📝🚀 Coursepilot

6.0 Software Design Description

6.1 Introduction:

With innovative tools and frameworks emerging surrounding LLMs we wanted to apply some new techniques such as RAG (Retrieval Augmented Generation) to provide value to students by making learning more effective and engaging. Our idea is to embed the semantic meaning of documents, which could be student-taken notes or slides uploaded by a professor, store the documents in a vector database, and use them to provide greater context to generate a better output when the LLM is used. Coursepilot's backend will be the RAG engine, that will parse documents, embed their semantic meaning, and store each document in a MongoDB Atlas database with an id, the text, and its vector embedding. This vector embedding allows us to retrieve relevant documents when querying later. We will also be making our Gemini API calls from the backend and connecting it to the frontend with Flask. The frontend will be mainly built with Next.js, and will handle user authentication with Clerk.

6.1.1 System Objectives

The objective of this application is to create a user interface to accelerate note taking using AI, providing study tools, quizzes, and a jumpstart for presentations and projects. The goal of this application is to help teach its users, without causing them to avoid learning.

6.1.2 Hardware, Software, and Human Interfaces

6.1.2.1 Hardware Resources

Resource	**Dev**	**Execution**
Windows PC	X	X
AMD Ryzen 5 5600 3.8GHz 6 core	X	
32gb DDR5 RAM, Nvidia 3070 8gb VRAM	X	
Macbook Pro	X	X
Apple M1 Max	X	
32gb RAM	X	

6.1.2.2 Software & Human Interface Resources

Resource	**Dev**	**Execution**
Next.js	X	X
Flask	X	X
MongoDB	X	X
Heroku		X
Visual Studio Code	X	
Cursor	X	
Clerk Auth	X	X

Google Gemini LLM	X	X
TipTap	X	X

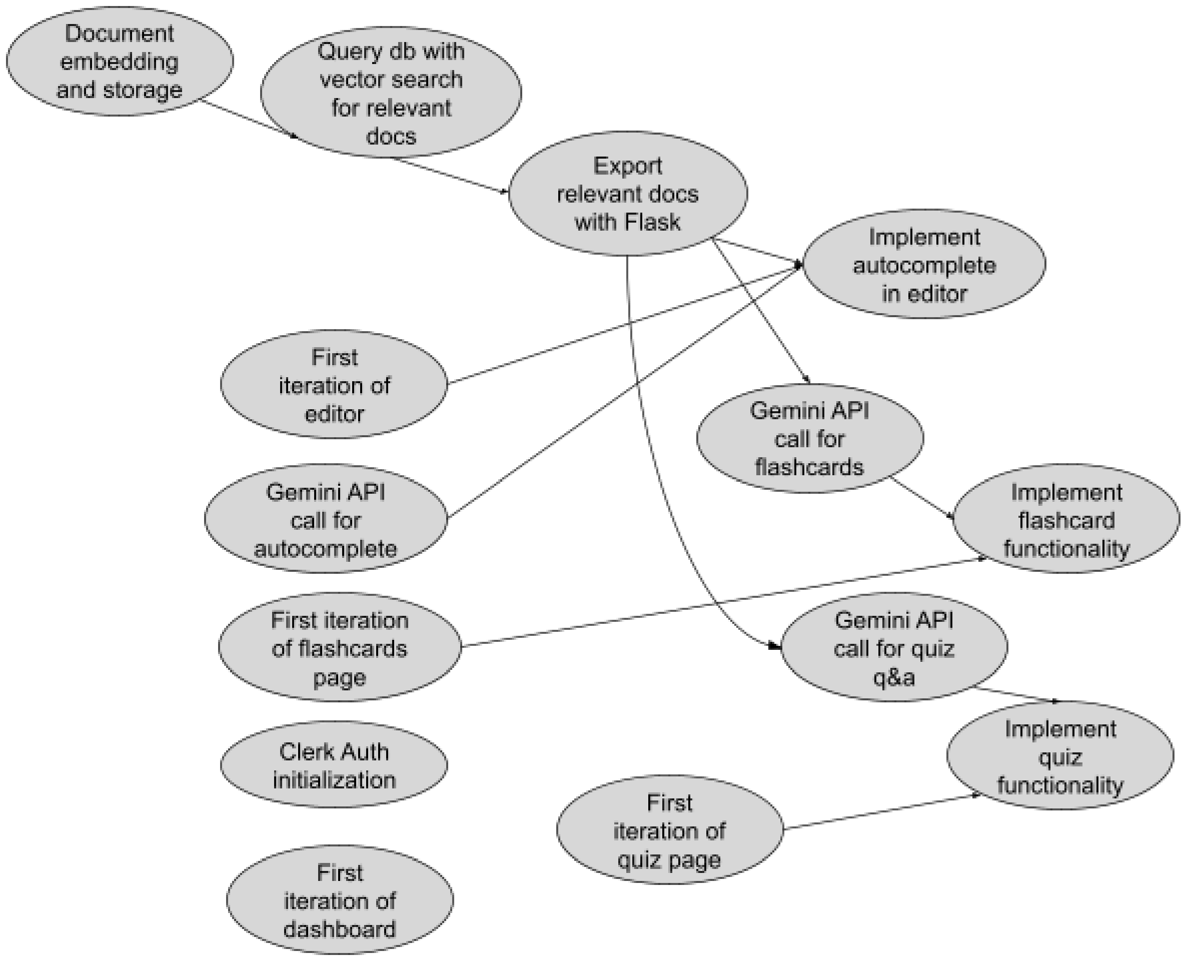
6.2 Architectural Design

6.2.1 Major Software Components

- 6.2.1.1 Classlist - a list view for organization displaying all classes added by the user
    - Emoji picker - an emoji picker to select icons for different classes
    - Title - a customizable title input for class name
    - Backend - selection updates note in storage
- 6.2.1.2 Notelist - a list view for organization displaying all notes within the selected class
    - Emoji picker - an emoji picker to select icons for different notes
    - Title - a customizable title input for the note
    - Backend - selection updates note in storage
- 6.2.1.3 Text Editor - a rich text editor for the selected note
    - Menubar - a menu of buttons to control text options
        - Connection to the text area and its selections
        - Bold - button to bold text
        - Italics - button to italicize text
        - Lists - button to create a numbered/bulleted list
        - Size - button to increase/decrease font size
        - Color - a picker for font color
    - Editor - the main text area
        - Connection to the menu bar and its selections
        - Formatting - markdown support for headings, lists, code blocks
        - AI - a debounced autocomplete
            - Preview - a gray text preview of autocompleted text that can be filled using tab
            - API - request made to Gemini using the context of the user’s notes
        - Backend - modification updates note in storage
- 6.2.1.4 Quizzes - a list view for generated flashcards from notes
    - Flashcard - a front/back Q&A
        - Front - a question to be answered by the back of the card

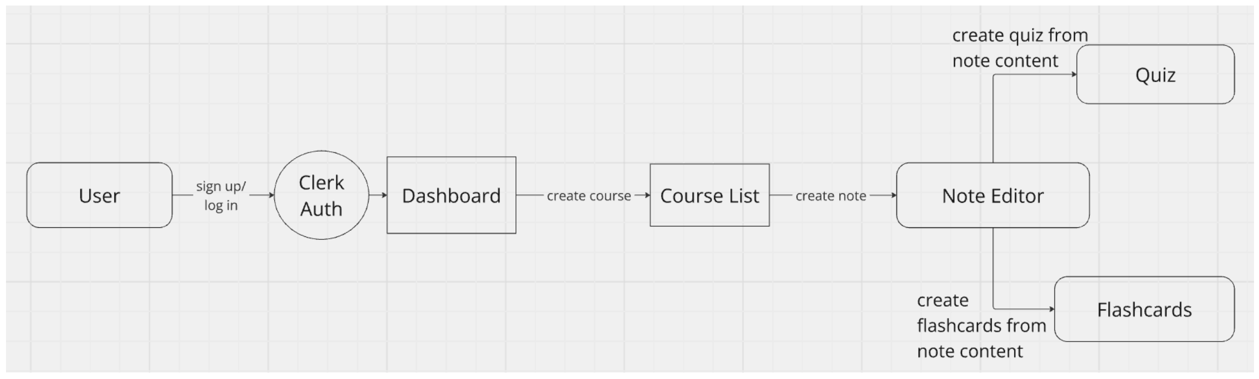
        - Back - the answer to the question on the front of the card
- 6.2.1.5 Document chunker - currently implemented as a sentence based chunker but can be extended to perform semantic chunking
- 6.2.1.6 Document embedder - utilizing the BERT (Bidirectional Encoder Representation for Transformers) language model to capture semantic meaning of text chunks in vector representations
- 6.2.1.47 MongoDB Atlas Vector database - allows for storage of text data along with its vector representation, which allows for effective querying and retrieval using the KNN algorithm
- 6.2.1.8 Flask server hosting an API will create a data pipeline from the RAG engine to the frontend
    - "/documents"
        - POST request - takes corpus of text, chunks it, then embeds and saves to database
        - GET request - takes search query and returns the n most semantically similar sentences from database
    - "/upload_pdf"
        - POST request - takes user uploaded pdf document, parses it using LlamaParse, chunks based on .md formatting, embeds chunks, and stores chunks with embeddings as well as the original pdf for later viewing

6.2.2 Major Software Interactions

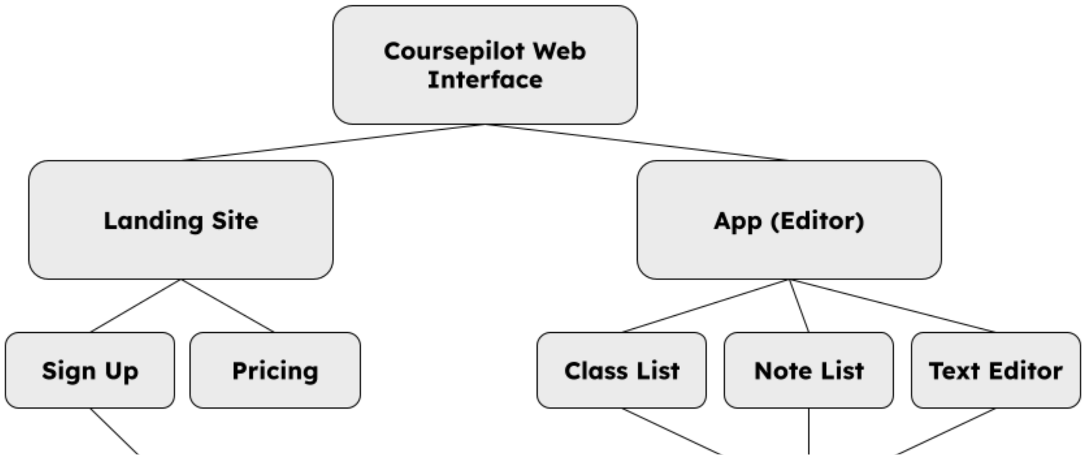

Document embedding and storage
Query db with vector search for relevant docs
Export relevant docs with Flask
Implement autocomplete in editor
First iteration of editor
Gemini API call for flashcards
Gemini API call for autocomplete
Implement flashcard functionality
First iteration of flashcards page
Gemini API call for quiz q&a
Clerk Auth initialization
Implement quiz functionality
First iteration of quiz page
First iteration of dashboard

6.2.3 Architectural Design Diagrams Section

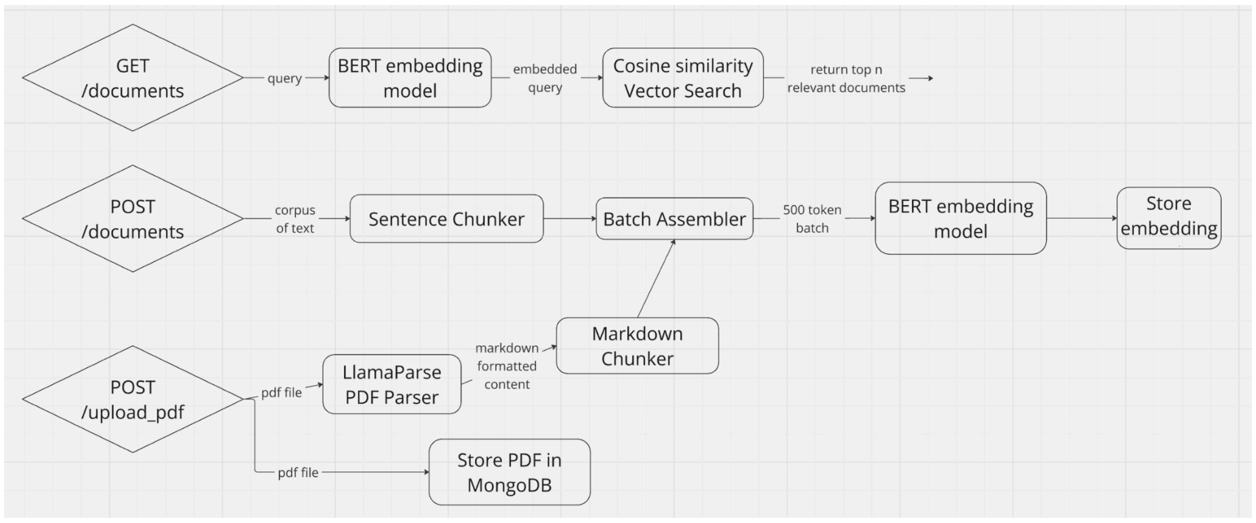
Use case UML



Frontend Component diagram



Backend Component diagram



6.3 Detailed CSC and CSU Descriptions

6.3.1 Detailed Class Descriptions Section

Document Schemas

- Course (Schema)
  - ID (string)
  - Title (string)
  - Emoji (string)

    - UserID (string)
    - Notes (Note[])
    - CreatedAt (Date)
    - UpdatedAt (Date)
- Note (Schema)
    - ID (string)
    - Title (string)
    - CourseID (ObjectID)
    - UserID (string)
    - Content (string)
    - CreatedAt (Date)
    - UpdatedAt (Date)
- FlashcardSet (Schema)
    - ID (string)
    - Title (string)
    - CourseID (ObjectID)
    - UserID (Sstring)
    - Flashcards (Flashcard[])
    - CreatedAt (Date)
    - UpdatedAt (Date)
- Flashcard (Schema)
    - Front (string)
    - Back (string)

6.3.2 Detailed Interface Descriptions Section

The web interface is divided into two main sections: the Landing Site and the Dashboard (Courses). The Landing Site includes pages for Sign Up and Pricing, designed to introduce new users to the platform and provide subscription details. The Dashboard serves as the main workspace, with components for managing classes (Class List), organizing notes (Note List), and editing content (Text Editor) with components for Flashcards and Quizzes. This structure allows users to quickly navigate between onboarding information and content creation within the app.

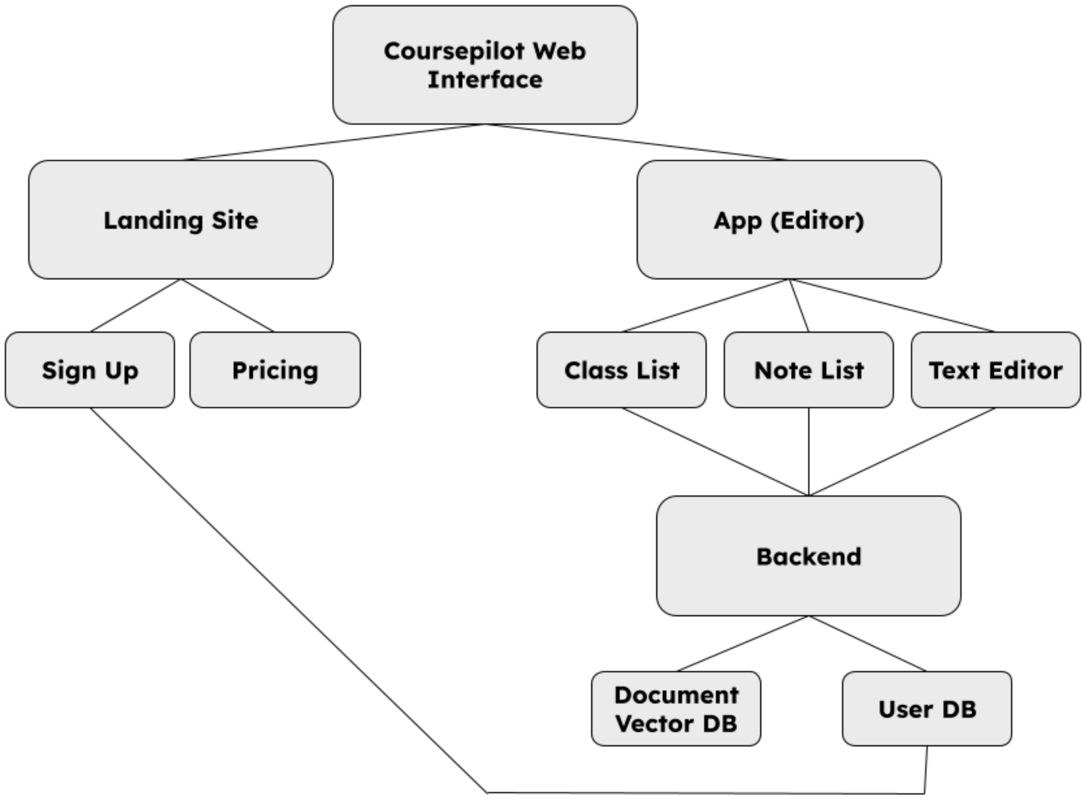
6.3.3 Detailed Data Structure Descriptions Section

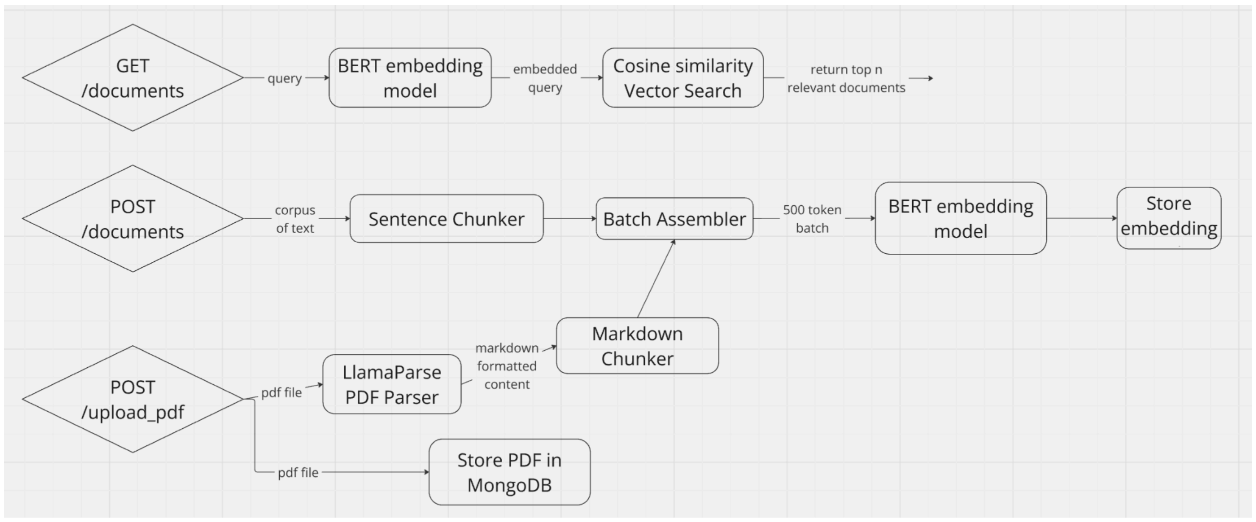
Documents on the client side are TypeScript objects that match the Document schemas, as follows:

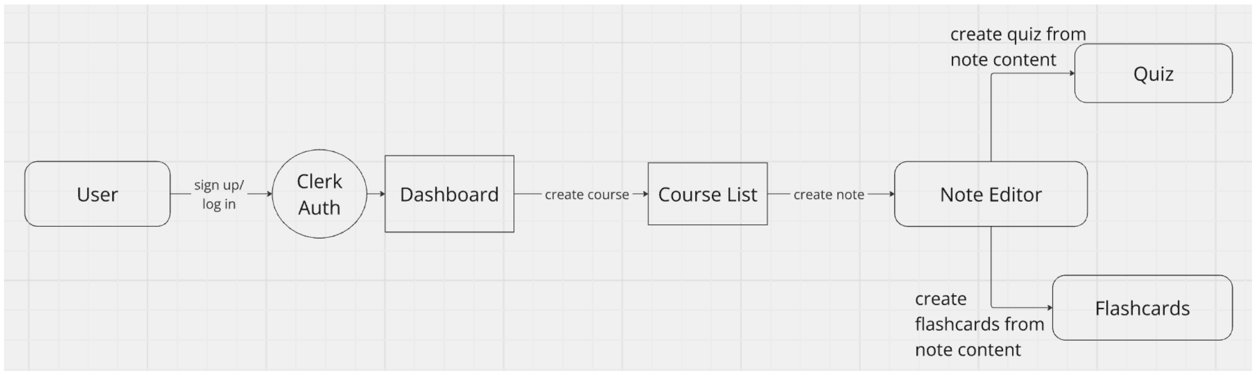
- Course (Object)
    - ID (string)
    - Title (string)

    - Emoji (string)
    - UserID (string)
    - Notes (Note[])
    - CreatedAt (Date)
    - UpdatedAt (Date)
- Note (Object)
    - ID (string)
    - Title (string)
    - CourseID (ObjectID)
    - UserID Sstring)
    - Content (string)
    - CreatedAt (Date)
    - UpdatedAt (Date)
- FlashcardSet (Object)
    - ID (string)
    - Title (string)
    - CourseID (ObjectID)
    - UserID (string)
    - Flashcards (Flashcard[])
    - CreatedAt (Date)
    - UpdatedAt (Date)
- Flashcard (Object)
    - Front (string)
    - Back (string)

6.3.4 Detailed Design Diagrams Section







6.4 Database Design and Description Section

The backend document schema consists of three main documents: Courses, Notes, and FlashcardSets. Each Course has an ID, Title, Emoji, UserID, a list of associated Notes, and timestamps for creation and updates. Notes are linked to a Course via CourseID and contain a Title, Content, and timestamps. The FlashcardSet is also linked to a Course and contains a list of Flashcards, each with a Front and Back. Each schema includes the UserID to associate data with a specific user, along with creation and update timestamps.