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Understanding dynamical and statistical properties of urban mobility

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The Complex Systems Science looks for power law distributions for relevant observables as a fingerprint of the complexity character.
However the identification of an empirical power law behavior of a complex system is rarely scientifically useful by itself, but needs to be model-informed. Since multiple competing models can explain the same pattern, it even risks swamping future research with years of replicating the same, and possibly wrong, pattern analysis.
Understanding individual mobility has important implications for traffic forecasting, epidemics spreading or the evolution of cities. Remarkably enough, what appears to be under-evaluated in the study of human mobility is the relevance of travel dynamics. Human traveling behavior is usually described as a sequence of rest times and jumps in space. These two processes need to be separated, since costs are in general associated to trips while a positive utility can be associated to activities performed during stops. However, the proposed models usually neglect the role of travel time and the moving velocity and assume instantaneous jumps. We show that the observed truncated power laws in the jump size distribution can be the consequence of simple processes such as random walks with random velocities. The model is validated over a large GPS database describing the mobility of 780,000 private vehicles in Italy, where travels and stops can be easily separated, as the transition is identified by the moment when the engine is turned on or off. This allows us to evaluate accurately not only the displacements, but also travel times, speeds and rest times, and to propose a random walk acceleration model for human mobility based on simple, reasonable assumptions. Our random acceleration model leads to predictions in excellent agreement with data, and brings evidence that the long-standing interpretation with L\'evy flights is incorrect.

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