Course guide
270727 - MBM - Minds, Brains and Machines

Last modified: 04/02/2025

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.
1004 - UB - (ENG)Universitat de Barcelona.

Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Optional subject).

Academic year: 2024 **ECTS Credits:** 4.0 **Languages:** English

LECTURER

Coordinating lecturer: ALFREDO VELLIDO ALCACENA - RUTH DE DIEGO BALAGUER

Others:

PRIOR SKILLS

Students are expected to have at least some basic background in the area of artificial intelligence and, more specifically, with the areas of Machine Leaning and Computational Intelligence.
Some basic knowledge of probability theory and statistics, as well as neuroscience would be beneficial, but not essential.
Other than this, the course is open to students and researchers of all types of background

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEA11. Capability to understand the advanced techniques of Computational Intelligence, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.

Generical:
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

TEACHING METHODOLOGY

This course will build on different teaching methodology (TM) aspects, including:
TM1: Expositive seminars
TM2: Expositive-participative seminars
TM3: Orientation for individual assignments (essays)
TM4: Individual tutorization

LEARNING OBJECTIVES OF THE SUBJECT

1.Understanding some Neuroscience basics
2.Understanding some Neuroimaging basics as a basis for Neuroscience
3.Understanding some basics of Computational Neuroscience
4.Application of Machine Learning and Computational Intelligence to Computational Neuroscience
5.Reward processing as a Computational Neuroscience problem
6.Computational Neuroscience of vision

STUDY LOAD

Type	Hours	Percentage
Self study	64,0	64.00
Hours large group	36,0	36.00

Total learning time: 100 h

CONTENTS

Basic concepts of brain function

Description:
Basic concepts of brain function

Introduction to Neuroimage Techniques in Neuroscience

Description:
Introduction to Neuroimage Techniques in Neuroscience

Brain functions in brain networks and their connectivity

Description:
Brain functions in brain networks and their connectivity

Basics of Computational Intelligence

Description:
Basics of Computational Intelligence

Decoding neurocognitive states with neural networks

Description:
Decoding neurocognitive states with neural networks

Reward processing and reinforcement learning

Description:
Reward processing and reinforcement learning

Computational Intelligence of Vision

Description:
Computational Intelligence of Vision

ACTIVITIES

essay on a topic of Computational Neuroscience

Description:
essay on a topic of Computational Neuroscience

Specific objectives:
1, 2, 3, 4, 5, 6

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEA11. Capability to understand the advanced techniques of Computational Intelligence, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

Full-or-part-time: 3h
Guided activities: 3h

Basic concepts of brain function

Description:
Basic concepts of brain function

Specific objectives:
1

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study: 12h

Introduction to Neuroimage Techniques in Neuroscience

Description:
Introduction to Neuroimage Techniques in Neuroscience

Specific objectives:
2

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

Full-or-part-time: 9h
Theory classes: 2h
Practical classes: 1h
Self study: 6h

Brain functions in brain networks and their connectivity

Description:
Brain functions in brain networks and their connectivity

Specific objectives:
1, 3

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

Full-or-part-time: 9h
Theory classes: 2h
Practical classes: 1h
Self study: 6h

Basics of Computational Intelligence

Description:
Basics of Computational Intelligence

Specific objectives:
3

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

Full-or-part-time: 21h
Theory classes: 6h
Practical classes: 1h
Self study: 14h

Decoding neurocognitive states with neural networks

Description:
Decoding neurocognitive states with neural networks

Specific objectives:
3, 4

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEA4. Capability to understand the basic operation principles of Computational Intelligence main techniques, and to know how to use in the environment of an intelligent system or service.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. APPROPIATE ATTITUDE TOWARDS WORK: Capability to be motivated for professional development, to meet new challenges and for continuous improvement. Capability to work in situations with lack of information.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

Full-or-part-time: 11h
Theory classes: 2h
Self study: 9h

Reward processing and reinforcement learning

Description:
Reward processing and reinforcement learning

Specific objectives:
5

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

Full-or-part-time: 8h
Theory classes: 2h
Self study: 6h

Computational Intelligence of Vision

Description:
Computational Intelligence of Vision

Specific objectives:
6

Related competencies :
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CEA8. Capability to research in new techniques, methodologies, architectures, services or systems in the area of ??Artificial Intelligence.
CEA11. Capability to understand the advanced techniques of Computational Intelligence, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Full-or-part-time: 21h
Theory classes: 6h
Practical classes: 1h
Guided activities: 3h
Self study: 11h

GRADING SYSTEM

The course will be evaluated through a final essay that will take one of these three modalities:
1. State of the art on an specific IDA-DM topic
2. Evaluation of an IDA-DM software tool with original experiments
3. Pure research essay, with original experimental content

BIBLIOGRAPHY

Basic:

- Churchland, P.S.; Sejnowski, T.J. The computational brain. Cambridge, Mass.: The MIT Press, 1992. ISBN 9780262531207.
- Dayan, P.; Abbott. L.F. Theoretical neuroscience: computational and mathematical modeling of neural systems. Cambridge: The MIT Press, 2001. ISBN 0262041995.
- Cabeza, R.; Kingstone, A. (eds.). Handbook of functional neuroimaging of cognition. 2nd ed. Cambridge, Mass.: The MIT Press, 2005. ISBN 0262033445.
- Miikkulainen, R. [et al.]. Computational maps in the visual cortex. Berlin: Springer, 2005. ISBN 9780387220246.