



Keynote Lecture

Wednesday 28, 9:00-10:30

From Pareto Optimality to Topological Communities: tools for navigating complex systems with applications to language networks

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All species possess some communication system, some of them quite complex. Human language is unique in several ways: (i) It provides infinite expressivity with finite means. (ii) It contains words, quite complex devices (different from indexes or signals from other animal systems) able to form associations independent of the objects involved. (iii) Words, and other linguistic elements, enable discussing situations not present (in space or time—including speculation about past, future, possibilities, and counterfactuals). (iv) Language enables a unique internal, hierarchical representation of the world. Etc. “Language” is too big to condense in short lectures, but its study through computational means is rich enough, and calls upon methods of relevance for Complex Systems at large. We will introduce some of this methodology through examples from my work in linguistics. We will open with a short introduction to human language, to motivate its study and why it fascinated so many people over the years. Then, issues of optimality in linguistic codes will serve as an excuse to explore Pareto (or multi-objective) optimization. We will see how Pareto optimality underlies phase transition and criticality in Statistical Physics, what this reveals about linguistic codes, and how this might be of relevance in other fields. Finally we will turn our attention to syntax networks. They will illustrate how methods from dimensionality reduction help us extract insights about evolution and development. We will see how these methods are generally useful across networked systems—a field ripe with potential in which dimensionality reduction has not made a stride yet.