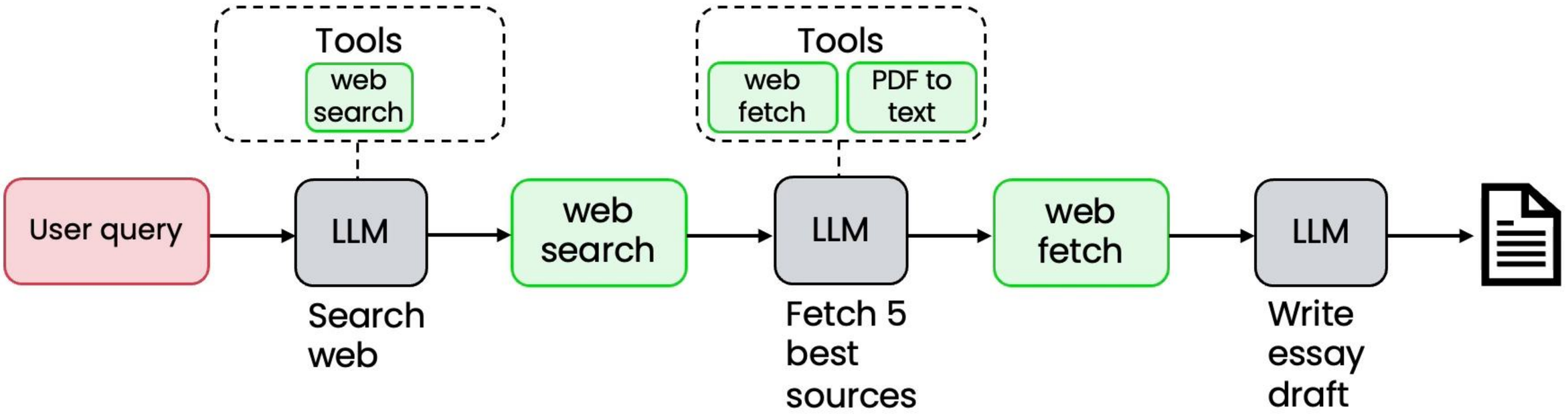
LLM steps too long?

- Try smaller/less intelligent model, or faster LLM provider

Costing your workflow

- LLM steps (pay per token)
- Any API-calling tools (pay per API call)
- Compute steps (based on server capacity/cost)

Costing your workflow



Development process summary

Build

Build end-to-end system

Improve individual component

Analyze

Examine outputs; traces

Build evals; compute metrics

Error analysis

Component-level evals

Planning example: Customer service agent

Inventory Database

id	name	description	price	stock
1001	Aviator	Timeless pilot style for any occasion, metal frame	80	12
1002	Catseye	Glamorous 1950s profile, plastic frame	60	28
1003	Moon	Oversized round style, plastic frame	120	15
1004	Classic	Classic round profile, gold frame	60	9

Customer query:

Do you have any round sunglasses in stock that are under $100?

Yes, we have our **Classic** sunglasses, which are a classic round metal frame and cost $60

Planning example: Customer service agent

system prompt

You have access to the following tools:

{description of tools}

Return a step-by-step plan to carry out the user's request.

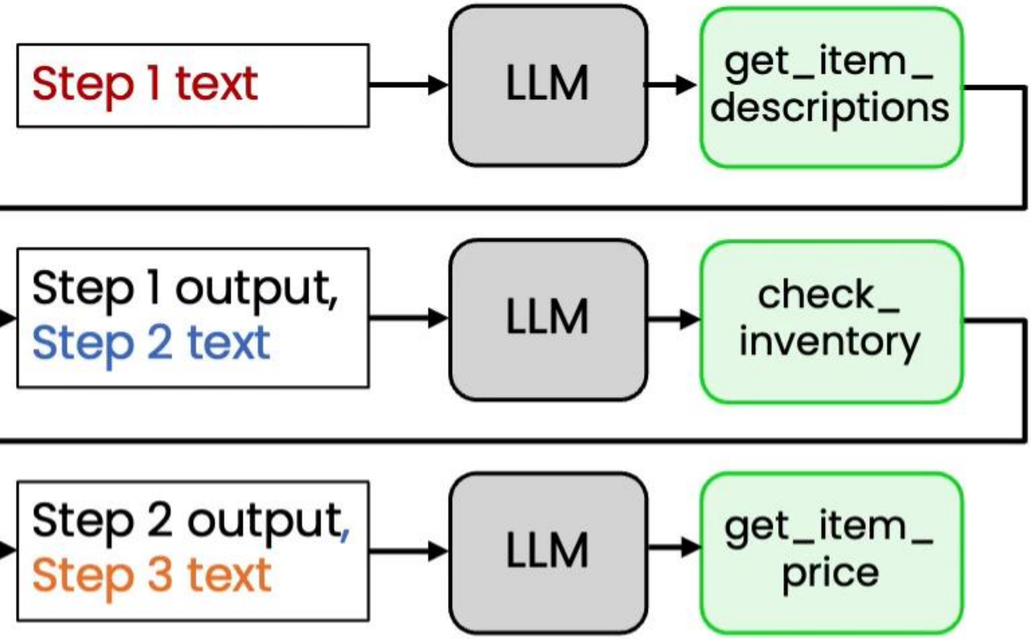
Tools

- get_item_descriptions
- check_inventory
- process_item_return
- get_item_price
- check_past_transactions
- process_item_sale

Do you have any round sunglasses in stock that are under $100?

LLM

1. Use **get_item_descriptions** tool to find round sunglasses
2. Use **check_inventory** to see if results are in stock
3. Use **get_item_price** to see if in-stock results are <$100



Planning example: Customer service agent

system prompt

You have access to the following tools:

{description of tools}

Return a step-by-step plan to carry out the user's request.

I would like to return the gold frame glasses I purchased, but not the metal frame ones.

LLM

1. Use check_past_transactions

Tools

- get_item_descriptions
- check_inventory
- process_item_return
- get_item_price
- check_past_transactions
- process_item_sale

Planning example: Customer service agent

system prompt

You have access to the following tools:

{description of tools}

Return a step-by-step plan to carry out the user's request.

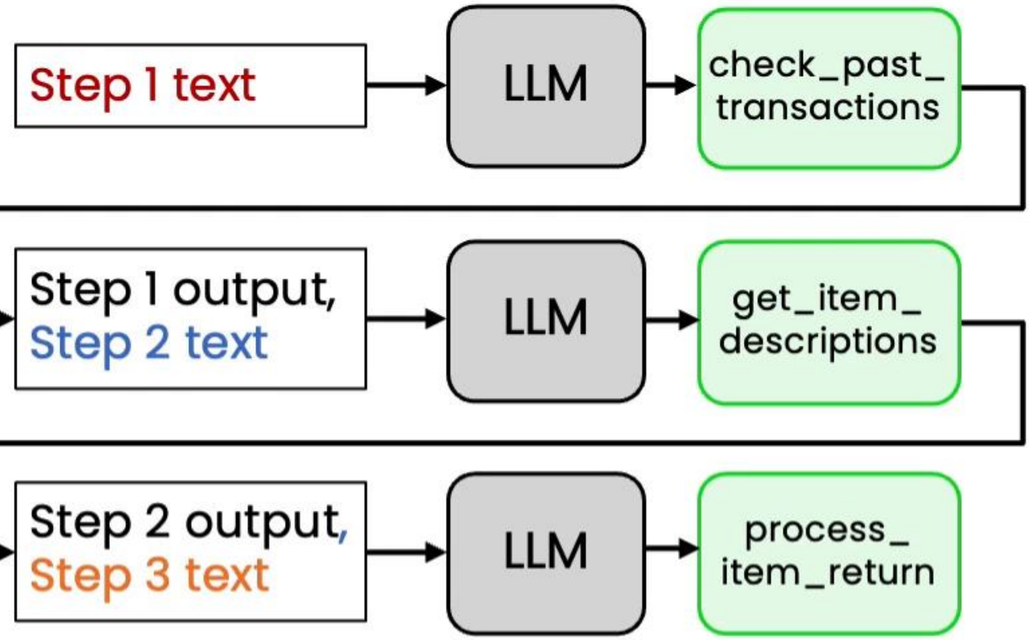
I would like to return the gold frame glasses I purchased, but not the metal frame ones.

LLM

1. Use **check_past_transactions** to find which glasses they bought
2. Use **get_item_descriptions** to find the gold frame glasses
3. Use **process_item_return** to return the gold-framed glasses

Tools

- get_item_descriptions
- check_inventory
- process_item_return
- get_item_price
- check_past_transactions
- process_item_sale



Planning example: Email assistant

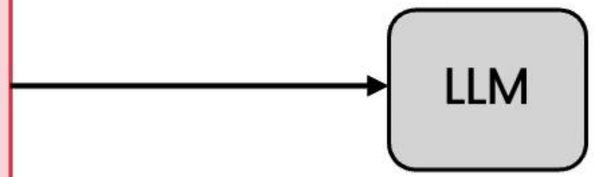
system prompt

You have access to the following tools:

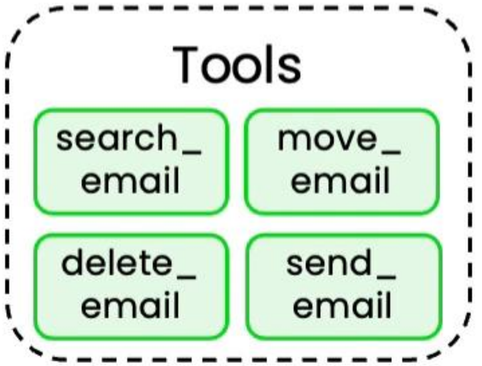
{description of tools}

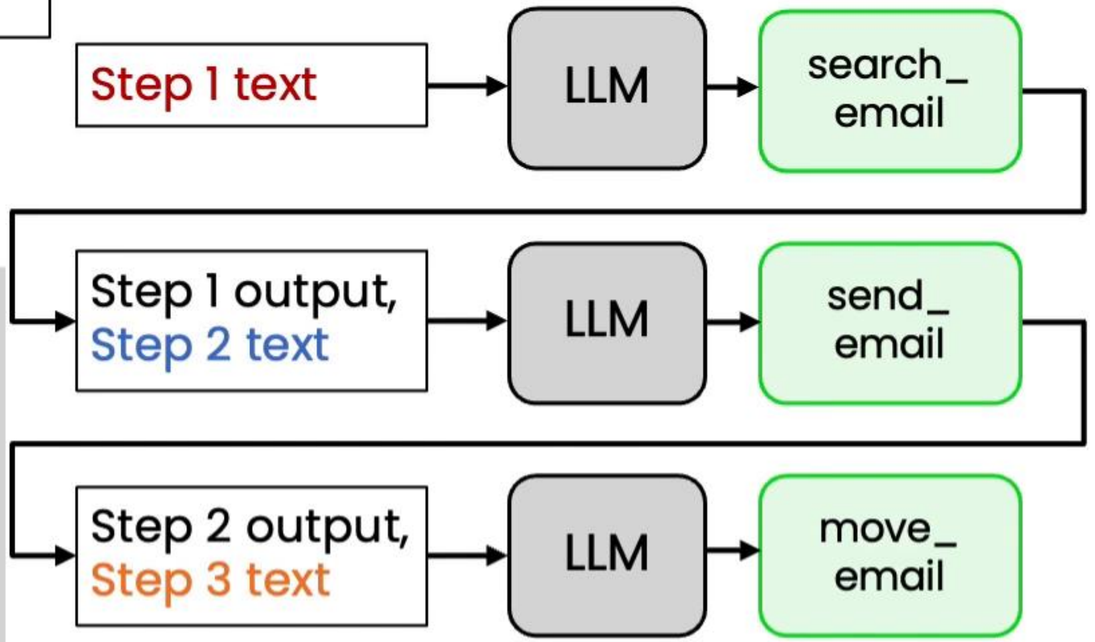
Return a step-by-step plan to carry out the user's request.

Reply to that email invitation from Bob about dinner in New York and tell him I'll attend. Then archive his email.



1. Use **search_email** to find emails from "Bob" that mention "dinner" and "New York"
2. Use **send_email** tool to reply and confirm attendance
3. Use **move_email** tool to move email to "archive" folder





Planning example: Customer service agent

system prompt

You have access to the following tools:

{description of tools}

Return a step-by-step plan to carry out the user's request.

Tools

- get_item_descriptions
- check_inventory
- process_item_return
- get_item_price
- check_past_transactions
- process_item_sale

Do you have any round sunglasses in stock that are under $100?

LLM

1. Use **get_item_descriptions** tool to find round sunglasses
2. Use **check_inventory** to see if results are in stock
3. Use **get_item_price** to see if in-stock results are <$100

Step 1 text → LLM → get_item_descriptions

Step 1 output, Step 2 text → LLM → check_inventory

Step 2 output, Step 3 text → LLM → get_item_price

Formatting plan as JSON

Updated system prompt

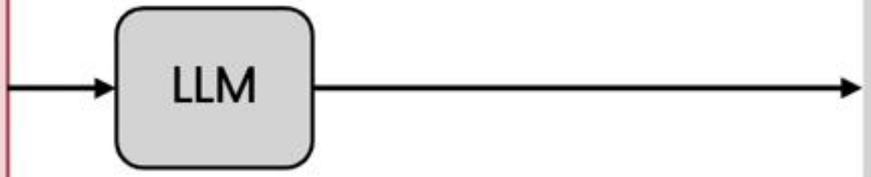
You have access to the following tools:

{description of tools}

Create a step-by-step plan in JSON format.

Each step should have the following items: step number, description, tool name, and args.

Do you have any round sunglasses in stock that are under $100?




```
{
  "plan": [
    {
      "step": 1,
      "description": "Find round sunglasses",
      "tool": "get_item_descriptions",
      "args": {"query": "round sunglasses"}
    },
    {
      "step": 2,
      "description": "Check available stock",
      "tool": "check_inventory",
      "args": {"items": "results from step 1"}
    },
    …
  ]
}
```

The challenge of planning with tools

Which month had the highest sales of hot chocolate?

→ LLM

Tools

- get_column_max
- get_column_mean
- filter_rows
- get_column_min
- get_column_median
- sum_rows

date	price	coffee_name	Size
2024-01-28	3.87	Hot Chocolate	M
2024-03-01	2.89	Cappuccino	S
2024-03-04	3.87	Latte	M
...	...	...	
2025-03-23	4.57	Latte	L

coffee_sales.csv

1. Use the **filter_rows** tool to extract transactions in January with coffee_name “Hot Chocolate”
2. Use the **get_column_mean** to find the average amount
3. Use the **filter_rows** tool to extract transactions in February with coffee_name “Hot Chocolate”
4. Use the **get_column_mean** to find the average amount
5. Repeat for March, April, May, ..., December
6. Determine the month with highest average using results of previous steps

The challenge of planning with tools

Which month had the highest sales of hot chocolate?

LLM

Tools

- get_column_max
- get_column_mean
- filter_rows
- get_column_min
- get_column_median
- sum_rows

date	price	coffee_name	Size
2024-01-28	3.87	Hot Chocolate	M
2024-03-01	2.89	Cappuccino	S
2024-03-04	3.87	Latte	M
...	...	...	
2025-03-23	4.57	Latte	L

How many unique transactions last week?

get_unique_entries

What were the amounts of the last 5 transactions?

get_last_N_values

... ...

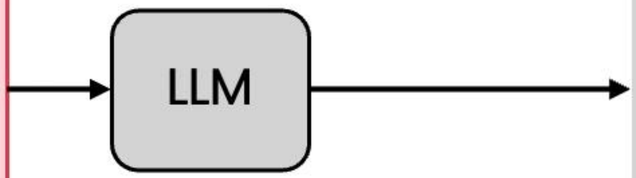
- Brittle
- Inefficient
- Continuously dealing with edge cases

Planning with code execution

system prompt

Write code to solve the user's query. Return your answer as python code delimited with <execute_python> and </execute_python> tags.

What were the amounts of the last 5 transactions?



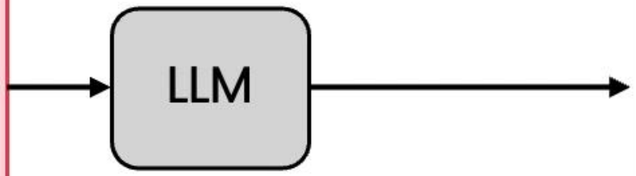

```
<execute_python>

import pandas as pd

# Load CSV
df = pd.read_csv("transactions.csv")

# Ensure date column is parsed as datetime
df["date"] = pd.to_datetime(df["date"])

# Sort by date to get most recent transactions
df_sorted = df.sort_values(by="date",
ascending=False)

# Select the last 5 transactions
last_5 = df_sorted.head(5)

# Show just the price column (amounts)
print("Last 5 transaction amounts:")
print(last_5["price"].to_list())

</execute_python>
```

Planning with code execution

system prompt

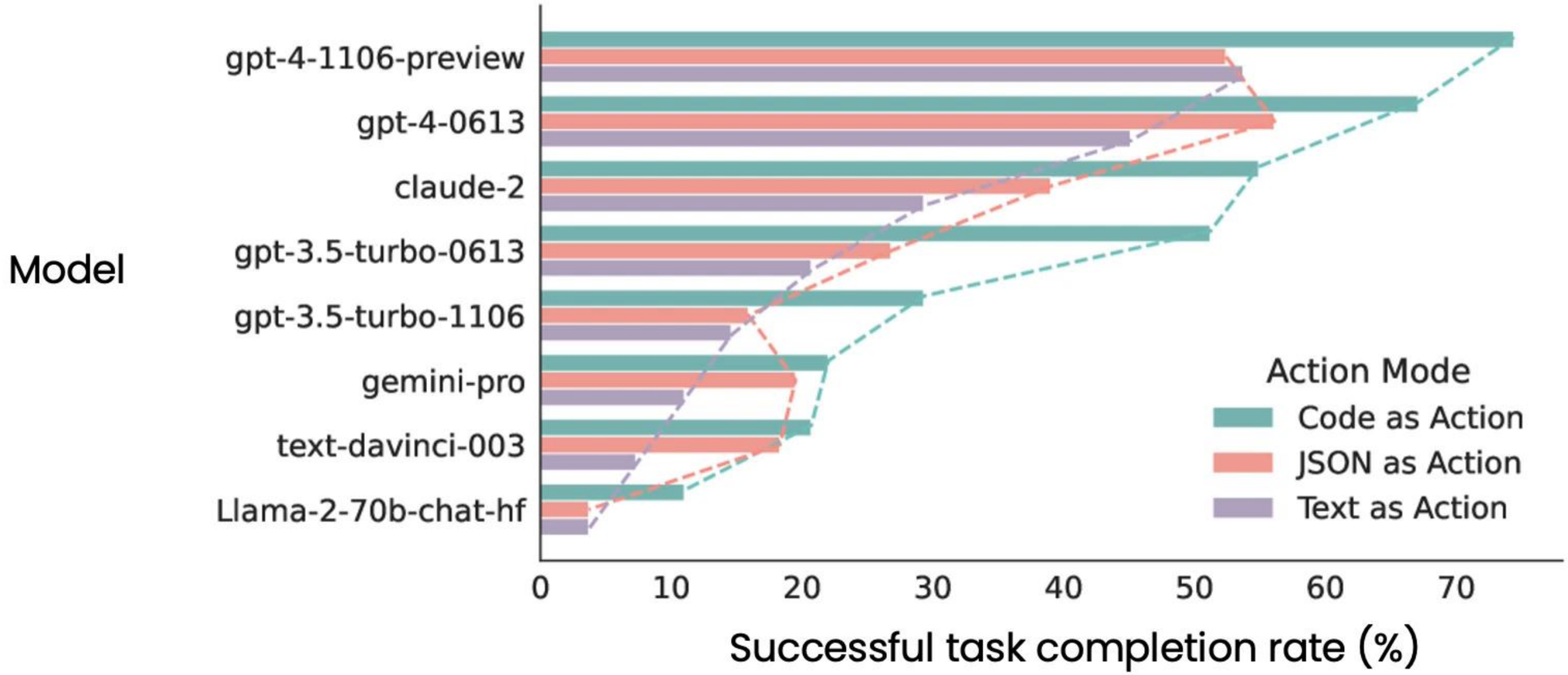
Write code to solve the user's query. Return your answer as python code delimited with <execute_python> and </execute_python> tags.

How many unique transactions last week?




```
<execute_python>

import pandas as pd

# Read CSV and parse the "date" column as datetime
df = pd.read_csv("transactions.csv",
parse_dates=["date"])

# Define time window
today = pd.Timestamp.today()
week_ago = today - pd.Timedelta(days=7)

# Filter rows where date is within last week
last_week = df[df["date"].between(week_ago, today)]

# Drop duplicate rows and count
print(last_week.drop_duplicates().shape[0])

</execute_python>
```

Planning with code improves performance



[Adapted from "Executable Code actions Elicit Better LLM Agents", Wang et al. 2024]

Some tasks require more than 1 person!

Task	Team
Create marketing assets	Researcher Graphic Designer Writer
Writing a research article	Researcher Statistician Lead writer Editor
Preparing a legal case	Associate Paralegal Investigator

Example: Marketing team

Researcher

Tasks
- Analyze market trends
- Research competitors

Tools
- Web search

Graphic designer

Tasks
- Create data visualizations
- Create artwork

Tools
- Image generation, manipulation
- Code execution for chart generation

Writer

Tasks
- Transform research into report text and marketing copy

Tools
- (None)

Example: Marketing team with linear plan

Create a summer marketing campaign for sunglasses

researcher

research

graphic designer

research, visualizations, artworks

writer

Here are current sunglasses trends and competitor offerings...

Here are 5 data visualizations and 5 artwork options for the report...

Final report

Example: Planning with multiple agents

system prompt

You are a marketing manager and have the following team of agents to work with:

{description of agents}

Return a step-by-step plan to carry out the user's request.

Agents

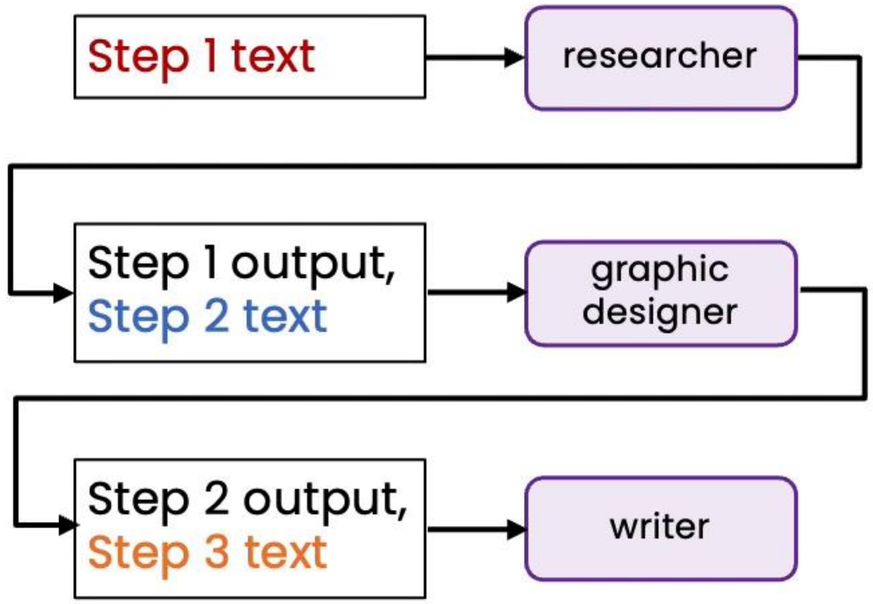
researcher | graphic designer | writer

Create a summer marketing campaign for sunglasses

LLM

marketing manager

1. Ask **researcher** to research current sunglasses trends
2. Ask **graphic designer** to create ad images
3. Ask **writer** to create report
4. Review report



Example: Marketing team with linear plan

Create a summer marketing campaign for sunglasses

researcher

research

graphic designer

research, visualizations, artworks

writer

Here are current sunglasses trends and competitor offerings...

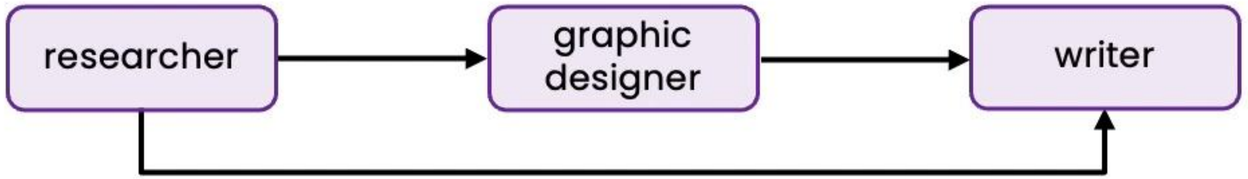
Here are 5 data visualizations and 5 artwork options for the report...

Final report

Example: Marketing team with linear plan

Create a sum
marketing
campaign for
sunglasses

Communication Pattern



writer

Final report

Example: Planning with multiple agents

system prompt

You are a marketing manager and have the following team of agents to work with:

{description of agents}

Return a step-by-step plan to carry out the user's request.

Agents

researcher | graphic designer | writer

Create a summer marketing campaign for sunglasses

→ LLM (marketing manager)

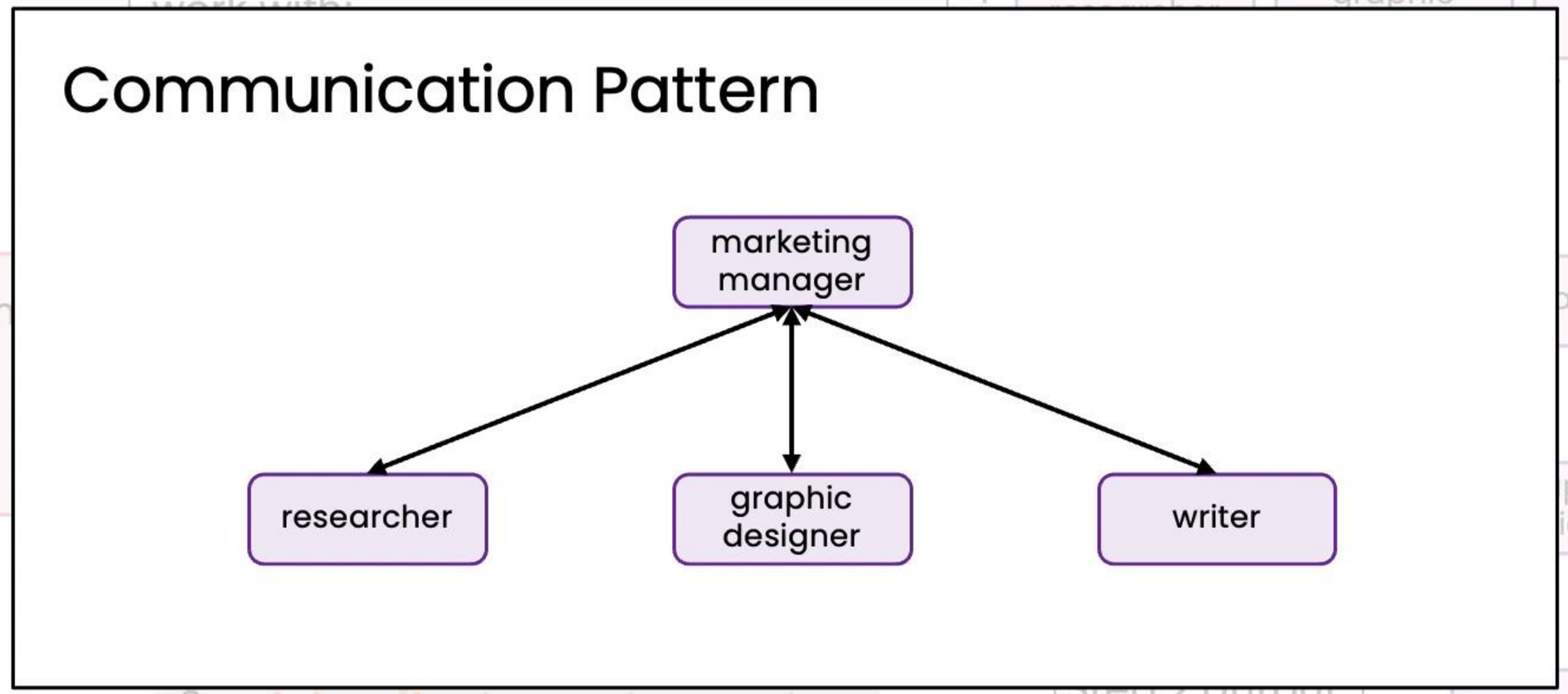
1. Ask **researcher** to research current sunglasses trends
2. Ask **graphic designer** to create ad images
3. Ask **writer** to create report
4. Review report

Step 1 text → researcher

Step 1 output, Step 2 text → graphic designer

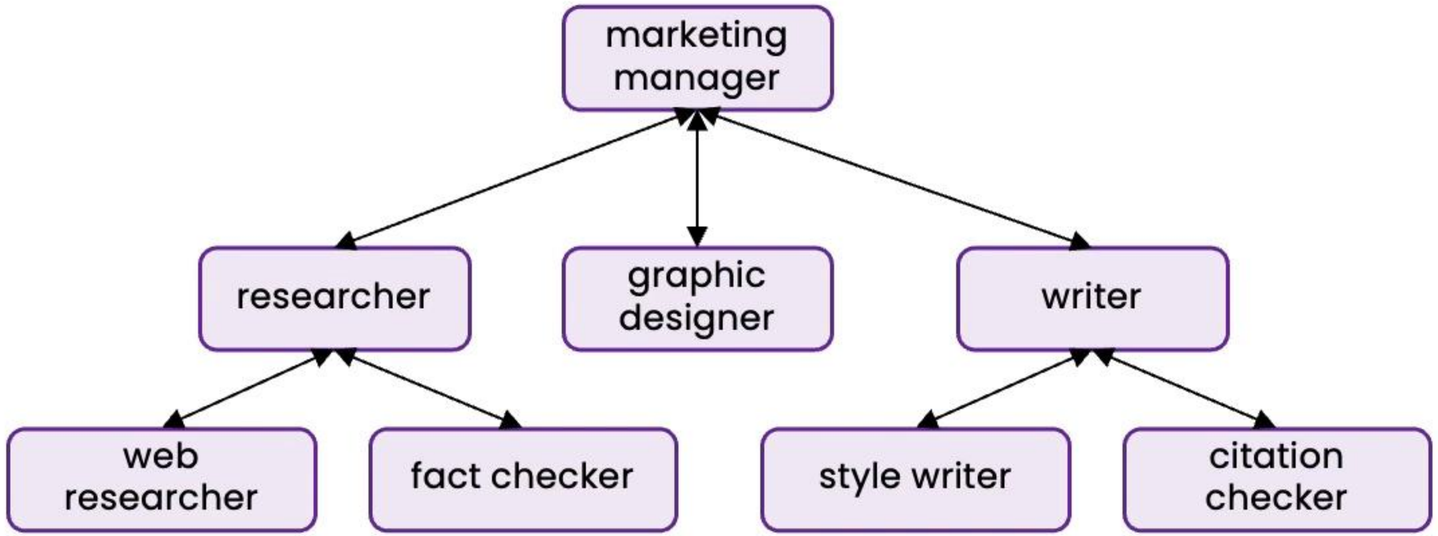
Step 2 output, Step 3 text → writer

Example: Planning with multiple agents

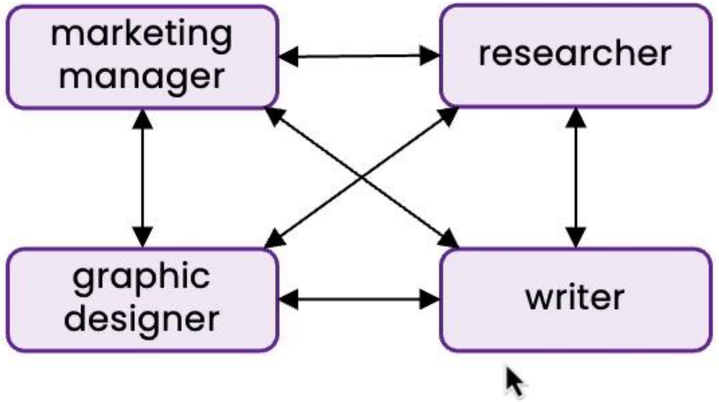


Other communication patterns

Deeper hierarchy



All-to-all



Summary

- Why Agentic AI
- Reflection design pattern
- Tool use (function calling)
- Evals, error analysis
- Planning, multi-agent systems