COM 116 Machine Problem 1

Sunrise, sunset
20 Points
Assigned: October 23, 2018
Due: October 25, 2018

As the documentary, "I Am Legend," reveals, there is a particular subspecies of zombie that will only come out at night. (I realize that there is a debate as to whether that particular species of undead are zombies or vampires, but at this critical point in history, I find such debate pedantic and counterproductive). Therefore, it is of the utmost importance that we be able to calculate the time of the local sunrise and sunset.

Fortunately, astronomers have left us the equations that allow us to calculate this. Unfortunately, they were eaten by zombies before they could turn the math into a useful program. What follows is the algorithm that is their legacy.

The Algorithm

To calculate the local time of sunrise and sunset, need the following data:

latitude	Latitude of the current location in degrees (+ = North, - = South)
longitude	Longitude of the current location in degrees (+ = East, - = West)
timezone	The local timezone as offset from UTC (e.g. CST=-6)
day_of_year	The numerical day of the year for which we are performing the calculation

Here are the equations to calculate sunrise and sunset times.

γ is the day of the year converted into an angle in radians.

$$\gamma = \frac{2\pi}{365}(day\_of\_year - 1)$$

eqtime is the equation of time in minutes (the number of minutes that the position of the sun differs from the actual time).

$$eqtime = 229.18(0.000075 + 0.001868\cos(\gamma) - 0.032077\sin(\gamma) - 0.014615\cos(2\gamma) - 0.040849\sin(2\gamma))$$

decl is the declination of the sun in radians.

$$\begin{aligned} decl = {} & 0.006918 - 0.399912\cos(\gamma) + 0.070257\sin(\gamma) \\ & - 0.006758\cos(2\gamma) + 0.000907\sin(2\gamma) \\ & - 0.002697\cos(3\gamma) + 0.00148\sin(3\gamma) \end{aligned}$$

ha is the hour angle of the sun in degrees.

$$ha = \arccos\left(\frac{\cos(1.5853)}{\cos(latitude \cdot \frac{\pi}{180})\cos(decl)} - \tan(latitude \cdot \frac{\pi}{180})\tan(decl)\right) \cdot \frac{180}{\pi}$$

sunrise is the time in local minutes of sunrise.

$$sunrise = 720 + 4(longitude - ha) - eqtime - 60 \cdot timezone$$

sunset is the time in UTC minutes of sunset.

$$sunset = 720 + 4(longitude + ha) - eqtime - 60 \cdot timezone$$

To convert a time in local minutes to local time you can use the following equations (the sunset equations look the same).

$$\begin{aligned} sunrise\_hour &= \left\lfloor \frac{sunrise}{60} \right\rfloor \\ sunrise\_minute &= sunrise - (sunrise\_hour \cdot 60) \end{aligned}$$

Note: The strange brackets are the floor function, which rounds the expression inside them down. You can easily achieve this in C by simply assigning the value to an integer variable, or you can use the floor function defined in math.h.

Coding Details

- To use the transcendental functions (sin, cos), you will need to add the following line to the top of your file:

  ```
  #include <cmath>
  ```

- To ensure that your calculation match mine, use 3.1415926 as the value of π.

Please note, that these equations are low-precision approximations and can result in times that are up to 15 minutes off from the actual local sunrise and sunset. Please make sure take these discrepancies into account when planning your foraging missions. We wish we could provide more exact equations, but of course, the brains that derived these equations currently reside in the stomachs of our adversaries.

Sample Runs

```
Daylight-Sensitive Zombie Protection System
This program will calculate sunrise and sunset time for any date and location

Enter latitude, longitude:40.75 -74
Enter Timezone:-5
Enter day of year:180
Sunrise:  4:34
Sunset:  19:39

Daylight-Sensitive Zombie Protection System
This program will calculate sunrise and sunset time for any date and location

Enter latitude, longitude:37.5 -88.0
Enter Timezone:-6
Enter day of the year:11
Sunrise:  7:22
Sunset:  17:07
```