

Mila University
Faculty of Mathematics and Computer Science
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Master 1 I2A

Year: 2026/2027

Advanced Algorithmic and Complexity

Tutorial 1

Exercise 1:

Give the order of growth of the complexity of the following three algorithms:

Algorithm 1.

```
S ← 0;
For i = 1 to n do
    S ← S + i;
EndFor
return S;
```

Algorithm 2.

```
S ← 0;
For i = 1 to 100 do
    For j = i to 10 do
        S ← S + j;
    EndFor
EndFor
return S;
```

Algorithm 3.

Inputs: T: matrix of integers sorted by row; n, S: integer;

Output: boolean;

i ← 1; found ← false;

While (i ≤ n And not found) do

 Min ← 0; Max ← |T[i]|;

 While (not found And Min < Max) do

 Avg ← integerPart ((Min + Max) / 2));

 If (T[i][Avg] = S) then found ← true;

 Else

 If (T[i][Avg] < S) then Min ← Avg + 1;

 Else Max ← Avg - 1;

 EndIf

 EndWhile

EndWhile

i ← i + 1;

EndWhile

Return found;

Exercise 2:

1. Give the order of growth of the following functions:

- | | |
|---|---|
| 1) $f(n) = n^4 - n + 1$; | 2) $f(n) = 1000n^4 + 2 \times n!$ |
| 3) $f(n) = n^2 + n \times 2024$; | 4) $f(n) = 15! \times n + 4 \times n^3$; |
| 5) $f(n) = n^9 + 3^{2n} + 2023 + 2 \times n + 5 \times \log(n)$; | |

2. State whether each of the following statements is true or false:

A1 : $n \in O(n \log(n))$?

A2 : $4n^{2n} \in O(n^3)$?

A3 : $n / \log(n) \in O(n)$?

A4 : $100n^2 + n + 5 \in O(n^2)$?

A5 : $4^n + 3^n \times 6 \in O(5^n)$?

Exercise 3:

We want to implement a hash table (of size n) to store integers that are less than $n/2$ and divisible by 3. Considering the open addressing with linear probing to handle collisions:

- 1) Propose a hash function;
- 2) Write the algorithm that implements the insertion of an integer into this table;
- 3) Write the algorithm that checks whether an integer exists in this table or not;
- 4) Write the algorithm that deletes an integer from this table.