



- 1. Código:** 35678 **Nombre:** Signal and natural leanguage processing with deep learning
- 2. Créditos:** 6,00 **--Teoría:** 3,00 **--Prácticas:** 3,00 **Carácter:** Optativo
- Titulación:** 2314-Máster Universitario en Ingeniería de Telecomunicación
- Módulo:** 3-Módulo de Optativas **Materia:** 5-Formación Optativa
- Centro:** E.T.S.I. DE TELECOMUNICACIÓN
- 3. Coordinador:** López Monfort, José Javier
- Departamento:** COMUNICACIONES

4. Bibliografía

Deep learning for natural language processing Raaijmakers, Stephan
 Deep Learning for Natural Language Processing : Creating Neural Networks with Python Goyal, Palash.
 Deep learning for natural language processing : solve your natural language processing problems with smart deep neural networks Bokka, Karthiek Reddy

5. Descripción general de la asignatura

Objetivos de la asignatura

The objective of this course is to provide students with a comprehensive understanding of Natural Language Processing (NLP). Starting with an introduction to the field of NLP, students will learn about feature extraction and the development of deep neural network (DNN) models using KERAS. The course will cover advanced techniques such as word embeddings, data preparation, and access to corpora, as well as recurrent neural networks (RNN) and long short-term memory networks (LSTM). Additionally, transformer networks and large language models (LLM) will be explored. Finally, students will gain knowledge in voice processing applications, including synthesis, translation and imitation, preparing them to tackle complex challenges in the field of NLP.

Contextualización de la asignatura

This course is part of the Artificial Intelligence specialization within the Master's in Telecommunications program. It is scheduled in the first semester of the second year of the Master's. Students have already completed a general AI course in the first year. The objective of this course, along with the other AI courses accompanying it, is to modernize the Telecommunications Engineering curriculum to align with this disruptive technology. By focusing on Natural Language Processing (NLP), the course aims to equip students with advanced skills and knowledge, enabling them to integrate AI solutions into telecommunications systems. This course not only builds on the foundational AI concepts covered previously but also delves into specialized topics such as feature extraction, deep neural networks, word embeddings, and voice processing. Thus, it plays a crucial role in preparing students for the evolving landscape of telecommunications, where AI and NLP are increasingly becoming integral components.

6. Conocimientos recomendados

(35677) Advanced methods of artificial vision

- Fundamentals of Machine Learning
- Python programming

7. Resultados

Resultados fundamentales

BA3(GE) Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios;

Competencias transversales

(5) Responsabilidad y toma de decisiones

- Actividades desarrolladas relacionadas con la adquisición de la competencia

The students will work on an NLP project from scratch, starting from problem identification to solution implementation. This endeavor will enable them to make informed decisions at every stage of the project.

- Criterios de evaluación

The decision-making process of each team will be assessed through a comprehensive report, which includes justification for decisions made at each phase of the project, as well as an analysis of potential risks and measures taken to mitigate them.

Resultados de Aprendizaje Específicos

RA5.2 - Desarrollar y realizar trabajos e investigaciones, prácticas o experimentales, interpretando datos y extrayendo





7. Resultados

Competencias transversales

conclusiones fundamentadas en los principios de la disciplina

8. Unidades didácticas

1. Introduction to Natural Language Processing
 1. Course Structure
 2. Applications of Deep Learning in Audio Signals
 3. Applications of Deep Learning in Language Processing
2. Features Extraction
 1. Introduction to Audio Feature Extraction
 2. Spectrogram based Audio Features
 3. Other audio features
 4. Tools and Libraries for Feature Extraction
 5. Applications of Audio Feature Extraction
3. Development of DNN Models for audio with KERAS
 1. Building basic Neural Networks for audio with Keras
 2. Key Hyperparameters in Deep Learning
 3. Convolutional Neural Networks (CNNs) for Audio
 4. Improving Model Generalization and Accuracy
 5. Recurrent Neural Networks (RNNs) for Sequential Audio Data
 6. Encoder-Decoder Architectures
 7. Datasets for Audio Deep Learning
4. Natural Language Processing
 1. Introduction, Definition and Applications
 2. Discrete Text Representations (BoW, TF-IDF)
 3. Distributed/Continuous Text Representations (Co-Occurrence Matrix)
 4. Word2Vec
 5. GloVe
 6. fastText
 7. Advanced Topics
5. Transformers and Large Language Models (LLM)
 1. Evolution to Transformers
 2. Understanding Transformers
 3. Major Transformer-Based Architectures (BERT, GPT, BART, T5)
 4. Introduction to Large Language Models (LLMs)
 5. Exploring Major LLMs and Their Characteristics
 6. LLMs in Practice
 7. Evaluating and Benchmarking LLMs
 8. Challenges and Limitations (Hallucinations, Bias, Cost, Alignment, Token Limit, Temperature, Prompt Injection)
 9. Reasoning LLMs and future.
6. Voice Processing (synthesis, imitation, etc.)
 1. Introduction to DNN-based Voice Processing
 2. Fundamentals of Human Voice Production
 3. Deep Neural Networks for Speech Synthesis (Text-to-Speech - TTS)
 4. Deep Neural Networks for Voice Cloning
 5. Training and Evaluating DNNs for Voice Tasks
 6. Applications and Challenges and Future Trends of DNNs in Voice Processing

9. Método de enseñanza-aprendizaje

<u>UD</u>	<u>TA</u>	<u>SE</u>	<u>PA</u>	<u>PL</u>	<u>PC</u>	<u>PI</u>	<u>EVA</u>	<u>TP</u>	<u>TNP</u>	<u>TOTAL HORAS</u>
1	1,00	--	--	--	--	--	--	1,00	5,00	6,00
2	3,00	--	2,00	--	--	1,00	0,50	6,50	15,00	21,50
3	8,00	--	6,00	--	--	4,00	1,50	19,50	25,00	44,50
4	8,00	--	6,00	--	--	4,00	2,00	20,00	25,00	45,00

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9. Método de enseñanza-aprendizaje

<u>UD</u>	<u>TA</u>	<u>SE</u>	<u>PA</u>	<u>PL</u>	<u>PC</u>	<u>PI</u>	<u>EVA</u>	<u>TP</u>	<u>TNP</u>	<u>TOTAL HORAS</u>
5	8,00	--	3,00	--	--	2,00	1,50	14,50	17,00	31,50
6	2,00	--	1,00	--	--	1,00	0,50	4,50	5,00	9,50
TOTAL HORAS	30,00	--	18,00	--	--	12,00	6,00	66,00	92,00	158,00

UD: Unidad Didáctica. TA: Teoría de Aula. SE: Seminario. PA: Práctica de Aula. PL: Práctica de Laboratorio. PC: Práctica de Campo. PI: Práctica de Informática. EVA: Actividades de Evaluación. TP: Trabajo Presencial. TNP: Trabajo No Presencial.

10. Evaluación

Descripción

- (05) Trabajos académicos
- (15) Prueba práctica de laboratorio/campo/informática/aula
- (14) Prueba escrita

Nº Actos Peso (%)

1	40
1	20
1	40

The assessment will consist of:

- One individual academic assignment within the scope of the course.(40%)
- One Written Exam of theoretical multiple choice questions (40%)
- One Practical Laboratory Test (this test will be a continuous assessment throughout the course)" (20%)

Students "EXCUSED FROM ATTENDANCE" (dispensa de asistencia) will complete the "Practical Laboratory Test" and the end of the course in ONE FINAL ACT, because continuous assessment throughout the course is no possible.

Students who not pass the course will undergo an recovery examination comprising a written theoretical test and a laboratory practical test, similar to those conducted during the course. If they score previously at least a 5 in one of the two tests (theoretical or practical), they may choose to only retake the one they did not pass.

11. Porcentaje máximo de ausencia

<u>Actividad</u>	<u>Porcentaje</u>	<u>Observaciones</u>
Teoría Aula	0	
Teoría Seminario	0	
Práctica Aula	0	
Práctica Laboratorio	20	Si no cumple la asistencia será declarado "No presentado", salvo dispensa de asistencia.
Práctica Informática	0	
Práctica Campo	0	

