SUBJECT TEACHING GUIDE

1454 - Computing in Civil Engineering

Master's Degree in civil Engineering, Canal and Port Engineering

Academic year 2023-2024

1. IDENTIFYING DATA				
Degree	Master's Degree in civil Engineering, Canal and Port Engineering		Type and Year	Compulsory. Year 1
Faculty	School of civil Engineering			
Discipline	EXTENSION OF COMPUTING IN CIVIL ENGINEERING			
Course unit title and code	1454 - Computing in Civil Engineering			
Number of ECTS credits allocated	9	Term	Semester based (2)	
Web				
Language of instruction	English		Mode of delivery	Face-to-face

Department	DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION
Name of lecturer	JAVIER GONZALEZ VILLA
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Other lecturers	CESAR ANTONIO OTERO GONZALEZ FERNANDO JAVIER MENDEZ INCERA BORJA ARROYO MARTINEZ LAURA CAGIGAL GIL

3.1 LEARNING OUTCOMES
- Solve problems in the field of civil engineering using programming techniques and data structures.
- Handle regression, classification and clustering methods on data sets of application in the different fields related to civil engineering using machine learning techniques.
- Handle tools for tackling big data problems and modelling with supervised and unsupervised learning techniques.
- Statistically modelling extreme events, choosing the most appropriate model in each situation.
- Spatially modelling geographic datasets.
- Identify the random variables that influence engineering projects and how they are dealt with.
- Conduct reliability studies of engineering projects and design and implement and solve engineering problems as optimisation problems.
- Skills to develop and integrate software for automation or modelling of tasks in the field of civil engineering.
- Describe the basic and fundamental elements of object-oriented programming.
- Handling relational databases and their application to engineering processes.
- Addressing visual programming processes, and in particular in BIM environments.

4. OBJECTIVES
To learn the basics of Python programming and the use of the most common libraries.
Knowing the techniques and tools for designing, developing and using computer programmes to solve problems in the field of civil engineering.
To know the machine learning techniques and tools needed to create predictive regression , classification and clustering models.
To know the techniques and tools for the processing and analysis of large volumes of data.
Acquire the ability to work through Visual Programming with advanced analytical and numerical models of project , planning and management of Civil Works.
Acquire the ability to interpret the results obtained by means of Visual Programming.

6. COURSE ORGANIZATION	
	CONTENTS
1	Block I: Programming with Python. 1. Anaconda and JupyterLab environment. 2. Python fundamentals. 3. Object-oriented programming. 4. Basic libraries and databases.
2	Block II: Computational Statistics. 1. Time series. 2. Theory of extremes. 3. Multivariate data analysis. 4. Geostatistics. 5. Spatial data infrastructure. 6. Data dimensional reduction techniques. 7. Remote sensing and image analysis. 8. Interpolation / Krigging.
3	Block III: Optimisation. 1. Linear optimisation. 2. Non-linear optimisation. 3. Dynamic optimisation. 4. Genetic algorithms. 5. Heuristic evolutionary algorithms . 6. Multi-objective optimisation. 7. Mathematical modelling with optimisation.
4	Block IV: Machine learning. 1. Data preparation. 2. Selection and classification techniques. 3. Dimensional reduction techniques. 4. Decision trees. 5. Artificial neural networks.
5	Block V: Visual programming in BIM models. 1. Dynamo environment. 2. Computational design. 3. Dynamo for Revit and Civil 3D. 4. BIM data flow in civil engineering projects: interchangers. 5. Python scripts in Dynamo.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Evaluation: Programming with Ptyhon, Computational Statistics and Optimisation.	Others	No	Yes	50,00
Evaluation: Machine Learning and Visual Programming in BIM models.	Others	No	Yes	50,00
TOTAL				100,00

Observations

Those students who do not pass the evaluation criteria may, during the extraordinary exam period, carry out additional work to increase their grades, allowing them to pass the subject. The final mark of the subject in the extraordinary exam period, for those students who present themselves for the extraordinary exam, will be calculated according to the same criteria of the ordinary evaluation referred to in this teaching guide.

Observations for part-time students

For part-time students, practical laboratory tests may be replaced by practical assignments.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Hunt, J. (2019). A Beginners Guide to Python 3 Programming. Springer.

Hunt, J. (2019). Advanced Guide to Python 3 Programming. Springer.

Géron, A. (2019). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media.

AutoDesk (2019). The Dynamo Primer. https://primer.dynamobim.org