COMOKIT

AN AGENT-BASED SPATIALLY EXPLICIT MODELING KIT FOR ANALYZING AND COMPARING INTERVENTIONS AGAINST THE COVID-19 EPIDEMIC AT THE SCALE OF A CITY

Project key information

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Partner institutions

IRD UMMISCO, The National Institute of Hygiene and Epidemiology (NIHE), INRAE MIAT, and more particularly the MAD team, The Cooperative Multi-Agent System (SMAC) team of the UMR CNRS IRIT

Context

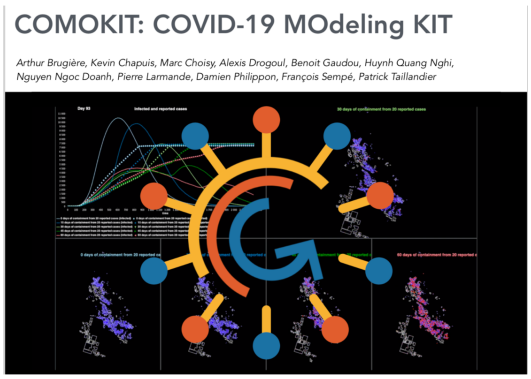
In less than 3 months after its emergence in China, the COVID-19 pandemic has spread to at least 180 countries. In the absence of previous experience with this novel disease, public health authorities have been forced to experiment, in a short period of time and in a largely uninformed way, various combinations of interventions, in terms of modalities (more or less localized containment, massive testing campaigns, encouragement to wear masks, closing of schools, companies, public transportations, etc.) and temporality (reaction time, duration, delay after announcements, etc.) (Chang et al., 2020; Koo et al., 2020). For instance, Vietnam quickly quarantined outbreaks (e.g. communes of Son Loi and Ha Loi in the province of Vinh Phuc) and limited trade with China (La, et al., 2020; Thanh et al., 2020; Nguyen et al., 2020). In contrast, South Korea decided to move to a massive drive-through virus testing program (UNDP, 2020) while France chose a late lockdown of the whole country. An interesting overview of the strategies of 11 EU countries is provided in (Flaxman et al., 2020). Needless to say, many questions remain unanswered about the effectiveness of these policies, their feasibility and their temporal aspects: when should containment be introduced? When should it be stopped? Is selective quarantine preferable to containment of the entire population? What is/would be the impact of closing schools alone? What is the best strategy to implement with respect to the countries' resources constraints (existence of a state able to enforce containment, capacity of hospitals, capacity of inhabitants to survive in a containment situation, etc.)? How should deconfinement be organized while controlling the epidemic (identifying and confining the contaminated, identifying and preserving fragile populations) to avoid a sudden rebound of the epidemic in certain areas?

As the pandemic is progressing, data sets are building up at an increasing pace. This brings great possibilities for authorities to answer some of these questions or make informed adjustments to the current and planned interventions. But doing so requires the availability of tools and methodologies that enable fast analysis, understanding, comparison and forecasting of the effectiveness of the responses against COVID-19 across different communities and contexts (Koo et al. 2020).

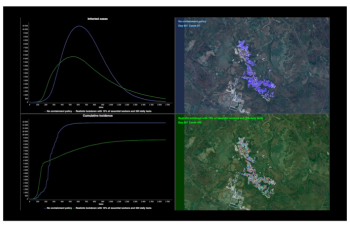
In practice, the challenge is to combine current epidemiological knowledge of the disease with more qualitative studies, in particular on the social and psychological aspects of the implementation of these responses. Indeed, people are both the main targets and generally the principal actors of these responses, and a large part of their success depend ultimately on the willingness of people to comply with them.

Objectives

The objective of this project is to design, implement and make available an agent-based simulator built on the GAMA platform (Taillandier et al. 2019) designed to be generic, scalable and therefore portable across a variety of social and geographical contexts, provided the appropriate input data is made available. In particular, the simulator will be based on the description of realistic individual behaviors (with respect, particularly, to their compliance to mitigation and suppression policies). Finally, while it will be implemented for an immediate application to COVID-19, the modeling kit will be designed to be quickly adaptable to other infectious diseases, paving the way for epidemiological models that incorporate more ambitious social components.



EXAMPLE OF A REALISTIC lockdown policy: locking schools, positive cases at home, allowing 10% of workers to go to work, 100% of non-positive people to go shopping once a day. Detection is done at a rate of 300 tests / day.



Organisation and expected results

The project was born from the collaboration between a number of research teams in France and Vietnam, gathered together through the long-standing partnerships established in Vietnam by IRD since 1995, on one hand, and by the design of a common, general purpose, modeling platform, GAMA (http://gama-platform.org), since 2007, on the other hand. They are IRD UMMISCO, The National Institute of Hygiene and Epidemiology (NIHE), INRAE MIAT or more particularly the MAD team and The Cooperative Multi-Agent System (SMAC) team of the UMR CNRS IRIT.

The combination of these complementary research networks will allow the project team to address the most prominent challenges of building realistic and operational socio-epidemiological models.

The main expected result of COMOKIT is a web-based application, akin to a decision-support system, built on top of a simulator, which can be used to analyze and compare interventions against the COVID-19 epidemic in specific case studies. It will be based on the integrated model described in this document. The simulator will come with built-in synthetic population and built environment generation algorithms, a set of built-in mitigation policies and default individual behaviors so that users can build and run simple models in a matter of minutes.

Applications in the South

Application 1: Simulation supports the study of epidemic developments and proposes epidemic response plans at Da Nang Hospital and serves as a supporting document for training on epidemic prevention at hospitals throughout Vietnam.

Application 2: Simulation supports research and proposes options to respond to the epidemic spreading across borders of Vietnam (concentrating through the open-path trail - illegally) with the scope of transmission at 2 levels: (1) level 1- spreading within the areas around the border; (2) level 2- spreading to other provinces, affecting residential areas and industrial zones.

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