

Data Analysis and Machine Learning: Machine learning with Gaussian Processes

Christian Forssén¹ Morten Hjorth-Jensen^{2,3}

Department of Physics, Chalmers University of Technology, Sweden¹

Department of Physics, University of Oslo²

Department of Physics and Astronomy and National Superconducting Cyclotron Laboratory, Michigan State University³

Mar 19, 2018

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What is a Gaussian Process?

- ▶ We have considered splines and kernel regression methods. These

require choice of somewhat arbitrary set of knots.

- ▶ Another possibility is to setup a prior distribution for the regression function using a *Gaussian Process*.
- ▶ This is a very flexible class of models that has distinct computational and theoretical advantages. It can be viewed as a potentially infinite-dimensional generalization of Gaussian distributions.
- ▶ See the excellent (and free) book [Gaussian Processes for Machine Learning](#) by Carl Edward Rasmussen and Christopher K. I. Williams.

Gaussian process regression

- ▶ Realizations from a Gaussian process correspond to random functions
- ▶ Let us first consider an unknown regression function $\mu(x)$ that depends on a single, continuous variable x .
- ▶ The Gaussian process is written as $\mu \sim \text{GP}(m, k)$, and is parametrized in terms of a mean function $m(x)$ and a covariance function $k(x, x')$.
- ▶ The GP prior on μ describes it as a random function for which the values at any set of N prespecified points $\{x_i\}_{i=1}^N$ are a draw from a N -dimensional normal distribution

$$\mu(x_1), \dots, \mu(x_N) \sim \text{N}((m(x_1), \dots, m(x_N)), K(x_1, \dots, x_N)),$$

with mean m and covariance K .

Topics

- ▶ More mathematical details
- ▶ The role of the covariance function (different kernels)
- ▶ multidimensional case
- ▶ examples.