1. Algorithms: Introduction

José Proença

Algorithms (CC4010) 2023/2024

CISTER – U.Porto, Porto, Portugal

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

Algorithms (CC4010)

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

Contents of the module

We will study is a ***good/better*** algorithm

- correct (do what is expected and always terminates)
- fast/faster (does not take forever...)

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
- Fundamentals of asymptotic analysis
- Average-case and randomized algorithms
- Recursive algorithms
- Sorting algorithms
- Amortized analysis
- Graph traversals and Dynamic programming
- 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.org

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

- *José Proença:* Friday afternoon

Assessment

Assessment will consist of

- **20%** (IT) – an individual intermediate test in the middle of the semester;
- **80%** (FE) – a final exam at the end;
- **80%** (IE) – an improvement exam that can replace the final exam (if taken);

There will be 2 exam periods:

- Normal period:

$$max(FE, IE) * 0.8 + IT * 0.2 \quad (\geq 9.5)$$

- Extra period (*recurso*):

$$max(FE * 0.8 + IT * 0.2, FE) \quad (\geq 9.5)$$