جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Computational Statistics - STAT 340

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	STAT 340
Course Title	Computational Statistics
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Haavard Rue	HAAVARD.RUE@KAUST.EDU.SA	+966128080640	4110, 1, Al-Khawarizmi (bldg. 1)	By appointment.

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	This course will discuss computational techniques for Bayesian and frequentistic inference. Topics to be discussed, are exact recursions for hidden Markov chains, change point models, Gaussian Markov random fields (GMRFs) and its applications in latent Gaussian models, inference for latent Gaussian models using Markov chain Monte Carlo with block-sampling and auxiliary variables, deterministic approximations in latent Gaussian models using integrated nested Laplace approximations (INLA), GMRF models for splines, approximate GMRF models, and the EM-algorithm.
Course Description from Program Guide	In this course we will discuss computational techniques for Bayesian inference, including exact recursions for hidden Markov chains, Gaussian Markov random fields and its applications in latent Gaussian models, inference for latent Gaussian models using Markov chain Monte Carlo using block-sampling and auxiliary variables, and deterministic approximations using nested Laplace approximations. We will also discuss how to construct Markov approximations of continuous time and space processes, using finite element methods.
Goals and Objectives	The objective of this course is to discuss computational challenges that appear in statistical inference, and strategies to overcome them. A recurrent theme is the Markov property of the model, that we will take advantage of in both hidden Markov models and for Gaussian Markov random fields. The goal is that the student should know of, and master, the various techniques and be able to apply them in new situations
Required Knowledge	The student is expected to be fluent, or at least to have good knowledge, in R.

Reference Texts	-'State space and hidden Markov models', by H.R.Kunsch, chapter 3 in the book 'Complex Stochastic Systems' edited by O.E.Barndorff-Nielsen, D.R.Cox and C.Kluppenberg, 2001, Chapman & Hall -'Gaussian Markov random fields: Theory and applications', by H.Rue and L.Held, 2005, Chapman & Hall -H.Rue, S.Martino, and N.Chopin (2009), Approximate Bayesian Inference for Latent Gaussian Models Using Integrated Nested Laplace Approximations (with discussion), Journal of the Royal Statistical Society B, 71, 319-392. -H.Rue, A.Riebler, S.H.Sorbye, J.B.Illian, D.P.Simpson and F.K.Lindgren, "Bayesian computing with INLA: A review", Annual Reviews of Statistics and Its Applications, vol 4, March 395-421, 2017. -F. Lindgren and H. Rue. A note on the second order random walk model for irregular locations. Scandinavian Journal of Statistics, 35(4):691–700, 2008. -J. Wyse, N. Friel, and H. Rue. Approximate simulation-free Bayesian inference for multiple changepoint models with dependence within segments (with discussion). Bayesian Analysis, 6(4):501–546, 2011 -Theory and Use of the EM Algorithm, By Maya R. Gupta and Yihua Chen, Foundations and trends in Signal Processing Vol. 4, No. 3 (2010)
Method of evaluation	**20.00**% - Scientific review article presentation **80.00**% - Course Project(s)
Nature of the assignments	The student will be evaluated from four course-projects and a paper presentation.
Course Policies	If you are unable to complete a course project on time please contact me for appropriate arrangements, otherwise, it will be given a grade of zero.
Additional Information	Official announcements will be those made in class

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/27/2018 Thu 08/30/2018	Recursions for hidden Markov models (part 1)
2	Mon 09/03/2018 Thu 09/06/2018	Recursions for hidden Markov models (part 2)
3	Mon 09/10/2018 Thu 09/13/2018	Gaussian Markov random fields (part 1)
4	Mon 09/17/2018 Thu 09/20/2018	Gaussian Markov random fields (part 2)
5	Mon 09/24/2018 Thu 09/27/2018	Intrinsic Gaussian Markov random fields
6	Mon 10/01/2018 Thu 10/04/2018	Latent Gaussian models
7	Mon 10/08/2018 Thu 10/11/2018	Markov chain Monte Carlo methods for latent Gaussian models
8	Mon 10/15/2018 Thu 10/18/2018	Auxiliary variable methods
9	Mon 10/22/2018 Thu 10/25/2018	Block sampling methods
10	Mon 10/29/2018 Thu 11/01/2018	Integrated nested Laplace approximations (part 1)
11	Mon 11/05/2018 Thu 11/08/2018	Integrated nested Laplace approximations (part 2)
12	Mon 11/12/2018 Thu 11/15/2018	Integrated nested Laplace approximations (part 3)
13	Mon 11/19/2018 Thu 11/22/2018	Changepoint models
14	Mon 11/26/2018 Thu 11/29/2018	The EM algorithm
15	Mon 12/03/2018 Thu 12/06/2018	Paper presentations
16	Mon 12/10/2018	Approximate Markov models
17		
18		

Note

The instructor reserves the right to make changes to this syllabus as necessary.