Densely Connected Neural Network and Permutation Entropy in the Early Diagnostic in COVID patients

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Abstract

The COVID-19 pandemic has been characterized by the high number of infected cases due to its rapid spread around the world, with more than 6 million of deaths. Given that we are all at risk of acquiring this disease and that vaccines do not completely stop its spread, it is necessary to continue proposing tools that help mitigate it. This is the reason why it is ideal to develop a method for early detection of the disease, for which this work uses the Stanford University database to classify patients with COVID-19 and healthy ones. In order to do that we used a densely connected neural network on a total of 77 statistical features, including permutation entropy, that were contrasted from two different time windows, extracted from the heart rate of 24 COVID patients and 24 healthy people. The results of the classification process reached an accuracy of 86.67% and 100% of precision with the additional parameters of recall and F1-score being 80% and 88.89% respectively. Finally, from the ROC curve for this classification model it could be calculated an AUC of 0.982.

1. Introduction

The Coronavirus disease 2019, commonly known as COVID-19, is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), belonging to the coronaviridae family. It was first detected in Wuhan, in December 2019, and has been responsible of the greatest pandemic of the last 100 years [1]. Compared to SARS-CoV-1 and Middle East respiratory syndrome (MERS-CoV) viruses, COVID-19 has lower morbidity and mortality, but has spread faster [10] and studies suggest that most of the transmission is respiratory, with viruses suspended in droplets, and the dynamics of transmission are heterogeneous [9]. According to the World Health Organization, until March 2022, globally there have been about 486 millions of confirmed infection cases, and more than 6 millions of deaths [2]. Despite of the virus has muted in several variants [3–5], product of the high number of infections, the clinical manifestation of COVID-19 are similar to many viral illnesses [6] main symptoms are fever, disnea, cough [7, 8]. It mainly affects the respiratory system, and while we are all at risk of developing serious illness, factors such as age and underlying medical or comorbide conditions, such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer, are determinants of disease severity and progression [11] and even more so if the disease is not detected early. With the advancement of technology, mainly the field of artificial intelligence, it has been possible to detect infection cases before the onset of symptoms or in asymtomatic persons, using different data of patients such us clinical variables, blood test, computed tomography, X-ray among others [12–14] and deep learning and machine laerning algorithms with a high degree of accuracy, and specially some of them have used variables obtained from smart devices, which are very convenient for a non invasive diagnosis [15]. Taking into account that after the advent of vaccines, the spread of COVID-19 has slightly decreased, but has not stopped, it is very important to develop useful tools that help to decrease the spread and continuity of this pandemic, that's why this work uses an artificial neural network in order to discriminate and predict COVID-19 cases using a database which has variables from wearable devices.

2. Method

2.1. Preprocessed

The database used is from Stanford University [16]. They conducted a study using data of heart rate and quantity of steps using smart watches and from a smartphone