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A Comparative Study of ChatGPT, Gemini, and Perplexity

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ABSTRACT - Generative AI is making buzz all over the globe and has mostly drawn attention due to it's ability to generate variety of content that mimics human behaviour and intelligence along with the ease of access. It comprises of the ability to generate text, images, video, and even audio that are almost unrecognizable from human-created content. Thus there is a huge scope of research in this field due to its vast applicability and motivates this research work. This research work presents comparatively analysis of the three Generative Artificial Intelligence (AI) tool, namely ChatGPT, Gemini, Perplexity AI, based on the content generation, ownership and developing technology, context understanding, transparency, and information retrieval.

KEYWORDS: Generative Artificial Intelligence, ChatGPT, Gemini, Perplexity AI.

I. INTRODUCTION

In recent years, the rapid integration of artificial intelligence (AI) into education has sparked extensive discourse concerning its influence on traditional pedagogical methods and practices [1][2]. Artificial intelligence (AI) is a branch of computer science that concentrates on developing and creating hardware or software that exhibits some sort of human intelligence. Artificial Intelligence (AI) refers to the mimicking of human intelligence or the human behaviour in machines. It involves developing various kinds of algorithms and computer programs to process and make decisions.

It comprises of the several approaches and the technologies consisting of the robotics, natural language processing, deep learning, machine learning, and computer vision, etc. The goal of AI is to develop a system that can process the data and make decisions requiring human intelligence. In Today's world, Artificial Intelligence (AI) is incredibly important since it can change so many different fields. Artificial intelligence has permeated various facets of the educational landscape, reshaping teaching and learning processes [3].

Artificial Intelligence (AI) has been around for thousands of years. Alan Turing published his work "Computer Machinery and Intelligence" in 1950 which eventually became The Turing Test, which experts used to measure computer intelligence. John McCarthy held a workshop at Dartmouth on "artificial intelligence" which is the first use of the word and that is why it is considered as the birthplace of artificial intelligence (AI).

Generative AI is a subsection of artificial intelligence that develops algorithms to create new data samples that are similar to a given dataset. Unlike traditional AI, which mainly focuses on tasks like classification or prediction, generative AI aims to understand the underlying structure and patterns within the data.

Generative AI has become increasingly popular due to its ability to generate any kind of content like text, video, audio, images, etc. Also, it generates realistic and novel content. Artificial intelligence has advanced significantly with the outbreak of generative AI tools such as ChatGPT developed by OpenAI, Gemini, Perplexity, Midjourney, etc. which can produce material such as text, audio, video, and images in a variety of fields. These tools are categorized as generative AI, which refers to AI tools that can generate new data by identifying pertinent trends and patterns in previously gathered data [4].

Generative AI tools also have a common key characteristic; they are pre-trained using transformers [5], and they can generate all sorts of responses ranging from written text to visual as well as audio data [6]. They have also become the basis for building chatbots, described as intelligent systems developed using rule-based or self-learning (AI) methods [7]. This is in large part due to the ability of these tools to generate human-like texts that are difficult to detect even by experts [8]. Generative Artificial Intelligence tools have become captivating subject in the tech market. However, various researchers and domain experts are paying attention over various paradigms associated with the use of tools relying on generative AI. Therefore, this research work evaluates and compares the performance of three premium Generative AI tools namely ChatGPT, Gemini, and Perplexity with respect to their underlying merits and demerits. The next section of this research paper discusses and presents comparative study of stated generative AI tools.

II. GENERATIVE AI MODEL

A. What are generative AI models?

Generative AI models are an aspect of artificial intelligence system that generates fresh data sets that are identical to current data. These models play a critical role in a number of sectors, promoting Generative AI services and encouraging development innovation. The main goal of generative AI models is to generate different kinds of data that can be audio, video, images, text, and other data types. They accomplish this by identifying structures and patterns in the received data and generating fresh instances that are consistent with them. These models employ powerful deep learning approaches, which include generative adversarial

networks (GANs), variational autoencoders (VAEs), autoregressive models, and Boltzmann machines.

B. Types of Generative AI algorithm

There are different types of generative AI algorithm that have distinct applications and methodology.

- ***Generative adversarial networks:*** GANs are made up of a discriminator and a generator, two neural networks that are competing with one another. The generator generates data, whereas discriminator examines its accuracy and truthfulness. GANs are prosper in generating and developing visuals, making data better, and transmitting styles.
- ***Variational autoencoders:*** VAEs are probabilistic models which generate new samples by reversing the process of encoding data into a lower-dimensional space. They are very useful and helpful in generating data such as text and images or visuals.
- ***Auto Regressive Models:*** Time series analysis uses a class of statistical models called autoregressive models. These models determine a variable's value based on its prior values at that particular point. The variable is considered to be "autoregressive" if it is regressed using its own prior values.
- ***Boltzmann Machines:*** Boltzmann machine is the subset of the deep neural network that serves as an unsupervised learning model. Generative models termed Boltzmann Machines are capable of capturing complicated connections among many kinds of data.

C. Why Compare Generative AI Models

It is very important to select the best and most appropriate generative AI model for the assigned task by comparing the various kinds of models. Every model has its own distinct set of pros and cons. Therefore, it is needed to evaluate every model to identify its performance, accuracy, effectiveness, and output quality.

By comparison of generative AI models, it is very easy to make data-driven decisions and promote the implementation of the best possible solution in a wide range of applications throughout the various sectors.

D. Comparative Analysis Methodology Explained

The Comparative Overview of Generative AI Models utilizes a structured framework to precisely evaluate and contrast various models. Generally, the process involves the following important steps:

- ***Selection of Metrics:*** Initially appropriate metrics are chosen in accordance with the particular purpose and goals. To guarantee a comprehensive assessment, they may involve domain-specific performance measures, output quality, diversity, resource use, and speed.
- ***Data Preparation:*** Employing appropriate and trustworthy data is essential. Sufficient preprocessing is done to make sure uniformity consistency among models.
- ***Training and fine-tuning:*** In order to minimize bias, generative AI models undergo training using identical data under constant conditions. Adjusting fine-tuning situations to maximize the performance.
- ***Evaluation:*** By employing the selected measures, each model's performance is determined. User input might be included into qualitative as well as quantitative analyses and generative AI services.
- ***Comparison:*** Models are compared depending on how effectively they perform on a set of chosen metrics, illustrating the benefits and drawbacks of each one.
- ***Iterative Process:*** Several rounds of model and technique improvement are frequently necessary for comparative analysis to yield the most substantial findings.

III. COMPARATIVE ANALYSIS OF GENERATIVE AI MODELS

A. GANs, or Generative Adversarial Networks

In the past few years, GAN has superior output samples compared with other generative models, and it has been widely applied in the fields of image generation and natural language processing [16]. Due to the popularity and success of GANs [17], numerous improvements to the standard GAN model have been recommended in attempts to enhance training.

The first produced sample can never perfectly approximate real data, thus we have kept on training and fine-tuning the GAN. However, the training of GAN is different from the previous single neural network training, and we adopt separate alternating iterative training [18][19][20]. In GAN, we use fixed generator to optimize the discriminator, or fixed discriminator to optimize the generator [21].

B. VAEs, or Variational Autoencoders

Autoencoder is a data compression algorithm, in which the data compression and decompression are realized by neural network self-learning [22]. The input data is mapped by the encoder to the low-latitude features that we want, and the decoder then recreates the original data that was provided. Variational Autoencoder [23] is a method that adds "Gaussian noise" to the result of the encoder in Autoencoder to make the result of decoder robust to noise.

$$p(X) = \sum p(X|Z)\, p(Z)$$

The training data is denoted by X in the formula above, and the concealed feature that is not visible in X data is expressed by Z. The characteristic of VAE is that every one-dimensional distribution of Z conforms to a normal distribution, and the learning of characteristics is introduced to make the decoding effect better [24, 25]. However, VAE adopted the Variational Inference [26] for approximation. According to the generated image's result, GAN's picture clarity is better to VAE's.

C. Auto Regressive Model

Auto-regressive models are often applied to the prediction of economics, informatics and natural phenomena [27]. The auto-regressive model falls under the field of supervised learning and is a guided probability model lacking of potential random variables. Auto-regressive models are often used to deal with problems of time series [28].

Pixel recursive neural network (Pixel RNN) [29] is a relatively new generation method in recent years, this model's fundamental premise is to create images by transferring pixels from one to another, with the former serving as an indicator for the latter. Overall, the conditional distribution is created through converting the predicted value of the joint distribution for every pixel within the image.

In addition to RNN [30, 31], the author also adopted the method of convolutional neural network (CNN) to carry out convolution around the generated pixel points and later researchers also improved and optimized this kind of approach [32, 33]. For DeepMind's latest research, an Autoregressive Model of 3D Meshes was proposed [34]. The overall accuracy of grid vertex prediction from 2D to 3D becomes better by this approach. In addition, the advancement of autoregressive networks indicates that this approach remains relevant for meeting the demands of the most recent generation.

IV. REVIEW OF GENERATIVE ALGORITHMIC APPROACH

Algorithms are the foundation of generative AI systems and provide the basic frameworks for modeling and data distribution. They allow computers to learn from data structures, patterns, and relationships, allowing them to generate new, artificial data sets that are similar to real-world samples. There are three predominant algorithm families that provide frameworks for developing generative AI systems - generative adversarial networks, auto encoders[35], and autoregressive models. We are reviewing each of the techniques:

A. Generative Adversarial Network

Generative Adversarial Network (GANs) are a type of neural network consisting of two neural models - Generator and discriminator are competing against each other. Generator is a creative force which takes random noises as input and transform it into data instances which resembling the training data. Discriminator analyze each data point and check if its real or syntactically generated. Through this competition, the networks evolve to improve output quality. Architectural innovations allow generators to generate high-quality images, sound, video, 3D models, and more.

B. Autoencoders

Autocoders are generative model which can generate new data samples resembling the training data. Consist of two neural network - encoders and decoders. Encoders are used for Encoders are used for compressing input data to a smaller representation of it which is all known as latent space and the Decoders are to reconstruct the input from it. The encoder component is trained in parallel with the decoder component. Variational autoencoders (VAEs)[36] provide additional constraints for the latent vectors to conform to the specified distributions. Once trained, the decoder portion generates new samples by sampling latent vectors from distribution priors and mapping encodings to outputs.[37] VAEs offer a more consistent approach over GANs, but they tend to produce blanks with little to no high frequency detail.

C. Autoregressive Models

Autoregressive models (AR models) are a different data generation approach compared to GANs[38] and VAEs. Autoregressive models create data by modeling each data point's conditional probability distribution over its prior data points. They are focused on predicting the output sequences iteratively based upon the prior element. These are the class of statistical models used in time series analysis and generative modeling. Air models have various applications in fields that majorly deals with sequential data Such as Natural language processing and Time series forecasting.

V. CHATGPT

ChatGPT is a language-based model developed by OpenAI. It is an artificial intelligence model that is specially designed for natural language understanding and interaction on a conversational basis. It has drawn a lot of focus in recent years because of it's ability to generate quality responses efficiently to human inquiries.

ChatGPT is trained using a large amount of text data from the internet, including diverse sources such as books, articles, websites, and more, and analyzes the data using various algorithms to generate desired output. It was developed based on the GPT (Generative Pre-trained Transformers) architecture, which uses multi-layered transformers with attention mechanisms that allow it to process input sequences of variable length [9].

ChatGPT is trained on a massive amount of text-based data, and its model parameter is well-defined and well-trained for text generation, among many other tasks it is designed for. This training allows ChatGPT to identify patterns, structures, and subtleties of human speech, and relationships in the data which helps in predicting the upcoming future text in a sentence and also, enables it to create text that mimics human speech.

The foundation of ChatGPT is built on the transformer structure which is highly effective on various NLP tasks. The transformers used in ChatGPT also consist of encoder-decoder layers. As well as self-attention layers as part of its architecture [10]. This allows it to generate text responses according to the user inputs. ChatGPT has proven to be a very effective tool in various fields for different tasks. It has multiple language processing capabilities which also helps in breaking down the language barrier, facilitating global communication and collaboration.

ChatGPT has acquired tremendous amounts of popularity because it can generate correct and efficient responses on its free open source version ChatGPT 3.5 although there exists an advanced version GPT-4 which has more additional features and can be available with paid subscription. ChatGPT's adaptability and versatility make it an advantageous resource for learners, industry professionals, instructors, organizations, and businesses across various sectors and anybody seeking up-to-date information in various sectors. There are many other general-purpose AI tools out there, and each one has its advantages and disadvantages. This paper will look at whether this is a different type of general-purpose AI tool from the others, and if so, what are the differences?

VI. GEMINI

Gemini, developed by Google AI, comprises a family of LLMs, with Gemini Ultra 1.5 being the most advanced version [11] [12]. Google AI built Gemini, a large language model named Bard. Google's AI-powered Gemini assistant is incorporated into a number of Google Workspace products, including Docs, Sheets, Gmail, and so on. Gemini is intended to assist users with a variety of tasks such as generating text-based and visual-based data for many purposes. Gemini's enterprise-grade security and privacy features ensure that user data is preserved. Gemini can communicate and generate text that reflects human behavior in response to the user's queries since it has been trained on the extensive amount of dataset of code and text.

In today's digital world, Gemini shines out because of having the ability to give precise, accurate, and up-to-the-minute answers to your queries or questions. Unlike the other generative AI tools, which totally depend on the data they contain, Gemini employs Google Search to discover the newest and the most up-to-date information in real time. This makes sure that the responses you get are built on the latest knowledge, making it a very beneficial tool for staying updated.

Moreover, Gemini focuses on factual correctness by rating the information it gets according to the quality. In a world where staying with the correct information becomes the biggest challenge, Gemini can be very useful to overcome this challenge as it provides accurate, precise, latest, trustworthy, and relevant information. Beyond that, Gemini has a wonderful ability to comprehend context and logical thinking. It does not merely drop data at anyone, it understands the subtleties of the problem that you have asked and uses its reasoning skill to deliver comprehensive and accurate answers in response.

Gemini is easy to access as it has a user-friendly interface, permitting individuals who have different technical abilities to effortlessly ask inquiries and receive properly organized outcomes. Furthermore, Gemini employs various kinds of machine learning algorithms that will help the model to continue to develop, learn, improve, and expand so that it can process more data and engage with more users, its ability to comprehend sophisticated queries, and provide correct and accurate responses continues to get better.

Overall, Gemini's flexibility, adaptability, and diversity make it an indispensable tool for scholars, business professionals, educators, instructors, organizations, and companies across various sectors, as well as individuals who want current and newest knowledge in different kinds of fields. There are many other Generative AI tools out there, and each one has its merits and drawbacks. This paper will look at whether this is a different type of general-purpose AI tool from the others, and if so, what are the differences?

VII. PERPLEXITY AI

The Perplexity AI model combines the features of OpenAI along with Google to provide quick responses to queries. This model utilizes OpenAI's GPT-3.5 language model to facilitate text generation and up-to-date information. Perplexity AI aims to enhance the online search experience by offering more than just information. It searches the Internet for pertinent information using natural language processing (NLP) and machine learning to deliver answers to user requests [13].

The model is constructed similarly to ChatGPT and determines the likelihood that the current word will be properly predicted based on the context of previous words [14]. Its motive is to provide a user-friendly interface that can provide the most relevant information for our queries from all over the internet. It uses natural language processing (NLP) so that it can understand your queries then it finds and summarizes the most relevant information from various sources including websites and academic journals.

This generative AI tool searches the whole web in real time, ensuring that users have access to the most recent information on a variety of topics by combining the technologies such as artificial intelligence (AI), and natural language processing (NLP), machine learning (ML). It is crucial to remember that Perplexity AI is a demonstration inspired by OpenAI WebGPT rather than a finished product [15]. Because of its intuitive interface, individuals can easily browse through a variety of topics, making it a highly effective tool for plenty of applications.

Perplexity AI has become increasingly popular in recent years for the reason of its capability to interpret user requests and react with the most appropriate information. Perplexity Artificial intelligence (AI) proposes a free version making it accessible for every user and provides accurate responses by aggregating information from many sources like websites and academic journals, making it outstanding for activities such as answering tricky inquiries or generating text. Perplexity AI's adaptability and intuitive appearance make it a wonderful resource for professionals, students and anybody in search of latest information in various sectors.

Perplexity AI's adaptability and user-friendly design make it an advantageous resource for learners, industry professionals, instructors, and anybody seeking up-to-date information in various sectors. Many other generative AI tools are similar to this and every tool has its pros and cons. This paper will examine whether this generative AI tool is different from previous tools. If so, then how is it different?

VIII. A COMPARATIVE ANALYSIS OF DIFFERENT GENERATIVE AI TOOLS CHATGPT, GEMINI, AND PERPLEXITY AI

Table.1: Comparative analysis of ChatGPT, Gemini, Perplexity AI

Domain	ChatGPT	Gemini	Perplexity AI
Content Generation	ChatGPT proficient at generating more innovative and descriptive text-based content such as poem, scripts and even code.	Gemini generate more accurate, up-to date and credible Text-based, visual information such as text, image, scripts, and even code.	Perplexity AI generate more reliable, precise and summarize information in the form of text, images, and videos.
Ownership and Development	ChatGPT was developed by OpenAI, an AI research Company.	Gemini was developed by the Google DeepMind.	Perplexity AI tool was developed by the Aravind Srinivas.
Information Retrieval	ChatGPT relies on the dataset to create responses based on trends discovered during training.	Gemini retrieves and analyze data from the Google search in real-time for the realistic queries.	Perplexity AI is skilled at information retrieval, integrating data from multiple sources and

			providing well-sourced summaries.
Transparency	ChatGPT lacks transparency because it doesn't reveal information sources, making it difficult to determine factual accuracy.	Gemini also lacks transparency because it retrieves information form google search that doesn't directly cite the specific sources.	Perplexity AI permits transparency by citing its information sources in summaries, permitting you for analyzing accuracy.
Context understanding	ChatGPT proficient at understanding textual content.	Gemini proficient at understanding both textual and visual content.	Perplexity AI is also proficient at understanding textual and visual content.
Pricing	ChatGPT provides a free version and its pro version costs $20 per month.	Gemini also provides a free version and its pro version costs $20 per month.	Perplexity AI also provides free version and its pro version costs $20 per month or $200 per year.

As discussed in Table 1, In the context of content generation, ChatGPT is comparatively better at generating creative content than Gemini and Perplexity AI, while Gemini is comparatively better at providing up-to-date information than ChatGPT and Perplexity AI, and Perplexity is comparatively better in providing information with citations. Now, In the context of information retrieval, ChatGPT totally depends on the trained data for information retrieval, while Gemini retrieves information from the Google search in real-time, and Perplexity retrieves information by aggregating data from different sources.

In reference to context understanding, ChatGPT is best at understanding textual data, while comparatively Gemini is capable of understanding both text-based and visual-based data, and Perplexity is also capable of understanding text-based and visual-based data.

About transparency, ChatGPT is deficient in transparency because it does not expose information sources, which leads to difficulty in deriving factual accuracy, while Gemini is also deficient in transparency because it does not directly cite the information, and comparatively Perplexity allows transparency because it cites its information, making the information source accessible. And in the context of the pricing, all of these three generative AI tools have their own cost of the platform.

IX. CONCLUSION

This research work explores capabilities of generative AI tools namely CHATGPT, GEMINI, AND PERPLEXITY AI and its significance. This research work compares the performance of these tools based on content generation, information retrieval, transparency, and context understanding. Among all ChatGPT has become extensively famous for processing natural languages making it a very effective tool for the users and the authors. On the other hand, Gemini is popular for providing the most recent information or up-to-date information that enhances the user search results.

However, Perplexity AI has also become extensively famous for providing accurate, precise, and relevant information by aggregating or summarizing resources from various sources such as websites or journals. Perplexity AI is also proficient in providing answers with citations in it.

The future of generative AI is bright, with technological developments raising innovation and transformation across a wide range of industries. By employing tools such as ChatGPT, Gemini, and Perplexity AI, new opportunities are opened for creativity, productivity, and human-computer interaction, leading to a more connected and educated world.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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