

ICI Project: Individual-based epidemic propagation simulator based on a Digital Twin

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Introduction

Multi-agent simulation can be used in the field of epidemiology to evaluate sanitary policies with a custom application on targeted sub-population or location. A multi-disciplinary team of geomaticians and probabilists develops the ICI project. It generates a very detailed and realistic geographical environment and simulates the propagation of an indoor-driven epidemic in a middle sized city.

Methods

We create original data fusion algorithms using multiple datasources. We first model an exhausting census of activity or housing units within each buildings with spatial and functional attributes. We then generate a geolocalized and well-detailed synthetic population. Each individual is assigned to a building's activity for every time-lapses of the simulation. A last module calculates probabilities of infections with a 9-state epidemiological model. Monte-Carlo replication are run in order to obtain robust results.

Results

A dedicated online application enables users to explore different characteristics of each set of input parameters (characteristics of the contamination, policies application, geographical zone...) or output indicators (sub-population, location of infection...). Spatio-temporal visual indicators are used to highlight spatial dynamic patterns. ICI simulations are run by the OpenMOLE platform for model exploration purposes (sensitivity and diversity analysis, multi-objective optimizations of sanitary policies).

Conclusion

The ICI platform makes it possible to elaborate and compare a wide range of precise sanitary policies onto well-detailed urban models. It raised great interest in the interventional epidemiologist community. A collaboration with public sanitary authorities starts in order to adapt the platform for the simulation of future pandemics. ICI is also part of the French National Digital Twin project.