

Research internship: Fairness under ordinal or partial preferences in preference-based assignment

1 Subject

1.1 Context

Many real-life applications deal with *preference-based assignments*. In such multi-agent problems, agents have preferences over elements (activities, resources, or even other agents), and these preferences must be aggregated into a collective decision which is an assignment of agents to these elements. Preference-based assignments include well-known problems of collective decision, such as the *allocation of indivisible resources* (assignment of students/teachers to courses, design of schedules, division of inheritance or household tasks, division of resources payed in common, etc.), or the *formation of coalitions* (formation of clubs or teams, formation of working groups, construction of strategic or military international alliances, etc.). These problems are fundamental in Computational Social Choice [Brandt et al., 2016], subfield of Artificial Intelligence (AI) which studies the algorithmic aspects of collective decision. When agents express preferences over other elements to be matched with, it is key to ensure the *fairness* of the allocation: no agent should feel unequally treated.

Most of fairness criteria have been designed for the context where agents express utilities, and even often additive utilities. Only a few works deal with ordinal preferences (see, e.g., [Bouveret et al., 2010, Belahcène et al., 2021]). Such works also deal with partial preferences in the sense that only a ranking over single items is communicated. However, in general, partial preferences have been barely explored. One notable exception is the work of Halpern and Shah [2021] assuming top- k preferences where bounds on the value of k are given for achieving given fairness criteria.

1.2 Objective

In real-life situations, it is very rare that all agents express cardinal valuations for all elements. Therefore, it is crucial to design reasonable fairness concepts which can handle other types of preferences, which may be ordinal, dichotomous, or even defined with acceptability thresholds. Moreover, for the sake of realism, being able to adapt to partial preferences is key (e.g., expressing preferences via the ranking of top k items is very common in scenarios where the number of items is large). While in the literature, partial preferences have been addressed via distortion measures with respect to an implicit utility function [Halpern and Shah, 2021] or via the possible or necessary satisfaction of classical fairness criteria [Bouveret et al., 2010], we aim at investigating proper defined notions of fairness for partial preferences.

The goal of this internship is thus to investigate fairness in general preference-based assignments in order to derive concepts that can adapt to non-cardinal and/or partial preferences.

Keywords: Computational social choice, Fairness, Preferences.



References

- K. Belahcène, V. Mousseau, and A. Wilczynski. Combining Fairness and Optimality when Selecting and Allocating Projects. In *Proceedings of the 30th International Joint Conference on Artificial Intelligence (IJCAI-21)*, pages 38–44, 2021.
- S. Bouveret, U. Endriss, J. Lang, et al. Fair division under ordinal preferences: Computing envy-free allocations of indivisible goods. In *Proceedings of the 19th European Conference on Artificial Intelligence (ECAI-10)*, pages 387–392, 2010.
- F. Brandt, V. Conitzer, U. Endriss, J. Lang, and A. D. Procaccia, editors. *Handbook of Computational Social Choice*. Cambridge University Press, 2016.
- D. Halpern and N. Shah. Fair and Efficient Resource Allocation with Partial Information. In *Proceedings of the 30th International Joint Conference on Artificial Intelligence (IJCAI-21)*, pages 224–230, 2021.

2 Environment

The internship will last 6 months, and will start in March or April 2023 (dates can be adapted), and be part of the ANR project APPLE-PIE. The intern student will be welcomed in the [MICS](#) lab at CentraleSupélec (3 rue Joliot Curie, 91190 Gif-sur-Yvette), and supervised by [Anaëlle Wilczynski](#), Vincent Mousseau and Wassila Ouerdane (MICS, CentraleSupélec). The internship may be followed by a PhD thesis.

3 Candidate

We are looking for interested candidates who search for a master or an engineer internship (Bac+5 level). Solid skills in algorithmics are required, and a good knowledge in (algorithmic) game theory or computational social choice is appreciated. Most of all, the candidate should be interested by questions related to the contribution of AI to social justice.

4 How to apply

The interested candidates must send an email to Anaëlle Wilczynski (anaelle.wilczynski@centralesupelec.fr) with the following documents:

- a Curriculum Vitae,
- a motivation letter (max 2 pages),
- a transcript of the available grades for the current year and the past year,
- [optional] at most two recommendations.