Group Fairness: From Multiwinner Voting to Participatory Budgeting

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Abstract

Many cities around the world allocate a part of their budget based on residents' votes, following a process known as participatory budgeting. It is important to understand which outcomes of this process should be viewed as fair, and whether fair outcomes could be computed efficiently. We summarise recent progress on this topic. We first focus on a special case of participatory budgeting where all candidate projects have the same cost (known as multiwinner voting), formulate progressively more demanding notions of fairness for this setting, and identify efficiently computable voting rules that satisfy them. We then discuss the challenges of extending these ideas to the general model.

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1 Talk Summary

Many cities around the world allocate a fraction of their budget using a process known as *participatory budgeting*: the local authority decides on a budget, collects proposals for projects to be implemented (such as, e.g., renovating a playground, building an outdoor gym, or planting trees), vets them for suitability, comes up with a cost estimate for each candidate project, and then elicits the residents' preferences over these projects [5, 11, 3]. The ballots are then aggregated to decide which subset of projects should be implemented. The goal of the aggregation process is to select a set of projects that fits within the given budget, yet reflects the residents' desires.

The implementation details of preference elicitation and aggregation processes vary from one municipality to another. Some localities ask the voters to rank the projects or to approve the projects they like (sometimes there is a bound on the number of projects that one is allowed to approve), while others ask them to specify their "ideal" budget allocation (see, e.g., the discussion in the work of Benade et al. [4]). Then, once the preferences are submitted, there is a multitude of procedures that can be used to aggregate the ballots into a collective decision. For instance, if voters are required to submit approval ballots, i.e., list all projects that they approve, the simplest (and widely used) method is to use the greedy strategy: one can order all projects either by the number of approvals they receive or by the number of approvals divided by the cost of the projects ('bang for the buck'), and add the projects to the selection one by one, skipping over the projects if adding them would violate the budget constraint.

However, the greedy approach may result in outcomes that are clearly undesirable. Imagine, for instance, that a city is partitioned into two districts by the railroad tracks, with 300,000 people living south of the tracks and 280,000 people living north of the tracks. As there are few track crossings, the residents of each district only approve projects in their own district. Now, suppose the overall budget is \$1,000,000, and in each district there

are five popular proposals that cost \$200,000 each to implement (as well as various other less popular proposals). Then, if 60% of the residents of each district participate in the selection process, all five south-of-the-tracks popular projects receive more votes than all five north-of-the-tracks projects, so the greedy approach would result in all money being spent according to the wishes of the south-of-the-tracks district residents. Obviously, a much fairer solution would be to implement three projects in the south and two projects in the north.

One can ensure fair distribution of funding across geographic areas by explicitly dividing the budget among the districts in proportion to their population, but geographic diversity is not the only concern that we need to worry about. For instance, we do not want the entire budget to be spent on cycling infrastructure, or on children's facilities; indeed, we want our decisions to be fair to all groups of residents, including those that the city council is not aware of. Conceptually, one can argue that if the total budget is B and the population size is n, each resident should be entitled to allocate B/n dollars in any way they wish. This idea, which is closely related to the concept of the core on cooperative game theory, suggests a decentralised procedure, where residents can form groups to jointly support various projects. However, the majority of residents would probably find it too burdensome to engage in negotiations. Is there a simple voting rule that provides the same guarantees, but can be implemented by the city council based on the residents' ballots?

In this survey, we summarise the state of the art regarding participatory budgeting with group fairness guarantees, under the assumption that voters' preferences are captured by approval ballots (i.e., each voter approves a subset of projects, and is indifferent among all projects they approve). We formulate several axioms that aim to capture what it means for a budget allocation process to be fair, describe voting rules that satisfy (some of) these axioms, and discuss their algorithmic complexity.

In more detail, we start by considering the setting of multiwinner voting, i.e., a special case of participatory budgeting where all projects have the same cost. We formulate several fairness axioms for this model, such as justified representation [1], proportional justified representation [10], extended justified representation [1], full justified representation [8], and the core [1]. We present the definitions of popular multiwinner voting rules, focusing, in particular, on Proportional Approval Voting (PAV) [6], the recently introduced Method of Equal Shares [9], and their variants [2], and discuss their computational complexity. We then discuss generalisations of these axioms and voting rules to the setting of participatory budgeting, and outline their strengths and limitations [9, 7].

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