

Course guide

230720 - INMAN - Optimization and Artificial Intelligence Techniques in Network Management

Last modified: 25/05/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 744 - ENTEL - Department of Network Engineering.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura>

Others: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma>

TEACHING METHODOLOGY

- Descriptive classes
- Lectures by the students to show applications of acquired knowledge
- Individual work consisting in the search and analysis of bibliography (remote)
- Individual work intended as a means of learning (remote)
- Use of software tools
- Exercises assigned by teachers (remote)

LEARNING OBJECTIVES OF THE SUBJECT

- Understand the nature of problems that solve the management and control of networks and services
- Understand and know how to use the most common optimization techniques in the field of telecommunication networks
- Understand and know how to use the most common techniques of statistical inference
- Understand and know how to use reinforcement learning techniques to solve network management problems

STUDY LOAD

Type	Hours	Percentage
Self study	86,0	68.80
Hours large group	39,0	31.20

Total learning time: 125 h

CONTENTS

1. Introduction to network control and management

Description:

This topic will introduce the management and control of existing telecommunication networks and services. Once the work scenario of the subject has been identified from a global perspective, an introduction will be made to the problems that are commonly presented and how the so-called artificial intelligence techniques can be applied to solve them. Finally, the three major techniques studied in the subject: optimization, statistical inference and reinforcement learning will be presented.

Full-or-part-time: 20h 48m

Theory classes: 6h 30m

Self study : 14h 18m

2. Network optimization problems

Description:

In this topic we will study different mathematical tools used to solve optimization problems in telecommunication networks. By optimizing, understood as the efficient use of network resources, we will identify different mathematical models for the use of these networks, among others, the models based on problems of constraint satisfaction, linear programming or combinatorial optimization. The type problems that are most often given in optimization will be identified and numerical exercises will be performed applying the techniques explained in this topic.

Full-or-part-time: 41h 36m

Theory classes: 13h

Self study : 28h 36m

3. Probabilistic diagnosis and inference of network behaviours

Description:

In this topic, the behavior of telecommunication networks is studied from a statistical point of view. Starting from a system of statistical sampling of certain network operation parameters, the corresponding probabilistic model will be generated with a set of random variables. The dependence relations between these random variables will be studied to later model the overall behavior of the system through a Bayesian Network. From this Bayesian Network we will study how statistical inferences can be made, such as: the diagnosis of the operation of the network or the forecast of the future behavior of the network when the conditions of operation of the network change.

Full-or-part-time: 20h 48m

Theory classes: 6h 30m

Self study : 14h 18m

4. Reinforcement learning applied to network management

Description:

This topic will study the reinforcement learning technique applied to network management. This technique consists of modeling the behavior of a telecommunications network as a state machine where each state is characterized by the quantification of a reward function or system performance as a result of being in this state. The reinforcement learning technique involves taking actions or modifying the operating parameters of the system in order to improve the performance of the network. Any action exerted on the system will cause a change of state of the system and therefore obtaining a new reward or performance of the system. The ultimate purpose will be to maximize long-term performance.

Full-or-part-time: 41h 36m

Theory classes: 13h

Self study : 28h 36m



GRADING SYSTEM

There will be two partial exams, one around midterm (C1) and the other at the end (C2). The scope of each exam will be determined later but likely will be half of the matter each. On the other hand the individual homework (TI) will be also evaluated. The grade of continuous evaluation will be $0,7 \cdot (C1+C2)/2 + 0,3 \cdot TI$. If this grade is greater or equal to five the matter will be passed and it won't be necessary the final exam. Otherwise it will be necessary to pass a final exam of the whole program.

BIBLIOGRAPHY

Basic:

- Sutton, R.S.; Barto, A.G. Reinforcement learning: an introduction [on line]. 2nd ed. Cambridge, Mass.: MIT Press, 2018 [Consultation: 14/09/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=6260249>. ISBN 9780262039246.
- Winston, W.L. Operations research: applications and algorithms. 4th ed. Belmont: Brooks/Cole - Thomson Learning, 2004. ISBN 0534423620.
- Russell, S.; Norvig, P. Artificial intelligence: a modern approach. 4th ed., global ed. Harlow: Pearson Education Limited, 2022. ISBN 9781292401133.
- Clemm, A. Network management fundamentals: a guide to understanding how network management technology really works. Indianapolis, IN: Cisco Press, 2007. ISBN 9781587201370.