

Course guide

480075 - 480075 - Intelligent Sustainability Decision Support Systems

Last modified: 12/06/2023

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 723 - CS - Department of Computer Science.
Degree: MASTER'S DEGREE IN SUSTAINABILITY SCIENCE AND TECHNOLOGY (Syllabus 2013). (Optional subject).
Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: MIQUEL SÀNCHEZ MARRÈ

Others: Sanchez Marre, Miquel

PRIOR SKILLS

Fundamentals of Statistics
Fundamentals of programming

REQUIREMENTS

Fundamentals of Applied Statistics and Measure of Sustainability and Development
Socio-Environmental Data Science is recommended but not strictly mandatory

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

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.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

MD1. Master class or conference (EXP): exposition of knowledge by teachers through master classes or by external people through invited conferences.

MD4. Guided Theoretical-practical work (TD): performing in the classroom an activity or exercise of a theoretical or practical nature, individually or in small groups, with the advice of the teacher.

LEARNING OBJECTIVES OF THE SUBJECT

Decision making is a particularly complex activity in systems related to sustainability, including environmental systems, energy systems or sustainability policy making.

A main issue of the course is to provide students with the basics to identify which kind of complexities are involved in the domain and which is the nature of the associated decisions.

Intelligent decision support systems are complex software tools encompassing data and knowledge management to provide support to decision making, by combining data analytics with artificial intelligence and visualization. The course is a perfect complement of the Socioenvironmental Data Science course as it permits to see data science processes inserted in a wider perspective of more complex systems that considers also expert knowledge and economical information to establish recommendations. However, the course is also suitable for students that do not have followed the Socioenvironmental Data Science course. Several ISDSS and recommenders will be explored related to different sustainability issues and global discussion on strengths and weaknesses of these systems will be followed along the course.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	24,0	19.20
Hours medium group	12,0	9.60
Hours small group	9,0	7.20

Total learning time: 125 h

CONTENTS

1. Introduction to Intelligent Sustainability Decision Support Systems (ISDSS)

Description:

- 1.1. Complexity of Sustainability and of real-world systems
- 1.2. Need for decision support tools

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 3h

Theory classes: 3h

2. Decision Theory

Description:

- 2.1. Decision Theory. Types of decisions
- 2.2. Modelling of Decision Process. Single Decision Scenario
- 2.3. Multiple Decision Process: Influence diagrams, decision trees

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 6h

Theory classes: 6h

3. Introduction of the Practical Works

Description:

The 3 practical assignments to be done during the course will be presented, giving the needed information and the basic data for each of them.

Full-or-part-time: 3h

Theory classes: 2h

Practical classes: 1h

4. Evolution of Decision Support Systems (DSS)

Description:

4.1 Historical Perspective of Management Information Systems

4.2 From Decision Support Systems (DSS) to Intelligent Decision Support Systems (IDSS)

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 2h

Theory classes: 2h

5. Intelligent DEcision Support Systems (IDSS)

Description:

5.1. Typology

5.2. Conceptual components

5.3. Requirements and support provided

5.4. Validation

Full-or-part-time: 2h

Theory classes: 2h

6. General IDSS Architectures

Description:

6.1. Analysis and design. Implementation

6.2. General Frameworks:

6.2.1. Integrated hybrid framework (Poch et al., 2004)

6.2.2. Knowledge Modelling Framework (Oprea, 2018)

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 4h

Theory classes: 4h

7. Data-driven tools for ISDSS

Description:

- 7.1. Knowledge Discovery from Data. Data Science process
- 7.2. Unsupervised methods: descriptive and associative
- 7.3. Supervised methods: discriminant and predictive
- 7.4. Tools: Weka, RapidMiner, R System, Python

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 2h

Theory classes: 2h

8. Model-driven Tools for ISDSS

Description:

- 8.1. Model-driven Techniques
- 8.2. Expert-based Models
- 8.3. Qualitative Reasoning Models
- 8.4. Eines: CLIPS, SysDyn

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 4h

Theory classes: 4h

9. Conclusions

Description:

- 9.1. Comparative analysis of ISDSS systems: strong and weak points in sustainability
- 9.2. Open Challenges
- 9.3. Future Trends

Related competencies :

CE29. The ability to design, develop, apply and assess conceptual frameworks, methods and techniques for modelling, simulating and assessing socio-environmental systems using complex networks, intelligent decision-making support systems and continuous models, for the promotion of sustainable development and sustainability.

Full-or-part-time: 2h

Theory classes: 2h

GRADING SYSTEM

AV3. Work done individually or in group throughout the course (TR). It includes both the evaluation of results and reports, and the oral presentation of them.

AV4. Attendance and participation in classes and laboratories (AP).

AV5. Quality and performance of group work (TG).

The assessment will be done taking into account the qualifications of 3 practical works:

PRAC1: Practical Work 1 (individual) on the Decision Modelling Process in Sustainability

PRAC2: Practical Work 2 (Individual) on Research on Intelligent Sustainability Decision Support Systems (ISDSS)

PRAC3: Practical Work 3 (in groups) on Identification of sustainability decisions that can be supported with an ISDSS system seen, planning the system's use to obtain the necessary support and analyze the results

$$\text{Final Grade} = 0.3 * \text{NPR1} + 0.3 * \text{NPR2} + 0.4 * \alpha * \text{NPR3}$$

where

NPR1 = Grade from the PRAC1 = $0.4 * \text{interest in the sustainability decision selected} + 0.6 * \text{quality of the decision model developed}$

NPR2 = Grade from PRAC2 = $0.3 * \text{Identified system interest} + 0.3 * \text{Interest on the sustainability problem that is supported} + 0.4 * \text{Quality of the synthesis presented by the system}$

NPR3 = Grade from the PRAC3 = $0.4 * \text{quality of the written document} + 0.3 * \text{quality of the oral presentation and discussion} + 0.2 * \text{individual performance shown in the laboratory sessions and participation in class}$

Alpha = Correcting factor computed from the individual grade of the cross-evaluation process of teamwork (ICEPW3) = $((\text{GPW3} + \text{ICEPW3}) / 2) / \text{GPW3}$

EXAMINATION RULES.

PRAC1: Practical Work 1 will be done individually

PRAC2: Practical Work 2 will be done individually

PRAC3: Practical Work 3 will be done in teams

BIBLIOGRAPHY

Basic:

- Jakeman, A.J. [et.al.]. Environmental modelling, software and decision support : state of the art and new perspectives. Amsterdam: Elsevier, 2008. ISBN 9780080568867.

- Marakas, G.M. Decision support systems in the 21st century. 2nd ed. Upper Saddle River: Pearson Education, 2003. ISBN 013122848X.

- Sharda, R.; Delen, D.; Turban, E. Business intelligence and analytics : systems for decision support [on line]. 10th ed., global ed. Harlow, Essex: Pearson Education Limited, 2014 [Consultation: 26/11/2018]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5174161>. ISBN 9781292009209.

- Power, D.J.; Heavin, C. Decision support, analytics and business intelligence. 3rd ed. New York, NY: Business Expert Press, 2017. ISBN 9781631573910.

- Hopgood, A.A. Intelligent systems for engineers and scientists. 3rd ed. Boca Raton, FL: CRC Press, 2012. ISBN 9781439821206.

- Dhar, V.; Stein, R. Intelligent decision support methods : the science of knowledge work. Upper Saddle River, NJ: Prentice Hall, 1997. ISBN 0135199352.

- Sànchez-Marrè, Miquel. Intelligent decision support systems [on line]. Cham: Springer, 2022 Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-030-87790-3>. ISBN 9783030877903.

Complementary:

- Russell, S.J.; Norvig, P. Artificial intelligence: a modern approach. 4th ed., global ed. Harlow: Pearson Education Limited, 2022. ISBN 9781292401133.

- Poch, M.; Cortés, U.; Comas, J.; Rodríguez-Roda, I.; Sànchez-Marrè, M. Decisions on urban water systems: some support [on line]. Girona: Servei de Publicacions, Universitat de Girona, 2012 [Consultation: 02/02/2021]. Available on:

<http://hdl.handle.net/10256/7162>. ISBN 97884584018.

- Simon, H.A.; Norton, T.L. The new science of management decision. Literary Licensing, LLC, 2012. ISBN 9781258355067.

- Sànchez-Marrè, M.; Gibert, K.; Sojda, R.S.; Steyer, J.P.; Struss, P.; Rodríguez-Roda, I.; Comas, J.; Brilhante, V. and Roehl, E.A. "Intelligent environmental decision support systems". Jakeman, A.J.; Rizzoli, A.; Voinov, A. and Chen, S. (Eds.). Environmental modelling, software and decision support : state of the art and new perspectives. Amsterdam: Elsevier Science, 2008. Chapter 8, pp. 119-144.

- Dewhurst, F. Quantitative methods for business and management. 2nd ed. New York: McGraw-Hill, 2006. ISBN 9780077109028.

- Poch, M.; Comas, J.; Rodríguez-Roda, I.; Sànchez-Marrè, M.; Cortés, U. "Designing and building real environmental decision support systems". Environmental modelling and software [on line]. 2004, vol. 19, núm. 9, pp. 857-873 [Consultation: 15/02/2021]. Available on: <https://www.sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S1364815203002068>. - Cortés, U.; Sànchez-Marrè, M.; Ceccaroni, L.; R-Roda, I. and Poch, M. "Artificial intelligence and environmental decision support systems". Applied Intelligence [on line]. vol. 13, núm. 1, (july 2000), p. 77-91 [Consultation: 19/09/2018]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/article/10.1023/A%3A1008331413864>.