Graph Neural Networks for Immune Cell Prediction Accuracy

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ABSTRACT

- Understanding immune cell spatial organization is crucial for research in autoimmune disorders and cancer immunotherapy.
- Our project uses Graph Neural Networks (GNNs) to detect immune cells in tissue samples.
- The GNN approach uses contextual data to identify immune cells, offering a scalable and objective solution for analysis.
- Model performance is evaluated using metrics like accuracy and F1-score to ensure reliable immune cell detection.

INTRODUCTION

The immune system's complexity, with diverse cell types and interactions, plays crucial roles in health and disease. Understanding the spatial organization and interactions of immune cells is vital for insights into immune response, autoimmune disorders, and cancer immunotherapy. Current methods for studying immune cells rely heavily on manual tissue sample analysis, which is labor-intensive, time-consuming, and subjective. This often results in inconsistent findings. Automating and scaling the process will enhance research and clinical diagnostics.

Aims and Goals:

Develop a Graph Neural Network (GNN)-based algorithm to accurately and efficiently identify and map immune cells' spatial relationships in tissue samples.

Integrate image analysis into immune cell-annotated WSIs to accurately locate the positions of white blood cells and lymphocytes within clusters. We aim to develop a deep learning algorithm that incorporates this technology to locate cells that are difficult to detect within complex structures.

METHODS

- **Goal:** Develop a deep learning algorithm incorporating image analysis to accurately identify white blood cells within complex cell clusters.

- **Experimental Design:**

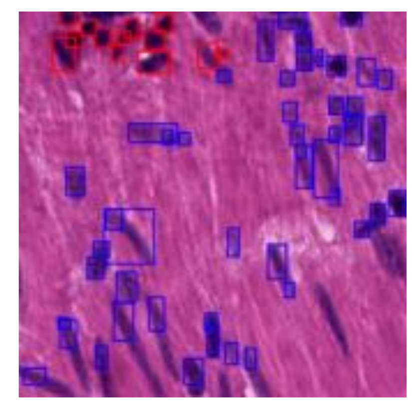
- H&E stained slides were scanned into whole slide images (WSIs) generating 11,727 subarray images.
- Developed a nuclei segmentation dataset using 6,892 annotated nuclei from a public dataset.

- **Approach:**

- A scoring algorithm based on F1-score to enhance patch selection for machine learning models.

- Plan to integrate image analysis with GNN to detect efficiently.

RESULTS



Model	Accuracy	F1-Score
GNN	81.31	0.8121

- GNN obtained an F1-Score of 0.8121
- GNN had an accuracy of 81.31

CONCLUSION

Potential for Clinical Impact:

Suggests that GNNs can provide accurate detection of immune cells within complex structures, contributing to improved diagnostics and insights into immunotherapy.

Limitations:

Limited project time may prevent full deployment of a comprehensive model, given the challenges and extensive research required in immunotherapy.

Manual processes like tissue staining and batch effects could still introduce variability and inaccuracies.

Using more images to train the data could allow for better and more accurate results.

Future Directions:

Continue optimizing the algorithm for more reliable immune cell detection, as these results wouldn't be too effective in real medical research as of now.

Explore advanced image analysis techniques and further enhance GNN capabilities for better spatial understanding.

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