IB3J3-15 Mathematical Game Theory: Combinatorial and Search Games

23/24

Department
Warwick Business School
Level
Undergraduate Level 3
Module leader
Steve Alpern
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

N/A

Module web page

Module aims

The module presents game theory from a mathematical perspective, with rigorous proofs and connections with other branches of mathematics.

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.

Syllabus(by weeks):

1. The Game of Nim
2. Combinatorial Games I

3. Combinatorial Games II
4. Game of Hex and variations
5. Proof of Brouwer Fixed-Point Theorem using Hex
6. Search Theory: Introduction
7. Search Games I: Immobile Hider on a Tree
8. Search Games II: Immobile Hider on Weakly Eulerian Network
9. Search Games III: Mazes
10. Review
    Note: these topics have been chosen so that there is virtually no overlap with courses in game

Learning outcomes

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

- By completing this module, students will have a firm grasp of search theory and in particular the antagonistic version known as search games. They should be able to identify to problems that could be modelled by this theory, and to some extent have a start on how to attack such models. They should be able to extend our use of dynamic programming in search problems to other areas. Their ability to prove general theorems should be enhanced.

Indicative reading list

Steve Alpern (2017) "Hide-and-seek games on a network, using combinatorial search paths ", Operations Research, 65, 5, 1207-1214

Steve Alpern (2011) "A new approach to Gal's Theory of Search Games on Weakly Eulerian networks", Dynamic Games and Applications, 1, 2, 209-219

S. Alpern, S. Gal. The Theory of Search Games and Rendezvous, International Series in Operations Research and Management Science. Kluwer, New York (reprinted by Springer) (2003)

S. Alpern. Network search from a game theoretic perspective. INFORMS Tutorials (2013)

Gal, S., & Anderson, E. (1990). Search in a Maze. Probability in the

Engineering and Informational Sciences, 4(3), 311-318. doi:10.1017/S0269964800001625

Additional reading

- J. H. Reijnierse and J. A. M. Potter (1993). Search games with immobile hider. Int. J. Game Theory 21 , 385-394.
- L. Pavlovic (1993). Search game on an odd number of arcs with immobile hider. Yugosl. J. Oper. Res. 3, no. 1, 11--19.
  S. Gal (2013). Search games: a review. In: Alpern, Steve, et al., eds. Search theory: a game theoretic perspective. Springer,
  New York.
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- Dagan and S. Gal (2008), Network search games, with arbitrary searcher starting point, Networks 52, 156--161.
  V. Baston and K. Kikuta. Search games on a network with travelling and search costs. International Journal of Game Theory 44,
  no. 2 (2015): 347-365

Subject specific skills

Use game theory to analyse conflict situations. Suggest strategies appropriate to the problems

Transferable skills

Formulate business and other game problems in a structured form (trees, matrices) suited to game theoretic analysis. Apply these techniques to the solution of the problems. Interpret the results of the solution techniques in terms of the original problems faced by the players. Apply search algorithms to find objects and efficiency.

Study

Study time

Type	Required
Lectures	10 sessions of 3 hours (38%)
Private study	48 hours (62%)
Total	78 hours

Private study description

No private study requirements defined for this module.

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 B2

	Weighting	Study time
Online Examination Exam ~Platforms - AEP	100%	72 hours

- Online examination: No Answerbook required

Feedback on assessment

Each week there will be a problem set and these will be marked (possibly not all questions) and returned to students. Depending\r\non the precise hourly schedule, the assignment will be handed in prior to the lecture/problem session and returned in the\r\nlecture/problem session; or possibly handed in one week and returned the next week in the lecture/problem session. These\r\ngrades are meant only to provide students with feedback as to their understanding of the course and will not be part of the final\r\nassessment.\r\n

Past exam papers for IB3J3

Availability

Courses

This module is Optional for:

- UECA-3 Undergraduate Economics 3 Year Variants
  - Year 3 of L116 Economics and Industrial Organization
  - Year 3 of L116 Economics and Industrial Organization
- Year 4 of UECA-4 Undergraduate Economics 4 Year Variants
- UECA-LM1D Undergraduate Economics, Politics and International Studies

    - Year 3 of LM1D Economics, Politics and International Studies
    - Year 3 of LM1D Economics, Politics and International Studies
- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
    - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
    - Year 4 of G300 Mathematics, Operational Research, Statistics and Economics
- USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
    - Year 3 of G1G3 Mathematics and Statistics (BSc MMathStat)
    - Year 4 of G1G3 Mathematics and Statistics (BSc MMathStat)
- USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)
    - Year 4 of G1G4 Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)
    - Year 5 of G1G4 Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Unusual option for:

- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
    - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
    - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)
    - Year 3 of V7ML Philosophy, Politics and Economics (Tripartite)

This module is Option list A for:

- USTA-Y602 Undergraduate Mathematics,Operational Research,Statistics and Economics
    - Year 3 of Y602 Mathematics,Operational Research,Stats,Economics
    - Year 3 of Y602 Mathematics,Operational Research,Stats,Economics
- Year 4 of USTA-Y603 Undergraduate Mathematics,Operational Research,Statistics,Economics (with Intercalated Year)

This module is Option list B for:

- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
    - Year 3 of GG14 Mathematics and Statistics
    - Year 3 of GG14 Mathematics and Statistics
- Year 4 of USTA-GG17 Undergraduate Mathematics and Statistics (with Intercalated Year)

This module is Option list C for:

- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
    - Year 4 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
    - Year 4 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
- Year 5 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated

This module is Option list D for:

- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
    - Year 3 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
    - Year 3 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
- USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated
    - Year 3 of G30G Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream) Int
    - Year 4 of G30G Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream) Int

This module is Option list G for:

- UPHA-V7ML Undergraduate Philosophy, Politics and Economics
    - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
    - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)
    - Year 2 of V7ML Philosophy, Politics and Economics (Tripartite)