



Visvesvaraya National Institute of Technology (VNIT), Nagpur

Personalized EdTech Mentor (An RAG Based Project)

Project Report

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Problem Statement

Students these days juggle slides, PDFs, articles and more—and it's tough to sort out what really matters. Most e-learning sites push everyone through the exact same modules and quizzes, no matter their background or pace. The result? Frustration, wasted time, and half-remembered lessons. What we need is a smarter helper: one that reads whatever you upload, pulls out the key ideas, quizzes you on your weak spots, answers your follow-ups in context, and tracks your progress so you can see exactly where you stand. This project builds that AI-powered study buddy—responsive to each student's unique pace and learning style.

Abstract

We've built the Personalized Education Mentor, a web app that turns your own PDFs—be they lecture notes, research papers or chapters—into tailored study sessions. After you upload a file, a language model breaks it down into topics you can explore. A vector database makes finding the right paragraph nearly instant, and a quiz engine generates questions targeting your trouble spots. As you work through the material, the app notes which concepts you've mastered and which need more attention, then suggests what to tackle next. Developed with Python, Streamlit and LangChain, and powered by GPT-4, HuggingFace embeddings and Chroma DB, our prototype shows how modern NLP tools can make independent learning both efficient and engaging.

Introduction

Personalized learning isn't a luxury—it's essential. Every student brings their own mix of prior knowledge, interests and stumbling blocks, yet most online courses ignore that fact. Thanks to advances in NLP and machine learning, we can now flip the script: upload any PDF, and an LLM will parse it into bite-sized concepts. A vector store then lets you query specific sections on demand or dive into quizzes tailored to what you haven't yet grasped. If you hit a snag, the system pulls the answer straight from your material, in context. Over time, it quietly learns where you shine—and where you need a bit more practice—then guides you toward the next topic. In the chapters that follow, we'll cover related work, walk through our system's architecture and implementation, and share the results from our initial tests.

Tools Used

- Python 3.x
- Streamlit
- LangChain
- OpenAI GPT-4
- HuggingFace Embeddings and Chroma DB (Vector Store)

Procedure

1. Data Collection : To kick things off, students upload their own PDFs—lecture notes, textbook excerpts or journal articles—through the Streamlit UI.

Each file automatically lands in the `data/` folder so we always have the original to fall back on.

2. Text Segmentation : A recursive splitter slices each document into neat, self-contained fragments (we avoid cutting sentences in half).

The result: bite-sized passages that remain meaningful on their own.

3. Embedding Generation : Every fragment is converted into a semantic vector via HuggingFace’s sentence-transformers. These vectors capture the “aboutness” of each passage and power our later searches.

4. Vector Store Construction : We load all embeddings into Chroma DB, which serves as our fast similarity index. In practice, a query against Chroma returns top matches in milliseconds.

5. Topic Discovery : GPT-4 combs through the indexed fragments to pull out major topics and subtopics.

That topic hierarchy is saved in JSON format, giving users a clear menu of study options.

6. Dialog-Driven Q&A : When a learner picks a topic, the system fetches the most relevant text pieces from Chroma.

GPT-4 then weaves those snippets into concise, context-aware answers—keeping prior questions in mind.

7. Quiz Crafting & Feedback : For each topic, the app auto-generates multiple-choice questions using only the educational text (no headers, no captions).

Students answer right in the UI and instantly see which items they got right or wrong.

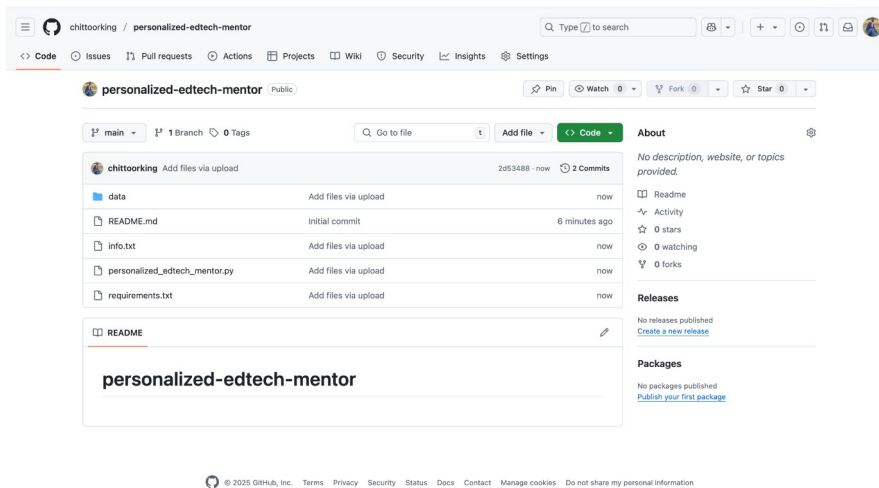
8. Performance Tracking & Recommendations : Every quiz result updates a per-topic mastery profile.

Based on that profile, the system flags concepts needing review and suggests the best next steps—so each learner’s path stays personalized.

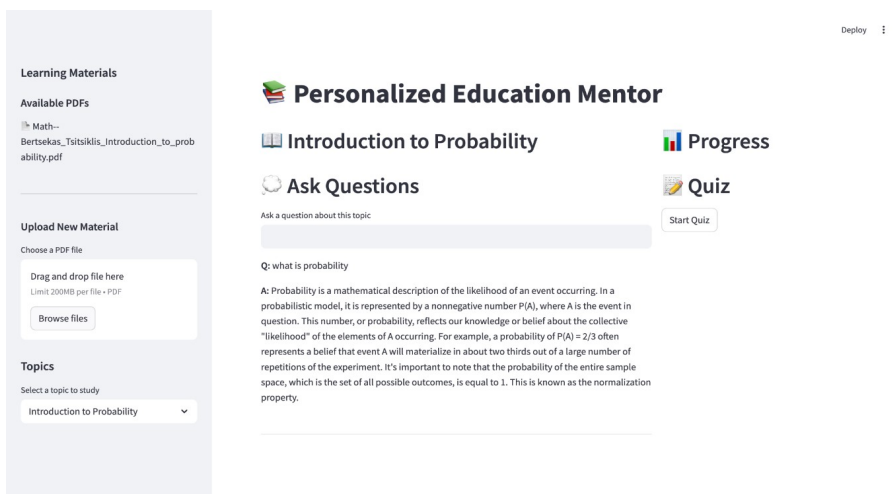
Results

The Personalized Education Mentor was successfully implemented as a web application. Users can upload their own PDFs, extract topics, ask questions, and take quizzes. The system provides immediate feedback and tracks progress for each topic. The following images illustrate the application's interface and workflow:

Repo setup of the code



1. Chat Interface: User interacts with the bot to ask questions about the selected topic.



2. Dynamic Quiz Generation: User starts quiz with questions automatically generated on the right side of the screen.

Learning Materials

Available PDFs

Math-- Bertsekas_Tsitsiklis_Introduction_to_probability.pdf

Upload New Material

Choose a PDF file

Drag and drop file here
Limit 200MB per file • PDF

Browse files

Topics

Select a topic to study

Introduction to Probability

Personalized Education Mentor

Introduction to Probability

Ask Questions

Ask a question about this topic

Q: what is probability

A: Probability is a mathematical description of the likelihood of an event occurring. In a probabilistic model, it is represented by a nonnegative number $P(A)$, where A is the event in question. This number, or probability, reflects our knowledge or belief about the collective "likelihood" of the elements of A occurring. For example, a probability of $P(A) = 2/3$ often represents a belief that event A will materialize in about two thirds out of a large number of repetitions of the experiment. It's important to note that the probability of the entire sample space, which is the set of all possible outcomes, is equal to 1. This is known as the normalization property.

Q: why

A: The concept of probability is used to quantify the uncertainty associated with events chosen from a some universe of events, and it's based on the logic of our understanding of the world.

Progress

Quiz

Question 1

What is the probability of an event A when the sample space has a finite number of equally likely outcomes?

Choose your answer:

☒ $P(A) = p \cdot (\text{Number of elements of } A)$

☐ $P(A) = \text{Number of elements of } A / \text{Number of elements of } \Omega$

☐ $P(A) = P(A_1 \cap B) + \dots + P(A_n \cap B)$

☐ $P(A) = 1 / \text{Number of elements of } A$

Question 2

What is the Total Probability Theorem?

Choose your answer:

☒ $P(B) = P(A_1 \cap B) + \dots + P(A_n \cap B)$

☐ $P(A) = \text{Number of elements of } A$

3. Score & Explanations: User receives quiz score and detailed explanations for incorrect answers.

Learning Materials

Available PDFs

Math-- Bertsekas_Tsitsiklis_Introduction_to_probability.pdf

Upload New Material

Choose a PDF file

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Topics

Select a topic to study

Introduction to Probability

or an event in a sample space

Submit Quiz

Your score: 33.33%

Question 1: Correct!

Question 2: Incorrect

Explanation: The Total Probability Theorem states that for any event B , we have $P(B) = P(A_1 \cap B) + \dots + P(A_n \cap B)$, where A_1, \dots, A_n are disjoint events that form a partition of the sample space.

Question 3: Incorrect

Explanation: A binomial random variable represents the number of successes (in this case, "heads") in a fixed number of independent Bernoulli trials (in this case, coin tosses) with the same probability of success on each trial.

4. Smart Recommendations: System provides personalized recommendations based on all previous attempts for the topic.

Learning Materials

Available PDFs

Bertsekas_Tsitsiklis_introduction_to_probability.pdf

Upload New Material

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Topics

Select a topic to study

Introduction to Probability

Deploy

Recommendations

- 1. Review Lecture Notes: The student seems to be struggling with the basics of probability. The lecture notes provided by Professors Dimitri P. Bertsekas and John N. Tsitsiklis from MIT could be a valuable resource. The student should go through these notes, focusing particularly on sections such as "Probabilistic Models", "Conditional Probability", "Total Probability Theorem and Bayes' Rule", and "Independence".
- 2. Practice Problems: Since the notes include solutions to all problems, the student should attempt these problems for practice. By solving problems, the student can better understand the application of the concepts and this will help improve their score.
- 3. Seek Assistance: The student should not hesitate to contact the professors (their emails are provided) if they have any questions or difficulties understanding the concepts. The professors have expressed their willingness to help and their feedback could be very

5. Progress Tracking: Returning users see a progress card showing average score and total attempts count. Users can reattempt to improve their average.

Learning Materials

Available PDFs

Bertsekas_Tsitsiklis_introduction_to_probability.pdf

Upload New Material

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Topics

Select a topic to study

Introduction to Probability

Deploy

Personalized Education Mentor

Introduction to Probability

Ask Questions

Ask a question about this topic

Q: what is probability

A: Probability is a mathematical description of the likelihood of an event occurring. In a probabilistic model, it is represented by a nonnegative number $P(A)$, where A is the event in question. This number, or probability, reflects our knowledge or belief about the collective "likelihood" of the elements of A occurring. For example, a probability of $P(A) = 2/3$ often represents a belief that event A will materialize in about two thirds out of a large number of repetitions of the experiment. It's important to note that the probability of the entire sample space, which is the set of all possible outcomes, is equal to 1. This is known as the normalization property.

Q: why

A: The concept of probability is used to quantify the uncertainty associated with events chosen from a some universe of events, and it's based on the logic of our understanding of the world.

Progress

Status

Needs Review

Average Score

33.33%

Attempts

1

Quiz

Start Quiz

6. Score Impact: Incorrect answers lower the average score for the topic.

Learning Materials

Available PDFs

Math--

Bertsekas_Tsitsiklis_Introduction_to_probability.pdf

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Topics

Select a topic to study

Introduction to Probability

Deploy

Your score: 0.00%

Question 1: Incorrect

Explanation: The Total Probability Theorem states that the probability of an event B is the sum of the probabilities of the intersection of B with each event A_i , where A_1, \dots, A_n form a partition of the sample space.

Question 2: Incorrect

Explanation: A Bernoulli random variable is used to model probabilistic situations with just two outcomes, such as free or busy, healthy or sick, etc.

Question 3: Incorrect

Explanation: A binomial random variable represents the number of successes in n independent Bernoulli trials, such as the number of heads in a sequence of coin tosses.

7. Adaptive Recommendations: Recommendations update automatically based on progress card data and attempt history.

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Topics

Select a topic to study

Introduction to Probability

Deploy

Recommendations

- 1. Review the Basics: The student seems to be struggling with the fundamental aspects of probability, as indicated by their low average score. It is recommended that they revisit the topics of "Sets" and "Probabilistic Models" and ensure they have a solid understanding of these foundational concepts. They should take advantage of the solutions provided in the notes and try to understand the step-by-step process of solving the problems.
- 2. Practice Problems: The student should invest more time in doing additional problems related to each topic. The notes mention there are problems suitable for homework assignments. They should make sure to complete these problems, as practice is key in understanding probability. If they are having difficulty, they should review the respective section again and try to understand the solution provided.
- 3. Seek Clarification: Since the authors of the notes are open to comments, the student should not hesitate to send them an email if

8. **Score Decline:** Average score decreases after poor performance.

Learning Materials

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ability.pdf

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Topics

Select a topic to study

Introduction to Probability

Personalized Education Mentor

Introduction to Probability

Ask Questions

Ask a question about this topic

Q: what is probability

A: Probability is a mathematical description of the likelihood of an event occurring. In a probabilistic model, it is represented by a nonnegative number $P(A)$, where A is the event in question. This number, or probability, reflects our knowledge or belief about the collective "likelihood" of the elements of A occurring. For example, a probability of $P(A) = 2/3$ often represents a belief that event A will materialize in about two thirds out of a large number of repetitions of the experiment. It's important to note that the probability of the entire sample space, which is the set of all possible outcomes, is equal to 1. This is known as the normalization property.

Q: why

A: The concept of probability is used to quantify the uncertainty associated with events chosen from a some universe of events, and it's based on the logic of our understanding of the world.

Progress

Status

Needs Review

Average Score

16.67%

Attempts

2

Quiz

Start Quiz

9. **Perfect Score Handling:** All correct answers generate no explanations but still update recommendations based on latest progress.

Learning Materials

Available PDFs

Math--

Bertsekas_Tsitsiklis_Introduction_to_prob

ability.pdf

Upload New Material

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Browse files

Topics

Select a topic to study

Introduction to Probability

Question 3

What is a binomial random variable?

Choose your answer:

A variable that represents the number of successes in n independent Bernoulli trials

A variable that represents the number of failures in n independent Bernoulli trials

A variable that represents the total number of trials in a Bernoulli process

A variable that represents the probability of success in a Bernoulli process

Submit Quiz

Your score: 100.00%

Question 1: Correct!

Question 2: Correct!

Question 3: Correct!

Recommendations

Learning Materials

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ability.pdf

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Topics

Select a topic to study

Introduction to Probability

Learning Materials

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ability.pdf

Upload New Material

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Topics

Select a topic to study

Introduction to Probability

Deploy

Recommendations

• 1. Revisit the Basics: Given the student's low average score, it might be beneficial to revisit some of the fundamental concepts in probability. The student should start from the beginning of the lecture notes, paying particular attention to sections like "Sample Space and Probability", "Sets", and "Probabilistic Models". These sections will help solidify understanding of the foundational principles.

•

• 2. Practice Problems: The student has made three attempts already, which suggests they are putting in effort but perhaps not effectively. They should try working through additional problems provided in the notes, which are suitable for homework assignments. This provides an opportunity to apply theoretical knowledge and practice problem-solving skills. The student might also benefit from seeking out additional problems from other resources to get more practice.

•

Deploy

• 2. Practice Problems: The student has made three attempts already, which suggests they are putting in effort but perhaps not effectively. They should try working through additional problems provided in the notes, which are suitable for homework assignments. This provides an opportunity to apply theoretical knowledge and practice problem-solving skills. The student might also benefit from seeking out additional problems from other resources to get more practice.

•

• 3. Seek Clarification: The student should reach out to their instructor or peers if they are struggling with certain concepts. If certain sections like "Conditional Probability", "Total Probability Theorem and Bayes' Rule", or "Independence" are difficult, they should not hesitate to seek help. They can also reach out to the authors of the lecture notes, Dimitri P. Bertsekas (bertsekas@lids.mit.edu) and John N. Tsitsiklis (jnt@mit.edu), for clarification on the material.

•

10. Score Improvement: Average score increases with better performance.

Learning Materials

Available PDFs

Math--

Bertsekas_Tsitsiklis_Introduction_to_prob

ability.pdf

Upload New Material

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Browse files

Topics

Select a topic to study

Introduction to Probability

Personalized Education Mentor

Introduction to Probability

Ask Questions

Ask a question about this topic

Q: what is probability

A: Probability is a mathematical description of the likelihood of an event occurring. In a probabilistic model, it is represented by a nonnegative number $P(A)$, where A is the event in question. This number, or probability, reflects our knowledge or belief about the collective "likelihood" of the elements of A occurring. For example, a probability of $P(A) = 2/3$ often represents a belief that event A will materialize in about two thirds out of a large number of repetitions of the experiment. It's important to note that the probability of the entire sample space, which is the set of all possible outcomes, is equal to 1. This is known as the normalization property.

Q: why

A: The concept of probability is used to quantify the uncertainty associated with events chosen from a some universe of events. and it's based on the logic of our understandine of the world.

Progress

Status

Needs Review

Average Score

44.44%

Attempts

3

Quiz

Start Quiz

11. Continuous Learning: Users can reattempt quizzes until they clear the topic completely.

Learning Materials

Available PDFs

Math--
Bertsekas_Tsitsiklis_Introduction_to_prob
ability.pdf

Upload New Material

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Browse files

Topics

Select a topic to study

Introduction to Probability

BURNING... Stop Deploy

The number of heads in a sequence of coin tosses

The state of a telephone at a given time

The preference of a person for or against a political candidate

A person who can be either healthy or sick with a certain disease

Submit Quiz

Your score: 100.00%

Question 1: Correct!

Question 2: Correct!

Question 3: Correct!

Recommendations

Learning Materials

Available PDFs

Math--
Bertsekas_Tsitsiklis_Introduction_to_prob
ability.pdf

Upload New Material

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Browse files

Topics

Select a topic to study

Introduction to Probability

Personalized Education Mentor

Introduction to Probability

Ask Questions

Ask a question about this topic

Q: what is probability

A: Probability is a mathematical description of the likelihood of an event occurring. In a probabilistic model, it is represented by a nonnegative number $P(A)$, where A is the event in question. This number, or probability, reflects our knowledge or belief about the collective "likelihood" of the elements of A occurring. For example, a probability of $P(A) = 2/3$ often represents a belief that event A will materialize in about two thirds out of a large number of repetitions of the experiment. It's important to note that the probability of the entire sample space, which is the set of all possible outcomes, is equal to 1. This is known as the normalization property.

Q: why

A: The concept of probability is used to quantify the uncertainty associated with events chosen from a some universe of events. and it's based on the logic of our understanding of the world.

Progress

Status

Needs Review

Average Score

58.33%

Attempts

4

Quiz

Start Quiz

Learning Materials

Available PDFs

Math--
Bertsekas_Tsitsiklis_Introduction_to_prob
ability.pdf

Upload New Material

Choose a PDF file

Drag and drop file here
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Browse files

Topics

Select a topic to study

Introduction to Probability

Theorem and Bayes' Rule", and "Independence". These are key areas in the topic "Introduction to Probability".

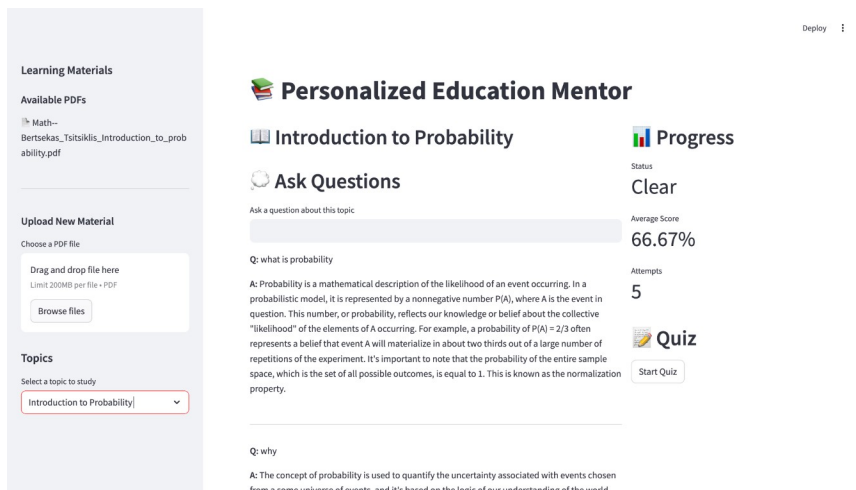
•

• 2. Practice Problems: The student has completed only five attempts. Increased practice is often associated with better understanding and improvement in scores. The student should take advantage of the additional problems suitable for homework assignments provided in the notes. Solving these problems will give them a hands-on experience and better grasp of the topic.

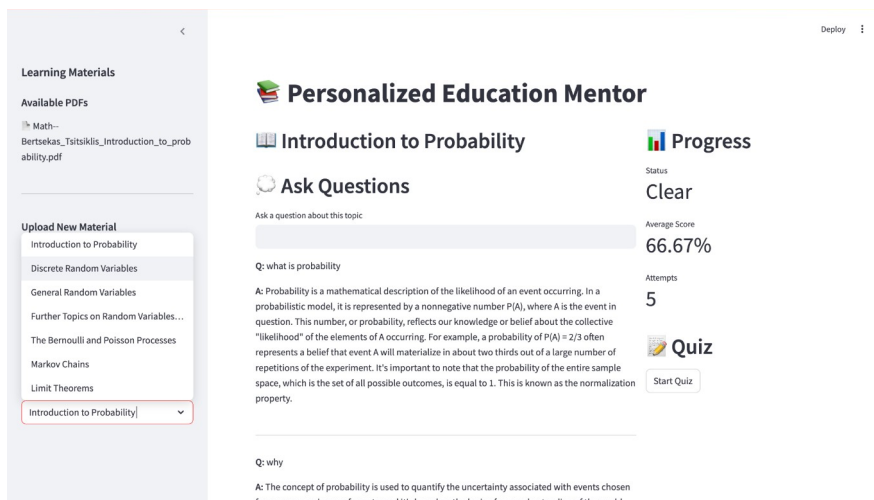
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• 3. Engage with Instructors: The student should consider reaching out to their instructors (Dimitri P. Bertsekas bertsekas@mit.edu and John N. Tsitsiklis jnt@mit.edu) with specific questions or areas of difficulty. They could provide further clarification and guidance, as well as provide additional resources for study. The student could also request for more problems to solve, to further improve their understanding of the topic.

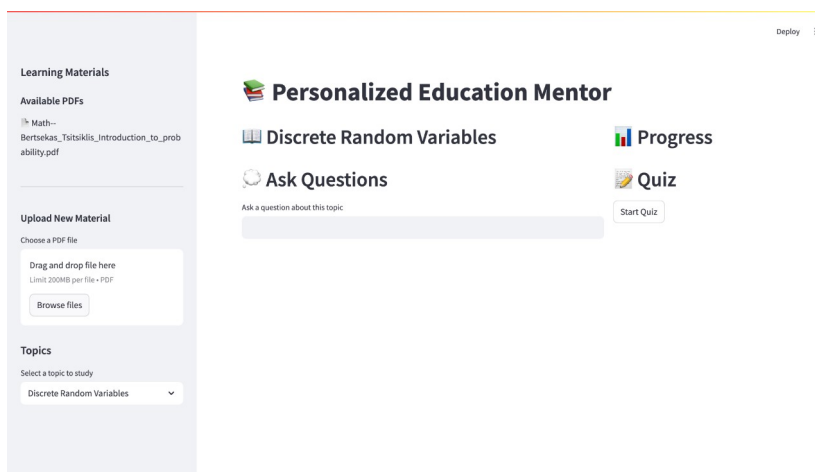
12. Topic Mastery: After 5 attempts, the score improved and status changed to "clear"



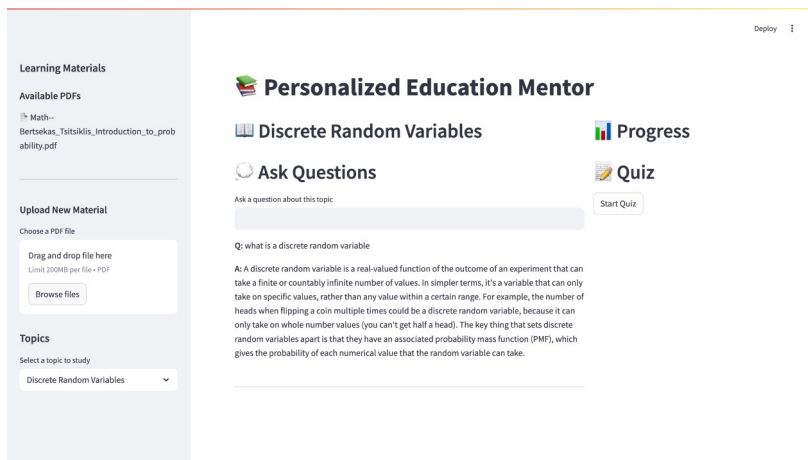
13. Topic Switching: Users can easily change topics at any time.



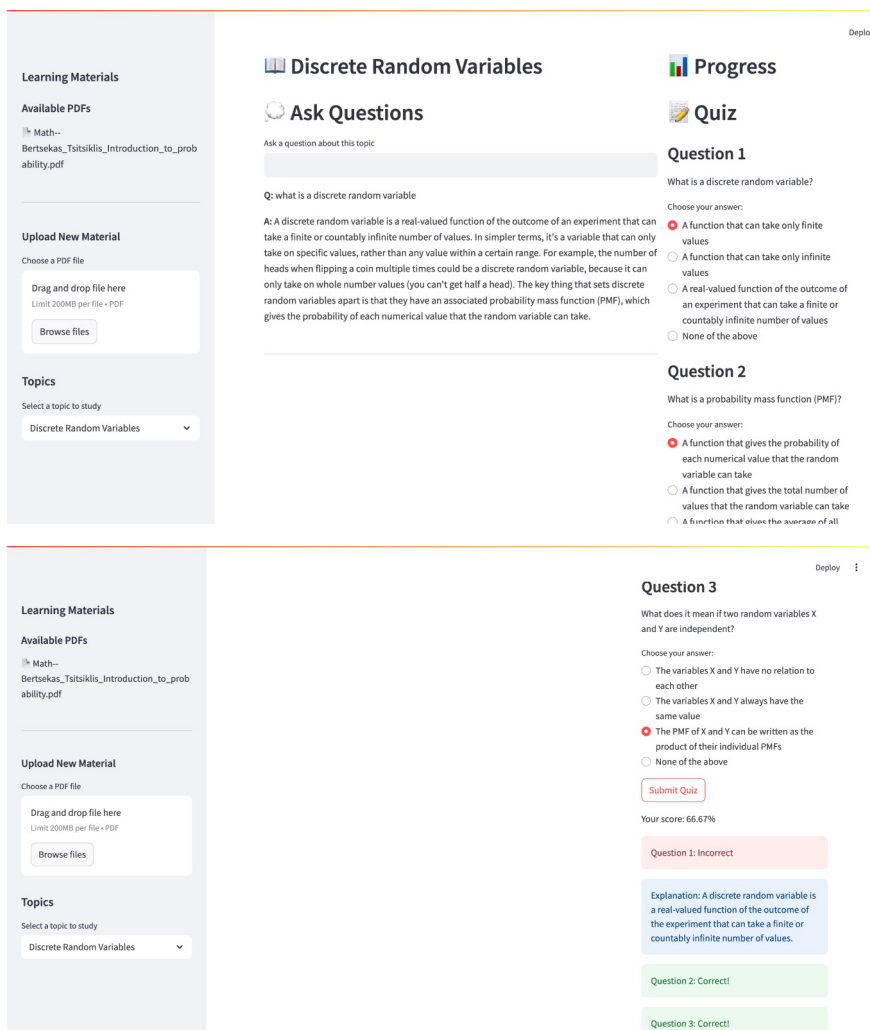
14. Fresh Start: New topic selection provides fresh chat history and a new progress card specific to that topic.

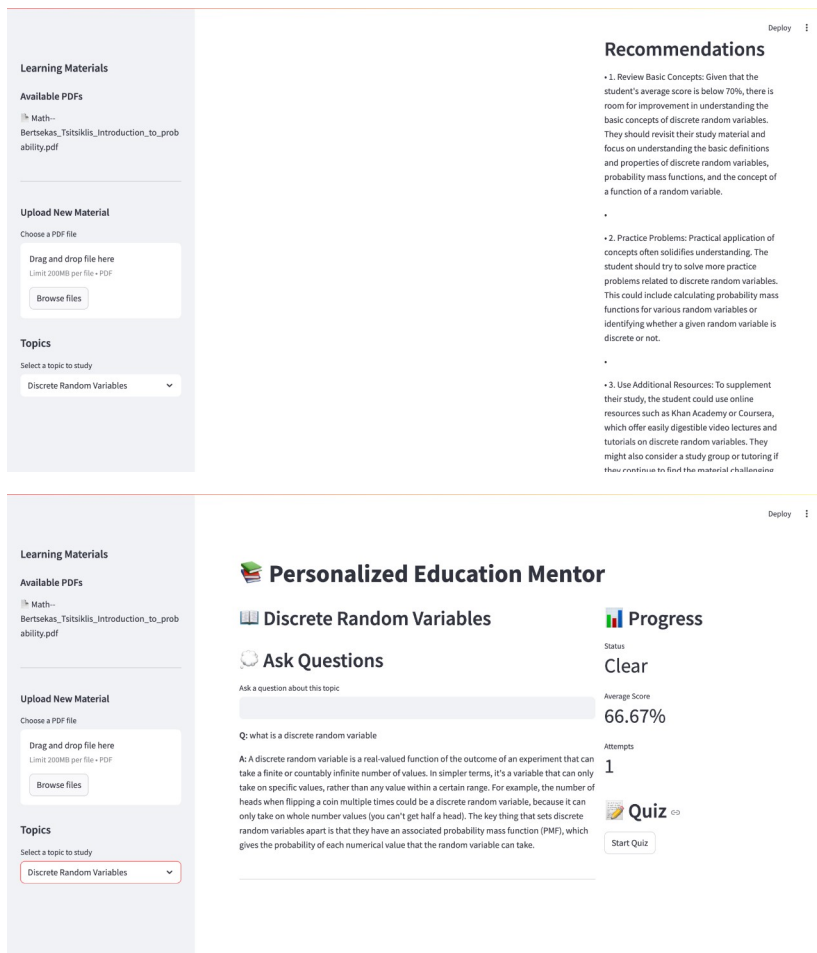


15. Topic-Specific Help: Users can ask questions about their newly selected topic.

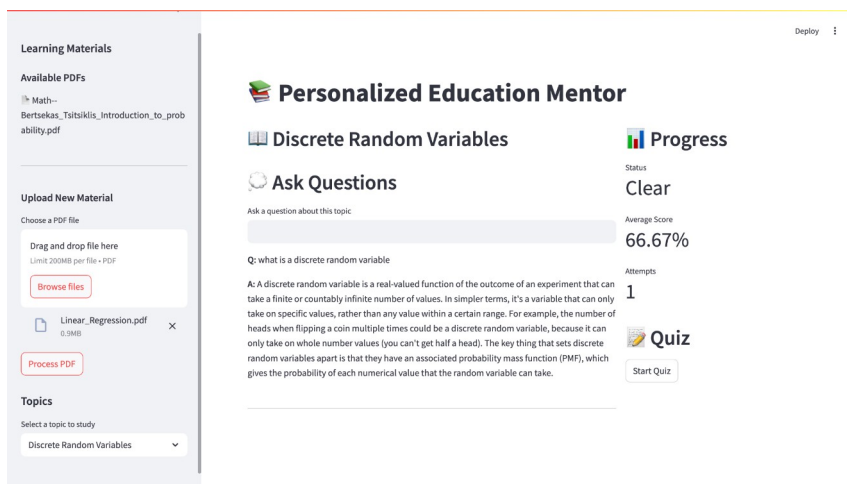


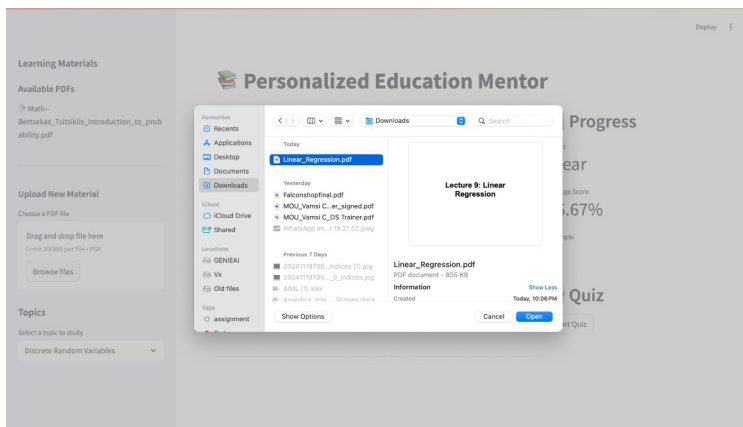
16. Consistent Process: Same quiz workflow applies - attempt until cleared with explanations and recommendations provided.



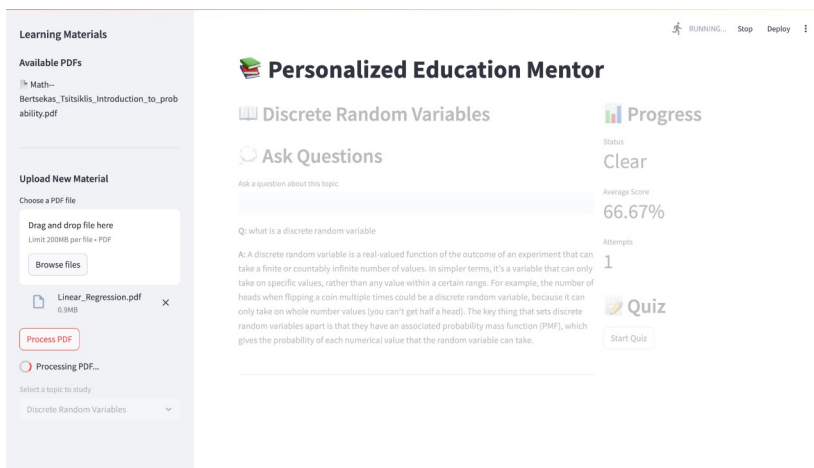


17. PDF Upload: Users can upload new PDFs by clicking "Browse Files" and selecting documents.

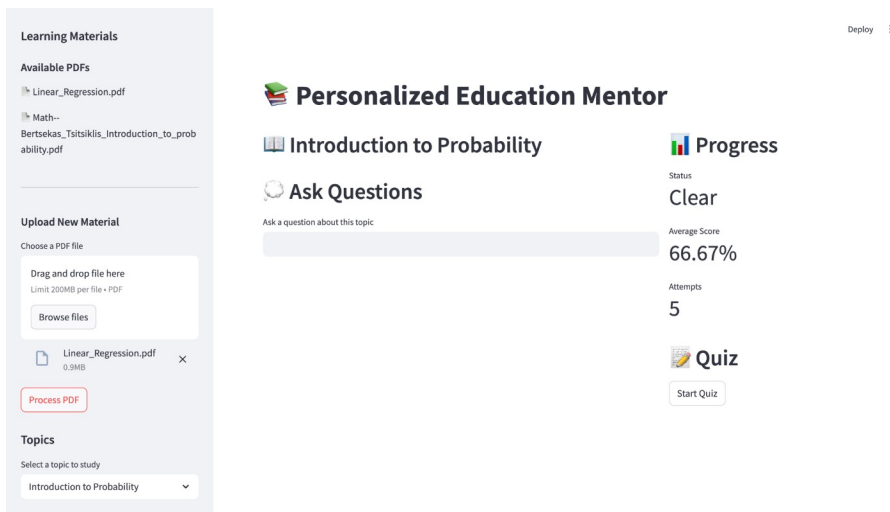




18. Auto-Processing: New PDFs are embedded into ChromaDB and topics are automatically updated after clicking "Process PDF."



19. Database Integration: Newly uploaded PDFs appear in the available documents list within ChromaDB.



20. **Seamless Integration:** Users can select new topics and follow the same learning process as before.

Available PDFs

Linear_Regression.pdf

Math-- Bertsekas, Tsitsiklis, Introduction_to_prob ability.pdf

Upload New Material

Choose a PDF file

Drag and drop file here

Lecture 9: Linear Regression

Regression

Regression Lingo

Why Linear Regression?

Linear Regression

Linear Probabilistic Model

True Regression Line

Introduction to Probability

Deploy

Personalized Education Mentor

Introduction to Probability

Ask Questions

Ask a question about this topic

Progress

Status

Clear

Average Score

66.67%

Attempts

5

Quiz

Start Quiz

Available PDFs

Linear_Regression.pdf

Math-- Bertsekas, Tsitsiklis, Introduction_to_prob ability.pdf

Upload New Material

Choose a PDF file

Drag and drop file here

Limit 200MB per file • PDF

Browse files

Linear_Regression.pdf

0 MB

Process PDF

Topics

Select a topic to study

Why Linear Regression?

Deploy

Personalized Education Mentor

Why Linear Regression?

Ask Questions

Ask a question about this topic

Progress

Quiz

Start Quiz

System Architecture

Overview

This system helps learners by letting them upload study materials and ask questions about them. It also creates quizzes to test their understanding. The system is designed to work entirely from the documents the user provides.

Main Parts

1. User Interface

A simple website lets users upload PDFs, choose topics, take quizzes, and ask questions.

2. Breaking Down the Documents

When a PDF is uploaded, it is split into smaller overlapping sections to keep the meaning clear.

3. Turning Text Into Searchable Data

These text sections are turned into numbers (called embeddings) that make it possible to find similar content later.

4. Storing the Data

The embeddings are saved in a special database that can quickly find similar ones when needed.

5. Finding Topics

The system looks at the uploaded document and picks out the main subjects and related areas. Users can then pick what they want to focus on.

6. Answering Questions

When a user asks something, the system searches for related content from the uploaded document. It also considers what the user and system talked about earlier.

7. Writing the Response

The answer is based only on what's in the document and the ongoing conversation. If the system can't find an answer, it will say so and suggest other areas to look into.

8. Making Quizzes

The system can create short quizzes (3 questions per topic) based on the chosen subject. It removes things like author notes and focuses on the main content.

9. Scoring and Feedback

Quiz answers are checked automatically. Users get a score and see how they're doing over time. The system recommends what to review next.

How It Works?

For Questions:

1. Looks at current and previous user questions.
2. Searches for 3 matching sections from the document.

3. Uses these sections and the conversation to form an answer.

For Quizzes:

1. Picks 5 relevant content sections.
2. Cleans the content to keep only useful material.
3. Writes 3 multiple-choice questions.
4. Scores the answers and tracks how the user performs.

Scoring System

80% or more: Mastered

60–79%: Clear understanding

Below 60%: Needs review

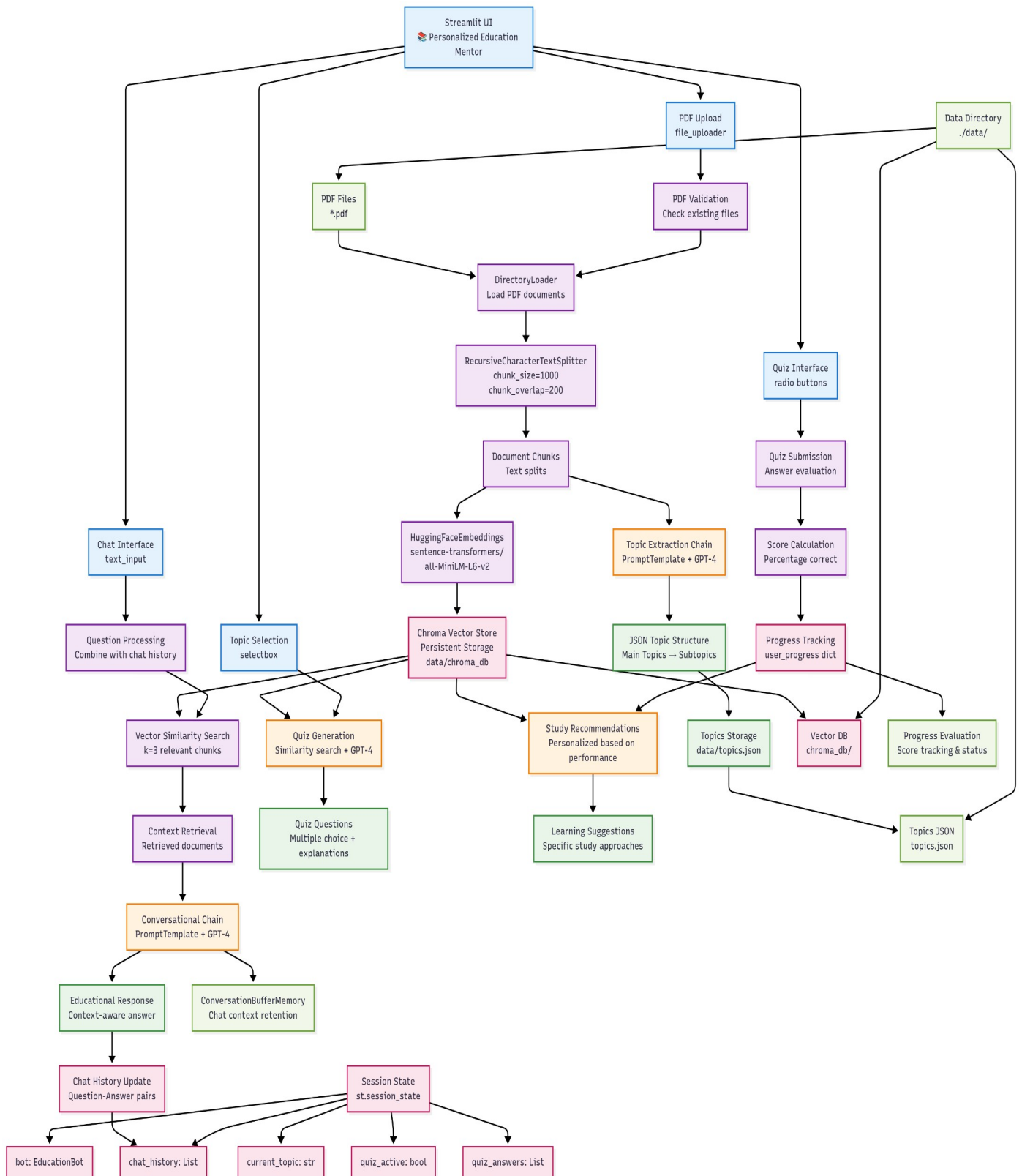
Personal Progress

Tracks how many times a topic was studied and the average score.
Offers suggestions based on past performance.

Note

This system doesn't add any outside information. All answers and quizzes are based only on the uploaded PDFs and what's been discussed in the conversation.

System Architecture Diagram



Discussions

To create a customized study aid, we integrated semantic search, large language models, and an interactive web interface. Here is what we discovered about what succeeded, what failed, and our next steps.

What was Effective?

1. Lively Interactions : Follow-up questions appear natural since the system remembers previous queries and finds pertinent content, saving you from having to start over every time.

2. Instant, On-Demand Tests: Students can attempt practice quizzes with immediate feedback after reading.

What failed?

1. The Detection of Subjects Is Not Perfect : Papers with unusual layouts or nonstandard titles result in messy subject lists that look like rough outlines.

2. Quiz Depth Vary : Unstructured source information often produces surface-level inquiries rather than profound ones.

3. Computational Overhead : Standard laptops are strained by large text processing, and when usage increases, they drastically slow down.

Ideas for Future Projects

1. Offer Extra Format Assistance : The addition of EPUB, DOCX, and HTML would allow students to use e-books, web articles, and other resources directly.

2. Intelligent Quiz Level : After incorrect replies, questions should become easier, and as students demonstrate proficiency, they should become harder.

3. Contextual Link-Out : Direct access to scholarly publications, Wikipedia, or MOOCs for students who wish to go further into a subject.

4. Instructor & Parent Views : Dashboards for teachers and parents to track learning patterns, see class progress and provide targeted support.

Conclusion

This project puts students in control of their learning through an AI-powered study companion. By working with materials students already have, using advanced text processing, and creating interactive practice sessions, we've built a system that can adapt to different learners without requiring massive infrastructure.

Since we built it in separate pieces, adding new features or tweaking it for other subjects becomes straightforward. This project demonstrates that students don't need expensive tools to get personalized help—they just need better ways to work with what they already have.

References

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