Society Design and Cooperative Agents

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Purpose

How should agents work together when communication and processing are limited?

We move from small groups to large societies looking at the limitation and possibilities of organization.

Committees

Focus: Optimal testing of structured knowledge.

Example: Ph.D. Committees, multiple professors testing one student. Should they work together or work independently and aggregated their findings at the end?

Model: We have a Bayesian network model of the student to be tested and the abilities of the agents testing. Each agent's time is limited, and the group structure has to be decided before the testing starts.

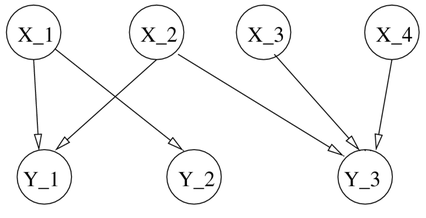
Goal: Optimal or approximately optimal conditional plans for testing and a choice of group structure.

Results

Depending on the structure of knowledge to be tested, there are some cases where working in a grand committee is maximally better than working individually, and vice versa

Finding an optimal plan and approximating an optimal plan better than the prior are both NP-Hard

Even given an oracle to solve the optimal plan problem, simply deciding between two committee structures is NP-Hard



Voting

Focus: Quantifying the quality of different voting rules

Example: All non-dictatorial voting rules violate the natural condition of Monotonicity, however the extent of this violation is unknown. What are the chances of this problem happening?

Technique: The violation graph is a new framework for thinking about these problems, and allows us quantify the problem using natural graph properties that have intuitive explanations.

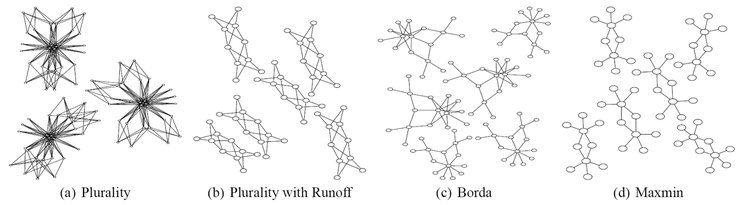
Goal: Which voting rule should we use in practice?

Results

Analytically, the ratio of edges in the violation graph goes to zero as the number of voters gets large. This suggests that if we have two elections in a row, the chance of a cross-election problem is small.

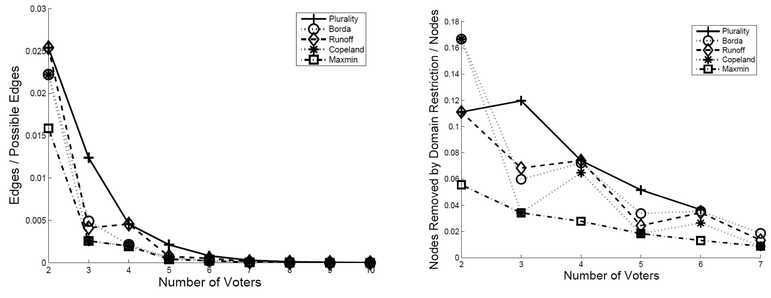
However, the proportion of 'situations' where there is a possible problem is almost one. Nevertheless, most of these problems stem from only a few problematic profiles, and if these are of low probability, then our voting systems work quite well.

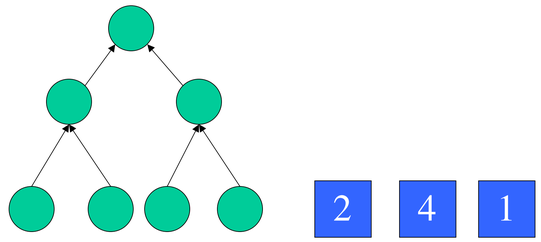
Our results suggest pairwise voting methods work the best.



(a) Plurality (b) Plurality with Runoff (c) Borda (d) Maxmin

Figure 2: Violation Graphs for Three Voters and Three Candidates





Structure of the Problem Available Agents

How do we assign agents to the problem?

Society Design

Focus: Organize a set of available agents in order to solve a structured problem

Example: A corporation wants to roll out a new product and they know the key components necessary, but who do they assign to what parts of the project?

Model: A directed graph representing the problem to be solved with weights on edges and node for communication and processing costs. A set of gents with budgets for communication and processing.

Goal: An algorithm to efficiently generate organizational plans

Results and Future Work

A greedy algorithm works when the problem has a tree structure.

This problem gives an actionable structure to multiagent organization. Future work is necessary to see if these techniques can be applied to team organization in practice and also to the organization of networked systems where the agents have vastly differing capabilities.