Last update: 04-07-2019

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

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 744 - ENTEL - Department of Network Engineering

Academic year: 2019

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

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Serrat Fernandez, Juan

Others: Serrat Fernandez, Juan
Gorricho Moreno, Juan Luis

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
- Exercices 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

Total learning time: 125h	Hours large group:	39h	31.20%
	Self study:	86h	68.80%

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Content

1. Introduction to network control and management

Learning time: 20h 48m

Theory classes: 6h 30m
Self study : 14h 18m

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.

2. Network optimization problems

Learning time: 41h 36m

Theory classes: 13h
Self study : 28h 36m

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.

3. Probabilistic diagnosis and inference of network behaviours

Learning time: 20h 48m

Theory classes: 6h 30m
Self study : 14h 18m

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.

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4. Reinforcement learning applied to network management	Learning time: 41h 36m Theory classes: 13h Self study : 28h 36m

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.

Qualification 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*(C1+C2)/2 + 0,3*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:

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. 2nd ed. Cambridge, MA: MIT Press, 2018. ISBN 9780262039246.

Russell, S.; Norvig, P. Artificial intelligence: a modern approach. 3rd ed. Upper Saddle River, N.J.: Prentice Hall, 2016. ISBN 9781292153964.

Winston, W.L. Operations research: applications and algorithms. 4th ed. Belmont: Brooks/Cole - Thomson Learning, 2004. ISBN 0534423620.