# Generative AI for Science Communication

Diego Valle

Elgin Community College, CCI Intern- FERMILAB-PUB-24-0421-COM

Maura Barone

Fermilab, Advisor

**Abstract**

Generative artificial intelligence has brought innovations across multiple fields, offering great tools for enhanced communication and efficiency. This project consisted of developing a custom AI chatbot to support science communication, with a focus on increasing efficiency and optimization. A market research identified OpenAI's ChatGPT as the optimal chatbot choice, leading to the adoption of its Team's version. The scope of the project included the creation of four distinct personas to tailor responses to specific audiences. Samples of Fermilab's published content were fed to the chatbot to ensure tone consistency. After adequate training involving iterative prompt trials, the custom chatbot resulted in a responsive and effective communication assistant. Initial evaluations indicate that the custom GPT shows promising applications.

## 1. Introduction

In recent years, generative AI has been at the forefront of innovation and used across various industries for many use cases. While the first chatbots were introduced in the 1960s, it is only recently that generative AI became a commonly used tool. For this project, we explored the most popular and current generative AI chatbots and selected OpenAI's ChatGPT (GPT-4o or Generative Pre-trained Transformer-4o), which was released in spring 2024. Among the key parameters we evaluated for comparison were quality, knowledge, and cost. OpenAI also offers an option to edit and make your own custom GPT model. The option is based on the GPT-4o model but allows to build up from there for more specific tasks. We customized the GPT by providing a library of recently published science communication material related to Fermilab, creating personas to represent the target audiences, and training it to use Fermilab's tone for communicating science.

# 2. Purpose

The project aims to leverage generative AI to support science communication efforts. By developing and implementing a custom GPT shareable among communications team members, we seek to optimize efforts and improve the team's efficiency. The GPT allows to creation of easy-to-use custom prompts, also called quick prompts. In the GPT we created, these pre-made questions focus on optimizing content and metadata for search engine optimization (SEO), targeting and engaging specific audiences when communicating science, all while maintaining Fermilab's tone and writing style. We also made available a quick prompt for requesting assistance in creating alternative text, or alt text - a text description that complements non-text elements in web pages for ensuring the content is web accessible to all readers.

The ability of the custom GPT to answer the questions is strictly related to the quality of the training we did when defining them. The quick prompts are displayed on the custom GPT screen and can be used along with the standard GPT prompt. With this addition, the custom GPT we created, called "Fermilab Science Communications GPT", has proved to be a fast, friendly, and promising tool.

# 3. Research and Methods

## 3.1 Background Research

Artificial intelligence (AI) is a field of computer science that focuses on making machines do tasks that usually need human intelligence to be completed. AI systems use an algorithmic approach to process data, learn from it, and make decisions. There are different types of AI, from simple ones that react to specific situations to more advanced models that can complete complex tasks, like optimization.

Generative AI is a type of artificial intelligence able to generate content like text, images, music, and videos, by learning from large data. It uses a type of artificial neural network, the so-called multimodal large language models, or LLMs, to make decisions and generate content. Generative AI allows machines to not only understand and analyze large-scale sets of textual data but also use the acquired knowledge to generate new data. This makes it useful in many areas from creative fields to scientific research.

There are two key techniques for training a generative AI model: fine-tuning and prompt engineering. Fine-tuning is retraining a pre-trained model on a specific dataset to improve its performance, whereas prompt engineering focuses on making input prompts to provide specific instructions and guide the responses. Fine-tuning gives a deeper customization but needs much more work and is more suitable for performing specific tasks, prompt engineering is more flexible and can generate excellent outputs if it is formulated to provide the right context.

When it came to market research of existing generative AI tools, we first began by searching the market to find the best AI chatbots available for this project and identify which of them met needs and expectations. Currently, the top companies with AI chatbots are OpenAI, Anthropic, Google, Meta, and Microsoft. We looked at comparative analysis available online called artificial analysis [2], as well as data provided by the individual companies. Given the objectives of the project, when deciding which AI tool would be the best, we valued the quality aspect of the responses and subscription cost, over speed. We also felt it was important to have the option to customize the chatbot and create a centralized solution for our organization, making it available to team members at no additional cost - this makes for great future collaboration and is more cost-effective. The option to create a custom GPT is currently only available for certain models. Last, we were interested in the possibility of completing numerous tasks with the so-called actions code. An example use case is for the chatbot to stay up to date with current scientific communication news. For all these reasons, we felt that OpenAI's ChatGPT-4o Team [1] was the best choice among the available models and OpenAI plans.

### 3.2 Methods

To target specific audiences, we used ChatGPT to generate four personas. This step is described in detail in section 4.1.

To further fine-tune the GPT in understanding and communicating using Fermilab's voice, we fed documents of published content in PDF format as described in 4.2.

To scan the most up-to-date news and ensure the GPT remained current on science news and activities, we used a JSON Schema from a specialized schema GPT (see section 4.3). JSON is code, and Schema is a certain function of that code defining the format of the JSON data. We then adapted the code of this data definition, called action, to monitor the Fermilab website in real-time or retrieve the latest news published on any given day - the day can be provided as a parameter. This is important also to ensure there are no hallucinations. Hallucination is a term used to indicate that AI is making up data because it does not know enough about it - an attempt to cover up the blind spot.

We also created and refined several quick prompts meant to get the most out of the GPT. Every prompt was trained through at least two rounds of training, ensuring the response would be accurate on point, and of high quality.

## 4. Training

### 4.1 Personas

Open and clear scientific communication fills the gap between 103 scientific progress and the public's understanding of it. From the outset of this project, we had factored in the need to create personas. In digital communications, a persona is a character rep-

resenting individuals who belong to a segment of the target audience. A well-defined persona includes demographic characteristics, as well as motivations, pain points, challenges, expectations, and behaviors. We targeted four major groups: interested students in the field of science, technology, engineering, and mathematics (STEM); government stakeholders and funding agencies; physics collaborators; and all other members of the public. We first created our own detailed description of each persona. For example, we want members of the public to understand that Fermilab is a particle physics laboratory that aims to answer fundamental questions about the universe, and we also want them to make a human connection to it. Effective public communication uplifts science, making it more approachable and relevant to their lives. Government stakeholders use clear and extensive communications to help create policies and allocate resources. Engaging with the laboratory's international physics collaborators through effective communication fosters collaboration and innovation. We added to each of these descriptions specific facts to ensure the best impact and reach of scientific information.

We then fed these descriptions into ChatGPT, which can generate custom personas as if they were real people, with their names, job titles, interests, challenges, and different levels of understanding of scientific concepts. To ensure the most realistic result, we made several rounds of refining and editing. We then included the four personas in our custom GPT, providing them as specific instructions for the chatbot. See section 4.4 for more information. We also made a prompt called "What personas will understand this". This quick prompt makes the chatbot ask the user to provide the content they plan to communicate, after which it gives a detailed analysis of the level of understanding for each persona, providing a reading score and estimated grade level. It also provides an insight into how the text may be improved for some specific personas by for example identifying details that were not addressed in the content and that instead the persona will likely be interested in knowing.

## 4.2 Public Content

ChatGPT provides users the option to upload files in support of the so-called synthesis and transformation capabilities of the GPT. This feature is an essential part of replicating Fermilab's tone and emotion of the staff writers and providing feedback on content drafts when it relates to the target audience. While the number of files that can be uploaded to each GPT is currently capped at 20, the Team plan allows to upload files up to 512MB each.

For granting an additional layer of information, we found it beneficial to upload content in the format of PDF files into the GPT library. For the initial proof of concept, we chose some of the recently published feature articles and press releases, as well as public relations webpages that provide an overview of the laboratory, the science and technology research, and the people. For the choice, we also used analytics data to determine which assets are the most popular among our audiences. In addition to providing an overview of the science

at the laboratory, this whole compilation helped us draw out some of our organization's key elements, such as our values, culture, and history. The PDFs were then scanned by the GPT, under the title "Knowledge," and uploaded to the back end of the GPT. This library is now a component of its knowledge base. This made it possible to add to the custom GPT a quick prompt focused on addressing tone and emotion in writing. Users of the custom GPT can click the quick prompt called "Does this have a Fermilab tone?" From there, the GPT will ask for the text and give suggestions. This is crucial because it's necessary to put out articles that have a consistent-sounding voice. Proper communication in science ensures that scientific findings and progress reach a wider audience. For stakeholders, clear and precise communication helps in the development of relevant policies concerning the government and the further allocation of resources to them. Working on effective communication with physics collaborators leads to effective collaboration and thus innovation. Engaging the public with effective communication demystifies science and makes it user-friendly. We make scientific information more impactful and reach more people by making the communication strategies more person specific. This benefits students, policymakers, collaborators, and the public at large. Adding PDFs also allows for other functions, such as being able to write alt text descriptions. One of the PDF files is a detailed guide to writing alt text, allowing the GPT to become very knowledgeable on what type of descriptions are needed.

## 4.3 Real-Time Scanning

The "actions" feature allows the GPT to perform actions on different websites, such as sending emails, scanning for data, or other tasks. Actions can be added to a dedicated action tab. We felt it was best to use this feature for real-time scanning if the GPT was prompted to, as opposed to running continuously. For example, you can ask the GPT questions like "What articles were posted today?" to get new information. Since the current ChatGPT model only has data up to October of 2023, this feature is useful for keeping the GPT updated on the tone and writing style of websites.

## 4.4 Trial and error

When training the GPT, it would take at least two iterations to develop each quick prompt. For feeding published material, we initially had GPT scan PDF files and provide outputs, but it soon became clear the importance of also retrieving recent news. We therefore modified the code from an old version of ChatGPT and enabled the news scanning feature.

The custom GPT has two different ways you can upload data. One allows one to provide specific instructions, while the other is more conversational. We used both options. However, we found the results were more consistent and had better memory when uploaded as instructions. Instructions need to be very specific and detailed.

With regards to personas, the first few that the GPT generates were unnecessarily

detailed in demographics, which could make it biased. After several refinements, we uploaded personas to the GPT in the form of instructions.

Descriptions generated using the alt text prompt were initially overly lengthy. Asking for shorter responses nudged the chatbot to create more concise and helpful descriptions.

Along the way through several iterations, we developed the functionality of the custom GPT to provide the right and unbiased information.

## 5. Results and Conclusion

In the end, we did what we set out to do well: We have successfully created a functioning custom GPT tailored to give us correct and constant outputs, helpful for communicating Fermilab's science. We did detailed persona development - uploaded a filtered collection of PDFs to our library - and experimented with a real-time scanning feature. The GPT works fine now, and we are getting the output we need with the Fermilab voice preserved for us. The next step is to onboard members of the communications team for further practical uses. The customized GPT will continue to be a useful tool for communicating the laboratory's mission and scientific success with others.

## 6. References


[1] OpenAI ChatGPT (openai.com)

[2] Artificial Analysis models (artificialanalysis.ai/models)


## 7. Acknowledgments


- This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.

- This work was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Community College Internship (CCI)

- We thank Fermilab's Communication Division for providing some of the resources necessary for carrying out this research.