

A phenomenological methodology for wave detection in epidemics

Brettenny, W; Holloway, Jennifer P; Fabris-Rotelli, I; Dudeni-Tlhone, Nontembeko; Abdelatif, Nontembeko; Le Roux, Wouter J; Manjoo-Docrat, R; Debba, Pravesh

Abstract

In both the management and modelling of epidemic outbreaks, the ability to determine the start of a wave of infections is of vital importance. Not only does this advantage the modelling of the outbreak, but, if done in real-time, can assist with a nation's response to the disease. In this study, a bidirectional long-short-term-memory (Bi-LSTM) network is used to determine the start and end of the COVID-19 waves experienced in the district and metropolitan municipalities of Gauteng, South Africa, from 2020-2022 as well as the waves of the cholera outbreaks occurring in the Beira area of Mozambique between 1999 and 2005, in real-time. The problem of real-time scaling of the data prior to the first wave of an epidemic is addressed using globally available real-time information from first waves experienced in other countries and independent territories alongside the observed South African data. The use of the Bi-LSTM predicted starting dates is demonstrated for the second waves of COVID-19 infections experienced in Gauteng in 2020/21. Using the predicted starting dates, spatial-SEIR models are used to predict hospitalisations as a result of COVID-19 infections in each of the district and metropolitan municipalities of Gauteng. The fitted Bi-LSTM model demonstrates effectiveness in predicting the start and end dates of epidemic waves in real-time, allowing for pre-emptive disease modelling and predictions of spread. Moreover, it is shown that the use cases for the fitted model are not limited to COVID-19 studies, but can also be applied to other disease outbreaks that follow similar wave patterns.