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<h1>Using space-time analysis to evaluate the relationship between cultural, social and economic indicators and corona mortality rate using comparison of Iran and other countries</h1>

<h2>Introduction</h2>

<p>Throughout the development of human society, infectious diseases have been a public health problem that can not be ignored. In late 2019, the Wuhan Municipal Health Committee reported an unexplained pneumonia, which was later named by the World Health Organization as a new disease of the coronavirus. The virus spreads very fast, which is why the virus has spread rapidly around the world, and by the time of this study, 222 countries have been infected with the disease. Since the first outbreak was confirmed, more than 4 million people have died from the virus, and the world is suffering at a high cost in terms of human casualties, economic consequences and increasing poverty due to the epidemic, Iran has not been an exception to this rule. The coronavirus is spread through close contact and respiratory droplets, which should be controlled immediately to limit the number of deaths, as previous epidemic experiences has shown that focusing on treating patients is insufficient. Geographical Information System in many respects such as monitoring and tracking of coronavirus cases has played an important role. In this study, to compare the situation of Iran with other countries in the world, space time analysis including space time cube and clustering have been used. In the second part of the study, the relationship between cultural, social and economic indicators including education, employment, GDP per capita, life expectancy, human development index and Internet users with the Corona virus mortality rate has been investigated.</p>

<h2>Methodology</h2>

<p>The space time cube is a three dimensional visual form of a geographical phenomenon that the horizontal axis of the cube shows the location and the vertical axis of the cube shows the time, and the cube consists of a number of bins. Each bin has a fixed position in space and time, the columns have the same position and show a time series in that space, and the number of points in each bin shows the number of times a phenomenon occurs at that particular time and place. This cube helps users understand spatio temporal patterns. Using this model, the behavior of diseases can be studied. Monitoring the transmission of the corona virus is crucial, so with this model, areas that need serious treatment can be identified, and with this monitoring, the corona virus is expected to be managed effectively and efficiently.

Clustering is a data mining method in which similar data are placed in related or homogeneous groups without any advanced information about group definitions, each group is called a cluster. A special type of clustering is time series clustering. Time series databases contain valuable information that can be obtained through pattern recognition. Clustering is a common solution used to discover these patterns in time series datasets and to analyze datasets. In this research, the Kmeans++ clustering method has been used. In this method, the center of the first cluster is selected randomly, then the distance of all data to this center is calculated. The center of the next cluster is also selected randomly, with the difference that each data has a weight to be selected, in fact for each data, the distance to the nearest center of the existing clusters is considered as the chance of selection. Also in this research, Pearson correlation coefficient is used for clustering, which shows the degree of dependence between two datasets.The elbow method was used to determine the number of optimal classes for clustering. The elbow method explains the percentage of variance as a function of the number of clusters. This method is based on the idea that a number of clusters should be selected so that adding another cluster does not model the data better. The percentage of variance explained by the clusters is plotted against the number of clusters. The first clusters will add a lot of information, but in some places the marginal profit will be significantly reduced and give the chart an angle.</p>

<h2>Results and discussion</h2>

<p>In this study, Pearson correlation coefficient is used for clustering, which shows the degree of dependence between the data of the two countries. In fact, Pearson correlation coefficient between the data of Iran and other countries has been calculated and these coefficients have been used to divide countries into three clusters. Thus, countries in which the mortality rate is similar to Iran have been extracted, the results show that Armenia is the most similar to Iran. In the second part of the study, the relationship between cultural, social and economic indicators including education, employment, GDP per capita, life expectancy, human development and Internet users with the spread of Corona virus has been investigated. For this purpose, the countries of the world have been divided into three clusters based on their similarity to Iran in these indicators, and these clusters have been compared with clusters related to corona death data. The results show that the GDP per capita index has a direct relationship with the mortality rate caused by the corona virus. The most similar country to Iran in terms of GDP per capita is Azerbaijan, which is very similar to Iran in terms of corona mortality rate.</p>

<h2>Conclusion</h2>

<p>The countries of the world were divided into three clusters in terms of similarity to Iran in the rate of death due to corona and the mentioned indicators. These clusters were compared and the results show that the GDP index has the highest correlation with the death rate due to the corona. In fact, countries with similar GDP to Iran have similar deaths to Iran. The most similar country to Iran in terms of GDP per capita is Azerbaijan, which is very similar to Iran in terms of corona mortality rate. It is noteworthy that this study was conducted before the start of the fifth corona peak in Iran.</p>

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