

# Prediction of the Winner by Using a Weighted Approach of Preferential Balloting Systems on the Basis of Their Satisfied Criteria and Artifice Behavioral Complexity

Siddharth Shrotriya<sup>1</sup> and Animesh Pandey<sup>2</sup>

<sup>1</sup> Department of Electronics and Communication, <sup>2</sup>Department of Information and Technology  
Jaypee Institute of Information Technology, Noida -201307, India

**Abstract.** In almost all forms of government, voting holds an important role in selecting the winner who could be the head of the department, state or the country. In those states in which preferential voting takes place, the selection of winner becomes a tedious task. There are many algorithms or methods available for preferential voting systems but all of them fail in at least one of the fourteen recognized criteria. Some behavioral strategies exist which can hamper the solution of the selection methods. These strategies cover all those tricks applied by the politicians around the world to increase their chances of winning the election. These tricks can be of the form of manipulation, control or bribery. In order to predict the right winner of the election, we tried to make an algorithm which make use of some the existing methods or algorithms. The algorithm takes into account the number of criteria satisfied by that particular method. It also calculates the effect of complexity of behavioral strategies and the available theorems which can diminish that effect on the selection methods. Our algorithm makes a weighted graph of all the candidates on the basis of the individual weights calculated using the above mentioned factors and then select the most preferred candidate as the winner of the preferential elections.

**Keywords:** Artificial Intelligence, Voting Systems<sup>[8]</sup>, Condorcet Methods<sup>[9]</sup>, Game Theory, Machine Learning and Strategic Behaviour Analysis.

## 1. Introduction

Every election has a winner. Mostly voting systems count the final number of votes of the candidates and then directly tell who the winner is. In preferential voting systems the counting is associated with the ranking of the candidates as well as the preferences of the party or the common man. A voting system or electoral system is a method by which voters make a choice between options, often in an election or on a policy referendum.

A voting system contains rules for valid voting, and how votes are counted and aggregated to yield a final result. Since voting involves counting, it is algorithmic in nature, and, since it involves polling the sentiments of a person, this represents affective data. Together, with the exception of proxy voting, this corresponds to in-degree centrality in graph theory and social network analysis, with votes as directed edges, and voters and candidates as nodes. Common voting systems are majority rule, proportional representation or plurality voting with a number of variations and methods such as first-past-the-post or preferential voting. We will, mainly, be dealing with Preferential Voting.

## 2. Voting Systems and their Deciding Criteria

---

<sup>+</sup> Siddharth Shrotriya Tel.: +91 8800723941  
E-mail address: siddharth@ieee.org

## 2.1. Balloting Systems used

In our research we have used five types of preferential voting systems. They are:

- Schulze Method<sup>[5]</sup>
- Ranked Pairs<sup>[5]</sup>
- Copeland Method<sup>[3]</sup>
- Borda Count<sup>[1]</sup>
- Plurality<sup>[6]</sup>

### A. Schulze Method

You can think of the Schulze Method as a tournament where the winner must defeat its opponents in each one-on-one game. To determine who wins each game of the tournament, we look at the ballots that the voters cast. It's a lot faster than asking the voters to come back and vote for each game. If 20 people preferred A over B and 10 people prefer B over A, then A wins that game. To be thorough, the winner must defeat every other candidate, not just a few up a tournament tree. Because we already have the ballots to determine each game's winner, time isn't a constraint here and we can take our time to be careful.

### B. Ranked Pairs

Each "vote" is a rank-ordering of all the N candidates, for example "Nader>Gore>Bush>Buchanan" would be a possible vote (with N=4). We then find the candidate pair AB with the largest pairwise margin of victory A>B (this is the pairwise victory we are "most sure is valid") and "lock it in" by drawing an arrow from A to B. We proceed through all victories in decreasing-magnitude order, "locking them in" if so doing does not create a directed cycle in the directed graph we are drawing. The root of the resulting directed-graph (the only candidate with no arrows pointing to him) then is the winner.

### C. Copeland Method

In the Copeland system, each vote is a rank-ordering of the candidates and the candidate with the greatest "Copeland score" (i.e. defeating the most rivals pairwise) wins. Copeland has an unfortunate propensity for exactly-tied winners and it is highly vulnerable to candidate-cloning. But it enjoys some good properties of "resistance to strategic voting".

### D. Borda Count Method

Voting system where a vote is a rank-ordering of all the N candidates. The k<sup>th</sup>-ranked candidate gets score N-k. The candidate with the highest score-sum is elected. (It is also possible in various ways to allow "truncated ballots" in Borda voting where you only rank some of the candidates; but it is unclear how best to do that and there are several competing approaches.) This is a weighted positional voting system.

### E. Plurality Voting

Plurality is simple and easy to count, but its well-known pathologies include the "spoiler effect", "vote-splitting" and manipulability of elections via "candidate cloning." Plurality also has the frustrating disadvantage that there is no way for a voter to express any of his opinions about any of the other candidates, and it often is strategically best for a voter to dishonestly vote for somebody who is not his true favourite – the system encourages lying.

## 2.2. How can one system be better than the other? – List of decision criteria

Any voting system is bound to have its pros and cons. These pros and cons turn themselves into criteria that help us to determine which is the most accurate and which will be unaffected by any external or internal agent. These criteria are – Monotonicity, Condorcet Winner, Majority Winner, Condorcet Loser, Majority Loser, Mutual Majority, Smith Criterion, Independence of Smith-dominated Alternatives, Independence of irrelevant alternatives, Clone Independence, Reversal Symmetry, Polynomial time, Participation/consistency and Resolvability.

Apart from above there are seven strategic behavioural models that serve as the deciding criteria for the voting systems namely Manipulation, Constructive Add Alteration, Destructive Add Alteration, Delete Alteration, Add Votes, Delete Votes and Bribery. The voting systems may give more than one winners that is also considered to be a potential problem.

### 3. Procedure applied for deducing the algorithm

#### A. Schulze's Method:

Schulze is vulnerable to manipulation. In case of strategic behaviours this method is not resistant to Destructive addition of alternatives but resistive to constructive addition of alternatives. It is not resistive to deletion of alternatives. It is resistive to addition/deletion of votes and bribery.

#### B. Ranked pairs:

Ranked Pairs is vulnerable to manipulation as it is NP-complete to compute destructive manipulation for ranked pairs, for any fixed number of manipulators and any fixed tie-breaking mechanism. This mechanism is resistive to all types of addition/deletion of alternatives, votes as well as bribery.

#### C. Borda system:

Borda is immune to manipulation. But, it is less immune than Copeland as Borda can turn any negative reference to positive reference. It can handle ties better than Copeland. The susceptibility of Borda is greater than plurality rule. Borda is vulnerable to constructive addition, deletion of votes and bribery. Un-weighted Borda is resistant to constructive control by adding voters.

#### D. Copeland System:

Copeland is vulnerable to ties. Borque formulated a solution to problem associated with Copeland which is termed as Borque's solution.

Final count of votes =  $1/3$  Positional count +  $1/5$  Copeland +  $2/7$  Max count.

A second order Copeland was introduced that is immune to manipulation as it is NP-complete and hence, it behaves like ranked pairs.

#### E. Plurality System:

It is partially resistant to manipulation, addition/deletion of votes and bribery. It is vulnerable to addition/deletion of alternatives. Conitzer and Sandholm showed the effect of manipulation on many voting systems.

Hybrid Plurality makes it partial resistant to the strategic behavioral criterions as it rates the candidates rather than to order them.

### 4. Giving weights to different criterions

We decided to give the criterions a weight. The initial 14 general voting criterions were given a weight of 1 and the other strategic behavioural criterions were given a weight of 2 as these have a higher effect of the result of the voting systems.

The algorithm goes as follows:

Let the general criterions be  $g_1, g_2, \dots, g_{14}$  and  $G$  be the set of them.

Let the strategic behavioural criterions are  $s_1, s_2, \dots, s_7$  and  $S$  be their set.

Let the weight given to general criterions when satisfied be  $w_g = 1$ .

Let the weight given to Strategic criterions when satisfied be  $w_b = 2$ .

Let the weight given to Ties criterion be  $w_t = 2$ .

The satisfied general criterion set is  $G_s$  and for the other it is  $S_s$ .

Note:

- The Strategic behavioural criterions have been given a higher weight because they have higher chances of changing the final result.
- When a criterion is not satisfied the weight given will be 0 (zero) i.e.  $w_z$ .

Therefore, the total general weight is  $WT_g = \sum |G_s|w_g$  and the total behavioural weight is  $BT_g = \sum |S_s|w_b$ .

So, the final weightage will be the sum of the above two values and tie weight. The one with higher value will be considered more accurate and resistant to external or internal changes.

The maximum value of final weightage is 30 i.e.  $14x1 + 7x2 + 2$ .

The weights of the voting systems are – Schulze:  $12x1+5x2 = 22$ , Ranked Pairs:  $13x1+7x2 = 27$ , Copeland:  $10x1+7x2 = 24$ , Borda:  $7x1+4x2+2 = 17$  and Plurality:  $5x1+2x2+2 = 11$ .

The weight given to the winner is ratio of weight of the voting

Due to the discrepancies introduced in the result due to the criteria or ties, we will have to calculate the sum of ratios of weights of the voting systems and maximum weights.

*EXAMPLE:*

Suppose the five systems give a list of the winners from a candidate list of A, B, C, D and E in the following manner: A, [A,B,D], A, B, A respectively. Therefore the ratios from the weighted approach for A are 22/30, 27/30, 24/30, 11/30, for B are 27/30, 17/30 and for D is 27/30. Hence the weights for A, B and D are 2.566, 1.466 and 0.9 respectively. This method concludes A to be the rightful winner of the elections.

## 5. Conclusion

Many preferential voting systems are available but only those are acceptable that are immune to any intrinsic or extrinsic factors that may affect the desired result of a voting. We have discussed five balloting systems where Ranked pairs and Second Order Copeland have the highest weights and hence can prove to be the most reliable and accurate systems among all other. Our method diminishes the error probability by considering the weighted approach and provides an accurate answer. But the final result will always depend on the preference lists in a ballot and the results from the different voting systems.

## 6. References

- [1] Nathan F. Russel *Complexity of Control Borda Count Elections*, 2007
- [2] Gabriel Carroll, *A Quantitative Approach to Incentives: Application to Voting Rules*, 2011
- [3] Piotr Faliszewski , Edith Hemaspaandra , Henning Schnoor, *Copeland voting: Ties Matter*, 2008
- [4] J.J Bartholdi III, C.A. Tovey and M.A. Trick, *The Computational Difficulty of Manipulating an Election*, 1988
- [5] David C. Parker, Lirong Xia *A Complexity-of-Strategic-Behavior Comparison between Schulze's Rule and Ranked Pairs*, AAAI, 2010
- [6] Joerg Rothe, Lena Schend *Control Complexity in Bucklin, Fallback, and Plurality Voting: An Experimental Approach*, 2012
- [7] *Ranked Pairs* (Xia et al. 2009)
- [8] *Nanson's and Baldwin's Rules* (Narodytska et al. 2011)
- [9] [en.wikipedia.org/Schulze\\_method](https://en.wikipedia.org/Schulze_method)
- [10] Nicolaus Tideman (2006), *Collective Decisions and Voting: The Potential for Public Choice*, Burlington: Ashgate, ISBN 0-7546-4717-X