A Proportional Voting System for Awards Nominations Resistant to Voting Blocs

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Abstract

We propose a novel proportional voting system based on approval ballots: Single Divisible Vote with Least-Popular Elimination (SDV-LPE). The system was developed to reduce the power of minority voting blocs, in response to events involving such a bloc in the nominations for the 2015 Hugo Awards. SDV-LPE is designed to resist most strategic manipulation while giving similar results as a naive multi-winner plurality system in the absence of strategy, specifically the absence of an incentive to bullet vote. We describe the context for the system's development, and begin to analyze its effectiveness and strategic implications.

1 Introduction

Many elections include a separate nomination phase, in order to highlight the most viable or high-quality candidates and allow subsequent phases of the process to focus attention on these nominees. A reasonable goal in such a nomination phase is to prevent a minority from circumventing the will of the majority by leaving no candidates acceptable to the majority as nominees. Proportionally representative (PR) voting systems accomplish this by not allowing the minority to ensure its control of any more than a proportionally sized minority of the nomination slots. Such systems are typified by adherence to criteria such as that of Droop Proportionality [Laa80, Woo94, HG05], which states that if N voters are electing W winners, and more than $MN/(W+1)$ of them (where M is an integer from 1 to W) unanimously express a preference for candidates in set $\mathcal{S}$ over all other candidates, then at least M of the winners must be from $\mathcal{S}$. Insofar as the majority does not vote ineffectively, a PR system can resist minority takeover.

PR systems use a variety of ballot formats. Arguably the simplest is approval ballots, in which each voter chooses a set of approved candidates. The question of how to use approval ballots to elect a proportionally representative set of winners has been considered before [KM11]. Like any voting system, these solutions have various issues. For instance, some, such as some versions of Satisfaction Approval Voting, can be computationally burdensome, while others, such as Weighted Minimax ($MMAX_w$) are particularly vulnerable to strategic voting.

This paper lays out a novel PR system, and discusses its potential usefulness in the context of a science fiction award. This system is based on a bottom-up "greedy" algorithm (though perhaps "remorseless" would be a better word for a system based on eliminations). In each elimination, the two weakest candidates are chosen by a proportional rule, and the weakest of those two is eliminated based on a more strategy-resistant, non-proportional, rule. The resulting system obeys a proportionality criterion slightly weaker than Droop proportionality, while at the same time minimizes the risk of strategic voting, most importantly the incentive for a voter to bullet vote.

2 Historical Background

Established in 1953, the Hugo Awards (colloquially, the Hugos) are an annual set of prizes awarded to the best science fiction works in a variety of categories. They are voted on in two stages. The first is a nomination ballot in which members of the annual Worldcon science-fiction convention collectively choose five finalists for each category using a simple Approval Voting (AV) system [BF78]. That is, that is, each voter simply nominates a set of deserving works, without ranking any of these as more or less deserving. Any work published in the previous year is eligible for nomination, and the five finalists are the five works that get the largest number of nominations. The second stage is an Instant-Runoff Voting system where the same members decide on a single winner in each category.

The 2015 Hugo Awards were co-opted by a minority voting bloc.

The bloc first organized in 2013. Then, science fiction author Larry Correia suggested on his blog that his readers should register to vote for the Hugos [Cor13]. Like-minded bloggers took up the call, and over the following two years, this movement became known as the Sad Puppies.

In 2014, the Sad Puppies published a specific slate of works that followers were encouraged to vote for [Cor14]. Because the number of people who voted according to the slate was small, only a few of these works received sufficient votes to make the final ballot, and none of those won.

In 2015, Brad Torgensen published a Sad Puppies slate of works that were chosen primarily for philosophical reasons [Cor15]. Additionally, author and editor Theodore Beale (aka Vox Day) published an overlapping slate on his blog, which he called the Rabid Puppies [Bea15a]. Both called on their followers to vote their respective slates.

This time, the slate voters were more successful. In seven of 17 categories, all five of the works originally offered the finalist slots were on one or both of the Puppy lists.[1] In six other categories, all the eligible Puppy-listed works were offered finalist positions, but the Puppies had not listed a full five candidates, so non-Puppy works could be offered the remaining finalist positions. There were only four categories where any non-Puppy works earned initial offers of finalist positions despite the existence of at least five eligible Puppy candidates: a total of five non-Puppy works. Subsequently, some of the authors of Puppy-listed works were found to be ineligible or declined their finalist positions. In the end, two of the seven "sweep" categories ended up having non-Puppy finalists [Sas15] on the ballot.

The success of the slate strategy was upsetting to many in the Worldcon community [And15, Chu15a, Chu15b]. Some of the issues had to do with political and literary aspects that are beyond the scope of this paper. But the essential issue in terms of voting theory was the fact that voters for the two Puppy slates, who were a minority of the Hugo voters as a whole, had managed to take over a majority or a totality of the nomination slots in most categories.

This led the World Science Fiction Society (WSFS), the governing body of the Hugos, to try to figure out what—if anything—to do.

3 Motivation and Problem

The Hugo nominations election is traditionally one where many different works are eligible, with each winner receiving a small number of votes.[2] In the nomination election, readers nominate works that they feel are worthy of an award.

It is, of course, difficult to prove a negative, so we can never be 100% certain that slate voting never occurred prior to this. But Jo Walton, author of the upcoming book *An Informal History of the Hugos*, says that according to her research:

> Between 1953 and 2014...there were no slates, and there were no allegations that there were slates, there were no controversies about slates, for the simple reason that slates had never crossed anybody's mind. [Walt15]

In the 2015 Hugo nominations election, the Puppy slates effectively acted as a political party (technically, two closely-overlapping parties) in an process that had never had parties before. In this context, parties are powerful for two reasons.

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[1]This count considers John W. Campbell award for best new writer. This award is voted on at the same time by the same voters in the same manner. It is effectively another Hugo category, though technically it is not.

[2]The terminology of the Hugo first round election is different from that common in election theory. In the Hugos, members nominate a number of works, and the winners become finalists; in more general cases, voters approve of (or, in the case of plurality voting, vote for) a number of candidates, and the winners are elected. In this paper, we will use both sets of terms, as appropriate for the context, with the understanding that they are synonymous.

The first is that they focus voters' preferences onto specific candidates in an election where candidate preferences are naturally diffuse. This increases the power of slate voters. For example, assume there are two types of candidates, Yellow and Purple, of which there are 20 candidates from each category that are in serious convention. Suppose voters who prefer Yellow candidates are uncoordinated, giving a relatively even number of votes to each Yellow candidate. If there 800 Yellow voters and they nominate an average of three candidates each, they will distribute their 2,400 nominating votes relatively evenly. Candidates might in this case receive vote totals ranging from 80 to 160. But if Purple voters are perfectly coordinated and all vote for a single slate of five candidates, the 20% minority can ensure that their five picks receive 200 votes each, thereby dominating the final ballot with their selections.

The second reason political parties are powerful is that they provide a shorthand for marginal voters. Voters who do not know the candidates—in the context of this election, who did not read, see, or hear the works being nominated—can vote for the slate simply because they share the views of the people who created them. This makes it easier for them to vote, and therefore more likely for them to vote. Note that, as discussed above, the various published rationales favoring the Puppy slates emphasized the moral, ethical, and political philosophy the books exemplified, broadening their appeal to include audiences without strong opinions about the aesthetic qualities of the works.

This was particularly problematic for the Hugos, in a way that parties are not in political elections. In a normal political election, the parties are strongly correlated with the issues of the election. So when people choose to vote for a given party, they are choosing a set of policies that the party can be reasonably expected to follow. The Hugos are different. The prize was created to recognize overall quality; many long-time Hugo voters expressed the view that moral, ethical, or political philosophy should be extraneous considerations [Mar15].

Of course, one way to fight a political party is with a rival political party. Many people expect that rival slates will appear in 2016 [Mam15]. This idea is widely seen as undesirable in the context of the Hugos; most fear that it would mean the awards would become a battle of rival ideologies rather than a referendum on the quality of specific works of fiction.

Another option is to redesign the nominations system so as to reduce the power of slate voting. This is the solution we explored.

The PR voting system described in this paper is our attempt to modify the Hugo nominations process to be more resistant to this kind of slate voting while at the same time encouraging voters to vote for many works. For this purpose, the existing body of theory around voting systems for proportional representation is germane. This theory was, of course, developed in a different context from artistic awards: that of political elections. But insofar as a system can ensure that political parties get a share of seats in a legislature that is proportional to their support in the population, it should by the same token help avoid the possibility that an aesthetic minority could get a disproportionate share of nominations. A voting theorist's understanding of potential strategies in different voting systems is also useful in the context of awards.

4 Requirements for a New Voting System

In the initial discussion of creating a new system for Hugo nominations voting, Bruce Schneier summarized the requirements as follows [Sch15b]:

1. It should be fair.
2. It should be perceived as fair.
3. It should be relatively easy to explain, both to the voters and at the WSFS business meeting.
4. It should be relatively easy to administer.
5. It should encourage people to nominate, and also not to bullet vote.
6. It shouldn't result in too many nominees for the electorate to reasonably read and rank by the Worldcon.
7. It should be resilient to some degree against strategic voting: i.e., minority voting blocs.

In the more technical terms of social choice theory, requirement 1 could refer to several things. At a minimum, we should look for anonymity (which in this context means that everyone's vote is counted equally) and neutrality (all candidates are treated equally). Other characteristics that could be associated with fairness are Droop-proportionality (the formal meaning of PR; also addressed by other items of the list above), and Pareto-optimality (that it will not give result X if it is clear that Y would make all the voters happier).

Requirements 2–4 all refer to the simplicity of the system. Proportional voting systems can involve complicated mathematical formulas with confusing technical names: Droop and Hare quotas, Sainte-Lage and D'Hondt divisors, Phragmen and Ebert residuals. While these can be well-justified by mathematical analysis, they are far from easy for a layperson to understand. And it's much harder to trust what we don't understand. It is also harder to administer. The Hugos are administered by volunteers, and often by new volunteers every year.

Another aspect that relates to the simplicity desirable under these three requirements is ballot format. The Hugo nomination ballots have traditionally been in an approval format; that is, each voter simply nominates a set of deserving works, without ranking any of these as more or less deserving. In the discussion of new voting systems, voters seemed to want to preserve this simple ballot format. Approval ballots, like any voting system with any ballot format, can lead to strategic incentives [SEF11], and no approval-based system can be entirely free of bullet-voting incentives [Dud14]. Most importantly, it is much simpler for voters to list works they feel eligible for the award, rather than be forced to rank them.

Requirement 5 refers to a relative lack of strategic incentives to nominate fewer works or to "bullet vote" for only one work. Prior work by Lago suggests that voters use strategic heuristics, and can over-apply heuristics that seem to work [Lag08]. If voters perceive that a bullet voting heuristic is likely to be helpful, then the number of votes for any given work will plummet, and the number of ballots which nominate only a work with no viable chance of winning will skyrocket. This is the "long tail" problem, and could have the perverse effect of increasing the power of slates. In effect, slates are competing only against "viable" non-slate ballots which vote for one of the 6 or so most popular non-slate works; if all non-slate voters only chose one work, only a fraction of non-slate ballots would be viable.

In somewhat more technical terms, we can say that requirement 5 relates to the multi-winner analogue of the Favorite Betrayal criterion for single-winner voting systems [Smi05]. This criterion imagines a voter who prefers X over Y and Y over all others voting in an election where all other ballots are fixed. The criterion states that if there is a way for this voter to elect candidate Y, then there must be a way for them to elect one of Y or X without rating Y above X. A strong bullet voting incentive would mean that a voter should "betray" other candidates such as X in order to elect Y.

Requirement 6 is relatively easy to satisfy, as most voting systems allow the number of winners to be set arbitrarily, except perhaps in rare cases of ties.

Requirement 7 could in principle be satisfied in a number of ways. However, one broad, well-understood class of voting systems that tends to satisfy it relatively well is those that are Droop-proportional, as already discussed above.

Requirements 5 and 7 are in some degree of tension with one another. It might appear that requirement 7 is more important for avoiding the slate-voting problem, because proportionality is what avoids a minority takeover with a given fixed set of ballots. However, if a bullet voting incentive leads to an impoverished set of ballots, slate voters could be advantaged. Additionally—even without slate voters—the ability to discern consensus winners would be statistically weaker. Thus, in designing a voting system, we gave greater weight to requirement 5 in cases where the two conflict.

5 Issues with Existing Voting Systems

A number of existing systems were considered [Sch15b]. All of these were seen to have defects as compared to the proposal described in this paper. We, the authors, were participants in this process of discussion and consideration of various options, and we are generally in agreement with its conclusions, which we present here with footnotes to the voting theory literature as appropriate.

There was some limited discussion of preferential systems such as Single Transferrable Vote or Condorcet systems. However, these systems did not get much support, as a preferential ballot format was seen as too complicated and/or otherwise undesirable for the nominations process. The ideal voter in such a system would give preferences based on all the eligible works published in a given year; since it is nearly impossible for a real Hugo nominator to read or analyze all such works, that ideal is unrealizable in practice. Furthermore, such additional ballot complexity could tend to increase, rather than decrease, the strategic advantages of organized voting blocs.

Globally maximizing systems such as Satisfaction Approval Voting were another alternative mentioned. However, in the versions of such systems that were discussed, where a voter's satisfaction is not a linear function of the number of winners they approved, it can be computationally difficult (perhaps even NP-hard) to find the correct winner [KM11,AGG+15, MNS15]. Once this hurdle was appreciated, these systems had little support. There are other versions of SAV which are computationally tractable because satisfaction is a linear function of approved candidates [BSK14]. These were not discussed, and may involve considerable strategic incentives.

A considerable amount of time was spent discussing sequential Reweighted Approval Voting systems, such as first proposed by Thiele [Thi95]. However, it was felt that these systems were too hard to explain, and involved stronger strategic incentives not to vote for frontrunners. Similarly, the early proposal of Single Divisible Vote (SDV) was largely abandoned because of strategic incentives involving frontrunners and how it incentivizes bullet voting.

The final class of systems that was considered was semiproportional limited voting systems, such as one in in which each voter is allowed to nominate four candidates, and the six eligible candidates with the most votes are elected.[3]

One class of systems which was not considered were those based on "squared loads", such as originally discussed by Phragmen [Phr99]. Though modern takes on such systems such as that of [Per16] have promising characteristics for situations with overlapping partisan blocs, the mathematical ideas motivating squared loads remain hard to explain.

6 SDV-LPE: A New Voting System

Single Divisible Vote with Least-Popular Elimination (SDV-LPE) is the PR voting system we developed for solving the problem of bloc voting in the Hugo nomination election [Qui15]. At its core, SDV-LPE is a combination of a SDV system and an AV system. Candidates are sorted according to SDV and then bottom-up eliminated according to AV. This system allows voters to propose as many candidates as they feel worthy without worrying about diluting their vote, while ensuring that candidates with broad support do better than candidates only supported by a bloc-voting minority.

While the voting system proposed for this election is novel—that is, divisible votes, bottom-up elimination, and pairwise elimination using two related metrics—all of its elements have been discussed before in the voting literature. Divisible votes and bottom-up elimination are long-time staples of voting theory. However, the concept of sequential pairwise eliminations, using one metric to select the pair and another metric to determine which to eliminate, is to our knowledge a more recent one. Forest Simmons proposed such a system in 2011, and showed how the two metrics used could be carefully selected so that each of them ensures some characteristic for the final set of winners [Sim11].

[3]This modification was formally proposed to the WSFS governing body along with proposal described in this paper. It passed, and will be voted on again in 2016.

SDV-LPE works as follows:

1. Each voter selects as many candidates as she wishes.
2. Then, election is resolved as a series of rounds.
3. In each round:
   (a) Candidates are ranked in SDV order. That is, each voter's vote is given 1 "point", which is divided up equally among all the (surviving) candidates she nominated. All points for each candidate are summed, and then candidates are ranked in order of total points. (The related SDV-LPE-SL system, proposed below, would modify this step slightly.)
   (b) The two candidates receiving the fewest SDVs are compared, and the one with the fewest approval votes is eliminated. That is, the candidate that has the fewer number of voters selected is eliminated, even if it has more SDVs.
4. This process is repeated until the required number of candidates remain; those are declared winners.

Ties are handled in a straightforward manner. If more than two candidates have the fewest SDVs, the one with the fewest AVs is eliminated. If there is a tie in the number of AVs, the candidate with the lower SDVs is eliminated. If both are tied, then all are eliminated unless the remaining number of candidates is less than the required number of candidates.

6.1 SDV-LPE-SL: A Modification of SDV-LPE

In step 3a of SDV-LPE, each ballot assigns points to its surviving nominees, according the number of such nominees. Thus, if a given ballot has 3 surviving nominees, it would give 1/3 of a point to each of them.

In the study of proportional voting systems, this simple series of fractions—1, 1/2, 1/3, 1/4, or 1/5, for the 1, 2, 3, 4, or 5 surviving nominees, respectively—is known as the D'Hondt divisors [DHo82]. The prototypical alternative to the D'Hondt divisors are the Sainte-Laguë divisors: 1, 1/3, 1/5, 1/7, 1/9 [Sai10]. It is well-understood in voting theory that if two parties (groups of identical voters) are assigned seats according to either of these series of divisors (or anything suitably "in between" these options), then the share of seats between these parties will be Droop proportional [Lip03].

The Sainte-Laguë divisors may be used in step 3a of SDV-LPE, leading to the modified system we call SDV-LPE-SL. This does in theory increase the incentives for bullet voting slightly, but the use of full approvals in step 3b to determine eliminations still acts as a bulwark against such incentives, especially for a typical voter who only expects to be able to get 1 or 2 of her nominees to be finalists. The incentives for a group of slate voters to engage in careful vote management so that each voter only votes for some of the slate are a bit stronger; but such vote management is tricky and delicate, so we do not expect it would tend to be a wise strategy in practice.

7 Analysis of SDV-LPE and SDV-LPE-SL

Referring to the requirements enumerated in Section IV:

- Requirement 1: SDV-LPE and SDV-LPE-SL satisfy anonymity, neutrality, and (ballot-based) Pareto optimality. They don't exactly satisfy Droop-proportionality, but as discussed below in point 7, they come close.
- Requirements 2–4: SDV-LPE and SDV-LPE-SL are not precisely simple, but each of their steps can be explained in simple terms, and related directly to the ballots and the will of the voters. SDV-LPE-SL is more complicated than SDV-LPE. For a proportional system, they do reasonably well in this regard. Furthermore, they maintain the same simple ballot format as the prior system of approval voting (AV).
- Requirement 5: This is the primary reason for the LPE portion of SDV-LPE and SDV-LPE-SL. We felt that SDV alone would promote bullet voting and accentuate the long tail problem. SDV-LPE or SDV-LPE-SL, on the other hand, should not discourage people from nominating as many works as is allowed. As we argue below, there is no practical advantage to bullet voting, even though (as with any proportional system) there are theoretical cases where it could work. Roughly speaking, the argument is that adding extra nominations for less-popular works does not affect the result because those works will be eliminated early and not count in the decisive final rounds; and adding extra nominations for more-popular works does not affect the result because, with or without the extra votes, those more-popular works likely have enough nominations to survive elimination matchups. Other work suggests that in approval-like systems, bullet-voting heuristics may not be embraced if they are not clearly advantageous [Mye91], and that such clarity is often hard to come by [SEF11].
- Requirement 6: As implemented for the Hugos, SDV-LPE and SDV-LPE-SL don't change the number of works on the final ballot.
- Requirement 7: As we will show below, SDV-LPE and SDV-LPE-SL both reduce the power of slates. It's not arbitrary: slates are not banned, nor are works eliminated because they appear on a slate. But anyone who nominates a full set of five works will find that each of the nominations only count one-fifth as much as a nomination from someone who only nominates one work. With SDV-LPE and SDV-LPE-SL, slates cannot receive a disproportionate share of the final ballot compared to "viable" non-slate voters (those who vote for at least one work with broad support).

  The formal property that relates to reducing slate power is Droop-proportionality. SDV-LPE and SDV-LPE-SL are not Droop-proportional, but they are nearly so; that is, there is always a Droop-proportional set of winners that differs from the SDV-LPE or SDV-LPE-SL winners set by no more than one candidate.

7.1 Analysis with 2015 Hugo Nominations Data

In order to evaluate SDV-LPE and SDV-LPE-SL for this paper, we were given access to ballot data from the 2015 Hugo nominations election, anonymized so that individual voters could not be identified across categories.

This data required significant clean-up, as different voters frequently used slightly different names for a given work. This clean-up work is outside the scope of this analysis, as it would be required for reliable results under any system. We believe we did a good job with this clean-up, but cannot be certain that it was perfect, and so the results below are given for illustrative purposes only.

Table I compares the results of the 2015 Hugo nominations election under three conditions: the actual results under AV, the hypothetical results under SDV without LPE, the hypothetical results under SDV-LPE, and the hypothetical results under SDV-LPE-SL. Note that data cleanup was especially problematic for the "Best Dramatic Presentation (short form)" category. Names of television series, episode names, and episode numbers were recorded in extremely different ways on different ballots. For this reason, results for that category are not given.

Table 1

Comparison of AV and SDV-LPE using data from the 2015 Hugo nominations election [Gly15a], [Gly15b], [Moe15], [Sta15a], [Sta15b], [Sta15c].

Category	Number of Voters	Number of Slate Nominations under AV [1]	Number of Slate Nominations under SDV	Number of Slate Nominations under SDV-LPE [2]	Number of Slate Nominations under SDV-LPE-SL
Novel	1,830	4 [3]	2	2	2
Novella	1,085	5	3	4	3
Novelette	1,044	5 [4]	4 [5]	4	3
Short Story	1,176	5 [6]	4	4	3
Related Work	1,151	5	3	3	3
Graphic Story	786	1	1	1	1
Dram. Presentation (long)	1,277	3 [7]	3	3	3
Dram. Presentation (short)	939	no analysis done			
Best Editor (short)	782	5 [8]	3	3	2
Best Editor (long)	713	5	4	4	4
Best Pro Artist	754	4 [9]	3	3	3
Best Semiprozine	662	2	2	2	2
Best Fanzine	577	4 [10]	3	4	3
Best Fancast	669	3	3	3	3
Best Fan Writer	778	4	3	3	2
Best Fan Artist	297	0 [11]	0	0	0
John W. Campbell	853	4	3	4	3

Notes to Table:

[1] This is the initial number of nominees that appeared on at least one of the Puppy slates. The actual number of Puppy nominees was often different, due to eligibility requirements, nominee acceptances, and so on. Those differences will be explained in subsequent notes.

[2] This is the "*E Pluribus Hugo*" voting system proposed at the 2015 SWFS Business Meeting

[3] Puppy nominee Larry Correia declined the nomination for *Monster Hunter Nemesis*. It was replaced by the non-Puppy *The Goblin Emperor*, by Katherine Addison. Another Puppy nominee, Marko Kloos, withdrew *Lines of Departure*. It was replaced by the non-Puppy *Three-Body Problem* by Cixin Liu, for a final number of two Puppy novel nominees.

[4] "Yes, Virginia, There is a Santa Claus," by John C. Wright was deemed non-eligible, and was replaced by "The Day the World Turned Upside Down," non-Puppy nominee by Thomas Olde Heuvelt.

[5] There was a near tie for 5th place. A one-point difference and there would have been only 3 Puppy nominations in this category.

[6] Annie Bellet withdrew "Goodnight Stars," a Puppy nominee, and it was replaced by Steven Diamond's "A Single Samurai," another Puppy nominee.

[7] This is the only category where a Puppy nominee won a Hugo, and—looking at the votes—it's pretty clear that the same work would have been nominated and won even without Puppy votes. In fact, two of the "Puppy" nominees in Best Dramatic Presentation (long), including the eventual winner, got more than twice the total votes as the winning Puppy nominee in other categories, suggesting that non-Puppy votes accounted for the majority of their support.

[8] Puppy nominee Edmund R. Schubert withdrew after the ballot was finalized.

[9] Kirk DouPonce replaced Jon Eno on the ballot after it was determined Eno produced no qualifying work in 2014. Both were Puppy nominees.

[10] *Black Gate*, a Puppy nominee, withdrew after the ballot was finalized.

[11] Neither Puppy slates included nominees in this category.

At least for 2015, SDV-LPE represents clear progress on Requirement 7, reducing the power of slates to hijack the voting process. The number of slate nominees would have been reduced by 1 in 6 categories, and by 2 in 2 categories, leaving no category without at least one non-slate nominee. SDV, without LPE, would have further reduced the power of slates in this ballot set, leading to 3 fewer slate nominees overall, but at the cost of a higher incentive to bullet voting (which could potentially lead to a more-impoverished ballot set in practice).

SDV-LPE-SL comes even closer to giving slate voters a proportional share, with 7 fewer slate nominees overall, and only 1 category without a choice between at least 2 non-slate nominees.

Since Droop-proportionality constrains the possible winner sets, other Droop-proportional systems would have probably performed very similarly to SDV, unless they led to a change in the ballot set, for instance by allowing more than 5 approvals per category per ballot (which would have reduced the number of non-slate ballots which supported nothing but nonviable long tail works).

The data demonstrates the power of the Puppies. The category Best Novelette provides a good example. This category had 1044 voters, distributed over 149 different works with 3 or more votes.4 Of these voters, around 300 (29%) voted for more Puppy-slate works than non-Puppy ones, and about half of those (14%) voted for only Puppy-slate works. These numbers are also roughly typical. The other 71% of the ballots included under 3% with votes for any Puppy work (this is relatively low, but not anomalously so, compared to other categories).

Despite being a majority, the non-Puppy voters spread their votes more thinly; only 24% of them voted for any of the top 5 non-Puppy works. This meant that 4 of the 5 nominees would have been from the Puppy slate under SDV-LPE or SDV, though SDV-LPE-SL reduces that to 3.

How many more non-Puppy approvals would it have taken to get an extra non-Puppy winner in this category? If those approvals were carefully chosen, it would take just 1 under SDV, 14 under SDV-LPE, or 19 under SDV-LPE-SL[5]. If the approvals were randomly chosen from the same distribution of works as the other non-Puppy votes, those numbers would be about 38 for SDV, 600 for SDV-LPE, or 700 for SDV-LPE-SL. Such approvals could have come from around 12, 200, or 240 more non-slate voters, respectively, or from increasing the average number of approvals per non-slate voter from 3.2 to either 3.3, 4.0, or 4.2 respectively.

7.2 Analysis with Simulated Data

To better understand the behavior of SDV-LPE and SDV-LPE-SL in the presence of bloc voting, we simulated the voting patterns of bloc voters using actual Hugo nominations data. We took the actual nominations result from the 2014 Hugos nominations election in the six representative categories of Novel, Novella, Novelette, Short Story, Related Work, and Campbell Award, and added additional nominations ballots by a hypothetical slate of varying sizes.[6]

We then ran simulations under AV, SDV (without LPE), SDV-LPE, and SDV-LPE-SL, and averaged the number of winning bloc nominations across the Hugo categories. Figures 1 and 2 show the results of these simulations. In both of these figures, percentage of bloc voters is calculated as a percentage of the total. For example, if there were 1,000 nominations ballots in the Hugo category and we wanted to simulate a 20% voting bloc, we added an additional 250 fictitious bloc voters.

In Figure 1, we assume perfectly correlated bloc voters. They vote in lockstep (with minimal exceptions to prevent ties), and their five nominations are completely disjoint from the other nominations. As you can see, both SDV-LPE and SDV reduce the power of the bloc voters considerably. Under AV, the voting bloc reliably nominates 3 candidates when they make up 10.5% of the voters, 4 candidates when they make up 12.5%, and 5 when they make up 19%. Under SDV-LPE, they need to be 26% of voters to reliably nominate 3 candidates, 36.5% to reliably nominate 4, and 54% to reliably nominate 5. Under SDV-LPE-SL, they need to be 35% for 3, 49% for 4, and 66% for 5.

Figure 2 simulates a more realistic voting bloc. We sample the actual behavior of the bloc voters in the 2015 Hugo nominations election, and add them to the actual 2014 nominations data. For the purposes of this simulation, we define bloc voters as people who voted for more Puppy candidates than non-Puppy candidates. In this case, the actual bloc voters did not vote in lockstep: some voted for a few members of the slate, and some combined slate

[4]These numbers are slightly lower than, but comparable to, most of the other fiction categories, and higher than most of the non-fiction categories.

[5] Note that the number for SDV-LPE-SL is not comparable to the other two, because that system already has two non-slate finalists, so the number given is the amount needed to raise that to three.

[6] The 2014 Hugos were awarded at Loncon in London.

Figure 1: Slate finalists as a function of slate voters

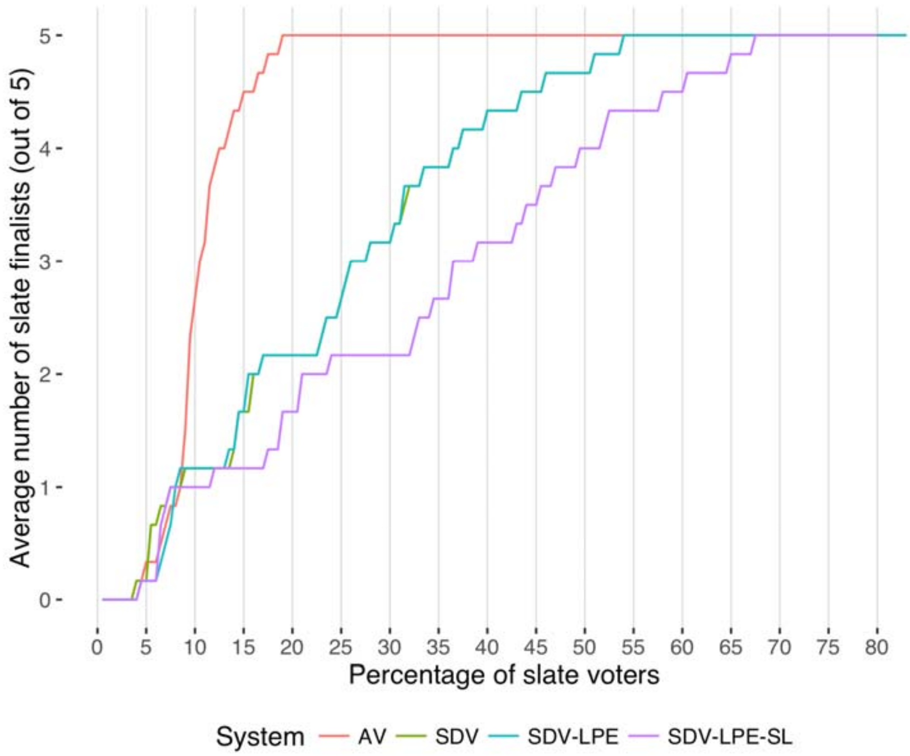
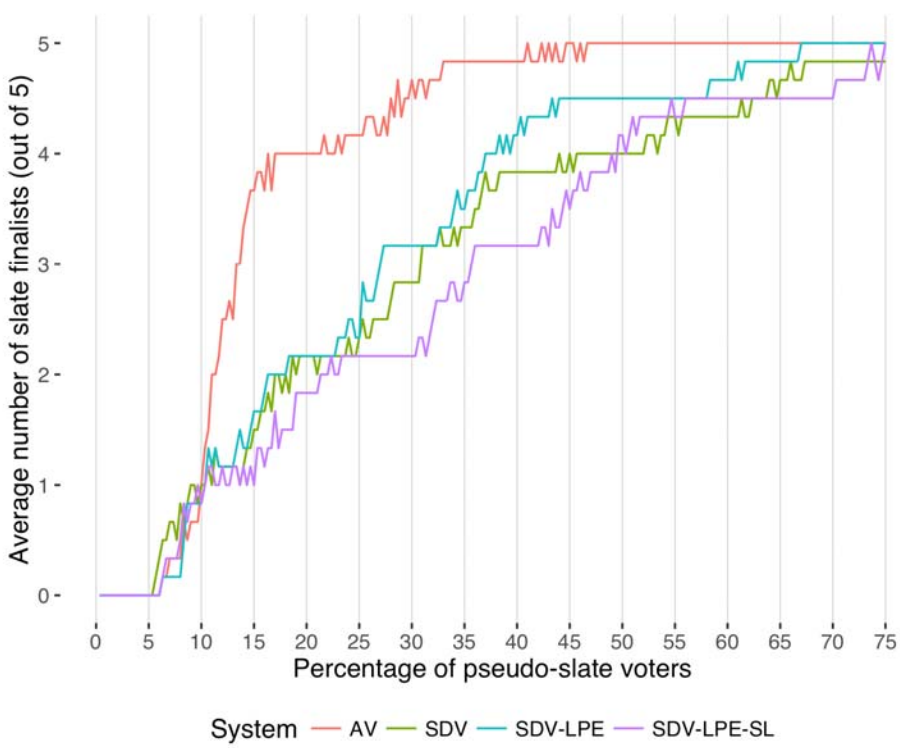


Figure 2: Slate finalists as a function of pseudo-slate voters



nominations with non-slate nominations. For the purposes of the simulation, when they voted for the nth most popular non-Puppy candidate in 2015, we imputed that into a vote for the nth most popular non-Puppy candidate in 2014. In this case, SDV-LPE and SDV reduce the power of those voting blocs even further. Under AV, the voting bloc reliably nominates 3 candidates with 14% of the voters, 4 candidates with 17% of the voters, and 5 with 39%. Under SDV-LPE, they need to make up 27.5% to nominate 3 candidates, 38% to nominate 4, and 69.5% to nominate 5. Under SDV-LPE-SL, they need 36% for 3, 49% for 4, and over 70% for 5. Jitters in the graph are a result of random sampling, and give a rough idea of the imprecision of this simulation with these voter types.

Note that the 2015 results still differ from the “realistic” version of the data in figure 2 below, because in addition to the slate voters voting for non-slate candidates, in 2015 there were a few non-slate voters voting for slate candidates. This explains the fact that slates did slightly better in 2015 than one might expect from figure 2.

7.3 Strategic Analysis

7.3.1 The Best Strategy Is to Vote True Preferences

As shown by Gibbard and Satterthwaite, no voting system—indeed, no multiplayer game with finite players and multiple yet finite possible outcomes—is immune to strategy in all cases. Yet some strategic possibilities are more severe than others.

Ideally, the nomination round would use the wisdom of all the nominators to find the five works that are most likely to include the one that would be most liked by the second-round voters once they read it. This means the system must make sure that voting similar ballots is roughly strategically neutral. If blocs of similar votes were to get an advantage, this advantage would tend to allow a minority bloc to take over the nominations, as the Puppy factions did. But if similar ballots were too strategically disadvantageous, it would encourage voters to bullet vote in order to minimize similarity. This would mean that voters will tend to give the minimum possible meaningful information about their preferences, ultimately leading to impoverished, non-robust results.

SDV-LPE was designed to avoid both of these pitfalls. First, it must resist strategic voting by an organized, cohesive bloc of voters. We will show that, if there is no overlap between the bloc’s preferences and those of other voters, then a bloc’s best strategy—involving complicated management of how many candidates each voter supports—only elects at most one more candidate than their simple honest strategy of nominating their top collective preferences. We will further argue, albeit without rigorous proof, that in the more general case where there is some overlap between the preferences of a bloc and those of non-bloc voters, optimal strategy is similarly difficult to execute and unimpressive in payoff.

(For the purposes of this proof, we will consider a version of the SDV-LPE system that breaks all ties randomly. This is in keeping with common practice in social choice theory of neglecting or minimizing ties, as ties are asymptotically impossible in large electorates.)

Consider an electorate composed of two parts, $\mathcal{E}=\mathcal{A}\cup\mathcal{B}$, where $\mathcal{B}$, the set of bloc voters, is disjoint from $\mathcal{A}$, the set of non-bloc voters. If we use the notation $A \overset{v}{>} B$ to denote the fact that voter v prefers candidate A over candidate B, then let us assume that the bloc voters’ preferences are:

1. Coherent—that is, each voter b in the voter set $\mathcal{B}$ prefers the candidate set $\{B_i\}$ in order or, in other words, $\forall a \in A, C \notin \{B_i\}, i : C > B_i$
2. Non-overlapping with the non-bloc preferences—that is, $\forall a \in \mathcal{A}, C \in \{B_i\}, i : C \overset{a}{>} B_i$

Under these assumptions, take σ to represent the “honest” voting strategy profile, with $\sigma_{\mathcal{A}}$ and $\sigma_{\mathcal{B}}$ as the votes of groups $\mathcal{A}$ and $\mathcal{B}$ respectively, and $\sigma_{\mathcal{B}}$ consisting uniformly of votes for $\{B_1,\ldots,B_5\}$. The winner under this profile is $w(\sigma)$, and the payoff for bloc $\mathcal{B}$ is the number of candidates they successfully elect, $p_{\mathcal{B}}(\sigma)\equiv|w(\sigma)\cap\{B_i\}|$. We intend to show that for any strategy σ' such that the non-bloc votes are unchanged ($\sigma'_{\mathcal{A}}=\sigma'_{\mathcal{A}}$), the bloc voters can elect no more than one extra candidate: $p_{\mathcal{B}}(\sigma')\leq 1+p_{\mathcal{B}}(\sigma)$. To begin with, let us assume the contrary: there is some strategy to get two or more extra seats above the honest result.

Under the honest strategy σ, consider the winning non-bloc candidate with the lowest final point score; let’s call this candidate A, its final point score $s(A)$, and number of nomination votes $v(A)$. If $v(A) \geq |\mathcal{B}|$—that is, if the weakest non-bloc winner has more raw votes than the size of the bloc—then there is no strategy the bloc can use to do any better, because none of their candidates can win a matchup against *A*. So the interesting case is the one where $v(A) < |\mathcal{B}|$.

In this case, any non-winning bloc candidates B_i must have been eliminated by other bloc candidates; if they had been eliminated by a non-bloc candidate, that candidate would have to have had a higher number of votes, and thus would have survived eliminating them, and thus would either be the same candidate as *A* or have been eliminated by *A*, which contradicts our assumption that $v(A) < |\mathcal{B}|$. Consider the points of the surviving bloc candidates just prior to the final elimination round in the strategic case. There are three possibilities:

1. The strategic winning bloc candidates avoid eliminating each other in the final round because, at the time of the last elimination, all of them have higher scores than *A*. However, in this case, it is easy to show that they must number no more than the honest winning bloc candidates; that is, that there is no strategic advantage.
2. The strategic winning bloc candidates avoid eliminating each other in the final round because only one of them has a lower point score than $s(A)$. Thus, the low-scoring bloc candidate is matched against *A* and wins, resulting in a strategic payoff that is one higher than under honesty. (Note that if *A* is eliminated before the final round, this same logic still applies to the round when that happens; that is, no more than $p_{\mathcal{B}}(\sigma)$ of them can have a score higher than $s(A)$, and no more than one of them can survive with a lower score.)
3. There are two or more bloc candidates with lower points than $s(A)$. In that case, one of them is eliminated, leaving no strategic payoff.

Thus, the best outcome for strategy under these assumptions is an advantage of one nomination slot, effectively allowing a bloc of voters to round up rather than round down their proportional share of slots.

Though this proof is not exactly constructive, it points the way toward how a more formal proof would be accomplished. The strategic bloc would have to calculate exactly $p_{\mathcal{B}}(\sigma)$, how many nominations they would get under honesty. Then, all of their voters would vote for at least that number of their candidates, starting from the top. Some number *n* of them would also vote for one more candidate, with *n* sufficiently high to ensure that this “second-tier” candidate would have enough votes to beat *A*, but sufficiently low so as not to bring the points of their first-tier candidates below $s(A)$.

This strategy involves getting an accurate read on $s(A)$ and $v(A)$. In the context of the Hugo awards, that level of precise foreknowledge is very unlikely.

In the more general case, where there may be some (generally minor) preference overlap between the preferences of the voting bloc and the non-bloc voters, rigorous proofs would be much messier and ridden with special cases. However, it seems on an intuitive level that the basic structure of the argument above should still apply. That is, a bloc could, by strategically distributing its votes, get only a certain number of its favorite candidates simultaneously above some rival in points; and then get only one of its candidates past that rival despite having lower points. Thus, though the vote management strategies in this case could be much more complex, the strategic payoff would still seem to be sharply limited.

7.3.2 Bullet Voting Is Not an Effective Strategy

If SDV-LPE and SDV-LPE-SL do not provide incentive for voters to vote similarly, are there incentives for them to strategically avoid similarity: e.g., through bullet voting? The strategy of avoiding “wasting” votes on a candidate who can win anyway can be effective across a variety of PR systems, including SDV [Dud14]. Is it an effective strategy in SDV-LPE or SDV-LPE-SL?

To understand the effectiveness of strategic voting, it’s useful to have a model for how “honest” voters will vote. In the case of the Hugos, a simple model would be that each work has an intrinsic quality that governs its probability of being nominated by each voter. In this model, the chance of work A being nominated on a given ballot is independent of whether work B is nominated. This means that, at every point in the elimination process, a higher-quality work will tend to lead a lower-quality work in both points and raw nominations; the two measures are essentially redundant.

Consider, then, a faction that wishes to strategically ensure that their preferred work is in the top five. Let’s say their favorite already has the sixth-highest quality. If they bullet vote for that favorite, it will have slightly more points, because the points from their ballots will not be shared among any other works. In particular, for each time the faction's honest vote would have included one of the top five works, their strategic vote might give as much as half a point extra to their favorite at the time of the last elimination.

If these extra half points move their favorite from sixth place in points up to fifth place, it will still be matched against the true fifth place for elimination. Since bullet voting cannot add nominations to a work, their favorite will still be eliminated. In order for their strategy to function, they'd have to get enough extra points for their favorite to move it from its honest sixth place position all the way up to fourth place. It seems unlikely that their work has enough overlap with the top five for that big of a move to be possible. And if supporters of the top five begin to defensively bullet vote in response, their strategic chances are likely to actually be worse than their honest chances.

The moral is that bullet voting is not likely to be an effective strategy. By the time of the crucial last elimination step, many ballots will naturally be bullet votes, as all but one of their supported candidates will have been eliminated. And for the remainder, bullet voting to give half a point more support to your favorite, when eliminations are decided on nominations rather than points, is hardly worth it.

8 Approving SDV-LPE for the Hugo Nominations Process

SDV-LPE was conceived and discussed on the blog Making Light in the weeks after the 2015 Hugo nominations were announced [Sch15a, Sch15b, Sut15a, Sut15b, Sut15c, Sut15d, Sut15e]. Of the two co-authors, Bruce Schneier wrote the guest post that initiated the conversation[Sch15a], and Jameson Quinn first synthesized the various essential ingredients of SDV-LPE into a single system [Qui15]. It was dubbed "*E Pluribus Hugo*"—out of many, a Hugo—or "EPH," and officially proposed to WSFS at its business meeting at the 2015 Worldcon.

Only one nominee that had been on a Puppy slate won a Hugo Award at the 2015 Worldcon in Spokane: the film *Guardians of the Galaxy*. Since this film had received more than double the nominations of most other slate nominees, it would almost certainly have been a finalist even without any support from slate voters. In other categories, a few of the slate nominees declined their nomination, allowing other nominees to take their place. But most importantly, the Hugo election rules allow for members to vote "No Award," which many did above every nominee from one or both of the slates. In 11 categories, a non-slate nominee won the award. In the other five categories, No Award had the most votes, thus equaling in one night the number of No Award results from over 50 years of prior history [Chu15c, Sas15, Wall15].

E Pluribus Hugo was formally voted on at the WSFS business meeting at the 2015 Worldcon.[7] The measure passed by a margin of 186 to 62, and was sent to the 2016 business meeting for ratification. If it is successfully ratified at the 2016 Worldcon in Kansas City, it will be adopted for Hugo nomination elections starting in 2017 [WSFS15].

SDV-LPE-SL was developed in 2016, after the authors were able to test the various voting systems with actual data. It is our intention to propose this variant at the 2016 business meeting. If it is passed, it would be ratified at the 2017 Worldcon in Helsinki and go into effect for the Hugo nominations election in 2018.

Meanwhile, the Puppy leaders created slates for the 2016 Hugo elections. The leadership of the Sad Puppy leadership was passed from Larry Correia to Kate Paulk, who engaged in an open nomination and voting process for determining the "ten or so most popular recommendations in each Hugo category" for the 2015 Hugos [Pau15,Pau16a, Pau16b]. Their recommendations had minimal impact in the 2015 nominations election. Rabid Puppies leader Theodore Beale produced a slate, which succeeded in capturing most of the nomination slots [Bea16,Gly16]. The 2016 Hugos will be voted on at the Worldcon in Kansas City, and many expect "no award" to again win above any of the Puppy nominees.

No other groups put forth slates in 2016. The widespread condemnation of slates by the community, and the fact that many people will vote No Award above the works on any slate, is a strong disincentive to doing so.

9 Conclusions

SDV-LPE and SDV-LPE-SL are novel PR voting systems that are suitable for elections in which an organized minority can coordinate their

[7] The only change made was to limit the number of candidates that a voter can nominate to five. This was implemented to minimize the changes in the voting process to the voter.

votes and overwhelm a more diffuse minority. Specifically, we see applicability in situations where the minority chooses their candidates based on different criteria than the majority.

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