Automated Real Estate Chatbot

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***Abstract* - Fully automated chatbots are increasingly being applied in the real-estate industry. Although, they are not completely able replace interaction between the real-estate agents, they can automate customer support, save human resources for qualitative tasks, accelerate operations, and improve business branding. In this paper, a chatbot for real-estate is developed. The chatbot is able to engage clients in meaningful conversations in real-time. It provides a 24/7 service and effectively reduces administrative costs. The architecture and infrastructure overview are presented. The rule matching algorithm is presented and discussed in detail.**

Keywords - chatbot; real-estate; task-orientated chatbots; recommendation score;

I. INTRODUCTION

Chatbots, are interface agents, a category of software agents that allow human-computer interaction based on natural language. The interaction is either text-based or voice-based. They are also known as conversational agents and conversational interfaces. Conversational interface is a new way to expose software [1].

Chatbot based human-computer interaction can provide customer feedback on 24/7 basis and is able to reach broad audiences. Chatbots improve efficiency, reduce the administrative cost, and improve business branding. They automate and accelerate operations and effectively manage stuff cost.

Although chatbot technology has been in existence since 1966 [2], in recent years, chatbots have become an emerging trend in customer relations. The fact that chatbots a significantly more relevant today than a few decades ago is not just due to improvements in artificial intelligence and natural language processing technologies, but it is also rooted in the significant change in the overall communication landscape. The newer generations are more used to short text or voice messaging exchange, whereas older prefer direct communication [3], [4]. Conversing via chatbots and with virtual assistants, such as Microsoft's Cortana, Apple's Siri, Tencent's Xiaowei, Alibaba's AliGenie, Samsung's Bixby, Brainasoft's Braina, Amazon's Echo and Google assistant has become a norm.

Real estate agents today are trying to gather more potential clients. This is done through a remarkably large human effort of collecting property and client data, responding to client offers, obtaining approvals and signing paperwork. Chatbots can help and represent potential solutions to all these problems. By automating customer inquiries, chatbots can provide a great base for further development of chatbot database of questions.

When we discuss digital transformation, many companies, when trying to automate their business, incorporate chatbots into their systems. Today we have most of these discussions about Artificial Intelligence (AI) chatbots, but dedicated chatbots are a necessity if we want to position the company on the market better. There are essentially no areas where chatbots do not currently exist or will not exist soon [20].

Although we can find several papers in the literature about parts of chatbots or chatbot architecture, there are only three papers on topic "chatbot real estate" in Wos and ten papers in Scopus library. That lack of literature was motivation for writing this paper. We also wanted to represent a simple model of a real estate chatbot. Different analysis available is on topic "chatbot" where we can find 666 in category Computer Science Information Systems of all 3.718 publications in Web of science search. 662 publications are in the category Computer Science Theory Methods. This makes us think that most publications relate to Computer Science. If we analyze distribution over the years, we can notice that chatbot became popular in 2023, with 1089 publications, or 29% of papers listed on Web of science. Year before we found 691 publications on the same topic. This fact only proves that the topic is current, but since there is not enough literature on the topic of real estate, it is necessary to do more research in that area as well. Research results of Web of science for last ten years are shown in the table below:

TABLE I. PUBLICATIONS ON TOPIC "CHATBOT" OVER LAST TEN YEARS IN WEB OF SCIENCE

Publication Years	Record Count	% of 3.718
2023	1089	29.29
2022	691	18.585
2021	628	16.891
2020	440	11.834
2019	377	10.14
2018	240	6.455
2024	85	2.286
2017	72	1.937
2016	24	0.646
2014	15	0.403
2013	11	0.296

Chatbots are flexible easy to use technology and are thus applied for a range of different tasks in a variety of different industries. Chatbots are used in automotive industry, e-commerce [5], hospitality [6], finance [7], media [8], education [9], healthcare [10], insurance [11], real-estate [12]. They are used to provide customer support, suggest products, prevent churn, qualify leads, reserve services, handle queries and complaints, resolve insurance claims, investment management, money transfer, news delivery, collect public opinion, marketing, psychiatric counseling in mental healthcare service, education support, and many other tasks.

In this paper, the development of a real-estate chatbot is presented. The chatbot developed in the paper engages clients in real-time conversations, provides 24/7 service, and reduces administrative costs. The architecture, infrastructure overview, and rule matching algorithm are presented. The paper is organized as follows. A brief historical review of chatbots is presented in section 2. Classification of chatbot technology is presented in Section 3. The architecture, infrastructure and the rule matching algorithm and other technical specifications of the developed chatbot is presented in Section 4. Section 5 concludes the paper.

II. A BRIEF HISTORICAL REVIEW OF CHATBOTS

A chatbot communicates with a person using natural language. It is desired to have a communication where the person will have impression that it is a conversation with a real person, rather than with a computer program or an algorithm. Over the years many attempts have been made to design a chatbot that can pass the Turing test. The Turing test, created by Alan Turing in 1950, is designed to evaluate machine's "intelligence", whereby a human questioner is participating in an interview with a machine and a human. If, after the extensive interview, the questioner is not able to explicitly identify the machine, then it is considered that the machine has passed the Turing test.

This chatbot is a rule-based chatbot. The rule-based approach involves asking simple questions but can also develop complicated rules. One major downside of such chatbots is they don't learn from user interactions. A rule-based bot relies heavily on customer input and cannot answer questions outside the pre-set options or scenarios. This often leads to frustrating experiences for the users. The rule-based chatbot architecture is based on the likely behavior or responses of the customers. Based on this, they present them with questions like a flow chart. The customer can select the most suitable option to proceed. And often, selecting one option triggers a list of follow-up options and continues until an action is taken.

The first chatbot ELIZA was developed Joseph Weizenbaum and the MIT Artificial Intelligence Laboratory in 1966 [2]. The program was based on simple declarative rules. The ELIZA chatbot performed good in the search-based scenario, but it ultimately failed in conversation-based interactions, and thus, it was unable to pass the Turing test.

In 1972, psychiatrist Kenneth Colby designed a chatbot called PARRY. This rule-based natural language program was designed to simulate the conversational model of a person with paranoid schizophrenia. The conversational model misinterpreted what people said, if others have wicked and concealed motives. Parry was the first chatbot that was able to pass a version of the Turing, whereby a group of 33 actual human psychologists, were unable distinguish Parry from the actual paranoid individuals with more than random accuracy.

Another important landmark in chatbot development arrived with the computerized psychologist chatbot called Dr. Sbaitso, in 1991. The chatbot was able to synthesize speech and communicate verbally. Dr. Sbaitso (Sound Blaster Artificial Intelligent Text to Speech Operator) was distributed with some sound cards created by Creative Labs, and it was designed to demonstrate the range of different digitized voices the cards are able to generate.

In 1995, Dr. Richard Wallace developed a chatbot called ALICE (Artificial Linguistic Internet Computer Entity). The chatbot design is inspired by ELIZA, however it uses Artificial Intelligence Markup Language (AIML). The use of heuristic pattern matching rules enables the chatbot to have a variety of more sophisticated responses. Although ALICE was not able to pass the Turing test, its subsequent upgrades won the Loebner Prize in 2000, 2001, and 2004.

Robert Hoffer created SmarterChild, a chatbot that is able to answer fact-based questions and to provide users with news reports, weather reports, movie listing, stock information, etc. The chatbot was released by ActiveBuddy as a web service integrated in AOL's Instant Messenger in 2001.

The intelligent service Siri was developed by Apple and released in 2010 and was designed as the intelligent virtual personal assistant. It uses machine learning and natural language processing to hear the question, interpret the question and to generate natural language. Since than many other virtual personal assistants have become popular, such as Google Now (2012), Cortana (2015) and Alexa (2015).

The end of year 2022 brought us Chat GPT. Most of publications we were able to find explore the topic of education and different aspects of using for example Chat GPT in education. Different authors investigated the use, for example, of chatbot in training or even grading students automatically. Ethical and different research on plagiarism when using services like this is very important and popular – because the world is incorporating artificial intelligence into everyday life. It is important to find a model of improving business efficiency using these popular technologies. Business of real estate is one of them. ChatGPT's Improved Accuracy model has several features that make it a powerful NLP system that utilizes a deep learning-based AI architecture that would produce accurate and meaningful conversations. Deep learning

enables it to make decisions based on data by finding and extracting data patterns from large datasets that are accurately mapped into valid output decisions. In a model presented in this paper, we had prepared questions and answers, with no need to incorporate, for example ChatGPT. Still, the potential of this software, which is a global phenomenon, should neither be ignored nor denied.

Real estate agents today spend most of their time generating leads (or potential clients). This is done through a remarkably large human effort of collecting property and client data, responding to client quotes, obtaining approvals, and signing paperwork. Chatbots are a potential solution to all these problems. By automating customer queries, chatbots can create a valuable database of profiles of potential prospects and are very useful for lead capture through automated conversation. While chatbots cannot completely replace the traditional relationship between agents and homebuyers, they can help engage prospects (or leads) in meaningful conversations (or leads) into meaningful conversations in real time. But the fact customers use chatbot in everyday life, and applications they use every day, it is mandatory to incorporate these technologies in business applications such as real estate sale. We already said that chatbot can be defined as a computer program based on artificial intelligence that imitates human communication by textual and/or auditory means. Today different terms are used in connection with chatbots that do not have the same meaning: Chatterbot, Smartbot, Educabot, Quizbot, digital assistant, personal assistant, virtual tutor, conversational agent, etc. We will show the use of chatbot, defined by the first definition in this paper.

III. CHATBOT CLASSIFICATION

There are two types of chatbot models, generative model, and retrieval-based models [4]. Retrieval based models, as the one in this paper, form responses using a repository of predefined responses [14]. An appropriate response is chosen based on user input and context. Retrieval-based chatbots are free from grammatical mistakes but have limitations with respect to the unseen data for which appropriate predefined responses do not exist. Generative models are more complex as they generate responses from scratch rather than relying on a set of predefined responses [15-17]. Generative models are typically based on machine learning techniques. They are capable of learning from historical data to generate new responses and can handle unseen queries. However, they require a large training corpus and are also capable of making grammatical mistakes.

Chatbots can be designed as task-orientated or non-task oriented [18]. Task orientated chatbots are designed to serve a particular task. They are set up to have brief conversations to extract the information from the user to enable task completion. The non-task oriented chatbots, also known as chit-chat chatbots, are set up to converse with users and give contextually relevant responses.

Knowing all this, we must mention that all chatbots are circular and deterministic [20]. We get one final answer on asked questions. In this paper we will show a task-oriented chatbot.

IV. CHATBOT DESIGN

In this paper, a retrieval-based real-estate chatbot is designed. The chatbot architecture is presented in figure

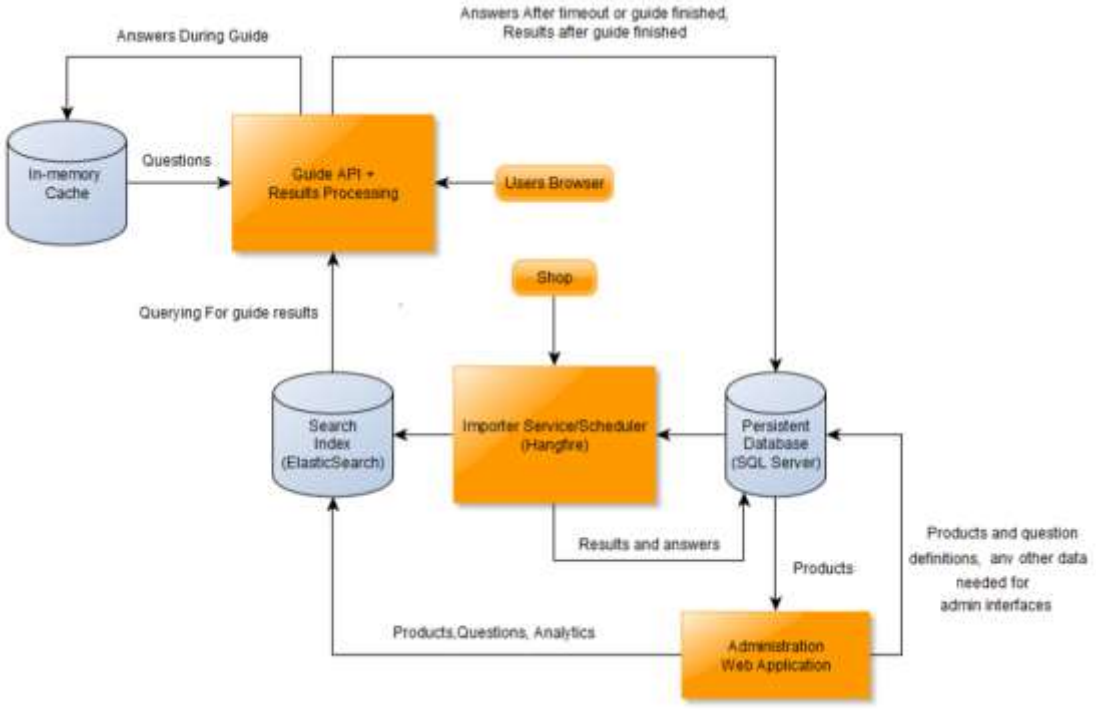

Figure 1. Real-estate chatbot architecture

1, and it is shown that it forms responses using a repository of predefined responses. This type of chatbot is suitable for task-oriented interactions and can provide accurate responses based on predefined rules and data. It is free from grammatical mistakes and can handle a wide range of user queries effectively. Additionally, retrieval-based models are easier to implement compared to generative models, as they do not require generating responses from scratch based on historical data. This simplicity in design and implementation makes retrieval-based chatbots a practical choice for applications like real estate where specific information needs to be provided efficiently and accurately.

Figure 1 shows the two system approaches combined – User Browser as entry point and the place where results are delivered, and the Administration Web Application where all products' question definitions and any other data for admin interfaces are provided. Administration Web application lays on Persistent Database, and Importer, which is an actual shop, has its own Elastic Search database. Customers' answer are collected in memory cache and later forwarded to Persistent Database.

The following technologies were used:

- Backend Technology: ASP.NET (C#)
- Frontend Technology: Javascript, Jquery, Angular 4, HTML5, CSS3
- Databases: SQL Server (relationship database), Elastic Search (NoSQL Database)

Using the .NET framework enables the development of scalable and secure web and desktop applications with a high level of flexibility and support for different programming languages, and that was the reason it was used in this paper. As the SQL is a powerful database management language that allows fast access and manipulation of data and ease of integration with various applications, it provided reliability and efficiency in data management.

In what follows, the recommendation algorithm (RA) of real-estate chatbot is described in detail. The algorithm differentiates between strict questions and non-strict questions. If a product does not match a strict question, it is excluded from consideration. An example of a strict question is "Do you want a single or double story house?". If the consumer answers double story, then all single-story houses are excluded from consideration.

Rule matching evaluates if the product matches the question and answer. In the previous examples, the double stories „match the rule", while all single houses „do not match the rule".

Neutral score refers to base score used for the recommendation algorithm RA score calculation. It allows change the strength of a question and answer. Its default value is 10, but it can be any number from 0 – 100. Up/Down L1/L2/L3 Neutral Reduction allows the products that don't satisfy the "Rule Match" to be considered if they are close alternatives. For example, if the user answers the question "How many bedrooms would you like?" as "one", then products with two, three, and four bedrooms "do not match the rule".

However, three levels can be formed to reduce the neutral score of the products that do not match the rule. For example, L1 Neutral Reduction (two bedroom) = 40%, L2 Neutral Reduction (three bedroom) =60%, L3 Neutral Reduction (four bedroom) = 70%. Weight is another way of assign different levels of priority. And it can take values from 1%-100%.

The *Yes Score* is used to denote the maximum score a question and answer can receive:

$$Yes\ Score=(Neutral\ Score*Weight)+Neutral\ Score \quad (1)$$

Yes, Score changes if the "Up/Down L1/L2/L3 Neutral Reduction" gets a match. In that case Yes Score is evaluated as:

$$Yes\ Score =((100\% - Neutral\ Reduction)*Neutral\ Score) + ((100\% - Neutral\ Reduction)*Neutral\ Score)*Weight \quad (2)$$

The Match Score is used to refer to the score a question and answer get if the rule matches.

$$Match\ Score=(Neutral\ Score*Weight) \quad (3)$$

The recommendation algorithm score without taking into account budget is given as:

$$RA\ Score\ (without\ budget) = (All\ Neutral+Match\ Scores\ Combined)/(\ All\ Yes\ Scores\ Combined) \quad (4)$$

The effect of budget is on the overall recomendation score is determined using the following parameter:

$$Over\ budget = ((Product\ Price))/((Budget\ Answer))-1 \quad (5)$$

The final recommendation algorithm score is defined as:

$$RA\ Score = RA\ Score\ (without\ budget) - Over\ budget \quad (6)$$

For each product the recommendation algorithm score is evaluated on the basis of the following 10 questions.

1. What is your maximum budget?
2. Do you want a single or double?
3. What size lot do you have?
4. Pick your favourite designs?
5. Do you prefer Floorboards or tiles?
6. How many bedrooms would you like?
7. Would you prefer all bedrooms to have an ensuite?
8. Do you often entertain outdoors?
9. Do you prefer open plan living?
10. How many cars do you want garaged?

The neutral score and weightings allow to priorities different questions. Let us consider question no.6: "How many bedrooms would you like?". Let us consider the

case where the *neutral score* = 10, and the *weight* = 75%. If the answer is Four bedroom, let us consider two cases, one where there is rule match and one where there is 2nd level match 50% Neutral Reduction. If there is rule match, the Yes score is obtained as:

$$Yes\ Score=(Neutral\ Score*Weight)+Neutral\ Score \quad (7)$$

$$Yes\ Score=(10*0.75)+10=17.5$$

However, if there is L3 match, then the Yes score has a reduced value:

$$Yes\ Score=((100\% - Neutral\ Reduction)*Neutral\ Score) + ((100\% - Neutral\ Reduction)*Neutral\ Score)*Weight \quad (8)$$

$$Yes\ Score=(1-0.50)*10+(1-0.5)*10*0.75=8.75$$

Table II. shows the results of real key performance indicators 6 months after the implementation of rule-based chatbot in Real Estate Agency in Australia. The results have shown all 10 positive results with a total ratio of implementation of 91% of the successfully implemented key performance indicators. Based on this, we can conclude that this rule-base chatbot is successfully implemented in Real Estate Agency in Australia.

TABLE II. KPI RESULTS IN REAL ESTATE AGENCY IN AUSTRALIA

KPI	**Result of KPI**	**Satisfied result**
Total number of users	952	YES
Number of new users in the last month	45	YES
Goal completion rate	65%	YES
Number of sessions initiated	84	YES
The average number of daily sessions	26	YES
Total number of conversations	12	YES
Agent Request Frequency	95%	YES
Average Conversation Time	97 seconds	YES
Bounce rate	12%	YES
Interaction rate	92%	YES

RAG, or "Retrieval-Augmented Generation," is a model that combines the advantages of retrieval-based and generation-based approaches to building chatbots. This model uses a retrieval-based component to search and extract relevant information from a large database or corpus, and then uses a generation-based approach to generate natural and contextually enriched responses based on that information. This achieves a better understanding of user queries and ensures a better response. RAG models often use techniques like text search and matching and generative modeling to achieve high performance in chatbot systems. The algorithm allows assignment of different question waiting and neutral score values to change priorities of the questions. This, as fine tuning is left and suggested for further research on real estate chatbots.

When we discuss datasets of real ads, we have bear in mind that this is a system implemented for one client, in a very specific territory of Australia. For any serious expansion of the dataset, it is necessary to first expand the market to the EU and the USA. This would automatically help the creation of a new dataset.

V. CONLUSION

In this paper, an overview of chatbot technology is presented. A historical context and classification of the design of real-estate chatbot is presented. The architecture of the chatbot and technology used for its implementation is described is outlined. The chatbot is based on the algorithm recommendation score which is described in detail. The algorithm allows assignment of different question waiting and neutral score values to change priorities of the questions. In addition, the parameter Neutral Reduction is used to allow the products to be considered that don't satisfy the "Rule Match" but are close alternatives. The proposed Chatbot is able improve efficiency, reduce the administrative cost, improve business branding, reach broad audiences, and provide customer feedback on 24/7 basis.

As we already said it is necessary to provide dedicated chatbot, with known algorithm as it base, because of all potential problems that could happen with using generic ones. This paper provides theoretical base, but it is a tool designed to be incorporated in real company to help its digital transformation and better market position. The main processes connected to chatbot are in the background, but what customers see is the base for the business improvement process.

The thing that could significantly improve chatbot use is the native language of the area where the application is implemented. This could not only help companies, but enable acquirement of the new customers, that are not English speakers.

This paper describes the use of a chatbot in a company that deals with brokering the purchase and sale of real estate. The chatbot as a tool can enable the segmentation of adequate supply and demand for buyers and sellers, which increases efficiency in the search for the desired property and achieves multiple benefits on the part of the real estate seekers and the agents who mediate in real estate transactions.

Future research should involve AI-aided chatbots which can help customers with making simple decisions. Chatbot of the future should not only help customers to make their decisions, but also business owners in making decisions which real estate to buy, where will it be easy to sell, etc., or even use a chatbot as an instrument for processes other than simple decision making. One of the processes could be incorporated into risk management or business continuity management. Modern chatbots include new functions such as speech recognition, customizable interaction, integration with third-party applications, omnichannel deployment, and multiturn capacity [21], but even if all industries could not use all the functions, some of them could be applicable on industry such as real estate. The interaction between chatbots and customers may aid in creating a platform for a new business model.

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