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Towards Model Reduction of Individual-Based Models in Epidemiology: when Reinforcement Learning meets Control Theory.

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Modelling epidemics via classical population-based models suffers from shortcomings that so-called individual-based models are able to overcome, for they are able to take into account heterogeneity (e.g. super-spreaders) and describe the dynamics involved in small clusters. In return, such models often involve large graphs which are expensive to simulate and difficult to optimise, be it in theory or practically.

By combining the reinforcement-learning philosophy with reduced models, we propose a scalable numerical approach to determining (in some sense) optimal health policies for a stochastic epidemiological graph-model taking into account super-spreaders. More precisely, we introduce a deterministic reduced model involving a neural network, and use it to derive optimal health policies through an optimal control approach. It is meant to faithfully mimic the local dynamics of the original, more complex, graph-model. Roughly speaking, this is achieved by sequentially training the network until an optimal control strategy for the corresponding reduced model manages to equally well contain the epidemic when simulated on the graph-model.

Having described the practical implementation of this approach, we will discuss the range of applicability of the reduced model and to what extent the estimated control strategies could provide useful qualitative information to health authorities.

REFERENCES

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