COURSE DETAILS

Course Code: F70SC
Full Course Title: Statistical Computing
SCQF Level: 10
SCAF Credits: 15
Available as Elective: No

DELIVERY LEVEL

Undergraduate: Yes
Postgraduate Taught: No
Postgraduate Research: No

COURSE AIMS

- To introduce the students to the challenges of performing statistical inference in problems involving high-dimensional models and massively large data sets, with a focus on Big Data analytics.
- To reinforce basic concepts and introduce further ideas related to statistical computation.
- To introduce students to appropriate algorithms for the numerical solution of large-scale statistical analysis problems.
- To provide students with experience of computational statistics tools for the analysis of complex data.

LEARNING OUTCOMES – SUBJECT MASTERY

After studying this module (and depending on which topics are covered in the module), students should be able to demonstrate some of the following skills:

- Understand the idea of Monte Carlo integration, and apply various Markov chain Monte Carlo methodologies.
- Implement high-dimensional Markov chain Monte Carlo methods, such as Hamiltonian Monte Carlo algorithms.
- Understand the Sequential Monte Carlo methodology for inference in time series models.
- Implement sequential Monte Carlo samplers for state space models.
- Explain the concept of variational inference, and apply variational Bayes, message passing, and expectation propagation techniques.
- Implement algorithms to perform variational inference in high-dimensional models.
- Explain the main concepts of deterministic and stochastic convex optimisation.
- Implement deterministic and stochastic convex optimisation algorithms for solving large or high-dimensional optimisation problems.
- Understand the concept of non-parametric Bayesian inference
- Implement algorithms to perform inference with non-parametric Bayesian models, such as Gaussian processes.

LEARNING OUTCOMES – PERSONAL ABILITIES

At the end of the module, students should be able to:

- Demonstrate the ability to learn independently
- Manage time work to deadlines and prioritise workloads
- Use computer intensive methodologies to solve analytically intractable statistical problems
F70SC Statistical Computing

- Present results in a way which demonstrates that they have understood the technical and broader issues related to computational statistics
- Have awareness of the applications of high-dimensional statistical computing in research and industry

SYLLABUS

This course is delivered as a guided reading / seminar course with assigned computing work. The syllabus for the course in any given year will be determined by the member of staff assigned to teach the course.

Some examples of possible course topics include:

- Markov chain Monte Carlo methodology for high-dimensional inference problems, and for problems involving massively large datasets.
- Deterministic and stochastic optimisation methods for high-dimensional inference problems and for problems involving massively large datasets.
- Variational Bayesian inference, message passing, belief propagation for large-scale inference problems.
- Sequential Monte Carlo methods for inference in time-series models.
- Non-parametric Bayesian methods.

Each academic year the exact content of the module will be approved by the Course Director in consultation with the MACS Learning and Teaching Committee

COURSE RELATIONSHIPS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Level</th>
<th>Title</th>
<th>School</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>F79MA</td>
<td>9</td>
<td>Statistical Models A</td>
<td>School of Math and Comp Sci.</td>
<td>Pre-Requisite</td>
</tr>
<tr>
<td>F79MB</td>
<td>9</td>
<td>Statistical Models B</td>
<td>School of Math and Comp Sci.</td>
<td>Pre-Requisite</td>
</tr>
</tbody>
</table>

LOCATION AND ASSESSMENT METHODS

<table>
<thead>
<tr>
<th>Edi</th>
<th>SBC</th>
<th>Ork</th>
<th>Dub</th>
<th>Malay</th>
<th>IDL</th>
<th>COLL</th>
<th>ALP</th>
<th>OTH</th>
<th>Method</th>
<th>Weight</th>
<th>Exam Mins</th>
<th>Type</th>
<th>Diet</th>
<th>Synoptic Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coursework</td>
<td>100</td>
<td>Assessment</td>
<td>Semester 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>