Early detection of infectious diseases using large-scale sensory data from mobile devices

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Judging by the past, infectious diseases pose the greatest risk for a global catastrophe. Just like the spread of wildfires, early detection of infectious disease and a comprehensive understanding of its transmission dynamics in real-time are instrumental to contain an outbreak. We will develop an algorithm for early detection of influenza transmission by analyzing sensory data from mobile devices. Our work is motivated by exceptional data of 17 billion records, documenting the location of 1.6 million cellular users during the winter of 2012-13, and detailed medical data of influenza cases during this period. Our methodological approach to detect influenza includes the integration of information about 1) **the individual**, by developing machine learning models to analyze personal-level movement patterns that can indicate a behavioral change due to influenza infection, 2) **the general population**, by developing a contact network to describe the contact mixing patterns in the Israeli population, based on the cellular location data and demographic data from the Israeli Central Bureau of Statistics, and 3) **the disease dynamics**, by developing a transmission model for influenza infection. Our study can improve the understanding of the spatiotemporal dynamics of influenza, and set the first step towards the development of a detection system able to identify abnormalities in the population due to a bioterrorist attack or natural-cause epidemic in real-time.