# THE INSTITUTE OF INTELLIGENT SYSTEMS AND ROBOTICS*
## INTERNSHIP OFFER

## Machine Learning for Social Behaviour Generation

**Abstract**: A part of the success of human-agent interactions relies on the ability of social agents to perform behaviors that are easily understood by humans. This means that the human is able to infer the meaning and/or the intention of such behaviors that could take several forms: pointing, gaze, head movements, etc. To increase the understanding of agent intentions by humans, the notion of legibility is often considered in robotics. Legibility is defined as the ability to anticipate the goal of a action. This notion has been differentiated from predictability, which is defined as the ability to predict the trajectory for a given goal. To address the modeling of such notions, mathematical approaches show the need of explicitly integrating human observers. The models able to generate such actions / behaviors take into account how a human observer will perceive them [Wallkotter et al. 2020].

**Objectives:** We aim to develop machine learning algorithms able to generate behaviors mainly movements that are explicitly taking into account human observers. Recent works on movement generation for artificial agents have shown the relevance of generative models such as Variational Auto-Encoders (VAE). The main intuition is that latent representation and regularization allows controlling the generation of data. In (Marmpena et al., 2019), a VAE based approach has been proposed to generate various body language animations. Interestingly, modulation of motion is made possible through affective related spaces.

Here, we propose to address a similar behavior generation problem while focusing on communicative demonstrations, which are naturally employed by humans when teaching (Ho et al. 2018). Communicative demonstrations are intelligent modifications of demonstrator's actions and/or behaviors with the aim of influencing the mental representation that an observer ascribes to the demonstration.

We target situations in which an agent is demonstrating a series of actions such as writing or reaching objects. The idea will be to control the generation in a communicative space from instrumental to pedagogical intentions. We will firstly develop a VAE model able to learn a representation of communicative actions and analyze the latent space. We will then develop specific regularization techniques to control the communicative intention.

The main steps are:
- Development a first generative model
- Analysis of the latent space
- Development of a regularization technique able to control the communicative intention.
- If possible, evaluation with real humans.

**Skills**: Python, Machine learning

**Supervisor**: **Mohamed CHETOUANI**

**Duration**: 5/6 months internship

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Send your application by email, with [Machine Learning for Social Behaviour Generation] in the subject line, a CV and a covering letter.

**References**:
Ho, M., Littman, M., Cushman, F., & Austerweil, J.L. (2018). Effectively Learning from Pedagogical Demonstrations. Cognitive Science.

Marmpena, M., Lim, A., Dahl, T. S. and Hemion, N. "Generating robotic emotional body language with variational autoencoders," 2019 8th International Conference on Affective Computing and Intelligent Interaction (ACII), Cambridge, United Kingdom, 2019, pp. 545-551, doi: 10.1109/ACII.2019.8925459.

Wallkotter, S., Tulli, S., Castellano, G., Paiva, A., and Chetouani, M., "Explainable Agents Through Social Cues: A Review", 2020, arXiv:2003.05251