TOPOLOGY SHAPES DYNAMICS OF HIGHER-ORDER NETWORKS

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ABSTRACT

Complex systems like the brain, climate, and next-generation artificial intelligence rely on higher-order interactions that extend beyond simple pairwise relationships. These many-body interactions are captured by higher-order networks [1].

By integrating algebraic topology with non-linear dynamics, theoretical physics and machine learning, this talk reveals the critical role of topology in shaping the dynamics of such systems [2].

The research highlights how topological signals, dynamical variables defined on nodes, edges, triangles, and other higher-order structures, drive phenomena such as topological synchronization, pattern formation, and triadic percolation. The surprising result that emerges from this research is that topological operators including the Topological Dirac operator, offer a common language for treating complexity, AI algorithms, and quantum physics.

These findings not only advance the understanding of the underlying mechanisms in neuroscience and climate science but also pave the way for transformative machine learning algorithms inspired by theoretical physics.

REFERENCES

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