# Master in Computer science
## Focus Professional

The master programme includes three main types of courses: computer science lectures, an introduction to research through the writing of a Master's dissertation, and courses intended to prepare students to enter the job market.

The programme is designed for students who have general skills in computer science, which they can have acquired during the Bachelor in Computer Science at ULB:

- they are able to gather information and acquire new knowledge autonomously and with scientific rigour, and are able to adopt a critical attitude in this process.
- they master the main mathematical and formal tools needed in computer science.
- they can read technical literature in English and engage in a technical conversation in English, as most of the courses in the programme are taught in English (with a few exceptions for electives).
- They master the main concepts and skills related to programming, programming languages, algorithms, software engineering, operating systems, and fundamental theoretical results in computer science.
- they are able to design—alone or within a group—a computer application of significant complexity, efficiently using the tools of software engineering.

Students who have not acquired the appropriate background during their Bachelor may, in some cases, have the opportunity to compensate for deficiencies with a tailored curriculum.

**Bloc 1** | M-INFOS | MA-INFO

## Cours obligatoires

ELEC-H473 — Microprocessor architecture | Dragomir MILOJEVIC (Coordinator)
5 credits [lecture: 24h, practical work: 36h] second term English

INFO-F403 — Introduction to language theory and compiling | Gilles GEERAERTS (Coordinator)
5 credits [lecture: 24h, tutorial classes: 24h, project: 30h] first term English

INFO-F404 — Real-Time Operating Systems | Joël GOOSSENS (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 30h] first term English

INFO-F405 — Introduction to cryptography | Christophe PETIT (Coordinator) and Gilles VAN ASSCHE
5 credits [lecture: 24h, tutorial classes: 24h, project: 30h] first term English

INFO-F408 — Computability and complexity | Jean-François RASKIN (Coordinator)
5 credits [lecture: 36h, tutorial classes: 12h, practical work: 12h] first term English

MEMO-F403 — Preparatory work for the master thesis | Maarten JANSEN (Coordinator)
5 credits [personal assignments: 60h] second term English

## Options 1

Option - 2 modules complets dans la liste des modules 1.1 à 1.5 à choisir au cours des deux blocs.

*A total of 30 credits chosen from the following*

### Module 1.1. Software and critical systems

INFO-F410 (optional) — Embedded systems design | Jean-François RASKIN (Coordinator)
5 credits [lecture: 12h, tutorial classes: 12h, project: 60h] second term English

INFO-F412 (optional) — Formal verification of computer systems | Jean-François RASKIN (Coordinator)
5 credits [lecture: 36h, tutorial classes: 12h] second term English

INFO-F514 (optional) Protocols, cryptanalysis and mathematical cryptology | Olivier MARKOWITCH (Coordinator), Liran LERMAN and Christophe PETIT
5 credits [lecture: 24h] second term English

## Module 1.2. Computational Intelligence

INFO-F409 (optional) Learning dynamics | Tom LENAERTS (Coordinator)
5 credits [lecture: 24h, project: 60h] first term English

INFO-F422 (optional) Statistical foundations of machine learning | Gianluca BONTEMPI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] second term English

INFO-H410 (optional) Techniques of artificial intelligence | Hugues BERSINI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h] second term English

## Module 1.3. Optimization

INFO-F424 (optional) Combinatorial optimization | Bernard FORTZ (Coordinator) and RENAUD CHICOISNE
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 12h, project: 30h] second term English

INFO-F524 (optional) Continuous optimization | Bernard FORTZ (Coordinator) and Dimitrios PAPADIMITRIOU
5 credits [lecture: 24h, project: 60h] second term English

INFO-H413 (optional) Heuristic optimisation | Thomas,T STUTZLE (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] second term English

## Module 1.4. Algorithms

INFO-F413 (optional) Data structures and algorithms | Jean CARDINAL (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] first term English

INFO-F420 (optional) Computational geometry | Stefan LANGERMAN F. SWARZBERG (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] first term English

INFO-F521 (optional) Graph theory | Gwenaël JORET (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] first term English

## Module 1.5. Web and information systems

INFO-H415 (optional) Advanced databases | Esteban ZIMANYI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] first term English

INFO-H417 (optional) Database systems architecture | Mahmoud SAKR (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] first term English

INFO-H515 (optional) Big Data: Distributed Data Management and Scalable Analytics | Dimitrios SACHARIDIS (Coordinator) and Gianluca BONTEMPI
5 credits [lecture: 24h, tutorial classes: 12h, project: 24h] second term English

# Master in Computer science
## Focus Professional

**Bloc 2** | M-INFOS | MA-INFO

## Cours obligatoires

INFO-F530 — Computer science seminar | Tom LENAERTS (Coordinator), Jérôme De Boeck, Bernard FORTZ, John IACONO and Olivier MARKOWITCH
5 credits [seminars: 36h, project: 60h] | first and second terms | English

MEMO-F524 — Masters thesis | Jean-François RASKIN (Coordinator)
20 credits [mfe/tfe: 240h] | first and second terms

*An alternative chosen from the two following*

## Options 1

35 ECTS à choisir dans les options 1 dont minimum 2 modules complets au cours des 2 blocs. (60 crédits sur l'ensemble du cycle)

*Up to 60 credits chosen from the following*

### Module 1.1 Software and critical systems

INFO-F410 (optional) — Embedded systems design | Jean-François RASKIN (Coordinator)
5 credits [lecture: 12h, tutorial classes: 12h, project: 60h] | second term | English

INFO-F412 (optional) — Formal verification of computer systems | Jean-François RASKIN (Coordinator)
5 credits [lecture: 36h, tutorial classes: 12h] | second term | English

INFO-F514 (optional) — Protocols, cryptanalysis and mathematical cryptology | Olivier MARKOWITCH (Coordinator), Liran LERMAN and Christophe PETIT
5 credits [lecture: 24h] | second term | English

### Module 1.2 Computational Intelligence

INFO-F409 (optional) — Learning dynamics | Tom LENAERTS (Coordinator)
5 credits [lecture: 24h, project: 60h] | first term | English

INFO-F422 (optional) — Statistical foundations of machine learning | Gianluca BONTEMPI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] | second term | English

INFO-H410 (optional) — Techniques of artificial intelligence | Hugues BERSINI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h] | second term | English

### Module 1.3 Optimization

INFO-F424 (optional) — Combinatorial optimization | Bernard FORTZ (Coordinator) and RENAUD CHICOISNE
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 12h, project: 30h] | second term | English

INFO-F524 (optional) — Continuous optimization | Bernard FORTZ (Coordinator) and Dimitrios PAPADIMITRIOU
5 credits [lecture: 24h, project: 60h] | second term | English

INFO-H413 (optional) — Heuristic optimisation | Thomas,T STUTZLE (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] | second term | English

## Module 1.4 Algorithms

INFO-F413 (optional)
Data structures and algorithms | Jean CARDINAL (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] first term English

INFO-F420 (optional)
Computational geometry | Stefan LANGERMAN F. SWARZBERG (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] first term English

INFO-F521 (optional)
Graph theory | Gwenaël JORET (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] first term English

## Module 1.5 Web and Information Systems

INFO-H415 (optional)
Advanced databases | Esteban ZIMANYI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] first term English

INFO-H417 (optional)
Database systems architecture | Mahmoud SAKR (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] first term English

INFO-H515 (optional)
Big Data: Distributed Data Management and Scalable Analytics | Dimitrios SACHARIDIS (Coordinator) and Gianluca BONTEMPI
5 credits [lecture: 24h, tutorial classes: 12h, project: 24h] second term English

## Module 2.1 Software and critical systems

INFO-Y082 (optional)
Distributed and mobile programming paradigms | Elisa GONZALEZ BOIX
6 credits [lecture: 26h, tutorial classes: 26h, project: 30h] first term English

INFO-Y085 (optional)
Functional programming | Wolfgang DE MEUTER (Coordinator)
6 credits [lecture: 26h, tutorial classes: 26h] second term English

INFO-Y099 (optional)
Multicore programming | SWALLENS Janwillem
6 credits [lecture: 26h, tutorial classes: 26h] second term English

INFO-Y1001 (optional)
Practical Parallel Program | Jan LEMEIRE
3 credits [lecture: 12h, project: 30h] first term French

INFO-Y1002 (optional)
GPU computing | Jan LEMEIRE
5 credits [lecture: 12h, project: 45h] second term French

INFO-Y110 (optional)
Higher Order Programming | Nicolas JENS
6 credits [lecture: 26h, tutorial classes: 26h] first term

## Module 2.2 Computational Intelligence

INFO-F439 (optional)
Advanced Methods in Bioinformatics | Matthieu DEFRANCE (Coordinator) and Wim VRANKEN
5 credits [lecture: 24h, project: 90h] second term English

INFO-H414 (optional)
Swarm Intelligence | Marco DORIGO (Coordinator) and Mauro BIRATTARI
5 credits [lecture: 12h, practical work: 48h] second term English

INFO-H515 (optional)
Big Data: Distributed Data Management and Scalable Analytics | Dimitrios SACHARIDIS (Coordinator) and Gianluca BONTEMPI
5 credits [lecture: 24h, tutorial classes: 12h, project: 24h] second term English

INFO-Y004 (optional)
Natural language processing | Paul VAN EECKE
6 credits [lecture: 26h, tutorial classes: 26h] first term English

INFO-Y087 (optional)
Declarative programming | WIGGINS Geraint and VAN EECKE Paul
6 credits [lecture: 26h, tutorial classes: 26h] second term English

## Module 2.3 Optimization

## Module 2.4 Algorithms

INFO-F440 (optional)
Algorithms for big data | John IACONO (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] second term English

INFO-H514 (optional) Quantum information and computation | Nicolas CERF (Coordinator), Ognyan Oreshkov and Jérémie ROLAND
5 credits [lecture: 24h, tutorial classes: 24h] second term English

## Module 2.5 Web and Information Systems

INFO-H419 (optional) Data warehouses | Esteban ZIMANYI (Coordinator)
5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] first term English

INFO-H420 (optional) Management of Data Science and Business Workflows | Dimitrios SACHARIDIS (Coordinator)
5 credits [lecture: 24h, tutorial classes: 36h] first term English

INFO-H509 (optional) Geo-Spatial and web technologies | Mahmoud SAKR (Coordinator)
5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] second term English

INFO-Y528 (optional) Information visualisation
6 credits [lecture: 26h, tutorial classes: 26h] second term English

## Module 2.6 Internship

GEST-S483 (optional) Digital and IT Governance | Georges ATAYA (Coordinator)
5 credits [lecture: 24h] second term English

TRAN-F501 (optional) Internship | Gianluca BONTEMPI (Coordinator) and Maarten JANSEN
15 credits [project: 200h] first term English

*or*

# Variante Master ORO - Université de Nantes

Students attending one or two semesters at the University of Nantes in the framework of the double diploma register to the 30 or 60 ECTS corresponding to their stay in Nantes in Block 2.

INFO-Y515 (optional) Large Scale Optimisation
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y516 (optional) Discrete Constraint Programming
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y517 (optional) Global Optimization
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y518 (optional) Black-box Optimization
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y519 (optional) Multi-Objective Optimization
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y520 (optional) Cloud Artifcial Intelligence Services
3 credits [lecture: 13h, tutorial classes: 13h] academic year English

INFO-Y521 (optional) Transportation and Logistics
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y522 (optional) Planning and Scheduling
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y523 (optional) Bioinfomatics
3 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y524 (optional) OR Special Topic II
2 credits [lecture: 13h, tutorial classes: 13h] academic year

INFO-Y525 (optional) Conferences
1 credit [tutorial classes: 26h] academic year

INFO-Y526 (optional) Master Thesis (track research)
20 credits academic year

INFO-Y527 (optional) Internship (track application)
10 credits academic year