**SEMINAR #9**

# SOLVING ZIPF: THE GROWTH EQUATION OF CITIES

## ABSTRACT

A fundamental problem for the Science of Cities is to understand the hierarchical organization of city population and the statistical occurrence of megacities. This was first thought to be described by a universal principle known as Zipf's law. However, the validity of this law has been challenged by recent empirical studies. In addition, a theoretical model must also be able to explain the rises and falls of cities and civilizations. Despite many attempts that I will briefly review here (the Gibrat and Gabaix models), these fundamental questions have not yet been satisfactorily answered. In this talk, starting from an empirical analysis of recent datasets (for Canada, France, the UK and the USA) I will derive a stochastic equation with multiplicative noises for modelling population growth in cities. This model reveals how rare, but large, interurban migratory shocks dominate city growth and predicts a complex shape for the distribution of city population. It also shows that, owing to finite-time effects, Zipf's law does not hold in general, implying a more complex organization of cities. It also predicts the existence of multiple temporal variations in the city hierarchy, in agreement with empirical observations.
If time allows, I will end this talk with a discussion about future challenges.

## PRESENTED BY

**Marc Barthelemy** is a former student of the Ecole Normale Superieure of Paris. In 1992, he graduated at the University of Paris VI with a thesis in theoretical physics titled "Random walks in random media". Since 1992, Marc Barthelemy has held a permanent position at the CEA and is now research director at the Institute of Theoretical Physics (IPhT) in Saclay and a member of the Center of Social Analysis and Mathematics (CAMS) at the Ecole des Hautes Etudes en Sciences Sociales (EHESS).

His research interests moved towards applications of statistical physics to complex systems, complex networks, theoretical epidemiology, and spatial networks. Focusing on both data analysis and modeling with the tools of statistical physics, Marc Barthelemy is working on various aspects of the emerging science of cities. He is the author of recent books on spatial networks (Morphogenesis of spatial networks, Springer) and on cities (The structure and dynamics of cities, Cambridge Univ. Press.).

## MARC BARTHELEMY

CNRS, PARIS

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