STAT 3317/6011/6111/7611 **Lectures: Mon 2:30-3:20 Room T3 (Meng Wah Complex)**
Fall 2016 **Thu 1:30-3:20 Room TT404 (T.T. Tsui Building)**

COMPUTATIONAL STATISTICS

Course Description: This course aims to introduce modern computationally-intensive methods in statistics. It emphasizes the role of computation as a fundamental tool of statistical estimation, inference, discovery in data analysis, and for development of statistical theory and methods. The course content includes generation of random variables; optimization techniques including Newton's method, the expectation-maximization (EM) algorithm and the minorization-maximization (MM) algorithm; integration including Laplace approximation, Gaussian quadrature, and the importance sampling method; Markov chain Monte Carlo methods including data augmentation algorithm, Gibbs sampler, and the Metropolis-Hastings algorithm; Bootstrap methods. Python programming is required throughout the course.

Instructor: Dr. YIN Guosheng, Rm 304, e-mail: gyin@hku.hk

Tutor: **Mr. LIU Yehong,** Rm 112, e-mail: liuyh@connect.hku.hk

Texts Used: Lecture notes will be provided. No text is required while relevant references are listed as follows:

References:

[1] Carlin, B. and Louis, T. (2008). Bayesian Methods for Data Analysis. Third Edition. Chapman and Hall/CRC.

[2] Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A. and Rubin, D. B. (2014). Bayesian Data Analysis. Third Edition. Chapman and Hall/CRC.

[3] Tan, M., Tian, G.L. and Ng, K.W. (2010). *Bayesian Missing Data Problems: EM, Data Augmentation and Non-iterative Computation*. Chapman & Hall/CRC, Boca Raton.

[4] Givens, G.H. and Hoeting, J.A. (2005). *Computational Statistics.* Wiley, New York.

[5] Gentle, J.E. (2002). *Elements of Computational Statistics.* Springer, New York.

[6] Gentle, J.E. (2003). *Random Number Generation and Monte Carlo Methods.* Springer, New York.

[7] Robert, C.P. and Casella, G. (2005). *Monte Carlo Statistical Methods (2nd Ed.).* Springer, New York.

[8] Tanner, M.A. (1996). Tools for Statistical Inference: Methods for the Exploration of Posterior Distributions and Likelihood Functions (3rd Ed.). Springer, New York.

[9] McLachlan, G.J. and Krishnan, T. (1997). *The EM Algorithm and Extensions*. Wiley, New York.

[10] Gilks, W.R., Richardson, S. and Spiegelhalter, D.J. (1996). *Markov Chain Monte Carlo in Practice*. Chapman & Hall, London.

[11] Efron, B. and Tibshirani, R.J. (1993). *An Introduction to the Bootstrap*. Chapman & Hall, London.

[12] Davison, A.C. and Hinkley, D.V. (1997). Bootstrap Methods and Their Application. Cambridge University Press, New York.

[13] Lange, K. (1999). *Numerical Analysis for Statistics.* Springer, New York.

[14] Lange, K. (2004). *Optimization.* Springer, New York.

Teaching and Assessment

One 3-hour lecture and one 1-hour tutorial per week. Students will be graded according to one 2-hour written examination (50% weighting) and a coursework assessment (50% weighting) based on assignments, tutorials and a class test. Partially or wholly copied assignments will be penalized and/or reported as plagiarism. (See university website: http://www.hku.hk/plagiarism)

Learning Objectives and Outcomes:
Upon successful completion of the course, students should understand

(1) Bayesian estimation and inference procedures
(2) Bayesian modeling and computation
(3) Markov chain Monte Carlo methods
(4) random variable generation
(5) Monte Carlo integration
(6) bootstrapping methods
(7) Newton-Raphson and Fisher scoring algorithms
(8) EM and MM algorithms
(9) Missing data problems

Most importantly, students should be able to apply them to solve practical problems.

Department's policy on absence from class test
If for any reason you are or have been unable to attend a mid-term/class test, and if you wish to have a supplementary mid-term/class test, within **7 days** of the absence,

(a) all **full-time** students should write to the General Office of the Department of Statistics and Actuarial Science giving reasons for your absence;
(b) all **part-time** students should write to the course instructor giving reasons for your absence.

A special/supplementary test is normally granted to those absent from the original test due to illness and with original medical certificate provided. Students absent due to other reasons are not granted a special/supplementary test unless with very special circumstances and with valid documental proofs provided.