This dissertation aims mainly at obtaining robust variants of Gaussian processes (GPs) that do not require using non-Gaussian likelihoods to compensate for outliers in the training data. Bayesian kernel methods, and in particular GPs, have been used to solve a variety of machine learning problems, equating or exceeding the performance of other successful techniques. That is the case of a recently proposed approach to GP-based novelty detection that uses standard GPs (i.e. GPs employing Gaussian likelihoods). However, standard GPs are sensitive to outliers in training data, and this limitation carries over to GP-based novelty detection. This limitation has been typically addressed by using robust non-Gaussian likelihoods. However, non-Gaussian likelihoods lead to analytically intractable inferences, which require using approximation techniques that are typically complex and computationally expensive. Inspired by the use of weights in quasi-robust statistics, this work introduces a particular type of weight functions, called here data weighers, in order to obtain robust GPs that do not require approximation techniques and retain the simplicity of standard GPs. This work proposes implicit weighted variants of batch GP, online GP, and sparse online GP (SOGP) that employ weighted Gaussian likelihoods. Mathematical expressions for calculating the posterior implicit weighted GPs are derived in this work. In our experiments, novelty detection based on our weighted batch GPs consistently and significantly outperformed standard batch GP-based novelty detection whenever data was contaminated with outliers. Additionally, our experiments show that novelty detection based on online GPs can perform similarly to batch GP-based novelty detection. Membership scores previously introduced by other authors are also compared in our experiments.

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The public is welcome to attend.