SIMPEST: an agent-based model to simulate plague epidemics in Madagascar

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Abstract:
Since European settlers brought plague to Madagascar, research on this particular epidemiologic case has been focusing upon this disease’s transmission process—between the main host, rats, and the secondary one, humans, via a vector, fleas. Epidemiologists’ research based on experimental method has achieved a fair knowledge of the transmission process. Nowadays, research aims to a better control of plague, studying its behaviour by the way it appears, reappears, remains and spreads in its environment. This new purpose is to be fulfilled via a new kind of computer-based modelling derived from artificial intelligence techniques and complexity paradigm.

Agent-based simulation offers a new way to investigate communicable diseases patterns, since it helps understanding the relation between assumptions made at an individual level and the disease dynamics arising at the level of a population. We designed a theoretical model, SIMPEST to simulate bubonic plague transmission in Madagascar, in which the specific behaviour of rats, fleas and humans is spatially formalized. Fundamental assumptions are that individuals are heterogeneous, mobile and interact locally. We performed some first sensitivity analyses to classify parameters and input variables with respect to their influence on a selected output variable: the potential force of infection to humans during a rodent epidemic phase. The parameters taken into consideration were those dealing with agents reproduction and individual disease transmission and duration. The sensitivity analysis showed that the most important parameters are those governing life and disease individual duration.

Keywords:
Plague, Madagascar, Agent-based modelling, sensitivity analysis