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Nowcasting well-being in societies: at the crossroads of big data, network science, and complex systems

Topic 3 – More rapid statistics and indicators on new phenomena

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Introduction

Data-driven modeling and social mining has the potential of yielding a planetary nervous system capable of supporting the computation, monitoring and nowcasting of new indices of social well-being, a novel compass long-awaited by decision-makers and citizens, well beyond the limitations of the gross national product (GDP) per capita. The key scientific challenge is to make the different dimensions of social well-being globally measurable in real-time: besides material living standards (income, consumption and wealth), it is important to consider many other factors, such as health, education, personal activities including work, political voice and governance, social connections and relationships, environment, security. We discuss how the availability of big data sources, such as mobile phone data, together with novel social mining methods powered by network science and complex system modeling, are paving new avenues to quantify the human and social capital in our societies, and therefore to monitor and nowcast the various facets of well-being.

Methods / Problem statement

We propose a data-driven analytical framework that uses Big Data to extract meaningful measures of human behavior and estimate indicators for the socio-economic development. The analytical framework we propose is repeatable for different countries and geographic scales since it is based on mobile phone data, the so-called CDRs (Call Detail Records) of calling and texting activity of users. Moreover, CDR data have proven to be a hi-fi proxy for individuals' movements and social interactions. We apply our analytical framework on large-scale mobile phone data – 20 million users and 5.7 billions calls – and quantify the relations between human mobility, social interactions and economic development in France using municipality-level official statistics as external comparison measurements. We first define four individual measures derived from mobile phone data which describe different aspects of individual human behavior: the volume of mobility, the diversity of mobility, the volume of sociality and the diversity of sociality. Each individual measure is computed for every user in our dataset based on locations and calls as recorded in the mobile phone data. In a second stage, we aggregate the four individual measures at the level of French municipalities and explore the correlations between the four measures and two external indicators of socio-economic development.

Results / Proposed solution

We find that the average mobility diversity of individuals resident in the same municipality exhibits a superior correlation degree with the socio-economic indicators. We confirm these results against two different null models, an observation that allows us to reject the hypothesis that our discovery occurred by chance. Next, we build regression and classification models to predict the external socio-economic indicators from the population density and the social and mobility measures aggregated at municipality scale. We show that the diversity of human mobility significantly adds a predictive power in both regression

and classification models, substantially more than the diversity of social contacts and demographic measures such as population density, a factor that is known to be correlated with the intensity of human activities.

Conclusions

The importance of our findings is twofold. On one side, it offers a new stimulus to social research: Diversity is a key concept not only for natural ecosystems but also for the social ecosystems, and can be used to better understand the complexity of our interconnected society. On the other side, our results reveal the high potential of Big Data in providing representative, relatively inexpensive and readily available measures as proxies of socio-economic development. Our analytical framework opens an interesting perspective to engineer official statistic processes to monitor human behavior through mobile phone data. New statistical indicators can be defined to describe and possibly “nowcast” the economic status of a territory, even when such measurements would be impossible using traditional censuses and surveys.