Systems Programming

Bachelor in Telecommunication Technology Engineering
Bachelor in Communication System Engineering
Carlos III University of Madrid

Leganés, May 9th, 2014.
Duration: **75 min.**

Full name: ....

Signature: ....

Instructions

You are only allowed a black or blue **pen** (or two), a clock or a watch and the DNI or the Student Identification Card. This means: no pencils, phones, calculators. . . .

Ignore this line: .,..,,.,

Problem 1 (0.75 points)

Write the code for the `public static void reverseWord(char[] word, int first, int last)` method. This method reverse the word contained in the char array `word`. Notice that you do not have to return a new array, but reverse the given one. You can assume that `first` and `last` are always positive numbers or zero, and that `last` will be smaller than the array length.

You MUST implement this method using recursion. **Solutions using iterative or any other approaches will not be graded.**

You do not need to create new arrays. Solutions based on creating new arrays will be penalized.

You can see an example of use below:

```java
public class TestingRecursion {

  public static void main(String args[]) {
    char[] word = {'f','l','o','w','e','r'};
    reverseWord(word, 0, word.length-1);
    System.out.println(new String(word)); //Prints rewolf

    char[] word2 = {'w','h','e','e','l'};
    reverseWord(word2, 0, word2.length-1);
    System.out.println(new String(word2)); //Prints leehw

    char[] word3 = {'e','l','e','v','a','t','o','r'};
    reverseWord(word3, 1, 4);
    System.out.println(new String(word3)); //Prints eaveltor
  }

  public static void reverseWord(char[] word, int first, int last) {













  }
}
```

Problem 2 (2 points)

Observe carefully the `Node<E>` and `ExamLinkedList<E>` classes. Implement the `public double calculateElementsAverage(E searchedContent)` method in `ExamLinkedList<E>` class. This method must average the `value` attribute of every node whose `content` is equal to the one passed as parameter, `searchedContent`. This is, the method must find the nodes which content is equal to `searchedContent`, and calculate the average of the `values` stored in such nodes. The `content` of each node can be anything, including `null`.

Solutions that define and/or use new attributes or new methods (except for equals()) will be penalized.

```
public class Node<E> {
  public E content;
  public int value;
  public Node<E> following;

  public Node(E info, int value, Node<E> next) {
    this.content = info;
    this.value = value;
    this.following = next;
  }
}
```

```
public class ExamLinkedList<E> {
  private Node<E> first;

  public ExamLinkedList() { this.first = null; }

  public double calculateElementsAverage(E searchedContent) {



  }
}
```

Problem 3 (2.25 points)

Observe carefully the code for the `BSTNode<E>` (Binary Search Tree Node) and `BSTree<E>` (Binary Search Tree) classes below. Assume that the root of every subtree will always have two child subtrees, which can be empty or not, but cannot be null.

```
public class BSTNode<E> {
  private E info;
  private String key;
  private BSTree<E> left;
  private BSTree<E> right;

  public BSTNode(E info, String key) {
    this.info = info;
    this.key = key;
    this.left = new BSTree<E>();
    this.right = new BSTree<E>();
  }

  public E getInfo() { return this.info; }
  public String getKey() { return this.key; }
  public BSTree<E> getLeft { return this.left; }
  public BSTree<E> getRight { return this.right; }

  public void setLeft(BSTree<E> left) {
    if(left == null) {
      this.left = new BSTree<E>();
    } else {
      this.left = left;
    }
  }

  public void setRight(BSTree<E> right) {
    if(right == null) {
      this.right = new BSTree<E>();
    } else {
      this.right = right;
    }
  }
}
```

```
public class BSTree<E> {
  private BSTNode<E> root;

  public BSTree(){ this.root = null; }

  public BSTree(E info, String key) {
    this.root = new BSTNode<E>(info, key);
  }

```

```java
  public boolean isEmpty() { return (this.root == null); }

  public String toStringAlphabetical(boolean reverse) {
    /* Your code here */
  }
}
```

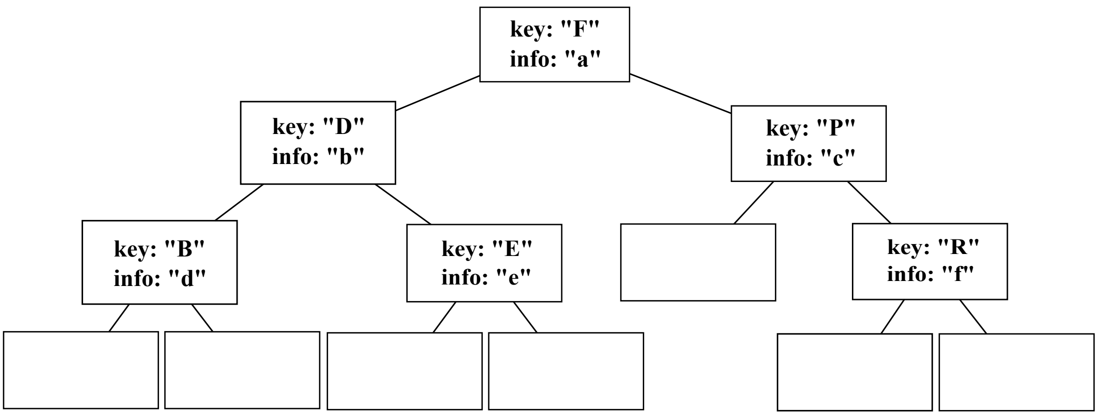
Section 1 (0.1 points)

Which kind of tree traversal would you use in order to obtain the nodes of a tree in alphabetical order of its keys?

Section 2 (2.15 points)

Write the code for the `public String toStringAlphabetical(boolean reverse)` method. This method will return a string with the textual representation of the tree in alphabetical order of its keys, with the format `key1:info1 key2:info2 key3:info3 ...` (notice that there is only one space between elements). The parameter `reverse` indicates if the alphabetical order is reverse (`true`) or not (`false`). If the tree is empty, the method must return an empty string.

For instance, the string returned by this method for the tree



would be

```java
BSTree<String> examTree = new BSTree<String>();
```

```java
/* Tree construction */
...

String strAlphabetical = examTree.toStringAlphabetical(false));
// strAlphabetical would be B:d D:b E:e F:a P:c R:f

String strAlphabeticalReverse = examTree.toStringAlphabetical(true));
// strAlphabeticalReverse would be R:f P:c F:a E:e D:b B:d
```

```java
public String toStringAlphabetical(boolean reverse) {









}
```

Answer to problem 1

```
public class TestingRecursion {

  public static void main(String args[]) {
    char[] word = {'f','l','o','w','e','r'};
    reverseWord(word, 0, word.length-1);
    System.out.println(new String(word)); //Prints rewolf

    char[] word2 = {'w','h','e','e','l'};
    reverseWord(word2, 0, word2.length-1);
    System.out.println(new String(word2)); //Prints leehw

    char[] word3 = {'e','l','e','v','a','t','o','r'};
    reverseWord(word3, 1, 4);
    System.out.println(new String(word3)); //Prints eaveltor
  }

  public static void reverseWord(char[] word, int first, int last) {
    if( first >= last) { //Stop condition. Might be this one or any equivalent
      return;
    } else {
      char aux = word[first];
      word[first] = word[last];
      word[last] = aux;
      reverseWord(word,first+1,last-1);
    }
  }
}
```

Evaluation criteria for problem 1

```
The problem is graded from 0 to 7.5, being 0 the lowest mark and 7.5 the
highest.

The student mark starts at 0, then the following modifiers are applied
in order:

[C100] (+2) Stop condition defined and correctly applied.

[C102] (+1) Define auxiliary char for storing first or last char.

[C103] (+1) Swipe (current) first and last letters.

[C104] (+2.5) Recursive call: 1 call to the recursive method, 0.5 for
 using same array, 0.5 for using first+1, 0.5 for using last-1.

[C105] (+1) Not returning anything.

[C106] (-1) (may be applied several times) For each time the naming
conventions are not applied, or for code style and clarity missing.

[C107] (-1) If new arrays are created.
```

[C108] (grade=0) If iterative or any no recursive approach is used.

Answer to problem 2

```
public class ExamLinkedList<E> {
  private Node<E> first ;

  public ExamLinkedList() { this. first = null; }

  public double calculateElementsAverage(E searchedContent) {
    Node<E> current = this.first;
    double average = 0;
    double sum = 0;
    double count = 0;

    while (current != null) {
      if (searchedContent != null) {
        if (searchedContent.equals(current.content)) {
          count++;
          sum += current.value;
        }
      else {
        if (current.content == null) {
          count++;
          sum += current.value;
        }
      current = current.following;
    }

    if(count>0) {
      average = sum/count;
    }

    return average;
  }
}
```

Evaluation criteria for problem 2

The problem is graded from 0 to 20, being 0 the lowest mark and 20 the highest.

The student mark starts at 0, then the following modifiers are applied in order:

[C200] (+1) Define reference to current node.

[C201] (+1) Define reference to current node as Node<E> (use of generics).

[C202] (+2) Define count and sum variables outside the list traversal (1) as doubles (1).

[C203] (+2) Check if list is empty.

[C204] (+1) Traversal of list (1/2: loop).

[C205] (+2) Check if searchedContent is not null and if searchedContent matches with the content of the current node.

[C206] (+2) Check if contentWanted is null and if the content of the current node is null.

[C207] (+1) Increment count in the case of matching (both cases).

[C208] (+1) Increment sum in the case of matching (both cases).

[C209] (+2) Traversal of list (2/2: go to next node).

[C210] (+1) Check if count>0 (avoid dividing by zero).

[C211] (+2) Calculate average.

[C212] (+2) Finish with return clause.

[C213] (-1) (may be applyed several times) Every call to any method not defined (getContent(), getInfo(), getNext(), getFollowing()...)

[C214] (-1) (may be applied several times) For each time naming conventions are not applied, or for code style and clarity missing.

Answer to problem 3

Section 1

Inorder

Section 2

```
public class BSTree<E> {
  private BSTNode<E> root;

  public BSTree(){ this.root = null; }

  public BSTree(E info, String key) {
    this.root = new BSTNode<E>(info, key);
  }

  public boolean isEmpty() { return (this.root == null); }

  public String toStringAlphabetical(boolean reverse) {
    String leftSubtree = "";
```

```java
    String current = "";
    String rightSubtree = "";

    if (!this.isEmpty()) {
      current = this.root.getKey() + ":" + this.root.getInfo();

      leftSubtree = this.root.getLeft().toStringAlphabetical(reverse);
      if(!leftSubtree.equals("")) {
        leftSubtree = leftSubtree + " ";
      }

      rightSubtree = this.root.getRight().toStringAlphabetical(reverse);
      if(!rightSubtree.equals("")) {
        rightSubtree = rightSubtree + " ";
      }
    } else {
      return "";
    }

    if (reverse) {
      return rightSubtree + current + leftSubtree;
    } else {
      return leftSubtree + current + rightSubtree;
    }
  }

}
```

Evaluation criteria for problem 3

The problem is graded from 0 to 21.5, being 0 the lowest mark and 21.5 the highest.

The student mark starts at 0, then the following modifiers are applied in order:

[C300] (+2.5) Stop condition defined and correctly applied (empty tree).

[C301] (+2.5) Obtain current node's textual representation: 0.5 accessing root, 0.5 accessing key, 0.5 applying ":" format, 0.5 accessing root, 0.5 accessing content.

[C302] (+2.5) Obtain left subtree's textual representation: 0.5 accessing root, 0.5 accessing left subtree, 1 applying recursive method, 0.5 passing reverse as parameter.

[C303] (+2.5) Obtain right subtree's textual representation: 0.5 accessing root, 0.5 accessing right subtree, 1 applying recursive method, 0.5 passing reverse as parameter.

[C304] (+1) Add space after left subtree representation, if left subtree is not empty.

[C305] (+1) Add space after right subtree representation, if right subtree is not empty.

[C306] (+2) Return empty string if tree is empty.

[C307] (+1) Check if order required is reverse or not.

[C308] (+1) Return clauses (for both orders).

[C309] (+1.5) Reverse inorder (right - current - left).

[C310] (+1.5) Straight inorder (left - current - right).

[C311] (+2.5) Format applied (spaces between right/left - current - left/right).

[C312] (-1) (may be applyed several times) For each time naming conventions are not applied, or for code style and clarity missing.