TEMPLE UNIVERSITY
Department of Mathematics

Applied Mathematics and Scientific Computing Seminar

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The Paradoxical Stability of Traffic Flow

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Abstract.

Equilibrium traffic flow, in which all vehicles move with the same velocity, is advantageous with regards to fuel efficiency and low accident risk, compared to an unsteady flow. Therefore, ways to influence traffic systems towards maintaining a near-to-equilibrium state are of great importance.

In a certain regime of traffic flow, equilibrium states are unstable, i.e., any infinitesimal perturbation will eventually evolve into a large deviation. Our interest lies in stabilizing the flow via a single actuator, for example, a well-programmed autonomous vehicle. One can formulate control strategies that can, in theory, stabilize an arbitrarily large system of vehicles. That, however, contradicts basic common sense. In the first half of the talk, I will present our latest work in resolving this paradox.

In turn, if the equilibrium flow is unstable, traffic waves arise. Certain traffic models exhibit intrinsic features of supporting non-smooth traveling waves, the so-called jamitons, which stand as a consistent representation of real traffic waves. Yet, again we encounter a paradox: the model allows for traveling waves that travel forward and waves that travel backwards. However, observed traffic waves commonly travel backwards only. We resolve this paradox via a systematic numerical study, revealing that backwards traveling jamitons exhibit relatively stronger stability over forward traveling ones.