UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Dibris

Thesis Project Form

Title (tentative): Deep Learning and Eye-Tracking for Quantifying Representational Gaps in Autism

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Description

Motivation and application domain

Visual attention, communication skills, and the mental representation of concepts significantly diverge in children with Autism Spectrum Disorder (ASD) compared to Typically Developing (TD) peers. While linguistic expression can be a major barrier, visual-spatial processing is often a strength in ASD. In this context, sketching serves as a powerful bridge to analyze and reduce representational and communicative gaps. Drawing allows children to externalize their internal models of the world, providing a window into how they conceptualize objects and social intent. Within cognitive rehabilitation, a robot-mediated sketching task offers a controlled, repeatable environment to stimulate and measure these skills. Multimodal deep learning methods, com-bining online sketch features with wearable eye-tracking data, enable the extraction of precise, quantitative measures of clinical interest. These parameters, related to representational devel-opment, social monitoring, and joint attention, are fundamental to tracking progress in social-cognitive rehabilitation and tailoring interventions to the specific needs of the child.

General objectives and main activities

The project aims to develop a multimodal framework to quantify differences in drawing strategies and gaze dynamics between TD and ASD children during a symbolic communication task with the iCub robot. Main activities include:
â€¢ Designing and implementing an HRI experiment.
â€¢ Collecting and synchronizing high-frequency data from a digital tablet (stroke coordinates, pressure, timing) and wearable eye-tracking glasses (gaze vectors, pupillometry) during HRI.
â€¢ Applying multimodal deep learning models (e.g., Transformers or Variational Autoencoders) to analyze behavioral, gaze, and drawing data.
â€¢ Quantifying measures of clinical interest suitable to identify specific markers of communicative, attentive, and representational divergence between TD and ASD groups.

Training Objectives (technical/analytical tools, experimental methodologies)

1. Multimodal Machine Learning: Gain expertise in processing synchronized temporal data (strokes and gaze) using state-of-the-art Deep Learning models.
2. Clinical Data Science: Learn to translate raw sensor data into quantitative measures with clinical relevance for neurodevelopmental disorders.
3. Human-Robot Interaction (HRI): Develop skills in designing and conducting experimental protocols for cognitive rehabilitation using social robots (iCub).

The thesis may also produce a scientific article to be submitted to an international conference or journal (the student may optionally contribute to the writing of the article).

Place(s) where the thesis work will be carried out: The thesis will be jointly performed at DIBRIS and at the Center for Human Technologies of the Istituto Italiano di

Tecnologia. The student will collaborate with the IIT Cognitive Architecture for Collaborative Technologies (CONTACT) research line and wil

Additional information

Pre-requisite abilities/skills: - Scripting and programming skills (Python and PyTorch, optionally C++) - Experience with Github (preferred) - Strong written and verbal communication skills in English

Maximum number of students: 1