DS 3000 HW 3

Due: Monday July 15th @ 11:59 PM EST

Submission Instructions

Submit this `ipynb` file to Gradescope (this can also be done via the assignment on Canvas). To ensure that your submitted files represent your latest code, make sure to give a fresh `Kernel > Restart & Run All` just before uploading the files to gradescope.

Tips for success

- **Start early**
- **Make use of Piazza**
- **Make use of Office hour**
- **Remember to use cells and headings to make the notebook easy to read (if a grader cannot find the answer to a problem, you will receive no points for it)**
- **Under no circumstances may one student view or share their ungraded homework or quiz with another student (see also), though you are welcome to talk about (not show each other) the problems.**

Part 1: FIFA Players (30 points)

Create a plotly scatter plot which shows the mean `Overall` rating for all soccer players (rows) of a particular `Age`. Color your scatter plot per `Nationality` of the player, focusing on three countries (`England`, `Germany`, `Spain`). Download the `players_fifa23.csv` from Canvas and make sure it is in the same directory as this notebook file.

Export your graph as an html file `age_ratings_nationality.html` and submit it with your completed homework `ipynb` to gradescope.

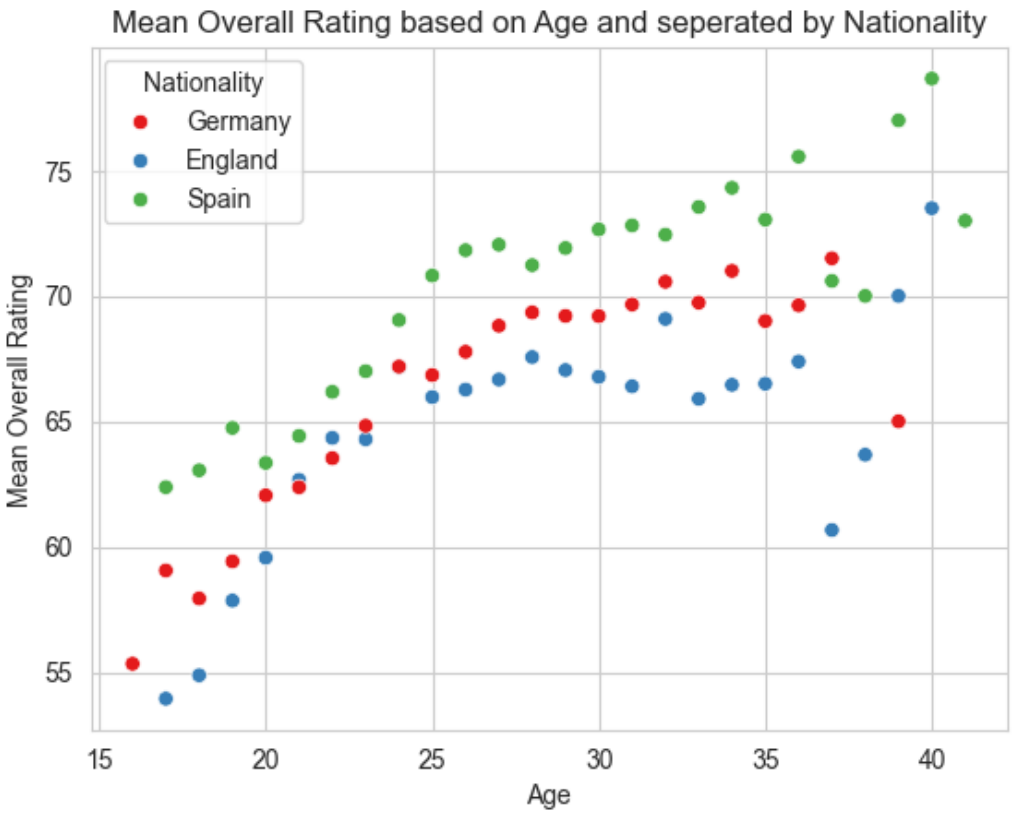
Hints:

- **There may be multiple ways/approaches to accomplish this task.**
- **One approach: you may use `groupby()` and boolean indexing to build these values in a loop which runs per each `Nationality`.**
- **`px.scatter()` will only graph data from columns (not the index). Some approaches may need to graph data from the index. You can use df.reset_index() to make your index a new column as shown in this example**
- **In some approaches you may need to pass multiple rows to df.append() if need be as shown in this example**
- **In some approaches you may need to go from "wide" data to "long" data by using df.melt() as discussed here**
- **The first few code cells below get you started with looking at the data set.**

In [6]:

```
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)

# use pandas to read in the data
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

df_fifa = pd.read_csv('players_fifa23.csv', index_col = 'ID')


countries = ['England', 'Germany', 'Spain']
```

```
df_fifa2 = df_fifa[df_fifa['Nationality'].isin(countries)]

df_fifa3 = df_fifa2.groupby(['Age', 'Nationality'])['Overall'].mean().reset_index()

sns.scatterplot(data=df_fifa3, x='Age', y='Overall', hue='Nationality', palette='Set1')

plt.title('Mean Overall Rating based on Age and seperated by Nationality')
plt.xlabel('Age')
plt.ylabel('Mean Overall Rating')

plt.savefig('age_ratings_nationality.png')

plt.show()
```



In [ ]:

```
```

Part 2: Daylight through the year

The remainder of the homework asks you to complete the pipeline which, given the lattitude / longitude and timezone of some cities:

```
loc_dict = {'Boston': (42.3601, -71.0589, 'US/Eastern'),
            'Lusaka': (-15.3875, 28.3228, 'Africa/Lusaka'),
            'Sydney': (-33.8688, 151.2093, 'Australia/Sydney')}
```

the keys are the `name` of the city and the values are tuples of `lat, lon, timezone_name`

is able to:

- **query a sunrise / sunset API**
- **clean and process data (timezone management & building `datetime` objects)**

Part 2.1: Getting Sunrise Sunset via API (20 points)

Write the `get_sunrise_sunset()` function below so that it uses [this sunrise sunset API] to produce the result in the test case:

It may be helpful to know that this particular API...

- **requires no api key**
- **returns about 2.5 queries per second**
- **did not block me when I tried to make 100 consecutive calls as quickly as possible**

In [15]:

```
# you will need to run pip install requests in the terminal
# no need to install json, it is built into python
import requests
import json

# make sure to write a good docstring! I will do this for you for the other functions in
this homework, but you should practice here!
def get_sunrise_sunset(lat, lng, date):
    """ fetches the sunrise sunset API information on a particular date for a given latit
ude-longitude

    Args:
        lat (float): latitude of interest
        lng (float): longitude of interest
        date (str): date of interest

    Returns:
        gss_dict (dictionary): a dictionary that contains the API information, as well as
the arguments
    """

    url = f'https://api.sunrise-sunset.org/json?lat={lat}&lng={lng}&date={date}'
    response = requests.get(url)

    if response.status_code == 200:
        data = response.json()
        if data['status'] == 'OK':
            data['tzid'] = 'UTC'
            data['lat-lng'] = (lat, lng)
            data['date'] = date
            return data
        else:
            raise ValueError(data['status'])
    else:
        response.raise_for_status()
```

In [16]:

```
sun_dict = get_sunrise_sunset(lat=42.3601, lng=-71.0589, date='2022-02-15')
sun_dict_expected = \
{'results': {'sunrise': '11:38:48 AM',
             'sunset': '10:17:50 PM',
             'solar_noon': '4:58:19 PM',
             'day_length': '10:39:02',
             'civil_twilight_begin': '11:11:30 AM',
             'civil_twilight_end': '10:45:08 PM',
             'nautical_twilight_begin': '10:38:37 AM',
             'nautical_twilight_end': '11:18:00 PM',
             'astronomical_twilight_begin': '10:06:05 AM',
             'astronomical_twilight_end': '11:50:33 PM'},
 'status': 'OK',
 'tzid': 'UTC',
 'lat-lng': (42.3601, -71.0589),
 'date': '2022-02-15'}

assert sun_dict == sun_dict_expected, 'get_sunrise_sunset() error'
```

Part 2.2: (10 points)

A look at the API's documentation reminds us:

```
"NOTE: All times are in UTC and summer time adjustments are not included in the ret
urned data."
```

Complete the `change_tz()` below so that it passes the given test case.

In [41]:

```
import pytz
from datetime import datetime

def change_tz(dt, timezone_from, timezone_to):
    """ converts timezone of a timezone naive datetime object

    Args:
        dt (datetime): datetime (or time) object without timezone
        timezone_from (str): timezone of input
        timezone_to (str): timezone of output datetime

    Returns:
        dt (datetime): datetime object corresponding to
            unix_time
    """
    tz = pytz.timezone(timezone_from)
    dt_tz = tz.localize(dt)

    tz_to = pytz.timezone(timezone_to)
    dt = dt_tz.astimezone(tz_to)

    return dt
```

In [42]:

```
# If things work, you should not get an error in this block
# build test case input / output
dt_no_tz = datetime(2021, 2, 13, 9, 54, 4, 270088)
dt_expect = datetime(2021, 2, 13, 14, 54, 4, 270088, tzinfo=pytz.timezone('GMT'))

# compute actual output
dt = change_tz(dt_no_tz, timezone_from='US/Eastern', timezone_to='GMT')

assert dt == dt_expect, 'change_tz() error'
```

Part 2.3: (25 points)

Build `clean_sun_dict()` to pass each of the two test cases below. Note that:

- **sunrise and sunset are `time` objects which account for daylight's saving:**
  - **include the date when building these objects**
  - **use `change_tz()` above to cast them to the proper timezone**
  - **build `time` objects by calling `datetime.time()` to discard the date of a `datetime`**
  - **importing `pandas as pd` and using `pd.to_datetime` may also be helpful**
- **`sunrise_hr` and `sunset_hr` are the hours since the day began in local timezone (more easily graphed)**
  - **you may use `.strftime()` and `int()` to cast time objects to strings and then integers (which may be helpful)**

NOTE: There may be more than one way to accomplish writing this function; as long as the function passes both `assert` test cases, you may continue. Just do be sure to comment and present your code as cleanly as possible.

In [45]:

```
from datetime import datetime, time
import pandas as pd

def clean_sun_dict(sun_dict, timezone_to):
```

```
    """ builds pandas series and cleans output of API

    Args:
        sun_dict (dict): dict of json (see ex below)
        timezone_to (str): timezone of outputs (API returns
            UTC times)

    Returns:
        sun_series (pd.Series): all times converted to
            time objects

    example sun_series:

    date            2021-02-13 00:00:00
    lat-lng        (36.72016, -4.42034)
    sunrise                    02:11:06
    sunrise_hr                    2.185
    sunset                     13:00:34
    sunset_hr                   13.0094
    dtype: object
    """
    date_string = sun_dict['date']
    date = datetime.strptime(date_string, '%Y-%m-%d')
    lat_lng = sun_dict['lat-lng']

    sunrise_utc_string = sun_dict['results']['sunrise']
    sunset_utc_string = sun_dict['results']['sunset']

    sunrise_utc = pd.to_datetime(f"{date_string} {sunrise_utc_string}", utc=True)
    sunset_utc = pd.to_datetime(f"{date_string} {sunset_utc_string}", utc=True)

    sunrise_local = change_tz(sunrise_utc, 'UTC', timezone_to)
    sunset_local = change_tz(sunset_utc, 'UTC', timezone_to)

    sunrise = sunrise_local.time()
    sunset = sunset_local.time()

    sunrise_hr = sunrise_local.hour + sunrise_local.minute / 60 + sunrise_local.second /
3600
    sunset_hr = sunset_local.hour + sunset_local.minute / 60 + sunset_local.second / 360
0

    sun_series = pd.Series({
        'date': date,
        'lat-lng': lat_lng,
        'sunrise': sunrise,
        'sunrise_hr': sunrise_hr,
        'sunset': sunset,
        'sunset_hr': sunset_hr
    })

    return sun_series
```

In [46]:

```
sun_dict = {'results': {'sunrise': '11:38:48 AM',
                        'sunset': '10:17:50 PM',
                        'solar_noon': '4:58:19 PM',
                        'day_length': '10:39:02',
                        'civil_twilight_begin': '11:11:30 AM',
                        'civil_twilight_end': '10:45:08 PM',
                        'nautical_twilight_begin': '10:38:37 AM',
                        'nautical_twilight_end': '11:18:00 PM',
                        'astronomical_twilight_begin': '10:06:05 AM',
                        'astronomical_twilight_end': '11:50:33 PM'},
            'status': 'OK',
            'lat-lng': (42.3601, -71.0589),
            'date': '2022-02-15'}

# test without timezone conversion
sun_series = clean_sun_dict(sun_dict, timezone_to='GMT')
```

```
sun_series_exp = pd.Series(
{'date': datetime(year=2022, month=2, day=15),
'lat-lng': (42.3601, -71.0589),
'sunrise': time(hour=11, minute=38, second=48),
'sunrise_hr': 11.646666666666667,
'sunset': time(hour=22, minute=17, second=50),
'sunset_hr': 22.297222222222224})

assert sun_series.eq(sun_series_exp).all(), 'clean_sun_dict() error (GMT)'
```

```
---------------------------------------------------------------------------
AssertionError                            Traceback (most recent call last)
Cell In[46], line 26
     16 sun_series = clean_sun_dict(sun_dict, timezone_to='GMT')
     18 sun_series_exp = pd.Series(
     19 {'date': datetime(year=2022, month=2, day=15),
     20 'lat-lng': (42.3601, -71.0589),
   (...)
     23 'sunset': time(hour=22, minute=17, second=50),
     24 'sunset_hr': 22.297222222222224})
---> 26 assert sun_series.eq(sun_series_exp).all(), 'clean_sun_dict() error (GMT)'

AssertionError: clean_sun_dict() error (GMT)
```

In [33]:

```
# test with timezone conversion
sun_series = clean_sun_dict(sun_dict, timezone_to='US/Eastern',)

sun_series_exp = pd.Series(
{'date': datetime(year=2022, month=2, day=15),
'lat-lng': (42.3601, -71.0589),
'sunrise': time(hour=6, minute=38, second=48),
'sunrise_hr': 6.6466666666666665,
'sunset': time(hour=17, minute=17, second=50),
'sunset_hr': 17.297222222222224})

assert sun_series.eq(sun_series_exp).all(), 'clean_sun_dict() error (EST)'
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[33], line 2
      1 # test with timezone conversion
----> 2 sun_series = clean_sun_dict(sun_dict, timezone_to='US/Eastern',)
      4 sun_series_exp = pd.Series(
      5 {'date': datetime(year=2022, month=2, day=15),
      6 'lat-lng': (42.3601, -71.0589),
   (...)
      9 'sunset': time(hour=17, minute=17, second=50),
     10 'sunset_hr': 17.297222222222224})
     12 assert sun_series.eq(sun_series_exp).all(), 'clean_sun_dict() error (EST)'

Cell In[30], line 39, in clean_sun_dict(sun_dict, timezone_to)
     36 sunset_utc = pd.to_datetime(f"{date_str} {sunset_utc_str}", utc=True)
     38 # Use change_tz to convert to the specified timezone
---> 39 sunrise_local = change_tz(sunrise_utc, 'UTC', timezone_to)
     40 sunset_local = change_tz(sunset_utc, 'UTC', timezone_to)
     42 # Extract time parts from datetime objects

Cell In[27], line 17, in change_tz(dt, timezone_from, timezone_to)
      5 """ converts timezone of a timezone naive datetime object
      6
      7 Args:
   (...)
     14         unix_time
     15 """
     16 tz = pytz.timezone(timezone_from)
---> 17 dt_tz = tz.localize(dt)
     19 tz_to = pytz.timezone(timezone_to)
     20 dt = dt_tz.astimezone(tz_to)
```

```
File ~\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages\pytz\__init__.py:245, in UTC.localize(self, dt, is_dst)
    243 '''Convert naive time to local time'''
    244 if dt.tzinfo is not None:
--> 245     raise ValueError('Not naive datetime (tzinfo is already set)')
    246 return dt.replace(tzinfo=self)

ValueError: Not naive datetime (tzinfo is already set)
```

Part 2.4: (15 points)

Write the `get_annual_sun_data()` function so that it produces the outputs shown below. This function should make use of:

- `get_sunrise_sunset()`
- `clean_sun_dict()`

as built above.

The following snippet:

```
loc_dict = {'Boston': (42.3601, -71.0589, 'US/Eastern'),
            'Lusaka': (-15.3875, 28.3228, 'Africa/Lusaka'),
            'Sydney': (-33.8688, 151.2093, 'Australia/Sydney')}
df_annual_sun = get_annual_sun_data(loc_dict, year=2021, period_day=30)
df_annual_sun.head(15)
```

should generate:

	city	date	lat-lng	sunrise	sunrise_hr	sunset	sunset_hr
0	Boston	2021-01-01	(42.3601, -71.0589)	07:11:49	7.196944	16:24:12	16.403333
1	Lusaka	2021-01-01	(-15.3875, 28.3228)	05:38:33	5.642500	18:42:09	18.702500
2	Sydney	2021-01-01	(-33.8688, 151.2093)	05:46:24	5.773333	20:10:53	20.181389
3	Boston	2021-01-31	(42.3601, -71.0589)	06:56:43	6.945278	16:58:42	16.978333
4	Lusaka	2021-01-31	(-15.3875, 28.3228)	05:55:43	5.928611	18:44:35	18.743056
5	Sydney	2021-01-31	(-33.8688, 151.2093)	06:14:24	6.240000	20:02:42	20.045000
6	Boston	2021-03-02	(42.3601, -71.0589)	06:15:41	6.261389	17:36:50	17.613889
7	Lusaka	2021-03-02	(-15.3875, 28.3228)	06:06:23	6.106389	18:31:11	18.519722
8	Sydney	2021-03-02	(-33.8688, 151.2093)	06:42:34	6.709444	19:32:04	19.534444
9	Boston	2021-04-01	(42.3601, -71.0589)	06:24:21	6.405833	19:11:35	19.193056
10	Lusaka	2021-04-01	(-15.3875, 28.3228)	06:11:08	6.185556	18:09:54	18.165000
11	Sydney	2021-04-01	(-33.8688, 151.2093)	07:06:04	7.101111	18:52:05	18.868056
12	Boston	2021-05-01	(42.3601, -71.0589)	05:37:09	5.619167	19:45:25	19.756944
13	Lusaka	2021-05-01	(-15.3875, 28.3228)	06:16:13	6.270278	17:51:21	17.855833
14	Sydney	2021-05-01	(-33.8688, 151.2093)	06:28:28	6.474444	17:16:05	17.268056

In [47]:

```
from datetime import timedelta

def get_annual_sun_data(loc_dict, year=2021, period_day=30):
    """ pulls evenly spaced sunrise / sunsets from API over year per city

    Args:
        loc_dict (dict): keys are cities, values are tuples of
            (lat, lon, tz_str) where tz_str is a timezone
            string included in pytz.all_timezones
```

```
        year (int): year to query
        period_day (int): how many days between data queries
            (i.e. period_day=1 will get every day for the year)

    Returns:
        df_annual_sun (DataFrame): each row represents a
            sunrise / sunset datapoint, see get_sunrise_sunset()
    """
    data = []

    for city, (lat, lon, tz_str) in loc_dict.items():
        date = datetime(year, 1, 1)
        while date.year == year:
            sun_dict = get_sunrise_sunset(lat, lon, date)

            sun_series = clean_sun_dict(sun_dict, tz_str)

            sun_series['city'] = city

            data.append(sun_series.to_dict())

            date += timedelta(days=period_day)
    df = pd.DataFrame(data)

    return df
```

Once you have finished the function, you should be able to run the following codes to get the result.

In [48]:

```
loc_dict = {'Boston': (42.3601, -71.0589, 'US/Eastern'),
            'Lusaka': (-15.3875, 28.3228, 'Africa/Lusaka'),
            'Sydney': (-33.8688, 151.2093, 'Australia/Sydney')}

# you may find that setting period_day to a larger value is quicker for debug
# period_day=5 takes about a minute or so given the API does 2-3 requests / sec
df_annual_sun = get_annual_sun_data(loc_dict, year=2021, period_day=30)
```

```
---------------------------------------------------------------------------
JSONDecodeError                           Traceback (most recent call last)
File ~\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages\requests\models.py:974, in Response.json(self, **kwargs)
    973 try:
--> 974     return complexjson.loads(self.text, **kwargs)
    975 except JSONDecodeError as e:
    976     # Catch JSON-related errors and raise as requests.JSONDecodeError
    977     # This aliases json.JSONDecodeError and simplejson.JSONDecodeError

File C:\Program Files\WindowsApps\PythonSoftwareFoundation.Python.3.11_3.11.2544.0_x64__qbz5n2kfra8p0\Lib\json\__init__.py:346, in loads(s, cls, object_hook, parse_float, parse_int, parse_constant, object_pairs_hook, **kw)
    343 if (cls is None and object_hook is None and
    344         parse_int is None and parse_float is None and
    345         parse_constant is None and object_pairs_hook is None and not kw):
--> 346     return _default_decoder.decode(s)
    347 if cls is None:

File C:\Program Files\WindowsApps\PythonSoftwareFoundation.Python.3.11_3.11.2544.0_x64__qbz5n2kfra8p0\Lib\json\decoder.py:337, in JSONDecoder.decode(self, s, _w)
    333 """Return the Python representation of ``s`` (a ``str`` instance
    334 containing a JSON document).
    335
    336 """
--> 337 obj, end = self.raw_decode(s, idx=_w(s, 0).end())
    338 end = _w(s, end).end()

File C:\Program Files\WindowsApps\PythonSoftwareFoundation.Python.3.11_3.11.2544.0_x64__qbz5n2kfra8p0\Lib\json\decoder.py:355, in JSONDecoder.raw_decode(self, s, idx)
    354 except StopIteration as err:
--> 355     raise JSONDecodeError("Expecting value", s, err.value) from None
```

```
    356 return obj, end

JSONDecodeError: Expecting value: line 1 column 1 (char 0)

During handling of the above exception, another exception occurred:

JSONDecodeError                           Traceback (most recent call last)
Cell In[48], line 7
      1 loc_dict = {'Boston': (42.3601, -71.0589, 'US/Eastern'),
      2             'Lusaka': (-15.3875, 28.3228, 'Africa/Lusaka'),
      3             'Sydney': (-33.8688, 151.2093, 'Australia/Sydney')}
      5 # you may find that setting period_day to a larger value is quicker for debug
      6 # period_day=5 takes about a minute or so given the API does 2-3 requests / sec
----> 7 df_annual_sun = get_annual_sun_data(loc_dict, year=2021, period_day=30)

Cell In[47], line 26, in get_annual_sun_data(loc_dict, year, period_day)
     23 date = datetime(year, 1, 1)
     24 while date.year == year:
     25     # Fetch sunrise and sunset data for current date and city
---> 26     sun_dict = get_sunrise_sunset(lat, lon, date)
     28     # Clean and format the sunrise and sunset data
     29     sun_series = clean_sun_dict(sun_dict, tz_str)

Cell In[15], line 23, in get_sunrise_sunset(lat, lng, date)
     20 response = requests.get(url)
     22 if response.status_code == 200:
---> 23     data = response.json()
     24     if data['status'] == 'OK':
     25         data['tzid'] = 'UTC'

File ~\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCac
he\local-packages\Python311\site-packages\requests\models.py:978, in Response.json(self,
**kwargs)
    974     return complexjson.loads(self.text, **kwargs)
    975 except JSONDecodeError as e:
    976     # Catch JSON-related errors and raise as requests.JSONDecodeError
    977     # This aliases json.JSONDecodeError and simplejson.JSONDecodeError
--> 978     raise RequestsJSONDecodeError(e.msg, e.doc, e.pos)

JSONDecodeError: Expecting value: line 1 column 1 (char 0)


In [49]:
df_annual_sun.head(15)
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[49], line 1
----> 1 df_annual_sun.head(15)

NameError: name 'df_annual_sun' is not defined
```