Descriptive Study of 2014 air temperature of major cities in China

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Abstract:
This paper is to find the distribution of 2014 air temperatures in China major cities. Each major city is the capital city of certain China province. This paper firstly demonstrates that the cities in the east coastline have higher annual average air temperature, while the cities in northeast and west of China have lower annual average air temperature. Based on the analysis of air temperature, the suitable cities for travel in summer and winter are recommended. Hierarchical Clustering method is then used to segment 31 cities by their monthly average temperature.

Keywords: China air temperature; Tourism; Hierarchical Clustering.

1. Introduction

A temperature is an objective comparative measure of hot or cold. It is measured by a thermometer. Several scales and units exist for measuring temperature, the most common being Celsius (denoted °C), Fahrenheit (denoted °F), and, especially in science, Kelvin (denoted K). For the daily air temperature, the Celsius is normally used, and in this paper all the temperature data are in the unit of Celsius. Air temperature can be used to characterize the thermal state of a place, and it is important in fields and applications of theoretical research, tourism, national defense and economic construction. However, in this paper, we mainly focus the influence of air temperature on tourism. Temperature is one of the most common factors to be measured in the ground meteorological observation. The basic meteorological stations often record the air temperature 4 times a day, while the standard meteorological stations often record it 24 times a day.

In this paper, the authors analyses air temperature situation in China, and the data are obtained from China statistical yearbook. China statistic office publish the yearbook every year and it contains the data for previous year. As the 2016 yearbook are not available now, we have to use the data in 2015 yearbook, so the data is year 2014. The data are downloaded from the following webpage: http://www.stats.gov.cn/tjsj/ndsj/2015/indexch.htm. The statistics yearbook offers the monthly average air temperature data for 31 major cities in China, and each major city is the capital city of certain China province. The analysis of this paper is done on the monthly average air temperature data.

Tourism is travel for pleasure; also the theory and practice of touring, the business of attracting, accommodating, and entertaining tourists, and the business of operating tours. Today, tourism is a major source of income for many areas, and affects the economy of both the source and host areas, in some cases being of vital importance. The air temperature is an important factor for tourism, as at summer time people prefer to traveling to warm areas and at winter people preferring to warm areas too. In this paper, based on the analysis of air temperature, the suitable travelling cities are recommended.

2. Hierarchical Clustering

Hierarchical clustering essentially consists of progressively organizing all of the candidate objects into clusters comprising mutually similar objects as determined by some measure of inter-object and inter-cluster similarity, proceeding in succession from the formation of small clusters containing just two objects to large clusters containing many objects. It is characteristic of this procedure that the clusters formed in each step can be graphically displayed in tree diagrams referred to as dendrograms. Hierarchical clustering is widely used as it visually, but it is less efficient for large observations. In this
paper, the dataset only has 31 observations and 12 columns, and each observation represents a major city, while each column represents a monthly average air temperature. The dataset is suitable for hierarchical clustering method. The data are transformed by z-score standardized before clustering.

By clustering, the 31 major cities are grouped into several clusters, and the analysis about these clusters is then performed. The result is useful to show the difference and similarity of these 31 observations.

3. Descriptive study

The 2014 annual average air temperature in 31 major cities are shown in Figure 1, and the annual average air temperature for each city is the mean value of 12 monthly average air temperatures. There is a color index in the Figure 1, which shows how the average air temperature value changes with the color from blue to red. The color of each city is proportional to its average air temperature. It can be seen that the cities in the east coastline have higher annual average air temperature, while the cities in northeast and west of China have lower annual average air temperature. Haikou has the highest average air temperature, which is almost 5 times larger than that of Haerbin who has the lowest air temperature. This phenomenon is reasonable and corresponding with their latitudes and the distance to the sea. However, the annual average air temperature cannot display all the air temperature information.

![Figure 1. The 2014 annual average air temperature in 31 major cities and the annual average air temperature for each city is the mean value of 12 monthly average air temperatures. The color of each city is proportional to its average air temperature.](image-url)
is proportional to its maximum air temperature. The maximum air temperature of each city happened in summer time, and it does not mean the maximum air temperature of a city as the monthly average temperature is the mean value of all recorded air temperature. From Figure 2, it can be seen that the maximum air temperature has similar distribution with the annual average air temperature, but the gap of maximum air temperatures between this cities are far less than those of annual average air temperatures. In the view of air temperature, the suitable travelling cities at summer time are Lasha, Xining, Lanzhou, Kunming, Guiyang, Huhehaote, Shenyang, Changchun, and Haerbin.

Figure 2. The 2014 annual monthly maximum air temperature in 31 major cities and the annual maximum air temperature for each city is the maximum value of 12 monthly average air temperatures. The color of each region is proportional to its maximum air temperature.

The 2014 annual monthly minimum air temperature in 31 major cities are expressed in Figure 3, and the annual minimum air temperature for each city is the minimum value of 12 monthly average air temperature. The color of each city is proportional to its minimum air temperature. The minimum air temperature of each city happened in winter time, and it does not mean the minimum air temperature of a city as the monthly average temperature is the mean value of all recorded air temperature. From Figure 3, it can be seen that the minimum air temperature has similar distribution with the annual average air temperature, and the gap of minimum air temperatures between this cities are similar to those of annual average air temperatures. In the view of air temperature, the suitable travelling cities at winter time are Haikou, Nanning, Guangzhu and Fuzhou.
Figure 3. The 2014 annual monthly minimum air temperature in 31 major cities, and the annual minimum air temperature for each city is the minimum value of 12 monthly average air temperature. The color of each region is proportional to its minimum air temperature.

4. **Clustering result**

After the Hierarchical Clustering, the tree-diagram are shown in Figure 4, and it demonstrate how the areas are grouped into small groups in detail.
From the figure 4, the 31 cities are grouped into 5 sub-groups, and they are shown in Figure 5. In the figure 5, the bar chart of annual average air temperature of each city is also shown, and the clusters are ordered by the annual air temperature of their cities. In each cluster, the cities have similar air temperature. It can be seen that areas in Cluster 1-3 have higher average air temperature than mean value, while areas in other clusters have lower average air temperature values.
The spatial distribution of clusters based on monthly average air temperature are shown in Figure 6. In the map, the cities from the same cluster are marked by the same sign. The spatial correlations can be found in the map, and the cities in cluster 1 are close to the south coastline of China with lowest latitudes, and the second cluster are close to the east coastline of China. The third cluster is in the south part of China but farther to South China Sea, comparing with the cluster 1. The fourth cluster are form central China and northeast China, but Wulumuqi from northwest of China. The fifth clusters are both from Northwest China.
5. Conclusions

This paper does a descriptive study of 2014 China air temperature of major cities. This paper firstly demonstrates that the cities in the east coastline have higher annual average air temperature, while the cities in northeast and west of China have lower annual average air temperature. In the view of air temperature, the suitable travelling cities at summer time are Lasha, Xining, Lanzhou, Kunming, Guiyang, Huhehaote, Shenyang, Changchun, and Haerbin, while the suitable travelling cities at winter time are Haikou, Nanning, Guangzhu and Fuzhou. By the Hierarchical Clustering analysis, the 31 cities are grouped into 5 sub-groups. It is found that areas in Cluster 1-3 have higher salaries than mean value, while areas in other clusters have lower salaries. This paper is just a simple descriptive study, and it can give a little help to government, travelers and researchers as a reference.

Acknowledgements

This paper is funded by the project of National Natural Science Fund, Logistics distribution of artificial order picking random process model analysis and research (Project number: 71371033); and funded by intelligent logistics system Beijing Key Laboratory (No.BZ0211) and Beijing Intelligent Logistics System Collaborative Innovation Center; and funded by scientific-research bases---Science & Technology Innovation Platform---Modern logistics information and control technology research (Project number:PXM2015_014214_000001); University Cultivation Fund Project of 2014-Research on Congestion Model and algorithm of picking system in distribution center(0541502703).
References


