NATIONAL PH.D. PROGRAM IN AUTONOMOUS SYSTEMS

Real-time optimization with application to autonomous systems

Ph.D. candidate

Masha Ghavami

Cycle

XXXIX cycle

Tutors

Prof. Francesco Vasca

1. Description of the research program

These days, the popularity of electric vehicles has soared due to battery technologies and government policies to decrease air pollution. Therefore, if an efficient charging plan for EVs are not devised, EVs charging demand could have detrimental effects on power system operation such as an increase in demand peak and therefore the need for the new generation capacity. Through unit electricity price, we can incentivize EVs to charge at less demand hours. Methods for charging management of EVs are categorized as cooperative and competitive mechanism. In cooperative methods, EVs are considered as cooperative agents which are intended to decrease a total charging cost. Since EVs are inherently competitive agents, they may have an incentive to deviate from the external imposition. However, utilizing game-theoretic based approaches, in the PhD program, we aim to analyse the competition between EVs, design and implement the Nash equilibrium seeking algorithm.

The equilibrium seeking methods we aim to design must take into account issues such as scalability, communication bandwidth, and privacy. Additionally, they should be applicable for geographically distributed EVs, where they are located in a large geographically area. At the final step, due to highly random behaviour of EVs, we aim to employ model predictive control to make a decision according to the latest information.

2. Schedule of the research activities

First academic year (planned)

	Description	**Period**	**Activity abroad**
Study of the relevant literature	Analysis of the state of art on game-theoretic approaches	1-6	NO
Models for charging management system	Study of decentralized equilibrium seeking algorithm	6-12	NO

Second academic year (planned)

	Description	**Period**	**Activity abroad**
Application domain	Selection of the communication structure between electric vehicles and coordinators	1-12	NO
Methods for steady-state analysis	Study of the most proper equilibrium seeking algorithm for the proposed communication structure	1-12	NO

Third academic year (planned)

	Description	**Period**	**Activity abroad**
Model for real data representation	Real time implementation for the charging management system	1-12	NO
Validation	Numerical validation of the theoretical results	1-12	NO

3. Training and research activities plan

First academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	Control for optimization (DAUSY course)	1-12	Yes	1
	The reinforcement learning framework for control engineering applications (University of Sannio)	1-12	Yes	4
	Game theory for controlling autonomous systems (DAUSY course)	1-12	Yes	2
B. Master's degree courses	Multiagent Systems (University of Sannio)	6-12	Yes	9
C. Soft skill courses				
D. Participation to seminars	Participation to 7 hours of seminars according to availability	1-12	No	2
E. Participation to international congresses or workshops				
F. Presentation of research products at international congresses or workshops				
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			18
G. Individual research activity	Research activity in the topics of game theory and equilibrium seeking algorithm	1-12		24
H. Supervision of students	Supervision of students under the guidance of the tutor	8-12		3
I. Integrative teaching activities	Integrative didactive activities to be carried out under the supervision of the tutor	6-12		5
J. Preparation of manuscripts for conferences or journals	Verbalization of the results obtained, in the form of a paper for a conference or a journal.	6-12		10
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			42
	TOTAL OF ECTS			**60**

Second academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	Introduction to optimal linear quadratic control (DAUSY course)	1-12	Yes	2
B. Master's degree courses				
C. Soft skill courses				
D. Participation to seminars				
	Participation to 10 hours of seminars according to availability	1-12	No	3
E. Participation to international congresses or workshops	Participation to five-day international congress of workshop according to availability, and/or SIDRA Doctoral school	1-12	No	5
F. Presentation of research products at international congresses or workshops	Presentation of two papers at international conferences according to availability.	1-12	No	4
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			14
G. Individual research activity	Research activity in the topics game theory and equilibrium seeking algorithm	1-12		28

H. Supervision of students	Supervision of students under the guidance of the tutor	1-12		3
I. Integrative teaching activities	Integrative didactive activities to be carried out under the supervision of the tutor	1-12		5
J. Preparation of manuscripts for conferences or journals	Verbalization of the results obtained, in the form of a paper for a conference or a journal.	1-12		10
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			46
	TOTAL OF ECTS			**60**

Third academic year (planned)

	Description	**Period**	**Final Exam**	**ECTS**
A. Ph.D. courses				
B. Master's degree courses				
C. Soft skill courses				
D. Participation to seminars				
E. Participation to international congresses or workshops	Participation to a five-day congress of workshop according to availability, and/or SIDRA Doctoral school	1-12	No	5
F. Presentation of research products at international congresses or workshops	Presentation of the results obtained to at least one international congress or workshop associated to a high impact factor	1-12	No	2
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			7
G. Individual research activity	Research activity in the topics of game theory and equilibrium seeking algorithm	1-12		35
H. Supervision of students	Supervision of students under the guidance of the tutor	8-12		3
I. Integrative teaching activities	Integrative didactive activities to be carried out under the supervision of the tutor	6-12		5
J. Preparation of manuscripts for conferences or journals	Verbalization of the results obtained, in the form of a paper for a conference or a journal.	6-12		10
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			53
	TOTAL OF ECTS			**60**

4. List of the publications written by the candidate in the triennium

None.

Mahsa Ghavami

Prof. Francesco Vasca