

## Computational Intelligence Group

The Computational Intelligence Group (CIG) was created in 2008 and is led by professors Pedro Larrañaga and Concha Bielza. Research of CIG members, both theoretical and practical, is devoted to modelization (from a statistical and machine learning perspectives) and heuristic optimization, with different application areas. The main research area is machine learning, whose current main issues include: data streams, multi-dimensional supervised classification, multi-label classification, clustering in high-dimensional spaces, feature subset selection using Bayesian networks and regularization. In heuristic optimization we investigate improvements of state-of-the-art methods and their extension to complex problems (e.g., multi-objective functions, non-continuous objective functions), with special emphasis on estimation of distribution algorithms.

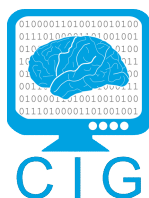
Neuroscience is an important field of application. Some problems that we face include: (a) neuroanatomy issues, like modeling and simulation of dendritic trees and classification of neuron types based on morphological features; (b) neurodegenerative diseases, like predicting health-related quality of life in Parkinson's disease and searching for genetic biomarkers in Alzheimer's disease. The second main field of application is Industry 4.0 where we develop machine learning solutions for cyber-physical systems. The third application field is sports, where we develop intelligent systems for coach assistance, injury prediction, football player performance prediction and their potential transfer to other clubs.

CIG has been involved in more than 100 research projects, mostly in public competitive calls but also for private companies

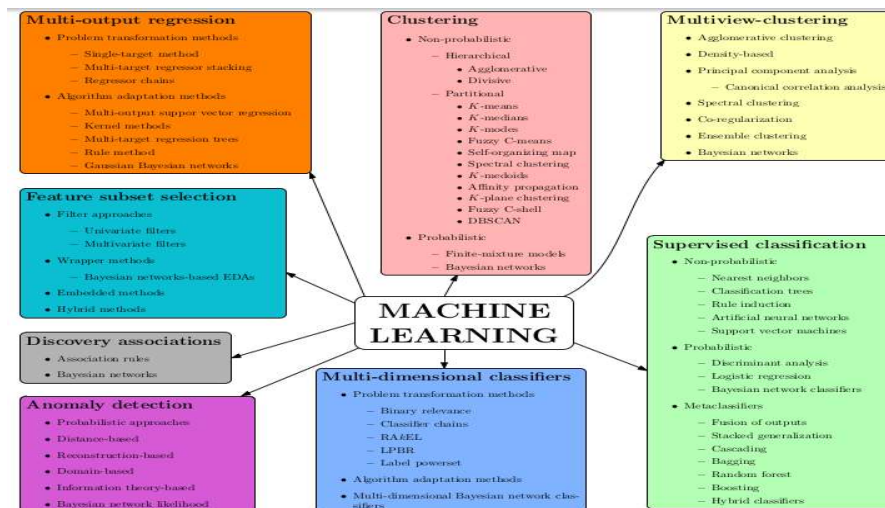
### Facilities and infrastructures



The Computational Intelligence Group belongs to the Artificial Intelligence Department. It is located at the buildings of the School of Computer Science, which belongs to the Universidad Politécnica de Madrid (UPM). The School is located at the Montegancedo Campus, which belongs to the UPM and it is situated within a residential area called Urbanización Montepríncipe, on the outskirts of a small residential town called Boadilla del Monte, about 7 km northwest of Madrid.



## Research areas associated with Big Science



## Main projects in Big Science

- **Human Brain Project (2013-2023)**, FET Flagship Initiative Objective: to advance our knowledge in the fields of neuroscience, computing, and brain-related medicine.
- **Excellence Network on Supercomputing for Artificial Intelligence (2018-2020)**, Spanish Ministry of Economy, Industry, and Competitiveness.
- **Excellence Network on Artificial Intelligence in Biomedicine (2020-2021)**, Spanish Ministry of Economy, Industry, and Competitiveness.
- **New Industrial IoT Infrastructure for the Factory that Learns (2017-2020)** Etxe-Tar S.A. Likelihood based anomaly detection method by means of static Bayesian networks.
- **Score-based Nonstationary Temporal Bayesian Networks. Applications in Climate and Neuroscience (2020-2022)** BBVA Foundation. A causal Bayesian network algorithm based on score+search has been proposed.
- **Research and Development of Methodology in AI (ML) oriented to industrial cases of use of continuous ultra-high speed data (2020-2023)** Spanish Ministry of Science, Innovation and Universities. Anomaly detection based on dynamic Bayesian networks.

## Collaboration with Large European Scientific Facilities

- **ELLIS**: ELLIS European Laboratory's membership since 2019. The ELLIS mission is to create a diverse European network that promotes research excellence and advances breakthroughs in AI.

## Software, tools or licenses to be applied to Big Science

- **NeuroSuites (2018-2020)**: a web-based platform for learning, visualizing, and interpreting Bayesian networks.
- **3DSpineS and spineSimulation (2018)**: two software tools that allow to characterize dendritic spine geometry, perform model-based clustering according to dendritic spine morphology and simulate artificial dendritic spines.
- **3DSynapsesSA (2015)**: an R package for spatial analysis of synapses.
- **Optimal Wiring (2016)**: software for analyzing optimal neuronal wiring.
- **3DSomaMS (2015)**: an R package to segment the neuronal soma.
- **3DBasalRM (2017)**: data-driven repairing model that detects cut-points in the basal arborization and then repairs them using a growth model built from complete 3D neuron reconstructions.

UPM contact:

Pedro Larrañaga and Concha Bielza

pedro.larranaga@upm.fi.upm.es

mcbielza@fi.upm.es