Course guides
310764 - 310764 - Artificial Intelligence in Construction

Unit in charge: Barcelona School of Building Construction
Teaching unit: 748 - FIS - Department of Physics.
753 - TA - Department of Architectural Technology.
749 - MAT - Department of Mathematics.

Degree: BACHELOR’S DEGREE IN ARCHITECTURAL TECHNOLOGY AND BUILDING CONSTRUCTION (Syllabus 2019).
(Optional subject).

Academic year: 2021  ECTS Credits: 3.0  Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Guillamon Grabolosa, Antoni
Others: Rodriguez Cantalapiedra, Inmaculada
Lopez Almansa, Francisco
Berigüete Alcántara, Fanny Esther

PRIOR SKILLS

No prior programming knowledge is required. At the beginning of the course, a review of specific questions of mathematical foundations is advised: matrix representation, linear systems, elementary derivatives (chain rule) and optimization of functions of one or more variables.

TEACHING METHODOLOGY

In each block of the course, there will be introductory sessions to the subject by the teachers, and practical exercises will be proposed as homework. The other sessions will focus on the analysis of selected publications: students will work in groups and teachers will have a role to support learning. Other sessions will be dedicated to oral presentations by the students.

LEARNING OBJECTIVES OF THE SUBJECT

- Get the knowledge about the main applications of artificial intelligence in the field of building construction.
- Understand the basic knowledge of artificial intelligence, as well as the main ideas that govern machine learning algorithms.
- Learn to locate and manage the resources needed for the application of artificial intelligence methods, and incorporate them into the execution processes in building construction.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>40.00</td>
</tr>
<tr>
<td>Self study</td>
<td>45,0</td>
<td>60.00</td>
</tr>
</tbody>
</table>

Total learning time: 75 h
CONTENTS

**Artificial intelligence: examples of applications to building construction.**

**Description:**
Diagnosis of pathologies.  
Real estate valuation.  
Energy efficiency.  
Estimation of construction costs.

**Specific objectives:**
Introduce, through examples, applications of artificial intelligence in the field of construction.

**Related activities:**
Introductory lectures. Reading of specialized articles and oral presentation.

**Full-or-part-time:** 15h  
Theory classes: 2h 24m  
Practical classes: 3h 36m  
Self study : 9h

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**Regression**

**Description:**
Introduction of an overview of supervised learning versus unsupervised learning, and of classification problems versus regression problems.  
Study of supervised learning problems using regression methods, both linear and multilinear.

**Specific objectives:**
Distinguish between supervised and unsupervised learning.  
Distinguish between classification and regression problems.  
Understand the concepts and procedures needed to perform a (multi)linear regression from experimental data: regression model, cost functions, gradient descent method.  
State the possibility of other type of regressions.

**Related activities:**
Exercises for assimilating concepts, reading articles and modifying programming code. The block culminates with a practical application of solving a multilinear regression problem based on construction-related problem data.

**Full-or-part-time:** 20h  
Theory classes: 4h 48m  
Practical classes: 3h 12m  
Self study : 12h
Artificial neural networks.

Description:
Basic structure of an artificial neural network.
Elementary examples of artificial neural networks.
Analysis of network components in an application to building construction.
Other methods of artificial intelligence.

Specific objectives:
Understand the basic knowledge of artificial intelligence, as well as the main ideas that govern machine learning algorithms.
Learn to locate and manage the resources needed for the application of artificial intelligence methods, and incorporate them into the execution processes in building construction.

Related activities:
Exercises to assimilate concepts, reading articles and modifying programming code. The block culminates with a practical application of using software to solve a classification or regression problem, based on data from construction-related problems.

Full-or-part-time: 20h
Theory classes: 3h 12m
Practical classes: 4h 48m
Self study : 12h

Optimization

Description:
Optimization is a mathematical formulation that aims to obtain the optimal solution of a certain problem according to a given criterion; in general, such solution depends on the considered criterion. For instance, structural optimization refers to find the "best" design of a certain structure, but "best" can be defined in different ways: cheapest, fastest to be built, lightest, less invasive, most durable, most sustainable, nicest, among many others. Usually, the "quality" of a solution is quantified in terms of a scalar function (index) known as "Cost function"; then the optimization consists in the mathematical minimization of such index.

Specific objectives:
- Continuous vs. discrete optimization. Constrained vs. unconstrained optimization. Single-objective vs. multi-objective optimization.
- Convex vs. concave optimization. Linear programming. Sensitivity analysis.
- Probabilistic optimization.
- Structural optimization. Cost minimization.
- Optimization software. Applications.

Full-or-part-time: 20h
Theory classes: 4h 48m
Practical classes: 3h 12m
Self study : 12h

GRADING SYSTEM

In each of the 3 blocks (regression, neural networks, optimization) a continuous evaluation will be carried out, which will consist of:
(a) resolution of elementary exercises (2 or 3); (b) realization (in group) of a mini-project of application of tools of artificial intelligence to a building construction problem, of which a brief report and an oral presentation will be delivered. The final grade of the subject is the average of the grades obtained in each of the blocks. Within each block, the grade assigned to the mini-project will be approximately 60% (i.e., between 15% and 20% of the total of the subject); the presentations will take place on October 20, November 15 and December 20, respectively.
BIBLIOGRAPHY

Basic:

RESOURCES

Computer material:

Hyperlink: