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Non-regular spacetime geometry via metric geometry and optimal transport

I present an approach to Lorentzian geometry and General Relativity that does neither rely on smoothness nor on manifolds, thereby leaving the framework of classical differential geometry. This opens up the possibility to study curvature (bounds) for spacetimes of low regularity or even more general spaces. An analogous shift in perspective proved extremely fruitful in the Riemannian case (Alexandrov-, CAT(k)- and CD-spaces). Using strategies from metric geometry and tools from optimal transport this approach to non-regular spacetime geometry has given rise to a fresh and very active line of research. I will report on the recently introduced first-order calculus for causal functions and its implications for the Lorentzian splitting theorem.