Mathematics 747
Topics in Mathematical Biology
Course Information Sheet, Fall 2017

Topic: *Evolutionary Game Theory*

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Class Location:

Class Times:

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- – ***Availability before and after these times?***
- **No classes on the following dates:**
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Prerequisites: Understanding of basic real analysis and the qualitative theory of nonlinear ordinary differential equations. Interest in mathematical biology.

Tentative Course Content: Optimality models, optimality *vs.* evolutionary stability, discrete strategy games, continuous strategy games, asymmetric games, games between relatives. Replicator dynamics. Adaptive dynamics. Finite population effects. *If time permits:* Other topics such as stochastic evolutionary game theory.

Course Objectives:

- Improve skills in creating and analyzing mathematical models of biological systems.
- Learn the basics of evolutionary game theory and become familiar with some primary research literature in this field.

- Develop skills and experience in conducting collaborative research in mathematical biology.
- For assignments and oral presentations, use typesetting and graphics software that are standard in the professional mathematics community.

Course github: `https://github.com/davidearn/tmb2017`
Course information, potentially including announcements, handouts, assignments, links to downloadable course-related software, *etc.*, will be available on the course github. You are expected check it regularly. You may find it simplest to clone the github and then `git pull` to obtain updates.

Groups: An important aspect of the course will be to learn to work effectively in small groups (ideally 4 students per group). Groups will be formed early in the course and you will work together on the assignments. Formation of groups will be discussed in class.

Peer evaluation: Individuals must complete a group contribution survey after each group assignment, and a peer evaluation survey after each oral presentation.

Assignments: There will be several assignments. Assignments must be submitted on time at the start of the class on the due date.
Each group will submit one joint document for each assignment. The document must be typeset in LaTeX and all graphics must be prepared using `R` or `XPPAUT`. Assignments must be submitted both as hardcopy and by e-mail (one e-mail message from each group, with attachments including all source documents and the final compiled pdf file).

Solutions to selected problems will be discussed in class or distributed by e-mail after the due date. ***Note:*** *Only a selection of problems on each assignment will be marked; your grade on each assignment will be based only on the problems selected for marking. Problems to be marked will be selected after the due date.*

Oral Presentations: Each student will be required to prepare and give oral presentations to the class, based on selected topics in Evolutionary Game Theory and/or publications in the game theory research literature. Presentations must be given using slides prepared with the `beamer` package in LaTeX. The slides, including all source code, must be submitted to the instructor.

Software: In order to complete the assignments and prepare the oral presentations, you will be required to develop basic competence with software for mathematical typesetting (LaTeX), graphics and numerical analysis (`R`), and numerical solution of differential equations and bifurcation analysis (`XPPAUT`). These applications are all open-source free software projects and can be downloaded and installed on any computer.

- LaTeX: `http://www.latex-project.org/`
- `R`: `http://www.r-project.org`

- XPPAUT: `http://www.math.pitt.edu/~bard/xpp/xpp.html`

You will need to install these applications on your laptop. If you do not have a laptop, let the instructor know immediately.

Course style: ***To be discussed.***
Initially, we will work through the draft textbook "Game Theory for Biologists" by Johnstone and Earn, and assignments will be based on the exercises, problems and projects listed at the end of each chapter of the book. Draft book chapters will be posted on the course github as the term progresses. Suggestions for improvement of the text will be greatly appreciated. Keep notes as you work through the text. You will be expected to read draft chapters before they are discussed at length in class. There may be lectures (by the instructor and/or the students). Some classes might consist of demonstrations/tutorials about the required software. Later in the term, students will choose or be assigned sections from game theory textbooks and/or papers from the primary research literature to read and present to the class.

Communicating with the instructor: You will need to send e-mail messages to the instructor. Bear in mind that the instructor typically receives 100 e-mail messages per day and it is easy for messages to be missed or get backlogged. Every e-mail message you send to the instructor must have a helpful, descriptive subject line. The subject line should always have the form "`Math 747: ...`". Examples might be:

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Math 747: confusion about assignment 1, problem 2a
Math 747: progress on extra credit problem
Math 747: dog ate our group's assignment
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Final Grade: ***To be discussed.***
Tentatively, your final grade will be determined as follows:

Component	Weight
Assignments	50%
Oral Presentations	30%
Participation	20%

Note that participation includes completing online surveys and peer evaluations as required.

Reference list

Game Theory books

[1] Dockner EJ, Jorgensen S, Van Long N, Sorger G. Differential games in economics and management science. Cambridge: Cambridge University Press; 2000.

[2] Dugatkin LA, Reeve HK, editors. Game Theory and Animal Behavior. New York: Oxford University Press; 2000.

[3] Fudenberg F, Tirole J. Game Theory. Cambridge: The MIT Press; 1991.

[4] Gibbons R. A Primer in Game Theory. Toronto: Harvester Wheatheaf; 1992.

[5] Gintis H. Game Theory Evolving. Princeton: Princeton University Press; 2000.

[6] Hofbauer J, Sigmund K. Evolutionary Games and Population Dynamics. Cambridge: Cambridge University Press; 1998.

[7] Kuhn HW, editor. Classics in Game Theory. Princeton: Princeton University Press; 1997.

[8] Maynard Smith J. Evolution and the Theory of Games. Cambridge, UK: Cambridge University Press; 1982.

[9] Mesterton-Gibbons M. An introduction to game-theoretic modelling. vol. 11 of Student Mathematical Library. 2nd ed. Providence: American Mathematical Society; 2001.

[10] Morrow JD. Game Theory for Political Scientists. Princeton: Princeton University Press; 1994.

[11] Sigmund K. Games of Life. Oxford: Oxford University Press; 1993.

[12] Vincent TL, Brown JS. Evolutionary game theory, natural selection, and darwinian dynamics. New York: Cambridge University Press; 2005.

Nonlinear Dynamics books

[13] Strogatz SH. Nonlinear Dynamics and Chaos. New York: Addison Wesley; 1994.

[14] Ermentrout B. Simulating, analyzing, and animating dynamical systems: a guide to XPPAUT for researchers and students. Software, Environments, and Tools. Philadelphia: Society for Industrial and Applied Mathematics; 2002.

e-books on R available through the McMaster library system

[15] Stevens MHH. A primer of ecology with R. Use R!. Dordrecht ; New York: Springer; 2009.

[16] Spector P. Data manipulation with R. Use R!. New York: Springer; 2008.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in priniciples of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences,

e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes dishonesty. For information on the various kinds of a academic dishonesty please refer to the Academic Integrity Policy located at `http://www.mcmaster.ca/academicintegrity`. The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work. In this course, you are encouraged to discuss the assigned problems with other students in your class. However, you must write the solutions in your own words without referring to any other students' work. The copying or even paraphrasing of other students' solutions will be considered academic dishonesty.
3. Copying or using unauthorized aids during tests, quizzes and examinations.

David Earn
20 August 2017