School of Computing
Queen's University

CISC365

Fall 2022

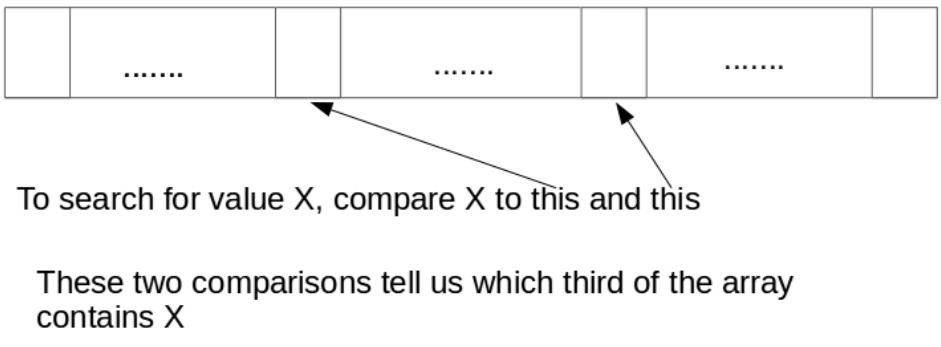
Project 1

Deadline: Oct 5, 2022, 11:59 PM

The binary search algorithm for searching a sorted array is well known:

```
bin_search(A,first,last,target):
     # returns index of target in A, if present
     # returns -1 if target is not present in A
     if first > last:
          return -1
     else:
          mid = (first+last)/2
          if A[mid] == target:
               return mid
          else if A[mid] > target:
               return bin_search(A,first,mid-1,target)
          else:
               return bin_search(A,mid+1,last,target)
```

Binary search reduces the number of possible locations for the target value by (about) halfeach time, which makes it quite efficient. But we could eliminate **more** locations by looking at two values in the range A[first ... last]. If we look at the value 1/3 of the way from first to last, and the value 2/3 of the way from first to last, we can eliminate about 2/3of the locations each time. We can call this algorithm **trinary search :**



Pseudo-code for the trinary search algorithm is on the next page:

```
trin_search(A,first,last,target):
      # returns index of target in A, if present
      # returns -1 if target is not present in A
      if first > last:
            return -1
      else:
            one_third = first + (last-first)/3
            two_thirds = first + 2*(last-first)/3
            if A[one_third] == target:
                  return one_third
            else if A[one_third] > target:
                  # search the left-hand third
                  return trin_search(A,first,one_third-1,target)
            else if A[two_thirds] == target:
                  return two_thirds
            else if A[two_thirds] > target:
                  # search the middle third
                  return trin_search(A,one_third+1,two_thirds-1,target)
            else:
                  # search the right-hand third
                  return trin_search(A,two_thirds+1,last,target)
```

Your assignment is to empirically evaluate the efficiency of these two search algorithms.

Preliminary Work:

Learn how to use clock functions in the programming language that you plan to use forthis assignment. You will need to measure elapsed time in small amounts.

Experiment 1:

For this range of values of n: n = 1000, n = 2000, n = 4000, n = 8000, n = 16000 complete the following steps. (Note that for your particular language/hardware combination, you mayneed to let n be much larger than this to get useful results from your clock functions. It isalso possible that you may not be able to complete the experiment for the larger data sets.If so, that's ok – just do the largest cases that you can):

Step 1: Generate an array (or list, in Python) of n randomly selected integers. Sortthe integers into ascending order. You should be able to write your own sorting function.

Step 2: Generate a set of 10*n search values, consisting of each value in the list repeated 10 times.

Step 3: Use binary search to search the array for the values in this set. Measure the
total time required to conduct the binary searches**.**

Step 4. Use trinary search to search the array for the values in this set. Measure the
total time required to conduct the trinary searches.

Experiment 2:

Repeat Experiment 1, but this time search only for values that are **not present** in the array. (One easy way to do this is to fill your array with even values, then search for odd values.) In this experiment you should randomly generate the set of 10*n search values.

Create tables or graphs for the results of the two algorithms within the two experiments.

Based on the results of your experiments, answer the following questions:

1. Binary search and trinary search both fall into the O(log n) complexity class. Doyour experiments show growth in execution time that is consistent with this?

2. Compare the total time for the two search algorithms:
   - Do they ever differ by more than 10%, or are they always within 10% of eachother?
   - Under what conditions (if any) is binary search at least 10% faster and underwhat conditions (if any) is trinary search at least 10% faster?

Logistics:

You must complete the programming part of this assignment in Python.

You must submit your source code, properly documented according to standards established in CISC-121 and CISC-124. You must also submit a PDF file containing your answers to the questions. Both files must contain your names and student numbers, and must contain the following statement: "I confirm that this submission is our own work and is consistent with the Queen's regulations on Academic Integrity."

You are required to work in groups of 5 students on this project. You may discuss the problemin general terms with other groups and brainstorm ideas, but you may not share code. This includes letting others read your code or your written conclusions of a group.

How to Submit:

Collect the above two mentioned files in a Zip file and name it according to the following format :
365-1234 –Proj1.zip
where 1234 stands for your *last 4 digits of your students ID*. Notice the extension of the file is "zip."
Then upload "365-1234 –Proj1.zip into Projects 1 drop-box on onQ. You may upload several times if you wish, however, onQ keeps only the last uploaded file. Please check your files after uploading.
An "*I uploaded the wrong file*" excuse will result in a mark of zero, no exceptions please!

Please submit once for the five students' group, if you submit the same work twice you will lose marks, and if a group submit 2 different sets or work, then the lower grade will be considered for this project.

Also note that last uploaded file always replaces previous file, and onQ is set for this assignment to have/show/keep only the last uploaded file, and all previous files will be deleted from the system.