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 2025/2026

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

Approved by the EPS School Board on June 16th, 2025

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.

en_CB1 - That students have demonstrated to possess and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

en_CB2 - That the students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

en_CB3 - That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

en_CB4 - That students can transmit information, ideas, problems and solutions to both a specialized and non-specialized public.

en_CB5 - That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

en_TRU1 - Capacity of analysis and synthesis.

en_TRU2 - Oral and written competencies.

en_TRU3 - Ability to manage information.

en_TRU4 - Autonomous learning skills.

en_TRU5 - Team work.

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.

ASSESSMENT CRITERIA

Regular Examination: Assessment in the regular examination session must be based on continuous assessment criteria (Regulations for the Regulation of Teaching and Learning Processes, NRPEA, art. 3), always considering the acquisition of the competencies specified in the subject:

a. Continuous Assessment: Consisting of the evaluation of the work completed, both individually and in groups, throughout the entire semester, of the practical work completed and attendance, and the completion of a written assessment test. This type of assessment will account for 100% of the final grade for the subject.

b. Final Assessment: This will consist of taking and passing a final exam (a written theoretical and practical test with questions and/or problems related to the subject content). Students who have not passed the continuous assessment will also be eligible for this assessment.

Extraordinary Examination: This will consist of taking and passing a final exam (a written theoretical and practical test, with questions and/or problems on the subject content).

To participate in the final evaluation process, students must request it in writing to the school director within the first two weeks of joining the school, stating the reasons why they cannot participate in the continuous evaluation system. The school director will communicate the decision within a maximum of 15 days. If no response is received, the request will be considered approved.

5.2. EVALUATION

ASSESSMENT CRITERIA

For students who opt for the continuous assessment system, the assessment criteria will be as follows:

• Attendance at laboratory exercises.
• Submission of prerequisite studies for laboratory exercises before the exercises begin.
• Submission of justified results from laboratory exercises.
• Quality of the work proposed to students.
• Presentation of the work in class.
• Participation in discussions on course topics.
• Final written exam consisting of problem-solving related to the subject matter.

For students who opt for a final written exam, the assessment criteria will be as follows:

• Problem-solving related to the subject matter.
• Multiple-choice test on theoretical knowledge of the subject.
• Resolution of questions related to the course's practical work.

In the written tests, both for students who opt for continuous assessment and those who opt for a final exam, the following will be assessed:

• Correctness of the proposed problem statement.
• Accurate mathematical results.
• Justifications for the results obtained.
• Good presentation of the submitted documents, including neatness in writing and spelling.

The Assessment Criteria must reflect the student's level of acquisition of these skills. The following criteria are defined for this purpose.

CE1. Students demonstrate an ability to understand the main paradigms of evolutionary computation and neural computation.

CE2. Students demonstrate an ability to program these paradigms and solve problems through their application.

CE3. Students demonstrate initiative in applying the computational paradigms explained in the course to new problems.

CE4. Students are able to effectively present the work developed in the course.

GRADING TOOLS

This section summarizes the grading tools that will be applied to each of the assessment criteria.

- **Laboratory Deliverables (LD)**: Submissions of results and conclusions from the practical

exercises proposed throughout the course.
- **Laboratory Practice (LP)**: Final joint practice.
- **Intermediate Assessment Test (IAT)**: Written test with short questions to be completed throughout the course.
- **Course Assignment (CA)**: Answers given in class, problem-solving, etc.
- **Final Assessment Test (FAT)**: A single written test (only for students who have not passed the course with the previous tests and assignments). To take this final exam, the students must complete and submit the laboratory practice.

GRADING CRITERIA

In the regular continuous assessment session, the relationship between competencies, learning outcomes, criteria, and assessment instruments is as follows.

Skills	Evaluation Criteria	Learning Outcomes	Grading Tool	Contribution to the final mark
CG5, CG9, CG10, CB1-CB5, TRU1-TRU5, CC4, CC5, CC6, CC7	CE1, CE2	RA1,RA2,RA5	Laboratory work (LP)	40%
CG5, CG9, CG10, CB1-CB5, TRU1-TRU5, CC4, CC5, CC6, CC7	CE1, CE3	RA1,RA2,RA3,RA4	Class work (CA)	10%
CG5, CG9, CG10, CB1-CB5, TRU1-TRU5, CC5, CC6 CG5, CG9, CG10, CB1-CB5, TRU1-TRU5, CC5, CC6 CG5, CG9, CG10, CB1-CB5, TRU1-TRU5, CC5, CC6	CE4 CE1, CE2, CE4 CE1, CE2, CE4	RA1,RA2,RA3,RA4 RA1,RA2,RA3,RA4 RA1,RA2,RA3,RA4	Laboratory Reports (LD) Mid-term exam (IAT) Final exam	10% 40% 100% Only for students who have not passed the continuous evaluation.

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

Skills	Evaluation criteria	Grading Tool	Contribution to the final mark
CG5, CG9, CG10, CB1-CB5, TRU1-TRU5, CC4, CC5, CC6, CC7	CE1, CE2, CE3, CE4	Final Evaluation Exam (FAT)	100%

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

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.