

## Report on the outcomes of a Short-Term Scientific Mission<sup>1</sup>

Action number: CA16228

Grantee name: Gergely Kál Csáji

### **Details of the STSM**

Title: **Algorithmic and complexity theoretic study of special stable matching problems**

Start and end date: 17/02/2022 to 27/02/2022

### **Description of the work carried out during the STSM**

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

*(max. 500 words)*

During my stay at the TU Wien University, I have worked with professor Jiehua Chen, a postdoctoral student Sanjukta Roy and a PhD student of Jiehua, Sofia Simola. We worked on a daily basis. We investigated two kinds of problems. One of them was about stable matchings with special preferences. We looked at whether special restrictions on the preference lists of the agents of a stable roommate problem can guarantee a stable outcome or at least guarantee polynomial-time solvability. One such model, that arises from location-based preferences are single-peaked and narcissistic preferences, where we assume that each agent ranks the others by how similar they are to himself. We also looked at other restrictions including group-separability, single-valleyiness, single-crossingness and more. We found that if ties are allowed than, if the preferences can be incomplete, most cases remain hard to solve, but if the preferences must be complete, then there are several cases, where a stable matching always exists and can be found efficiently.

The other main topic we worked on is a kind of hedonic games. Hedonic games are games, where the players are assigned to coalitions, but each player only cares about the others in his own coalition. Hedonic games are a more general framework than stable matchings, but they are quite related, since a standard stable matching or stable roommate problem can be regarded as a hedonic game, where the coalitions we assign the players to has to be of size 2. We investigated the computational complexity of the core verification problem for a special variant of hedonic games and answered an open question by Gerhard Woeginger.

<sup>1</sup> This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

### **Description of the STSM main achievements and planned follow-up activities**

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

*(max. 500 words)*

The scientific mission was very successful. We managed to solve many of the problems we set out to solve, and we could even answer some long-standing open questions about similar topics in the field.

Regarding the topic of stable matchings with restricted preferences, we managed to extend previous works of Jiehua Chen. Our main findings are the following. We showed that in the stable roommate problem with ties and incomplete preferences the problem of deciding whether there is a weakly stable solution is NP-complete, even if the preferences are restricted in almost every way we considered. On the positive side, we showed that in the case of complete preferences, even with ties, if the preferences are both narcissistic and group-separable, then a stable matching always exists and can be found in polynomial time. But when we only restrict the preferences to be double-peaked, then we proved that the problem again becomes NP-hard.

For the other topic we worked on, we managed to answer a long-standing open question about a special variant of hedonic games. We proved that deciding whether a given partition in a graphical hedonic game with friend-oriented preferences is core stable is co-NP-complete. We showed it even for very restricted instances. We also made some positive results, as we identified special kinds of instances where the problem becomes efficiently solvable. Our results will be available on arXiv in the next few weeks.

We plan to continue working together on these two areas and answer the remaining open questions we could not yet solve. We expect a publication from at least one of the two mentioned results by the end of the year.

In summary, the STSM provided a wonderful opportunity for me, for which I am very grateful to the COST Action organizers. We achieved even more during my visit, than what was originally planned, as well as identified many future research directions we can continue working on.