Machine Learning: neural networks and advanced models (AA2)

Master Programme in Computer Science
Master Programme in Bionics Engineering

Code: 321AA ECTS: 6 Semester: 2 Acronym: AA2

Alessio Micheli & Davide Bacciu

micheli@di.unipi.it bacciu@di.unipi.it

Dept. Computer Science
University of Pisa - Italy

Computational Intelligence & Machine Learning Group

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General Info

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- **AA2 - *Machine Learning: neural networks and advanced models*** (Corso di Laurea Magistrale in Informatica - Master programme in Computer Science) is borrowed from CNS for years 2016 and 2017.

- **CNS** (**Computational neuroscience**) 6 CFU SSD: INF/01 is part of *Applied Brain Science (12 CFU)* - Master programme in Bionics Engineering

- **Instructors** (2016):
  - Alessio Micheli
  - Davide Bacciu
  - Seminars from experts in CNS

AA2 Aims

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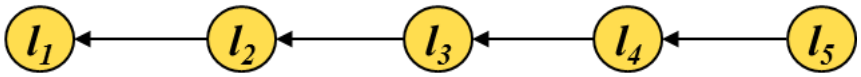
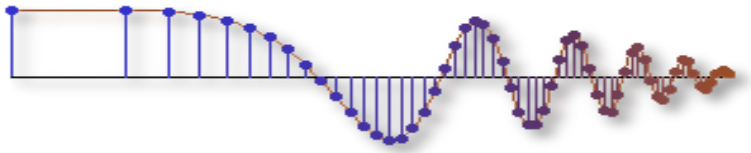
- The aim of AA2 is to course provide the methodologies needed to specialize in the area of design of new advanced machine learning models,
  - including state-of-the-art neural networks,
  - considering the processing of complex domains and non-vectorial data.





Objectives AA2-CNS

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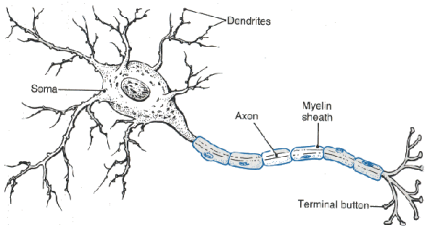
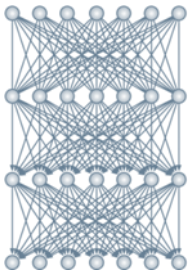
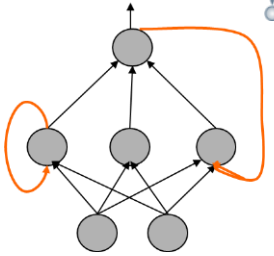
- Introduction to the basic knowledge of the CNS, considering both the **bio-inspired neural** modelling **and computational** point of view.
- Gain practical knowledge on simple CNS models by lab experience
- Including, as for Syllabus,
  - Bio-inspired neural modelling
    - Neuroscience modeling



  - Advanced computational learning models:
    - Representation/deep learning



  - Recurrent neural networks
    - Dynamical models for sequences



Toward brain science: biological and artificial motivations

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- Advancements in the studies for "intelligence":
  - IT view – construct new intelligent systems + data science→ success in current industry developments , e.g. *deep learning*
  - Brain understanding: e.g. brain's projects
- We will follow these two motivational approaches/objectives

Nature, jan 2016

Self-driving cars

Brain's projects

Brain understanding: A look ahead

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An "instructive" current history for the interest, USA versus EU

- The White House **BRAIN Initiative** (Brain Research through Advancing Innovative Neurotechnologies)

"Understanding how the brain works is arguably one of the greatest scientific challenges of our time."

- **Human Brain Project:** > 1 billion euro for 10 years research by EC (flagship project)

European Commission

Human Brain Project

Future: still open! E.g. integrate the two approaches:
Data-driven/computational approaches
& cognitive/neurobiological analysis

Formal Info

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Prerequisites:

- Math:
  - mathematical analysis (functions, differential calculus), Basic knowledge of multivariate calculus, differential equations
  - linear algebra, matrix notation and calculus,
  - elements of probability and statistics
- Basic knowledge of algorithms
- Basic of machine learning and artificial neural networks (AA1)
- Programming: MATLAB for our lab.

Exam:

- Typically a presentation or a project with a report.
- Oral exam

Syllabus

- bio-inspired neural modelling
- computational learning models
- recurrent neural networks

More Information

- **Program**: contact us to be upgraded

- **AA1/AA2 pages**:
  http://www.di.unipi.it/~micheli/DID/

- **Alessio Micheli**: micheli@di.unipi.it
- **Davide Bacciu:** bacciu@di.unipi.it

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