SLIPGURU Research Themes

http://slipguru.disi.unige.it

Machine learning, computer vision, computational biology

Deadline for application is september 20, 2013

Online application available from August 5, 2013 at 12:00 to September 20, 2013 at 12:00 (italian time). When applying remember to mention the specific theme you are interested in.

Please visit the official webpage of the University of Genova:
http://www.studenti.unige.it/postlaurea/dottorati/XXIX/bandoGenerale (italian version)
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For more information contact francesca.odone@unige.it

PhD Program in Computer Science and Engineering

THEME 1. Regularization Methods for Learning Effective Data Representation

Tutor: Alessandro Verri

Department: DIBRIS (University of Genova) http://www.dibris.unige.it

Description: Regularization methods provide a theoretically sound framework for addressing learning problems. In the case of classification and regression smoothness plays the role of the regularization principle leading to effective algorithms starting from a given representation. As for feature selection sparsity is the key to find parsimonious representations starting from a fixed dictionary of (possibly infinite) features. The project aims at investigating regularization methods able to develop adaptive dictionary of features starting from large amounts of data in a loosely supervised setting. The methods to be developed will incorporate domain knowledge derived from the specific application scenario and benefit from optimization schemes capable of dealing with nonstandard penalties and huge datasets. Within the proposed project several directions of research can be explored ranging from contributions in learning theory and algorithms to application-driven contribution in computer vision and computational biology.
The ideal candidate would have a background in computer science and engineering, and mathematics. vInternational applications are encouraged.

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PhD Program in Bioengineering and Robotics

Curriculum Bioengineering and Bioelectronics

THEME 1. Statistical learning methods for computational biology

Tutor: Annalisa Barla

Department: DIBRIS (University of Genova) http://www.dibris.unige.it

Description: The data made available by recent advances in biotechnologies and biomedical imaging provide unprecedented opportunities to improve the understanding of complex pathogenetic mechanisms. However, extracting knowledge from these data, characterized by an ever increasing dimensionality, requires the development of new computational methods. This project aims at investigating adaptive methods for determining the data representation best suited to deal with specific problems. Through a close interaction with domain experts, like medical doctors and molecular biologists, these methods will have to incorporate the knowledge stored in the appropriate biobanks and atlases and leverage on the large body of available, heterogeneous data. The developed algorithms will be validated in real contexts and applications such as biomarker quantitative assessment, reconstruction of phylogenetic trees, and gene regulatory network reconstruction and validation.

Requirements: background in computer science, bioengineering, computer engineering, physics or related disciplines. Attitude for problem solving. Interests in understanding/learning basic biology.

Contacts: annalisa.barla@unige.it

Curriculum Cognitive Robotics, Interaction and Rehabilitation Technologies

THEME 16. Visual perception and the interpretation of social cues

Tutors: Francesca Odone, Giulio Sandini, Alessandra Sciutti

Department: DIBRIS (University of Genova) – RBCS (Istituto Italiano di Tecnologia)
http://www.dibris.unige.it

Description: Social skills play a fundamental role since the very early development stages. Infants present a marked inclination for social interaction, ranging from the preference for biological motion and mutual gaze to imitation of facial expressions and auditory, oral, and motor matching. Such social inclination is supported by the gradual evolution of the production and understanding of social signals, such as gestures, gaze direction and emotional displays. To gain a deeper understanding of this crucial stage of human development our goal is to design models of the perceptual primitives supporting the acquisition of social skills in infants and to test them on a humanoid robot. Computer vision and machine learning state-of-the-art methods will be the building blocks of the research to be carried out.

Requirements: degree in robotics, bioengineering, computer science, computer engineering, or related disciplines, attitude for problem solving. A background on computer vision is an asset.

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Curriculum Humanoid Robotics

THEME 5. Machine Learning for Perception and Classification in Robotics

Tutors: Giorgio Metta, Lorenzo Rosasco

Department: iCub Facility (Istituto Italiano di Tecnologia)
http://www.iit.it/iCub

Machine Learning techniques are key to the success of modern Intelligent systems (such as for example Siri or Watson). While certainly impressive, these systems are still confined to a single domain or task. Moreover, a large amount of annotated data is required for their training which in turn calls for expensive computations and substantial human supervision. These limitations are ever more evident in the context of humanoid robotics where one wishes to design flexible systems capable of solving diverse problems, on a computational budget and with limited human supervision. The goal of this project is to develop novel machine learning techniques to achieve this goal. The project will focus on the problem of provably learning perceptual/classification capable of extracting and exploiting structure in the data, hence reducing the need of labeled data. In particular data representation and classification methods based on multi-scale/ hierarchical models will be explored to handle complex high dimensional data.

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THEME 6. Deep Hierarchical Learning for Robotics

Tutors: Lorenzo Natale, Lorenzo Rosasco

Department: iCub Facility (Istituto Italiano di Tecnologia)
http://www.iit.it/iCub

Hierarchical models, and corresponding architectures, are emerging as powerful tools for high dimensional machine learning. Indeed, hierarchical approaches allow modeling the rich structure contained in the data often leading to substantial reduction in the amount of human supervision needed in a machine learning process. An inspiration for this class of approaches comes from current neuroscience models of visual/audio information processing in the brain. In this project, we will explore the application of deep hierarchical method in perceptual and classification problem in robotics. Specifically we will work towards the developments of efficient, adaptive hierarchical systems to be applied in visual and navigation tasks. Special emphasis will be put on the development of fast, real time systems, considering the implementation of hierarchical models in specialized distributed architecture including GPUs.

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THEME 7. Human-Robot interaction: understanding actions and the dynamics of the scene

Tutors: Giorgio Metta, Francesca Odone

Department: iCub Facility (Istituto Italiano di Tecnologia)

http://www.iit.it/iCub

Action understanding from medium or close-range observations has been long studied by the computer vision community. The general goal is to interact with an artificial system by means of key-gestures, mimicking a natural ability of human perception to understand the speaker intentions from his/her body language. The implementation of such general idea is often simplified by adopting visual markers or special gloves. More recently RGB-D sensors such as the Kinect provided new inputs to the community and opened a new trend of research.

In this project we will build on previous results on action recognition for the iCub, to set the basis for a human-robot interaction benchmark system. Machine learning will be used to devise computational models able to learn new actions, classify different actions, possibly from partial observations. In particular, temporal continuity of visual observations will be used to learn spatio-temporal models of actions of interest.

Requirements: To address these issues we seek one candidate strongly motivated on studying both the theoretical and applied aspects of computer vision and machine learning for action recognition tasks in the iCub humanoid robot perception model.

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