

LOCAL-to-GLOBAL: Algebraic Topology for Data, Networks, and Systems

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ABSTRACT/SUMMARY

The proposed project, “*LOCAL-to-GLOBAL: Algebraic Topology for Data, Networks, and Systems*,” has as its research objective a full-scale development of novel applications from the mathematical field of *algebraic topology* and *sheaf theory* to applied problems related to the passage from local objects [data, sensing, constraints, intelligence, and relation] to global system-scale information and inference. The technical tools to be used derive from the topological theories of sheaves (algebraic data structures over spaces), derived functors (collative transformations of such structures), Euler calculus (an example of such a derived functor appropriate for sensing and data fusion), and computational limits and colimits (explicit operations of localization and globalization for data structures in their broadest interpretation).

These tools, which have already demonstrated their effectiveness in problems of sensor networks, networked robots, and data aggregation, will be fully translated from ostensibly pure mathematical techniques into a computational data-centric setting, refined according to the constraints of the relevant application domains. This will lead to impact in a variety of challenge problems and DoD-related areas, including but not limited to sensor fusion, target tracking and disambiguation, pursuit-and-evasion, inference, and radar signal processing.

The impact of this research project will extend beyond the immediate anticipated applications. By developing a principled set of tools based on established mathematical theories, a large degree of “platform-independence” is built-in to the theory, permitting impact in other branches of the mathematical sciences, including network theory, data analysis, inference, and sensing.