

Study of the beginning of the COVID-19 pandemic in cities of Pernambuco, Brazil, and its spatial and socioeconomic relationship using topological data analysis

Marcela Portela Santos de Figueiredo¹, Joelma Mayara da Silva², Laura Alves Pacífico³, Wilson Rosa de Oliveira Júnior⁴

^{1,2,4} Federal Rural University of Pernambuco

³Federal University of Pernambuco

Abbreviated abstract: This work aims to analyze the portrait of the beginning of the COVID-19 pandemic in Pernambuco, its spatial, temporal, socioeconomic relationship at the municipal level. For this purpose, it is intended to use Ball Mapper. Thus, Recife, Olinda, Paulista, Camaribe, and Jaboatão dos Guararapes differed from other municipalities in PE when analyzing the IDHM, GDP per Capita, and Population Density using Ball Mapper. Ball Mapper shows that Recife, at the beginning of the pandemic in Brazil, was already leading the number of cases concerning other municipalities in PE.

Related publications: (up to 2 references)

–Dlotko, P., arXiv preprint arXiv:1901.07410 (2019).

– Dlotko, P. and Rudkin S., arXiv preprint arXiv:2004.03282 (2020).

Previous work, challenge, and approach

- In previous studies, was possible to construct an abstract representation of socioeconomic data, overlaying onto it the confirmed cases of Covid-19 in England, using the Topological Data Analysis Ball Mapper algorithm
- In this work, we proposed to analyze the relationship of covid-19 cases and socioeconomic data from cities in Pernambuco at the beginning of the pandemic using the Ball Mapper.
- This work is distinguished by using a new exploration and data representation technique in data from Brazilian cities.

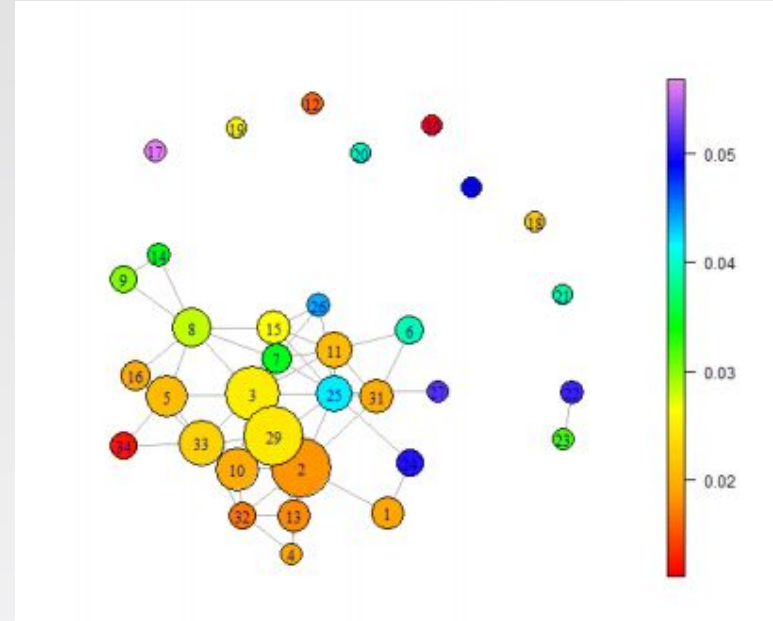


Figure 1: Ball mapper of England. Dlotko, P. and Rudkin S, 2020.

Techniques and Methods

Ball Mapper Algorithm

- Used for exploratory data analysis
- New alternative to the Mapper algorithm and persistent homology.
- Created in 2019 by Dlotko (Dlotko, 2019)
- R package: BallMapper. Available in : <[BallMapper.pdf \(r-project.org\)](#)>

Data

Data from 185 cities in Pernambuco that had confirmed cases of COVID-19 on March 26, 2020, were used.

- Municipal Human Development Index (IDHM 2010)
- Municipal Demographic Density (2010)
- Municipal GDP per capita (2017)
- Cumulative number of cases of COVID-19

Results and Conclusions

Cities: 35-Recife, 29-Olinda, 32-Paulista, 26-Jaboatão dos Guararapes, 13-Camaragibe. Epsilon 0,042.

Recife, Olinda, Paulista, Camaragibe and Jaboatão dos Guararapes differ from other municipalities of PE when analyzing the IDHM, GDP per capita and Population Density using Ball Mapper. Recife at the beginning of the pandemic in Brazil already led to the number of cases concerning other municipalities in Pernambuco.

Olinda, Paulista, Camaragibe, and Jaboatão dos Guararapes (cities in the Metropolitan Region of Recife) also had higher rates of COVID-19 cases compared to other municipalities in PE at the beginning of the pandemic.

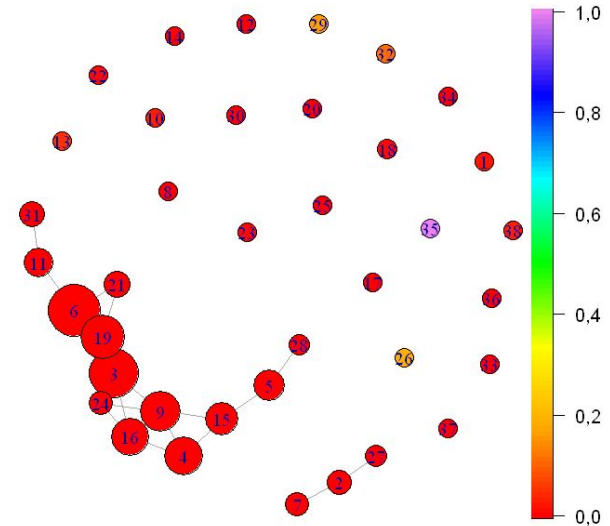


Figure 2: Ball mapper of Cities of Pernambuco.