Binomial STV

count automation

Bilateral election and exclusion count version of the Single Transferable Vote

Ranked Choice Vote (RCV)

or preference vote chooses candidates in order of choice, 1, 2, 3,…, up to the number of candidates.

A Binomial STV ballot looks like another ranked choice vote, singling out prefered candidates, in an order of choice. Unlike traditional STV, any preference, that exceeds the number of seats or vacancies, does not help to elect, but to exclude, that candidate.

For example, if there are 12 candidates, competing for 6 seats, preference 7 will count slightly against that candidate. Preference 12 may count as much to exclude a candidate, as preference 1 counts to elect a candidate.

Any preferences, from first to last, may be left unfilled. A completely unfilled ballot or carte blanche (blank paper) is equivalent to None Of The Above (NOTA). Unlike traditional STV, abstentions are counted, towards an unelective quota of votes.

A database, of all the (logged in) voters ranked choices, including abstentions, is compiled into a list, whose number of rows comprises the total number of votes.

The Quota

A proportional count is used for this basic (first order) Binomial STV.

The elective proportion of votes, or quota, is: total votes divided by one more than the number of seats. Or: votes/(seats plus one), which abbreviates to: V/(S+1).

Abstentions are proportionally counted, like the votes for any other candidate. Abstentions may have the alias "Nemo" or No-one. But abstentions may fill from zero cells to every cell, on a row of preferences, which equals the number of candidates. Whereas, actual candidates may be prefered only in zero cells or just one cell in the row of preferences. A quota of abstentions leaves a seat unoccupied. A quota of votes for a single candidate, leaves a seat occupied. Voters may prefer none, or one candidate, up to all the candidates. In so far as number order is not maintained, as by a missing numeral, the further preferences of the vote should count as abstentions.

The Election count

All the votes are counted to establish the total vote (given by the length of the list of preference votes). All the first preferences are counted for their respective candidates, including any first preference abstentions (for “Nemo”) if applicable.

The first column, of an election count table, is named, at the top, candidates, followed by a vertical list of the candidates names. The second column, named, at the top, first preferences, lists the number of first preferences, which each candidate gains, trailed by a cell for (abstentions) candidate “Nemo.” Below is a cell for any invalid votes. And the foot of the column should sum to the total vote.

If there are no candidates with first preferences, in surplus of a quota, the election count halts. And if no candidates vote is equal to the quota, there is no provisional election of any candidates.

[Unlike traditional STV counts, there is no “last past the post” elimination of candidates, after election surpluses run out.]

Surplus Transfer

A (provisionally) elected candidates surplus vote is transferable to next prefered candidates, by (what statisticians call) “weighting in arithmetic proportion” (a.k.a. Gregory method): all an elected candidates votes, greater in number than (or surplus to) the quota, are transferable, in proportion to the (voting pattern of) next preferences of all that elected candidates vote, called the “total transferable vote.”

Any surplus to the total transferable vote minus the quota is the “surplus value” of an elected candidates vote.

The ratio of the surplus value to the total transferable vote, equals the “transfer value” of each next preference. (In the first instance, a surplus transfer is of second preferences, to an elected candidates first preferences).

(Surplus value)/(total transferable vote) = 1 –[(quota)/(total transferable vote)] = transfer value.

In a third, or further, column, the transfer value is multiplied by the number of next preferences for each candidate. These surplus votes, for next preferences, should sum, in this case, to the surplus value, at the foot of the column.
Each candidates surplus transfer of votes are added, in a fourth, or further, column, to their existing votes. In the surplus transfer, from an elected candidates vote, the elected candidate cell is tabulated, at just the quota of votes. This serves as an arithmetic check that the column of votes, after surplus transfers, still sums to the same total vote, at the foot of the column.

The surplus transfer procedure should be iterated with respect to every surplus voted candidate. And more than one surplus transfer for a given candidate, may be necessary, if the surplus vote is greater than the quota.

The candidate with the bigger surplus has prior transfer. A further surplus transfer is counted if the surplus is more than a quota in size. Surplus transfers may bring another candidates votes, into a surplus to the quota, resulting in that candidates own surplus transfer of votes.

The Exclusion count

The exclusion count is (completely symmetric) iteration of the election count, with the preferences reversed. (The database, of all the voters ranked choices, is reversed from first to last preferences, into last to first preferences, counting the preference order of cells, not from left to right, but from right to left.)

The election count elects candidates. The exclusion count excludes candidates.

The Quotient

A candidate, who is both elected and excluded, may be called “Schrödinger’s candidate” (a term from Forest Simmons, after the unfortunate quadruped, Schrödinger’s cat, deemed both dead and alive, in quantum theory). If the ratio of exclusion votes divided by election votes (“the quotient”) of a candidate, is unity or less than unity, that candidate is elected. Should there be two or more Schrödinger candidates, vying for a lesser number of vacancies, the candidate(s) with the smaller quotient below unity is deemed elected.

Generally, the lowness of candidates quotients establishes their order of precedence.

(The quotient is the square of the geometric mean, but taking the square root of that average (or statistical representation of voters by candidates) does not alter that order of precedence.)

Hand count election test for automation

Database:

32 voters for 8 candidates in 8 orders of choice.

voters	1	2	3	4	5	6	7	8
8	C	B	D	A	-	-	-	-
6	H	F	G	E	-		-	-
4	-	-	-	-	G	H	F	E
3	D	B	A	C	F	H	-	-
2	C	E	G	A	H	B	D	F
4	F	G	H	E	A	B	C	D
1	D	E	B	A	H	F	G	E
3	A	D	E	F	H	G	C	B
1	G	A	F	B	C	H	D	E
total: 32								

The database is a table of the voters permutations of preference for the candidates. Since there are 8 candidates, the possible number of preference permutations is factorial eight, a huge number. The dashes signify abstentions, which, unlike a candidate, are allowed in more than one cell per row. Abstentions would most probably curb the multiplicity of permutations. Even so, this simplistic example contains a mere nine permutations, which is drastically unrealistic, but leaves the arithmetic work, at managable levels, for only one person to make-up an example and calculate the resulting count.

This basic (first order) Binomial STV is itself a simplified procedure. Tho still not simple, it should be practical as a hand count, at least by a trained team of returning officers, when conducted on a large scale.
Whether one untutored old man could graphically program this binomial count, in nocode, is another matter.

Several versions of traditional STV have been coded by professionals into electronic counts. The republic of Ireland still uses the original random sample surplus transfer STV hand count. Cambridge Massachusetts has followed this essential model into an electronic count. Except for general elections, Northern Ireland uses surplus transfer (Gregory method) weighting in arithmetic proportion, by professional hand count. But Scotland uses an electronic count version, for local elections.
Meek method STV is a specialised computer count, which New Zealand uses for its health boards and a few local elections. But no conventional STV method uses a rational exclusion count, with their rational election count. In fact, no official election methods, in the world, use a rational exclusion count.

Quota

In Binomial STV, the quota is the same for both the election count and the exclusion count. This remains true for more than a first order Binomial STV, described here. But the more advanced version innovates a modified quota.

Quota, Q, of candidate election, per seat, is the total vote, V, divided by one more than the number of seats, S. Or, Q = V/(S+1). Therefore, for 32 voters electing candidates to four seats, Q = 32/(4+1) = 6.4

A candidate is elected on reaching a quota of 6.4 votes.

Election count

Table one: Election count

Candidates	First preferences	3.6 surplus transfer from C to B & E (see database)	Votes after surplus transfers
A	3		3
B	0	(8/10)*3.6 = 2.88	2.88
C	10	6.4	6.4
D	4		4
E	0	(2/10)*3.6 = 0.72	0.72
F	4		4
G	1		1
H	6		6
Abstentions: "Nemo"	4		4
Invalid votes	-		-
Total votes	32	10	32

Table one shows only one candidate elected to 4 seats. A standard deviation test shows whether any other candidate is not significantly below the election threshold. A standard deviation, SD, is given by the square root of [the total votes multiplied by an arithmetic mean (set at the quota ratio), and multiplied by (unity minus that ratio). In other words, in this case, SD = square root [32*(1/5)*(4/5)] = 2.26. Candidate H, with 6 votes, only 0.4 short of the quota, is well within one standard deviation of the quota. However, no other candidate is within one standard deviation of the quota.
If it was previously agreed beforehand to take this statistical significance in consideration, candidate H, as well as C, could be considered elected. This still leaves only two out of four seats filled.

Exclusion count

Table two: Exclusion count (reverse or right-to-left preference order count)

Candidates	Last preferences	Prior abstention surplus transfer to H (see database)	Further abstention surplus transfers to A & E	Consecutive surplus transfers to D & G	E surplus transfer 2.343 to F; to G & D	D surplus transfer 0.3165	Maximur exclusioi votes
A	0		(8/14)*6.4=3.657				3.657
B	3						1
C	0					0.3165	0.3165
D	4			(8/14)*4.071 =2.326	(1/6)*2.343 =0.3905	6.4	8.743
E	6		(6/14)*6.4=2.743		6.4		3.5616
F	2				(4/6)*2.343		1.562

					=1.562		
G	0			(6/14)*4.071 =1.745	(1/6)*2.342 =0.3905		2.1343
H	0	(3/17)*6.4=1.129					1.129
Abstentions: "Nemo"	17	17-6.4=11.6 + (14/17)*6.4=5.271	16.871-6.4 =10.471	6.4			17
Invalid votes	-	-	-	-	-	-	
Total votes	32-17=15	17	16.871	10.471	8.743	6.7165	

Binomial STV introduces the novelty of counting abstentions. (Abstentons counting is necessary to determine the balance of voters desire to elect or exclude candidates.) This example is marked by a much greater desire of voters (17 of their last preferences) not to exclude candidates, than (4 of their first preferences) not to elect candidates.

The exclusion count has nearly three quotas of abstentions. In other words, nearly three "Nemos" or No-ones are excluded. Correspondingly, only one actual candidate, E, is definitely excluded. None of the other candidates come close to being excluded, by a test of statistical significance. It must be remembered, however, that this simple example of voting is conducted at the extreme lower limit of numbers for any statistical test to be at all significant.
Even so, it was still necessary to conduct the count to four decimal places ("argument four") for consistency in the count.

The main reason why this example was not fully elective of all four seats is that the voting pattern did not follow a (random or) normal distribution. The typical random voting pattern for 32 voters would assign to candidates approximately the distribution: 0, 1, 5, 10, 10, 5, 1, 0. In the above election example, there was only one 10 (C) and no fives. Had there been this sort of distribution, two candidates would have been elected with surpuses, which would probably have helped the other two candidates with 5 first preferences, to fill all four vacancies.

Unlike traditional STV, Binomial STV does not assume that any line-up of candidates will fill all the vacancies, if they lack substantial support.