12998 – 344 (16) Simulation and Inference in Stochastic Systems (3L, 3P)

2021

Course summary:

Simulation and numerical inference of key stochastic systems such as random walks. Informationbased probability and core probabilistic concepts, deduction and induction, Bayes' Theorem. Characterisation and calculation with distributions and data, transformations, generating functions, connections to statistical physics.

Method of assessment: Flexible assessment

Prerequisite module:

- *Mathematics 214 or Applied Mathematics 214*
- *Physics 214*

Language policy:

Afrikaans and English in the same class groups:
During each lecture, all information is conveyed at least in English. Summaries and/or explanation of the core concepts will also be given in Afrikaans. Questions in Afrikaans and English will, at the least be answered in the language of the question. Students will be supported in Afrikaans and English during a combination of appropriate facilitated learning opportunities.

Module relevance in programme:

Monte Carlo methods are not only a numerical solution tool, but a means of performing numerical experiments from which one can learn much about the physics of interacting many-particle systems (such as about phase transitions). Here we introduce the necessary computational and statistical tools and concepts to write such codes and to analyse the data they produce. The simulation of a two-dimensional ferromagnet will be of benefit to students following honours statistical physics (Physics 721), complementing the analytical approaches there. The third-year module, Physics 314, introduces some of the ideas relevant to this module, but also exposes students to the nature of the physical systems that we would want to study using computer simulations.

Outcomes of course:

- Insight into the physics of many-particle systems.
- Basic knowledge of the application of statistical sampling theory to physics.
- Working knowledge of Monte Carlo simulation and its applications in physics and beyond.
- The ability to write and debug computer simulations of stochastic physical systems.

Lecturer:

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Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for honours programme and its modules is **Dr** P Neethling pietern@sun.ac.za

Course content:

Importance sampling and the Metropolis algorithm. Simulation of random systems such as random walks and the Ising model. Simulation and analysis of second order phase transitions.

Tutorials:

One afternoon per week, used mainly for computer simulations.

Study material:

Notes and reading materials posted on SUNLearn throughout the module.

Assessment:

Methods of Assessment

Flexible assessment, based on

- 3-4 programming assignments (reports, codes and working sheets);
- Online quizzes; and
- A final project presentation and report.

Venue and time of assessment opportunities

Throughout the semester. The final presentation is schedules to coincide with the final test date as scheduled by the University administration.

Availability of marks:

Turnaround time is typically one week. Feedback is given in terms of written and oral commentary as soon as possible.

Calculation of final mark:

60-70% assignments throughout semester, 10-20% quizzes, 20% final project and presentation.