Universidad de Navarra

Facultad de Ciencias

Propuesta de Trabajo Fin de Máster
Año académico 2025-2026
MÁSTER EN CIENCIA DE DATOS PARA CIENCIAS EXPERIMENTALES

Proyecto Nº 5	
Título: Aggregation of structured data	
Departamento/ Laboratorio: Física y Matemática Aplicada	
Director: Dr. Jorge Elorza **Correo electrónico: jelorza@unav.es** **Codirector:** **Correo electrónico:**	

Resumen:

The aggregation of data with uncertainty to obtain a representative of them is a very relevant issue that we intend to address, especially when the data present a certain structure. In this case, it is important to study when the structure of the input data is preserved. In [TBAE] we studied the aggregation of fuzzy graphs obtaining conditions to ensure the preservation of several structures within graphs with uncertainty.

Simplicial complexes can be seen as a generalization of graphs where, in addition to vertices (0-dimensional) and edges (1-dimensional), higher dimensional elements (n-dimensional simplices) are included. The notion of fuzzy simplicial complex includes the fuzzy graph as a particular case. This notion is interesting because a biunivocal correspondence can be established between simplicial fuzzy complexes and filtrations of simplicial complexes. The filtrations of simplicial complexes are a key ingredient of persistent homology.

One objective is the study of the aggregation of fuzzy simplicial complexes. This can be useful in topological data analysis, in order to analyze simultaneously data sets that do not share all their points (there are no inclusions in any sense, although they usually have a large intersection).

Another objective is to explore the combination of global topological features with local geometric information in order to analyze dynamical systems represented by fuzzy simplicial complexes. This approach could be especially valuable for identifying persistent patterns in temporal or spatial data with inherent uncertainty. For example, when studying the evolution of a filtration, it would be possible to integrate the robustness of topological metrics with geometric measures that capture local details of the system. A related approach has already been successfully employed in the context of traditional time series, as described in [ZSZPL], where the combination of these properties has made it possible to identify patterns in biological and economic data even under noisy conditions.

[TBAE] Talavera, F. J., Bejines, C., Ardanza-Trevijano, S., & Elorza, J. (2024). Aggregation of fuzzy graphs. International Journal of Approximate Reasoning, 172, 109243.

[ZSZPL], Zhang, Y., Shi, Q., Zhu, J., Peng, J., & Li, H. (2021). Time series clustering with topological and geometric mixed distance. Mathematics, 9(9), 1046.

OPTATIVAS RECOMENDADAS
1. Procesamiento de imágenes
2. Programación avanzada
3. Deep Learning
4. Machine Learning II