Two-Week Temperature Analysis in Pasay City

Veronica S. Frances Baron
Adamson University
Computer Engineering Department
Las Piñas City, Philippines
veronica.frances.baron@adamson.edu.ph

Allivia P. Jaazielle Caiña
Adamson University
Computer Engineering Department
Caloocan City, Philippines
allivia.jaazielle.caina@adamson.edu.ph

Justine Marie R. Dusaran
Adamson University
Computer Engineering Department
San Pedro, Laguna, Philippines
justine.marie.dusaran@adamson.edu.ph

Poncholo T. Riego de Dios
Adamson University
Computer Engineering Department
Pasay City, Philippines
poncholo.riego.de.dios@adamson.edu.ph

***Abstract*— *This project delves into the investigation of temperature patterns within Pasay City, spanning from October 17 to October 31, 2023. An assortment of theories and methodologies has been employed to facilitate a comprehensive analysis of this dataset. Utilizing the straightforward connectivity of an ESP32 module, temperature data was meticulously collected and systematically stored within a Google spreadsheet, offering a robust dataset for examination. In an effort to enhance comprehension of temperature behavior, the research team has meticulously crafted graphical representations, including amplitude-frequency waveforms and temperature-time histograms. These visualizations are pivotal in providing insights into the variations and trends within the temperature data, thus contributing to a more comprehensive understanding of the environmental conditions during this specific time frame.*

Keywords—*Amplitude-frequency waveforms, DHT11, ESP32 Dev Board, Temperature-time histogram*

I. Introduction

The scientific study of the atmosphere's short-term changes, which range from minutes to weeks, is called meteorology, or simply "weather." It aims to comprehend current and predict future atmospheric conditions by concentrating on variables such as temperature and precipitation [1]. Temperature, which can be expressed in Kelvin, Celsius, or Fahrenheit, is a measure of heat. It rises when an object takes in heat from its surroundings and falls when it releases heat into the environment [2]. These fundamental concepts support the nature of the study.

In this study, the researchers focus on analyzing real-time temperature data from Pasay City for two weeks. Through the use of the DHT11 sensor and ESP32 Dev Board, the researchers aim to analyze Pasay City's weather patterns and temperature variations. The motivation for this study arises from the need to comprehend the conditions of changing climate. Climate change has emphasized the importance of studying weather patterns and their impact on day-to-day lives [3]. By focusing on Pasay City's temperature data, the researchers intend to determine temperature patterns based on different time frames, such as time of the day, days of the week, and general data. Furthermore, this study enables the researchers to apply digital signal processing techniques in the data analysis of local weather patterns, specifically in temperature.

II. Theory Discussion

A. Statistics

Statistics is a way of using numbers and data to better understand things. It helps us make sense of information, find patterns, and draw conclusions from the data we have. In digital signal processing, statistics is like a toolbox that helps improve the quality and reliability of signals by reducing noise, making data smaller, and correcting errors. It is all about making sense of information and using it to make better decisions [4].

a. Central Limit Theorem (CLT)

This theorem is primarily used to present large populations by getting the average or mean of each equally divided sample throughout the whole data set which, in certain situations, shall result in an approximately normal or bell curve when in graph form.

$$\bar{x} \sim N(\mu, \frac{\sigma}{n}) \quad (2)$$

Equation (2) provides the relationship of the random variable with a sample mean and standard deviation which shall result in a bell curve distribution. Here, X is the random variable, μ is the sample mean, σ^2 is the standard deviation, n is the sample size, and N is the total sample size of the population [5].

i. Central Tendencies

Central tendency refers to a single value that represents the midpoint of a dataset, indicating what is considered average within the data. There are three methods to calculate central tendency, which are mean, median, and mode [6].

1. *Mean:* The mean or average is the most popular and well-known measure of central tendency. It can be used with both discrete and continuous data, although its use is most often with continuous data. The mean is equal to the sum of all the values in the data set divided by the number of values in the data set.

$$\bar{x} = \frac{\sum x}{n} \tag{3}$$

Equation (3) shows the formula of mean, where $\bar{x}$ is the sample mean, $\sum x$ is the sum of each value in the population, and n is the number of values in the population [7].

2. *Median:* The median is the middle value when observations are arranged in ascending or descending order, dividing the distribution into two equal parts. It represents the 50th percentile, indicating that 50% of the observations are at or below this value [8].

ii. Percentile

Percentiles involve dividing observations into 100 equal parts, allowing us to specify values like 25%, 50%, 75%, or any other percentile [9]

1. *25th Percentile - First Quartile:* The 25th percentile, often referred to as the first quartile, is a statistical measure that identifies the value below which 25% of the data points in a dataset reside. In other words, when a dataset is sorted in ascending order, the 25th percentile represents the value at which one-quarter (25%) of the data points are lower or equal to that specific value, while three-quarters (75%) of the data points are higher or equal to it.
2. *50th Percentile - Median:* The 50th percentile, also known as the median, is a central measure that divides a dataset into two halves. In other words, it is the value at which half (50%) of the data points in the dataset are located below it, and the other half is situated above it. The median is often used as a representation of the center of a dataset.
3. *75th Percentile - Third Quartile:* The 75th percentile, commonly referred to as the third quartile, is a statistical metric that designates the value below which 25% of the data points in a dataset lie above. When the dataset is organized in ascending order, the 75th percentile corresponds to the value at which one-quarter (25%) of the data points are higher or equal to that value, while three-quarters (75%) of the data points are lower or equal to it. This measure is useful for understanding the upper portion of a dataset's distribution.

iii. Variance

The term variance refers to a statistical measurement of the spread between numbers in a data set. More specifically, variance measures how far each number in the set is from the mean or the average, and thus from every other number in the set. The variance is the square of the standard deviation [10].

$$\sigma^2 = \left(\frac{\sum (x-\bar{x})^2}{n-1}\right)^2 \tag{4}$$

Equation (4) shows the formula of variance where $\bar{x}$ is the mean value of the data set, and n is the number of data points in the data set.

iv. Standard Deviation

Standard deviation is a statistic that measures the dispersion of a dataset relative to its mean and is calculated as the square root of the variance. The standard deviation is calculated as the square root of variance by determining each data point's deviation relative to the mean [11].

$$\sigma = \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}} \tag{5}$$

Equation (5) shows the formula of standard deviation where $\bar{x}$ is the mean value of the data set and n is the number of data points in the data set.

v. Maxima and minima

Maxima and minima are known as the extrema of a function. Maxima and minima are the maximum or the minimum value of a function within the given set of ranges. For the function, under the entire range, the maximum value of the function is known as the absolute maxima, and the minimum value is known as the absolute minima.

vi. Skewness

Skewness evaluates the asymmetry of a distribution. A normal distribution has a skew value of zero, representing symmetry. A positive skew suggests a longer right tail and most values on the left of the mean, while a negative skew indicates a longer left tail with most values on the right of the mean. [12].

$$\mu^3 = \frac{\sum_{i=1}^{N} (x_i - \bar{x})^3}{(N-1)\sigma^3} \tag{6}$$

Equation (6) shows the formula for skewness where σ is the standard deviation, $\bar{x}$ is the mean of distribution and N is the number of observations of the sample.

vii. Kurtosis

Kurtosis measures the peakedness of a distribution. A value greater than three indicates a highly peaked distribution called leptokurtic, equal to three signifies standard peakedness called mesokurtic, and less than three suggests a less peaked distribution called platykurtic [13].

$$kurt = \frac{\mu^4}{\sigma^4} \tag{7}$$

In (7), the formula of kurtosis is shown where μ^4 is the fourth central movement and σ is the standard deviation.

b. Histogram

The histogram displays the number of samples there are in the signal that have each of these possible values. The histogram can be used to efficiently calculate the mean and standard deviation of very large data sets. This is especially important for images, which can contain millions of samples. The histogram groups samples together that have the same value. This allows the statistics to be calculated by working with a few groups, rather than a large number of individual samples [4].

i. Binning

The important aspect of a histogram is its bin width, as it determines the balance between providing excessive detail, which is called undersmoothing, or insufficient detail, also called oversmoothing, concerning the actual distribution [14].

$$bins = \sqrt{n} \tag{8}$$

Equation (8) shows the formula for binning where n is the total number of sample data.

c. Precision and Accuracy

Precision and accuracy are crucial factors in statistics, representing the degree to which values reflect true or accurate information. Precision refers to the consistency and proximity of values, aiming to provide a true representation of the data. Accuracy, on the other hand, pertains to the process of obtaining values that align closely with the desired or computed data point within the dataset.

These two methods are used to assess a wide range of data in a population. By analyzing the precision and accuracy of processed data, they can draw conclusions, measure data quality, and make predictions, enabling them to identify potential errors.

In datasets with consistent data collection repetitions, random errors may occasionally occur, potentially affecting data validity. Conversely, systematic errors, stemming from inaccuracies, result in slender histograms and are typically associated with calibration issues.

B. Periodicity

In digital signal processing, periodicity is a fundamental concept where signals repeat their pattern over time. This property enables signals to be analyzed and manipulated efficiently.

$$x(t + t_0) = x(t) \tag{9}$$

Equation (10) explains the concept of periodicity in a signal, where x represents the signal, t represents time and t_0 represents the fundamental period. A signal, denoted as $x(t)$, is considered periodic if there is a specific finite value $t_0 > 0$, applicable to every instance of time, t [15].

a. Aperiodic Signal

Aperiodic signals do not have a repeating pattern and extend infinitely over time [15].

b. Frequency

Frequency, measured in Hertz (Hz), represents how many cycles a signal completes within one second [16]. A signal $x(t)$ that has a fundamental period t_0 that results in fundamental frequency defined in (11).

$$f_0 = \frac{1}{t_0} \tag{10}$$

For aperiodic signals with infinite periods, the fundamental frequency is defined as zero, indicating that the signal completes zero cycles in one second or any given duration [16].

c. Waves

There are various types of periodic signals, like pulse trains, square waves, and sawtooth waves. Among these, sinusoids, which include sine and cosine waves, are particularly important and well-behaved mathematically. The term "wave" is often used to refer to sinusoids specifically [15].

III. Methodology

The project's primary objective is to collect temperature data consistently over two weeks, with readings taken at fifteen-minute intervals. It employs two main components: the DHT11 sensor and the ESP32 module.

The DHT11 sensor is a sensor capable of measuring both temperature and humidity. However, in this project, it is being used exclusively for temperature data collection.

The ESP32 module serves as the platform for interfacing with the DHT11 sensor. It is responsible for data collection, and transmission of collected data.

To manage and represent the collected temperature data, a Google Apps Script code is utilized. This code established a connection with Google Sheets, an online cloud-based spreadsheet application to create a tabulated representation of the temperature data. This representation is then shared with the group members to keep track of its data collection. After the collection, the data is then processed via data processing procedures.

The choice of a fifteen-minute interval for data collection is an important aspect of the project. This interval determines how frequently temperature readings are recorded. In consideration of noise, the group decided to tweak the intervals to fourteen minutes to ensure consistency of data of nearly fifteen minutes instead of going over the desired interval time.

Table I outlines the step-by-step process for analyzing temperature data using Python and various data analysis libraries. It includes importing necessary libraries, defining functions for data visualization, performing data filtering and manipulation, generating summary statistics, and preparing visualizations for different time ranges and days of the week.

TABLE I. ALGORITHMIC TABLE

Step	Description
1	Import necessary libraries: numpy, pandas, datetime, matplotlib.pyplot, seaborn, statistics, and requests.
2	Define Google Drive file ID and construct download URL.
3	Download CSV data using requests and read into a Pandas DataFrame.
4	Define generate_histogram function: create histogram with mean, standard deviation, skewness, and kurtosis overlays.
5	Define generate_line_graph function: create line graph for temperature data against specified temporal division.
6	Define generate_waveform function: create waveform from given data in the DataFrame.
7	Define calculate_variance function: calculate and return column variance.
8	Convert 'Time' column to datetime format in the DataFrame.
9	Create 'DateTime' column by combining 'Date' and 'Time' columns.
10	Filter DataFrame for 'Early Morning' time range (12 AM to 5:59 AM).
11	Select relevant columns, format 'Time' as string, and print resulting DataFrame.
12	Generate summary statistics and calculate variance for the 'Early Morning' DataFrame.
13	Display histogram and waveform for early morning temperature data.
14	Repeat steps 10-13 for 'Morning', 'Afternoon', 'Evening' time ranges.
15	Convert 'Date' column to datetime format in the DataFrame.
16	Sort DataFrame by 'Date' column in ascending order.
17	Filter DataFrame for each day of the week (Monday to Sunday) and perform analysis steps 11-13.
18	Prepare general temperature DataFrame, format 'Time' as string.
19	Conduct analysis steps 11-13 for the general temperature DataFrame.

IV. RESULTS AND DISCUSSION

This section explores the outcomes and insights derived from the data obtained via a DHT11 sensor. This data has been systematically archived in a Google Sheets spreadsheet, enabling the researchers to conduct a comprehensive examination and apply digital signal processing methods to derive valuable insights and make informed interpretations from the sensor's data records.

In Table II, which contains temperature measurements in degrees Celsius, we have a total of 1347 data points. The average temperature is approximately 28.55 degrees Celsius, indicating the dataset's central tendency. The standard deviation of 0.88 suggests that the temperature values exhibit a moderate degree of variability or spread around the mean. The lowest recorded temperature is 25.6 degrees Celsius, and the highest is 30.9 degrees Celsius, demonstrating the range of temperatures in the dataset.

The quartiles provide additional insights: the 25th percentile (Q1) is 28 degrees Celsius, implying that 25% of the data points fall at or below this temperature. The median (50th percentile) is 28.5 degrees Celsius, indicating that the dataset's middle value is very close to the mean. The 75th percentile (Q3) is 29.1 degrees Celsius, signifying that 75% of the data points have temperatures at or below this value.

Moreover, the variance of 0.77 quantifies how much individual temperature measurements deviate from the mean. Overall, the dataset appears to exhibit a relatively narrow temperature range, with the majority of measurements clustering around the mean temperature. However, the standard deviation and variance values highlight some degree of variability in the dataset. Further analysis or visual representation may be necessary to gain a more comprehensive understanding of the temperature distribution.

TABLE II. STATISTICAL SUMMARY TIME OF DAY

Statistical Summary in General	
count	1347
mean	28.55
standard dev.	0.88
minima	25.6
25%	28
50%	28.5
75%	29.1
maxima	30.9
variance	0.77

Table III provides the statistical summary, which offers a comprehensive view of temperature measurements across various times of the day, namely Early Morning, Morning, Afternoon, and Evening. The measurements count varies, with the Morning category having the highest count at 357, while Early Morning has 327 measurements. The mean temperature, which represents the average, ranges from 28.06 degrees in the Morning to 28.96 degrees in the Afternoon, with the Early Morning and Evening temperatures falling in between. The standard deviation, which measures the variability of the data, is relatively consistent across the different times of the day. The minimum temperatures are relatively low in the Early Morning and Morning, with 25.7 and 25.6 degrees, respectively. The 25th percentile, median, and 75th percentile offer insights into the distribution of temperatures, indicating that Afternoon has the highest 75th percentile temperature at 29.6 degrees. The maximum temperatures reach 30.9 degrees in the

Afternoon, and the variance, which quantifies the spread of the data, ranges from 0.572 to 0.766, with the lowest variance observed in the Evening and the highest in the Afternoon.

TABLE III. STATISTICAL SUMMARY TIME OF DAY

Statistical Summary Time of Day				
	Early Morning	**Morning**	**Afternoon**	**Evening**
count	327	357	329	334
mean	28.365749	28.058263	28.955319	28.876347
standard dev.	0.787199	0.765932	0.876546	0.757194
minima	25.7	25.6	27	27.3
25%	27.85	27.6	28.4	28.2
50%	28.5	28.2	28.7	28.7
75%	28.9	28.6	29.6	29.5
maxima	30	30.4	30.9	30.6
variance	0.61778713	0.58500875	0.76599754	0.57162618

Table IV presents a comprehensive summary of temperature measurements for each day of the week. The data includes key statistics such as count, mean, standard deviation, minimum, 25th percentile, 50th percentile, also known as the median, 75th percentile, maximum, and variance. The count of temperature measurements ranges from 181 to 204, reflecting varying data availability across the days. Regarding the mean temperature, Wednesday stands out with the highest average temperature, ranging from 28.28 to 28.77 degrees. Standard deviation is used to gauge temperature data variability, with Wednesday exhibiting the lowest standard deviation, suggesting relatively consistent temperature measurements. In contrast, Tuesday shows the highest standard deviation, implying greater variability in its temperature data. Minimum and maximum temperatures reveal that Saturday experiences the lowest recorded minimum temperature, while Sunday and Monday record the highest maximum temperatures. The percentiles provide insights into temperature distribution, and variance, representing the average squared deviation from the mean, indicating that Wednesday's temperature measurements are relatively consistent, whereas Tuesday exhibits the highest variance, signifying more variability in its temperature data.

TABLE IV. STATISTICAL SUMMARY DAY OF WEEK

Statistical Summary Day of Week							
	Sun	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
count	194	200	181	200	204	185	183
mean	28.55	28.45	28.28	28.77	28.53	28.61	28.68
standard dev.	0.98	1.07	1.18	0.88	0.67	0.46	0.59
minima	26.4	26.6	25.6	26.8	26.6	27.6	27.2
25%	27.9	27.8	27.6	28.3	28.28	28.3	28.2
50%	28.4	28.3	28	28.7	28.6	28.6	28.6
75%	29.38	29.2	29.2	29.3	29	28.9	29.1
maxima	30.8	30.8	30.8	30.9	30	29.9	30.3
variance	0.95	1.14	1.39	0.77	0.44	0.21	0.35

A. Graphs of Overall (General) Temperature

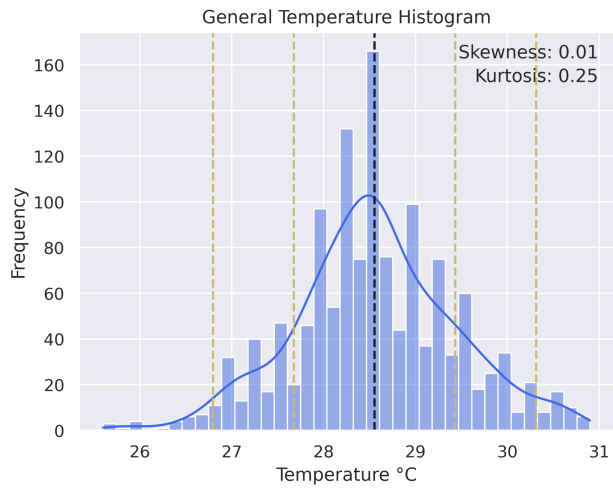

Fig. 1.1. Histogram of Overall (General) Temperature measured in °C

The histogram illustrates the distribution of temperatures in Celsius, collected approximately every fifteen minutes over two weeks. The horizontal axis represents temperatures, divided into bins, while the vertical axis shows the frequency of the temperatures. The height of each bar indicates the number of temperatures in a certain range. The histogram reveals a normal distribution, with a peak around the middle temperatures, suggesting that most temperatures were around 28.5 degrees Celsius. Fewer temperatures were exceptionally high or low, as indicated by the decreasing frequency towards the extremes of the score range.

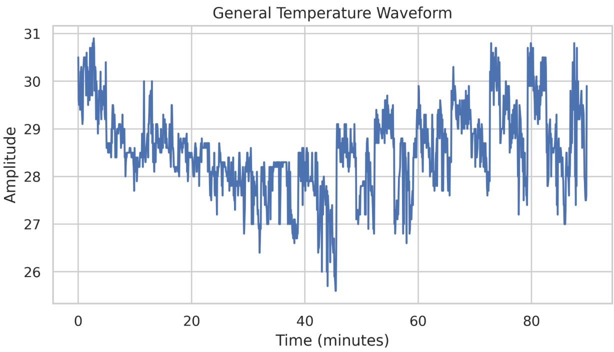

Fig. 1.2. Waveform of Overall (General) Temperature measured in °C

Explain bat by 20 yung interval here

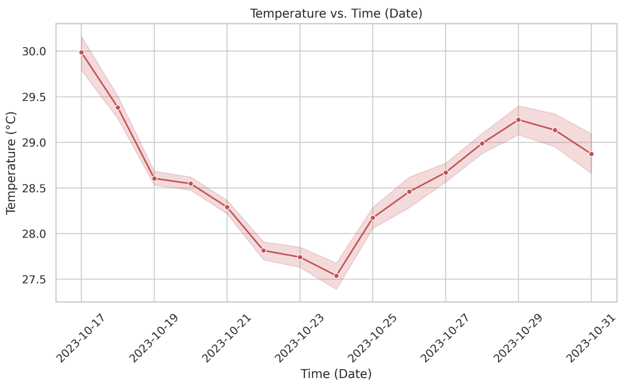

Fig. 1.3. Line Graph of Temperature measured in °C and the number of days

Figure 1.3 depicts

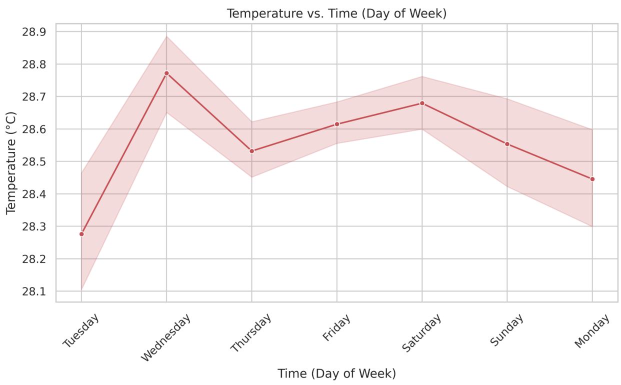

Fig. 1.4. Line Graph of Temperature measured in °C and each day of the week

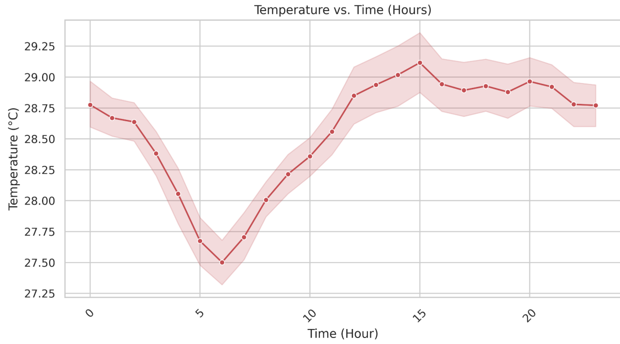

Fig. 1.5. Line Graph of Temperature measured in °C and time per hour

B. Graphs of Time of Day

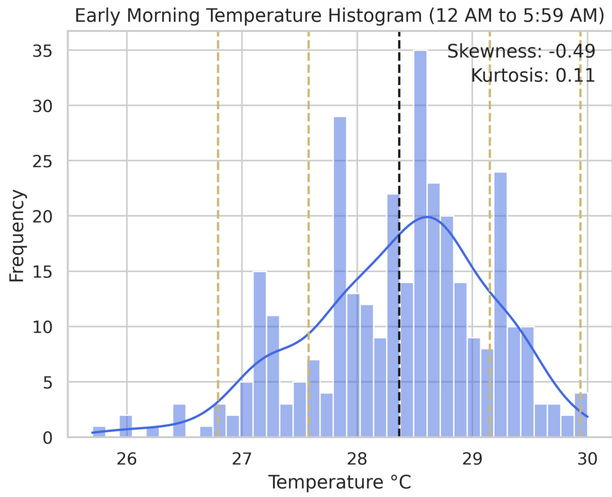

Fig. 2.1 Histogram of Temperature in °C within 12 AM and 5:59AM (Early Morning)

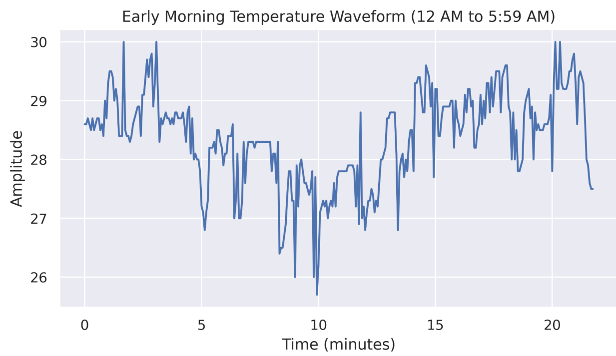

Fig. 2.2 Waveform of Temperature in °C within 12 AM and 5:59 AM (Early Morning)

Figure 2.1 displays the distribution of early morning temperatures, from 12 AM to 5:59 AM. The horizontal axis of the histogram represents temperature ranges divided into bins, while the vertical axis indicates the corresponding frequency of occurrence. The histogram exhibits a negative skewness of -0.49, indicating that there are more occurrences of higher temperatures on the right side of the graph compared to the left side. Additionally, the kurtosis value of 0.11 classifies the distribution is platykurtic, signifying a relatively flat peak compared to a normal distribution.

Figure 2.2 shows the early morning temperature waveform. The x-axis of the waveform graph represents time in fifteen-minute intervals, while the y-axis indicates the corresponding amplitude of temperature. The graph illustrates a lower temperature during the middle period in contrast to the rising temperatures at the beginning and end of the observed time frame.

The correlation between the two figures highlights the relationship between temperature distribution and waveform patterns during the specified time frame.

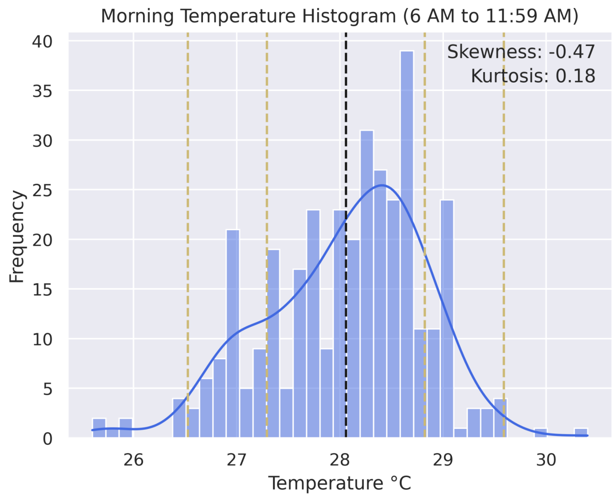

Fig. 3.1 Histogram of Temperature in °C within 6AM and 11:59AM (Morning)

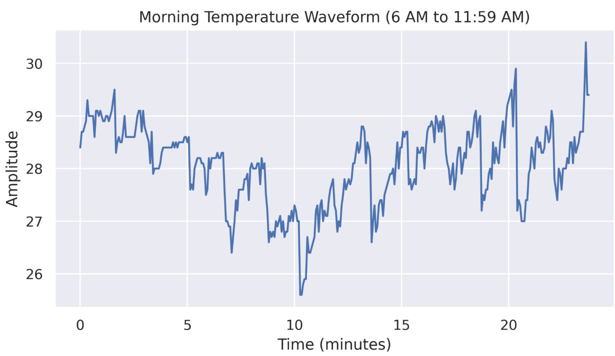

Fig. 3.2 Waveform of Temperature in °C within 6AM and 11:59AM (Morning)

Figures 3.1 and 3.2 show how the temperature changes in the morning. The histogram, which is like a bar chart, tells us that most of the temperatures are higher than the average temperature. It also has a kurtosis value of 0.18, which means the temperature data is a bit more peaky compared to a standard pattern. The negative skewness of -0.47 suggests that more high temperatures happen later in the morning, closer to the afternoon.

The histogram and the waveform both confirm that the temperatures are higher in the later morning, and the histogram shows that the data is not perfectly spread out, but rather has a bit of a bump in the shape. This helps us understand how the temperature changes during the morning hours.

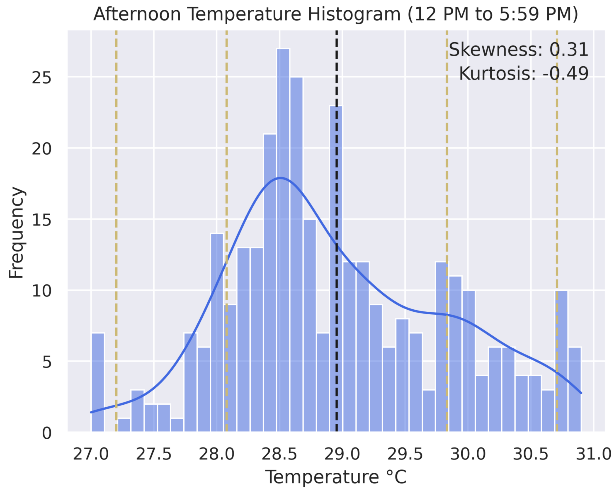

Fig. 4.1 Histogram of Temperature in °C within 12 PM and 5:59 PM (Afternoon)

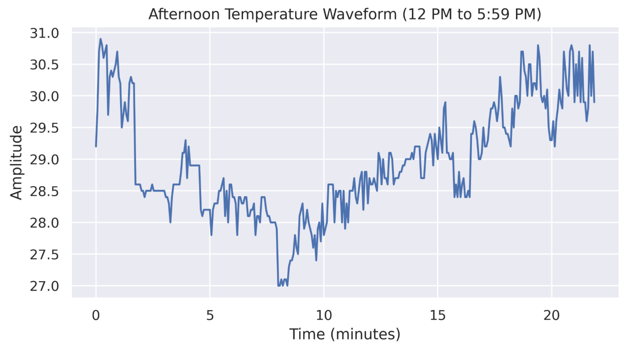

Fig. 4.2 Waveform of Temperature in °C within 12 PM and 5:59 PM (Afternoon)

Figure 4.1 illustrates the distribution of afternoon temperatures between 12 PM to 5:59 PM. Temperature ranges are represented on the horizontal axis, and their frequencies are shown on the vertical axis in the histogram. The graph demonstrates a positive skewness of 0.31, indicating more occurrences of higher temperatures on the left side compared to the right. Additionally, with a kurtosis value of -0.49, the distribution is categorized as platykurtic, indicating a relatively flat peak compared to a normal distribution.

In Figure 4.2, the afternoon temperature waveform is depicted, displaying time intervals of fifteen minutes on the x-axis and corresponding temperature amplitudes on the y-axis. The graph reveals lower temperatures during the middle period, contrasting with higher temperatures at the beginning and end of the observed time frame.

The correlation between these figures emphasizes the link between temperature distribution and waveform patterns during the specified time frame.

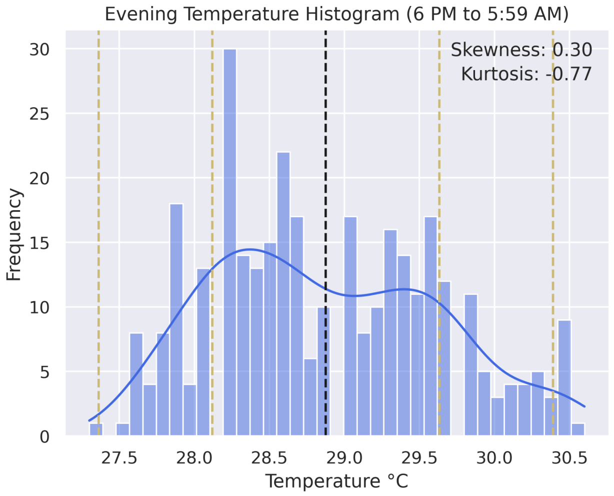

Fig. 5.1 Histogram of Temperature in °C within 6 PM and 11:59 PM (Evening)

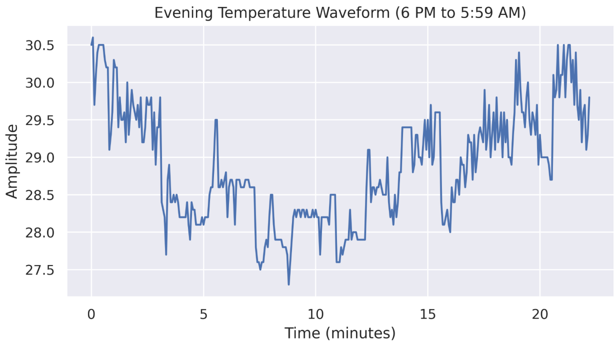

Fig. 5.2 Waveform of Temperature in °C within 6PM and 11:59PM (Evening)

The correlation between the histogram and waveform in Figures 5.1 to 5.2 provides an interesting perspective on the temperature data between 6 pm and 11:59 pm.

The histogram indicates that temperatures are distributed in a balanced manner on both sides of the average, with values on one side roughly matching the values on the other side. This suggests that the middle part of the evening (around the mean) experiences temperatures that are neither too hot nor too cold, while the extremes are cooler.

On the other hand, the waveform highlights a different balance. It shows that the lowest temperatures occur in the middle of the time period, while it gets warmer both in the early afternoon and at dawn near nighttime. This is the opposite of what the histogram indicates.

The correlation between the two graphs emphasizes the symmetry in temperature data during the evening hours. However, they present this symmetry in contrasting ways: the histogram indicates balance around the mean, while the waveform emphasizes balance with cooler temperatures in the middle and warmer temperatures at the edges of the time range. This dual perspective helps us gain a more comprehensive understanding of the temperature patterns during this time frame.

C. Graphs of Day of the Week

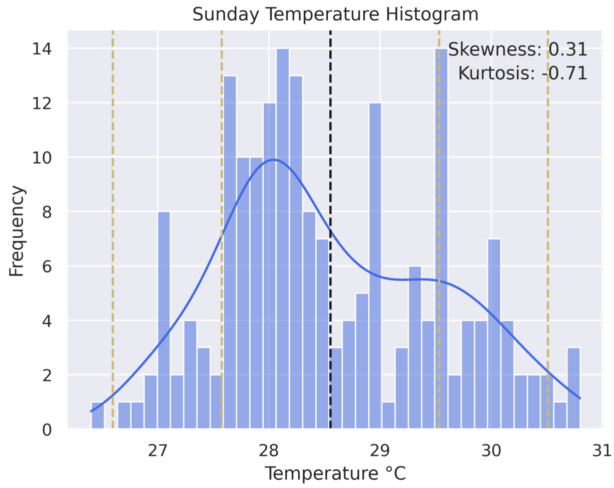

Fig. 6.1 Sundays Temperature Histogram

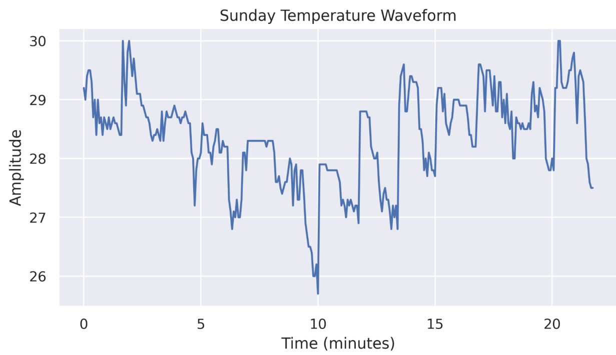

Fig. 6.2 Sundays Temperature Waveform

Figure 6.1 displays the Sunday temperature distribution, representing temperature ranges on the horizontal axis and their frequencies on the vertical axis. The histogram exhibits a positive skewness of 0.31, indicating more instances of higher temperatures on the left side, and a platykurtic distribution with a kurtosis value of -0.71.

Figure 6.2 illustrates the Sunday temperature waveform, with time intervals on the x-axis and corresponding temperature amplitudes on the y-axis. The graph reveals lower temperatures in the middle period, contrasting with higher and moderate temperatures at the beginning and end of the observed timeframe.

The correlation between these figures highlights the relationship between temperature distribution and waveform patterns during the specified time frame.

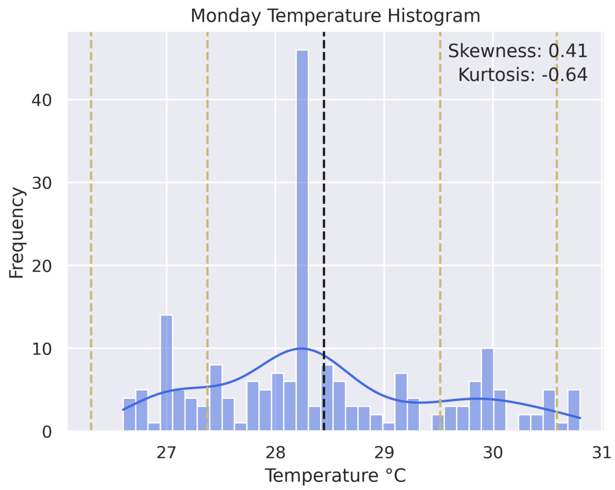

Fig. 7.1 Mondays Temperature Histogram

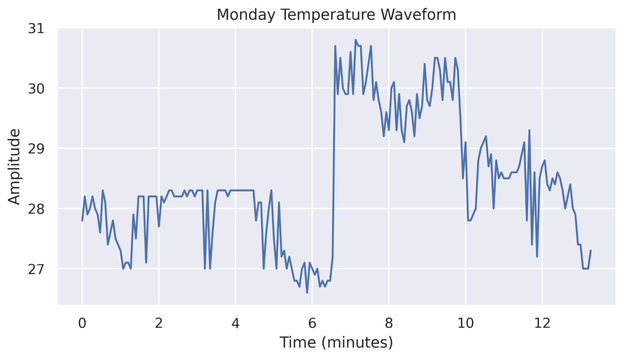

Fig. 7.2 Mondays Temperature Waveform

The temperature data for Monday is shown in Figures 7.1 and 7.2. It's not evenly spread out, which means it goes up and down in an irregular way. Let's first look at the histogram in Figure 7.1. There's a sudden jump in temperature by 45 units, and it's a bit to the left of the average temperature. It's interesting that apart from this big jump in temperature, all the other temperature values are mostly lower, happening fewer than 10 times.

Now, when we consider the waveform, it has a clear pattern. The left side and the right side of the mean temperature are similar. On the left side, the temperature values stay at around 28 units, not changing much. But on the right side, they go down in a wavy pattern.

To summarize, the temperature data for Monday is kind of all over the place. There's one big spike on the left side of the average temperature in the histogram, and the rest of the temperatures are mostly low. The waveform shows a clear pattern with one half staying constant and the other half going up and down. This helps us understand how temperatures vary on Monday.

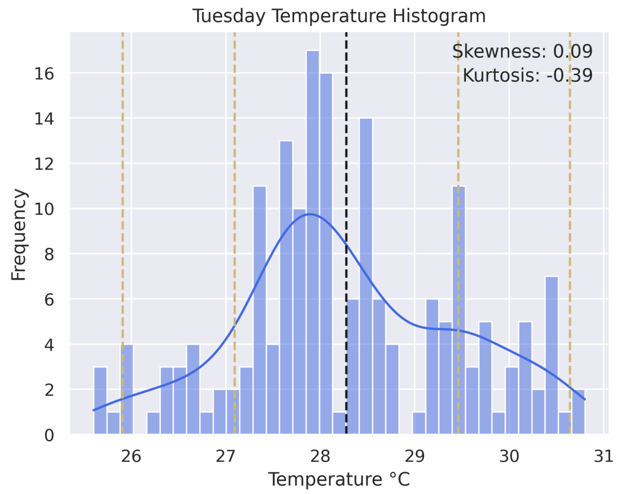

Fig. 8.1 Tuesdays Temperature Histogram

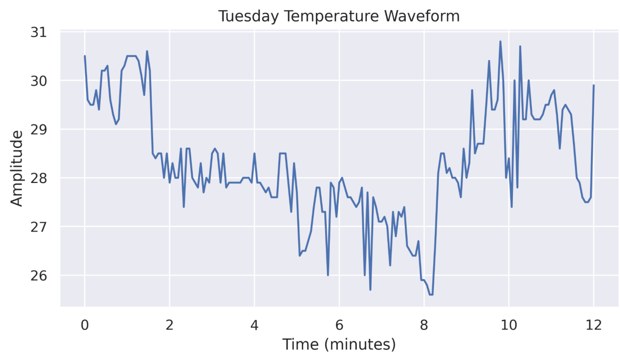

Fig. 8.2 Tuesdays Temperature Waveform

Figure 8.1 shows the temperature distribution for Tuesday, with temperature ranges on the horizontal axis and their frequencies on the vertical axis. The histogram displays a positive skewness of 0.09, indicating more occurrences of higher temperatures on the left side, and a platykurtic distribution with a kurtosis of -0.39.

In Figure 8.2, the Tuesday temperature waveform is depicted, featuring time intervals on the x-axis and corresponding temperature amplitudes on the y-axis. The graph demonstrates lower temperatures during the wide middle period, in contrast to higher temperatures at the beginning and end of the observed timeframe.

The correlation between these figures underscores the connection between temperature distribution and waveform patterns within the specified time frame.

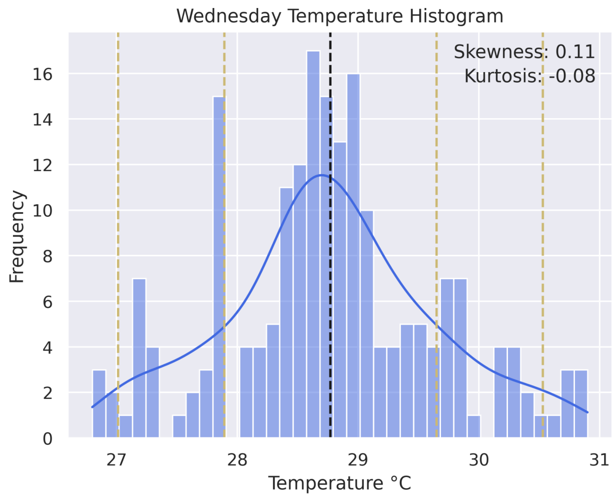

Fig. 9.1 Wednesdays Temperature Histogram

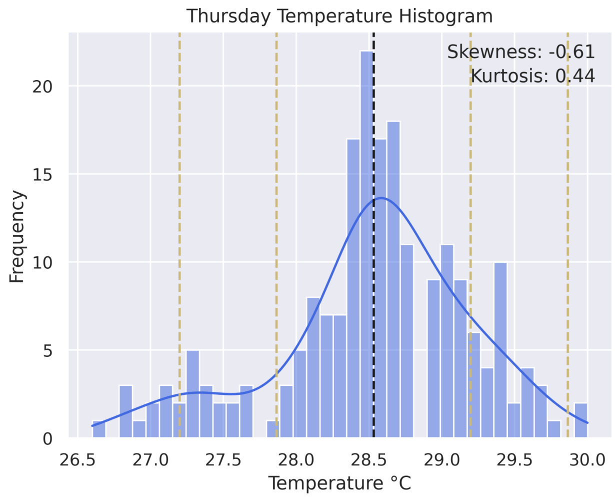

Fig. 10.1 Thursdays Temperature Histogram

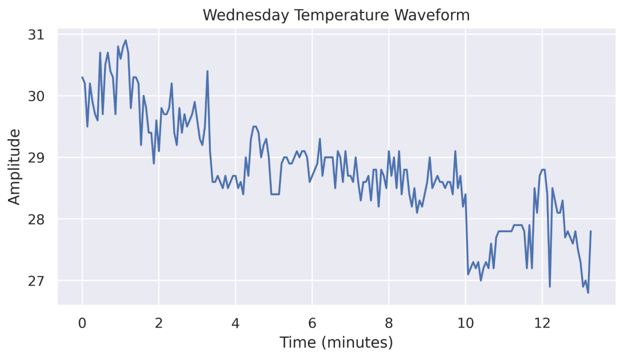

Fig. 9.2 Wednesdays Temperature Waveform

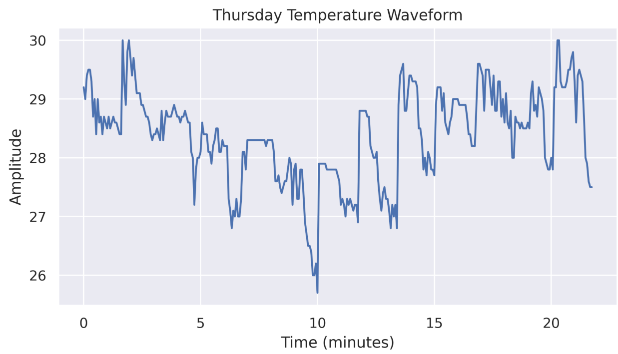

Fig. 10.2 Thursdays Temperature Waveform

The temperature data for Wednesdays stands out for its remarkable consistency when compared to data from other days. The histogram reveals a nearly perfect bell curve shape, indicating that most temperature values cluster around the daily average. This symmetry suggests that the highest temperatures occur close to the average, creating a well-balanced distribution. Simultaneously, the waveform illustrates a continuous decline in temperature amplitudes as the day progresses, indicating a consistent decrease in temperatures over time.

The correlation between the histogram and waveform is strikingly evident, emphasizing the synchronized trend in Wednesday's temperature data. Both graphs display a gradual decline in values along both the x and y axes, highlighting the steady nature of temperature throughout the day. In summary, Wednesdays exhibit a distinct and constant temperature pattern, with the histogram and waveform providing a clear visual representation of this consistency, underscoring that temperatures remain relatively close to the daily average for the entire day.

Figure 10.1 presents the distribution of Thursday temperatures, with temperature ranges on the horizontal axis and their respective frequencies on the vertical axis. The histogram displays a negative skewness of -0.61, indicating more occurrences of higher temperatures on the right side. Additionally, the kurtosis value of 0.44 categorizes the distribution as mesokurtic.

In Figure 10.2, the Thursday temperature waveform is depicted, showcasing time on the x-axis and temperature amplitude on the y-axis. The graph shows lower temperatures during the middle period, contrasting with higher and moderate temperatures at the start and end of the observed time frame.

The correlation between these two figures emphasizes the connection between temperature distribution and waveform patterns within the specified time frame.

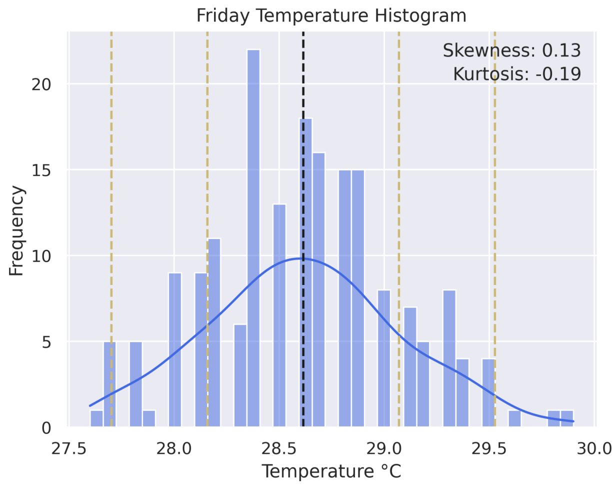

Fig. 11.1 Fridays Temperature Histogram

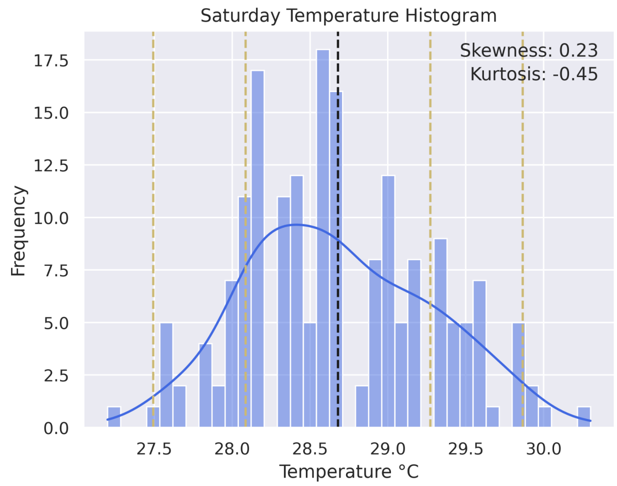

Fig. 12.1 Saturdays Temperature Histogram

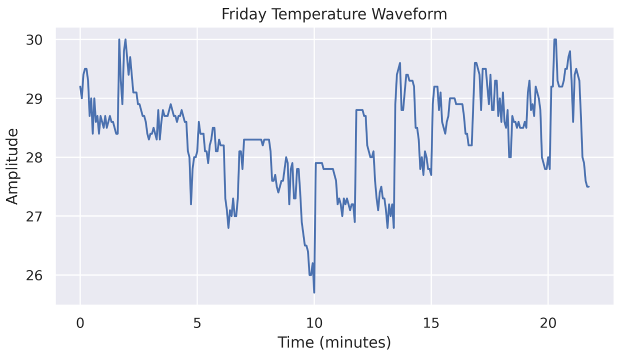

Fig. 11.2 Fridays Temperature Waveform

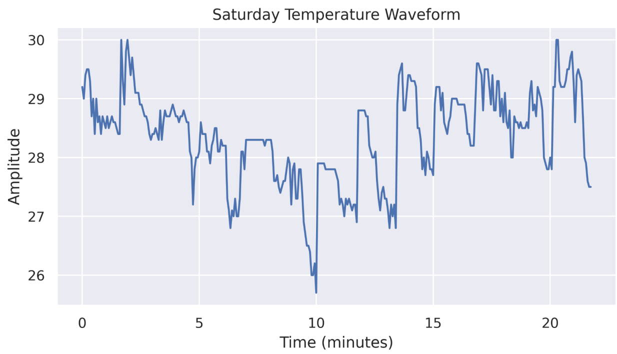

Fig. 12.2 Saturdays Temperature Waveform

Fridays, akin to Wednesdays, notably exhibit a distinct pattern in their temperature data, characterized by a histogram that closely approximates a symmetrical bell curve. This bell curve shape suggests a highly organized distribution of temperature values, with the majority of these values gravitating toward the central average. Consequently, it signifies that temperatures on Fridays tend to be evenly distributed around the daily mean temperature.

The correlation between the histogram and the waveform representing Friday's temperature data is particularly notable. Both graphs are consistent in their depiction of temperature trends throughout the day. In the histogram, the symmetrical bell curve underscores the equilibrium of temperature values, while the waveform showcases a decrease in amplitudes as time progresses. This synchronous trend implies that as the day unfolds, temperatures steadily decrease, maintaining the balance seen in the histogram. Thus, the harmonic relationship between the two graphs underscores that Fridays exhibit a well-structured and consistent temperature pattern, with values predominantly hovering around the daily mean temperature, creating a noteworthy contrast with other days of the week.

Figure 12.1 illustrates the distribution of Saturday temperatures, presenting temperature ranges on the horizontal axis divided into bins, and the corresponding frequency of occurrence on the vertical axis. The histogram displays a positive skewness of 0.23, indicating more occurrences of higher temperatures on the left side of the graph. Additionally, the kurtosis value of -0.45 categorizes the distribution as platykurtic.

Figure 12.2 depicts the Saturday temperature waveform, with time on the x-axis and the corresponding temperature amplitude on the y-axis. The graph shows lower temperatures during the middle period, contrasting with the higher temperatures at the beginning and end of the observed time frame.

The correlation between these two figures underscores the relationship between temperature distribution and waveform patterns within the specified time frame.

V. Conclusion

In this study, the researchers conducted an in-depth analysis of temperature data collected every 15 minutes over two weeks in Pasay City. As such, the data exhibits a periodicity of 24 hours, corresponding to a daily cycle. Temperature readings are collected every 15 minutes, capturing the fluctuations in temperature throughout the day and night. The periodicity is essential for understanding the daily temperature patterns in Pasay City.

The findings revealed patterns and trends in the local climate, providing insights into the city's temperature dynamics. The data exhibited a clear periodicity, following a 24-hour cycle, showcasing consistent daily temperature fluctuations. The researchers observed distinct central tendencies based on specific temporal divisions: the morning hours (6 AM to 11:59 AM) recorded the lowest temperatures, averaging around 28.06°C, while the afternoon (12 PM to 5:59 PM) experienced peak temperatures, with a maxima of approximately 30.9°C.

Throughout the week, both weekdays and weekends displayed relatively stable temperature patterns, with minor variations between days. Considering the entire dataset, the average temperature over the two-week period is 28.55°C. The standard deviation indicates the variability around this mean, providing insights into temperature stability. This analysis has significant implications for various sectors, including urban planning, agriculture, and public health. By understanding these intricate temperature dynamics, policymakers and stakeholders can make informed decisions, bolstering the city's resilience to climate-related challenges. The research conducted by the team contributes essential knowledge to the field of local climate studies, setting the stage for further investigations into the factors driving temperature fluctuations and their impacts on Pasay City's residents and environment.

References

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

[1] J.S.M. Coleman and K.T. Law, "Meteorology," Reference Module in Earth Systems and Environmental Sciences, Elsevier, 2015. doi: 10.1016/B978-0-12-409548-9.09492-6.

[2] M. Wilson, "Temperature measurement," Anaesthesia & Intensive Care Medicine, vol 22, no. 3, pp. 202-207, 2021. doi: 10.1016/j.mpaic.2021.01.015.

[3] H. M. Heshmati, 'Impact of Climate Change on Life', Environmental Issues and Sustainable Development. IntechOpen, May 27, 2021. doi: 10.5772/intechopen.94538.

[4] S. W. Smith, "Statistics, Probability and Noise," in The Scientist and Engineer's Guide to Digital Signal Processing, 2nd ed. California Technical Publishing, 1999, pp. 11-34.

[5] S. G. Kwak and J. H. Kim, "Central limit theorem: the cornerstone of modern statistics," Korean Journal of Anaesthology, vol. 70, pp. 144–156, Feb. 2017, doi: https://doi.org/10.4097/kjae.2017.70.2.144.

[6] C. Bakker, "An Introduction to Statistics for Librarians (Part Two): Frequency Distributions and Measures of Central Tendency", Hypothesis, vol. 35, no. 1, Mar. 2023.

[7] S. Manikandan, "Measures of central tendency: The mean," Journal of Pharmacology & Pharmacotherapeutics, vol. 2, no. 2, pp. 140-142, 2011, doi: 10.4103/0976-500X.81920.

[8] S. Manikandan, "Measures of central tendency: Median and mode," Journal of Pharmacology & Pharmacotherapeutics, vol. 2, no. 3, pp. 214-215, 2011, doi: 10.4103/0976-500X.83300.

[9] Z. Ali and S. B. Bhaskar, "Basic statistical tools in research and data analysis," Indian Journal of Anaesthesia, vol. 60, no. 9, pp. 662-669, 2016. doi: 10.4103/0019-5049.190623.

[10] R. R. Wadhwa and D. Azzam, "Variance," StatPearls, Treasure Island, StatPearls Publishing, 2023

[11] S. El Omda and S. R. Sergent, "Standard Deviation," Treasure Island, StatPearls Publishing, 2023

[12] Y. Kim, "Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis," Restorative Dentistry & Endodontics, vol. 38, no. 1, pp. 52-54, 2013. doi: 10.5395/rde.2013.38.1.52.

[13] S.M. Gandhi, B.C. Sarkar, "Chapter 11 - Conventional and Statistical Resource/Reserve Estimation," in Essentials of Mineral Exploration and Evaluation, Elsevier, 2016, pp. 271-288, doi: 10.1016/B978-0-12-805329-4.00018-1.

[14] M.P. Wand, "Data-Based Choice of Histogram Bin Width," The American Statistician, vol. 51, no. 1, pp. 59-64, 2012. doi: 10.1080/00031305.1997.10473591.

[15] B. Mcfee, "1.2 Periodicity and waves," in Digital Signals Theory, Staten Island: Routledge, 2023

[16] D.R. Kaufman, "Chapter 20 - Industrial Wireless Technology and Planning," in Instrumentation Reference Book, 4th Ed., W. Boyes, Butterworth-Heinemann, 2010, pp. 253-265. doi: 10.1016/B978-0-7506-8308-1.00020-6.

not