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Hyperbolic Traffic Models with Uncertain Accident Dynamics

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We consider hyperbolic partial differential equations (PDEs) with a space-dependent flux function to describe traffic flow dynamics. The PDE is coupled with a stochastic process modeling traffic accidents, thereby capturing the interplay between traffic dynamics and accident occurrence. This framework enables the analysis of accident risk and its consequences in road networks.

A key aspect of the modeling approach is the comparison of different stochastic processes for accident occurrence. Beyond a baseline accident risk, these processes allow for the modeling of short- and medium-term accident characteristics as well as subsequent accidents. In particular, we employ a self-exciting Hawkes process, originally introduced in earthquake modeling, as well as related process classes.

In this talk, we present numerical methods for solving the coupled system, with a focus on the statistical moments and long-time behavior of the accident process. The effectiveness of the proposed methods is demonstrated through numerical simulations. Finally, we validate the model using real-world accident data, highlighting the impact of self-excitation on traffic risk assessment.

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