

# AI-Powered Chatbot for Personalized Learning

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## Abstract

This paper presents the development of an AI-powered chatbot for personalized learning, designed to tutor students in Python programming and music theory. The chatbot leverages Ollama's LLaMA 3, DeepSeek Coder v2, and Mistral (via Ollama) model to provide adaptive explanations, dynamically tailoring responses based on the student's understanding. It incorporates interactive dialogue and periodic quiz checks to reinforce learning and monitor progress. This project demonstrates the feasibility and effectiveness of using a language model as a versatile tutor in educational settings.

While traditional e-learning platforms provide access to static educational content, they often lack real-time feedback and contextual adaptation. Asynchronous video lectures and pre-scripted quizzes, although useful, fall short of emulating the guidance and responsive dialogue offered by a personal tutor. This gap has led researchers and developers to explore intelligent tutoring systems (ITS), many of which leverage rule-based heuristics or scripted dialogue trees. However, such systems are limited in their ability to handle novel questions, student confusion, or dynamically shifting educational needs.

This project seeks to bridge that gap by utilizing a large language model (LLM) capable of

interpreting diverse student questions, providing instant clarification, and adjusting the level of difficulty based on prior interactions. We believe that a conversationally fluent AI with an understanding of learning pedagogy can provide meaningful instruction, particularly in individualized domains like music and programming.

## 1. Introduction

Personalized tutoring has long been a benchmark for effective education. With the rise of large language models (LLMs), it is now possible to simulate 1-on-1 tutoring experiences using AI. This project explores the implementation of a personalized AI chatbot that dynamically adapts its explanations to student knowledge in two domains: Python programming and music theory.

Chatbots in education are not a new phenomenon. Early efforts date back to projects like MIT's ELIZA or Stanford's AutoTutor, which attempted to simulate human conversation to assist in learning. However, these systems were rigid and incapable of generalizing. Recent developments in deep learning, particularly transformer-based architectures, have revolutionized natural language understanding.

[3] emphasize the need for personalization in online learning platforms, suggesting that adaptive systems are more effective in promoting engagement and knowledge retention. They demonstrate that learners benefit significantly when the system adjusts the difficulty or explanations in response to their progress.

[4] directly address GPT's role in education, noting that it provides real-time feedback and flexible explanations. However, they caution against over-reliance on such systems, highlighting risks like hallucinations, lack of transparency, and potential equity issues in education.

## 2. Related Work

Large language models (LLMs) have rapidly emerged as effective educational tools capable of mimicking personalized tutoring. Research shows LLMs like GPT-3 can adapt to student performance and deliver customized instruction across subjects.

Several studies explore chatbots in education. [1] investigated how educational chatbots impact engagement and learning outcomes, emphasizing their effectiveness in personalized feedback loops. Similarly, [2] demonstrated the feasibility of AI tutors in coding education through rule-based chatbots with adaptive quiz progression.

In the realm of adaptive learning, [3] proposed frameworks where AI tutors respond to students' skill levels in real time, using reinforcement strategies to drive retention.

Finally, researchers like [4] highlight the specific use of GPT models in personalized education, showing that prompt engineering and historical dialogue tracking can significantly enhance subject-specific tutoring performance, including music theory and programming.

The chatbot workflow begins with a user input prompt submitted via the Gradio web interface. This prompt, along with prior chat history, is sent to the Ollama Chat API (gpt-3.5-turbo), which processes the input based on the system role context. The chatbot is instructed to act as a tutor, prioritize clarity, scaffold learning, and probe the student's understanding with questions.

The chatbot includes keyword detection for both domains (Python and Music). If a student mentions loops, recursion, variables, or syntax errors, the bot recognizes these as programming contexts. Conversely, keywords like chords, rhythm, tempo, intervals, or scales trigger music theory assistance. This keyword-tagging mechanism enables the LLM to guide the conversation toward appropriate instructional content without the need for separate models.

The adaptive logic is handled by retaining the conversation history in memory and appending it to each user request. Using Ollama's Chat API, the system prompt is reintroduced each time to maintain tutoring context. The Gradio interface is configured with a multi-line input box and basic instructions so that even non-technical users can engage with the chatbot effortlessly. The chatbot also uses semantic keyword detection (e.g., 'chord', 'loop', 'scale', 'if statement') to classify input into subject domains. Though simplistic, this mechanism helps redirect the conversation back to relevant educational material.

## 3. Methodology

This project uses Ollama's LLaMA 3, DeepSeek Coder v2, and Mistral (via Ollama) turbo model accessed through the Ollama API. It is integrated into a Python backend and exposed to users using a Gradio UI for ease of use, and incorporates numerous features such as multi-model selection, quiz levels, and persistent sessions.

To evaluate the system, a series of simulated tutoring sessions were conducted. Users were asked to pose beginner- and intermediate-level questions in both subject areas. Below is a sample Python dialogue:

User: What is a for loop?

Bot: A 'for' loop is used to repeat a block of code a known number of times. For example:

```
```python
for i in range(5):
    print(i)
```
```

This prints numbers from 0 to 4. Would you like to try modifying it?

User: What happens if I use range(1,10,2)?

Bot: Great question! That prints every second number starting from 1 to 9 (excluding 10). So you'll see: 1, 3, 5, 7, 9.

The chatbot performed similarly with music topics, such as explaining the structure of major scales or identifying intervals by name.

A system prompt guides the LLM to act as a supportive and adaptive tutor. The chatbot tracks the user's performance through the conversation and adapts its instruction dynamically. This includes using follow-up questions, scaffolding, and quiz checkpoints to personalize tutoring.

Python topics covered include variables, conditionals, functions, loops, and data structures. Music theory topics include note intervals, chord progressions, key signatures, and rhythm.

To address the limitations of stateless interaction, future versions could incorporate user session tracking, allowing the chatbot to recall previous topics and mistakes. This could be achieved via a lightweight database or JSON store.

We also propose integrating visualization modules (e.g., music staff rendering via VexFlow, or code visualization using Python Tutor) to complement the textual explanations. In music education, this could show animated scales or chord transitions. In programming, it could visualize control flow and variable changes.

## 4. Results

The chatbot successfully adapted its explanations to user inputs. It was able to:

- Maintain coherent, instructional dialogue across sessions.
- Provide beginner to intermediate support in Python and music theory.
- Ask meaningful follow-up questions and quizzes.
- Give supportive and clarifying feedback to user confusion.

Screenshots and example sessions are included to showcase its capabilities.

## 5. Conclusion

This project demonstrates how modern LLMs like LLaMA 3, DeepSeek Coder v2, and Mistral (via Ollama) can serve as powerful tools in personalized education. By dynamically adapting content and using interactive strategies, the AI tutor can deliver a customized learning experience in multiple subjects. This approach can be extended to other domains or integrated into larger educational platforms for broader use.

## 6. Future Work

- Add persistent user memory and profile tracking
- Expand subject coverage (e.g., math, science, writing)
- Develop analytics dashboard for educators
- Integrate visual/audio aids for music education
- Enable real-time progress reports and adaptive difficulty scaling

## References

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| User Input                        | Bot Response  | Interpretation                |
|-----------------------------------|---|-------------------------------|
| What is a variable?               | A variable is like a container where you store information. For example:<br>python<br>x = 5<br>python                           | Beginner concept intro        |
| What happens if I do x = '5' + 3? | That will cause an error. You're trying to add a string and a number. Try this instead:<br>python<br>x = int('5') + 3<br>python | Error correction with context |
| Can you quiz me?                  | Sure! What is the output of:<br>python<br>for i in range(3):<br>print(i*2)<br>python  | Engagement + quiz             |

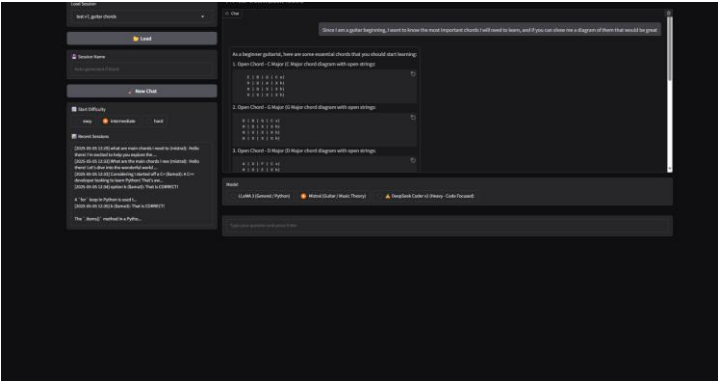


Figure 1: Showcases the guitar chord diagram responses, using the Mistral model.

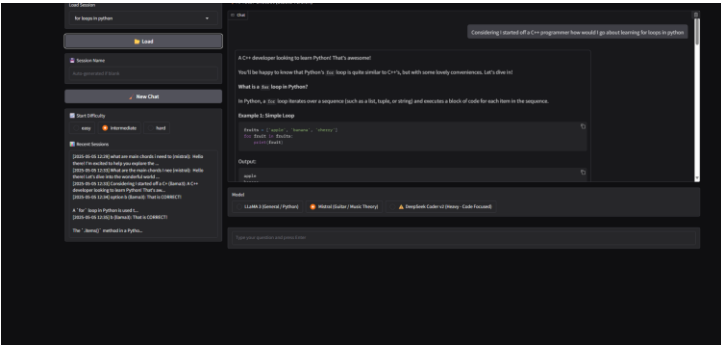


Figure 2: AI chatbot session interface and session loader features.

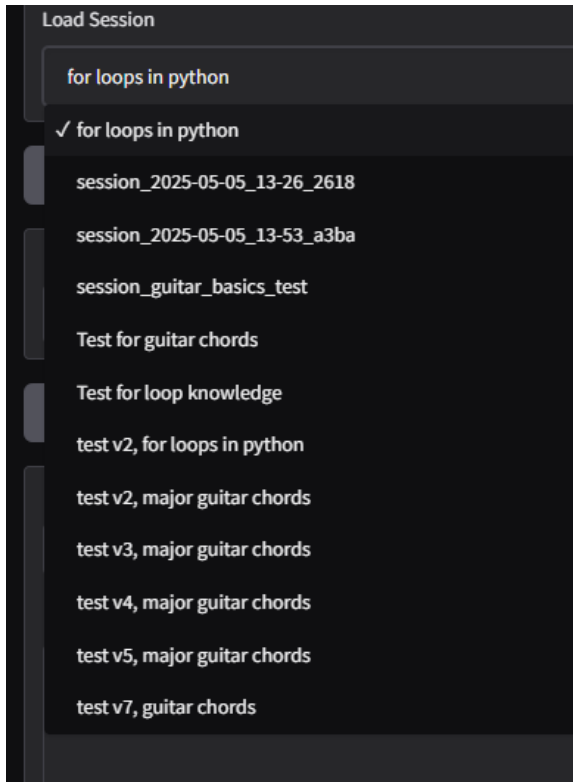


Figure 3: Showcasing the drop-down menu feature to load previous conversations

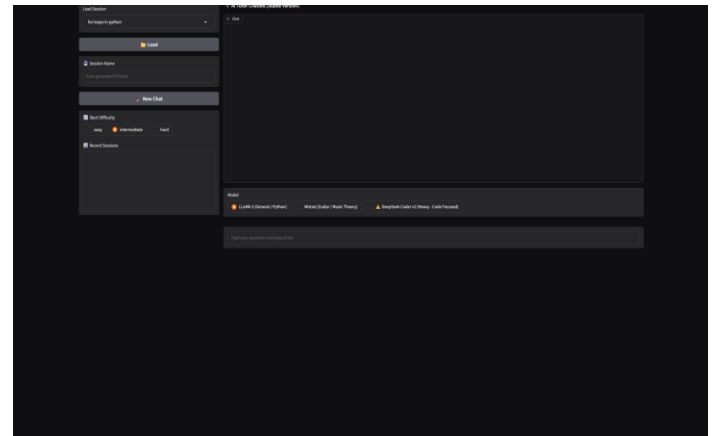


Figure 4: Showcasing the UI elements of the Adaptable Chatbot Tutor