ST3457 Statistical Inference I

Examinable material

Important: the distributions introduced during the course (Bernoulli, Binomial, Beta, Poisson, Gamma, inverse-Gamma, Normal and multivariate Normal) must be known as they won't be provided with the exam.

The exam will cover both theory and problems. Problems will be of similar type to those of the mock exam. As for theory, beside the questions on theory which can be found in the mock exam, all the topics in the list below must be considered examinable.

I was asked if old ST3457 papers could be useful in preparing the exam. The syllabus of this year's course differs from the syllabus of previous editions. Thus only some of the questions of the old exams represent a useful exercise. Namely,

- May 2016: Q1 a) i, iii, iv; Q2 a) i, ii; Q3 a), b).
- April 2014: Q1 b) i, ii, iii; Q2 a) i, ii, iv, v.

The next list is meant to help you with the revision of the material covered during the course.

- Belief function, axiom of beliefs and axiom of probability
- Bayes theorem, sampling model, prior and posterior distribution
- Exchangeability; i.i.d. observations; conditionally i.i.d. observations
- i.i.d $\Rightarrow$ exchangeable (with proof)
- conditionally i.i.d. $\Rightarrow$ exchangeability (with proof)
- de Finetti's representation theorem (without proof)
- Conjugate priors
- Quantile based posterior credible intervals
- Posterior predictive distribution
- The Binomial model:
    - conjugacy of the Beta prior (with proof)
    - posterior mean as a combination of prior information and data
    - posterior mean and posterior variance as the sample size becomes large

    - posterior predictive distribution (with derivation)
- The Poisson model:
    - conjugacy of the Gamma prior (with proof)
    - posterior mean as a combination of prior information and data
    - posterior mean as the sample size becomes large
    - posterior predictive distribution (with derivation)
- One-dimensional exponential family
- Conjugate prior for the exponential family (with proof of the conjugacy)
- Non-informative priors
- Posterior inference via Monte Carlo methods
- Posterior predictive distribution: definition and simulation via Monte Carlo
- The Normal model (with fixed variance)
    - Conjugacy of the Normal prior (with proof)
    - Posterior predictive distribution (with derivation)
- The normal model (with mean and variance as parameters)
    - Conjugacy of the Normal/Inverse-Gamma prior (without proof)
    - Semi-conjugate specification of the model
- (Bayesian) point estimators
- Properties of point estimators: bias, MSE
- Posterior inference via Gibbs sampling
- Stationarity and mixing of Markov chain Monte Carlo methods: good or bad approximation?
- ~~MCMC diagnostics~~
- The multivariate normal model
    - semi-conjugate Normal/Inverse-Wishart prior
    - (derivation of Inverse-Wishart distribution is tedious and can be skipped)
- The multivariate normal model: posterior inference via Gibbs sampling
- Normal linear regression model

- Bayesian estimation for linear regression: posterior inference via Gibbs sampling
- Bayesian approach to model selection
- Bayes factor
- Spike and slab priors