

# Data Science for Energy Efficiency of Cities

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I present a complex system approach applied to large data sets. I characterize how humans interact with built environment and to plan for better usage of urban resources.

First I present a modeling framework, TimeGeo, that generates individual trajectories in high spatial-temporal resolutions, with interpretable mechanisms and parameters capturing heterogeneous individual travel choices at urban scale. Then I assign these trips to the streets. I demonstrate that the percentage of time lost in congestion is a function of the proportion of vehicular travel demand to road infrastructure capacity, and can be studied in the framework of non-equilibrium phase transitions. In the second part, I In the second part, we address strategies of retrofitting the urban building stock. We propose a novel ranking algorithm that allows the scaling of the buildings' energy consumption from records of energy bills with building footprint and physical attributes of heat losses. Implemented for 6.204 residential buildings in Cambridge, MA, we demonstrate that the proposed ranking algorithm based on the inferred heat loss rate of buildings exhibits a power-law distribution akin to Zipf's Law, which provides a means to map an optimum path for energy savings per retrofit at city scale.