CS 100: Programming Assignment P6

Due: Friday, April 16, 5pm, Carpenter Lab (or in lecture)

You may work in pairs. Do not submit your assignment for grading unless you have read and understand the CS100 webpage on Academic Integrity. Follow the course rules for the submission of assignments or lose points.

Background

The Matlab script

```matlab
% Script File: P6Demo.
% Plots Ithaca temperature data over the span of a year. Displayed are the record high, the average high, the average low, and the record low.
D = ithacaData;
mStr = '     Jan    Feb   Mar    Apr    May   Jun    Jul    Aug    Sep   Oct    Nov    Dec';
m = [1 32 60 91 121 152 182 213 244 274 305 335 366];
close all
% Closes all open figure window—a good habit
axis([1 365 -40 120])                % Horizontal range from 1 to 365 and vertical range –40 to 120
plot(D')
% Closes all open figure window—a good habit
axis([1 365 -40 120])
% Horizontal range from 1 to 365 and vertical range –40 to 120
set(gca,'Xtick',m,'XtickLabel',[])   % Put tick marks at the xvalues named by m but don’t label
grid on
% Put a title on top.
ylabel('Temperature (°F)')        % Label the y-axis
set(gca,'Xtick',m,'XtickLabel',[]) % Put tick marks at the xvalues named by m but don’t label
text(-10,-50,mStr)                   % Display the string mStr along the bottom edge
grid on
% Show the grid lines
```

produces the following plot:

![Ithaca Weather Data](image)

This script and the functions

```matlab
function D = ithacaData
% Yields a 4-by-365 matrix D. For i=1:365,
% D(1,i) record high temperature for day i.
% D(2,i) average high temperature for day i.
% D(3,i) average low temperature for day i.
% D(4,i) record low temperature for day i.
% Days are indexed from 1 (= Jan 1) to 365 (= December 31)
```

```matlab
function D = D98
% Yields a 2-by-365 matrix D. For i=1:365,
% D(1,i) the high temperature for day i in 1998
% D(2,i) the low temperature for day i in 1998.
% Days are indexed from 1 (= Jan 1) to 365 (= December 31)
```
are available on the website. In this assignment you graphically depict various aspects of the Ithaca weather scene using these two functions to generate the necessary data. Matlab is available in all public labs. Use the course ID CS100 (case insensitive) and the password Code4 (case sensitive) to gain access. Create files P6Demo, ithacaData, and D98 from the Matlab editor and copy into them the corresponding source codes available on the website.

**Part A. (5 correctness points and 2 style points)**

We say that a day is hot if the high temperature is closer to the record high for that day than to the average high for that day. Thus, if today’s high is 70 and the record high is 80 and the average high is 50, then today is hot because 80-70<70-50. Likewise, a day is cold if the lowest temperature during the day is closer to the record low than to the average low. Write a script that “adds” the hot and cold days of 1998 to the plot shown above. Proceed by copying P6Demo into a new file P6A and then augment it as follows

- Get the 1998 data on tap via the statement LastYear = D98. As a result, LastYear be a 2-by-365 array whose first row has all the 1998 daily highs and whose second row contains all the 1998 daily lows.
- Compute a vector hotDays of hot day indices and a vector coldDays of cold day indices. Thus, if days 22, 100, and 254 are hot days and days 150 and 200 are cold days, then hotDays should be [22 100 254] and coldDays should be [150 200]. Use find to help generate these arrays.
- Designate the hot days with a red circle and the cold days with a blue circle via the sequence

  ```matlab
  hold on
  plot(hotDays,LastYear(1,hotDays),'or',coldDays,LastYear(2,coldDays),'ob')
  hold off
  ```

Style points deducted if your solution uses loops and/or lacks comments. Submit a listing of P6A and the plot.

**Part B. (4 correctness points and 2 style points)**

The following functions can be used to approximate the average high and average low:

- \[ \text{High}(t) = 55.8301 - 25.1551 \sin((t + 70.0800) \times 2\pi/365) \]
- \[ \text{Low}(t) = 36.3452 + 21.7682 \sin((t - 115.4738) \times 2\pi/365) \]

Implement each of these as Matlab functions and write a script P6B that graphically displays the error for each in separate windows. In particular,

- As in P6Demo, get the necessary data on hand via the command D = ithacaData.
- Compute a vector errHigh where \( \text{errHigh}(i) = D(2,i) - \text{high}(i) \) for \( i=1:365 \), then execute plot(err).
  Make the plot informative as we did in P6Demo with appropriate axis, title, ylabel, grid, set, and text commands.
- Generate another figure window with figure and place in it the corresponding error plot for the \( \text{Low}(t) \) function.

Style points deducted if your Part B solution requires a loop and/or lacks comments. Submit a listing of P6B and the plots.

**Part C. (5 correctness points and 2 style points)**

For each month define the average monthly high as the average of all the average daily highs. Likewise, define the average monthly low as the average of all the average daily lows. If these values are stored in vectors highs and lows (each length 12) then the sequence

  ```matlab
  bar(highs,'r')
  hold on
  bar(lows,'b')
  hold off
  ```

produces a nice bar graph that simultaneously depicts the monthly highs and lows. Write a script P6C that does this. (The vector \( m \) in P6Demo defines some useful day indices for this purpose. More example, if \( D = \text{ithacaData} \) then \( D(1,m(1):m(2)-1) \) is a vector that consists of the average daily highs for February.) Adjust the axis range to make things look nice, include a title, and label the vertical axis. For bar graphs the string labeling of the horizontal axis is best done with set(gca,'XTickLabel','Jan|Feb|Mar|Apr|May|Jun|Jul|Aug|Sep|Oct|Nov|Dec').

Submit a listing of P6C and the bar graph. Style points deducted if nested loops used and/or inadequate comments.