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An introduction to Lorentzian length spaces

We introduce an analogue of the theory of length spaces into the setting of Lorentzian geometry and causality theory. The role of the metric is taken over by the time separation function, in terms of which all basic notions are formulated. In this way we recover many fundamental results in greater generality, while at the same time clarifying the minimal requirements for and the interdependence of the basic building blocks of the theory. A main focus of this work is the introduction of synthetic curvature bounds, akin to the theory of Alexandrov and CAT(k)-spaces, based on triangle comparison. Applications include Lorentzian manifolds with metrics of low regularity, closed cone structures, and warped products of a line with a (Riemannian) length space. Moreover, we give an application to the low regularity (in)-extendibility of spacetimes and show that inextendibility is related to a (synthetic) curvature blow-up. In a follow-up talk Melanie Graf will detail the application to *generalized cones*, i.e., Lorentzian warped products with one-dimensional base, and their causality, curvature and also discuss singularity theorems in this setting.