

1. Algorithms: Introduction

José Proença

Algorithms (CC4010) 2023/2024

CISTER – U.Porto, Porto, Portugal

<https://cister-labs.github.io/alg2324>



CISTER - Research Centre in
Real-Time & Embedded
Computing Systems

Algorithms (CC4010)

An **algorithm** in CS is:

- a **method** for solving a (computational) problem
 - given some **input**
 - must produce some **output**
- **independent** of programming languages, computational machines, etc.

Sorting Problem

Input: a sequence

a_1, a_2, \dots, a_n

Output: a sorted permutation

$a'_1 \leq a'_2 \leq \dots \leq a'_n$

Instance

Input: 4, 1, 5, 3, 7

Output: 1, 3, 4, 5, 7

Algorithm

```
int i, j;
for (i=1; i<n; i++)
    j = i-1;
    while (j>=0 &&
           arr[j]>arr[i])
        arr[j+1] = arr[j];
        j = j-1;
    arr[j+1] = arr[i];
```

Contents of the module

How well can we solve a *problem*:

- is there an algorithm guaranteed to solve it in finite time? (**Decidable**)
- if so, is it really solving the problem? (**Correct**)
- if so, how well does it work in practice? (**Feasible**)

We will be **formal**

- precisely formulate concepts
- proof correctness
- calculate how fast
- pen-and-paper (no tool support)

We will see **examples**

- Some well known algorithms
- Understand how to reason about them

- Algorithm Correctness
- Complexity: worst/best-case analysis
- Asymptotic analysis
- Recursive algorithms
- Average-case and randomized algorithms
- Amortized analysis
- Lower bounds
- Graph traversals and Dynamic programming
- Fundamentals of NP-completeness

Logistics

Relevant class material and announcements will be posted on the website periodically

```
https://cister-labs.github.io/alg2324
```

Lecturer

- José Proença – <https://jose.proenca.org>
- jose.proenca@fc.up.pt

Office hours (please send an email the day before if you wish to meet):

- *José Proença*: Friday afternoon

Assessment will consist of

- **30% (IT)** – an individual **intermediate test** in the middle of the semester
 - **10 Nov 2023;**
- **70% (FE)** – a **final exam** at the end;
- **70% (IT2)** – an **improvement test** that can replace the final exam (if taken);

There will be 2 exam periods:

- Normal period:

$$\max(\text{FE}, \text{IT2}) * 0.7 + \text{IT} * 0.3 \quad (\geq 9.5)$$

- Extra period (*recurso*):

$$\max(\text{FE} * 0.7 + \text{IT} * 0.3, \text{FE}) \quad (\geq 9.5)$$