HOW ACCURATE ARE THE WEATHER FORECAST WEBSITES IN SINGAPORE?

Research question & Motivation

Our research focused on investigating the accuracy of weather forecasts for Singapore, namely **AccuWeather, *BBC Weather,* *MSS* & *NEA forecast.***

We were inspired to focus on this due to our real life experiences, where we checked the weather forecast beforehand, but once we reached our destination, the weather was not the same as predicted. Thus we wanted to see **which commonly used weather forecast** is the **most accurate**, to reduce the inconvenience and problems brought about by **inaccurate predictions** such as getting caught in the rain or suffering from heat stroke.

Introduction

With climate change expecting to make **weather patterns more erratic** (**such as recent flashfloods that have been plauging the nation**), weather forecasts have become **increasingly essential** in aiding us to carry out everyday tasks. Thus finding the **most reliable weather forecast** that the public can rely on is of **utmost importance**.

Purpose and hypothesis

We want to **find the most reliable commonly used weather forecast in Singapore**. Weather forecasts are used almost daily by everyone and play an extremely crucial role in our lives, it does not merely help us decide what activities to do and what items to bring, it can save lives by giving early warnings of storm, heatwaves and other natural disasters and determines the amount of harvest farmers would obtain. In ***Singapore***'s context, it can help us to **predict flash floods,** reducing damage to properties.
Our **hypothesis** is that between AccuWeather, BBC Weather, MSS and NEA forecast, **NEA forecast is the most accurate** for both **forecasting of temperature** and **presence of rain** and that local weather forecast websites are more accurate than foreign weather forecast websites for both. We used AccuWeather and BBC as they are widely acclaimed, while MSS is a weather forecast dedicated to Singapore's weather and NEA forecast is managed by the local authorities.

Methodology

The method we used to test our hypothesis was to **collect** the daily forecasted temperature and presence of rain from *AccuWeather, BBC Weather, MSS and NEA forecast* before **comparing** the collected data to the raw data recorded by NEA. To collect the required data, we used web scraping to collect the temperature and presence of rain in all neighbourhoods around Singapore stated on the websites at 12 am daily, which minimises human error as it collects the large amount of data that we require simultaneously. We collected the data over a period of 4 months.

Presence of rain

For all 4 weather forecasts, if prediction does not show key words like "rain", "shower" or "thunderstorm" for the whole 24 hours in a day at the specific neighbourhood, assume no rain is predicted, otherwise assume rain is predicted. If NEA records more than 0 mm of rainfall at a location on a particular day, but no rain is predicted in the forecast, we will consider that forecast "false." Conversely, if NEA's rainfall data shows 0 mm and no rain is predicted, the forecast will be marked as "true."

$$\text{Rain Matching Percentage} = \frac{\text{Number of "true" predictions}}{\text{Total number of data collected}} \times 100\%$$

Temperature

To find the accuracy of the weather forecasts, we compared the predicted minimum and maximum value to the actual values provided by NEA using Mean Absolute Percentage Error (***MAPE***), Weighted Absolute Percentage Error (***WAPE***) and Mean Squared Error (***MSE***) which finds the amount of error for each weather forecast. We used all 3 methods to minimise the drawbacks that each method brings. MAPE expresses the average magnitude of errors between forecasted and actual values as a percentage. WAPE and MSE is similar to MAPE but WAPE distributes weightage based on magnitude of actual value, normalising the error relative to overall size of data while MSE gives more weightage to larger errors, making the errors more prominent.
Let n = number of forecasted observations, A_i = actual value and F_i = forecasted value,

$$\text{Mean Absolute Percentage Error (MAPE)} = \frac{1}{n}\sum_{i=1}^{n}\frac{|A_i - F_i|}{A_i} \times 100\%$$

$$\text{Weighted Absolute Percentage Error (WAPE)} = \frac{\sum_{i=1}^{n}|A_i - F_i|}{\sum_{i=1}^{n}A_i} \times 100\%$$

$$\text{Mean Squared Error (MSE)} = \frac{1}{n}\sum_{i=1}^{n}(A_i - F_i)^2$$

Data Analysis

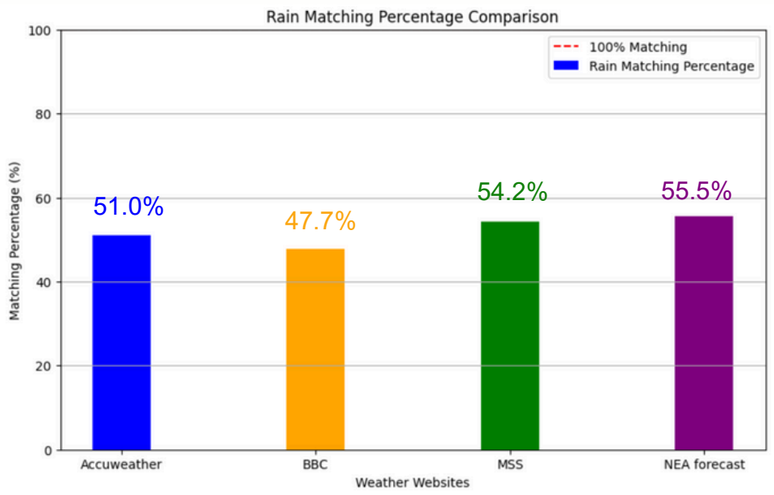

Figure 1: Bar graph showing rain matching percentage of each website

From Figure 1, we can observe that NEA forecast has the greatest accuracy, with 55.5% of its data matching with the raw data collected. MSS has the second greatest accuracy, with 54.2% of its data matching with the raw data collected. Thus we can conclude that **NEA forecast** is the **most accurate** in terms of forecasting the presence of rain and that **local weather forecast websites** are **generally more accurate** than foreign weather forecast websites in terms of **forecasting presence of rain**.

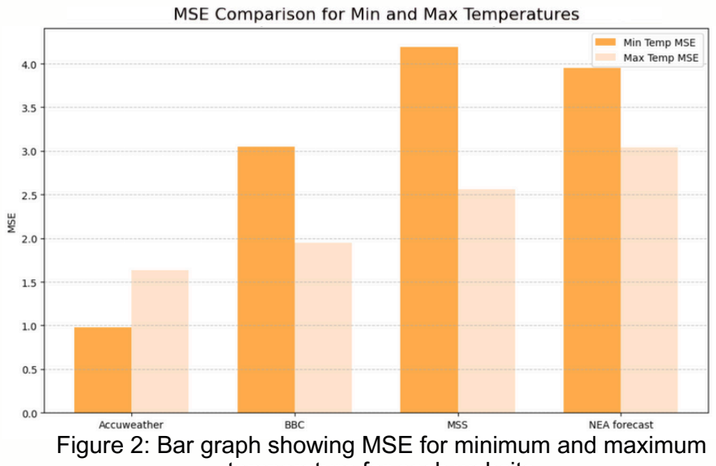

Figure 2: Bar graph showing MSE for minimum and maximum temperature for each website

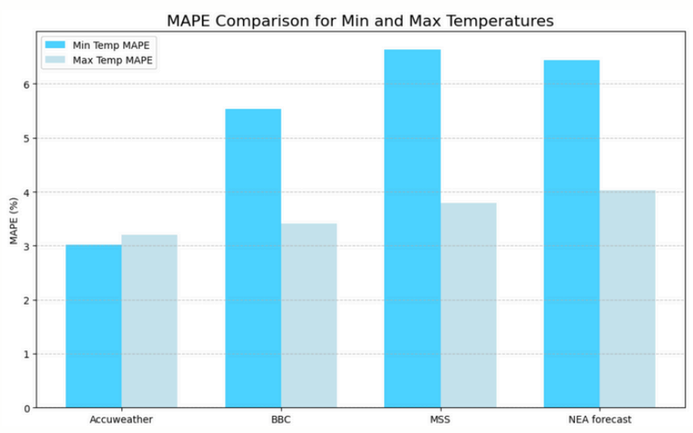

Figure 3: Bar graph showing MAPE for minimum and maximum temperature for each website

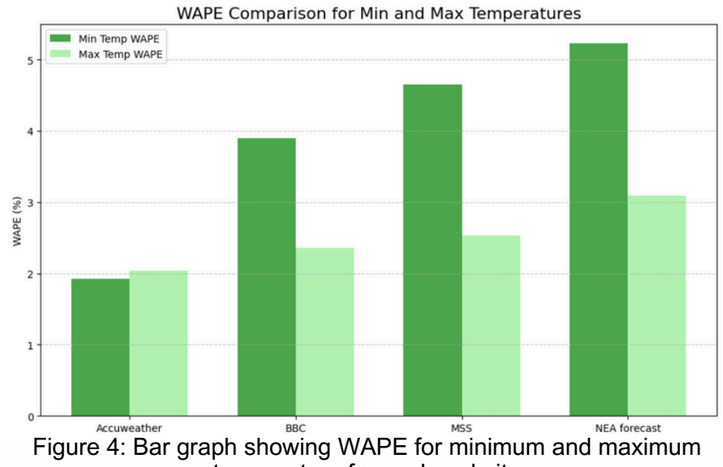

Figure 4: Bar graph showing WAPE for minimum and maximum temperature for each website

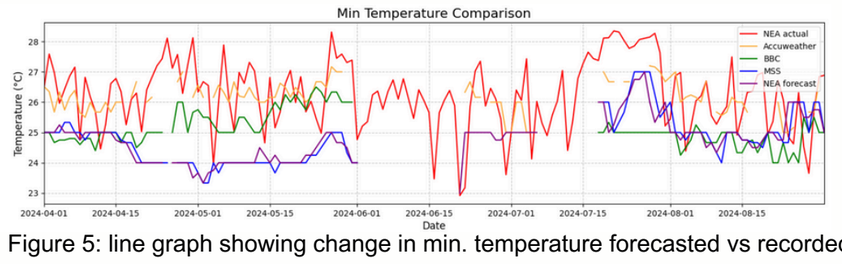

Figure 5: line graph showing change in min. temperature forecasted vs recorded

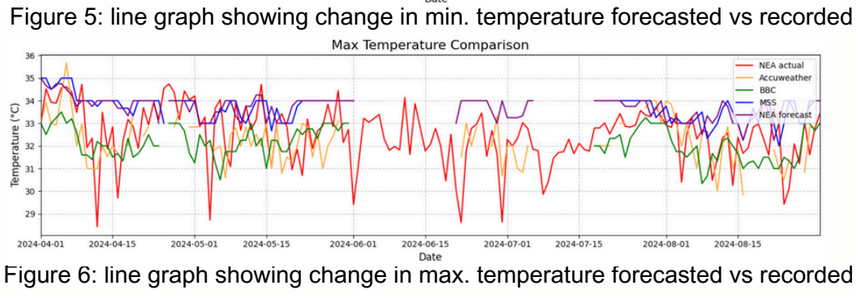

Figure 6: line graph showing change in max. temperature forecasted vs recorded

Since WAPE, MAPE and MSE finds the amount of error of each forecast, so to find which weather forecast has the least error, we have to find the website with the lowest value using all 3 methods. From Figure 2, 3 and 4, AccuWeather has the greatest accuracy, with the smallest error value for both minimum and maximum temperature using MSE, WAPE and MAPE. BBC Weather has the second greatest accuracy, with the second smallest error value for both minimum and maximum temperature using MSE, WAPE and MAPE. Thus we can conclude **AccuWeather is the most accurate** in terms of **forecasting temperature** and that **foreign weather forecast websites** are **generally more accurate** than local weather forecast websites in terms of **forecasting temperature.**

Conclusion

This proves that **our hypothesis is wrong**. Although **NEA forecast is most accurate for the forecasting of presence of rain** just like we hypothesised, however unlike what we hypothesised, **Accuweather is most accurate for the forecasting of temperature**. This shows that local weather forecasting websites are generally better at predicting if it would rain, while foreign weather forecasting websites are generally better at predicting the temperature. This may be due to several reasons. Local weather forecasting websites may be able to better predict if it would rain due to their better understanding of local rainfall patterns which is less predictable than temperature, while foreign or international weather forecasting websites might be better at predicting temperature as they have better access to state of the art technology.

Future Applications

The data could be collected over a **longer period of time** (1 year) to test the accuracy of the different weather forecasts during occurrence of different weather phenomena.
Likewise, a **larger variety of weather forecasting websites** could be analysed so that we can see which foreign weather forecasting website is the most accurate and potentially see common trends. For example, if weather forecasting apps used by smartphones are generally more accurate.

Limitations

One limitation is the **lack of time**, resulting in a insufficient sample size that might cause the analysis to be less reliable due to the presence of anomalies such as sudden extreme weather events due to climate change. When sudden extreme weather events occur, weather forecasts might be unable to predict it causing a increase in the error value for the different weather forecasts. Moreover, with only a 4 month period, we are unable to test the accuracy of the weather forecasts during the occurrence of different weather phenomena which occur at different parts of the year.

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