Frédéric Dehais - Neuroadaptive technology for Human Machine Learning

This chair aimed to explore a flexible mixed-initiative planning and execution paradigm, involving interactions between humans and artificial agents. Achieving this interaction required the development of a passive Brain-Computer Interface (pBCI), primarily utilizing electrophysiological (EEG) signals to assess human performance and cognitive states, which has challenges due to EEG signal variability. We explored various solutions, including spatial decomposition for EEG dimensionality reduction, temporal analysis using the path signature for time-independent features, and spatiotemporal dynamics analysis through topological data analysis (TDA). These efforts optimized the estimation of human mental states, serving as outputs to dynamically adapt human-machine interactions through a decision system. We also developed an offline reinforcement learning-based decision unit, aiming to learn decision policies from previously collected experiences efficiently and with risk sensitivity. Our contributions encompassed methods for enhancing datasets by identifying system dynamics symmetries, offline risk-sensitive policy selection (Exploitation vs. Caution or EvC) using Bayesian Markov decision processes, and an explainability paradigm for multi-agent cooperative systems employing Myerson analysis. Additionally, we discussed the potential application of the EvC approach in adapting interaction control policies in human-robot scenarios, exemplified by the ISAE Robot Firefighter Game’s proof-of-concept scenario.