EEN118 LAB NINE

This lab involves some scientific data processing. You will download a Geographical Database File which contains the coordinates of the boundaries of the 48 connected states and the five great lakes, and write a program that draws maps requested by the user.

Download the file "`usamap.txt`" from the class web site. The format of the file is very simple; it describes the outlines of the 48 older states plus the five great lakes. Here is the beginning of the file:

```
FL
 81500  30666
 80500  28500
 80166  27000
 80166  26000
 80416  25166
 81166  25166
 81750  26000
 82916  27833
 82833  29000
 84000  30166
 85166  29666
 86000  30333
 87500  30416
 87500  31000
 85000  31000
 84833  30666
 82250  30500
 82216  30300
 82050  30300
 81950  30716
 81500  30666
-1 -1
AL
 85000  31000
 85000  32500
 85666  35000
 88166  35000...
```

and it continues like that for a long time. The first line "`FL`" indicates that this is the description of a state: `FL` is the postal abbreviation for Florida. The next 21 lines give the coordinates of a point along the border of the state. The coordinates are actually longitude and latitude measured in thousandths of a degree, but you can treat them simply as x and y values. The two `-1`'s after the list of numbers are simply to give you an easy way of telling that the list has finished (no real data in this file is ever negative). Then you see "`AL`" introducing the next state, Alabama's, description.

The whole file is just like that. First a state's abbreviation, then a list of coordinates, then `-1 -1`, all repeated 55 times. Notice that the coordinates of the last point are the same as the coordinates of the first point (81500, 30666). This is true of every state's description; they all make nice closed figures. The coordinates 81500, 30666 represent the point 30⅔ degrees North of the equator and 81½ degrees West of the Greenwich meridian.

At the end of the file, which looks like this...

```
KS
102000  40000
102000  37000
 94666  37000
 94666  39166
 95333  40000
 95333  40000
102000  40000
-1 -1
END
```

... you'll find the word `END`. The last state, Kansas's description ends as usual with `-1 -1`, then the word `END` appears. No state has "`END`" as its postal abbreviation. There is no data following the "`END`".

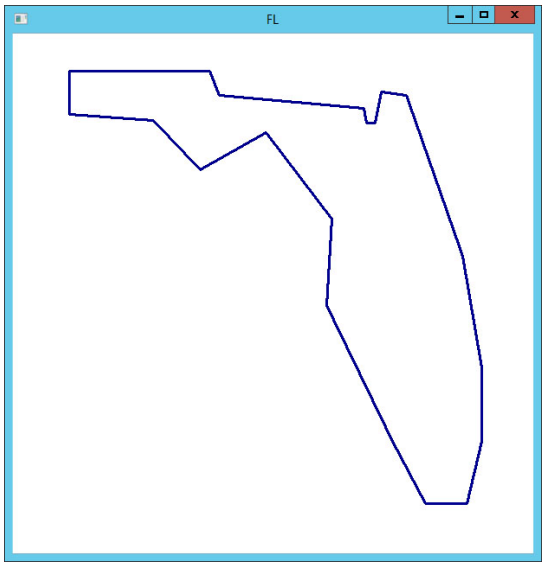
For your information, these are the extreme data values that appear in the file:

Minimum Longitude (x)	67000
Maximum Longitude (x)	124666
Minimum Latitude (y)	25166
Maximum Latitude (y)	49333

The states all have their standard two-letter postal abbreviations. The great lakes are given three-letter abbreviations: `LKE`, `LKH`, `LKM`, `LKO`, and `LKS`.

1. *Draw Florida*

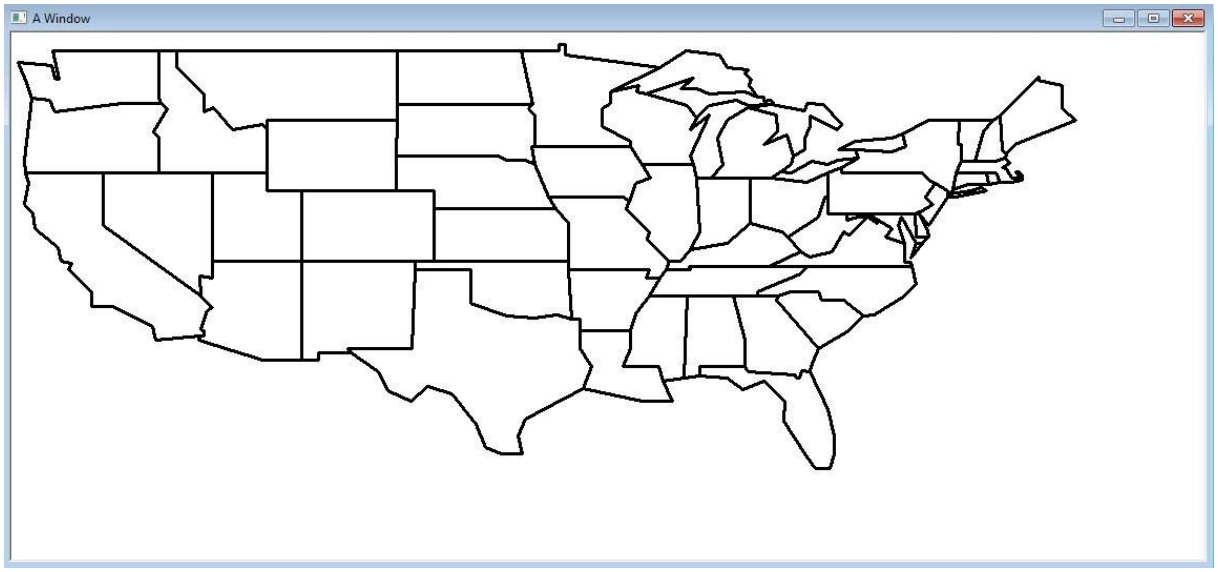
Write a program that opens a reasonably large graphics window (you decide the size), and draws the outline of the first state that appears in the data file (i.e. Florida). You will have to scale and shift the coordinates before plotting, as one of the points in Florida is (81500, 30666) and there's no way you're going to get a window that big. Make sure your picture comes out the right way round:



2. *Draw all states*

Modify your program so that draws the outlines of all the states (in the same window), so that a map of the whole country appears. Make the window big enough to draw the whole country, and just draw the each state in its correct position.

Two of the states, Michigan (MI) and Virginia (VA) are not contiguous; they come in two sections separated from each other by water. The two sections of these states have their own descriptions in the data file: there are two sections beginning with VA and two beginning with MI. Make sure that they are drawn properly.



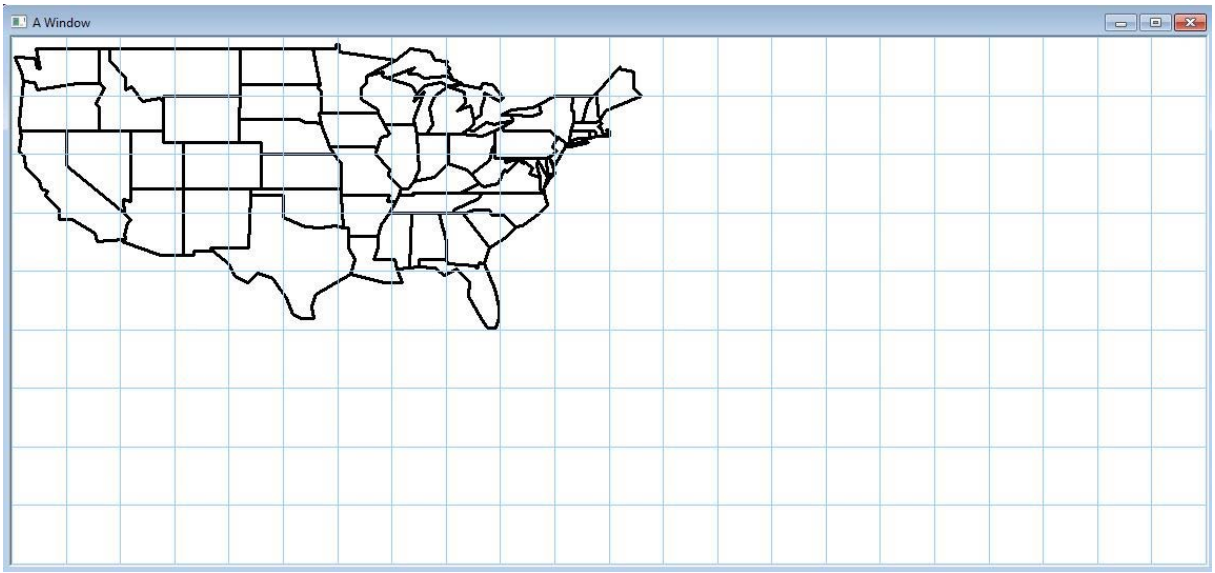
The map will look a bit over-crowded unless your create a really big window, but there isn't much that could reasonably be done about that.

3. *Make the map scalable*

Make sure that the map can be scaled easily to any range of latitude and longitude values. Moving the map so that the longtitude starts at around 15.0 degrees West and ends at 125.0 degrees West while latitude starts at 5.0 degrees North and 50.0 degrees North will result in the USA map in the upper left quadrant. This will make some space for the storm plots

4. *Add Latitude and Longitude Lines*

Now, add some latitude and longitude lines as a reference. These are evenly spaced. Try different spacings such as 5.0 degrees apart or 10.0 degrees apart.



You may also add labels to the lines with the values of latitude and longitude.

Download the file "2017_hur_dat.txt" from the class web site. The format of the file is very simple; it shows the tracks of every tropical system (depression/storm/hurricane) for 2017. Here is the beginning of the file:

```
AL012017 ARLENE 27
20170416 0600 X EX 35.8 50.3 55 992
20170416 1200 X EX 35.1 49.5 55 989
20170416 1800 X EX 34.4 48.7 55 986
20170417 0000 X EX 33.7 47.8 50 987
20170417 0600 X EX 33.2 47.0 45 988
20170417 1200 X EX 32.7 46.1 45 989
20170417 1800 X EX 32.3 45.3 40 991
20170418 0000 X EX 32.1 44.7 40 993
20170418 0600 X EX 31.9 44.4 35 994
20170418 1200 X EX 31.6 44.1 35 995
20170418 1800 X EX 31.1 43.5 30 996
20170419 0000 X SD 31.1 42.6 30 996
20170419 0600 X SD 31.3 41.8 30 996
20170419 1200 X SD 31.7 41.1 30 996
20170419 1800 X SD 32.1 40.4 30 996
20170420 0000 X TD 32.8 39.6 30 996
20170420 0600 X TS 33.8 39.2 35 994
20170420 1200 X TS 35.4 39.6 35 994
20170420 1800 X TS 37.3 40.7 40 992
20170421 0000 X TS 39.0 43.0 45 990
20170421 0600 X TS 40.0 46.3 45 990
20170421 1200 X EX 39.9 49.3 45 990
20170421 1800 X EX 38.5 50.8 40 992
20170422 0000 X EX 36.3 51.2 40 994
20170422 0600 X EX 34.7 50.0 40 996
20170422 1200 X EX 32.8 48.7 35 999
20170422 1800 X EX 31.9 46.4 30 1001
AL022017 BRET 9
20170618 1800 X DB 7.5 49.6 30 1008
20170619 0000 X DB 7.8 51.7 35 1008
20170619 0600 X DB 8.1 53.9 35 1007
20170619 1200 X DB 8.6 56.5 35 1007
20170619 1800 X TS 9.2 58.9 40 1007
20170620 0000 X TS 9.7 60.5 40 1008
.
.
.
```

The first line gives the identification of a storm, in this case ARLENE. The AL means that it is an Atlantic storm, the 01 is the official number of the storm (the first of the season), the 2017 is the year, next the name of the storm and finally the number of observations for that storm, 27 observations for ARLENE.

Each observation line has, in order:

```
Date(YYYYMMDD)  Time(24hr)  Record_Code  Status_Code  Latitude  Longitude
WindSpeed(knots) Pressure(millibars)
```

So the first observation for ARLENE:

```
20170416 0600 X EX 35.8 50.3 55 992
```

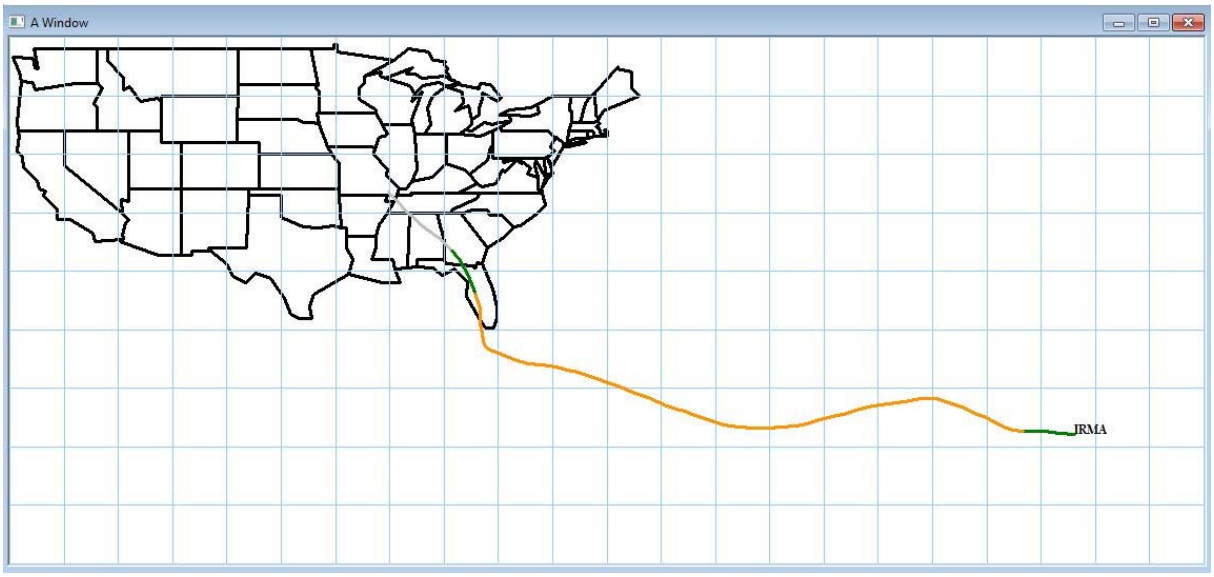
was on April 16, 2017 at 0600hrs and indicated the system was at 35.8 latitude and 50.3 longitude with a wind speed of 55 knots and a pressure of 992 millibars. We can ignore the codes for now (There is a listing at the end that shows their meaning).

5. *Plot one storm*

Now, using the "`2017_hur_dat.txt`" file, you will plot the path a single storm. The example shows the path for IRMA.

You will have to open the file and read the data until you find the first line with the storm name "IRMA". This line will also tell you how many observations were taken for the storm.

You need another loop to read these observations to get the latitude and longitude value for the storm as well as the wind speed. Plot these the same way you plotted the states, but remember that the latitude and longtitude data in this file is a real number, so you will have to read it as a double not an integer.



Make is interesting by color coding the lines to indicate the storm wind speed. The example uses dark-green for tropical storm and orange for hurricanes (obvisouly) and gray otherwise.

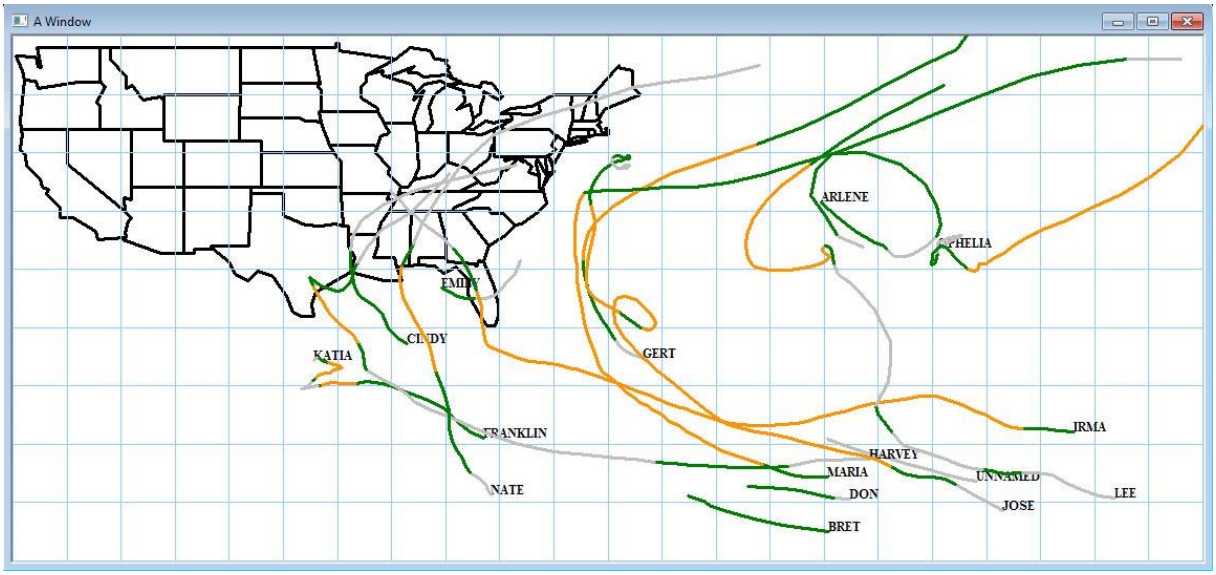
Remember that the wind speeds are in knots and the following definitions hold:

Tropical storm wind speeds: 34 knots ≤ wind speed < 64 knots
Hurricane wind speeds: wind speed ≥ 64 knots

Add a name for the storm, remember to use `write_string` to write to the graphics window.

6. *Plot all storms for year*

Now plot all the storms for 2017 using the same file.



You can make the storm plotting into a function that takes the name of the file and the storm name to plot. That way you can use a special storm name "ALL" to plot all storms.

EXTRA CREDIT. – TRY DIFFERENT YEARS

Allow the user to specify a year for the tracks. The files are named using the year as the first part of the file, so data for 2017 is in the file: "`2017_hur_dat.txt`" and data for 2016 is in the file: "`2016_hur_dat.txt`" etc.

Give the user a list of the storms in the year and allow them to specify which storm to plot.

HURRICANE DATA CODES:

For those who are interested, the code do convey some meaning as described by the National Hurricane Center:

Record_Code

- L – Landfall (center of system crossing a coastline)
- P – Minimum in central pressure
- I – An intensity peak in terms of both pressure and maximum wind
- S – Change of status of the system
- T – Provides additional detail on the track (position) of the cyclone
- X – No code

Status_Code

- TD – Tropical cyclone of tropical depression intensity (< 34 knots)
- TS – Tropical cyclone of tropical storm intensity (34-63 knots)
- HU – Tropical cyclone of hurricane intensity (> 64 knots)
- EX – Extratropical cyclone (of any intensity)
- SD – Subtropical cyclone of subtropical depression intensity (< 34 knots)
- SS – Subtropical cyclone of subtropical storm intensity (> 34 knots)
- LO – A low that is neither a tropical cyclone, a subtropical cyclone, nor an extratropical cyclone (of any intensity)
- DB – Disturbance (of any intensity)

Saffir-Simpson Hurricane Wind Scale:

1	64-82 kt	Very dangerous winds will produce some damage
2	83-95 kt	Extremely dangerous winds will cause extensive damage
3	96-112 kt	(major) Devastating damage will occur
4	113-136 kt	(major) Catastrophic damage will occur
5	≥137 kt	(major) Catastrophic damage will occur