

## Course guide

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

Last modified: 19/06/2024

**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:** 2024    **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>

### PRIOR SKILLS

programming in Python

### 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 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

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### 1. Introduction to network and service management

**Description:**

This unit will introduce the management and control of existing telecommunication networks and services. Complementary, it will introduce the techniques of mathematical optimization and reinforcement learning for their use in the management of networks and services. Once the working 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.

**Full-or-part-time:** 18h

Theory classes: 6h

Self study : 12h

### 2. Network optimization problems

**Description:**

In this unit we will study different mathematical tools used to solve optimization problems in telecommunication networks, understanding by optimization the efficient use of network resources. We will identify different mathematical models for the use of these networks, among others, the models based on solving problems of constraint satisfaction, linear programming or combinatorial optimization. The types of problems that are mostly addressed in the optimization arena will be identified and programming exercises will be performed applying the techniques explained in this unit.

**Full-or-part-time:** 53h 30m

Theory classes: 16h 30m

Self study : 37h

### 3. Reinforcement learning applied to network management

**Description:**

This unit 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 visiting that 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 goal will be to maximize the long-term performance of the system.

**Full-or-part-time:** 53h 30m

Theory classes: 16h 30m

Self study : 37h

## GRADING SYSTEM

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The final grade will be obtained from the average of all marks resulting from the assessment of the different programming exercises to be submitted along the term. There are no partial exams or a final exam for this course.

## BIBLIOGRAPHY

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### Basic:

- Clemm, A. Network management fundamentals: a guide to understanding how network management technology really works. Indianapolis, IN: Cisco Press, 2007. ISBN 9781587201370.
- 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.
- Russell, S.; Norvig, P. Artificial intelligence: a modern approach. 4th ed., global ed. Harlow: Pearson Education Limited, 2022. ISBN 9781292401133.
- Winston, W.L. Operations research: applications and algorithms. 4th ed. Belmont: Brooks/Cole - Thomson Learning, 2004. ISBN 0534423620.