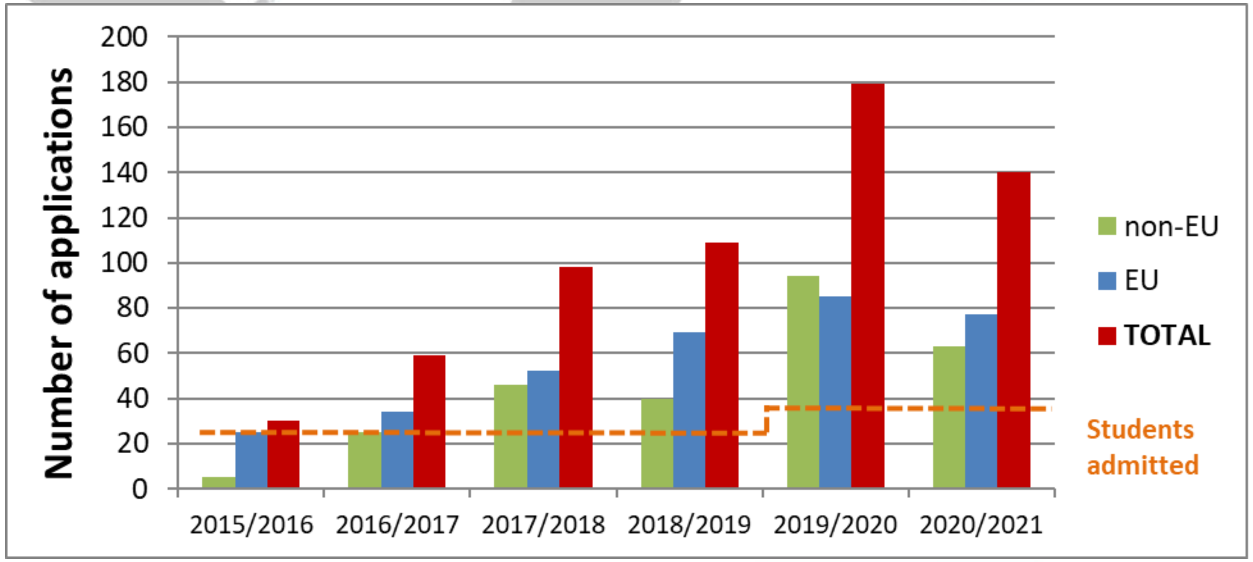
M.Sc. in Bionics Engineering – UNIPI, SSSA and IMT, since 2015



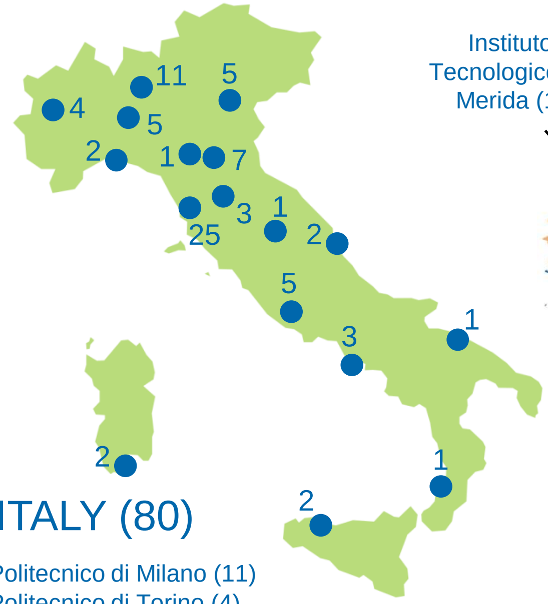
- International program
- Limited enrollment (30 students per year)
- 2 majors: biorobotics and neural engineering

http://www.bionicsengineering.it/

M.Sc. in Bionics Engineering – UNIPI, SSSA and IMT, since 2015

M.Sc. in Bionics Engineering

Classes of 15/16-16/17-17/18 -18/19 -19/20



ITALY (80)

Politecnico di Milano (11)
Politecnico di Torino (4)
Università di Bologna (7)
Università di Pisa (24)
Università di Pavia (5)
Università di Cagliari (2)
Università Roma Tre (1)
Università Roma La Sapienza (3)
Università Roma Tor Vergata (1)
Università di Modena e Reggio Emilia (1)
Università degli Studi di Napoli Federico II (3)
Università Politecnica delle Marche (2)
Università di Padova (5)
Università di Genova (2)
Università della Calabria (1)

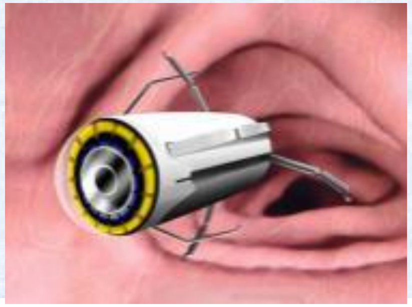
Scuola Superiore Sant’Anna (1)
Università di Firenze (3)
Università di Perugia (1)
Università di Palermo (2)
Politecnico di Bari (1)

Mission of the M.Sc. in Bionics Engineering

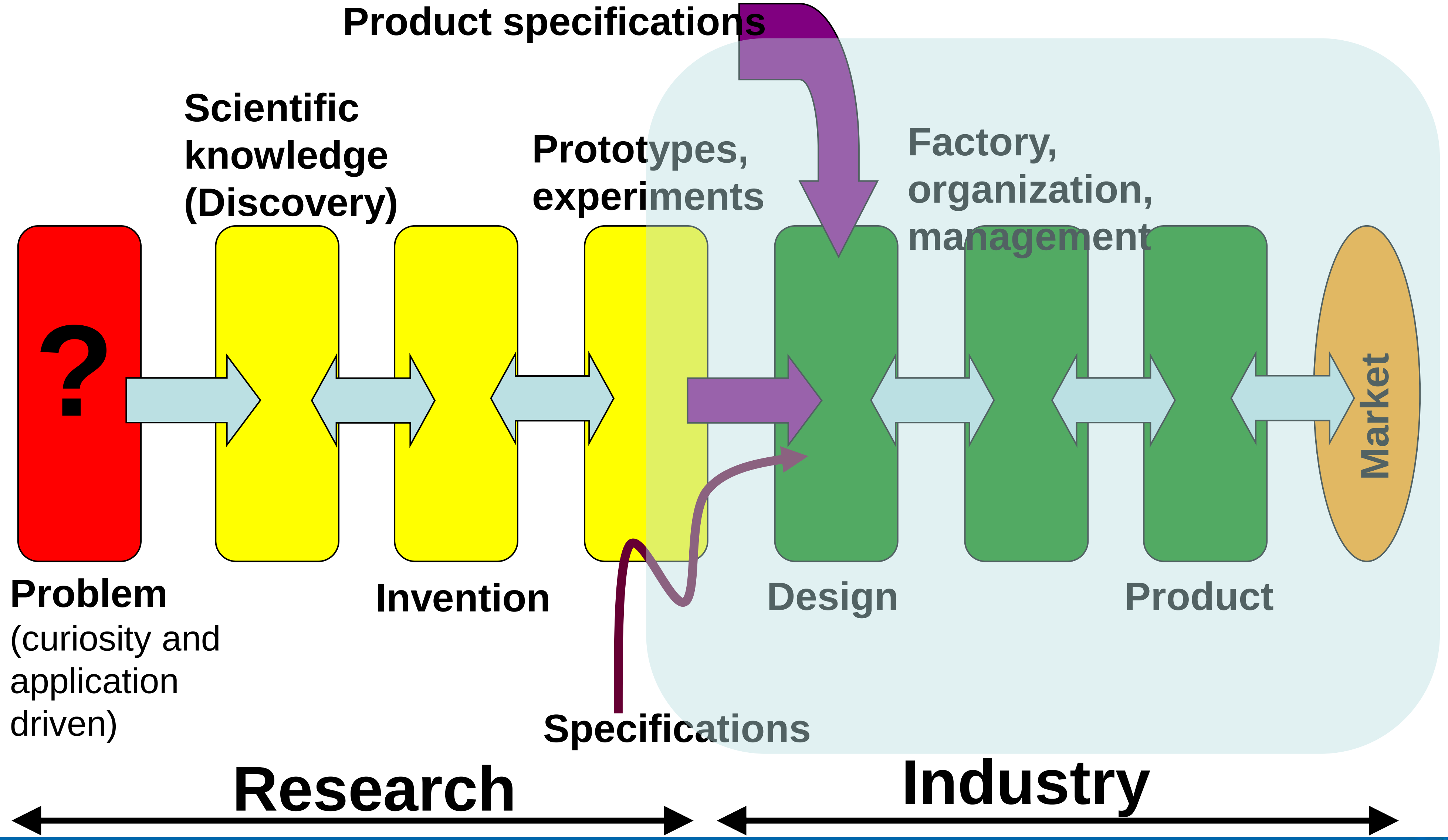
Educating the Engineer of the 21st Century

able to face new challenges and to foster opportunities for Society and Industry

Biorobotics and Neural engineering are a fantastic “gym” to train new INNOVATORS



Going beyond traditional engineering education



The birth of Bionics

Bionics as an inter-science discipline officially dates back to **1958** when **Major J. E. Steele** coined the term making reference to a research program at the **Wright-Patterson Air Force Base in Dayton, OH, USA**

Jack E. Steele

Wright-Patterson Air Force Base

Steele used the term **bionics** to mean “**a life-like system that copies some functions and characteristics of a natural system**”

Science

AAAS

Meetings

Bionics

The unities underlying the behavior of animals, men, and machines were brought into clearer focus at a national symposium held 13–15 September 1960 in Dayton, Ohio. The meeting, under the sponsorship of the Wright Air Development Division of the United States Air Force, was attended by approximately 700 persons. Thirty invited speakers reported new developments concerning methods of information handling used by living systems and artificial models of such systems. The magnitude of the recent advances so impressed the participants that they virtually demanded that such a meeting be made a regular event. This report is based entirely on my notes; I apologize for any errors of fact or interpretation, and for not mentioning many talks because of lack of space.

At the start, H. E. Savely of the Air Force Office of Scientific Research pointed out three aspects of living systems which are worthy of study for incorporation into artificial systems: (i) the extreme sensitivity of certain receptor organs—for example, the ability of certain fish to detect a change in the electric field in the water around them of as little as 0.003 μv/mm; (ii) the ability of even simple living brains to integrate the activity of many sensor and effector organs; (iii) the ability to retrieve information rapidly in the central nervous system; and (iv) the ability to store information at molecular levels, even for periods of generations, as in the chromosomes. An example of the successful use of a living system as a prototype for an artificial system is the application in an optical ground-speed indicator for airplanes of the simple principle in the beetle's visual system that provides information on velocity.

H. E. Savely cautioned (i) that as long as we lack fundamental understanding of the laws of organized complexity, it may not be possible to duplicate the living system; (ii) that nature is limited simply to building on and modifying pre-existing systems and that the living system therefore may not provide the most economical approach to a particular information-handling problem; and (iii) that it is common for the physical scientist to think that he can take a quick look at some biological system, work out the principles in a very short time, and then apply them to the design of some artificial system. Not only is he mistaken in this belief but he is very much like Brer Rabbit attacking the Tar Baby. The harder he attacks the problems of biology the more deeply does he become enmeshed, so that he soon finds himself unable to drop them.

An analysis of the relatively simple servomechanism controlling the size of the pupil of the human eye was presented by Lawrence Stark, now of the Massachusetts Institute of Technology. This paper and one other were the only reports dealing directly with the information-handling mechanisms of living systems—evidence perhaps of the difficulty of such an approach. The other talks dealt with the design of artificial systems. E. E. Loebner of RCA Research Laboratories pointed out that man, because he has few outputs (muscles), has built only a few information inputs into the gear he controls, to match his few outputs. This restriction on the number of inputs has been carried over into equipment not under human control. It would often be preferable to give such equipment multiple inputs, such as man has in his sense organs.

The general logical operations that a computer must perform in order to behave like an organism were described by Peter M. Kelly of Aeronutronics. It must take inputs from a sensory field, code them into groups, act on them by some internal logic, code the outputs, and carry out responses in terms of this output code. The coding of the sensory input to the internal logic can be fixed in advance—that is, preorganized. It is also possible to design machines which are self-organized—that is, capable of learning how to code their sensory input and their output so as to achieve the desired responses to particular sensory situations. Kelly, and also Walter Reitman of Carnegie Institute of Technology, discussed the design of such machines and gave examples of existing machines in which the two types of design are used. (Could it be that when we intuitively judge one type of organism to have more "consciousness' than another, the distinction in physical terms is that it has a greater capacity for self organization?)

W. P. Tanner of the University of Michigan argued that the human being is not completely preorganized so as to give a fixed response for a particular sensory input but is capable of self-organization. Therefore, the human being subjected to psychophysical tests should not be considered to have a sensory threshold but should be treated as a computer which is testing the statistics of the test situation and making decisions which optimize some aspect of that situation. Tanner is analyzing such performances of human beings in auditory test situations.

The problem of designing a machine which can differentiate or recognize one out of all possible sensory functions was discussed by Seymour Papart of the National Physical Laboratory, Teddington, England. The problem is simplified by the fact (i) that the input functions possible are only a portion of all functions, and (ii) that as the number of dimensions of the input functions increase, the chance of separating any two input functions increases, even with a simple machine. He has roughly estimated that one human being during his lifetime could learn up to 10^{8} particles of information. This much learning could be handled by any of the systems of self-organization described at the symposium. (Compare this estimate with the estimate of 10^{15} made some years ago by W. S. McCulloch and of 10^{13} to 10^{18} made by H. von Foerster.)

Artificial devices which recognize patterns, including one device capable of recognizing cancerous cells under the microscope, were mentioned by P. Metzelaar of Space Technology Laboratories. Some machines have given performance superior to the human—for example, a checker playing program for the IBM 704 computer. Other machines have been designed that can predict the future of a sequence from its past. Metzelaar suggested that if the design problems can be solved, the future machine will do preliminary pattern transformations on its sensory inputs in order to reduce the amount of information that must be handled and stored. It will also be able to consider its sensory input in either gross outline or fine detail and know which type of consideration is needed, decide how to divide its attention among its different sensory inputs, and know which of various recognition mechanisms it should use.

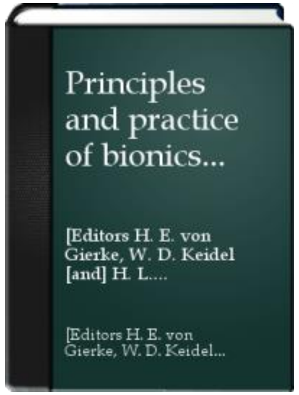
In a talk that was as remarkable for its witty asides as for its lucid exposition, A. Novikoff of Stanford Research Institute briefly described integral geometry and illustrated its use in the

588

SCIENCE, VOL. 133

J.E. Steele. *Bionics Symposium: Living Prototypes – The Key to New Technology*, ed. C.H. Gray. New York, 55–60 (1960)

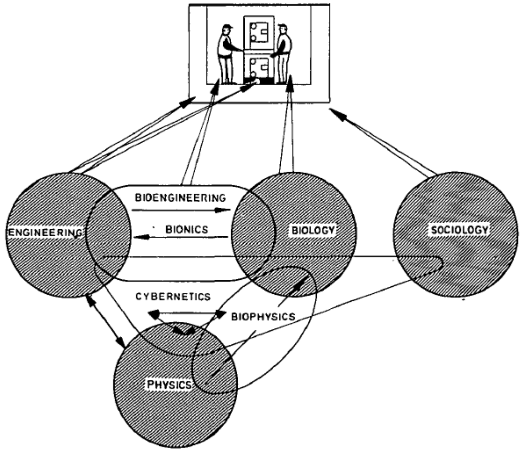
The birth of Bionics



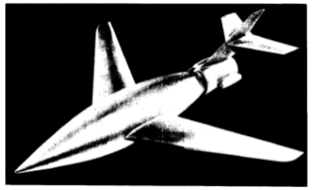
The primary goal of bionics is *"to extend man's **physical and intellectual capabilities** by prosthetic devices in the most general sense, and to replace man by **automata and intelligent machines**"*

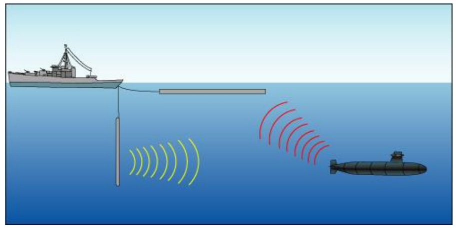
Henning Edgar von Gierke

These objectives were pursued by using models from the animal kingdom…



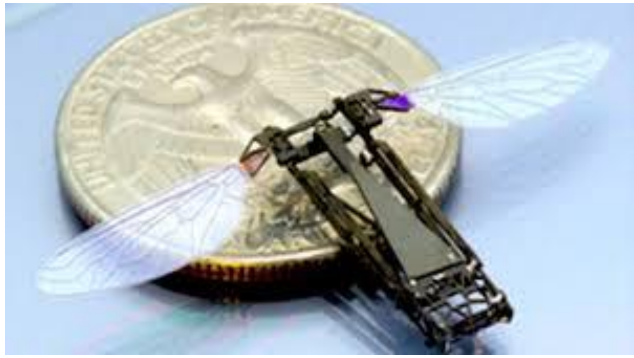
Research efforts were mainly driven by **military applications**

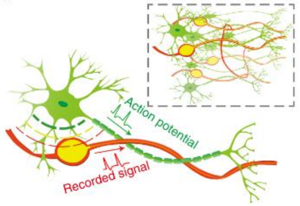


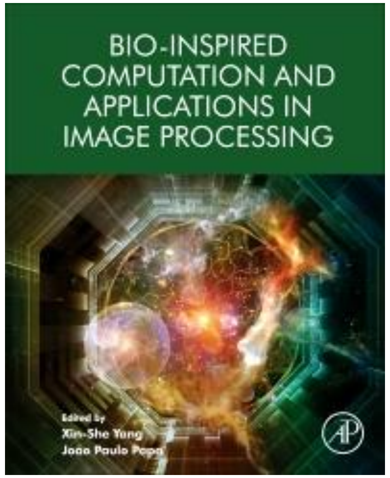


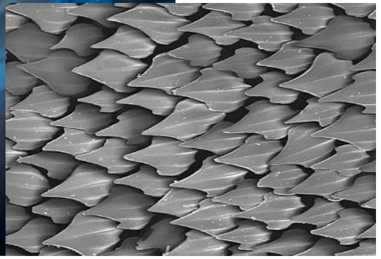
H.E.Von Gierke, W.D. Keidel. Principles and practice of bionics. *Technivision Services* (1970)

Current applications of bionic technologies

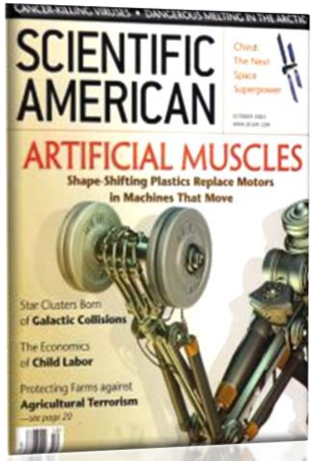


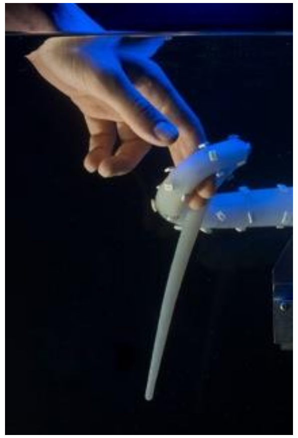


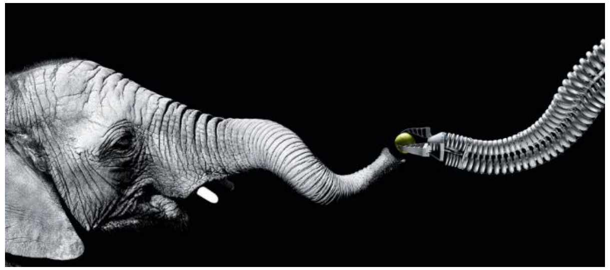


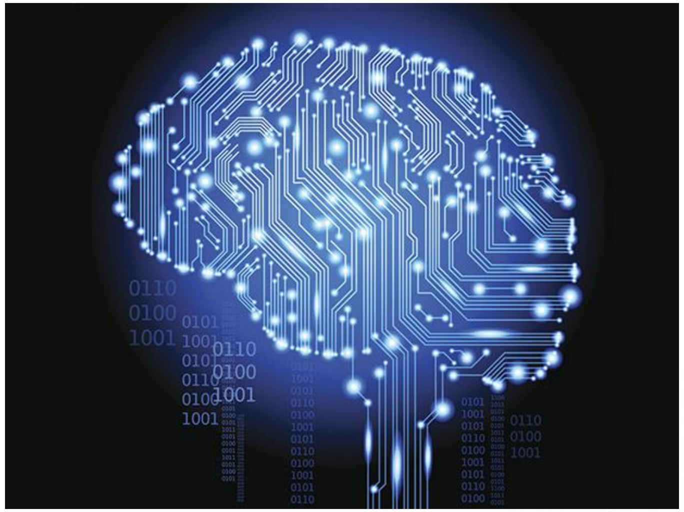


Shark skin-inspired swimsuits

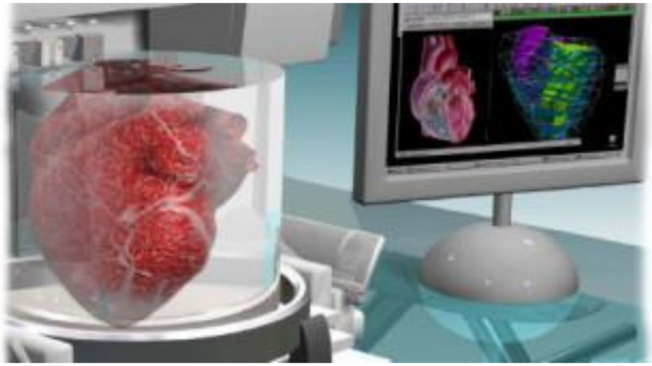


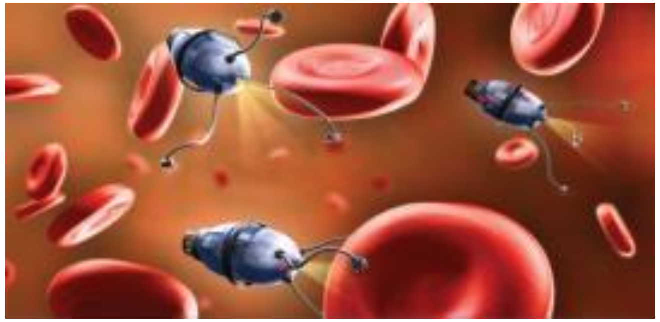






Bionics intended as technologies intimately interacting with the body



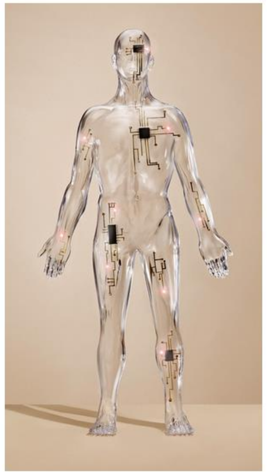


We Will End Disability by Becoming Cyborgs

Neural interfaces and prosthetics will do away with biology's failings

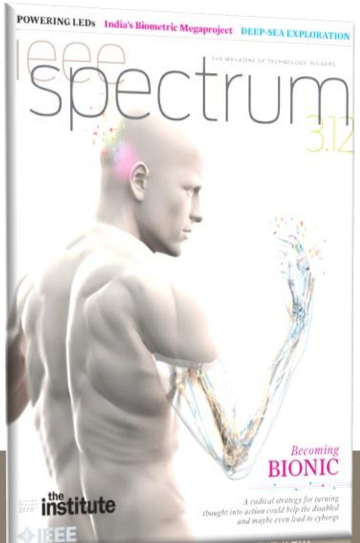
By Eliza Strickland
Posted 27 May 2014 | 15:03 GMT

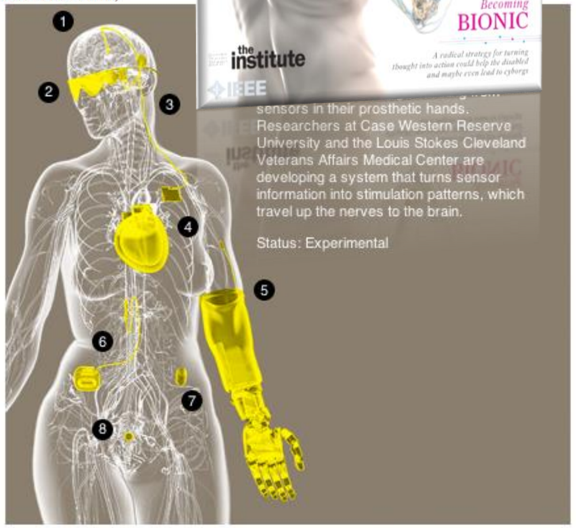
Share | Email | Print



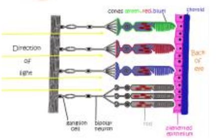
Hugh Herr is a living exemplar of the maxim that the best way to predict the future is to invent it. At the age of 17, Herr was already an accomplished mountaineer, but during an ice-climbing expedition he lost his way in a blizzard and was stranded on a mountainside for three days. By the time rescuers found him, both of his legs wer
frostbite and had to
below the knee. On
healed, Herr spent
rooms trying out pr
he found them una
could he climb with
things? Surely, he t
technologists could
replacement parts t
him down.

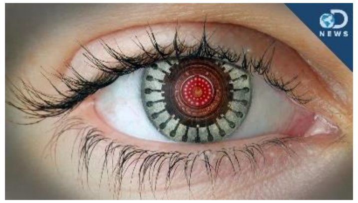
Today, three decad





The Revolution Will Be Prosthetized





Hacking the Human OS > Reading the Code > Monitoring

Diabetes Has a New Enemy: Robo-Pancreas

Sensors, actuators, and algorithms can automatically control blood sugar

By Philip E. Ross
Posted 27 May 2015 | 21:00 GMT

M.Sc. in Bionics Engineering

1st year	
1st semester	**2nd semester**
Statistical signal processing (Fulvio Gini) – 6 ECTS	Biomechanics of human motion (Vito Monaco)- 6 ECTS
Soft and smart materials (Matteo Cianchetti) – 6 ECTS	Instrumentation and measurements for bionic systems (Angelo Maria Sabatini) – 6 ECTS
Biological data mining (Francesco Marcelloni) – 6 ECTS	Neural and fuzzy computation (Beatrice Lazzerini) – 6 ECTS
Behavioral and cognitive neuroscience (Emiliano Ricciardi) – 6 ECTS	Computational neuroscience (Alessio Micheli) – 6 ECTS
Principles of bionics engineering (Paolo Dario) – 6 ECTS	Economic assessment of medical technologies and robotics for healthcare (Giuseppe Turchetti) – 6 ECTS
Neuromorphic engineering (Calogero Maria Oddo) – 6 ECTS	Electronics for bionics engineering (Daniele Rossi) – 6 ECTS
Mechanics of elastic solids and biorobotic structures (Antonio De Simone) – 6 ECTS	

In black: mandatory courses

In orange: elective courses (students need to complete at least 12 ECTS by choosing elective courses)

M.Sc. in Bionics Engineering

2nd year – Curriculum: Biorobotics	
1st semester	**2nd semester**
Prostheses (Christian Cipriani) – 6 ECTS	Exoskeletons (Nicola Vitiello) – 6 ECTS
Robot companions for assisted living (Maria Chiara Carrozza) – 6 ECTS	Micro/nano robotics and biomaterials (Leonardo Ricotti) – 6 ECTS
Human and animal models in biorobotics (Marcello Calisti) – 6 ECTS	Cloud robotics (Egidio Falotico) – 6 ECTS
Robotics for minimally invasive therapy (Arianna Menciassi) – 6 ECTS	

2nd year – Curriculum: Neural Engineering	
1st semester	**2nd semester**
Advanced image processing (Nicola Vanello) – 6 ECTS	Integrative cerebral function (Angelo Gemignani) – 6 ECTS
Neural tissue engineering (Giovanni Vozzi) – 6 ECTS	Neural interfaces and bioelectronic medicine (Silvestro Micera) – 6 ECTS
Bionic senses (Alessandro Tognetti) – 6 ECTS	Affective computing (Enzo Pasquale Scilingo) – 6 ECTS
Interactive systems (Daniele Mazzei) - 6 ECTS	

Final duties: Lab training (3 ECTS) and Thesis (15 ECTS)

M.Sc. in Bionics Engineering

1st Year

(1st semester)

Statistical signal processing

Focus

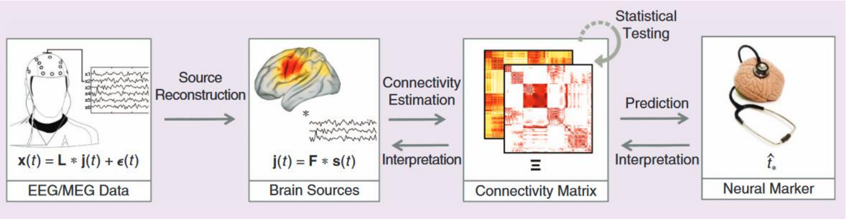
- Statistical signal processing methods for deterministic and random parameter estimation, data analysis, random signal recovery and filtering, model identification, power spectral density estimation.

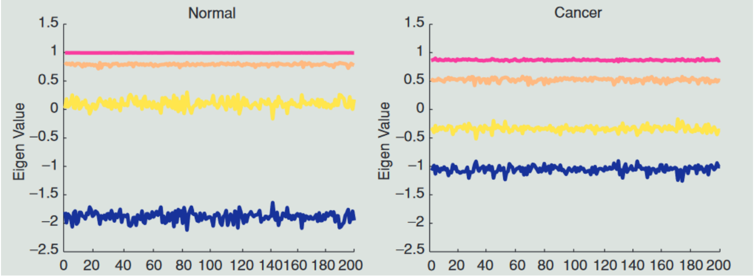
Learning Outcomes

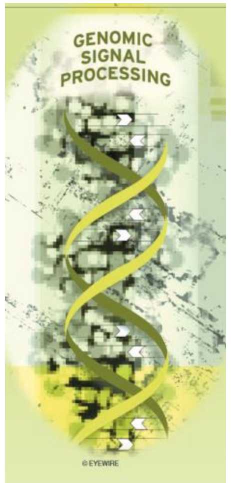
- Background knowledge necessary to solve typical problems by using methods of statistical signal processing

Main Contents

- Orthonormal base signal expansion, Principal Component Analysis (PCA), Sample estimators, Method of moments estimators, Maximum likelihood estimators, Linear and Non Linear Least Squares Least, Bayes estimation, Minimum Mean Square Error (MMSE) and Maximum A Posteriori (MAP) estimation, Linear MMSE (LMMSE) estimation, ARMA modeling, Wiener filter for signal filtering, prediction and interpolation, parametric and non Parametric power spectral density estimation.







Soft and smart materials

Focus

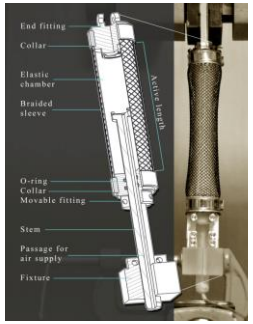
- Use of soft materials for developing innovative sensors and actuators

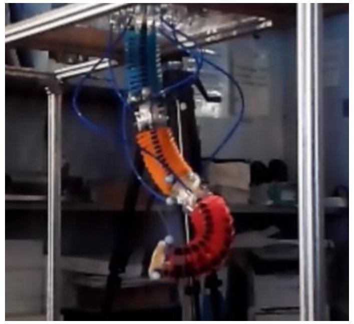
Learning Outcomes

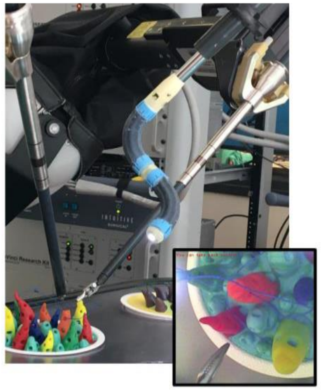
- Use of soft/compliant material for the design of intelligent mechatronic systems

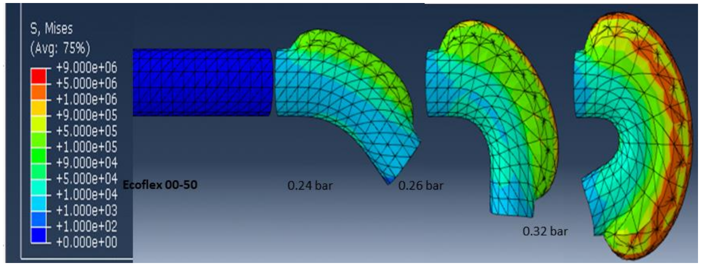
Main Contents

- Novel actuation technologies
- Introduction to Finite Element Models (FEM)
- FEM implemented in ANSYS software for non-linear analysis for design purposes









Biological data mining

Focus

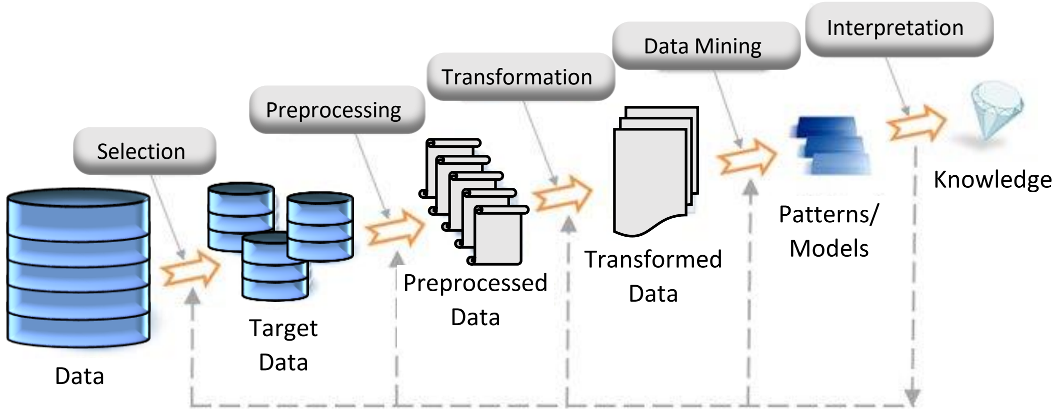
- Main techniques used in Data Mining

Contenuti principali

- Data Preprocessing
- Frequent pattern mining
- Classification
- Clustering
- Outlier Detection
- Laboratories on the application of the methods presented during the course

Learning Outcomes

- To provide a solid knowledge of the main techniques used in data mining. This knowledge will allow identifying the most suitable approach for solving each type of data mining problem.



Behavioral and cognitive neuroscience

Focus

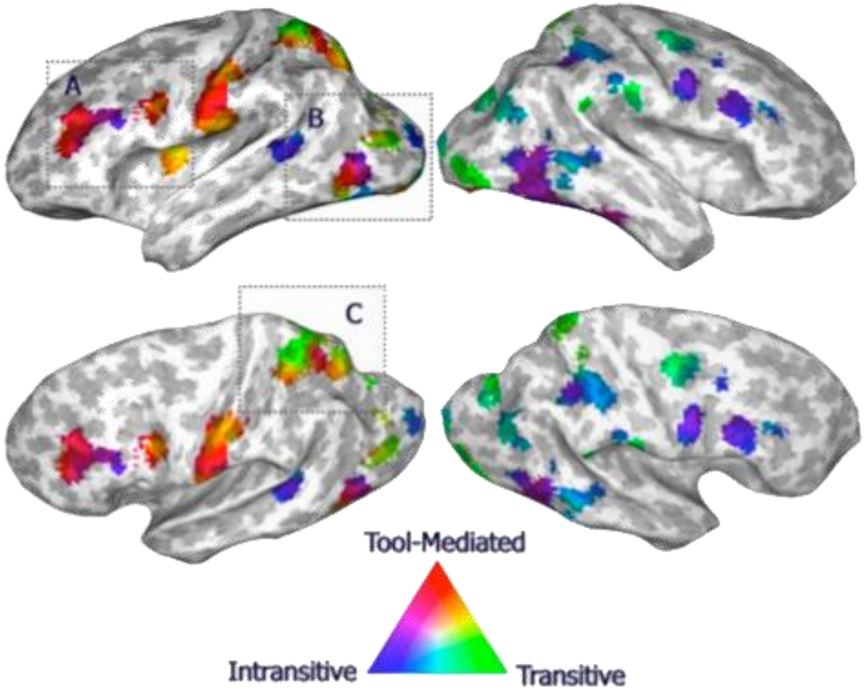
- Neuroimaging has revolutionized neuroscience, allowing us to investigate the neural correlates of behavior and mental functions

Main contents

- basics of brain anatomy and physiology
- neuroimaging methodologies: principles, applications, methods of analysis
- neurobiological correlates of cognition and behavior
- functional neuroanatomy of perception, consciousness and sleep, language, emotions and behavior motor control and representation of action, development of brain-computer interfaces

Objective

The course introduces the theoretical and methodological aspects of cognitive and social neuroscience, introducing to the fundamentals of brain anatomy and physiology, and to neuroimaging techniques



M.Sc. in Bionics Engineering

1st Year

(2nd semester)

Biomechanics of human motion

Focus

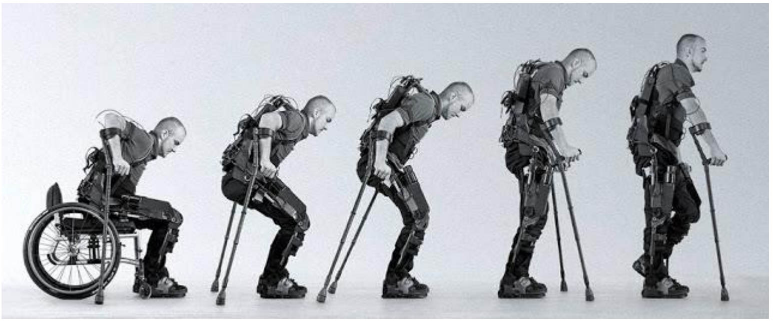
- Biomechanics of human movements and physiological principles underlying motor control.

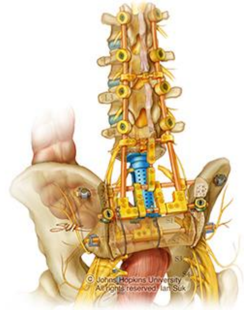
Main Topics

- 3D kinematics and kinetics;
- physiology of muscle contraction
- modeling of muscle-tendon actuators;
- numerical methods to solve dynamic models adopted in biomechanics;
- EMG signals
- instruments in a motion lab

Learning Outcomes

- Methodological approach for the study of human motion during dynamic motor tasks mediated by muscle-tendon actuators





Instrumentation and measurements for bionic systems

Focus

- Methods and techniques for the measurement of physical and electrical variables in bionic systems

Main Contents

- Application and design of measurement systems
- Measurement systems behavior through mathematical modeling
- Probability & statistics for analysis of experimental data

Learning Outcomes

- How to deal with measurement problem solving (data acquisition, analysis and interpretation)

Neural and fuzzy computation

Focus

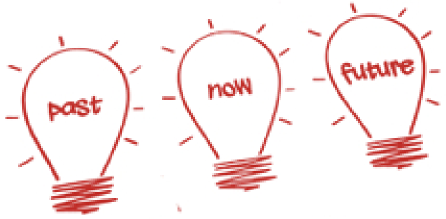
- Basic concepts and models of Computational Intelligence
- Application of the associated techniques to real-world problems in several application domains

Main Contents

- Artificial neural networks
- Deep learning
- Fuzzy logic
- Fuzzy systems
- Genetic algorithms

Learning Outcomes

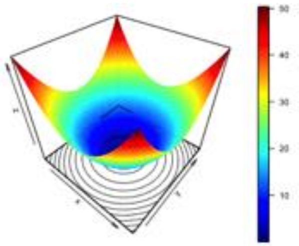
- Design and develop intelligent systems with human-like capabilities in terms of reasoning, learning and adaptation



forecasting


profiling


decision making


Multi-objective optimization

Computational neuroscience

Focus

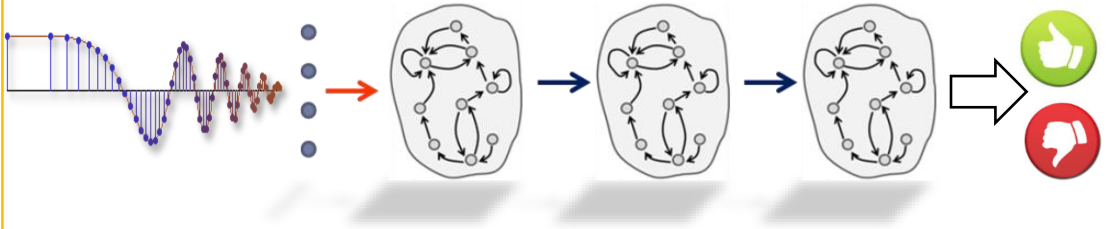
- Introduction to fundamentals of the CNS considering both the bio-inspired neural modelling and computational point of view

Learning Outcomes

- Capability of analysis and development of advanced CNS/Machine Learning models

Main Contents

- Neuroscience modeling
- Spiking and reservoir computing neural networks
- Advanced computational learning models
- Dynamical/Recurrent neural networks



Deep Recurrent Neural Network

M.Sc. in Bionics Engineering

1st Year

(Additional courses that can be selected by students) – 1st semester

Principles of bionics engineering

Focus

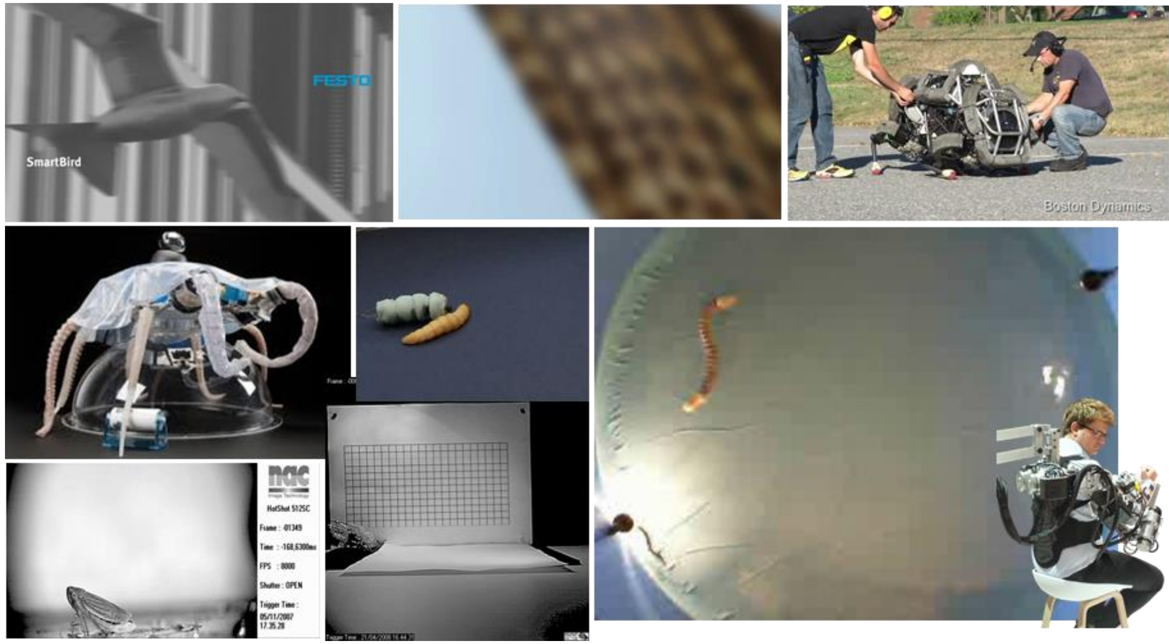
- Make students able to face frontier engineering problems, by combining science and hi-tech approaches (proper of bionics design)

Main Contents

- Introduction to the course, historical hints and definitions
- Bionic structural design and main material classes and fabrication technologies
- Bionic locomotion principles and robotic zoo
- Swarm intelligence and collective behaviors
- Morphological computation
- Bionic sensors and actuators
- Bionic energy management: comparison between animals and robots
- Examples of current bionics systems and applications
- Ethical, economic and legal considerations related to bionics

Learning Outcomes

- Providing basic knowledge and principles on design, fabrication, and control processes of bionics systems
- Highlighting current bionics systems and their applications
- Stimulating students directly to develop innovative bionic concepts by exploiting the knowledge acquired during the course



Neuromorphic engineering

Focus

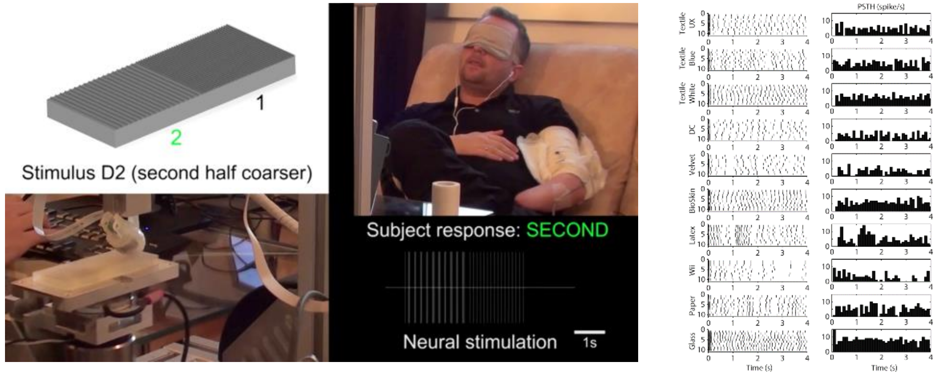
- Computational and physical models that emulate neuron dynamics

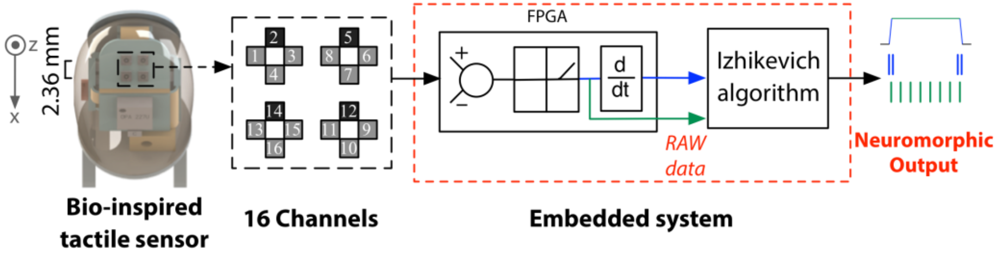
Learning Outcomes

- Neurorobotic systems and neurophysiological data for restoring sensori-motor functions

Main Contents

- Technologial solutions for embedded spiking systems
- Signal processing techniques for spiking signals (artificial or physiological)
- Methods for simulating neuron dynamics (e.g. Izhikevich model)
- Use and design of neuromorphic systems





Mechanics of elastic solids and biorobotic structures

Focus

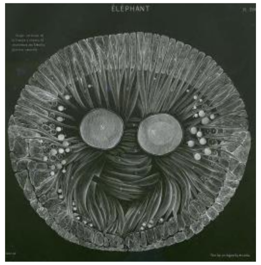
- Non linear mechanics of one-dimensional active and elastic systems in the regime of large deformations: from robotic arms to elephant trunks

Main Topics

- Infinitesimal and finite rotations
- Kinematics and equilibrium of deformable rods
- Material properties and consitutive models
- Prinicple of virtual powers and the Finite Element Method
- Applications: wires and tendons, Euler's elastica and Galileo's beam, bending with large deformations, buckling and post-critical behavior of elastic systems

Learning Outcomes

- Methodological aproach for the study of shape control problems in biological and robotic systems



1st Year

(Additional courses that can be selected by students) – 2nd semester

Economic assessment of medical technologies and robotics for healthcare

Focus

- To analyze the economic and business dimensions of the medical technologies and of the robotics for healthcare sectors

Main contents

- Specificities of the healthcare sector and economic dimension of medical technologies and robotics for healthcare
- Economic assessment techniques of robotics for healthcare and its sustainability
- Business and marketing models of robotics for healthcare

Learning Outcomes

- To understand the specificities and mechanisms of the healthcare sector and to define the strategies to favor the acquisition and transfer to the clinical practice of medical technologies and robotics for healthcare.

Electronics for Bionics Engineering

Focus

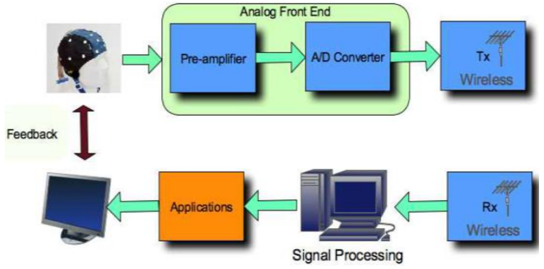
- Analysis and design of the building blocks of an electronic system for the acquisition and processing of biological sensor data

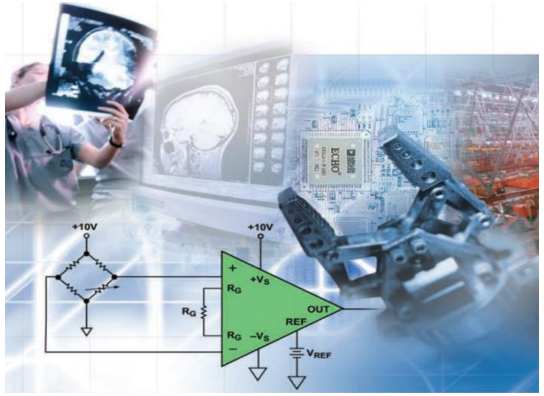
Learning Outcomes

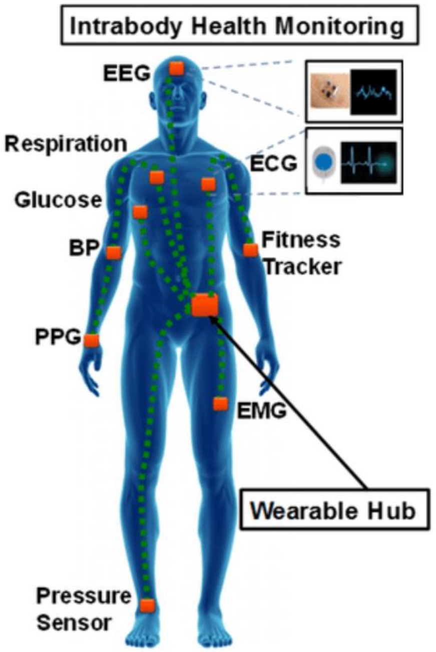
- Acquisition of a solid knowledge of the techniques and methods related to the design of sensor based electronic systems

Main Contents

- Analog front-end building blocks: instrumentation amplifiers, filters and ADC/DAC converters
- Digital interfaces transferring digitalised sensor data to an embedded microcontroller
- Design principles for energy and power efficient electronic systems for wearable applications







M.Sc. in Bionics Engineering

2nd Year

Curriculum: BIOROBOTICS

(1st semester)

Prostheses

Focus

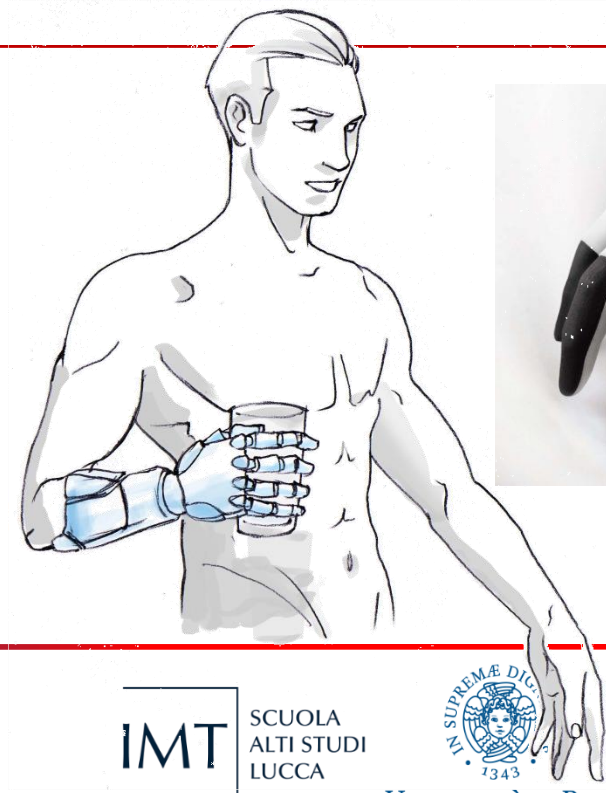
- Restoration of the upper limb sensorimotor function through prostheses

Main Contents

- Anatomy and neurophysiology of the upper limb
- Upper limb prosthetic components
- Human-machine interfaces for prosthetics
- Pattern recognition control
- Embedded controls

Learning Outcomes

- Technologies and methods to design and assess upper limb prosthetic components and systems



Robot companions for assisted living

Focus

- Robotics for rehabilitation and assistance and technologies for functional assessment

Learning Outcomes

- Design of robots for rehabilitation and assistance
- Human-centered control strategies for safe and reliable human-robot interaction

Main contents

- Introduction to rehabilitation and assistive robotics
- State of the art of robotic systems for rehabilitation and assistance
- Human-robot interaction: kinematics, dynamics and control tecniques

Human and animal models in biorobotics

Focus

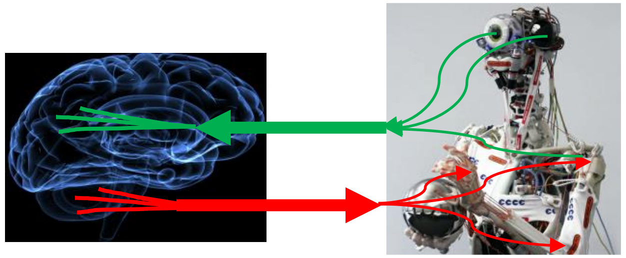
- Bioinspired robotics and biorobotic platforms for neuroscience and biology

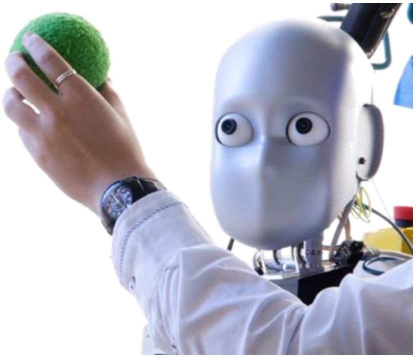
Learning Outcomes

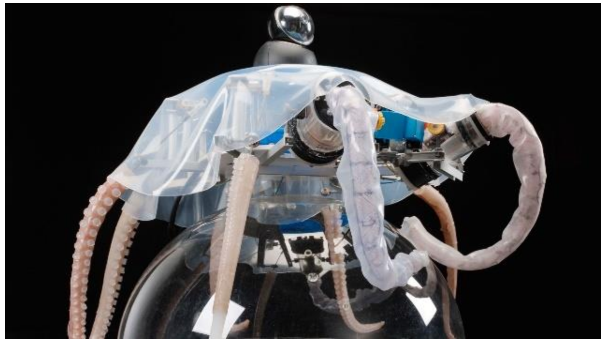
- How to design and control robots using bio-inspired principles

Main contents

- Humanoid Robotics, Neurocontrollers
- Bioinspired perception, Robot vision
- Embodied Intelligence and Soft Robotics, Underactuated mechanisms







Robotics for minimally invasive therapy

Focus

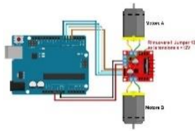
- Robot, intelligent tools, integrated mechatronic systems to improve accuracy and repeatability in surgical interventions

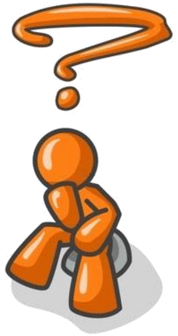
Learning Outcomes

- Knowledge and tools to build/use robots in surgical/diagnostic/therapeutic fields

Main Contents

- Why do we need surgical robots?
- Surgical operation : autonomous robots, tele-opearated robots, hand held, shared control. Endoluminal robotic approaches.
- Guidelines for designing easy to use robots, featured by a limited invasiveness





M.Sc. in Bionics Engineering

2nd Year

Curriculum: BIOROBOTICS

(2nd semester)

Exoskeletons

Focus

- Design challenges and state-of-the-art solutions of wearable robots

Main Contents

- Introduction to wearable robotics
- State of the art of upper- and lower-limb robotic exoskeletons
- Multi-layered control architectures running on real-time targets with FPGA processors
- Labview RT and FPGA modules

Learning Outcomes

- Design of wearable powered robots for movement assistance, rehabilitation, augmentation and/or functional replacement.

Micro/nano robotics and biomaterials

Focus

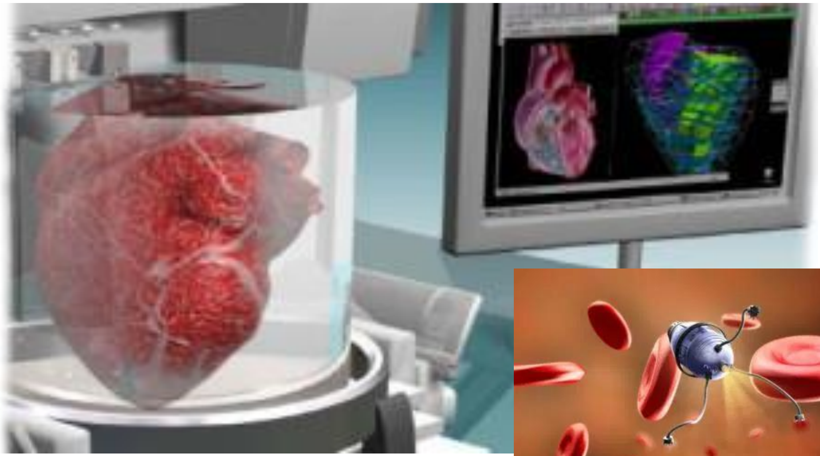
- Regenerative medicine and micro/nano-medicine

Main Contents

- Microfabrication technologies
- Molecular biology, stem cells and regenerative medicine
- Biomaterials promoting tissue regeneration
- Micro/nano robots for advanced therapies
- Physical triggers to promote drug delivery

Learning Outcomes

- Technologies and approches to regenerate human tissues
- Techniques to use micro/nano-technologies for targeted therapies



Cloud robotics

Focus

- Basic knowledge and methodologies for designing and implementing service robotic solutions based on the integration of mobile robotic platforms, sensor networks and Cloud computing.

Main Contents

- State of the art of social robotics and human robot interaction
- Architecture and functioning of Internet of Things devices based on STM32 microcontroller
- Software and hardware architecture for programming robotic platforms with ROS and Gazebo
- Design and implementation of perception-reasoning paradigms for human robot interaction

Learning Outcomes

- Design and development of cloud social robots for assistance, geriatric assessment and support in assisted living applications

2nd Year

Curriculum: NEURAL ENGINEERING

(1st semester)

Advanced image processing

Focus

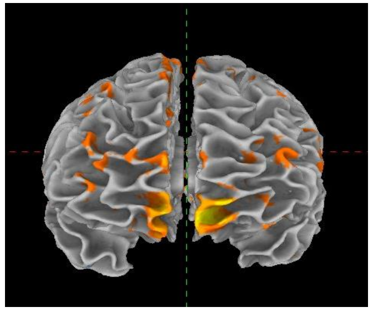
- Models and Methods fo brain function analysis

Main Contents

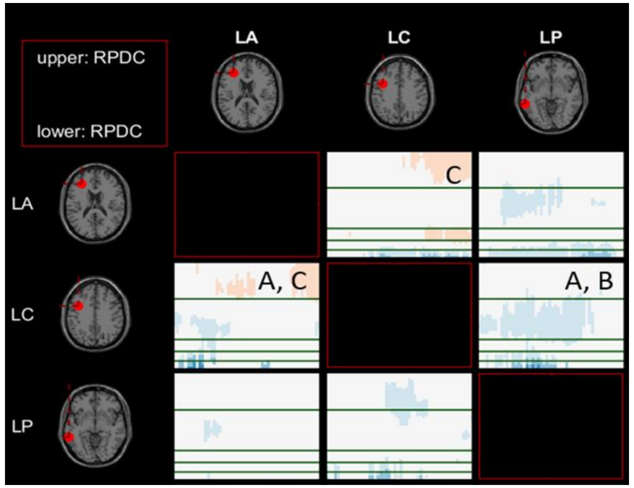
- Functional Magnetic Resonance Imaging (fMRI)
- Brain connectivity from fMRI and Electroencephalography (EEG)
- Source imaging from EEG e MRI

Learning Outcomes

- How different methods for brain function studies are applied
- Link between experimental desgin and data analysis approaches



fMRI analysis



Time frequency analysis of brain connectivity

Neural tissue engineering

Focus

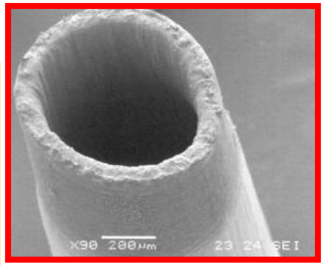
- Technological processes and materials to build neural grafts and promote their interaction with physiological neural tissue

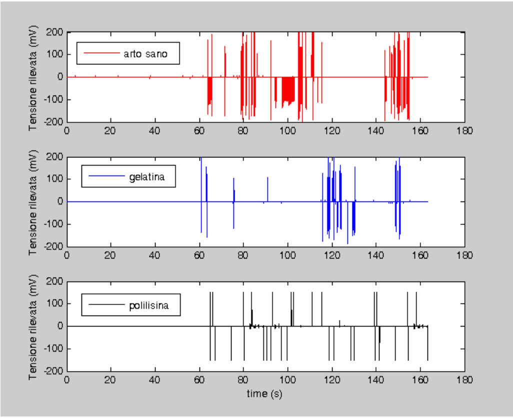
Learning Outcomes

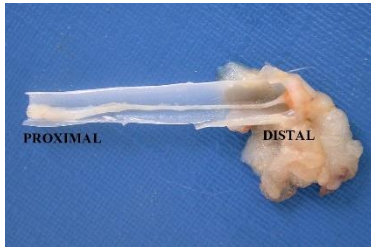
- Acquire the strategies to develop grafts and scaffolds that can be implanted to promote nerve regeneration and to repair neural damage

Main Contents

- Bioactive materials and their characterisation
- 2D and 3D Fabrication
- Neuro-Chemical functionalisation







Bionic senses

Focus

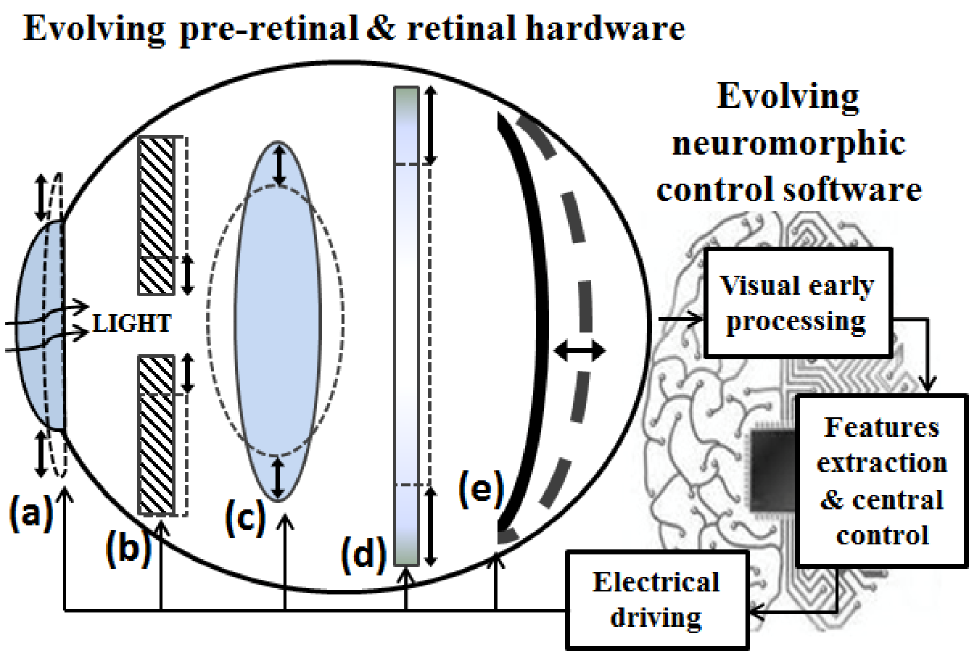
- Pre-neural and neural components of human and animal senses.
- Bionics senses design

Learning Outcomes

- Engineering artificial sensing and perceptual systems through biological principles to implement neural-prostheses to restore lost functions, for human augmentation and bio-inspired perceptional machines

Main Contents

- Introduction to natural senses
- Properties of biological receptors
- Physics of pre-neural media
- Sensations and perceptions
- The human senses
- Modeling and design of bionic senses



Interactive systems

Focus

- Complex system used for interaction with humans

Main Contents

- Human-centred Design
- Smart objects and systems
- Internet of things

Learning Outcomes

- Design of systems able to interface with humans
- Learning base concepts of "human-centered design"

2nd Year

Curriculum: NEURAL ENGINEERING

(2nd semester)

Integrative cerebral function

Focus

- Cognitive and emotional brain functions as the by-product of the activity of anatomo-functional distributed and integrated brain networks.

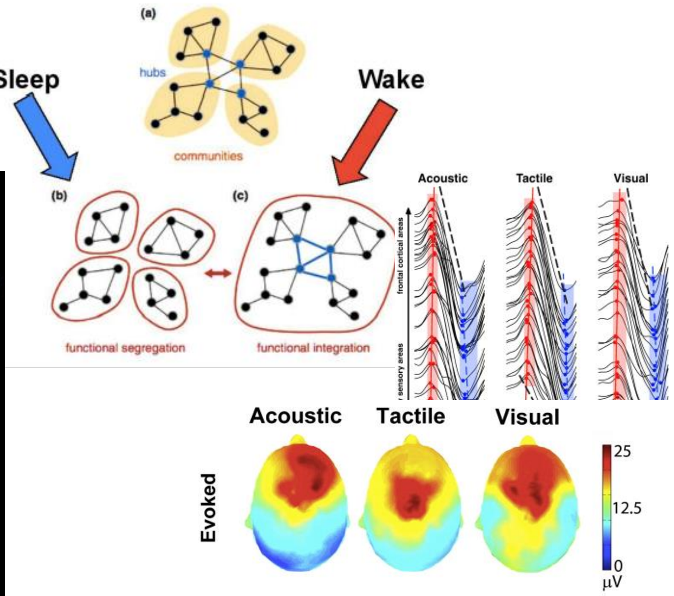
Learning Outcomes

- Methodological aproach for the study of complex brain functions and their biological bases

Main Contents

- Node and rich-clubs in the human connectome
- Sleep, mentation and dreaming
- Biological bases of consciousness
- Theory of mind and mirror neuron system
- Empathy in the emotional context

  Stress in the context of body and mind integration



Neural interfaces and bioelectronic medicine

Focus

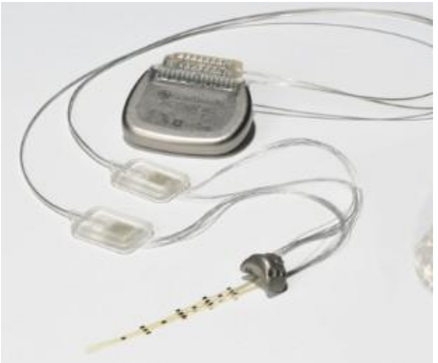
- Implantable neuroprostheses

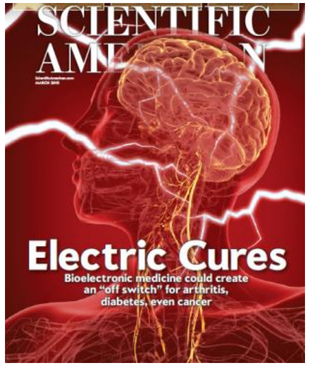
Learning Outcomes

- Provide students with methodologies for the development and validation of implantable systems for neuromodulation

Main Contents

- Brain-to-machine interfaces
- Artificial limbs with neural control
- Sensory and motor neuroprostheses
- Neuromodulation of the autonomic nervous system





Affective computing

Focus

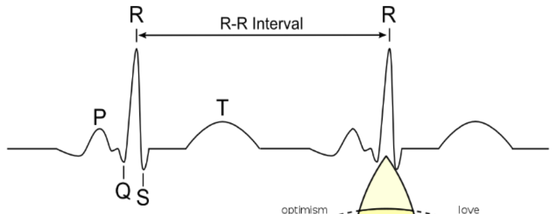
- Advanced techniques for monitoring and process physiological signals for studying emotions

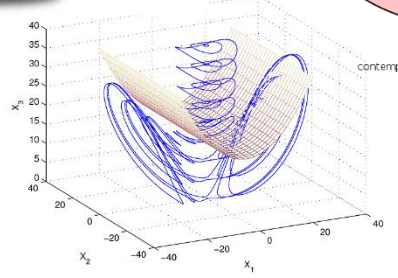
Learning Outcomes

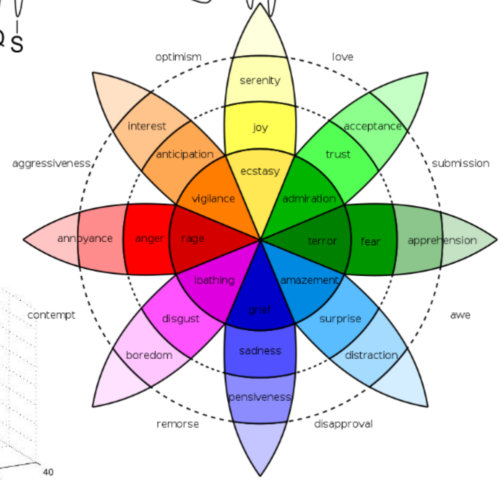
- Acquire basic knowledge to monitor and process physiological signal corresponding to different emotional states

Main Contents

- Physiology of emotional response
- Computatitonal modeling of emotions
- Origin, processing and monitoring of ECG, breathing pattern, EDA and voice
- Nonlinear methods and models for biomedical signal processing
- Eye tracking, body movement analysis and facial emotion recognition







2nd Year
Final duties

Lab training (3 CFU)

This activity will consist of 75 h of Lab training that the student will perform in dedicated facilities and laboratories, with the aim to increase his/her experience in laboratory practice.

Thesis (15 CFU)

The final examination involves the preparation of a report on a research activity, and in its presentation and discussion.