

Evaluating SimCLR and Graph Contrastive Learning for Embedding and Clustering Chorionic Villi

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ABSTRACT

- **The Placenta** is a temporary organ often discarded after birth
- Chronic villi are one of the **keys** to transporting nutrients and waste between the mother and fetus
- Identifying abnormalities in placental villi is thought to **require** metrics such as number of syncytial knots or stromal cells
- We worked to identify a **connection** between the superficial villi image and
- To identify abnormalities we clustered using various **embedding methods**: morphological data, a contrastive CNN model, and graph contrastive learning
- Overall these resulted in Silhouette Score and Davies-Bouldin Index of 0.577, 0.592, 0.452, 0.780, 0.217, 1.536 for the three methods respectively

INTRODUCTION

- The **placenta** in a pregnancy is a vital organ that supplies oxygen and nutrients to the fetus (lung, gut, endocrine, and immune system)
- **Placental histopathology** identifies and examines disease related changes in the placenta
 - Chorionic villi are the basic fundamental functional units of the placenta (described as "tree-like structures")
- There are difficulties in analyzing placental health due to:
 - **Limited number of perinatal pathologists** in the field of placental histopathology
 - Challenges in robust, reproducible histological analysis and detection of pathological changes
 - Only a small amount of post-pregnancy placentas studied
- Deep learning offers an **automated, quantitative approach** to the field of placental histopathology:
 - Improve quality control issues in the field
 - Quantitatively measure and assess placental features, which can help in predicting miscarriages

METHODS

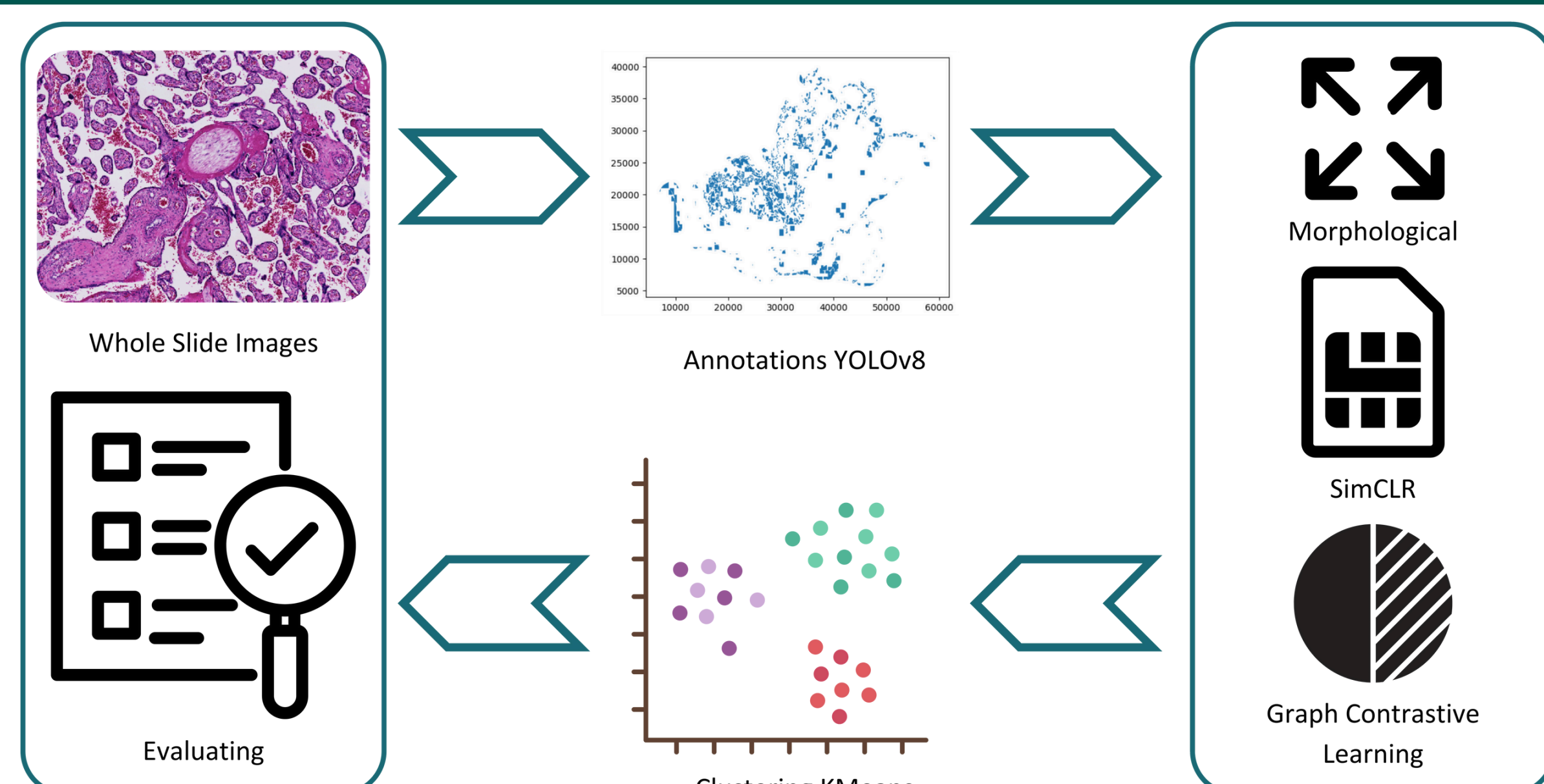


Figure 1. Flowchart of methods

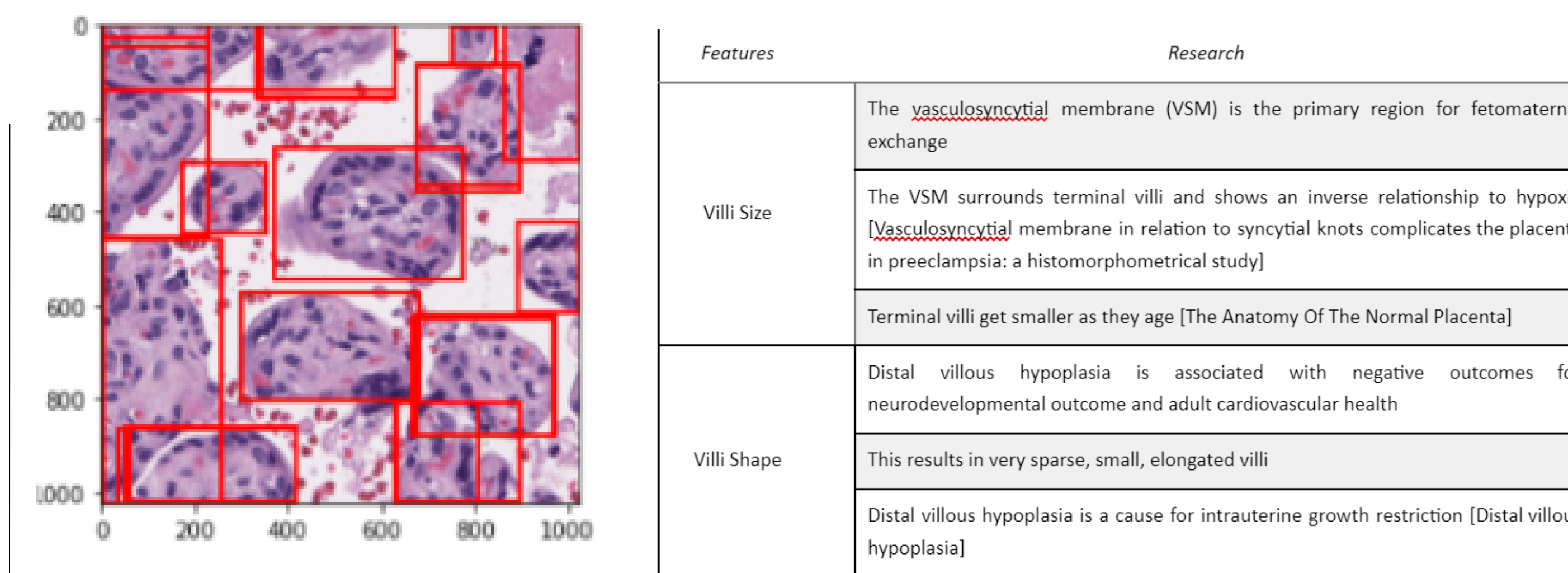


Figure 1. YOLOv8 annotations and research on metrics

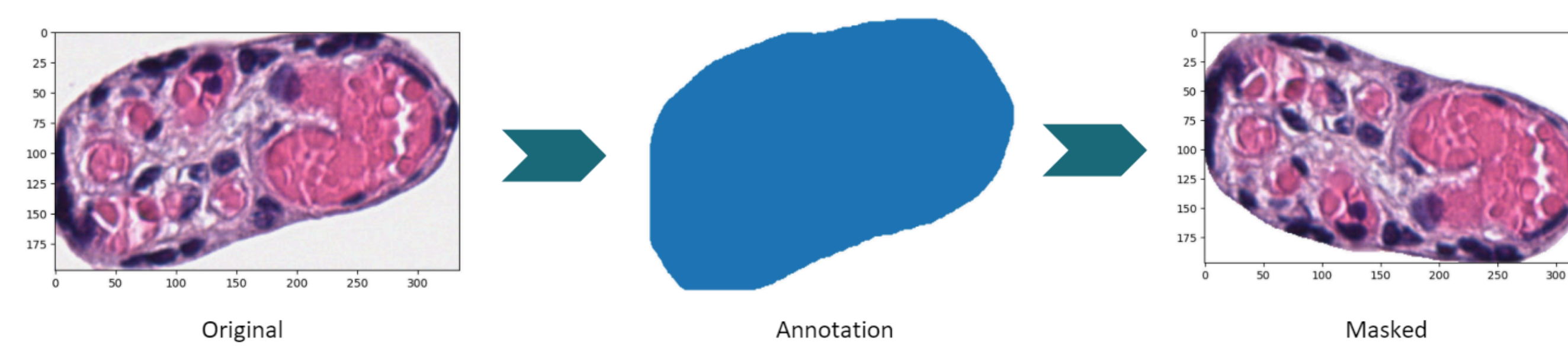


Figure 1. Preprocessing for SimCLR

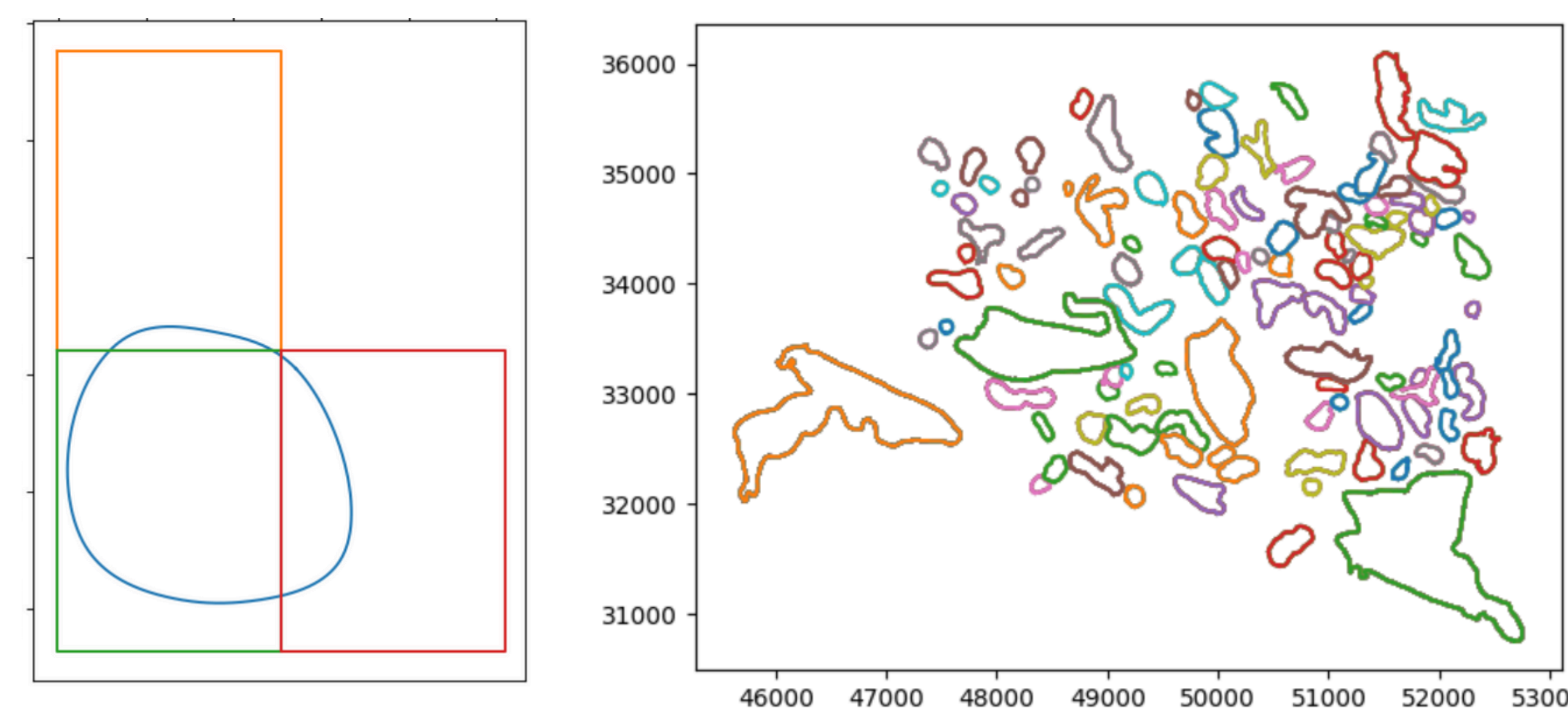


Figure 1. Patches in Graph Contrastive Learning

RESULTS

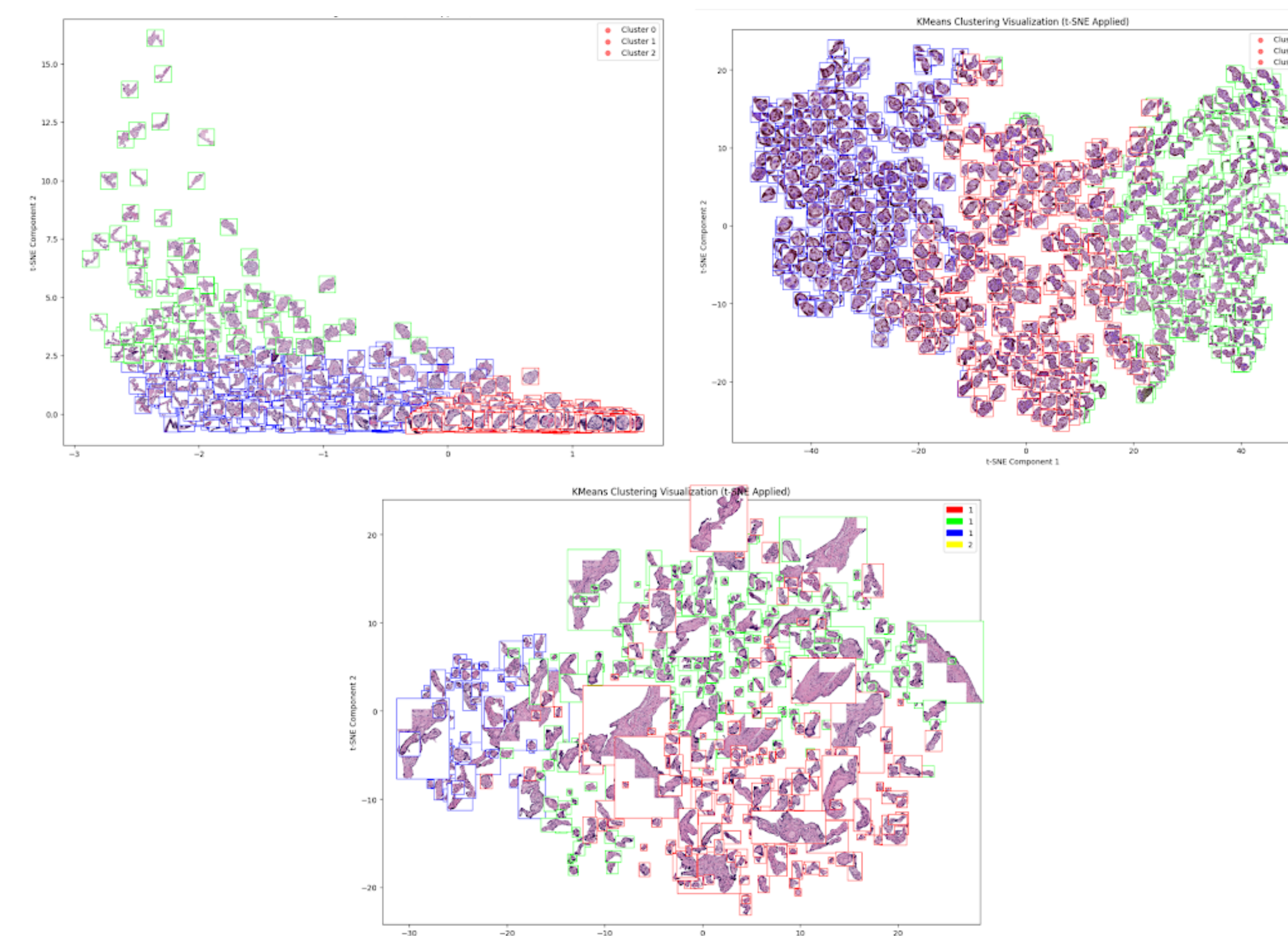


Figure 1. Patches in Graph Contrastive Learning

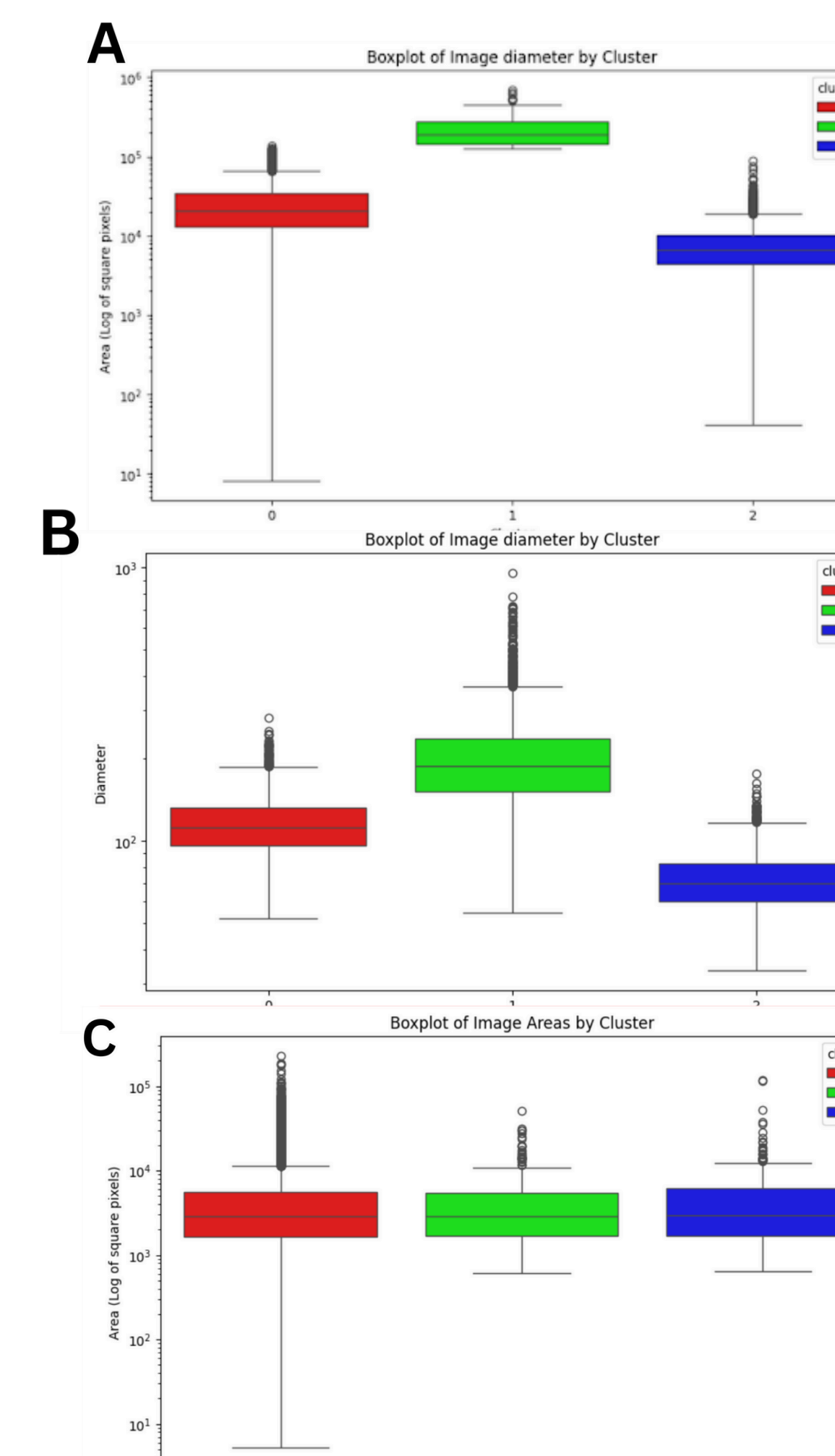


Figure 5. Confusion Matrix from NHBCS Villi Prediction

Method	Silhouette Score	DaviesBouldin
Morphological	0.576665	0.592298
SimCLR	0.452	0.7804
Graph Contrastive Learning	0.21662076	1.5357790069871144

CONCLUSION & NEXT STEPS

- **Potential for Clinical Impact:**
 - **SimCLR** can be used to identify potential abnormalities in placental health
 - This can later be connected to maternal and fetal health
- **Limitations:**
 - Trained on placentas only after carrying full-term (NHBCS)
 - The models were trained on a subset of the full annotations
- **Future Directions:**
 - **New embedding methods** using U&I and the Image-Net pretrained CNN
 - **Vessels and cell type** as evaluating metrics for the villi

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