Development of a User Interface for Deep-zoom Whole Slide Images to Overlay Predictions from Deep Learning Models

Chris Rüttimann

Supervisor(s): Dr. Amjad Khan
Institution(s): Institute of Tissue Medicine and Pathology, University of Bern

Introduction

With the surge in Artificial Intelligence (AI) applications in healthcare, there's a pressing need for tools that allow for the effortless integration of AI into clinical settings. One such application is the viewing of Whole Slide Images (WSIs) along the results of deep learning algorithms in pathology settings.
Current tools, primarily designed for research purposes, often present clinicians with a steep learning curve due to their intricate interfaces and the prerequisite of additional software installations.
Additionally, these tools fall short when it comes to integrating with established high-performance computing (HPC) infrastructures, such as Ubelix at the University of Bern. In this study, we aim to develop a comprehensive tool that facilitates the viewing of WSIs by seamlessly integrating advanced AI models through HPC, thereby enabling the streamlined visualization of AI predictions within a single platform for pathology experts.

Materials and Methods

The application was developed using the Vue.js [1] framework for the frontend, which interacts with the backend via protocols such as HTTP and WebSockets. The backend was implemented in Python, handles complex tasks such as data synchronization with a shared drive and connectivity with Ubelix via SSH. The application currently uses an SQLite [2] database, with plans for future replacement with a more sophisticated system. The application was tested and evaluated for performance, usability, and functionality.

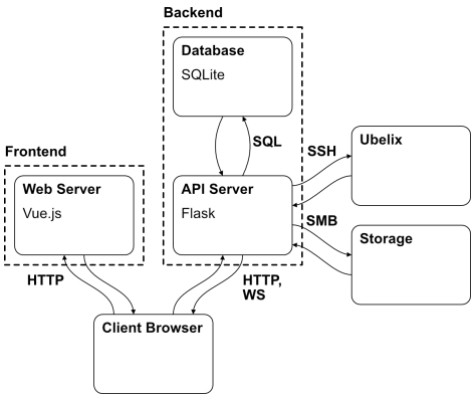

Fig. 1 Architectural Overview of the Application: Featuring Vue.js-based Frontend, Python Backend with SQLite Database, and Connectivity Mechanisms (HTTP, WebSockets, SSH).

Results

The application successfully enables users to view WSIs and deep learning outcomes for lymph node metastasis detection [3]. It exhibits high usability, supported by an intuitive user interface, and showcases commendable performance in terms of its speed and responsiveness. However, several challenges and areas for improvement were identified, including an offset issue in the classification mask, a significant bottleneck in the connection with the storage module, and limitations in user-started classification due to the duration of the classification process.

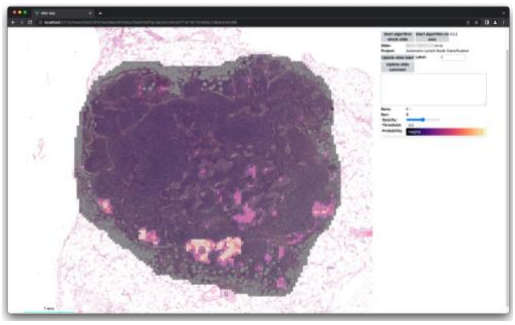

Fig. 2 WSI overlayed with the result of the deep learning algorithm from [3] shown in the final version of the frontend.

Discussion

Despite the identified challenges, the project was deemed successful, achieving its primary objective. Future work includes optimizing the system architecture by deploying dedicated servers for both frontend and backend, replacing the SQLite database with a more sophisticated system, and incorporating a user management system to facilitate concurrent use and project sharing among users.

References

[1] https://vuejs.org/
[2] https://www.sqlite.org/index.html
[3] A. Khan et al., Computer-assisted diagnosis of lymph node metastases in colorectal cancers using transfer learning with an ensemble model, Modern Pathology, vol. 36, no. 5, p. 100 118, 2023.

Acknowledgements

I am grateful for everyone who supported me during this project. Calculations were performed on UBELIX (http://www.id.unibe.ch/hpc), the HPC cluster at the University of Bern.