

# Piecewise linear modelling and change-point analysis of COVID-19 outbreak in Malaysia

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**Abstract.** In Malaysia, COVID-19 were first detected as imported cases on 25 January and as local infection on 4 February 2020. A surge of positive cases ensued by March 2020 which led to a series of countrywide containment and mitigation measures known as Movement Control Order (MCO). We study the direct effects of MCO on the course of epidemic by analyzing the cumulative and daily infection cases of COVID-19 up to 31 December 2020 in Malaysia and its states using piecewise linear regression and segment neighborhoods algorithm of change-point analysis, respectively. Through piecewise regression on nationwide cases, MCO were likely to almost flatten the epidemic curve in just one month after it was first initiated. While for stateswise cases, the average length of series of concave downward is six months before it turn to concave upward, indicating the period of which deceleration of new cases can be expected. However, the starting of this wave of COVID-19 can be relatively vary for three months in different states and federal territories. Together with change-point analysis on daily cases, the statewide epidemic phases could be subdivided into two to four regimes, whereby the majority of phase transitions fall in April and last quarter of 2020. Overall, the statistical modelling shows that the immediate effect of MCO appears to be effective.

## 1. Introduction

Coronavirus Disease 2019 (COVID-19) is an acute respiratory illness caused by a novel strain of coronavirus, namely Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2), believed to be derived from bats [1–2]. The disease first emerged in December 2019 in Wuhan city of Hubei Province; the epicenter of COVID-19 outbreak in China. Within three months, the disease has spread interminably on a global scale prompting the World Health Organization (WHO) to declare it as a pandemic on March 2020 [3]. As of 23 February 2021, there have been approximately 111,400,000 laboratory-confirmed cases of COVID-19 reported worldwide with 2,470,772 fatalities according to WHO [4].

Malaysia initially joined the extensive list of countries affected by the novel coronavirus when three imported cases of COVID-19 were detected on 25 January 2020 amongst Chinese nationals who visited Malaysia via Singapore on 23 January 2020 [5]. By the beginning of February, the first local infection was identified on 4 February 2020, in which the victim had been travelling to Singapore for business purposes [6–7]. Two days later, Malaysia announced its first case of COVID-19 infected via local

