Assessing the closeness of 2022 Australian Senate outcomes

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Abstract

1 Introduction

Australian Senate elections use a version of the Single Transferable Vote (STV) algorithm. In the 2022 Australian federal election, six states elected six senators each, and two territories elected two senators each. Unlike most other vote-counting algorithms, STV makes it computationally difficult to compute election margins. That is, it is hard to answer the question, "given a set of votes, how many changes are necessary in order to alter the election outcome?"

Although exact margin computation is infeasible, we have developed heuristic techniques that find small changes that are *sufficient* to change at least one elected candidate. We previously applied these tools to the NSW local government elections.[1] In this report we examine the 2022 Australian Senate elections, based on the full preference data made openly available by the AEC.[2]

Like our results for NSW local government elections, these vote changes are *sufficient* but may not be *minimal*. That is, each one is a valid way of changing the election outcome, but we may have missed other, smaller vote-changes that can also alter the outcome. Algorithmic improvements or more sophisticated techniques [BCST20] may produce better results.

This calculation is important because, unlike Australian House of Representatives ballots, Senate ballots are not counted manually in view of scrutineers—it would probably not be feasible to count millions of STV ballots manually. Instead, after a manual first-preference count, Senate ballots are scanned, digitized and output in an electronic form that is electronically counted. The Australian Electoral Commission (AEC) makes the electronic preference data openly available, so the counting step can be independently verified. However,

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[1] https://github.com/AndrewConway/ConcreteSTV/blob/main/reports/NSWLGE2021Report.pdf

[2] https://tallyroom.aec.gov.au/SenateDownloadsMenu-27966-Csv.htm

the digitisation step itself needs to be audited, in order to verify that the ballots have been accurately converted into electronic form. Otherwise there is a risk that an undetected software error or security problem could cause the electronic ballot records to diverge from the intentions expressed on the ballot papers.

This year, for the first time, the AEC was obliged by law to perform an audit of randomly-chosen ballot papers against their digitised preferences, in order to estimate the error rate of the digitisation process. Unfortunately, their methodology is not available at the time of writing, though a process sketch is available[3] and we have made a Freedom of Information request for the methodology also.[4]. In past years, the AEC has stated that "it was stated the error rate appears to be $< 0.5\%$," though the evidence supporting this claim has not been published, and it is not clear whether this is a per-ballot or per-digit rate. Some relevant data was released under Freedom of Information,[5] but we were not able to understand how the 0.5% figure was derived from it.

In separate work, we have also contributed some suggestions for appropriate auditing techniques.[6] This report constitutes the margin estimation required in Section 3.3.2 of that paper. These results are preliminary and we welcome corrections, comments and suggestions for improvement. Our code is openly available at `https://github.com/AndrewConway/ConcreteSTV/` and all our results can be replicated by following the instructions in Appendix A.

2 Results

Because first preferences are manually counted in the polling place in the presence of scrutineers, the opportunity for them to be altered undetectably by software problems is fairly limited. We therefore give two versions of the smallest-change values: one that allows for first preferences to be altered, and one that is limited to changes in later preferences only. Full results are in Table 1.

Victoria seems to be the closest, with 9341 vote changes, or 0.24%, sufficient to change the outcome. Western Australia (0.77%) and South Australia (0.82%) are next. The other states do not seem close—the smallest changes we could find all required more than a 1% vote change. It would therefore make sense to concentrate auditing effort on Victoria, WA and SA. If the error rate is indeed less than 0.5%, then we can be fairly confident that the WA and SA results are correct, but it may take a fairly large sample to have confidence that the error rate is sufficiently small. In the case of Victoria, based on previous AEC statements, it is possible that the overall error rate may be larger than the number of changes sufficient to change the outcome. This does not imply that the results are wrong, but it does mean that more extensive re-examination of the ballot papers may be required in order to be confident of the result.

[3] `https://www.aec.gov.au/About_AEC/cea-notices/files/2022/s273AC-senate-assurance-methodology-fe2022.pdf`

[4] `https://www.righttoknow.org.au/request/audit_methodology_for_the_senate`

[5] `https://www.righttoknow.org.au/request/ibms_report_on_the_error_rate_of`

[6] `https://arxiv.org/abs/2205.14634`

State or Territory	Formal votes	Allow 1st-prefs Change	Allow 1st-prefs (%)	No 1st-prefs Change	No 1st-prefs (%)	Effect
ACT	285217	14137	4.96%	×	×	+Seselja(LP); -Pocock(Ind)
NSW	4800722	57340	1.19%	57340	1.19%	+McCulloch(ON); -Molan(LP)
NT	103617	11412	11.01%	×	×	+Anlezark(Grn); -McCarthy(ALP)
QLD	3013868	54810	1.82%	59428	1.97%	+Stoker(LP); -Chisolm (ALP) (1st pref changes) -Hanson(ON) (no 1st prefs)
SA	1128524	9306	0.82%	12558	1.11%	+Gill(ALP); -Liddle(LP)
TAS	361048	11697	3.24%	×	×	+Mav(ON); -Tyrrell(JL)
VIC	3821539	9341	0.24%	9341	0.24%	+Pickering(ON); -Babet(UAP)
WA	1526123	11745	0.77%	×	×	+Filing (ON); -Payman (ALP)

Table 1: Vote changes that can change Senate outcomes for 2022 Australian Senate results. Two kinds of changes are shown. 'Allow 1st-prefs' lets first-preferences be different. In 'No 1st-prefs', first-preferences are assumed to be perfectly recorded. In some cases, this results in a slightly larger number of vote changes, in others it makes no difference, and in some cases it precludes any solution—this is indicated with a '×'.

3 Conclusion and next steps

At the time of writing, the AEC's estimated error rate has not yet been released. However, we trust that it will be published soon. When it is, we hope this report contributes to understanding which results pass the audit and which ones need more careful checking to ensure that the accuracy of the digitisation process is high enough to be confident in the announced outcome.

References

[BCST20] Michelle Blom, Andrew Conway, Peter J Stuckey, and Vanessa J Teague. Did that lost ballot box cost me a seat? Computing manipulations of STV elections. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 34, pages 13235–13240, 2020. `https://web.archive.org/web/20201103172932id_/https://aaai.org/ojs/index.php/AAAI/article/download/7029/6883`.

A Instructions for replicating these results

1. Clone the repository at `https://github.com/AndrewConway/ConcreteSTV/` and follow the instructions for compiling the software and downloading the necessary data files from the AEC.

2. Parse each state or territory's preference data zip file. For example, `../target/release/parse_ec_data AEC2022 NT --out NT2022.stv` parses the AEC's formal preferences zip file for the Northern Territory and outputs the result into a file called `NT2022.stv`.

   Do likewise for ACT, QLD, NSW, SA, TAS, VIC, WA.

3. Run the `change_outcomes` program using the `FederalPost2021` rules, for example
   `../target/release/change_outcomes FederalPost2021 NT2022.stv --verbose`
   This produces a file called `NT2022_FederalPost2021.vchange` that summarises the smallest changes discovered.

4. Follow the instructions at `https://github.com/AndrewConway/ConcreteSTV/` for viewing the `.vchange` files.

5. Do likewise for ACT, QLD, NSW, SA, TAS, VIC, WA. Large states can take a very long time, on the order of days for VIC and NSW.