Tecnun
Universidad
de Navarra

PROYECTOS GRUPALES PARA ALUMNOS INTERNOS

CURSO 2026-2027

Departamento

☐Ing. Mecánica y Materiales

☐Ing. Biomédica y Ciencias

☐Ing. Eléctrica y Electrónica

☒Organización Industrial

Profesor/a responsable

Nombre y Apellidos: Matheus Puime Pedra

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Investigadores involucrados (profesores, post-doc, doctorandos)

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2. **Nombre y Apellidos: Sahar Elkady**
3. **Nombre y Apellidos: Josune Hernantes**

Datos del proyecto

Título (divulgativo)**:**

Uholde: Flood Risk Prediction in the Cantábrico Oriental Basin through Automated Reasoning

Breve resumen:

Spain has good flood hazard maps, including the SNCZI (Sistema Nacional de Cartografía de Zonas Inundables, the national flood-mapping system) at state level, and for the Basque Country, URA's (Agencia Vasca del Agua, the Basque Water Agency) own MAPRI maps (Mapas de Peligrosidad y Riesgo de Inundación, flood hazard and risk maps), but these are static. They show where a river could flood at a given return period, not whether current conditions make that more or less likely at a given moment. Existing flood hazard maps for the basin are thorough but revised only every six years, so they cannot reflect this week's saturated soil or an incoming storm. Meanwhile, the region already produces the real-time data needed to close that gap, but it sits unused across separate systems (SAIH, AEMET, SINOBAS), with no tool that brings it together and explains what it means for a specific place.

The project proposes a two-stage system, following recent work in reasoning-based geospatial prediction (FireScope). A first model observes satellite imagery, terrain, and hydrological/meteorological conditions for an area and produces a short explanation together

with a risk score. A second model uses that score to condition a map-generation network that produces a detailed flood risk map. The project is scoped to a single basin, the Cantábrico Oriental (Gipuzkoa, Bizkaia, and part of Álava), which brings together three distinct flood mechanisms: fluvial, pluvial (short, intense rainfall), and coastal. Its boundaries also align reasonably well with provincial limits, making it easier to incorporate exposure data (population, buildings) with little extra work.

By the end of the project, the team will deliver a working system that generates a flood risk map together with an explanation of the factors behind the prediction, checked against real, documented flood events in the basin. This project gives students hands-on experience with a genuinely current AI technique, reasoning-based geospatial prediction, published only months ago, applied to a real, local, and socially relevant problem, using entirely public Spanish and Basque data sources, and produces something with a plausible path to real use by regional water authorities.

Tareas a realizar:

The project is organized into four roles, each covering a distinct stage of the pipeline: from raw data collection, through model development, to the final risk map. Student 1 builds the static spatial dataset (hazard maps, terrain, exposure data). Student 2 adds the imagery and real-time hydro-meteorological data on top of that foundation. Student 3 uses both to build the reasoning model that produces a risk score and explanation for a given area. Student 4 takes that score and generates the final, detailed flood risk map, which is then tested against real historical events. Each role is described below, together with its main tasks, expected outputs, and the skills it involves.

Role	**Data & GIS Engineer (Student 1)**
Main action	Harmonize all static, non-real-time spatial data into a single reference framework the rest of the team can build on
Description of tasks	Download and reproject the flood hazard maps (URA/SNCZI) into a common CRS (Coordinate Reference System), ETRS89. Process the digital terrain model (IGN) to derive slope and drainage networks. Process building data (Catastro) and population data (INE) at municipality level. Build the historical flood event catalog for the basin (dates, location, severity), drawing on SAIH records, SINOBAS reports, and documented episodes
Generated outputs	A harmonized, tiled dataset (hazard maps, terrain, exposure layers) in a single CRS, ready for modeling. A structured historical flood event catalog for the basin
Adopted/learned skills	GIS data processing, working with official Spanish/Basque geospatial data portals, basic terrain analysis (slope, drainage), building a structured event dataset from heterogeneous sources

Role	**Remote Sensing & Real-Time Data Engineer (Student 2)**
Position in pipeline	Adds imagery and real-time hydro-meteorological data on top of the foundation built by Student 1
Main action	Acquire and prepare all imagery and time-varying (real-time and forecast) data feeding into the model

Description of tasks	Download and cloud-filter Sentinel-2 optical imagery for the pilot catchment. Process Sentinel-1 radar imagery as a cloud-independent alternative. Set up automated data pulls from AEMET OpenData and SAIH/GOTA (precipitation, river levels, reservoir state). Cross-reference SINOBAS reports with the historical catalog built by Student 1
Generated outputs	A processed satellite imagery archive for the pilot catchment. An automated pipeline pulling current/historical precipitation, river, and reservoir data. A cross-referenced SINOBAS/event dataset
Adopted/learned skills	Satellite image processing, working with public APIs (AEMET OpenData), building automated data-ingestion pipelines, handling multi-source time series data

Role	**Reasoning Model Developer (Student 3)**
Position in pipeline	Uses the datasets from Students 1 and 2 to build the reasoning model that produces a risk score and explanation for a given area
Main action	Build the component that turns raw imagery and hydro-meteorological data into a risk score and a written explanation
Description of tasks	Design the input/output format (image, terrain, and hydro-meteorological data in; risk score and explanation out). Decide between prompting an existing model (Claude, GPT, Gemini) or fine-tuning an open model. Test whether the generated explanation genuinely reflects the input conditions rather than sounding plausible but disconnected from them. Generate risk scores for the training dataset
Generated outputs	A working reasoning model producing a risk score + explanation per tile/area. A labeled set of risk scores covering the training data, used to condition the map-generation model
Adopted/learned skills	Prompt design and/or model fine-tuning, working with vision-language models, designing and running qualitative evaluation of model explanations, reward/evaluation design if fine-tuning is chosen

Role	**Map Generation Model Developer (Student 4)**
Position in pipeline	Takes the risk score from Student 3 and generates the final, detailed flood risk map, which is then tested against real historical events
Main action	Build the component that turns the reasoning model's risk score into a detailed, pixel-level flood risk map
Description of tasks	Implement a model taking satellite imagery as input. Condition the model on the reasoning model's risk score via FiLM (Feature-wise Linear Modulation). Train and tune the model to output a flood risk raster. Compare against a version without conditioning, to check it's actually helping. Build a simple map viewer to display results
Generated outputs	A trained map-generation model producing flood risk rasters for the pilot catchment. A comparison showing the effect of conditioning on model performance. A working map viewer for presenting results
Adopted/learned skills	Computer vision model design and training (U-Net, conditioning mechanisms like FiLM), model evaluation and ablation studies, basic front-end/visualization work for the map viewer

Distribución temporal del proyecto:

Tecnun
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☐1er cuatrimestre

☐2do cuatrimestre

☒Anual

☐Enero

☐Verano

Perfil de estudiantes

Grado:

☒Ing. Inteligencia Artificial

☐Ing. Tecnologías Industriales

☐Ing. Mecánica

☐Ing. Eléctrica

☐Ing. Electrónica Industrial

☐Ing. Sistemas de Telecomunicación

☒Ing. Organización Industrial

☒Ing. Organización Industrial e International Industrial Management Program

☒Ing. Diseño Industrial y Desarrollo de Productos

☐Ing. Diseño Industrial y Desarrollo de Productos + Ing. Mecánica

☐Ing. Biomédica

Curso:

☐2

☒3

☒4

¿Cuántos estudiantes se espera que trabajen en este proyecto?
4 estudiantes.

Otros comentarios o datos de interés

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