

COMOKIT-Albatross: An agent-based, activity-based model on COVID-19 simulation

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Keywords

COMOKIT, Albatross, Activity-based model

Abstract

COVID-19 may become a norm in our day-to-day life the way flu did. However, given the unique characteristics of COVID-19 pandemic, our societies are not ready to effectively respond to extensive changes such as expensive lockdowns or teleworking. Society cannot afford operating, in the long run, under lockdown restrictions. Therefore, policies so far adopted by many politicians is to impose and relax restriction measures on periodic basis to assure the economy and wellbeing of the society are guaranteed while being able to manage the influx of hospitalized citizens. Nonetheless, the effectiveness of these restrictive policies, which are typically hypothetical, is to large extent unknown to us. Most of the already implemented policies are defined around quarantining people (including infected and uninfected). The main goal of these quarantine-based policies is to reduce the exposure of the susceptible population to the disease. However, several activities remain vital for the society, e.g., grocery shopping, and medical work trips. Thus, modeling human activities and their mobility patterns is critical for studying the spatial transmission of infectious diseases in large-scale urban areas.

Activity-based models (ABMs) have been developed by transport modelers in the past decades replicating the mobility of people with high temporal and spatial resolution. We are working with such model (i.e., Albatross) which can simulate data-driven activity pattern and travel of all people in the Netherlands which such fine granularity. Albatross mimics the decision-making process of the agent based on decision-trees derived from activity diary data. We understand from this model who interacts with who, where, for how long, how is using which transport mode and so on. In addition to location and modes of transportation of activities, detailed information about demographic attributes of people can be provided by Albatross. In epidemiology, it is essential to know age, gender, and any health background of individuals. Nonetheless, the existing SEIR (Susceptible – Exposed – Infectious – Recovered) models are completely blind to these attributes of people because of their intrinsic crude aggregation in time, space and demographics.

Against this background, we plan to combine the activity-based model (Albatross) with an epidemiology agent-based model (COMOKIT). COMOKIT-Albatross is a dedicated custom adaptation of COMOKIT. It simulates the spread of COVID-19 at the scale of the Netherlands. A large-scale (multi-million agents) simulation with the aid of Dutch supercomputer Cartesius. The activity diary for COMOKIT comes from the pre-generated mobility agenda in Albatross. The daily activities in Albatross are modelled at the precision of a minute, while the default COMOKIT behavior is modelled at the precision of one hour. The atomic spatial unit of this extension is at a Dutch 6-digit Postal Block level compared to the building level in COMOKIT. Epidemiological dynamics for COMOKIT-Albatross has also been modified to take into account this larger atomic spatial unit. The larger spatial resolution makes it possible to simulate a wider region, and fits the required spatial distribution of activities as modelled in Albatross agenda generator.

Additional material

Website: <https://comokit.org/docs/officialExtensions/C-Albatross>