OIST Analysis on Metric Spaces Seminar February 25, 2026

Ollivier-Ricci curvature in non-smooth Lorentzian geometry and causal set theory

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This talk will explore some aspects of non-smooth Lorentzian geometry, the mathematical framework underlying Einstein's general relativity, which is currently being developed. Just as metric length spaces provide a synthetic generalisation of smooth Riemannian manifolds, the time-separation function plays the role of a "distance" in Lorentzian geometry. The need for a non-smooth Lorentzian framework appeared early on, most famously with Penrose's singularity theorems. After introducing the basic concepts and some initial results in this synthetic setting, we will turn to causal set theory, a radical approach to quantum gravity in which spacetime is modelled as a discrete causal graph. I will formulate a new notion of curvature, inspired by Ollivier-Ricci curvature on metric graphs, using optimal transport between causal diamonds. We will see that it does recover Ricci curvature on smooth Lorentzian manifolds, and numerical examples will be presented.