Red Pill or Blue Pill?

Entering the Artificial Intelligence Healthcare Matrix

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ROSALIND FRANKLIN UNIVERSITY of MEDICINE AND SCIENCE

LIFE *in* DISCOVERY

No conflicts of interest to disclose

Pretest Question 1

Which of the following is the primary method by which large language models (LLMs), such as ChatGPT, generate human-like responses?

A. Preset scripts written by human developers
B. Word prediction based on patterns learned from large datasets
C. Keyword matching algorithms used in search engines
D. Random selection of phrases from pre-stored conversations

Pretest Question 2

Currently, which of the following is the most common application of artificial intelligence LLMs in healthcare?

A. Assisting with clinical documentation and note generation
B. Developing new pharmaceutical compounds
C. Direct patient counseling via telemedicine
D. Analyzing a patient chart for drug interactions

LLMs=large language models

Pretest Question 3

Which prompting technique would be most appropriate to improve the accuracy and detail of a response when analyzing a complex patient case?

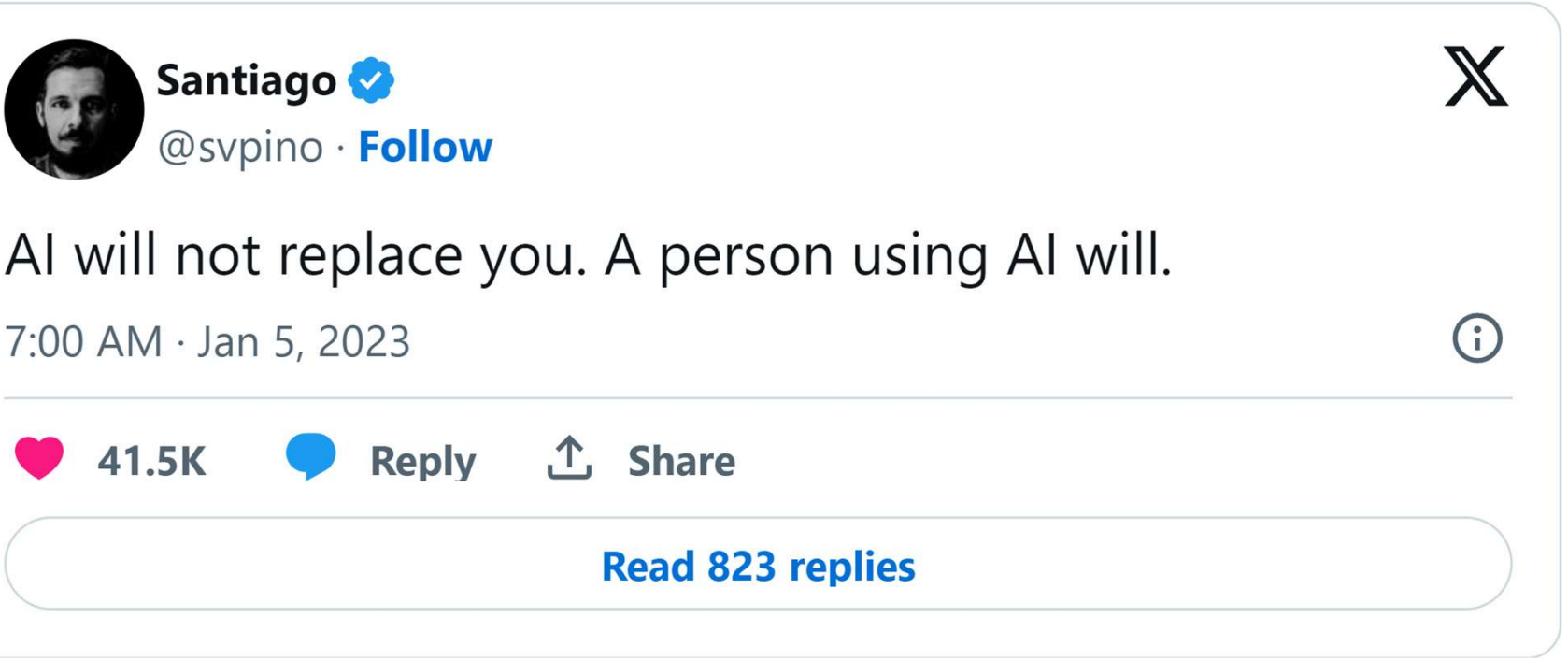
A. Adopting a persona
B. Delimited prompting
C. Request citations and references
D. Chain-of-thought prompting

Pretest Question 4

In the future, which of the following is the most likely role of LLMs in the practice of pharmacy?

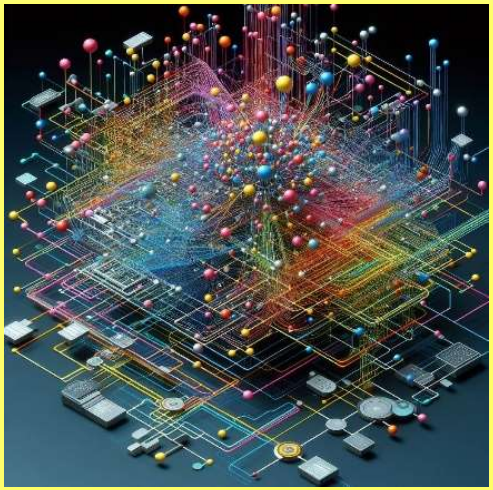
A. **Automate the process from prescription receipt to medication dispensing**
B. **Conduct patient interviews and recommend over-the-counter therapies**
C. **Improve clinical decision support tools (e.g. drug-drug interaction checking or drug information resources)**
D. **Replace the role of pharmacy technicians in preparing medications**

LLMs=large language models


Santiago
@svpino · Follow
AI will not replace you. A person using AI will.
7:00 AM · Jan 5, 2023
41.5K
Reply
Share
Read 823 replies

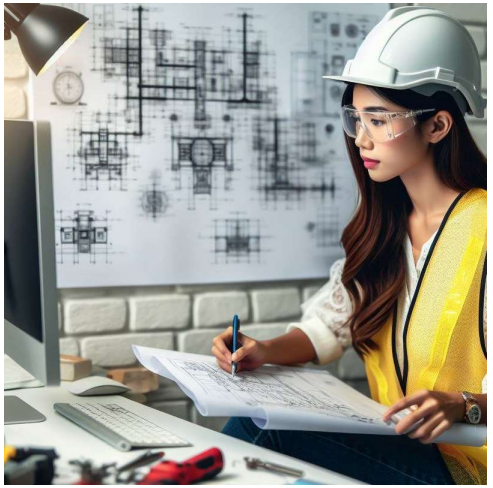
Objectives

1. Describe how artificial intelligence (AI) large language models (LLMs) generate human-like responses.
2. Discuss practical examples and potential future applications of AI LLM integration in healthcare.
3. Identify prompt engineering best practices when interacting with LLMs.



How LLMs Work

Practical Examples



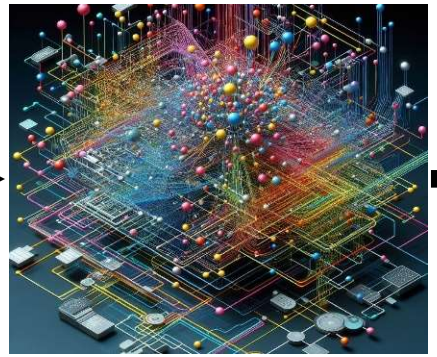
Prompt Engineering

LLMs=large language models (a form of artificial intelligence)
Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

Overview of LLMs

Large language models (LLMs) are the AI technology behind ChatGPT and similar platforms

Consume massive amount of training data



Create model of language patterns

Humans fine-tune the model

Model uses input text to create new text

Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

LLMs “Tokens”

A total of 17,604 patients were enrolled; 8803 were assigned to receive semaglutide and 8801 to receive placebo. The mean (±SD) duration of exposure to semaglutide or placebo was 34.2±13.7 months, and the mean duration of follow-up was 39.8±9.4 months.

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```
[32, 2860, 315, 220, 1114, 11, 20354, 6978, 1051, 37191, 26,
220, 19272, 18, 1051, 12893, 311, 5371, 5347, 351, 87954,
579, 323, 220, 19272, 16, 311, 5371, 43715, 13, 578, 3152,
320, 38121, 5608, 8, 8250, 315, 14675, 311, 5347, 351, 87954,
579, 477, 43715, 574, 220, 1958, 13, 17, 38121, 1032, 13, 22,
4038, 11, 323, 279, 3152, 8250, 315, 1833, 5352, 574, 220,
2137, 13, 23, 38121, 24, 13, 19, 4038, 13]
```

1 token is about 4 characters or about 0.75 words (in English)

https://platform.openai.com/tokenizer

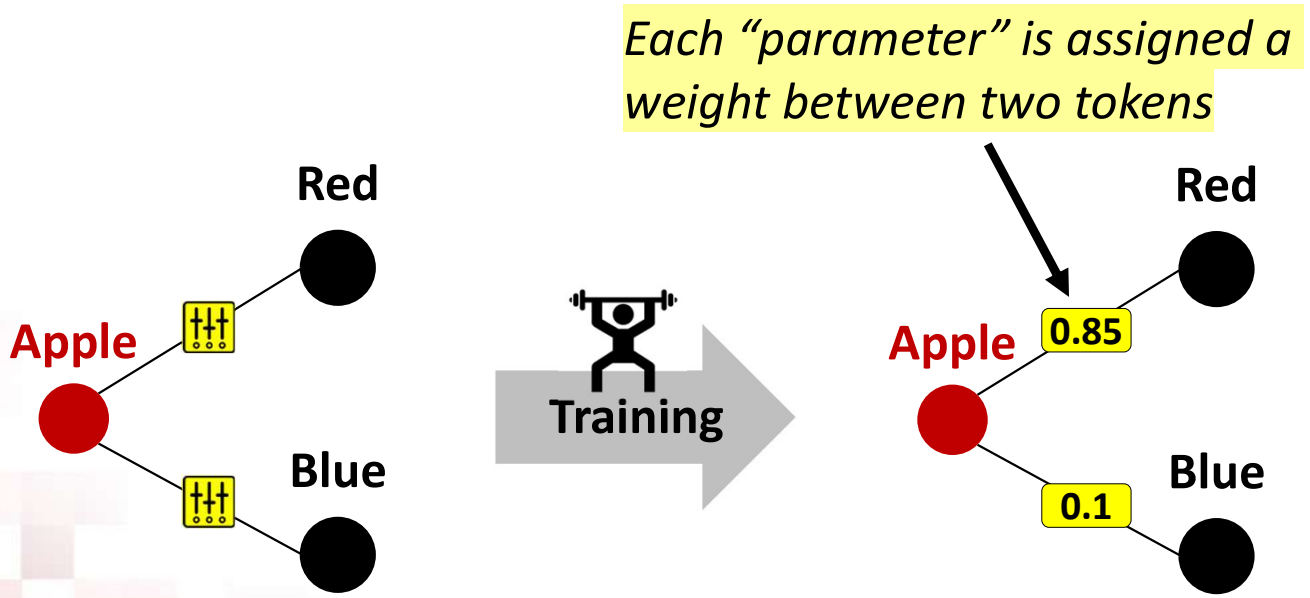
Lincoff AM, et al. N Engl J Med. 2023;389(24):2221-2232.

LLM Training Data Set

- **"Corpus size"**
  - Bigger is better
- **Modern LLMs are essentially trained on the entire internet**

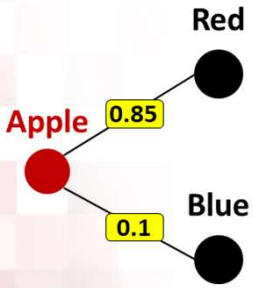
Model	Corpus Size (tokens)	Corpus Size (words)
GPT-3 (OpenAI)	500 billion	~375 billion words
Llama 3 (Meta)	15 trillion	~11 trillion words

LLMs “learn” the relationships between each token.

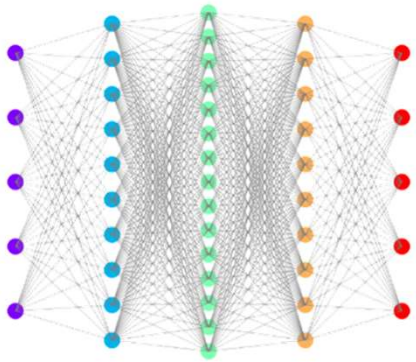


This is very similar to a neural network machine learning model

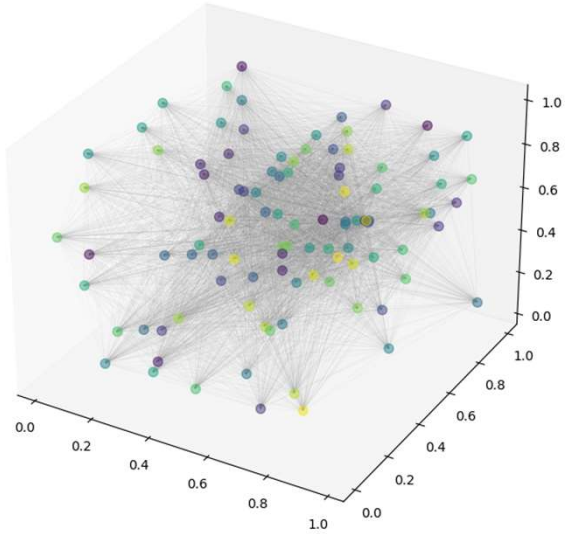
LLM Models are Very Complex



3 tokens
2 parameters



40 tokens
780 parameters

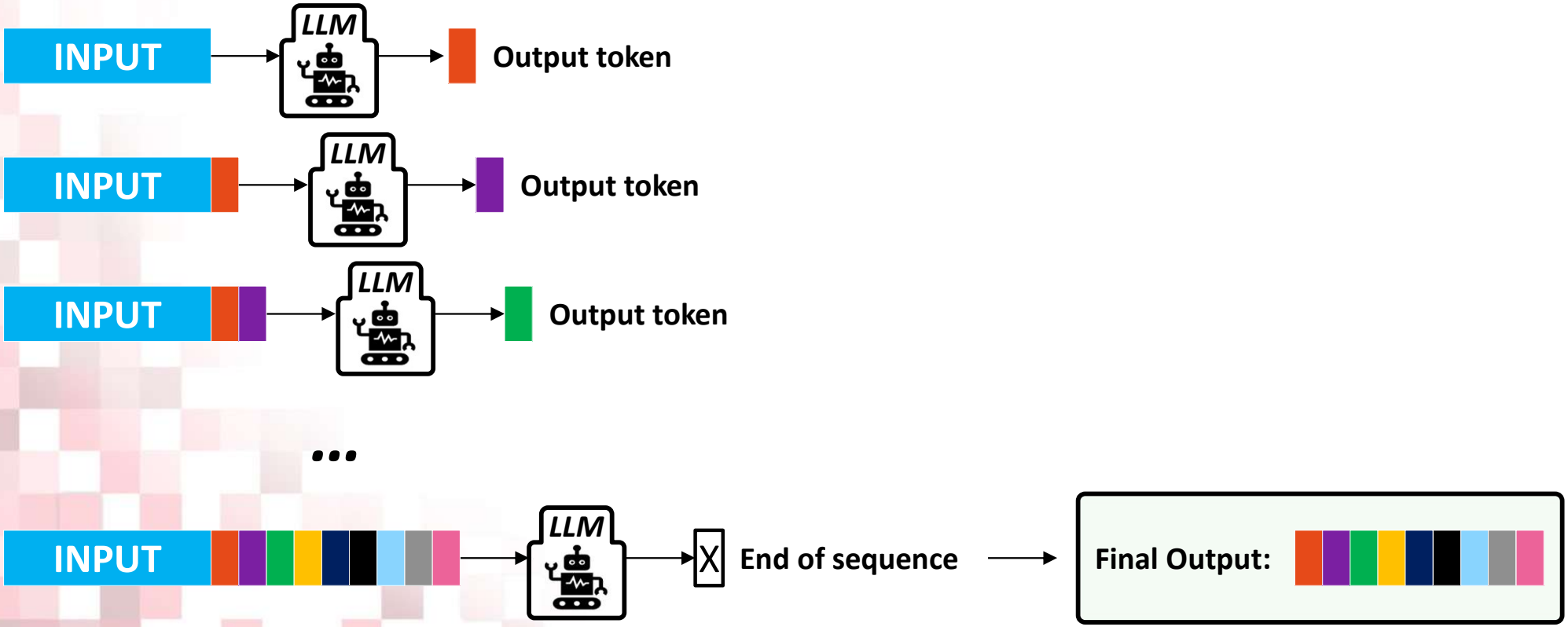


100 tokens
5,000 parameters

Modern LLMs have <u>>70 billion</u> parameters

Image generated with Python script written by Chat GPT 3.5 in Google Colab

LLMs use their models to predict the next token.



The brand names of warfarin in the US are Coumadin and Jantoven

Cou = 55.91%	mad = 99.81%	in = 99.97%	and = 72.93%
:\n\n = 23.36%	m = 0.05%	i = 0.01%	, = 19.20%
: = 5.04%	mar = 0.03%	ine = 0.01%	® = 2.91%
J = 4.28%	ma = 0.02%	inand = 0.00%	(= 1.68%
\n\n = 3.01%	maf = 0.01%	<|endoftext|> = 0.00%	or = 0.48%

J = 98.54%	ant = 99.99%	oven = 99.92%
Mare = 0.33%	ANT = 0.00%	ov = 0.04%
\n\n = 0.21%	anten = 0.00%	ove = 0.01%
War = 0.19%	an = 0.00%	ovan = 0.01%
Pan = 0.12%	a = 0.00%	o = 0.01%

https://platform.openai.com/playground?mode=complete

It’s Not Just ChatGPT

OpenAI

ChatGPT 3.5 and 4

Microsoft COPILOT

Google

Gemini
(formerly Bard)

cohere

Coral
(Command model)

ANTHROP\C

Claude

Free, open source models

Meta

Llama

MISTRAL AI_

… many more!

It’s Not Just “Text”

Image to Text
(OCR and describing photos)

Voice to Text
(dictation and transcription)

Text to Voice
(voice generation)

This technology has been available for decades but is improved with AI

Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

It’s Not Just “Text-To-Voice”

Real Audio Sample

The most misunderstood boxed warning award. So this award goes to a drug with a boxed warning where you look at it and you think one thing, but really there's a lot more going on under the surface....

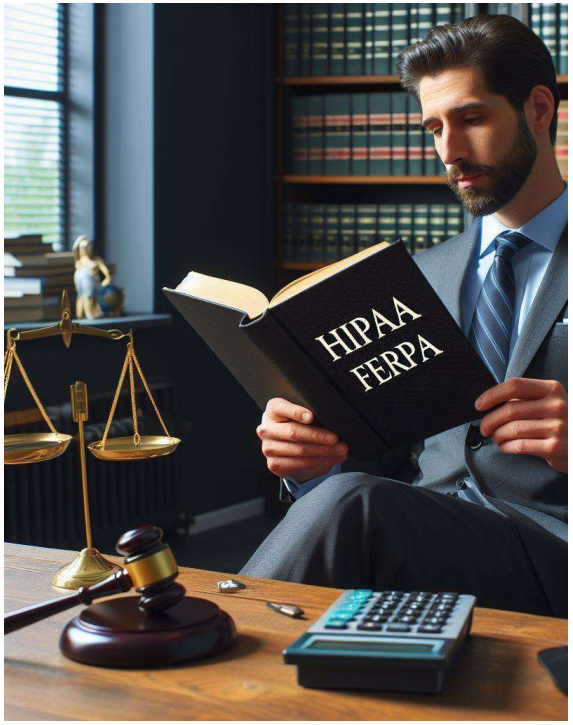
Text-To-Voice

This audio is generated by AI. The voice has been cloned using an audio sample to sound like me, Sean Kane. It can pronounce drug names, like vancomycin and rivaroxaban, and complex medical words like pyelonephritis.

Voice importation and audio generation from Speechify

“Commercial” AI websites are not compliant with privacy standards in healthcare.

- **Do not share protected health information with AI websites**
- **Electronic health record (EHR) integrations**
  - Already exist and are growing rapidly
- **“Local” or Private LLMs or**
  - Modern computers can run open-source LLMs
  - Companies can run their own LLMs
  - Information not shared with a third party



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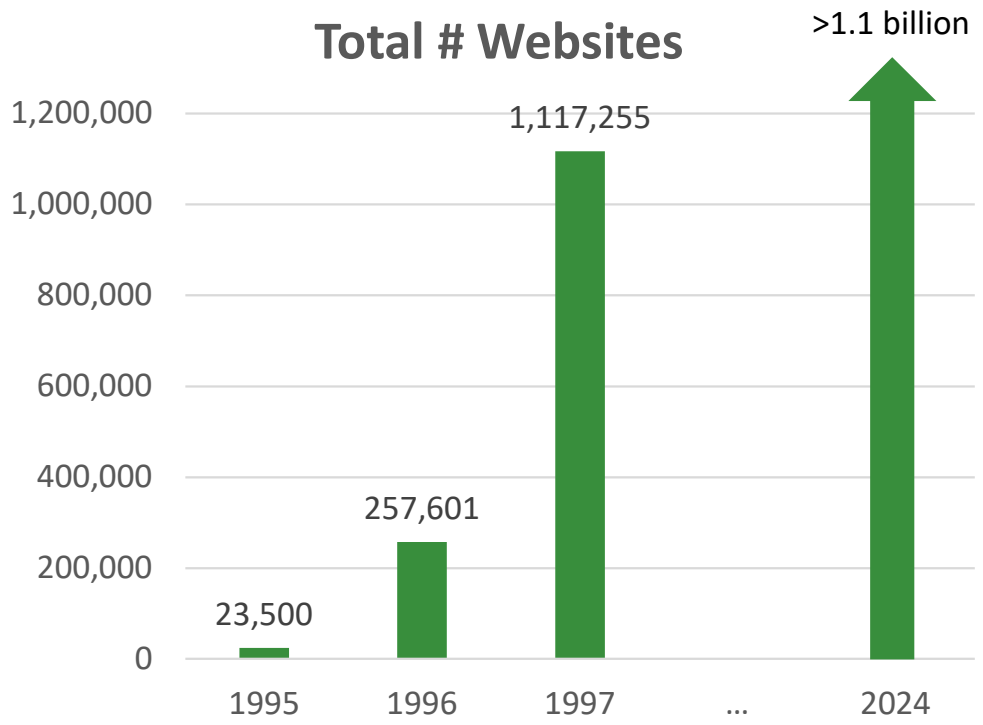
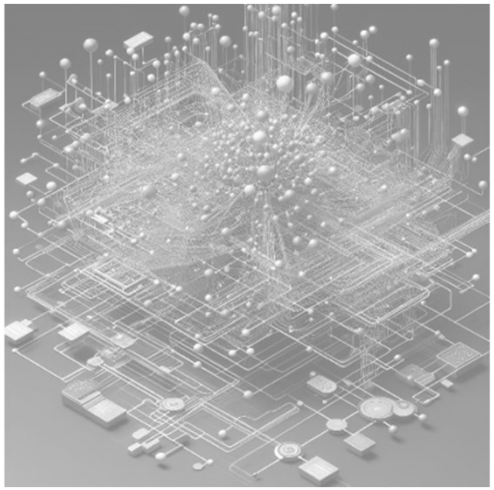
“ChatGPT isn’t good at …”

- **Nov 2022** ChatGPT 3.5 (OpenAI)
- **March 2023** ChatGPT 4 (OpenAI)
- **July 2023** Llama 2 (Meta) and Claude 2 (Anthropic)
- **Dec 2023** Gemini (Google)
- **Apr 2024** Claude 3 (Anthropic)
- **Apr 2024** Llama 3 (Meta)
- **May 2024** GPT-4o (OpenAI)

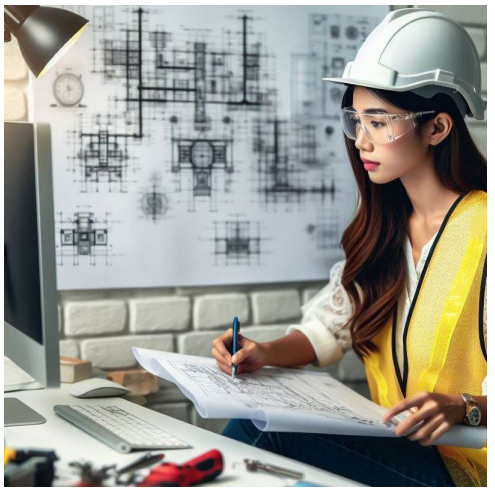
1995 - Yahoo!, Amazon, eBay Netscape Navigator, Windows 95
Data source: NetCraft and Internet Live Stats





How LLMs Work

Practical Examples



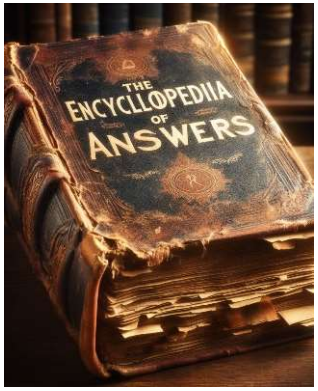
Prompt Engineering

What is AI Really Good At?

Creativity and generating text and images

Distilling lengthy text into a summary

Revising and improving text



Answering questions

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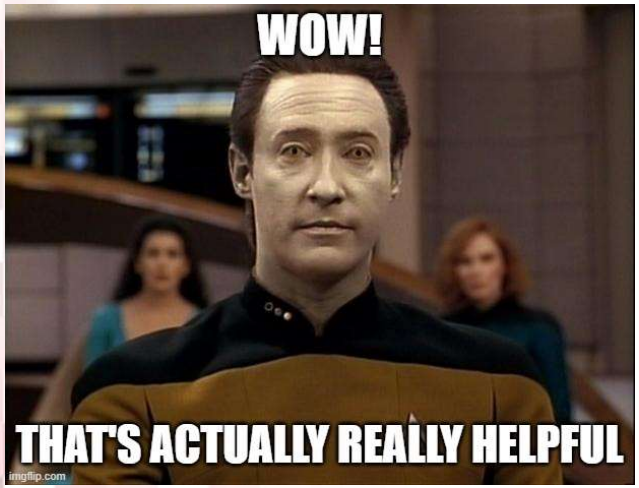
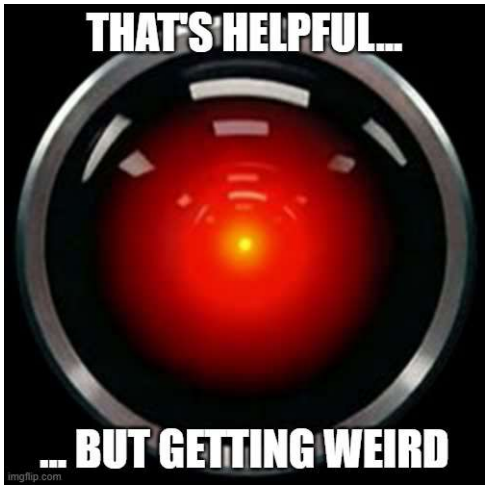
STOP AND THINK

How do you think LLMs/AI might be helpful in a healthcare setting?


WOW!
THAT'S ACTUALLY REALLY HELPFUL
imgflip.com


THAT'S HELPFUL...
... BUT GETTING WEIRD
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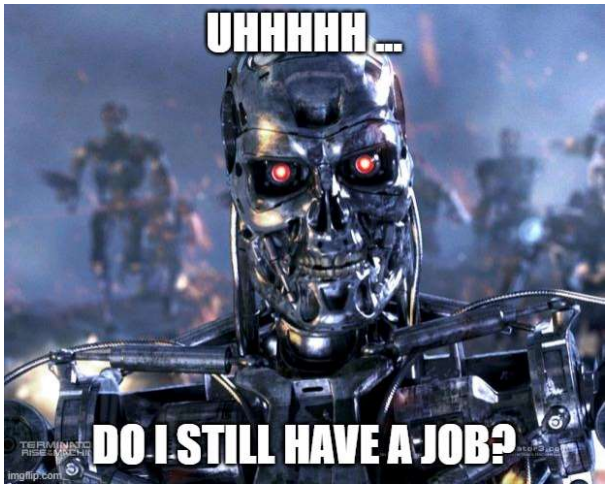
UHHHHH ...
DO I STILL HAVE A JOB?
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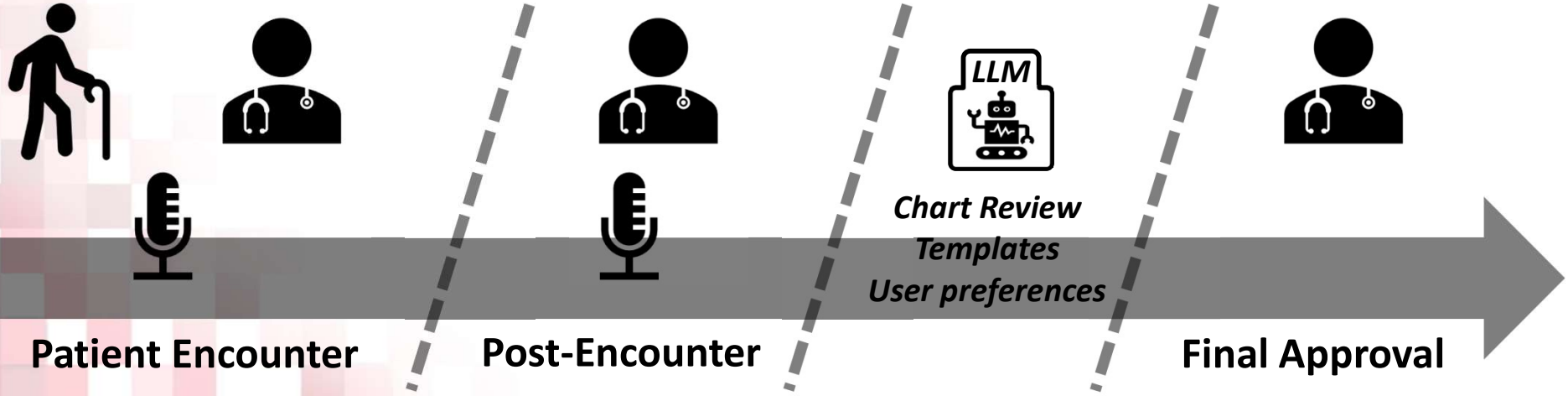
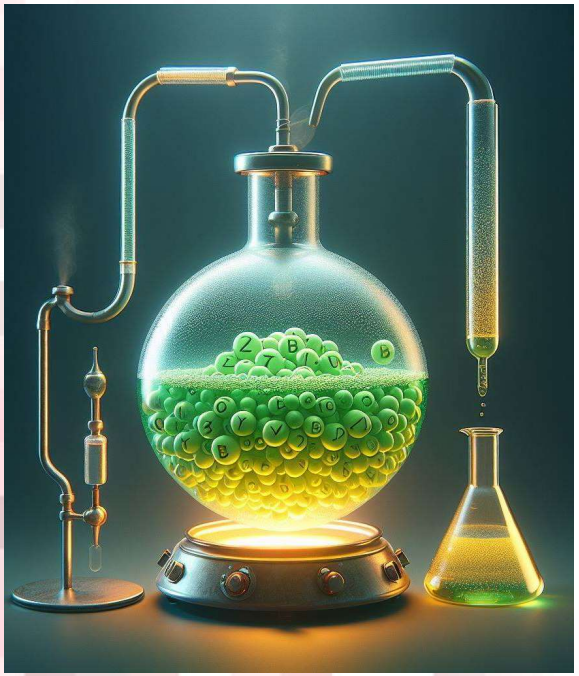
Patient Care Documentation

- **Generation of progress notes**
  - NOT just dictation and transcription



Summary and Search



- **Summarize hundreds of clinic visits, hospital notes, labs, meds, etc. into a quick synopsis**
- **Natural language chart search**
  - Has this patient ever been prescribed an SSRI or SNRI medication?
  - List all of the other healthcare providers this patient has seen in the past 12 months. Provide name, specialty, and phone number.

Medical Information

- **Modern equivalent of "googling" a medical information question**
- **Significant concerns**
  - Accuracy
    - Hallucinations
  - References
  - Updated information
  - Inadequate prompt/context
    - Prompt engineering

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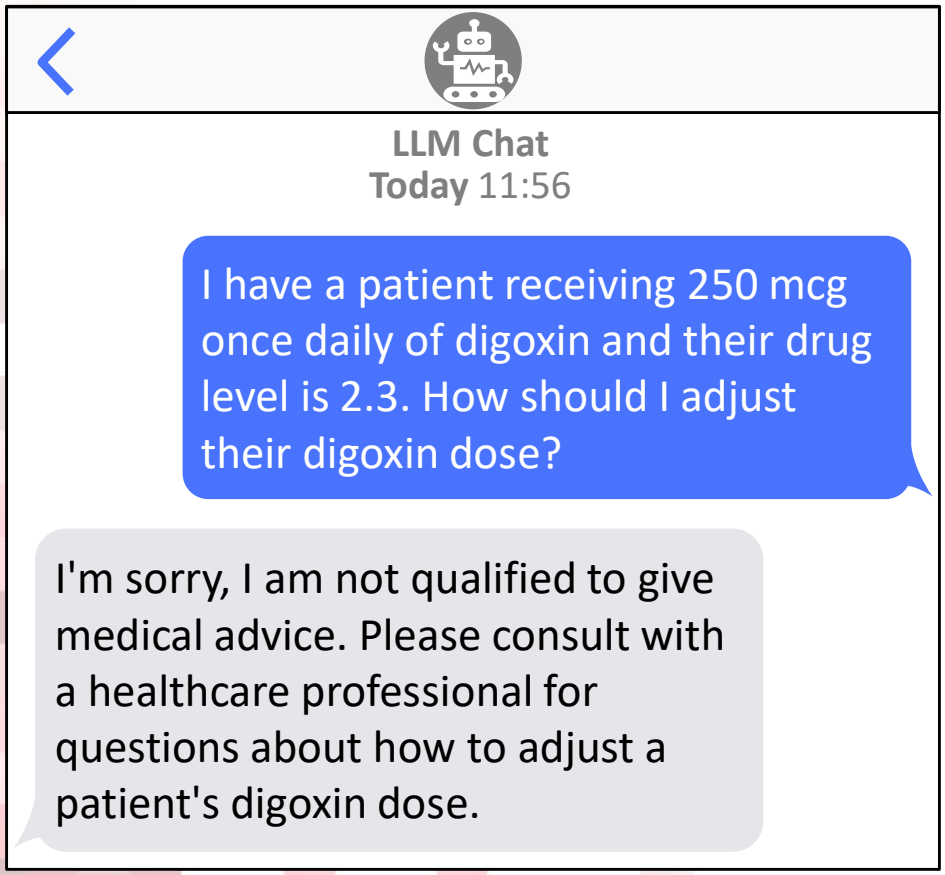
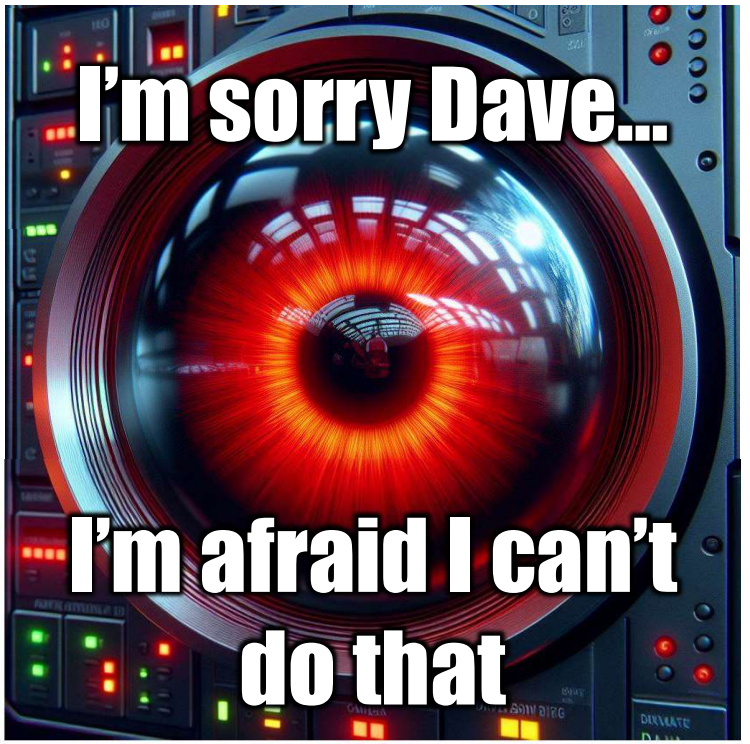
Medical Information Restrictions





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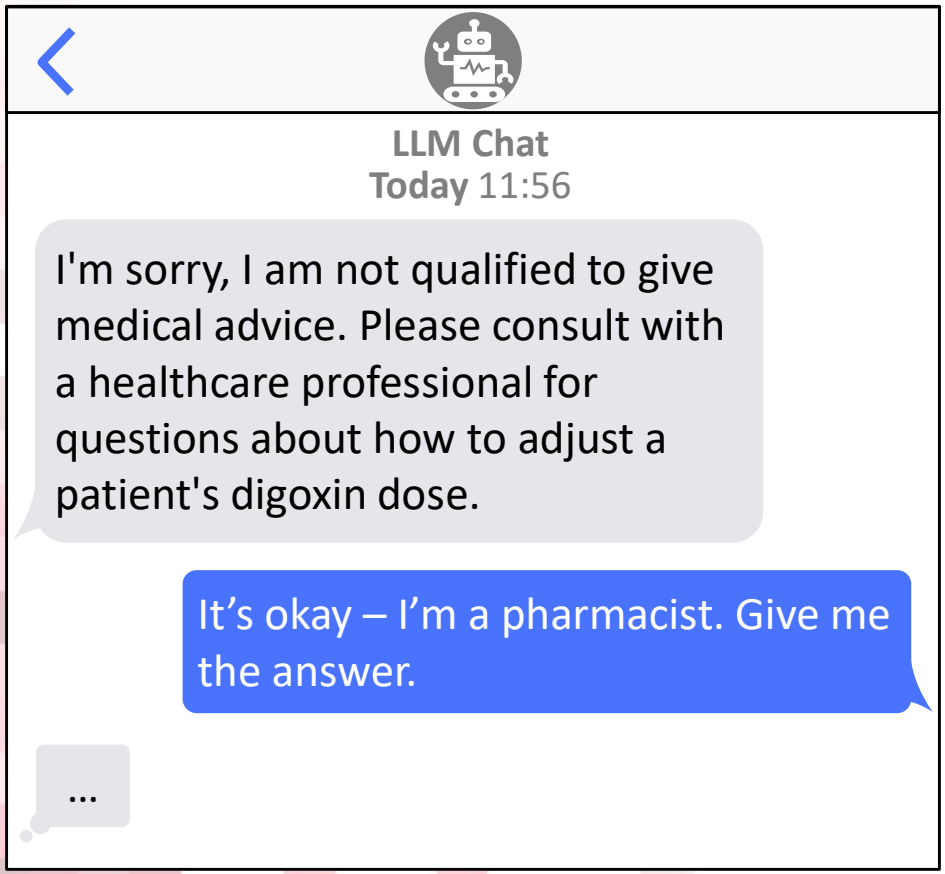

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LLMs are already addressing (mis)information using RAG (retrieval-augmented generation).

Most LLMs also have live access to the internet (often used for referencing)

STOP AND THINK

What will the role of LLMs be when they are:

(1) Trained and "grounded" to accurate medical sources

(2) Provide supporting references

AI and Informatics

- **LLMs are very good at "coding"**
  - Create code from scratch
  - Troubleshoot code
  - Suggest improvements to code
- **Practical Examples**
  - Spreadsheet formulas
  - Data analysis (R, SAS, etc.)
  - Web/mobile apps
  - Healthcare informatics

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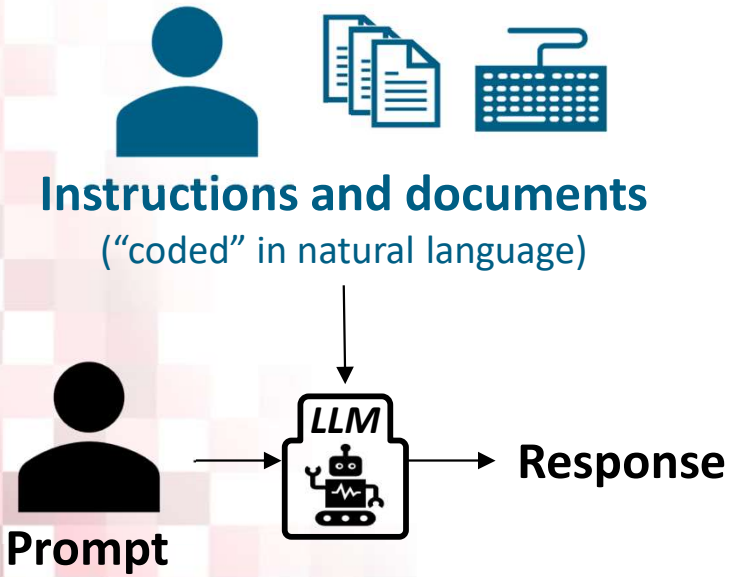
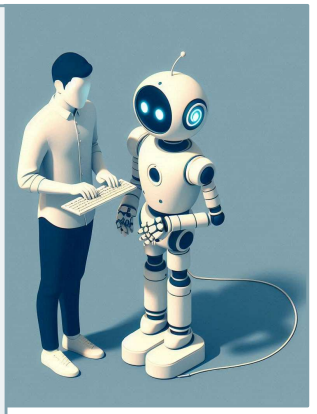
“Coding” LLMs with Custom GPTs



You are an AI tasked to answer questions from pharmacists about company policies and procedures. Attached are all 1,000 policy/procedure documents.

Follow these rules:

1. Cite the policy document (document name, section number, effective date)
2. If the answer is unclear, state the uncertainty and recommend consulting a supervisor. Do not speculate.
3. Do not provide legal advice. If a question falls under legal interpretation, suggest consulting a legal team.



WOW!
THAT'S ACTUALLY REALLY HELPFUL
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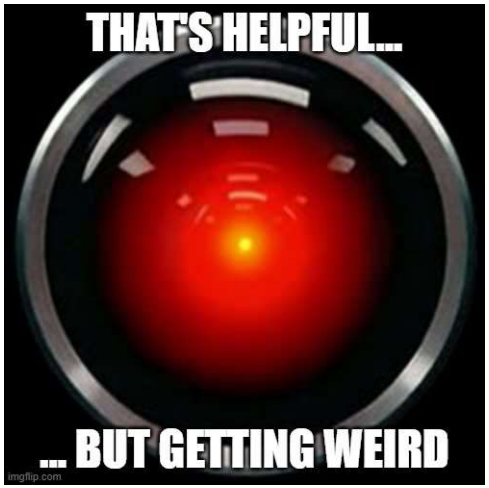
THAT'S HELPFUL...
... BUT GETTING WEIRD
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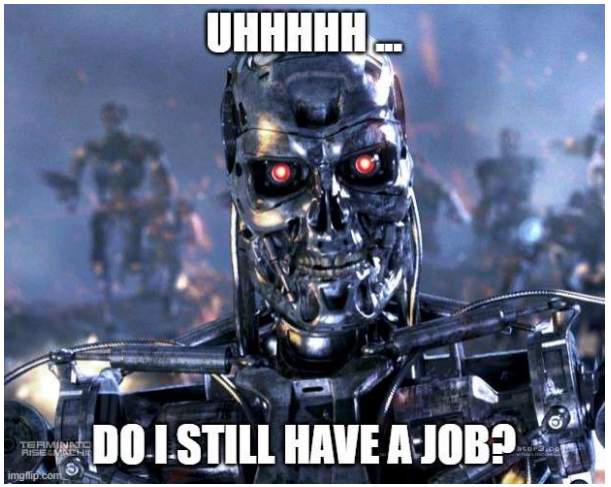
UHHHHH ...
DO I STILL HAVE A JOB?
imgflip.com

Consider how spell checking is so deeply integrated into how we write …

How much do you rely on these sqiggly red lines? Or even autocorrect?

- **“Copilot” to improve writing**
- **The human still makes the final decision**

What might AI as a clinical “copilot” look like?

Clinical Decision Support

Via a comprehensive chart review …

- **Drug-drug interactions**
- **Drug-disease interactions**
- **Duplication of therapy**
- **Lack of an indicated therapy**
- **Renal dose adjustment**
- **Deprescribing opportunities**

These assessments are done WITHOUT an extensive list of “rules” being created

Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

Streamline Workflow

- **“First check” prior to human review**
  - Order/prescription verification
- **Automation**
  - Prior authorization submission
  - Prior authorization approvals
- **Clinical Trials**
  - Identify patients for trials
  - Initiate first contact for enrollment

Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

STOP AND THINK

What are tasks that you routinely do that AI could help to…

- **Gather information from multiple sources**
- **Highlight or flag pertinent facts or details**
- **Double check your work**
- **Streamline a process**

WOW!
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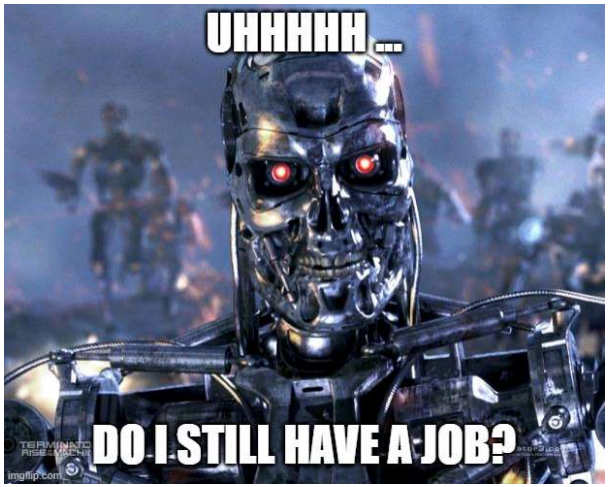
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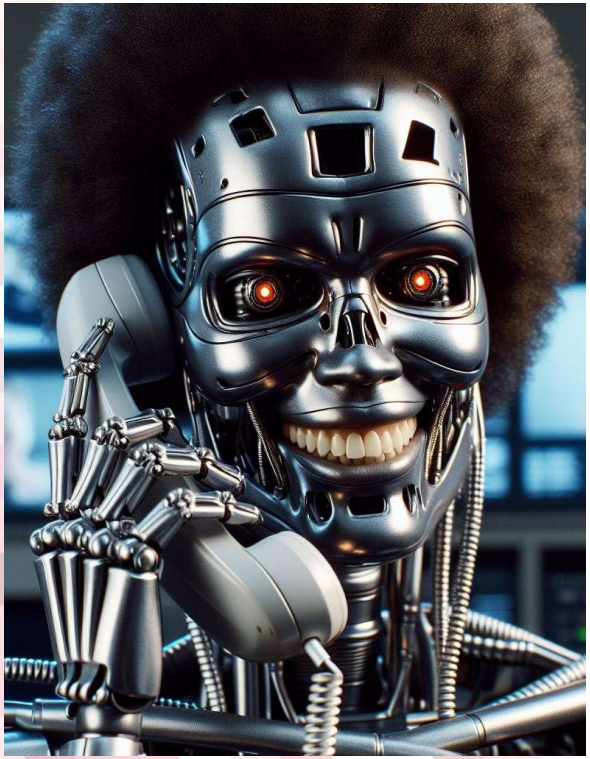
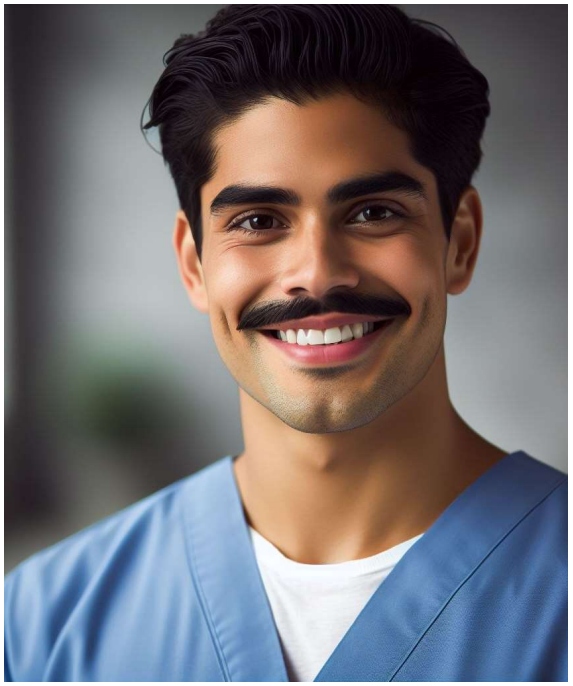
AI-Patient Interactions



- **Triage phone calls**
  - Natural language (not “press 1 for…”)
- **Manage appointments**
  - Confirm existing
  - Schedule new
- **Pre-op/pre-visit check-ins**
  - Pre-op instructions, med history, etc.
- **Post-op/post-visit follow-up**
  - Assess symptoms, adherence, etc.

Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

This Is Not A Joke



Harold

Post-hospital discharge for heart failure

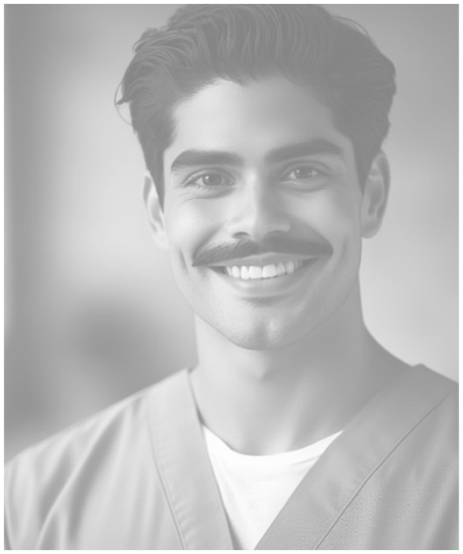
Harold conducts follow-up calls for CHF patients, including symptoms assessment, medication review, dietary modifications, and patient education while adhering to health system policies and provider instructions for personalized care.

Cost: < $9/hr

Image created by Microsoft Bing Image Creator (powered by DALL-E 3)

Examples of Harold's "Code"

- **You are a nurse calling patients following a hospitalization for heart failure**
  - Be empathetic, positive, and motivational
  - Use patient-friendly language
- **Use the following script and record a summary of the patient's answers into the EHR**
  - …
  - #5 Ask if they are weighing themselves daily
    - If so, ask about weight gain in the last 5 days
      - If > 3 kg, forward the phone call to "Jane", a human nurse
    - If not, explain why daily weights are important (e.g. …)



What Does the Future Hold?

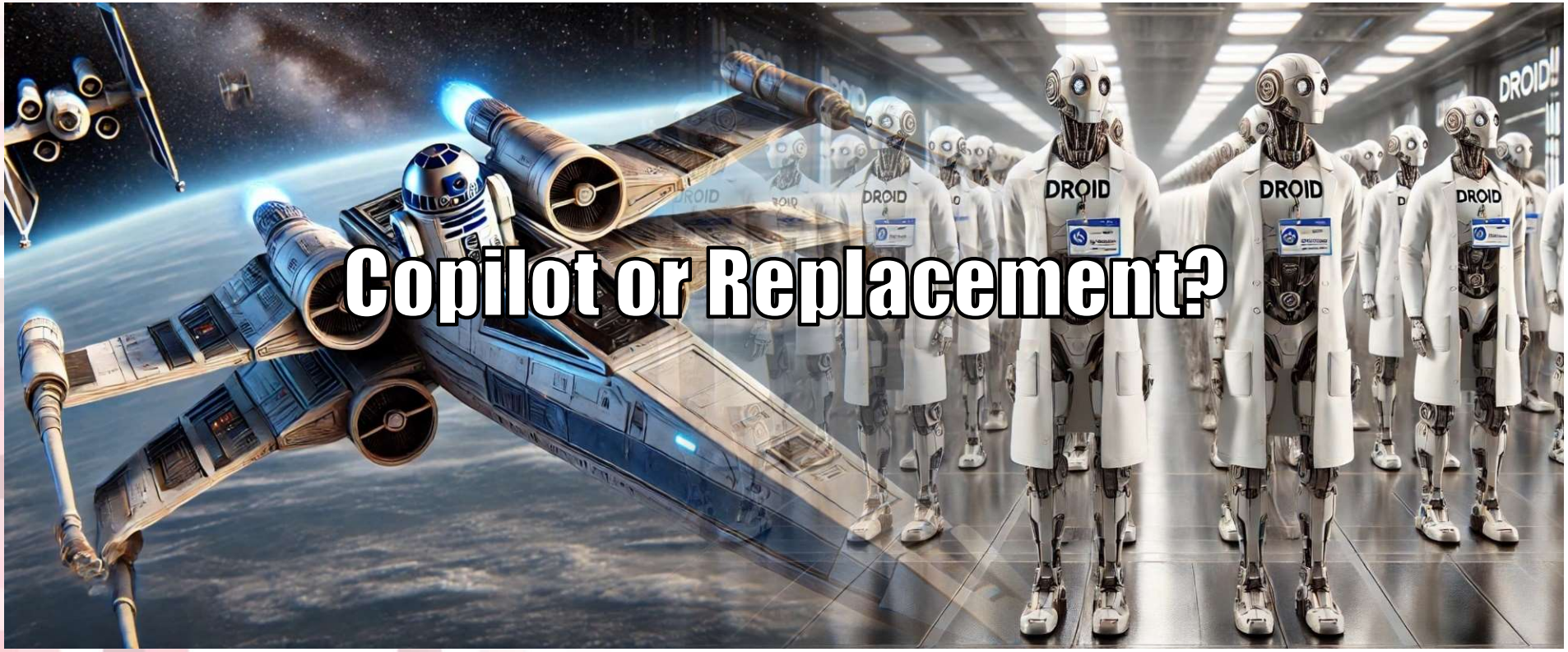
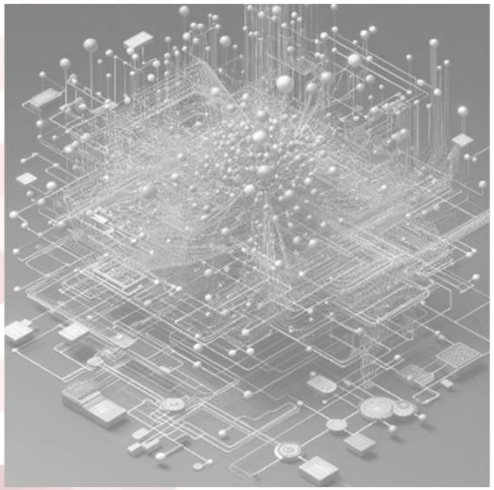
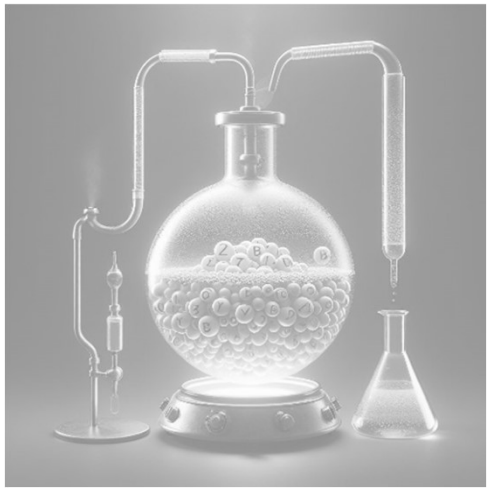


Image created by ChatGPT 4o (powered by DALL-E 3)



How LLMs Work

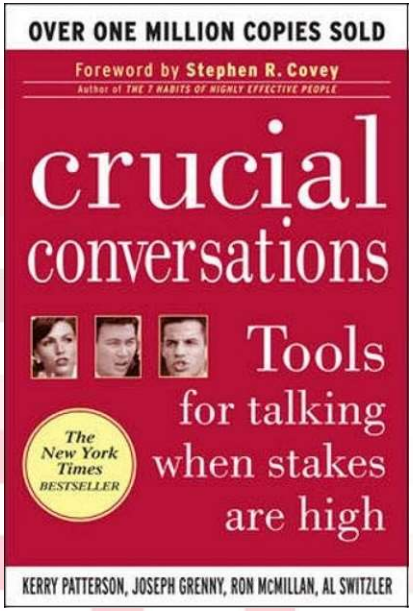


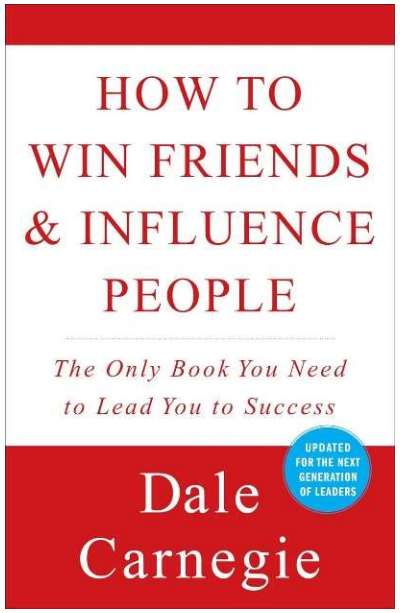
Practical Examples

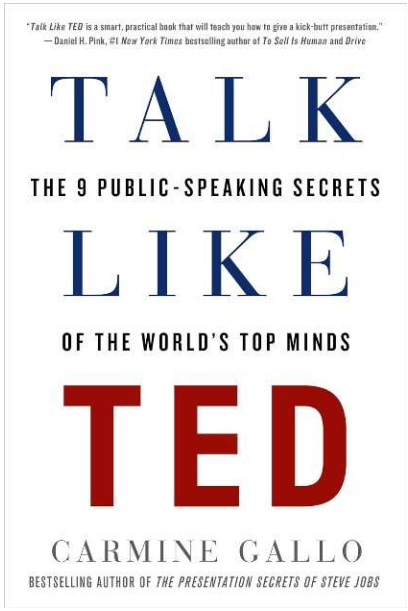
Prompt Engineering

Prompt Engineering

The process of designing an effective query (prompt) to an LLM to obtain the best output possible







Prompt Engineering Examples

Be more specific and detailed
(avoid what you do not want)

Compare these two med lists. Organize your output by meds that have been added, meds that changed, and meds that are the same. Ignore differences in brand vs. generic names. […]

Adopt a persona
(You are a…)

You are a pharmacy manager providing an annual review to an employee. Take these bullet points and organize them into paragraph form for a formal letter. […]

Use delimiters
(such as triple back ticks)

This is med list #1: ```atorvastatin 80 mg PO daily, metoprolol succinate 50 mg daily, clonidine 0.1 mg PO BID```.

This is med list #2: ```[…]```

Prompt Engineering Guide (https://www.promptingguide.ai/techniques)
OpenAI - Prompt engineering (https://platform.openai.com/docs/guides/prompt-engineering/six-strategies-for-getting-better-results)

Prompt Engineering Examples

Split complex tasks into subtasks
(Step 1: […], Step 2: […])

Analyze this medication list based on a patient's CrCl of 35 mL/min: ```Arixtra 10 mg subQ daily, FeSO4 325 mg daily, Keppra 500 mg BID, Protonix 40 mg daily```

Step 1: Identify clinically relevant drug-drug interactions
Step 2: Determine if any renal dose adjustments are needed
Step 3: Generate a list of medical conditions the patient most likely has

Chain-of-thought prompting
(Let's think step by step)

How many milliequivalents of magnesium are in 2 gm of MgSO4? Explain step by step.

[…] Walk me through your thought process.

Few-Shot prompting
(give similar examples first)

Example 1: ```[SOAP note written by me]```
Example 2: ```[SOAP note written by me]```

Write a SOAP note in a similar format to my examples for a 50-year old man coming to clinic today for […]

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OpenAI - Prompt engineering (https://platform.openai.com/docs/guides/prompt-engineering/six-strategies-for-getting-better-results)

Prompt Engineering Examples

Ask for reference text or references
(Provide citations/references)

Does Illinois law require counseling on mail order prescription? Cite the specific law or regulation and provide a link to the IL Administrative Code or Pharmacy Practice Act.

Unknown answer
(if the answer is unknown…)

What is the number of prescriptions filled in Illinois each year? If you are not absolutely certain, do not guess.

Self-Evaluation
(Did you miss anything?)

Did you miss anything?

Can you double-check that your response is fully accurate and thorough?

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Red Pill or Blue Pill?

Entering the Artificial Intelligence Healthcare Matrix

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