STAT 8810: Special Topics in Uncertainty Quantification via Tree-based Models and Approximate Computations

3 CREDIT HOURS

Term: Fall, 2017
Instructor: Matthew T. Pratola
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Location: MWF@1:50pm in CH228
Office Hours: Mondays 3-4pm in CH204D
Text: none
Course Website: `http://www.matthewpratola.com/teaching/stat8810-fall-2017/`
Transcript Abbreviation: Stat 8810
Final Exam: Project

Course description:

Statistical uncertainty quantification is a modern area of statistics concerned with modeling a wide variety of complex real-world processes that exhibit challenging features, such as high dimensionality, non-linear response behaviour, non-stationarity and large datasets. These problem features have lead to many innovations in flexible statistical models, methodolgy for statistical computation and efficient use of parallel computing for statistical inference and prediction. They can be broadly categorized into two subsets of problem types: (i) problems where a well-founded theoretical model is postulated but data collection is expensive or sparse; (ii) problems where a theoretical model is unavailable but data collection is cheap or dense. Statistics 8810 will introduce students to a selection of these modern statistical models, methodologies and computational techniques. This will include: Gaussian Process regression (including Bayesian inference and MCMC, kroenecker forms, localized approximations, dimension-reduction methods, etc), Bayesian Additive Regression Trees (including inference and MCMC, heteroscedasticity, influence, etc), Convolutional Neural Networks (including stochastic gradient descent) and Approximate Bayesian Computation. Motivating applications and datasets in this course will include glacier flow, worldclim temperature anomalies, space weather, stochastic weather generators, aerial beach data, rocket drag data and photovoltaic/solar radiation data.

Topics:

- Gaussian Process Regression and Emulation
- Local Approximate Gaussian Processes
- Space-filling Design
- Sensitivity Analysis
- Model Calibration
- Approximate Bayesian Computation
- Bayesian Regression Trees and Bayesian Additive Regression Trees (BART)
- Heteroscedastic BART
- BART Scalability and Diagnostics
- BART Dimension Reduction*
- Artificial Neural Networks and Backpropagation*
- Convolutional Neural Networks (CNN's) and Stochastic Gradient Descent*

* time permitting.

Course Requirements:
You are responsible for all material covered in class; this includes derivation, proofs, computational techniques, etc. This is a graduate topics course and the emphasis will be on implementing concepts learned in class in computer code and applying concepts learned in class to real-world datasets. However, there will be a strong theoretical flavor to the ideas presented which will help you better understand the methodologies which you will employ on datasets. I will primarily use **R** to demonstrate ideas and examples, however much of the responsibility to program solutions will be left to you. Independent reading of research papers will be an important component of this course.

Grading:
Will be based on assignments, and a term project + project presentation.

Academic Misconduct:
It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term academic misconduct includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Special Accomodations:
Students with disabilities that have been certified by the Office for Disability Services will be approporiately accommodated and should inform the instruc- tor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue, telephone 292-3307, TDD 292-0901 (or see http://www.ods.ohio-state.edu/).