KTH Electrical Engineering

Electric Power Systems Lab

EG3131 MONTE CARLO METHODS IN ELECTRIC POWER RESEARCH

1 November 2013

Syllabus

This course is an extended version of the second cycle course EG2080. This syllabus mostly contains information that is specific for the graduate course. Further details can be found in the second cycle course; the syllabus of which can be found on the KTH course web (www.kth.se/social/course/EG2080). Students are also welcome to contact the examiner:

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Objectives

The topic of this course is methods for solving complicated mathematical problems using sample surveys. Applications of Monte Carlo methods can be found in many fields, from opinion polls to simulation of technical systems. The focus of this course is going to be on Monte Carlo methods that are useful for research projects in electric power engineering.

After the course, the student should be able to

- state basic definitions concerning probability theory, random variables and sampling techniques,
- apply computation methods for random number generation, simple sampling and variance reduction techniques,
- formulate mathematical models appropriate for Monte Carlo simulation,
- analyse a simulation problem related to electric power research and design an efficient Monte Carlo simulation method for that problem.

Learning Activities

The learning activities of this course includes lectures, lecture assignments, home assignments and self-studies. Lectures and assignments are the same as for the second cycle course; please refer to the course syllabus of EG2080 for further details.

Examination

The examination of this course is divided in three parts: home assignments, a written exam and a project assignment. Students should complete the home assignments before starting with the exam and the project assignment.

Home assignments

The home assignments consists of small problems, which either are solved by hand or with a computer program. The students should prepare oral presentations of the solutions to the home assignments. The procedure is the same as in the second cycle course, except that students in the graduate course have to solve all home assignments in order to pass. Please refer to the course syllabus of EG2080 for further details.

Exam

Students should write an exam corresponding to the exam of the second cycle course EG2080. Students who have written an equivalent exam at some other university may include that exam in this course. Otherwise, the student will have to write the exam together with the EG2080 students.

In order to attend the exam, the student must have completed the home assignments. The student must also notify the course responsible of EG2080 in order to make sure that there is a seat available.

The written exam consists of short, basic problems, and can give a total score of 40 points. Students must receive at least 33 points to pass the exam. Solutions should include sufficient detail that the argument and calculations can be easily followed.

Exams are given twice a year. The duration of the exam is four hours. The following aids are allowed in the exam:

- Calculator without information relevant to the course.
- Formulae sheet.

The formulae sheet will be appended to the exam. A preliminary version of the formulae sheet is available on the web pages of EG2080. You are welcome to contact the examiner and suggest improvements of the formulae sheet!

Project assignment

The objective of the project assignment is that the students should be able to apply the methods taught during the lectures on a larger simulation problem. It is free for each student to decide which system that will be simulated. It is recommended that students consider systems that are relevant for their Ph.D. research, but if that is not possible or would result in an overwhelming work load, students can create their own fictitious systems similar to the Ice-cream Company in Lecture 1 or the Product Company in part II of the home assignments.

The result should be presented as a scientific paper. The format of the paper can be adapted to what is common in the student's field of research. It is not necessary that the paper is accepted for publication in a conference or a journal to pass the course, but the paper should have such quality that it could be published after minor further editing.

The paper should first describe the mathematical model of the system to be simulated. You should then analyse which simulations method are applicable and efficient for your simulation problem. Start with a theoretical analysis, i.e., describe to which inputs you may apply complementary random numbers and dagger sampling, if you can find a suitable control variate, and if you can find scenarios for the input values, which are likely to be of particular interest, and which therefore should be the target for importance sampling or stratified sampling. After the theoretical analysis, you should set up the necessary software to simulate the system, and test those simulation methods that you have identified as suitable for your problem. Try to estimate the accuracy of the different simulation methods by investigating the variance of the estimates. Finally, you should

summarise how one should carry out efficient Monte Carlo simulation of the system you have studied and point out directions for future research in this field.

The project assignment is to be solved individually. It is of course acceptable to ask colleagues or the supervisor of your Ph.D. research for advice, and it is possible to schedule meetings with the lecturer to discuss your simulation approach.

Schedule

The lectures of the course are given in period 2. Please refer to the course syllabus of EG2080 for the present schedule. The home assignments should performed in period 2, but the project assignment can be completed at any time.