ISTITUTO ITALIANO DI TECNOLOGIA | PhD@IIT

Research Topics for
Doctorate in Science & Technologies for Electronics & Telecommunication Engineering,
curriculum in Computer Vision, Automatic Recognition and Learning

ATTENTION

The PhD application also implies to submit a research proposal under one or more themes chosen among those below indicated.
To write a proper research proposal, please follow the instructions indicated in the following file: https://pavisdata.iit.it/data/phd/ResearchProjectTemplate.pdf

Research Topics

1. 3D scene understanding with geometrical and deep learning reasoning

Tutors
Alessio Del Bue, Pietro Morerio

Research Line
Pattern Analysis and Computer Vision, IIT, Genova

Description
Classical multi-view geometry problems make use of geometric reasoning to infer the scene 3D structure and its dynamic. These approaches often neglect the semantic composition of the scene that instead provides important cues about objects motion and their current spatial configuration.
Instead, such context and semantic information can be given by current deep learning architectures but very few works attempted to merge geometrical reasoning with such semantic information. This research theme will have the aim to bridge this gap and to provide

solutions that can be applied on intelligent system for robotics and autonomous driving. This research will study different methods and tools involving scene graphs, object detection with either multi-view images or 3D data, deep learning methods for scene representation and large-scale 3D reconstruction in dynamic environments. The research activities will build over and expand the current expertise on these problems developed under the Spatial AI topics at PAVIS research line.

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2. Deep Learning for Multi-modal scene understanding

Tutors
Alessio Del Bue, Pietro Morerio, Vittorio Murino

Research Line
Pattern Analysis and Computer Vision, IIT, Genova

Description
This topic is related to the research and implementation of algorithms that leverage multimodal data, namely data coming from different sensors, for general purposes such as classification, recognition and, more in general, scene understanding. In particular, we primarily aim at exploiting optical (RGB) sensors, range or depth sensors, thermal sensors (thermal and near-infrared cameras), acoustic sensors to detect persons and objects, tracking and classifying objects, events and behaviors in general. The main focus will be on learning and developing new deep learning methods, as particularly suitable to merge heterogeneous information coming from different sensor modalities.

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3. Self-Supervised and Unsupervised Deep Learning

Tutors
Alessio Del Bue

Research Line
Pattern Analysis and Computer Vision, IIT, Genova

Description
One of the key factors behind the recent popularity of deep learning algorithms is the possibility of leveraging a large corpus of labelled data. Despite gathering massive amount of data is nowadays not problematic, differently, data annotation is surely a major bottleneck. In fact, not

only it is time-consuming and economically expensive, but it is also prone to errors since requiring human intervention. This research topic focuses on how to relax the level of supervision required to develop (deep) machine learning algorithms. The ultimate goal is to devise new computational techniques which exploit and discover geometrical inner properties of the data (e.g., self-supervised learning, clustering), while also considering the transfer of knowledge from existing labelled datasets in order to recognize categories and classes for which a little or even no labelled data is provided (few-shot or zero-shot learning).

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4. Visual Reasoning with Knowledge and Graph Neural Networks

Tutors

Alessio Del Bue, Pietro Morerio

Research Line

Pattern Analysis and Computer Vision, IIT, Genova

Description

Machine ability to detect objects within images has surpassed human ability, however, when posed with relatively simple more complex tasks machines quickly struggle. This theme focuses on developing AI systems that are able to access knowledge stored in Knowledge Graphs to understand the world around the camera view. Few works have successfully integrated knowledge in Computer Vision systems and knowledge graphs provide one avenue. This research will study methods to integrate knowledge for user interaction via retrieval or visual question and answering within real world environments. In particular, shallow and deep graph-based methodologies are promising computational framework to include external knowledge and also maintaining a high degree of interpretability, a necessary feature for modern AI systems.

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