Title: Proportional Representation with Ranked Preferences

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A major recent focus in the literature on computational social choice (COMSOC) is on proportional representation: aggregation rules that aim to give each voter approximately equal influence. This is often formalized through group fairness axioms, requiring the output to represent cohesive groups of voters to an extent proportional to the size of the group [Aziz et al., 2017]. The literature has mostly focused on approval votes. These are simple to analyze, but are not the only possible input format. In particular, political multi-winner elections that use proportional representation (but without party lists), such as in Ireland, let voters rank the candidates. The academic study of proportional representation based on ranked preferences is in its infancy, compared to the approval case.

There do exist several proposed voting methods that satisfy some proportionality axioms, including the widely-used Single Transferable Vote (STV) [Tideman, 1995]. But STV comes in many varieties, differing in particular in how they handle fractional votes and how they reassign votes. There are also more advanced versions based on fixed-point methods (like Meek-STV, in use in some parts of New Zealand), as well as Condorcet-like variants. But it is poorly understood what distinguishes these methods, and which methods are the best in terms of axiomatic properties and empirical performance [Aziz and Lee, 2020, Brill and Peters, 2023].

The aim of this PhD topic will be to

- catalog existing proposals for ranked proportional representation multi-winner rules and where necessary to develop new ones,

- develop formal properties that are satisfied by some of the proposals but not others, such as ones about proportionality, efficiency, consistency, or robustness to strategic behavior,

- compare rules based on simulations on synthetic and real-world data (such as data from Scottish municipal council elections, McCune and Graham-Squire, 2024).

The insights developed as part of this project may also be applied to other models in social choice, such as to portioning [Airiau et al., 2023], multi-issue decision making [Chandak et al., 2024], participatory budgeting [Peters et al., 2021], and emerging issues in artificial intelligence [Peters, 2024].

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