4th MARA Get-Together: Workshop on Multiagent Resource Allocation

http://www.lamsade.dauphine.fr/~maudet/mara
with the support of the cost Action "Algorithmic Decision Theory" (http://cost-ic0602.org)

Paris, 17-18 June 2010

Thursday (**room A405**)	
9h30	Welcome coffee
10h00	Tutorial on Economic Inequality (**Ulle Endriss**)
11h00	Distributed Learning of Nash Equilibria in Resource Allocation Problems: Continuous vs. Discrete Algorithms (**Corinne Touati**)
	Lunch
14h00	The Efficiency of Fair Division (**Panagiotis Kanellopoulos**)
14h45	LP Solvable Models for Multiagent Resource Allocation Problems (**Patrice Perny**)
15h30	Coffee break
16h00	Complexity of Social Welfare Optimization in Multiagent Resource Allocation (**Jorg Rothe**)
16h45	Fair Division under Ordinal Preferences: Computing Envy-Free Allocation of Indivisible Goods (**Sylvain Bouveret**)

Friday (**room A701**)	
9h30	Graph-based Representations for Combinatorial Auctions (**Madalina Croitoru**)
10h15	Coffe break
10h45	Rump session
	Lunch
14h00	Multiagent Resource Allocation with Sharable Items: Simple Protocols and Nash Equilibria (**Stéphane Airiau**)
14h45	A Qualitative Vickrey Auction (**Paul Harrenstein**)
15h30	Coffee bye bye

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Tutorial on Economic Inequality (Ulle Endriss) :
The first part of this tutorial will be a review of some of the formal criteria for measuring economic inequality that have been developed in the welfare economics literature. These include the Lorenz curve, the Gini index, and the Robin Hood index. In a slight departure from the usual presentation of this kind of material, I will define these concepts in the context of a model of fair division with indivisible goods. This gives rise to the combinatorial optimisation problem of computing an allocation that reduces inequality with respect to an initial allocation and a chosen inequality measure. I will then make some tentative remarks on possible research directions for the MARA community in view of this problem, touching on issues such as computational complexity, centralised algorithms based on integer programming, and the challenge of devising distributed protocols for the reduction of economic inequality.

Distributed Learning of Nash Equilibria in Resource Allocation Problems: Continuous vs. Discrete Algorithms (Corinne Touati) :
In this talk, we review and classify a few learning algorithms of Nash Equilibria adapted to distributed systems. We shall start with classical simple best response algorithms and their extensions. Then, a general family of continuous dynamics will be introduced together with some basic properties and their applications to routing problems.

The Efficiency of Fair Division (Panagiotis Kanellopoulos) :
In this talk we consider the impact of fairness on the efficiency of allocations. We consider three different notions of fairness, namely proportionality, envy-freeness, and equitability for allocations of divisible and indivisible goods and chores. We present a series of results on the price of fairness under the three different notions that quantify the efficiency loss in fair allocations compared to optimal ones. Most of our bounds are either exact or tight within constant factors.

LP Solvable Models for Multiagent Resource Allocation Problems (Patrice Perny) :
We present some recent results obtained with two students, Julien Lesca [1] and Boris Golden [2], on fair allocation problems in the context of multiagent optimization. These problems arise in various contexts such as assigning conference papers to referees or sharing of indivisible goods among agents. We present and discuss different preference models that might be used to maximize the satisfaction of agents while maintaining a notion of fairness in the distribution. We show that, for all these models, the determination of fair optimals solutions requires the optimzation of a non-linear social evaluation function. Hence we present a Mixed Integer Linear Programming formulation of the allocation problem that can be efficiently solved using standard solvers. We also present the results of numerical tests we conducted on realistic cases to illustrate the practical feasibility of the proposed approaches.

References :

[1] Julien Lesca and Patrice Perny, 2010, "LP Solvable Models for Multiagent Fair Allocation problems", to appear in the proceeding of ECAI'10.

[2] Boris Golden and Patrice Perny, 2010, "Infinite order Lorenz dominance for fair multiagent optimization", International Conference on Autonomous Agents and Multiagent Systems (2010), pp. 383–390

Complexity of Social Welfare Optimization in Multiagent Resource Allocation (Jorg Rothe) :
We study the complexity of social welfare optimization in multiagent resource allocation. We assume resources to be indivisible and nonshareable and agents to express their utilities over bundles of resources, where utilities can be represented in either the bundle form or the k-additive form. Solving some of the open problems raised by Chevaleyre et al. [Informatica 30:3-31, 2006] and confirming their conjectures, we prove that egalitarian social welfare optimization is NP-complete for both the bundle and the k-additive form, and both exact utilitarian and exact egalitarian social welfare optimization are DP-complete, each for both the bundle and the k-additive form, where DP is the second level of the boolean hierarchy over NP. In addition, we prove that social welfare optimization with respect to the Nash product is NP-complete for both forms.

This is joint work with Magnus Roos.

Fair Division under Ordinal Preferences: Computing Envy-Free Allocation of Indivisible Goods (Sylvain Bouveret) :
In this talk, we will deal with the problem of fairly dividing a set of goods amongst a group of agents, when those agents have preferences that are ordinal relations over alternative bundles of goods (rather than utility functions) and when our knowledge of those preferences is incomplete. The incompleteness of the preferences stems from the fact that each agent reports their preferences by means of an expression of bounded size in a compact preference representation language. Specifically, we assume that each agent only provides a ranking of individual goods (rather than of bundles). In this context, we will consider the algorithmic problem of deciding whether there exists an allocation that is possibly (or necessarily) envy-free, given the incomplete preference information available, if in addition some mild economic efficiency criteria need to be satisfied. We provide simple characterisations, giving rise to simple algorithms, for some instances of the problem, and computational complexity results, establishing the intractability of the problem, for others.

Graph-based Representations for Combinatorial Auctions (Madalina Croitoru) :
This talk addresses the problem of (1) representing bids for combinatorial auctions and (2) employing those structures for WD. We detail a graph-based language who's novelty lies (1) in the use of generalized network flows to represent the bids and (2) in the interpretation of WD as a adequate aggregation of individual preferences. We motivate the language both from a representational point of view (conciseness, expressivity) and expose its potential for winner determinations combinatorial optimisation. We discuss how this language represents the same class of expressivity of bids more concisely compared to existing work.

Multiagent Resource Allocation with Sharable Items: Simple Protocols and Nash Equilibria (Stéphane Airiau):
We study a particular multiagent resource allocation problem with indivisible, but sharable resources. In our model, the utility of an agent for using a bundle of resources is the difference between the valuation of that bundle and a congestion cost (or delay), a figure formed by adding up the individual congestion costs of each resource in the bundle. The valuation and the delay can be agent-dependent. When the agents that share a resource also share the resource's control, the current users of a resource will require some compensation when a new agent wants to use the resource. We study the existence of distributed protocols that lead to a social optimum. Depending on constraints on the valuation functions (mainly modularity), on the delay functions (e.g., convexity), and the structural complexity of the deals between agents, we prove either the existence of some sequences of deals or the convergence of all sequences of deals to a social optimum. When the agents do not have joint control over the resources (i.e., they can use any resource they want), we study the existence of pure Nash equilibria. We provide results for modular valuation functions and relate them to results from the literature on congestion games.

A Qualitative Vickrey Auction (Paul Harrenstein) :
Restricting the preferences of the agents by assuming that their utility functions linearly depend on a payment allows for the positive results of the Vickrey auction and the Vickrey-Clarke-Groves mechanism. These results, however, are limited to settings where there is some commonly desired commodity or numeraire—money, shells, beads, etcetera—which is commensurable with utility. We propose a generalization of the Vickrey auction that does not assume that the agents' preferences are quasilinear, but nevertheless retains some of the Vickrey auction's desirable proper- ties. In this auction, a bid can be any alternative, rather than just a monetary offer. As a consequence, the auction is also applicable to situa- tions where there is a fixed budget, or no numeraire is available at all (or it is undesirable to use payments for other reasons)—such as, for example, in the allocation of the task of contributing a module to an open-source project. We show that in two general settings, this qualitative Vickrey auction has a dominant-strategy equilibrium, invariably yields a weakly Pareto efficient outcome in this equilibrium, and is individually rational. In the first setting, the center has a linear preference order over a finite set of alternatives, and in the second setting, the bidders' preferences can be represented by continuous utility functions over a closed metric space of alternatives and the center's utility is equipeaked. The traditional Vickrey auction turns out to be a special case of the qualitative Vickrey auction in this second setting.

This is joint work with Mathijs de Weerdt and Vincent Conitzer.