



NUI MAYNOOTH

Ollscoil na hÉireann Má Nuad

OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

AUTUMN 2012 EXAMINATION

CS210

Algorithms & Data Structures 1

Dr. M. McNeill, Dr. A. Winstanley, Dr. P. Maguire

Time allowed: 2 hours

Answer ***all*** questions

All questions carry equal marks

[20 marks]

- 1 (a) Design a method that takes in three `Strings`, and returns the `String` that would come last in the dictionary. [4 marks]

Provide a pseudocode or Java implementation of your algorithm and explain how it works.

- (b) Design an algorithm that finds the lowest number divisible by every digit (i.e. the lowest number that is divisible by 1, 2, 3....9). [4 marks]

Provide a pseudocode or Java implementation of your algorithm and explain how it works. (**Hint:** try all the possibilities, working your way up until you find the right number).

- (c) Discuss the concept of encapsulation with reference to object-oriented programming. In your answer you should discuss how encapsulation enhances programming efficiency. [4 marks]

- (d) Describe the binary search algorithm in your own words. Show step by step how the values of `lowerbound` and `upperbound` would be updated if this method was used to search for the number 25 in the following array. [4 marks]

[12 24 37 58 64 69 73 78 83 86 97]

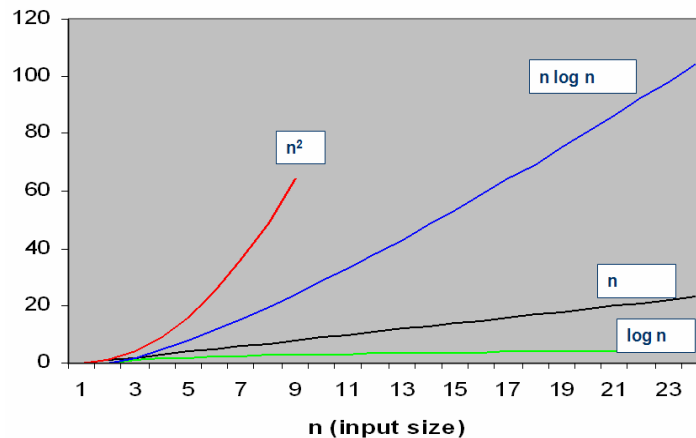
- (e) Explain how the method below works. Describe step by step how it would delete the number 32 from the following ordered array, showing how the variables are updated. [4 marks]

15 32 47 53 82

```
public boolean delete(int value){
    int j=0;
    while(array[j] != value && j<nElems){
        j++;
    }
    if(j==nElems){
        return false;
    }else{
        for(int k=j; k<nElems-1; k++){
            array[k] = array[k+1];
        }
        nElems--;
        return true;
    }
}
```

[20 marks]

- 2 (a) Describe the concept of Big O Notation in your own words and discuss its utility for evaluating the efficiency of an algorithm. In your answer you should explain the significance of the diagram below: [4 marks]



- (b) For the code below, derive a function that expresses how many times `counter` will be incremented, expressed in terms of n . State this function's Big O Complexity. [4 marks]

```
for(int i = 5; i < n*30; i++){
    for(int j = 20; j >= 0; j--){
        for(int k = 4; k < n; k++){
            counter++;
        }
    }
}
```

- (c) Describe in brief how the following sorting algorithms work: [8 marks]

- i) Bubble sort
- ii) Selection sort
- iii) Insertion sort
- iv) Merge sort

- (d) Show clearly how these four algorithms would sort the following numbers: [4 marks]

32 91 67 21 85 34

[20 marks]

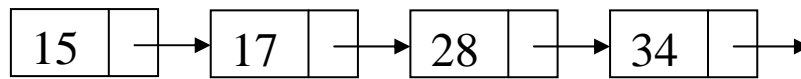
- 3 (a) Describe how the following data structures work, using diagrams as appropriate: [8 marks]

- i) Stack
- ii) Queue
- iii) Priority Queue
- iv) Deque

- (b) Design a method that uses a `Stack` object to reverse a `String`. You can assume that a `Stack` class is available with `push()` and `pop()` methods. [4 marks]

Provide a pseudocode or Java implementation of your algorithm and explain how it works.

- (c) Explain how the method below works. Describe step-by-step how it would delete the number 15 from the following linked list, showing how the variables `current` and `previous` are updated: [4 marks]



```
public Link delete(int key){  
  
    Link current = first;  
    Link previous = first;  
    while(current.data != key){  
        if(current.next == null){  
            return null;  
        }else{  
            previous = current;  
            current = current.next;  
        }  
    }  
    if(current == first){  
        first = first.next;  
    }else{  
        previous.next = current.next;  
    }  
    return current;  
}
```

- (d) Describe the concept of recursion in your own words. Write a recursive method that takes in a number n , and calculates n factorial (e.g. $3! = 3 \times 2 \times 1 = 6$). [4 marks]

Provide a pseudocode or Java implementation of your recursive algorithm and explain how it works.