The subject gives a review of the pattern classification and recognition from the mathematical point of view and at the same time, applies the methods to several areas of signal processing. The structure of the general problem of pattern recognition (i.e., pre-processing, feature extraction and classification), can be applied to different areas, such as quality control, biomedical applications and diagnosis, communication systems, image processing, and speech recognition. The subject, will give a general view of the bayesian desision theory, maximum likelihood estimation, non parametric
classification techniques and non supervised learning, with application to different areas of signal processing, such as classification of biomedical signals, images, signal detection, signal modulation, etc. For each of the selected applications, the work done in class, will deal with different classification criteria, in order to analyze the compromise between good performance and computation efficiency of each classifier. The 6 credits of the subject are divided between theoretical classes, and at the same time, practical classes at the laboratory (MATLAB), where the student will develop the selected applications, with emphasis in the applications on medical diagnosis, image possessing, and communications. In each of the theoretical parts, the methods and algorithms will be developed so that they can be understood and programmed at the same time. Some advanced techniques will also be presented. In the last weeks of the course all the students will participate in a machine learning competition proposed by the teacher.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>26h</th>
<th>17.33%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>26h</td>
<td>17.33%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>98h</td>
<td>65.33%</td>
</tr>
<tr>
<td>Content</td>
<td>Learning time:</td>
<td>Theory classes:</td>
<td>Laboratory classes:</td>
</tr>
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<tr>
<td><strong>1. Introduction</strong></td>
<td>6h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
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<td></td>
</tr>
<tr>
<td>1.1 Introduction to pattern classification</td>
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<td></td>
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<tr>
<td>1.2 Feature extraction</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1.3 Classes and models</td>
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<tr>
<td><strong>2. Decision theory</strong></td>
<td>10h</td>
<td>4h</td>
<td>4h</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>2.1 Minimization of the Bayesian risk</td>
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<tr>
<td>2.2 Gaussian model</td>
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<tr>
<td>2.3 Linear and quadratic discriminants</td>
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<tr>
<td>2.4 Maximum likelihood estimation</td>
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<tr>
<td><strong>3. Feature selection</strong></td>
<td>10h</td>
<td>4h</td>
<td>4h</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td></td>
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<td></td>
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<tr>
<td>3.1 Principal components analysis</td>
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<tr>
<td>3.2 Multiple discriminants analysis</td>
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</tbody>
</table>
# 4. Non-parametric techniques for supervised learning

**Learning time:** 24h  
- Theory classes: 11h  
- Laboratory classes: 11h  
- Guided activities: 1h  
- Self study: 1h

**Description:**  
1. Parzen windows and k-nearest neighbours  
2. Support vector machines  
3. Neural networks  
4. Decision trees

---

# 5. Evaluation, combination and selection of classifiers

**Learning time:** 6h  
- Theory classes: 2h  
- Laboratory classes: 2h  
- Guided activities: 1h  
- Self study: 1h

**Description:**  
1. Lack of superiority of any classifier  
2. Complexity  
3. Bias and variance  
4. Resampling for classifier design  
5. Combining classifiers  
6. Comparing classifiers  
7. Launching a ML project

---

# 6. Unsupervised learning

**Learning time:** 8h  
- Theory classes: 3h  
- Laboratory classes: 3h  
- Guided activities: 1h  
- Self study: 1h

**Description:**  
1. Parametric methods: EM i k-means  
2. Non-parametric methods: clustering
Planning of activities

<table>
<thead>
<tr>
<th>Laboratories</th>
<th>Hours: 26h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory classes: 26h</td>
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</tbody>
</table>

**Description:**
- PRAC0: Exploratory data analysis
- PRAC1: MAP for Gaussian data
- PRAC2: Data basis and feature selection
- PRAC3: K-Nearest
- PRAC4: SVM
- PRAC5: Neural networks
- PRAC6: Tree classifiers
- PRAC7: Competition

**Support materials:**
Matlab code and data bases will be available in Atenea.

**Descriptions of the assignments due and their relation to the assessment:**
Every second week, a report of the laboratory will have to be uploaded to Atenea.

Qualification system

Final exam: 45%
Laboratory: 25%
Competition: 15%
Deliverable exercises: 15%

Regulations for carrying out activities

The use of calculators, mobile phones or class notes is not allowed.
Bibliography

Basic:


Complementary:


Others resources:

For the development of the laboratories, applications in Matlab will be provided through Atenea.