

## COST Action IC1205 on Computational Social Choice: STSM Report

**Applicant:** David Manlove

**Home institution:** University of Glasgow

**Home country:** UK

**Host 1:** Péter Biró

**Host 1 institution:** Corvinus University of Budapest

**Host 1 country:** Hungary

**Dates:** 23/11/2015 to 25/11/2015

**Host 2:** Katarína Cechlárová

**Host 2 institution:** PJ Šafárik University of Košice

**Host 2 country:** Slovakia

**Dates:** 26/11/2015 to 27/11/2015

The purpose of this visit was to continue research on a matching problem involving preferences that has applications to the assignments of students to courses at a university. Work on this problem was initiated by a working group which met at Dagstuhl seminar 15241 on “Computational Social Choice: Theory and Applications”, 7-12 June 2015.

To describe the problem, we are given a set of applicants, a set of courses, and each applicant has a set of acceptable courses that she ranks in strict order. There are prerequisite constraints on courses (e.g., course  $c_1$  cannot be taken unless  $c_2$  is also taken) that are modelled by a partial order. These prerequisite constraints can be specific to applicants, or else uniform for all applicants. Each applicant and each course has a capacity indicating the maximum number of courses and applicants that they can be assigned to, respectively. The problem is to find matchings of applicants to courses satisfying various optimality properties, where any matching must satisfy the acceptance, capacity and prerequisite constraints.

Together with Péter Biró, Katarína Cechlárová, Tamás Fleiner and Bettina Klaus, we worked on proving algorithmic and characterisation results relating to mechanisms for finding types of optimal matchings. For example we showed that finding a maximum cardinality matching is NP-hard, as is finding a maximum cardinality Pareto optimal matching. We also proved that finding an arbitrary Pareto optimal matching is NP-hard for additive preferences, though solvable in polynomial time for lexicographic preferences. Even deciding whether a matching is Pareto optimal is NP-complete for lexicographic preferences.

We also considered a variant of the course allocation problem with prerequisites where courses can be co-requisites. That is, a subset  $C'$  of courses are co-requisites if, whenever an applicant takes one course in  $C'$ , she must take all courses in  $C'$ . Again, similar hardness results hold in the co-requisites case, though a Pareto optimal matching may be found in polynomial time.

This was a very fruitful research visit in terms of the results obtained, and we are confident that a paper on course allocation with pre-requisite and co-requisite constraints will emerge in due course, with the support of the COST Action acknowledged.

During the research visit I gave a talk entitled “Stable Marriage and Roommates problems with restricted edges” at the Game Theory seminar series of Corvinus University of Budapest, and another talk entitled “Algorithms for Paired and Altruistic Kidney Donation in the UK” at the Institute of Mathematics, PJ Šafárik University of Košice.

I am grateful for the support of COST Action IC1205 on Computational Social Choice which made this visit possible through the STSM award, and to the two hosts for their hospitality.