## Course Title

**CAP 5993/4993 Game Theory/Introduction to Game Theory**

**Spring 2017**

## Catalog Description

Game theory is the study of strategic interaction. It has been applied to every scientific discipline -- most notably economics, but also political science, business, military, biology, and many others. Recently it has been a major area of research in computer science, as the field of artificial intelligence, which initially studied settings with a single agent, is expanding its scope to domains with multiple strategic (and potentially adversarial) agents. Topics will include game representations, solution concepts, imperfect information, repeated games, learning, auctions, and voting. There will be a project to pursue an application (or theoretical topic) of interest. The class could be of interest to students in computer science, mathematics, physical sciences, business, social sciences, engineering, and life sciences (including medicine). It would be helpful to have familiarity with mathematical proofs, and some problems will involve computational implementation.

**3 Credits**

## Instructor

Samuel Ganzfried, 305-348-2034, sganzfri@cis.fiu.edu, School of Computing and Information Sciences, ECS 381.

Office hours: Tuesday Thursday 2-3pm

## Prerequisites

One mathematical course beyond MAC2312 (Calculus 2), for example MAD 2104 (Discrete Math) or an equivalent course.

## Type

CAP 5993 is an elective graduate course, and CAP 4993 is an advanced undergraduate course. Students from other departments are welcome.

## Objectives

Introduce the main concepts of game theory, which has been applied to every scientific field -- most notably economics, but also political science, business, military, and biology.

## Evaluation

Homeworks (every 1-2 weeks), midterm exam, final exam, class project. For graduate students, each component is worth 25% of the final grade. Undergraduate students have a choice of either taking the final exam or doing the class project (while graduate students do both). The choice must be specified by 4pm on the third day after the midterm exam by email to the instructor. Each of the three components will be worth 1/3 of the final grade.

## Project

Students can apply a topic from class to an application of interest (e.g., formulate a problem game-theoretically and compute/analyze equilibrium strategies), study a new theoretical topic, or present a novel survey and discussion of recent literature on a topic (e.g., opponent modeling in security games, medical applications of equilibrium computation). Ambitious original projects are encouraged even if they are not complete or successful.

## Topics

1. Strategic-form games and solution concepts
* pure vs. mixed strategies, domination, best response, Nash equilibrium, zero-sum games, minimax/maximin, evolutionarily stable strategies
1. Extensive-form games
* game trees, relationship to strategic form, imperfect information, perfect vs. imperfect recall, behavior strategies, Kuhn’s Theorem, sequence form
1. Algorithms and complexity
* P/NP/PPAD, linear programming, two-player zero-sum formulation, Lemke-Howson algorithm, support enumeration, Gambit and Game Theory Explorer
1. Equilibrium refinements
* subgame perfect equilibrium, backwards induction, trembling-hand perfect equilibrium, sequential equilibrium, proper equilibrium
1. Repeated games
* finitely and infinitely repeated games, solution concepts, Folk Theorem
1. Learning in games
* fictitious play, no-regret algorithms, counterfactual regret minimization, robust responses, opponent modeling and exploitation
1. Alternative solution concepts
* strategy commitment, Stackelberg equilibrium, correlated equilibrium
1. Auctions
* English/Dutch/sealed-bid/Vickrey auctions, equilibria, mechanism design
1. Social choice (voting)
* Arrow’s Impossibility Theorem, Gibbard-Satterthwaite Theorem, majority/Borda/Condorcet rules, range voting
1. Stable matching
* Gale-Shapley algorithm, application to National Resident Matching Program
1. Applications to education, security, and medicine.

## Textbook(s)

1. Game Theory by Michael Maschler, Eilon Solan, and Shmuel Zamir (required)
2. Game Theory with Engineering Applications by Dario Bauso (optional)
3. Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations by Yoav Shoham and Kevin Leyton-Brown (optional)

## Miscellaneous

University drop date: 3/20

Attendance is encouraged but not mandatory. Lectures will be recorded and made available.

Students can use laptops during class provided it is not disruptive to others.