ORIGINAL ARTICLE

COVID-19 Community Temporal Visualizer: a new methodology for the network-based analysis and visualization of COVID-19 data

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Abstract

Understanding the evolution of the spread of the COVID-19 pandemic requires the analysis of several data at the spatial and temporal levels. Here, we present a new network-based methodology to analyze COVID-19 data measures containing spatial and temporal features and its application on a real dataset. The goal of the methodology is to analyze sets of homogeneous datasets (i.e. COVID-19 data taken in different periods and in several regions) using a statistical test to find similar/dissimilar datasets, mapping such similarity information on a graph and then using a community detection algorithm to visualize and analyze the spatio-temporal evolution of data. We evaluated diverse Italian COVID-19 data made publicly available by the Italian Protezione Civile Department at https://github.com/pcm-dpc/COVID-19/. Furthermore, we considered the climate data related to two periods and we integrated them with COVID-19 data measures to detect new communities related to climate changes. In conclusion, the application of the proposed methodology provides a network-based representation of the COVID-19 measures by highlighting the different behaviour of regions with respect to pandemics data released by Protezione Civile and climate data. The methodology and its implementation as R function are publicly available at https://github.com/mmilano87/analyzeC19D.

Keywords COVID-19 · Network analysis · Community detection

1 Introduction

The coronavirus epidemic started in China, in November 2019 (Wu and McGoogan 2020) and it has quickly spread in hundreds of countries in the world. COVID-19 disease is a viral infection produced by Sars-CoV-2, a new coronavirus (Wu and McGoogan 2020). The high transmissibility, the high level of infectivity (Huang et al. 2020), and the initial absence of a COVID-19 vaccine caused a huge number of deaths. In March 2020, World Health Organization (WHO) declared COVID-19 as a serious epidemic. In Italy, the first transmission of COVID-19 disease was reported on February, 2020, in the Italian northern regions (Lai et al. 2020) and it spreaded rapidly in the rest of the regions. Italy was seriously influenced by the epidemic with 2697,296 infected and 93,045 deaths recorded at the end of February, 2020. At the time to writing the infected are 4172,525 and the deaths are 124,646.

The data about COVID-19 cases include spatial information (e.g.the geographical regions where data are recorded), and temporal information (e.g., the day of measurement). Thus, an effective analysis methodology must include these two features. This requirement is reinforced if COVID-19 evolution would be related to clinical data that have similar spatio-temporal features.

In this work, we present COVID-19 Community Temporal Visualizer (CCTV) a new methodology for the network-based analysis and visualization of COVID-19 data.

CCTV methodology enables to depict COVID-19 data as networks where each node represents an Italian region and each edge connects statistically similar regions. Then, CCTV methodology ensures to extract clusters of regions

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