

**PhD research topic proposal**  
**BME, Doctoral School of Mathematics and Computer Science**

**Name of supervisor:**

Balázs Csanád Csáji

**Degree:**

Ph.D. in Computer Science

**Title of the topic:**

Reinforcement Learning

**Short description:**

Reinforcement learning (RL) is one of the main branches of machine learning and it deals with the problem of learning from sequential interactions with an uncertain, dynamic environment based on feedbacks (e.g., states and immediate costs). Markov decision processes (MDPs) constitute the main mathematical background of RL. However, unlike in classical MDP studies, in RL the model of the system is typically unavailable, therefore, the dynamics and the costs have to be learned (estimated) while the decision maker tries to work efficiently. These two goals (exploring the environment and exploiting the information gathered so far) are working against each other leading to the fundamental problem of exploration vs exploitation (estimation vs control). Theoretical support for classical RL methods, such as Q-learning and TD( $\lambda$ ), are usually asymptotic and presuppose either a tabular representation of the value function or a linear function approximation. Novel challenges in RL include providing methods with non-asymptotic (and distribution-free) guarantees, handling partial observability and changing environments, as well as studying the notorious exploration-exploitation trade-off (even in simplified problems, such as multi-armed- or contextual bandits). Distributed RL methods is another possible research direction. The theory of stochastic approximation (especially in Markovian environments) and various distribution-free statistical methods are of high importance to provide guarantees for RL.

**Requirements:**

Solid background in probability and statistics, programming skills (e.g., Matlab, Python)

**Contact:**

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**Place of work:**

SZTAKI (Institute for Computer Science and Control, Budapest, Hungary)

**Statement:** *The conditions of the research above are satisfied, the theme is confirmed by the Head of the Department/Institute*