2SC7210 – Game Theory for Smart Cities

Instructors: Mohamad Assaad
Department: DÉPARTEMENT SIGNAL, INFORMATION, COMMUNICATION
Language of instruction: ANGLAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 34,50

Description
This course explains the fundamental principles of game theory (rationality, Nash equilibrium, correlated equilibria, etc.) and presents the solution of several types of games (finite games and mixed strategies, revolutionary games, repeated games, etc.). Several practical examples of the use of game theory in smart cities are presented and analyzed. In particular, the distributed optimization of telecommunications network infrastructures, the routing of data in networks and the problem of smart vehicle charging are studied.

Quarter number
ST7

Prerequisites (in terms of CS courses)
Communication networks (basic notions), optimization

Syllabus

- General introduction
  - smart cities and game theory
  - Game theory: normal and extensive form
  - Decision and solution concepts (rationality, Nash equilibrium, etc)
  - Correlated Equilibria
- Different Game types and application to the problems of smart cities
  a. Zero sum and non zero sum games
  b. Finite games and mixed strategies
  c. Routing games
  d. Revolutionary games
  e. Repeated games
  f. Stable Matching: stable mariage games
- Case Study: Application to smart charging problems, application to frequency allocation in wireless networks

Class components (lecture, labs, etc.)
Organization of the lectures

- General Introduction: 6h CM + 1.5 TD
- Different types of games (zero sum, routing, etc.): 9h CM + 7.5h TD
- Case study: 3h CM

Grading
- Final Exam - 1.5h

Course support, bibliography

- Rida Laraki, Jérôme Renault, Sylvain Sorin, Bases Mathématiques de la Théorie des Jeux, Ecole Polytechnique, 2013.

-E. Altman, Advances in Dynamic Games and Applications, 2013

- D.Bertsekas and J. Tsitsiklis, Parallel and Distributed : Numerical Methods, athena scientific, 2015.

- D. Bertsekas and R. Gallager, Data Networks, Prentice Hall.

- Chen, C., Zhu, S., Guan, X., Shen, X.S, Wireless Sensor Networks : Distributed Consensus Estimation, Springer, 2014.

- G. Ferrari, Sensor Networks : Where Theory Meets Practice, Springer-Verlag, 2009.

- Recent papers on IoT, smart cities and wireless networks.

Resources
Lecturers: Mohamad Assaad (CS), Mikael Touati (Orange Labs)
Exercices sessions (TD): 25 students per classroom
software to use: Matlab

Learning outcomes covered on the course

At the end of the course the student will be able to:

1- know various emerging problems in smart cities (telecommunications networks, smart charging, etc.)

2- model a network in the context of smart cities with its main functions
3- formulate emerging problems in smart cities using distributed optimization and tools from Game Theory
4-know the tools of game theory and their use in smart cities
5-implement game theory algorithms in Matlab

Description of the skills acquired at the end of the course

C1.1: "be able to make the list of parameters that impact the studied system, the list of elements with which it is in relation" and "know how to identify the important parameters with respect to the problem posed"
C1.2: "Know how to use a model presented in class in a relevant way. Make the choice of simplifying assumptions adapted to the studied problem"
C1.3: "Solve a problem using an approach based on approximation", "Make a relevant simulation choice for a given problem " and
"Know the limitations of numerical simulations and what one can expect from, know how to criticize results of numerical simulations"