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Adapted SEIR Model for Analyzing the Status of COVID-19 in Ontario, using Age Stratification, Contact Rates, and Mobility Data

Abstract: As of July 7th, 2020, there have been over 12 million worldwide cases of COVID-19, including over 100 000 in Canada. Many groups have taken various approaches to modeling the spread of this pandemic. We propose our approach to modelling COVID-19 in Ontario, extending the classic SEIR compartmental model by introducing three novel components. First, we incorporate age stratification into our population structure, distinguishing between 0-19 year olds, 20-59 year olds, and individuals aged 60+. Secondly, we apply the age stratified contact rate matrix for Canada found by Prem, Cook, and Jit (2017) to our model. Lastly, we introduce several additional compartments to the SEIR model, distinguishing between pre-symptomatic, asymptomatic and symptomatic infectious individuals, and including an isolation compartment. Using a derivative-free optimization algorithm, we solve for the optimal effective contact rate to fit our model to reported cases of COVID-19 in Ontario by case onset date, as reported by Ontario's integrated Public Health Information System (iPHIS). Lastly, we explore the use of Google Mobility data to infer its effect on contact rates under social-distancing guidelines. As individuals' mobility changes through various phases of containment measures (lockdown, stage 1, stage 2, etc.) we explore the change on pathogen transmission as influenced by other factors such as mask use/wear requirements, bans on social gatherings, reduced social bubbles, working from home policies, etc.