Universidad de Alcalá

TEACHING GUIDE

Applications of Soft-Computing in Energy, Voice and Image

Degree in
Information System Engineering (GISI)
Computer Engineering (GIC)
Computer Science Engineering (GII)

Universidad de Alcalá

Academic Year 2024/2025

4th Year - 1st Semester (GISI+GIC+GII)

Approved by the EPS School Board on June 14th, 2024

TEACHING GUIDE

Course Name:	**Applications of Soft-Computing in Energy, Voice and Image**
Code:	**780034 (GISI+GIC+GII)**
Degree in:	**Information System Engineering (GISI)** **Computer Engineering (GIC)** **Computer Science Engineering (GII)**
Department and area:	**Teoría de la Señal y Comunicaciones** **Signal Theory and Communications**
Type:	**Optional (Generic) (GISI+GIC+GII)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year - 1st Semester (GISI+GIC+GII)**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish/English Friendly

1. COURSE SUMMARY

This face to face subject is focused on the application of Soft-Computing techniques (Neural computation, evolutionary algorithms, etc.) in problems related to renewable energy, and signal processing in voice and image.

First, different problems in these fields will be analyzed, and solutions by means of classical methods will be illustrated, in such a way that the issues with these methods will be pointed out. Then, the application of modern soft-computing techniques will be illustrated, including several algorithms such as k-nearest-neighbors, Support Vector Machines, or kernel methods). Different optimization problems will be also described, and the main methods to tackle them based on meta-heuristics, such as simulated annealing, Ant Colony Optimization, particle swarm optimization, etc. will be detailed. Specific applications in Renewable Energy, Voice and Image treatment will be described.

It would be advisable that the students have previous knowledge of computer programming for the correct follow of the lectures.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills:

en_CG5 - Ability to conceive, develop and maintain computer systems, services and applications using software engineering methods as an instrument for quality assurance, in accordance with the knowledge acquired as established in section 5, annex 2, of the resolution BOE-A-2009-12977.

en_CG9 - Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to know how to communicate and transmit the knowledge, skills and abilities of the profession of Computer Engineering Engineer.

en_CG10 - Knowledge to perform measurements, calculations, assessments, appraisals, appraisals, studies, reports, task planning and other similar computer work, in accordance with the knowledge acquired as set out in section 5, annex 2, of BOE resolution -A-2009-12977.

Specific Skills

This course contributes to acquire the following specific skills:

en_CC4 - Ability to know the fundamentals, paradigms and techniques of intelligent systems and analyze, design and build systems, services and computer applications that use these techniques in any field of application.

en_CC5 - Ability to acquire, obtain, formalize and represent human knowledge in a computable way to solve problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.

en_CC6 - Ability to develop and evaluate interactive systems and complex information presentation and its application to the resolution of problems of interaction design person computer.

en_CC7 - Ability to know and develop computational learning techniques and design and implement applications and systems that use them, including those dedicated to automatic extraction of information and knowledge from large volumes of data.

Learning Outcomes

RA1: Capacity to understand problems arising in Energy, voice and image processing.
RA2: Capacity to use optimization techniques to solve problems in Energy, voice and image processing.
RA3: Capacity to use classification and regression techniques to solve problems in Energy, voice and image processing.
RA4: Capacity to use Feature Selection techniques in classification and regression problems in Energy, voice and image processing.
RA5: Capacity to apply evolutionary-computation techniques to different optimization problemsin Energy, voice and image processing.

3. CONTENTS

Contents Blocks	Total number of hours
Section 1. Introduction Introduction to Soft-Computing. Renewable energy and associated problems. Introduction to problems arising in voice and image applications.	4 hours
Section 2. Soft-Computing algorithms Neural computation techniques. Evolutionary computation techniques. Fuzzy logic approaches.	18 hours
Section 3. Applications in Renewable Energy Description of problems tackled with Soft-Computing algorithms in the field of Renewable Energy: Wind farm design and turbine layout, wind speed prediction, solar radiation prediction, optimization and fail detection in wind turbines, etc.	18 hours
Section 4. Applications in Voice and Image Processing Description of problems tackled with Soft-Computing algorithms in the field of voice and image processing: voice recognition, noise cancelling, object recognition in images, image segmentation, etc.	16 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours (56 hours on-site +4 exams hours)
Number of hours of student work:	90
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Teaching activities:

1. Theoretical class with the teacher.
2. Practical class in the laboratory, with PC simulations.
3. Indiviudal or groupal work deliveries.
4. Specific tutorial classes, both individual or groupal.

Theoretical classes (4 ECTS), they will be teaching lessons by the Professor, in which the theoretical key points of the subject will be reviewed. Slices or backboard will be used.

Practical lessons in the laboratory (2 ECTS), using Computers, the students will be able to improve their algorithms' knowledge by means of these classes. The teacher will provide the corresponding material such as guides for the simulations, etc.

The teacher will deliver different works individual or groupal, so the students can show their understanding of the subject.

In the tutorial classes, the students will be able to solve doubts or make specific questions about the subject.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

The main assessment tools will be:

1. Lab Notebooks (LN): Students collect data and comments about the lab session.
2. Final Lab practice (PL): A final lab practice will be carried ou
3. Written Exam (PE). Performing written tests focused on both practical and theoretical aspects of the subject.
4. Working development (WD): Answer during class, question resolutions, etc
5. Final Evaluation Exam : A single weitten exam

Students must attend 100% of the laboratory sessions and deliver the corresponding reports to all laboratory practices. Recovery sessions will be enabled for those students who have not attended any of the sessions and justify it documentarily.

The students, as a group, will deliver the reports of the laboratory practices following the established schedule. These practices will be evaluated by the professor responsible for the laboratory group, to assess if the objectives indicated in the script of the same have been met.

Assessment through final exam:

In the case of evaluation by means of a final exam, the evaluation elements to be used will be a single written exam

Extraordinary Call

The procedure will be the same as that described for the assessment by means of a final exam in the ordinary call.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

CE1. Learning of Evolutionary Computation and Neural Computation.

CE2. Programming of algorithms and computing paradigms.

CE3. The student is able to apply Soft-Computing algorithms to solve different problems in Energy, voice and image processing areas.

CE4. The student is able to present the work carried out in class with a good quality.

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

Ordinary Call:

a. Laboratory practices of the subject (PA):
   meta-heuristics (1 point). There will be different programming exercises on optimization meta-heuristics (evolutionary strategies, evolutionary algorithms and Harmony Search), tested over benchmark functions.
b. Meta-heuristic application to the design of a renewable energy system (4 points).
c. Soft-Computing approaches in image and voice processing, four exercises (1.25 points each), on different aspects of classification and clustering approaches over image and voice processing problems.

Extraordinary call. Final assessment (PEF)

GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
RA1,RA2,RA5 RA1,RA2,RA3,RA4 RA1, RA2, RA3, RA4, RA5 RA1, RA2, RA3, RA4 RA1, RA2, RA3, RA4	CE1, CE2 CE1, CE3 CE1, CE2, CE3, CE4 CE1, CE2, CE3, CE4 CE1, CE2, CE3, CE4	Lab. Notebook Class Work Lab Notebooks Intermidiate exam Final Lab Practice	20% 10% 10% 40% 20%

In the extraordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
RA1, RA2, RA3, RA4, RA5	CE1, CE2, CE3, CE4	Final Evaluation Exam	100%

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Soft-Computing : Integrating Evolutionary, Neural, and Fuzzy Systems
  Autor: Tettamanzi, Andrea, Tomassini y Marco
  Edita: Springer-Verlag
- Soft-Computing and Intelligent Systems Design - Theory, Tools and Applications
  Autor: T. Karray and C. de Silva.
  Edita: Addison Wesley
- Introduction to evolutionary computing
  Autor: A. E. Eiben y J. E. Smith
  Edita: Springer-Verlag

6.2. Additional Bibliography

- Neural networks: a comprenhensive foundation
  Autor: S. Haykin
  Edita: Prentice Hall

- Fuzzy Logic with Engineering Applications
  Autor: T. Ross
  Edita: J. Wiley and Sons

- Pattern Classification
  Autor: Richard O. Duda
  Edita: J. Wiley and Sons

- Pattern Recognition and Machine Learning
  Autor: Cristopher Bishop
  Edita: Springer

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.