**PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA**

**MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH**

# HARMONIZATION

# MASTER TRAINING OFFER

## ACADEMIC

| Establishment | Faculty / Institute | Department |
|---|---|---|
| **University of Mohamed Khider Biskra** | **Faculty of Exact Sciences and natural and life sciences** | **Computer sciences department** |

**Domain : Mathematics and Computer Science**

**Sector : Computer sciences**

**Speciality : Artificial intelligence**

**College year : 2023/2024**

# الجمهورية الجزائرية الديمقراطية الشعبية

## وزارة التعليم العالي والبحث العلمي

# مواءمة

# عرض تكوين ماستر

# أكاديمي

| المؤسسة | الكلية/ المعهد | القسم |
|---|---|---|
| جامعة محمد خيضر بسكرة | كلية العلوم الدقيقة و علوم الطبيعة و الحياة | قسم الإعلام الآلي |

**الميدان : رياضيات و اعلام آلي**

**الشعبة : اعلام آلي**

**التخصص : الذكاء الاصطناعي**

**السنة الجامعية: 2024/2023**

# SUMMARY

# I – Fiche d'identité du Master
## (Tous les champs doivent être obligatoirement remplis)

# 1 - Training location :

**Faculty (or Institute) : Faculty of exact sciences and natural and life sciences**

**Department : Computer sciences department**

# 2- Training partners *:

- other academic establishments:

- businesses and other socio-economic partners:

- International partners:

* = Present the conventions as an appendix to the training

# 3 – Context and objectives of the training

## A – Access conditions *(indicate the license specialties which can give access to the Master)*

### In M1 :

- Academic Degree in Computer Science
- A recognized equivalent title

### In M2 :

- M1 with bases in artificial intelligence
- (File study)

## B - Training aims *(targeted skills, pedagogical knowledge acquired at the end of the training - maximum 20 lines)*

The Master's program in Computer Science offers specialized training in computer science. It prepares students for managerial roles in the field of information technology, whether in businesses or research centers and laboratories. The curriculum combines fundamental theoretical instruction with the implementation of applications through supervised projects, as well as an introduction to the professional environment through internships in companies or laboratories.

This Master's program enhances and broadens basic knowledge in computer science, particularly in software engineering, algorithmics, and artificial intelligence. Through the selection of options, students have the opportunity to explore various specialized areas such as Artificial Intelligence, Expert Systems, Natural Language Processing, and Computer Vision.

The curriculum is structured around the acquisition of fundamental knowledge that enables students to adapt to the necessary evolution of their future activities. Practical skills are developed through machine-based projects, facilitating a quick integration into the professional world.

- The training is built upon a strong common theoretical foundation in the first year (M1), followed by a specific track in 'Artificial Intelligence' in the second year (M2).

## C – Targeted job profiles and skills *(in terms of professional integration) :*

This training aims to strengthen candidates with a solid understanding of artificial intelligence that they can use to address research questions. On one hand, it focuses on the most open areas in artificial intelligence, such as multi-agent systems, neural networks, and natural language processing. On the other hand, it emphasizes the application of artificial intelligence techniques in databases, information systems, and the web.

## D- Regional and national employability potential of graduates

The research topics addressed within the research team have contributed to promoting skills in the field of Artificial Intelligence at the national level. This is attributed to the positive results

achieved in regular training programs, especially at the master's level in the same field through Postgraduate (LMD) programs. Consequently, the expected impact is anticipated both in terms of training and research at the regional and national levels.

## E – Gateways to other specialties

- Towards other Masters with equivalent units.

## F – Training monitoring indicators

## G – Supervisory capacity (give the number of students that can be supported)

30 Students

## 4 – Human resources available

### A : Teachers of the establishment working in the specialty :

| Nom, prénom | Diplôme graduation + Spécialité | Diplôme Post graduation + Spécialité | Grade | Type d'intervention * | Emargement |
|---|---|---|---|---|---|
| KAZAR Okba | Ingénieur en Informatique | Doctorat d'état en Informatique | Prof | Cours, TD, TP, Encadrement | |
| SAOULI Rachida | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| BABAHENINI Mohamed Chaouki | Ingénieur en Informatique | Doctorat d'état en Informatique | Prof | Cours, TD, TP, Encadrement | |
| TERRISSA Sadek Labib | Ingénieur en électronique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| KAHLOUL Laid | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| BENNOUI Hammadi | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| REZEG Khaled | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| DJEROU Leila | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| DJEFFAL Abdelhamid | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| BITAM Salim | Ingénieur en Informatique | Habilitation en Informatique | Prof | Cours, TD, TP, Encadrement | |
| SLATNIA Siham | Ingénieur en Informatique | Habilitation en Informatique | M.C.A | Cours, TD, TP, Encadrement | |

| | | | | | |
|---|---|---|---|---|---|
| AYAD Soheyb | Ingénieur en Informatique | Habilitation en Informatique | M.C.A | Cours, TD, TP, Encadrement | |
| BOUREKKACHE Samir | Ingénieur en Informatique | Habilitation en Informatique | M.C.A | Cours, TD, TP, Encadrement | |
| TIBERMACINE Ahmed | Master en Informatique | Habilitation en Informatique | M.C.A | Cours, TD, TP, Encadrement | |
| SAHRAOUI Somia | Master en Informatique | Habilitation en Informatique | M.C.A | Cours, TD, TP, Encadrement | |
| BENSGHIR Nadia | Ingénieur en Informatique | Habilitation en Informatique | M.C.A | Cours, TD, TP, Encadrement | |
| ABDELLI Belkacem | Ingénieur en Informatique | Doctorat en Informatique | M.C.B | Cours, TD, TP, Encadrement | |
| MERIZIG Abdelhak | Master en Informatique | Doctorat en Informatique | M.C.B | Cours, TD, TP, Encadrement | |
| BELOUAAR Hocine | Ingénieur en Informatique | Doctorat en Informatique | M.C.B | Cours, TD, TP, Encadrement | |
| BERGHIDA Meryem | Master en Informatique | Doctorat en Informatique | M.C.B | Cours, TD, TP, Encadrement | |
| BENDAHMANE TAWFIK | Ingénieur en Informatique | Magister en Informatique | M.A.A | Cours, TD, TP, Encadrement | |
| MOHAMEDI Amira | Ingénieur en Informatique | Magister en Informatique | M.A.A | Cours, TD, TP, Encadrement | |
| HAMIDA Ammar | Ingénieur en Informatique | Magister en Informatique | M.A.A | Cours, TD, TP, Encadrement | |
| ZOUAI Meftah | Master en Informatique | Doctorat en Informatique | M.A.B | Cours, TD, TP, Encadrement | |
| AMMARI Asma | Master en Informatique | Doctorat en Informatique | M.A.B | Cours, TD, TP, Encadrement | |
| BELAALA Abir | Master en Informatique | Doctorat en Informatique | M.A.B | Cours, TD, TP, Encadrement | |

| | | | | | |
|---|---|---|---|---|---|
| GUERROUF Fayçal | Ingénieur en Informatique | Doctorat en informatique | M.C.B | Cours, TD |  |

*** = Course, Tutorials, practical work, Internship supervision, Memory framing, other ( specify)**

## B : External supervision:

**Home establishment:** INSA University of Lyon

| Full name | Graduation Diploma + Specialty | Post graduation diploma + Specialty | Grade | Type of intervention* | Registration |
|---|---|---|---|---|---|
| Jean Marie Pinon | | HDR + PhD | **Prof** | **Course, Tutorials, practical work supervision** | |
| Youssef AMGHAR | | HDR + PhD | **Prof** | **Course, Tutorials, practical work supervision** | |
| Nabila BENHARKAT | | HDR + PhD | **MCA** | **Course, Tutorials, practical work, supervision** | |

**Etablissement de rattachement :** Université Lumière de Lyon2

| Nom, prénom | Graduation Diploma + Specialty | Post graduation diploma + Specialty | Grade | Type of intervention * | Registration |
|---|---|---|---|---|---|
| Abdelaziz BOURAS | | HDR + PhD | Prof | **Course, Tutorials, practical work, supervision** | |
| Omar Boussaid | | HDR + PhD | Prof | **Course, Tutorials, practical work, supervision** | |

# 5 – Specific material resources available

## A- Educational Laboratories and Equipment : Sheet of existing educational equipment for the practical work of the planned training **(1 sheet per laboratory)**

**Laboratory title: Computing center**

| N° | Equipment title | Quantity | Observations |
|---|---|---|---|
| 01 | SERVER HP ProLiant ML370G5<br>* 2 processors Intel Xeon Quadricoeur :.33 GHZ<br>* RAM :6 Go<br>* DD : 6x 140 Go<br>* DAT player : Hp Dat 72 USB. * TFT Screen + Keyboard | 06 | Local networks + permanent internet access Operating systems. Windows/Linux |
| 02 | HP thin client workstation:<br>19 screen + Light unit + keyboard + Mouse | 25 | |
| 03 | PC HP Compaq dx 2300 dual core 1.8 ghz, Ram: 1 GB, D D: 160 GB + Mouse + keyboard + Screen 19`` | 25 | |
| 04 | Dell proc dual core 1.80 Ghz<br>Ram : 512 Mo D.D: 80 Go | 25 | |
| 05 | PC : HP Compaq dx 2400 dual core<br>RAM: 1 Go DD: 160 Go écran 17`` | 10 | |
| 06 | Network cabinet<br>3000 VA UPS<br>2 MB ADSL modem<br>Switch catalyst 2960 24 ports | 01<br>01<br>01<br>05 | Local network |

**Laboratory title:** Network laboratory

| N° | Equipment title | Quantity | Observations |
|---|---|---|---|
| 01 | PC Dell P4 3.06 Ghz<br>Ram: 512Mo D.D: 80Go | 20 | |
| 02 | Laboratoire CISCO (switch, materiel de formation) | | |

**Laboratory title:** Computer Rooms

| N° | Equipment title | Nombre | Observations |
|---|---|---|---|
| 01 | Dell PC | 25 | |
| 02 | Computing station | 02 | |

## B- Terrains de stage et formation en entreprise :

| Lieu du stage | Nombre d'étudiants | Durée du stage |
|---|---|---|
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## C- Laboratoire(s) de recherche de soutien au master :

| Chef du laboratoire : KAZAR Okba |
|---|
| N° Agrément du laboratoire : Num 242 |
| Date : du 03/04/2013<br>Avis du chef de laboratoire : |

## B- Master's support research project(s):

| Title of the research project | Project code | Project start date | Project end date |
|---|---|---|---|
| Système décisionnel prédictif pour l'amélioration de production agricole dans les zones arides | C00L07UN070120220009 | | |
| Un environnement de développement des approches sur les systèmes intelligents et la science de données (data science) | C00L07UN070120210001 | | |
| L'intelligence artificielle et le cloud computing pour la réalisation d'une plateforme | C00L07UN070120220003 | | |
| Automatisation de migration des applications monolithiques aux applications microservices dans le contexte de Cloud. | C00L07UN070120220008 | | |

## C- Personal work spaces and ICT:

- Intranet space of Mohamed Khider Biskra University.
- LINFI laboratory
- Computer center of the computer science department.
- Conference vision room
- Documentation center (all dissertations from 2000 to 2021: engineer, master's license)
- Remote teaching room for final-year students.
- Wireless network (wifi internet) of the IT department

## II – Half-yearly teaching organization sheet

(Please present the forms for the 4 semesters)

## 1- Semester 1 :

| Teaching unit | SHV | Weekly H.V | | | | Coeff | Credits | Evaluation mode | |
|---|---|---|---|---|---|---|---|---|---|
| | 14-16 sem | C | TD | TP | Others/ Personal work | | | Continuous | Exam |
| **Fundamental EU** | | | | | | | | | |
| **FEU1. Advanced systems and architectures** | **168h** | **4h30** | **3h** | **4h30** | **4h** | **9** | **18** | | |
| Distributed systems | 63h | 1h30 | 1h30 | 1h30 | 1h30 | 3 | 6 | 50% | 50% |
| Advanced algorithms and parallel architectures | 63h | 1h30 | 1h30 | 1h30 | 1h | 3 | 6 | 50% | 50% |
| Communication networks | 42h | 1h30 | - | 1h30 | 1h30 | 3 | 6 | 33% | 67% |
| **Methodology EU** | | | | | | | | | |
| **MEU1. Data Science and Learning** | **105h** | **3h** | **1h30** | **3h** | **2h** | **4** | **9** | | |
| Introduction to Data Science | 63h | 1h30 | 1h30 | 1h30 | 1h | 2 | 5 | 50% | 50% |
| Artificial learning | 42h | 1h30 | - | 1h30 | 1h | 2 | 4 | 50% | 50% |
| **Transverse EU** | | | | | | | | | |
| **TEU1. Entrepreneurship and English** | **42h** | **3h** | **-** | **-** | **1h** | **2** | **3** | | |
| Entrepreneurship | 21h | 1h30 | - | - | 1h | 1 | 2 | - | 100% |
| English 1 | 21h | 1h30 | - | - | 1h | 1 | 1 | - | 100% |
| **Total Semester 1** | 315h | 10h30 | 4h30 | 7h30 | 7h | **15** | **30** | | |

## 2- Semester 2 :

| Teaching unit | SHV | Weekly H.V | | | | Coeff | Credits 14-16 sem | Evaluation mode | |
|---|---|---|---|---|---|---|---|---|---|
| | 14-16 sem | C | TD | TP | Others/ Personal work | | | C | TD |
| **Fundamental EU** | | | | | | | | | |
| **FEU2.1 Representation of knowledge for AI** | **126h** | **3h** | **3h** | **3h** | **2h30** | **6** | **11** | | |
| Knowledge representation and reasoning | 63h | 1h30 | 1h30 | 1h30 | 1h30 | 3 | 6 | 50% | 50% |
| Logic for artificial intelligence | 63h | 1h30 | 1h30 | 1h30 | 1h | 3 | 5 | 50% | 50% |
| **FEU2.2 Cloud computing and modeling** | **84h** | **3h** | **-** | **3h** | **2h30** | **4** | **8** | | |
| Cloud Computing and Bigdata | 42h | 1h30 | - | 1h30 | 1h | 2 | 4 | 50% | 50% |
| Modeling and evaluation of system performance | 42h | 1h30 | - | 1h30 | 1h30 | 2 | 4 | 33% | 67% |
| **Methodology EU** | | | | | | | | | |
| **MEU2. Complexity and data analysis** | **105h** | **3h** | **3h** | **1h30** | **2h** | **4** | **9** | | |
| Complexity and Optimization | 63h | 1h30 | 1h30 | 1h30 | 1h | 2 | 5 | 50% | 50% |
| Data analysis | 42h | 1h30 | 1h30 | - | 1h | 2 | 4 | 33% | 67% |
| **Transverse EU** | | | | | | | | | |
| **TEU2. Research methodology** | **21h** | **1h30** | **-** | - | **1h** | **1** | **2** | | |
| Research methodology | 21h | 1h30 | - | - | 1h | 1 | 2 | - | 100% |
| **Total Semester 2** | 336h | 10h30 | 6h | 7h30 | 8h | 15 | **30** | | |

## 3- Semester 3 :

| Teaching unit | SHV | Weekly H.V | | | | Coeff | Credits 14-16 sem | Evaluation mode | |
|---|---|---|---|---|---|---|---|---|---|
| | 14-16 sem | C | TD | TP | Others/ Personal work | | | C | TD |
| **Fundamental EU** | | | | | | | | | |
| **FEU3. Fondement de l'intelligence Artificielle** | **147h** | **6h** | **1h30** | **3h** | **3h** | **9** | **18** | | |
| Advanced Artificial Intelligence techniques | 42h | 3h | - | - | 1h | 3 | 6 | 25% | 75% |
| Web intelligence and IoT | 63h | 1h30 | 1h30 | 1h30 | 1h | 3 | 6 | 50% | 50% |
| Distributed artificial intelligence and multi-agent systems | 42h | 1h30 | - | 1h30 | 1h | 3 | 6 | 50% | 50% |
| **Methodology EU** | | | | | | | | | |
| **MEU3. Artificial intelligence techniques** | **105h** | **4h30** | **1h30** | **3h** | **2h** | **4** | **9** | | |
| Natural language processing and pattern recognition | 63h | 1h30 | 1h30 | 1h30 | 1h | 2 | 5 | 50% | 50% |
| Bioinformatics systems | 42h | 1h30 | - | 1h30 | 1h | 2 | 4 | 50% | 50% |
| **Transverse EU** | | | | | | | | | |
| **TEU3. Software project management and English** | **42h** | **1h30** | **-** | **-** | **2h** | **2** | **3** | | |
| Software project management | 21h | 1h30 | - | - | 1h | 1 | 2 | - | 100% |
| English 2 | 21h | 1h30 | - | - | 1h | 1 | 1 | - | 100% |
| **Total Semester 3** | 294h | 12h | 3h | 6h | 7h | **15** | **30** | | |

## 4- Semester 4 :

**Domain : Maths - Computer Science**
**Sector : Computer Science**
**Speciality : Artificial Intelligence**

Internship in a company culminating in a dissertation and a defense.

The S4 semester is reserved for an internship or introductory research work, culminated by a dissertation and a defense.

| | SHV | Coeff | Credits |
|---|---|---|---|
| **Personal work** | | | |
| **Internship in company** | | | |
| **Seminars** | | | |
| **other (explain)** | 12h/weekly, i.e. 144 hours for the semester | 15 | 30 |
| **Total Semester 4** | 144h | 30h | 30h |

## 5- Overall summary of the training: (indicate the separate global HV in progress, Tutorials, for the 04 semesters of teaching, for the different types of EU)

| EU / HV | FEU | MEU | DEU | TEU | Total |
|---|---|---|---|---|---|
| **Course** | 231 | 126 | - | 84 | 441 |
| **Tutorials** | 105 | 84 | - | - | 189 |
| **Practical work** | 189 | 105 | - | - | 294 |
| **Personal work** | 168 | 84 | - | 70 | 322 |
| **other (explain)** | 144 | - | - | - | 144 |
| **Total** | 837 | 399 | 0 | 154 | 1390 |
| **Credits** | 85 | 27 | 0 | 8 | 120 |
| **% in credits for each EU** | 70% | 22.5% | - | 7.5% | 100% |

# III - Detailed program by subject

(1 detailed sheet per subject)

## Title of the Master: Artificial Intelligence

**Semester: S1**
**EU title: Advanced systems and architectures**
**Subject title: Distributed systems**
**Credits: 6**
**Coefficients: 3**

### Teaching objectives

This course is dedicated to the fundamental aspects of distributed systems and the challenges involved in their design and implementation. Special emphasis will be placed on addressing the lack of global time in asynchronous systems and on basic techniques for designing fault-tolerant systems.

### Recommended prior knowledge

Concepts of processes, synchronization, and communication in a centralized system. In the L cycle of the LMD system, students have taken two courses dedicated to these concepts.

### Content of the subject:

I- Concept of competition.
- The different interpretations of competition.

II- Time and state in a distributed system.
- Causality and ordering of events in a distributed system;
- Overall state of a distributed system; consistent cuts applications: save-resume algorithms, detection of stable properties;
- Global scheduling by logical application clocks: mutual exclusion, distributed queues;
- Causal scheduling by vector clocks applications: observation, fine-tuning;
- Synchronization of physical clocks

III- Distributed process cooperation
- Virtual ring, insertion and removal protocols, failure management;
- Application election algorithms: group management;
- Termination detection algorithms. Application: distributed garbage collection.

IV- Fault tolerance
- Failure hypotheses;
- Specification of coherence: linearization, sequential coherence, causal coherence;
- Primary copy and active duplication;Algorithmes de diffusion fiable et gestion de groupes de processus.

V- Distributed information management
- Principles of distributed object management;
- Implementation: virtual memory, distributed objects;
- Large-scale distribution;

- Cache management, duplication, consistency;
- Applications: P2P systems.

**Evaluation method:** 50 % Exam + 25 % Tutorials + 25 % practical works

**References**


1. R. Guerraoui, L. Rodrigues, ***Reliable Distributed Programming***, Springer, 2006.
2. A. S. Tanenbaum, M. van Steen, ***Distributed Systems - Principles & Paradigms***, Prentice Hall, 2002.
3. S. Mullender (editor), ***Distributed Systems***, 2nd ed., Addison-Wesley, 1993.
4. M. Singhal, N. G. Shivaratri, ***Advanced Concepts in Operating Systems***, McGraw-Hill, 1994.
5. V. C. Barbosa, ***Introduction to Distributed Algorithms***, MIT Press, 1996.
6. C.A.R. Hoare, *Communicating Sequential Process*, Prentice Hall Intern. 2004.
7. A. Silberschatz et J.L. Peterson, ***Operating System Concepts***, Addison-Wesley, 1983.

## Title of the Master : Artificial Intelligence

**Semester *: S1***
**EU title : Advanced systems and architectures**
**Title of the subject : Advanced Algorithmics and Parallel Architectures**
**Credits : 6**
**Coefficients : 3**

### Teaching objectives

This course introduces students to parallel architectures and algorithms, specifically vector architectures, systolic architectures, and their associated algorithms.

**Recommended prior knowledge**

Basic architecture of a Von Neumann machine. Indeed, in the LMD system, students have taken courses dedicated to computer architecture in the Bachelor's degree cycle.

### Content of the subject:

**Chapiter I. Introduction to parallel architectures**

- Motivations for parallelism.
- Sequential and parallel architectures.
- Organization of Parallel Architectures.
- Sources of parallelism.
- Sequential VS Parallel Complexity.
- P-RAM (Parallel - Random Access Machine) model and algorithms:
- Illustration of Coole's algorithm for parallel merge sort
- Evaluation of the Performance of parallel programs.

**Chapiter II. Parallel programming models**

- SPMD type programming model:
  Presentation of the distributed memory model: OpenMPI,
  Presentation of the shared memory model: OpenMP,
- SIMD type programming model:
  GPGPU (general graphics card processing)

**Chapiter III. Interconnection networks**

- Static graphs and topologies
- Communication protocols in parallel machines:
  *Circuit switching, Store & Forward, Wormhole*
- The interconnection of dynamic topologies
- Routing in Crossbar networks
- Case study: Hypercube
  (architecture and routing algorithms)

**Chapiter IV. High performance parallel architectures**

- Reminder on floating point calculation,
- Vector execution and principle of interleaved memory,
- Vectorization conditions: illustration of the raster product,
- Introduction to BLAS (Level 1),

- Illustration of the LU matrix decomposition algorithm,
- Vector instruction and Vectorization of a scalar product,

**Evaluation method:**

50 % Exam + 25 % practical works + 25 % tutorials

**References** *(Books and handouts, websites, etc.).*


[1]. Legrand et Y. Robert, Algorithmique Parallèle, Dunod (2004).

[2]. Olivier Pironneau, Optimisation des performances et Parallélisme en C/C++ - openMP - MPI - UPC - CUDA –openCL, University of Paris VI

[3]. Barbara Chapman, Gabriele Jost, Ruud van der Pas. Using OpenMP Portable Shared Memory Parallel Programming, The MIT Press, Cambridge, Massachusetts London, England (2008).

[4]. Jean-Paul Sansonnet. Architectures des machines parallèles CNRS 1992.

[5]. A. Legrand et Y. Robert. Algorithmique Parallèle. Dunod (2004).

[6]. Philippe MARQUET. Programmation parallèle et distribuée. Université des sciences et technologies de Lille. 2008

## Title of the Master : Artificial Intelligence

**Semester *: S1***

**EU title : Advanced systems and architectures**

**Title of the subject : Communication networks**

**Credits : 6**

**Coefficients : 3**

### Teaching objectives

The communication networks subject aims to enable the student to:

- Understand and be able to implement various devices and protocols used in both fixed and mobile networks.
- Design, configure, and manage fixed and mobile networks, considering the requirements of applications.

### Recommended prior knowledge

- Networks (Bechlor 2), distributed systems.

### Content of the material:

1- Reminder on the link layer

- Concurrent access to support, the CSMA/CD protocol, ...

2- The network layer

- Reminder on the IPv4 protocol
- Routing in IP networks:
  * Distance vector routing protocols
  * Link-state routing protocols.
- The IPv6 protocol
- Management of coexistence between IPv4 and IPv6 networks.
  * Coexistence based on Tunneling.
  * Coexistence based on Gateways.

3- The transport layer

- TCP protocols
- The UDP protocol

4- Quality of service (QoS) in IP networks

- QoS settings
- Network factors that influence the QoS of communications.
- TCP/IP and QoS protocols

5- Introduction to wireless communication networks

- Cellular wireless networks
- Ad Hoc wireless networks

**Evaluation method :** 50 % Exam + 25 % practical works + 25 % Personal work

### References


1. Kurose, J. F., & Ross, K. W. (2021). Computer Networking A Top-Down Approach. Peasron Editions. 2021.
2. Bonaventure, O., Networking : Principles, Protocols and Practice, 3 rd Edition, 2021.
3. Lannone, E., Telecommunication networks, O'Reilly Edition, 2017.

## Title of the Master : Artificial Intelligence

**Semester *: S1***

**EU title : Data science and learning**

**Subject title : Introduction to data science**

**Credits : 5**

**Coefficients :** 2

### Teaching objectives

The student will be introduced to basic concepts necessary for a rigorous and valid analysis of data (big data). They will be introduced to the processes of collecting, manipulating, and cleaning data while gaining experience in evaluating the quality of data sources. The student can also use statistical analysis and predictive modeling tools, as well as apply data evaluation and visualization techniques in various domains. The student will also be able to validate their programming knowledge to perform these tests in a suitable programming language using existing statistical libraries (Python)..

### Recommended prior knowledge

Programming language : python, linear algebra

### Content of the material:

**Chapter 1. Learning problem**

- The Data Science Lifecycle
- Learning Components
- Types of learning
- Learning feasibility
- Data error and noise

**Chapter 2. Learning versus model testing**

- Generalization theorem
- Interpretation of bound generalization
- Approximation-generalization compromise

**Chapter 3 : Data Analysis and Intelligent Data Mining**

**Chapter 4 : Linear models**

- Linear classification
- Linear regression
- Logistic regression
- Non-linear transformation

**Chapter 5 : The Overfitting problem**

**Chapter 6 : Data evaluation and visualization**

### Evaluation method:

50% Final exam + 25% tutorials + 25% practical works.

### References


1. Yaser S Abu-mostafa, malik magdom Ismail, Hauam Tieu Lin, “Learning from data”, 2012.
2. Alan agresti, Christine franklin, “Statistics: the art and science of learning from data 4th edition”, 2006.
3. Venelin Valkov, “Hacker’s guide to machine learning with python”, Kindle Edition, 2020
4. Laura Igual, Santi Seguí, “Introduction to Data Science A Python Approach to Concepts, Techniques and Applications”, 2017., Springer.
5. Martin Braschler, Thilo Stadelmann, Kurt Stockinger, “Applied Data Science”, Springer, 2019.

## Title of the Master : Artificial Intelligence

**Semester *: S1***
**EU title : Data science and learning**
**Subject title : Artificial learning**
**Credits : 4**
**Coefficients : 2**

### Teaching objectives

This course will enable students to understand various types of Artificial Learning, primarily through optimization, to acquire skills in *Machine Learning* and *Deep Learning*.

### Recommended prior knowledge

- Programming language: C, python
- Probabilities

### Content of the material:

**Chapter I. Neural networks**

- Machine learning and types of learning,
- Fundamentals of artificial neurons,
- The Perceptron Single-layer and Multi-layer network
- Learning RNs:
  Case of a 2C and multi-C single layer perceptron
- Error gradient backpropagation algorithm

**Chapter II. AI and deep learning**

- Machine Learning vs. Deep Learning Workflows
- Neural networks and deep learning
- Description of training data
- Overview of Convolutional Neural Networks (CNN):
  The convolution operation and the neural network,
  Control parameters and activation functions,
- Overview of learning VGGnet networks

**Chapter III. Bayesian Networks**

- Presentation of the RBs
- Conditional independence and d-separation
- Definition of a RB
- Inference schemes in RBs
- Generalized d- separation
- RB learning algorithms:
  Case of incomplete data and known structure
  Case of incomplete data and known structure
- RBs adapted to classification

**Chapter IV. Hidden Markov Chains**

- The observable Markov model
- The Hidden Markov Model (HMM)
- Algorithms for evaluating the probability of observing a sequence:
- Direct assessment

Evaluation using forward-backward functions

- Finding the most likely path
  (the Viterbi algorithm)
- Learning HMMs
  Baum-Welch algorithm and re-estimation forms

**Evaluation method.**

50 % Exam + 25% Practical work + 25 % Personal work.

**References.**


- A. Cornuéjols, L. Miclet, Y. Kodratoff . Apprentissage artificiel - Concepts et algorithmes. Eyrolles 2002 (1ère edition).
- P. Naïm, P. Wuillemin, P. Leray, O. Pourret, A. Becker. Réseaux bayésiens. Eyrolles2007 (3e édition).
- Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep learning. Cambridge : MIT press. (Vol. 1).
- Stephen Marsland. MACHINE LEARNING, An Algorithmic Perspective. Second Edition. Chapman & Hall/CRC. 2015.
- Welch, L. R. (2003). Hidden markov models and the baum-welch algorithm. IEEE Information Theory Society Newsletter , 53(4), 10- 13.
- Barra, V., Miclet, L., & Cornuéjols, A. (2021). Apprentissage artificiel-4e édition: Concepts et algorithmes-De Bayes et Hume au Deep Learning. Editions Eyrolles.
- Murphy, K. P. (2022). Probabilistic machine learning: an introduction. MIT press.

## Title of the Master: Artificial Intelligence

**Semester*: S1***
**EU title: Entrepreneurship and English**
**Subject title: Entrepreneurship**
**Credits: 2**
**Coefficients: 1**

**Teaching objectives**.

Raise students' awareness of the challenges of entrepreneurship and prepare them to consider setting up a project to create a new activity in its different components. Develop students' entrepreneurial skills. Learn to identify good ideas and false good ideas Transform the good idea into a relevant offer for the customer. Represent the elements of a project, plan them over time. Identify critical passages (project bottlenecks). Quantify the necessary resources. Learn how to develop the business using business management optimization indicators

**Recommended prior knowledge**

**Content of the material:**

- The classic questions of the entrepreneur (SARL, SA, SAS? What share capital?...)
- Project management
- Planning and development prospects
- Market study: (analysis of competitors' existing offers, etc.)
- Marketing and commercial strategy
- Production management of goods and services
- Human ressources
- Law and labor relations
- Legally secure a project
- Taxation
- The main financial accounting tools (cost structure, break-even point, WCR, TPFF, etc.)
  - Economic and legal environment
  - Approach of the innovative creator
  - The main accounting indicators of performance (turnover, margin, ROE/ROI... and their evolution)
  - Non-financial indicators of performance
  - Company valuation methods (DCF, multiples, stock market comparables, etc.)

Accounting and financial forecasting tools
Accompanying devices

**Evaluation method:**

100% Final exam

**References**

1- Alexander Osterwalder, Yves Pigneur, "Business Model Generation", John Wiley and Sons, 2010.

## Title of the Master: Artificial Intelligence

**Semester *: S1***
**EU title: Entrepreneurship and English**
**Subject title: English 1**
**Credits : 1**
**Coefficients : 1**

### Teaching objectives

Allows the student to learn to read, understand and write reports, articles, computer texts, and to present their work in English.

### Recommended prior knowledge

A technical English module was followed during cycle L of the system (LMD).

**Content of the material.**

**Evaluation method.**

100 % Exam.

**References.**

Any reference deemed useful.

## Title of the Master : Artificial Intelligence

**Semester *: S2***
**EU title : Knowledge representation for AI**
**Subject title: Knowledge representation and reasoning**
**Credits : 6**
**Coefficients : 3**

### Teaching objectives

This course allows the student to familiarize themselves with the techniques used in artificial intelligence. It is highly recommended to complement the knowledge provided in class with readings on current topics.

### Recommended prior knowledge

Course: Mathematical logic, artificial intelligence

**Content of the material.**

**Chapter 1. Introduction**

1. Introduction
2. What is knowledge
3. Type of knowledge

**Chapter 2. Knowledge representation**

1. Introduction
2. Types of knowledge representation
3. Modes of knowledge representation
4. Types of knowledge
5. Knowledge categories
6. Basic element of representation

**Chapter 3. Knowledge representation paradigms**

1. Logical representations
   a. Propositional logic
   b. Predicate logic (of order 1)
   c. Logical reasoning
   d. Reasoning and problem solving
   e. Advantages and disadvantages of logical representations
2. Semantic networks
   a. Definition
   b. Characteristics and construction of semantic networks
   c. Advantages and disadvantages
3. Object systems
   a. Principle of object systems
   b. The basic concepts
   c. Concept of inheritance
4. Production rules
5. Structured objects

a. Frames
b. Scripts
c. Concept of inheritance
d. Advantages and disadvantages

6. How to choose a good representation

**Chapter 4. Use of the semantic web for knowledge representation**

1. Introduction to the semantic web.
2. RDF Presentation
3. Semantics of RDF.
4. Semantics of named graphs.
5. Descriptive logic and OWL
6. Use of protégé for the creation of ontologies

**Evaluation method.**

50 % Exam + 25% Practical works + 25 % tutorials.

**References**


1. Charu C. Aggarwal, “Artificial Intelligence: A Textbook”, 1st edition, 2021, Springer.
2. Munesh Chandra Trivedi, “A Classical Approach to Artificial Intelligence”, 2nd edition, 2018, Khanna publishing,
3. Ela Kumar, “Artificial Intelligence”, 2020, Wiley.
4. A.HAYSE et al. « **Approche logique de l’IA** » Edition Dunod Informatique, 1990.
5. Russell, Stuart J., and Peter Norvig. “Artificial Intelligence-A Modern Approach”, Third Int. Edition (2010).
6. Michael M. Richter, Rosina O. Weber, “Case-Based Reasoning a textbook”, 2013, Springer.

## Title of the Master : Artificial Intelligence

**Semester *: S2***
**EU title : Knowledge representation for AI**
**Subject title : Logic for artificial intelligence**
**Credits : 5**
**Coefficients : 3**

**Teaching objectives**

Ensure the student mastery of the logical approaches used in artificial intelligence, from the logic of propositions to modal and epistemological logic.

**Recommended prior knowledge**

Course : Mathematical logic

**Content of the material:**

- **I.** Reminder of classical logics (propositional/first order predicate)
  - **I.1.** Formal languages
  - **I.2.** Deduction systems
  - **I.3.** Semantics
  - **I.4.** Properties on classic logics (Correction/Completeness/Decidability)
  - **I.5.** Limits of classical logics
- **II.** Multivalued logics
  - **II.1.** Tri-valued logics
  - **II.2.** Lukasiewisz logics
- **III.** Fuzzy logic
  - **III.1.** Fuzzy sets
  - **III.2.** Fuzzy Logic Operators
  - **III.3.** Fuzzy inference rules
- **IV.** Modal logic
  - **IV.1.** Language and modal operators
  - **IV.2.** Standard/universal model
  - **IV.3.** Axioms and rules
  - **IV.4.** Proof methods
- **V.** Temporal logic
  - **V.1.** Temporal operators
  - **V.2.** Linear temporal logic
  - **V.3.** Tree-based temporal logic

**Evaluation method:**

50% final Exam + 25% Practical work + 25% Tutorials

**References**

*Maurice Bernadet, « Introduction pratique aux logiques non-classique », éditeur Hermann, février 2011*

*Thiry, Philippe. « Chapter 4. Les logiques non-classiques », Notions de logique. 3e édition, sous la direction de Thiry Philippe. De Boeck Supérieur, 2007, pp. 147-166.*

*Graham Priest, « An Introduction to Non-Classical Logic, From If to Is », Second Edition, Cambridge University Press, 2008*

## Title of the Master: Artificial Intelligence

**Semester*: S2***

**EU title: Cloud computing and modeling**

**Subject title: Cloud Computing and Big data**

**Credits : 4**

**Coefficients : 2**

**Teaching objectives**

Cloud Computing allows us to easily use software and platforms from anywhere through internet services. Big data offers us a new intelligence from massive datasets. This subject covers important concepts related to these emerging technologies.

**Recommended prior knowledge**

- Databases, Web programming, Computer communication networks

**Content of the material:**

1. Cloud computing
    - Fundamental principles
    - Cloud computing models. (Infrastructure, Platform, Software as a service)
    - Problems in Cloud computing (Management, resource allocation,)
    - Study of some OpenSource platforms (Eucalyptus, OpenStack, Nimbus, OpenNebula, etc.)
2. Big data
    - Introduction to Intelligent Databases
    - Business intelligence or data warehouses
    - Principle of a Data Warehouse (Data warehousing)
        - Design of a Data Warehouse
        - Powering a Data Warehouse
    - Data Challenges
    - History of Big Data
    - Dimensions of Big Data
    - Big Data Representation
    - Perspectives and developments
3. Big Data Analysis
    - Data modeling and prediction

**Evaluation method:**

50 % Exam + 25 % Practical works + 25 % Personal work.

**Reference :**

- Francesco Corea, “An Introduction to Data Everything You Need to Know About AI, Big Data and Data Science”, Springer, 2019.

- Nayan B. Ruparelia, “Cloud Computing”, The MIT Press, 2016.

- Zaigham. Mahmood - Richard Hill, Cloud Computing for Enterprise Architectures, Springer, 2011 -

- PRAJAPATI, Vignesh. Big data analytics with R and Hadoop. Packt Publishing Ltd, 2013.

- HILL, Richard, HIRSCH, Laurie, LAKE, Peter, etal. Guide to cloud computing: principles and practice. Springer Science & Business Media, 2012.

## Title of the Master : Artificial Intelligence

**Semester *: S2***
**EU title : Cloud computing and Modeling**
**Subject title : Modeling and evaluation of system performance**
**Credits : 4**
**Coefficients : 2**

### Teaching objectives

This course is intended to deepen the student's knowledge in the field of modeling and simulation. Additionally, it introduces performance evaluation techniques.

### Recommended prior knowledge

**Content of the material:**

1. Systems modeling.
2. Problem of performance evaluation.
3. Performance evaluation techniques.
4. Markov chains
5. Waiting lines.
6. Simple Petri nets (structural, behavioral, invariant analysis).
7. Stochastic Petri nets, Performance analysis.
8. Simulation methods

**Evaluation method:**

50 % Exam + 25 % Practical work + 25 % Personal work.

**References**


1. S. S. Lavenberg: « **Computer systems performance evaluation** » Academic Press 1983.
2. I. Mitrani: "Modelling **of computer and communication systems**" Cambridge University Press 1987.
3. M. Pidd: "**Computer simulation in management science**" J.Wiley and Sons Ed 1984.
4. K. S. Trivedi: "**Probability and statistics with reliability, queuing and computer science applications**" Prentice Hall, 1982.

## Title of the Master : Artificial Intelligence

**Semester *: S2***

**EU title : Complexity and data analysis**

**Subject title : Complexity and Optimization**

**Credits : 5**

**Coefficients : 2**

### Teaching objectives

This subject allows students to deepen their knowledge in algorithms acquired in the second year of the bachelor's degree, especially concerning exploration for solving NP-Complete problems.

### Recommended prior knowledge

Algorithmic notions.

**Content of the material:**

1. Course presentation
2. Fundamental notions: algorithmic and complexity
   - The Basics of Algorithm Analysis
   - Complexity of an algorithm
   - Complexity of a problem
     - The performance of the algorithm
     - The problem solving strategy
     - Landau's notions
   - Complexity classes: P, NP, PSPACE, EXPTIME
3. Recursion and the Divide and Conquer algorithm
   - Sorting Algorithm Analysis
   - Search algorithm
   - Graph algorithm
   - Tree algorithm
4. Optimization methods for problem solving
   - Definition of Optimization
   - Combinatorial optimization:
     - Exact methods: Branch and bound
     - Approximate methods:
       - Specialized heuristics: Glutons algorithm, hill climbing,
       - Metaheuristics
5. Metaheuristics and Evolutionary algorithms
   - Single solution-based metaheuristics, trajectory methods
     - Local Search Algorithm
     - Search Algorithm with Taboo
     - SIMULATED ANNEAL search algorithm
   - Algorithms based on solution population, Evolutionary algorithms
     - Genetic Algorithms

**Evaluation method.**

50 % Exam + 25 % tutorials + 25 % Personal work.

**References**

Cormen, Leiserson, Rivest, Stein. **Introduction aux algorithmes**. Seconde édition, Dunod, 2002

Sylvain Perifel, Complexité Algorithmique, ellipses, 2014.

## Title of the Master: Artificial Intelligence

**Semester: S2**

**EU title: Complexity and data analysis**

**Subject title: data analysis**

**Credits: 4**

**Coefficients: 2**

**Teaching objectives**

This course is dedicated to the fundamental aspects of data analysis, such as PCA and CA, CM, etc., and also relies on the practical processing of data and the applications of various analysis methods..

**Recommended prior knowledge**

Concepts related to linear algebra, statistics, and probability. In the Bachelor's degree program of the LMD system, students have taken courses dedicated to these concepts.

**Content of the material:**

1. Introduction.
2. Importance of data analysis.
3. Simple and multiple linear models.
4. Types of Data Analysis Methods:
    - Analysis of variance.
    - Dimension reduction analysis: Principal component analysis (PCA).
    - Qualitative and quantitative data analysis
    - Factorial analyzes of single (CFA) and multiple (ACM) correspondences.
    - Discriminant analysis.
    - Descriptive analysis
    - Exploratory analysis
    - Predictive analysis
5. Practical work: Sales analysis, investment analysis, price/profit analysis, etc.

**Evaluation method:**

67 % Exam + 33 % tutorials

**References:**


1. Benzécri, J.-P., & Coll., (1980). L'analyse des données, Tome 1 : la taxinomie, Dunod
2. Benzécri, J.-P., & Coll., (1980). L'analyse des données, Tome 2 : l'analyse des correspondances, Dunod.
3. Benzécri, J.-P., Benzécri F., (1980). Pratique de l'analyse des données, Tome 1 : Analyse des correspondances. Exposé élémentaire, Dunod
4. Benzécri, J.-P., & Coll., (1981). Pratique de l'analyse des données, Tome 3 : Linguistique et lexicologie, Dunod
5. Benzécri, J.-P., (1982). Histoire et préhistoire de l'analyse des données, Dunod
6. Benzécri, J.-P., & Coll., (1986). Pratique de l'analyse des données, Tome 5 : Economie, Dunod

## Title of the Master : Artificial Intelligence

**Semester *: S2***
**EU title : Research methodology**
**Subject title : Research methodology**
**Credits : 2**
**Coefficients : 1**

### Teaching objectives

The objectives of the research methodology subject are to provide students with the tools allowing them to write written reports and in particular their work reflecting their professional mission and their master's thesis during Semester 4.

### Recommended prior knowledge

Course: Scientific writing

#### Content of the material:

1. Concepts of scientific research methodology
2. Formulation of the research question and research design
3. Review of the literature from a critical point of view
4. Scientific research methods; quantitative and qualitative method
5. Analysis, interpretation, and reporting of research results
6. Writing and presenting a research project

**Evaluation method.**
100 % Exam

**References**


1. Blaxter, L. Hughes, C. & Tight, M. (1998) How to Research *Buckingham: Open University Press*
2. Denscombe, M. (2002) Ground Rules for Good Research *Maidenhead: Open University Press*

## Title of the Master: Artificial Intelligence

**Semester*: S3***
**EU title: Foundation of Artificial Intelligence**
**Subject title: Advanced techniques of artificial intelligence**
**Credits: 6**
**Coefficients: 3**

### Teaching objectives

At the end of this course, the student will acquire knowledge related to artificial intelligence, including its origin, objectives, types of problems addressed, knowledge representation, and reasoning.

### Recommended prior knowledge

Course : artificial intelligence

### Content of the material:

#### Chapter 1. General Introduction

1. What is artificial intelligence
    a. Cognitive approach
    b. Logistics approach
2. History of AI
3. AI today
4. Some applications of artificial intelligence
5. Reminder on knowledge representation models

#### Chapter 2. Reasoning in artificial intelligence

**1.** Introduction
    a. Definition of reasoning
    b. Statement in AI
**2.** Objective of reasoning
**3.** AI reasoning
    a. Deductive reasoning
    b. Inductive reasoning
    c. Abductive reasoning
    d. Reasoning by analogy
    e. Monotonic reasoning
    f. Non-monotonic reasoning
**4.** Applications on types of reasoning
**5.** Inferences

#### Chapter 3. Problems solving

1- Formalization of problems
    a. Use of predicates in Artificial Intelligence
    b. Example: Vacuum cleaner.
    c. Example : Puzzle 8.

2- Resolution using search methods;
3- Resolution using heuristics;
4- Beyond traditional research methods.
5- Constraint satisfaction problem.

**Chapter 4. Planning**

1- Introduction
2- STRIPS formalism
3- Example: Blocks mode
4- Planning in sub-goals
5- Planning - graph traversal
6- Introduction to robotics
7- Reinforcement learning for robotics

### Evaluation method :

75% Final exam + 25% an oral presentation with a report submitted on the subject

### References :


1- Wolfgang Ertel, Introduction to Artificial Intelligence 2nd edition (2017), Springer.
2- Russell, Stuart J., and Peter Norvig. “Artificial Intelligence-A Modern Approach”, Third Int. Edition (2010).
3- Louis Frécon, Okba Kazar, “Manuel d'intelligence artificielle », 2009.
4- Charu C. Aggarwal, “Artificial Intelligence: A Textbook”, 1st edition, 2021, Springer.
5- Munesh Chandra Trivedi, “A Classical Approach to Artificial Intelligence”, 2nd edition, 2018, Khanna publishing,
6- Ela Kumar, “Artificial Intelligence”, 2020, Wiley.

## Title of the Master: Artificial Intelligence

**Semester*: S3***
**EU title: Foundation of Artificial Intelligence**
**Subject title: Web Intelligence and Internet of Things**
**Credits: 6**
**Coefficients: 3**

### Teaching objectives

The Web Intelligence (WI) technology is known as a new avenue of research and development aimed at exploring both the fundamental roles and practical impacts of Artificial Intelligence (i.e., knowledge representation, planning, knowledge discovery, data mining, intelligent agents, social networks) on one hand, and on the other hand, advanced information technologies (i.e., wireless networks, pervasive computing, data/knowledge grids) on the new generation of products, systems, services, and activities relying on the web.

### Recommended prior knowledge

**Content of the material.**
**Chapter 1 : Introduction to Web Intelligence**
**Chapter 2 : Search web related development**

- Security and networks
- Data mining and information research
- Modeling and user understanding
- Pervasive computing
- Social networks
- Interaction: Man/Machine through the web

**Chapter 3 : Web intelligence applications**

- e-Business
- e-Commerce
- e-Learning
- e-Administration
- e-Publishing
- Intelligent information systems on the Web

**Chapter 4 : Introduction to the Internet of Things.**
**Chapter 5 : Communication models of the Internet of Things**

**Evaluation method.**
50 % Exam + 25 % Practical work + 25 % tutorials

**References.**

GUBBI, Jayavardhana, BUYYA, Rajkumar, MARUSIC, Slaven, et al. Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 2013, vol. 29, no 7, p. 1645-1660.

## Title of the Master : Artificial Intelligence

**Semester *: S3***
**EU title : Foundation of Artificial Intelligence**
**Subject title : Distributed Artificial Intelligence and Multi-Agent Systems**
**Credits : 6**
**Coefficients : 3**

**Teaching objectives**.

The agent paradigm has become an indispensable tool for modeling intelligent distributed systems. It defines the dimensions of the multi-agent paradigm (Agent, Environment, Interaction, Organization, and User), as well as architectures, formalisms, and techniques based on Multi-Agent Systems (MAS) for modeling and solving complex problems. This involves the implementation of collective intelligence, decentralized control, self-organization, self-adaptation, etc. The student will gain a different perspective compared to mono-expertise artificial intelligence.

**Recommended prior knowledge**

Course: artificial intelligence, parallel system

**Content of the material :**

- Distributed artificial intelligence
- State of the art on SMA
- Agent topology
- Mode of communication in SMAs
- SMA architecture
- SMA Platform
- JADE and FIPA ACL

**Evaluation method :**

Final exam (50%), practical work (25%), an oral presentation with a report submitted on the subject *(25%)*

**References :**


1. Weyns, Danny. Architecture-based design of multi-agent systems. Springer Science & Business Media, 2010.
2. Russell, Stuart J., and Peter Norvig. "Artificial Intelligence-A Modern Approach, Third Int. Edition" (2010).
3. Weiming Shen, Douglas H.Nome and Jean-Paul Barthès. "Multi-Agent Systems for Concurrent Intelligent Design and Manufacturing", Taylor and Farncis (2001).
4. Multiagent Systems 2nd edition, The MIT Press, 2013, ISBN-13 : 978-0262018890.
5. Jacques Ferber, Les systèmes multi agents : vers une intelligence collective, InterEdition,1995.
6. Lunze, J. (2019). Networked control of multi-agent systems. MoRa Edition, 2nd edition 2022.
7. Cai, H., Su, Y., & Huang, J. (2022). Cooperative Control of Multi-agent Systems: Distributed Observer and Distributed Internal Model

## Title of the Master : Artificial Intelligence

**Semester *: S3***

**EU title : Artificial intelligence techniques**

**Subject title : Natural Language Processing and Pattern Recognition**

**Credits :** 5

**Coefficients :** 2

**Teaching objectives**.

Research on natural languages is a highly rich field of investigation. The student can leverage the content of the material, particularly for the development of interactive interfaces for intelligent systems in natural language. It can also be utilized in this context for speech recognition and potentially synthesis.

**Recommended prior knowledge**

***Course****: artificial intelligence, logic for artificial intelligence*

**Content of the material :**

- I.1. General Introduction and History
- I.2. Applications of TLN and the ILN Natural Language Interface
- I.3. Automatic translation of natural languages and the ambiguities of natural language
- I.4. The stages of natural language analysis
  - I.4.1. Morphological and lexical analysis
  - I.4.2. Syntactic processing
    - I.4.2.1. Processing by Out-of-Context Grammars
    - I.4.2.2. Treatment with RTN and ATN
    - I.4.2.3. Processing by logical grammar
    - I.4.2.4. Knowledge-based processing
    - I.4.2.5. Probability-based processing
  - I.4.3. Semantic processing
    - I.4.3.1. Semantic networks
    - I.4.3.2. The theory of Conceptual Dependence DC (Roger SCHANK)
    - I.4.3.3. Chave's theory
    - I.4.3.4. Minsky's theory (Frame)
- II.1. General introduction to pattern recognition
- II.2. Pattern Recognition Pattern Recognition Definitions
- II.3. Pattern recognition techniques
- II.4. Application areas

**Evaluation method:**

50% Final exam + 25% Tutorials + 25 Pratical work

**References:**


1. Jalaj Thanaki, “Python Natural Language Processing”, 2017, Packt Publishing.
2. Christopher Bishop, “Pattern Recognition and Machine Learning”, 2006. Springer.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, “Harshit Surana, “Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems”, 1st Edition, 2020, O’reilly.

## Title of the Master : Artificial Intelligence

**Semester *: S3***

**EU titleT : Artificial intelligence techniques**

**Subject title : Bioinformatics systems**

**Credits : 4**

**Coefficients : 2**

### Teaching objectives

The course aims to introduce students to various fields of application in bioinformatics. It places particular emphasis on learning key tools in bioinformatics related to sequence and structure databases, genome sequencing and assembly methods, analysis and alignment of nucleic acid and protein sequences, modeling protein structure from sequence, modeling protein-ligand interactions (e.g., antibiotic, substrate, inhibitor) through molecular docking, and phylogenetic analysis. Students are also introduced to concepts in systems biology.

### Recommended prior knowledge

**Content of the material.**

1. Introduction to complex systems
    - Examples
    - Properties of complex systems
    - Emergence
    - Bioinformatics
2. Data banks: biological, biometric
3. Pairwise Alignment
    - Principles
    - An alignment algorithm: dynamic programming
    - Global alignment, local alignment
4. Multiple Sequence Alignment
    - Complexity of the problem
    - Scoring functions
    - Heuristic methods
    - Iterative methods
5. Gene prediction
6. Protein annotation

**Evaluation method :**

50 % Exam + 50% pratical works.

**References.**

- Gilbert Deléage, Manolo Gouy, Bioinformatique - Cours et cas pratique, Sciences Sup, 2013.
- Jean-Loup Risler, Denis Tagu, Bio-informatique - Principes d'utilisation des outils, Quae éditions, 2010
- SupratimChoudhuri, Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, Academic Press, 2014
-Yaneer Bar-yam, “Dynamics of complex systems”, Addison-Wesley, 1997.

## Title of the Master : Artificial Intelligence

**Semester *: S3***

**EU title : Software Project Management and English**

**Subject title : Software Project Management**

**Credits : 2**

**Coefficients : 1**

### Teaching objectives

The objective of this course is to provide students with a methodology that enables them to successfully carry out a large-scale software project. Their goal will be to complete a project based on proven and rigorous methodologies. They must be able to address feasibility issues and adhere to the specifications. Students should be able to defend their project both at the conceptual level and in terms of technological choices. This approach implies that students need to familiarize themselves with project planning techniques. The evaluation of the work and its progress will largely result from reports that must be integrated into the project planning.

### Recommended prior knowledge

Classic Software Engineering Life Cycle

### Content of the material.

I. Needs Analysis,
II. Specifications,
III. Planning,
IV. Resource management,
V. Code quality,
VI. Software Architecture,
VII. Test,
VIII. Tasks and Roles in development.

### Evaluation method :

70% Exam + 30 % Personal work de l'étudiant.

### References.

1. B. Boehm: "**Software Engineering Economics**", Prentice Hall, 1981.

2. R.S. Pressman: "**Software Engineering: A Practitioner's Approach**", McGraw-Hill Inc., 1981.

## Title of the Master : Artificial Intelligence

**Semester *: S3***

**EU title : Software Project Management and English**

**Subject title : English 2**

**Credits :** 1

**Coefficients :** 1

**Teaching objectives**.

Allows the student to learn to read, understand and write reports, articles, computer texts, and to present their work in English.

**Recommended prior knowledge**

Technical English was followed during cycle L of the system (LMD)

**Content of the material :**

**Evaluation method :** 100 % Exam

**References :**

# VI – Agreements/conventions