PhD research topic proposal

BME, Doctoral School of Mathematics and Computer Science

Name of supervisor :

Tamás Péni

Degree:

PhD

Title of the topic:

Gaussian Processes in modeling and control of complex dynamical systems

Short description:

From machine learning perspective, Gaussian Process (GP) is a powerful parametric model, widely used in high dimensional regression and classification problems. As GP is an extension of the Gaussian distribution, the full power of Bayesian inference, probability theory as well as the computational advances of normal distribution can be exploited in both the training and the evaluation of a GP model. Thanks to the stochastic framework, a GP is able to provide uncertainty information about the reliability of the regression (classification), which can be used to compute confidence regions or select relevant training points. In spite of the plenty of advantageous properties there is a need and large room for improvement. Some open problems, for example are the efficient regression of vector valued functions, handling large datasets (sparse-GP solutions) and increasing the modeling capability of GP by making the structure deep. The research during the PhD period should focus on these topics. The goal is to elaborate novel algorithms and methods that are based on solid theoretical foundations. The solutions have to be tailored specifically to the applications related to modeling and control of complex nonlinear, mechanical systems (robot arms, drones, autonomous vehicles, etc.). In these applications the GP is part of the system model and/or the controller, which allows the control structure to learn during operation. By combining GP models with the most advanced data driven and optimization based control design approaches e.g. Reinforcement Learning and Model Predictive Control, efficient adaptive control architectures can be built that are able to learn to control high complexity nonlinear systems and are able to cope with rapidly changing operating conditions.

Requirements:

Msc degree in mathematics or computer science, solid background in probability theory, linear algebra, differental equations. Programming skills. Some prior experience in Matlab is an advantage.

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