Survey: Unconventional Categories of Chatbots that make use of Machine Learning Techniques

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Abstract

A growing trend in computer interaction approaches is human-computer interaction, which describes communication between a person and a computer and is known as a chatbot. A conversational agent, often known as a chatbot, is a computer program that attempts to provide responses that appear human during a conversation. Studies on several chatbot applications, are been carried out in this research on the areas of Natural Language Processing (NLP), the Natural Language understanding (NLU), and Intent recognition in recent years. There are several NLU applications in various fields, including Chatbots, search in natural language, voice-driven assistants, web- scale information extraction, legal discovery, and content summarization. Intent classification is one of the biggest challenges in NLP. Some of the chatbots classifies students requests to make them simpler to comprehend. A chatbot is an appliance of software that replicates and processes human communication to offer real-time digital assistance. Various tasks that were previously handled by human agents, like assistance to customers, medical counselling, digital commerce and issues addressing, are now being assigned to chatbots. Due to the appearance of machine learning techniques, the main step in chatbot development was defining the rules that would be used to create responses. Here are

DOI: https://doi.org/10.36548/jitdw.2023.3.006
Received: 16-07-2023. received in revised form: 12-08-2023, accepted: 01-09-2023, published: 15-09-2023
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some strategies for chatbot applications and the machine-learning techniques that underpin them.

Keywords: Natural Language Processing, Machine Learning, Natural Language Understanding, Artificial intelligence;, Intent Recognition Framework, Machine Learning Algorithms, Uses for various groups of chatbots, Chatbot Approaches.

1. Introduction

The combination of computer science, AI, and linguistics is known as Natural Language Processing (NLP), and it is concerned with how humans and machines communicate. The concepts and methods of machine translation have received greater public interest in the present artificial intelligence trend [1]. It is important to note that there are still incorrect view about how NLP will affect machine translation and concerns that it will eventually replace human translation [2]. In 1998, Bill Manaris gave its definition in Advanced in Computers, “Natural Language Processing is defined as a discipline that studies language issues in human-to-human and human-to-machine communication” [3]. NLP is understood as a subset of machine learning in the structure of artificial intelligence, which includes both NLP and ML. Basically, machine learning helps the NLP algorithm to gather new information from every conversation and so develop on itself as time goes on. The field of artificial intelligence known as "Natural Language Understanding" (NLU) recruits computer software that can process information as a variety of phrases from spoken word, audio recordings, and even motion pictures. The main aim of NLU, is to start up with create the chats with humans - machine chat interactions. Now, as user can create chat using voice-depended technologies using chatbots system. The Table.1 below shows the Aspects of NLP and NLU

Table 1. Aspects of NLP and NLU

Aspect	NLP	NLU
Objective	Enable computers to understand and generate language	Enable computers to comprehend and interpret language
Tasks	Tokenization, POS tagging, machine translation, etc.	Semantic parsing, intent recognition, coreference resolution, etc.

Complexity	Statistical and Rule-based approaches	Advanced data mining methods, such as deep neural networks for learning
Focus	Structure and representation of language	Meaning, context, and intent behind language
Scope	Syntactic and shallow semantic analysis	Deeper understanding of language semantics and context
Examples	Sentiment analysis, text summarization, etc.	Intent recognition, entity linking, discourse analysis, etc.

2. Machine Learning Algorithm used for develop chatbot Application

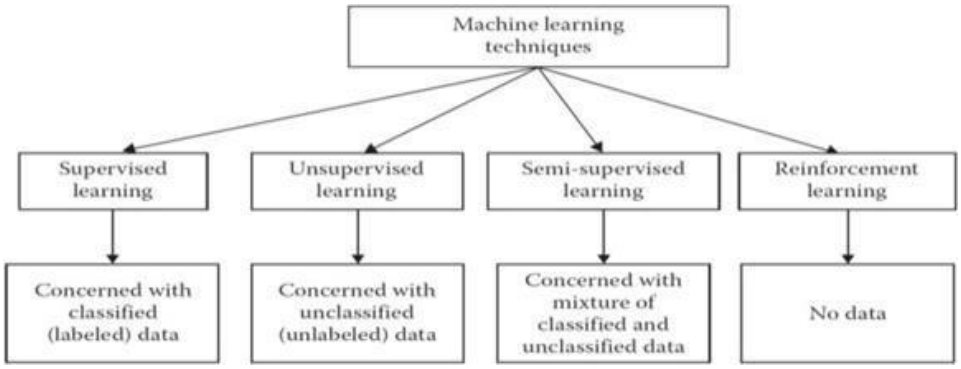

Figure 1. Different Machine Learning Techniques and Their Required Data [4]

The four primary categories of machine learning algorithms are as follows: Reinforcement learning, semi-supervisedlearning, unsupervised learning, and supervised learning [4]. The figure .1 shows the different machine learning techniques and their required data.

3. Intent Classification for Chatbot System

Intent Recognition, also often referred to as Intent Classification. Intent classification is the natural, automatic categorization of text data, and voice data based on customer goals. NLP combines computational critical work with linguistics, which has traditionally been placed for more accurate outcomes with predicted tasks.

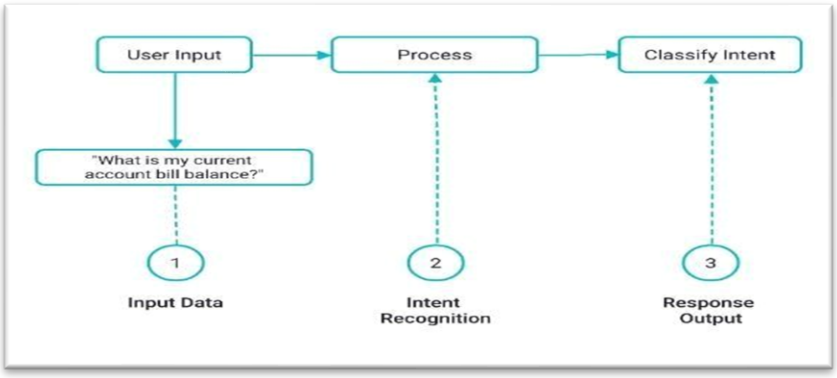

Figure 2. Work flow of Intent Classification [18]

Intent classification has been an important revolutionary to businesses, mainly in regards to customer experience. Chatboxes, for example are desired platform that uses intent recognition for sales conversation, customer supports and more. The characterization of intent is essential to how chatbots work. The purpose of chatbots is to understand the user's intent and respond appropriately [18]. The figure .2 shows the work flow of Intent Classification.

4. Chatbot Approaches

The growing trend of human-computer interaction through chatbots and various applications of NLP and NLU across different fields are discussed in this section. Machine learning algorithms used in chatbot development, as well as the significance of intent recognition in improving customer experience. Conversational technologies are evolving how individuals and groups communicate, causing technology to dominate digital communication rather than people. In order to deliver digital assistance in real-time, chatbots are software systems that process and replicate human speech. Chatbots are now being used for a variety of functions that were formerly done by human participants, including dealing with customers, medical counselling, online purchasing, and issues addressing. Chatbots are widely used by businesses to fulfil consumer needs and boost client retention. Chatbots therefore have the potential to support student inquiries and assistance in the academic advising process in the education domain in the current digital era. Conversational agents are one of the most forefront of methods of interaction with consumers in the world today [5].

1) Pattern matching and 2) Machine learning approaches are the two ways for creating a chatbot, depending on the algorithms and methods used.

4.1 Pattern Matching

Table 4.1. Different Types of Chatbot Approaches using Pattern Matching

Name	Algorithms / Techniques	Classification	Goal	Applications
ELIZA and PARRY in the 1960s [6]	Pattern Matching algorithm	Rule-based chatbots	built using pattern recognition technology	chatbots primarily use pattern-matching techniques and language techniques, They are implementing more NLP technology and moving towards AI.
Artificial Intelligence Markup Language (AIML) the years 1995 to 2000 [7]	Pattern-Matching algorithm	was used to develop the ALICE chatbot	use a rule based approach to respond to user queries based on inputs that match a pattern.	Chatbots highlight the need for design changes, including better NLP and NLU, a more advanced approach to pattern recognition, larger knowledge bases, and better knowledge structure and representation. Further study should be done on the use of personally modified ontologies that can offer reasoning functionality and define a particular personality by comparing past conversational behaviour patterns.
AIML and Latent Semantic Analysis (LSA) [8]	Pattern-Matching Algorithms sometimes used Latent Semantic Analysis (LSA) or other techniques.	chatbot based on pattern matching	The AIMLchatbot answers informational queries on specific templates, while questions that cannot be answered in this way can use LSA for ther production of responses.	The chatbot's design makes it so that it generates random responses for a single template. LSA-based questions are returning accurate results. By adding more templates and patterns, the chatbot will eventually be able to respond to questions of a more general form.

RiveScript , in 2009 [9]	Use line-based scripting language, XML code (like AIML)	In syntax, the symbol ‘‘+’’ indicates a user input, while ‘‘-’’ denotes the chatbot response	RiveScript, an open-source framework, matches user input with stored responses, considering context and using interfaces for languages like Python and Java, allowing wildcards and conversational redirects through user and chatbot variables.	The primary problem now facing chatbots is that they're unable to interpret and produce a natural conversation. Based on current NLP technology. The usage of chatbots is mostly related to the security of personal data. However, in this field, protection technologies are being created.
ChatScript was released in 2011 [10]	It matches user inputs to chatbot outputs using pattern matching, Used Neural networks based on deep learning	An expert system for developing rule-based chatbots with an open- source scripting language that is very compact	ChatScript employs word groups for meaning, utilizes short and long-term memory through user-specific variables, and integrates conditionals to formulate chatbot responses.	Chatbots have advanced greatly from earlier simple pattern-matching systems based on retrieval to neural networks based on deep learning. So It is quite challenging to simulate such conversations kinds of social media platforms like Facebook, Twitter, and others.

The table .4.1 shows the different types of chatbot approaches using pattern matching A method where predefined patterns or rules are used to match user input and generate corresponding responses.

Pattern matching-based approaches and producing predefined outputs that fit the inputs are the common ways utilised in today's chatbot development. The negative aspect of this strategy is that it occasionally fails to establish a satisfying dialogue that will direct conversation towards the desired goal. The development and evolution of chatbot algorithms and techniques from the 1960s to recent years. It discusses notable approaches such as ELIZA, PARRY, AIML, Latent Semantic Analysis (LSA), RiveScript, and ChatScript. These methods range from pattern-matching algorithms to rule-based systems and deep learning-based neural networks. The mentioned algorithms and techniques, such as ELIZA and PARRY in the 1960s,

AIML, AIML with Latent Semantic Analysis (LSA), RiveScript, and ChatScript, represent historical and modern approaches to building rule-based chatbots using pattern-matching technology. These approaches focus on recognizing predefined patterns in user inputs and generating responses accordingly. While these methods have paved the way for chatbot development, they also face limitations and challenges. They struggle to engage in natural conversations, often producing repetitive or nonsensical replies. The transition from pattern recognition to more advanced natural language processing (NLP) and artificial intelligence (AI) is necessary to overcome these limitations. Additionally, the need for better NLP and NLU improved design, larger knowledge bases, and personalized reasoning capabilities has been highlighted. Furthermore, as chatbots become more prevalent, security and privacy concerns, especially regarding personal data protection, have emerged as significant challenges in this field. Efforts are being directed towards developing technologies that ensure the safe and ethical deployment of chatbot systems, particularly on social media platforms.

The research highlights the transition from pattern recognition to more advanced natural language processing (NLP) and artificial intelligence (AI) technologies. It also identifies research gaps such as the need for improved NLP, knowledge representation, reasoning functionality, and the challenges in simulating natural conversations.

4.1.1 Limitations

The common limitations across the chatbot systems are as follows:

I. ELIZA and PARRY in the 1960s [6]

Limitation: These early chatbots rely on rule-based pattern-matching techniques and lack genuine comprehension of language subtleties.

II. Artificial Intelligence Markup Language (AIML) the years 1995 to 2000 [7]

Limitation: AIML-driven chatbots operate within confined patterns, leading to restricted and templated interactions.

III. AIML and Latent Semantic Analysis (LSA) [8]

Limitation: AIML-based chatbots are confined to templated responses, while LSA- enriched responses are general yet limited by the existing patterns.

IV. RiveScript, in 2009 [9]

Limitation: Despite context-awareness, RiveScript chatbots struggle to generate fully natural conversations.

V. ChatScript was released in 2011 [10]

Limitation: ChatScript-based chatbots incorporate pattern matching and neural networks, but simulating intricate social media interactions poses challenges.

These limitations reflect the evolution of chatbot systems and highlight the common hurdles in achieving natural and contextually-rich conversations. To address the limits of conventional pattern matching algorithms, machine learning methodologies are introduced, allowing chatbots to comprehend linguistic complexity, adjust to context, and offer more accurate and contextually relevant responses.

4.2 Machine Learning Approaches

Table 4.2. Different Types of Chatbot Approaches using Machine Learning

Name	Algorithms / Techniques	Classification	Goal	Applications/Limitations
Cleverbot, founded by British AI scientist Rollo Carpenter in 2008 [11]	Markov Chain and Artificial Neural Networks	The procedure searches for all exact phrases that match the user's input after receiving some text from them. By determining the manner in which the user responded to that source, it provides responses to the user's input.	Cleverbot was developed to simulate conversation and learn from previous interactions with GPU (Graphics Processing Unit) designed.	A GPU is a specialised electronic circuit designed to quickly operate and change memory to produce images and a displayable frame buffer. The component of the engine that powers Cleverbot and its API is currently on the market and has access to all developers worldwide.

Facebook Messenger Bots, 2016 [12]	Support Vector Machines (SVM), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Gradient Boosting	Facebook identified that messaging was becoming an increasingly popular way for individuals to interact with businesses, and they recognized an opportunity to improve the customer experience by using chatbots to automate certain processes and give quick and convenient help.	It gives developers the Messenger Platform, which includes various built-in NLP and ML technologies to enable bots to better understand user input and create more accurate and relevant responses.	According to the findings, bot programming is still in its early stages. The majority of them relay to humans when the discussion becomes boring, and only a selected minority of them are designed to prevent repetition in their responses (obvious purpose that you are speaking with a machine as opposed to a human.)
Xiaoice, 2016 [13]	ML algorithms, including deep learning, natural language processing (NLP), and cognitive computing	Developing emotional attachment to users; scalable skill set for user assistance	The first widely deployed social chatbot. 100MM users; published poem book; host TV programs, The concept of modal: Text, picture, voice	Establishing ethical standards for developing and deploying such AI systems is essential as AI becomes more common in our lives and manifests itself in the form of robots, Internet of Things (IoT) devices, and online chatbots. These are challenging, unresolved AI issues.
GPT-2, 2019 [14]	Uses a combination of deep learning algorithms, including multi-layer feedforward neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).	For text classification using Hugging face transformers library on a custom dataset.	To adjust the GPT2 model for text classification using the digression transformer library on a custom dataset.	GPT embeddings provide a lot of potential for dealing with many issues. The usefulness of GPT embeddings in different NLP tasks and datasets can be explored in more detail, and methods to improve their performance may be inquired too.

GPT-3, 2020 [15]	Convolutional neural networks (CNNs), and recurrent neural networks (RNNs)	It can be implemented for many different NLP tasks, such as text generation, language translation, and summarization.	It has been used to create conversational AI systems like chatbots and virtual assistants that can communicate with users naturally and entertainingly.	A language model that generates high-quality samples, displays strong qualitative performance on tasks that are defined on the fly, and performs well on many NLP tasks and benchmarks in the zero-shot, one-shot, and few- shot settings, sometimes coming close to matching the performance of cutting- edge fine-tuned systems. Generally predictable tendencies of performance scaling without using fine-tuning was noticed. It was additionally addressed how this class of models affected society. These results suggest that, in spite of several shortcomings and restrictions, very large language models may contribute significantly to the development of flexible, general language systems.
Replika, 2021 [16]	Natural language processing (NLP) and machine learning (ML) techniques, deep learning algorithms, Neural networks	It is primarily used for personal, emotional, and mental wellness and is classified as an intelligent virtual assistant overall.	With the help of Replika,users can receive individualized responses based on their interests, choices, and previous interactions. It is a helpful tool for anyone looking for emotional support or counselling because it is also capable of detecting and reacting to user emotions.	It is not truly intelligent or aware of anything. Its reliance on pre-programmed responses and machine learning algorithms, its understanding is constrained to what it has been exposed to throughout training data, Challenge in Having Complex Conversations, Issues Regarding Data Privacy. So some of these restrictions might become less severe as time goes on and technology develops.

ChatGPT, 2022 [17]	NLP techniques, Neural networks (DNNs), which are a type of Artificial neural network (ANN)	It can provide information, answer questions, perform tasks, and even engage in small talk withusers. AI- powered conversational agents and is primarily used for text-based interactions with users.	ChatGPT is to recreate human-like conversation while responding to user inputs with accuracy and attention to context. It performs this via analysing and producing text sequences using innovative natural language processing (NLP) methods and deep learning algorithms.	People will figure out ways to deftly link various AI technologies together, using one tool's output as another tool's input. the creation and assessment of term papers, essays, and homework assignments in education. On the other hand, even creation processes frequently use variants and recombination of pre-existing patterns. Additionally, the lexical space of the Internet is neither a single, closed setnor is it strictly convex. In this way, even straightforward interpolation has the potential to increase knowledge and close gaps. Therefore, the use of LLMsin the future will be exciting for society, science, and the BISE community.

The study introduces the concepts of natural language processing (NLP) and natural language understanding (NLU), which are essential for enabling computers to understand and generate human language. NLP focuses on the structure and representation of language, while NLU delves into the meaning, context, and intent behind language. The scope of NLU goes beyond syntactic and shallow semantic analysis to achieve deeper understanding. The study also covers various machine learning-based approaches to chatbot development. For Example Cleverbot, Facebook Messenger Bots, Xiaoice, GPT-2, GPT-3, Replika, and ChatGPT. These approaches utilize deep learning algorithms, neural networks, and NLP techniques to enhance chatbot interactions, personalize responses, and improve user engagement. The Table.4.2 shows the different types of chatbot approaches using machine learning.

4.2.1 Limitations

I. Lack of True Understanding

Cleverbot's responses and similar systems rely on phrase matching and context rather than genuine comprehension, limiting their ability to provide nuanced and accurate responses[11].

II. Repetitive Conversations

Early-stage chatbots like Facebook Messenger Bots often struggle to maintain engaging and diverse conversations, leading to user dissatisfaction due to repetitive or boring interactions[12].

III. Ethical Concerns

Systems like Xiaoice aim to evoke emotional attachment, raising ethical questions about the appropriate use of AI for emotional engagement and the need for clear guidelines[13].

IV. Performance Potential

Despite potential, GPT-2 and similar models might not consistently deliver optimal performance in various natural language processing tasks, requiring ongoing research to refine their capabilities[14].

V. Contextual Limitations

GPT-3, despite its strengths, might exhibit shortcomings in specific contexts, prompting continued research to identify and address these limitations for improved results[15].

VI. Pre-programmed Responses

Chatbots like Replika heavily rely on pre-existing patterns, which can limit their conversational depth and adaptability, prompting research into more sophisticated interaction methods[16].

VII. Biased and Inaccurate Outputs

Integrating multiple AI technologies in systems like ChatGPT can introduce biases or inaccuracies, necessitating research to ensure reliable and unbiased outputs[17].

Machine learning algorithms for chatbots outperform pattern matching due to their capacity to learn from data. Unlike fixed patterns, ML algorithms adapt to diverse user inputs, making them more versatile. They understand context, handle ambiguity, and generalize responses for greater accuracy. ML-driven chatbots continuously improve through training on large datasets, enhancing their performance over time. While pattern matching requires manual rule creation and struggles with complexity, ML algorithms provide intricate responses, making them the preferred choice for accurate, contextually relevant, and adaptable conversations.

4.3 Solutions

These solutions aim to address the identified limitations by leveraging advancements in AI research, machine learning techniques, and responsible development practices.

To address the common limitations in AI-driven systems requires a multi-faceted approach. Firstly, advancing natural language processing (NLP) techniques to grasp semantics and context is crucial. Integrating machine learning models that comprehend underlying meanings, rather than just phrases, can yield nuanced and contextually precise responses. Secondly, the implementation of reinforcement learning and dynamic response generation algorithms can enrich early-stage chatbots. By adapting responses based on user engagement and feedback, these chatbots can ensure diverse and engaging conversations. Ethical engagement in emotionally resonant AI, like Xiaoice, can be achieved through clear guidelines and oversight boards involving AI experts and ethicists, promoting responsible deployment. Additionally, continuous model training, domain adaptation, and context-specific fine-tuning enhance performance in models like GPT-2 and GPT-3 across varied NLP tasks. For greater authenticity, introducing reinforcement learning with user interactions and generative adversarial networks (GANs) in chatbots like Replika can improve conversational depth. Lastly, the integration of bias detection and mitigation algorithms, combined with regular

audits, ensures reliable and fair interactions in AI technologies like ChatGPT. These solutions collectively pave the way for more effective and ethically sound AI systems.

5. Real World Examples that Illustrate the Practical Applications for Chatbot Certainly

Table .5.1 here presents a few real-world examples of practical applications for chatbot applications with the use of Machine Learning (ML) algorithms :

Table 5.1 Real World Examples that Illustrate the Practical Applications for Chatbot

Industry /Application	Practical Example	ML Algorithm Used
Healthcare	Symptom Assessment: Chatbots assess COVID-19 symptoms and recommend appropriate medical actions.	Natural Language Processing(NLP), Machine Learning (ML) algorithms
Retail	Personalized Shopping: Chatbots offer tailored product recommendations based on user preferences.	Recommender Systems, NLP
Finance	Investment Advice: Chatbots provide investment recommendations based on user risk profiles.	Data Analysis, NLP, ML algorithms
Mental Health	Emotional Support: Chatbots engage users in empathetic conversations and offer coping strategies.	Sentiment Analysis, NLP, ML algorithms
Language Learning	Language Practice: Chatbots help users practice languages. Through interactive conversations.	NLP, Speech Recognition, ML algorithms
Customer Service	Automated Helpdesk: Chatbots resolve customerqueries and route complex issues to human agents.	NLP, ML algorithms
HR Recruitment	Resume Screening: Chatbots analyze resumes and shortlist candidates based on job requirements.	NLP, ML algorithms
Travel Planning	Trip Recommendations: Chatbots suggest travel destinations and itineraries based on user preferences.	Data Analysis, NLP, ML algorithms
Home Automation	Energy Management: Chatbots control smartdevices and optimize energy usage in homes.	Data Analysis, NLP, ML algorithms

Media	Personalized News: Chatbots deliver tailored news updates based on user interests.	NLP, Recommender Systems,ML algorithms

These examples showcase the diverse applications of ML-driven chatbots in various industries, enhancing user experiences and providing valuable assistance.

6. Challenges and Future Directions

The paper highlights several challenges and research gaps in chatbot technology, including the need for improved natural language understanding, better knowledge representation, ethical concerns, data privacy, and more complex conversations. The ongoing development and evolution of chatbot algorithms and techniques are noted, with an emphasis on incorporating AI technologies and addressing societal impacts.

In conclusion, the paper presents a comprehensive overview of chatbot technology, from its foundational concepts in NLP and NLU to the evolution of different chatbot development approaches. The study emphasizes the role of machine learning algorithms in improving chatbot capabilities and discusses the challenges and potential solutions for enhancing chatbot interactions in various contexts. These chatbot systems and approaches show the advancement and broad variety of applications of AI in exchange training ML techniques, servicing consumers, connections with individuals, and text classifications. The ongoing challenges in enhancing chatbot interactions, eliminating repetitive responses, addressing ethical concerns, and fully using AI-based technology are highlighted by the unmet research needs.

7. Conclusion

This study, has reviewed several paradigms in the development of NLP techniques based on Natural language understanding with AI concepts and machine learning algorithms. For that, relevant articles and journals were selected and reviewed. Using that algorithm with intent recognition there are many possibilities for the development of different types of chatbot applications with different machine language algorithms It is possible to create many different

sorts of chatbot apps using different machine language algorithms by combining that algorithm with intent recognition. Further, a literature review has been conducted on the works of the scholars and research gaps have been identified.

Where the future researchers can work to contribute their knowledge, first the chatbot system which primarily uses pattern matching techniques and language technique, that are implemented using more NLP technology and moving towards AI were studied. NLP and NLU, have a more advanced approach to pattern recognition, larger knowledge bases, and better knowledge structure and representation. For more studies should be done on the use of personally modified ontologies that can offer reasoning functionality and define a particular personality by comparing past conversational behavior patterns. By adding more templates and patterns, the chatbot will eventually be able to respond to questions of a more general form. However, in this field, technologies to provide security measures are also being created. It is challenging to recreate social media dialogues using ANN-based algorithms on platforms like Facebook, Twitter, and others. All developers now have access to an API that will provide them with more accurate results. Robots, Internet of Things (IoT) gadgets, and online chatbots are examples of how AI is becoming increasingly prevalent in our daily lives. Different NLP tasks and datasets can be explored in more detail, and methods to improve their performance may be inquired too. The performance of many NLP tasks and benchmarks in the zero-shot, one-shot, and few-shot settings sometimes comes close to matching that of cutting-edge fine-tuned systems. Without employing fine-tuning, generally predictable trends of performance scaling were observed. The social effects of this class of models were also covered. These findings imply that very large language models may play a significant role in the creation of flexible, general language systems, regardless of numerous drawbacks and limitations. On the other hand, even development processes frequently used variants and recombination of pre-existing patterns. In this way, even straightforward interpolation has the potential to increase knowledge and close gaps. Therefore, the use of machine learning and deep learning techniques in the future will be changing in the framework or model for exciting society, science, and the community.

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