SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: **CA16228 - European Network for Game Theory**
STSM title: **Integer programming for matching under preferences and distributional/diversity requirements**
STSM start and end date: **2019-01-05 - 2019-01-12**
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PURPOSE OF THE STSM/

As described in the research plan, the aim of the STSM is to further investigate the the IP model for team formation problem and finding efficiently its fair solutions in the presence of preferences from both sides. The set of problems related to the topic are Japanese resident allocation (Efficient Matching Under Distributional Constraints: Theory and Applications), Israeli Mechinot programmes (Matching for the Israeli "Mechinot" Gap Year: Handling Rich Diversity Requirements), and a new setting for the ROADEF Challenge 2007. The specific objectives of STSM are: 1. To examine the existing literature and models for the problems of market matching with preferences and distributional and diversity constraints. 2. Formulate the extended IP formulation for the market matching problem with preferences with respect to team formation problem. 3. To demonstrate finally the applicability of the obtained results on several data sets available to the public.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

We had very fruitful discussions on different aspects optimisation within the framework of the the complex two sides markets. In particular, we focus our attention on the problem and the associated models and application of the formation of effective and skilful teams. We consider the one-to-many matching problem taking for motivational examples from variaties of application such as allocation of students to projects, assignment experts to the teams, forming the teams in hedonic environment and others.

We propose the generalized framework for the problem and the integer linear programming model to respect all constraints. Different objective functions are proposed to deal with stability and fairness of the solutions. Finally, we set the plan the test computationally obtained models on the artificial data as well as on the instances from the real world.

Practical applications: Formation of effective and skillful teams is an imperative everyday task for many companies to ensure their market and technological advantages. The participation in the good and appropriate team has even more importance for the individual involved where one can further develops her expertise in the domain. The problem of team formation appears in the

literature under different frameworks and various names. In the most general terms, we take here the perspective of a set of agents (experts, players, technicians, students, researchers etc.) to be assigned to one or many different teams (projects, tasks, etc.). The set of practical applications consists of team formation for the Massively multiplayer online games, the team formation for skilled individuals for collaborations in the presence of some social network or an online database, the many-to-one matching problems and its applications in the presence of preferences over colleagues or the distributional and diversity constraints on on the composition of the teams, assigning evaluators to research grant applications and others.

Models and solutions of the problem: We propose the generalized framework for the problem and the integer linear programming model to respect different types of constraints that appear in different real world applications. Different objective functions are proposed to deal with stability and fairness of the solutions. The proposed model is general in the sense that dropping or restraining further some constraints the model will then describes and models well the whole set of very different problems considered so far as very distinct and non-related problems. We developed effectively the IP model and it is ready to be employed and tested on the data.

Computational tests: We plan to test computationally obtained models on the artificial data as well as on the instances from the real world. Several data sets mentioned in the literature exists together with the results obtained using different techniques so far. These computational tests will be main subject of our collaboration in the near future together with further development of the model.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Practical application: Several different problems were recognized as related and similar. They all can be presented under the same framework which is the team formation with or without presence of game theory constraints. In the same manner, we can consider solution purely structural respecting all given constraints but also, in the presence of preferences, we can examine the stability of these solutions.

Models and solutions of the problem: We discussed and proposed the integer linear programming model for a set of different problems, all related to the team formation.

Computational tests: We did not have time to do computational tests but we made a plan how to effectuate them in the future.

FUTURE COLLABORATIONS (if applicable)

Practical application: We will try to discover new applications of the proposed model.

Models and solutions of the problem: We will work jointly on the possible new methodologies, such as heuritstics, to be able to solve efficiently even big instances with millions of agents that appears in the domain of online multiplayer games.

Computational tests: We are planning to conduct simulations on real world data as well as on the artificially created data.