

SUBJECT TEACHING GUIDE

M2090 - Computing in Civil Engineering

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

Academic year 2022-2023

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	M2090 - Computing in Civil Engineering				
Number of ECTS credits allocated	9	Term	Semester based (1)		
Web					
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION
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Other lecturers	CESAR ANTONIO OTERO GONZALEZ VICTOR MANUEL GIL ELIZALDE FERNANDO JAVIER MENDEZ INCERA ALBA RICONDO CUEVA

3.1 LEARNING OUTCOMES

- Solve problems in the field of civil engineering using programming techniques and data structures.
- Manage regression, classification and clustering methods on data sets for application in the various fields of civil engineering using machine learning techniques.
- Manage tools to address problems of large amounts of data and create models with supervised and unsupervised learning techniques.
- Statistically model extreme events, choosing the most appropriate model in each situation.
- Spatially modeling of geographic data sets.
- Identify the random variables that influence engineering projects and how they are treated.
- Carry out studies of the reliability of engineering works and pose and solve engineering problems as optimization problems.
- Ability to develop and integrate software for automation or modeling of tasks typical of the field of civil engineering.
- Describe the basic and fundamental elements of object-oriented programming.
- Manage relational databases and their application to engineering processes.
- Approach visual programming processes, and in particular in BIM environments.

4. OBJECTIVES

- Know the basics of Python programming and the use of the most common libraries.
- Know the techniques and tools to design, develop and use computer programs to solve problems in the field of civil engineering.
- Know the machine learning techniques and tools necessary to create predictive regression, classification and clustering models.
- Know the techniques and tools for the treatment and analysis of large volumes of data.
- Acquire the ability to work through Visual Programming with advanced analytical and numerical models for projects , planning and management of Civil Works.
- Acquire the ability to interpret the results obtained through such Visual Programming.

6. COURSE ORGANIZATION

CONTENTS

1	Programming with Python: Jupyter Notebooks environment. Python Basics. Basic libraries.
2	Computational statistics: Time series. Theory of extremes. Multivariate data analysis. Geostatistics. Spatial data infrastructure. Dimensional data reduction techniques (PCA). Remote sensing and image analysis. Interpolation / Krigging.
3	Optimization: Linear optimization. Nonlinear optimization. Dynamic optimization. Genetic algorithms. Heuristic evolutionary algorithms. Multi-objective optimization. Mathematical modeling with optimization.
4	Advanced programming: Data structures. Object-oriented programming. Relational databases.
5	Machine Learning: Data Preparation. Regression, classification and clustering. Performance metrics and model optimization. Dimensional reduction. Linear regression, logistic regression, SVM, decision trees, k-neighbors, neural networks, ensemble methods. Deep learning and image analysis. Reinforcement learning.
6	Visual programming in BIM models: Dynamo environment. Computational design. Dynamo for Revit and Civil 3D. BIM data flow in civil engineering projects: interchanges.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Python programming exam	Laboratory evaluation	No	Yes	25,00
Project based on machine learning models and advanced programming techniques.	Work	No	No	25,00
Programming practice exam with DYNAMO	Laboratory evaluation	No	Yes	25,00
Computational statistics and optimization project	Work	No	Yes	25,00
TOTAL				100,00
Observations				
For students covered by part-time schemes, practical tests in the laboratory may be replaced by practical work.				
Given the uncertain situation that the social distancing measures established by the health authorities do not allow practical tests to be carried out in person in the classroom for all students enrolled with the necessary guarantees, a distance evaluation modality will be adopted using telematic means.				
Observations for part-time students				
For students covered by part-time schemes, the practical tests in the laboratory may be replaced by 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