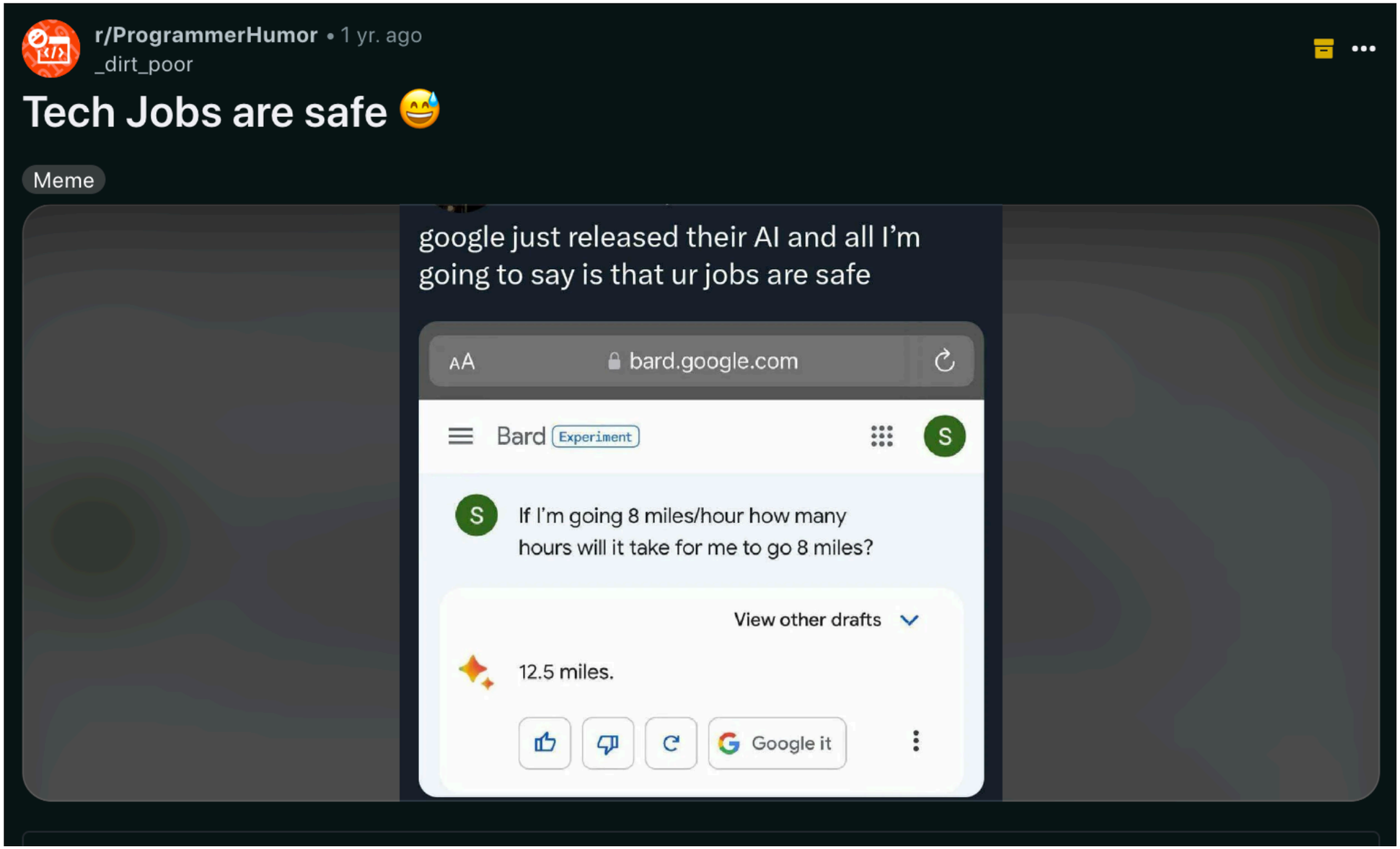
AI Chat Demo

Chatbot with Custom MultiModal Agent using LangChain

Keith Kenemer

Tech Jobs & AI



https://www.reddit.com/r/ProgrammerHumor/comments/11y97dr/tech_jobs_are_safe/

What about agents? Same conclusion?

Goal: Chatbot with Custom Multimodal Agent

- **We would like a chatbot that functions like ChatGPT (gpt-3.5) for generic queries but utilizes a custom math agent when the query is math-related**

- **We would like to handle the following types of math queries: basic math, symbolic math (e.g. calculus), word problems**

- **We would like a multimodal agent capable of generating images**

- **Possible applications: tutor, research assistant (future)**

- **Let's leverage the LangChain framework to make development easier**

- **Proof-of-concept/Prototype code**

Generative vs Discriminative Models I

$$p(y \mid x)$$

class label data sample

A discriminative model models the conditional probability of a class label given an input sample x (e.g. classifier).

Analogy: Asking someone which musical genre a particular song belongs to

$$p(x, y)$$

A generative model models the joint distribution of the input samples and associated labels. Able to synthesize data.

Analogy: Asking someone to compose or play a song and tell us the genre

$$p(x \mid y)$$

Analogy: Asking someone to compose or play a song given the genre

Generative vs Discriminative Models II

Discriminative task

Generative models sample from joint distribution

Can be expressed in terms of class conditionals via Baye's Theorem

$$p(y \mid x) = \frac{p(x, y)}{p(x)} = \frac{p(x \mid y)p(y)}{p(x)}$$

Generative model can estimate this

Generative models can be used for discriminative tasks. They are generally considered to be complementary to discriminative models (not a superset) b/c discriminative models have potentially better performance for discriminative tasks

LangChain

What is LangChain?

LangChain is a framework designed to simplify the creation of applications using large language models (LLMs). As a language model integration framework, LangChain's use-cases largely overlap with those of language models in general, including document analysis and summarization, chatbots, and code analysis.[2]

https://en.wikipedia.org/wiki/LangChain

https://www.langchain.com/

https://aws.amazon.com/what-is/langchain/

LangChain Modules

```
from langchain.chains import LLMChain
from langchain.chains import LLMMathChain
from langchain.prompts import PromptTemplate
from langchain_openai import ChatOpenAI
from langchain_experimental.pal_chain.base import PALChain
from langchain_experimental.llm_symbolic_math.base import LLMSymbolicMathChain
```

- **LLMChain** (generic queries) → calls LLM with prompt
- **LLMMathChain** (basic math) → calls numexpr
- **LLMSymbolicMathChain** → calls sympy
- **PALChain** (word problems) → creates/runs solution function

numexpr = numerical expression evaluator (python module)

simpy = symbolic math (python module)

PAL = program-aided language model

Classifying the User Query via a Meta Query

The meta-query asks the LLM (gpt-3.5) to categorize the appended user query into one of 5 classes:

- **Generic Query (non-math related)**
- **Basic Math Query**
- **Symbolic Math Query (e.g. calculus)**
- **Word Problem**
- **Image Generation Request**

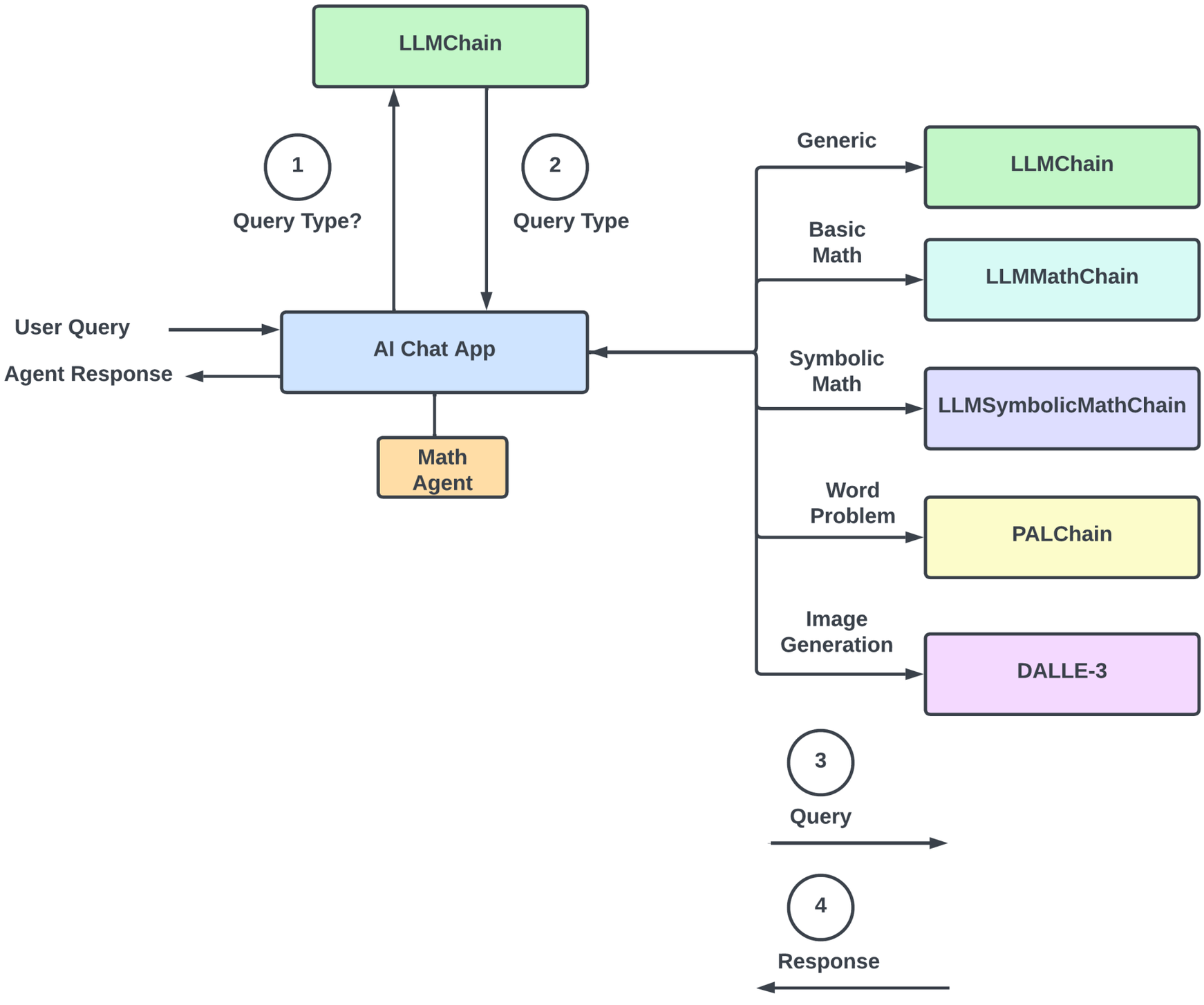
```
# base LLM (determine query type)
self.llm = ChatOpenAI(model_name="gpt-3.5-turbo", temperature = TEMPERATURE, request_timeout=REQ_TIMEOUT)
self.prompt_template = PromptTemplate(
    input_variables=["query_type1", "query_type2", "query_type3", "query_type4", "user_input"],
    template="Categorize the following query as either a {query_type1}, {query_type2},"
             "{query_type3}, {query_type4}, or {query_type5}:\n{user_input}")
self.llm_chat_category = LLMChain(llm=self.llm, prompt=self.prompt_template)

# base LLM (generic)
self.prompt_template_generic = PromptTemplate(
    input_variables=["user_input"],
    template="{user_input}")
self.llm_chat_generic = LLMChain(llm=self.llm, prompt=self.prompt_template_generic)


# basic math LLM
self.llm_basic_math = LLMMathChain.from_llm(self.llm, verbose=True)

# symbolic math LLM
self.llm_symbolic_math=LLMSymbolicMathChain.from_llm(self.llm, verbose=True)

# word problem LLM
self.palchain = PALChain.from_math_prompt(llm=self.llm, verbose=True, timeout=REQ_TIMEOUT)

# for image generation requests
self.open_ai_client = OpenAI()
```

Agent Query Processing

The agent switches between processing chains depending on what the category the user query was determined to be.

```
# query the base llm to categorize the query type
category_response = self.llm_chat_category.invoke({"query_type1":QUERY_TYPE1,"query_type2":QUERY_TYPE2,
                                                   "query_type3":QUERY_TYPE3, "query_type4":QUERY_TYPE4,
                                                   "query_type5":QUERY_TYPE5,"user_input":user_input})

# call the appropriate chain
category_response_txt = category_response["text"]

if "basic" in category_response_txt:
    print("\n(interpreting as a basic math query)")
    response = self.llm_basic_math.invoke(user_input)
    response = response["answer"]
elif "symbolic" in category_response_txt:
    print("\n(interpreting as a symbolic math query)")
    response = self.llm_symbolic_math.invoke(user_input)
    response = response["answer"]
elif "word" in category_response_txt:
    print("\n(interpreting as a word problem)")
    response = self.palchain.invoke(user_input)
    response = response["result"]
elif "image" or "generation" in category_response_txt:

    # call DALL-E3 for image request
    print("\n(interpreting as an image generation request)")
    dalle_response = self.open_ai_client.images.generate(
    model="dall-e-3",
    prompt=user_input,
    size="1024x1024",
    quality="standard",
    n=1,
    )

    # show the result that was pushed in the response url
    url = dalle_response.data[0].url
    self.display_image_from_url(url, 1024, 1024)
    response = "image generation complete"
else:
    print("\n(interpreting as a generic query)")
    response = self.llm_chat_generic.invoke({"user_input":user_input})
    response = response["text"]
```

Demo App Architecture



Takeaways & Observations

- **Generative Models can also be used for discriminative tasks**
- **Agents expand the capabilities of LLMs by connecting them with other computational tools. The discriminative capability can be useful for building agents since it can inform the agent how to select the appropriate processing tools for different types of queries**
- **LangChain provides a framework which makes it easier to incorporate LLMs into applications by constructing processing chains**
- **We can observe the effects of prompt engineering even with this simple agent. When we can provide hints, the resulting classification of the user query can change**

LangChain Resources

Below are a few tutorials and resources on LangChain including how to run various processing chains:

https://towardsdatascience.com/a-gentle-intro-to-chaining-llms-agents-and-utils-via-langchain-16cd385fca81

https://python.langchain.com/docs/additional_resources/tutorials

https://www.youtube.com/watch?v=DkBc4hfGle8&t=2s