Hardware project: Weather Forecasting with Arduino Temperature and Luminance Sensors Group 13

Elliot Alexander Fernin, 105003 Hallvard Bjørgen, 105243 Manuel Sach, 105357 Miguel Cruz Irimia, 104537

Professors: Jo˜ao Sousa, Jo˜ao Santos

Get temperature from API

```
import requests

# Replace with the latitude and longitude of the location you want to get weather data for
latitude = 38.72
longitude = -9.13

# Replace with the start and end date in the format 'yyyy-mm-dd'
start_date = '2022-01-01'
end_date = '2023-01-01'

url = f'https://archive-api.open-meteo.com/v1/archive?latitude={latitude}&longitude={longitude}&start_date={start_date}&end_date={end_da

response = requests.get(url)

data = response.json()
```

```
import pandas as pd
df = pd.DataFrame(data['hourly'])
df.head(365)
```

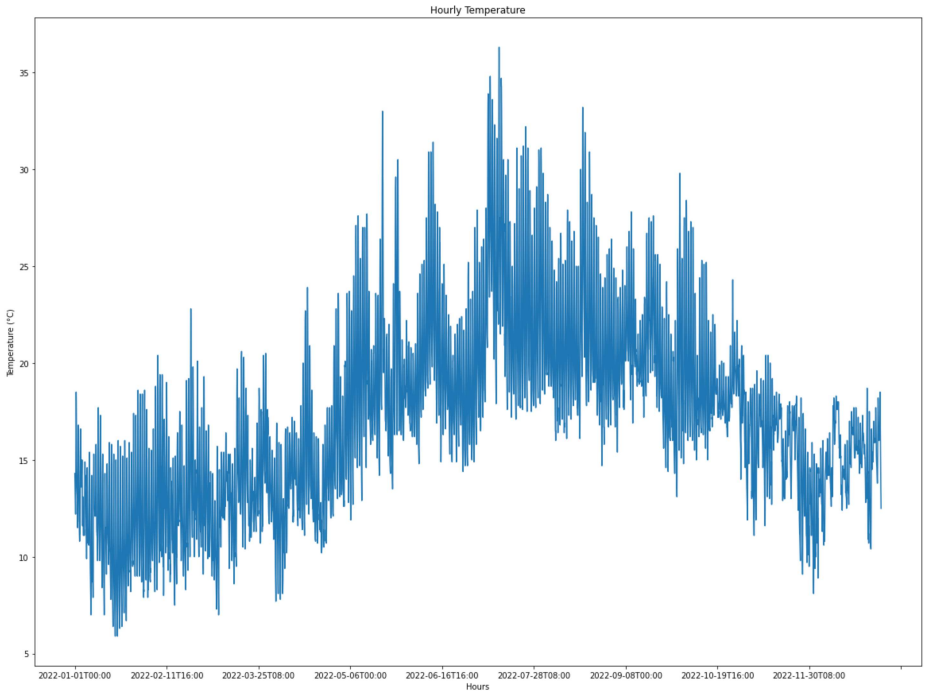
	time	temperature_2m
0	2022-01-01T00:00	14.3
3	2022-01-01T03:00	13.6
4	2022-01-01T04:00	13.3
...	...	...
360	2022-01-16T00:00	11.2
361	2022-01-16T01:00	11.0
362	2022-01-16T02:00	10.8
363	2022-01-16T03:00	10.6
364	2022-01-16T04:00	10.6

365 rows × 2 columns

Plot the temperature against time

```
import matplotlib.pyplot as plt
from matplotlib.ticker import MaxNLocator
# Replace with the data you want to plot
x = df['time']
y = df['temperature_2m']

# Create a new figure and axis
fig, ax = plt.subplots(figsize=(20, 15))

# Plot the data
ax.plot(x, y)

# Set labels for the x and y axis
ax.set_xlabel('Hours')
ax.xaxis.set_major_locator(MaxNLocator(nbins=10))
ax.set_ylabel('Temperature (°C)')

# Set title for the plot
ax.set_title('Hourly Temperature')
```

```
# Show the plot
plt.show()
```



Fehler beim automatischen Speichern Diese Datei wurde im Remotezugriff oder in einem anderen Tab aktualisiert. Unterschied anzeigen

Data preprocessing

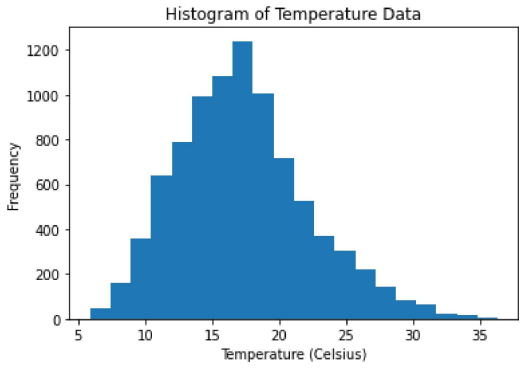
```
import pandas as pd

# load data into a dataframe
df = pd.DataFrame(data['hourly'])

# Convertir la columna de fecha en un tipo de fecha
df['fecha'] = pd.to_datetime(df['time'])

# Establecer la columna de fecha como el índice del DataFrame
df.set_index('fecha', inplace=True)

# Eliminar las filas con valores faltantes
df.dropna(inplace=True)

# Agrupar los datos por mes y calcular la temperatura promedio
df_agrupado = df.groupby(df.index.month).mean()
```

Relationship between temperature and hour:

```
import pandas as pd
import matplotlib.pyplot as plt

# load the temperature dataset
df = pd.DataFrame(data['hourly'])
```

```
# print basic information about the dataset
print(df.info())

# calculate basic statistics
print(df.describe())

# plot a histogram of the temperature data
plt.hist(df['temperature_2m'], bins = 20)
plt.xlabel('Temperature (Celsius)')
plt.ylabel('Frequency')
plt.title('Histogram of Temperature Data')
plt.show()

# plot a line graph of the temperature data over time
plt.plot(df['time'], df['temperature_2m'])
plt.xlabel('time')
plt.ylabel('Temperature (Celsius)')
plt.title('Temperature over Time')
plt.show()

# plot a box plot of the temperature data
plt.boxplot(df['temperature_2m'])
plt.ylabel('Temperature (Celsius)')
plt.title('Box Plot of Temperature Data')
plt.show()
# convert time column to datetime format
df['time'] = pd.to_datetime(df['time'])

# group the temperature data by month and calculate the mean temperature for each month
monthly_temperatures = df.groupby(df['time'].dt.month)['temperature_2m'].mean()

# plot the mean temperature for each month
monthly_temperatures.plot(kind='bar')
plt.xlabel('Month')
plt.ylabel('Mean Temperature (Celsius)')
plt.title('Mean Temperature by Month')
plt.show()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8784 entries, 0 to 8783
Data columns (total 2 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   time            8784 non-null   object 
 1   temperature_2m  8784 non-null   float64
dtypes: float64(1), object(1)
memory usage: 137.4+ KB
None
       temperature_2m
count     8784.000000
mean        17.301526
std          4.908199
min          5.900000
25%         13.800000
50%         17.000000
75%         20.100000
max         36.300000
```



Zum Bearbeiten doppelklicken (oder Eingabe)

Arduino code

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```
int temp3=2;
int lum1 = 3;
int lum2=4;
int lum3=5;

int temp_val1;
int temp_val2;
int temp_val3;
int lum_val1;
int lum_val2;
int lum_val3;

void setup() {
  Serial.begin(9600);
}

void loop() {
  lum_val1 = analogRead(lum1);
  lum_val2 = analogRead(lum2);
  lum_val3 = analogRead(lum3);
  temp_val1 =analogRead(temp1);
  temp_val2 =analogRead(temp2);
  temp_val3 =analogRead(temp3);
  Serial.print(temp_val1);
  Serial.print(';');
  Serial.print(temp_val2);
  Serial.print(';');
  Serial.print(temp_val3);
  Serial.print(';');
  Serial.print(lum_val1);
  Serial.print(';');
  Serial.print(lum_val2);
  Serial.print(';');
  Serial.println(lum_val3);


  delay(30000);
```

```
}
```

```
  File "<ipython-input-12-645553043b36>", line 2
    int temp1 = 0;
        ^
SyntaxError: invalid syntax
```

SEARCH STACK OVERFLOW

```
## This code is to retrieve sensor data from Arduino and save in a .CSV data file. Do not run this!

import serial # module for serial communication with Arduino
import csv # module for working with CSV files
import time # module for adding delay

# Create a serial object to communicate with Arduino
ser = serial.Serial('COM3', 9600) # Connection to the arduino and the baudrate

# Name of the CSV file
filename = "sensor_data.csv"

# Open the file and write the headers
with open(filename, 'w', newline='') as csvfile:
    csvwriter = csv.writer(csvfile)
    csvwriter.writerow(['Timestamp', 'Sensor Value'])

while True:
    # Read data from the serial port
    data = ser.readline().decode().strip()

    # Split the data into timestamp and sensor value
    timestamp = time.time()
    sensor_value = data

    # Append the data to the CSV file
    with open(filename, 'a', newline='') as csvfile:
        csvwriter = csv.writer(csvfile)
        csvwriter.writerow([timestamp, sensor_value])

    # Print the data
```

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```
    print()

    # Add delay
    time.sleep(1)
```

```
## Read data sensor data csv and combine them.
import pandas as pd
df_1 = pd.read_csv("sensor_data_sunday.csv",delimiter=';')
df_2 = pd.read_csv("sensor_data_tuesday.csv",delimiter=';')
df_3 = pd.read_csv("sensor_data_wednesday.csv",delimiter=';')
df_arduino = pd.concat([df_1, df_2,df_3], axis=0)

df_arduino.head()
```

	Timestamp	Temperature1	Temperature2	Temperature3	Luminance1	Luminance2	Luminanc
0	1.673796e+09	387	385	384	244	864	8
1	1.673796e+09	356	354	353	199	870	8
2	1.673796e+09	362	360	359	196	903	8
3	1.673796e+09	356	354	353	200	867	8
4	1.673796e+09	361	359	357	203	879	8

As we can see, there is no real correlation between temperature and luminance. Exeptation is luminance 1 sensor readings, which can be explained by an obvious sensor error. Luminance 1 column should be dropped.

```
# drop luminance 1 because of obvious systematic error in lumunance sensor 1.

df_arduino=df_arduino.drop(columns = 'Luminance1')

print(df_arduino)
```

```
             Timestamp  Temperature1  Temperature2  Temperature3  Luminance2  \
    0    1.673796e+09           387           385           384         864
```

```
1    1.673796e+09          356          354          353          870
2    1.673796e+09          362          360          359          903
3    1.673796e+09          356          354          353          867
4    1.673796e+09          361          359          357          879
..            ...          ...          ...          ...          ...
232  1.674049e+09          352          350          348          631
233  1.674049e+09          353          351          350          629
234  1.674049e+09          368          367          365          632
235  1.674049e+09          392          390          389          635
236  1.674049e+09          391          389          388          612

     Luminance3
0           858
1           865
2           899
3           866
4           877
..          ...
232         711
233         710
234         713
235         715
236         691

[556 rows x 6 columns]
```

```
# Convert data into desired time format and temperature unit
import math
from datetime import datetime

df_arduino['date'] = pd.to_datetime(df_arduino['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
df_1['date'] = pd.to_datetime(df_1['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
df_2['date'] = pd.to_datetime(df_2['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
df_3['date'] = pd.to_datetime(df_3['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
#convert temperature from analog to celcius (50/1024), note that these temperatures was taken in sunlight, might affect result.
# only run code once, it overwrites the values in columns each time.
df_1['Temperature1']=df_1['Temperature1']*(50/1024)
df_2['Temperature1']=df_2['Temperature1']*(50/1024)
df_3['Temperature1']=df_3['Temperature1']*(50/1024)

df_arduino['Temperature1']=df_arduino['Temperature1']*(50/1024)
df_arduino['Temperature2']=df_arduino['Temperature2']*(50/1024)
```


	Timestamp	Temperature1	Temperature2	Temperature3	Luminance2	Luminance3	date
0	1.673796e+09	18.896484	18.798828	18.750000	864	858	15-01-202 15:22:0
1	1.673796e+09	17.382812	17.285156	17.236328	870	865	15-01-202 15:22:3
2	1.673796e+09	17.675781	17.578125	17.529297	903	899	15-01-202 15:23:0
3	1.673796e+09	17.382812	17.285156	17.236328	867	866	15-01-202 15:23:3
4	1.673796e+09	17.626953	17.529297	17.431641	879	877	15-01-202 15:24:0
...	...	...	...	...	...	...	..
							15-01

```
# Calculate the discrepancy between the sensors

df_arduino['discrepancy_temp'] = abs(df_arduino['Temperature1'] - df_arduino['Temperature2']) + abs(df_arduino['Temperature2'] - df_ardu
df_arduino['discrepancy_lum'] =  abs(df_arduino['Luminance2'] - df_arduino['Luminance3'])
print(df_arduino)
```

```
        Timestamp  Temperature1  Temperature2  Temperature3  Luminance2  \
0    1.673796e+09     18.896484     18.798828     18.750000         864
1    1.673796e+09     17.382812     17.285156     17.236328         870
2    1.673796e+09     17.675781     17.578125     17.529297         903
3    1.673796e+09     17.382812     17.285156     17.236328         867
4    1.673796e+09     17.626953     17.529297     17.431641         879
..            ...           ...           ...           ...         ...
232  1.674049e+09     17.187500     17.089844     16.992188         631
233  1.674049e+09     17.236328     17.138672     17.089844         629
```

```
234  1.674049e+09     17.968750     17.919922     17.822266         632
235  1.674049e+09     19.140625     19.042969     18.994141         635
236  1.674049e+09     19.091797     18.994141     18.945312         612

     Luminance3                date  discrepancy_temp  discrepancy_lum
0           858  15-01-2023 15:22:03          0.292969                6
1           865  15-01-2023 15:22:33          0.292969                5
2           899  15-01-2023 15:23:03          0.292969                4
3           866  15-01-2023 15:23:33          0.292969                1
4           877  15-01-2023 15:24:03          0.390625                2
..          ...                   ...               ...              ...
232         711  18-01-2023 13:31:33          0.390625               80
233         710  18-01-2023 13:32:03          0.292969               81
234         713  18-01-2023 13:32:33          0.292969               81
235         715  18-01-2023 13:33:03          0.292969               80
236         691  18-01-2023 13:33:33          0.292969               79

[556 rows x 9 columns]
```

Check the correlation between temperature and luminance

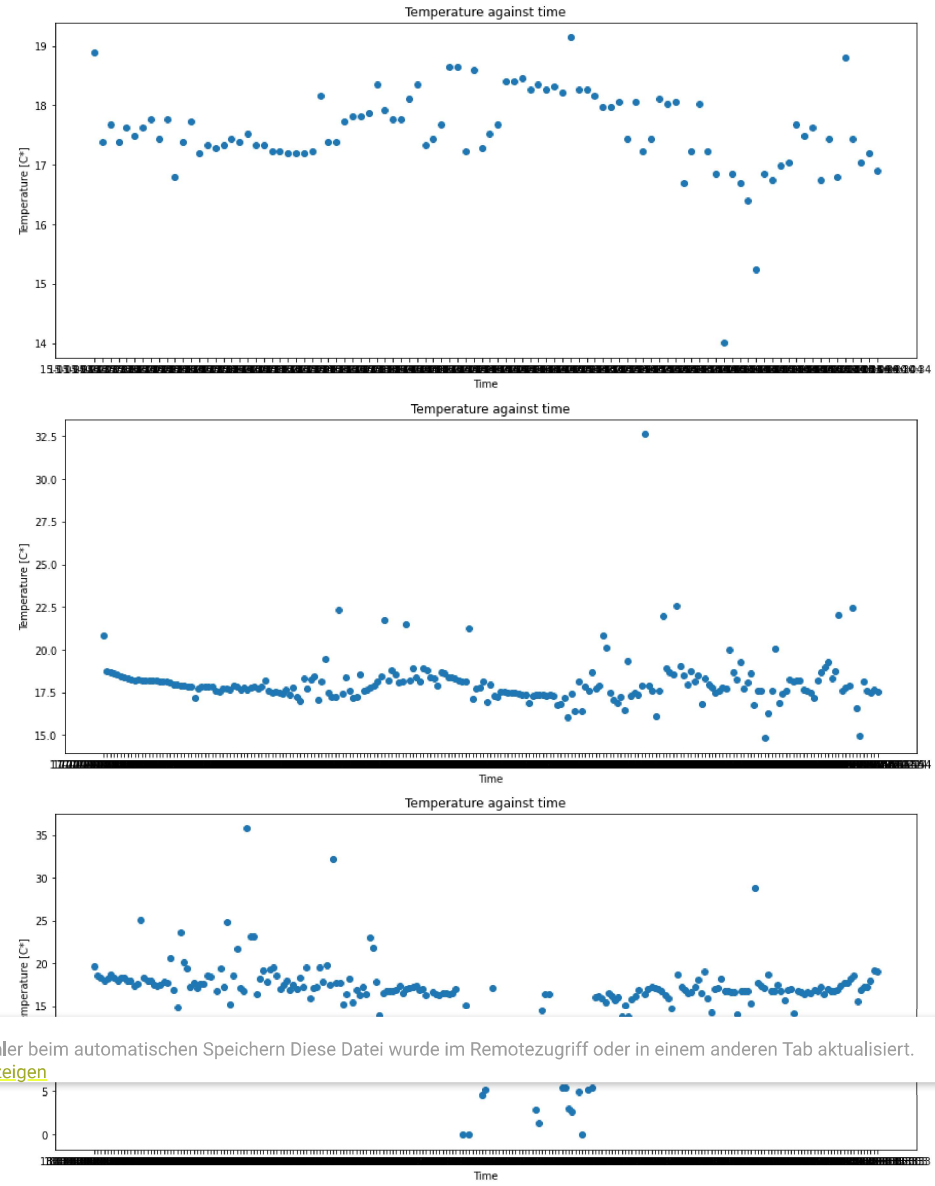
```
print from scipy.stats import pearsonr

## Calculate the correlations between the columns
df_compare=df_arduino.drop(columns=['Timestamp','date','discrepancy_temp','discrepancy_lum'])
df_corrs = df_compare.corr(method='pearson')

print(df_corrs)
```

```
                Temperature1  Temperature2  Temperature3  Luminance2  Luminance3
Temperature1        1.000000      0.991963      0.987543   -0.048186   -0.062949
Temperature2        0.991963      1.000000      0.999370   -0.066120   -0.082406
Temperature3        0.987543      0.999370      1.000000   -0.071746   -0.088699
Luminance2         -0.048186     -0.066120     -0.071746    1.000000    0.976337
Luminance3         -0.062949     -0.082406     -0.088699    0.976337    1.000000
```

```
import pandas as pd
import matplotlib.pyplot as plt
```



```
y1 = df_1["Temperature1"]

x2 = df_2["date"]
y2 = df_2["Temperature1"]

x3 = df_3["date"]
y3 = df_3["Temperature1"]

# Create a scatter plot for dataframe 1
plt.scatter(x1, y1)

# Add labels and title
plt.xlabel("Time")
plt.ylabel("Temperature [C*]")
plt.title("Temperature against time")
# show plot
plt.show()

# repeat for dataframe 2
plt.scatter(x2, y2)

# Add labels and title
plt.xlabel("Time")
plt.ylabel("Temperature [C*]")
plt.title("Temperature against time")

plt.show()
# repeat for dataframe 3
plt.scatter(x3, y3)

# add labels and title
plt.xlabel("Time")
plt.ylabel("Temperature [C*]")
plt.title("Temperature against time")

# show plot
plt.show()
```



Different models generated by OpenAI (remove?)

```
# ARIMA

import numpy as np
import statsmodels.api as sm

# Assume that you have temperature and luminance data for the previous 4 days
# stored in the variables 'temp_data' and 'lum_data', respectively.


# We'll use the temperature data to train the ARIMA model
model = sm.tsa.ARIMA(temp_data, order=(1, 1, 1))
arima_fit = model.fit()

# Now we can use the fitted model to make predictions on new data
forecast, stderr, conf_int = arima_fit.forecast(2)
```

```
# The forecast array will contain temperature predictions for the next 2 hours
# The 'stderr' and 'conf_int' arrays contain standard error and confidence interval information
# for the predictions

# We can also use the luminance data to train a separate ARIMA model
lum_model = sm.tsa.ARIMA(lum_data, order=(1, 1, 1))
lum_arima_fit = lum_model.fit()

# And use this model to make luminance predictions
lum_forecast, lum_stderr, lum_conf_int = lum_arima_fit.forecast(2)

# The lum_forecast array will contain luminance predictions for the next 2 hours


# DECISION TREE

import numpy as np
from sklearn.tree import DecisionTreeRegressor

# Assume that you have temperature and luminance data for the previous 4 days
# stored in the variables 'temp_data' and 'lum_data', respectively.

# Combine the temperature and luminance data into a single dataset
data = np.column_stack([temp_data, lum_data])

# Define the decision tree model.
model = DecisionTreeRegressor()

# Now we can train the model using the data
model.fit(data, data)

# Now that the model is trained, we can use it to make predictions on new data
forecast = model.predict(data)

# The forecast array will contain temperature and luminance predictions
# for the next few hours



# Feedforward neural network FNN
```

Fehler beim automatischen Speichern Diese Datei wurde im Remotezugriff oder in einem anderen Tab aktualisiert. Unterschied anzeigen

```
# Assume that you have temperature and luminance data for the previous 4 days
# stored in the variables 'temp_data' and 'lum_data', respectively.

# First, we'll combine the temperature and luminance data into a single dataset
data = torch.stack([temp_data, lum_data], dim=1)

# Next, we'll define the neural network.
# We'll use a single fully-connected hidden layer with 10 units, and a fully-connected
# output layer to predict temperature and luminance.

class Net(nn.Module):
    def __init__(self, input_size, hidden_size, output_size):
        super().__init__()
        self.fc1 = nn.Linear(input_size, hidden_size)
        self.fc2 = nn.Linear(hidden_size, output_size)

    def forward(self, x):
        x = self.fc1(x)
        x = self.fc2(x)
        return x

model = Net(2, 10, 2)

# Now we can train the model using an Adam optimizer and mean squared error loss
optimizer = torch.optim.Adam(model.parameters())
loss_fn = nn.MSELoss()

for epoch in range(100):
    # Clear the gradients
    optimizer.zero_grad()

    # Forward pass
    output = model(data)
    loss = loss_fn(output, data)

    # Backward pass
    loss.backward()
    optimizer.step()
```

```
# Now that the model is trained, we can use it to make predictions on new data
with torch.no_grad():
    forecast = model(data)

# The forecast tensor will contain temperature and luminance predictions
# for the next few hours


# LSTM

import torch
import torch.nn as nn

# Assume that you have temperature and luminance data for the previous 4 days
# stored in the variables 'temp_data' and 'lum_data', respectively.

# First, we'll combine the temperature and luminance data into a single dataset
data = torch.stack([temp_data, lum_data], dim=1)

# Next, we'll define the LSTM model.
# We'll use a single LSTM layer with hidden size 10, and a fully-connected
# output layer to predict temperature and luminance.

class LSTMModel(nn.Module):
    def __init__(self, input_size, hidden_size, output_size):
        super().__init__()
        self.lstm = nn.LSTM(input_size, hidden_size)
        self.fc = nn.Linear(hidden_size, output_size)

    def forward(self, x):
        x, _ = self.lstm(x)
        x = self.fc(x)
        return x

model = LSTMModel(2, 10, 2)

# Now we can train the model using an Adam optimizer and mean squared error loss
optimizer = torch.optim.Adam(model.parameters())
loss_fn = nn.MSELoss()
```



```
    optimizer.zero_grad()

    # Forward pass
    output = model(data)
    loss = loss_fn(output, data)

    # Backward pass
    loss.backward()
    optimizer.step()

# Now that the model is trained, we can use it to make predictions on new data
with torch.no_grad():
    forecast = model(data)

# The forecast tensor will contain temperature and luminance predictions
# for the next few hours



# Random forest

import numpy as np
from sklearn.ensemble import RandomForestRegressor

# Assume that you have temperature and luminance data for the previous 4 days
# stored in the variables 'temp_data' and 'lum_data', respectively.

# Combine the temperature and luminance data into a single dataset
data = np.column_stack([temp_data, lum_data])

# Define the random forest model. We'll use 10 decision trees in the forest.
model = RandomForestRegressor(n_estimators=10)

# Now we can train the model using the data
model.fit(data, data)

# Now that the model is trained, we can use it to make predictions on new data
forecast = model.predict(data)

# The forecast array will contain temperature and luminance predictions
```

```
# for the next few hours



# SVM

import numpy as np
from sklearn.svm import SVR

# Assume that you have temperature and luminance data for the previous 4 days
# stored in the variables 'temp_data' and 'lum_data', respectively.

# Combine the temperature and luminance data into a single dataset
data = np.column_stack([temp_data, lum_data])

# Define the SVM model. We'll use a linear SVR model to make predictions.
model = SVR(kernel='linear')

# Now we can train the model using the data
model.fit(data, data)

# Now that the model is trained, we can use it to make predictions on new data
forecast = model.predict(data)

# The forecast array will contain temperature and luminance predictions
# for the next few hours
```

More Pre-Processing and Model Fitting for API

Pre-Processing for Training

```
# Pre-Processing
import pandas as pd

# load data into a dataframe
df_default = pd.DataFrame(data['hourly'])
df_default.fillna(df_default.mean(), inplace=True)

# create a column with the day
df_default['day'] = pd.to_datetime(df_default['time']).dt.day

# create a column with the hour
df_default['hour'] = pd.to_datetime(df_default['time']).dt.hour

# group temperatures by hour and day
df_pretrain = df_default.groupby(['day','hour'], as_index=False)['temperature_2m'].mean()
df_pretrain
```



```
<ipython-input-92-9d313249880a>:8: FutureWarning: Dropping of nuisance columns in DataFram
  df_default.fillna(df_default.mean(), inplace=True)
```

	day	hour	temperature_2m
0	1	0	15.253846
1	1	1	14.976923
2	1	2	14.684615
3	1	3	14.415385
4	1	4	14.161538
...	...	...	...
739	31	19	18.742857
740	31	20	17.885714
741	31	21	17.285714
742	31	22	16.857143
743	31	23	16.557143

744 rows × 3 columns

Creating Training Dataframe

```
columnNames = ['minus5', 'minus4', 'minus3', 'minus2', 'minus1', 'now', 'desired_time', 'target_value']

length_df = len(df_pretrain)

df_train = pd.DataFrame(index = range(length_df-6), columns = columnNames)


for ii in range(6,length_df):
    df_train.iloc[ii-6]['minus5'] = df_pretrain['temperature_2m'].values[ii-6]
    df_train.iloc[ii-6]['minus4'] = df_pretrain['temperature_2m'].values[ii-5]
    df_train.iloc[ii-6]['minus3'] = df_pretrain['temperature_2m'].values[ii-4]
    df_train.iloc[ii-6]['minus2'] = df_pretrain['temperature_2m'].values[ii-3]
    df_train.iloc[ii-6]['minus1'] = df_pretrain['temperature_2m'].values[ii-2]
    df_train.iloc[ii-6]['now'] = df_pretrain['temperature_2m'].values[ii-1]
    df_train.iloc[ii-6]['desired_time'] = df_pretrain['hour'].values[ii]
    df_train.iloc[ii-6]['target_value'] = df_pretrain['temperature_2m'].values[ii]

df_train
```

	minus5	minus4	minus3	minus2	minus1	now	desired_time	target_v
0	15.253846	14.976923	14.684615	14.415385	14.161538	14.0	6	13.85
1	14.976923	14.684615	14.415385	14.161538	14.0	13.853846	7	14.06
2	14.684615	14.415385	14.161538	14.0	13.853846	14.061538	8	14.59
3	14.415385	14.161538	14.0	13.853846	14.061538	14.592308	9	15.95
4	14.161538	14.0	13.853846	14.061538	14.592308	15.953846	10	17.37
...	...	...	...	...	...	...	...	
733	21.3	21.571429	21.471429	21.142857	20.571429	19.714286	19	18.74
734	21.571429	21.471429	21.142857	20.571429	19.714286	18.742857	20	17.88
735	21.471429	21.142857	20.571429	19.714286	18.742857	17.885714	21	17.28
736	21.142857	20.571429	19.714286	18.742857	17.885714	17.285714	22	16.85
737	20.571429	19.714286	18.742857	17.885714	17.285714	16.857143	23	16.55

Linear Regression (this one shows r^2 = -0.010)?

```
from sklearn.preprocessing import PolynomialFeatures
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn import model_selection
from random import sample
import numpy as np
import random


X_df = df_train.drop(columns = 'target_value')

X = X_df.values
y = df_train['target_value'].values.reshape(-1,1)



# Establish the idxs of each test and train datasets
test_size = 0.3
seed = 100
random.seed(seed)
idxs_test = sample(range(df_train.shape[0]), int(test_size * df_train.shape[0]))
idxs_train = [i for i in range(df_train.shape[0]) if i not in idxs_test]

# Apply the polynomial transformation, for polynomial degrees of 2 and 10
poly = PolynomialFeatures(degree = 2, interaction_only=False, include_bias=False)
X_2 = poly.fit_transform(X)

X_train = X_2[idxs_train,:]
X_test = X_2[idxs_test,:]

y_train = y[idxs_train,:]
y_test = y[idxs_test,:]

regr = LinearRegression()
regr.fit(X_train, y_train)
```

```
medv_pred = regr.predict(X_test)
r2_value = r2_score(y_test, medv_pred)

print('R^2 : {:.3f}'.format(r2_value))
```

```
R^2 : 0.997
```

with normalized temperature

```
df_norm = df_pretrain.copy()

df_norm["normalized_temperature"] = (df_norm["temperature_2m"] - df_norm["temperature_2m"].min()) / (df_norm["temperature_2m"].max() - d

df_train_norm = pd.DataFrame(index = range(length_df-6), columns = columnNames)


for ii in range(6,length_df):
    df_train_norm.iloc[ii-6]['minus5'] = df_norm['normalized_temperature'].values[ii-6]
    df_train_norm.iloc[ii-6]['minus4'] = df_norm['normalized_temperature'].values[ii-5]
    df_train_norm.iloc[ii-6]['minus3'] = df_norm['normalized_temperature'].values[ii-4]
    df_train_norm.iloc[ii-6]['minus2'] = df_norm['normalized_temperature'].values[ii-3]
    df_train_norm.iloc[ii-6]['minus1'] = df_norm['normalized_temperature'].values[ii-2]
    df_train_norm.iloc[ii-6]['now'] = df_norm['normalized_temperature'].values[ii-1]
    df_train_norm.iloc[ii-6]['desired_time'] = df_norm['hour'].values[ii]
    df_train_norm.iloc[ii-6]['target_value'] = df_norm['normalized_temperature'].values[ii]

df_train_norm.head()
```

	minus5	minus4	minus3	minus2	minus1	now	desired_time	target_value
0	0.218252	0.189178	0.15849	0.130224	0.103574	0.086614	6	0.07127
1	0.189178	0.15849	0.130224	0.103574	0.086614	0.07127	7	0.093075
2	0.15849	0.130224	0.103574	0.086614	0.07127	0.093075	8	0.148799
3	0.130224	0.103574	0.086614	0.07127	0.093075	0.148799	9	0.291742
4	0.103574	0.086614	0.07127	0.093075	0.148799	0.291742	10	0.441147


```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn import model_selection
from random import sample
import random

X_df_norm = df_train_norm.drop(columns = 'target_value')

X_norm = X_df_norm.values
y_norm = df_train_norm['target_value'].values.reshape(-1,1)



# Establish the idxs of each test and train datasets
test_size = 0.3
seed = 100
random.seed(seed)
idxs_test = sample(range(df_train_norm.shape[0]), int(test_size * df_train_norm.shape[0]))
idxs_train = [i for i in range(df_train_norm.shape[0]) if i not in idxs_test]

# Apply the polynomial transformation, for polynomial degrees of 2 and 10
poly = PolynomialFeatures(degree = 2, interaction_only=False, include_bias=False)
X_2_norm = poly.fit_transform(X_norm)

X_train_norm = X_2_norm[idxs_train,:]
X_test_norm = X_2_norm[idxs_test,:]

y_train_norm = y[idxs_train,:]
y_test_norm = y[idxs_test,:]

regr_norm = LinearRegression()
regr_norm.fit(X_train_norm, y_train_norm)
medv_pred_norm = regr_norm.predict(X_test_norm)
r2_value_norm = r2_score(y_test_norm, medv_pred_norm)

print('R^2 : {:.3f}'.format(r2_value_norm))
```

```
R^2 : 0.997
```

Test without Polynomial Features

```
df_lin = df_pretrain.copy()

columnNames = ['minus5', 'minus4', 'minus3', 'minus2', 'minus1', 'now', 'desired_time', 'target_value']

length_df = len(df_lin)

df_train_lin = pd.DataFrame(index = range(length_df-6), columns = columnNames)


for ii in range(6,length_df):
    df_train_lin.iloc[ii-6]['minus5'] = df_pretrain['temperature_2m'].values[ii-6]
    df_train_lin.iloc[ii-6]['minus4'] = df_pretrain['temperature_2m'].values[ii-5]
    df_train_lin.iloc[ii-6]['minus3'] = df_pretrain['temperature_2m'].values[ii-4]
    df_train_lin.iloc[ii-6]['minus2'] = df_pretrain['temperature_2m'].values[ii-3]
    df_train_lin.iloc[ii-6]['minus1'] = df_pretrain['temperature_2m'].values[ii-2]
    df_train_lin.iloc[ii-6]['now'] = df_pretrain['temperature_2m'].values[ii-1]
    df_train_lin.iloc[ii-6]['desired_time'] = df_pretrain['hour'].values[ii]
    df_train_lin.iloc[ii-6]['target_value'] = df_pretrain['temperature_2m'].values[ii]

df_train_lin.head()
```

	minus5	minus4	minus3	minus2	minus1	now	desired_time	target_val
0	15.253846	14.976923	14.684615	14.415385	14.161538	14.0	6	13.8538
1	14.976923	14.684615	14.415385	14.161538	14.0	13.853846	7	14.0615
2	14.684615	14.415385	14.161538	14.0	13.853846	14.061538	8	14.5923
3	14.415385	14.161538	14.0	13.853846	14.061538	14.592308	9	15.9538
4	14.161538	14.0	13.853846	14.061538	14.592308	15.953846	10	17.3769

```
from sklearn.preprocessing import PolynomialFeatures
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn import model_selection
from random import sample
```

Fehler beim automatischen Speichern Diese Datei wurde im Remotezugriff oder in einem anderen Tab aktualisiert. Unterschied anzeigen

```
X_df = df_train_lin.drop(columns = 'target_value')

X = X_df.values
y = df_train_lin['target_value'].values.reshape(-1,1)

# Establish the idxs of each test and train datasets
test_size = 0.3
seed = 100
random.seed(seed)
idxs_test = sample(range(df_train_lin.shape[0]), int(test_size * df_train_lin.shape[0]))
idxs_train = [i for i in range(df_train_lin.shape[0]) if i not in idxs_test]


X_train = X[idxs_train,:]
X_test = X[idxs_test,:]

y_train = y[idxs_train,:]
y_test = y[idxs_test,:]

regr = LinearRegression()
regr.fit(X_train, y_train)
medv_pred = regr.predict(X_test)
r2_value = r2_score(y_test, medv_pred)

print('R^2 : {:.3f}'.format(r2_value))
```

```
R^2 : 0.995
```

Trying other models

SVR- SUPPORT VECTOR REGRESSION

```
from sklearn.preprocessing import PolynomialFeatures
from sklearn.svm import SVR
from sklearn.metrics import r2_score
```

```
from sklearn import model_selection
from random import sample
import random

X_df = df_train_lin.drop(columns = 'target_value')

X = X_df.values
y = df_train_lin['target_value'].values.reshape(-1,1)

# Establish the idxs of each test and train datasets
test_size = 0.3
seed = 100
random.seed(seed)
idxs_test = sample(range(df_train_lin.shape[0]), int(test_size * df_train_lin.shape[0]))
idxs_train = [i for i in range(df_train_lin.shape[0]) if i not in idxs_test]


X_train = X[idxs_train,:]
X_test = X[idxs_test,:]

y_train = y[idxs_train,:]
y_test = y[idxs_test,:]

# Specify the kernel function to be used
regr = SVR(kernel='poly'
#regr = SVR(kernel='rbf')
#regr = SVR(kernel='linea')
regr.fit(X_train, y_train)
medv_pred = regr.predict(X_test)
r2_value = r2_score(y_test, medv_pred)

print('R^2 : {:.3f}'.format(r2_value))
```

```
/usr/local/lib/python3.8/dist-packages/sklearn/utils/validation.py:993: DataConversionWarning: A column-vector y was passed when a
  y = column_or_1d(y, warn=True)
R^2 : 0.989
```

Neural Networks

Fehler beim automatischen Speichern Diese Datei wurde im Remotezugriff oder in einem anderen Tab aktualisiert. Unterschied anzeigen

```
import numpy as np
from sklearn.metrics import r2_score
from sklearn import model_selection
from random import sample
import random

X_df = df_train_lin.drop(columns = 'target_value')
X = X_df.values
y = df_train_lin['target_value'].values.reshape(-1,1)

# Establish the idxs of each test and train datasets
test_size = 0.3
seed = 100
random.seed(seed)
idxs_test = sample(range(df_train_lin.shape[0]), int(test_size * df_train_lin.shape[0]))
idxs_train = [i for i in range(df_train_lin.shape[0]) if i not in idxs_test]


X_train = X[idxs_train,:]
X_test = X[idxs_test,:]

y_train = y[idxs_train,:]
y_test = y[idxs_test,:]

X_train = X_train.astype(np.float32)
X_test = X_test.astype(np.float32)
y_train = y_train.astype(np.float32)
y_test = y_test.astype(np.float32)

# Define the model
model = tf.keras.Sequential([
    tf.keras.layers.Dense(128, activation='relu', input_shape=(X_train.shape[1],)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(1)
])

# Compile the model
model.compile(optimizer='adam', loss='mean_squared_error', metrics=['mae', 'mse'])
```

```
# Train the model
model.fit(X_train, y_train, epochs=100)

# Get the predictions on the test set
y_test_pred = model.predict(X_test)

# Calculate the r2_score
r2 = r2_score(y_test, y_test_pred)
print('R2 score:', r2)
```

```
Epoch 70/100
17/17 [==============================] - 0s 2ms/step - loss: 0.1142 - mae: 0.2577 - mse: 0.1142
Epoch 71/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0982 - mae: 0.2266 - mse: 0.0982
Epoch 72/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0958 - mae: 0.2243 - mse: 0.0958
Epoch 73/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0886 - mae: 0.2116 - mse: 0.0886
Epoch 74/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0890 - mae: 0.2183 - mse: 0.0890
Epoch 75/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0953 - mae: 0.2302 - mse: 0.0953
Epoch 76/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0933 - mae: 0.2372 - mse: 0.0933
Epoch 77/100
17/17 [==============================] - 0s 2ms/step - loss: 0.1097 - mae: 0.2595 - mse: 0.1097
Epoch 78/100
17/17 [==============================] - 0s 3ms/step - loss: 0.0858 - mae: 0.2131 - mse: 0.0858
Epoch 79/100
17/17 [==============================] - 0s 3ms/step - loss: 0.0820 - mae: 0.2121 - mse: 0.0820
Epoch 80/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0754 - mae: 0.1977 - mse: 0.0754
Epoch 81/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0766 - mae: 0.2037 - mse: 0.0766
Epoch 82/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0721 - mae: 0.1940 - mse: 0.0721
Epoch 83/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0713 - mae: 0.1947 - mse: 0.0713
Epoch 84/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0868 - mae: 0.2204 - mse: 0.0868
Epoch 85/100
17/17 [==============================] - 0s 3ms/step - loss: 0.1116 - mae: 0.2627 - mse: 0.1116
Epoch 86/100
```



```
Epoch 88/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0618 - mae: 0.1777 - mse: 0.0618
Epoch 89/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0620 - mae: 0.1818 - mse: 0.0620
Epoch 90/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0619 - mae: 0.1826 - mse: 0.0619
Epoch 91/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0611 - mae: 0.1836 - mse: 0.0611
Epoch 92/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0575 - mae: 0.1747 - mse: 0.0575
Epoch 93/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0550 - mae: 0.1675 - mse: 0.0550
Epoch 94/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0564 - mae: 0.1700 - mse: 0.0564
Epoch 95/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0564 - mae: 0.1778 - mse: 0.0564
Epoch 96/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0521 - mae: 0.1697 - mse: 0.0521
Epoch 97/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0597 - mae: 0.1838 - mse: 0.0597
Epoch 98/100
17/17 [==============================] - 0s 2ms/step - loss: 0.0490 - mae: 0.1603 - mse: 0.0490
Epoch 99/100
```

Data set for 365 days

```
import requests

# Replace with the latitude and longitude of the location you want to get weather data for
latitude = 38.72
longitude = -9.13

# Replace with the start and end date in the format 'yyyy-mm-dd'
start_date = '2022-01-01'
end_date = '2022-12-31'

url = f'https://archive-api.open-meteo.com/v1/archive?latitude={latitude}&longitude={longitude}&start_date={start_date}&end_date={end_da

response = requests.get(url)
```

```
data_big = response.json()

from datetime import datetime
import pandas as pd

# load data into a dataframe
df_big = pd.DataFrame(data_big['hourly'])

# replace missing values with the mean value
df_big.fillna(df_big.mean(), inplace=True)

# create a column with the hour
df_big['hour'] = pd.to_datetime(df_big['time']).dt.hour

day_of_year= []
# Encoding date to integer
for ii in range(len(df_big)):
    day_of_year.append(datetime.strptime(df_big.iloc[ii]['time'],'%Y-%m-%dT%H:%M').timetuple().tm_yday)

df_big['timestamp'] = day_of_year
```

```
<ipython-input-25-90b46add607b>:8: FutureWarning: Dropping of nuisance columns in DataFrame reductions (with 'numeric_only=None') i
  df_big.fillna(df_big.mean(), inplace=True)
```

```
columnNames = ['minus5', 'minus4', 'minus3', 'minus2', 'minus1', 'now', 'desired_time', 'dayofyear', 'target_value']

length_df = len(df_big)

df_train_big = pd.DataFrame(index = range(length_df-6), columns = columnNames)


for ii in range(6,length_df):
    df_train_big.iloc[ii-6]['minus5'] = df_big['temperature_2m'].values[ii-6]
    df_train_big.iloc[ii-6]['minus4'] = df_big['temperature_2m'].values[ii-5]
    df_train_big.iloc[ii-6]['minus3'] = df_big['temperature_2m'].values[ii-4]
    df_train_big.iloc[ii-6]['minus2'] = df_big['temperature_2m'].values[ii-3]
    df_train_big.iloc[ii-6]['minus1'] = df_big['temperature_2m'].values[ii-2]
    df_train_big.iloc[ii-6]['now'] = df_big['temperature_2m'].values[ii-1]
    df_train_big.iloc[ii-6]['desired_time'] = df_big['temperature_2m'].values[ii]
    df_train_big.iloc[ii-6]['dayofyear'] = df_big['timestamp'].values[ii]

df_train_big.head()
```


	minus5	minus4	minus3	minus2	minus1	now	desired_time	dayofyear	target_value
0	14.3	14.0	13.8	13.6	13.3	13.0	6	1	12.6
1	14.0	13.8	13.6	13.3	13.0	12.6	7	1	12.3
2	13.8	13.6	13.3	13.0	12.6	12.3	8	1	12.2
3	13.6	13.3	13.0	12.6	12.3	12.2	9	1	12.6
4	13.3	13.0	12.6	12.3	12.2	12.6	10	1	14.2

```
from sklearn.preprocessing import PolynomialFeatures
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
from sklearn import model_selection
from random import sample
import random


X_df = df_train_big.drop(columns = 'target_value')

X = X_df.values
y = df_train_big['target_value'].values.reshape(-1,1)



# Establish the idxs of each test and train datasets
test_size = 0.3
seed = 100
random.seed(seed)
idxs_test = sample(range(df_train_big.shape[0]), int(test_size * df_train_big.shape[0]))
idxs_train = [i for i in range(df_train_big.shape[0]) if i not in idxs_test]


# Apply the polynomial transformation, for polynomial degrees of 2 and 10
```

```
poly = PolynomialFeatures(degree = 2, interaction_only=False, include_bias=False)
X_2 = poly.fit_transform(X)

X_train = X_2[idxs_train,:]
X_test = X_2[idxs_test,:]

y_train = y[idxs_train,:]
y_test = y[idxs_test,:]

regr = LinearRegression()
regr.fit(X_train, y_train)
medv_pred = regr.predict(X_test)
r2_value = r2_score(y_test, medv_pred)


print('R^2 : {:.3f}'.format(r2_value))
```

```
R^2 : 0.994
```

Reading and preparing Arduino Data

```
import pandas as pd
df_1 = pd.read_csv("sensor_data_sunday.csv",delimiter=';')
df_2 = pd.read_csv("sensor_data_tuesday.csv",delimiter=';')
df_3 = pd.read_csv("sensor_data_wednesday.csv",delimiter=';')

df_arduino = pd.concat([df_1, df_2,df_3], axis=0)

df_arduino.head()
```

	Timestamp	Temperature1	Temperature2	Temperature3	Luminance1	Luminance2	Luminanc
0	1.673796e+09	387	385	384	244	864	8
1	1.673796e+09	356	354	353	199	870	8
2	1.673796e+09	362	360	359	196	903	8
3	1.673796e+09	356	354	353	200	867	8


```
# Convert data into desired time format and temperature unit
import math
from datetime import datetime

df_arduino['date'] = pd.to_datetime(df_arduino['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
df_1['date'] = pd.to_datetime(df_1['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
df_2['date'] = pd.to_datetime(df_2['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')
df_3['date'] = pd.to_datetime(df_3['Timestamp'], unit='s').dt.strftime('%d-%m-%Y %H:%M:%S')

#convert temperature from analog to celcius (50/1024), note that these temperatures was taken in sunlight, might affect result.
# only run code once, it overwrites the values in columns each time.
df_1['Temperature1']=df_1['Temperature1']*(50/1024)
df_2['Temperature1']=df_2['Temperature1']*(50/1024)
df_3['Temperature1']=df_3['Temperature1']*(50/1024)


df_arduino['Temperature1']=df_arduino['Temperature1']*(50/1024)
df_arduino['Temperature2']=df_arduino['Temperature2']*(50/1024)
df_arduino['Temperature3']=df_arduino['Temperature3']*(50/1024)
df_arduino.head(100)
```

	Timestamp	Temperature1	Temperature2	Temperature3	Luminance1	Luminance2	Luminar
0	1.673796e+09	18.896484	18.798828	18.750000	244	864	

```
df_mean = df_arduino.drop(columns=['Luminance1','Luminance2','Luminance3'])

temp_mean = []

for iii in range(len(df_mean)):
  tm = (df_mean.iloc[iii]['Temperature1'] + df_mean.iloc[iii]['Temperature2'] + df_mean.iloc[iii]['Temperature3'])/3
  temp_mean.append(tm)

df_mean['temperature'] = temp_mean

df_ard_pretest = df_mean.drop(columns=['Timestamp','Temperature1','Temperature2','Temperature3'])

df_ard_pretest.head(200)
```

	date	temperature
0	15-01-2023 15:22:03	18.815104
1	15-01-2023 15:22:33	17.301432
2	15-01-2023 15:23:03	17.594401
3	15-01-2023 15:23:33	17.301432
4	15-01-2023 15:24:03	17.529297
...	...	...
97	17-01-2023 12:10:23	18.489583
98	17-01-2023 12:10:53	18.310547
99	17-01-2023 12:11:23	18.245443
100	17-01-2023 12:11:53	18.196615
101	17-01-2023 12:12:23	18.098958

Fehler beim automatischen Speichern Diese Datei wurde im Remotezugriff oder in einem anderen Tab aktualisiert. Unterschied anzeigen

```
from datetime import datetime

day_of_year= []
# Encoding date to integer
for ii in range(len(df_ard_pretest)):
    day_of_year.append(datetime.strptime(df_ard_pretest.iloc[ii]['date'],'%d-%m-%Y %H:%M:%S').timetuple().tm_yday)

df_ard_pretest['timestamp'] = day_of_year


hour = []
for ii in range(len(df_ard_pretest)):
    hour.append(datetime.strptime(df_ard_pretest.iloc[ii]['date'],'%d-%m-%Y %H:%M:%S').hour)

df_ard_pretest['desired_time'] = hour

df_ard_pre = df_ard_pretest.drop(columns = 'date').groupby(["timestamp","desired_time"], as_index=False).mean()
df_ard_pre.head(100)
```

	timestamp	desired_time	temperature
0	15	15	17.669571
1	15	16	16.813151
2	17	11	17.871522
3	17	12	18.031971
4	17	13	18.084717
5	18	11	18.742360
6	18	12	13.602973
7	18	13	16.861979

Getting missing data from API (15.1. 10-14h; 17.1. 8-10h;

```
import requests

# Replace with the latitude and longitude of the location you want to get weather data for
latitude = 38.72
longitude = -9.13

# Replace with the start and end date in the format 'yyyy-mm-dd'
start_date = '2023-01-15'
end_date = '2023-01-18'

url = f'https://archive-api.open-meteo.com/v1/archive?latitude={latitude}&longitude={longitude}&start_date={start_date}&end_date={end_da

response = requests.get(url)

data_fill = response.json()


from datetime import datetime
import pandas as pd

# load data into a dataframe
df_fill = pd.DataFrame(data_big['hourly'])

# replace missing values with the mean value
#df_fill.fillna(df_fill.mean(), inplace=True)

# create a column with the hour
df_fill['hour'] = pd.to_datetime(df_fill['time']).dt.hour

day_of_year= []
# Encoding date to integer
for ii in range(len(df_fill)):
    day_of_year.append(datetime.strptime(df_fill.iloc[ii]['time'],'%Y-%m-%dT%H:%M').timetuple().tm_yday)

df_fill['timestamp'] = day_of_year
df_fill_2 = df_fill.drop(columns = ['time'])
df_fill_2.head()
```

	temperature_2m	hour	timestamp
0	14.3	0	1
1	14.0	1	1
2	13.8	2	1
3	13.6	3	1
4	13.3	4	1

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```
d = {'day': [15,15,15,15,15,17,17,17,17,18,18,18,18], 'hour': [14,13,12,11,10,10,9,8,7,10,9,8,7]}
times_needed = pd.DataFrame(data=d)
times_needed.head(20)
```

	day	hour
0	15	14
1	15	13
2	15	12
3	15	11
4	15	10
5	17	10
6	17	9
7	17	8
8	17	7
9	18	10
10	18	9
11	18	8
12	18	7

```
import pandas as pd

day_fill = []
hour_fill = []
```

```
hour_fill = []
temperature_fill = []
for i in range(len(df_fill)):
  for ii in range(len(times_needed)):
    if times_needed.iloc[ii]['day'] == df_fill_2.iloc[i]['timestamp'] and times_needed.iloc[ii]['hour'] == df_fill_2.iloc[i]['hour']:
      day_fill.append(df_fill_2.iloc[i]['timestamp'])
      hour_fill.append(df_fill_2.iloc[i]['hour'])
      temperature_fill.append(df_fill_2.iloc[i]['temperature_2m'])

for iii in range(len(df_ard_pre)):
  day_fill.append(df_ard_pre.iloc[iii]['timestamp'])
  hour_fill.append(df_ard_pre.iloc[iii]['desired_time'])
  temperature_fill.append(df_ard_pre.iloc[iii]['temperature'])


df_alm_fin = pd.DataFrame()
df_alm_fin['temperature_2m'] = temperature_fill
df_alm_fin['desired_time'] = hour_fill
df_alm_fin['timestamp'] = day_fill
df_fin = df_alm_fin.groupby(["timestamp"], as_index=False)
df_fin.head(40)
```

	temperature_2m	desired_time	timestamp
0	10.600000	10.0	15.0
1	12.000000	11.0	15.0
2	13.200000	12.0	15.0
3	14.000000	13.0	15.0
4	14.500000	14.0	15.0
5	8.100000	7.0	17.0
6	7.800000	8.0	17.0
7	8.200000	9.0	17.0
8	9.900000	10.0	17.0
9	6.600000	7.0	18.0
10	6.400000	8.0	18.0
11	7.400000	9.0	18.0
12	8.800000	10.0	18.0
13	17.669571	15.0	15.0
14	16.813151	16.0	15.0
15	17.871522	11.0	17.0
16	18.031971	12.0	17.0
17	18.084717	13.0	17.0
18	18.742360	11.0	18.0
19	13.602973	12.0	18.0
20	16.861979	13.0	18.0

Manually creating data Frame cause it doesnt work

```
d = {'minus5': [10.6, 8.1,6.6],'minus4': [12.0, 7.8,6.4],'minus3':[13.2,8.2,7.0],'minus2':[14.0,9.9,8.8],'minus1':[14.5,17.872,18.74],'n
df_manual = pd.DataFrame(data=d)

df_manual.head()
```

	minus5	minus4	minus3	minus2	minus1	now	desired_time	dayofyear	target_value
0	10.6	12.0	13.2	14.0	14.500	17.670	16	15	16.813
1	8.1	7.8	8.2	9.9	17.872	18.032	13	17	18.085
2	6.6	6.4	7.0	8.8	18.740	13.603	13	18	16.862

Testing with adjusted Arduino Data

```
X_test = df_manual.drop(columns = 'target_value')
X_test.head()
```

```
X_test.head()
```

	minus5	minus4	minus3	minus2	minus1	now	desired_time	dayofyear
0	10.6	12.0	13.2	14.0	14.500	17.670	16	15
1	8.1	7.8	8.2	9.9	17.872	18.032	13	17
2	6.6	6.4	7.0	8.8	18.740	13.603	13	18

```
from sklearn.metrics import r2_score
from sklearn.preprocessing import PolynomialFeatures
from sklearn.linear_model import LinearRegression
import tensorflow as tf
from sklearn.model_selection import train_test_split
import numpy as np
from sklearn.metrics import r2_score
from sklearn import model_selection
from random import sample
import random


# Apply the polynomial transformation, for polynomial degrees of 2 and 10
poly = PolynomialFeatures(degree = 2, interaction_only=False, include_bias=False)
X_2 = poly.fit_transform(X_test)
predicted_temp = regr.predict(X_2)
y_test_2 = df_manual['target_value'].values.reshape(-1,1)
print(predicted_temp)

r2_value = r2_score(y_test_2, predicted_temp)

print('R^2 : {:.3f}'.format(r2_value))
```

```
[[20.95603672]
 [18.1308047 ]
 [15.46890832]]
R^2 : -17.396
```

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✓ 0 s Abgeschlossen um 23:17