UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Matematica e Informatica
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	DATA, ALGORITHMS AND MACHINE INTELLIGENCE
SUBJECT	CLOUD AND HIGH PERFORMANCE COMPUTING
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20903-Attività formative affini o integrative
CODE	22451
SCIENTIFIC SECTOR(S)	FIS/05
HEAD PROFESSOR(S)	REALE FABIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	102
COURSE ACTIVITY (Hrs)	48
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**REALE FABIO** Tuesday 12:30 14:30 Ufficio, Via Archirafi 36 Thursday 12:30 14:30 Ufficio, Via Archirafi 36

DOCENTE: Prof. FABIO REALE

PREREQUISITES	The prerequisites for profitable learning of Cloud and High Performance Computing and to achieve the objectives which it is intended are a basic knowledge of hardware and software architectures, and of computer science, including C and/or Python programming language.
LEARNING OUTCOMES	Knowledge and understanding: knowledge and basic management on cloud computing topics and numerical high performance computing. Applying knowledge and understanding: Design, implementation and testing of programs of high-performance computing systems. Rating of the applicability, validity areas, and efficiency of the methods and programs. Making judgments: Acquisition of objective assessment tools through validation test programs. Assessment and selection of different solutions and numerical systems according to the problem to be addressed. Communication skills: Acquisition of skills presentation through answers for specific open questions asked within summary tests. Clear and well-founded description of the problem to be solved, of the assumptions made and of the method used in the solution. Learning skills: Ability to apply the programming concepts in the practical implementation of algorithms on large-scales. Acquired skills. Know how to - Analyze and compare several networking topologies in terms of robustness, expandability, and throughput used within a cloud enterprise. - Design a scalable parallel algorithm for a computer firm by applying task-based decomposition or data-parallel decomposition. - Write a program for a client that correctly terminates when all concurrent tasks terminate by considering actors and/or reactive processes, deadlocks, and properly synchronized queues. - Write a test program for a company that reveals a concurrent programming error (e.g., missing an update when two activities both try to increment a variable). - Present computational results of the work and span in a program by identifying independent tasks that may be parallelized and determining the critical path for a parallel execution diagram. - Implement a parallel divide-and-conquer (and/or graph algorithm) for a client by mapping and reducing operations for the real industry problem and empirically measure its performance relative to its sequential analog.
ASSESSMENT METHODS	The evaluation is based on the outcome of the final test, in which the student does a test with open questions on all topics of the course, and then illustrates the results of the parallel computing applications with a multimedia presentation. It assesses the knowledge and management of the course topics, and the correct use of language and ability of expression. Grading: 30-30 cum laude: Excellent knowledge of the topics, excellent use of language, good analytical ability, the student is able to apply the knowledge to solve problems proposed 26-29: Good competence on the subjects, full use of the language, the student is able to apply knowledge to solve problems proposed 24-25: Basic knowledge of the main topics, discrete properties of language, with limited ability to independently apply the knowledge to the solution of the proposed problems 21-23: He/she does not have full competence about the main issues but he/she has knowledge, satisfactory use of the language, poor ability to independently apply the knowledge acquired 18-20: Minimum basic knowledge of the main topics and the technical language, very little or no ability to independently apply the knowledge acquired Insufficient: He/she does not have an acceptable knowledge of the topics covered in the course
EDUCATIONAL OBJECTIVES	The course aims to provide students with an overview and application tools on the main topics of Cloud and High Performance Computing appropriate for the master degree in Data, Algorithms, And Machine Intelligence.
TEACHING METHODS	The course is half-year long and is divided into two parts, the first on Cloud Computing, the second on High Performance Computing. A preliminary lecture explains the reasons for the arguments. In the first part lectures are held on Cloud Computing foundations, management and services with various examples of solutions offered by today's market. In the second part, lectures are held on the concept, architectures, models, designs and examples of systems and parallel programming, and then applications are studied with guided exercises in an equipped room with MPI parallel programming.
SUGGESTED BIBLIOGRAPHY	Testi di riferimento/Reference textbooks [Cloud computing] - Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing: Principles and Paradigms, John Wiley & Sons, Inc., Hoboken, New Jersey, 2017 [Parallel computing] - Blaise Barney, Introduction to Parallel Computing, https://computing.llnl.gov/tutorials/parallelcomp/, 2022 Testi di approfondimento/Supplementary textbooks

	[MPI programming] - Blaise Barney, Message Passing Interface (MPI), https://computing.llnl.gov/tutorials/mpi/, 2022

SYLLABUS

Hrs	Frontal teaching
2	Introduction: the concept of cloud and high performance computing, the structure of the course, exams, examples on field
3	Cloud computing: foundations; The concept, features and origins, classification and requirements
2	Cloud Computing: Cloud Infrastructure Management; Features of VIM, Hypervisors, Review of VIM
3	Cloud computing: Infrastructure as a Service providers, Platform as a Service providers, cloud containers, topics and challenges of Cloud computing
2	High Performance Computing: overview, concepts and terminology
3	High Performance Computing: architecture and parallel computing models
2	High Performance Computing: Design of parallel programs
3	High Performance Computing: parallel examples
2	Message Passing Interface: generalities, structure and approach, routine management
3	Message Passing Interface: communication routines
2	Message Passing Interface: example with differential equations 2D
3	Message Passing Interface: examples of compilation and running C programs parallel with MPI
3	Message Passing Interface: sequential C program of a time-dependent equation
3	Message Passing Interface: parallelizing C program on time-dependent equation
3	Message Passing Interface: implementation communication between processors with MPI
3	Message Passing Interface: test of parallel program
3	Message Passing Interface: output of parallel program
3	Message Passing Interface: analisys of the results and parallel efficiency