CS942-15 Mathematical Methods in Computing

26/27

Department
Computer Science
Level
Taught Postgraduate Level
Module leader
Arpan Mukhopadhyay
Credit value
15
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The aim of this module will be to introduce mathematical concepts and techniques from probability theory and optimisation that are fundamental to many modern computing applications and are necessary for more advanced topics in computer science. The module will blend theory with examples to illustrate how mathematical methods can be applied to solve real-life computing problems.

Module aims

The module will introduce fundamental mathematical tools in the areas of probability theory and optimisation that have wide applicability in all areas of modern computing. These tools will help students gain deeper understanding of more specialised topics in computer science taught in the MSc curriculum.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be

covered. Actual sessions held may differ.

Probability:

Measurable Sets, Axioms of Probability, Conditional Probability, Bayes Theorem

Random Variables, common distributions, expectation, moments, generating functions, probabilistic inequalities

Jointly distributed random variables, covariance, correlation, conditional expectations, independence, laws of large numbers, central limit theorem

Markov chains, statistical estimation, hypothesis testing

Optimisation:

Introduction to mathematical optimization, linear, non-linear, and convex optimization

Convex sets, convex functions, Duality, Optimality Conditions

Gradient descent, stochastic gradient descent, Newton's method, Simplex Method

Learning outcomes

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

- Apply concepts and techniques from optimization and probability theory to a broad range of computational problems including algorithm design, data analysis, and statistical modelling.
- Develop abstract mathematical models for real-world systems and formally analyse them using suitable mathematical techniques.
- Solve real-world problems and communicate their solutions in a rigorous manner.

Indicative reading list

Reading lists can be found in Talis

Research element

Coursework will include a research element.

Subject specific skills

Ability to apply concepts and techniques from optimization and probability theory to a broad range of computational problems including algorithm design, data analysis, and statistical modelling.

Ability to develop abstract mathematical models for real-world systems and formally analyse them using suitable mathematical techniques in a rigorous manner.

Transferable skills

Being able to apply mathematical knowledge in computer science and understanding of specialist theoretical and methodological approaches, suggesting and incorporating interrelationships with other relevant disciplines in abstract and unpredictably complex contexts.

Students will obtain the cognitive skills to critically contribute to existing discourses and developing mathematical methodologies for developing algorithms in computer science, suggesting new ideas, and designing systematic investigations based on critical analysis and evaluation.

Students will obtain practical skills in organising and communicating information, improving Interpersonal, team
and networking skills through engaging in classes and computer laboratories. Formative assesssment will allow students to strategically enhance their own learning.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (21%)
Seminars	5 sessions of 1 hour (3%)
Supervised practical classes	4 sessions of 1 hour (3%)
Private study	57 hours (39%)
Assessment	50 hours (34%)
Total	146 hours

Private study description

Private study, background reading and revision.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time	Eligible for self-certification
Problem Set 1	15%	4 hours	Yes (extension)

	Weighting	Study time	Eligible for self-certification
Problem set containing questions and programming assignments on probability theory.			
Problem Set 2	15%	4 hours	Yes (extension)
Problem set containing questions and programming assignments on optimisation.			
Final Exam	70%	42 hours	No

- Students may use a calculator

Assessment group R

	Weighting	Study time	Eligible for self-certification
Resit Exam	100%		No

- Students may use a calculator

Feedback on assessment

For problem sets 1-2 individual feedback will be provided. There will be a class test in week nine (formative assessment, not for credit). For the final exam cohort-level feedback will be provided.

Past exam papers for CS942

Availability

Courses

This module is Core for:

- TCSA-G5PD Postgraduate Taught Computer Science
  - Year 1 of G5PD Computer Science
  - Year 1 of G5PG Computer Science with specialism in Artificial Intelligence and Machine Learning
  - Year 1 of G5PH Computer Science with specialism in Cyber Security
  - Year 1 of G5PI Computer Science with specialism in Data Analytics