Counting choice voting (STV) elections with fractional transfers
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1. Introduction

This document provides complete instructions for counting ballots in a choice voting election using fractional transfers. Note that there are numerous minor variations in methods of counting choice voting ballots, so it's important to specify these details in appropriate bylaws, standing rules, etc prior to conducting an election.

This method assumes the use of a threshold equal to Votes / (Seats + 1) plus 1 vote, rounded down to the nearest whole number. This is known as the Droop threshold.

Voters vote by ranking as many or as few of the candidates as they like.

2. Balloting

The easiest way to handle balloting is to give delegates a ballot that looks like this:

INSTRUCTIONS:
Write the name of your first choice candidate, your second choice candidate and so on. You may vote for as many or as few choices as you like.

1st choice: _____
2nd choice: _____
3rd choice: _____
4th choice: _____

Voters then simply write in the names of the candidates they wish to vote for.

3. Ballot counting

Remember to check your work every step of the way. Each time you count a pile of ballots, have someone else check it. When you divide ballots into piles, make sure that the sum of the piles is the total number you started with. When a candidate is elected with surplus votes and you distribute the surplus, make sure that the total number of 2nd choice votes distributed to the other candidates equals the original number of first choice votes for the elected candidate, and so on.

The first step in ballot counting is to examine each ballot to make sure that it is properly completed. If a ballot is unclear or improperly filled out, the people counting the ballots should try to infer the intent of the voter, recognizing that if they can infer the voter's 1st choice, the ballot can be counted. If the ballot counters have reasonable confidence that they know the intent of the voter, then that intent should be honored. If this is not possible, then the ballot should be set aside and considered a spoiled ballot.

Once you've interpreted each ballot and separated any spoiled ballots, count the total number of valid ballots.

Choice voting requires calculation of a the threshold of election and then the successive distribution of surplus ballots from winning candidates and all ballots from eliminated candidates until all seats are filled.

A few important terms

Threshold: We're using the Droop threshold, which in terms of votes is:
Votes / (Seats + 1) + 1 vote, rounded down to the nearest whole number, which means you simply ignore any fractions or decimals when you compute the threshold. For example, with 50 voters for 3 seats, the threshold is 50 / (3 + 1) + 1 vote, which is 13.5, and when you ignore the decimal, you get a threshold equal to 13 votes. Once a candidate receives 13 votes or more, she or he is elected.

Fractions and Rounding: When the number of ballots is small, the way you round fractions can affect the outcome of the election. Thus, you need to be careful about transferring fractional surplus votes. In this case, we will transfer fractional ballots based on the threshold. We recommend doing your calculations in a spreadsheet, which uses an accuracy of 15 decimals or so, which means rounding errors are so small as to be insignificant.

Surplus: The number or percentage of votes a candidate receives in excess of the threshold. For example, if a candidate receives 100 first choice votes and the threshold is 80, the surplus is 20 votes, or 20 / 100 votes, which is .2 or 20% when expressed as a percentage. If a candidate has 19 votes and the threshold is 16, the surplus is 3 votes or a percentage equal 3 / 19, which is .1579 or 15.79%. When you distribute the 19 ballots, each will have a surplus value of .1579, which means you will be distributing a total of 19 * .1579 votes, which equals the 3 total surplus votes.

Distribute: To distribute surplus votes from an elected candidate or all of the votes from an eliminated candidate to the next ranked choice on each ballot. The easiest way to do this is to write the value on each ballot and then physically move each ballot to the pile of the candidate ranked next on the ballot. Each remaining candidate's vote total will consist of the sum of the whole votes plus the sum of the fractional surplus votes that the candidate received. Votes from an eliminated candidate transfer at the current face value.

Exhausted ballot: If a ballot is distributed and there is either no lower ranked candidate on the ballot <u>or</u> all of the lower ranked candidates have already been elected or eliminated, the ballot becomes "exhausted" and should be placed in a pile with other exhausted ballots. These ballots will not play any role in the rest of the ballot counting.

Elected, eliminated and continuing candidates: The first two are obvious. Continuing candidates are everyone else: candidates who have not yet been elected or eliminated. Only continuing candidates can receive transfer votes.

Some general guidance

The basic process is to sort the ballots into first choice votes, and then distribute all the surplus votes of candidates crossing the threshold, in order of finish, starting with the highest vote receiver. Once all the surplus votes are transferred, you eliminate candidates starting with the last place finisher until a candidate crosses the threshold. Every time you transfer votes, you will be physically moving ballots from the elected or eliminated candidate to the other candidates. The key is to keep track of which ballots count as whole votes, which are fractions of ballots, which are fractions of fractions and so on.

You continue the process of transferring surplus votes and eliminating candidates until: all seats are filled or the number of continuing candidates equals the number of seats to be filled, at which point all continuing candidates are declared elected.

Remember that if a candidate is elected or eliminated, she cannot receive any distributed votes. A ballot that would otherwise distributed to an elected or eliminated candidate transfers to the next candidate on the ballot. If no candidate remains on the ballot, the ballot is exhausted.

In case of ties between elected candidates or eliminated candidates, use the number of votes each candidate had in the previous round to determine who is elected first or eliminated first. If the candidates had the same number of votes back to the beginning round, flip a coin to determine which one to elect or eliminate.

The actual counting process

I recommend having one person coordinating the effort and keeping track on paper, a couple people counting and double checking, and one person operating a spreadsheet to keep track of totals. Follow these steps:

1. Calculate the threshold number of votes: Votes / (Seats +1) + 1 vote, and then ignore the decimals if any.

2. Sort ballots into piles, count each pile and order the piles from largest to smallest. Check that the sum of the piles is the total number of valid ballots.

3. If any candidates has reached threshold, start with the candidate with the most votes, who is elected. Calculate the surplus as a percentage of that candidate's votes: surplus percentage = (Number of votes - threshold) / (Number of votes) expressed as a percentage.

4. Distribute each vote for the elected candidate to the second choice on the ballot at a value equal to the surplus percentage of the vote. If the surplus is 7%, then each transferred vote equal .07 votes. **You must keep track of which ballots are worth full value and which are worth a fraction of their value.** An easy way to do this is to cross out the name of the elected candidate and write the value of the surplus vote on the ballot. This makes it easy to keep track of which candidate the ballot counts for.

5. Compute the revised totals for each candidate, keeping track that totals now consist of whole votes and fractional votes (and eventually fractions of fractions). See if any

candidates have crossed the threshold. If so, go back to step 3. Be careful at this step, because you could have fractions of fractions of votes.

6. Once you've complete distributing all surplus votes, determine which remaining candidate has the fewest votes. In cases of ties, eliminate the candidate who had the fewest votes in the previous round. Flip a coin if two candidates have the same number of votes back to the first round.

7. Eliminate this candidate and distribute all votes to the next ranked candidate on each ballot, keeping track that some ballots may be fractions or fractions of fractions, and others may be whole numbers. Ballots may exhaust at this stage. Simply move each of the ballots to a new pile and calculate the new totals. If any candidate has reached threshold, go to step 3. If not, go to step 6.

This process continues until all the seats are filled or the number of continuing candidates equals the number of unfilled seats, at which point all continuing candidates are declared elected.

4. Reporting results of a choice voting election

The results of a choice voting election consist of round-by-round vote totals for all candidates, including the number of exhausted ballots, like this:

Candidate	1st Round	2nd Round	3rd Round
Andrew	12 (elected)	8.00	8.00
Betty	5	5.00	6.00 (eliminated)
Carl	3	4.33 (eliminated)	--
Doris	5	5.33	6.33 (elected)
Ellen	5	6.67	7.67 (elected)
Exhausted	--	0.67	2.00
Total	30	30.00	30.00

Elected candidates are Andrew, Doris and Ellen.