



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Sistemi di Calcolo Parallelo

2324-2-F1801Q117

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#### Aims

The student understands the computational paradigms of parallel applications. To complete the analysis of these applications, performance metrics are introduced and used in the exercise activities on parallel machines in OpenMP, MPI and CUDA with the algorithms presented in class and developed by the students.

#### Contents

The course presents a comprehensive overview of parallel architectures and associated computational paradigms. It also introduces the student to the design and implementation of parallel applications in distributed environments and GPGPU with CUDA development environment emphasis. It is introduced the problem of distributed applications with access to large amounts of data, analyzing the Hadoop framework.

#### Detailed program

1. Basic considerations and performance measurement.
2. The classification of parallel architectures and computational paradigms, with SIMD and MIMD architectures deepening."
3. Types of interconnection and communication patterns.
4. Examples of shared-memory platforms with references to multicore architectures.
5. Examples of distributed platform: PC clusters / networks of workstations and local and dedicated systems with

graphics accelerators.

6. Parallelization techniques: types of decomposition, mapping, load balancing and optimization techniques.
7. Inhibitors of parallelization
8. Basic communication operations"
9. Analytical modelling of parallel programs
10. Overview on some relevant parallel algorithms"
11. Programming on shared memory platforms, introduction to OpenMP
12. Use of libraries Message Passing Interface (MPI) as a programming environment for the realization of parallel algorithms on multiprocessor architectures: initialization, global operations, modularity
13. The architecture of graphics accelerators and related computational paradigms
14. Introduction to the programming on graphics accelerators: CUDA environment."
15. Parallel Filesystems
16. Presentation of the Hadoop framework: the model Map-Reduce

## **Prerequisites**

Knowledge of computer architecture; elements of networking; programming languages, with particular regard to the C / C + +/Java languages; algorithms and models of computability and complexity.

## **Teaching form**

Lesson, tutorial, seminars, individual study activities supported by teaching materials in e-learning, and project activity developed in a parallel environment, especially on systems with GP-GPU accelerators from Nvidia and CUDA environment. The teaching is held in Italian, the support material is in English. The teaching is held in Italian, at the request of the students it can be delivered in English; the support material is partially in Italian and English.

## **Textbook and teaching resource**

1. R. Ansoorge, Programming in Parallel with CUDA: A Practical Guide, Elsevier, Cambridge University Press, 2022.
2. A. Grama, A. Gupta, G. Karypis, V. Kumar. Introduction to Parallel Computing, 2°Ed., Addison-Wesley, 2003.
3. CUDA C++ Programming Guide - Design Guide, v11.2, NVIDIA docs, 2021

4. T. White, Hadoop: The Definitive Guide, O'Reilly, 2012.

Teaching resources available on the e-learning platform of the course: lessons, articles, reference exercises.

## **Semester**

Second Semester 2023/2024

## **Assessment method**

The assessment includes seminar activities by the students and the discussion of a project on a particular topic addressed during the course, with the development of code and analysis of performance on parallel architectures. The vote is determined as follows: 40% seminar activity, 60% project.

## **Office hours**

By reservation, by student request via email or via the messaging on the e-learning platform.

## **Sustainable Development Goals**

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE

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