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AI and Deep Learning-driven Chatbots: A Comprehensive Analysis and Application Trends

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***Abstract*— Chatbots are the next big technological evolution in the realm of conversational assistants and voice assistants in the modern technology era. A chatbot, sometimes known as a bot, is a piece of code developed and built to respond effectively to users' input, utilizing natural skills in understanding inquiries and delivering appropriate replies. Top industries and organizations are embracing new artificial intelligence-driven and deep learning-based interactive chatbots in various sectors, including banking, healthcare, finance, legal, telecommunications, retail, logistics, travel, auto, sports, entertainment, and media. This paper presents a comprehensive analysis of chatbots, their applications trends, and general chatbot architecture for response generation. Moreover, we compare various chatbots based on their features, technologies, languages, and application areas. Chatbots based on AI and deep learning are now becoming an indispensable part of interaction with machines for assistance and resolving customers' queries.**

Keywords*— *Chatbot, NLP, HMI, ML, AI, Conversational Assistant

I. INTRODUCTION

Chatbots are conversational assistants that can facilitate human and machine interaction through various means, including text, voice, or any visual information. Because of their ability to understand natural language texts and associated contexts, chatbots are extensively used in academia and industry for availing services, interactively responding to queries, and resolving problems associated with search retrieval of information. Smart technologies and intelligent digital assistants that can respond and resolve user queries to access and avail services are in great demand in industries in this ftechnological era. Hence, digital assistants or chatbots based on artificial intelligence (AI) and deep learning technologies, along with (NLP) and (NLU) capabilities, are used to handle automatically various operations and services with high speed and accuracy [1].

In various industries, AI has a variety of applications that have contributed significantly to improving operations and services in various sectors including banking, retail, health, and e-commerce. According to a CNBC [1] report, intelligent Chatbots through their automated services might help the Retail, E-Commerce, Banking & Healthcare industries save more than $8 billion a year by 2022. Bots engaged in debates in the IT industry for years and with legitimate reasons with the majority of customers accepting or preferring chatbots services to resolve queries. The year 2020-21 has been nicknamed "the year of the customer service chatbot" [2]. Indeed, AI-driven intelligent chatbots are nowadays used in a variety of industries and multi-domain, like as E-Commerce, all types of Insurance domains,

The banking sector, Healthcare departments, Finance and tax, Legal, telecommunications, Logistics, Retail, Auto industries, Tour Travel, Sports, Entertainment, Media channel, and many other industries. Gartner Summits projected that more than 85 percent of customer interactions are managed without a human by 2020. As per Tech Emergence [3], chatbots are predicted to become the most popular AI commercial application in the next five years. Conversational chatbot platforms that leverage language processing technology appears to be a practical option for many applications and services that allow human-to-computer interaction through text or voice-based on natural language [4].

This research work presents a comprehensive analytical study of deep learning and AI-driven chatbots, recent trends, and applications. We also present a general functioning and response generation by a conversational chat.

II. BACKGROUND

Artificial intelligence and automation are being used all over the world in various sectors and industries, making lives smarter and more innovative. According to a recent Juniper Research analysis [2], global investment in "cognitive and artificial intelligence systems" is projected to achieve $52.2 billion by 2023, with a multiple annual development rate of 46.2 percent from 2016 to 2021. The most significant influence of AI in 2018 was on automated customer service, which received $2.4 billion [3] in investment. AI across industries is applied to enhance product and service quality, and help clients gain greater value from the company's services. Machine learning and deep learning algorithms along with AI-based technologies have been effectively applied to areas of Natural Language Processing (NLP) to produce intelligent chatbots [5]. In 2016, the global market value of chatbots was $703.3 million, and it is predicted to rise at a compound rate of 35.2 percent to $3,172.0 million [4] by 2021. energy business, 13 percent of AI is used in customer services compared to information technology services. Other businesses, such as housing, events, governance, trade unions, accountancy, construction, service desks, and development, are also investing in AI technology[5].

There are several advantages of adopting chatbots for both enterprises and consumers. According to a 2016 study [6], chatbots might save organizations up to £6 billion per year across sectors on average. Furthermore, according to PWC, 34% of CEOs said that employing chatbots removed needless duties, allowing them to focus on deep thought and creation [6].

III. CHATBOT ARCHITECTURE AND APPLICATIONS

With the emergence of edge computing in recent years, Chatbots have grown in popularity as corporations find creative ways to employ them. Today, having a chatbot has various advantages for businesses, as they make life simpler for consumers, are accessible 24/7, save time, and are simple to use. Depending upon the required applications and services, chatbots are designed in with different architectures. Figure 1 presents the general functional architectural details of a chatbot along with response generation. The chatbot users need to create an account and log in using their credentials, which are authenticated by the authentication module. Once logged in, the user can have a voice or text-based interaction with the chatbot system. The automatic speech recognition (ASR) system processes the audio into data understandable to the chatbot to determine users' intent and process the response accordingly by applying different NLP/NLU algorithms. Text to speech (TTS) system generates a voice or text-based response understandable to the user [7].

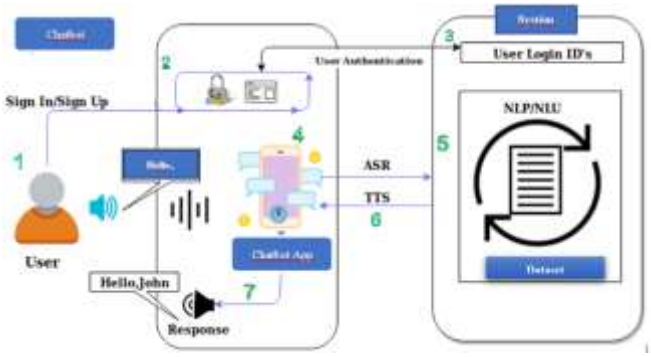

Fig. 1. Architecture models of chatbot and response generation.

A. Personal Assistant (Chatbot)

A chatbot is an AI-powered tool with the ability to automate consumer interactions and can help as a personal assistant to customers through voice- and text-based interactions. According to a study in banking sectors, two-thirds of those polled thought AI-powered chatbots would help them provide a supportive response to customers' queries, and 44% prefer to involve with a chatbot rather than a human person to get their questions answered. Using ontology to handle dialogue in the banking and financial industry is another important application of AI-enabled personal assistants. AI can help clients in acting their actions and handling a large volume of information with more accuracy.

B. Chatbot in E-commerce

Chatbot technology, particularly smartphones and the internet, has made it easier for individuals to perform daily activities such as conversing and purchasing through messaging and user engagement with the e-commerce engine. A conversational chatbot for e-commerce allows buyers to make online purchases by interacting with a chatbot through a messaging application, which is becoming more popular in the e-commerce business. Certain basic bot anatomies must be addressed while creating a chatbot to respond to messages and assist people with online shopping including personality, branding, human interaction, artificial intelligence, Conversation, rich communications, context, and retention, finding, and installation, engagement, and marriage approaches, and Monetisation.

C. Chatbot in Healthcare

Chatbots in healthcare offer monitoring of users 'behavior, anxiety, nutritional facts, tracking of weight loss, and consultation of sensitive and mental health problems. A spoken language medical-based chatbot may provide an accurate response and help to guide in diagnosis of the patients by employing symptom analysis and a conversational approach. Furthermore, the bot's comparative performance shows that, as time passes, automated medical items may evolve and play a
bigger role in healthcare. The Chatbot begins by asking the user how he or she is feeling. Once it has collected the

required quantity of data, it determines the most probable disease that the user may suffer from based on the input information.

D. Chatbot in Shopping

Conversational chatbots in the shopping and retail industries help customers to search for products, locate stores, track packages, and get recommendations. Customers who are blind or visually challenged would communicate with the chatbot by asking it questions via speech or text input. These queries will

be mapped to their corresponding replies, which may be trained to discriminate questions to search for an answer in a knowledge base, ask for clarification, or refer customers to a human, depending on the situation. Voice-enabled chatbots accept queries about the goods that the consumer inquiries about and help by assisting in purchasing and leading them through the navigation and payment process. The IoT-based Supermarket Automation with Chatbot and AI improved the supermarket experience, where there are no cashiers or lineups, allowing us to buy without difficulty.

E. Entertainment chatbot

AI-powered chatbots help in building emotional and meaningful conversational interactions, thereby increasing audience growth and engagements. Chatbots can have an impact on the integration of brand sponsorships and subscriptions services. Conversational bots can be used for entertainment purposes through online chatting. Whenever a user is tired, he/she can talk with the bot to keep busy by interacting with conversational AI-driven chatbots. They assist us by offering entertainment, saving time, and resolving complicated issues. Cleverbot is a popular entertainment chatbot that applies rule-based AI approaches to converse with humans [8].

F. Legal and Finance

Chatbots in a legal context may assist in acquiring legal knowledge, getting guidance about legal terms and conditions, filling out forms, contesting an appeal, and other legal challenges and activities. The growth of chatbots in the financial sector is the most recent disruptive factor that has altered how consumers engage. It is claimed that 76 percent of respondents who utilize chatbots work in the IT or financial industries.

G. Chatbot in E-learning

Chatbots are employed in e-learning to promote interactivity, facilitate students in organizing their studies and educational activities, and deliver real-time information. AI and deep learning-based chatbots can detect learners' level of expertise, modify conversational tones, and procure selective information appropriate for a particular learner. In e-learning chatbots may facilitate a variety of tasks, including sharing and submitting application forms, assisting students and instructors by responding to frequently asked questions, widespread distribution of school and test schedules, making announcements and communicating with parents, educating pupils about extracurricular and club activities, simplifying sign-ups, registrations, and cancellations, gathering feedback. disseminating educational resources to parents, students, and instructors and creating communities.

IV. COMPARATIVE ANALYSIS OF CHATBOT

The chatbots imitating human conversations have been developed using various technologies and platforms to perform diverse tasks and handle multiple customers simultaneously, increasing the speed of response, reach, and level of satisfaction to customers and businesses. Technologies used to develop recent and intelligent chatbots include AI, Deep Learning, and NLP. These chatbots maybe goal specific to respond to specific queries, domain-specific to perform knowledge-based responses to specific topics, and services oriented to perform specialized services, or generate priority-based responses. Table 1 presents the comparative analysis of chatbots based on their developmental platforms, techniques, programming langue, conversational language, domain-specific applications, and services

V. ARTIFICIAL INTELLIGENCE TECHNIQUES FOR CHATBOT

Here are the Artificial Intelligence techniques used in chatbots

- *Natural Language Processing*
- *Named Entity Recognition*
- *Machine Learning in Chatbots*
- *Augmentation capacities*
- *Personality AI in Chatbots*
- *Conversational AI in Chatbots*
- *Problem Solving in Chatbots*

TABLE I. COMPARATIVE CHATBOT ANALYSIS

Chatbot Name	Platforms	Features/Techniques	Programming languages	Languages	Website	Clients
Watson Conversation Service by IBM [9].	Natural language processing technology	Neural network	SDK, Node.js Python	English, and Japanese	speech images & text-based	Healthcare, Finance, Legal, Retail, Fantasy Football
AgentBot [10].	Natural language processing technique	NLP	Python	English,	voice	Telecommunications, online services, e-commerce banks, Financial Services
Twyla [11].	A proprietary AI platform.	NLP	Python, node js	English	Facebook, Telegram	Customer support service
Live Agent [12].	-	Node js,	-	English + 39 other languages	Email Voice Social Chat	Customer service Ticketing. Support portals, call centers, & social media management.
DigitalGenius [13].	Deep learning	Deep neural network model, Metadata, AI etc.	Customer Service with Human + AI	Multilingual	Email Social Media Mobile Messaging Live Chat	Customer Services
Semantic Machines [14].	AI chatbot	Speech Synthesis, Conversation Engine Reinforcement, Deep Learning. Natural language generation (NLG)	AI	English	Text and voice	E-Commerce, Business, Search, Productivity, & Automotive, Travel.
wit.ai [15].	AI chatbot	NLP	Node.js, Python, Ruby,	English	Voice and text	Talkable apps & gadgets.
Dialogflow [16].	AI framework chatbot.	Dialogflow. NLP, NLU Node js	HTML, JavaScript, Node.js, .NET, C++, Python, Ruby, Java	Multilingual conversation bot.	Google, Facebook, Slack, Twilio, Skype, Tropo, Telegram, Kik, LINE, Spark, Alexa, Cortana, and Twitter are some of the most popular social media platforms	The mobile app, web app, device, bot, IVR system, & more.
rasa NLU [17].	Conversationach atbot	NLP,NLG	Node js Python	English, Multilingual	Runs local system.	Insurance, Banking and Health Telecoms Travel
Microsoft Bot Framework [18].	AI chatbot	NLP, NLU LUIS,	.NET, Node.jsslac S Bot Connector Developer Portal Bot Directory		Text, Skype, Slack, Facebook, Office 365.	High-quality bots for business.

VI. INFORMATION EXTRACTION & VISUALIZATION TECHNIQUE

A. Named Entities

Named entities are actual things; nouns, are in the method of data extraction. These could include people, places, organizations, things, etc. It could be identified by a name, be conceptual, or have a tangible existence. Called entities to include "Ronald Reagan," "Amsterdam," "Porsche," and "Microsoft"; in fact, everything that may be named. A Named Entity can alternatively be thought of as an entity instance; for example, Amsterdam is an instance of a city. Porsche is an example of a car, and so on [19].

B. Entity Linking

The easiest method to introduce things is to use the line "Mumbai is a city in India." The point is that "Mumbai" is a city, not a name or any other entity that may be referenced as "Mumbai." Because it is regarded as an Indian city. As a result, the target knowledge base is determined by the application area. The notion of connecting elements to provide some type of context and improve the performance of information retrieval emerges as a subject [20].

C. Impediment to Entity Linking

Name Variations: Take, for example, city names... Some NLP systems assume that a city name is a single word. As a result, a name like "Cape Town" is problematic. Multiple spellings and languages may exist for the same thing.
Ambiguity is something that we all suffer from. Is the term "web" used to refer to a spider's web or the internet? Is the term "kiosk" used to describe a tiny business or a computerized identity station? Then there are the issues of numerous languages, material that is developing and changing with varied meanings and contexts, and the inability of the analysis framework to scale at a rapid pace [21].

D. Disambiguation

The removal of ambiguity by establishing clarity is referred to as disambiguation. User input might be vague and unclear. To correctly gather the required information components, the Conversation Interaction or chatbot must disambiguate the input from the user [22].

CONCLUSION

Conversation chatbots and voice assistants have grown in popularity in recent years in various industrial and organizational sectors. Microsoft, Google, Apple, and Amazon have developed their intelligent voice-assisted systems and constantly improving their platforms with Apple's *Siri*, Google's *OK/Hey*, Microsoft's *Hey Cortana*, and Amazon's *Alexa* are all examples of classic virtual voice assistants that communicate using voice devices. In this paper, we discussed a comprehensive analysis of chatbots, and their applications trends and presented a general architecture of a conversational chatbot. According to our analysis, we observed that each deep learning and AI-driven chatbot has its unique set of capabilities and enhanced accuracies in voice, language, and functionalities. There are a plethora of competent chatbots that have re-defined the term convenience by helping individuals with anything from discovering excellent bargains online to moving money and even buying cars. Besides these, chatbots can help organize meetings, measure employee happiness, collect lunch orders, and even take a virtual coffee break.

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