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AVA: KNOWLEDGE-BASED CHATBOT AS VIRTUAL ASSISTANT IN UNIVERSITY

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Abstract. *The development of a chatbot for virtual assistant to make an interactive conversation, and the ability for answering Frequently Asked Questions (FAQ) is very rare and can be used in a humanoid robot. The chatbot is one of the most promising expressions of interaction between humans and machines. Chatbot also represents a question answering system as part of Natural Language Processing (NLP). It can be used as a virtual assistant for students or prospective students. In this paper, we propose a model of question answering system based on Google Dialogflow, that has the ability as a virtual assistant. From our experiment, the accuracy of this chatbot reaches 90% of 20 questions obtained by 4 respondents.*
Keywords: Chatbot, Humanoid robot, Virtual assistant, NLP, Dialogflow, Knowledge base chatbot

1. **Introduction.** Intelligent humanoid robots with interactive conversations based on chatbots are our hope for the future. Chatbots are programs to sense the context of the conversation and execute the right actions based on user requests. On the other hand, a virtual assistant can crawl through existing resources and help with a wide range of requests [1]. Dialogflow is a technology from Google, a build-once deploy-everywhere development suite for creating conversational interfaces for websites & mobile applications. It provides natural and rich conversational experiences, such as virtual assistants. Virtual assistants based on Dialogflow takes the complexity out and the technologies being implemented today are no longer the stuff of science-fiction; virtual reality and much more are now possible [2]. Dialogflow handles the job of translating natural language into machine-readable data, using a machine learning model trained by the examples. Once it identifies what the user is talking about, it can handle this data to the backend to make the response [3].

Many new kinds of research for virtual assistants were developed by the researcher. Reyes et al. [4] developed a virtual assistant that enables students to access interactive content adapted for an introductory undergraduate course on artificial intelligence. This chatbot can show answers to FAQ in a hierarchically structured manner, leading students by either voice, text, or tactile input to the content that better solves their questions and doubts [4]. Dutta [5] developed an intelligent chatbot tool to assist high school students in learning general knowledge subjects. Using a chatbot as an intelligent tutor has some advantages that it can be available 24/7 and giving the student the freedom of learning at their own pace, at any moment, and from anywhere with Internet access. Different

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chatbot platforms were compared for this research: Dialogflow.com, Wit.ai, Luis.ai, and Pandorabots.com, based on NLP capability and feature development ability. Based on the evaluation, Dialogflow can handle sub-intent purposes of the user's text as input and can be accessed using the web browser and Android apps. In another experiment, which was done by Sörensen [6], eight users had to talk to two different kinds of chatbots, one behaving more human-like and one behaving more robotic. In this context, they had to fulfill certain tasks, like ordering an insurance policy or demanding an insurance certification. All of the participants instinctively started to chat by using natural human language. In cases in which the bot did not respond to their queries satisfyingly, the users' sentences continuously got shorter until they ended up with writing keywords only.

Another approach to bridging the connection from human to the robot as a virtual assistant is by using visual communication. Tan and Sato [7] studied the use of visual communication between a robot and a human, to make a robot understand human thought related to object recognition or pattern understanding. The proposed system intends to be used by those who find it difficult for shopping, such as patients, disabled or elderly people. The robot can pick items in the rack automatically. Empathy for a chatbot is needed too, to make the user feel comfortable. Yacoubi and Sabouret [8] researched TEATIME, an architecture for the agent-based dialog management system. TEATIME uses the emotional state as a driver for actions, e.g., when the bot is perceived unhelpful, that emotion leads the bot to apologize.

In this paper, our objective is to make a knowledge-based chatbot as a virtual assistant. The main contribution of this research is to develop a novel model of chatbot based on the knowledge obtained from the FAQ on the university web. This contribution can reduce the redundancy of simple tasks. The significance of this study is to support society 5.0, where everything integrates technology and supports the intelligence system. The result of this study shows that the accuracy of AVA (ANITA Virtual Assistant) reaches 90% when being tested with several respondents. In summary, our model is very simple, reliable, and can be used as a novel model for developing an intelligent chatbot for a humanoid robot. Part 1 is an introduction, Part 2 is the literature review, Part 3 is the proposed method, Part 4 is the experimental result, and Part 5 is the conclusions. Figure 1 shows our prototype of a chatbot named AVA that can be used in answering students' questions at our university.

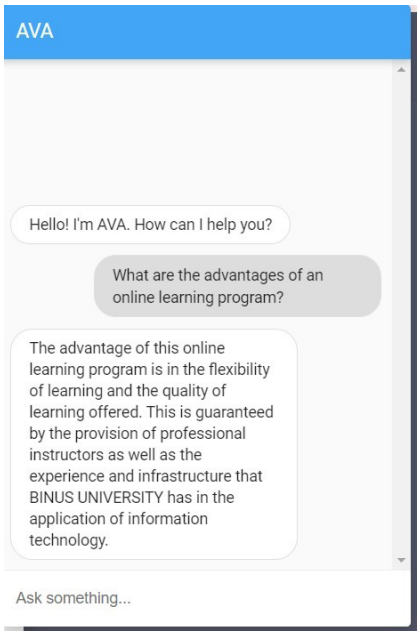

FIGURE 1. Our chatbot named AVA (ANITA Virtual Assistant)

2. Literature Review.

2.1. Chatbot.

ALICE and ELIZA as psychotherapist questioning technique programs from Joseph Weizenbaum are examples of early question-answering research and artificial intelligence [9,10]. Human-chatbot communication lacked much of the richness of vocabulary found in conversations among people and exhibited greater profanity. Chatbot or cognitive assistants use messaging services as the platform and have some advantages by making personalized user-to-user experiences [1]. Chatbots are used in many organizational domains where they can replace humans. There are many types of cloud-based chatbot platforms, such as Dialogflow, Pandorabots.com, Luis.ai, and Wit.ai. Contextual chatbots are backed by Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP). This technology enables chatbots to continuously learn, offer accurate responses, and retain context to personalize conversations.

Research about University Chatbot related to Frequently Asked Questions (FAQ) was developed by Ranoliya et al. [11], which is used as a question answering application about FAQ at the university. The FAQ chatbot was developed using the Artificial Intelligence Markup Language (AIML) pattern that retrieves a set of matching information from the FAQ databases. The chatbot FAQs will assist students to get the information needed, like availability of services, updates regarding activities happening inside the campus, ranking of the university, university environment, and many more about academic information.

Lee et al. [12] studied the effect of FAQ chatbot service in the university on the workload of Administrative Officers. The chatbot uses Kakao Talk API and Dialogflow and provides information such as graduation requirements, majors, notices, and events inside the campus. The result of this experiment shows that there is a reduced amount of workload at the administrative office, including the inquiries received by email when the chatbot was introduced. Ricciardelli and Biswas [13] used Reinforcement Learning (RL) to make the chatbot improve the performance from user conversation. The scores predicted by the model are used as rewards for the RL agent. The result shows an increase in performance from an initial 50% success rate to 75% in 20-30 training epochs.

2.2. Dialogflow.

In a chatbot system, an agent is essentially your entire chatbot application, the system of collecting what the user is saying, mapping it to an intent, taking an action on it, and providing the user with a response. In the agent, this all starts with a trigger event, called an Utterance. This is how our users invoke the chatbot. Dialogflow is a Google service that runs on the Google Cloud Platform which allows any user to build engaging voice and text-based conversational interfaces [14]. It also offers a new analytical tool that can help in assessing usage patterns, latency issues, and the high intents of the agent. Because of GUI (Graphical User Interface), users who are not from technical backgrounds can also easily build an AI-based chatbot using Dialogflow [15]. Dialogflow has another benefit that it can be used not limited to the text base but can be applied in speech-based, such as using Google Assistant as the medium, like done by Hadi et al. [16]. They use Dialogflow API via Google Assistant for monitoring and controlling electronic appliances. The users can use Google Assistant app on their smartphone to monitor and control electronic appliances. Another approach to making smart home assistants using Dialogflow was done by Salvi et al. [17]. They use some sensors, hardware, and microcontroller to test the IoT, and use Webhook to process and redirect request-response between Dialogflow and local server.

Prange et al. [18] used Dialogflow to build a multimodal speech-based dialogue system for the Mini-Mental State Examination (MMSE). From the experiment, they compare the proposed system with the traditional approach and find that both models show equal performance in terms of usability. Based on the comparison between IBM Watson and Google Dialogflow for a voice-based assistant done by Patil et al. [19], it shows Dialogflow has the advantages in terms of easy maintenance software, can convert user's expression

to structured data, and support multi-language. Dialogflow also has other capabilities, such as speech recognition, object detection, and cross-platform API to request and check permissions for the other applications present in the device.

Some important keywords in Dialogflow are as the following.

1) Intent

   The intent is a feature that contains elements and logic to analyze information based on user's requests to answer their questions [14]. The questions or requests given by the user will be attempted to match in corresponding intent. If none of the intents match with Dialogflow, the fallback intent will handle user requests. Fallback attempts typically re-prompt the user to provide the user's action with the required input. Users may define re-prompt phrases in the response area or may use a webhook for re-answering those questions [14]. Default Fallback Intent is automatically configured when the user creates an agent with a variety of static text responses, such as "I didn't get that. Can you say it again?" and "Sorry, what was that?" or can customize the message. This intent is matched when the user's input does not match any other intent. In other words, it is a sort of catch-all for any unrecognized and unknown user input [14].

2) Entity

   Entity reflects a word or object applicable to intent and providing a particular content for intent. The words that have synonyms that may be entered by users must be listed in the entity to make sure the intent could handle it when the user asks the same questions using different words and phrases [14]. Some built-in-entities are provided by Dialogflow for dates, currency, etc. The developer can define new entities like departments, colors, models, and food menu [14].

3) Fulfillment

   Fulfillment is code that is deployed as a webhook that will be called by the Dialogflow agent. Fulfillment will use the information extracted by Dialogflow's natural-language processing to generate dynamic responses or trigger actions at the back-end [14]. Fulfillment uses for intent that required more complex actions, for example, fulfillment to book a flight ticket, or Fulfillment to handle an email subscription.

4) Context

   Context enables the assistant to speak more like humans by maintaining the context and responding to end-users. Contexts use to track a communication state and control the intent and conduct a conversation based on the user's previous answers. Context also holds the values of entities and parameters, based on what the user said earlier [14].

3. **Proposed Method.** Entities are a mechanism in Dialogflow for identifying and extracting useful data from natural-language inputs. While intents allow the agent to understand the motivation behind a particular user input, entities are used to pick out specific pieces of information that the users mention, such as names, email addresses, and curriculum names. Any important data that you want to get from a user's request will have a corresponding entity. The conversation's flow between the user and the chatbot is shown in Figure 2.

Users can interact with Dialogflow by using two methods, text-based and voice-based. The user request or question will be received by Dialogflow, then will be forwarded to the agent. The agent will match user requests or questions to suitable intent. If the suitable intent has the fulfillment, the fulfillment will be processed by using a webhook to the server, and then the webhook server will send the response to the intent. The intent will send the response back to the Dialogflow, and Dialogflow will send the response to the user. AVA can answer frequently asked questions asked by the user, related to the university online learning program. AVA also can check the curriculum detail from

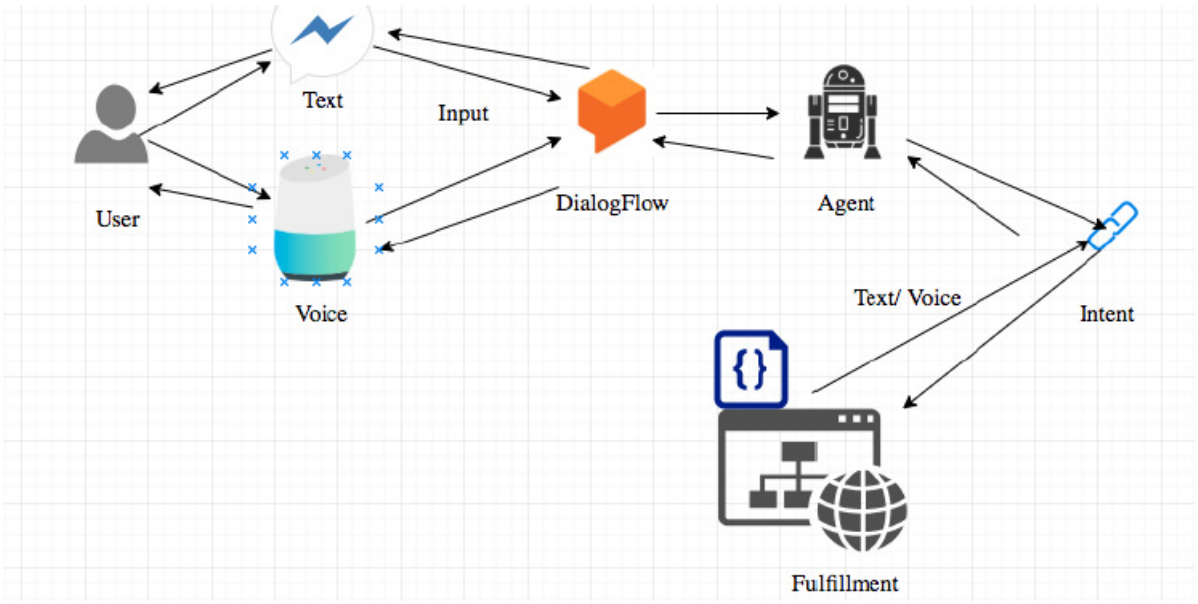

FIGURE 2. Flow of the conversation in Dialogflow [20]

TABLE 1. Dialogflow component used in AVA

No	Type	Used for	Name
1	Intent	Match the user input to specific response	advantage-program-intent apply-binus-intent general-info-intent fallback-intent welcome-intent curriculum-intent
2	Entity	Email address for the newsletter Curriculum name	email-entity curriculum-entity
3	Fulfillment	Webhook to university web service Check curriculum service	check-curriculum-fulfillment general-info-fulfillment
4	Context	Curriculum input Email address input	await-curr-context await-email-context

each major based on user input and add the user's email to the email subscription. The component used for AVA is listed in Table 1.

4. **Experimental Result.** The experiment was conducted using Google Dialogflow, and webhook service for fulfilment in another server to handle email subscriptions and get the curriculum detail. To run the AVA, we must provide the knowledge base to train the AVA and the knowledge data shown in Table 2.

4 respondents ask questions related to BINUS Online Learning to AVA as shown in Table 3.

We can count the accuracy of the performance by using the accuracy formula:

$$Accuracy = \frac{Correct\ Questions}{Total\ Questions}$$

Based on our experiment, the accuracy of the chatbot reaches 90%. The wrong answer occurred because the question's sentences asked by the user have some similarities with

TABLE 2. Example of knowledge base to train AVA

No	Question	Answer
1	What are the courses of computer science in the first semester?	There are character building: Pancasila, discrete mathematics, linear algebra, algorithm, and programming, program design methods.
2	How to submit assignments given by the lecturer?	You can see the assignment given by the lecturer through the Assignment menu. For submission of assignments, answers can be given via the answer upload menu. The answers given can be accompanied by attachments if needed.
3	What is the maximum absence in one semester?	Student may not absence in a class maximum three times.
4	What are the advantages of an online learning program?	The advantage of this online learning program is in the flexibility of learning and the quality of learning offered. This is guaranteed by the provision of professional instructors as well as the experience and infrastructure that BINUS University has in the application of information technology.
5	How do I apply for an online learning program?	Registration for the online learning program can be done online through www.online.binus.ac.id, click Online Registration. In addition, you can also register through the BINUS University admission on the Anggrek campus.
6	How long does it take to study until graduation?	For undergraduate programs, the length of study is 8 semesters, while for D3 $\rightarrow$ S1 programs it is 4 semesters.
7	Are all lectures conducted via the Internet?	Not all lecture sessions are conducted via the Internet network, there will be face-to-face sessions with lecturers through solving a case (Problem Based Learning).
8	What are the requirements for registering for an online learning program?	The general requirement to register as a student of BINUS University online learning is that you have passed high school. For complete information, please visit www.online.binus.ac.id or contact the BINUS University admissions.
9	What should I do during the online lectures?	In online lectures, students are expected to be able to learn independently through material that has been given by the lecturer. You must read the material, actively discuss through discussion forums to ask questions, respond to and discuss group assignments.
10	How do I interact with lecturers and classmates when studying online?	Students can interact with lecturers and other class members through the discussion forums that have been provided. For questions related to the subject, it can be done in the classroom, for discussion group assignments can be done in the team room, while questions or personal consultations with lecturers are carried out through the personal room.
11	When is the deadline for the submission of assignments?	The time for submitting assignments will be informed each week. For students who exceed the maximum deadline for the collection of assignments that have been set, the student cannot upload answers to the LMS, so the score will automatically be zero.
12	How to subscribe to the BINUS newsletter? I want to subscribe.	Great! Please input your email.

TABLE 3. Performance results of the response from AVA

Respondents	Total question	Correct response	Incorrect response
User 1	5	5	0
User 2	5	4	1
User 3	5	4	1
User 4	5	5	0
Total	20	18	2

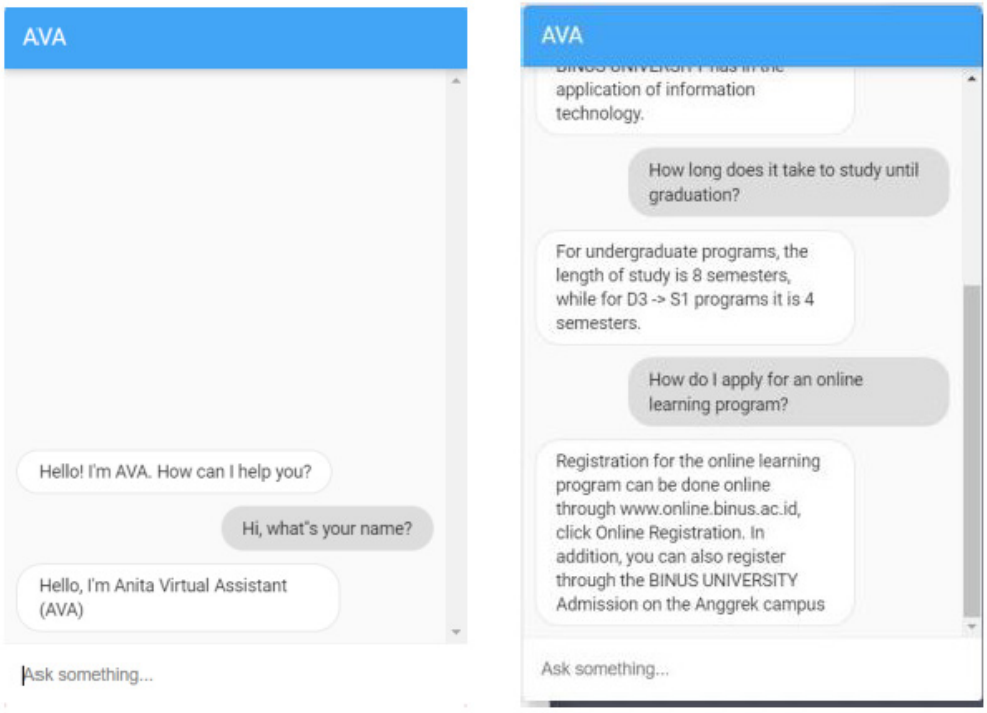

FIGURE 3. AVA as a virtual assistant is able for answering the question.

other intent, so the chatbot failed to answer correctly. One of the examples is when the user asks "what is the advantage if I apply to an online learning program?" The answer should be the advantage of the online learning program, but the chatbot answers it about step by step how to apply for the online learning program.

5. **Conclusions.** Conversational AI/virtual assistants are propelling the world with astounding levels of automation that drive productivity up and costs down. The virtual assistant can answer user's questions based on the knowledge base, and information processing in the webhook server. In our model, chatbot for virtual assistant successfully developed with 90% accuracy. For further research, we want to make the intent to behave more specific and dynamic using artificial intelligence.

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