

# Numerical methods notes

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The course is held by Michela Mapelli: a team leader in GW astronomy.

The first lessons are about basic Linux and Python, I will not take notes now, I will start later on.

**Thu Nov 07 2019**

## 1 Sorting

Useful for astrophysics since we often deal with large files.

**Bubble sort** We loop through the file, and swap each pair if it is not ordered.  
It is  $O(n^2)$  in general.

**Selection sort** We look for the minimum and put it at the beginning, then scan the remaining array.  
It is  $O(n^2)$  in general.

### Quicksort

1. We pick an element, the *pivot*;
2. we reorder the array so that all elements less than the pivot come before it;
3. we do this recursively to the subarrays to the left and right of the pivot.

It is  $O(n^2)$  in the worst case,  $O(n \log n)$  usually.

**Merge sort** We divide the array into small subarrays, and merge them to produce larger subarrays.

It is  $O(n^2)$  in the worst case,  $O(n \log n)$  usually.

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One can time a bash command using

```
1 time [Command]
```

## 2 Linear systems

We want to solve a linear system, in the form  $A\vec{x} = \vec{b}$ , with unknown  $\vec{x}$ . How do we solve this numerically? We can transform our system to an equivalent one, by

1. exchanging two rows;
2. multiplying an equation by a nonzero constant;
3. adding an equation to another.

These allow us to do Gaussian elimination, and LU decomposition. These are *direct methods*.

Another class is that of *indirect methods*: we start with an *ansatz* and refine it. These are easier to implement, more generally applicable, more efficient if the matrix is sparse. They, however, do not always converge.

An example is the Gauss-Seidel method.

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Not much to say today. TODO: insert new algorithms.