Interpolation for Meteorological Data

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ABSTRACT

This independent study explores polynomials interpolation to estimate rainfall and temperature in Chiang Mai province from October 2012 to October 2023. Interval estimation is done by taking the average data of temperature and rainfall in each month, and dividing the interval estimation into 3 seasons: winter, summer and rainy season. This study will show the trend of changes in rainfall and temperature in Chiang Mai.

INTRODUCTION

This study will focus on interpolation using polynomial functions for temperature and rainfall data, which are meteorological data from Chiang Mai Province. Generally, the Meteorological Department presents meteorological data from January to December each year, such as the cumulative rainfall data for the Northern region and temperature data from the Meteorological Department. These reports show rainfall data from January to December every year or display the average for each year, as shown in Figures 1 and 2, respectively.

Therefore, in this independent research, the focus will be on interpolation using polynomials to estimate the average temperature and average rainfall for each month. The estimation will be divided to align with the three seasons in Thailand: the winter, summer, and rainy seasons.

Figure 1: A graph showing the cumulative rainfall data for the Northern region from the Meteorological Department, displaying rainfall data from January to December.
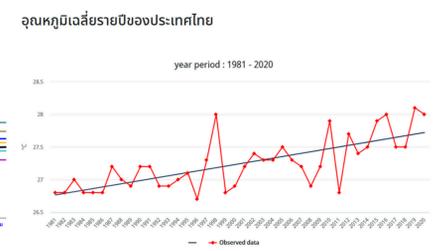
Figure 2: A graph showing the annual average temperature data for Thailand from the Meteorological Department, displaying the average temperature for each year.

OBJECTIVE

- To study interpolation using polynomial functions for temperature and rainfall data.
- To study curve fitting with linear equations to observe the trend of the data.

RESULTS

The study results, using temperature and rainfall data from Chiang Mai Province, from October 2012 to October 2023, employed interpolation to estimate the data. The polynomial functions derived must have coefficients with more than 10 decimal places. The estimated values for temperature and rainfall were then compared by calculating the RMSE. It was found that the dataset starting from the middle of one month to the middle of the next month showed less deviation and provided estimates that were closer to the actual data compared to the dataset starting from the beginning to the end of the month.
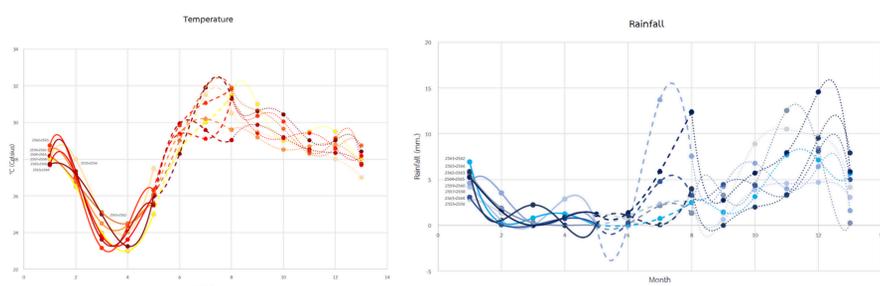
A graph of the average temperature and average rainfall in Chiang Mai Province over a 10-year period, from October 2012 to October 2023, from the Northern Meteorological Center, Muang District, Chiang Mai, and the Weather Spark website. The data is divided into three seasons: winter, summer, and rainy season, using interpolation with polynomial functions.
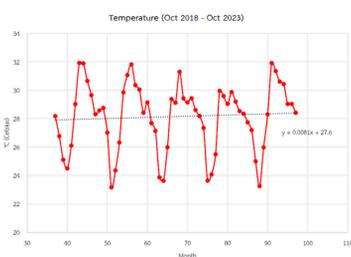
The average temperature in Chiang Mai Province from October 2018 to October 2023.

By using curve fitting with linear equations to observe the trend of temperature in Chiang Mai Province over a 5-year period, it was found that the coefficient has a positive value, indicating that from October 2018 to October 2023, the temperature in Chiang Mai Province has shown an increasing trend.

METHODOLOGY

Data Collection

Meteorological data, including temperature and rainfall in Chiang Mai Province, from October 2012 to October 2023, from the Northern Meteorological Center, Muang District, Chiang Mai, and the Weather Spark website:

- Temperature data consists of daily maximum and minimum temperatures, as well as average temperature.
- Rainfall data includes daily rainfall and average rainfall.

Seasons:

- Winter - October to February
- Summer - February to May
- Rainy Season - May to October

Interpolation is the process of finding a function $y = f(x)$ that passes through all the given points, where these points have specific $(x_0, y_0), (x_1, y_1), \ldots (x_N, y_N)$ coordinates

interpolation using **polynomial functions** will use polynomial functions of the form M or $p_M(x)$:

$$p_M(x) = a_0 + a_1 x + \ldots a_M x^M$$

When $a_0, a_1, \ldots, a_M$ is the coefficient of the polynomial function $p_M(x)$, with $M + 1$ terms.

Root Mean Square Error (RMSE) is used to compare datasets.

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^{n} \left(\widehat{y}_i - y_i \right)^2}$$

Let y_i be the actual data, $\widehat{y}_i$ be the data obtained from the estimation, and n be the number of days.

Curve fitting using linear equations to observe the trend of the data is represented by the following equation:

$$y = mx + b$$

Where y is the value to be predicted, x is the independent variable, m is the slope of the line, and b is the y-intercept.

CONCLUSION

The study of interpolation using polynomial functions aims to find the relationship between the daily maximum-minimum temperatures and the average temperature, as well as between daily rainfall and average rainfall. The RMSE is also calculated to compare datasets. It was found that the dataset starting from the middle of the month to the middle of the month had less deviation and provided estimates that were closer to the actual data than the dataset starting from the beginning to the end of the month. Additionally, curve fitting was used to observe the trend of temperature fluctuations over a 5-year period. The results showed that the temperature in Chiang Mai Province has been increasing over the past 5 years.