Anime Educational Chatbot – Backend Technical Report

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# Abstract

This report provides a comprehensive overview of the backend architecture of the Anime Educational Chatbot — a dynamic, AI-driven educational platform designed for interactive learning using anime-themed characters. The backend is implemented using the Flask framework in Python and leverages a combination of machine learning models, cloud-based APIs, and robust database systems to ensure scalable, secure, and responsive performance. The system is architected to support multi-modal learning through real-time chat, quizzes, file processing, and performance tracking, integrated seamlessly with frontend components via RESTful APIs.

# Keywords

Flask, Python, SQLAlchemy, REST API, AI Integration, Cohere, Google Cloud, MySQL, Educational Technology, OCR, Session Management, Token-Based Authentication, Backend Architecture

# System Architecture

* - Flask, SQLAlchemy, Flask-Login, Flask-Session for server-side state and session management.
* - Primary DB: MySQL. Fallback: SQLite. Optimized with connection pooling and indexing.
* - External Integrations: Google Cloud (TTS, Translation), Cohere (NLP), PyTorch (QA), Tesseract OCR (Text extraction).

# Database Design

* - User Management, ChatMessage, LearningProgress – structured using SQLAlchemy ORM.
* - Uses JSON columns to store flexible structures like quiz scores, profile data, and chat context.

# Core Functionalities

* - Secure Authentication with PBKDF2 hashing, session and token-based auth.
* - Real-time AI-driven chat with context tracking.
* - Educational support through quiz generation, progress monitoring, and achievement assignment.
* - File upload support, OCR processing of PDFs/images, and content validation.

# API Endpoints

* - User Auth: /login, /register, /logout, /reset-password
* - Chat API: /chat, /chat/history, /chat/context
* - Learning Features: /quiz/generate, /progress/update, /achievements/check

# Security Implementation

* - Password hashing using PBKDF2 with SHA256.
* - Input validation to block malicious or malformed data.
* - Secure session generation and lifecycle management.

# AI Integration

* - Cohere API for generating AI responses.
* - Google TTS for voice support in multiple languages.
* - Dynamic question generation using NLP and MCQ formulation.

# Performance Optimization

* - Query indexing and optimization in database.
* - API and session-level caching implemented.
* - Load management via rate limiting, queuing, and resource balancing.

# Error Handling & Logging

* - Custom Exception handling for APIs.
* - Structured logging with log rotation and performance monitors.

# Testing Architecture

* - Unit and Integration tests covering APIs, DB operations, and AI logic.
* - Security and load testing integrated into QA process.

# Deployment Configuration

* - Environment segmentation: dev, staging, production.
* - CI/CD pipeline, version control, migration handling, and backups.

# Monitoring and Maintenance

* - Metrics tracking, log management, cache clean-up, and security patching.

# Future Roadmap

* - Technical: Microservices, Docker, Kubernetes.
* - Features: Advanced AI, analytics, real-time collaboration, mobile API support.

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