CS2204 Homework: GPS tracking

Objectives

- Gain experience in working with CSV datasets
- Understand the need for data type conversions
- Implement mathematical formulas in Python

Background

You are given a GPS track of a vehicle in CSV format. The data file contains a series of coordinate points with timestamps. The three columns in the data file are as follows:

1. `Time` : the timestamp in fractional seconds of the GPS location. **Do not assume that all timestamps fall on integer second boundaries. Neither they are at uniform intervals from each other.**
2. `Latitude` : the geographic latitude in signed decimal degrees. The latitude is preceded by a minus sign (-) if it is south of the equator (a positive number implies north)
3. `Longitude` : the geographic longitude in signed decimal degrees. The longitude is preceded by a minus sign if it is west of the prime meridian (a positive number implies east).

A quick intro/refresher on the geographic coordinate system can be found here: https://journeynorth.org/tm/LongitudeIntro.html

Tasks

Finish the `gps_tracking.py` script which reads and the processes the GPS track data. Use the `csv` Python module to work with this file.

Your first task is to implement the `distance()` function, which calculates the distance in miles between two GPS coordinates. See the docstring and the hints below for details.

Than, your script should compute and print the following metrics:

- *Overall distance*: the entire length of the trip (sum of distances between the measurement points). You should print this information in miles rouded to one decimal place precision.
- *Average speed*: the ratio of overall distance and overall time of the trip in miles per hour (mph) rounded to the closest integer.
- *Maximum speed*: the maximum speed observed between consecutive GPS track points in miles per hour (mph) rounded to the closest integer.

If done correctly, your output should look like this (use the exact same output format):

```
Distance: 19.1 miles
Average speed: 52 mph
Maximum speed: 84 mph
```

Hints

The first challenge in this assignment is to compute the distance on the surface of Earth between two geographic coordinate points (p_1 and p_2). You should use and implement the haversine formula to calculate the distance (d) in miles:

- φ_1, φ_2: latitude of p_1 and p_2 in radians, respecitvely
- λ_1, λ_2: longitude of p_1 and p_2 in radians, respecitvely
- R: mean radius of Earth in miles (use: `3,958.8` miles)

$$d\varphi = \varphi_2 - \varphi_1$$

$$d\lambda = \lambda_2 - \lambda_1$$

$$a = \sin^2\left(\frac{d\varphi}{2}\right) + \cos\varphi_1 \cdot \cos\varphi_2 \cdot \sin^2\left(\frac{d\lambda}{2}\right)$$

$$c = 2 \cdot \arctan\frac{\sqrt{a}}{\sqrt{1-a}}$$

$$d = R \cdot c$$

Notes:

- All the required mathematical functions (`sin` , `cos` , `atan2` , `sqrt` , `radians`) are available from the Python `math` module.
- Use the `atan2` function to calculate the arctangent in the formula.
- The trigonometric functions use radians (**not degrees**). You can convert from degrees to radians using the `math.radians()` function.

Grading

You can use the attached `validator.py` program to check your work (and the instructor's original mistakes). It will also estimate your final score for the homework. The program is in the same folder as your homework assignment. Open the `validator.py` script and run it in the Spyder environment to track your progress.

Penalties

Points will be deducted if you fail to set `__author__` variable (-10 pts) and for **each PEP 8 style errors** (-1 pt for each) in your program.

Submission

Please, upload the final version of the following file(s) (**and only those files**) to Brightspace:

- `gps_tracking.py`