STAT 547R, 2021-22 Term 2, Feb. 21–Apr. 8 (in-person)
(A Gentle) Introduction to Gaussian Processes
Instructor: William J. Welch

Course contents

A Gaussian Process (GP), also called a Gaussian Stochastic Process (GaSP), is a flexible, data-adaptive nonparametric regression model. A GP is the model of choice to replace a complex, slow computer code with a fast statistical surrogate (my research interest), as well as for observational data. Applications abound across all areas of science and engineering.

The course will introduce the main ideas of GP methodology and application. Topics to be covered include:

- The GP statistical model to predict the output (response) of a computer code or observational system from its inputs/explanatory variables. A key idea here is that even if the system is deterministic, there is uncertainty when predicting at a new input configuration; uncertainty quantification comes automatically.
- An introduction to the R package GaSP to implement many of the computations we need to do
- Estimation of parameters of the GP model using likelihood and Bayesian methods
- Assessment of prediction error; statistical-model diagnostics
- Design of computer experiments (mainly for deterministic computer codes)
- Using a trained GP model for scientific and engineering objectives: sensitivity analysis, visualization, optimization of systems, propagation of variation
- Selecting the components of a GP model
- Calibration of unknown physical parameters such as rate constants using data from both a computer experiment and a physical experiment
- Assessment of a computer code against data from a physical experiment
- Calibration of unknown parameters when a computer code is systematically biased

Administrative details

Instructor	Will Welch, ESB 3132, Ext 2-3339, email will [AT] stat [DOT] ubc [DOT] ca
Office hours:	TBA
Lecture time/place	Monday, Wednesday 12:30–2:00 pm, MATH 105
Course web page	TBA
Course text	Slides and some notes will be provided, but *The Design and Analysis of Computer Experiments* by T.J. Santner, B.J. Williams, and W.I. Notz, 2nd ed., 2018, Springer is comprehensive and available online at the library

Mode of instruction

A review of the above topics and their computer implementation will take about half the course. Students will present reviews of key papers in an informal discussion setting for the remaining classes.

There will also be a project, e.g., a comparison of several methods or adding some functionality to the GaSP package.

Grading

Assignments 30%; paper presentation(s) 30%; analysis / computing mini project 40%