Optimal Budget Aggregation with Single-Peaked Preferences

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We study the problem of aggregating distributions, such as budget proposals, into a collective distribution. An ideal aggregation mechanism would be Pareto efficient, strategyproof, and fair. Most previous work assumes that agents evaluate budgets according to the ℓ_1 distance to their ideal budget. We investigate and compare different models from the larger class of *star-shaped utility functions*—a multi-dimensional generalization of single-peaked preferences. For the case of two alternatives, we extend existing results by proving that under very general assumptions, the *uniform phantom mechanism* is the only strategyproof mechanism that satisfies proportionality—a minimal notion of fairness introduced by Freeman et al. [2021]. Moving to the case of more than two alternatives, we establish sweeping impossibilities for ℓ_1 and ℓ_∞ disutilities: no mechanism satisfies efficiency, strategyproofness, and proportionality. We then propose a new kind of star-shaped utilities based on evaluating budgets by the *ratios* of shares between a given budget and an ideal budget. For these utilities, efficiency, strategyproofness, and fairness become compatible. In particular, we prove that the mechanism that maximizes the Nash product of individual utilities is characterized by group-strategyproofness and a core-based fairness condition.

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CCS Concepts: • **Applied computing → Economics**; • **Theory of computation → Algorithmic mechanism design**.

Additional Key Words and Phrases: mechanism design, collective decision making, budget aggregation, portioning, single-peaked preferences

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