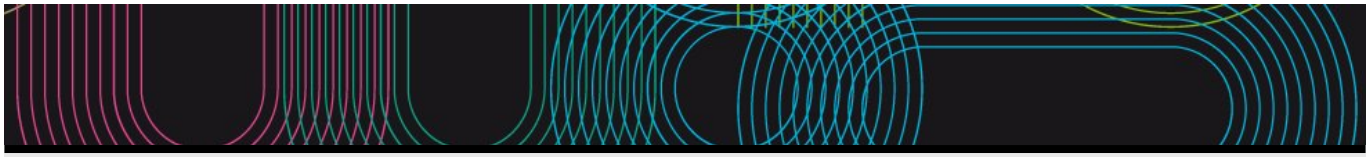

IDENTIFYING DATA				
(*)Recoñecemento Estatístico de Patróns e Redes Neuronais				
Subject	(*)Recoñecemento Estatístico de Patróns e Redes Neuronais			
Code	V05M038V01103			
Study programme	(*)Máster Universitario en Teoría do Sinal e Comunicacións.			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	1st	1st
Teaching language	Spanish English			
Department				
Coordinator	Alba Castro, José Luis			
Lecturers	Alba Castro, José Luis			
E-mail	jalba@gts.uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	This course examines the theoretical bases that support the main models used in pattern recognition applications. The emphasis is on learning techniques, both statistical models and Artificial Neural Networks and explains its usefulness in practical problems of signal processing and image processing. The main goal is teaching students to acquire sufficient skills to deal with an application that provides data representative of an input-output system, natural or artificial, and be able to build a model that explains the system and answer in an analogous way, both as a functional approximation problem and as a classification problem. To achieve this objective, the student should be able to develop proficiency in the use of concepts such as curse of dimensionality, generalisation, sample size, complexity of the model, approximation error, error estimation, empirical error, bias and variance of the model, etc..			

Competencies	
Code	
A3	(*)interpretar la relación entre dimensionalidad de un problema de clasificación/decisión, complejidad, sesgo y varianza del modelo, tamaño del universo muestral y capacidad de generalización; y seleccionar el método de aprendizaje-máquina más adecuado para modelar el problema
B1	(*)Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios o multidisciplinares relacionados con el campo de estudio
B5	(*)Que los estudiantes adquieran habilidades de aprendizaje que les permitan actualizar sus conocimientos de un modo autónomo, consciente y crítico
B7	(*)manejar de forma efectiva la búsqueda de artículos científicos y resumir de forma coherente y útil el nuevo conocimiento adquirido
B11	(*)definir, realizar y ejecutar modelos de simulación en un lenguaje de programación de alto nivel como el Matlab o de bajo nivel como el C/C++
B15	(*)desenvolverse en un contexto de trabajo internacional, sin prejuicios ni valoraciones infundadas sobre las capacidades de los demás compañeros
B16	(*)demostrar su capacidad para aprender nuevos conceptos, metodologías y técnicas en el campo del procesado de señal y comunicaciones de forma autónoma
B17	(*)predecir el comportamiento o funcionamiento de sistemas, modelos y algoritmos conocidos en entornos no vistos anteriormente
B18	(*)tener iniciativa y creatividad en la propuesta de soluciones sistémicas y algorítmicas alternativas a las estándar

Learning aims		
Expected results from this subject	Typology	Training and Learning Results

Mastering several techniques of statistical learning through exemplars	Know How	A3 B1 B5 B7 B11 B15 B16 B17 B18
Mastering the relationship among problem dimensionality, sample size, model complexity, bias and variance	know Know How	A3 B1 B5 B7 B11 B15 B16 B17 B18
Mastering several machine learning techniques	Know How	A3 B1 B5 B7 B15 B16 B17 B18

Contents

Topic	
Introduction	Approximation to the problem of pattern recognition. Review of Probability Theory and Rule of *Bayes
Classical concepts of classification and dimensionality reduction	Unsupervised classification or clustering. K-means algorithm. Non parametric supervised classification. K nearest neighbour algorithm. Statistical classification. Minimum distance classifier. Optimum Bayes classifier. Methods of extraction of characteristics: optimisation for representation (PCA), optimisation for classification (LDA)
Gaussian Mixture Models to estimate probability density functions	Gaussian Mixture Models for representation and for classification. Esimate of maximum likelihood for the model: The EM algorithm. Particular cases. Application to speech and speaker recognition: Hidden Markov Models.
Learning processes and introduction to the artificial neural networks	Foundamentals of learning theory. The statistical nature of the learning process. Usual Learning Rules. Concepts of Learning theory: approximation error, estimation error and calculation error. Bias and variance of models. Llearning techniques: correction error, Hebb rule, competition and supervision. Taxonomy of ANN. Discriminative Models versus Generative Models.
The multilayer perceptron (MLP).	The perceptron rule. Theorem of convergence. Separability, the XOR problem. Minimisation of the Mean Square error. The multilayer perceptron. The backpropagation algorithm. The generalisation problem, cross-validation. Interpretation of the outputs as a posteriori probabilities.
Radial Basis Function (RBF).	Cover´s theorem on the separability of patterns. The interpolation problem. Regularisation theory. Generalized Radial Basis Functions. Strategies of learning. Comparison between RBF and MLP. Analogy between RBF-GMM (Discrimination versus representation)
Support Vector Machines (SVM).	Classifiers of maximum margin. The dimension of Vapnik-Chervonenkis. Kernel-based spaces of characteristics. SVM for binary classification (SVC). SVM for non-linear regression (SVR). SVM for clustering (SVND).
Self-organized Networks.	Hebbian learning network: analysis of principal components. Maps of self-organized features, adaptative learning classifiers, Learning vector quantization (LVQ). Autoassociative Networks.

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	26	39	65
Case studies / analysis of situations	0	10	10
Forum Index	0	10	10

Practical tests, real task execution and / or simulated.	0	20	20
Troubleshooting and / or exercises	0	20	20

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Master Session	Study of the educational material and virtual or real assistance to the seminars. The student has to assimilate the new concepts exposed in the accessible educational material in the e-learning platform. The professors encourage the study by means of complementary readings and questions in the forums.
Case studies / analysis of situations	For the most advanced topics, the student has to do critical reading of research articles of different qualities and has to present his/her conclusions.
Forum Index	It fosters the critical analysis and the discussion between the student and the professor, in private form; as well as the explanation of arguments to the other students, so much for the questions realised by the professors as for the review of mates' works

Personalized attention

Methodologies	Description
Master Session	For these three activities of education-learning, some hours of personalized attention are recommended. The student can consult presentially or virtually his doubts with the professor or professors of the subject or with a specific lecturer. For this aim he can use the ways enabled in the program: presential query, e-mail, forums, chat.
Forum Index	For these three activities of education-learning, some hours of personalized attention are recommended. The student can consult presentially or virtually his doubts with the professor or professors of the subject or with a specific lecturer. For this aim he can use the ways enabled in the program: presential query, e-mail, forums, chat.

Assessment

	Description	Qualification
Case studies / analysis of situations	Individual evaluation of a short research paper. There could also be evaluation by peers and evaluation of the evaluators.	20
Forum Index	Continuous evaluation of the comprehension of educational material. Continuos evaluation of the activity: opportunity, precision and originality of the posts.	20
Practical tests, real task execution and / or simulated.	Individual evaluation of the tasks and reports. There could also be evaluation by peers and evaluation of the evaluators.	30
Troubleshooting and / or exercises	Individual evaluation of the exercises. There could also be evaluation by peers and evaluation of the evaluators.	30

Other comments on the Evaluation

In case of not passing the subject by means of the acts of evaluation defined in the educational guide for the first opportunity, the coordinator of the subject will communicate to the student in the fifteen following days to the end of the academic activities of the corresponding semester which acts of evaluation has to realise to pass the subject in the second opportunity.

Sources of information

Simon Haykin, **Neural Networks. A comprehensive foundation**, 2,

R. Duda, P. Hart & D. Stork, **Pattern classification**, 2,

N. Cristianini and J. Shawe-Taylor, **An introduction to support vector machines**, 1,

Toussaint, Godfried T., **Pattern Recognition on the Web: http://cgm.cs.mcgill.ca/~godfried/teaching/pr-web.html**,

Recommendations

Subjects that continue the syllabus

(*)Recoñecemento Biométrico/V05M038V01204

(*)Recoñecemento de Fala/V05M038V01203

Subjects that are recommended to be taken simultaneously

(*)Métodos de Simulación de Sinais Aleatorios/V05M038V01101

(*)Procesado Estatístico de Sinal e Técnicas Bootstrap/V05M038V01102