Instructions on how to prepare for the exam

Lecture 1

- **Notation**: learn to write down probabilities (Pr()), expectations and probability functions in discrete (distribution, PMF,etc.) and continuous (CDF, pdf etc.) space. This includes marginals, joints and conditionals.
- **Equations, laws and identities**: Bayes theorem, law of large numbers, ingredients (= what they are saying) of normal and logarithmic central-limit theorems
- **Terminology & concepts**: mode, likelihood
- You need **not** learn exact forms of distributions by heart. If they are needed in the exam, they will be given. However, some characteristics of distributions like their relation to some stochastic processes you should know – not more than what is covered in lecture notes and exercises.
- **Main features of the nature of different processes and distributions related to them**.
- Make sure you understand the **small calculations and derivations** that are related to central concepts and characteristics: you should be able to **apply the Bayes theorem, the law of total probability etc.** when asked to derive something.
- I will **not** ask anything about random number generators; they were presented for you to understand by doing the assignment.

Lecture 2

- Everything is relevant, so learn it.
- However, I will **not** ask anything about importance resampling.

Lecture 3

- Everything is relevant and to be learnt.
- I will **not ask** anything about martingales.

Lecture 4

- Learn and understand **the fundamentals of Markov Chains**, so that when specified if the state space and time are discrete or continuous you can write the basic concepts down and do small derivations/calculations.
- The same central concepts keep repeating in different cases for time and space. Some of the stuff and the way of formulating models are specific to a case, like writing things down in terms of a transition rate matrix Q (p. 33). You should understand and remember basic definitions and identities.
- **Properties of Markov chains** (detailed balance etc.) are important
- You might be asked to write down a stochastic computational model based on verbal description.
- **Poisson processes**, both homogeneous and inhomogeneous, are important.
- Understanding of the methods at a general level.
- Understanding of how to implement methods: You might be given equations for discrete event simulation and asked to explain how you would implement it as an algorithm; this means pseudocode – you are not expected to remember python functions and such by heart.

Lecture 5

- Learn and understand **the principles of MCMC Bayesian inference**: how and why it is done.

- Knowledge and understanding of **Gibbs algorithm** (and the prelude to it, justification for sampling from a bivariate distribution) and **Metropolis-Hastings method** (and Metropolis sampling).
- I will **not** ask anything about latent variable or missing data stuff.
- **central concepts and equations**: stationary distribution, equilibrium (qualitatively), detailed balance, reversibility, ergodicity, Boltzmann weight, stochastic transfer matrix and density, hazard etc.
- go through the **examples and models** so that you understand them.

Lecture 6

Hamiltonian Monte Carlo (HMC) method

- **learn this well!**
- you should understand how the method works, motivation for it etc.
- you should also be able to do t**he necessary derivations/calculations for implementing HMC for simulating a target distribution.**
- make sure you understand the depictions of the method in phase space
- to understand, in addition to lecture slides (lecture 6) read Betancourt, chapters 1 – 4.1, so from page to the top of page 30.
- Again, the central concepts in this context

In general: Learn the central concepts so you understand them and why they are relevant. Make sure you understand the examples and models in lecture slides. When given the notation like $\Pr\{x \leq X\}$ or $p(x_1, x_2)$ you should be able to do a small calculation or derivation that is asked.

I try to be reasonable. If it should turn out that I failed in that, I will modify the scale for grading the exam.

In the exam:

- Even if you should have just a somewhat vague idea about something, write it down. A possible modification of the grading will not help if you leave problems unanswered.
- **A basic function calculator is allowed.** I try to make the problems such that all calculations can be done without a calculator, but having one with you might still be a good idea.

One last remark: Markov chain with its transition probability matrix is the root of everything. The formulation looks deceivingly simple. Make sure you understand it. You can check that you do, for example, by doing a couple of exercises in Chapters 3.1 and 3.2 of the book Pinsky, Karlin: Stochastic Modeling (In the “Books” folder under “Materials” in MyCourses.) The answers are given in the back.