CS205 C/C++ Programming Lab Assignment 1

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Part 1 - Analysis

The problem is to calculate the distance between two cities by using the data which user entered.
Assume the Earth is a perfect sphere. Let all angles be measured in signed degrees (negative latitude means South; negative longitude means West).
Let phi = 90 - latitude. The North Pole has phi = 0, the South Pole has phi = 180, and 0 <= phi <= 180.
Let theta = longitude. Greenwich, England, has theta = 0, and -180 <= theta <= 180.
Let the angles for the two points be (phi1, theta1) and (phi2, theta2). Then compute c = sin(phi1)*sin(phi2)*cos(theta1-theta2) + cos(phi1)*cos(phi2).
Then the shortest great circle distance between the two points is d = R*arccos(c) where R is the radius of the earth in kilometers, and the arccosine is taken between 0 and 180 degrees, inclusive. (Earth radius: 6,371 km)

Part 2 - Code

```
#include <iostream>
#include <math.h>
#include <string>
#include <regex>
using namespace std;
struct City {
    string name;
    float latitude;
    float longitude;
};
float calc(City city1, City city2);
int main() {
    regex pattern("^([A-Za-z]+[,]*[\\s]*[,]*[\\s]*)+$");
    City city1;
    cout << "The first city: ";
    getline(cin, city1.name);
    if (!regex_match(city1.name, pattern)) {
        cout << "The name of first city is illegal.";
        return 0;
    }
    cout << "The latitude and longitude of first city: ";
    cin >> city1.latitude;

    if (cin.fail() || city1.latitude >= 90.01 || city1.latitude <= -90.01) {
        cout << "The latitude of first city is illegal.";
        return 0;
    }
```

```
    cin >> city1.longitude;
    if (cin.fail() || city1.longitude >= 180.01 || city1.longitude <= -180.01) {
        cout << "The longitude of first city is illegal.";
        return 0;
    }
    if (char buf = getchar() != '\n' && buf != EOF) {
        cout << "The latitude or longitude of first city is illegal.";
        return 0;
    }
    City city2;
    cout << "The second city: ";
    getline(cin, city2.name);
    if (!regex_match(city2.name, pattern)) {
        cout << "The name of second city is illegal.";
        return 0;
    }
    cout << "The latitude and longitude of second city: ";
    cin >> city2.latitude;
    if (cin.fail() || city1.latitude >= 90.01 || city1.latitude <= -90.01) {
        cout << "The latitude of second city is illegal.";
        return 0;
    }
    cin >> city2.longitude;
    if (cin.fail() || city1.longitude >= 180.01 || city1.longitude <= -180.01) {
        cout << "The longitude of second city is illegal.";
        return 0;
    }
    if (char buf = getchar() != '\n' && buf != EOF) {
        cout << "The latitude or longitude of second city is illegal.";
        return 0;
    }
    cout << "The distance between " << city1.name << " and " << city2.name << " is
" << calc(city1, city2) << "km";
    return 0;
}
float calc(City city1, City city2) {
    float phi1 = 90.0 - city1.latitude;
    float phi2 = 90.0 - city2.latitude;
    float theta1 = city1.longitude;
    float theta2 = city2.longitude;
    float c = sin(phi1) * sin(phi2) * cos(theta1 - theta2) + cos(phi1) * cos(phi2);
    return 6371 * acos(c);
}
```

Part 3 - Result & Verification

Test Case #1: Normal Case
Input:
Shenzhen: 22.55 114.1

Tokyo: 35.42 139.46

```
~/Courses/CPP/assignment1 ./distance
The first city: Shenzhen
The latitude and longitude of first city: 22.55 114.1
The second city: Tokyo
The latitude and longitude of second city: 35.42 139.46
The distance between Shenzhen and Tokyo is 2386.5km
```

Test Case #2: City name with blank or comma

Input:

Shen Zhen: 22.55 114.1

Tokyo, JP: 35.42 139.46

```
~/Courses/CPP/assignment1 ./distance
The first city: Shen Zhen
The latitude and longitude of first city: 22.55 114.1
The second city: Tokyo, JP
The latitude and longitude of second city: 35.42 139.46
The distance between Shen Zhen and Tokyo, JP is 2386.5km
```

Test Case #3: City name with number

Input:

Shenzhen233: 22.55 114.1

```
~/Courses/CPP/assignment1 ./distance
The first city: Shenzhen233
The name of first city is illegal.
```

Test Case #4: City name with other characters

Input:

Shenzhen.!: 22.55 114.1

```
~/Courses/CPP/assignment1 ./distance
The first city: Shenzhen.!
The name of first city is illegal.
```

Test Case #5: Negative latitude and longitude

Input:

Rio de Janeiro: -22.9083 -43.1964

Sydney: -33.865 151.209444

```
~/Courses/CPP/assignment1 ./distance
The first city: Rio de Janeiro
The latitude and longitude of first city: -22.9083 -43.1964
The second city: Sydney
The latitude and longitude of second city: -33.865 151.209444
The distance between Rio de Janeiro and Sydney is 10335.4km
```

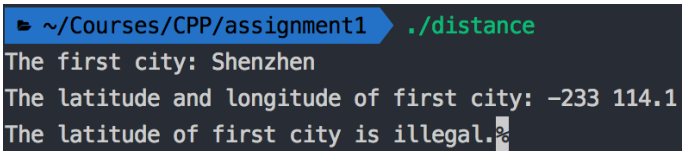
Test Case #6: Latitude/Longitude too large

Input:

Shenzhen: 233 114.1

```
~/Courses/CPP/assignment1 ./distance
The first city: Shenzhen
The latitude and longitude of first city: 233 114.1
The latitude of first city is illegal.
```

Test Case #6: Latitude/Longitude too small
Input:
Shenzhen: -233 114.1



Part 4 - Difficulties & Solutions

Determine whether the input city name string meets the rules is the main difficulty of this assignment. I use regex to test the input string, so it is much easier to determine the rules.