230155 - GXS - Networks and Services Management

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

**Teaching unit:** 744 - ENTEL - Department of Network Engineering

**Academic year:** 2018

**Degree:**
- BACHELOR’S DEGREE IN NETWORK ENGINEERING (Syllabus 2010). (Teaching unit Optional)
- BACHELOR’S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Teaching unit Optional)
- BACHELOR’S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Optional)

**ECTS credits:** 6

**Teaching languages:** Catalan, Spanish, English

### Teaching staff

**Coordinator:** JOAN SERRAT

**Others:**
- Juan-Luis Gorricho
- Joan Serrat

### Teaching methodology

- Descriptive classes
- Lectures by the students to show applications
- Individual work consisting in the search and analysis of bibliography (remote)
- Individual work intended as a means of learning (remote)
- 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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>52h</th>
<th>34.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self study:</td>
<td>98h</td>
<td>65.33%</td>
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</table>
# 1. Introduction to network control and management

**Learning time:** 25h  
Theory classes: 10h  
Self study: 15h

**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:** 35h  
Theory classes: 14h  
Self study: 21h

**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:** 35h  
Theory classes: 14h  
Self study: 21h

**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.
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.

**Bibliography**

**Basic:**