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| **Module Title**  **Programming, Algorithms & Data Structures** | | | |
| **Deadline date**  **28 Nov 2019** | **Actual word**  **Count NA** | | **Tutor**  **CYCheng** |
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| VTC210CT Programming, Algorithms and Data Structures Assignment Report |
| **Student Name: Thajudeen Kamel Mohamed**  **Student ID: 197100857**  **Course: VTC20CT** |
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**Basic Exercise**

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| **Week 1**  **Q1. Program to check if a 3-digit number is an Armstrong number.**  **import** java.util.Scanner;  /\*q1 is about checking whether the number entered is  an 3 digit armstrong number or not  \*/  **public** **class** Q1  {  **public** **static** **void** main(String args[])  {  **int** num, onum, total=0, rem;  Scanner scan = **new** Scanner(System.***in***);    System.***out***.print("Enter 3 digit number : ");  num = scan.nextInt();    onum = num;    **while**(onum != 0)  {  //formula for finding the armstrong number  rem = onum%10;  total = total + rem\*rem\*rem;  onum = onum/10;  }  **if**(total == num)  {  System.***out***.print(num+ " is an Armstrong Number");  }  **else**  {  System.***out***.print(num + " is not an Armstrong Number");  }  }  }  **Output of Q1:**    **Q2. Program to check whether the string is a substring.**  **import** java.util.Scanner;  /\*Q2 is about entering two strings and checking  whether the second string is the substring or not  \*/  **public** **class** Q2 {  **public** **static** **void** main(String[] args) {    Scanner in = **new** Scanner(System.***in***);    System.***out***.print("Enter string s1: ");  String s1 = in.nextLine();    System.***out***.print("Enter string s2: ");  String s2 = in.nextLine();    **if** (s1.indexOf(s2) != -1) {  System.***out***.printf(s2 + " is a substring of " + s1);  }  **else**{  System.***out***.printf(s2 + " is not a substring of " + s1);  }  }  }  **Output of Q2:**    **Week 2**  **Q3.**   1. **Circle class**   **public** **class** Circle **extends** Shape {    **private** Point center ;  **private** **double** radius;    **public** Circle(String n, Point center, **double** radius) {  **super**(n);  **this**.center = center;  **this**.radius = radius;  // **TODO** Auto-generated constructor stub  }  **public** **double** setRadius() {  **return** radius ;  }    **public** **double** getRadius() {  **return** radius;  }    **public** Point setCenter() {  **return** center;  }    **public** Point getCenter() {  **return** center;  }  **public** **double** getArea() {  // **TODO** Auto-generated method stub  **return** Math.***PI*** \* radius \* radius;  }    **public** String toString() {  **return** "Circle [center=" + center + ", radius=" + radius + "]";  }  }   1. **Square class**   **public** **class** Square **extends** Shape {  **private** Point topLeft;  **private** **double** width;    **public** Square(String n, Point topLeft, **double** width) {  **super**(n);    **this**.width = width;  **this**.topLeft = topLeft;  // **TODO** Auto-generated constructor stub  }  **public** **double** getArea() {  // **TODO** Auto-generated method stub  **return** width\*width;  }    **public** **double** setWidth() {  **return** width ;  }    **public** **double** getWidth() {  **return** width ;  }    **public** Point setTopLeft() {  **return** topLeft ;  }    **public** Point getTopLeft() {    **return** topLeft ;  }  **public** String toString() {  **return** "Square [topLeft=" + topLeft + " width=" + width + "]";  }  }  **Shape class**  **public** **abstract** **class** Shape {    **protected** String name;  **public** Shape(String n) {  name = **new** String(n);  }  **public** **abstract** **double** getArea();  **public** String getName() {    **return** name  }  }  **Class Point**  **public** **class** Point {  **private** **double** x, y; // coordinates of the Point  // constructor  **public** Point( **double** a, **double** b ) { setPoint( a, b ); }  // Set x and y coordinates of Point  **public** **void** setPoint( **double** a, **double** b ) {  x = a;  y = b;  }  // get x coordinate  **public** **double** getX() { **return** x; }  // get y coordinate  **public** **double** getY() { **return** y; }  // convert the point into a String representation  **public** String toString()  { **return** "[" + x + ", " + y + "]"; }  }  **Output of Q3:**    **Week 3**  **Q4. LinkedList method**  // q4 using linked list method to test the cases.  **class** ListNode {  **private** Object data;  **private** ListNode next;  ListNode(Object o) { data = o; next = **null**; }  ListNode(Object o, ListNode nextNode)  { data = o; next = nextNode; }  Object getData() { **return** data; }  ListNode getNext() { **return** next; }  **void** setData(Object data){  **this**.data = data;  }  **void** setNext(ListNode next){  **this**.next = next;  }  } // class ListNode    **class** EmptyListException **extends** RuntimeException {  **public** EmptyListException () { **super** ("List is empty"); }  } // class EmptyListException    **class** LinkedList {  **private** ListNode head;  **private** ListNode tail;  **public** LinkedList() { head = tail = **null**; }  **public** **boolean** isEmpty() { **return** head == **null**; }  **public** **void** addToHead(Object item) {  // TO BE COMPLETED  **if**(isEmpty())  head = tail = **new** ListNode(item);  **else**  head = **new** ListNode(item,head);  }  **public** **void** addToTail(Object item) {  // TO BE COMPLETED  **if**(isEmpty())  head = tail = **new** ListNode(item);  **else** {  tail.setNext(**new** ListNode(item));  tail = tail.getNext();  }  }    **public** Object removeFromHead() **throws** EmptyListException {  // TO BE COMPLETED  Object item = **null**;  **if**(isEmpty())  **throw** **new** EmptyListException();  item = head.getData();  **if**(head == tail)  head = tail = **null**;  **else**  head = head.getNext();  **return** item;  }  **public** Object removeFromTail() **throws** EmptyListException {  // TO BE COMPLETED  Object item = **null**;  **if**(isEmpty())  **throw** **new** EmptyListException();  item = tail.getData();  **if**(head == tail)  head = tail = **null**;  **else**{  ListNode current = head;  **while**(current.getNext() != tail)  current = current.getNext();  tail = current;  current.setNext(**null**);  }  **return** item;  }  **public** String toString () {  String s = "[ ";  ListNode current = head;  **while** (current != **null**) {  s += current.getData() + " ";  current = current.getNext();  }  **return** s + "]";  }  }  **public** **class** TestLinkedList {  **public** **static** **void** main (String args[]) {  LinkedList s = **new** LinkedList();  System.***out***.println(s);    s.addToTail (**new** Integer(42));  System.***out***.println(s);  s.addToTail (**new** Character('n'));  System.***out***.println(s);  s.addToTail (**new** String("hello"));  System.***out***.println(s);    **while** (!s.isEmpty()) {  System.***out***.println("removed:" + s.removeFromHead());  System.***out***.println(s);  }    s.addToHead (**new** Integer(42));  System.***out***.println(s);  s.addToHead (**new** Character('n'));  System.***out***.println(s);  s.addToHead (**new** String("hello"));  System.***out***.println(s);    **while** (!s.isEmpty()) {  System.***out***.println("removed:" + s.removeFromTail());  System.***out***.println(s);  }  }  }  **Output of Q4:**    **Week 4**  **Q6. ListStack**  **//using the same LinkedList class from the previous question**  // Q6 about stacks using push, pop, peek and search method.  **public** **class** Q6 **extends** LinkedList {  **public** Q6() {  **super**();  }  **public** **boolean** empty() {  **if** (isEmpty()) {  **return** **true**;  } **else** {  **return** **false**;  }  }  **public** Object push(Object item) {  addToHead(item);  **return** item;  }  **public** Object pop() {  Object item = removeFromHead();  **return** item;  }  **public** Object peek() {  Object item = get(0);  **return** item;  }  **public** **int** search(Object item) {  ListNode current = head;  **int** num = -1;  **for** (**int** i = 0; i < length; i++) {  **if** (item.equals(current.getData())) {  **return** i;  } **else** {  current = current.getNext();  }  }  **return** num;  }    **public** **static** **void** main (String args[]) {  Q6 s = **new** Q6();    System.***out***.println(s);  System.***out***.println("Patrick is at " + s.search("Patrick"));  s.push(**new** Character('A'));  System.***out***.println(s);  s.push(**new** Character('B'));  System.***out***.println(s);  s.push("Cat");  System.***out***.println(s);  s.push("Dog");  System.***out***.println(s);  s.push(**new** Integer(123));  System.***out***.println(s);  s.push("Patrick");  System.***out***.println(s);  s.push(**new** Character('E'));  System.***out***.println(s);  s.push(**new** Double(789.123));  System.***out***.println(s);  System.***out***.println("peek() returns: " + s.peek());  System.***out***.println("Patrick is at " + s.search("Patrick"));  System.***out***.println("A is at " + s.search(**new** Character('A')));  System.***out***.println("789.123 is at " + s.search(**new** Double(789.123)));  System.***out***.println("Peter is at " + s.search("Peter"));  System.***out***.println();  }  }  **Output of Q6:**    **Q7. Using linkedlist class to develop queue class**  // q7 is about queue  **public** **class** Q7 **extends** LinkedList {  **public** Q7() {  **super**();  }  **public** **void** enqueue(Object item) {  **if** (head == **null**) {  head = **new** ListNode(item);  tail = head;  } **else** {  tail.setNext(**new** ListNode(item));  tail = tail.getNext();  }  }  **public** Object dequeue() {  Object item;  **if** (head == **null**)  **return** **null**;  item = head.getData();  head = head.getNext();  **if** (head == **null**)  tail = **null**;  **return** item;  }  **public** **boolean** empty() {  **return** (head == **null**);  }    // to test the program  **public** **static** **void** main(String[] args) {  Q7 q = **new** Q7();      q.enqueue(10);  q.enqueue(20);  q.dequeue();  q.dequeue();  q.enqueue(30);  q.enqueue(40);  q.enqueue(50);    System.***out***.println("Dequeued item is " + q.dequeue());  }  }  **Output of Q7:**    **Week 5**  **Q8. Binary search algorithm**  // question no.8 about binary search  **public** **class** Q8 {  // it Returns index of x if the value is presented in arr[]  // r], else return -1  **int** binarySearch(**int** arr[], **int** l, **int** r, **int** x)  {  **if** (r >= l) {  **int** middle = l + (r - l) / 2;    // If the element is present at the  // middle itself  **if** (arr[middle] == x)  **return** middle;    // If element is smaller than mid, then  // it can only be present in left subarray  **if** (arr[middle] > x)  **return** binarySearch(arr, l, middle - 1, x);    // Else the element can only be present  // in right subarray  **return** binarySearch(arr, middle + 1, r, x);  }  // We reach here when element is not present  // in array  **return** -1;  }  // to test the program  **public** **static** **void** main(String args[])  {  Q8 ob = **new** Q8();  **int** arr[] = { 11, 12, 34, 55, 66, 77, 88 };  **int** n = arr.length;  **int** x = 77;  **int** result = ob.binarySearch(arr, 0, n - 1, x);  **if** (result == -1)  System.***out***.println("Number can't be found!");  **else**  System.***out***.println("Number " + x + " founded in index " + result);  }  }  **Output of Q8:**    **Q9. Binary Search tree with all necessary methods**  // q9 about binary search tree with traverse  //this class represent the nodes  **class** Node {    **private** Node left;  **private** Node right;  **private** Integer data;    **public** Node(Integer data) {  **this**.data = data;  }    **public** Node getLeft() {  **return** left;  }  **public** **void** setLeft(Node left) {  **this**.left = left;  }  **public** Node getRight() {  **return** right;  }  **public** **void** setRight(Node right) {  **this**.right = right;  }    **public** Integer getData() {  **return** data;  }  }    **public** **class** Q9 {    **private** Node root;    **public** **boolean** isEmpty() {    **return** (**this**.root == **null**);  }    **public** **void** insert(Integer data) {    System.***out***.print("[input: "+data+"]");  **if**(root == **null**) {  **this**.root = **new** Node(data);  System.***out***.println(" -> inserted: "+data);  **return**;  }    insertNode(**this**.root, data);  System.***out***.print(" -> inserted: "+data);  System.***out***.println();  }    **private** Node insertNode(Node root, Integer data) {    Node tmpNode = **null**;  System.***out***.print(" ->"+root.getData());  **if**(root.getData() >= data) {  System.***out***.print(" [L]");  **if**(root.getLeft() == **null**) {  root.setLeft(**new** Node(data));  **return** root.getLeft();  } **else** {  tmpNode = root.getLeft();  }  } **else** {  System.***out***.print(" [R]");  **if**(root.getRight() == **null**) {  root.setRight(**new** Node(data));  **return** root.getRight();  } **else** {  tmpNode = root.getRight();  }  }    **return** insertNode(tmpNode, data);  }    **public** **void** postOrderTraversal() {  doPostOrder(**this**.root);  }    //implementing postorder method  **private** **void** doPostOrder(Node root) {    **if**(root == **null**) **return**;  doPostOrder(root.getLeft());  doPostOrder(root.getRight());  System.***out***.print(root.getData()+" ");  }    **public** **void** inOrderTraversal() {  doInOrder(**this**.root);  }    //implementing inorder method  **private** **void** doInOrder(Node root) {    **if**(root == **null**) **return**;  doInOrder(root.getLeft());  System.***out***.print(root.getData()+" ");  doInOrder(root.getRight());  }    **public** **void** preOrderTraversal() {  doPreOrder(**this**.root);  }    // Implementing preorder method  **private** **void** doPreOrder(Node root) {    **if**(root == **null**) **return**;  System.***out***.print(root.getData()+" ");  doPreOrder(root.getLeft());  doPreOrder(root.getRight());  }    // to test the program  **public** **static** **void** main(String a[]) {    Q9 bst = **new** Q9();  bst.insert(7);  bst.insert(9);  bst.insert(4);  bst.insert(1);  bst.insert(5);  bst.insert(3);  bst.insert(6);  bst.insert(0);  bst.insert(8);  //For spacing  System.***out***.println("");    System.***out***.println("In-order Traverse:");  bst.inOrderTraversal();    System.***out***.println("");    System.***out***.println("Post-order Traverse:");  bst.postOrderTraversal();    System.***out***.println("");    System.***out***.println("Pre-order Traverse:");  bst.preOrderTraversal();    }  }  **Output of Q9:**    **Week 6**  **Q10. Program to delete the node from the binary search tree.**  // q9 about binary search tree with traverse  //this class represent the nodes  **class** Node {    **private** Node left;  **private** Node right;  **private** Integer data;    **public** Node(Integer data) {  **this**.data = data;  }    **public** Node getLeft() {  **return** left;  }  **public** **void** setLeft(Node left) {  **this**.left = left;  }  **public** Node getRight() {  **return** right;  }  **public** **void** setRight(Node right) {  **this**.right = right;  }  **public** **void** setData(Integer data) {  **this**.data = data;  }    **public** Integer getData() {  **return** data;  }  }    **public** **class** Q10 {    **private** Node root;    **public** **boolean** isEmpty() {    **return** (**this**.root == **null**);  }    **public** **void** insert(Integer data) {    System.***out***.print("[input: "+data+"]");  **if**(root == **null**) {  **this**.root = **new** Node(data);  System.***out***.println(" -> inserted: "+data);  **return**;  }    insertNode(**this**.root, data);  System.***out***.print(" -> inserted: "+data);  System.***out***.println();  }    **private** Node insertNode(Node root, Integer data) {    Node tmpNode = **null**;  System.***out***.print(" ->"+root.getData());  **if**(root.getData() >= data) {  System.***out***.print(" [L]");  **if**(root.getLeft() == **null**) {  root.setLeft(**new** Node(data));  **return** root.getLeft();  } **else** {  tmpNode = root.getLeft();  }  } **else** {  System.***out***.print(" [R]");  **if**(root.getRight() == **null**) {  root.setRight(**new** Node(data));  **return** root.getRight();  } **else** {  tmpNode = root.getRight();  }  }    **return** insertNode(tmpNode, data);  }      **public** **void** delete(Integer data) {    deleteNode(**this**.root, data);  }    **private** Node deleteNode(Node root, Integer data) {    **if**(root == **null**) **return** root;    **if**(data < root.getData()) {  root.setLeft(deleteNode(root.getLeft(), data));  } **else** **if**(data > root.getData()) {  root.setRight(deleteNode(root.getRight(), data));  } **else** {  // node with no leaf nodes  **if**(root.getLeft() == **null** && root.getRight() == **null**) {  System.***out***.println("After deleting "+data+":");  **return** **null**;  } **else** **if**(root.getLeft() == **null**) {  // node with one node (no left node)  System.***out***.println("After deleting "+data+":");  **return** root.getRight();  } **else** **if**(root.getRight() == **null**) {  // node with one node (no right node)  System.***out***.println("After deleting "+data+":");  **return** root.getLeft();  } **else** {  // nodes with two nodes  // search for min number in right sub tree  Integer minValue = minValue(root.getRight());  root.setData(minValue);  root.setRight(deleteNode(root.getRight(), minValue));  System.***out***.println("After deleting "+data+":");  }  }    **return** root;  }  // this method is to find the minimum number after the nodes been deleted  **private** Integer minValue(Node node) {    **if**(node.getLeft() != **null**) {  **return** minValue(node.getLeft());  }  **return** node.getData();  }    **public** **void** inOrderTraversal() {  doInOrder(**this**.root);  }    //implementing inorder method  **private** **void** doInOrder(Node root) {    **if**(root == **null**) **return**;  doInOrder(root.getLeft());  System.***out***.print(root.getData()+" ");  doInOrder(root.getRight());  }  // to test the program  **public** **static** **void** main(String a[]) {    Q10 bst = **new** Q10();  // to inset data into the node  bst.insert(7);  bst.insert(9);  bst.insert(4);  bst.insert(1);  bst.insert(5);  bst.insert(3);  bst.insert(6);  bst.insert(0);  bst.insert(8);  //For spacing  System.***out***.println("");  // to print output in ascending order  System.***out***.println("In-order Traverse:");  bst.inOrderTraversal();    System.***out***.println();  //deleting the node  bst.delete(9);  bst.inOrderTraversal();  }  }  **Output of Q10:**    **Week 7**  **Q11. Merge sort algorithm**  **import** java.util.Arrays;  //q11 about sorting  **public** **class** Q11  {  // using the merge sorting method  **public** **static** **void** merge(Integer[] a,  **int** iLeft, **int** iMiddle, **int** iRight,  Integer[] tmp)  {  **int** i, j, k;  i = iLeft;  j = iMiddle;  k = iLeft;  **while** ( i < iMiddle || j < iRight )  {  **if** ( i < iMiddle && j < iRight )  { // Both array have elements  **if** ( a[i] < a[j] )  tmp[k++] = a[i++];  **else**  tmp[k++] = a[j++];  }  **else** **if** ( i == iMiddle )  tmp[k++] = a[j++]; // a is empty  **else** **if** ( j == iRight )  tmp[k++] = a[i++]; // b is empty  }  }  **public** **static** **void** sort(Integer[] a, Integer[] tmp)  {  **int** width;  **for** ( width = 1; width < a.length; width = 2\*width )  {  // Combine sections of array a of width "width"  **int** i;  **for** ( i = 0; i < a.length; i = i + 2\*width )  {  **int** left, middle, right;  left = i;  middle = i + width;  right = i + 2\*width;  *merge*( a, left, middle, right, tmp );  }  // Copy tmp[ ] back to a[ ] for next iteration    **for** ( i = 0; i < a.length; i++ )  a[i] = tmp[i];  System.***out***.println("Steps: " + Arrays.*toString*(a) );  }  }  // run the program  **public** **static** **void** main( String[] args )  {  Integer[] x = {99, 22, 11,3} ;  Integer[] help = **new** Integer[x.length];  System.***out***.println("Before sorting: " + Arrays.*toString*(x) );  //for spacing  System.***out***.println("");  Q11.*sort*( x, help ); // Merge sort  System.***out***.println("\nAfter sorting: " + Arrays.*toString*(x) );  }  }  **Output of Q11:**    **Q12. Program to sort sequence with quick sorting method**  **import** java.util.Arrays;  //Q12 is about using the quick sort method  **public** **class** Q12 {  **public** **static** **void** main(String[] args) {  **int** input[] = **new** **int**[] {99, 22, 3, 11};  *sort*(input, 0, input.length - 1);    System.***out***.println("After sorting: " + Arrays.*toString*(input));  }  **private** **static** **void** sort(**int**[] array, **int** left, **int** right) {  **if** (left >= right) {  **return**;  }  //breakdown each part  System.***out***.print("Partition: " + *printArray*(array, left, right));  **int** pindex = *partition*(array, left, right);  System.***out***.println("\nSorted: " + *printArray*(array, left, right) + "\n");  // Sort left portion - recursive call  *sort*(array, left, pindex - 1);    // Sort right portion - recursive call  *sort*(array, pindex, right);  }    **private** **static** **int** partition(**int**[] arr, **int** left, **int** right) {  // Consider middle index as pivot  **int** pivot = arr[(left + right) / 2];    System.***out***.print(" Pivot : "+ pivot);  **while** (left <= right) {  // find a number which is greater than pivot  **while** (arr[left] < pivot) {  left++;  }  // find a number which is less than pivot  **while** (arr[right] > pivot) {  right--;  }  /\*  \* Swap the left and right numbers  \* cause pivot left side numbers should be less than pivot and right side numbers should be greater than pivot  \*/  **if** (left <= right) {  **if** (left != right) {  System.***out***.print(" => Swap : " + arr[left] + ", " + arr[right]);  **int** temp = arr[left];  arr[left] = arr[right];  arr[right] = temp;  }  left++;  right--;  }  }  // this is partition index - actually pivot index  **return** left;  }  // Utility method organize the output well  **private** **static** String printArray(**int**[] arr, **int** sindex, **int** eindex) {  String s = "";    **for** (**int** i = 0; i < arr.length; i++) {    **if**(i == sindex) s = s + " {";  **if**(!s.equals("")) s = s + " ";  s = s + arr[i];  **if**(i == eindex) s = s + " }";    }  **return** s;  }  }  **Output of Q12:** |