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Weather Modelling Using a Quadratic Solution

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Project: Software Engineering Lab

1. Objective

To implement a weather modelling program in Python that predicts the temperature for a given time of day. The model is based on a quadratic equation of the form y=ax2+bx+c, where y is the temperature and x is the hour. The implementation covers three approaches for data handling: hardcoded values, dynamic keyboard input, and reading from an Excel file. The project concludes with versioning the code using Git and GitHub.

2. Mathematical Model

The core of the weather model is a quadratic equation. To find the coefficients a, b, and c, we use three known data points (time, temperature):

- At 6 AM (x=6), the temperature is 20°C.
- At 12 PM (x=12), the temperature is 32°C.
- At 6 PM (x=18), the temperature is 22°C.

Substituting these values into the equation y=ax2+bx+c yields a system of three linear equations:

1. a(6)2+b(6)+c=20implies36a+6b+c=20
2. a(12)2+b(12)+c=32implies144a+12b+c=32
3. a(18)2+b(18)+c=22implies324a+18b+c=22

Solving this system gives the coefficients:

- a=−11/36approx−0.3056
- b=135/18=7.5
- c=−14

The final derived model is:

y=−0.3056x2+7.5x−14

3. Python Implementation

The project is implemented in distinct parts as per the requirements.

Part 1: Hardcoded Modelling

This approach involves hardcoding the initial data points directly into the Python script. The numpy library is used to solve the system of linear equations programmatically.

Code:

```
import numpy as np


# Hardcoded data points (Hour, Temperature)
x1, y1 = 6, 20
x2, y2 = 12, 32
x3, y3 = 18, 22


# Create matrix A for the coefficients of a, b, c
A = np.array([
    [x1**2, x1, 1],
    [x2**2, x2, 1],
    [x3**2, x3, 1]
])


# Create vector Y with the temperature values
Y = np.array([y1, y2, y3])


# Solve the linear system Ax = Y for the coefficients
try:
    a, b, c = np.linalg.solve(A, Y)
    print(f"Derived Quadratic Model: y = {a:.3f}x^2 + {b:.3f}x + {c:.3f}\n")
```

```
    # Define a prediction function
    def predict_temperature(hour):
        return a * hour**2 + b * hour + c

    # Example: Predict temperature at 12 PM
    hour = 12
    predicted_temp = predict_temperature(hour)
    print(f"Predicted temperature at {hour:02d}:00 is {predicted_temp:.2f}°C")

except np.linalg.LinAlgError:
    print("Could not solve the system. The data points may be collinear.")
```

Output:

Derived Quadratic Model: y = -0.306x^2 + 7.500x + -14.000

Predicted temperature at 12:00 is 32.00°C

Part 2: Keyboard Input for Predictions

This part extends the first model by allowing the user to input an hour and get a temperature prediction in real-time.

Code:

```
# Assuming a, b, c and predict_temperature() are defined from Part 1

while True:
    try:
        hour_input = int(input("Enter hour of the day (0-23): "))
        if 0 <= hour_input <= 23:
            predicted_temp = predict_temperature(hour_input)
            print(f"--> Predicted temperature at {hour_input:02d}:00 is {predicted_temp:.2f}°C")
```

```
        else:
            print("Error: Please enter an hour between 0 and 23.")
    except ValueError:
        print("Error: Invalid input. Please enter a number.")

    another = input("Check another hour? (y/n): ").strip().lower()
    if another != 'y':
        print("Exited.")
        break
```

Output:

```
Enter hour of the day (0-23): 2
--> Predicted temperature at 02:00 is -0.22°C
Check another hour? (y/n): y
Enter hour of the day (0-23): 22
--> Predicted temperature at 22:00 is 3.78°C
Check another hour? (y/n): n
Exited.
```

Part 3: Accessing Data From an Excel File

This approach makes the model more flexible by reading data points from an external Excel file named weather_data.xlsx.

Prerequisites:

```
pip install pandas openpyxl
```

Code:

```
import numpy as np
import pandas as pd

try:
```

```python
    # Read data from Excel file
    data = pd.read_excel("weather_data.xlsx")
    x_vals = data['Hour'].values
    y_vals = data['Temperature'].values

    if len(x_vals) < 3:
        print("Error: At least 3 data points are required from the Excel file.")
    else:
        # Use the first 3 points to build the model
        x1, x2, x3 = x_vals[0], x_vals[1], x_vals[2]
        y1, y2, y3 = y_vals[0], y_vals[1], y_vals[2]

        A = np.array([[x1**2, x1, 1], [x2**2, x2, 1], [x3**2, x3, 1]])
        Y = np.array([y1, y2, y3])

        a, b, c = np.linalg.solve(A, Y)
        print("Model derived from Excel data.")
        print(f"y = {a:.3f}x^2 + {b:.3f}x + {c:.3f}\n")

        # Interactive prediction loop can be added here

except FileNotFoundError:
    print("Error: 'weather_data.xlsx' not found.")
except Exception as e:
    print(f"An error occurred: {e}")
```

4. Data Visualization

To better understand the model, the original data points can be plotted alongside the fitted quadratic curve using matplotlib.

Prerequisites:

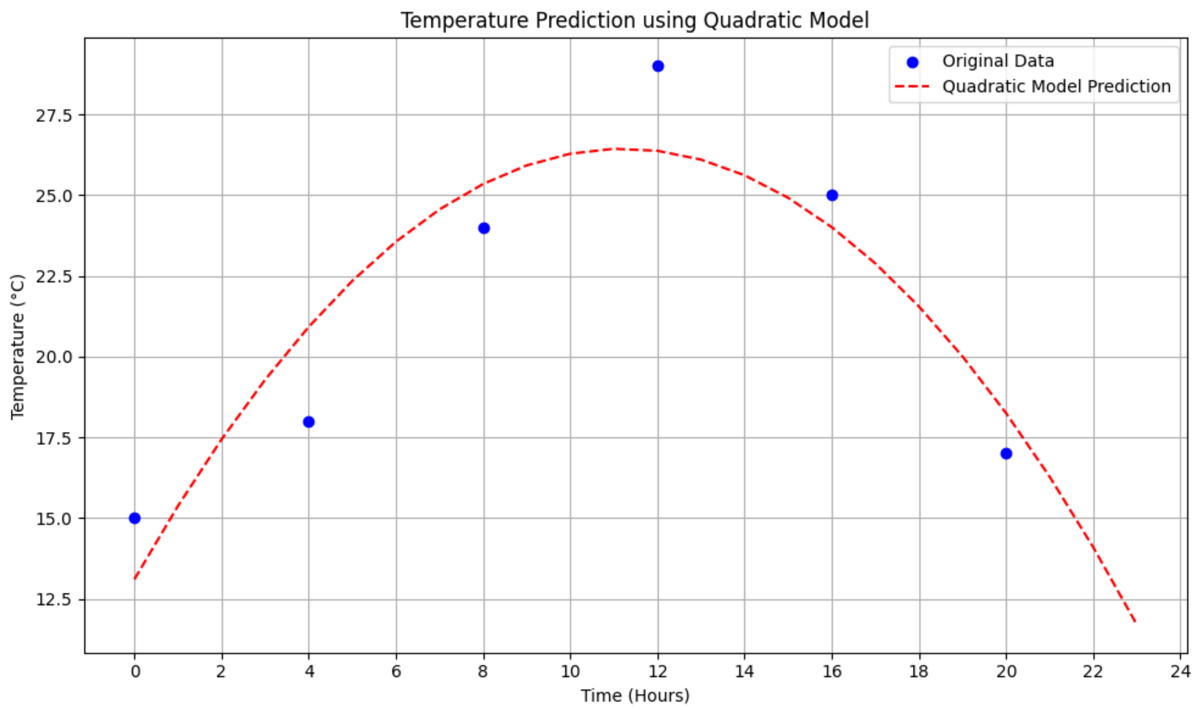
```
pip install matplotlib
```

Code:

```
import numpy as np

import matplotlib.pyplot as plt


# Using polyfit for a more direct approach with multiple points

time = np.array([0, 4, 8, 12, 16, 20])

temperature = np.array([15, 18, 24, 29, 25, 17])


# Fit a 2nd degree polynomial (quadratic)

a, b, c = np.polyfit(time, temperature, 2)


# Generate a smooth curve for the model

t_values = np.arange(0, 24, 1)

predicted_temp = a * t_values**2 + b * t_values + c


# Plotting

plt.figure(figsize=(10, 6))

plt.scatter(time, temperature, color='blue', label='Original Data', zorder=5)

plt.plot(t_values, predicted_temp, color='red', linestyle='--', label='Quadratic Model Prediction')


plt.title('Temperature Prediction using Quadratic Model')

plt.xlabel('Time (Hours)')

plt.ylabel('Temperature (°C)')

plt.xticks(np.arange(0, 25, 2))
```

```
plt.grid(True)
plt.legend()
plt.tight_layout()
plt.show()
```

output:



Resulting Plot:

5. Create GitHub Repository

The final step is to manage the project code using version control.

1. **Create a GitHub Account:** If not already present, sign up for a free account at github.com.
2. **Create a New Repository:** On the GitHub dashboard, create a new repository named weather-modelling-py.
3. **Upload Files:** Upload the Python script(s) (.py or .ipynb files) and the weather_data.xlsx file to the repository.
4. **Commit Changes:** Add a commit message (e.g., "Initial commit of weather modelling project") and commit the files. This ensures the project is saved, versioned, and can be shared easily.