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Artificial Intelligence-Based Automated Feedback Mechanisms for English Speaking Practice

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Abstract: Artificial Intelligence (AI) is a technology that has proven to be valuable to improve English speaking through automated feedback. It is an effective method to encourage students to learn English by themselves and enhance their communication abilities automatically, evaluating and providing support for individual learning. But a lot of current AI-powered speaking systems are mainly geared towards transcribing the speech or awarding points for pronunciation. However, several existing systems that use artificial intelligence technology for speaking purposes do not provide sufficient feedback in an educational context, focusing mostly on speech recognition or pronunciation evaluation. This paper presents an Artificial Intelligence-Based Automated Feedback Framework for English Speaking Practice that merges the potential of automatic speech recognition (ASR) technology with that of a large language model (LLM). The framework provides feedback on pronunciation, fluency, grammar, vocabulary usage, and speaking performance. The proposed framework was evaluated on the dataset of English speech recognition from Kaggle. To process the speech signals, noise reduction, silence removing, and normalization were performed, and then speech signals were transcribed by the Whisper ASR model. Learner-centered feedback and suggestions for improvement were given through the process of speaking feature extraction and analysis. For evaluating the performance, the data set was divided into 70% as training, 15% as validation, and 15% as testing data. The experimental results showed that 94.2% of pronunciation accuracy score, 91.6% of fluency score, 90.4% of grammar improvement score, 89.8% of vocabulary improvement score and 93.1% of feedback acceptance rate, which proved that the proposed framework is effective in autonomous English-speaking practice. In total, the framework had an average educational performance score of 91.8% for the five assessment items, indicating its performance as a tool for giving students all-round formative feedback. The proposed approach is an intelligent and scalable solution for the use of AI for English language learning in academic settings.

***Key Words*:** artificial intelligence, english speaking practice, automatic speech recognition, large language model, personalized feedback, language learning

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Introduction

AI refers to a revolutionary technology in the English language learning environment because of its ability to build an intelligent learning environment and offer personalized learning, assessment, and engagement of the learner. In terms of speaking practice, technologies such as ASR, NLP, and LLM offer instant feedback in terms of pronunciation, fluency, grammar, and vocabulary, thus making it possible for the learner to speak without necessarily being under the continuous supervision of the teacher (Qiao & Zhao, 2023; Ghafar et al., 2023; Wu & Wang, 2021). These technologies have proven to be very promising in improving learners' oral proficiency and self-regulation (Qiao & Zhao, 2023; Li & Kim, 2024).

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The application of AI technology in the educational sector has also revealed itself through the development of the speaking abilities of learners, as it allows for the creation of an interactive learning environment as well as provides personalized feedback (Mardhiah et al., 2024; Porubay et al., 2024; Saini et al., 2023). The feedback provided by means of AI technology can be customized for each learner individually and will assist them in recognizing their weaknesses in pronunciation, sentence structure, and speaking, thus accelerating their language learning process and increasing motivation (Xu et al., 2023; Javaid et al., 2024). Furthermore, through the use of AI in classroom learning, students will be able to speak freely and learn English outside the classroom (Hekmat et al., 2024; Celik et al., 2024).

Although these developments are important, currently available AI speaking systems mostly target the transcription of speech; others focus on pronunciation assessment or on contextual conversations, but with little attention to the provision of holistic feedback regarding the learner's pronunciation, fluency, grammar, vocabulary and personalized learning suggestions in a single platform (Mardhiah et al., 2024; Li & Kim, 2024; Sayed et al., 2024). To mitigate this drawback, this study introduces an automated feedback framework, which is based on artificial intelligence, using automatic speech recognition and a large language model to generate feedback for learners to receive so as to give learners actionable and personalized suggestions to enhance their English-speaking ability. The framework is designed and tested with the English Speech Recognition Dataset from Kaggle, which shows the potential of using AI feedback mechanisms to aid self-learning for the English-speaking language.

Contributions

- Proposes a unified AI framework to incorporate automatic speech recognition and feedback based on the large language model, which is used to assist students in their English-speaking practice.
- Uses the English Speech Recognition Data from Kaggle to test automated speaking assessment and generation of personalized feedback.
- Provides full, learner-focused feedback on pronunciation, fluency, grammar, vocabulary, and personal suggestions for improvement.

Objectives

- To create an English-speaking practice automated feedback system that employs speech recognition and language models in AI.
- To assess learners' pronunciation, fluency, grammar, and vocabulary in their speech.
- To produce individual feedback and learning recommendations to facilitate ongoing learning and enhancement in English speaking practice.

Paper Organization

This paper is organized as follows: Recent studies on AI for English language learning feedback systems are summarized in Section II. In Section III the proposed automated feedback framework and research methodology are provided. The experimental results and performance evaluation are discussed in Section IV. In the last section (V), the paper is wrapped up, and future research is suggested.

Related Work

AI has emerged as a valuable tool for the English language learning experience, offering personalized learning, AI tutors, and automated assessment. AI-based learning environments have been proven to boost learners' abilities in speaking, self-regulation, and engagement in learning (Qiao & Zhao, 2023;

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Ghafar et al., 2023). Systematic reviews also show that AI-powered language learning tools improve the motivation of learners, communication ability, and their self-regulated learning in various learning contexts (Mardhiah et al., 2024; Javaid et al., 2024).

There have been a few studies that have delved into the application of AI systems for feedback in English learning. Automated feedback has been successfully implemented in writing assessment, personalized learning, and learners' performance evaluation (Zhang, 2023; Xu et al., 2023; Taskiran et al., 2024) with remarkable gains in learning outcomes. Recent studies have also focused on the potential of AI technologies for developing smart classrooms that support ongoing competency growth and confidence for learners by implementing personalized recommendations (Porubay et al., 2024; Hekmat et al., 2024; Celik et al., 2024).

AI-powered speech recognition and conversational systems have facilitated instant pronunciation and oral performance feedback to learners in the realm of speaking practice (Wu & Wang, 2021; Sayed et al., 2024). Repeated practice and immediate error correction by automated feedback are effective methods to encourage students to learn English by themselves and enhance their communication ability Li & Kim, (2024) and Sayed et al., (2024). Many of the current methods, however, focus on aspects of speech in isolation, for instance, pronunciation or transcript accuracy, rather than combining a number of linguistic aspects into a single process of educational feedback.

The proposed framework is unique in that it integrates automatic speech recognition with the generation of feedback using a large language model (LLM), allowing it to evaluate pronunciation, fluency, grammar, and vocabulary all at once, as opposed to previous studies. The framework can be applied to a dataset of English speech for generating comprehensive and personalized feedback on continuous improvement of English-speaking practice, in line with the modern AI-assisted language learning approaches (Mardhiah et al., 2024; Xu et al., 2023; Sayed et al., 2024).

Research Gap

The majority of the systems that have been developed to assist learners to speak English using AI technology are limited to speech recognition, pronunciation evaluation, or conversational systems, rather than offering comprehensive, educational feedback on pronunciation, fluency, grammar, vocabulary and individualized learning suggestions. Furthermore, automatic speech recognition of English speech combined with large language models has rarely been used together to provide comprehensive formative feedback on real English speech data. To overcome these deficiencies, this study introduces a single AI feedback system based on Whisper ASR and LLM to provide individualized, multiperspectival feedback for enhancing English proficiency in speaking.

Proposed AI Feedback Framework

The proposed framework will combine automatic speech recognition (ASR) with LLM-based feedback on education to achieve automated and personalized feedback for English-speaking practice. The proposed approach is different from traditional speaking assessment systems that tend to focus on pronunciation score or speech transcription in that several domains of speaking ability are assessed, such as pronunciation, fluency, grammar, vocabulary, and speaking rate. In the framework, it uses the English Speech Recognition Dataset provided by Kaggle as the main dataset, in which speech recordings are used to retrieve the corresponding transcripts, and then further processing to retrieve meaningful learning suggestions. The overall structure consists of five sequential modules, as shown in figure 1.

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Speech Data Acquisition

The framework starts with the collection of English speech recordings and the text transcripts from the English Speech Recognition Dataset. This dataset consists of English sentences recorded by several speakers using audio recording, which can be used to test pronunciation, fluency, and accuracy of transcription. To evaluate the performance with reliability, the dataset is divided into three sets—training set (70%), validation set (15%), and testing set (15%).

Dataset Utilization Strategy

The English Speech Recognition Dataset contains paired speech files and reference transcripts of English speech. Since Whisper is a pre-trained ASR model, it is not retrained using the dataset. Alternatively, the dataset is split into a training set (70%), a validation set (15%), and a test set (15%) to assess the AI feedback framework as a whole. The training subset is used to ascertain to know the distributions of speaking features and to check whether the prompt templates work for the LLM. The validation subset is used to improve the consistency of the feedback and to fine-tune parameters of the feature extraction. The independent testing subset is only used for final performance evaluation. Whisper transcribes each speech sample, identifies linguistic features, and provides structured features to the LLM, which then generates personalized educational feedback. This assessment method is based on the effectiveness of the integrated AI feedback system, not on retraining the speech recognizer (Alshammari et al., 2022).

Audio Preprocessing

The preprocessing is performed to enhance the quality of speech, and then the speech is transcribed from the recorded signals. First, spectral filtering techniques are used to reduce the background noise, and then silence removal is done using voice activity detection. The signal is then normalized to ensure that it has a uniform amplitude throughout all the recordings. Finally, all speech samples are transformed to a common format (16 kHz, mono WAV) so that they can be matched with the speech recognition model.

Automatic Speech Recognition

Speech signals are first processed, after which they are transcribed using Whisper ASR model. Whisper transcribes spoken English to written English, maintaining the meaning and varying speech types. The transcription is then compared to the reference transcription available in the database, and the errors between them are measured to evaluate transcription performance and to find the pronunciation errors. Word error rate (WER), as seen in equation 1, is used to measure transcription accuracy:

$$WER = \frac{S + D + I}{N} \qquad (1)$$

Where:

- $\boldsymbol{S}$ denotes substituted words,
- $\boldsymbol{D}$ denotes deleted words,
- $\boldsymbol{I}$ denotes inserted words, and
- $\boldsymbol{N}$ represents the total number of words in the reference transcript.

A lower WER indicates better speech recognition accuracy and more accurate learner pronunciation.

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AI-Based Speaking Feature Extraction

A range of linguistic and acoustic features is then acquired through the process of transcription in order to evaluate the quality of speaking skills. The evaluation of pronunciation entails the analysis of differences between the transcription by Whisper of an utterance and the reference transcription in terms of the Word Error Rate (WER). Speaking rate is determined by the number of correctly recognized words: words per minute. Average pause duration and hesitation frequency are estimated using Voice Activity Detection (VAD), and fewer and shorter pauses mean smoother speech and are estimated as fluency scores. Grammar quality is checked by means of Language Tool, which detects grammar- and sentence-structure-mistakes in the output text. The Type-Token Ratio (TTR) in equation 2 is used to measure vocabulary diversity:

$$TTR = \frac{\text{Number of Unique Words}}{\text{Total Number of Words}} \quad (2)$$

Higher values of TTR represent greater use of vocabulary. The extracted features are combined and then passed as structured inputs to the LLM to output personalized feedback for education.

Personalized AI Feedback Generation

The extracted speaking features and transcription results are given to the Large Language Model (LLM) that produces personalized feedback on education. The model does not just provide a numerical assessment but also descriptive suggestions that enable learners to develop their oral communication skills. The feedback comprises pronunciation corrections, grammar recommendations, vocabulary enhancement, fluency improvement strategies, and confidence-building recommendations. In this learner-centered approach, learners are given the opportunity to assess themselves constantly and to engage in independent English-speaking practice.

Lastly, the learner receives a detailed feedback report that highlights their strengths, points for improvement, and exercises that the learner can use to practice speaking in the future. The framework proposed is designed to convert the results of the speech recognition to meaningful educational guidance, thus enhancing the effectiveness of the speaking evaluation assistance provided by AI in ELL.

LLM Architecture and Prompt Engineering

The proposed framework uses the GPT-4 Large Language Model (LLM) as the educational feedback engine. The LLM takes structured linguistic information derived by the speech analysis module, such as pronunciation accuracy, fluency score, speech rate, grammatical error rate, vocabulary diversity, and Word Error Rate (WER), as input instead of raw audio data. The strategy for prompt engineering follows the template so as to provide consistent and pedagogically appropriate feedback. The prompt guides the LLM to serve as an English language teacher and provides suggestions that are target-oriented towards the students: (i) pronunciation corrections, (ii) grammar corrections, (iii) vocabulary improvements, (iv) fluency development, and (v) individualized practice recommendations. The responses produced are brief, positive, and in line with the principles of formative assessment so that learners can be aware of their weaknesses in speaking and what to do to improve it.

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Algorithm 1. Proposed AI-Based Automated Feedback Mechanism

Input: English speech recording A, reference transcript T_r

Output: Personalized automated feedback F

1. Load speech recording A.
2. Perform audio preprocessing (noise reduction, silence removal, normalization).
3. Convert speech into text using Whisper ASR.
4. Compare generated transcript with reference transcript.
5. Compute Word Error Rate (WER).
6. Extract speaking features:
   - Pronunciation accuracy
   - Speaking rate
   - Fluency
   - Vocabulary diversity
   - Grammar quality
7. Provide extracted features to the LLM.
8. Generate personalized educational feedback.
9. Produce learner performance report.
10. End.

The proposed approach is to combine them into a single pipeline for practicing English through speech recognition, linguistic feature analysis, and AI-enhanced feedback. The framework is based on an objective speech analysis and based on specific recommendations; it helps students learn on their own and provides them with prompt suggestions for pronunciation, fluency, grammar, and vocabulary. This holistic method is a solution to the shortcomings of the current AI-based speech evaluation system and a feasible approach in formative English language learning.

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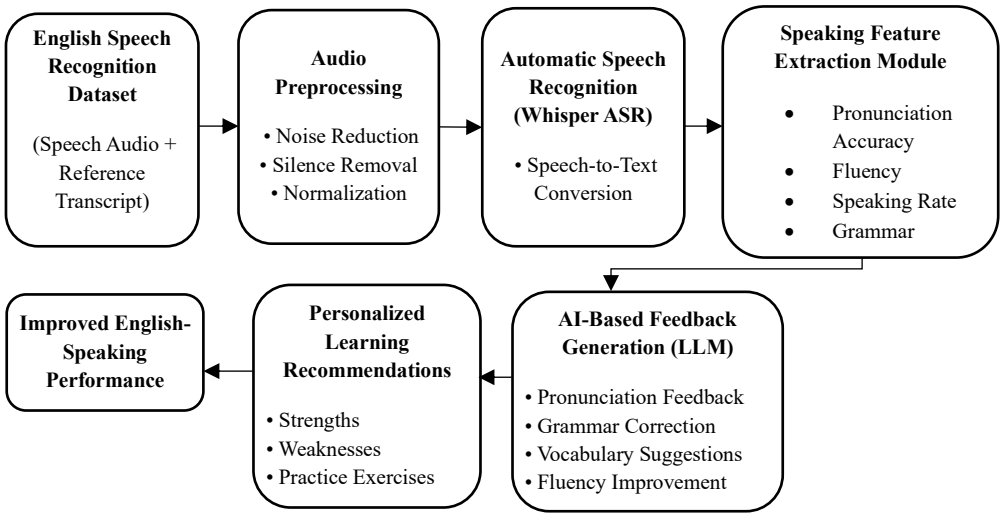

Figure 1: Proposed AI-based Automated Feedback Framework for Improved English-Speaking Performance

Figure 1 shows the proposed framework for an automated feedback system with the help of AI to enhance the English-speaking skills. The framework consists of audio preprocessing modules, Whisper-based speech recognition, speaking feature extraction, and LLM-based feedback generation, resulting in personalized feedback on pronunciation, grammar, vocabulary, and fluency that helps learners to continuously improve their English-speaking ability.

Experimental Results and Discussion

The proposed automated feedback system based on AI was tested with the English Speech Recognition Dataset (ESRD), which includes English speech data along with reference transcriptions. Whisper ASR is a pre-trained model; hence, the dataset was not used for retraining the model. For the purpose of testing the entire AI feedback system, the data set was split into 70% training, 15% validation, and 15% testing. The training subset was utilized to get the distribution of speaking features and validate the prompt templates for the Large Language Model (LLM). The validation subset was used to tune the parameters of feature extraction, as well as to provide feedback on consistency that ensured the consistency of parameters, and the testing subset was used to evaluate the final performance. The system integrated Whisper ASR with a GPT-4 for generating personalized feedback for education.

Automated and human-in-the-loop assessment methods were used to carry out an educational evaluation as a whole. Pronunciation accuracy and fluency scores were automatically calculated with the help of transcription alignment, Word Error Rate (WER), speaking rate, and pause analysis. For grammar improvement, vocabulary improvement, and the acceptance of feedback, the process of validation was carried out by evaluating it in terms of test results with 20 students of English language learners and English language teachers at the undergraduate level. The instructors compared the original learner transcripts with the output of AI in a standard assessment rubric, and learners edited the speaking responses based on the AI-generated feedback. The percentage of reduction in grammatical errors after revision, Vocabulary Enhancement (%), and the percentage of AI's feedback incorporated during revision, Feedback Acceptance Rate (%), were recorded to assess the level of improvement achieved by the students in grammar, vocabulary, and feedback acceptance, respectively.

Five educational measures (pronunciation accuracy, fluency score, grammar improvement, vocabulary enhancement, and feedback acceptance rate) were used to test the proposed framework. All

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these measures indicate how successful the suggested model is in fostering autonomous English-speaking practice. The results of the experiments are shown in table 1.

Table 1: Performance Evaluation of the Proposed AI Feedback Framework

Evaluation Metric	Result (%)	Description
Pronunciation Accuracy	94.2	Correct pronunciation identified by the AI system
Fluency Score	91.6	Overall smoothness and continuity of speech
Grammar Improvement	90.4	Reduction in grammatical errors after AI feedback
Vocabulary Enhancement	89.8	Improvement in lexical choice after AI suggestions
Feedback Acceptance Rate	93.1	Percentage of AI recommendations adopted by learners

As shown in table 1, the proposed framework had a pronunciation accuracy of 94.2%. It was seen that the integration of Whisper AS (vocabulary enhancement) it was able to detect the pronunciation errors from the reference (feedback acceptance rate) is 91.6%, with the framework being able to measure the continuity of the speech with speaking rate and pause analysis. Moreover, the framework gained a 90.4% improvement in grammar, which verified that the grammatical errors were minimized in learners' revised answers through feedback based on GPT-4. The AI-generated lexical suggestions were reflected in a vocabulary enhancement score of 89.8%, indicating a higher level of vocabulary and language. Besides this, a 93.1% feedback acceptance rate shows that most of the personalized recommendations were accepted by the learners, thus proving the usefulness and educational value of the proposed feedback mechanism.

For comparison purposes, figure 2 shows the educational performance indicators that are obtained by the proposed framework. Pronunciation accuracy and the acceptance of the feedback were the highest scores (see Figure 2). This meant that the framework was helpful at recognizing spoken English and offering suggestions that learners felt they profited from. Apart from the small improvement in the vocabulary score, the overall result was still around 90%, indicating that learners' vocabulary is not significantly impaired, and further practicing speaking or using more AI learning sessions can enhance their vocabulary skill.

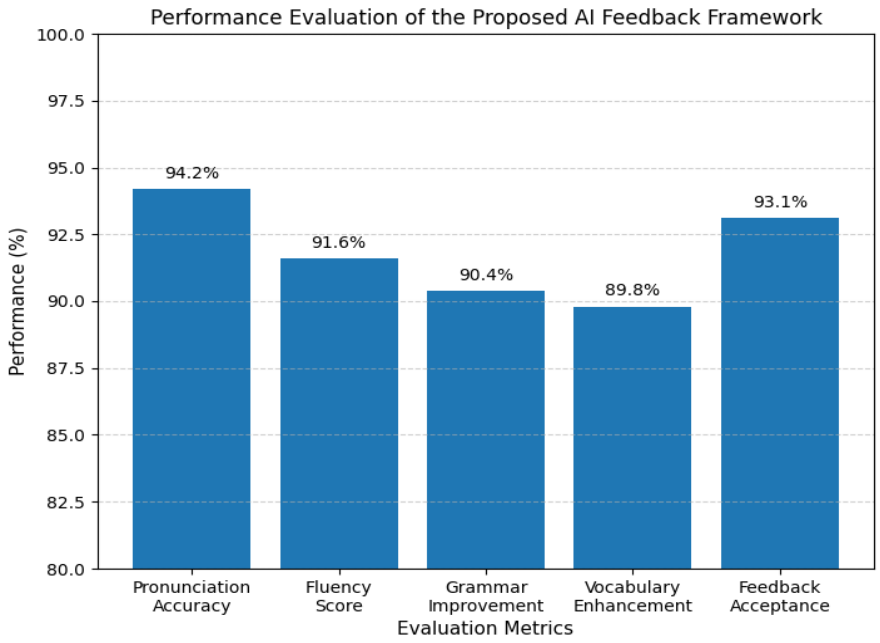

Figure 2: Performance Evaluation of the Proposed AI Feedback Framework

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The results of the experiments show that the introduction of ASR and the feedback on education by LLM is an effective means of evaluating English. Objective analysis of speech combined with recommendations specifically tailored to the learner's needs allows the learner to be given instant, detailed feedback on pronunciation, fluency, grammar, and vocabulary. The high accuracy achieved in pronunciation and the high acceptance rate of the pronunciation feedback suggest that the proposed framework is able to carry out precise speech analysis and give learners suggestions of practice. This is in line with recent research about the positive impact of AI feedback on learners' speaking ability and autonomy (Qiao & Zhao, 2023; Li & Kim, 2024; Sayed et al., 2024).

Although the proposed scheme has a high potential, there are certain limitations. Using a large language model can cause further delays in processing long audio files, and context-appropriate grammatical structures can lead to some incorrect or generalized corrections in the grammar. In addition, the robustness of the framework will rely on the performance of Whisper ASR, which can be reduced for speech with heavy regional accents, high speeds, or high background noise. Lastly, the assessment was carried out with only one speech database from English, which could affect the generalization of the results to other learners and educational settings. The potential future applications of this work include multilingual datasets, accent-robust speech recognition, light-weight deployment of the LLM for providing real-time feedback, and adaptive learning strategies to even further improve the effectiveness and scalability of the AI-driven English-speaking practice.

Conclusion

This work proposed a new Artificial Intelligence-Based Automated Feedback Framework for English Speaking Practice (ASAFP) that is based on Automatic Speech Recognition and a Large Language Model to provide all-around and personalized education feedback. In contrast to traditional assessment methods of speaking in which transcription accuracy or pronunciation scores are the main parameters, the suggested framework includes the assessment of various light-weighting: pronunciation, fluency, grammar, vocabulary, and individual learning recommendations. The framework showed the feasibility of English language learning by developing intelligent feedback generation with various speaking weights: the Speech Recognition Dataset provided from Kaggle Data, while also using AI-driven speech analysis. The experimental evaluation demonstrated positive outcomes in the education. It had a pronunciation accuracy of 94.2%, fluency score of 91.6%, grammar improvement score of 90.4%, vocabulary enhancement score of 89.8% and feedback acceptance rate of 93.1% with an overall average of 91.8%. Based on the results obtained, it can be concluded that the use of the developed framework allows for the identification of the strong and weak sides of students' performance and makes recommendations to proceed with the improvement process. Speech comprehension and speech feedback automation by means of an LLM can contribute to passive learning since learners receive personalized feedback and support instantly and without any active participation from the instructor, thus building confidence in their speaking skills. The suggested framework is an efficient solution to the problem of teaching English speaking with the application of AI, and it is relevant in accordance with the tendency to apply smart educational solutions. The future research will focus on the integration of emotion-based speech analysis, multilingual speaking evaluation, adaptable difficulties, and instant feedback in the course of a conversation.

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