The AI Epidemiologist

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Abstract

We propose a real-time approach for localized bio-surveillance and intervention to prevent new pandemic outbreaks. We aim to show that highly-targeted, localized lock-downs could be as effective as large-scale long-term lock-downs, if not more.

At any given time, there is high uncertainty about the state of the world (i.e., Who is infected? Who is contagious?), backed by incomplete, anonymized, delayed data (e.g. test results, contact and location history). There are decisions which must be made under uncertainty (Who can go outside? Which businesses can open?), and hard resource constraints (We can only test 1000 people per day – who is it most critical that we test?) This yields an optimization question: with limited knowledge and limited resources, what actions minimize economic and social costs? Costs include those due to actual infections (deaths, healthcare expense, etc.) and measures taken to prevent infection (quarantines causing unemployment lost productivity). We frame this as a reinforcement learning problem, with agents (policy-makers, businesses, individuals) taking actions within an environment (a stochastic model of disease spread) to maximize reward (or minimize cost). We are inspired by the AI Economist, which shows the potential of reinforcement learning in designing dynamic economic policies to maximize a given socioeconomic objective. Along similar lines, we envision an “AI Epidemiologist” which can dynamically respond to an evolving pandemic situation, to maximize an objective function.

We aim to create a unified simulation environment in which multiple intervention strategies can be compared, to select the best one(s). Additionally, such a platform could help expose which simulation parameters are most critical to model. (E.g. how much would the value of a certain parameter, e.g. incubation period, affect what actions we should take?) Many efforts are being made to model the dynamics of COVID-19 spread; putting these models into a decision-theoretic context could help guide the activity of researchers.

With no surveillance, the "safe" answer is large-scale lock-down until the disease is eradicated. But with partial data, a more intelligent, fine-grained approach should be possible – enabling most people to return to "normal", only requiring sub-populations to isolate for limited times.

I. Introduction

References