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Real-time estimation of the effective reproduction number of COVID-19 from behavioral data

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Near-real time estimations of the effective reproduction number are among the most important tools to track the progression of a pandemic and to inform policy makers and the general public. However, these estimations rely on reported case numbers, commonly recorded with significant biases. The epidemic outcome is strongly influenced by the dynamics of social contacts, which are neglected in conventional surveillance systems as their real-time observation is challenging.

Here, we propose a concept using online and offline behavioral data, recording age stratified contact matrices at a daily rate. These contact matrices serve as an input to age structured compartmental models of transmission dynamics, expressed by a high-dimensional system of differential equations. Modeling the epidemic using the reconstructed matrices we dynamically estimate the effective reproduction number during the two first waves of the COVID-19 pandemic in Hungary by the spectral radius of a time-varying next generation matrix. Our results demonstrate how behavioral data combined with differential equation models can be used to build alternative monitoring systems complementing the established public health surveillance. They can identify and provide better signals during periods when official estimates appear unreliable due to observational biases.

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