Classification of Gastric Tissue: Detecting Inflammation and Gastric Regions in Digital Pathology

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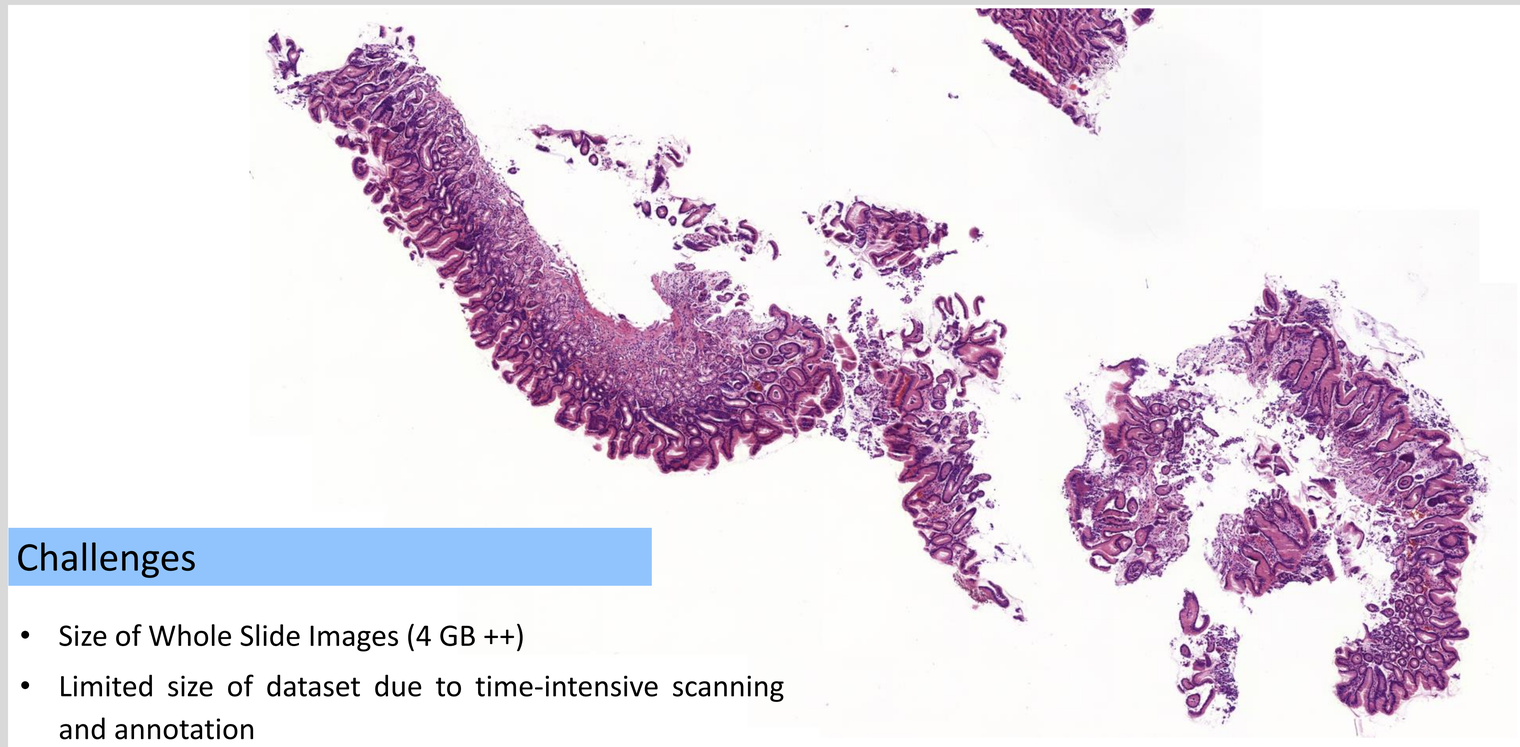
Introduction

This project includes a bachelor's thesis (Tom Hempel) and a master's thesis (Philipp Höfling), developed in collaboration with Nuremberg Hospital.

It focuses on the development of an AI-based system for classifying digitized images of gastric tissue, specifically targeting gastric regions and the detection of inflammation (gastritis).



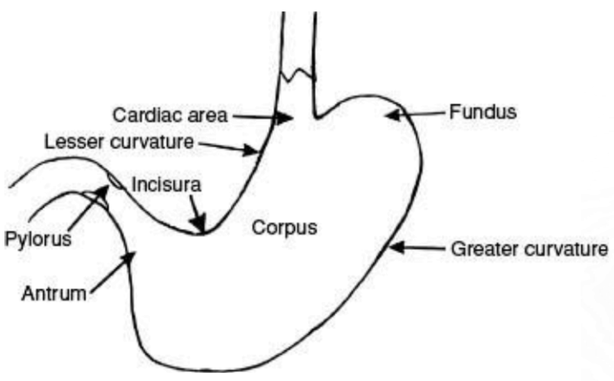
Goals of Bachelor Thesis

1. Create a labeled dataset of digitized gastric tissue slides
2. Annotate gastric regions and inflammation (gastritis)
3. Develop models for tissue and inflammation classification
4. Lay foundation for further refinement in master thesis

Challenges

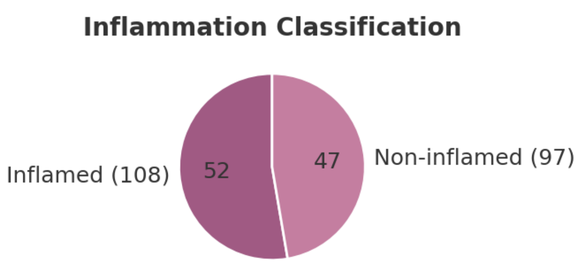
- Size of Whole Slide Images (4 GB ++)
- Limited size of dataset due to time-intensive scanning and annotation
- Inconsistent scan quality (e.g. artifacts, blur)
- Communication between medical staff and technical students

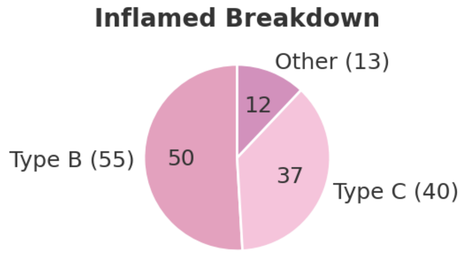
Methodology

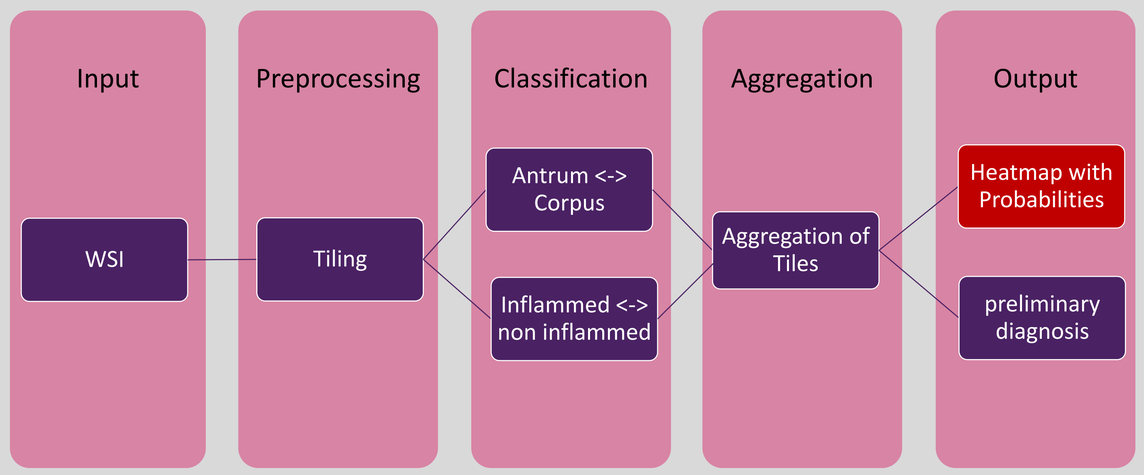


The dataset created as part of the bachelor's thesis includes digitized gastric mucosa biopsies from the antrum and corpus. The data consists of whole slide images of Type B gastritis (bacterial) and Type C gastritis (chemical) cases,

as well as pathologically non-relevant cases. The cases were selected and anonymized by experienced pathologists at Nuremberg Hospital. The slide preparations were digitized independently by the students using the hospital's whole slide image scanner.







First, the tissue slides are digitized using a specialized scanner. The resulting images are then divided into smaller sections (tiles) to ensure a manageable resolution for subsequent processing. Based on these tiles, the tissue types are classified, and it is determined whether a significant inflammation is present or not. These classifications are performed using a recurrent neural network.

The individual tiles are then reassembled, taking their respective classifications into account, to represent the classification of the entire tissue structure. Finally, the system outputs a heatmap of the probability distribution along with a preliminary diagnosis. During the project, the **ResNet-18** and **Xception** architectures were tested and compared for their performance in classifying the tiles.

Ergebnisse

The models performed well in classifying both gastric regions and inflammation. Antrum reached an F1 score of 0.89, corpus scored 1.0, and intermediate regions scored 0.46, but with perfect recall.

Inflammation was classified with an F1 score of 1.0 for both inflamed and non-inflamed cases. However, the results should be viewed with caution due to the small dataset and the use of clear, unambiguous samples.

Conclusion

The bachelor thesis developed a dataset of digitized gastric tissue and implemented baseline AI models for classifying gastric regions and detecting inflammation. The models performed well on clear cases, but intermediate regions proved challenging, highlighting areas for improvement.

In his master thesis, Philipp Andreas Höfling refined these models, expanded the classification to include gastritis subtypes, and improved system usability. He also conducted detailed evaluations and addressed key aspects for future clinical application.

References:

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In Kooperation mit Institut für Pathologie der Paracelsus Medizinischen Privatuniversität Klinikum Nürnberg
21.03.2025