# CS409-15 Algorithmic Game Theory

## 24/25

**Department**
Computer Science
**Level**
Undergraduate Level 4
**Module leader**
Matthias Englert
**Credit value**
15
**Module duration**
10 weeks
**Assessment**
Multiple
**Study location**
University of Warwick main campus, Coventry

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# Description

### Introductory description

The focus of the module is on algorithmic and computational complexity aspects of game-theoretic models.

### Module aims

To familiarise students with formal methods of strategic interaction, as studied in game theory. One of the aims will be to give a flavour of current research and most recent advances in the field of algorithmic game theory.

### 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.

Game models: Strategic form, extensive form, games of incomplete information (eg auctions), succinct representations, market equilibria, network games, co-operative games;
Solution concepts: Nash equilibria, subgame perfection, correlated equilibria, Bayesian equilibria, core and Shapley value;
Quality of equilibria: Price of anarchy, price of stability, fairness;
Finding equilibria: Linear programming algorithms, Lemke-Howson algorithm, finding all equilibria;

Complexity results: Efficient algorithms, NP-completeness of decision problems relating to set of equilibria, PPAD-completeness;
Some parts of the module will be research-led, so some topics will vary from year to year.

## Learning outcomes

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

- Understand the fundamental concepts of non-cooperative and co-operative game theory, in particular standard game models and solution concepts.
- Understand a variety of advanced algorithmic techniques and complexity results for computing game-theoretic solution concepts (equilibria).
- Apply solution concepts, algorithms, and complexity results to unseen games that are variants of known examples.
- Understand the state of the art in some areas of algorithmic research, including new developments and open problems.

## Indicative reading list

Osborne and Rubinstein, A Course in Game Theory;
Roughgarden, Selfish Routing and the Price of Anarchy;
Nisan, Roughgarden, Tardos and Vazirani (eds), Algorithmic Game Theory;
Selected research papers.

## Subject specific skills

Advanced algorithmic techniques;

## Transferable skills

Problem Solving;
Communication skills

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# Study

# Study time

| Type | Required |
| --- | --- |
| Lectures | 30 sessions of 1 hour (20%) |
| Seminars | 9 sessions of 1 hour (6%) |
| Private study | 111 hours (74%) |
| Total | 150 hours |

## Private study description

private reading and revision

# Costs

No further costs have been identified for this module.

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# Assessment

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

Students can register for this module without taking any assessment.

## Assessment group D4

|  | Weighting | Study time |
|---|---|---|
| Coursework 1<br>question sheet 1 - peer assessed | 5% | |
| coursework 2<br>question sheet | 15% | |
| In-person Examination<br>CS409 examination | 80% | |

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- Answerbook Gold (24 page)

## Assessment group R1

|  | Weighting | Study time |
|---|---|---|
| In-person Examination - Resit<br>CS409 resit paper | 100% | |

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- Answerbook Gold (24 page)

## Feedback on assessment

Written comments and marks.

Past exam papers for CS409

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# Availability

## Pre-requisites

Students must have studied the material in CS260 or equivalent relevant content.

# Courses

This module is Optional for:

- Year 5 of UCSA-G504 MEng Computer Science (with intercalated year)
- Year 1 of TCSA-G5PD Postgraduate Taught Computer Science
- UCSA-G503 Undergraduate Computer Science MEng
  - Year 4 of G503 Computer Science MEng
  - Year 4 of G503 Computer Science MEng
- Year 4 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)

This module is Option list A for:

- Year 5 of UCSA-G504 MEng Computer Science (with intercalated year)
- RMAA-G1PG Postgraduate Research Mathematics of Systems
  - Year 1 of G1PG Mathematics of Systems
  - Year 1 of G1PG Mathematics of Systems
- Year 1 of TMAA-G1PF Postgraduate Taught Mathematics of Systems
- UCSA-G503 Undergraduate Computer Science MEng
  - Year 4 of G503 Computer Science MEng
  - Year 4 of G503 Computer Science MEng
- Year 4 of USTA-G304 Undergraduate Data Science (MSci)
- Year 4 of UCSA-G4G3 Undergraduate Discrete Mathematics
- Year 5 of UCSA-G4G4 Undergraduate Discrete Mathematics (with Intercalated Year)
- UMAA-G100 Undergraduate Mathematics (BSc)
  - Year 3 of G100 Mathematics
  - Year 3 of G100 Mathematics
  - Year 3 of G100 Mathematics
- Year 3 of UMAA-G103 Undergraduate Mathematics (MMath)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year

This module is Option list B for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
  - Year 4 of G105 Mathematics (MMath) with Intercalated Year
  - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 3 of G103 Mathematics (MMath)
  - Year 3 of G103 Mathematics (MMath)
  - Year 4 of G103 Mathematics (MMath)

- ○ Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G107 Undergraduate Mathematics (MMath) with Study Abroad
- UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
  - ○ Year 3 of G106 Mathematics (MMath) with Study in Europe
  - ○ Year 4 of G106 Mathematics (MMath) with Study in Europe