Ph.D. in Information Technology: Theses Defenses

January 17th, 2018

DEIB Seminar Room "Alessandra Alario" (building 21)

11.00 am

First Ph.D. presentation and discussion:

Emanuele MASON – XXX Cycle

"Beyond full rationality: modeling tradeoff dynamics in multi-objective water management"

Advisor: Prof. **Andrea Castelletti**

Co-advisor: Dr. **Matteo Giuliani**

Abstract:

Anthropocene denotes the scale and intensity of the anthropic influence on natural processes and ecosystems. A crucial role is played by decision making, which mediates human interactions at the various levels of system governance, ranging from institutional to operational decisions that directly impact natural resources. According to the normative approach of decision-making modeling, it is assumed that an agent's decisions seek to rationally achieve a certain goal. However, the rationality hypothesis limits the development of behavioral models in systems operated for multiple objectives. Another limitation is found whenever the balance among the multiple goals changes in response to exogenous influences, such as regulatory changes, or extreme events, such as floods or droughts, originated by the inherent variability within the system.

The objective of the research presented is to advance algorithms adopting the normative approach to develop behavioral models of system operators. The two proposed algorithms are able to cope with tradeoffs among multiple objectives, and with the time evolution of preferences. The first algorithm adopts Inverse Reinforcement Learning, while the second, inspired by multi-agent negotiation protocols, is called Set-based Egocentric Concession protocol. Both are able to achieve good performance in the developed applications, and constitute a promising start to explain the evolution of the tradeoff of a time serie of decisions with dynamic preferences. More significantly, they allow to frame the testing of possible models of preference evolution in a scientific approach that has significant implications for the construction of reliable projections of the future evolutions of coupled human and natural systems.

Second Ph.D. presentation and discussion:

Francesca RECANATI – XXX Cycle

"Sustainable design and management of agroecosystems - Integrating ecological models and optimization techniques to support decision-making"

Advisor: Prof. **Paco Melia'**

Abstract:

Sustainability in the agri-food sector is key in the global development context defined by the Agenda 2030 and the 17 Sustainable Development Goals. The food systems are complex due to the presence of nutritional, economic, and environmental goals, which are often conflicting. This thesis aims at the design of quantitative mathematical tools to support actors and decision makers in the agri-food sector to develop more sustainable agricultural systems, with a focus on multi-species agroecosystems. Three stages compose this research. The first step is two-fold: it includes (i) the understanding the main biophysical components and processes of an agroecosystem, and (ii) the development of mathematical models of agricultural systems. The developed model simulates the dynamics of agroecosystems, and it is flexible enough to describe both monoculture and multi-species systems. The second step aims at the investigation of how the sustainability concept can be put into operation to assess agroecosystems. In this direction, we firstly develop a sustainability assessment framework for agricultural systems, including a set of quantitative indicators covering the three dimensions of sustainability, and we test it onto the assessment of domestic food production in the Gaza Strip. We then focus on the environmental sphere considering two frameworks: the Life Cycle Assessment (LCA) and Ecosystem Services Assessment. The application of LCA to food supply chains allowed highlighting (i) the potential contribution of the agricultural phase within the environmental profile of food products, and (ii) the high variability of environmental impacts brought by alternative agroecosystems. Regarding the Ecosystem Services assessment, we propose and test two methodologies for the assessment of climate and water regulation services of agroecosystems, and apply the dynamic crop model developed in the first step to assess and compare agroecosystems in terms of provisioning, and climate and nutrient regulation services. The last step aims at formulating an optimization problem to support the decision behind the development of 'more' sustainable agroecosystems. Its formulation, implementation, and application allowed (i) understanding the link between species composition of agroecosystems and sustainability performances, (ii) to investigate conflicts and synergies between the considered objectives, and (iii) to highlight the main challenges in the development of such tools linked to lack of proper data, and selection of time horizon and objective function. The work included in this thesis contributed to put the sustainability concept into operation within the agri-food sector through both the definition of general and widely applicable indicators and specific mathematical models and frameworks, and the application of all the developed tools to real-

world case demonstrated how comprehensive and quantitative assessments can effectively support informed development of sustainable agroecosystems.

PhD Committee:

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