

Pianalyze

AI-based piano learning with real-time feedback and
personalized progress tracking

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PROBLEM



SIMILAR APPLICATIONS



• Yousician



• Skoove



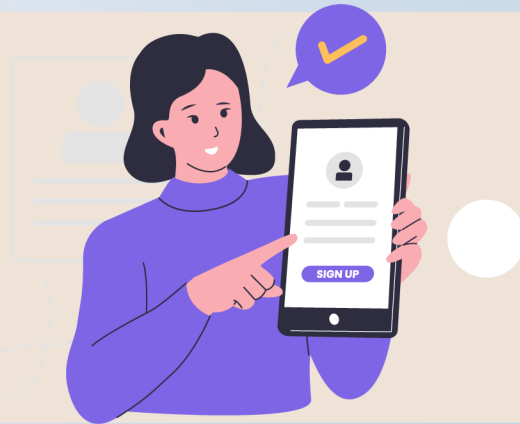
• Flowkey



The proposed solution – PIANALYZE

1

Creating an account.



4

Practical exercises assisted by the virtual teacher



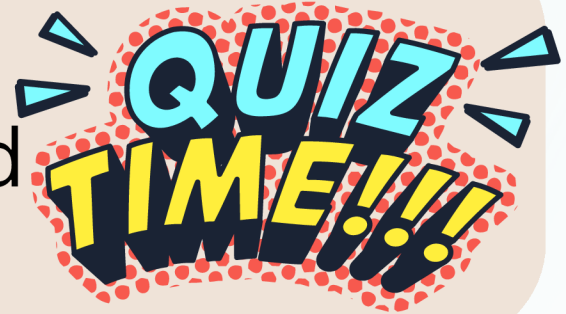
2

Enrolling in an available lesson



5

Completing a quiz with theoretical questions and practical exercises.



3

Studying the theoretical course.

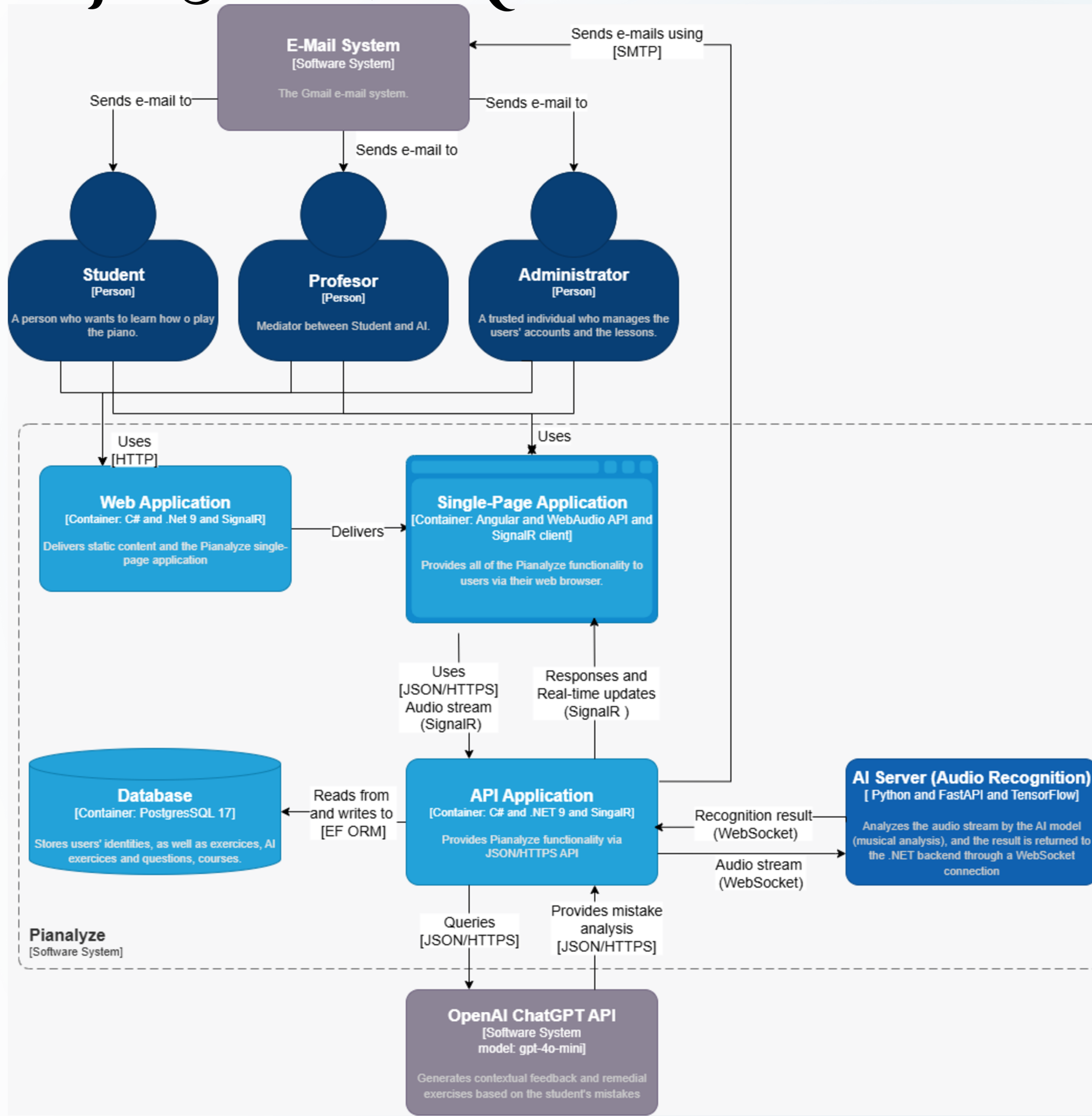


6

Reviewing mistakes and receiving additional personalized exercises generated by AI.



THE SYSTEM'S ARCHITECTURE



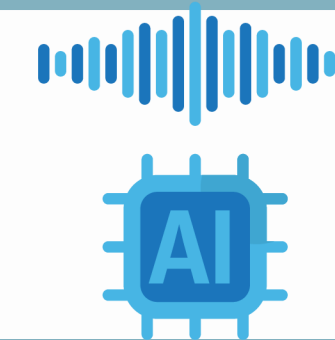
TECHNOLOGIES USED



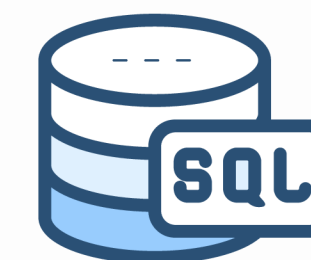
- .NET
- C#
- ChatGPT API
- WebSocket



- Angular
- WebAudio API
- SignalR



- FastAPI
- TensorFlow
- Python



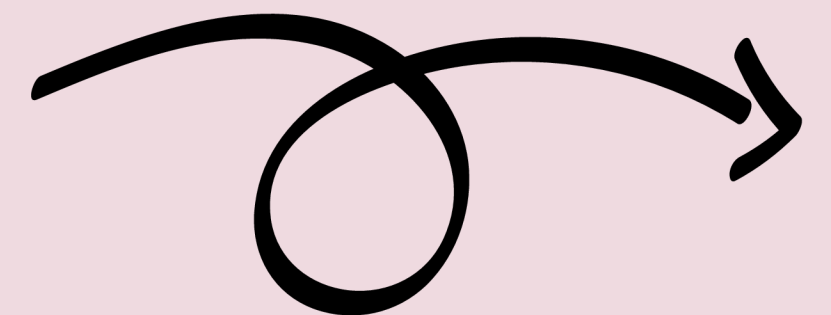
- PostgreSQL

Învată să cânti la pian. Găsește-ți ritmul. Bucură-te de fiecare notă.

Ești gata să-ți descoperi dragostea pentru muzică? Să înveți să cânti la pian n-a fost niciodată mai simplu și mai plăcut! Tot ce-ți trebuie e un pian sau o orgă și dorința de a te lăsa purtat de melodie.



APPLICATION'S MODULES



LESSON COMPLETION MODULE

Enrolling the student by selecting a teacher from the available list for the chosen lesson

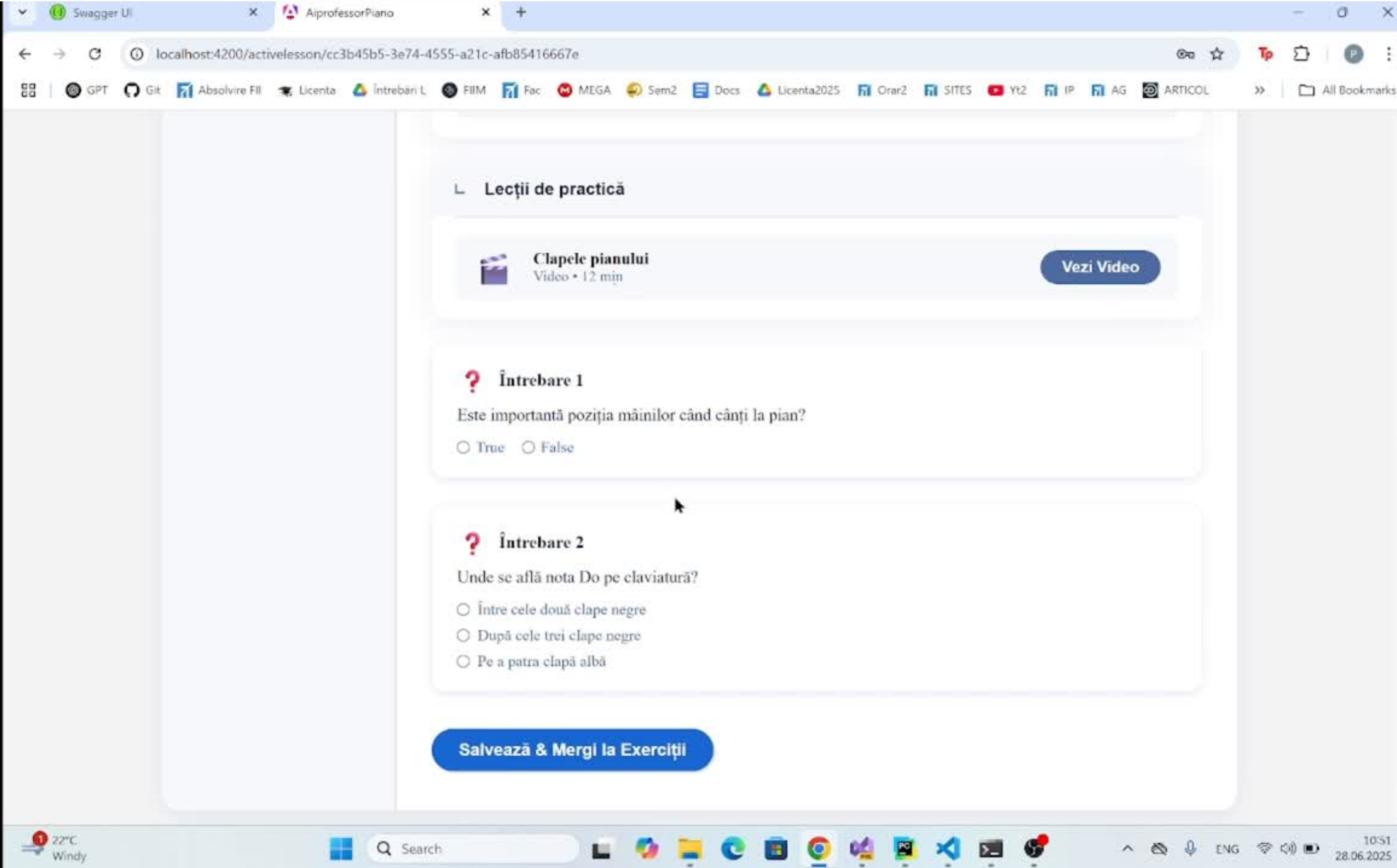


Starting a lesson

- Going through the **course** content
- Completing **practical exercises**
- Taking the **quiz**
- Displaying **the results**
- Reading **mistake analysis** and **personalized exercises**

A screenshot of a web browser showing the AiprofessorPiano application. The browser has multiple tabs open, including 'Swagger UI', 'AiprofessorPiano', 'Resetare parolă - pirlacdiana@...', and another 'AiprofessorPiano' tab. The address bar shows 'localhost:4200/lessons/0196f708-48e8-7f3b-abf3-797a3b3006e8/0197db56-3c1a-79a9-8090-58c7db9d7052'. The page content is in Romanian and features a header 'Introducere în pian – Prima lecție' (Introduction to piano – First lesson). Below the header is a paragraph: 'Această lecție te va învăța poziția corectă a mâinilor, notele de bază și un exercițiu simplu pentru familiarizarea cu clapele.' (This lesson will teach you the correct hand position, basic notes, and a simple exercise for familiarization with the keys). The main content area is titled 'Bazele pianului' (Piano basics) and includes a sub-section 'Welcome lectures' with two video thumbnails: 'Teaser' (Video - 3 min) and 'Welcome' (Video - 4 min), each with a 'Vezi Video' button. Below this is a 'Theory lectures' section. The Windows taskbar at the bottom shows the date and time as 19:07 on 05.07.2025, along with various system icons and application shortcuts.

LESSON COMPLETION MODULE

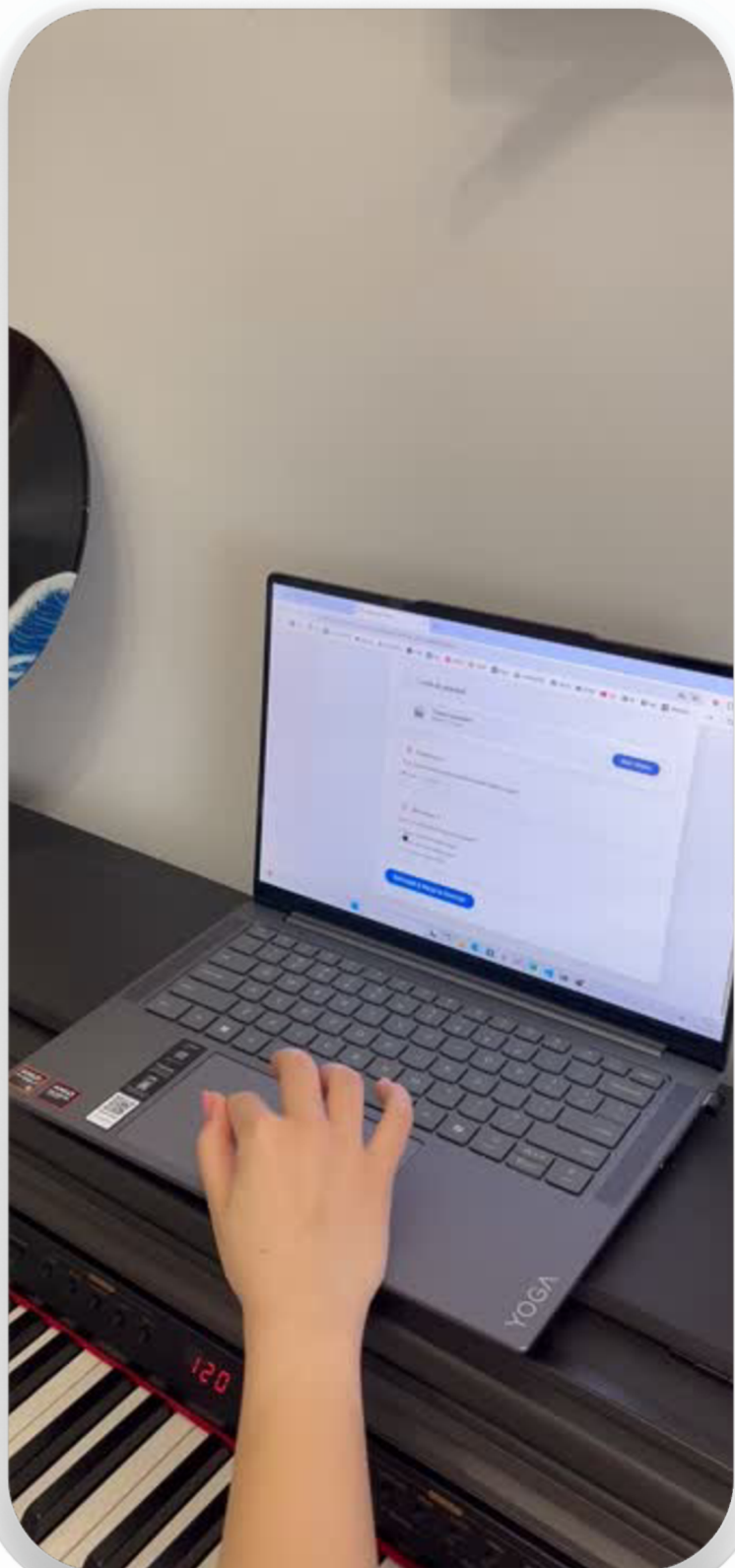


The screenshot displays a web browser window with two tabs: 'Swagger UI' and 'AiprofessorPiano'. The address bar shows the URL 'localhost:4200/activelesson/cc3b45b5-3e74-4555-a21c-afb85416667e'. The browser's bookmark bar contains various links including GPT, Git, Absolvire Fil, Licenta, Intrebări L, FIIM, Fac, MEGA, Sem2, Docs, Licenta2025, Orar2, SITES, Yt2, IP, AG, ARTICOL, and All Bookmarks.

The main content area of the browser shows a lesson completion module with the following elements:

- Lecții de practică** (Practice Lessons)
- A video player section titled **Clapele pianului** (Piano Keys) with a duration of 12 minutes and a **Vezi Video** (Watch Video) button.
- Întrebare 1** (Question 1): Este importantă poziția mâinilor când cânti la pian? (Is hand position important when playing piano?). Options: ☐ True, ☐ False.
- Întrebare 2** (Question 2): Unde se află nota Do pe claviatură? (Where is the note Do on the keyboard?). Options: ☐ Între cele două clape negre (Between the two black keys), ☐ După cele trei clape negre (After the three black keys), ☐ Pe a patra clapă albă (On the fourth white key).
- A **Salvează & Mergi la Exerciții** (Save & Go to Exercises) button at the bottom.

The Windows taskbar at the bottom shows the system clock as 10:51 on 28.06.2025, with a temperature of 22°C and a 'Windy' weather condition.



MISTAKES ANALYSIS MODULE

Analiza greșelilor realizate în rezolvarea lecțiilor

Aici poți găsi exercițiile AI generate pentru tine.

💡 Ce ai greșit în rezolvarea exercițiului?

Ai început bine cu nota Do4, dar nu ai inclus toate notele din exercițiu. Încearcă să adaugi Re4 și Mi4 data viitoare.

🎹 **Exercițiu: Notele Do-Re-Mi**

Dificultate: **Începător**

Model audio așteptat: **Do4,Re4,Mi4**

Tip exercițiu: **Exerciții de gamă**

Rezolvă acest exercițiu

Status: **Verificat**

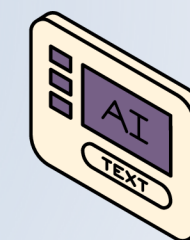
Nerezolvat



Tracking mistakes during the lesson exercises



Generating an explanation of the mistake using ChatGPT



Generating AI exercises or AI questions similar to the mistake made, with the help of ChatGPT

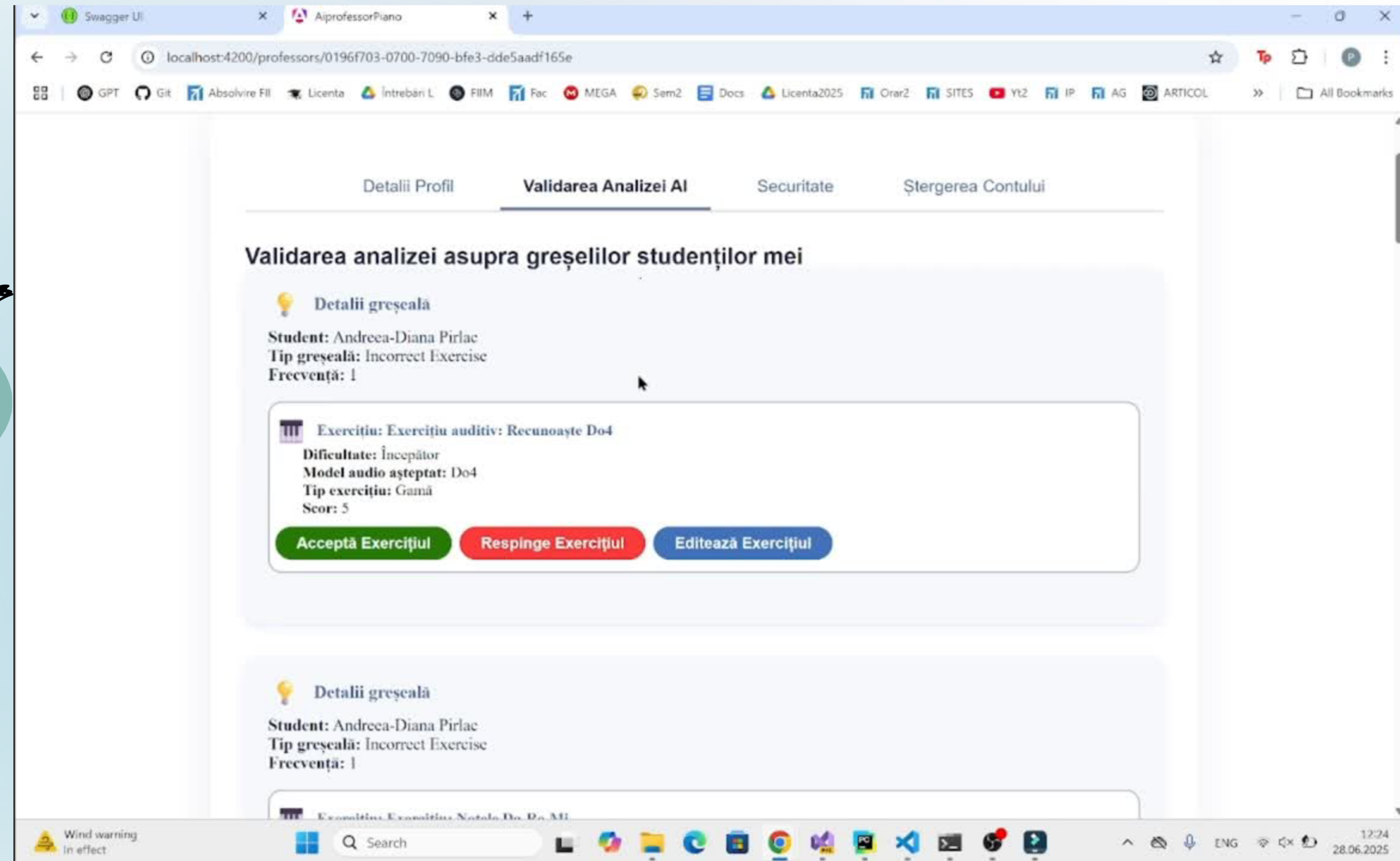
AI ANALYSIS VALIDATION AND LESSON CREATION MODULE

To ensure **pedagogical quality**, additional exercises and questions automatically generated by ChatGPT cannot be accessed by the student **until they are approved** by a professor.

Professor

- Can **view** the analysis
- Can **edit** the analysis
- Can **reject** the analysis

Creating a lesson, viewing, or deleting existing lessons



PIANO SOUND RECOGNITION MODULE



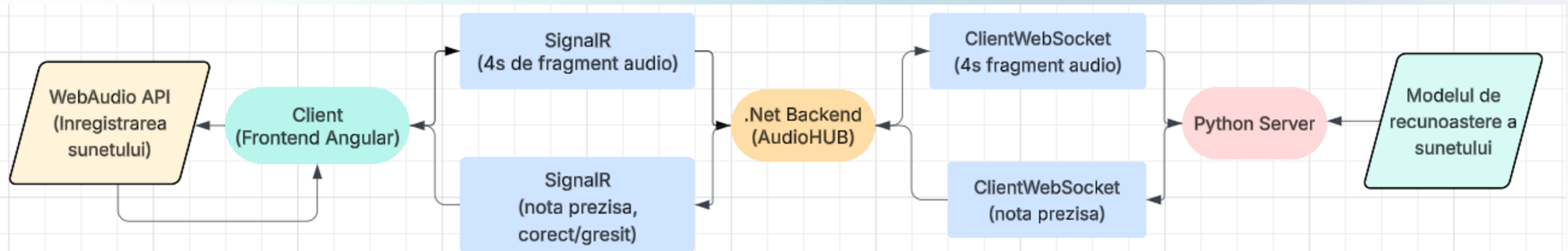
Development of a virtual teacher that recognizes in real time all 88 piano and organ notes and provides instant feedback.



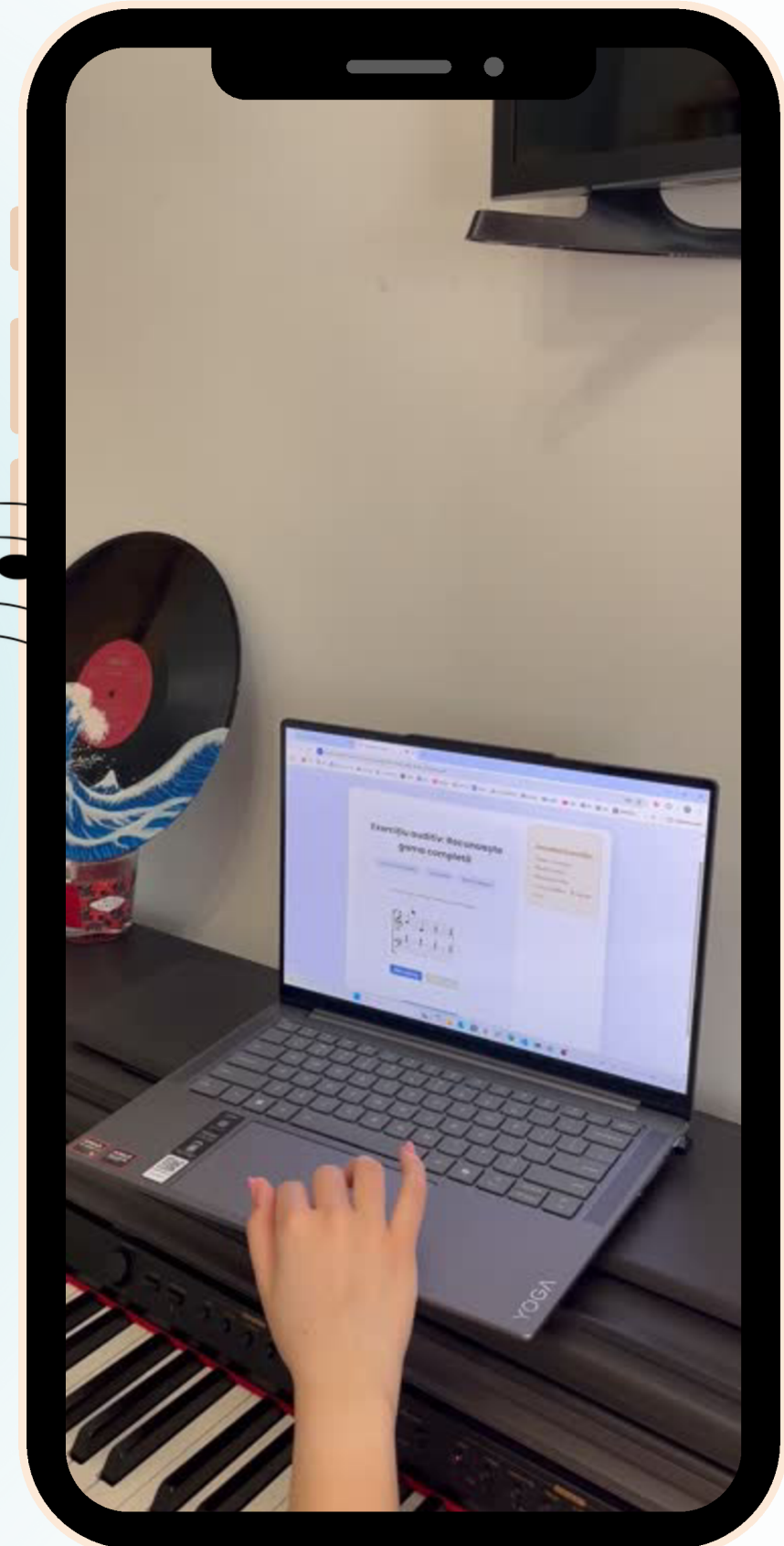
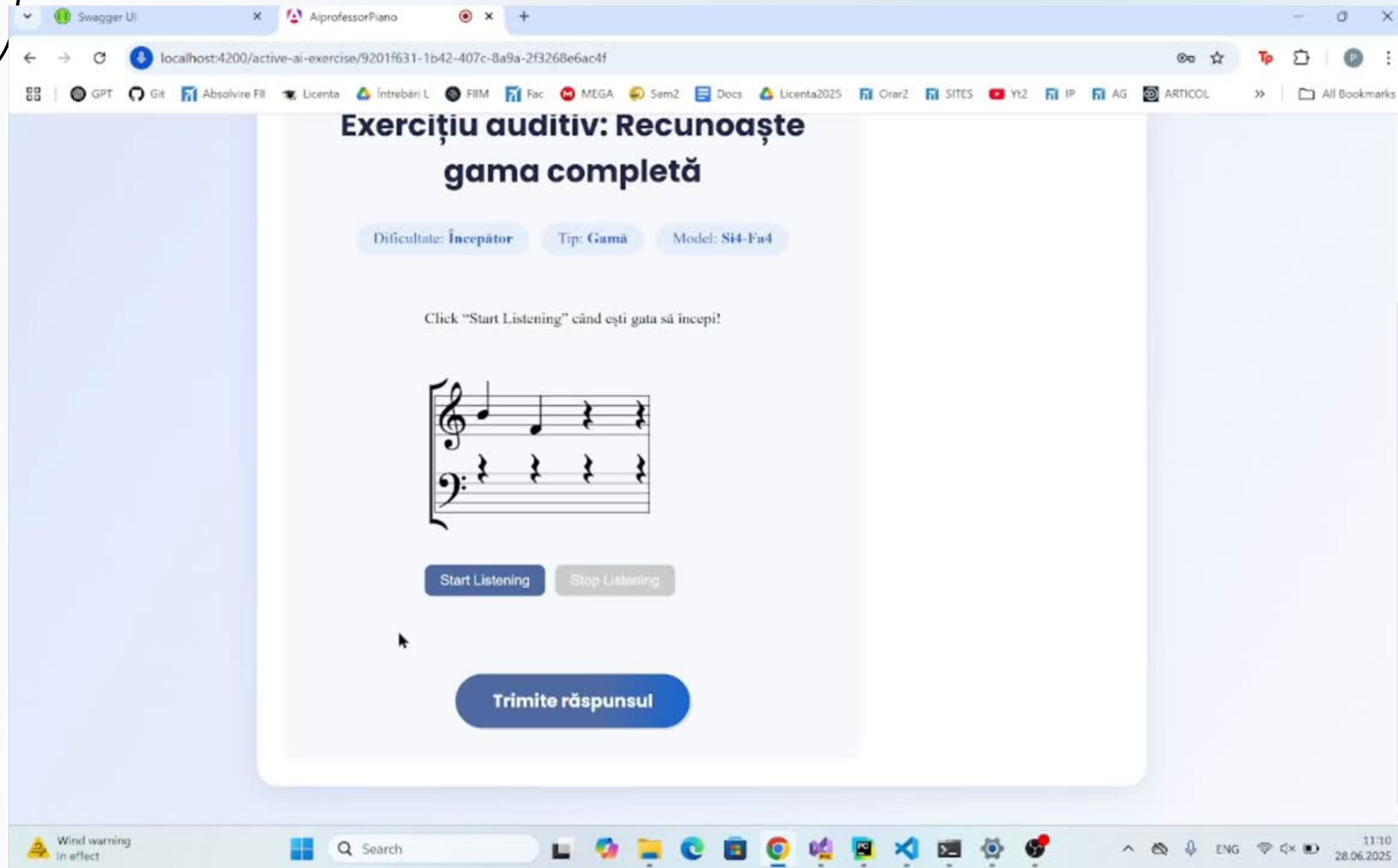
Background noise, amplitude and timbre variations, overlapping harmonics, very close notes (C vs. C #).



Adapting the TensorFlow MiniSpeech architecture for piano harmonic spectra, testing three types of networks: **CNN**, **RNN**, and **MLP**.



PIANO SOUND RECOGNITION MODULE

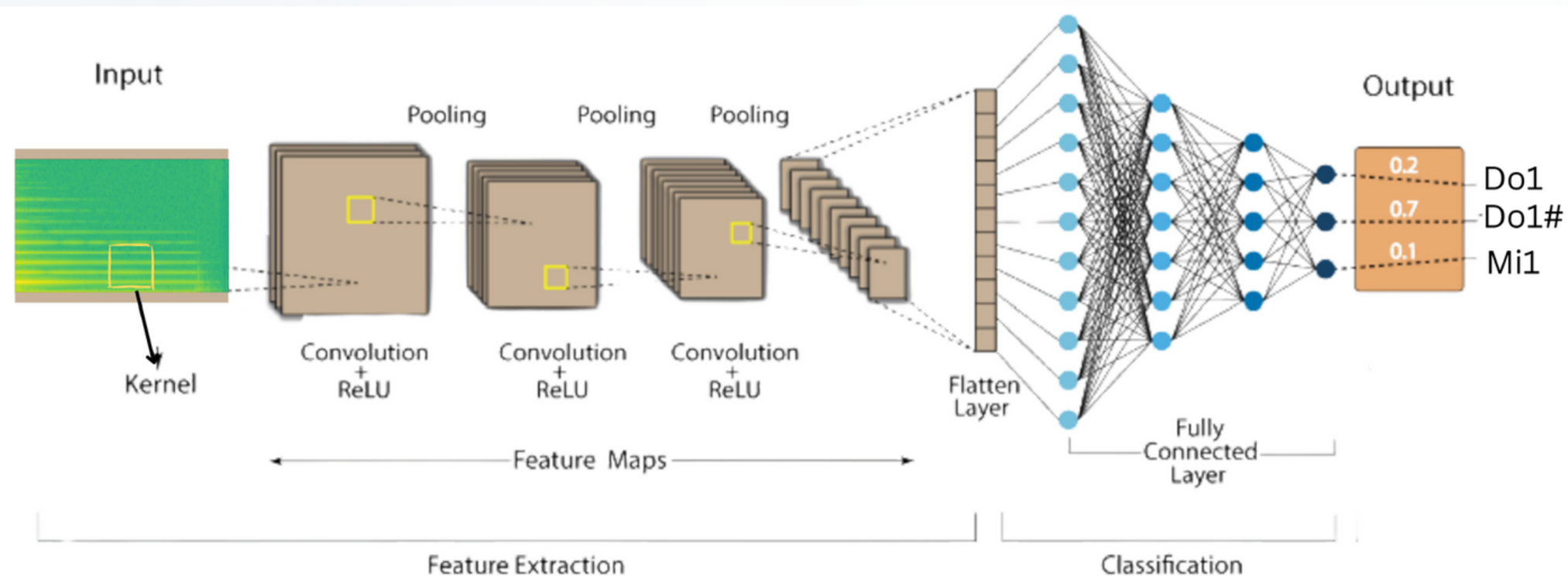
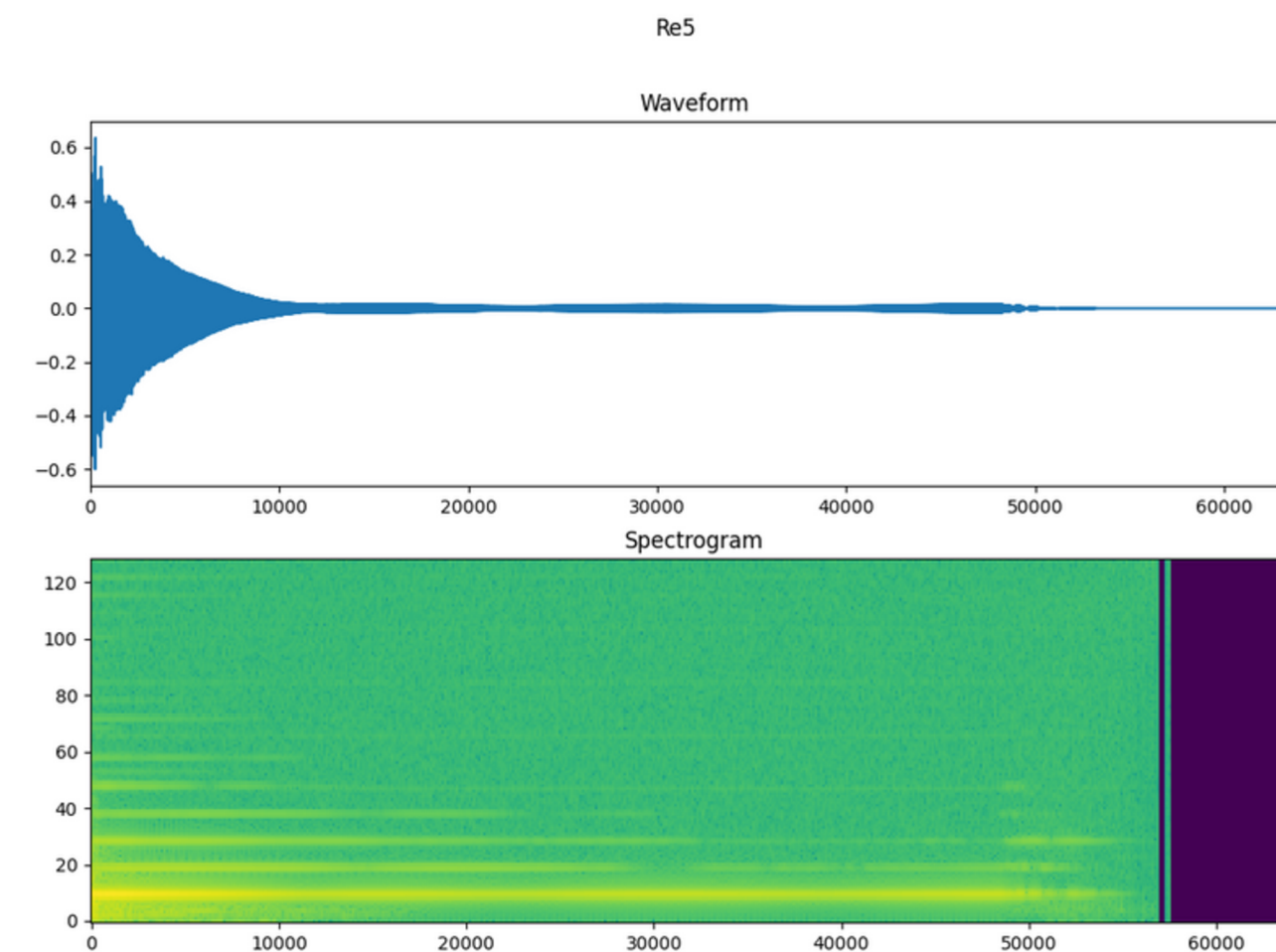


CNN - CONVOLUTIONAL NEURAL NETWORKS

1. Transforming the audio signal (air pressure variations over time) → spectrogram.

2. Convolutional filters “scan” local regions to learn distinctive patterns (e.g., C vs. C #).

3. Pooling introduces invariance to small shifts in time and frequency, making the model robust to variations in pitch and duration.



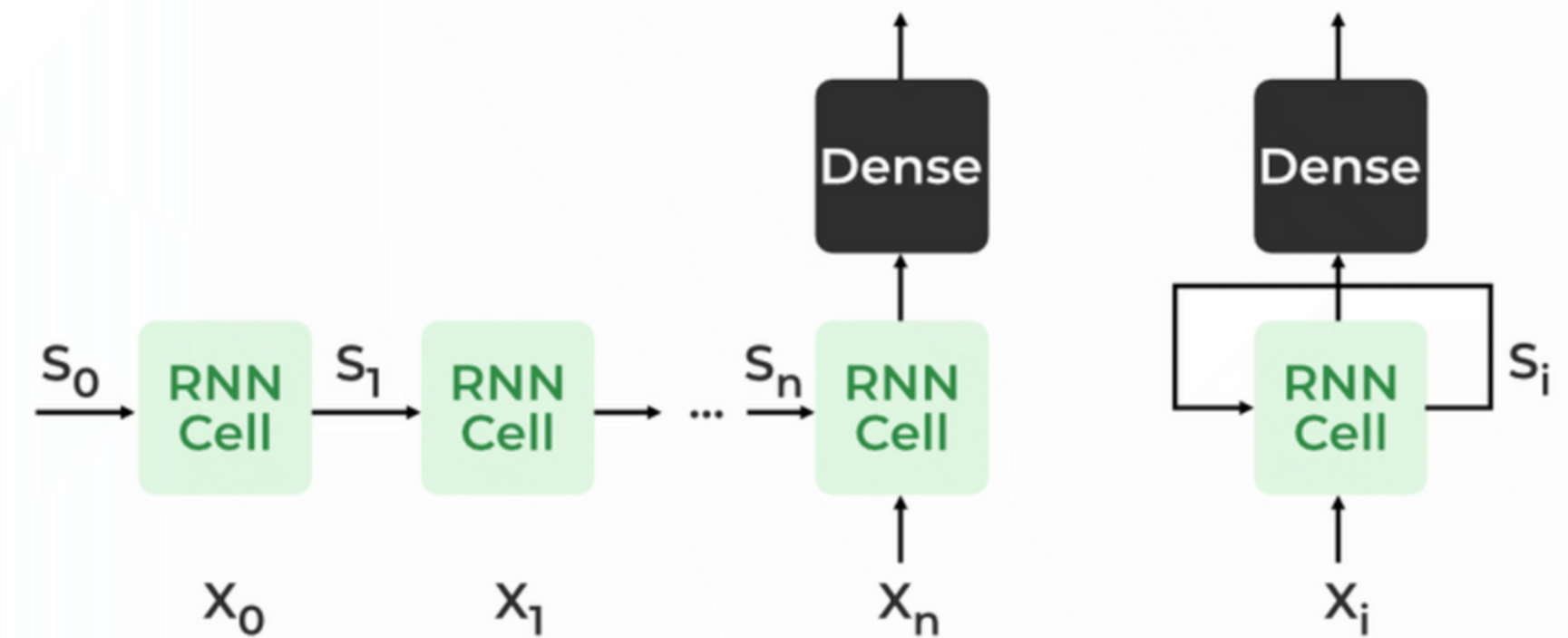
➤ **Results after 10 epochs:**

- Test set accuracy: 67.36%
- F1 score: 0.5928

RNN – RECURRENT NEURAL NETWORKS

1. Transforming the audio signal (air pressure variations over time) → spectrogram.
2. Captures the relationships and dependencies between successive moments in the audio signal.
3. Propagates state over time, memorizing the evolution of the note: attack, sustain, decay.

RECURRENT NEURAL NETWORKS



Results after 10 epochs:

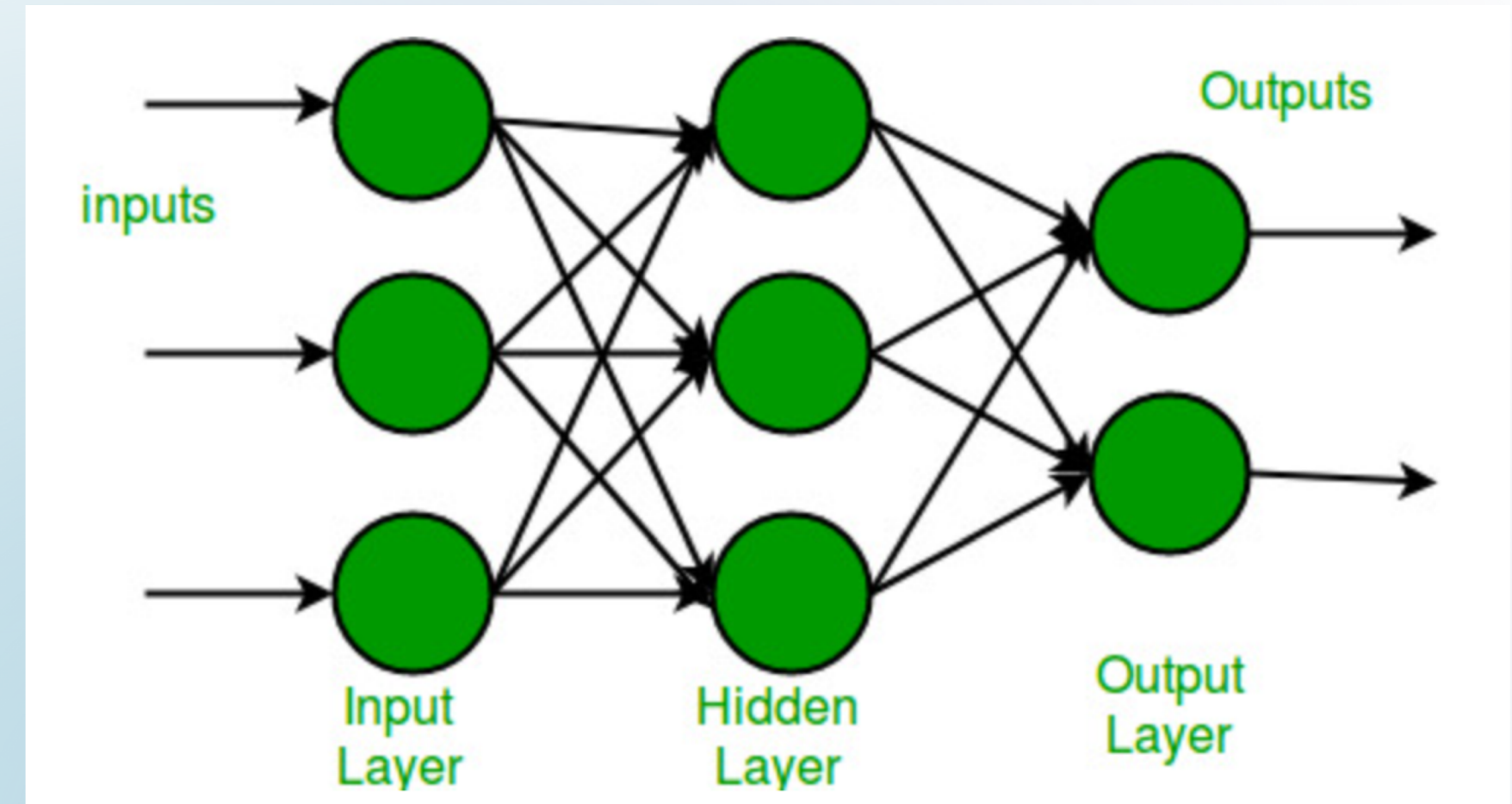
- Test set accuracy: 38.60%
- F1 score: 0.385

✦ MLP - MULTILAYER PERCEPTRON NEURAL NETWORKS ✦

1. Transforming the audio signal (air pressure variations over time) → spectrogram.

2. Converting the flattened spectrogram into a vector.

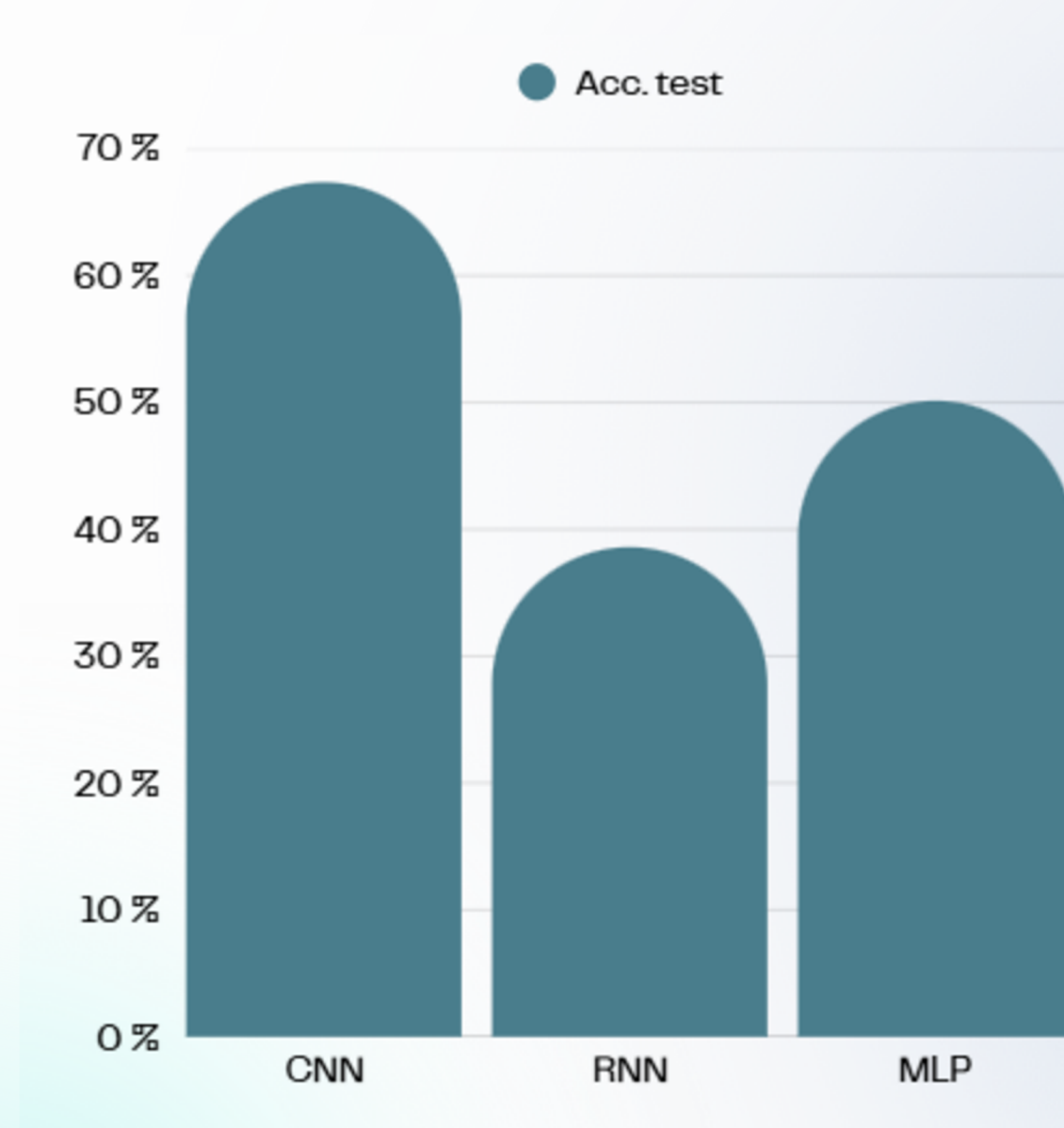
3. Learning nonlinear relationships between these values for classification.



➤ **Results after 10 epochs:**

- Test set accuracy: 50.14%%
- F1 score: 0.49

CHOOSING THE BEST MODEL



Evaluation criteria

- Accuracy and F1-score on the test/validation set
- Training time per epoch and number of parameters
- Inference latency for real-time feedback
- Robustness to variations in intensity and background noise



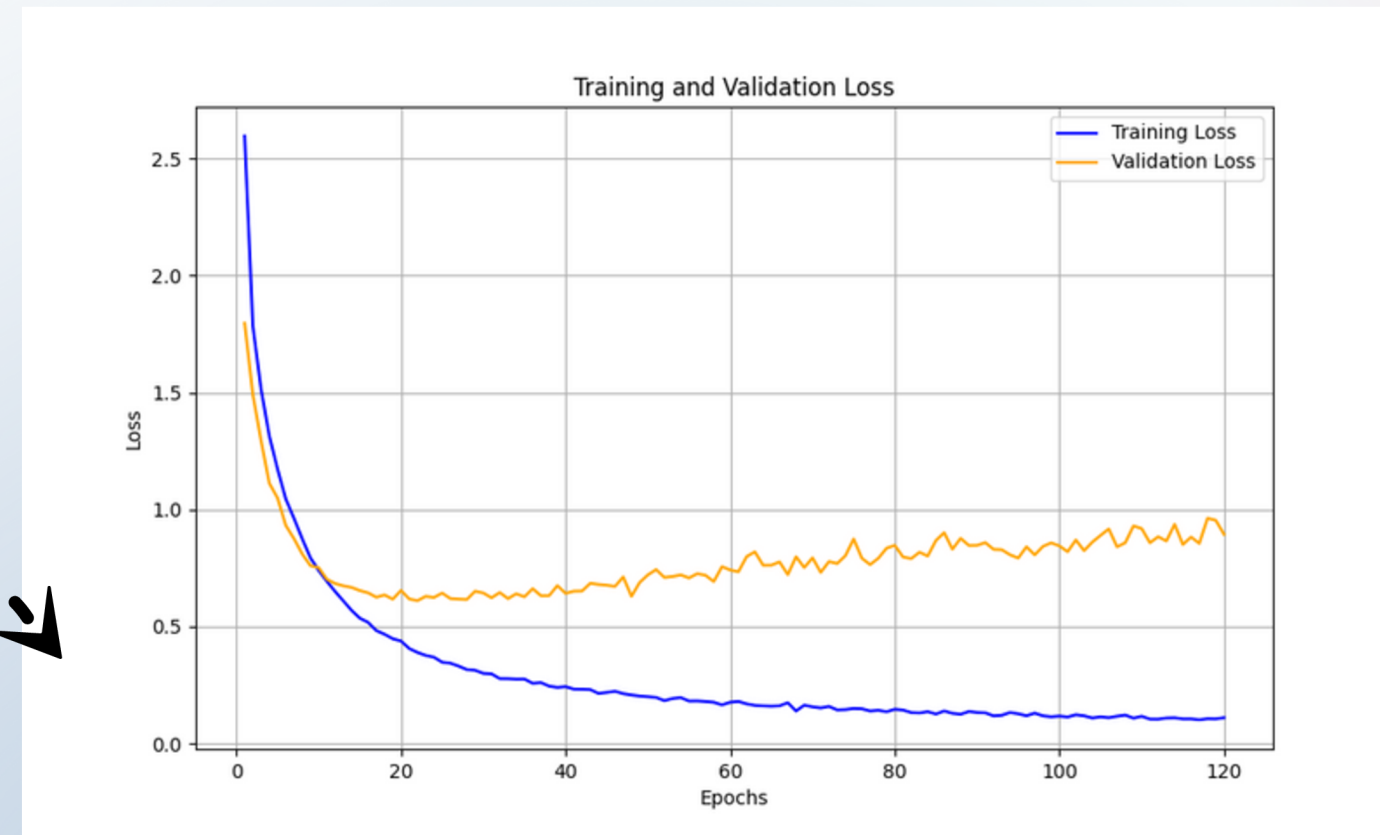
Result: CNN



IMPROVING THE CNN MODEL

Training over 10 epochs (initial model):

- Validation accuracy increases rapidly from 46% → 66.5%
- Validation loss decreases from 2.08 → 1.20
- Final test accuracy: 65.5%
- Conclusion: good convergence, but performance still moderate.



20 epochs

30 epochs

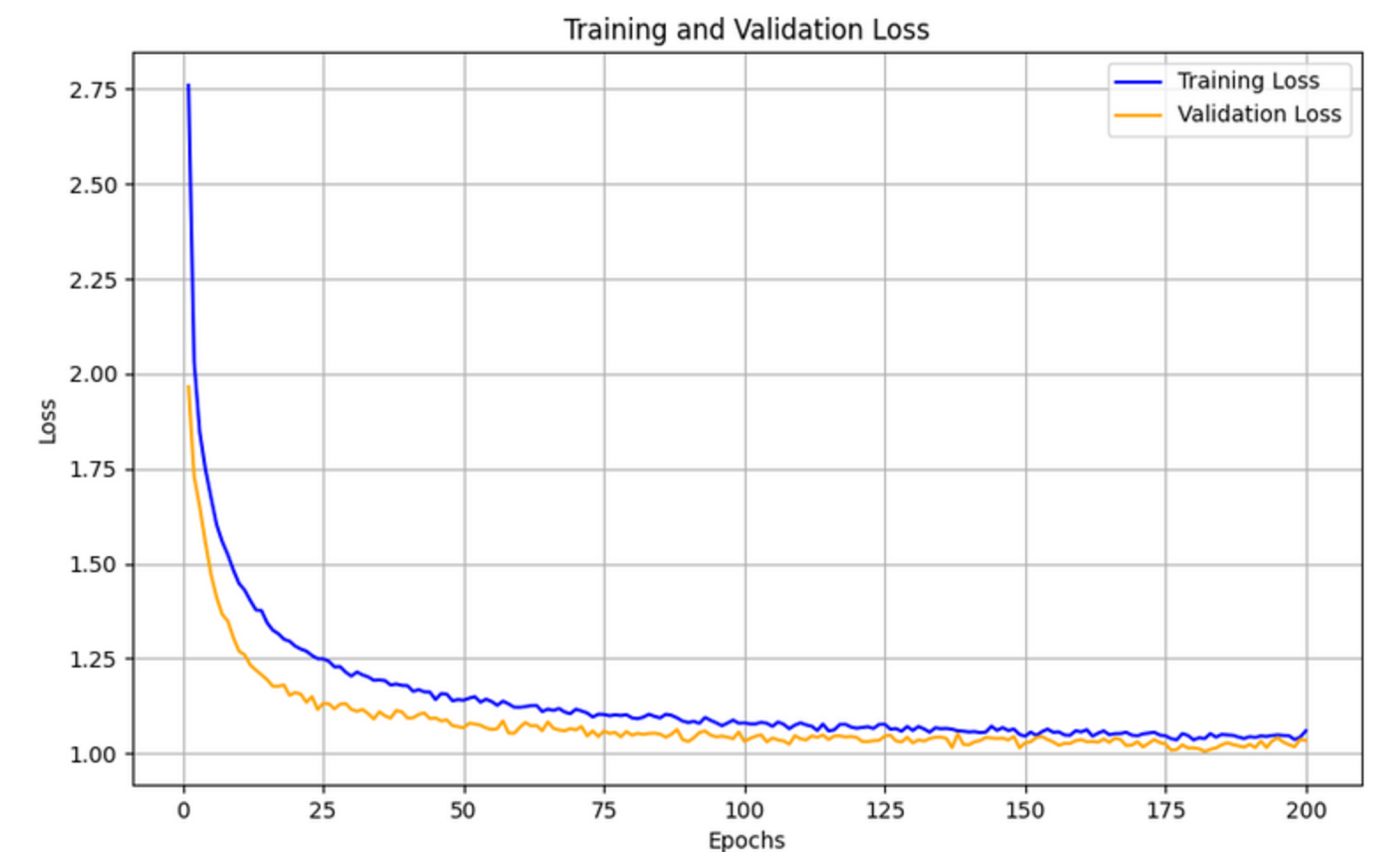
120 epochs (without EarlyStopping)

Adding L2 regularization + Dropout, 50 epochs

100 epochs (without EarlyStopping)

Training over 200 epochs with EarlyStopping

- Train loss/accuracy: 1.0592 / 86.05 %
- Val loss/accuracy: 1.0336 / 87.28 %
- F1-score on validation/test: 0.8177
- Regularization and EarlyStopping prevented overfitting, resulting in a robust and balanced model.



FUTURE DIRECTIONS

1 Polyphony recognition: simultaneous detection of chords and arpeggios.

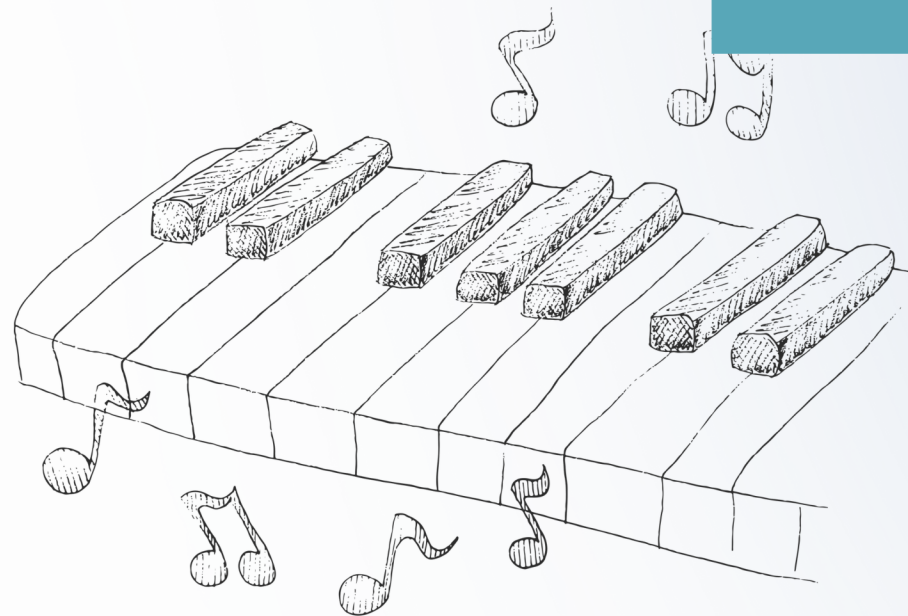
2

Advanced **AI features:**

- Repertoire recommendations: personalized suggestions based on progress.
- Advanced error analysis: diagnosis of rhythm, intonation, dynamics + graphical reports.

3

Email notifications: lesson confirmations, teacher feedback, course launches.





**THANK YOU VERY MUCH
FOR YOUR ATTENTION!**

