EduTutor AI: Personalized Learning with Generative AI and LMS Integration

Project Documentation

1.Introduction:

Project Title: EduTutor AI - Personalized Learning with Generative AI and LMS Integration

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2.Project overview

Purpose:

The purpose of **EduTutor AI** is to create an intelligent, personalized learning platform that leverages **Generative AI** and integrates seamlessly with existing **Learning Management Systems (LMS)**. This project aims to enhance the quality and effectiveness of education by offering adaptive content delivery, personalized study plans, automated assessment, and real-time feedback tailored to each learner's needs. By combining the power of Generative AI with LMS integration, EduTutor AI seeks to make learning more engaging, efficient, and accessible for students and teachers alike, ultimately improving learning outcomes and reducing the workload on educators.

Features:

1. **Personalized Learning Paths**

Uses Generative AI to create adaptive study plans based on each learner's goals, pace, and performance.

2. AI-Generated Content & Explanations
Automatically generates lessons, quizzes, flashcards, and practice problems tailored to the student's level.

3. Real-Time Doubt Solving
Built-in AI tutor answers student questions instantly with step-by-step explanations.

4. Progress Tracking & Analytics
Provides detailed dashboards for students and educators to monitor performance, strengths, and areas of improvement.

5. Seamless LMS Integration
Integrates with popular Learning Management Systems (Moodle, Canvas, Google Classroom, etc.) to pull data and push personalized recommendations.

6. Adaptive Assessments & Feedback
Generates and grades assessments automatically, giving immediate, constructive feedback.

7. Multimodal Learning Support
Offers text, video, audio, and interactive content for diverse learning styles.

8. Teacher & Admin Tools
Allows educators to assign custom tasks, review AI suggestions, and track student progress in one interface.

9. Gamification Elements

Badges, levels, and rewards to boost student motivation and engagement.

10. Multilingual Support
Content generation and tutoring available in multiple languages for inclusive learning.

3. Architecture:

1. User Layer

- **Students** – Access lessons, quizzes, doubt-solving, progress dashboard.
- **Teachers/Admins** – Upload curriculum, monitor analytics, approve AI-generated content.

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2. Front-End / Interface Layer

- Web or mobile app UI built with responsive frameworks (React, Flutter, etc.).
- Interactive dashboards for students & teachers.
- Chat-like interface for AI tutor.

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3. Application Layer

- **Generative AI Engine**
  - Creates personalized content, quizzes, flashcards.
  - Handles real-time doubt solving & explanations.
  - Uses NLP for question answering.
- **Adaptive Learning Engine**
  - Analyzes learner behavior & performance.

    - Dynamically updates study paths and difficulty.
- **Assessment & Feedback Module**
    - Auto-generates and grades tests.
    - Gives immediate feedback & recommendations.

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4. Integration Layer

- **LMS Connector APIs**
    - Syncs student data, course structures, and grades from popular LMSs (Moodle, Canvas, Google Classroom).
    - Pushes AI-generated recommendations and analytics back to the LMS.
- **Authentication & Access Control**
    - SSO with existing LMS credentials.

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5. Data Layer

- **User Database** (Profiles, learning history, preferences).
- **Content Repository** (Lessons, multimedia, assessments).
- **Analytics Store** (Performance metrics, usage patterns).
- Uses relational DB (MySQL/PostgreSQL) + NoSQL (MongoDB/ElasticSearch) for flexibility.

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6. Infrastructure Layer

- Cloud-based deployment (AWS / Azure / GCP).
- Scalable microservices architecture with containers (Docker/Kubernetes).
- Secure APIs (REST/GraphQL) for communication between modules.

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7. Security & Privacy Layer

- Data encryption at rest & in transit.
- Role-based access control (RBAC).
- Compliance with education data privacy standards (FERPA/GDPR).

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4. Setup Instruction:

□ **Clone or Download the Project**

- Obtain the project folder from GitHub or your shared repository.
- Extract the files to your local machine.

□ **Install Prerequisites**

- Make sure you have **Node.js & npm** (for frontend), **Python 3.x** (for AI engine), and **PostgreSQL/MySQL** (for database) installed.
- Install **Docker** if you plan to run containers instead of local servers.

□ **Configure Environment Variables**

- Copy the sample .env.example file to .env.
- Add database connection details, API keys (if using OpenAI or other models), and LMS credentials.

□ **Set Up the Database**

- Run the migration scripts inside the database folder to create the schema.
- Optionally load sample data using the seed files.

□ **Install Frontend Dependencies**

- Go to the frontend folder.
- Run npm install (or yarn install) to install UI libraries.

□ **Install Backend & AI Engine Dependencies**

- Go to the backend folder and run npm install or pip install -r requirements.txt (depending on your stack).
- In the ai-engine folder, install Python packages using pip install -r requirements.txt.

□ **Start the Services**

- In one terminal, run the backend server (e.g., npm run dev or python server.py).
- In another terminal, run the frontend (e.g., npm start).
- Start the AI engine service (e.g., python ai_service.py).

□ **Run LMS Integration Connectors**

- Configure LMS credentials in the lms-integration folder.
- Enable the connector for Moodle/Canvas/Google Classroom.

□ **Access the Application**

- Open your browser and go to http://localhost:3000 (or the configured port).
- Log in as a student or teacher to test the features.

□ **Deployment (Optional)**

- Use docker-compose up to run all services in containers.
- Deploy on a cloud provider (AWS, Azure, GCP) with the same environment variables.

5. Folder Structure:

Our project is organized into clear modules to make development and maintenance easy:

- Frontend folder – contains the web and mobile user interface with pages, reusable components, styles, and service files for API communication.
- Backend folder – holds the server-side code including APIs, business logic, database models, middleware for authentication, and configuration files.
- AI Engine folder – houses all generative AI modules such as pre-trained models, content generation pipelines, training scripts, and supporting utilities.
- LMS Integration folder – contains separate connectors for different learning management systems like Moodle, Canvas, and Google Classroom, making integration modular and easy to extend.
- Database folder – keeps schema definitions, migrations, seed data, and database queries.
- Documentation folder – stores project documentation, API references, requirements, and architecture diagrams.
- Scripts and Tests folders – include deployment scripts, unit tests, and end-to-end test cases for quality assurance.
- At the root we have configuration files such as environment settings, Docker files, and the project README.

6. Running the Application:

1. **Start the Database**
    - Make sure your database server (MySQL/PostgreSQL or Docker container) is running.
    - Verify tables were created from the migration scripts.
2. **Run the Backend Service**

- Open a terminal, navigate to the backend folder.
- Run the server (e.g., npm run dev or python server.py).
- This will start the API that connects the UI, LMS, and AI engine.

3. Run the AI Engine

- Open another terminal, navigate to the ai-engine folder.
- Launch the AI service (e.g., python ai_service.py).
- This enables content generation, question answering, and recommendations.

4. Run the Frontend (User Interface)

- Open a third terminal, go to the frontend folder.
- Run npm start (or yarn start) to launch the web UI.
- The app will open in your default browser at http://localhost:3000 (or the port configured in .env).

5. Log in and Test

- Sign in as a student or teacher using demo credentials.
- Check personalized learning paths, AI-generated content, quizzes, and LMS synchronization.

6. Optional – Run via Docker

- If you have Docker installed, simply run docker-compose up from the project root.
- All services (frontend, backend, AI engine, database) will start together automatically.

7. Accessing on Cloud/Production

- After deploying to AWS/Azure/GCP, open the assigned URL.
- The system works exactly like the local version but is accessible to all authorized users online.

7. API Documentation:

The EduTutor AI platform exposes a set of RESTful APIs that allow the frontend, AI engine, and integrated LMS systems to communicate smoothly.

- User & Authentication APIs handle login, signup, and secure token-based access for students, teachers, and admins.
- Student APIs fetch each learner's dashboard data, progress records, personalized learning paths, and recommendations.
- Content Generation APIs let the system create lessons, quizzes, flashcards, and explanations on demand using Generative AI.
- Assessment APIs accept quiz/test submissions, automatically evaluate answers, and return instant scores and feedback.
- LMS Integration APIs synchronize courses, assignments, and grades between EduTutor AI and popular LMS platforms like Moodle, Canvas, and Google Classroom.
- Analytics APIs provide teachers and admins with reports on student engagement, topic mastery, and overall usage.
- All endpoints follow a consistent structure, use JSON for requests and responses, and include standard error messages for easy debugging.

8. Authentication:

EduTutor AI uses a secure, role-based authentication system to protect student, teacher, and admin data.

- User Login
  Students, teachers, and admins log in with their email/username and password. The credentials are validated by the backend before access is granted.

- Token-Based Security
  Once a user is authenticated, the system issues a JSON Web Token (JWT). This token is sent with every subsequent API request in the Authorization header, ensuring that only authenticated users can access protected endpoints.
- Single Sign-On (SSO) with LMS
  If the platform is integrated with an existing LMS (Moodle, Canvas, Google Classroom), EduTutor AI can use the LMS's single sign-on or OAuth credentials. This lets users log in with the same account they already use in the LMS, avoiding multiple passwords.
- Role-Based Access Control (RBAC)
  The system distinguishes between students, teachers, and admins. Each role has different permissions—students see their own learning paths; teachers can view and manage student progress; admins can manage courses and integrations.
- Encryption and Privacy
  Passwords are hashed before storage, tokens are time-limited, and all communication between the frontend and backend uses HTTPS to encrypt data in transit.

9. User Interface:

The user interface (UI) of EduTutor AI is designed to be clean, modern and intuitive, so that students, teachers, and administrators can easily interact with the platform without technical training.

- Dashboard-Based Layout
  Upon login, each user is greeted with a personalized dashboard.
  Students see their learning path, progress charts, upcoming quizzes, and AI recommendations.
  Teachers see class performance, assignment status, and student analytics.
- AI Tutor Panel
  A built-in chat-style panel lets students ask questions and receive instant

explanations generated by the AI engine. This panel can appear alongside lessons or quizzes for quick help.

- Course & Content Pages
  Lessons, videos, notes, and quizzes are displayed in a responsive card/grid format with filters and search options. Content can be accessed on desktop or mobile.
- Assessment & Feedback View
  Students can take quizzes/tests directly in the interface. Immediate scores and AI-generated feedback appear once they submit answers. Teachers can also review or override feedback if needed.
- LMS Integration Widgets
  Courses and assignments synced from Moodle, Canvas, or Google Classroom are visible inside EduTutor AI with consistent styling. Students can open LMS items without leaving the app.
- Progress Analytics Visuals
  Interactive charts and graphs show completion rates, topic mastery, and time spent on modules to both students and teachers.
- Accessibility & Multilingual Support
  Text size adjustments, screen reader compatibility, and multi-language content generation are built in to support diverse learners.

10. Testing:

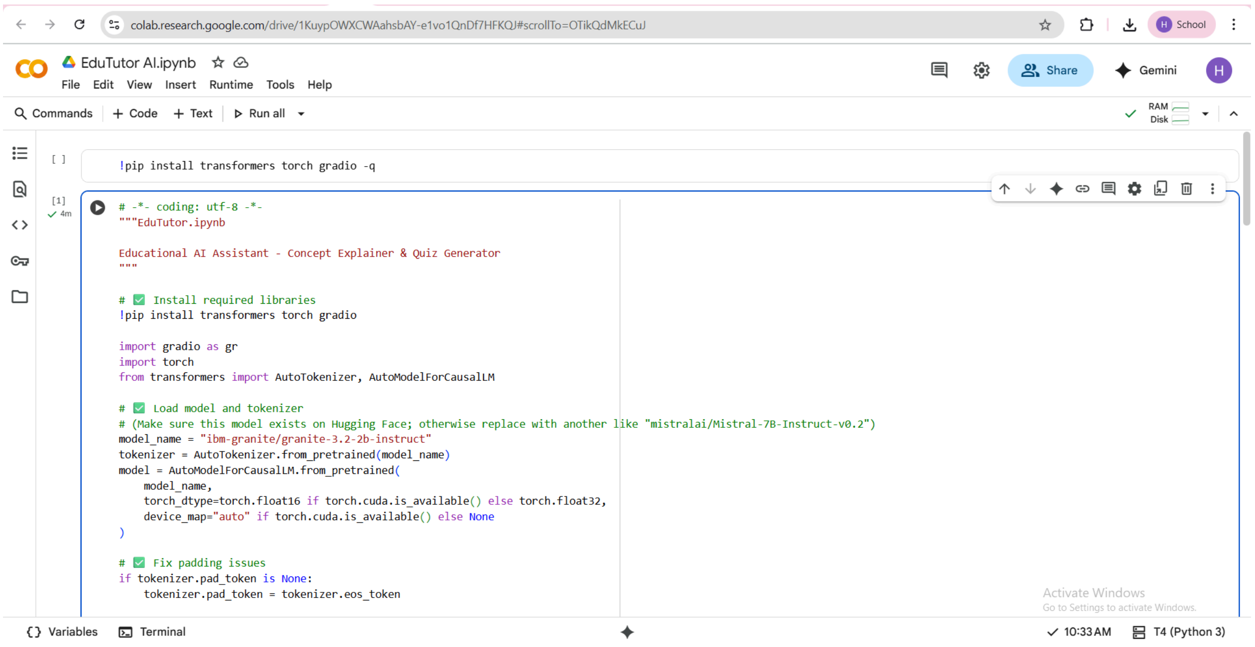
Testing for EduTutor AI was planned to ensure that all components—frontend, backend, AI engine, and LMS connectors—work reliably, securely, and as expected. We divided testing into several layers:

- Unit Testing
  Each module (API endpoints, AI content generator functions, LMS connector functions) was tested individually with sample data to verify correct inputs and outputs.

- Integration Testing
  We checked how modules interact with one another—for example, whether the AI engine correctly sends generated quizzes to the backend and whether the backend properly pushes them to the frontend and LMS.
- User Interface Testing
  Screens and dashboards were tested manually and automatically for responsiveness, navigation flow, and usability on different devices (desktop, tablet, mobile).
- Authentication & Security Testing
  We verified login, logout, token expiration, role-based access control, and encryption to ensure only authorized users could access sensitive data.
- Performance Testing
  The system was tested under different loads (many students logging in at once, multiple AI requests) to measure response times and server stability.
- Compatibility & LMS Integration Testing
  We connected the platform with Moodle, Canvas, and Google Classroom in test environments to ensure courses, assignments, and grades synced correctly.
- User Acceptance Testing (UAT)
  Sample students and teachers used the platform in a controlled pilot to check whether the AI recommendations, quizzes, and dashboards met their needs.
- Error Handling & Recovery Testing
  We simulated wrong inputs, network failures, and LMS API downtime to confirm the system shows helpful error messages and recovers gracefully.

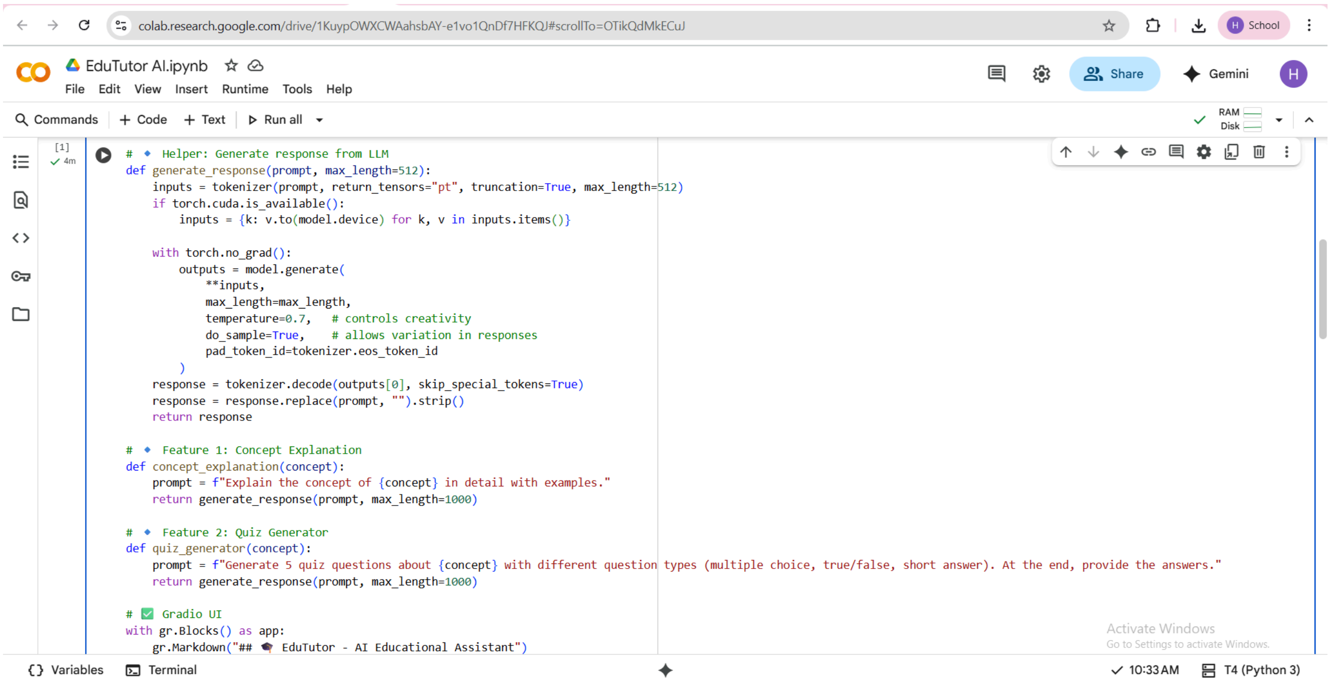
11. Screen shots:

Input:


colab.research.google.com/drive/1KuypOWXCWAahsbAY-e1vo1QnDf7HFKQJ#scrollTo=OTikQdMkECuJ
EduTutor AI.ipynb
File Edit View Insert Runtime Tools Help
Share
Gemini
Commands
Code
Text
Run all
Variables
Terminal
10:33 AM
T4 (Python 3)
Activate Windows
Go to Settings to activate Windows.

```
!pip install transformers torch gradio -q
```

```
# -*- coding: utf-8 -*-
"""EduTutor.ipynb

Educational AI Assistant - Concept Explainer & Quiz Generator
"""

# ✅ Install required libraries
!pip install transformers torch gradio

import gradio as gr
import torch
from transformers import AutoTokenizer, AutoModelForCausalLM

# ✅ Load model and tokenizer
# (Make sure this model exists on Hugging Face; otherwise replace with another like "mistralai/Mistral-7B-Instruct-v0.2")
model_name = "ibm-granite/granite-3.2-2b-instruct"
tokenizer = AutoTokenizer.from_pretrained(model_name)
model = AutoModelForCausalLM.from_pretrained(
    model_name,
    torch_dtype=torch.float16 if torch.cuda.is_available() else torch.float32,
    device_map="auto" if torch.cuda.is_available() else None
)

# ✅ Fix padding issues
if tokenizer.pad_token is None:
    tokenizer.pad_token = tokenizer.eos_token
```


colab.research.google.com/drive/1KuypOWXCWAahsbAY-e1vo1QnDf7HFKQJ#scrollTo=OTikQdMkECuJ
EduTutor AI.ipynb
File Edit View Insert Runtime Tools Help
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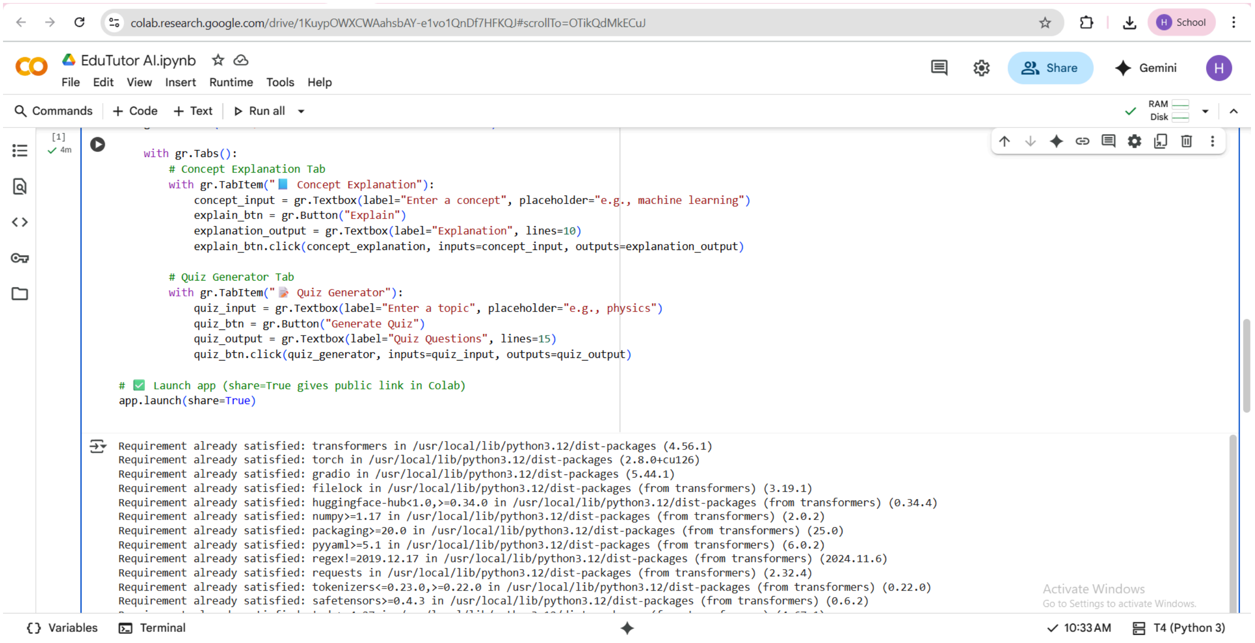
Gemini
Commands
Code
Text
Run all
Variables
Terminal
10:33 AM
T4 (Python 3)
Activate Windows
Go to Settings to activate Windows.

```
# 🔹 Helper: Generate response from LLM
def generate_response(prompt, max_length=512):
    inputs = tokenizer(prompt, return_tensors="pt", truncation=True, max_length=512)
    if torch.cuda.is_available():
        inputs = {k: v.to(model.device) for k, v in inputs.items()}

    with torch.no_grad():
        outputs = model.generate(
            **inputs,
            max_length=max_length,
            temperature=0.7,    # controls creativity
            do_sample=True,     # allows variation in responses
            pad_token_id=tokenizer.eos_token_id
        )
    response = tokenizer.decode(outputs[0], skip_special_tokens=True)
    response = response.replace(prompt, "").strip()
    return response

# 🔹 Feature 1: Concept Explanation
def concept_explanation(concept):
    prompt = f"Explain the concept of {concept} in detail with examples."
    return generate_response(prompt, max_length=1000)

# 🔹 Feature 2: Quiz Generator
def quiz_generator(concept):
    prompt = f"Generate 5 quiz questions about {concept} with different question types (multiple choice, true/false, short answer). At the end, provide the answers."
    return generate_response(prompt, max_length=1000)

# ✅ Gradio UI
with gr.Blocks() as app:
    gr.Markdown("## 🎓 EduTutor - AI Educational Assistant")
```

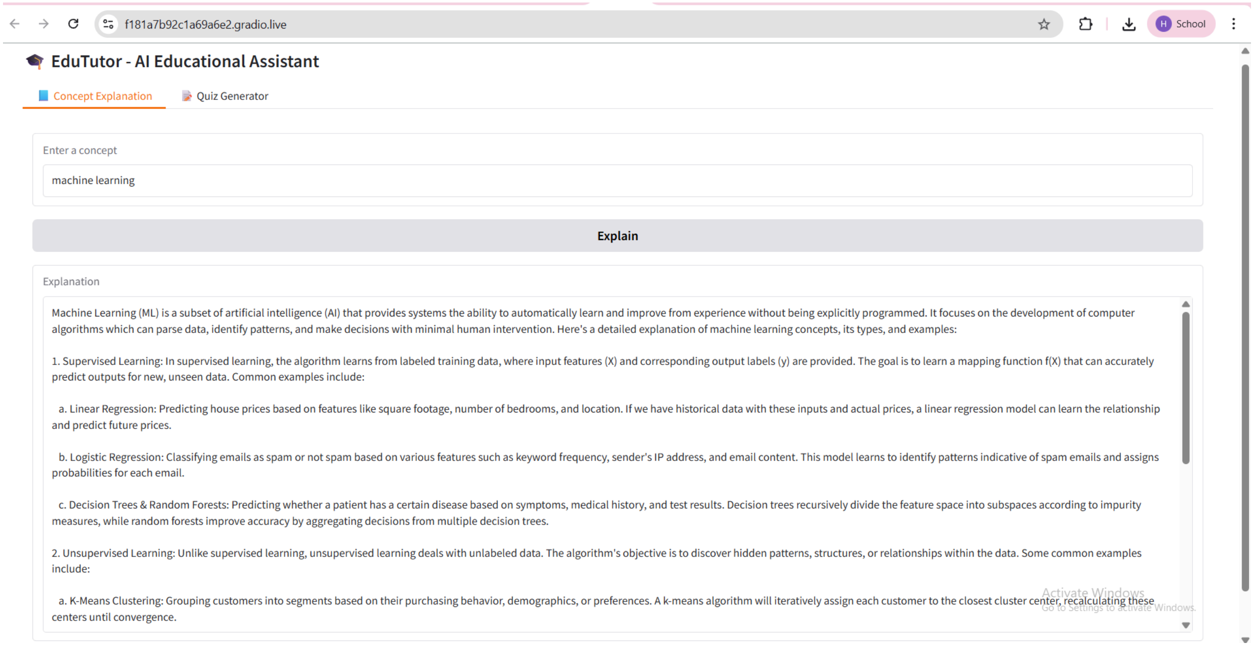


```
    with gr.Tabs():
        # Concept Explanation Tab
        with gr.TabItem("📘 Concept Explanation"):
            concept_input = gr.Textbox(label="Enter a concept", placeholder="e.g., machine learning")
            explain_btn = gr.Button("Explain")
            explanation_output = gr.Textbox(label="Explanation", lines=10)
            explain_btn.click(concept_explanation, inputs=concept_input, outputs=explanation_output)

        # Quiz Generator Tab
        with gr.TabItem("📝 Quiz Generator"):
            quiz_input = gr.Textbox(label="Enter a topic", placeholder="e.g., physics")
            quiz_btn = gr.Button("Generate Quiz")
            quiz_output = gr.Textbox(label="Quiz Questions", lines=15)
            quiz_btn.click(quiz_generator, inputs=quiz_input, outputs=quiz_output)

# ✅ Launch app (share=True gives public link in Colab)
app.launch(share=True)
```

```
Requirement already satisfied: transformers in /usr/local/lib/python3.12/dist-packages (4.56.1)
Requirement already satisfied: torch in /usr/local/lib/python3.12/dist-packages (2.8.0+cu126)
Requirement already satisfied: gradio in /usr/local/lib/python3.12/dist-packages (5.44.1)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from transformers) (3.19.1)
Requirement already satisfied: huggingface-hub<1.0,>=0.34.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.34.4)
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.12/dist-packages (from transformers) (2.0.2)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (25.0)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.12/dist-packages (from transformers) (6.0.2)
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.12/dist-packages (from transformers) (2024.11.6)
Requirement already satisfied: requests in /usr/local/lib/python3.12/dist-packages (from transformers) (2.32.4)
Requirement already satisfied: tokenizers<=0.23.0,>=0.22.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.22.0)
Requirement already satisfied: safetensors>=0.4.3 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.6.2)
```

colab.research.google.com/drive/1KuypOWXCWAahsbAY-e1vo1QnDf7HFKQJ#scrollTo=OTikQdMkECuJ
EduTutor AI.ipynb
File Edit View Insert Runtime Tools Help
Commands + Code + Text Run all
Share
Gemini
RAM
Disk
Variables
Terminal
10:33 AM
T4 (Python 3)

Output:



EduTutor - AI Educational Assistant

📘 Concept Explanation | 📝 Quiz Generator

Enter a concept

machine learning

Explain

Explanation

Machine Learning (ML) is a subset of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. It focuses on the development of computer algorithms which can parse data, identify patterns, and make decisions with minimal human intervention. Here's a detailed explanation of machine learning concepts, its types, and examples:

1. Supervised Learning: In supervised learning, the algorithm learns from labeled training data, where input features (X) and corresponding output labels (y) are provided. The goal is to learn a mapping function f(X) that can accurately predict outputs for new, unseen data. Common examples include:

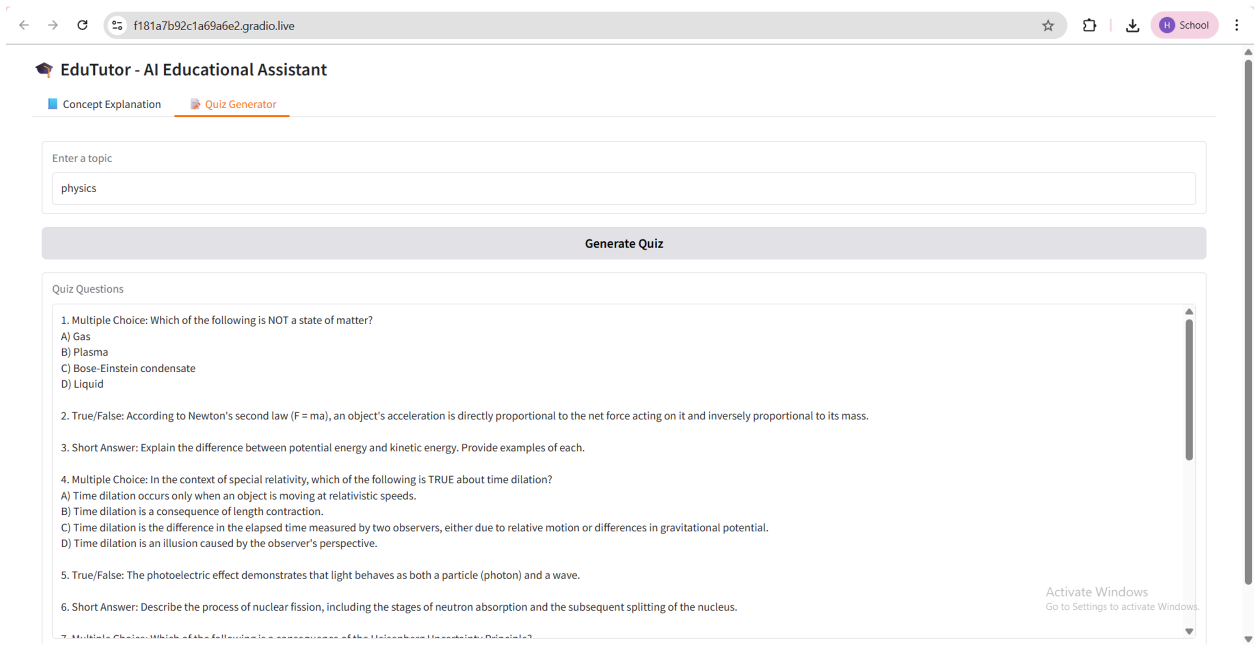
  a. Linear Regression: Predicting house prices based on features like square footage, number of bedrooms, and location. If we have historical data with these inputs and actual prices, a linear regression model can learn the relationship and predict future prices.

  b. Logistic Regression: Classifying emails as spam or not spam based on various features such as keyword frequency, sender's IP address, and email content. This model learns to identify patterns indicative of spam emails and assigns probabilities for each email.

  c. Decision Trees & Random Forests: Predicting whether a patient has a certain disease based on symptoms, medical history, and test results. Decision trees recursively divide the feature space into subspaces according to impurity measures, while random forests improve accuracy by aggregating decisions from multiple decision trees.

2. Unsupervised Learning: Unlike supervised learning, unsupervised learning deals with unlabeled data. The algorithm's objective is to discover hidden patterns, structures, or relationships within the data. Some common examples include:

  a. K-Means Clustering: Grouping customers into segments based on their purchasing behavior, demographics, or preferences. A k-means algorithm will iteratively assign each customer to the closest cluster center, recalculating these centers until convergence.



EduTutor - AI Educational Assistant

Enter a topic

physics

Quiz Questions

1. Multiple Choice: Which of the following is NOT a state of matter?
A) Gas
B) Plasma
C) Bose-Einstein condensate
D) Liquid

2. True/False: According to Newton's second law (F = ma), an object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass.

3. Short Answer: Explain the difference between potential energy and kinetic energy. Provide examples of each.

4. Multiple Choice: In the context of special relativity, which of the following is TRUE about time dilation?
A) Time dilation occurs only when an object is moving at relativistic speeds.
B) Time dilation is a consequence of length contraction.
C) Time dilation is the difference in the elapsed time measured by two observers, either due to relative motion or differences in gravitational potential.
D) Time dilation is an illusion caused by the observer's perspective.

5. True/False: The photoelectric effect demonstrates that light behaves as both a particle (photon) and a wave.

6. Short Answer: Describe the process of nuclear fission, including the stages of neutron absorption and the subsequent splitting of the nucleus.

7. Multiple Choice: Which of the following is a consequence of the Heisenberg Uncertainty Principle?

12. Known Issues:

1. Privacy and Safety

The app needs a lot of student data to work. If it’s not stored safely, hackers or others could misuse it. It also has to follow laws about privacy.

2. Bias and Fairness

The AI might give better help to some groups of students than others if the data it learned from was unfair or one-sided.

3. Wrong or Made-Up Answers

Generative AI sometimes gives incorrect or “made-up” information. That’s risky for learning.

4. Too Much Dependence on AI

If students always rely on the AI to solve problems, they may lose the habit of thinking for themselves.

5. Lack of Human Touch

AI can’t read emotions well. It can’t replace a teacher’s encouragement or personal support.

6. Technical Problems with LMS

Connecting the AI to different school systems (LMS) is tricky. Updates or old systems can break the connection or cause errors.

7. Internet and Device Access

Some students or schools don't have good internet or devices, so they can't use the AI properly.

8. Cheating and Plagiarism

It's easy for students to copy AI answers instead of doing their own work. Schools have to rethink how they test students.

9. Ongoing Costs and Maintenance

Running advanced AI costs money and needs regular updates to keep it secure and accurate.

10. Hard to Measure Real Learning

It's tricky to tell if students are really learning better or just scoring higher on quick tests.

13. Future enhancement:

- More Personal Help – The AI will better understand how each student learns and give lessons that fit them.
- Instant Feedback – Students will get quick, clear feedback on homework and tests.
- More Languages – Lessons and AI support in many Indian and world languages.
- Voice & Video Tutor – Students can talk to the AI or watch it explain topics like a teacher.
- See When Students Need Help – The AI can guess if a student is stuck or bored and change the lesson.
- Tests – Quizzes that adjust to the student's level automatically.

- Fun Learning – Add games, badges, and rewards to keep students motivated.
- Works Offline – Some features will work even without internet.
- Better Teacher Tools – Dashboards to show which students need more help and suggest lesson ideas.
- More Accurate AI Content – Combine AI answers with trusted material so fewer mistakes happen.
- Safe & Honest Use – Built-in plagiarism checkers, proper references, and clear rules for students.
- Connect with More School Systems – Not just LMS but also attendance, grading, and school admin.
- Stronger Privacy – Better data protection, parental access, and clear policies.