

Academic Year: (2022 / 2023)

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Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: MORENO LORENTE, LUIS ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

OBJECTIVES

The aim of this course is to acquaint students with some control techniques that includes in learning abilities, adaptation or are able to transfer some learning or experience of using a control device. Besides advanced optimization methods will be studied as the most intelligent control systems involve a way or another the use of optimization methods. Among them they will be studied: fuzzy control techniques (fuzzy), control techniques based on neural networks, and advanced optimization methods.

DESCRIPTION OF CONTENTS: PROGRAMME

The program is broken down as follows:

1. Bayesian estimation
 - 1.1. Fundamentals
 - 1.2. Kalman filtering
 - 1.3. Extended
 - 1.4. Bayesian filters
 - 1.5. Applications
2. Fundamentals of neural networks.
 - 2.1. Concept artificial neuron. Layers of neurons. Concept of neural network.
 - 2.2. Multilayer networks. Recurrent networks.
 - 2.3. Feedforward networks. Learning backpropagation.
3. Identification of neural network systems
 - 3.1. Function approximation with neural networks.
 - 3.2. Types of system models.
 - 3.3. Modeling systems with neural networks. NN-FIR. NN-ARX. NN-ARMAX, OE-NN, NN-SSIF. hybrid models.
 - 3.4. Types of networks used in modeling. Networks with delay in inner layers. backpropagation in dynamic systems.
 - 5.1. 5.5. Identification of dynamic systems.
4. Control systems with neural networks.
 - 4.1. Direct control schemes. reverse direct control. Internal model control. Feedback linearization. feedforward control.
 - 4.2. Indirect control schemes.
5. Fundamentals of optimization and evolutionary algorithms.
 - 5.1. Methods single point optimization.
 - 5.2. Methods based on the derivative: maximum slope, Newton-Raphson, Quasi-Newton, Conjugate gradient.
 - 5.3. non-derivative methods: brute force, random walk, Hooke-Jeeves, Simulated Annealing.
 - 5.4. multipoint optimization methods.
 - 5.5. Derivative Methods: MultiStart and clustering.
 - 5.6. non-derivative methods: Nelder-Mead, CRS, Genetic Algorithms, Differential Evolution, PSO

6. Reinforcement learning (RL)
 - 6.1 Markov's decision processes
 - 6.2 Basic concepts of reinforcement learning
 - 6.3 Modeling of the RL environment dynamics using MATLAB and Simulink
 - 6.4 Creation and configuration of RL agents using common algorithms: SARSA, DQN, DDPG y PPO
 - 6.5 Definition and representation of value functions and politics, as Deep Neural Networks and Q tables .
 - 6.6 Training and validation.

LEARNING ACTIVITIES AND METHODOLOGY

The activities carried out in the teaching of the subject are:

- Lectures. Presentation of the main concepts. Discussion and clarification of doubts on concepts. It will work on transparencies that will be given to students to facilitate also learning a basic text or reference texts on the subject required.
- Laboratories. The students (in teams of 2 or 3) are proposed some practical cases study, they must study and then make the simulation data and analysis. It will be used the knowledge of the topics covered in lectures and practical classes in the subject. It will make a previous study, will work in the laboratory and then a written report shall be submitted with the results and proposed solutions.

Addendum COVID-19:

Due to the situation caused by COVID-19, if necessary, both theory classes and practical exercises classes will be carried out online, the practices will be attempted in the laboratories, unless it is impossible, in which case they would also be adapted to do them. on line.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	0
% of continuous assessment (assignments, laboratory, practicals...):	100

A teaching job (small project) of some of the techniques studied over a problem of identification or control that will be simulated in Matlab is required to pass the subject (for the normal or extraordinary periods).

BASIC BIBLIOGRAPHY

- L. Moreno Transparencias de clase, -, 2016

ADDITIONAL BIBLIOGRAPHY

- Eiben and J. Smith Introduction to evolutionary computing,, Springer,, 2003
- Gerard Dreyfus Neural Networks: methodology and applications, , Springer Verlag,, 2005
- H. Zhang and D. Liu Fuzzy modelling and Fuzzy Control, , Birkhauser,, 2006
- J. Espinosa, J. Vandewalle and V. Wertz Fuzzy Logic, Identification and Predictive Control,, Springer, , 2004
- Oliver Nelles Nonlinear System Identification: from classical approaches to Neural Networks and Fuzzy Models, , Springer Verlag, , 2001
- R. Fletcher Practical methods of optimization, , John Wiley, , 1980