Data-intensive space engineering

Academic Year: (2023 / 2024) **Review date: 25/04/2023 17:42:06**

Department assigned to the subject: Aerospace Engineering Department

Coordinating teacher: IANIRO , ANDREA

Type: Electives ECTS Credits : 3.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The course will include practical examples related to dice from most of the subjects studied in the first course. For example, the following stand out:
Telecommunications and Signal Processing
Orbital dynamics
Space Systems

OBJECTIVES

CB6 To possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB7 To know how to apply the acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB8 To be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, including reflections on the social and ethical responsibilities linked to the application of the knowledge and judgments.
CB10 To possess the learning skills that will enable to continue studying in a way that will be largely self-directed or autonomous.
CG4 Ability to work in multidisciplinary teams in a cooperative way to complete work tasks.
CG5 Ability to handle the English, technical and colloquial language.
CE3 Ability to develop a complete system that meets the design specifications and the expectations of the interested parties. This includes the production of products; acquire, reuse or code products; integrate products in top-level assemblies; verify products against design specifications; validate the products against the expectations of the interested parties; and the transition of products to the next level of the system.
CE10 Ability to understand and apply the knowledge, methods and tools of space engineering to the analysis and design of the guidance, navigation and control subsystem of space vehicles.
CE11 Ability to understand and apply the knowledge, methods and tools of space engineering to the analysis and design of the communication subsystem of space vehicles.
CE12 Ability to understand and apply the knowledge, methods and tools of space engineering to the analysis and design of sensors and instruments used in space missions.

DESCRIPTION OF CONTENTS: PROGRAMME

The course will explore statistical and artificial intelligence techniques for the analysis of space-engineering data. For each technique, examples from the space sector will be presented. For selected cases, there will be practical sessions where students will perform case studies with representative datasets.
The topics will cover, among others, Treatment of random variables, Regression techniques, Classification, Dimensionality reduction, introduction to neural networks, and reinforcement learning.
Practical examples will cover, among others, orbital dynamics for trajectory prediction and collision avoidance, satellite image analysis, fault diagnosis in space systems, weather prediction with satellite data, and attitude control.

LEARNING ACTIVITIES AND METHODOLOGY

Theoretical sessions.
Laboratory sessions with computer.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	25
% of continuous assessment (assigments, laboratory, practicals…):	75

To pass the course, the following two requirements must be met:

1) Obtain a MINIMUM of 4.0/10 in the final exam;
2) To obtain a MINIMUM of 5.0/10 in the overall grade (obtained weighting 75% of the final exam and 25% of the continuous evaluation).
The continuous evaluation includes 5 laboratory sessions with corresponding reports (each corresponding to 15% of the final grade).

BASIC BIBLIOGRAPHY

- Aboul Ella Hassanien, Ashraf Darwish, Hesham El-Askary Machine Learning and Data Mining in Aerospace Technology, Springer, 2020

- Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola Dive into Deep Learning, Cambridge University Press, 2023

- Aurelien Geron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow 3e: Concepts, Tools, and Techniques to Build Intelligent Systems, O'Reilly Media, 2022

ADDITIONAL BIBLIOGRAPHY

- Enrico Camporeale, Simon Wing, Jay Johnson Machine Learning Techniques for Space Weather, Elsevier, 2018

BASIC ELECTRONIC RESOURCES

- Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola . Dive into Deep Learning: http://d2l.ai/