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Classification of Intestinal Gland Cell-Graphs Using Graph Neural Networks

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Motivation

Pathologist consider:

- Morphological changes in tissue
- Spatial relationship between cell (sub-) types
- Density of certain cells

Colorectal cancer:

- 3rd most common cancer type worldwide
- Adenocarcinoma originate from dysplastic glands
- Tumor grading is based on glandular formation

→ Use graphs to capture the geometrical and topological properties of **colorectal glands**

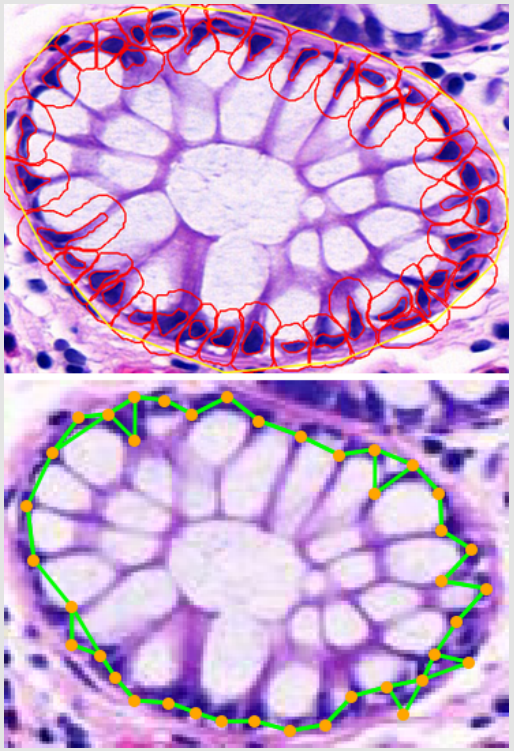


Fig. 1: Cell-graph of an intestinal gland

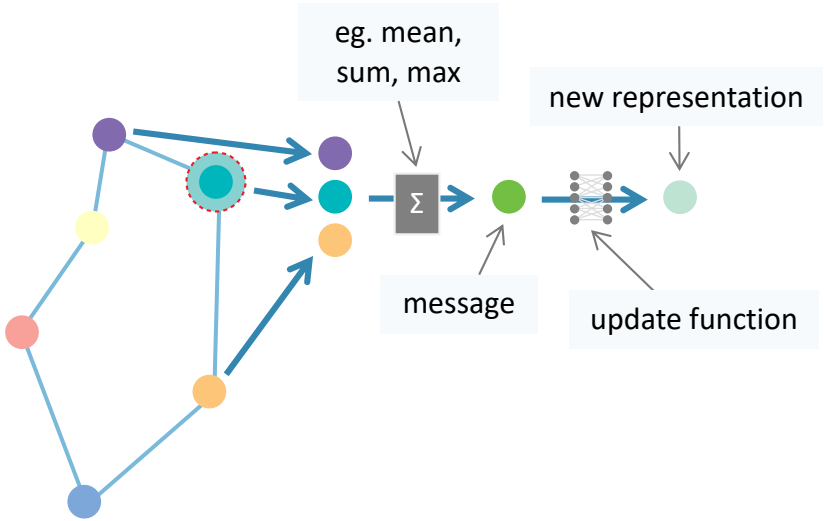
Graph Neural Networks

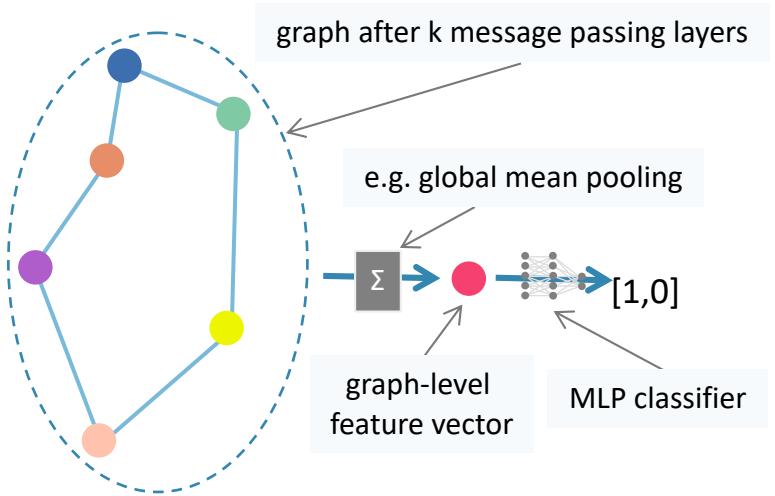
Message Passing:

- Graph Convolution → aggregate neighborhood information
- Several layers = larger neighborhood

Read-out Phase

- Vector representation for whole graph
- Input for classification MLP





Experimental Setup

- **Dataset: pT1 Gland Graph Dataset**
  - Binary classification: **normal or dysplastic gland**
  - 520 intestinal glands (H&E stained tissue)
  - Cell graph with 33 node features

- **Graph convolutional layers:**
  - Graph Convolution Network (GCN)
  - GraphSAGE
  - Graph Attention Networks (GAT)
  - Edge Network (enn)
  - Graph Isomorphism Network (GIN)
  - 1-dimensional GNN (1-GNN)

- **Compare two node feature sets:** 4 features used by baseline versus full features set (33)

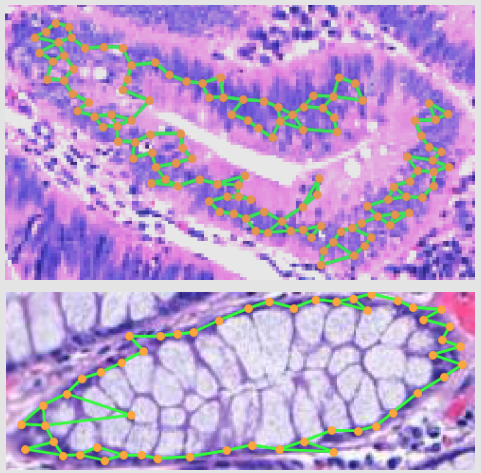


Fig. 2: Dysplastic and normal gland

Results and Conclusion

- **Beat SOTA results** achieved with Graph Edit Distance (GED)
- Different types of GNNs achieve similarly good results
- GNNs can profit from the full 33 node feature set

	# Node Features	
	4 (baseline)	33 (all)
1-GNN	**89.2 ± 3.8%**	94.6 ± 2.3%
GAT	85.5 ± 5.4%	94.3 ± 2.4%
GCN	85.5 ± 4.9%	94.5 ± 2.6%
GCN-JK	85.4 ± 4.5%	**94.8 ± 2.4%**
GIN	89.0 ± 4.1%	94.5 ± 2.6%
GraphSAGE	85.4 ± 4.5%	**94.8 ± 2.4%**
GraphSAGE-JK	85.1 ± 5.2%	94.7 ± 2.4%
enn	89.1 ± 3.7%	93.7 ± 3.0%
GED-Baseline[1]	83.3 ± 1.7%	n/a
CNN (VGG-16)	91.8 ± 5.5%	
CNN (VGG-16-Rotation)	92.0 ± 5.1%	

[1] Graph-based Classification of Intestinal Glands in Colorectal Cancer Tissue Images, Studer et. al., COMPAY workshop, MICCAI 2019