



# Universidad Carlos III de Madrid

Algorithms and Data Structures (ADS)

Bachelor in Informatics Engineering  
Computer Science Department

**YEAR: 1º / SEMESTER: 2º**

## **Exam 3**

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**Part 1—Short Answer**  
**[10 points each, 70 points total]**

- a)What are the three things that define an ADT (abstract data type)?
- a)What are the characteristics of a good hash function?
- a)Why is a singly linked list a good choice for storing the elements of a stack? Why not use a doubly linked list instead?
- a)When is recursion an appropriate choice for the implementation of an operation?
- a)Why is the asymptotic performance of the `insertElementBefore` and `insertElementAfter` operations of a doubly linked list  $O(n)$ ?
- a)Why is the number of elements of a collection as a separate field (usually called `size`)?
- a)How many elements can be stored by a BST?

**Part 2—True/False**  
**[5 points each, 60 points total]**

*If a statement is false, describe why it is false.*

- a)The priorities used by a priority queue must have a total ordering.
- a)Every tree is a graph.
- a)Using recursion to implement the operations of a balanced BST is appropriate.
- a)Using recursion to implement the operations of a BST is appropriate.
- a)An acyclic directed graph (that is, a directed graph that does not have a cycle) is a tree.
- a)A list backed by an array requires less memory than a list backed by a linked chain of nodes.
- a)A queue could be backed by a stack. (That is, the elements of the queue could be stored by a stack, and the operations of the queue could be implemented in terms of the operations of the stack.)
- a)The height of a binary tree determines the performance of the operations of the tree.
- a)An operation of an ADT is an algorithm.
- a)A graph can have more edges than nodes.
- a)Each node of a tree has exactly one parent.
- a)The performance of two `for` loops, one nested inside the other, is the sum of the number of iterations of each `for` loop.

**Part 3—Short Essay**  
**[20 points]**

How is using an array different from using a list that is backed by an array? Your answer should include a comparison of the available operations and their performance characteristics, as well as your opinion on the convenience of using one over the other.