Assignment 2 report

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Innehållsförteckning

1. Queue

1.1 Setup

The Queue is setup using different methods to make the different things a queue should be able to do.

1.1.1 Queue

The queue holds 3 properties when initialized, the array of size 10, the size 10, front value and back value. To begin with both front and back values are 0 because it is empty. The enqueue method sets the backvalue to the given enqueue element and then moves it back. This is if the list is not full because if so, the list must double in size. The dequeue almost works by removing a random element by swapping the random element with the back item then decreasing the size and moving back the back value. If after this the list is less than half the size of the list it halves the size making memory usage lower. The method count gives us the number of elements in list while empty checks if back and front are the same in that case meaning it is empty.

1.1.2 Iterator

The iterator works by creating a list and copying the elements from the array over to it and then shuffling them. The getNext first checks if there are more elements by checking hasNext method. If it has more, it returns the element at indexcount which is counted for every element removed.

2. AVL vs BST

2.1 Setup

I have setup two different classes for the different trees and then testing them and comparing the results.

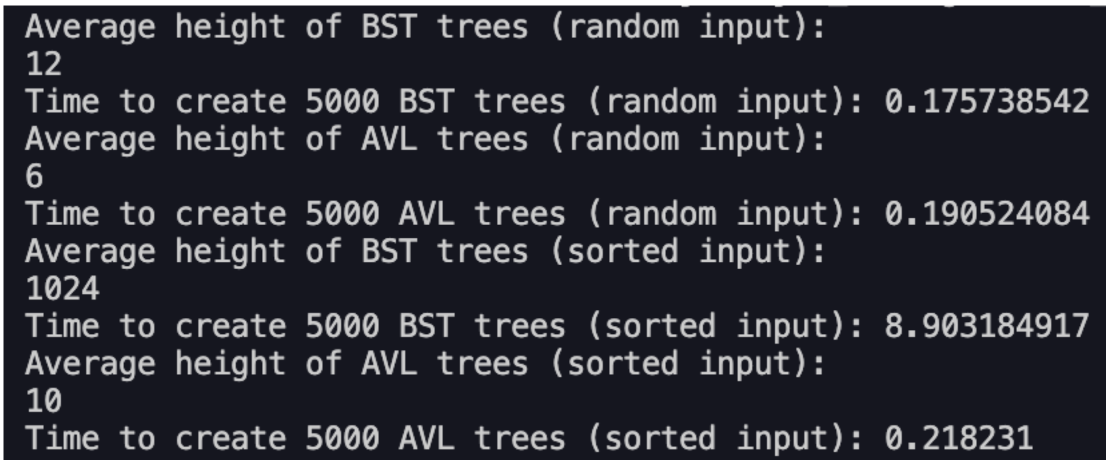
2.1.1 BST

The binary search tree is setup like a bst tree is supposed to where the values are always put left If less and right if higher. We have the basic add methods and the delete methods, the delete methods are more complicated as we could remove values inside three which means you have to relocate nodes to connect the tree together. There is also a depth method which calculates the depth of the tree but going down each side and comparing them, there is also the minvalue which goes to the farthest left to get the min value.

2.1.2 AVL

The avl tree is setup almost like the bst but instead of just adding values it always balances it out after each change in the tree. This is done by the balance method; this uses several other helping methods that rotates the nodes in the setup way. There are also the double rotation methods which uses the other rotation methods. These balance methods make the tree always be balanced, by balanced means that it branches out the nodes each add/delete making the depth much lower but also takes more time to make.

2.2 Results



```
Average height of BST trees (random input):
12
Time to create 5000 BST trees (random input): 0.175738542
Average height of AVL trees (random input):
6
Time to create 5000 AVL trees (random input): 0.190524084
Average height of BST trees (sorted input):
1024
Time to create 5000 BST trees (sorted input): 8.903184917
Average height of AVL trees (sorted input):
10
Time to create 5000 AVL trees (sorted input): 0.218231
```

In the picture you can see the results. Some things to notice is for example that the bst takes a long time to add and delete values if the input is sorted because this will just be a long line of nodes and not a “tree”. Something else to notice is that the avl trees take longer but the average height is half of the bst. The height makes a big difference when for example finding a value in the tree because a smaller depth allows for faster searching. You can also see that when working with sorted lists it’s not good to use either of these trees because it increases in both time and depth.

3. Ticket problem

3.1 Setup

This ticket problem I solved by making a binary search tree as a priority queue. The tree has node which includes a key, their priority level and the name of the person. If you then want to get a person from the tree the person with the highest priority and first added returns to the user.

3.1.1 Insert person method

The insert works as a standard bst except for if the key/priority is the same it adds it to the left as if it is lower.

3.1.2 Get person method

The get person gets the person at the most right in the tree meaning the one with the highest priority level or if the tree only consists of one person it returns that. The problem here is that if I get one out of the queue, I also want to delete that person after and here comes the delete method which is more complicated. The method checks whether it has a left child or if it has a right child or no children at all. If it for example has a left child, it replaces that node to be deleted with that child.

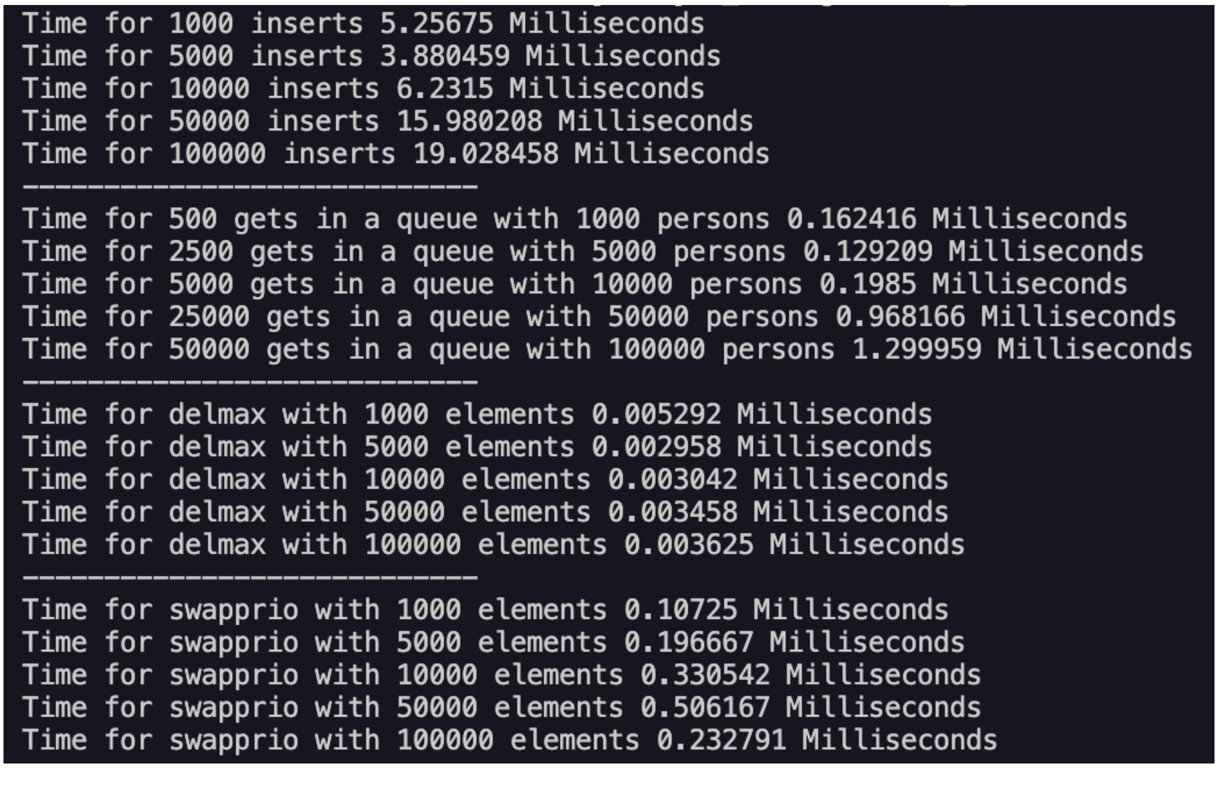
3.1.3 Delmaxprio method

The delmaxprio first finds the maximum prio in the tree and stores that so it can delete all nodes with that priority level. It then moves through the tree deleting all nodes with that priority level.

3.1.4 Swapprio method

The swap priority method works as simple as instead of swapping around nodes it only changes the names of the nodes which effectively also swaps their priority. This just checks through the tree until they find the names and after that swaps it.

3.2 Results



```
Time for 1000 inserts 5.25675 Milliseconds
Time for 5000 inserts 3.880459 Milliseconds
Time for 10000 inserts 6.2315 Milliseconds
Time for 50000 inserts 15.980208 Milliseconds
Time for 100000 inserts 19.028458 Milliseconds
----------------------------
Time for 500 gets in a queue with 1000 persons 0.162416 Milliseconds
Time for 2500 gets in a queue with 5000 persons 0.129209 Milliseconds
Time for 5000 gets in a queue with 10000 persons 0.1985 Milliseconds
Time for 25000 gets in a queue with 50000 persons 0.968166 Milliseconds
Time for 50000 gets in a queue with 100000 persons 1.299959 Milliseconds
----------------------------
Time for delmax with 1000 elements 0.005292 Milliseconds
Time for delmax with 5000 elements 0.002958 Milliseconds
Time for delmax with 10000 elements 0.003042 Milliseconds
Time for delmax with 50000 elements 0.003458 Milliseconds
Time for delmax with 100000 elements 0.003625 Milliseconds
----------------------------
Time for swapprio with 1000 elements 0.10725 Milliseconds
Time for swapprio with 5000 elements 0.196667 Milliseconds
Time for swapprio with 10000 elements 0.330542 Milliseconds
Time for swapprio with 50000 elements 0.506167 Milliseconds
Time for swapprio with 100000 elements 0.232791 Milliseconds
```

3.2.1 Insert person result

The insert person method has at best the time complexity of O(logN) but the worse the tree is, meaning as if it’s not at all balanced it could be as bad as O(N) when using insert. This is because the more correct time complexity is O(h) where h is the depth of the tree.

3.2.2 Get person result

The get person can have a time complexity of O(logN) just as the insert method but also relies on how balanced the tree is meaning it can have a O(N) time complexity but that is in a special case. This is because the more correct time complexity is also O(h) where h is the depth of the tree.

3.2.3 Delmaxprio result

The delmaxprio also has a time complexity of O(logN) which is about the same as O(h) but if all elements are the same prio it will have its worse which is O(N).

3.2.4 Swapprio result

The swappriority also relies on O(h) but in the case of a completely unbalanced tree it also can have the time complexity O(N) because the nodes need to be found.

4. Quicksort

4.1 Setup

Quicksort is setup to occur for as many recursions as the user wants to and after this it can either hop to insert- or heap sort based on the user's choice.

4.1.1 Quicksort

Quicksort is setup with a set depth of recursions and what method to use after that. The partition method fixes the pivot while the medianCalc method calculates the pivot index to be used. The median is gathered by taking three values and getting that median which the is supposed to increase the sorting speed of the algorithm. The sort methods basically sorts the array but only does the partitions and sorts until the depth has been reached and then calls for either heap- or insert sort.

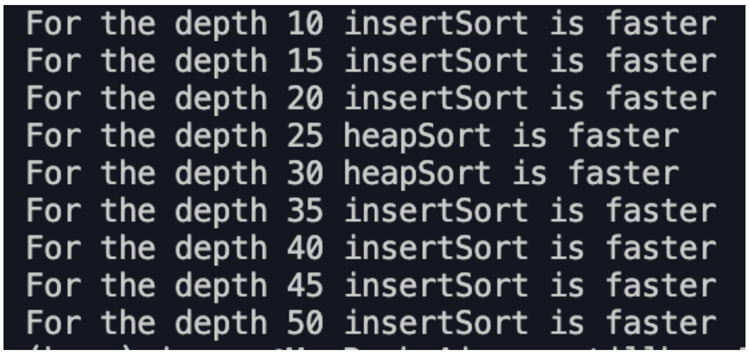
4.1.2 Insertsort

Insertsort goes through the list and sort it piece by piece using for loops that iterates over all values. This then swaps if the elements are in the incorrect order.

4.1.3 Heapsort

Heapsort has a property of the array and the size of the heap. The sort method uses the sink method on each non-leaf node then extracting the maximum element from the heap and placing it in the array. The sink method moves an element until it's in the correct place and compares it to its children making sure it's in the correct place.

4.2 Results



```
For the depth 10 insertSort is faster
For the depth 15 insertSort is faster
For the depth 20 insertSort is faster
For the depth 25 heapSort is faster
For the depth 30 heapSort is faster
For the depth 35 insertSort is faster
For the depth 40 insertSort is faster
For the depth 45 insertSort is faster
For the depth 50 insertSort is faster
```

Here we can see the results from the experiment. This experiment was conducted on an array with 100 000 random elements. The depths above 35 is somewhat not relevant as there is just a small difference but here, we can see insert sort is better when the list is less sorted before while heap sort works better on a list which already is somewhat sorted.