

Deep topological analysis of spatial transcriptomics for contextualization of high-resolution cellular interactions [1]

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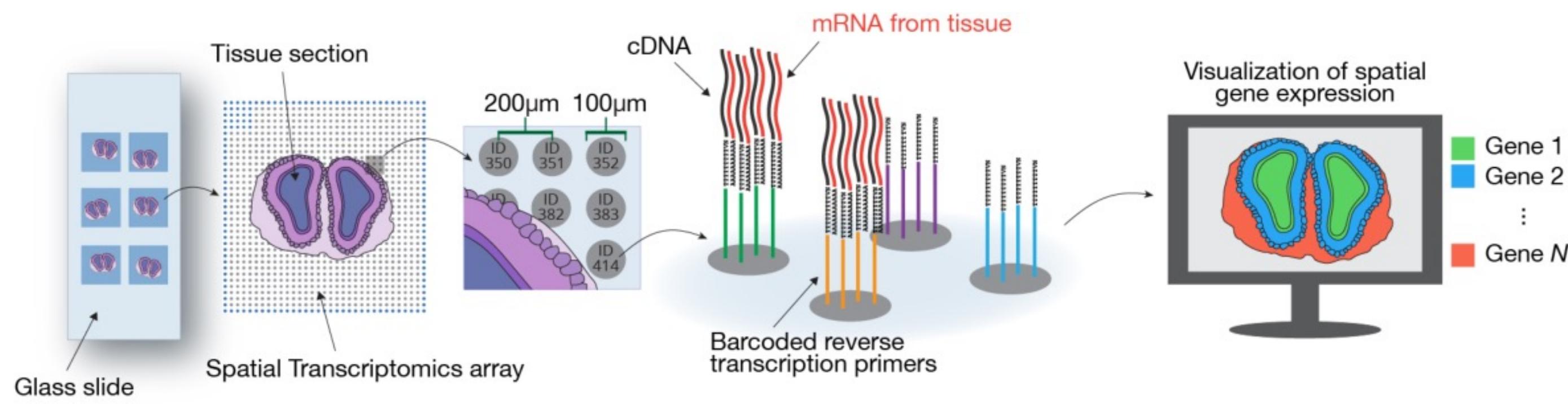


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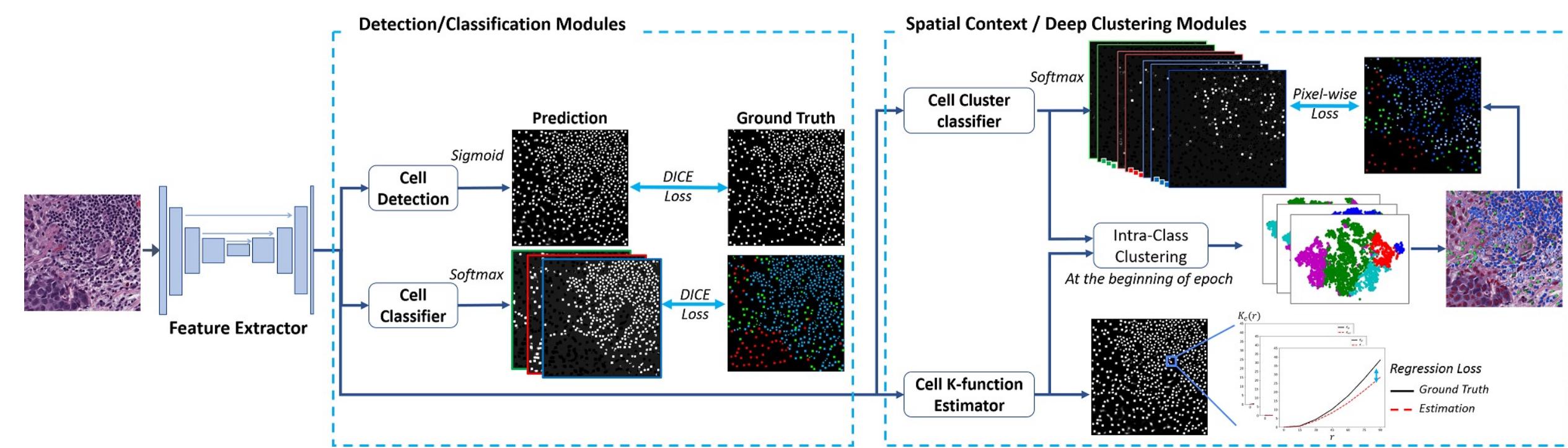
Objective: Study cell interactions through imaging context and localized transcriptomics.

Spatial transcriptomics – connecting the two



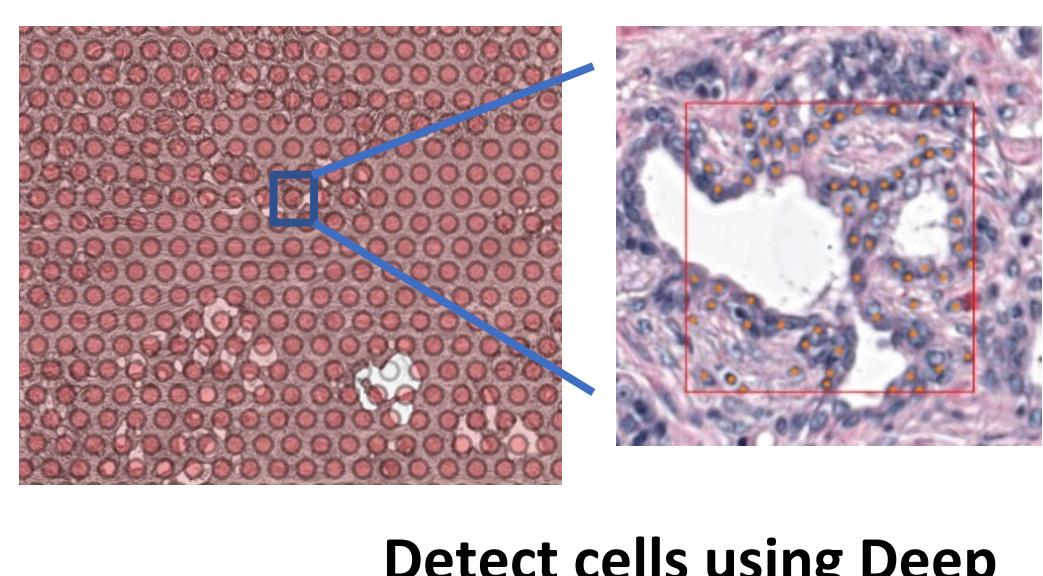
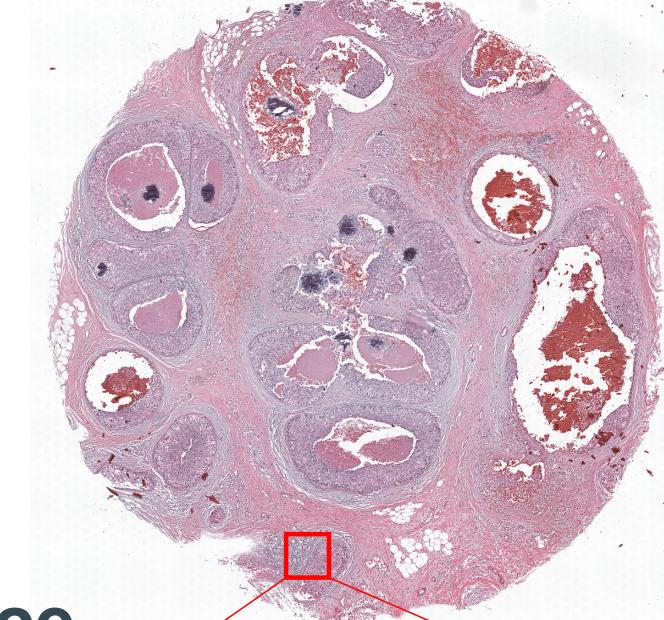
Deep image features and spatial profiling reveals cell context

-- Spatial statistics and deep learning for cell detection and classification [3]

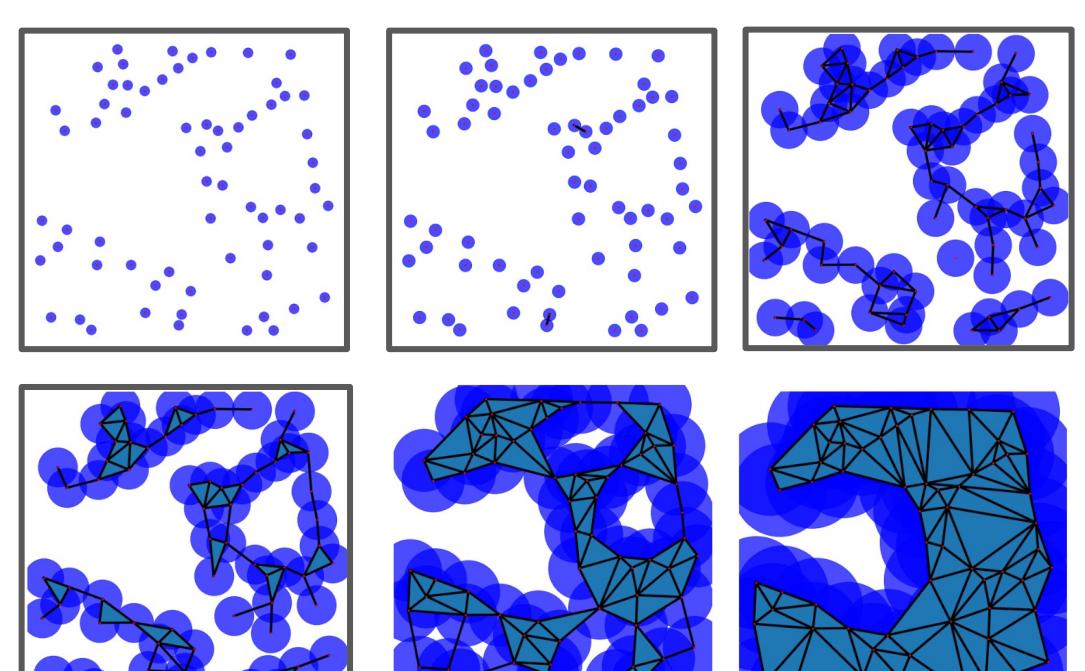


-- Topological features have prediction power regarding clinical outcomes (data: qmLF) [2]

- Persistent homology – clusters and holes of cells
- multiscale and robust to noise
- Grow balls at all neurons/points with a same radius (t)
- Topology changes as t increases
- 0D – components, 1D – holes/loops,
- Persistence diagram: persistence = life span = significance



Detect cells using Deep Learning Algorithms



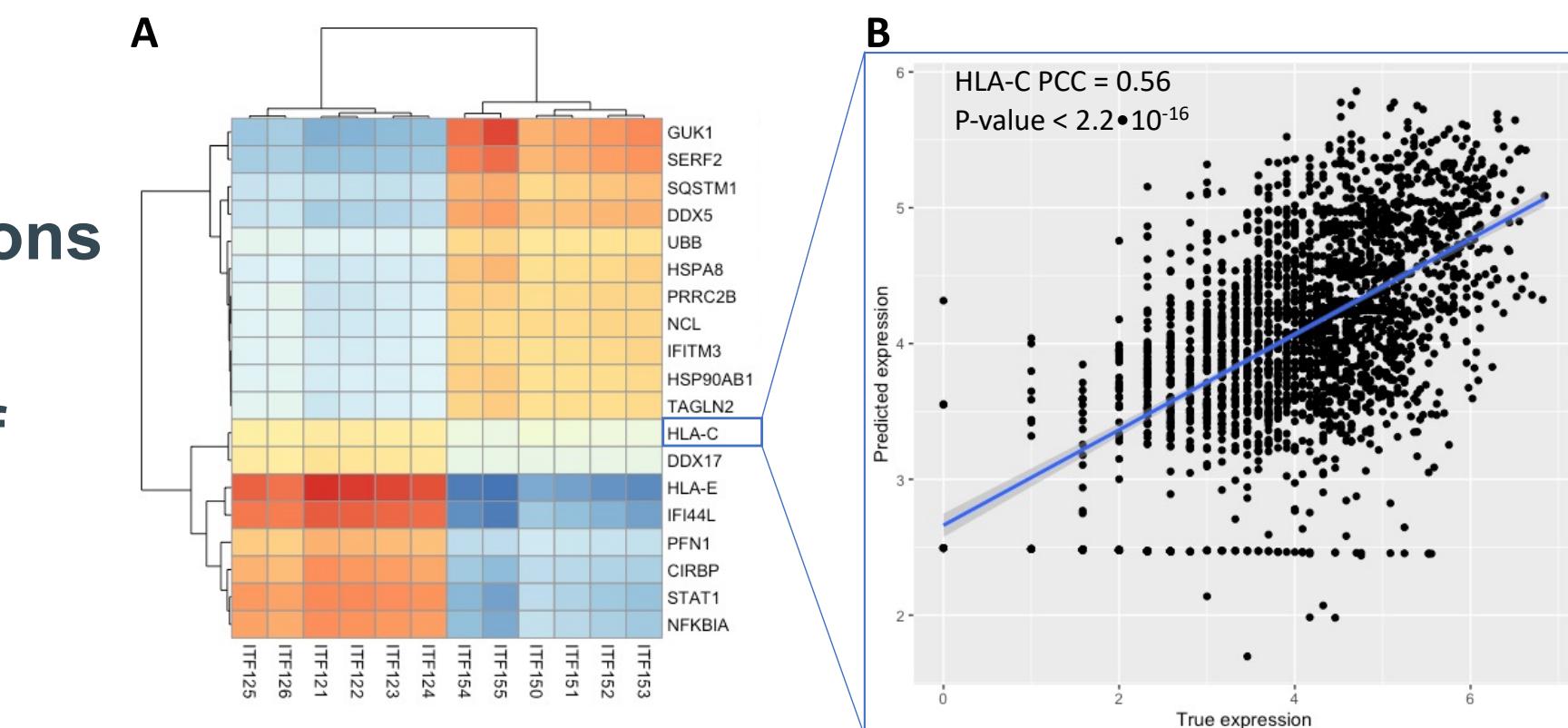
Persistence Diagram

Work flow:

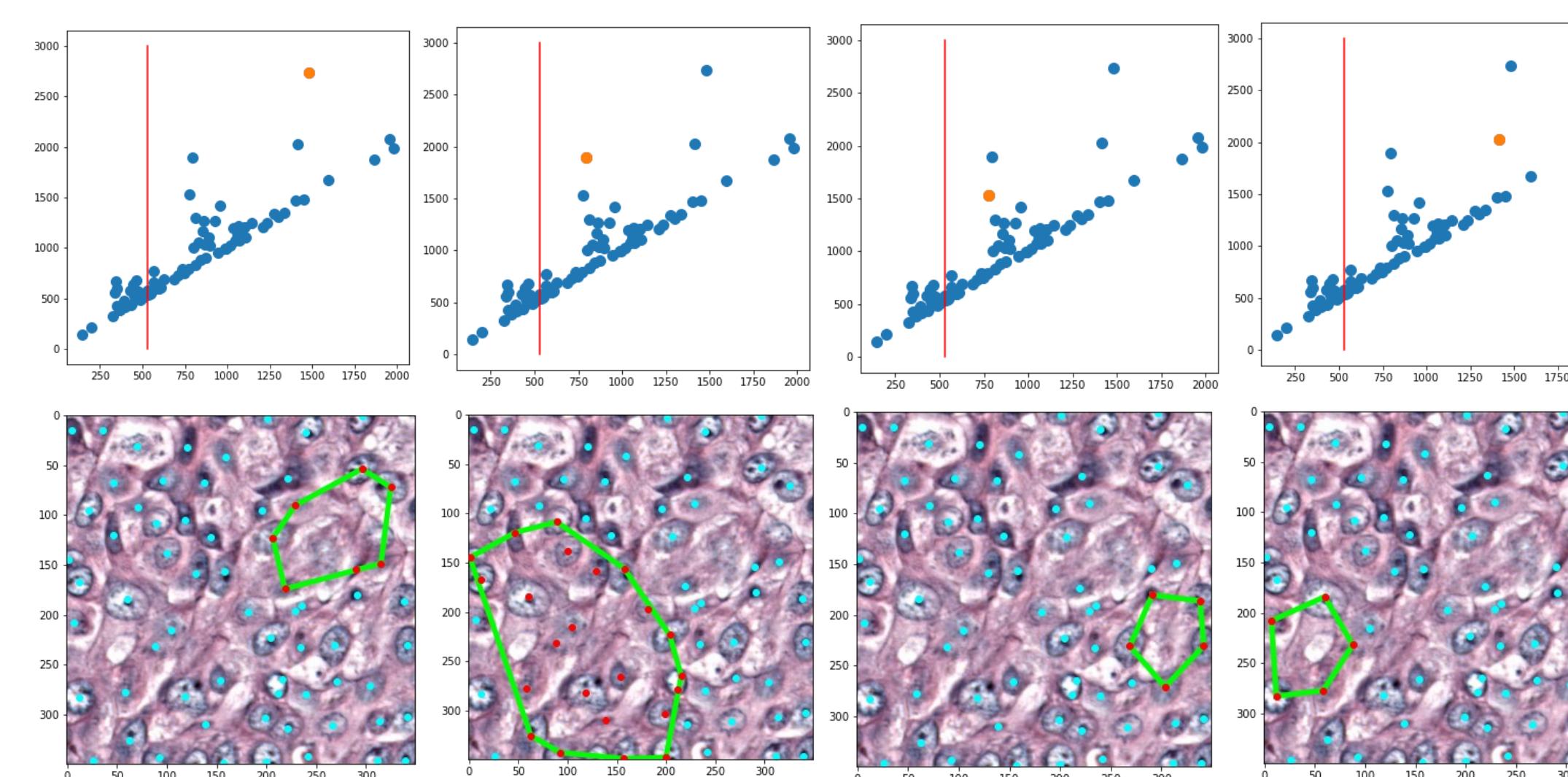
- Generate topological features for each spot (persistence diagram)
- Correlate image topological features (ITF) with genomic features

Result: ITF highly correlated with spot-wise gene expressions

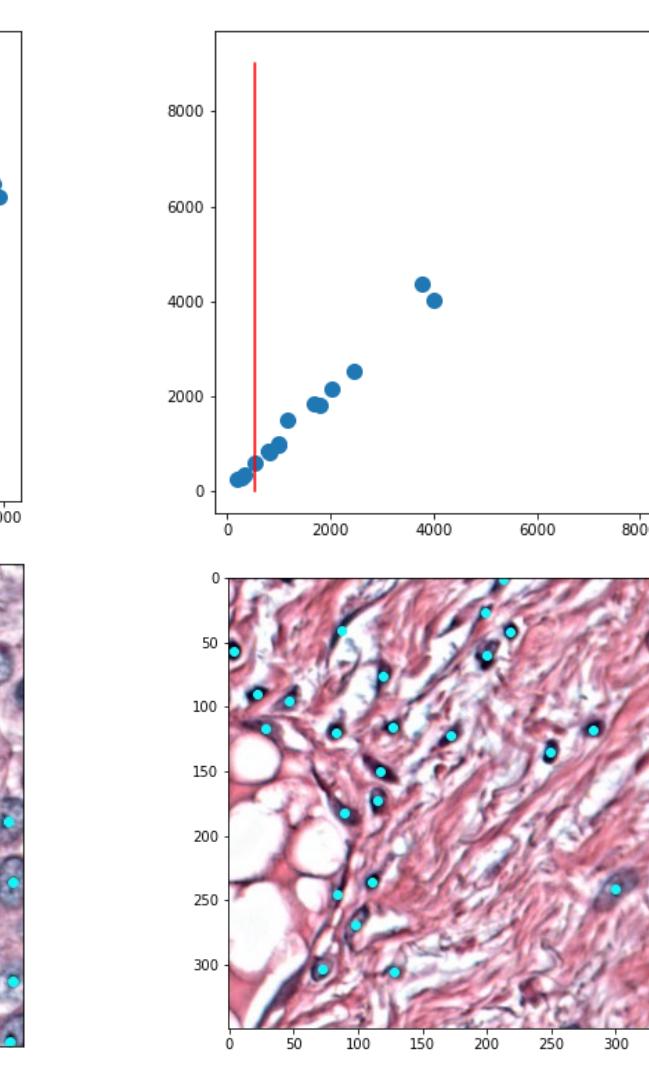
- A: correlation maps**
B: leave-one-out prediction of a gene feature (CatBoost)



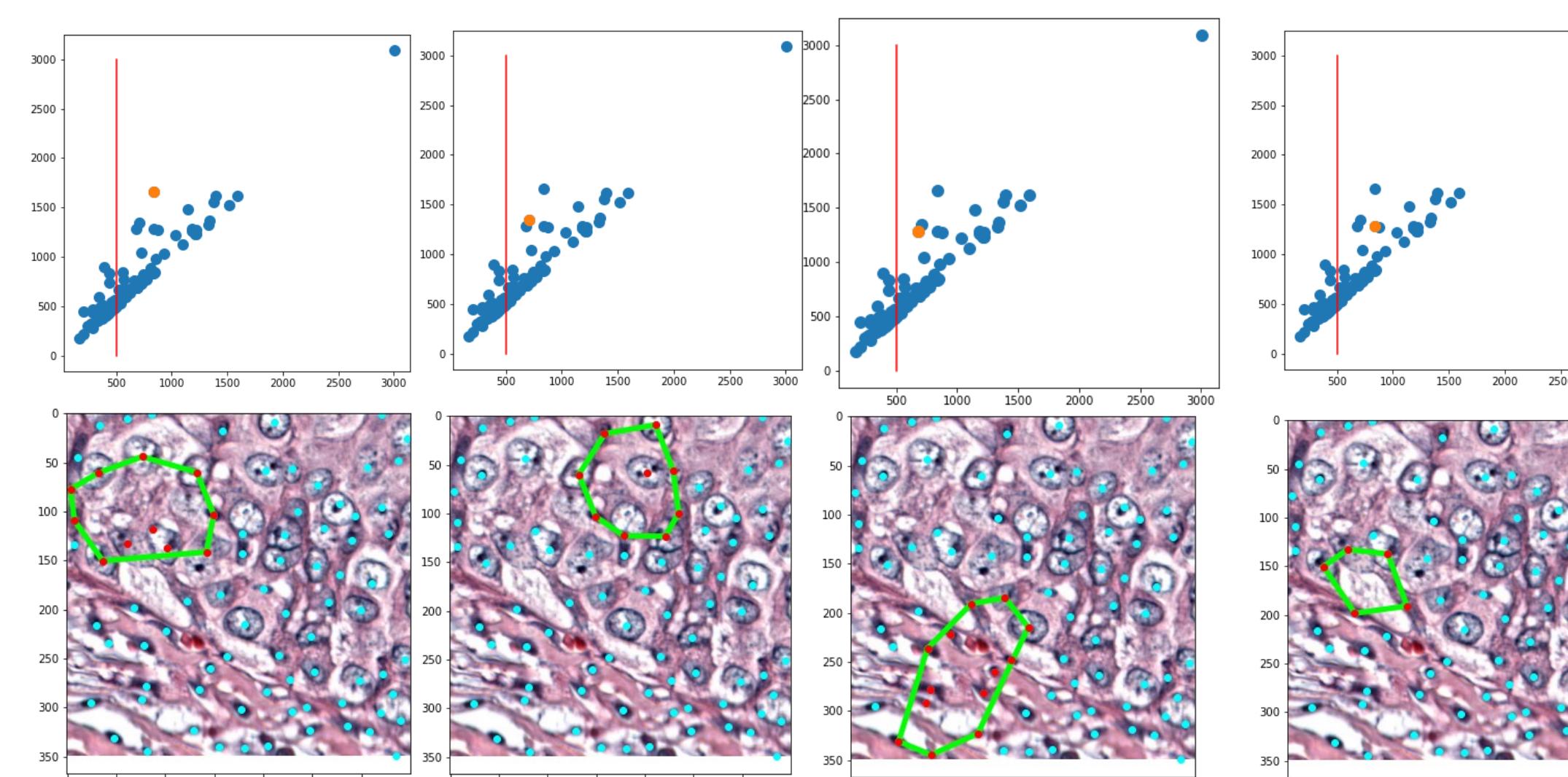
Holes contributing to high topological feature value



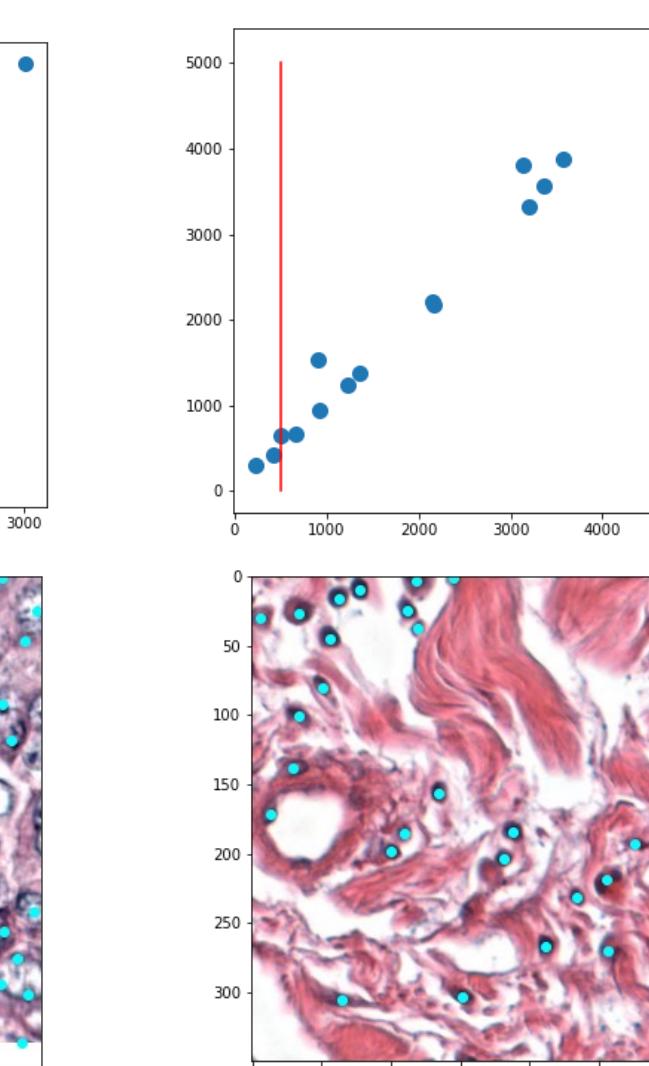
Low Topo. Feature Value



Holes contributing to high topological feature value



Low Topo. Feature Value



References

- [1] Alsaleh et al. : "Spatial transcriptomic analysis reveals associations between genes and cellular topology in breast and prostate cancers", Cancers, 14(19), 4856, 2022
- [2] Carrière et al. : "Persistent homology based characterization of the breast cancer immune microenvironment: a feasibility study", Journal of Computational Geometry, 2021
- [3] Abousamra et al. : "Multi-Class Cell Detection Using Spatial Context Representation", International Conference on Computer Vision, 2021

Future Work

- Identification and interpretation of topological features
- Focus on specific image regions
- Deep learning models + spatial features

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<https://chaochen.github.io/>
<https://medicine.iu.edu/faculty/51902/johnson-travis>

Topology-Driven Learning for Biomedical Images

- Topology-preserving segmentation (2D/3D).
- Topology-aware image generation.
- Topological analysis of neuronal/cellular systems.

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