

Question 3

November 13, 2022

```
[1]: import pandas as pd
import numpy as np
import datetime
import os
import requests
import json
from math import cos, asin, sqrt
import pyproj
```

```
[2]: path = os.getcwd()
path = path.replace('\\', '/')
print(path)
working_dir = path+"/"
```

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3

```
[3]: JANUARY = 1
FEBRUARY = 2
MARCH = 3
APRIL = 4
MAY = 5
JUNE = 6
JULY = 7
AUGUST = 8
SEPTEMBER = 9
OCTOBER = 10
NOVEMBER = 11
DECEMBER = 12
```

```
[4]: def get_days_in_month(month):
    if month == 1:
        return 31
    elif month == 2:
        return 28
    elif month == 3:
        return 31
    elif month == 4:
        return 30
```

```

elif month == 5:
    return 31
elif month == 6:
    return 31
elif month == 7:
    return 31
elif month == 8:
    return 31
elif month == 9:
    return 30
elif month == 10:
    return 31
elif month == 11:
    return 30
elif month == 12:
    return 31

```

```

[5]: def get_is_weekday(day, month, year):
    x_date = datetime.date(year, month, day)
    no = x_date.weekday()

    if no < 5:
        return 1
    else:
        return 0

```

```

[6]: def get_month_string(month):
    if month == 1:
        return "january"
    elif month == 2:
        return "february"
    elif month == 3:
        return "march"
    elif month == 4:
        return "april"
    elif month == 5:
        return "may"
    elif month == 6:
        return "june"
    elif month == 7:
        return "july"
    elif month == 8:
        return "august"
    elif month == 9:
        return "september"
    elif month == 10:
        return "october"

```

```

elif month == 11:
    return "november"
elif month == 12:
    return "december"

```

```

[7]: def get_weather_stations_locations():
    path = f'{working_dir}weather_stations_locations.json'
    is_file_exist = os.path.exists(path)

    if is_file_exist:
        print(f"{path} exists, loading...")
        df = pd.read_json(path)
        return df.to_dict(orient='records')
    else:
        print(f"{path} does not exist. Retrieving data from API...")
        expected_response = False
        weather_stations = []
        year = 2022
        month = 8
        day = 20
        while not expected_response:
            site = f'https://api.data.gov.sg/v1/environment/rainfall?
↪date_item={str(year)}-{str(month).zfill(2)}-{str(day).zfill(2)}'
            try:
                response_api = requests.get(site)
                data = response_api.text
                data = json.loads(data)
                print(data)
                for station in data['metadata']['stations']:
                    # print(f"Processing {station}...")
                    weather_stations.append({'id': station['id'],
                                            'longitude':_
↪station['location']['longitude'],
                                            'latitude':_
↪station['location']['latitude']})
                    # print(weather_stations)
                expected_response = True
                with open(path, 'w') as fp:
                    json.dump(weather_stations, fp)
                fp.close()
                df = pd.read_json(path)
                return df.to_dict(orient='records')
            except KeyError as e:
                print(e)
                pass

```

```
[8]: def get_lat_lon_from_coord(x_coord, y_coord):
      xfm = pyproj.Transformer.from_crs('EPSG:3414', 'EPSG:4326')

      return xfm.transform(x_coord, y_coord)
```

```
[118]: def get_carpark_locations():
        path = f'{working_dir}hdb-carpark-information.csv'
        is_file_exist = os.path.exists(path)

        if is_file_exist:
            print(f"{path} exists, loading...")
            df = pd.read_csv(path)

            latitudes, longitudes = get_lat_lon_from_coord(df['x_coord'],
↳df['y_coord'])
            columns_to_drop = ['address', 'type_of_parking_system',
                               'short_term_parking', 'free_parking',
                               'night_parking', 'car_park_decks',
                               'gantry_height', 'car_park_basement',
                               'x_coord', 'y_coord']

            df['longitude'] = longitudes
            df['latitude'] = latitudes
            df = df.drop(columns=columns_to_drop)
            print(df)
            return df.to_dict(orient='records')
        else:
            print(f"{path} does not exist.")
```

```
[203]: weather_stations = get_weather_stations_locations()
        carparks = get_carpark_locations()
        carparksDic = {}
        for item in carparks:
            carparksDic[item['car_park_no']] = {
                'car_park_type': item['car_park_type'],
                'longitude': item['longitude'],
                'latitude': item['latitude']
            }
        print('Done')
```

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/weather_stations_locations.json exists, loading...

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/hdb-carpark-information.csv exists, loading...

	car_park_no	car_park_type	longitude	latitude
0	ACB	BASEMENT CAR PARK	103.864682	1.290431
1	ACM	MULTI-STOREY CAR PARK	103.884496	1.321573
2	AH1	SURFACE CAR PARK	103.891727	1.280870
3	AK19	SURFACE CAR PARK	103.932271	1.271172

4	AK31	SURFACE CAR PARK	103.929320	1.282898
...
2177	Y77M	MULTI-STOREY CAR PARK	103.991246	1.286224
2178	Y78M	MULTI-STOREY CAR PARK	103.987566	1.288097
2179	Y8	SURFACE CAR PARK	103.992235	1.267438
2180	Y82M	MULTI-STOREY CAR PARK	103.992178	1.286996
2181	Y9	SURFACE CAR PARK	103.990632	1.270190

[2182 rows x 4 columns]

Done

```
[11]: def distance(lat1, lon1, lat2, lon2):
    p = 0.017453292519943295
    hav = 0.5 - cos((lat2-lat1)*p)/2 + cos(lat1*p)*cos(lat2*p) *
    ↪(1-cos((lon2-lon1)*p)) / 2
    return 12742 * asin(sqrt(hav))
```

```
[12]: def get_closest_weather_station_to_carpark(weather_stations, carpark):
    return min(weather_stations, key=lambda p: distance(carpark['latitude'],
    ↪carpark['longitude'], p['latitude'], p['longitude']))
```

```
[13]: def process_carpark_weather_stations(weather_stations, carparks):
    results = []
    for carpark in carparks:
        closest_weather_station =
    ↪get_closest_weather_station_to_carpark(weather_stations, carpark)
        results.append({'car_park_no': carpark['car_park_no'],
                        'id': closest_weather_station['id']})
    path = f'{working_dir}carpark_nearest_weather_stations.json'
    with open(path, 'w') as fp:
        json.dump(results, fp)
        fp.close()
    return results
```

```
[14]: nearest_weather_stations_to_carparks =
    ↪process_carpark_weather_stations(weather_stations, carparks)
```

```
[15]: def get_rainfall(month, year):
    path = f'{working_dir}{month}{year}_rainfall.csv'
    print(path)
    is_file_exist = os.path.exists(path)

    if is_file_exist:
        print(f"File exists, loading...")
        result_df = pd.read_csv(path)
    else:
        print(f"File does not exist. Retrieving...")
```

```

result_df = pd.DataFrame()

for day in range(1, get_days_in_month(month)+1):
    site = f'https://api.data.gov.sg/v1/environment/rainfall?
↳date={str(year)}-{str(month).zfill(2)}-{str(day).zfill(2)}'
    try:
        print(f"Processing {day}-{month}-{year}")
        response_api = requests.get(site)
        data = response_api.text
        data = json.loads(data)
        df = pd.json_normalize(data, record_path=['items'])
        df['readings'] = df['readings'].apply(json.dumps)
        df['day'] = day
        df['month'] = month
        df['year'] = year
        result_df = pd.concat([result_df, df])
    except KeyError as e:
        print("KeyError", e)
result_df.to_csv(path)
return result_df

```

```

[16]: nov_rainfall_df = get_rainfall(DECEMBER, 2021)
print(nov_rainfall_df)
nov_rainfall_df['timestamp'] = pd.to_datetime(nov_rainfall_df['timestamp'])
nov_rainfall_df.drop(nov_rainfall_df.columns[0], axis=1, inplace=True)
nov_rainfall_df.head()

dec_rainfall_df = get_rainfall(DECEMBER, 2021)
dec_rainfall_df['timestamp'] = pd.to_datetime(dec_rainfall_df['timestamp'])
dec_rainfall_df.drop(dec_rainfall_df.columns[0], axis=1, inplace=True)
dec_rainfall_df.head()
print(dec_rainfall_df)

```

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File exists, loading...

	Unnamed: 0	timestamp \
0	0	2021-12-01T00:05:00+08:00
1	1	2021-12-01T00:10:00+08:00
2	2	2021-12-01T00:15:00+08:00
3	3	2021-12-01T00:20:00+08:00
4	4	2021-12-01T00:25:00+08:00
...
8892	282	2021-12-31T23:35:00+08:00
8893	283	2021-12-31T23:40:00+08:00
8894	284	2021-12-31T23:45:00+08:00
8895	285	2021-12-31T23:50:00+08:00
8896	286	2021-12-31T23:55:00+08:00

		readings	day	month	year
0	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
1	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
2	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
3	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
4	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
...	
8892	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8893	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8894	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8895	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8896	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	

[8897 rows x 6 columns]

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/122021_rainfall.csv

File exists, loading...

	timestamp \
0	2021-12-01 00:05:00+08:00
1	2021-12-01 00:10:00+08:00
2	2021-12-01 00:15:00+08:00
3	2021-12-01 00:20:00+08:00
4	2021-12-01 00:25:00+08:00
...	...
8892	2021-12-31 23:35:00+08:00
8893	2021-12-31 23:40:00+08:00
8894	2021-12-31 23:45:00+08:00
8895	2021-12-31 23:50:00+08:00
8896	2021-12-31 23:55:00+08:00

		readings	day	month	year
0	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
1	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
2	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
3	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
4	[{"station_id": "S77", "value": 0}, {"station_...	1	12	2021	
...	
8892	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8893	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8894	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8895	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	
8896	[{"station_id": "S77", "value": 0}, {"station_...	31	12	2021	

[8897 rows x 5 columns]

```
[17]: new_df = nov_rainfall_df[(nov_rainfall_df['timestamp'] > '2021-11-01 00:00:00')_
->& (nov_rainfall_df['timestamp'] <= '2022-11-01 00:55:00')]
```

```

per_hour = {'hour': 5, 'stations': {}}

#print(per_hour)

for index, row in new_df.iterrows():
    value_string = row[1]
    value_string = value_string.replace("'", "\"")
    llist = json.loads(value_string)
    for station in llist:
        s_id = station['station_id']
        hourly_stations = per_hour['stations']
        # print(hourly_stations)
        if s_id not in hourly_stations.keys():
            hourly_stations[s_id] = 0
            hourly_stations[s_id] += station['value']

```

```

[18]: def aggregate_rainfall_per_hour(month, year):
    month_dataframe = get_rainfall(month, year)
    month_dataframe['timestamp'] = pd.to_datetime(month_dataframe['timestamp'])
    month_dataframe.drop(month_dataframe.columns[0], axis=1, inplace=True)
    month_dataframe.head()
    total_list = {}
    for day in range(1, get_days_in_month(month)):
        for hour in range(0, 24):
            try:
                start_time = (str(year) + "-" + str(month).zfill(2) + "-" +
↪str(day).zfill(2) + " " + str(hour).zfill(2) + ":00:00")
                end_time = (str(year) + "-" + str(month).zfill(2) + "-" +
↪str(day).zfill(2) + " " + str(hour).zfill(2) + ":55:00")
                new_df = month_dataframe[(month_dataframe['timestamp'] >=
↪start_time) & (month_dataframe['timestamp'] <= end_time)]
                date_hour = str(year) + str(day).zfill(2) + str(hour).zfill(2)
                stations = {}
                for index, row in new_df.iterrows():
                    value_string = row[1]
                    value_string = value_string.replace("'", "\"")
                    llist = json.loads(value_string)
                    for station in llist:
                        s_id = station['station_id']
                        if s_id not in stations.keys():
                            stations[s_id] = 0
                            stations[s_id] += station['value']
                total_list[date_hour] = stations
            except KeyError as e:
                print(e)
                continue

```



```
return total_list
```

```
[19]: nov_rainfall_aggregate = aggregate_rainfall_per_hour(NOVEMBER, 2021)
      dec_rainfall_aggregate = aggregate_rainfall_per_hour(DECEMBER, 2021)
```

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/112021_rainfall.csv

File exists, loading...

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/122021_rainfall.csv

File exists, loading...

```
[20]: def get_aggregate_rainfall_for_hour(x, df, hour, day, month, year):
      if month == 7:
          month_dataframe = july_rainfall_aggregate
      elif month == 8:
          month_dataframe = august_rainfall_aggregate
      elif month == 11:
          month_dataframe = nov_rainfall_aggregate
      elif month == 12:
          month_dataframe = dec_rainfall_aggregate
      key = str(year) + str(day).zfill(2) + str(hour).zfill(2)
      try:
          return month_dataframe[key][x]
      except KeyError as e:
          return 0
```

```
[21]: def get_nearest_weather_station(carpark_no):
      # Use this only when you have generated carpark_nearest_weather_stations.
      ↪ json
      with open(f"{working_dir}carpark_nearest_weather_stations.json") as ↪
      ↪ json_file:
          carpark_nearest_weather_stations = json.load(json_file)
          json_file.close()
      try:
          nearest_weather_station = next(item for item in ↪
      ↪ carpark_nearest_weather_stations if item['car_park_no'] == carpark_no)['id']
          return nearest_weather_station
      except StopIteration as e:
          return ""
```

```
[22]: def obtain_monthly_carpark_data_with_rainfall(month, year):
      path = f"{working_dir}{get_month_string(month)}_{year}_data"

      try:
          os.mkdir(path)
      except OSError as error:
          print(error)
```

```

carpark_site_list = []

minute = 10
second = 0

for day in range(1, get_days_in_month(month)+1):
    for hour in range(0, 24):
        name = f'{day}_{hour}'
        hour_str = str(hour)
        carpark_site = f'https://api.data.gov.sg/v1/transport/
↳carpark-availability?date_time={str(year)}-{str(month).zfill(2)}-{str(day).
↳zfill(2)}T{str(hour).zfill(2)}%3A{str(minute).zfill(2)}%3A{str(second).
↳zfill(2)}'
        check_path = f"{path}/{name}.csv"
        print(check_path)
        if os.path.exists(check_path):
            print("File exists")
        else:
            print("File does not exist")
            expected_response = False
            while not expected_response:
                try:
                    response_api = requests.get(carpark_site)
                    data = response_api.text
                    data = json.loads(data)
                    timestamp = data['items'][0]['timestamp']
                    print(timestamp)
                    expected_response = True
                    data = data['items'][0]['carpark_data']
                    with open("temp.json", 'w') as fp:
                        json.dump(data, fp)
                        fp.close()
                    df = pd.read_json("temp.json")
                    for heading in ("total_lots", "lot_type",
↳"lots_available"):
                        df[heading] = df["carpark_info"].apply(lambda x:
↳x[0][heading])

                    df = df.drop(["carpark_info"], axis=1)
                    df["nearest_weather_station"] = df["carpark_number"].
↳apply(get_nearest_weather_station)
                    df["rainfall"] = df["nearest_weather_station"].
↳apply(get_aggregate_rainfall_for_hour, args=(hour, day, month, year))
                    df = df.drop(["nearest_weather_station"], axis=1)
                    df.to_csv(f"{check_path}")
                except (KeyError, IndexError, ValueError) as e:
                    print(e)

```

```

        print(f"Did not receive valid response for_
↳{day}-{month}-{year}, reattempting...")
        break

```

```

[23]: obtain_monthly_carpark_data_with_rainfall(NOVEMBER, 2021)
      obtain_monthly_carpark_data_with_rainfall(DECEMBER, 2021)

```

```

[WinError 183] Cannot create a file when that file already exists:
'C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data'
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_0.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_1.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_2.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_3.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_4.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_5.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_6.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_7.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_8.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_9.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_10.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_11.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_12.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_13.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_14.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_15.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_16.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_17.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_18.csv
File exists

```

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_19.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_20.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_21.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_22.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/1_23.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_0.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_1.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_2.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_3.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_4.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_5.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_6.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_7.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_8.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_9.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_10.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_11.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_12.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_13.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_14.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_15.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_16.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/2_17.csv
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list index out of range
Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_1.csv
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Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_2.csv
File does not exist
list index out of range
Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_3.csv
File does not exist
list index out of range
Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_4.csv
File does not exist
list index out of range
Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_5.csv
File does not exist
list index out of range
Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_6.csv
File does not exist
list index out of range
Did not receive valid response for 28-11-2021, reattempting...
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_7.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_8.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_9.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_10.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_11.csv
File exists

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_12.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_13.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_14.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_15.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_16.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_17.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_19.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/28_23.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/29_0.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/29_1.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/29_2.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/29_5.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/30_0.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/30_1.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/30_2.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/30_3.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/30_9.csv
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File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/november_2021_data/30_23.csv
File exists
[WinError 183] Cannot create a file when that file already exists:
'C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data'
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_0.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_1.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_2.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_3.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_4.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_5.csv
File exists
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/1_11.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/2_1.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/3_0.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/3_1.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/4_0.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/4_1.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/5_23.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/6_0.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/6_1.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/6_2.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/6_3.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/6_4.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/6_5.csv
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C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/31_20.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/31_21.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/31_22.csv
File exists
C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/december_2021_data/31_23.csv
File exists

```

```

[94]: def get_combined_data_for_month(month, year):
    path = f"{working_dir}{get_month_string(month)}_{year}_data"

    minute = 1
    second = 0

    result_df = pd.DataFrame()

    for day in range(1, get_days_in_month(month)+1):
        for hour in range(0, 24):
            name = f'{day}_{hour}'
            actual_path = f"{path}/{name}.csv"
            try:
                df = pd.read_csv(actual_path)
            except FileNotFoundError as e:
                continue
            df['hour'] = hour
            df['day'] = day
            df['month'] = month
            df['year'] = year

```



```

        df['is_weekday'] = df.apply(lambda x: get_is_weekday(x['day'],
↪x['month'], x['year']), axis=1)
        df = df[(df['lots_available'] <= df['total_lots'])]
        df['percentage_availability'] = df['lots_available'] /
↪df['total_lots']
        df.loc[df['percentage_availability'] == 0,
↪'percentage_availability'] = 0.01
        result_df = pd.concat([result_df, df])
        output_path = f"{working_dir}{get_month_string(month)}_combined_data.csv"
        result_df.to_csv(output_path)

    return result_df

```

```

[158]: combined_df_nov = get_combined_data_for_month(NOVEMBER, 2021)
required_nov_df = combined_df_nov[['carpark_number', 'rainfall', 'hour', 'day',
↪'month', 'year', 'is_weekday', 'percentage_availability']]
unique_carparks = combined_df_nov['carpark_number'].unique()
columns_nov = np.concatenate(['hour', 'day', 'month', 'year', 'is_weekday'],
↪unique_carparks))

```

```

[159]: combined_df_dec = get_combined_data_for_month(DECEMBER, 2021)
required_dec_df = combined_df_dec[['carpark_number', 'rainfall', 'hour', 'day',
↪'month', 'year', 'is_weekday', 'percentage_availability']]
unique_carparks = combined_df_dec['carpark_number'].unique()
columns_dec = np.concatenate(['hour', 'day', 'month', 'year', 'is_weekday'],
↪unique_carparks))

```

```

[160]: from scipy import stats, mean

```

```

[206]: def get_carpark_latitude(carpark_number):
    try:
        carpark = next(item for item in carpark_data if item['car_park_no'] ==
↪carpark_number)
        return carpark['latitude']
    except StopIteration as e:
        return 0
def get_latitude(carpark_number):
    if carpark_number in carpark_data.keys():
        return carpark_data[carpark_number]['latitude']

```

```

[207]: def get_carpark_longitude(carpark_number):
    try:
        carpark = next(item for item in carpark_data if item['car_park_no'] ==
↪carpark_number)
        return carpark['longitude']
    except StopIteration as e:
        return 0

```

```
def get_longitude(carpark_number):
    if carpark_number in carparksDic.keys():
        return carparksDic[carpark_number]['longitude']
```

```
[228]: required_nov_df['latitude'] = required_nov_df['carpark_number'].
        ↪apply(get_latitude)
        required_nov_df['longitude'] = required_nov_df['carpark_number'].
        ↪apply(get_longitude)

        print(required_nov_df)
```

C:\Users\justi\AppData\Local\Temp\ipykernel_2932\2577066987.py:1:

SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame.

Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
required_nov_df['latitude'] =
required_nov_df['carpark_number'].apply(get_latitude)
```

	carpark_number	rainfall	hour	day	month	year	is_weekday \
0	HE12	0.0	0	1	11	2021	1
1	HLM	0.0	0	1	11	2021	1
2	RHM	0.0	0	1	11	2021	1
3	BM29	0.0	0	1	11	2021	1
4	Q81	0.0	0	1	11	2021	1
...
1949	B65L	0.0	23	30	11	2021	1
1950	BE3	0.0	23	30	11	2021	1
1951	BE3R	0.0	23	30	11	2021	1
1952	B8B	0.0	23	30	11	2021	1
1953	BM6	0.0	23	30	11	2021	1

	percentage_availability	latitude	longitude
0	0.638095	1.254733	103.851911
1	0.861063	1.281748	103.848481
2	0.392097	1.254660	103.850177
3	0.876289	1.253172	103.847366
4	0.781250	1.229082	103.871113
...
1949	0.010000	1.384536	103.881747
1950	0.166667	1.270590	103.925587
1951	0.523077	1.271666	103.926404
1952	0.838428	1.364736	103.888262
1953	0.010000	1.249816	103.853226

[1389403 rows x 10 columns]

C:\Users\justi\AppData\Local\Temp\ipykernel_2932\2577066987.py:2:

SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame.

Try using `.loc[row_indexer,col_indexer] = value` instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
required_nov_df['longitude'] =  
required_nov_df['carpark_number'].apply(get_longitude)
```

```
[229]: # the line right below is to load data for HE12 only  
# final_nov_df = required_nov_df[required_nov_df['carpark_number'] == 'HLM']  
#final_nov_df = final_nov_df[['latitude', 'longitude', 'hour', 'is_weekday',  
    ↪ 'rainfall', 'percentage_availability']]  
final_nov_df = required_nov_df[['latitude', 'longitude', 'hour', 'is_weekday',  
    ↪ 'rainfall', 'percentage_availability']]  
  
print(final_nov_df)
```

	latitude	longitude	hour	is_weekday	rainfall	\
0	1.254733	103.851911	0	1	0.0	
1	1.281748	103.848481	0	1	0.0	
2	1.254660	103.850177	0	1	0.0	
3	1.253172	103.847366	0	1	0.0	
4	1.229082	103.871113	0	1	0.0	
...		
1949	1.384536	103.881747	23	1	0.0	
1950	1.270590	103.925587	23	1	0.0	
1951	1.271666	103.926404	23	1	0.0	
1952	1.364736	103.888262	23	1	0.0	
1953	1.249816	103.853226	23	1	0.0	

	percentage_availability
0	0.638095
1	0.861063
2	0.392097
3	0.876289
4	0.781250
...	...
1949	0.010000
1950	0.166667
1951	0.523077
1952	0.838428
1953	0.010000

[1389403 rows x 6 columns]

```
[230]: required_dec_df['latitude'] = required_dec_df['carpark_number'].
        ↪apply(get_latitude)
        required_dec_df['longitude'] = required_dec_df['carpark_number'].
        ↪apply(get_longitude)
```

C:\Users\justi\AppData\Local\Temp\ipykernel_2932\1421288870.py:1:
 SettingWithCopyWarning:
 A value is trying to be set on a copy of a slice from a DataFrame.
 Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
required_dec_df['latitude'] =
required_dec_df['carpark_number'].apply(get_latitude)
```

C:\Users\justi\AppData\Local\Temp\ipykernel_2932\1421288870.py:2:
 SettingWithCopyWarning:
 A value is trying to be set on a copy of a slice from a DataFrame.
 Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
required_dec_df['longitude'] =
required_dec_df['carpark_number'].apply(get_longitude)
```

```
[231]: # the line right below is to load data for HE12 only
        #final_dec_df = required_dec_df[required_dec_df['carpark_number'] == 'HLM']
        # final_dec_df = final_dec_df[['latitude', 'longitude', 'hour', 'is_weekday',
        ↪'rainfall', 'percentage_availability']]
        final_dec_df = required_dec_df[['latitude', 'longitude', 'hour', 'is_weekday',
        ↪'rainfall', 'percentage_availability']]

        print(final_dec_df)
```

	latitude	longitude	hour	is_weekday	rainfall	\
0	1.254733	103.851911	0	1	0.0	
1	1.281748	103.848481	0	1	0.0	
2	1.254660	103.850177	0	1	0.0	
3	1.253172	103.847366	0	1	0.0	
4	1.229082	103.871113	0	1	0.0	
...		
1955	1.383241	103.881404	23	1	0.0	
1956	1.384536	103.881747	23	1	0.0	
1957	1.270590	103.925587	23	1	0.0	
1958	1.271666	103.926404	23	1	0.0	
1959	1.364736	103.888262	23	1	0.0	
	percentage_availability					
0	0.561905					

```

1          0.831904
2          0.373860
3          0.711340
4          0.729167
...          ...
1955       0.600000
1956       0.010000
1957       0.179739
1958       0.579487
1959       0.663755

```

[1451742 rows x 6 columns]

```

[232]: final_nov_df = final_nov_df.dropna()
       final_dec_df = final_nov_df.dropna()

       X_train = final_nov_df[['latitude', 'longitude', 'hour', 'is_weekday',
       ↪ 'rainfall']]
       y_train = final_nov_df[['percentage_availability']]
       X_test = final_dec_df[['latitude', 'longitude', 'hour', 'is_weekday',
       ↪ 'rainfall']]
       y_test = final_dec_df[['percentage_availability']]

```

```

[218]: def reg_metrics(y_test, y_pred, X_train):
       from sklearn.metrics import mean_squared_error, r2_score

       rmse = np.sqrt(mean_squared_error(y_test, y_pred))
       r2 = r2_score(y_test, y_pred)

       # Scikit-learn doesn't have adjusted r-square, hence custom code
       n = y_pred.shape[0]
       k = X_train.shape[1]
       adj_r_sq = 1 - (1 - r2)*(n-1)/(n-1-k)

       # print(rmse, r2, adj_r_sq)
       return (rmse, r2, adj_r_sq)

```

```

[219]: # Feature selection by ExtraTreesRegressor

       from sklearn.ensemble import ExtraTreesRegressor
       from sklearn.model_selection import train_test_split
       from sklearn.metrics import accuracy_score as acc
       import matplotlib.pyplot as plt

```

```

[220]: reg = ExtraTreesRegressor()
       reg.fit(X_train, y_train.values.ravel())
       y_test_pred = reg.predict(X_test)

```

```
agg_rmse = reg_metrics(y_test, y_test_pred, X_train)
print(f"The aggregated rmse is: {agg_rmse[0]}")
```

KeyboardInterrupt Traceback (most recent call last)

Cell In [220], line 2

```
1 reg = ExtraTreesRegressor()
----> 2 reg.fit(X_train, y_train.values.ravel())
3 y_test_pred = reg.predict(X_test)
4 agg_rmse = reg_metrics(y_test, y_test_pred, X_train)
```

File ~\anaconda3\lib\site-packages\sklearn\ensemble_forest.py:387, in

```
BaseForest.fit(self, X, y, sample_weight)
377 trees = [self._make_estimator(append=False,
378                               random_state=random_state)
379            for i in range(n_more_estimators)]
381 # Parallel loop: we prefer the threading backend as the Cython code
382 # for fitting the trees is internally releasing the Python GIL
383 # making threading more efficient than multiprocessing in
384 # that case. However, for joblib 0.12+ we respect any
385 # parallel_backend contexts set at a higher level,
386 # since correctness does not rely on using threads.
--> 387 trees = Parallel(n_jobs=self.n_jobs, verbose=self.verbose,
388                    **_joblib_parallel_args(prefer='threads'))(
389     delayed(_parallel_build_trees)(
390         t, self, X, y, sample_weight, i, len(trees),
391         verbose=self.verbose, class_weight=self.class_weight,
392         n_samples_bootstrap=n_samples_bootstrap)
393     for i, t in enumerate(trees))
395 # Collect newly grown trees
396 self.estimators_.extend(trees)
```

File ~\anaconda3\lib\site-packages\joblib\parallel.py:1046, in Parallel.

```
__call__(self, iterable)
1043 if self.dispatch_one_batch(iterator):
1044     self._iterating = self._original_iterator is not None
-> 1046 while self.dispatch_one_batch(iterator):
1047     pass
1049 if pre_dispatch == "all" or n_jobs == 1:
1050     # The iterable was consumed all at once by the above for loop.
1051     # No need to wait for async callbacks to trigger to
1052     # consumption.
```

File ~\anaconda3\lib\site-packages\joblib\parallel.py:861, in Parallel.

```
dispatch_one_batch(self, iterator)
859     return False
860 else:
```

```
--> 861     self._dispatch(tasks)
      862     return True
```

File ~\anaconda3\lib\site-packages\joblib\parallel.py:779, in Parallel.

```
↳ _dispatch(self, batch)
    777 with self._lock:
    778     job_idx = len(self._jobs)
--> 779     job = self._backend.apply_async(batch, callback=cb)
    780     # A job can complete so quickly than its callback is
    781     # called before we get here, causing self._jobs to
    782     # grow. To ensure correct results ordering, .insert is
    783     # used (rather than .append) in the following line
    784     self._jobs.insert(job_idx, job)
```

File ~\anaconda3\lib\site-packages\joblib_parallel_backends.py:208, in

```
↳ SequentialBackend.apply_async(self, func, callback)
    206 def apply_async(self, func, callback=None):
    207     """Schedule a func to be run"""
--> 208     result = ImmediateResult(func)
    209     if callback:
    210         callback(result)
```

File ~\anaconda3\lib\site-packages\joblib_parallel_backends.py:572, in

```
↳ ImmediateResult.__init__(self, batch)
    569 def __init__(self, batch):
    570     # Don't delay the application, to avoid keeping the input
    571     # arguments in memory
--> 572     self.results = batch()
```

File ~\anaconda3\lib\site-packages\joblib\parallel.py:262, in BatchedCalls.

```
↳ __call__(self)
    258 def __call__(self):
    259     # Set the default nested backend to self._backend but do not set th
    260     # change the default number of processes to -1
    261     with parallel_backend(self._backend, n_jobs=self._n_jobs):
--> 262         return [func(*args, **kwargs)
    263                 for func, args, kwargs in self.items]
```

File ~\anaconda3\lib\site-packages\joblib\parallel.py:262, in <listcomp>(.0)

```
    258 def __call__(self):
    259     # Set the default nested backend to self._backend but do not set th
    260     # change the default number of processes to -1
    261     with parallel_backend(self._backend, n_jobs=self._n_jobs):
--> 262         return [func(*args, **kwargs)
    263                 for func, args, kwargs in self.items]
```

File ~\anaconda3\lib\site-packages\sklearn\utils\fixes.py:222, in _FuncWrapper.

```
↳ __call__(self, *args, **kwargs)
```

```

220 def __call__(self, *args, **kwargs):
221     with config_context(**self.config):
--> 222         return self.function(*args, **kwargs)

```

```

File ~\anaconda3\lib\site-packages\sklearn\ensemble\_forest.py:171, in
↳ _parallel_build_trees(tree, forest, X, y, sample_weight, tree_idx, n_trees,
↳ verbose, class_weight, n_samples_bootstrap)
169     tree.fit(X, y, sample_weight=curr_sample_weight, check_input=False)
170 else:
--> 171     tree.fit(X, y, sample_weight=sample_weight, check_input=False)
173 return tree

```

```

File ~\anaconda3\lib\site-packages\sklearn\tree\_classes.py:1252, in
↳ DecisionTreeRegressor.fit(self, X, y, sample_weight, check_input, X_idx_sorted)
1216 def fit(self, X, y, sample_weight=None, check_input=True,
1217         X_idx_sorted="deprecated"):
1218     """Build a decision tree regressor from the training set (X, y).
1219
1220     Parameters
1221     (...)
1249     Fitted estimator.
1250     """
-> 1252     super().fit(
1253         X, y,
1254         sample_weight=sample_weight,
1255         check_input=check_input,
1256         X_idx_sorted=X_idx_sorted)
1257     return self

```

```

File ~\anaconda3\lib\site-packages\sklearn\tree\_classes.py:394, in
↳ BaseDecisionTree.fit(self, X, y, sample_weight, check_input, X_idx_sorted)
385 else:
386     builder = BestFirstTreeBuilder(splitter, min_samples_split,
387                                     min_samples_leaf,
388                                     min_weight_leaf,
391                                     self.min_impurity_decrease,
392                                     min_impurity_split)
--> 394     builder.build(self.tree_, X, y, sample_weight)
396 if self.n_outputs_ == 1 and is_classifier(self):
397     self.n_classes_ = self.n_classes_[0]

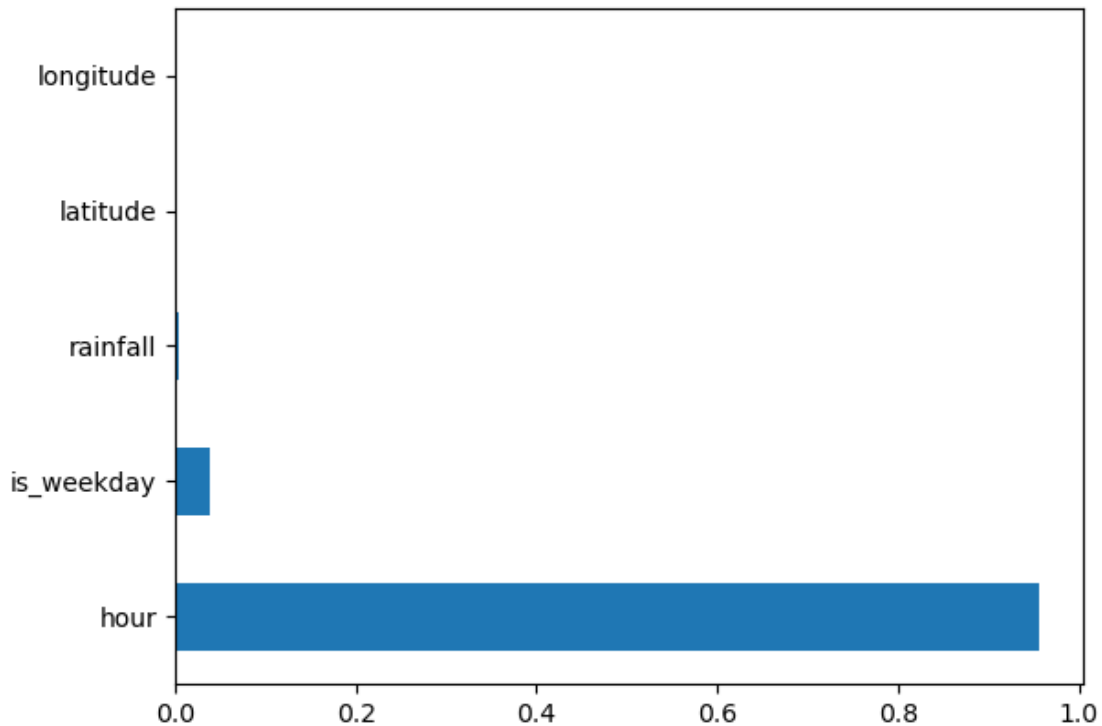
```

KeyboardInterrupt:

```
[ ]: reg.feature_importances_
```



```
[135]: feat_importances = pd.Series(reg.feature_importances_, index=X_train.columns)
feat_importances.nlargest(5).plot(kind='barh')
plt.show()
```



```
[136]: import sklearn.tree as tree

dtr = tree.DecisionTreeRegressor()
dtr.fit(X_train, y_train.values.ravel())
y_test_pred = dtr.predict(X_test)
```

```
[138]: def get_carpark_availability(day, month, year, hour, minute, seconds, carpark):
    # Get nearest weather station from carpark
    nearest_weather_station = get_nearest_weather_station(carpark)
    # Get current time carpark's rainfall
    rainfall_site = f'https://api.data.gov.sg/v1/environment/rainfall?
    ↪date_item={str(year)}-{str(month).zfill(2)}-{str(day).zfill(2)}'
    target_carpark = next(item for item in carpark if item['car_park_no'] ==
    ↪carpark)
    aggregate_rainfall = aggregate_rainfall_per_hour(month, year)
    try:
        print(f"Getting rainfall for {day}-{month}-{year}T{hour}:{minute}:
        ↪{str(seconds).zfill(2)}")
```

```

        response_api = requests.get(rainfall_site)
        data = response_api.text
        data = json.loads(data)
        weather_station_readings = data['items'][0]['readings']
        target_weather_station = next(item for item in weather_station_readings
↪if item['station_id'] == nearest_weather_station)
        target_aggregate_rainfall = aggregate_rainfall[str(year) + str(day).
↪zfill(2) + str(hour-1).zfill(2)]
        target_aggregate_rainfall =
↪target_aggregate_rainfall[target_weather_station['station_id']]
        input_data = {'latitude': [target_carpark['latitude']],
                      'longitude': [target_carpark['longitude']],
                      'hour': [hour],
                      'is_weekday': [get_is_weekday(day, month, year)],
                      'rainfall': [target_aggregate_rainfall]
                      }
        X = pd.DataFrame(input_data)
        return dtr.predict(X)
    except KeyError as e:
        print("KeyError", e)

carpark_availability = get_carpark_availability(12, 11, 2022, 10, 30, 0, 'ACB')
print(carpark_availability)

```

C:/Users/justi/OneDrive/Desktop/EE4211/project/Q3/112022_rainfall.csv

File exists, loading...

Getting rainfall for 12-11-2022T10:30:00

[0.64558319]

```

[233]: def sectorModels(longL, longR):
        df = final_nov_df[(final_nov_df['longitude'] > longL) &
↪(final_nov_df['longitude'] > longR)]
        testDf = final_dec_df[(final_dec_df['longitude'] > longL) &
↪(final_dec_df['longitude'] > longR)]

        X_train = df[['latitude', 'longitude', 'hour', 'is_weekday', 'rainfall']]
        y_train = df[['percentage_availability']]
        X_test = testDf[['latitude', 'longitude', 'hour', 'is_weekday', 'rainfall']]
        y_test = testDf[['percentage_availability']]
        reg = ExtraTreesRegressor()
        reg.fit(X_train, y_train.values.ravel())
        y_test_pred = reg.predict(X_test)
        acc = reg_metrics(y_test, y_test_pred, X_train)
        return acc

```

```

[234]: # The longitude boundaries for west, central and east
        # simplistic way fo splitting

```

```

westLong = (103.672, 103.768)
centralLong = (103.768, 103.858)
eastLong = (103.858, 103.960)
westAcc = sectorModels(westLong[0], westLong[1])
centralAcc = sectorModels(centralLong[0], centralLong[1])
eastAcc = sectorModels(eastLong[0], eastLong[1])

```

```

[235]: print(f"accuracy for west Sector is: {westAcc[0]}")
       print(f"accuracy for central Sector is: {centralAcc[0]}")
       print(f"accuracy for east Sector is: {eastAcc[0]}")

```

```

accuracy for west Sector is: 0.06462049274242403
accuracy for central Sector is: 0.06352849739026753
accuracy for east Sector is: 0.0584905830432861

```

```

[225]: one_carpark_nov_df = required_dec_df[required_dec_df['carpark_number'] == 'HLM']
       one_carpark_nov_df = one_carpark_nov_df[['latitude', 'longitude', 'hour',
       ↪ 'is_weekday', 'rainfall', 'percentage_availability']]

       one_carpark_dec_df = required_dec_df[required_dec_df['carpark_number'] == 'HLM']
       one_carpark_dec_df = one_carpark_dec_df[['latitude', 'longitude', 'hour',
       ↪ 'is_weekday', 'rainfall', 'percentage_availability']]

       final_nov_df = one_carpark_nov_df.dropna()
       final_dec_df = one_carpark_dec_df.dropna()

```

```

[226]: X_train = final_nov_df[['latitude', 'longitude', 'hour', 'is_weekday',
       ↪ 'rainfall']]
       y_train = final_nov_df[['percentage_availability']]
       X_test = final_dec_df[['latitude', 'longitude', 'hour', 'is_weekday',
       ↪ 'rainfall']]
       y_test = final_dec_df[['percentage_availability']]
       reg = ExtraTreesRegressor()
       reg.fit(X_train, y_train.values.ravel())
       y_test_pred = reg.predict(X_test)
       acc = reg_metrics(y_test, y_test_pred, X_train)
       print(f"Accuracy for HLM: {acc[0]}")

```

```

Accuracy for HLM: 0.047225484723516314

```

0.1 3.2 Based on the insights derived from the analysis, suggest a practical action that can be taken (i.e., an action that can be taken to benefit society. Do not suggest actions such as hyperparameter tuning here)

Some car parks with higher demand would have a greater chance of having vehicles idling while waiting for an available carpark lot. Idling can lead to unnecessary carbon emissions and we hope for our model to assist motorists in making the most informed decisions on the which car park they

should go to.

From our analysis, by checking if there are available carpark lots nearby using the function we provided, it can assist our country in lowering our carbon emissions and in turn, reduce the damage to our environment.

We can also identify carparks that are highly affected by rainfall, and the authorities can use this information to take necessary actions to alleviate the situation (such as a potential conversion of a non-sheltered carpark to a sheltered one)

Furthermore, it was observed that our aggregated model from Q2 performed better than our non-aggregated model as the aggregated model has a lower RMSE at 0.03 as compared to the RMSE of 0.09 for the non-aggregated model. Since our non-aggregated model also has more features, it suggests that we should ‘keep it simple’ as much as possible.

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