ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

53001159 - Machine learning and neural networks

DEGREE PROGRAMME

05AY - Master Universitario en Automatica y Robotica

ACADEMIC YEAR & SEMESTER

2017/18 - Semester 1

Index

Learning guide

1. Description

1.1. Subjet details

Name of the subject	53001159 - Machine learning and neural networks
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	05AY - Master Universitario en Automatica y Robotica
Centre	Escuela Tecnica Superior de Ingenieros Industriales
Academic year	2017-18

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Pascual Campoy Cervera (Subject coordinator)	en Automatica	pascual.campoy@upm.es	Tu - 12:30 - 14:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

El plan de estudios Master Universitario en Automatica y Robotica no tiene definidas asignaturas previas recomendadas para esta asignatura.

3.2. Other recommended learning outcomes

- Algebra

4. Skills and learning outcomes *

4.1. Skills to be learned

ML-01 - Get skills in the most relevant techniques in Machine Learning (ML) for solving practical problems

ML-02 - Get skills in properly using the available data for ML problems

ML-03 - Get skills to evaluate the results (training error and test error)

ML-04 - Get skills to write a technical report

4.2. Learning outcomes

RA84 - Be able to use the most common feature processing techniques (feature selection and supervised and non-supervised linear methods)

RA85 - Be able to use the most common standard classifiers (k-nn, Bayessian)

RA87 - Be able to use supervised Artificial Neural Network (i.e. MLP) for classification and for function learning

RA86 - Be able to use evaluate the results of a ML technique and to properly use available dat

RA88 - Be able to use non-supervised Artificial Neural Network (i.e. SOM) for data mapping and classification

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

1. Building machines able to think as humans is a challenging aim since the first computers. Expert systems are aimed for the machines to apply our human reasoning rules. But key question still remains on how do we get these reasoning rules? Do we learn them from previous experiences? or Are they wired in our brain from birth? There are evidences of both paradigms. However there is clear evidence that the cortex in the mammals is extremely flexible to learn new situations during the live span and letting other parts of the brain to behave more as wired systems, that have been refined by natural selection.

   Evolution has provided the cortex with a flexible and adaptive mechanism able to process efficiently the huge amount of information coming from all of our terminal sensors. More than 50% of our cortex is devoted to processing the visual information in order to recognize our environment, predict it and act accordingly in fragments of a second. This is in fact the aim to be achieved by our processing algorithms that have to deal wit a big amount of multidimensional data coming from any source. The scientific community is presently far from having a model with similar features as the cortex has, while it remains as an inspiration source for new intelligent systems, of which the Artificial Neural Networks is the paradigm.

   The main objective of this subject is the student to be able to apply the most important techniques for Machine Learning, both the ?Classical Techniques? and those based on ?Artificial Neural Networks?, to solve problems using actual data, some of them based on synthetic data, useful for getting familiar with the techniques, and some others based on data from real-word applications.

The problems to be solved include both supervised learning problems, as well as unsupervised problems. The student is aimed to understand the features common to any kind of machine learning technique, and also to be able to understand the advantages and drawbacks of every technique in order to solve a particular problem. The classical techniques are studied as the reference techniques that used mathematical solutions and with which the new soft-computing techniques based on Neural Networks are to be compared with.

The examples are solved using Matlab © and the specific toolbox of Statistics and Neural-Networks. A good motivation for using the techniques based in Neural Networks is given, by presenting the main features and the general methodology of such bio-inspired techniques, when compared to classical ones.

5.2. Syllabus

1. Intelligence & learning
   - 1.1. What is intelligence?
   - 1.2. What are intelligent machines?
   - 1.3. The learning relevance
   - 1.4. Building intelligent machines
   - 1.5. Objectives of the subject
2. Feature processing
   - 2.1. Objectives of feature processing
   - 2.2. Quality criteria
   - 2.3. feature selection
   - 2.4. Principal Component Analisys
   - 2.5. Fisher discriminant
3. Classical classifiers
   - 3.1. Nearest Neigbour
   - 3.2. Bayessian classifier

4. Machine Learning Methodology
   4.1. Supervised and not supervised learning
   4.2. Learning challenges
   4.3. Building machine learning models
   4.4. Errors and validation
5. Supervised ANN: Multilayer Perceptron
   5.1. Artificial Neural Networks
   5.2. Perceptron and the MLP structure
   5.3. The back-propagation learning algorithm
   5.4. MLP features and drawbacks
   5.5. The auto-encoder
6. Non supervised ANN: Self-organized Maps
   6.1. Objectives for non-supervised learning
   6.2. SOM Learning algorithm
   6.3. Examples and applications

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**introduction** Duration: 02:00 Lecture			
2	**Intelligence & Learning** Duration: 02:00 Lecture			
3	**Feature processing** Duration: 02:00 Lecture			
4	**Feature processing** Duration: 02:00 Lecture			
5	**Feature processing** Duration: 02:00 Cooperative activities			
6	**Classical Classifiers** Duration: 02:00 Lecture			
7	**Classical Classifiers** Duration: 02:00 Cooperative activities			
8	**Classical Classifiers** Duration: 02:00 Lecture			
9	**Machine Learning Methodology** Duration: 02:00 Lecture			
10	**Supervised Artificial Neural Network** Duration: 02:00 Lecture			
11	**Supervised Artificial Neural Network** Duration: 02:00 Lecture			
12	**Non supervised Artificial Neural Network** Duration: 02:00 Lecture			
13	**Practical Artificial Neural Network** Duration: 02:00 Cooperative activities			
14	**Summary and future trends** Duration: 02:00 Lecture			

15				
16				
17				**Exam** Written test Continuous assessment and final examination Duration: 02:00 **Work for solving a practical problem using the several techniques learned during the course** Group work Continuous assessment and final examination Duration: 00:00 **Results of a practical classification problem to be solved during the course and to be tested telematicly this week** Online test Continuous assessment and final examination Duration: 00:00 **Participation during the course, and optional public presentation** Other assessment Continuous assessment Duration: 00:00 **Oral Exam only for unique evaluation** Written test Final examination Duration: 01:00

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Exam	Written test	Face-to-face	02:00	35%	3.5 / 10	ML-03 ML-02 ML-01
17	Work for solving a practical problem using the several techniques learned during the course	Group work	Face-to-face	00:00	30%	3.5 / 10	ML-03 ML-02 ML-01 ML-04
17	Results of a practical classification problem to be solved during the course and to be tested telematicly this week	Online test	Face-to-face	00:00	20%	3.5 / 10	ML-03 ML-02 ML-01
17	Participation during the course, and optional public presentation	Other assessment	Face-to-face	00:00	15%	0 / 10	ML-01 ML-03 ML-02

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Exam	Written test	Face-to-face	02:00	35%	3.5 / 10	ML-03 ML-02 ML-01
17	Work for solving a practical problem using the several techniques learned during the course	Group work	Face-to-face	00:00	30%	3.5 / 10	ML-03 ML-02 ML-01 ML-04
17	Results of a practical classification problem to be solved during the course and to be tested telematicly this week	Online test	Face-to-face	00:00	20%	3.5 / 10	ML-03 ML-02 ML-01
17	Oral Exam only for unique evaluation	Written test	Face-to-face	01:00	15%	3.5 / 10	ML-01 ML-03 ML-02

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Evaluación continua:

* Practical work (min. 3.5/10) 50%
  document _____30%
  results _____ 20%
* Exam (min. 3.5/10) _____35%
* Participation (weekly assignments, participation in classroom, optional public presentation)_____15%

Evaluación única:

* Practical work (min. 3.5/10) 50%
  document _____30%
  results _____ 20%
* Exam (min. 3.5/10) _____35%
* Oral Exam _____15%

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Pagina Moodle de la asignatura	Web resource	descripción entera del curso, incluyendo diapositivas de clase, ejercicios semanales, trabajo de la asignatura, datos para ejercicios e información compementaria
Referencia bibliografica 1	Bibliography	"Pattern Classification" Duda-R, Hart-P, Stork-D Wiley-Interscience , 2004
Referencia bibliografica 2	Bibliography	"Pattern recognition & Machine Learning" by Christopher M. Bishop Springer, 2006