200131 - TP - Probability Theory

Coordinating unit: 200 - FME - School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics
715 - EIO - Department of Statistics and Operations Research

Academic year: 2019
Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 7,5 Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: JUAN JOSÉ RUE PERNA
Others: Primer quadrimestre:
   ANNA DE MIER VINUÉ - M-A, M-B
   SONIA PEREZ MANSILLA - M-A
   JUAN JOSÉ RUE PERNA - M-A, M-B

Degree competences to which the subject contributes

Specific:
1. CE-2. Solve problems in Mathematics, through basic calculation skills, taking into account tools availability and the constraints of time and resources.
2. CE-3. Have the knowledge of specific programming languages and software.
3. CE-4. Have the ability to use computational tools as an aid to mathematical processes.

General:
5. CB-1. Demonstrate knowledge and understanding in Mathematics that is founded upon and extends that typically associated with Bachelor's level, and that provides a basis for originality in developing and applying ideas, often within a research context.
6. CB-2. Know how to apply their mathematical knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader or multidisciplinary contexts related to Mathematics.
7. CB-3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements.
8. CG-1. Show knowledge and proficiency in the use of mathematical language.
10. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
11. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
4. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
Learning objectives of the subject

There are two main objectives: (1) to present Probability Theory as a rich, attractive and useful tool in modeling random phenomena and (2) to provide the necessary background in probability for other subjects in the Degree of Mathematics.

The particular goals of the subject are the achievement by the students of the following aspects:

* To know the notion of probability and its main properties.
* To know the basic discrete and continuous probability models.
* To use the concept of random variable in formalizing and solving problems in probability.
* To know the concept of moments of a random variable and the main results associated to this notion.
* To know the notion of convergence of random variables, particularly the Central Limit Theorem and the Laws of Large Numbers.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group: 45h</th>
<th>24.00%</th>
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<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>30h</td>
<td>16.00%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
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<tr>
<td>Self study:</td>
<td>112h 30m</td>
<td>60.00%</td>
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### Content

#### Probability Spaces and Random Variables

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 23h 30m</th>
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</table>
| - Random experiments, outcomes and events.  
- Probability.  
- Conditional Probability.  
- Independence.  
- Product Spaces.  
- Random Variables and probability distribution functions.  
- Random Vectors. Independence of random variables. |  
| Theory classes: 6h  
Practical classes: 2h  
Self study: 15h 30m |  

#### Random Variables (I): discrete variables

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 36h</th>
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</table>
| - Probability function.  
- Independence.  
- Expectation and Moments of a Random Variable.  
- Models of Discrete Random Variables.  
- Ramification processes (Galton-Watson trees)  
- Conditional distributions. Conditional Expectation.  
- Sums of Random Variables. |  
| Theory classes: 7h 30m  
Practical classes: 6h  
Self study: 22h 30m |  

#### Random variables (II): continuous variables

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<thead>
<tr>
<th>Description:</th>
<th>Learning time: 48h</th>
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| - Density Probability Function.  
- Expectation and Moments of a Random Variable.  
- Models of Continuum Random Variables.  
- Functions of Random Variables  
- Multivariate Normal distribution and related distributions. |  
| Theory classes: 12h  
Practical classes: 8h  
Self study: 28h |
### Generating Functions

**Description:**
- Probability Generating Function
- Moment Generating Function and Characteristic Function.
- Theorems of Inversion and Continuity.

**Learning time:** 36h
- Theory classes: 7h 30m
- Practical classes: 6h
- Self study: 22h 30m

### Convergence of Random Variables

**Description:**
- Sequences of Random Variables
- Modes of convergence
- Laws of large numbers
- Convergence in distribution. The Central Limit Theorem.

**Learning time:** 36h
- Theory classes: 7h 30m
- Practical classes: 6h
- Self study: 22h 30m
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

Grinstead, Charles M.; Snell, Laurie J. Introduction to Probability


The Probability Web (Teaching resources)

http://www.mathcs.carleton.edu/probweb/probweb.html

Chance

http://www.dartmouth.edu/~chance/

The R Project for Statistical Computing

R is a free software environment for statistical computing and graphics.

http://www.r-project.org/

Mat2: Materials Matemàtiques

http://www.mat.uab.es/matmat/Cast/index.html

Revista electrònica de divulgació matemàtica editada pel Departament de Matemàtiques de la Universitat Autònoma de Barcelona. Inclou articles molt interessants sobre temes de probabilitat.