Post-Doc position : Multifractal Analysis of urban/population/ressources data Physics Department of ENS de Lyon Available September 2019

Research themes : Multifractal analysis and modeling for cities.

Duration: 12 months, with possible 12-month renewal.

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Required qualifications : Candidates should have received a high-level academic formation in statistical signal processing. They must be strongly motivated by exploratory and multidisciplinary research topics. Skills and practice of Matlab and Python are expected. **Location :** The candidate will be hired by the University of Paris-Est through the project AAP Impulsion *MULTIFRAC*, and will work with the Signal, System and Physics team, within the Physics Laboratory at ENS Lyon.

Application : Interested candidates should send their CV, a motivation letter and at least two references.

Keywords : Geography, population, urbanism, city growth, image processing, scale-free, multifractal, point process, real-world data.

Description : Often, data associated with city organization or growth, such as population densities, building structures, ressources are multiscale in nature, that is their dynamics are spread across a wide range of scales, with no typical scale playing a specific role. The analysis and modeling of such scale-free organizations and dynamics in city-based data constitute a long standing research themes, with important stakes in term of territory management and population behaviors. However, because data can be very different in nature (density map, binary image of build area,...), in modality (teledetection data, simulated data, road network, population density...) and resolution, their analyses requires skills beyond the original-mother field "geography" and calls for interdisciplinary teams gathering expertize in computer sciences, mathematics and statistics.

An example of the data that will be treated : deciles of income in the Paris region



Since the early 1960s, fractal concepts were proposed as models to account for scale-

free dynamics of multiscale phenomena and multifractal analysis has nowadays become a standard tool in signal/image processing. However, the use of fractal concepts and tools to analyze city-type data implies to address several critical issues stemming from the nature and type of data, including heterogeneities, anisotropy, lacunarity,...

Therefore, the main goal of the current project will be to develop, assess and put at work on real data tools permitting an effective, accurate and relevant analysis of scale-free and multifractal properties in city-type data. These tools will need to take into account the binary (point-process like) nature of some such data and also will be orientated toward multivariate analysis (several images different in nature of the same area need to ne analyzed jointly). The project thus implies methodological contributions, numerical simulation assessment and application to real data. The project is thus highly interdisciplinary and will be conducted in collaboration with expert in urban/city organizations and structures as well as with mathematicians and image processing teams.