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Review Article

A Comparative Analysis of Generative Artificial Intelligence Tools for Natural Language Processing

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Abstract: Generative artificial intelligence tools have recently attracted a great deal of attention. This is because of their huge advantages, which include ease of usage, quick generation of answers to requests, and the human-like intelligence they possess. This paper presents a vivid comparative analysis of the top 9 generative artificial intelligence (AI) tools, namely ChatGPT, Perplexity AI, YouChat, ChatSonic, Google's Bard, Microsoft Bing Assistant, HuggingChat, Jasper AI, and Quora's Poe, paying attention to the Pros and Cons each of the AI tools presents. This comparative analysis shows that the generative AI tools have several Pros that outweigh the Cons. Further, we explore the transformative impact of generative AI in Natural Language Processing (NLP), focusing on its integration with search engines, privacy concerns, and ethical implications. A comparative analysis categorizes generative AI tools based on popularity and evaluates challenges in development, including data limitations and computational costs. The study highlights ethical considerations such as technology misuse and regulatory challenges. Additionally, we delved into AI Planning techniques in NLP, covering classical planning, probabilistic planning, hierarchical planning, temporal planning, knowledge-driven planning, and neural planning models. These planning approaches are vital in achieving specific goals in NLP tasks. In conclusion, we provide a concise overview of the current state of generative AI, including its challenges, ethical considerations, and potential applications, contributing to the academic discourse on human-computer interaction.

Keywords: Artificial Intelligence; AI Planning; AI Tools; Comparative Analysis; Generative AI; Natural Language Processing.

1. Introduction

Artificial Intelligence (AI) has revolutionized various aspects of our lives, from personal assistants on our smartphones to sophisticated language models capable of generating human-like responses. As AI advances at an unprecedented pace, it becomes crucial to critically evaluate and compare various AI tools to understand their capabilities, limitations, and potential impact on society. Research in AI, particularly in Natural Language Processing, has surged. This has led to the development of the popular ChatGPT, which in turn sparked the interest of researchers in several fields [1] to investigate its features and applications. This has also raised questions about several aspects of its usage, which include ethical concerns surrounding its usage in Academia [2], [3], concerns about its creativity, and the place of generative AI as a whole in Academia [4], [5] amongst others. An important point that seems recurrent in most of the research that has been carried out is that ChatGPT is quite useful and has a potential for universal application across multiple fields and disciplines, but it comes with a wide range of challenges, too. This belief is shared by the general public, as presented by Li et al. [4] in research that analyses the concerns and worries of ChatGPT users on social media. Although Li et al. explain how the concerns and worries of users constitute a major challenge in its usage and application across various fields and disciplines, Dwivedi et al. [6] argue that its potential and opportunities in several disciplines outweigh the notable challenges associated with the usage of ChatGPT.

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The advent of ChatGPT has brought more attention to generative AI by the scientific community. This is evident in the increasing number of scholarly articles and publications on the subject. However, most research in this area placed much emphasis on the building, fine-tuning, or analysis of AI algorithms that are generative in nature. As a result, several generative AI algorithms/models based on NLP can be customized and implemented in chatbots. But, not much research on individual implementations of generative has been done. This trend is gradually nuanced by the increasing use of ChatGPT and the advent of other publicly available implementations of Generative AI such as YouChat, Perplexity AI, Chatsonic, etc. A few scholars have studied some of these tools [7]–[9], but no research has been done yet that compares these AI tools, illuminating their features, use cases, and strengths and weaknesses.

This paper aims to provide a comparative analysis of several prominent AI tools, including ChatGPT, Perplexity AI, YouChat, ChatSonic, Google's Bard, Microsoft Bing Assistant, HuggingChat, Jasper AI, and Quora's Poe. 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 [10]. Generative AI tools also have a common key characteristic; they are pre-trained using transformers [11], and they can generate all sorts of responses ranging from written text to visual as well as audio data [12]. They have also become the basis for building chatbots, described as intelligent systems developed using rule-based or self-learning (AI) methods[13].

The selected AI tools represent various applications and technologies designed to fulfill specific needs and requirements. By comparing these tools, we can gain valuable insights into their functionalities, architectures, and implications for AI to objectively assess their strengths, weaknesses, unique features, and Ideal use cases. Understanding AI tools' capabilities and limitations is essential for researchers and practitioners to leverage these technologies effectively. Additionally, it allows us to delve into ethical considerations surrounding their use, including privacy concerns, potential biases, and the responsible deployment of AI in various contexts. By shedding light on the comparative performance of these AI tools, this paper strives to contribute to the ongoing discourse on the advancements and implications of artificial intelligence. The hope is that this analysis will provide valuable insights for individuals and organizations seeking to utilize AI tools in their respective domains.

This paper is structured as follows, section 2 reviews the relevant literature, section 3 presents the methodology we employed in selecting the AI tools we used in this study, section 4 explains each of the generative AI tools we used and their architectures, Section 5 presents a comparison of all the tools we used based on their architecture, training algorithm, strengths and weaknesses, Section 6 compares NLP and search engines, Section 7 compares the architectures and learning techniques used by 9 different AI generative tools, Section 8 exposes the privacy and safety concerns with the use of these generative AI tools particularly in Academia, Section 9 presents the limitations and potential ethical implications on relying on AI generated content, Section 10 discusses the selected AI tools on the basis of their popularity, Section 11 presents the challenges and problems of developing AI generative tools, Section 12 explains AI planning techniques as well as their algorithms and Section 13 provides the conclusion and future work.

2. Literature Review

Researchers have investigated the concept of NLP and their applications since 1950 [14]. For example, Singh and Thakur [15] surveyed the different AI chatbots considering the technology they were developed with. They noted that chatbots were very important to improve human workings with machines for efficient outputs. Again, Deshpande and Chandak [16] surveyed the available chatbots as of 2022 in terms of the tools used to develop these chatbots and pointed out the huge advantages these chatbots present, especially in serving in place of support agents. Ahmed et al. [17] compared ChatGPT and Bard and concluded that ChatGPT is superior in its capability to generate appealing text with high accuracy compared to Bard's AI tool. Kiryakova and Angelova [18] noted that ChatGPT tends to assist University Professors in creating top content for its learners. They, however, pointed out that learners seem to depend on the output of ChatGPT totally and may not check to ensure what the ChatGPT has produced is correct and authentic. Singh et al. [19] investigated the advantages and disadvantages of using ChatGPT in medical research. They pointed out that although ChatGPT

provides several advantages in medical research and publication, it needs human supervision to avoid making grievous mistakes that may cause loss of lives.

3. Methodology

The AI tools used for this study have been selected based on four distinctive criteria.

1. The year they were released compared to when ChatGPT was released (most were released between 2021 and 2024).
2. Their architecture (different implementations of a version of the GPT architecture or similar Architecture)
3. They are chatbots that are implementations of a generative AI model.
4. The public currently uses them.

While sticking to the four criteria mentioned above, we were able to put together 9 most popularly used generative AI tools upon which we shall carry out the comparison. Each generative AI tool was used for a period, conversations were carried out, text was generated, and their responses formed the basis for the comparison.

4. Generative AI Tools

4.1 ChatGPT

ChatGPT is a transformer-based language model developed by OpenAI. 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 [20]. ChatGPT is already trained using a huge amount of data that is in text format, and the model parameters are fine-tuned and well-prepared for text generation purposes, amongst several other tasks it is built to perform. The GPT architecture has been used for various applications, including chatbots, question-answering systems, and language translation [20].

The transformers used in ChatGPT also consist of encoder-decoder layers. As well as self-attention layers as part of its architecture[11]. At its core, ChatGPT has GPT-3, the third version of OpenAI's large language model. This means that it can generate text based on input prompts. ChatGPT has several strengths, including its ability to generate realistic, human-like responses for every user input. There is also no limit to the number of words or characters for user inputs. Another strength of ChatGPT is its creative responses that always appear relevant irrespective of the query or input. However, these strengths do not come without weaknesses that present a caveat for its usage. They include inaccurate or wrong information generated and, in some cases, outdated responses. This is because, at the moment, the training data used for ChatGPT is capped at 2021, so it does not generate any more recent responses than that year. There is also the issue of intellectual property rights because ChatGPT does not give the sources of the responses it generates in most cases.

4.2 Perplexity AI

Perplexity AI combines a huge language model with GPT-3's capabilities. It searches the Internet for pertinent information using natural language processing (NLP) and machine learning to deliver answers to user requests [21]. 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 [22]. It displays the information's source and is set up similarly to Google. It's crucial to remember that Perplexity AI is a demonstration inspired by OpenAI WebGPT rather than a finished product [23].

4.3 Youchat

Youchat is an AI-powered language model whose architecture is similarly built on transformer-based models like GPT-3. It uses a deep-learning neural network to receive and comprehend input in plain language and produce human-like responses [24]. YouChat has a design that enables it to learn from a lot of text input and develop its language processing skills over time. This allows it to help with various jobs and give accurate and detailed responses. It usually searches Google for references to the responses it generates and displays these references on the right-hand side of the page.

4.4 Chatsonic

Chatsonic is an AI-powered writing assistant tool developed by the company Writesonic. It is based on OpenAI's GPT-4 language model, a state-of-the-art machine-learning model that can generate text that looks like human generated text in various styles and formats. A complex machine learning algorithm based on neural networks powers ChatSonic, allowing it to mimic human speech. For picture generation, it integrates with Stable Diffusion and DALL-E, and it has a strong relationship with Google search that aids in producing hyper-relevant material[25].

Chatsonic allows users to generate high-quality written content and pictures quickly and easily without extensive writing experience or expertise. Users can input prompts, such as a topic or a short description of what they want to write about or a description of the features of a picture they would like to generate, and the writing or picture will be generated based on that input.

Chatsonic can be used for various writing tasks, including blog posts, articles, marketing copy, emails, etc. It is designed to help writers improve their productivity and efficiency by automating some of the more time-consuming aspects of the writing process.

4.5 Google's Bard

Bard is a language model Google AI developed to generate conversational responses to open-ended questions. It is based on the Transformer architecture, a type of neural network commonly used in natural language processing tasks such as language translation and text generation. It is powered by a light version of Google's LaMDA (Language Models for Dialogue Applications), a family of transformer-based models pre-trained with huge sets of dialogue and data designed for conversations [26]. Bard was trained using the DistilBERT algorithm. DistilBERT is a smaller, faster, and more efficient version of the Transformer algorithm. Google AI developed it, and it is based on the BERT algorithm. BERT (Bidirectional Encoder Representations from Transformers) is a large language model trained on a massive dataset of text and code.

Unlike other conversational AI systems that rely on pre-defined rules or scripted responses, Bard is designed to generate responses based on the context of the conversation and the input provided by the user. This allows Bard to adapt to conversations and provides more natural and engaging responses[27].

4.6 Microsoft Bing Chat

Bing Chat is a new feature in Microsoft Edge that allows you to chat with Bing to get answers to your questions, create content, and more. Bing Chat is powered by artificial intelligence, so it can learn from your interactions and improve over time. Microsoft's chatbot was built on top of OpenAI's GPT-4 architecture and developed with a proprietary technology called Prometheus [28].

Bing chat comes with a few strengths and weaknesses. One notable strength is its ability to generate updated responses that are highly credible, and this is a not-so-common feature of most generative AI. Another strength is its intuitive nature. Bing Chat was built as an extension of the Bing search engine. Hence, it intuitively decides which responses are best delivered as search results and which should be delivered conversationally.

A major weakness is its limited number of characters per chat. As of this writing, it is 4000 characters. Another weakness is in its responses, which are generally short and usually not in-depth compared to ChatGPT. It also isn't as creative as ChatGPT, and it usually assumes that whatever query you type must be searched for first before attempting to generate a response. Its responses are also not natural and can appear like a tailored-fitted response.

4.7 HuggingChat

HuggingChat is an open-source chatGPT clone built by a company called Hugging Face. It was trained using the OpenAssistant conversational model and datasets containing data updated up to April 2023. The data and the model are both part of the Open assistant project, which, according to Köpf et al. [29], this model is trained by data that humans generate. Interestingly, it is open source with messages that have very high ratings. The dataset originated from a worldwide crowd-sourcing effort by volunteers of over 13,000, an excellent way to

generate a high-quality multilingual dataset. However, the crowdsourcing approach introduced some limitations in the quality of datasets, which is seen in the subjective biases of the individuals as well as an uneven distribution of values and biases, as some participants contributed more to the training data than others.

Hugging chat is transformer-based and was pre-trained using Reinforced Learning from Human Feedback, and it is the same method used in pretraining ChatGPT. Its major strength is in its ability to generate human-like responses because it was trained data from user inputs. Also, the fact that it is open-source and free provides a degree of flexibility in its usage and gives room for further development and fine-tuning by the open-source community. However, it has several weaknesses, including its inability to understand information beyond text provided during the pretraining phase and inaccurate data entry, leading to incorrect information retrieval. A licensing issue has yet to be resolved, which might hinder using this tool for commercial purposes [30].

4.8 Jasper AI

Jasper AI is an AI tool containing several tools that make it an ideal writing assistant for most business owners and marketers. It was originally designed to serve as a tool for creating blog content, social media ads, etc. However, it currently does much more than that, offering users multiple templates of writing tasks to pick from. This determines the tone, content, and writing style it will use for the write-up. It then generates the desired write-up based on the selected template, the prompts given by the user, and other pieces of information provided. Jasper AI uses multiple language processing models, including GPT-3.5, Neo X, T5, and Bloom, to generate natural conversations and persuasive content for website landing pages and blog posts[31]. These models are trained with large datasets of common queries and answers to build their conversational understanding. Approximately 10% of web content was read to train the Jasper AI model. This was intended to aid it in understanding how humans write. This AI model has gone through millions of newspaper articles, Reddit posts, and blog entries to date, allowing it to replicate the great material. Although Jasper AI's training was completed in 2019 and cannot comprehend events occurring later than that time, when provided with adequate information on recent events, it can generate write-ups based on that. While the exact algorithm used to train Jasper AI is not specified, it is known that the platform is designed to be user-friendly and customizable, with features such as Grammarly integration, text and image AI generation, and brand voice customization [31]. Jasper AI has a chatbot-like conversational feature and a Chrome extension for generating content across the web. It works best with tactical, step-based, or marketing content that's already well-documented. The pricing for Jasper AI starts at $24 per month and comes with a free five-day trial. Its chatbot is only available to those on the Boss subscription.

It comes with several pros and cons; a notable pro is its versatility. It can be used for a variety of purposes, including academic writing. It is also ideal for generating content specific to a particular writing style or project and presents many templates for users. Among the cons are its pricing, which starts at $24 a month, and the fact that you can't access Jasper Chat until one upgrade to the Boss mode or a higher plan costs even more. It is also the only AI we have discussed that does not allow users to use their 7-day free trial period. Another con is you cannot always trust its output. Some fact-checking must always be done anytime it is used to generate any write-up.

4.9 Poe by Quora

Poe, which is short for "Platform for Open Exploration," is a platform that allows users to interact with a variety of different language models. These language models are trained on different datasets and have different strengths and weaknesses. For example, some language models are better at answering questions, while others are better at generating creative text formats. The language models included in this writing are Sage, GPT-4, Claude+, Claude Instant, and ChatGPT[32].

Users can choose which language model they want to use by selecting it from the Poe website. The website also provides information about each language model, such as its strengths, weaknesses, and the dataset it was trained on.

This flexibility allows users to choose the language model that is best suited to their specific needs. For example, suppose a user is looking for a language model that can answer

science questions. In that case, they can select the language model trained on a dataset of scientific articles.

Poe itself isn't a language model but a platform for using other language models; hence, it combines the strengths and weaknesses of each individual language model. However, its major advantage is that it provides a fast and intuitive interface for accessing several language models best suited to various tasks. Another advantage is its versatility and the options for generating responses from several chatbots. A notable disadvantage is the time it takes to generate the desired output from multiple AI models. Also, some AI models listed in Poe are not available for free usage. Only Sage, ChatGPT, and Claude-Instant are available for free use.

5. Comparing the Generative AI Tools

The AI tools investigated in this research are generally similar in several ways; they are all used for natural language processing and text generation tasks, and they are powered by Large Language models (LLM), mostly GPT-3, 3.5, and 4. This implies that some transformer algorithms were used in their pretraining. They also have a conversational-style interface much like ChatGPT that allows users to type prompts and get responses instantaneously, and some common use cases apply to all of them. For example, they provide answers to questions typed by users.

However, they differ in several ways, among which are the unique features of their interface designs and the specific training algorithms used by each of them. Most of which are proprietary and not available to the public. There are also minor differences in their strengths and weaknesses, as well as their ideal use cases and what they were originally designed for. Table 1 provides a summary of the comparison of the generative AI tools.

Table 1. Comparing the Different Generative AI Tools Based on Pros and Cons.

AI Tool	Architecture	Learning Technique	Algorithm(s)	Pros	Cons
ChatGPT	GPT-3.5 GPT-4.0(can used in the paid version)	Supervised, Reinforced Learning from Human Feedback	Proximal Policy Optimization	• It can generate highly human-like responses. • It can be fine-tuned for specific tasks. • Can handle input sequences of variable length.	• Requires large amounts of pretraining data. • It can be computationally expensive. • Its data is not very recent and does not generate results later than 2021
Perplexity AI	GPT-3	Deep learning	Undisclosed to the public	• It sites the sources it uses to provide answers to questions. • Produces a very concise and unambiguous response to input questions/queries	• Not always accurate • Input text must be very clear and exact for generating correct answers.
YouChat	GPT-3	Deep learning	Undisclosed to Public	• Easy to use and deploy • It can be customized using rule-based and machine-learning algorithms. • Displays references from web search results	• It sometimes displays outdated or irrelevant links in response to certain queries. • It is in its beta stage
Chatsonic	GPT-4	Deep Learning (Stable fusion)	Undisclosed to Public	• Offers several advanced AI capabilities. • Can generate images from text prompts, not just text alone.	• Only available in English as at the time of this writing • The free version limits users to 10000 words for both prompts and responses.

AI Tool	Architecture	Learning Technique	Algorithm(s)	Pros	Cons
Googles's Bard	Language model for dialogue application	Unsupervised learning	DistilBERT	• It is in sync with Google search, generating more updated results. • It can generate different creative text formats of text content, like poems, code, scripts, musical pieces, emails, and letters. • It can adapt to different kinds of conversation and generate more realistic responses	• It sometimes generates repetitive outputs. • It can be erroneous and sometimes generates wrong or inconsistent output. • It has limited generative capabilities as it can't produce long-form articles.
Microsoft Bing Chat	GPT-4	Supervised learning	Backpropagation	• Responses have a high degree of accuracy. • It cites sources for its responses. • It can generate images too in the chat box where text is generated	• You can only generate 30 responses per session. • Slightly slower response time • Responses are generally shorted with less details
Hugging Chat	Large Language Model Meta AI	Deep learning/ Reinforced Learning from Human Feedback	Undisclosed to Public	• It is open-source (currently the only open-source generative AI) and can be modified and improved rapidly. • It generates updated responses. • It can be used freely with no limitations at all	• The data used in training was updated up to 2021 and not beyond that. • Compared to other generative AI, its training data is limited (65 billion parameters). • It is less reliable as a result of its limited training data.
Jasper AI	GPT-3.5, Neo X, T5, and Bloom	Deep learning	Undisclosed to Public	• It is extremely versatile. • It has a simple-to-use interface. • It can generate content quickly.	• It isn't free, even the trial mode lasts for just seven days and requires user to input their credit card details upon registration. • Users can only access its chatbot on the Boss mode or Higher subscription, which is quite expensive. • The information it generates doesn't always add up
Quora's Poe	GPT-3,3.5 and 4	Deep learning, Reinforced Learning from Human Feedback, Unsupervised Learning	Different Algorithms were used for each model	• Provides a single platform for accessing multiple AI tools. • Allows users to generate content from multiple AI models and compare. • Users only create a single account, and they can access about five different chatbots	• Having multiple AI models in one platform sometimes makes it difficult to decide which to use or best. • There is still a subscription fee for accessing some of the AI models listed, like GPT-4, Claude-Instant-100k and Claude+ • The interface for some of the AI models in Poe is not as good as that used to access the AI model directly, for instance, ChatGPT has a better interface than it does in Poe

Even though generative AI tools present huge advantages, caution should be taken in their usage. For example, many academic institutions are against students using these tools for their assignments or coursework. This has led to some researchers developing AI tools capable of detecting AI-generated text.

6. Artificial Intelligence Natural Language Processing Versus Search Engines

Search engines function by indexing websites and storing them in databases for retrieval. When a user enters a search query, the engine retrieves relevant pages from this index and displays them as results[33].

Many NLP systems rely on search engines to obtain web pages for generating responses. However, search engines generally only work for simple keyword-based queries[34]. This limitation has led to the emergence of 'generative search engines' that directly produce responses to users by synthesizing content and providing accompanying citations. For instance, tools like Perplexity AI and Anthropic's Claude generate search results in natural language. However, it remains challenging for these systems to produce verifiable, relevant references. This has given rise to another type of generative AI called generative search engines [35], which directly generates responses to user queries and in-line citations [36]. Perplexity AI and Hugging chat have implemented this. While it is a welcome innovation, there is a challenge of how relevant and verifiable the references generated are [8]. Some tools have combined generative search with large language models to enable more conversational and human-like search experiences. Microsoft integrated Bing search with the chatbot Sydney, and Google recently launched Bard, pairing responses from Language Model for Dialogue Ap-plications (LaMDA) with traditional web results.

In essence, AI NLP is the technology that search engines utilize to interpret the purpose behind user queries effectively and give more relevant results.

Table 2. Summarizes the Key Differences Between Artificial Intelligence Natural Language Processing and Search Engines

AI Natural Language Processing	Search Engines
Analyse large datasets, extract patterns, and generate new insights	Rely on algorithms and indexing to retrieve existing information based on keywords
Enable computers to comprehend, generate, and manipulate human language	Use AI language processing to understand users' human language queries and to give feedback in human language
Interrogates any data with natural language text or voice	Does not interrogate data
The method of interaction with users is two-way, conversational, and contextual.	The method of interaction with users is one-way by keyword matching.
The core technology behind virtual assistants, such as the Oracle Digital Assistant (ODA), Siri, Cortana, or Alexa, web search, email spam filtering, automatic translation of text or speech, document summarization, sentiment analysis, and grammar/spell-checking	One of the technologies with which users interact is artificial intelligence. Examples of search engines include Google, Bing, Yahoo!, Yandex, DuckDuckGo, Baidu, Ask.com, Naver, Ecosia, AOL, and Internet Archive.
It can be applied to all human languages, especially written text and spoken words.	It matches all keywords available on the web.
It is used mainly for content creation, tutoring, and conversational search.	It is used mainly for information search and retrieval.

The key advantage of search engines is that they are excellent at searching and retrieving information on web pages. At the same time, AI–NLPs have the advantage of being excellent at interpreting natural language, which enables efficient natural conversational interactions.

The key disadvantage of search engines is that they are vulnerable to manipulation, in addition to the lack of complex abilities, while the key disadvantage of AI – NLPs, on the other hand, is that the responses may be incorrect or biased due to their reliance on complex data training abilities. Table 3 compares search engines and AI-NLP based on 11 parameters.

Table 3. Comparison of Search Engine and AI-NLP

Comparison Based on Parameters	AI Natural Language Processing	Search Engines
Interaction with users	Conversational, contextual	Keyword queries
Information Retrieval	Generates responses by understanding user data	Matches keywords, ranks web pages
Data Sources	Diverse text, including books and articles	Excellent at web pages and online media

Comparison Based on Parameters	AI Natural Language Processing	Search Engines
Language understanding	Understands and generates human-like text	Limited in language processing
Interpreting User Intent	Discerns a wider range of intents	Guesses based on queries or web searches
Context Handling	Maintains context for follow-up questions and conversations	Lacks conversational memory
Algorithm Updates	Enhance model understanding and responses	Affect search results
Usage	Content creation, tutoring, conversational search	Finding information, products, and services
Limitations	• It may provide incorrect or biased responses due to its dependence on data training. • Privacy and responsible data use are also active public and safety concerns.	• Vulnerable to manipulation, lacks complex abilities. • Limitations in language processing and intent discernment.
Privacy and Data	Emphasize data privacy	Used for adverts and personalization
Integration and Customization	Customizable for specific tasks	Offer developer APIs

7. AI Architectures and Learning Techniques Used by AI Tools

To better understand the architectures and learning techniques utilized by the AI tools considered in the paper, Table 4 presents an in-depth review about these architectures and learning techniques.

Table 4. AI Architectures and Learning Techniques Used by AI Tools

AI Tools	Architectures	Learning Techniques
ChatGPT	Transformer-based deep learning algorithm (GPT-3.5 Turbo and GPT-4)	It applies unsupervised learning on pre-trained humongous datasets. It attempts to learn patterns and relationships in text data and predicts possible text that should follow in some learning sequence.
Perplexity artificial intelligence	GPT models (GPT -4), ANN, NLP and Claude-2 model	It applies artificial intelligence, natural language processing, and machine learning to offer intelligent Internet searching to produce conversational, accurate, and up-to-date information found on the Internet with their respective sources. The Internet serves as its dataset for pre-training.
YouChat	Large Language Model (LLM), Natural language processing (NLP)	Applies LLM and NLP to learn from new data and user interactions. Data generated by users is used to train the chatbot to better respond to subsequent requests or questions. This improves the accuracy of its responses over time.
ChatSonic	ChatGPT	It uses natural language processing and AI algorithms to learn and generate content based on user prompts.
Google's Bard	Pathways Language Model 2 (PaLM 2) and Language Model for Dialogue Applications (LaMDA)	Utilise Transformers and Google's neural network architecture to learn from the Google search engine. The Transformer architecture is the framework for generative AI tools, including chatGPT
Microsoft Bing Assistant	Large Language Model	Applies LLM specifically to customize web searches. Bing employs machine learning to rank web pages to select the best results from trillions of web pages, which is trained using human-labeled data.
HuggingChat	Reinforcement learning from human feedback (RLHF), NLP, and ML	HuggingChat was trained using the OpenAssistant Conversations Dataset (OASST1). Its learning method is Reinforcement learning from human feedback.
Jasper AI	GPT-3 OpenAI API	It uses artificial intelligence to develop new original content from existing user prompts. It gathers information from a range of sources, such as social media, websites, and sensors.
Quora's Poe	Large Language Models (LLMs)	It extensively uses data to train its models and improve its language comprehension capabilities. Poe AI Chat understands a wide range of user queries and responses by accessing billions of talks from the Quora platform. This guarantees that the chatbot can provide users with accurate and relevant answers to their questions.

8. Privacy and Safety Concerns for Generative AI Tools

Generative AI is used for a variety of NLP tasks. Quite popular among these tasks are academic-related tasks, which include generating essays and other forms of written text. This has raised a major concern about whether generative AI should be considered a valid author in Academia. In his article, Thorp Described how ChatGPT works but concluded that it should not be regarded as an author[5]. But this is after a study was carried out in which ChatGPT was used to peer-review a scientific article for publication and performed well compared to human reviewers. Other challenges identified were its inability to review figures and images and its ambiguity in reviews generated for complex research [37]. This growing concern about the potential impact of generative AI on objectivity and academic integrity is not totally unfounded; several key challenges have been identified by Lo [38] in his review of literature on the impact of ChatGPT on education. They include bias and possible inaccuracies of generated content, Plagiarism issues, issues with copyright and licensing of the content generated, the difficulty in accessing students' performance when they used generative AI for their assessments, and the unfair advantage they have over those students that do not have access to these generative AI tools.

Additionally, privacy issues arise with the use of generative AI due to the collection, storage, and analysis of private data. The systematic collection of massive amounts of data raises ethical concerns, as it enables better performance for AI systems but also poses risks to privacy and security [39].

9. Limitations and Potential Ethical Implications of Relying on AI-Generated Content

These ethical challenges and limitations identified include the following: Technology misuse, Regulatory challenges, Misinformation and the spread of deepfakes, Risk of Job displacement in several industries, and Identity and Authenticity concerns. To address these concerns, principles for designing generative AI applications have been proposed, focusing on characteristics such as multiple outcomes, exploration and control, mental models, and explanations while also considering potential harms and displacement[40]. Considering these principles and ethical implications, the integration of generative AI technologies can be effectively managed to ensure productive and safe use.

Also, existing limitations have slowed the adoption of generative AI, including the Black-box issue, which raises the question of how generative AI produces responses to its prompts and the need for transparency in the entire process [41]. There's also the limitation of lack of control, which echoes the need for regulation of generative AI, as well as the Resource limitation, making it difficult to deploy generative AI tools since they typically rely on vast amounts of data for their training and highly sophisticated technology for their deployment. Researchers have suggested several approaches to solving these limitations. Solving the Black-box limitations of generative AI is a crucial challenge in various fields. In the context of artificial intelligence-generated works (AGW), the current copyright law has limitations in protecting AGW due to its difficulty in distinguishing them from human creations[42]. In the In Vitro Fertilization (IVF) field, the black-box nature of deep learning models hinders their interpretability and raises fairness concerns [43]. Objective faithfulness metrics have been proposed to evaluate explanation methods, but their application shows low agreement on model ranking[44].

Researchers have proposed various strategies to solve the limitations of lack of control for generative AI. One approach, called Fair Diffusion, allows for attenuating biases in generative text-to-image models after deployment [45]. Another solution involves verifying the outputs of generative AI from a data management perspective, which includes analyzing the underlying data and assessing its quality and consistency [42]. These approaches address the lack of control in generative AI by providing methods to mitigate biases, ensure correctness, and promote transparency and responsible use of AI.

10. Levels of Popularity of AI Generative Tools

We present three different Tiers (High, Moderate, and Lower) of popularity for each generative AI tool considered in this study.

Tier 1: High Popularity

- ChatGPT: Extremely popular for its conversational abilities and ease of use. It has a large user base and is frequently used for generating creative text formats, translating languages, and answering questions. It is currently referred to as the most popular [46], with over 180 million registered users.
- Google's Bard: Quickly gaining traction due to its integration with Google Search and its ability to access and process real-time information. It's also praised for its multilingual support and image upload capabilities.
- Microsoft Bing Chat: Powered by GPT-4, it offers advanced features like multimodal support, visual input/output, and chat history. Its integration with Bing Search makes it a powerful tool for information gathering and conversational interactions [47], with over 100 million users as of March 2023 [48].

Tier 2: Moderate Popularity

- Perplexity AI: Known for its focus on accuracy and citing reliable sources. It also offers a unique "GPT-4 co-pilot mode" for collaborative writing. It has about 2 million active monthly users as of April 2023[49].
- ChatSonic: Popular for its creative writing capabilities and diverse output formats. It offers a user-friendly interface and affordable pricing options.
- Jasper AI: Popular among marketing professionals for its ability to generate various marketing copy formats and optimize content for search engines. It has about 100,000 users[50].

Tier 3: Lower Popularity

- YouChat: A relatively new platform focused on creating AI companions. It still has a smaller user base but offers unique features like personality customization and emotional intelligence.
- HuggingFace: Primarily used by developers and researchers due to its open-source nature and access to various pre-trained language models.
- Quora's Poe: Specifically designed for generating poems, making it less widely used compared to the other tools.

There are some grey areas in the above categorization as we didn't consider that these tools perform similar functions. Furthermore, users may lean towards the tools that belong to a particular tier not because they perform better than the others but because they know about them first and have decided to keep using them.

11. Challenges and Problems in Developing AI-Generative Tools

The challenges and problems in developing AI tools include:

- Data limitations: Generative models require massive amounts of high-quality data for training because they are generally composed of deep learning architectures that require an enormous quantity of data to perform well. This quantity of data can be expensive and time-consuming to acquire and curate. Thus limiting the diversity and generalizability of the generated outputs [51].
- Computational cost: Training and running large generative AI models requires substantial computational resources like Graphics Processing Units and High-Performance Computing Systems, making them less accessible to smaller organizations and individuals [52].
- Explainability and interpretability: building explainable generative AI is almost as difficult as understanding how generative AI models make decisions and what factors influence their outputs. This lack of transparency can raise concerns about bias, fairness, and accountability[53].
- Safety and security: Generative AI models can be misused to create harmful content, such as deepfakes or hate speech. It is crucial to develop safeguards and mitigations to ensure responsible use of this technology.
- Lack of Skill: Developing generative AI requires special skills in AI and Deep learning, which can be difficult to find [54]. This becomes a challenge for startups looking to incorporate a customized generative AI solution tailored to meet their specific business needs.

These challenges are among the myriad of challenges plaguing generative AI builders and has further slowed the adoption of generative AI in various industries.

12. Artificial Intelligence Planning Techniques and Algorithms

Artificial Intelligence planning is a subfield of AI that develops algorithms and techniques for generating plans or sequences of actions to achieve specific goals [55]. Several types of planning techniques are used in AI, including hierarchical planning, optimal planning, partial order planning, and informed search.

In the Natural Language Processing (NLP) context, AI planning techniques and algorithms are crucial in various tasks, particularly text generation, dialogue systems, and machine translation [56]. By automating the process of planning and generating sequences of actions, these algorithms enable NLP models to achieve specific goals and fulfill user requests in a more structured and efficient manner. Some AI planning techniques and algorithms used in NLP are explained as follows:

- Classical Planning involves generating a sequence of actions to achieve a goal in a deterministic, fully observable environment. In NLP, this can be applied to tasks such as text summarization or content generation [56]. Classical planners like STRIPS (Stanford Research Institute Problem Solver) can be adapted to formulate planning problems in the language domain, where actions manipulate symbolic representations of text.
- Probabilistic Planning: In NLP, uncertainty is inherent due to the ambiguity of natural language. Probabilistic planning techniques, such as Markov Decision Processes (MDPs) and Partially Observable Markov Decision Processes (POMDPs)[57], are well-suited for scenarios where the outcomes are uncertain. These can be applied to dialogue systems and language generation tasks where multiple interpretations or responses are possible.
- Hierarchical Planning: Hierarchical planning involves breaking down complex tasks into simpler subtasks, facilitating more efficient planning. In NLP, hierarchical planning can be employed for tasks like document generation or multi-step content creation. Hierarchical Task Networks (HTNs) [57] are an example of a framework that allows for the specification of complex plans at different levels of abstraction.
- Temporal Planning: Temporal planning accounts for the temporal aspects of actions, ensuring that plans are feasible and temporally coherent. In NLP, this can be applied to tasks that involve time-sensitive generation, such as scheduling or dynamic content creation. Algorithms like SHOP (Simple Hierarchical Ordered Planner) can be adapted for generating text with temporal constraints.
- Knowledge-Driven Planning: This planning technique incorporates domain-specific knowledge into the planning process. In NLP, leveraging ontologies, semantic graphs, or domain-specific databases can enhance the quality and relevance of generated text. Planning algorithms can then reason about this knowledge to ensure contextually appropriate content generation.
- Neural Planning Models: With the advent of deep learning, neural models have been applied to planning problems in NLP. Sequence-to-sequence models with attention mechanisms, transformer architectures, and reinforcement learning can be integrated to learn and generate data-related plans. These models are particularly effective for end-to-end generation tasks.

Table 5 summarises AI planning techniques and Algorithms explained in this paper and key comments about each technique.

Table 5. Summary of AI Planning Techniques

AI Planning Techniques	Supported Algorithm(s)	Comments
Classical Planning	• Linear Planning Algorithm, • Sussman's Anomaly Algorithm, • Non-linear Planning Algorithm	Aims to determine a sequence of operators (a plan) that leads from an initial state to a goal state [58]
Probabilistic Planning	• Markov Decision Process, • Partially Observable Markov Decision Processes, • Learning depth-first search	Aimed at minimizing the expected cost of reaching a set of goal states[59]

AI Planning Techniques	Supported Algorithm(s)	Comments
Hierarchical Planning	• Angelic Hierarchical A* (AH-A*), • Decomposed, Angelic, State-abstracted, Hierarchical A*(DASH), • Abstract Lookahead Trees (ALT)	Aimed at problem decomposition, generating a solution consisting of a sequence of actions that's executable in a given initial state[60]
Temporal Planning	• TP Planner, • Temporal Planning with Single Hard Envelope (TPSHE) Planner, • Simultaneous Temporal Planner (STP)	Aimed at concurrent execution of actions and alignment with temporal constraints[61]
Knowledge-Driven Planning	• Hierarchical Task Networks (HTN), • Model-based Reinforcement Learning, • Propositional STRIPS	Aimed to create a flexible and efficient plan to achieve a desired objective in a complex and dynamic environment [62], [63]
Neural Planning Models	• Deep Q-Network (DQN), • Graph Neural Networks (GNNs), • Variational Autoencoders (VAEs)	Combines the strengths of traditional planning algorithms with the power of deep learning. They offer intriguing possibilities for tackling complex and dynamic planning problems [64]

13. Conclusion and Future Work

Generative AI tools have come to stay, and their uses and advantages outweigh their disadvantages in several ways. The generative AI tools we have investigated have been designed for specific purposes and use cases. There is an overlap in the ideal use cases each tool was designed to use. We also observed that while they are all generative AI tools and can generate text, some are better at certain tasks. For instance, ChatGPT may be ideal for creative writing, but Google's Bard may be a better option for academic writing. Some common tasks can be carried out reasonably similarly by all the AI tools discussed in this paper. This work has compared several generative AI tools based on their underlying architecture, learning techniques, training algorithms, and strengths and weaknesses. Furthermore, we presented a comprehensive comparative investigation encompassing all these technologies within a singular corpus. In addition to elucidating the architectural composition and algorithms underlying each system, we have delineated the strengths and limitations of these tools. Also, we have illuminated the diverse artificial intelligence planning techniques commonly employed in contemporary generative models. However, analysis of optimal use cases and task-specific performance remains an open pursuit for future work. We also suggest that integration of explainable artificial intelligence may help mitigate prevailing weaknesses of existing systems, including opacity and bias. We propose that augmenting generative models with traceable, transparent capabilities represents a promising direction for further research and development. There is still room for more research in privacy and safety concerns while using generative AI, particularly in Academia. This area is currently generating critical discourse in the scientific community, and we hope that more work will be done in the future.

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