THE UNIVERSITY OF WESTERN ONTARIO

DEPARTMENT OF COMPUTER SCIENCE
LONDON CANADA

Software Tools and Systems Programming

(Computer Science 2211a)

ASSIGNMENT 2 (amended - September 29, 2021 in red text)

Due date: Wednesday, October 06, 2021
11:55 pm Eastern Daylight Time – 3:55 am Greenwich Mean Time)
allow up to one day late ONLY – assignment closed Oct. 07, 2021 11:55pm EDT : 3:55am GMT

Assignment overview

The purpose of this assignment is to provide the student with experience with arrays. This assignment will further provide experience using the basic code control structures covered in class.

PREPERATION:
For this assignment, create a new directory under the assignments directory created in the first assignment. Label this new directory: asn2

All work should be performed in this directory. Use a UNIX editor like vi to create and compile the C code.

The code MUST compile in the UNIX environment to be considered correct.

note: this is not a trivial assignment. Start early. Break this down into discrete doable steps. You will also have the benefit of much easier access to the TAs since you will be beating the typical last minute rush.

Again, this assignment will be contained within a single main.c program.

Synopsis:
This program will generate an array of a randomly determined length.

It will populate that array with random numbers within a given range.
The program will then cycle though the array and remove duplicate values.
When a duplicate value is removed, all the remaining elements in the array will be shifted over to the left one place and the final shifted value location will be filled with a zero (0) value.
Once all the duplicated values are removed, the remaining values will be sorted in ascending order. The elements of the array will then be outputted to the screen.

The above process will loop and repeat all but the first step for a specified number of iterations.

EXAMPLE:
If the original array consisted of the values:

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
3	6	4	7	4	5	8	3	5	2

The program will start at index [0] and traverse the remainder of the array searching for duplicate values (in the case above the value 3).

If a duplicate is found (in this case at index [7], then all the remaining values in the array will be shifted to the left and the last value (index [9] in this case) will be replaced with a zero.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
3	6	4	7	4	5	8	5	2	0

The next duplicate value is 4 at index [4]. all the remaining values in the array will be shifted to the left and the last value (index 8 in this case) will be replaced with a zero.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
3	6	4	7	5	8	5	2	0	0

This process will continue until all the elements are checked and no duplicates remain.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
3	6	4	7	5	8	2	0	0	0

Once all the duplicates are removed only unique values remain. The total number of unique elements in the example above are 7 (the array size is still 10).

This process will then sort only the unique, non-zero values in ascending order.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
2	3	4	5	6	7	8	0	0	0

Size of the array:
The initial size of the array will be based on a random number between 50 and 50 times the number of iterations. This one array is used for the remainder of the program.
Example: if the number of iterations is set at 4 then the range would be from 50 to 200.
if the number of iterations was 10 then the range would be from 50 to 500.

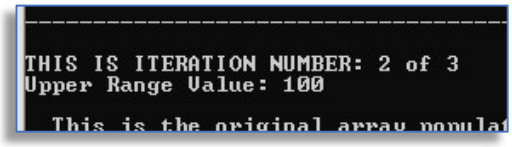
Populating the elements of the array:
The elements of the array will be populated with random numbers based on the value of the current iteration. The range will be decreased by a factor of 10 for each iteration.
For the last iteration, the values will be in the range of 1 to 10 inclusive.
For the second last iteration, the values will be in the range of 1 to 100 inclusive.
For the third last iteration, the values will be in the range of 1 to 1,000 inclusive.

For example, if the number of iterations is 6 then the first time through the range will be from 1 to 1,000,000 (six zeros), the second time through this will be reduced by a factor of 10, so the fifth iteration will be in the range of 1 to 100,000 (five zeros). The fourth iteration will be in the range of 1 to 10,000 (four zeros) and the last iteration, regardless of the total number of iterations, will always be in the range of 1 to 10.

The number of iterations of the program section outlined above will be denoted by a preprocessor definition with the label of: ITERATIONS.

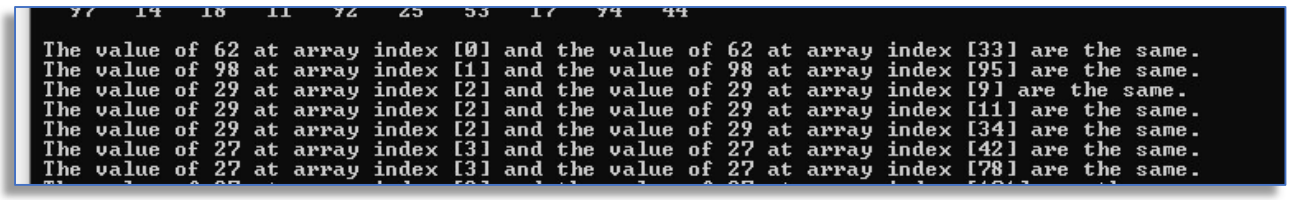
Debug Statements:

The program is to contain at least two debug statements.
There is to be one debug statement displaying the upper range value of the random number generator for the values being inserted into the array:



This is to appear immediately after the line showing the current iteration of the program.

The other debug is to display each time when matching values are found along with the indexes of the matching values.



All debug statements are to be included in your final copy of the program you submit but must not be compiled or executed. They cannot be commented out.

Random Number Generator:

```
#include <time.h>
#include <stdlib.h>

srand(time(NULL));   // Initialization, should only be called once.

int r = rand() % 10;     // Returns a pseudo-random integer between 0 and 9 inclusive.
```

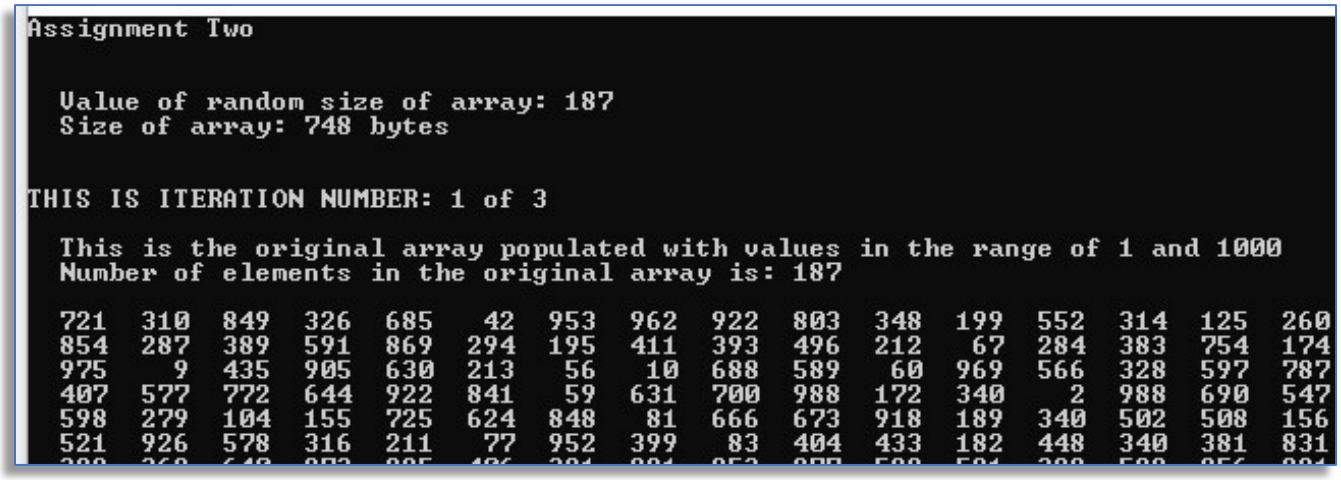
The code above will generate a random number between 0 and 9.

Use the rand() function to generate the value for the number of array elements in your array. The one array will be used throughout the program in all the iterations and no other arrays are to be generated or used. The <time.h> library must be included in your code for this to compile.

The rand() function will also be used to populate the values of the elements in the array.

Output:

The following are screen shots displaying the exact output and words expected:



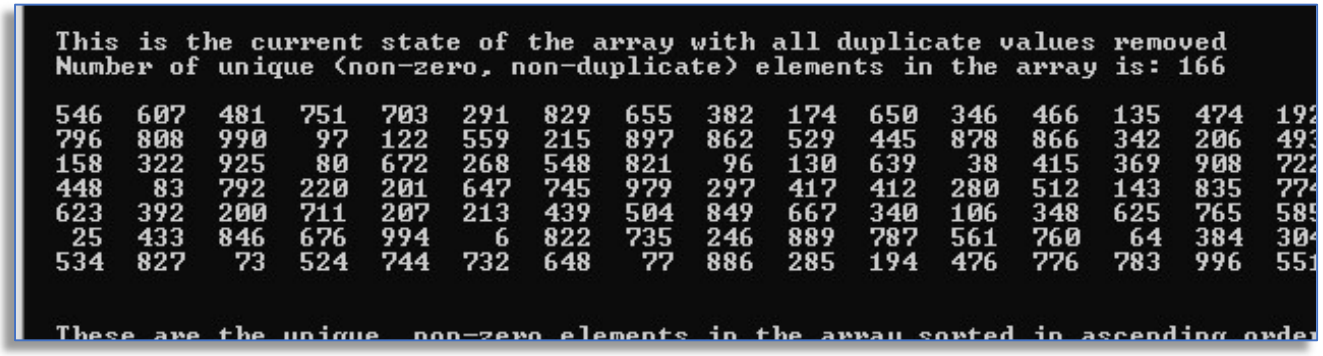
The program will display the assignment number.

It will then print out the randomly determined size of the array to be used throughout the rest of the program.

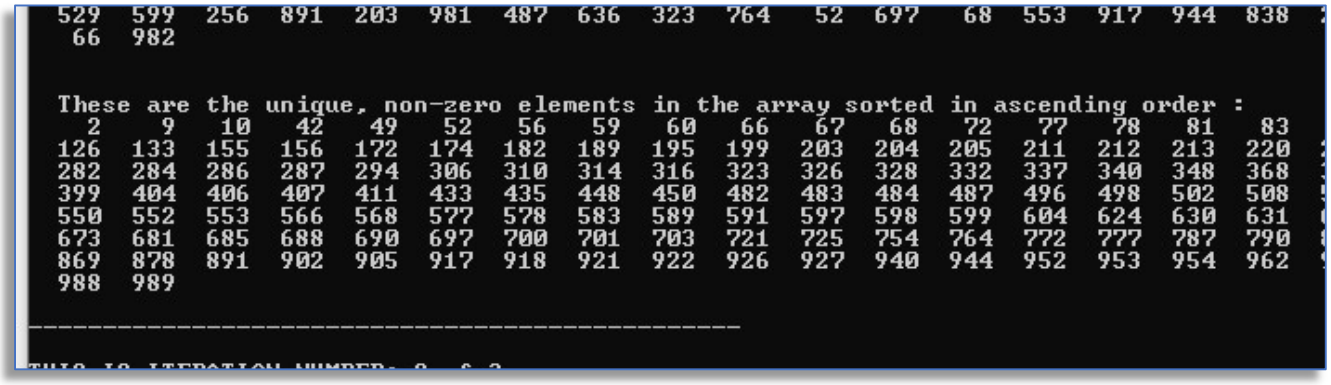
Next it will determine how many bytes this array will use based on the architecture of the O/S the program is currently being executed.

Then, for each iteration, the program will display the iteration, the range of the random numbers populating the array and the number of elements of the array (it will always match the size of the array – this is a good way to show the program is functioning correctly).
The program will then print out the elements of the array evenly spaced apart.

After the program has removed all duplicate values, the program will display the total number of unique, non-zero values of the array, followed by a printout of all these values, again evenly spaced out.



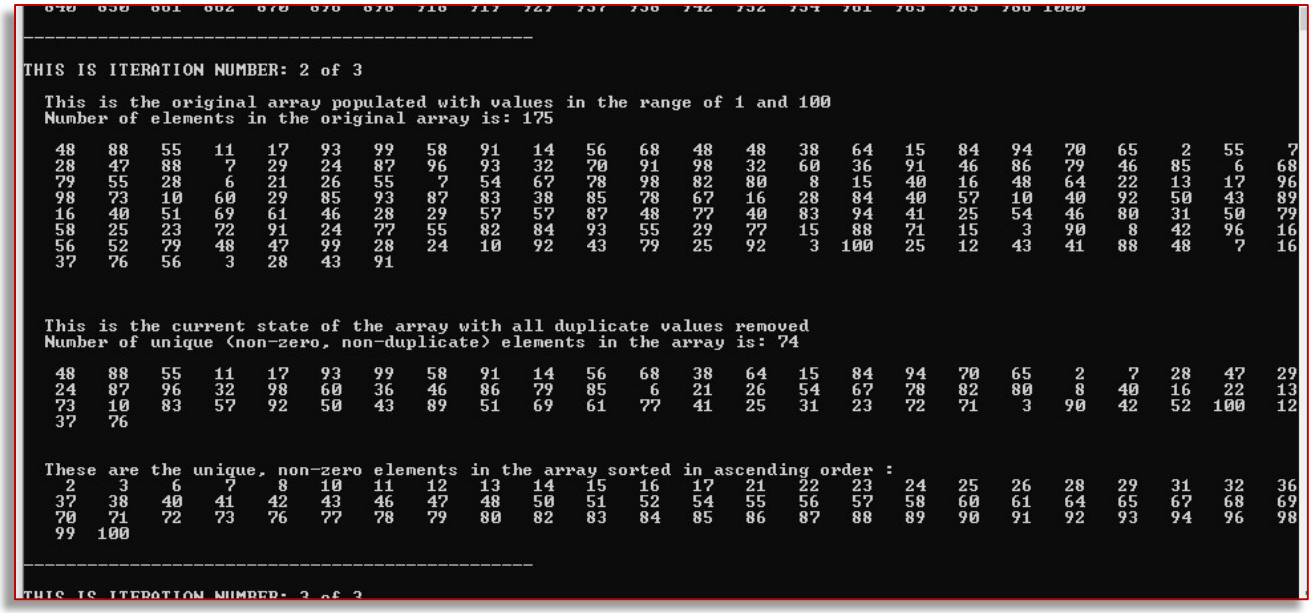
Finally, the program will sort the array in ascending order and then display the unique, non-zero elements of the array in sorted order, evenly spaced.



The program will then proceed to loop and repeat the process for the designated number of iterations, populating the array with a new set of numbers within the range that is based on the value of the current iteration.

Number of iterations:
The program is to be written to handle any number of iterations.
The program is to be submitted with the number of iterations set to three (3) but the code will be tested with different iterations (~~up to 20~~). (up to 5 – amended Sept. 29, 2021).

Example: Iteration 2 out of a set of 3 iterations of the program (without the debug statements)**:**



Required Coding Standards
All code is to be indented correctly.
Comments at the very beginning (top – first lines) of each of the C code files must be:

```
/* CS2211a 2021 */
/* Assignment 02 */
/* your name */
/* your student number */
/* your UWO User Name */
/* Date Completed */
```

Your program is to be submitted as C code file.
Your script will be a script file created in UNIX.

All variables MUST have a comment describing their intended use(s).

A comment describing the code for each section / operation must be included.
The comment(s) can be brief but must convey what that section of code performs.

ALSO – very important standard!
You are **NOT** to use the code

```
break
```

-or-

```
continue
```

anywhere in your code (except if you have a `switch` statement in your code).

This is bad coding practice and leads to 'spaghetti code' (with apologies to my Italian heritage…) where program execution control can go any which where.
We do not want to get into the habit of using these constructs. All the code can be written in a fluid manner without terminating the processes with a break or continue.

Working in UNIX.

Save this file and name it: **yourUserName_asn2.c**
(see the end of this document for a detailed explanation of **`yourUserName`**).

NEXT: Follow the steps below to complete Part 2.

1. Type the following to begin recording your session in a file called yourUserName_asn2.output

script YourUserName_asn2.output

note - (using your actual user name).

2. Display the current date and time using the appropriate command

3. Display your username using the appropriate command

4. Display the contents of the current working directory using the 'l' switch (lower case L).

5. Display the contents of the file yourUserName_asn2.c (i.e. show the C program)

6. Compile the program again ensuring the executable is labeled: **`asn2`**

7. Run the program.

8. Type **`exit`** to stop your screen capture session.

9. Compress the listed required submission files into a single .tar.gz file.
(Ensure have a complete of the Asn2_SubmissionForm in your asn2 directory.)
*YourUserName*_asn2.c
*YourUserName*_asn2.output
Asn2_SubmissionForm.txt (or .pdf)

10. Copy (i.e. using an FTP or any method of your choice) the .tar.gz file to your computer so you can upload it through OWL for submission.

Submission Instructions:

Complete the *CS2211b Assignment Submission Form* Name (or rename) that form to **Asn2_SubmissionForm.txt (or Asn2_SubmissionForm.pdf)**

Save this form in your asn2 directory as a text file or as **PDF** (most word processors have this option).

Submit via the CS2211 OWL Web Site the files in your asn2 directory using the instructions on how to compress and submit the single compressed .tar.gz file.

Submit via the CS2211 OWL Web Site the following three files inside your compressed submission file:
*YourUserName*_asn2.c
*YourUserName*_asn2.output
Asn2_SubmissionForm.txt (or .pdf)

note: do NOT include your executable file: asn2
note: you are submitting one tar file (and only one file).
this is a compressed file that contains the files listed above.
do NOT send any of the three above files separately.
note: If you have elected to use an SRA – it must be denoted in the Asn2_SubmissionForm or the SRA will not be applied.
note: marks will deducted if the Asn2_SubmissionForm is omitted.

It is the student's responsibility to ensure the work was submitted and posted in OWL.
OWL replies with a summation verification email (every time).

Submission date and time is based on the last file submitted. So if you re-submit after the due date, the entire assignment will be graded as late based on that timestamp.

The teaching assistant grading your assignment will compile and run your program.
If the program does not compile under UNIX, the TA will NOT attempt to correct or fix your program so it will run.

(*yourUserName* - example: assume my UWO email is kdoit373@uwo.ca
i.e. if my email is – **kdoit373@uwo.ca** then my user name will be – **kdoit373**
So, my UWO User Name is: **kdoit373** and this assignment is **asn1**
therefore, one of the file names that is to be used for submission is:
kdoit373_asn1.c

It is the student's responsibility to ensure the work was submitted and posted in OWL.
OWL replies with a summation verification email (every time).

Any assignment **not** submitted correctly will **not** be graded.

PS: remember: do your own work – you will need to know all this for the exam to pass !!!!

Please check CS2211 Assignment Submission Guidelines.
note: Guidelines mention the example for assignment 1 – please substitute a 2 for the 1.
note: Guidelines mention a top directory name Asn – ignore that and use assignments as specified in this (and the last assignment).