Assignment 5

100 points

Purpose

The purpose of this assignment is to give you some experience in writing simple classes, using C++ `vector`s and in writing multi-part programs.

Assignment

This assignment reads in a collection of data about ocean storms and generates some brief reports. The data for this assignment is condensed from the National Hurricane Center and Tropical Prediction Center's archive of past hurricane seasons and can be found on the web at http://www.nhc.noaa.gov/data/#hurdat.

The data in this set represents storms from 1851 to 2015 in the northern Atlantic Ocean and from 1949 to 2015 in the northeastern and north central Pacific Ocean.

Your program will read the data file into a vector and then process it, generating reports of the data in unsorted and sorted order, based on several sorting criteria.

Program

You will need to write a class and several functions for this assignment. From a design point of view this class is not a complete class. Only the methods needed to guarantee the proper functioning of the assignment are implemented.

`class Storm`

Your class should be implemented in a separate source code file, along with an associated header file. The header file should have appropriate header guards.

This class contains seven data members: four `int`s, two `char`s and a C++ `string`. The data members must be `private`. The class data member are:

- a single character indicating whether the storm was in the Atlantic or Pacific basin. An `'A'` indicates the Atlantic Ocean, an `'E'` the northeastern Pacific Ocean, and a `'C'` the central Pacific Ocean.
- the name of the storm. Storms before 1950 (and a fair number after) were not named and therefore have the data name `UNNAMED`
- an integer for the sequence number of the storm. The sequence numbers start at 1 for each year and are assigned to the storms in each ocean basin in order of creation.
- an integer for the year of the storm.

- an integer for the maximum wind speed in nautical miles per hour (knots) recorded for the storm. If no max wind speed was recorded for the storm, then a max wind speed of -1 is listed.
- an integer for the minimum air pressure in millibars recorded for the storm. If no air pressure was recorded for the storm, then an air pressure of 10000 is listed.
- a character classifying the storm. An `'H'` represents a storm that reached hurricane status (winds >= 64 knots). An `'S'` is for a storm that was at most a tropical storm or subtropical storm (winds between 34 and 64 knots). A `'D'` represents a tropical or subtropical depression (winds < 34 knots).

This class should have eight methods: (Don't worry. Most of them are quite small.)

- A default constructor. This should simply set the data members to values that would not normally be used. Default values of `'N'`, `'None'` and `'N'` should be used for the basin, name, and storm type, respectively. Zeros make good default values for the integer data members.
- A constructor that takes 7 values with which to set all of the data members of the class.
- A print method. This should print out the data fields of the instance on a single line. Examples of the fields can be seen below in the sample output. Points to be made here are
    1. The location and storm type should be printed out in a long form.
    2. The sequence and year should have a slash between them.
    3. If minimum pressure data does not exist, it should not be printed.
    4. If the storm category does not exist, it should not be printed.
    5. If the wind speed does not exist, it should not be printed.
- Five basic accessor methods. Specifically, methods for retrieving the storm type, sequence number, year, wind speed, and pressure. Accessor methods for the ocean basin and storm name will not be needed.

Main program

Your program should have at least seven more functions (in addition to `main()`). Two functions have to do with printing. One has to do with input, and four have to do with sorting.

One function will simply print a header for reports. It needs no arguments and returns no value.

One function will print an STL vector of constant `Storm` instances in the order given. The print function should keep track of the number of lines printed, printing out a break and a new header after every twenty lines. A symbolic constant should be used for this value of twenty lines.

When looping through the vector, you are required to use an iterator rather than an integer index.

One function should take an open `ifstream` and a `Storm` and read enough data from the file to fill the `Storm`.

The format of the data file is: each line contains the information for a single storm. The order of the data values on each line is basin, name, sequence number, year, max wind speed, minimum pressure, and storm type.

One function sorts an STL vector of `Storm` instances by increasing date.

One function sorts an STL vector of `Storm` instances by decreasing wind speed.

One function sorts an STL vector of `Storm` instances by increasing air pressure.

The sorting functions are all very similar. Their only difference is in how elements are compared. You may use any sorting algorithm you wish. But you may not use pre-built library sorting functions. Below is the pseudo-code for selection sort, if needed.

```
sort ( T data[])
{
   for(b = 0; b < data_size - 1; b++)
       minindex = b;
       for(i = b+1; i < data_size; i++)
          if  data[i] less than  data[minindex]
              minindex = i;

       swap data[b] and data[minindex]
}
```

You should write an additional function to compare two `Storm` instances by their dates and return true if the date of the first storm is less than the date of the second. This function is to assist your routine for sorting the storms by date.

The dates of two storms can be compared by their years. This comparison alone will determine the result unless the two years are the same. If the two years are equal, the sequence numbers should then be compared, and the result returned accordingly.

The main program should take the name of a data file to open as a command line argument. If the file can not be opened, an appropriate error message should be displayed and the program should exit.

The records from the file should be read into an STL vector of `Storm`s. The input function created above should help read in one `Storm`.

After reading the records, print out the number of records input.

The program should then call the print function to display the data in the order that it exists in the file (which has been randomized). It should then sort the array by increasing date, decreasing wind speed and increasing pressure, printing the sorted results after each step.

Input

A link to a data set can be found on the web site. If you are working on turing/hopper, you can also make a copy or link directly to your directory from
`/home/turing/duffin/courses/cs689/data/storm.dat`

Output

Partial sample output from this program on `turing/hopper` is found below.

Your output may be slightly different depending on the sorting algorithm you use, and the exact comparisons you make (< vs. <=). These differences are OK, as long as the data is properly sorted by the specified fields.

```
z123456@turing$ assign5 storm.dat

2864 storms read from storm.dat

Storm                               Name         Date     Wind mbar
-------------------------------------------------------------------
Eastern Pacific  Storm              ILSA        8/1967     60
Atlantic         Hurricane          UNNAMED     3/1881     80
Eastern Pacific  Storm              UNNAMED     6/1954     45
Atlantic         Hurricane          ILSA        9/1958     95  956
Eastern Pacific  Hurricane          MAGGIE     13/1974    120  934
Atlantic         Storm              UNNAMED     2/1865     50
Atlantic         Hurricane          IGOR       11/2010    135  924
Atlantic         Hurricane          UNNAMED     5/1923    105
Eastern Pacific  Storm              ODILE      16/2008     50  997
Atlantic         Depression         UNNAMED     3/1980     30
Eastern Pacific  Storm              UNNAMED     1/1959     45
Atlantic         Hurricane          JOSEPHINE  16/1984     90  965
Atlantic         Hurricane          UNNAMED     3/1904     70
Atlantic         Storm              UNNAMED     3/1912     45
Eastern Pacific  Depression         THREE       3/2007     30 1004
Atlantic         Depression         UNNAMED     5/1981     30
Atlantic         Storm              UNNAMED    22/1981     60  978
Atlantic         Hurricane          UNNAMED     9/1943     95
Atlantic         Storm              UNNAMED     7/1859     60
Atlantic         Storm              UNNAMED     2/1937     55

Storm                               Name         Date     Wind mbar
-------------------------------------------------------------------
Atlantic         Storm              UNNAMED     2/1931     60 1000
Atlantic         Hurricane          DEBBY       6/1982    115  950
Eastern Pacific  Storm              BORIS       2/2002     50  997
Atlantic         Hurricane          UNNAMED     2/1899     85  979
Eastern Pacific  Hurricane          JIMENA     13/2009    135  931

...

Sort by date:

Storm                               Name         Date     Wind mbar
-------------------------------------------------------------------
Atlantic         Hurricane          UNNAMED     1/1851     80
Atlantic         Hurricane          UNNAMED     2/1851     80
Atlantic         Storm              UNNAMED     3/1851     50
Atlantic         Hurricane          UNNAMED     4/1851    100
Atlantic         Storm              UNNAMED     5/1851     50
Atlantic         Storm              UNNAMED     6/1851     60
Atlantic         Hurricane          UNNAMED     1/1852    100  961
Atlantic         Hurricane          UNNAMED     2/1852     70
Atlantic         Hurricane          UNNAMED     3/1852     70
Atlantic         Hurricane          UNNAMED     4/1852     80
Atlantic         Hurricane          UNNAMED     5/1852     90
Atlantic         Storm              UNNAMED     1/1853     50
Atlantic         Storm              UNNAMED     2/1853     40
Atlantic         Hurricane          UNNAMED     3/1853    130  924
Atlantic         Hurricane          UNNAMED     4/1853    100
Atlantic         Storm              UNNAMED     5/1853     50
Atlantic         Hurricane          UNNAMED     6/1853     70
Atlantic         Storm              UNNAMED     7/1853     50
Atlantic         Hurricane          UNNAMED     8/1853     90
```

```
Atlantic          Hurricane           UNNAMED     1/1854      70

Storm                                 Name         Date     Wind mbar
-------------------------------------------------------------------
Atlantic          Storm               UNNAMED     2/1854      60
Atlantic          Hurricane           UNNAMED     3/1854     110  938
Atlantic          Hurricane           UNNAMED     4/1854      90
Atlantic          Storm               UNNAMED     5/1854      60
Atlantic          Hurricane           UNNAMED     1/1855      90
Atlantic          Hurricane           UNNAMED     2/1855      90
Atlantic          Hurricane           UNNAMED     3/1855      70
Atlantic          Storm               UNNAMED     4/1855      60  997
Atlantic          Hurricane           UNNAMED     5/1855     110

...

Sort by wind speed:

Storm                                 Name         Date     Wind mbar
-------------------------------------------------------------------
Eastern Pacific   Hurricane           PATRICIA   20/2015     185  872
Atlantic          Hurricane           ALLEN       4/1980     165  899
Atlantic          Hurricane           UNNAMED     3/1935     160  892
Atlantic          Hurricane           GILBERT     8/1988     160  888
Central Pacific   Hurricane           PAKA        5/1997     160
Eastern Pacific   Hurricane           LINDA      14/1997     160  902
Atlantic          Hurricane           WILMA      25/2005     160  882
Atlantic          Hurricane           MITCH      13/1998     155  905
Atlantic          Hurricane           RITA       18/2005     155  895
Eastern Pacific   Hurricane           RICK       20/2009     155  906
Atlantic          Hurricane           UNNAMED    14/1932     150  918
Atlantic          Hurricane           JANET      10/1955     150  914
Central Pacific   Hurricane           PATSY       2/1959     150
Atlantic          Hurricane           CARLA       3/1961     150  931
Atlantic          Hurricane           CAMILLE     9/1969     150  900
Atlantic          Hurricane           ANITA       5/1977     150  926
Atlantic          Hurricane           DAVID       9/1979     150  924
Atlantic          Hurricane           ANDREW      4/1992     150  922
Eastern Pacific   Hurricane           JOHN       10/1994     150  929
Atlantic          Hurricane           KATRINA    12/2005     150  902

Storm                                 Name         Date     Wind mbar
-------------------------------------------------------------------
Atlantic          Hurricane           DEAN        4/2007     150  905
Atlantic          Hurricane           FELIX       6/2007     150  929
Atlantic          Hurricane           UNNAMED    10/1924     145  910
Eastern Pacific   Hurricane           KENNA      14/2002     145  913
Atlantic          Hurricane           ISABEL     13/2003     145  915
Atlantic          Hurricane           IVAN        9/2004     145  910
Atlantic          Hurricane           UNNAMED     4/1928     140  929
Atlantic          Hurricane           UNNAMED     4/1932     140
Atlantic          Hurricane           UNNAMED     8/1933     140  940
Atlantic          Hurricane           UNNAMED    14/1933     140  929
Atlantic          Hurricane           UNNAMED     6/1938     140  940
Atlantic          Hurricane           CAROL       4/1953     140  929
Atlantic          Hurricane           HATTIE      9/1961     140  920
Atlantic          Hurricane           BEULAH     13/1967     140  923
Atlantic          Hurricane           EDITH      13/1971     140  943

...
```

```
Sort by pressure:

Storm                               Name         Date     Wind mbar
-------------------------------------------------------------------
Eastern Pacific  Hurricane          PATRICIA   20/2015     185  872
Atlantic         Hurricane          WILMA      25/2005     160  882
Atlantic         Hurricane          GILBERT     8/1988     160  888
Atlantic         Hurricane          UNNAMED     3/1935     160  892
Atlantic         Hurricane          RITA       18/2005     155  895
Atlantic         Hurricane          ALLEN       4/1980     165  899
Atlantic         Hurricane          CAMILLE     9/1969     150  900
Central Pacific  Hurricane          IOKE        1/2006     140  900
Eastern Pacific  Hurricane          LINDA      14/1997     160  902
Atlantic         Hurricane          KATRINA    12/2005     150  902
Atlantic         Hurricane          DEAN        4/2007     150  905
Atlantic         Hurricane          MITCH      13/1998     155  905
Eastern Pacific  Hurricane          RICK       20/2009     155  906
Atlantic         Hurricane          UNNAMED    10/1924     145  910
Atlantic         Hurricane          IVAN        9/2004     145  910
Eastern Pacific  Hurricane          KENNA      14/2002     145  913
Atlantic         Hurricane          JANET      10/1955     150  914
Atlantic         Hurricane          ISABEL     13/2003     145  915
Eastern Pacific  Hurricane          AVA         1/1973     140  915
Atlantic         Hurricane          OPAL       17/1995     130  916

Storm                               Name         Date     Wind mbar
-------------------------------------------------------------------
Atlantic         Hurricane          UNNAMED    14/1932     150  918
Atlantic         Hurricane          HUGO       11/1989     140  918
Eastern Pacific  Hurricane          GENEVIEVE   7/2014     140  918
Eastern Pacific  Hurricane          MARIE      13/2014     140  918
Eastern Pacific  Hurricane          ODILE      15/2014     120  918
Eastern Pacific  Hurricane          GUILLERMO   9/1997     140  919
Atlantic         Hurricane          HATTIE      9/1961     140  920
Eastern Pacific  Hurricane          GILMA       7/1994     140  920

...
```

Implementation Hints

- Focus first on getting the data read in, and printed out. Then work on the sorting.

Other Points

- You should have a source code file for `main()` and all the non-member functions. You should have a source code file for the implementation of the `Storm` class methods. You should have a header file for the the `Storm` class.
- Although they are short, none of your class methods should be inline.
- Your header file is required to have header guards.
- Use `const` as appropriate, both on methods and function arguments.
- Use references appropriately.
- Of course, a `Makefile` is required for this assignment.

- Symbolic constants should be used to avoid magic numbers. You should use `const` to make your symbolic constants.
- The name of your source code file containing main should be `assign5.cc`.
- Function prototypes are required for all functions you write (except `main()` of course)
- Programs that do not compile on `turing/hopper` automatically receive 0 points.
- Submit your program using the electronic submission guidelines.