DATA STRUCTURES (AND ALGORITHMS)

Exam details.

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2023 - 2024

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Faculty of Mathematics and Computer Science

In the previous lecture

- Heap
- ADT Priority Queue

Today

- Exam details

Exam - Prerequisits

 In order to take the exam you need at least **5** seminar attendances and **6** lab attendances.

Exam - Date, location, duration

- **Mathematics and Computer Science (including all students who have re-contracted the course)**
  - Exam date: **06 June**, 14-16, A2 (T. Mihali)
  - Retake exam date: 09 July, 8-10, G. Călugăreanu (Kogălniceanu 1)
- **Artificial Intelligence**
  - Primary exam date: **26 June**, 8-10, G. Călugăreanu (Kogălniceanu 1)
  - Secondary exam date: 19 June, 8-10, T. Popoviciu (Kogălniceanu 1)
  - Retake exam date: 09 July, 8-10, G. Călugăreanu (Kogălniceanu 1)
- **Information Engineering**
  - Primary exam date: **19 June**, 8-10, T. Popoviciu (Kogălniceanu 1)
  - Secondary exam date: 26 June, 8-10, G. Călugăreanu (Kogălniceanu 1)
  - Retake exam date: 09 July, 8-10, G. Călugăreanu (Kogălniceanu 1)

- You have to participate to the primary exam date. The secondary exam date is exclusively for exceptional cases.

Actual amount of working time: **90** minutes

Exam - Structure & grading scheme

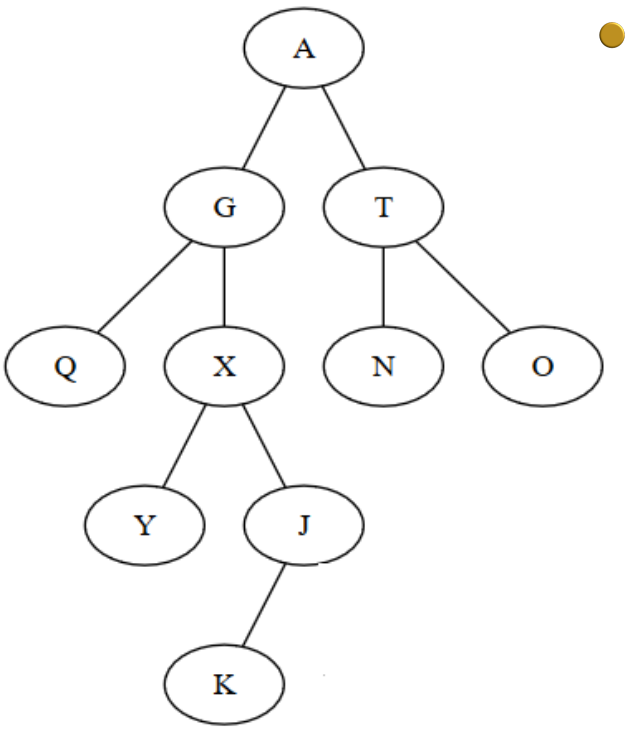
- **1** point *ex officio*
- **3** points - Subject **A**: Short-answer & drawings problems
  - 3 problems * 1 point
- **3** points - Subject **B**: Multiple choice problems
  - 6 problems * 0.5 points
- **3** points - Subject **C**: Implementation

Exam - Subject A - Short-answer & drawings problems

- **1** point - Subject A.1. **Binary Trees** - possible representations, terminology, properties & traversals (short answers questions)
- **1** point - Subject A.2. **Hash Tables** - operations (drawings)
- **1** point - Subject A.3 **Binary Search Trees** / **Heaps** - operations (drawings)

Exam - Subject A.1: Binary Trees - Terminology & traversals - Example

Example:



- Fill the following sentences about the given binary tree:
  - The internal nodes are:
  - The height of node X is:
  - The inorder traversal visits the nodes in the following order:
  - The postorder traversal visits the nodes in the following order:
  - The tree is a balanced binary tree (yes/no):

All the terminology discussed for binary trees as well as all types of traversals are possible for this problem.

Exam - Subject A.1: Binary Trees - Terminology & traversals - Example 2

Example 2:

1	2	3	4	5	6	7	8	9	10	11	12	13
4	**3**	**1**	**2**	**5**	**-1**	**9**	**-1**	**-1**	**6**	**-1**	**-1**	**-1**

- Fill the following sentences about the previously given binary tree in **array-based representation**:
  - The internal nodes are:
  - The depth of node 9 is:
  - The preorder traversal visits the nodes in the following order:
  - The level order traversal visits the nodes in the following order:
  - The tree is heap (yes/no):

Exam - Subject A.1: Binary Trees - Terminology & traversals - Example 3

Example 3:

	1	2	3	4	5	6	7	8
Info	**10**	**13**	**11**	**1**	**15**	**21**	**3**	
Left	**-1**	**-1**	**7**	**-1**	**-1**	**5**	**4**	
Right	**-1**	**6**	**2**	**-1**	**-1**	**-1**	**1**	

Root: 3

- Fill the following sentences about the previously given binary tree in **linked representation on array**:
  - The leaf nodes are:
  - The elements on the third level are:
  - The number of nodes visited by the inorder traversal before visiting the root is:
  - The tree is a binary search tree (yes/no):
  - The depth of the tree is:

Exam - Subject A.2: Hash Tables - Examples

Examples:

- Insert the integers 11, 12, 21, 33, 22 (in the given order) in an initially empty hash table with open addressing of size m = 11, using the division method and:
  - a) linear probing
  - b) quadratic probing with c1 = 0 and c2 = 1

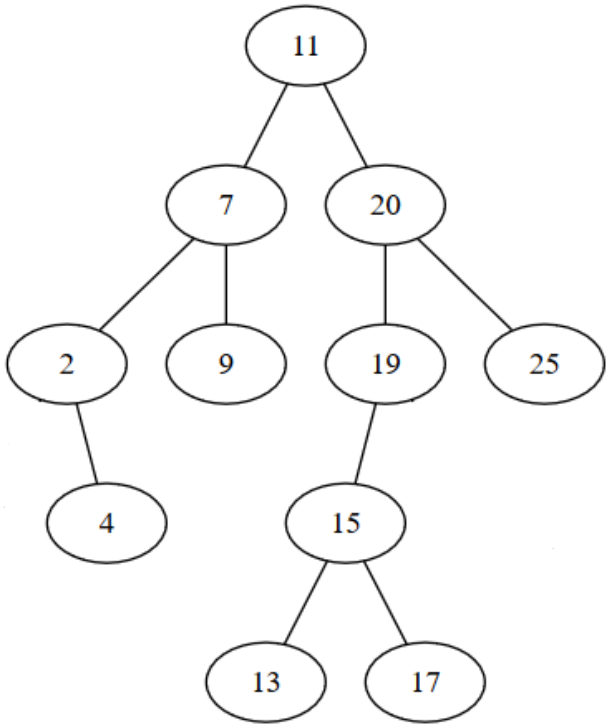
Exam - Subject A.2: Hash Tables - Examples

Examples:

- Insert the integers 11, 12, 21, 33, 22 (in the given order) in an initially empty hash table with open addressing of size m = 11, using the division method and:
  - a) linear probing
  - b) quadratic probing with c1 = 0 and c2 = 1

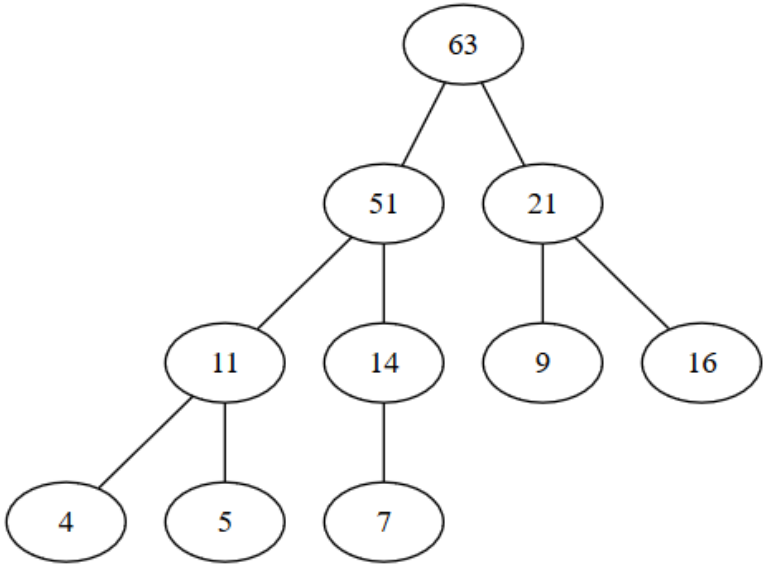
- Consider an initially empty hash table with coalesced chaining of size m = 10 positions, using the division method. Insert the following integers in the hash table: 13, 10, 163, 673, 30. After inserting all the elements, remove 13 from the hash table.

Exam - Subject A.3: Binary Search Trees or Heaps - Examples



Example 1: Given the binary search tree above, insert the element 14 and then remove 7 and 19.

Exam - Subject A.3: Binary Search Trees or Heaps - Examples



Example 2: Given the heap above, insert the element 55 and then perform one remove operation.

Exam - Subject B: Multiple choice problems - Examples I

⚠ **Do not forget to justify your answers. Otherwise, you will be penalized even if you provide the correct answers.**

Exam - Subject B: Multiple choice problems - Examples I

 **Do not forget to justify your answers. Otherwise, you will be penalized even if you provide the correct answers.**

1. $n^2 * log_2 n + n^4$ belongs to which of the following complexity classes?
   - a. $\Omega(n^3)$
   - b. $O(n^5)$
   - c. $\Theta(n^4)$
   - d. $O(n^3)$
   - e. $\Omega(n^5)$
   - f. none of them

Exam - Subject B: Multiple choice problems - Examples I

 **Do not forget to justify your answers. Otherwise, you will be penalized even if you provide the correct answers.**

1. $n^2 * log_2 n + n^4$ belongs to which of the following complexity classes?
   - a. $\Omega(n^3)$
   - b. $O(n^5)$
   - c. $\Theta(n^4)$
   - d. $O(n^3)$
   - e. $\Omega(n^5)$
   - f. none of them

2. Which of the following three sequences represent a binary heap?
   - a. [1, 12, 23, 10, 15, 38, 45, 15, 18, 20, 21]
   - b. [1, 8, 27, 10, 45, 83, 91, 31, 12, 52, 51]
   - c. [1, 13, 20, 21, 65, 54, 67, 41, 30, 83, 52]
   - d. none of them

Exam - Subject B: Multiple choice problems - Examples II

3. If we use a dynamic array as representation for a stack, where should we place the top for optimal performance for all stack operations?
   - a. beginning of the array
   - b. end of the array
   - c. either the beginning or the end
   - d. we cannot implement a stack on a dynamic array

Exam - Subject B: Multiple choice problems - Examples II

3. If we use a dynamic array as representation for a stack, where should we place the top for optimal performance for all stack operations?

- a. beginning of the array
- b. end of the array
- c. either the beginning or the end
- d. we cannot implement a stack on a dynamic array

4. For which of the following collision resolution methods might an insertion fail (we simply cannot add the element) even if the table contains empty slots?

- a.separate chaining
- b.coalesced chaining
- c.open addressing – linear probing
- d.open addressing – quadratic probing
- e.none of them

Exam - Subject B: Multiple choice problems - Examples III

5. What is the difference between the maximum and minimum possible depth of a binary tree with 7 nodes?

- b. 3
- c. 4
- d. 5
- e. 6
- f. 7

Exam - Subject B: Multiple choice problems - Examples III

5. What is the difference between the maximum and minimum possible depth of a binary tree with 7 nodes?

- b. 3
- c. 4
- d. 5
- e. 6
- f. 7

6. ADT Map and ADT MultiMap have a pretty similar interface. Which of the following operations do not have the same number of input parameters? Select one or more.

- a. add
- b. remove
- c. size
- d. iterator
- e. isEmpty

Exam - Subject C: Implementation

 Any operation (in conjunction with any ADT) / algorithm discussed during lectures, seminars or included in the labs problems might be tested here.

 Requirements to implement an iterator (all the specific operations), a tree traversal algorithm or any other algorithm discussed during lectures or seminars are possible.

 It's essential to give the **representation** (as constrained by the requirement).

 You also have to write the **specifications** for the operation and to compute the time **complexity** of the operation.

 The operation/algorithm must be implemented in **Pseudocode**.

Exam - Subject C: Implementation

Example:

- Consider a Set, represented on a singly linked list on array. Give the representation of the Set and specify and implement the *remove* operation. Compute the time complexity of the operation (best case, worst case and overall complexity). Please insert comments/explanations to document the representation and the implementation.

Thank you