The study of mutation tolerance of voting mechanisms

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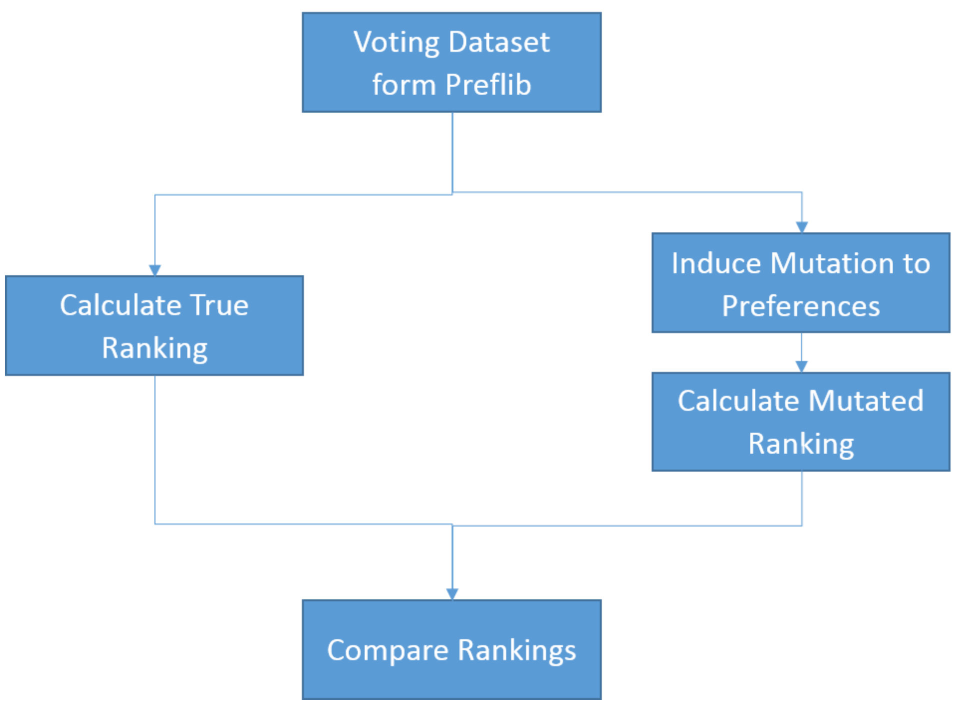
By this study we aim to compare popular voting mechanisms based on the deviation experienced after preference mutation. We plan to have 2 separate experiments, for the first experiment we will use a fixed mutation model to compare mutation-resistance of different voting mechanisms, for the second experiment we attempt to measure the mutation-resistance of a voting mechanism by incrementally increasing the degree of mutation in the preferences.

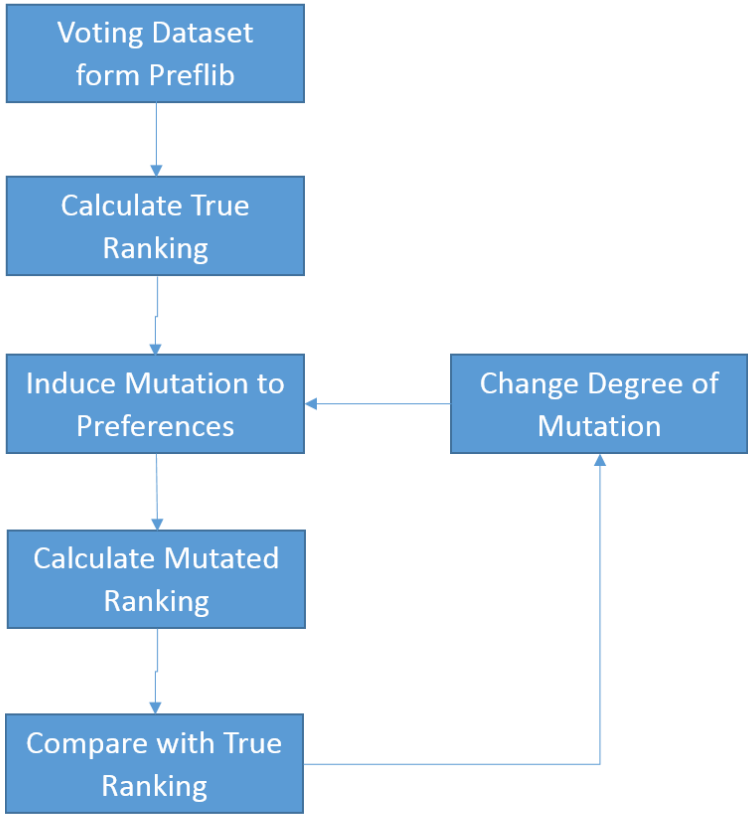
For evaluating a voting mechanism we first use it to calculate the ranking by using the un-mutated preferences, which is treated as the “True ranking” for the rest of the evaluation. We then induce mutation into the preferences and use the voting mechanism to calculate the ranking again using the mutated preferences, which is treated as the “mutated ranking”. The resilience of a voting mechanism to mutation is calculated based on the deviation found between the true and the mutated ranking.

The flow chart below illustrates the procedure followed for the experiment,

Experiment 1



Experiment 2



In the Voting Mechanisms section, we introduce 4 voting mechanisms that we might consider for this study. In the Preferences section, we talk about the changes that we need to make to the format of the preferences from Preflib. In the Noise Models section, we consider the potential use of noise models for mutation of preferences.

Voting Mechanisms

For our study, we are going to use popular mechanisms used in large elections involving a large number of voters and sufficiently larger number of candidates as well. We want to use popular mechanisms as we want to make the study relevant to real world scenarios.

We plan to consider the following mechanism for our study,

1) Single Transferable Vote (STV)
2) Instant-runoff voting (IRV)
3) Simple Plurality
4) Multi Vote Approval voting

- STV

The single transferable vote (STV) is a voting system designed to achieve proportional representation through ranked voting. Implemented in large settings in Parliamentary elections in Ireland, Australia, Upper house of Parliament elections and many more.

- IRV

Instant-runoff voting is an electoral system used to elect a single winner from a field of more than two candidates. It is a preferential voting system in which voters rank the candidates in order of preference rather than voting for a single candidate.

Ballots are initially distributed based on each elector's first preference. If a candidate secures more than half of votes cast, that candidate wins. Otherwise, the candidate with the fewest votes is eliminated. Ballots assigned to the eliminated candidate are recounted and assigned to those of the remaining candidates who rank next in order of preference on each ballot. This process continues until one candidate wins by obtaining more than half the votes.

Instant-runoff voting is used to elect members of the Australian House of Representatives and most Australian State Governments, the President of India, members of legislative councils in India, the President of Ireland, and the parliament in Papua New Guinea. It is also used in Northern Ireland by-elections and for electing hereditary peers for the British House of Lords.

- Simple Plurality

In simple plurality voting each elector has a single vote, and this is cast, in single member constituencies, for one candidate. The winner will be the candidate who has more votes than any other individual candidate.

The most common system, used in Canada, the lower house (Lok Sabha) in India, the United Kingdom, and most elections in the United States, is simple plurality.

Approval voting was used for papal conclaves, in Venice in the 13th through 18th centuries & the selection of the Secretary-General of the United Nations has involved rounds of approval polling

- Multi Vote Approval voting

By treating each candidate as a separate question, "Do you approve of this person for the job?" approval voting lets each voter indicate support for one, some, or all candidates. All votes count equally, and everyone gets the same number of votes: one vote per candidate, either for or against. Final tallies show how many voters support each candidate, and the winner is the candidate whom the most voters support.

Preferences

For our study we will be using a real preference dataset shared via [Preflib](). We plan to use a preferences that a complete ranking of all the candidates in the elections, but since some of the mechanisms used in the study cannot be computed over such preferences, we will need to process the preferences into suitable formats for these mechanisms.

Noise Models

Voting, as the most common approach of aggregating preferences from multiple agents, has been studying for decades and is still attracting scholars all over the world. However, from another perspective, voting can be viewed as a maximum likelihood estimation problem, since most voting has its true result, which is based on the absolute goodness of the candidates rather than the votes that voters provide. In this case, voter's votes become some noises, compared with the ideal result. Vincent Conitzer and Tuomas Sandholm first proposed the study on how common voting rules can be interpreted as maximum likelihood estimation problems in 2012[1]. Actually, investigation of noise models dates back to hundreds years ago when Marquis de Condorcet presented the earliest noise model in which voters are required to vote for a pair of candidates. The probability of voting correctly is $p > 1/2$ and voting incorrectly is $1 – p$. Afterwards, scholars constantly improve the system of noise models [2][3]. One of the noteworthy studies which probably can be used to our project is Critchlow et al.'s work in which they introduced four types of noise models [4].

References

[1] Conitzer, Vincent, and Tuomas Sandholm. "Common voting rules as maximum likelihood estimatorsConitzer, Vincent, and Tuomas Sandholm. "Common voting rules as maximum likelihood estimators." *arXiv preprint arXiv:1207.1368* (2012).." *arXiv preprint arXiv:1207.1368* (2012).

[2] Egger, Peter. "On the role of distance for bilateral trade." *The World Economy* 31.5 (2008): 653-662.

[3] Berger, Adam L., Vincent J. Della Pietra, and Stephen A. Della Pietra. "A maximum entropy approach to natural language processing." *Computational linguistics* 22.1 (1996): 39-71.

[4] Critchlow, Douglas E., Michael A. Fligner, and Joseph S. Verducci. "Probability models on rankings." *Journal of mathematical psychology* 35.3 (1991): 294-318.