Assignment 2

Due: 11:59pm, Friday June 6th

Please note: The use of generative AI for this assignment is **not permitted**. If the use of generative AI to complete either your code or your response to the question is suspected, then your submission will be referred for investigation as a breach of academic integrity.

Scenario

IoT devices collect data about the real world to help us make better decisions with that data. Raw data isn't particularly helpful, so we analyse data to try it into more meaningful information. Sometimes we want to use this data not just to tell us about the past, but also to make inferences about the future.

In this assignment, we are going to use machine learning trained on historic weather data to make an inference about the future. You have been provided with a data set consisting of weather data for 5 sites. The data covers temperature, humidity and wind observations that were recorded every half hour for almost 6 years per site.

This data will be used to create a simple IoT enabled 'lamp' device that uses machine learning to predict what the days weather conditions should be and compare it against the current reading.

Think of this lamp as being an object in the household that provides ambient notifications to it's owner. The owner configures the device by setting up the time and date on the device. It then asks the server for a prediction for that day, and changes colour to indicate its state based on its current temperature and humidity readings. The owner can also use a mobile app (simulated as a webpage) to view more information about the historic average temperature and humidity for the current day, in half hour increments.

This will consist of a simulated IoT hardware device (using the SenseHat emulator) and a server that runs the machine learning algorithms and offers more detailed information for the selected day.

Please note:

- The size of these data sets is quite large. The weather data is provided in xlsx format and will need to be cleaned up and converted to a suitable format before you can use it in your program – you should discard any data that you don't need to reduce the amount of time it will take to train your models.
- The data set includes data from 2015 – 2021 inclusive, but 2021 does not contain the full year. Your predictions should be for the year 2022.

Specification

Your IoT device should:

- Allow the user to input a date (day and month) and a site number, using the keys on the front of the device.
    - Press the middle key to enter setup entry mode. Press left and right to switch between day, month and Site ID. Use scrolling text to indicate which mode you are in. Press up and down to change the day, month and site ID(number). Press the middle key to save the date and site ID, and return to normal operation mode.
    - Your date should also include 2022 as the year – this is the next year outside of the data set.
    - Your site number indicates the location of the IoT device from among the 5 provided data sets.
- **Send** the date to your server and **return** the *predicted* minimum and maximum temperature, the *predicted* minimum and maximum humidity for the given date, and the name of the location as per the location ID.
    - Print these predicted values and location name to the terminal.
- While in normal mode, if the date has been set and a prediction returned, the device should visualize whether the current temperature and humidity is within the predictions for this day.
    - Press left and right to switch between temperature and humidity mode.
        - Indicate changes between these two modes using scrolling text.
    - Change the colour of the screen to red if the current temperature is higher or lower than the prediction, and green if it is within the current temperature prediction mode.
    - Change the colour of the screen to yellow if the current humidity is higher or lower than the prediction, and blue if it is within the current humidity prediction mode.
    - As the temperature changes on your sensehat, so should these visual indications.
        - Temperature and humidity measurements are local only and do not need to be sent to the server.
- All scrolling text messages should scroll quickly at 0.05 to reduce time taken to setup and use the device.

Your server should:

- Accept the date and location ID from the IoT device and store in an XML file for later access.
- Use machine learning to return a prediction to the IoT device.
    - You should return a predicted maximum and minimum temperature and a maximum and minimum humidity.
    - Your prediction should use PHP-ML to train a model based on the historic data (from the supplied data set) for the selected date.
        - Select an appropriate ML method and train it with the appropriate samples from the provided data sets to generate the above predictions.
- Your server should also provide a view that shows more information about the selected date. This information should be based on the data recorded in the data set.
    - Using the last stored date, generate a graph (using CanvasJS) that shows the **average** temperatures for the selected date in half hour increments. Below the graph you should display the predicted minimum and maximum temperatures (for the whole day).

- Using the last stored date, generate a graph (using CanvasJS) that shows the **average** humidity for the selected date in half hour increments. Below the graph you should display the predicted minimum and maximum humidity (for the whole day).
- This should be rendered as two separate graphs.
- The locations name and the type of data shown should be included as the graph title.

Documentation:

- Write a brief explanation explaining your choice of machine learning algorithm, and why it's an appropriate fit for this use case. Describe the training data that your models needs, and and any steps you had to take to sample that data from the data sets. (4 marks)
- Discuss your thoughts on the accuracy of the predicitions that your system has returned. Do you think they are particularly accurate? Discuss what are some of the factors that affect the accuracy of your system or what could be done to improve the accuracy of the system. (4 marks)

Demonstration *2 marks*

Along with your code (zipped), you should record a quick video that demonstrates your system. Your video should be a screen recording, whereby you demonstrate your virtual machine environment, showing off all the features of your webserver running in a browser. In your video, you should talk through the features as you demonstrate them to the marker.

Your demonstration should show you:

- Setting a date on the IoT device.
- The printed response in the terminal.
- The colour of the lights changing as you adjust the temperature and humidity sliders.
- Your webserver visualizing the temperature and humidity graphs for the selected date.
- Your demonstration should be recorded as a screen capture, as per the instructions on Mylo.

Marking Schedule

The assignment submission will include:

- Your code for the IoT device (python), server (php) and your cleaned data set as a zip file.
- Your documentation, including your explanation of ML methods/accuracy.
- A video demonstration of the system, as a screen capture.

Please submit this as 2 separate files (zip and video) via Mylo, as this will make the markers life much easier.

Your IoT system allows a user to send a date and location to the server	
• Enters setup mode, allows date and location to be set, sends data and location ID to the server, exits and enters normal operation mode, text scrolls at the correct speed.	**2**
• Partially implemented, but fails one or more of the above	1
• Not implemented	0
Your IoT system	
• Reads the current temperature and humidity, displays the correct status colour, switches between the two modes(temp/humidity), visually indicates the mode(at the correct speed).	**2**
• Partially implemented, but fails one or more of the above	1
• Not implemented	0
Your server accepts a date and ID from the IoT device	
• Your server accepts a date and location ID, stores this information as an XML file, returns a prediction from your machine learning model to the IoT Device.	**2**
• Partially implemented, but fails one or more of the above	1
• Not implemented	0
Your server uses machine learning to predict that days temp/humidity ranges for the selected date and location ID.	
• Sample the appropriate data from the data set, use an appropriate machine learning algorithm, train a machine learning model, predict the min/max temp and humidity for the location ID, returns a reasonably accurate result.	**5**
• Partially implemented, but fails one or more of the above	3
• Partially implemented, but fails two or more of the above	1
• Not Implemented	0
Your webserver visualizes data	
• Reads the date and ID from the XML, reads the half hourly temperature and humidity for those dates and ID from the data set, calculates an average for each half hour increment, graphs the data as two separate graphs.	**4**
• Partially implemented, but fails one or more of the above	2
• Partially implemented, but fails two or more of the above	1
• Not implemented	0
Demonstration	2
Explanation of ML choice	4
Discussion of Accuracy	4