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TOWARDS AN INTELLIGENT CHATBOT DEVELOPMENT USING NATURAL LANGUAGE PROCESSING SOFTWARE COMPONENTS

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During the Master's Degree course, we have created a chatbot, developed using Python, Tkinter, NLP (Natural Language Processing), and NLTK (Natural Language Toolkit) modules, as well as NLP tokenization techniques [1]. The developed intelligent chatbot demonstrates desired capabilities that enhance user interaction. In this paper, we explore its algorithm and evaluation process of the proposed chatbot.

The developed chatbot stands out in its ability to accurately understand complex user queries, providing contextually relevant and coherent responses, resulting in increased user engagement. Therefore, the proposed chatbot's algorithm focuses on:

1. User Understanding: The chatbot accurately comprehends complex user queries.
2. Contextual Responses: Leveraging NLP and tokenization, the chatbot provides contextually relevant and coherent responses.
3. User Engagement: User feedback and engagement metrics exhibit a substantial increase, indicating the chatbot's effectiveness and user-friendliness.

The general scheme of the proposed algorithm, developed as the UML (Unified Modeling Language) activity diagram, is demonstrated in Fig. 1 below.

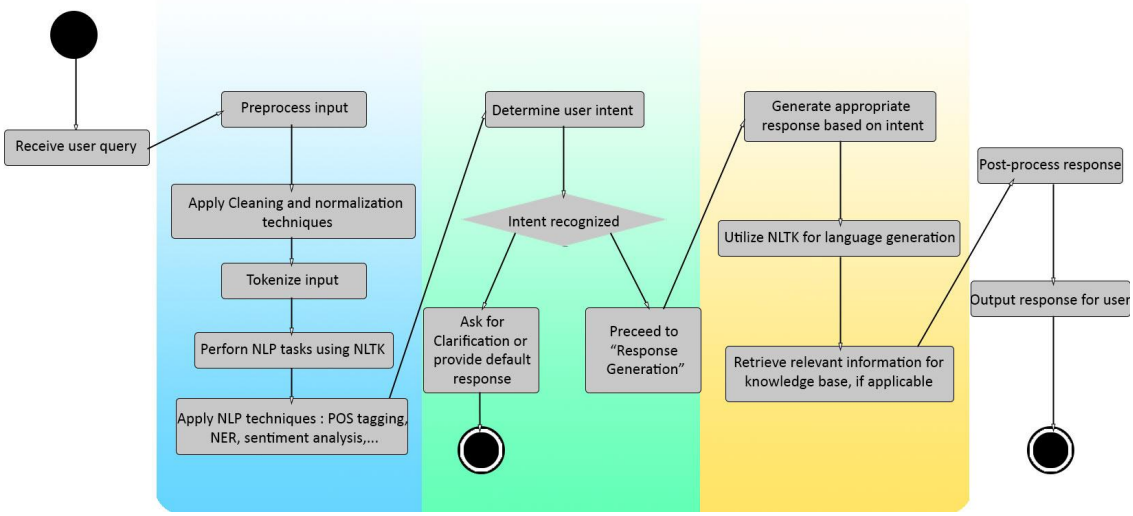

Fig. 1 – UML activity diagram of the proposed chatbot's algorithm

Also, let us provide the following definition for the concepts we use:

1. "User Understanding" is the accurate comprehension of complex queries.
2. "Contextual Responses" is the ability to provide contextually relevant responses.
3. "User Engagement" is the ability to assure the increased user satisfaction and interaction.

During the fuzzy logic-based evaluation of the developed intelligent chatbot against the GPT-3.5 chatbot (Generative Pre-trained Transformer) [2] via the OpenAI API (Application

Programming Interface), we calculated the "truth" values for each "evaluation statement" using the fuzzy trapezoidal membership function [3]:

– S1: NLP-based chatbot is of medium or high quality, while GPT-based is of medium or low quality.

– S2: NLP-based chatbot is of medium or low quality, while GPT-based is of medium or high quality.

– S3: Both NLP-based and GPT-based chatbots are of medium or high quality.

The "Chatbot answers" linguistic variable and its terms are demonstrated in Fig. 2 below.

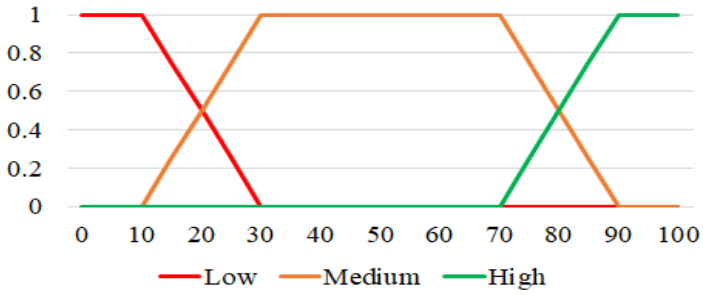

Fig. 2 – "Chatbot answers" linguistic variable's term set

During the chatbot's evaluation, we looked at two types of chatbots. One is the developed one, which giving short and accurate answers (NLP-based), while the other (GPT-based) provides more information and gives longer, detailed answers. As the result, the following "truth" scores were obtained for S1-S3 evaluation statements:

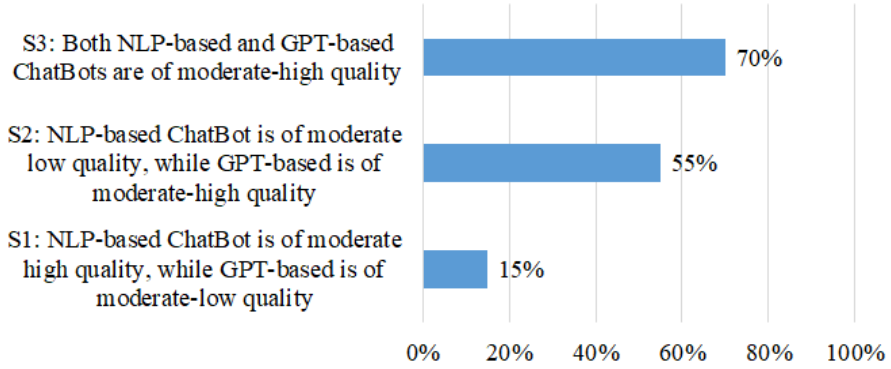

Fig. 3 – Evaluation statements' scores and their comparison

Let us conclude, the developed NLP-based chatbot is of moderately good (70%) at understanding and answering questions in a helpful way, basically as precise as GPT-based chat bots. Future research considers the improvement of NLP-based chatbot algorithms, models, and software components for common purposes without need of "heavy" GPT techniques.

References:

1. *NLTK. (2009). Natural Language Toolkit – NLTK 3.4.4 documentation. Nltk.org. https://www.nltk.org/*

2. *Zhao, W. X. et al. (2023). A Survey of Large Language Models. ArXiv (Cornell University). https://doi.org/10.48550/arxiv.2303.18223*

3. *Fuzzy Sets, Fuzzy Logic and Their Applications. (2021). In MDPI eBooks. https://doi.org/10.3390/books978-3-0365-2007-0*