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Mean Air Temperature Dublin

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Module:

MIS41130 Statistics & Simulation Methods

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Abstract

This report summarizes the statistical modeling and analysis results of the mean air temperature in County Dublin, Ireland, from 1962-2019. The report answers two hypotheses using two different types of hypothesis tests. First hypothesis: Temperature data is examined to see if the mean temperature of Dublin is increased or not since Jan 2000 compared to the mean temperature from 1962-1999. Second hypothesis: Examines if Dublin has a different mean air temperature compared to Cork and Belmullet.

The statistical model used for hypothesis testing of whether the mean temperature in the 1900s is different from the mean temperature in the 2000s is a one-sample Z-test. After the test, the mean air temperature in Dublin before and after 1999 were the same. The mean air temperature of Dublin is similar to that of Cork (which is in the south of Ireland), and no statistically significant difference observed between them. However, a significant difference in the mean air temperature can be observed between Dublin and Belmullet (which is in the west of Ireland), also between Cork and Belmullet using the ANOVA hypothesis test.

Introduction

Being the first time in Dublin, Ireland, and experiencing the weather, it was needed to check if the weather was always like this or it is different in the 2000s compared to the 1900s. To verify that, analyses are carried on the monthly mean air temperature data available on the Ireland government website from 1962 to 2019 for Dublin Airport station operated by Met Eireann (Data.gov.ie, 2019). Descriptive statistics are generated for the capital city and analyzed further. Also, mean air temperature data from Dublin Airport station are compared with Cork airport station (south of Ireland) to see if it is colder than Dublin (Independent.ie, 2019). Along with that, a test is conducted to check if the Dublin airport station's mean air temperature is different or not than the Belmullet station (West of Ireland). Figure 1 below shows all the synoptic weather stations in Ireland.

Figure 1: Location of synoptic weather stations in Ireland (Data.oireachtas.ie, 2008)

Statistical Analysis

Descriptive statistics:

The descriptive statistics of Dublin Airport station from 1962 – 2019 (N = 689):

As per Table 1 and figure 2, In 57 years, Dublin faced the coldest mean temperature in December 2010, and Hottest mean temperature in July 1983/89. The mean air temperature was 9.5772(C) with a standard deviation of 3.8214, and 95% confidence interval for mean was 9.2914 – 9.8631.

Descriptive Stats	Value
Count	689
Mean	9.5772
Standard Error	0.1456
Standard Deviation	3.8214
Variance	14.603
Minimum	-0.1
Q1	6.3
Median	8.9
Q3	13.1
Maximum	17.7
Range	17.8
IQR	6.8
Mode	6.4
Kurtosis	-1.1675
Skewness	0.1353

Table 1: Summary Statistics

Temperature (C)	Frequency
6.4	17
5.6	12
6	12
4.9	11
13	11
5.4	10
5.7	10
7	10
7.2	10

Table 2: Frequency table of top 10 temperature

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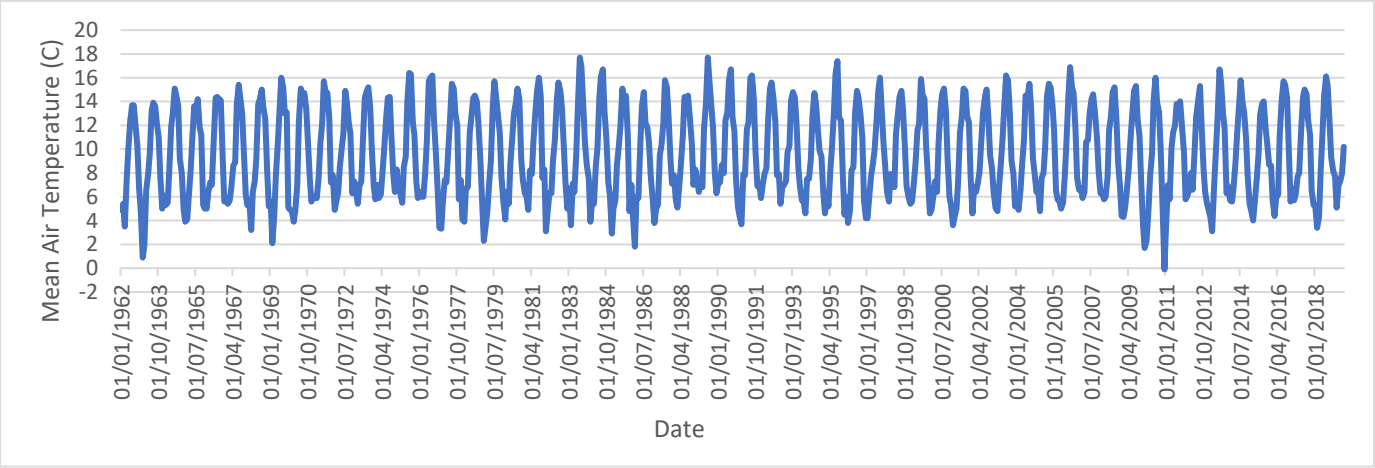

Figure 2: Dublin Airport Station Mean Air Temperature (C) from Jan 1962 to May 2019

Table 2 shows the frequency of the top 10 mean air temperature at Dublin airport station, which represents 16% of the data.

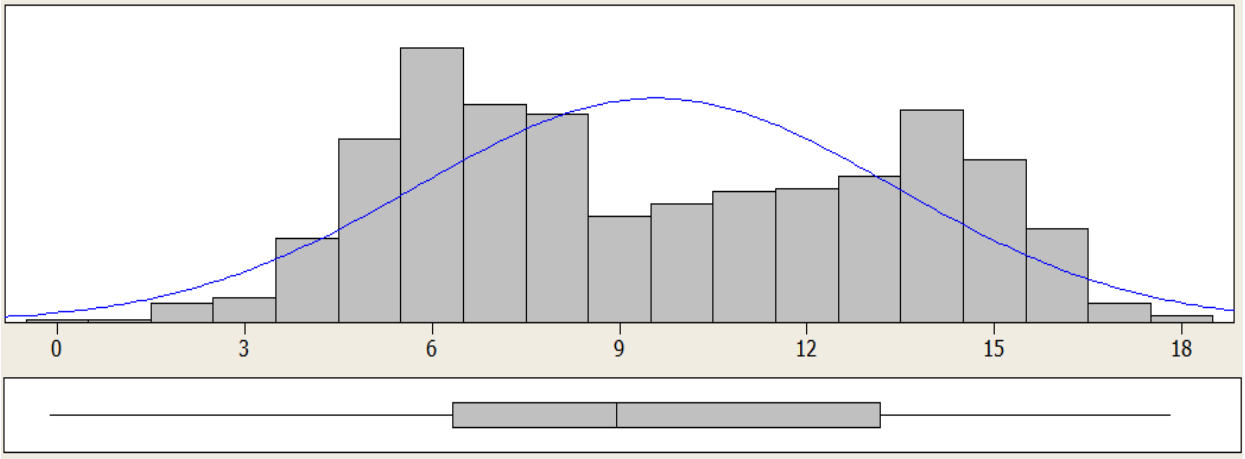

Figure 3: Histogram and Box plot of Dublin Airport Station data

As per figure 3: There are no outliers or unusual data points in the data (Medium, 2018).

Inferential Statistics:

➔ **Hypothesis 1**: Mean air temperature of Dublin airport station increased or decreased after 1999

Population temperature mean (from 1962 – 1999): 9.52926,
Population temperature standard deviation (from 1962 - 1999): 3.8214

Ho: null hypothesis: Mean air temperature of Dublin airport is the same as the population t temperature mean

Ha: alternate hypothesis: Mean air temperature of Dublin airport is different from the population temperature mean

For this, as the population temperature standard deviation is known, the One-Sample Z test is conducted with the 130 random samples selected with replacement between Jan 2000 – May 2019. There were no unusual data points, and since the sample size is large enough, the data is assumed as normally distributed.

Summary of One-Sample Z test: Dublin Sample

Variable	N	Mean	StDev	SE Mean	95% CI	Z	P
Dublin Sample	130	9.853	4.183	0.335	(9.196, 10.510)	0.97	0.334

Interpretation of the test:

-- The p-value of 0.334 indicates that Ho cannot be rejected, and there is not enough evidence to conclude that the mean differs from 9.52926 at the 0.05 level of significance between the years 2000 and 2019.

-- Confidence Interval: Quantifies the uncertainty associated with estimating the mean from sample data. It can be 95% confident that the true mean is between 9.196 and 10.510.

➔ **Hypothesis 2:** Mean temperature of Dublin, Cork, and Belmullet which represents East, South and west respectively are different from each other.

Ho: The mean air temperature of Dublin, Cork, and Belmullet are the same.
Ha: The mean air temperature of Dublin, Cork, and Belmullet are different.

Apply the ANOVA test for this hypothesis testing. There are no unusual data points in the sample of 300, which picked on random with replacement from 689 data between 1962-2019. Since the sample size is large enough, the data is assumed as normally distributed.

Summary of One-way ANOVA test: Dublin, Cork, Belmullet

Source	**DF**	**SS**	**MS**	**F**	**P**
Factor	2	156.9	78.4	6.15	0.002
Error	897	11435.0	12.7		
Total	899	11591.9			

Level	**N**	**Mean**	**StDev**	**95% CI**
Dublin	300	9.308	3.484	(8.9124, 9.7042)
Cork	300	9.592	3.659	(9.1763, 10.008)
Belmullet	300	10.301	3.566	(9.8959, 10.706)

Pooled StDev = 3.570

Interpretation of the test:

-- The p-value of 0.002 indicates that it can **reject the null hypothesis** and say that there is a difference among the means at the 0.05 level of significance. However, there is no implication on which pairs of groups are significantly different.

-- Apply the Tukey method to compare group means as a post hoc test.

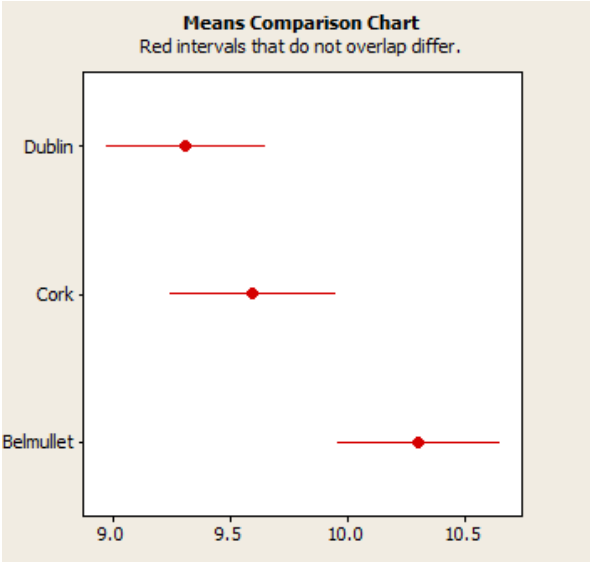

Figure 3: Mean comparison chart using the Tukey Method (Minitab, 2016)

As per figure 3, Grouping Information using Tukey Method are as follows:

	N	Mean	Grouping	95% CI
Dublin	300	9.308	B	(8.97529, 9.64137)
Cork	300	9.592	B	(9.24226, 9.94174)
Belmullet	300	10.301	A	(9.96035, 10.6416)

Individual confidence level = 98.05%

Means that do not share a letter are significantly different.

Interpretation of the Tukey method:

-- There is a significant difference between Dublin and Belmullet; the mean air temperature of Belmullet is higher than that of Dublin.

-- There is a significant difference between Cork and Belmullet, the mean air temperature of Belmullet is higher than that of Cork.

-- There is not enough evidence to conclude that the mean air temperature between Dublin and Cork differs at the 0.05 level of significance.

Conclusion

After statistical and inferential analysis, it came to know that since 1962, Dublin's mean air temperature ranges between 9.2914 – 9.8631 with 95% confidence. During the comparison, it came to know that east of Ireland (County Dublin) does not have mean air temperature different from the south of Ireland (County Cork). Moreover, Dublin and Cork have lower mean air temperatures than the Belmullet, which is in County Mayo, west of Ireland. Descriptive analyses obtained from Microsoft Excel and inferential analysis were carried out using Minitab 16 statistical tool.

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