Computation of Game and Market Equilibria **

Prof. Bruno Codenotti[1]

[1] *Research Director*
Istituto di Informatica e Telematica, CNR Pisa, Italy
Email bruno.codenotti@iit.cnr.it

Calendario: 20 ore, Lunedì 14.30-16.30 e Martedì ore 10.30 - 12.30. Prima lezione il 9 marzo 2009. Aula DEI/G (Piano 3, Dipartimento di Ingegneria dell'Informazione, Via Gradenigo 6/a).

Prerequisiti: Basic background in algorithms and mathematics.

Tipologia di esame: Each student is expected to give a presentation in the class on a topic previously agreed with the teacher. The presentation will be followed by a discussion with the teacher and the other students. The final grade will be based on the presentation and on the participation to class activities.

Aim: The widespread use of Internet has promoted tighter interactions between Computer Science and Game Theory. Game Theory techniques are being increasingly used to analyze scenarios featuring users with potentially conflicting interests. In such environments, a fundamental notion is the one of *equilibrium*. The main purpose of this course is to analyze different notions of equilibrium under suitable models (non-cooperative games, cooperative games, and markets). Specifically, we will discuss the computation of such equilibria and their applications to relevant case studies (e.g., routing, resource sharing, pricing of shared resources, etc.).

Topics:

1. Non-cooperative games in normal form
   - Two-player constant-sum games
   - Two-player variable-sum games
   - Multi-player games
   - Existence of Nash equilibria
2. Cooperative Games
   - Cooperative three-player games
   - Bargaining
   - Cooperative multi-player games
   - Coalitions
   - Equilibria in a cooperative environment (core, kernel, nucleolus, Shapley value)
3. Markets
   - Simple market models
   - Arrow-Debreu model
   - Walras equilibrium (definition, existence results)
   - Markets and games: comparison and reductions
4. Classical Algorithms

** Corso mutuato dalla *Scuola di Dottorato in "Ingegneria dell'Informazione"*

- Preliminaries: Sperner's lemma
- Scarf's algorithm
- Lemke-Howson's algorithm
- Variations and extensions

5. Recent Algorithms and Applications
   - Selection of recent algorithms (chosen based on the students' interests and inclinations)
   - Selfish routing: Nash equilibria vs optimal solution
   - Resource sharing: fairness criteria
   - Mechanism design and Internet protocols

References: The material for the class will be covered by excerpts from the following reference books.

- M.J. Osborne, A. Rubinstein. *A Course in Game Theory*. MIT Press, 2001.
- N. Nisan, T. Roughgarden, E. Tardos, V.V. Vazirani. *Algorithmic Game Theory*. Cambridge University Press, 2007
- W. Hildenbrand, H. Sonnenschein Eds. *Handbook of Mathematical Economics*. North Holland, 1991.
- G. Owen. *Game Theory*. Academic Press, 1982.
- A. Mas-Colell, M.D. Whinston, J. Green. *Microeconomic Theory*. Oxford Univ. Press, 1995.