Programming using Python

Assignment-1: Finding distance between two cities

Problem

Find the distance between two points on the surface of the earth given their latitude and longitude (in degrees).

Solution

Let the points be denoted by P_1: (ϕ_1, λ_1) and P_2: (ϕ_2, λ_2) with the ϕ's and λ's representing the latitudes and longitudes of the points. The distance $d(P_1, P_2)$ can be calculated as:

$$a = sin^2\left(\frac{\Delta\phi}{2}\right) + cos(\phi_1) \cdot cos(\phi_2) \cdot sin^2\left(\frac{\Delta\lambda}{2}\right)$$
$$b = 2\,\text{atan2}\left(\sqrt{a}, \sqrt{1-a}\right)$$
$$d(P_1, P_2) = R \cdot b$$

Where: $\Delta\phi = \phi_2 - \phi_1$, $\Delta\lambda = \lambda_2 - \lambda_1$, $R = 6371\text{km}$ is the radius of the Earth and 'atan2' is the two argument arctangent (see ("atan2" 2014)). If you are interested in the derivation of this formula, please see ("Haversine Formula" 2014).

Program Input

Take as input the latitudes and longitudes of the two cities. The latitudes and longitudes will be given as degrees. Example inputs are:

$$\phi_1 = 33.6547534$$
$$\lambda_1 = 73.2499975$$
$$\phi_2 = -22.9083$$
$$\lambda_2 = -43.1964$$

The first city (ϕ_1, λ_1) in the above example "Nilore" in Islamabad, Pakistan and the second city (ϕ_2, λ_2) is "Rio de Janeiro" in Brazil.

Program Output

The output is the distance. For the above example, the distance is: 13772.847km. You can use this example to test if your code is correct.

Hints

Introduction to Python modules

Python code (function, objects, variables, classes etc.) can be organized in "modules" which can then be imported in other Python code files. For example, the function "sin" exists in the built-in Python module "`math`". "`math`" also contains "`pi`". You can import functionality from a module in different ways:

Method 1: Importing the module

You can import modules by using the "`import`" keyword. The code below will print out the "sine" of $\pi/2$ radians.

```
import math
print math.sin(math.pi/2.0)
```

Note that you need to specify "`math.`" Before everything you want to use from that module.

Method 2: Importing specific functions and variables from the module

You can also import specific functions and variables declared in the module. This eliminates the need of writing the name of the module prior to the name of the function or variables.

```
from math import sin,pi
print sin(pi/2.0)
```

Method 3: Importing everything

You can also import everything in a module.

```
from math import *
print sin(pi/2.0)
```

Now you can use everything declared in the module.

More information on the math module

You can have more information on the math module from: https://docs.python.org/2/library/math.html

Submission

Naming your file

Please name your files as "assignment_1_name1.py" where "name1" is your name and if you chose to do this assignment in groups of two, include the 2nd name separated from the first by an underscore.

File contents

Please include the names of the coders in top level arguments in your file.

Deadline

Submit your files by email to fayyazafsar<AT> gmail [DOT] com. The deadline for submission is **0900HRS on Wednesday, July 16, 2014. This code will be used in the class on July 16, 2014 so please be sure to complete this assignment before the class.**

Office hours

If you encounter problems you can either send me an email about it or come to office hours on Monday, July 14, 2014: 12-1.30pm.

References:

"atan2." 2014. *Wikipedia, the Free Encyclopedia*. http://en.wikipedia.org/w/index.php?title=Atan2&oldid=616383313.
"Haversine Formula." 2014. *Wikipedia, the Free Encyclopedia*. http://en.wikipedia.org/w/index.php?title=Haversine_formula.