Project 1 – Searching and Sorting
Computer Science 2413 – Data Structures – Fall 2018
Due by 11:59 pm CST on Friday, 12 October 2018

This project is individual work. Each student must complete this assignment independently.

User Request:

"Create a simple system to read, store, write, <u>sort</u>, and <u>search</u> NVRA data using a <u>more complete</u> array library, error checking, and <u>user interaction</u>."

Objectives:

1	Use C++ file I/O to read and write files while using C++ standard I/O (`cin`, `cout`) for user interaction, using appropriate exception handling.	*10 points*
2	Encapsulate primitive arrays inside a templated class that provides controlled access to the array data, retains information on array capacity and use, and can be used to store data of any class or primitive type.	*5 points*
3	Integrate appropriate exception handling into the templated array class.	*5 points*
4	Efficiently sort the data based on the field specified by the user.	*35 points*
5	Efficiently search the data based on the field specified by the user.	*15 points*
6	Integrate appropriate exception handling into classes and/or functions that implement searching and sorting.	*10 points*
7	Develop and use an appropriate design.	*10 points*
8	Use proper documentation and formatting.	*10 points*

Description:

For this project, you will revise and improve VoteR from your labs in several ways. You are encouraged to reuse and build on your code from your labs. In addition to the functionality provided by VoteR 0.4, your new *VoteR 1.0* will take user input that allows users to specify the files in which data is stored and to sort and search for entries based on various data fields.

Operational Issues:

VoteR1.0 will read NVRA data files (text files) via C++ file I/O. The names of the data files will be specified by the user using standard input. When VoteR 1.0 starts, it will enter a data input loop, prompting the user for the name of a data file ("`Enter data file name: `") and waiting for the user to type a file name and hit enter. If the user enters the name of an available data file, VoteR 1.0 will open the file using C++ file I/O and read the data. If the user enters the name of a file that is not accessible, VoteR 1.0 will report the error to the user ("`File is not available.`") and continue in the loop, repeating the prompt and waiting again for a file name. If the user hits enter without entering anything else, VoteR 1.0 will exit the data input loop. If no data has been read in when VoteR 1.0 exits the data input loop, VoteR 1.0 will exit. Otherwise, VoteR 1.0 will move on to a data manipulation loop (see below).

The data files will be organized as they were in the labs. However, for this project, the NVRA data may be spread across multiple files. When VoteR reads in each file, it must make sure the data in that file is internally consistent and alert the user to any errors encountered (as described in Lab 1). If an NVRA

record number appears in more than one data file, VoteR will retain the data read **most recently** (note the difference from the labs, although it will still reject duplicates within the same file). As each file is read in, VoteR must update internal tallies of the total number of NVRA data lines it attempted to read, the total number of valid NVRA records read in, and the total number of NVRA records currently stored in memory. (Note that these totals may be the same, but they may be different, as some data lines may be invalid and some valid NVRA data lines may have the same record numbers.)

After reading in and storing all the NVRA data from all the specified files, VoteR will enter a data manipulation loop (as mentioned above). In this loop, VoteR 1.0 will prompt the user with four options: 'o' for output, 's' for sort, 'f' for find, and 'q' for quit ("`Enter (o)utput, (s)ort, (f)ind, or (q)uit: `").

If the user selects output, VoteR 1.0 will prompt the user for a filename ("`Enter output file name: `") and read it in from the console. If the user hits enter without specifying a filename, VoteR 1.0 will send the output to standard out. Otherwise, it will attempt to open the specified file for writing. If the user enters the name of a file that is not accessible, VoteR 1.0 will report the error ("`File is not available.`") and repeat the prompt for the file name. If the file is accessible or the user has specified the standard out, VoteR 1.0 will print out the NVRA data in whichever order it is presently ordered, followed by a row showing the internal tallies, for example:

`Data lines read: 15847; Valid NVRA records read: 13347; NVRA records in memory: 11879`

Other than this trailing row of tallies, and possible differences in the order of the rows, the data output format of VoteR 1.0 will exactly match the output format used by VoteR 0.1 through VoteR 0.4.

If the user selects sort, VoteR 1.0 will prompt the user for the data field on which to sort the records ("`Enter sort field (0-23): `"). The user may select any numeric value from 0 to 23 (inclusive), which corresponds to the column number on which to sort. If the user enters an invalid value for the data field on which to sort, VoteR 1.0 will return to the data manipulation loop. If the user selects to sort by any valid data field, VoteR 1.0 will sort the data based on that field.

If the user selects find from the data manipulation loop, VoteR 1.0 will prompt the user for the data field on which to search ("`Enter search field (0-23): `"). As with sort, the user may select any numeric value from 0 to 23 (inclusive) and if the user selects any other value, VoteR 1.0 will return to the data manipulation loop.

If the user chooses to find by any numeric column, VoteR 1.0 will prompt the user for the numeric value on which to search ("`Enter non-negative field value: `"). If the user enters any text (doesn't just hit enter), VoteR 1.0 will ensure that the value entered is valid (can be converted to a non-negative number) and, if it is, search for the given value. If the user entry is invalid, VoteR 1.0 will return to the data manipulation loop.

If the user chooses to find by any other valid field, VoteR 1.0 will prompt the user for the value on which to search ("`Enter exact text on which to search: `"). If the user enters any text (doesn't just hit enter), VoteR 1.0 will search for the given value but does not need to perform any validity check on the input data. If the user just hits enter without giving a search string, VoteR 1.0 will return to the data manipulation loop.

If VoteR 1.0 finds one or more fields exactly matching a user request, VoteR 1.0 should display for the user (by sending to standard out) all the corresponding rows, in the same format as when printing the data on all NVRAs, but with a trailing row that indicates the number of NVRA records found in the format shown in the following example:

`NVRA records found: 1897.`

If no matching records are found, VoteR 1.0 should simply send to standard out the line indicating that the number of NVRA records found was zero:

`NVRA records found: 0.`

If the user selects quit from the data manipulation loop, VoteR 1.0 should display a friendly parting message ("`Thanks for using VoteR.`") and exit.

Implementation Issues:

Given that the data may be read in from multiple files and that NVRA record IDs may be repeated across files but only the last read data for a given NVRA record ID should be retained, VoteR 1.0 will need to search for each NVRA record ID before the NVRA data is inserted into the data array. Consider how to most efficiently maintain the array and search for each record ID as its data is read in. Here you should assume that the number of duplicates is much less than ($\ll$) than the number of data items. Also, you should assume that if the user has not asked to sort the data by any column, then it should be sorted by record ID when it first leaves the data input loop and moves to the data manipulation loop. **You will create simple design document that explains and justifies your design choices with respect to these issues.** Please make this a PDF file and name it "**VoteR1design.pdf**" in your submission.

If the data is sorted on a different field from the one on which the user is searching, VoteR 1.0 will not be able to conduct a binary search for the data. In this case, VoteR 1.0 should conduct a linear search instead. On the contrary, if the data is sorted on the field on which the user is searching, VoteR 1.0 should conduct a binary search. Note that you will have to modify the binary search in an important way if the data in a given field is not guaranteed to be unique. **Your design document will explain and justify how you modified binary search to account for potential duplicates.** Further note that the only data field for which data is guaranteed to be unique is record ID. Here you should assume that the number of repeated data values in any column is much less than ($\ll$) than the number of data items.

Because you now have a templated, resizable array class and methods for efficiently sorting it and searching it, you may no longer use similar data structures from other sources, including the C++ Standard Template Library (including `vector`, `set`, and others), except for parsing input lines.

Be sure to **use all provided code**, **use efficient mutator methods** (e.g., don't make new arrays unless doubling or halving the array), and **check whether memory is available** on the stack when using `new` in your `TemplatedArray` class and throw `ExceptionMemoryNotAvailable` if `new` returns `NULL`.

Be sure to use good object-oriented design in this project. That includes appropriate use of encapsulation, inheritance, overloading, overriding, accessibility modifiers, etc.

Be sure to use good code documentation. This includes header comments for all classes and methods, explanatory comments for each section of code, meaningful variable and method names, consistent indentation, etc.

You may write your program from scratch or may start from programs for which the source code is freely available on the web or through other sources (such as friends or student organizations). If you do not start from scratch, you must give a complete and accurate accounting of where all of your code came from and indicate which parts are original or changed, and which you got from which other source(s). Failure to give credit where credit is due is academic fraud and will be dealt with accordingly.

Due Date:

You must submit an electronic copy of your VoteR 1.0 project to zyLabs **and your design document to the appropriate dropbox in Canvas** by **11:59 pm CST on Friday, 12 October 2018**.