1. Algorithms: Introduction

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Algorithms (CC4010) 2024/2025

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https://fm-dcc.github.io/alg2425

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 $a_1, a_2, \ldots, a_n$

Output: a sorted permutation $a'_1 \leq a'_2 \leq \ldots \leq a'_n$

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

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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

Syllabus

- Algorithm Correctness
- Complexity: worst/best-case analysis
- Asymptotic analysis
- Recursive algorithms
- Average-case and randomized algorithms
- Amortized analysis
- Lower bounds
- Data structures
- Fundamentals of NP-completeness

Logistics

Useful information

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:* TBD

Assessment

Assessment will consist of

- **30%** (IT) – an individual intermediate test in the middle of the semester (≥ 5.5);
- **70%** (FT) – a final test at the end, during the normal exam period (≥ 5.5);
- **100%** (RE) – a global exam at the end, during the recovery (*recurso*) exam period (≥ 9.5);

There will be possible evaluation periods:

- Normal period:

$$IT * 0.3 + FT * 0.7 \quad (\geq 9.5)$$

- Recovery period (*recurso*):

$$\text{RE} \quad (\geq 9.5)$$