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Covid-19: What about Resilience and Scaling Dynamics?

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The current Covid-19 pandemic has underlined the need to thoroughly revisit our conceptions of managing and developing urban systems and to make them resilient to epidemics. For instance, it fundamentally questions the long-held goal of continually increasing human mobility. More generally, the definition of optimal Covid-19 mitigation strategies remains worldwide on the top of public health agendas, especially in the face of a second wave. However, the relevance of resilient strategies depends heavily on our understanding and our ability to model epidemic dynamics.

Epidemic models are phenomenologically based on the paradigm of a cascade of contacts that spreads infection. However, scaling -a fundamental characteristic that easily results from cascade models,- is not taken into account by conventional epidemic models. The introduction of ad-hoc characteristic times and corresponding rates spuriously break their scale symmetry.

Here, we theoretically argue and empirically demonstrate that Covid-19 dynamics, during both growth and decline phases, is a cascade with a rather universal scale symmetry whose power-law statistics drastically differ from those of exponential processes. This implies slower but longer phases; which are furthermore linked by a fairly simple symmetry. The resulting variability across space-time scales is a major feature that requires alternative approaches with practical consequences for data analysis and modelling. We illustrate some of these consequences using the Johns Hopkins University Center for Systems Science and Engineering database.

The obtained results explain biases of epidemic models and help to improve them. By virtue of their generality, these results pave the way for a renewed approach to epidemics, and more generally to growth phenomena, towards more resilient development and management of our urban systems.