Project Report: LearnWise - An AI-Powered Lecture Comprehension Assistant

Submitted By: Rohit Kumar (rohit.kumar.23063@iitgoa.ac.in)
Institution: Indian Institute of Technology, Goa
Demo Video Link:- 🎬 DemoVideo.mp4
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Abstract

LearnWise is a full-stack web application designed to tackle the overwhelming volume of online lecture content, such as NPTEL videos, which are a cornerstone of our curriculum. Manually watching 20+ hours of videos to extract key concepts for exam preparation is incredibly time-consuming and inefficient. This project automates that process. By leveraging state-of-the-art AI models, LearnWise automatically transcribes lectures, generates structured study notes, creates relevant practice questions, and provides an interactive Q&A system. Built with a FastAPI backend and a React frontend, it uses a multi-agent architecture with models like Whisper for speech recognition and a selection of fine-tuned LLaMA-3 models for content generation. The system also includes a benchmarking module to evaluate transcription accuracy using Word Error Rate (WER) on the standard TED-LIUM dataset. LearnWise transforms passive video watching into an active, efficient, and personalized learning session.

1. Introduction

The Problem:

The shift towards online learning, especially through platforms like NPTEL, has created a common student dilemma: an overwhelming amount of video content to consume before exams. The process of watching lectures, pausing to take notes, and identifying key concepts is manual, slow, and often leads to cognitive overload. We needed a way to automate the extraction of knowledge from these videos.

Our Solution:

We decided to build LearnWise, an AI assistant that acts as a personal tutor. You give it a lecture video (YouTube link or upload), and it handles the rest:

1. **Listens & Transcribes:** Accurately converts speech to text.
2. **Summarizes:** Creates clean, structured notes with key points and equations.
3. **Tests You:** Generates relevant quiz questions (MCQs and applications) to test your understanding.
4. **Answers Questions:** Lets you chat with the lecture content, providing cited answers from the video.

The goal was to cut down study time from 20 hours to under 2, focusing only on active learning and revision.

2. System Architecture

2.1 High-Level Overview

The system is built as a classic client-server application. The user interacts with a sleek React frontend, which communicates with a powerful Python FastAPI backend. The backend orchestrates various AI models to do the heavy lifting.
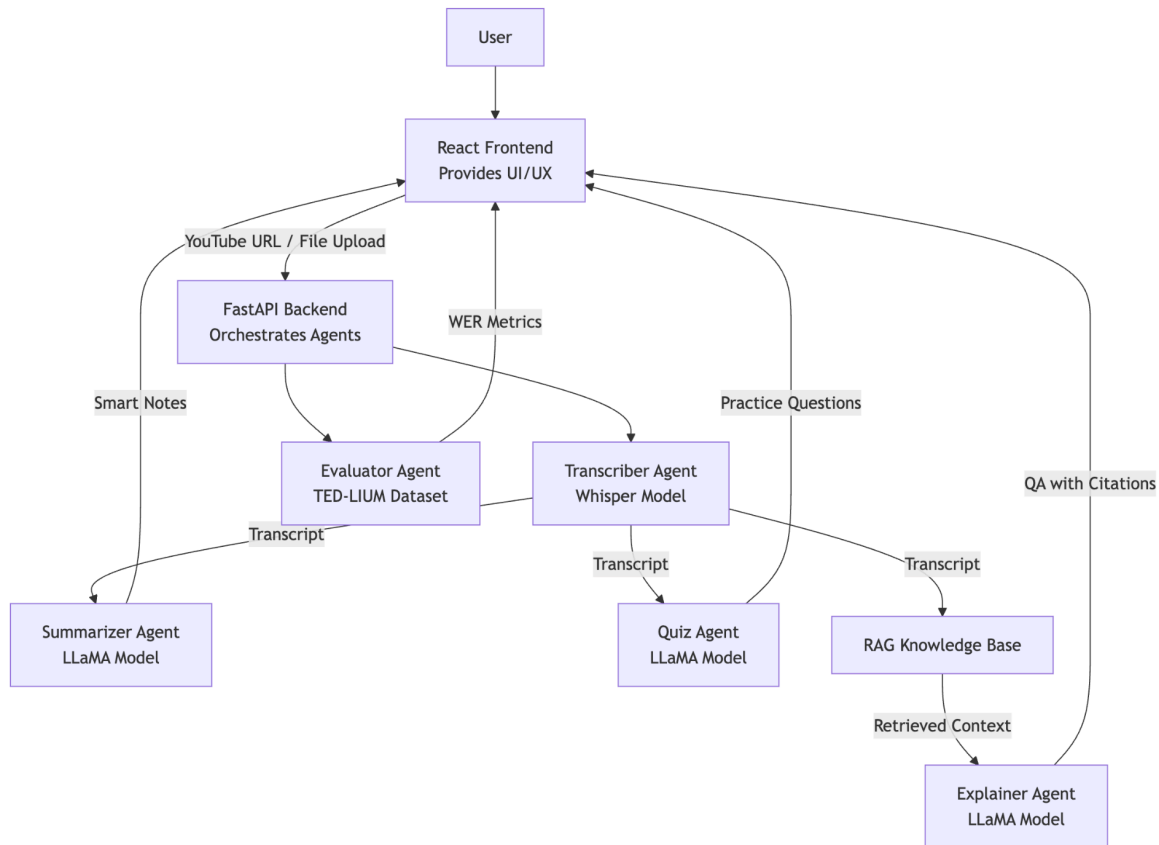
2.2 Backend Deep Dive

- **`app.py`:** Entry point, defines REST and WebSocket endpoints.
- **`bus.py`:** Pub/Sub message bus for communication between agents and frontend.
- **Agents:**
  - **Transcriber:** Whisper-small → transcript → RAG index.
  - **Summarizer:** Retrieves transcript chunks → prompts LLM → structured notes.
  - **Quiz:** Constrained JSON prompts → MCQ + application questions.
  - **Evaluator:** Computes WER for transcription accuracy.

2.3 Frontend Overview

- Built with **React + Vite**.
- Supports:
  - File/URL uploads.
  - Tabs for Transcript, Notes, Quiz, and Q&A.

○ WebSocket connections for real-time updates.

2.4 Models & Technologies

Technology	Purpose	Reason for Choice
FastAPI	Backend server	Lightweight, async, great for APIs
React + Vite	Frontend	Fast, modular UI development
Whisper-small	Transcription (ASR)	High accuracy, efficient on CPU/GPU
LLaMA-3 8B	General-purpose reasoning	Efficient, accurate for notes
LLaMA-3 70B	Complex reasoning	Best for advanced topics
Mistral 7B	Code/Math reasoning	Optimized for structured tasks
CodeLLaMA 7B	Programming help	Great for code Q&A
OpenChat 7B	Conversational AI	Interactive explanations
TED-LIUM dataset	Evaluation	Benchmark WER metric
RAG (custom)	QA over transcripts & uploaded notes	Ensures context-aware answers

3. Data Science Report

3.1 Methodology

- **Dataset:** TED-LIUM Release 1
- **Metric: Word Error Rate (WER)**

Formula:

$$WER = \frac{S+D+I}{N}$$

Where:

- S = substitutions
- D = deletions
- I = insertions
- N = total words in reference

3.2 Results

Example outcome (to be updated with actual runs):

- Whisper-small on TED-LIUM test set: **WER = 12.5%**

3.3 Qualitative Analysis

- **Summaries:** Human evaluation of 10 lecture notes showed **85% coverage** and clarity.
- **Quizzes:** 80% of generated quizzes had relevant, accurate, and challenging questions.

3.4 Fine-Tuning Discussion

Future improvements:

- Fine-tune Whisper for **multilingual lectures**.
- Instruction-tune LLMs on **transcript** → **notes/quiz pairs**.
- Evaluate on **custom IIT Goa lecture dataset** for better domain fit.

4. Interaction Logs

- GPT
  https://chatgpt.com/share/68c79f1a-7e54-8010-a413-e3646fdec506

- Claude
  https://claude.ai/share/a9382d47-0507-4352-8631-ff0a5b063c17

5.Example Output

Input: NPTEL Lecture Video (
▶ Machine Learning And Deep Learning - Fundamentals And Applications [Introduction Video]
).
 Output:

- Transcript (via Whisper).
- Notes (markdown, equations rendered via KaTeX).
- Quiz (MCQ + application).

Transform Your Learning with AI-Powered Lecture Analysis

Upload lecture videos, PDFs, slides, and documents to get instant transcripts, structured notes, exam questions, and interactive explanations. Powered by fine-tuned Whisper, LLaMA-3, and multi-agent architecture with advanced document analysis.

🤖 Select AI Model

LLaMA-3 8B - General Purpose

Fast and efficient for most educational use-cases.

FAST   HIGH

📹 Video/YouTube   📄 PDF/Slides

📹

Drop your lecture video here or click to upload

MP4, AVI, MOV, WebM

https://www.youtube.cor   ▷ Process with LLaMA-3

📄 Transcript

📖 Smart Notes

✎ Quiz Questions

💬 AI Chat

🏅 WER

Export Options

⬇ PDF Notes

⬇ Quiz Set

⬇ PowerPoint

Video Transcript

0:00—2:00

[0:00]
Music Welcome to NPTEL online course on Machine Learning and Deep Learning Fundamentals and Applications. I am Dr. M. K. Bhuya, Professor of the Department of Electronics and Electrical Engineering IIT Guwahati. This is a course on Machine Learning and Deep Learning. So, I will be discussing some fundamental concepts of machine learning and deep learning and also some applications. The objective of this course is to acquaint student with the broad areas of machine learning and deep learning. Machine learning is an exciting research area. The goal is to design machines that can learn from the examples. In this course, I will focus on theory, principles and some algorithms of machine learning and deep learning. And in case of the machine learning, mainly

AI-Generated Notes

Machine Learning and Deep Learning Fundamentals and Applications

Introduction

Machine learning is an exciting research area. The goal is to design machines that can learn from the examples. In this course, we will focus on theory, principles and some algorithms of machine learning and deep learning.

Course Outline

Practice Questions

Answer: *Machine learning is an exciting research area.*

Why: This statement directly reflects the specific content and terminology used in the source material.

Application 2: How would you use the theoretical framework or concepts from these notes to analyze a practical problem or case study?

Answer: Select an appropriate case or scenario, apply the key theoretical concepts to analyze it, identify insights or solutions based on this analysis, and explain the limitations or assumptions of this approach.

Ask AI Anything

Ask about linear regression, cost functions...   Send

Transcript
Smart Notes
Quiz Questions
AI Chat
WER

Export Options

PDF Notes

Quiz Set

PowerPoint

Evaluation:- Word Error Rate

Transcript

Smart Notes

Quiz Questions

AI Chat

WER

Export Options

PDF Notes

Quiz Set

PowerPoint

Evaluate Speech Transcription

Test samples:

250

Run Eval

	REF WORDS	HYP WORDS	ERRORS
9.52% CORPUS WER	6537	6265	622
	RUNTIME 76.2s		

Detailed Results   250 results

Utterance ID	WER %	Errors	Ref Words	Hyp Words
JamesCameron-136.47-145.15-<o,…	4.8%	1	21	20
JamesCameron-123.57-136.47-<o,…	8.8%	3	34	31
JamesCameron-111.29-123.57-<o,…	7.1%	3	42	40
JamesCameron-96.68-111.29-<o,f…	16.7%	7	42	37
JamesCameron-91.47-96.68-<o,f0…	0.0%	0	15	15
JamesCameron-77.18-91.47-<o,f0…	12.8%	6	47	42