Studying information dissemination in a d2d network using Call details records

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Labs

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Abstract

In a network of devices in close proximity such as Device to Device (D2D) communication, we study the dissemination of public safety information at country scale level. In order to provide a realistic model for the information dissemination, we extract spatial distribution of the population of Ivory Coast from census data and determine migration pattern from the call detail records obtained during the Data for Development (D4D) challenge [1]. We latter apply epidemic model towards the information dissemination process. We then propose enhancements to the dissemination model by adding latent states and beamforming to the epidemic model. In this paper, we study the transient states towards the evolution of the population having the information for different cases. Through the results we show that enhancements in the dissemination process can be achieved in large and realistic scenarios.

Context: Dissemination of emergency information in metapopulation and dynamic network using epidemic model.

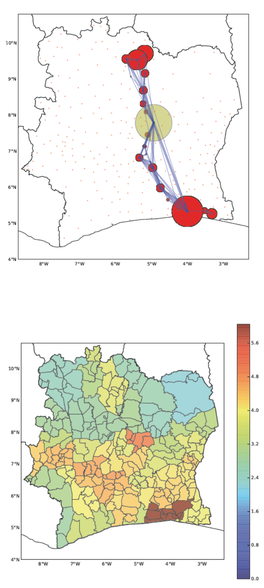
Data Analysis

- **Extract User's movement at the country level from Call Details Records provided by Orange [1].**
- **Generate transition probability matrix (ν) from all movement patterns.**
- **Determine population density from Census data.**

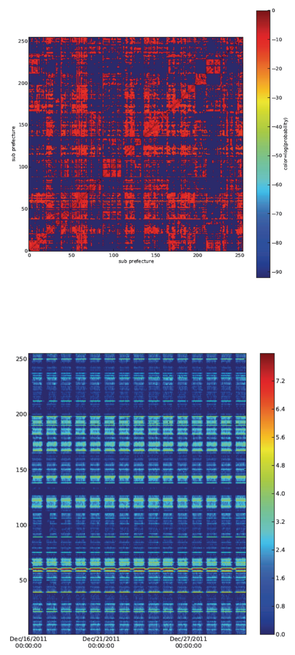
Model

- **Split the country into metapopulation [2,6] (subprefecture).**
- **Generate mobility between each meatpopulation base on our analysis of the CDR dataset of Orange.**
- **Add latent states to the initial SIR model in order to modelize a variable density of user in each metapopulation.**
- **Generate the epidemic process in order to simulate the spreading of information accross the country.**

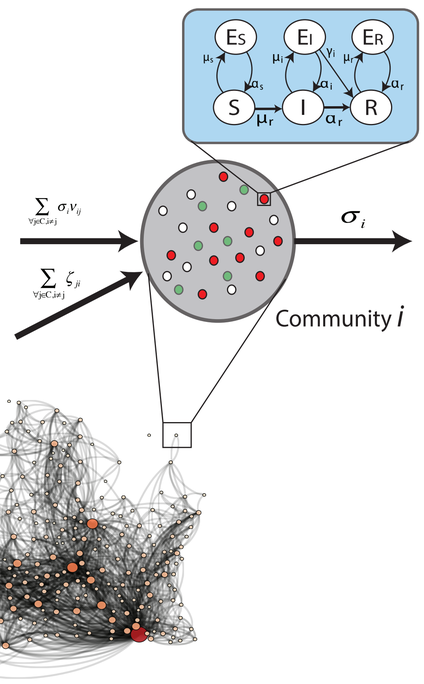
Raw data



Analysis

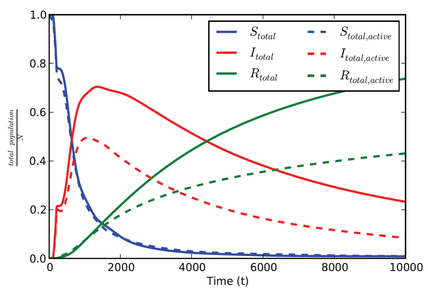


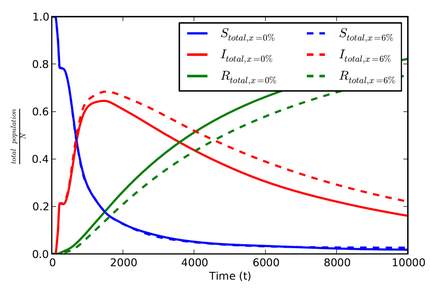
Diffusions model
(base on SIR spreading process)



Results

- **Variable people density affects the information spreading in mobile environment.**
- **Information spreading through local interaction could lead diffusion at country scale in a timely maner (Cf. Video [3]).**
- **We solve numerically a large system of differential equations to compute the spatio-temporal evolution of the diffusion.**
- **We validate the result by simulations using the Gillespie algorithm (Tau-Leap).**





Conclusion

We first display as supplementary material a movie [3] that shows the diffusion process in Ivory Coast. We can see that the diffusion that initially takes place in the East side of the country, is spreading quickly into the major cities of Ivory Coast through: Abidjan (the economic captital), Bouak (the second largest city), Youkousono, (Political Capital) Soudre. Later on, the information is spreading more slowly into less populated areas, mostly from Est to West. The West side of the country is well know to be mostly an agricultural region (Cooa, coffee, rice). We can also notice that the diffusion of the information takes a very long time to spread over the northern part of the country. As Suggested by [4] whom have been working on the same datasets, the fact that the northern part of the country is less diffusive might be the consequence of socio-economic disparity in place inside the country. Highlighting on the fact that this part of the country is still relatively "disconnected from the main economic and political center of Côte d'Ivoire".

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