# CS929-15 Algorithmic Game Theory

## 21/22

**Department**
Computer Science
**Level**
Taught Postgraduate Level
**Module leader**
Marcin Jurdzinski
**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 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.
- Understand the fundamental concepts of non-cooperative and co-operative game theory, in particular standard game models and solution concepts.

## 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 D1

| | Weighting | Study time | Eligible for self-certification |
|---|---|---|---|
| Coursework 1<br>question sheet 1 - peer assessed. | 5% | | Yes (waive) |
| coursework 2<br>question sheet | 15% | | Yes (extension) |
| In-person Examination<br>CS929 examination | 80% | | No |

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- Answerbook Gold (24 page)

### Assessment group R1

| | Weighting | Study time | Eligible for self-certification |
|---|---|---|---|
| In-person Examination - Resit<br>CS929 resit paper | 100% | | No |

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### Feedback on assessment

Written comments and marks.

Past exam papers for CS929

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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 1 of TCSA-G5PD Postgraduate Taught Computer Science
- Year 1 of TCSA-G5PA Postgraduate Taught Data Analytics
- Year 1 of TMAA-G1PF Postgraduate Taught Mathematics of Systems