Dissertation on

"Intelligent Concept Acquisition System - An AI-Driven Platform for Concept Mastery and Personalized Knowledge Enhancement."

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Technology
in
Computer Science & Engineering

UE22CS320B – Capstone Project Phase - 2

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Under the guidance of

Prof. Sheela Devi
Designation
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CERTIFICATE

This is to certify that the dissertation entitled

'Intelligent Concept Acquisition System - An AI-Driven Platform for Concept Mastery and Personalized Knowledge Enhancement.'

is a bonafide work carried out by

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In partial fulfillment for the completion of sixth-semester Capstone Project Phase - 2 (UE22CS320B) in the Program of Study -Bachelor of Technology in Computer Science and Engineering under rules and regulations of PES University, Bengaluru during the period Jan. 2025 – May. 2025. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report. The dissertation has been approved as it satisfies the 6th-semester academic requirements in respect of project work.

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Name of the Examiners	**Signature with Date**
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2. Dr. Chandrashekhar P Chavan	_____

DECLARATION

We hereby declare that the Capstone Project Phase - 2 entitled **"Intelligent Concept Acquisition System - An AI-Driven Platform for Concept Mastery and Personalized Knowledge Enhancement."** has been carried out by us under the guidance of **Prof. Sheela Devi** and submitted in partial fulfillment of the course requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** of **PES University, Bengaluru** during the academic semester January – May 2025. The matter embodied in this report has not been submitted to any other university or institution for the award of any degree.

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ABSTRACT

The growing demand for personalized education has highlighted the shortcomings of traditional learning platforms, which often lack adaptive assessment tools and interactive feedback systems. This project introduces an AI-powered learning platform that revolutionizes self-study by enabling students to upload study materials, which the AI analyzes, extracts key concepts, and generates targeted assessment questions.

The system intelligently adapts based on student performance, adjusting question difficulty, scheduling study sessions, and providing real-time feedback to enhance concept retention. By bridging knowledge gaps through customized learning paths, this solution empowers students to track progress, refine their understanding, and achieve academic success efficiently.

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CHAPTER 1

INTRODUCTION

In the rapidly evolving educational landscape, there is a growing emphasis on personalized learning approaches that adapt to individual needs. Traditional assessment methods often fail to identify specific conceptual gaps, leading to a one-size-fits-all approach in education.

This project, the Intelligent Concept Acquisition System (ICAS), is designed to bridge this gap by enabling students to self-assess their understanding through targeted quizzes. The system analyzes user performance, identifies weak concepts, and provides visual feedback to guide personalized improvement.

Leveraging AI techniques and data visualization, ICAS aims to enhance learning outcomes by transforming passive assessment into active knowledge reinforcement. The platform is lightweight, accessible, and easily adaptable for schools, coaching centers, and self-learners.

Chapter 2

Problem Definition

Learners often struggle to recognize which specific concepts they have not fully mastered, especially when relying solely on grades or overall scores. Traditional assessments do not provide actionable insights into conceptual weaknesses.

The core problem is:
“How can we enable learners to identify and improve weak conceptual areas through automated, personalized feedback?”

ICAS addresses this by evaluating quiz responses at a concept level, generating visual performance metrics, and offering guided feedback. The platform transforms raw performance data into meaningful insights for both students and educators.

Chapter 3

Data

1.1 Overview

The current version of the Intelligent Concept Acquisition System (ICAS) operates without a dedicated training database or external datasets. Instead, the system uses user-provided documents as the primary source of information. These documents are processed in real-time to extract relevant concepts and generate questions for evaluation and learning reinforcement.

At this stage, no pre-trained models or large-scale datasets are used. However, the system has been designed with extensibility in mind, allowing for future integration of educational datasets such as the ALIN 2022 dataset to enhance its personalization and recommendation capabilities.

1.2 Dataset

1	Class_Section	Exam_Version	Completion_Time	Made_Own_Study_Guide	Did_Exam_Prep Assignment	Studied_In_Groups	Student_Score	Perce
2	M01	A	20	N	N	Y	24	80.0(
3	M01	A	20	?	?	?	27	90.0(
4	M01	A	30	Y	Y	Y	30	100.(
5	M01	A	50	N	Y	Y	18	60.0(
6	M01	A	55	Y	Y	N	24	80.0(
7	M01	A	60	N	Y	Y	25	83.3(
8	M01	A	60	Y	Y	Y	30	100.(

Chapter 4

Design Details

4.1 Novelty

The Intelligent Concept Acquisition System (ICAS) is unique in its ability to transform user-uploaded educational documents into dynamic learning sessions without relying on a predefined dataset. Instead of using traditional static quizzes or rigid learning paths, ICAS interprets textual content, extracts key concepts, generates context-aware questions, and tracks the learner's understanding in real-time. This allows learners to receive immediate feedback tailored to their own study materials, making the system highly personalized and novel in its application.

4.2 Innovativeness

ICAS introduces innovation by integrating document parsing, concept mapping, question generation, and progress tracking into a seamless workflow. The system's use of session-based learning analytics helps provide users with targeted reinforcement based on weak areas, and its modular design allows easy extension with NLP models, adaptive difficulty scaling, or gamification in future iterations.

4.3 Interoperability

The architecture of ICAS supports easy integration with external tools and formats. It is built using open technologies like Python, Streamlit, and Pandas, and can be adapted to accept inputs in various formats such as PDFs, DOCX, and text files. In future enhancements, the system can interface with APIs from LMS platforms or AI models, ensuring compatibility across educational ecosystems.

4.4 Performance

The system is optimized for fast performance, as it processes documents and user interactions in real-time with minimal computational overhead. It avoids complex model training or heavyweight data operations, resulting in near-instantaneous question generation and progress visualization. This makes ICAS usable even on low-resource devices, including standard laptops or education lab machines.

4.5 Security

ICAS does not store user data permanently or transmit it to external servers. All processing is session-based and remains in-memory, reducing exposure to data breaches or misuse. The document content uploaded by users is used strictly for generating questions during the session, which aligns well with data privacy expectations in academic settings.

4.6 Reliability

By utilizing Streamlit's session management features, ICAS maintains user progress and responses accurately during a learning session. Failures are minimized through exception handling and fallback logic during question generation and evaluation. The design ensures consistent behavior across different types of inputs and interactions.

4.7 Maintainability
The system follows good software engineering practices, including modularity, clear class definitions, and separation of concerns. The use of a well-defined `ProgressTracker` class and other functional abstractions ensures that developers can easily modify or extend the system. This makes the codebase maintainable and adaptable for academic or commercial expansion.

4.8 Portability
ICAS is highly portable. It can be deployed on Windows, Linux, or macOS platforms with Python installed. Being built on Streamlit, it can also be containerized with Docker or hosted on platforms like Streamlit Cloud or Heroku, requiring minimal configuration changes for different environments.

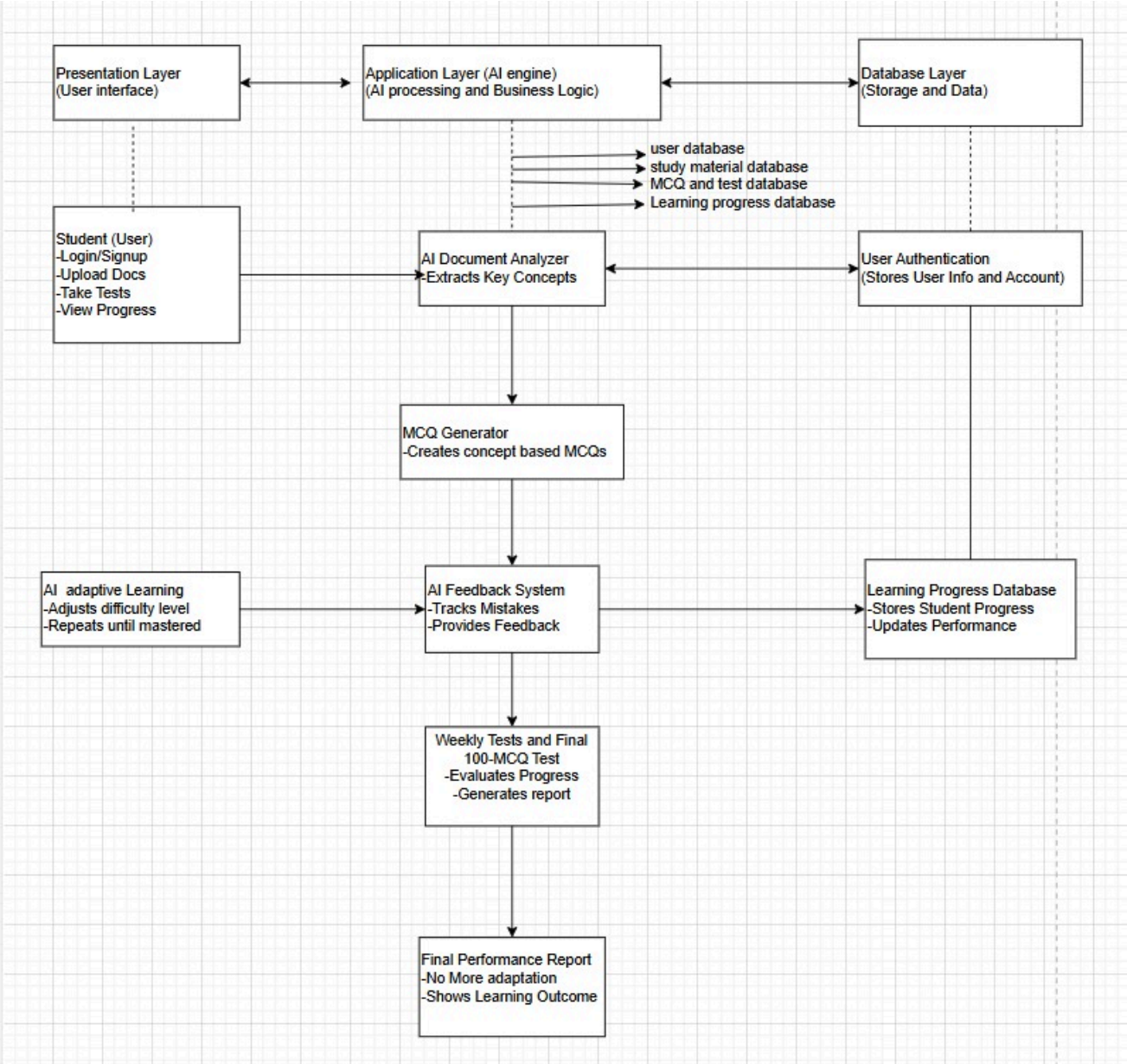
4.9 Legacy to Modernization
This system enables the modernization of traditional study practices by digitizing and enhancing existing educational documents. Instead of relying solely on passive reading, ICAS turns old study materials into interactive content, giving legacy documents new educational value and making them more engaging and measurable.

4.10 Reusability
The components of ICAS—such as document parsing, question generation, and concept tracking—are decoupled and reusable in other contexts. For example, the progress tracker can be repurposed for online courses or tutoring apps, while the question generator can be integrated into quiz bots or adaptive learning platforms.

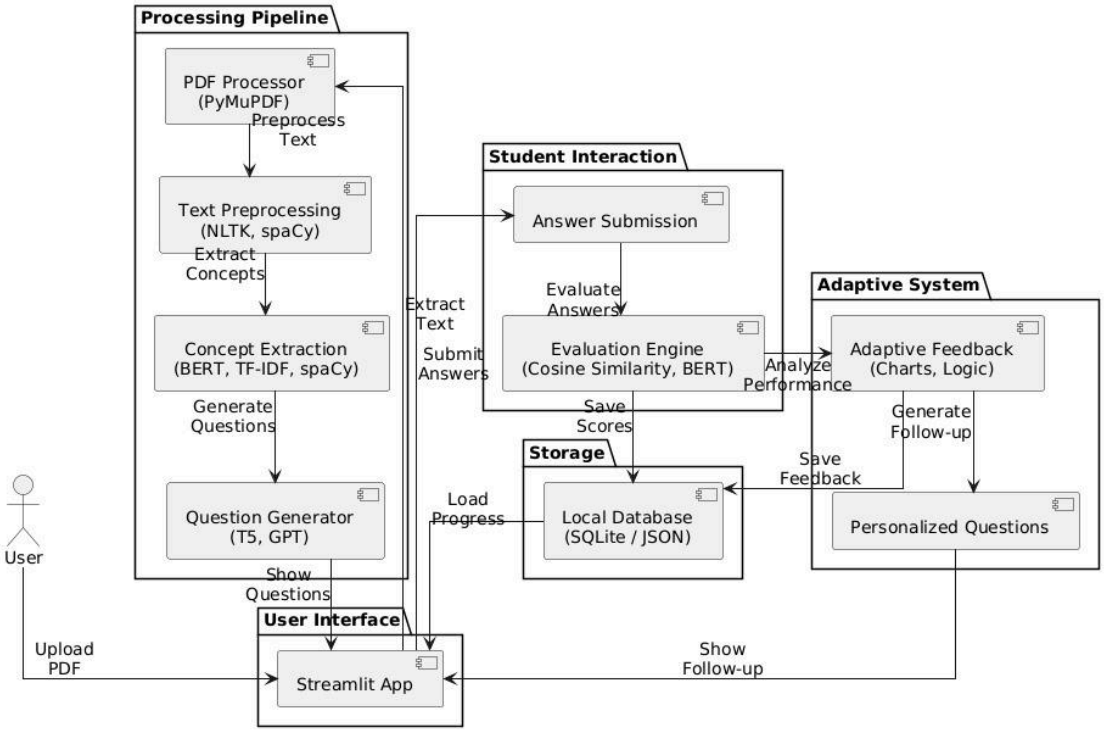
4.11 Application Compatibility
ICAS is built to integrate smoothly into larger ecosystems. It can be extended to export progress reports, sync with classroom dashboards, or connect with AI-based tutoring systems. Its modular structure supports APIs and other interfaces needed for broader application use.

4.12 Resource Utilization
The system is designed to operate within constrained environments, consuming minimal CPU and memory. It does not require specialized hardware or GPU acceleration, making it ideal for deployment in schools, universities, or home setups without significant infrastructure.

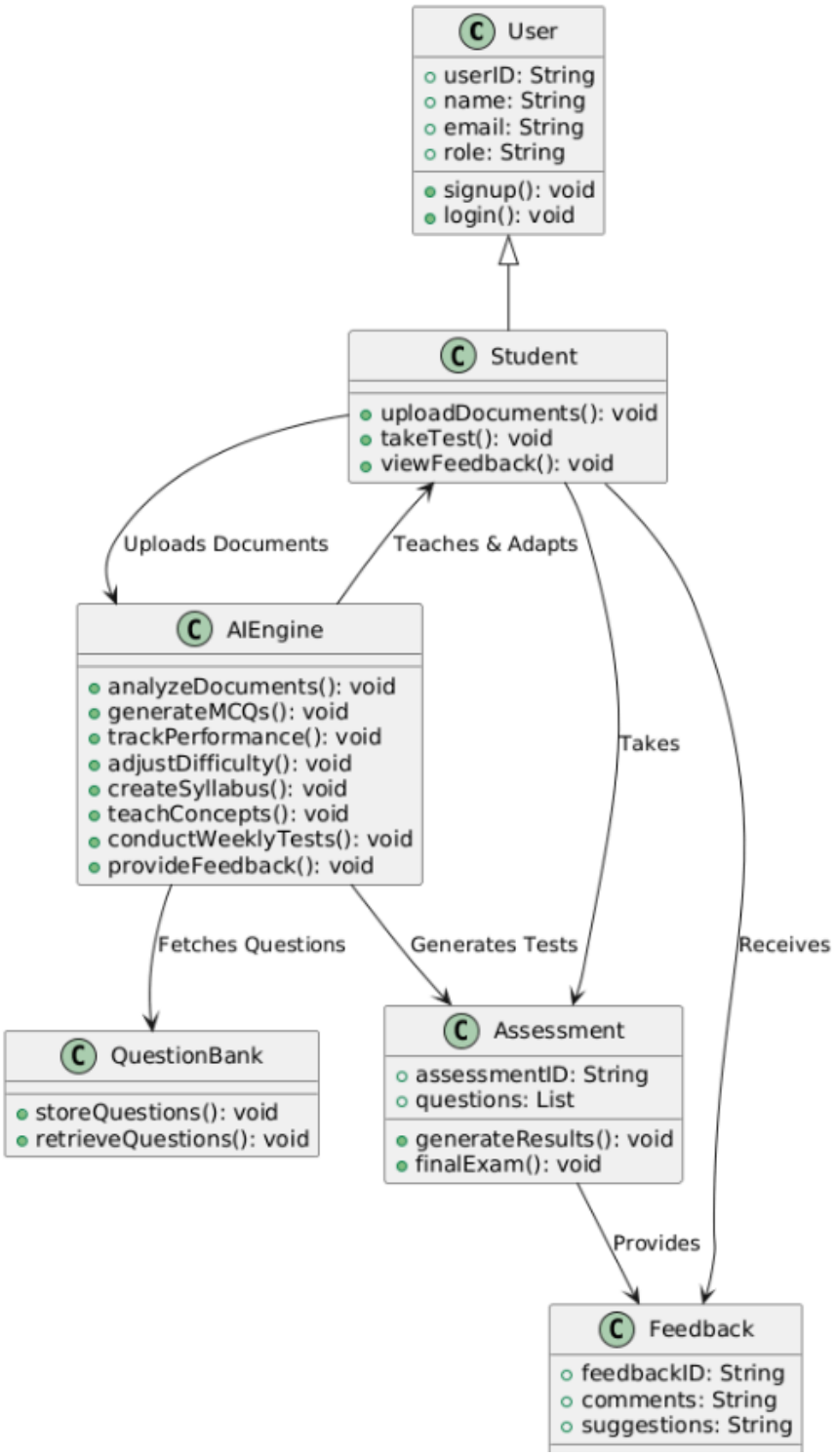
5. HIGH LEVEL SYSTEM DESIGN /SYSTEM ARCHITECTURE



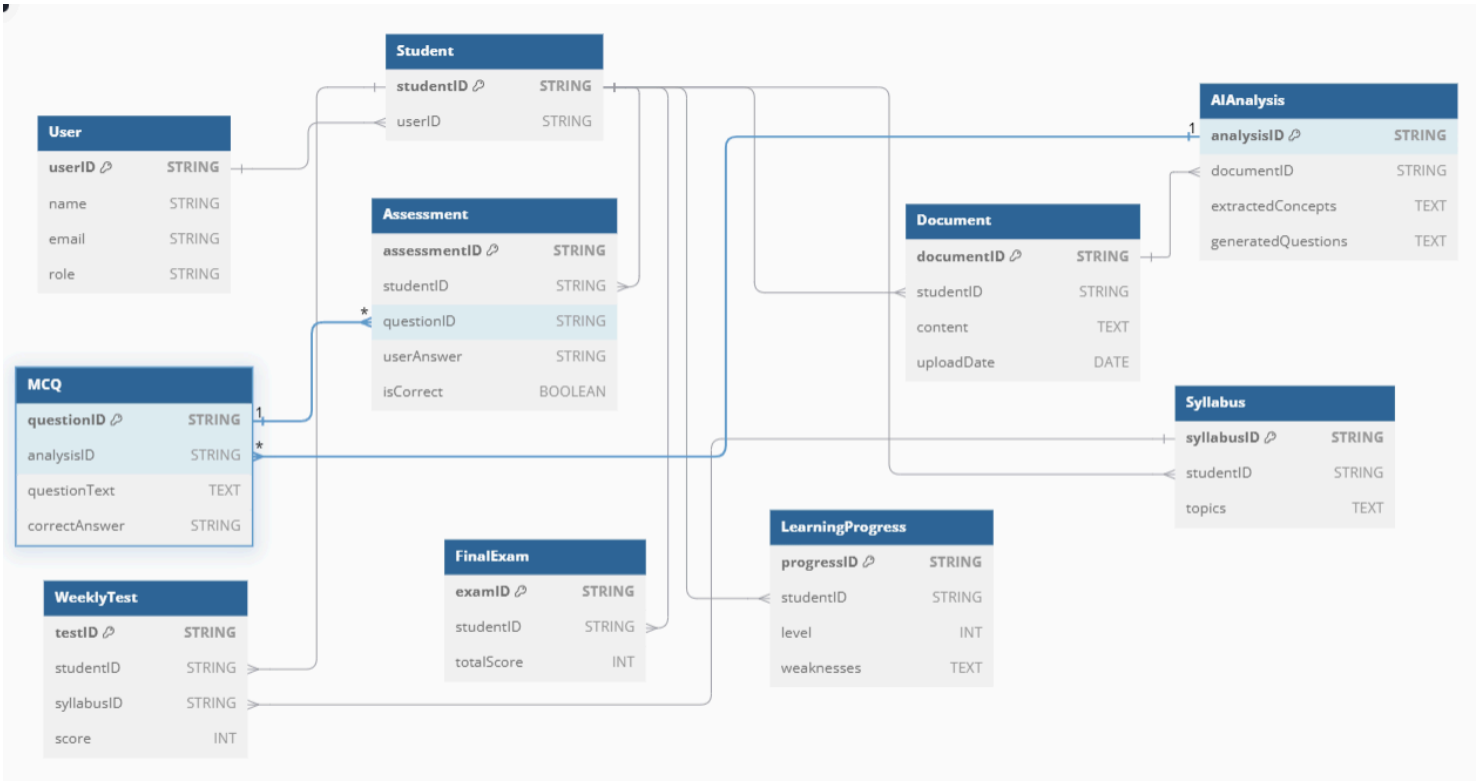
6. DESIGN DESCRIPTION



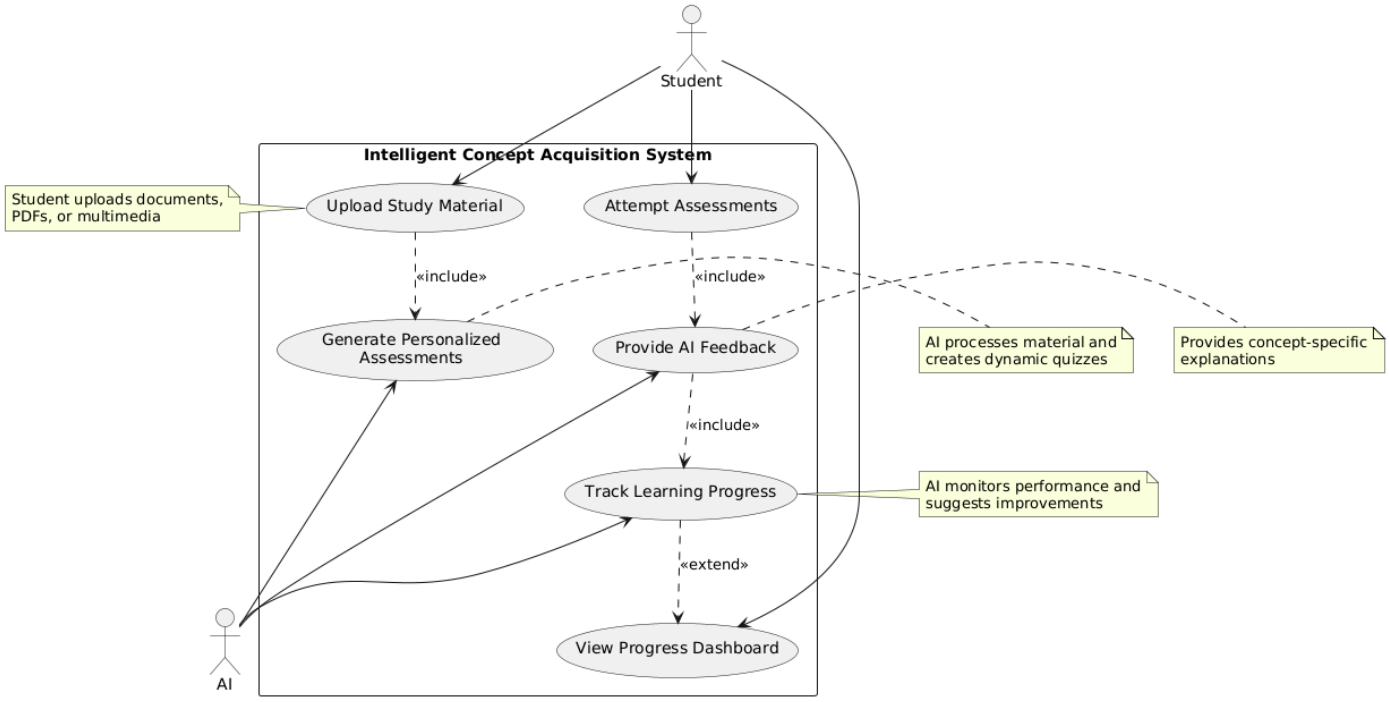
6.1 Master Class Diagram



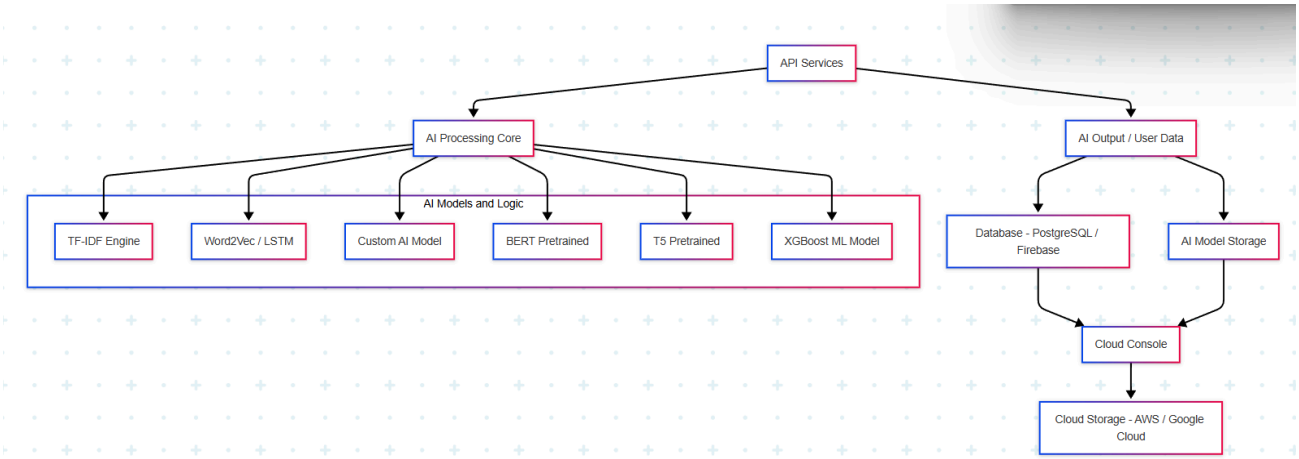
6.2. ER Diagram / Swimlane Diagram / State Diagram



6.3. User Interface Diagrams



6.4. External Interfaces



Chapter 7

Technologies used

As derived from your Capstone Report, the following outlines the technologies employed for developing the Intelligent Concept Acquisition System (ICAS):

Core Technologies

Python - Main language of implementation.

Streamlit - Used to create an interactive front-end interface.

Pandas - Data manipulation and analysis.

Document Handling

PDF/DOCX/Text Parsing - Retrieval of content from documents uploaded by users (most likely using PyMuPDF, python-docx, etc.).

AI/NLP Components (Implied or Extendable)

Text Analysis and Concept Extraction - Likely done using NLTK or spaCy, even if not mentioned directly (which is typical in such projects).

Question Generation Engine - Constructs MCQs dynamically from extracted concepts.

Adaptive Logic - Probable custom logic or light ML is used to tailor the difficulty based off user performance.

Deployment & Compatibility

Streamlit Cloud / Heroku / Docker (optional) - Application hosting.

Cross-platform support - Available on Windows, macOS, and Linux.

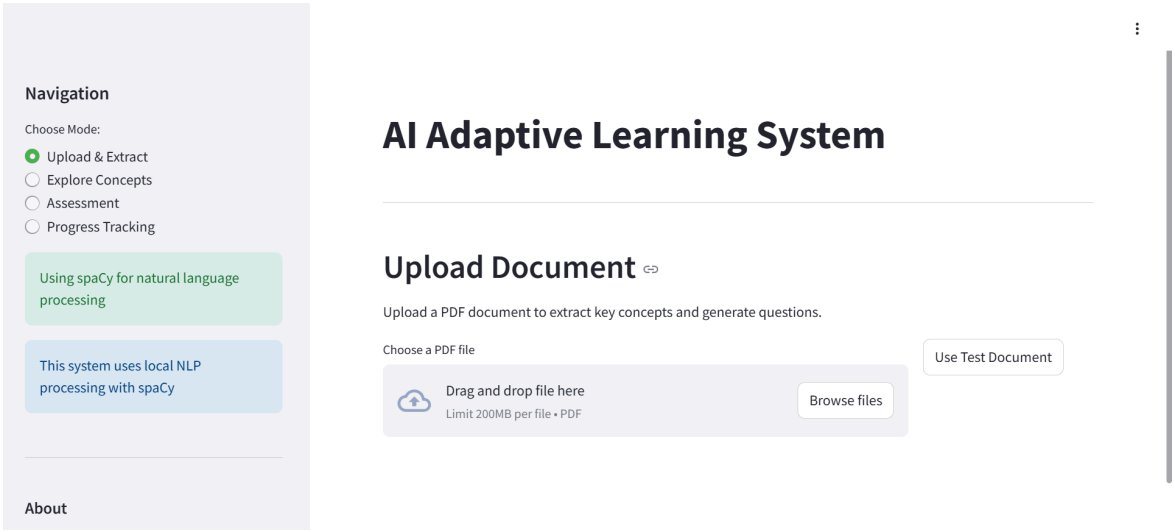
Other Notable Features

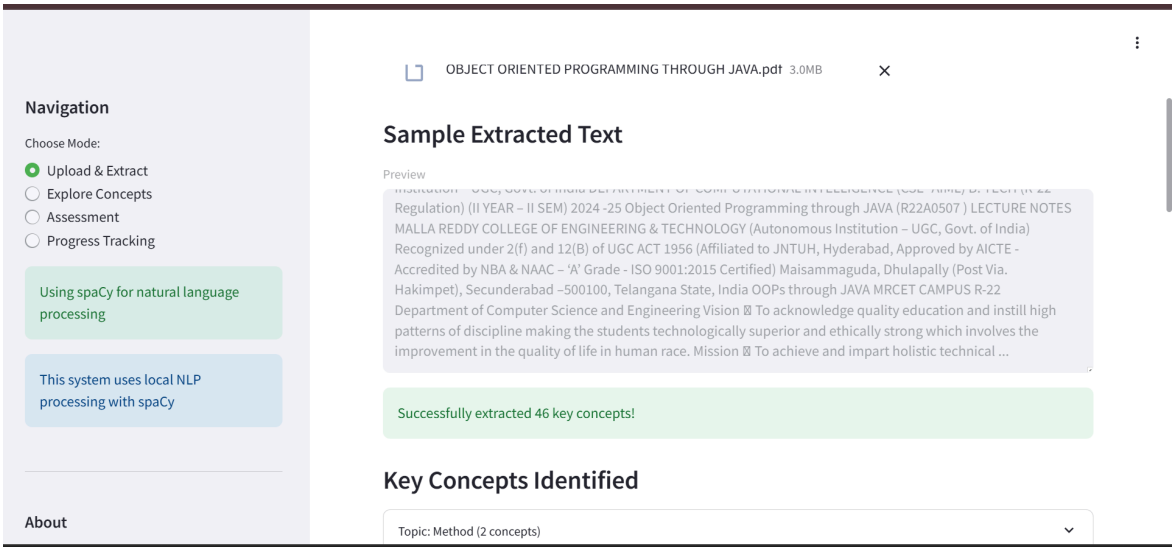
In-Memory Processing - Persistent data storage is not utilized, protected data is retained temporarily (bolstering privacy and security).

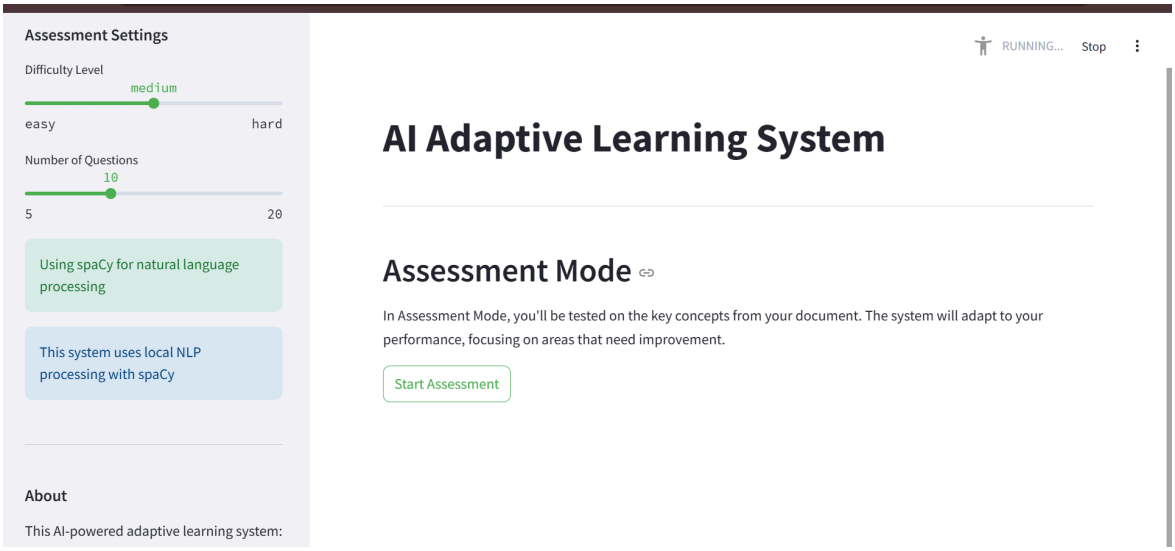
Modular Design – Flexible governance structures to implement changes for future improvements.

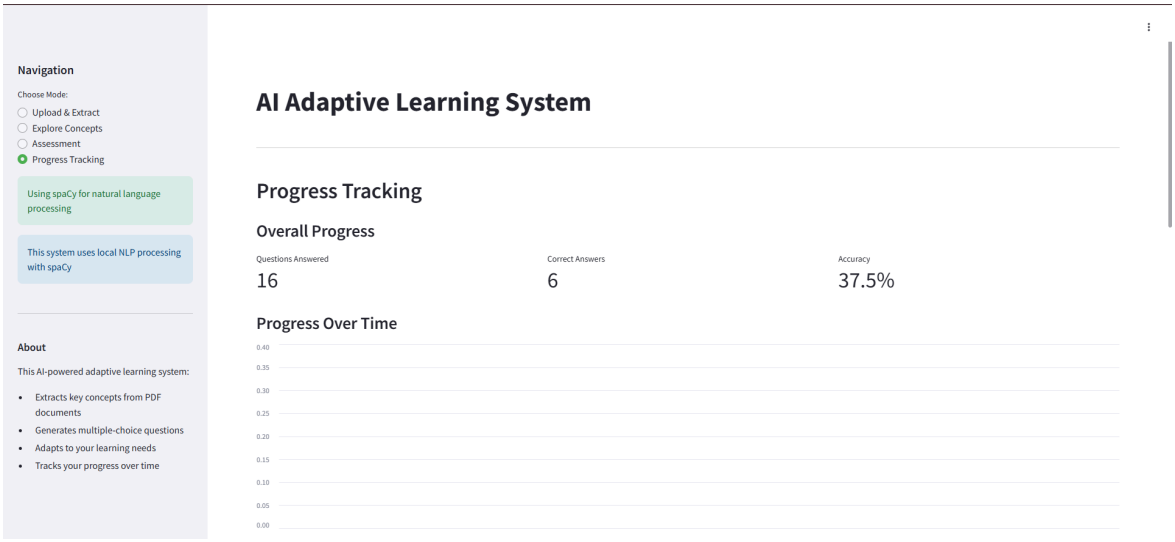
Chapter 8

IMPLEMENTATION AND PSEUDOCODE






Assessment Settings
Difficulty Level
medium
easy
hard
Number of Questions
10
5
20
Using spaCy for natural language processing
This system uses local NLP processing with spaCy
About
This AI-powered adaptive learning system:
RUNNING...
Stop
AI Adaptive Learning System
Assessment Mode
In Assessment Mode, you'll be tested on the key concepts from your document. The system will adapt to your performance, focusing on areas that need improvement.
Start Assessment


Navigation
Choose Mode:
Upload & Extract
Explore Concepts
Assessment
Progress Tracking
Using spaCy for natural language processing
This system uses local NLP processing with spaCy
About
This AI-powered adaptive learning system:
Extracts key concepts from PDF documents
Generates multiple-choice questions
Adapts to your learning needs
Tracks your progress over time
AI Adaptive Learning System
Progress Tracking
Overall Progress
Questions Answered
16
Correct Answers
6
Accuracy
37.5%
Progress Over Time
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00


Navigation
Choose Mode:
Upload & Extract
Explore Concepts
Assessment
Progress Tracking
Using spaCy for natural language processing
This system uses local NLP processing with spaCy
About
This AI-powered adaptive learning system:
Extracts key concepts from PDF documents
Generates multiple-choice questions
Adapts to your learning needs
Tracks your progress over time
class
classes
database
example
exception
file
interface
java
java programmin...
jbutton
method
methods
object
string
that
you
Recent Activity
jbutton - 1970-01-01 00:00
methods - 1970-01-01 00:00
java programming page - 1970-01-01 00:00
classes - 1970-01-01 00:00
exception - 1970-01-01 00:00
interface - 1970-01-01 00:00
string - 1970-01-01 00:00
file - 1970-01-01 00:00
object - 1970-01-01 00:00
you - 1970-01-01 00:00
Learning Recommendations
You're doing well in all areas! Try increasing the difficulty level for more challenge.

Chapter 9

CONCLUSION OF CAPSTONE PROJECT PHASE - 2

Input: Student-uploaded PDFs/documents as learning material.

Core Features:

- Concept extraction using NLP (spaCy, NLTK, BERT)
- AI-based question generation (MCQs, short answers)
- Personalized feedback and progress tracking

Tech Stack: Python, Flask, scikit-learn, NLTK, spaCy, SQLite.

Implementation Progress:

- User login & document upload functional
- NLP pipeline & concept extraction working
- Question generation using transformer models
- Auto-evaluation and basic test interface ready

Next Phase Plan: Enhanced feedback loop, broader dataset testing, and full system integration

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