

Summary

- ▶ Topology provides a simple, powerful, parameter-free, and unambiguous mathematical framework for relating the activity of a neural network to its underlying structure, both locally (in terms of simplices) and globally (in terms homology).
- ▶ The vast number and variety of directed cliques and cavities had not been observed before in any neural network. They are also far higher than in null models, even in those closely resembling the biology-based reconstructed microcircuit, but with some of the biological constraints released.
- ▶ Spike correlation of a pair of neurons strongly increases with the number and dimension of the cliques they belong to and it even depends on their specific position in a directed clique.

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- ▶ Topological metrics reflecting relationships among the cliques revealed biological differences in the connectivity of reconstructed microcircuits.

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- ▶ Topological metrics reflecting relationships among the cliques revealed biological differences in the connectivity of reconstructed microcircuits.
- ▶ The same topological metrics applied to time-series of transmission-response sub-graphs revealed a sequence of cavity formation and disintegration in response to stimuli, consistent across different stimuli and individual microcircuits.
- ▶ The higher degree of topological complexity of the reconstruction compared to any of the null models was found to depend on the morphological detail of neurons.

WHAT'S NEXT?

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- ▶ Study consistency of flow and information transfer in networks (“topological highways”)
- ▶ Apply more sophisticated topological methods to the complexes emerging from the network.
- ▶ Introduce topological generalisations of graph invariants used in neuroscience that will be more sensitive to higher structure.
- ▶ Investigate further constructions of combinatorial topology that may be relevant to neuroscience (e.g., configuration spaces, polyhedral products)
- ▶ Relate invariance of neural response to stimuli to forms of topological invariance.
- ▶ Develop a “topological neural code”.

The background of the slide is filled with a dense, chaotic pattern of thin, hand-drawn lines in shades of red and light blue. The lines are scattered across the entire page, creating a textured, artistic effect.

Thank You

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