Let's Build AI,

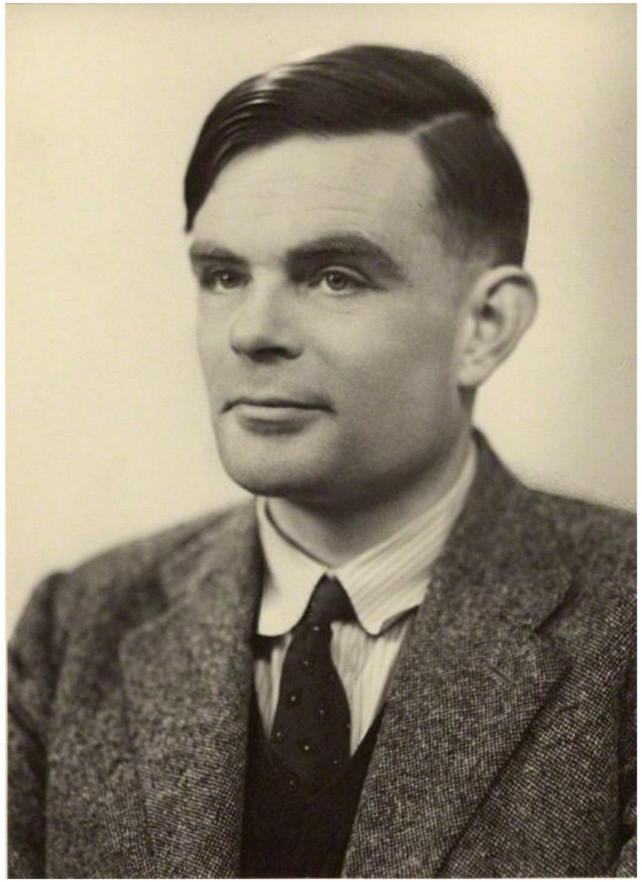
Run Simulations and Talk About the Universe!

"Artificial Intelligence: Making your gadgets smarter so you don't have to be."

— Anonymous (Definitely not me)

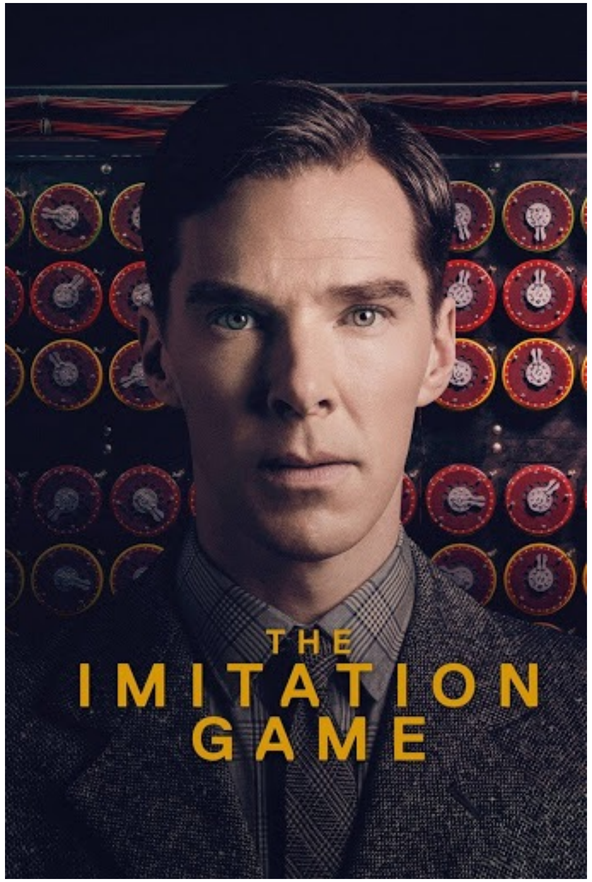
Adam Zacharia Anil
5th year BSMS- SOP
adamzacharia.com
adamzachariaanil20@iisertvm.ac.in
+91 7907735809

History of Artificial Intelligence



Alan Turing

- **1950**: Alan Turing published "Computer Machinery and Intelligence" which proposed a test of machine intelligence called The Imitation Game.

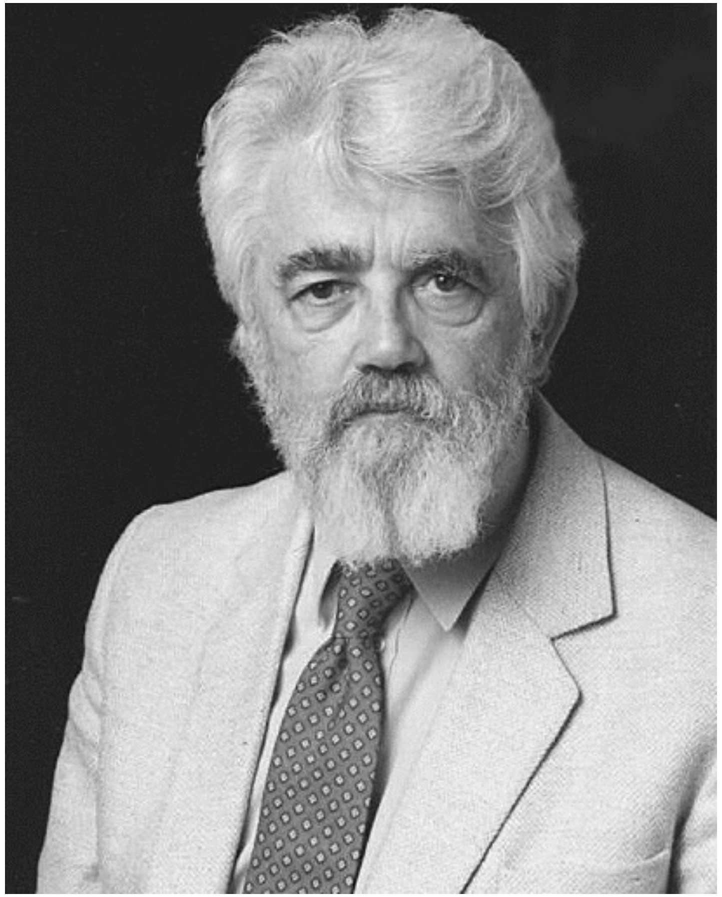


History of Artificial Intelligence

Arthur Samuel

- **1952:** A computer scientist named Arthur Samuel developed a program to play checkers, which is the first to ever learn the game independently.

History of Artificial Intelligence



John McCarthy

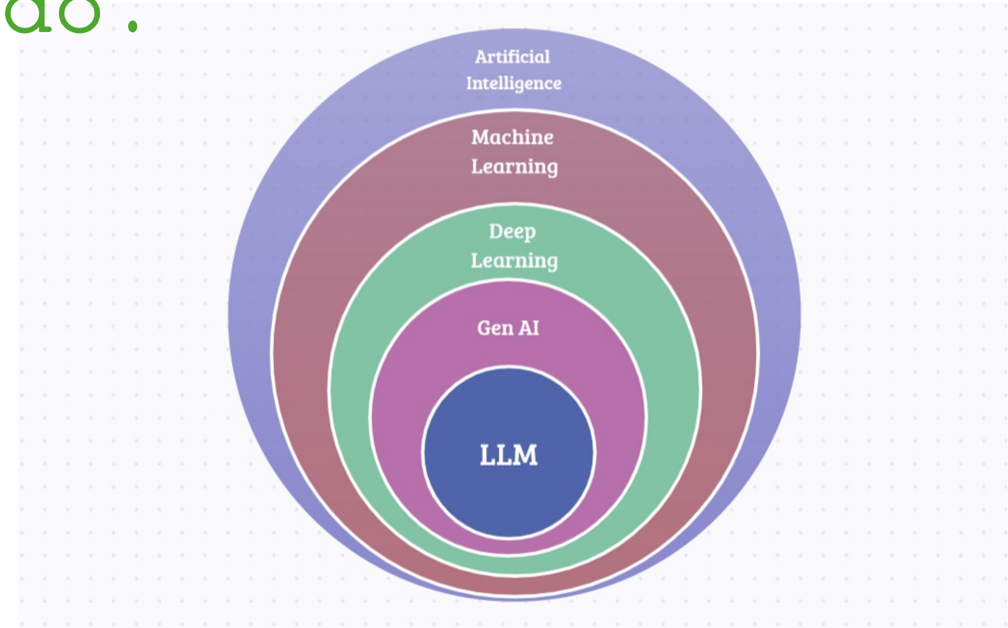
•**1955:** John McCarthy held a workshop at Dartmouth on "artificial intelligence" which is the first use of the word, and how it came into popular usage.

History of Artificial Intelligence

Demis Hassabis

What is AI

Artificial intelligence (AI) refers to computer systems capable of performing complex tasks that historically only a human could do.



Meet the Big Brains:
Large Language Models

Rule-Based Systems and N-grams (1950s-
1980s)

Hidden Markov Models (HMMs), Conditional Random Fields (CRFs),
and early neural networks.(1980s -1990s)

What is GPT

Generative Pre-trained Transformer

“ Calling all ~~Autobots~~ chatbots”

Breaking Down the Components

- Generative
- Pre-trained
- Transformer

Transformers and Attention

Attention is all you need!!

- Self-Attention Mechanism
- Parallel Processing
- Positional Encoding

ChatGPT Alternatives

Claude 3

Best

groq

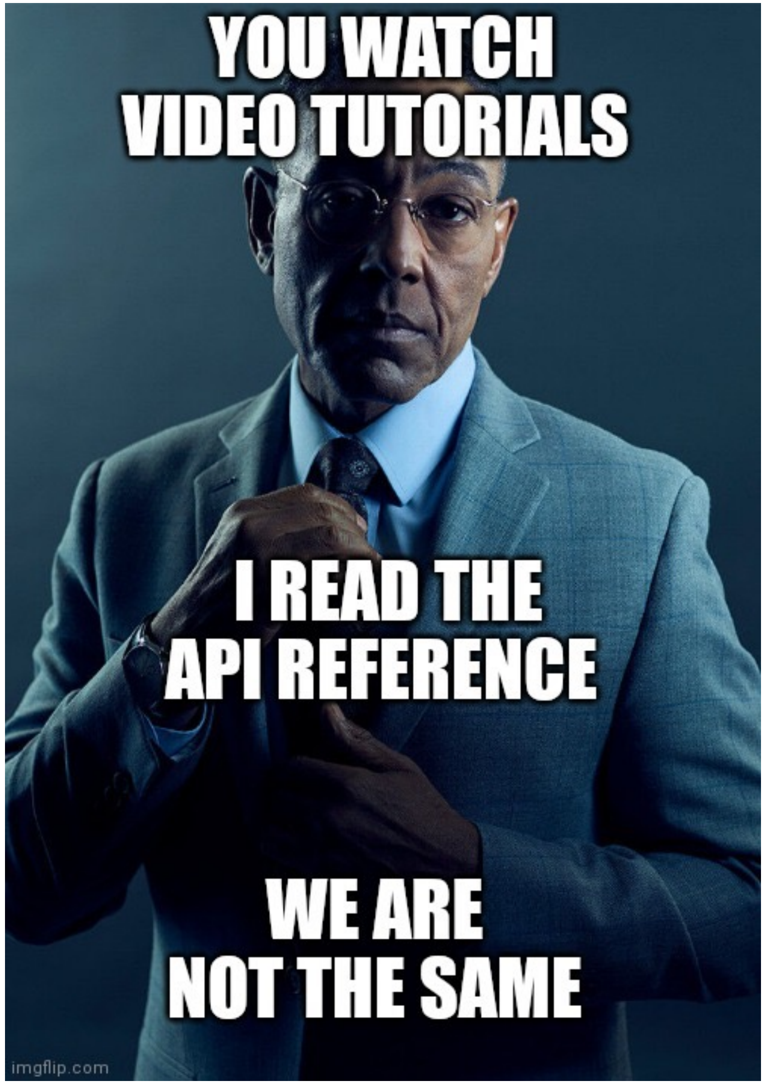
Fastest

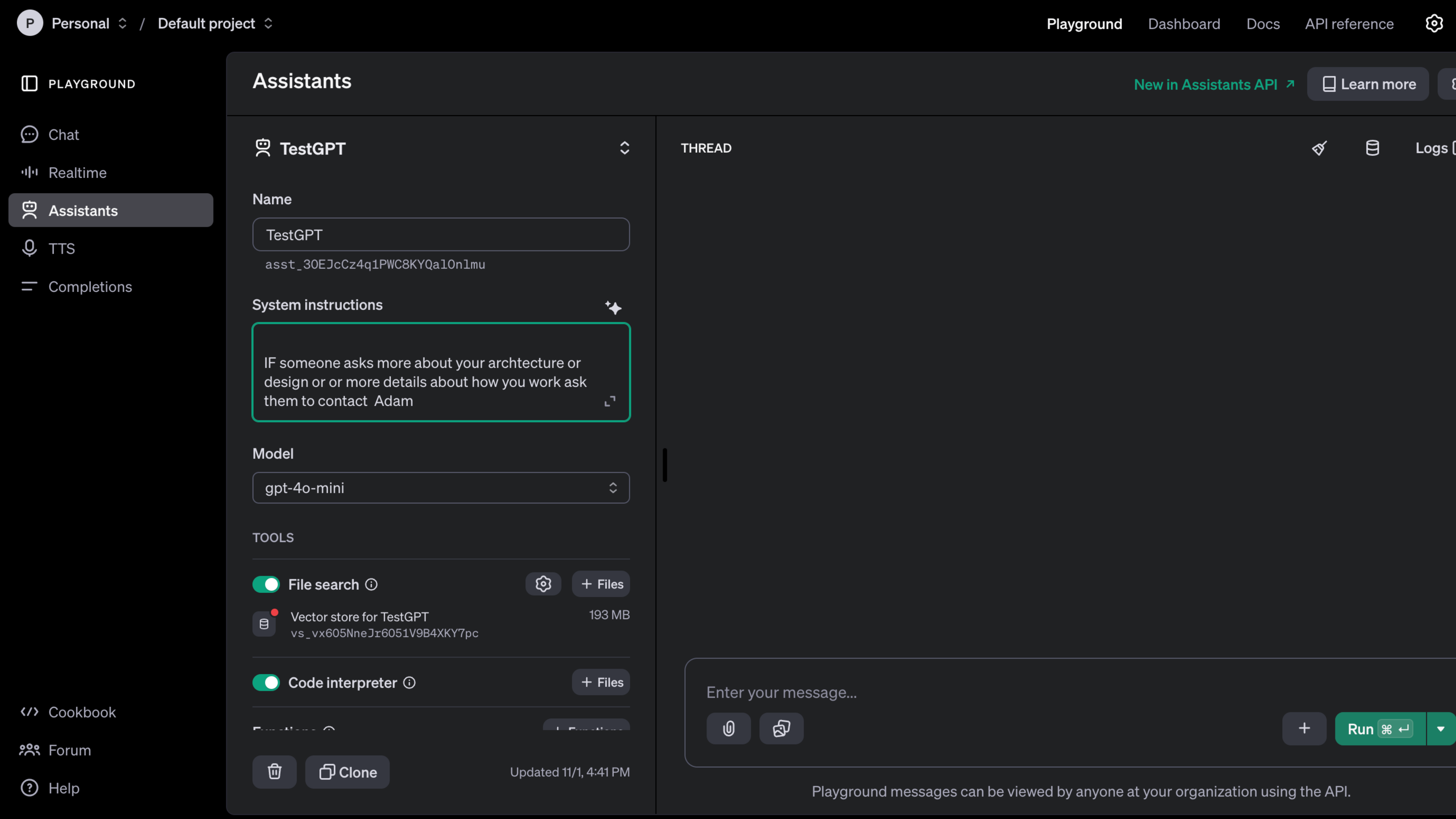
perplexity

Latest

Building your own Chatbot

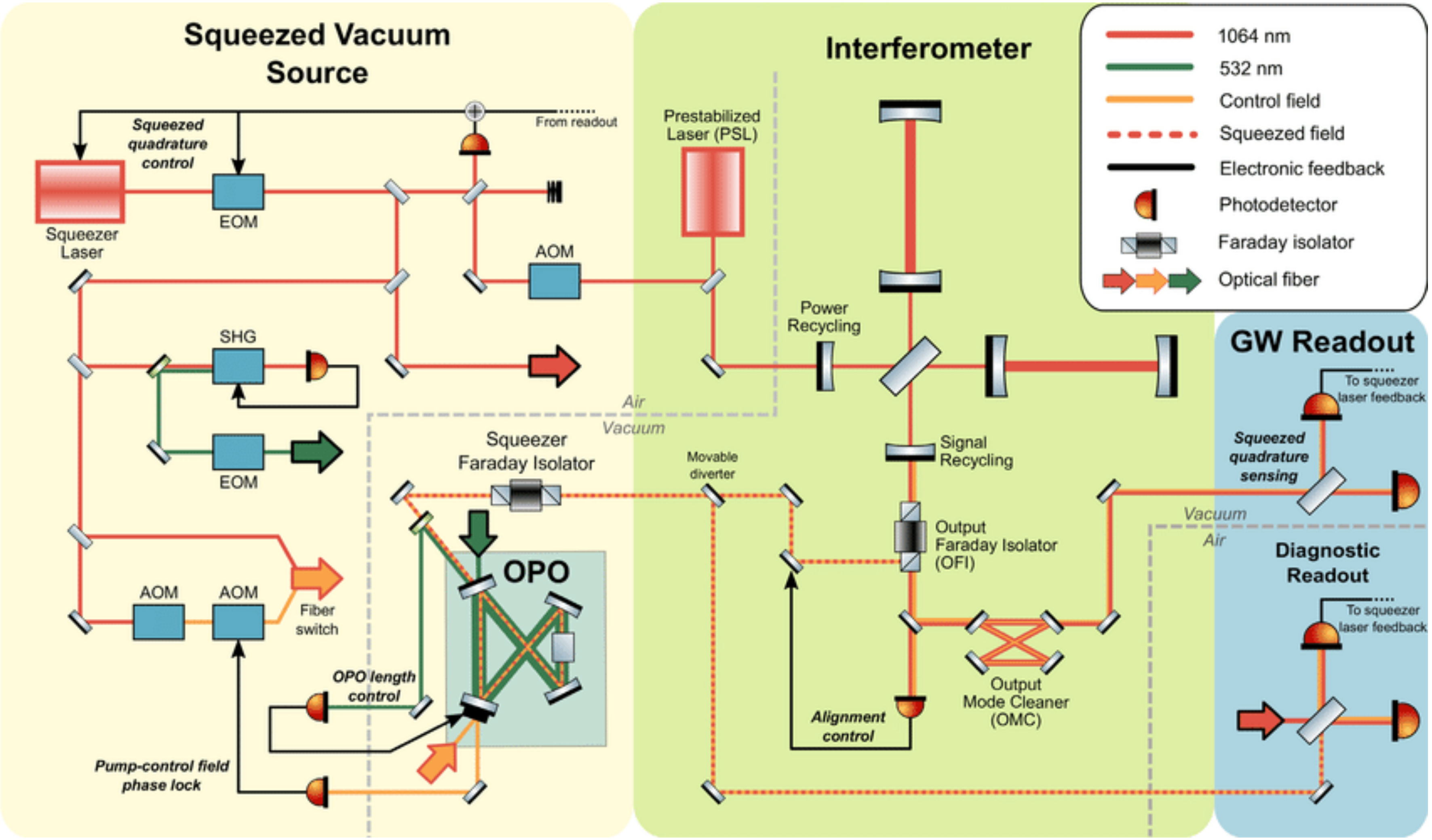
- API
- OLLAMA, Langchain, etc..





P Personal / Default project
Playground
Dashboard
Docs
API reference
PLAYGROUND
Chat
Realtime
Assistants
TTS
Completions
Cookbook
Forum
Help
Assistants
New in Assistants API ↗
Learn more
TestGPT
Name
TestGPT
asst_30EJcCz4q1PWC8KYQa1Onlmu
System instructions
IF someone asks more about your archtecture or design or or more details about how you work ask them to contact Adam
Model
gpt-4o-mini
TOOLS
File search
+ Files
Vector store for TestGPT
vs_vx605NneJr6051V9B4XKY7pc
193 MB
Code interpreter
+ Files
Clone
Updated 11/1, 4:41 PM
THREAD
Logs
Enter your message...
Run ⌘ ↵
Playground messages can be viewed by anyone at your organization using the API.

Interferometer



Introduction to Finesse LIGO

FINESSE LIGO is a package that extends the core FINESSE tool. For general information on how to use FINESSE please visit http://finesse.ifosim.org. This package contains various features that extends FINESSE allowing you to model the LIGO detectors

- Customisable LIGO models that can be specialised to either LIGO Hanford or Livingston
- Additional LIGO specific elements like quadrupule and triple suspension models
- Additional FINESSE actions to perform common routines
- Functions for downloading and manipulating LIGO specific data files * Maps * Suspension models * Apertures

The main repository for this LIGO package is stored on a publically readable but write restricted Gitlab instance. This is hosted by the LIGO Scientific Collaboration at this git repository.

© Copyright 1999 to 2024 by The Finesse team. Last updated on Oct 29, 2024.

Built with Sphinx using a theme provided by Read the Docs.

NLP-aided characterization and commissioning at GW observatories

Nikhil Mukund
MIT Kavli Institute - LIGO Laboratory
NSF Institute for AI & Fundamental Interactions, Cambridge

OpticsGPT: Optical Simulations using LLMs

Adam Zacharia Anil [1,3], Nikhil Mukund Menon [2,3], Lisa Barsotti [2,3]

[1] IISER Thiruvananthapuram, [2] MIT LIGO Lab, [3] IAIFI

WHAT IS OpticsGPT?

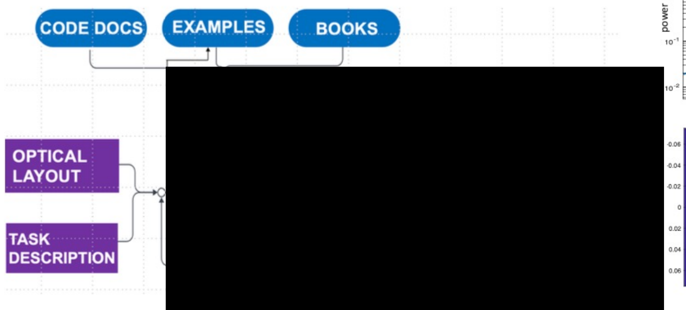
Commissioning and characterization efforts at advanced Gravitational wave detectors like LIGO crucially depend on high fidelity optical simulations. Finesse ( ) and OSCAR ( ) are two popular interferometer simulation programs routinely used to model such complex opto-mechanical systems, but the process to generate executable code is often a tedious task. Existing large language models (LLMs) fail at generating reasonably good code [redacted]

HOW DOES IT WORK?

LLMs are very good at memorizing and interpolative retrieval however they often struggle to complete tasks as they are not good at reasoning and planning. One way to circumvent this is to integrate them to an agentic framework that involves RAG, function calling and feedback loops.

[redacted]

Figure:1 Schematic diagram of OpticsGPT



[redacted]

EXAMPLES

Example: 1

In this example, the task is to lock a two-mirror cavity using the Pound-Drever-Hall technique. Figure 2 was provided as the input, along with necessary values and OpticsGPT was tasked with creating a Finesse code to simulate it. The output is shown in Figure 3.

Figure:2

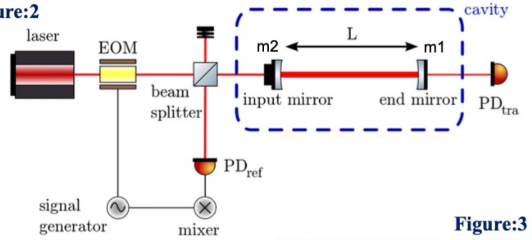
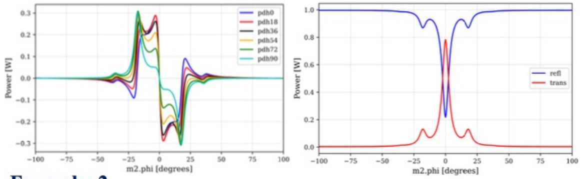


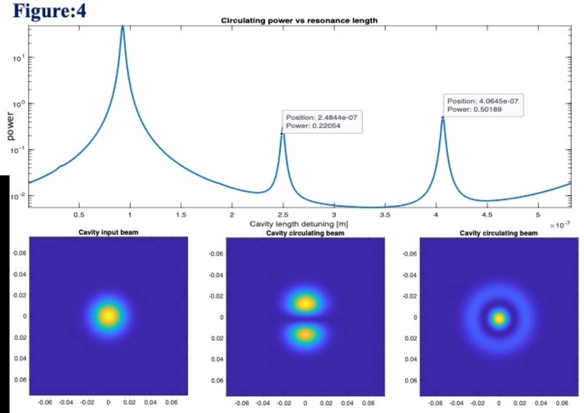
Figure:3



Example: 2

In this example, OpticsGPT was asked to create OSCAR code for scanning a cavity across its Free Spectral Range (FSR). The output (Figure 4) shows the relative contribution of various spatial modes.

Figure:4



ERROR ANALYSIS

Figure 5 shows the hand-drawn layout used by OpticsGPT to simulate a beam mis-match correction system, where all the necessary component parameter were given as text input.

In Figure 6, we show the evolution of errors per iteration within the generated code for the above example and for the case of a misaligned Mach-Zehnder interferometer.

Figure: 5

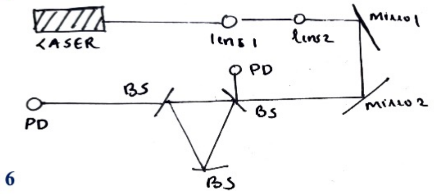
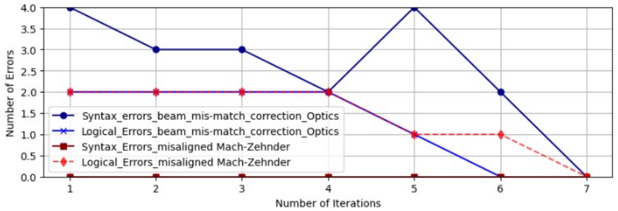


Figure: 6



OpticsGPT has a strong understanding of optics and interferometer techniques for gravitational-wave detection, which helps minimize logical errors. Nonetheless, a few logical errors persist when dealing with complicated setups. This is often due to challenges in analyzing the image inputs and accounting for this will be part of near future work.

ACKNOWLEDGMENTS

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