**Logbook**

**Bradley Pratt - Computer Games Programming U1664020314**

**Algorithms Processes and Data**

**Week 1-2 :**

**package** intArrays;

**import** java.util.Arrays;

**public** **class** CleverRandomListing **extends** RandomListing {

**public** CleverRandomListing (**int** size) {

**super**(size);

}

/\*\*

\* The purpose of this method is to rebuild an array in a completely random order

\* Passes an array in from the SortedListing class.

\*/

**protected** **void** randomise() {

**for** (**int** index = 0; index < getArray().length; index++) {

**int** randomArray = getRandomIndex(); // Uses the getRandomIndex method to randomise the array index

**int** newInt = getArray()[randomArray];

getArray()[randomArray] = getArray()[index]; // Changes the grabbed array to randomise its index

getArray()[index] = newInt; // Builds the array using its new index

}

}

**public** **static** **void** main(String[] args) {

RandomListing count = **new** CleverRandomListing(50); // create a new list, as long as the specified length.

System.***out***.println(Arrays.*toString*(count.getArray())); // prints the array to the console

}

}

The tests for this class showed that is more efficient than the standard sorting class, with a testMillionSize taking 96423 milliseconds. In SimpleRandomTesting testMillionSize took 261148 milliseconds in my last test; proving the above shown method is more efficient.

**Week 3-4**

/\*\*

\* Swaps the specified elements within the array

\* **@param** array the array which is passed into the method

\* **@param** index1 the index which needs to be swapped with index2

\* **@param** index2

\*/

**public** **static** <T> **void** swap(T[] array, **int** index1, **int** index2) {

T objectOne = array[index1];

T objectTwo = array[index2];

array[index1] = objectTwo; //Uses the defined first position and places "objectTwo" there

array[index2] = objectOne; //Uses the defined second position and places "objectOne" there

}

/\*\*

\* The purpose of max is to find the largest element in between index1 and index2.

\* **@param** array is the array that is passed in

\* **@param** index1 is the first index, which elements before it may be ignored

\* **@param** index2 is the second index location, which elements after it may be ignored

\* **@return** returns the largest element

\*/

**public** **static** <T> String max(String[] array, **int** index1, **int** index2) {

**int** index = 0;

**int** elementLength = array[0].length();

System.***out***.println();

**for** (**int** i = 0; i < array.length; i++) {

**if** (i >= index1 && i <= index2) {

**if** (array[i].length() > elementLength) {

index = i;

elementLength = array[i].length();

}

}

}

**return** array[index];

}

@Test

**public** **void** testMax() {

String[] nameTest = {"Hugh", "Andrew", "Ebrahim","Diane","Paula", "Simon"};

*assertEquals*("Ebrahim",GenericMethods.*max*(nameTest, 0, 5));

}

The tests class for the swap method shows that the elements are successfully swapped, using the array 1,2,3,4,5 and adding index1 as 1, and index2 as 2 showed that the array became 1,3,2,4,5 as expected.

**Week 5**

(10,000) = 180

(20,000) = 890

(30,000) = 2150

(40,000) = 4000

(50,000) = 6500

I ran the test three times and above are the results I got, the formulas show the average result found between the three tests. A function couldn’t be found since there doesn’t seem to be a running trend that would allow you to predict the next result with reasonably accuracy.

/\*\*

\* Method for the SelectionSort

\*/

**public** **void** sort(T[] array) {

**for** (**int** i = 0; i < array.length; i++) {

**int** minIndex = i;

**for** (**int** j = i + 1; j < array.length; j++) {

**if** (array[j].compareTo(array[minIndex]) < 0) {

minIndex = j;

}

}

**if** (minIndex != i) {

T temp = array[i];

array[i] = array[minIndex];

array[minIndex] = temp;

}

}

}

The SelectionSort algorithm builds the array first and sorts it as it is built. The algorithm checks the value of each element of the array as it is inputted, if the value of the element at the position of j is greater than the element at the position of minIndex, then j is checked if it is not equal to i then i is replaced with j.

/\*\*

\* Method for the quicksort

\*/

**private** **void** sort(T[] array,**int** from,**int** to) {

**if** (from < to) {

**int** pivotIndex = from;

**int** highIndex = to;

**int** lowIndex = pivotIndex;

T pivot = array[(highIndex + lowIndex) / 2];

**do** { //Runs a do-while loop so that the method is ran whilst the conditions are true

**while** (array[lowIndex].compareTo(pivot) < 0) lowIndex++; //Increases the lowIndex amount by the amount of elements before the pivot

**while** (pivot.compareTo(array[highIndex]) < 0) highIndex--; //Reduces the highIndex amount by the amount of elements above it, meaning elements above the pivot are ignored

**if** (lowIndex <= highIndex) { //Checks the size of the element to see if it can be swapped

T temp = array[lowIndex]; //Gets the lowIndex and places it in the generic temp

array[lowIndex] = array[highIndex]; //Moves the smaller element to the higher element

array[highIndex] = temp; //Changes the the value of highIndex to the temp

lowIndex++;

highIndex--;

}

} **while** (lowIndex <= highIndex); //Runs the do while this is true

sort(array, from, highIndex);//Reruns the do-while loop with the new pivot

sort(array, lowIndex, to);

}

}

|  |  |  |
| --- | --- | --- |
| 10000 | 64.472 | 65.462 |
| 20000 | 278.786 | 284.874 |
| 30000 | 690.19 | 678.444 |
| 40000 | 1281.19 | 1275.674 |
| 50000 | 2079.638 | 2026.574 |
| 60000 | 3033.605 | 3042.342 |
| 70000 | 4222.341 | 4223.89 |
| 80000 | 5605.172 | 5559.824 |

|  |  |  |
| --- | --- | --- |
| 1000000 | 204.888 | 204.813 |
| 2000000 | 479.814 | 455.249 |
| 3000000 | 734.502 | 735.89 |
| 4000000 | 1023.676 | 1062.652 |
| 5000000 | 1316.623 | 1347.981 |
| 6000000 | 1633.81 | 1659.239 |
| 7000000 | 2005.972 | 2142.408 |
| 8000000 | 2335.258 | 2526.845 |
| 9000000 | 2679.885 | 2798.874 |
| 10000000 | 2988.025 | 3154.712 |
| 20000000 | 6648.698 | 7149.259 |

I ran two graphs, the first being the results selection sort and the second graph being the results for the quick sort. The selection sort doesn’t seem to maintain a trend per each 10000. The quick sort shows an increase of 300 per 1000000 and overall looks a great deal more efficient than the selection sort algorithm.

**Week 6**

**private** Node<T> head = **null**;

**private** Node<T> tail = **null**;

**private** **int** noOfNodes = 0;

@Override

**public** **void** add(**int** index, T value) **throws** ListAccessError {

Node<T> addNode = **new** Node<T>(value); //Defines the value as a new "addNode"

**if** (isEmpty()) { //If the list is empty it adds it at the head

head = addNode;

tail = head;

} **else** {

Node<T> node = head;

**for** (**int** i = 0; i < index-1; i++) { //Traverse through each node but -1 to set next later

node = node.getNext();

}

node.setNext(addNode); //Continuation of the -1 so the next position can be set

node = addNode; //Sets the node to addNode from the beginning

}

noOfNodes++;

}

@Override

**public** T remove(**int** index) **throws** ListAccessError {

Node<T> node = head;

Node<T> temp = getNode(index);

//Node<T> previousNode = null;

//Node<T> removeNode = new Node<T>(value); //Defines the value as a new "addNode"

**if** (isEmpty()) { //If the list is empty it adds it at the head

**throw** **new** ListAccessError("Index out of bounds");

} **else** {

**if** (index < 0 || index >= noOfNodes) { // invalid index

**throw** **new** ListAccessError("Index out of bounds");

}

**for** (**int** i = 0; i < index-1; i++) { //Traverse through each node but -1 to set next later

node = node.getNext(); //Continuation of the -1 so the next position can be set

}

node.setNext(temp.getNext());

//node = addNode; //Sets the node to addNode from the beginning

}

noOfNodes--;

**return** node.getValue();

}

@Override

**public** T get(**int** index) **throws** ListAccessError {

**return** getNode(index).getValue();

}

**private** Node<T> getNode(**int** index) **throws** ListAccessError {

**if** (index < 0 || index >= noOfNodes) { // invalid index

**throw** **new** ListAccessError("Index out of bounds");

}

Node<T> node = head; // start at head of list

**for** (**int** i = 0; i < index; i++) { // walk through list to desired index

node = node.getNext(); // by following next references

}

**return** node; // return the node at the required index

}

The test I used for the get and add is the test class used in the model test class, I did however modify it for the remove method as shown here:-

@Test

**public** **void** testRemoveTail() **throws** ListAccessError {

SinglyLinkedList<Integer> list = **new** SinglyLinkedList<Integer>();

list.add(0, 5);

list.add(1, 7);

list.add(2, 23);

list.add(3, -6);

list.add(4, 0);

list.add(5,42);

list.remove(5);

thrown.expect(ListAccessError.**class**);

thrown.expectMessage("Index out of bounds");

list.get(5);

}

@Test

**public** **void** testRemove() **throws** ListAccessError {

SinglyLinkedList<Integer> list = **new** SinglyLinkedList<Integer>();

list.add(0, 5);

list.add(1, 7);

list.add(2, 23);

list.add(3, -6);

list.add(4, 0);

list.add(5,42);

list.remove(3);

*assertEquals*(**new** Integer(42),list.get(4));

}

Using the model test class and the modified test class for the remove method it showed that the program ran with no errors.

Both the remove and add methods work by going through each node until the index is reached, taking away by one so the getNext() can be used and and then setting the next variable outside of the for loop.

**Week 7**

**package** binaryTree;

**public** **class** BinaryTree<T **extends** Comparable<? **super** T>> **implements** BTree<T> {

TreeNode<T> root;

//BTree<T> left, right;

@Override

**public** **void** insert(T value) {

**if** (root == **null**) {

root = **new** TreeNode<T>(value);

} **else** **if** (value.compareTo(value()) < 0) {

root.left().insert(value);

} **else** {

root.right().insert(value);

}

}

@Override

**public** T value() {

**return** root.value;

}

@Override

**public** BTree<T> left() {

**return** root.left;

}

@Override

**public** BTree<T> right() {

**return** root.right;

}

**public** **static** **void** main(String[] args) {

BinaryTree<Integer> tree = **new** BinaryTree<>();

tree.insert(1);

tree.insert(0);

tree.insert(2);

Integer leftValue = tree.left().value();

Integer rightValue = tree.right().value();

System.***out***.println(tree.value());

System.***out***.println(leftValue);

System.***out***.println(rightValue);

}

}

**Week 8**

The hashtableWrapper in week 8 uses modular arithmetic to sort the positions of objects within the hashtable. The way it works out where to place these objects is to use the following equation of “object hash” % “length of hashtable”. This is an efficient way to store the objects of the hash table since conflicts are unlikely since the hash is unique for each object.

The size of the hashtable also increases once it has reached the threshold of 0.75 and seems to use a formula of 6 x 2n -1. N being the amount of times the array has increased in length.

When the first input is stored, it is put at position 2, the centre of the table. Using my above equation, the object hash of “fred” is 3151467 which modulo 5, is equal to 2. This obviously shows that it’s equal to the position of the table that it was placed in, which proves my equation is correct.

When I place the next equation, which has a hash of 3370, which modulo 5 is equal to 0, again the same as its position on the table.

When I get to placing the input of “but”, 999 the length of the table increases and the already placed objects are moved along with the new size of the table. I check the previous entries and change the equation from modulo 5, to modulo 11 the new length of the table. The results of this show that all the places of the elements have been moved to match the new length of the table. The table increases as I described earlier as well.

The next thing I notice upon adding the “not” entry, is that “is” is overwritten by this entry because the equation of its placement is equal to 4, the same as “is”. Rather than moving the entries about in any manner the previous entry is overwritten. Another possible idea is that the program would have bumped it up one spot but the entry in the fifth position is still “dead” which leads me to believe that it didn’t try to move the entry one spot and in fact this value was just overwritten.

The final value of “me!” just follows normal behaviour and does the formula for findings its position using the length of 11 and places it at position three.

**Week 10**

**public** **class** DepthFirstTraversal <T> **extends** AdjacencyGraph <T> **implements** Traversal <T> {

**private** List<T> traversal = **new** ArrayList<T>();

**private** List<T> visited = **new** ArrayList<T>();

@Override

**public** List<T> traverse() **throws** GraphError {

**while**(visited.size() < getNodes().size()) { //Makes sure that the visited array is smaller than the amount of nodes

**for** (T node: getNodes()) { //Goes through the nodes one by one to build the array

getUnvisitedNode(node); //Checks the node to see if it has been visited before

traverse(node); //Beings the depth first traversal with the new node

}

}

**return** traversal; // Returns the array once its completed

}

**void** traverse(T node) **throws** GraphError {

**for** (T neighbour: getNeighbours(node)) { //Goes through each neighbour of the node

node = neighbour; //Changes the node to the neighbour

**if**(node != **null** && !visited.contains(node)) // If the node hasn't been visited(to prevent going to the same neighbour over and over)

{

traversal.add(node); //Adds the node to the array

visited.add(node); //Adds the node to the visited array so it prevents infinite loops

traverse(node); //Traverses again

}

}

}

T getUnvisitedNode(T node) **throws** GraphError {

visited.add(node); //Adds the node to the visited array to prevent infinite loops

**return** node; //Returns the node to the traverse

}

**Week 11**

**public** **class** RefCountTopologicalSort<T> **extends** AdjacencyGraph<T> **implements** TopologicalSort<T> {

**private** HashMap<T,Integer> refCountTable = **new** HashMap<T,Integer>();

**private** Stack<T> sort = **new** Stack<T>();

@Override

**public** List<T> getSort() **throws** GraphError {

setUpRefCounts();

sort();

**return** sort;

}

**private** **void** setUpRefCounts() **throws** GraphError {

initialiseRefCounts();

countReferences();

}

**private** **void** countReferences() **throws** GraphError {

**for** (T node: getNodes()) { //Get all the nodes and go through them one by one

**for** (T neighbour: getNeighbours(node)) { //Get the neighbours of the selected node

**int** currentCount = refCountTable.get(neighbour); //Get the number of children of the neighbour

refCountTable.put(neighbour, ++currentCount); //Increment the current count in the refCountTable for the amount of neighbours

}

}

}

**private** **void** initialiseRefCounts() {

**for** (T node: getNodes()) { // Gather the nodes

refCountTable.put(node, 0); // Declare all nodes in the table as a count of 0

}

}

**private** **void** sort() **throws** GraphError {

T node; // Declare the node as a variable

**while** ((node = nextReferenceZeroNode()) != **null**) { // Check the nodes next reference and continue the loop whilst it isn't null

**for** (T neighbour: getNeighbours(node)) { // Check the neighbours of the node

Integer count = refCountTable.get(neighbour); // Get the amount of neighbours from the refCountTable

**if** (count != **null**) {

refCountTable.put(neighbour, count-1); // Reduce the count from the refCountTable by 1 for each neighbour

}

refCountTable.put(node, count-1);

}

refCountTable.remove(node); // Remove the node from the refCountTable

sort.add(node); // Add the node to the sort

}

}

**private** T nextReferenceZeroNode(){

**for** (Entry<T, Integer> entry : refCountTable.entrySet()) { // Get each T and Integer from the entrySet

**if**(entry.getValue() == 0){

**return** (T) entry.getKey(); // Returns the getKey to the sort

}

}

**return** **null**;

}

**Week 13**

Judging by the tests I ran it does always seem to terminate after a finite amount of time, usually between 30 seconds to a couple of minutes. Due to this I am confident in saying that it will always terminate if left running long enough.

The shortest possible outcome I received was 14 lines. Since two lines were outputting the “has finished” outputs and it was also counting the starting lines at 0, this is the shortest possible outcome if it counts straight from 10 to 0 and vice versa.

The largest possible outcome is 11 since if it reaches 10 it will automatically count up one and then will move down and hit 10, finishing this counter.

The smallest value the counter that can be reached is -1, this happens when it starts at 0 and counts down one. It will soon correct itself and finish this counter since it will attempt to move towards the finishing value.

**Week 14**

The problems with the first scenario are that it could end up with a loop only allowing the Bolivians to use the pass since as soon as they leave and remove the stone they could try to enter again as soon as they’ve left since the Peruvians could be resting.

If they both check for stones at the same time and place a stone at the same time they could both end up in the tunnel at the same time, causing a crash.

After making the changes and leaving the program to time out a couple of times I didn’t encounter any issues so I do believe that this method prevents crashes between the trains.

I’m not sure why there was a dispute over timetabling since both trainlines get an equal amount of passes and take turns in doing so.

**Peru & Bolivia**

**public** **void** runTrain() **throws** RailwaySystemError {

Clock clock = getRailwaySystem().getClock();

Basket basket = getBasket();

Railway nextRailway = getRailwaySystem().getNextRailway(**this**);

**while** (!clock.timeOut()) { // Whilst the clock is ticking

choochoo();

basket.putStone(**this**); // Place a stone in this railway systems basket

**while** (nextRailway.getBasket().hasStone(**this**)) { // While the next railway system has a stone in its basket

**if**(basket.hasStone(**this**) == nextRailway.getBasket().hasStone(**this**)) { // If this has stone or doesnt or the other railway has stone or doesnt

basket.takeStone(**this**);

**while**(nextRailway.getBasket().hasStone(**this**) != basket.hasStone(**this**)) { // While the next railways basket is not equal to this railways basket

siesta();

}

basket.putStone(**this**);

}

}

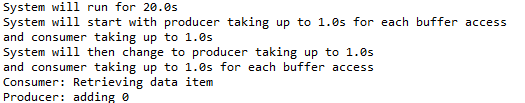
crossPass();

basket.takeStone(**this**);

}

}

**Week 15**



When the criticalSection.poll and noOfElements.poll are swapped it causes the buffer to freeze. This is due to the fact that there is no permit in the semaphore which causes this thread to stop and wait until it does have a permit, which will never happen and the it will timeout and move to the next test.

In the table below I’ve shown where the process freezes, when criticalSection.poll see’s there are no spaces in the criticalSection and the program freezes there.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Put | Get | noOfSpaces | noOfElements | criticalSection |
|  |  | 10 | 0 | 1 |
|  | criticalSection.poll | 10 | 0 | 0 |
| noOfSpaces.poll |  | 9 |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Put | Get | noOfSpaces | noOfElements | criticalSection |
|  |  | 10 | 0 | 1 |
|  | noOfElements.poll | 10 | 0 | 1 |
| criticalSection.poll |  | 9 |  |  |

When noOfSpaces.poll and criticalSection.poll is swapped in the put method it is immediately apparent that the order is not essential in this method and criticalSection still has a permit allowing the semaphore to run normally.

**Week 16**

**public** LockResourceManager(Resource resource, **int** maxUseages) {

**super**(resource, maxUseages);

// Define the locks for each possible priority

**for** (**int** priority = 0; priority < ***NO\_OF\_PRIORITIES***; priority++) {

conditions[priority] = lock.newCondition();

}

}

// Request resource method ran by the resource user class

**public** **void** requestResource(**int** priority) **throws** ResourceError {

// Locks the method to one process

lock.lock();

**try** {

**if** (resourceInUse) {

// Increases the number of processes waiting for this priority

increaseNumberWaiting(priority);

conditions[priority].await();

}

// Sets the resource in use boolean to true until set to false once the resource has been used

resourceInUse = **true**;

} **catch** (InterruptedException e) {

e.printStackTrace();

} **finally** {

lock.unlock();

}

}

**public** **int** releaseResource() **throws** ResourceError {

**int** highestPriority = -1;

lock.lock();

**try** {

// For loop which goes through each priority to find the highest priority waiting

**for** (**int** i = 0; i < ***NO\_OF\_PRIORITIES***; i++) {

**if**(getNumberWaiting(i) > 0) {

highestPriority = i;

}

}

resourceInUse = **false**;

**if** (highestPriority == -1) {

**return** ***NONE\_WAITING***;

} **else** {

decreaseNumberWaiting(highestPriority); // Decreases the number of processes waiting with the highest priority

conditions[highestPriority].signal(); // Signals the process with the highest priority waiting to run

**return** highestPriority;

}

} **finally** {

lock.unlock();

}

}

**Week 17**

NOT = [

0 1

1 0];

AND = [1,1,1,0;0,0,0,1];

%Tensor Product NOT AND

TPNANDOR = [

0 0 0 0 1 1 1 0

0 0 0 0 0 0 0 1

1 1 1 0 0 0 0 0

0 0 0 1 0 0 0 0

];

%Logbook Answer

Answer = [

0 0 0 0 1 1 1 0

1 1 1 1 0 0 0 1

];

**Week 20**

% Hadamard \* ZERO = 0.7071

ans =

0.7071

0.7071

% Hadamard \* 0.7071 = 1 or 0

ans =

1.0000

-0.0000

% The results with ONE are the same