



UNIVERSITY: Public University of Navarre (UPNA)

WIT PROGRAMME'S RESEARCH LINE NAME: Behaviour modelling and prediction in biological neuron networks

DOCTORAL PROGRAMME: Doctorate in Science and Industrial Technologies
<https://www.unavarra.es/escuela-doctorado/doctorate-programs/current-plan/science/doctorate-in-science-and-industrial-technologies?languageId=1>

COMPLETE DESCRIPTION OF THE LINE

The biological study of neurons is key to understanding a range of diseases, including neurodegenerative ones. However, the difficulty of working with cultures limits the extent of current analysis to either single cells or simple interactions. Thanks to the lab technology developed at King's College London (KCL) by A. Serio, we can now design, implement and monitor complex networks with living neurons, thus beginning the study of neuronal populations at medium scale.

This line aims at generating an automatic control system for these populations using electron microscopy. The system must carry out the location/identification of objects (neurons, astrocytes,...) and events (synapses, mitosis, death,...) in populations of neurons and neural stem cells. This system shall be used to understand and predict the behavior of neuron populations in long-range experiments, thus advancing towards a future of spinal cord injury recovery via personalized nerve tissue implantation.

RESEARCH GROUP NAME:

Grupo de Investigación en Inteligencia Artificial y Razonamiento Aproximado (GIARA).



COORDINATOR:

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MEMBERS OF THE LINE RESEARCH:

- Carlos López Molina (UPNA & NavarraBiomed, Tutor)
- Humberto Bustince (UPNA & NavarraBiomed)
- Andrea Serio (Francis Crick Institute, Tutor)
- David Gómez Cabrero (King Abdullah University of Science and Technology & NavarraBiomed)
- Ernesto Ruiz de Galarreta (Nasertic)

ANOTHER RESEARCH LINES OF THE GROUP: short description of each of them

- Fuzzy Set Theory and Approximate Reasoning
- Information aggregation and fusion operators
- Machine Learning, Neural Networks and Deep Learning
- Industrial, agronomic and medical image processing
- Medical and biotech data analysis
- Clustering and classification based on fuzzy rules



- Entities involved in research lines and contact person:

- ✓ Academic entities:
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 - Vicomtech (R. Orduna, rorduna@vicomtech.org)
- Joint supervision of doctoral thesis with international universities or non academic institutions:



- Sesma-Sara, Mikel, *Generalized forms of monotonicity in the data aggregation framework*, H. Bustince (UPNA), R. Mesiar (Slovak Technical University) Universidad Pública de Navarra 2019.
- De Miguel Turullols, Laura, *Computing with uncertainly truth degrees: a convolution-based degrees*. H. Bustince (UPNA), B. De Baets (Ghent University), 2017.
- Paternain Dallo, Daniel *Optimization of image reduction and restoration algorithms based on penalty functions and aggregation techniques*, H. Bustince (UPNA), F.J Fernández (UPNA), G. Beliakov (Deakin University), 2013.
- Lopez Molina, Carlos, *The Breakdown structure of edge detection: Analysis of individual components and revisit of the overall structure*. H. Bustince (UPNA), B. De Baets (Ghent University), 2012.

- Group review

The Artificial Intelligence and Approximate Reasoning Research Group (GIARA) began its trajectory focused on mathematical modeling, especially in the context of Fuzzy Set Theory. The experience gained in this line generated different theoretical-practical research, mostly based on machine learning and/or computer vision. This research has led to advances in topics as varied as automatic control, food safety, big data or convolutional/deep neural networks. Beyond the academic impact, the ability to connect mathematical theory with advanced technical tools has led to developments applied in industrial, agrobiotechnological and medical environments. To date, GIARA has generated more than 400 indexed articles, collaborating with more than 200 different authors, and it is actively involved in projects with researchers from 4 continents.

- Link of the group to the “Portal of scientific production”

<https://academicos.unavarra.es/CawDOS/?id=1adf33dba1eb5382&idioma=es&tipo=actGrupo>



- Pictures, links... to academic or industrial partners (if any)
 - UPNA: www.unavarra.es
 - NavarraBiomed: www.navarrabiomed.es
 - Nasertic: www.nasertic.es
 - King Abdullah University of Science and Technology, KAUST: www.kaust.edu.sa/en
 - Francis Crick Institute: www.crick.ac.uk

CANDIDATE REQUISITES

Degree in Computer Sciences or Mathematics

The candidate shall ideally have some experience in bio-related projects and/or developments. Also, needs to be open to integration in a multidisciplinary team involving different experts in the field.