The Will of the People:
How we vote and why it matters

Jeanne N. Clelland
University of Colorado, Boulder

League of Women Voters of Boulder County

Community Conversation

November 10, 2019

Why have elections?

Why have elections?

"The will of the people shall be the basis of the authority of government; this will shall be expressed in periodic and genuine elections which shall be by universal and equal suffrage and shall be held by secret vote or by equivalent free voting procedures."

– United Nations Universal Declaration of Human Rights, Article 21, December 1948

How do we vote?

How do we vote?

The classic system: Majority rules

How do we vote?

The classic system: Majority rules

The simplest elections feature a choice between two candidates, A and B.

How do we vote?

The classic system: Majority rules

The simplest elections feature a choice between two candidates, A and B.

In this case, the procedure is straightforward: Every voter votes for their preferred candidate, and the candidate with the most votes wins.

How do we vote?

But as soon as there are 3 or more candidates, the situation gets more complicated! The most common voting systems in this case are:

How do we vote?

But as soon as there are 3 or more candidates, the situation gets more complicated! The most common voting systems in this case are:

- **Plurality voting:** Whichever candidate gets the most votes wins, even if their vote total is less than 50%.

How do we vote?

But as soon as there are 3 or more candidates, the situation gets more complicated! The most common voting systems in this case are:

- **Plurality voting:** Whichever candidate gets the most votes wins, even if their vote total is less than 50%.
- **Runoff elections:** If no candidate wins more than 50% of the vote, a second election is held between the two candidates with the two largest vote totals in the original election.

How well does it work?

Even with just these two possibilities, different procedures may produce different results.

How well does it work?

Even with just these two possibilities, different procedures may produce different results.

Simple example: Suppose that 60% of the population likes both candidates A and B about equally, and dislikes candidate C. Meanwhile, the other 40% of the population prefers C and dislikes both A and B.

How well does it work?

Even with just these two possibilities, different procedures may produce different results.

Simple example: Suppose that 60% of the population likes both candidates A and B about equally, and dislikes candidate C. Meanwhile, the other 40% of the population prefers C and dislikes both A and B.

The initial election produces the following results:

$$A : 32\%, \qquad B : 28\%, \qquad C : 40\%.$$

How well does it work?

Even with just these two possibilities, different procedures may produce different results.

Simple example: Suppose that 60% of the population likes both candidates A and B about equally, and dislikes candidate C. Meanwhile, the other 40% of the population prefers C and dislikes both A and B.

The initial election produces the following results:

$$A : 32\%, \qquad B : 28\%, \qquad C : 40\%.$$

With a plurality vote, C wins. But in a runoff election between A and C, most of B's voters prefer A, and A wins.

How well does it work?

Slightly more complicated example: Suppose that:

How well does it work?

Slightly more complicated example: Suppose that:

- 36% of the population strongly favors A, thinks B would be a reasonable second choice, and HATES C.

How well does it work?

Slightly more complicated example: Suppose that:

- 36% of the population strongly favors A, thinks B would be a reasonable second choice, and HATES C.
- 34% of the population strongly favors C, thinks B would be a reasonable second choice, and HATES A.

How well does it work?

Slightly more complicated example: Suppose that:

- 36% of the population strongly favors A, thinks B would be a reasonable second choice, and HATES C.
- 34% of the population strongly favors C, thinks B would be a reasonable second choice, and HATES A.
- 30% of the population strongly favors B and strongly dislikes both A and C, but about 2/3 of them prefer C vs. A as a second choice.

How well does it work?

Slightly more complicated example: Suppose that:

- 36% of the population strongly favors A, thinks B would be a reasonable second choice, and HATES C.
- 34% of the population strongly favors C, thinks B would be a reasonable second choice, and HATES A.
- 30% of the population strongly favors B and strongly dislikes both A and C, but about 2/3 of them prefer C vs. A as a second choice.

With a plurality vote, A wins with 36% of the vote.
In a runoff election between A and C, C wins with 54% of the vote.

How well does it work?

Slightly more complicated example: Suppose that:

- 36% of the population strongly favors A, thinks B would be a reasonable second choice, and HATES C.
- 34% of the population strongly favors C, thinks B would be a reasonable second choice, and HATES A.
- 30% of the population strongly favors B and strongly dislikes both A and C, but about 2/3 of them prefer C vs. A as a second choice.

With a plurality vote, A wins with 36% of the vote.
In a runoff election between A and C, C wins with 54% of the vote.

But a strong case could be made that candidate B comes closest to representing "the will of the people."

How well does it work?

This is not a theoretical problem!

How well does it work?

This is not a theoretical problem!

- Party primary elections often have a large number of candidates. Some states and municipalities have runoffs for primary elections — and some don't! — but either way, voters' ability to express their preferences is very limited, and the outcome can leave most voters feeling dissatisfied.

How well does it work?

This is not a theoretical problem!

- Party primary elections often have a large number of candidates. Some states and municipalities have runoffs for primary elections — and some don't! — but either way, voters' ability to express their preferences is very limited, and the outcome can leave most voters feeling dissatisfied.
- General elections are almost always decided by plurality vote, and minor party candidates can easily play the role of spoiler.

How well does it work?

This is not a theoretical problem!

- Party primary elections often have a large number of candidates. Some states and municipalities have runoffs for primary elections — and some don't! — but either way, voters' ability to express their preferences is very limited, and the outcome can leave most voters feeling dissatisfied.
- General elections are almost always decided by plurality vote, and minor party candidates can easily play the role of spoiler.
  - 1992 Presidential election: Clinton 43%, Bush 38%, Perot 19%
  - 2000 Presidential election in Florida: Bush 48.85%, Gore 48.84%, Nader 1.6%

How well does it work?

Another weakness of this system is that, as in the example above, primary elections are often won by more extreme candidates who inspire strong opinions in both directions, while candidates who might be the second or third choice of most voters are eliminated from consideration.

How well does it work?

Another weakness of this system is that, as in the example above, primary elections are often won by more extreme candidates who inspire strong opinions in both directions, while candidates who might be the second or third choice of most voters are eliminated from consideration.

For this reason, many attempts have been made to tweak the rules in order to improve the chances of electing more moderate candidates in primary elections, who it is hoped will fare better in the subsequent general elections.

Variations on the system

Variations on the system

Blanket primary: In this system, voters may select one candidate for each office without regard to party; for instance, a voter might select a Democratic candidate for governor and a Republican candidate for senator.

Variations on the system

Blanket primary: In this system, voters may select one candidate for each office without regard to party; for instance, a voter might select a Democratic candidate for governor and a Republican candidate for senator.

In the traditional version, the candidates for each office *in each party* with the highest numbers of votes advance to the general election as their party's nominee.

Variations on the system

Blanket primary: In this system, voters may select one candidate for each office without regard to party; for instance, a voter might select a Democratic candidate for governor and a Republican candidate for senator.

In the traditional version, the candidates for each office *in each party* with the highest numbers of votes advance to the general election as their party's nominee.

The blanket primary system was used in Washington, California, and Alaska until the year 2000, when the Supreme Court ruled it unconstitutional in *California Democratic Party v. Jones* because it forced political parties to endorse candidates against their will.

Variations on the system

Nonpartisan blanket primary, a.k.a. "Jungle primary": In this system, all candidates for each office run against each other at once in the primary election, without regard to party affiliation. The top two candidates, regardless of party affiliation, advance to the general election.

Variations on the system

Nonpartisan blanket primary, a.k.a. "Jungle primary": In this system, all candidates for each office run against each other at once in the primary election, without regard to party affiliation. The top two candidates, regardless of party affiliation, advance to the general election.

This system is currently in use for all statewide primaries except presidential primaries in Washington and California. A similar, but slightly different, system is also used in Louisiana.

Variations on the system

The idea is to promote the election of more moderate candidates, as candidates must appeal to members of both parties. It intentionally allows two members of the same party to advance to the general election, where members of the opposite party are likely to prefer the more moderate candidate.

Variations on the system

The idea is to promote the election of more moderate candidates, as candidates must appeal to members of both parties. It intentionally allows two members of the same party to advance to the general election, where members of the opposite party are likely to prefer the more moderate candidate.

However, this can also occur when a party with minority support runs fewer candidates than the majority party and so has less vote-splitting between candidates.

Variations on the system

For example, in Washington's 2016 election for state treasurer, the primary results were as follows:

Candidate	Party	Vote percentage
Davidson	R	25.09%
Waite	R	23.33%
Liias	D	20.36%
Comerford	D	17.97%
Fisken	D	13.24%

Variations on the system

For example, in Washington's 2016 election for state treasurer, the primary results were as follows:

Candidate	Party	Vote percentage
Davidson	R	25.09%
Waite	R	23.33%
Liias	D	20.36%
Comerford	D	17.97%
Fisken	D	13.24%

Democrats received 51.57% of the primary vote but were shut out of the general election.

Is there a better way?

Is there a better way?

As you might imagine, this is not a new problem!

The obvious shortcoming of these standard voting systems is that voters are only allowed to provide partial information about their preferences: Each voter can vote for only one candidate and cannot say anything about their preferences among the rest.

Is there a better way?

As you might imagine, this is not a new problem!

The obvious shortcoming of these standard voting systems is that voters are only allowed to provide partial information about their preferences: Each voter can vote for only one candidate and cannot say anything about their preferences among the rest.

Many alternate systems have been proposed over the years in order to allow voters to express more nuanced opinions.

The Borda Count

The Borda Count

In 1770, the French mathematician Jean-Charles de Borda proposed the following algorithm: Suppose that there are N candidates.

The Borda Count

In 1770, the French mathematician Jean-Charles de Borda proposed the following algorithm: Suppose that there are N candidates.

- Each voter ranks the list of candidates in order of their preference.

The Borda Count

In 1770, the French mathematician Jean-Charles de Borda proposed the following algorithm: Suppose that there are N candidates.

- Each voter ranks the list of candidates in order of their preference.
- For each ballot, N points are given to the 1st place candidate, $N-1$ points to the 2nd place candidate, etc., down to 1 point for the last-place candidate. (Alternatively, points may range from $N-1$ down to 0.)

The Borda Count

In 1770, the French mathematician Jean-Charles de Borda proposed the following algorithm: Suppose that there are N candidates.

- Each voter ranks the list of candidates in order of their preference.
- For each ballot, N points are given to the 1st place candidate, $N-1$ points to the 2nd place candidate, etc., down to 1 point for the last-place candidate. (Alternatively, points may range from $N-1$ down to 0.)
- After all points are tallied, the candidate with the most points wins.

The Borda Count

In our example from before, the ballots might be cast as follows. (For simplicity, assume there are exactly 100 voters.)

Ordered preferences	Votes
(A, B, C)	36
(C, B, A)	34
(B, C, A)	20
(B, A, C)	10

The Borda Count

In our example from before, the ballots might be cast as follows. (For simplicity, assume there are exactly 100 voters.)

Ordered preferences	Votes
(A, B, C)	36
(C, B, A)	34
(B, C, A)	20
(B, A, C)	10

Candidate	Total points
A	
B	
C	

The Borda Count

In our example from before, the ballots might be cast as follows. (For simplicity, assume there are exactly 100 voters.)

Ordered preferences	Votes
(A, B, C)	36
(C, B, A)	34
(B, C, A)	20
(B, A, C)	10

Candidate	Total points
A	$(36 \times 3) + (34 \times 1) + (20 \times 1) + (10 \times 2) = 182$
B	
C	

The Borda Count

In our example from before, the ballots might be cast as follows. (For simplicity, assume there are exactly 100 voters.)

Ordered preferences	Votes
(A, B, C)	36
(C, B, A)	34
(B, C, A)	20
(B, A, C)	10

Candidate	Total points
A	$(36 \times 3) + (34 \times 1) + (20 \times 1) + (10 \times 2) = 182$
B	$(36 \times 2) + (34 \times 2) + (20 \times 3) + (10 \times 3) = 230$
C	

The Borda Count

In our example from before, the ballots might be cast as follows. (For simplicity, assume there are exactly 100 voters.)

Ordered preferences	Votes
(A, B, C)	36
(C, B, A)	34
(B, C, A)	20
(B, A, C)	10

Candidate	Total points
A	$(36 \times 3) + (34 \times 1) + (20 \times 1) + (10 \times 2) = 182$
B	$(36 \times 2) + (34 \times 2) + (20 \times 3) + (10 \times 3) = 230$
C	$(36 \times 1) + (34 \times 3) + (20 \times 2) + (10 \times 1) = 188$

The Borda Count

In our example from before, the ballots might be cast as follows. (For simplicity, assume there are exactly 100 voters.)

Ordered preferences	Votes
(A, B, C)	36
(C, B, A)	34
(B, C, A)	20
(B, A, C)	10

Candidate	Total points
A	$(36 \times 3) + (34 \times 1) + (20 \times 1) + (10 \times 2) = 182$
B	$(36 \times 2) + (34 \times 2) + (20 \times 3) + (10 \times 3) = 230$
C	$(36 \times 1) + (34 \times 3) + (20 \times 2) + (10 \times 1) = 188$

So with this system, B wins — despite coming in last place in the plurality vote!

The Borda Count

The Borda count was used by the French Academy of Sciences to elect its members for about two decades, until Napoleon Bonaparte imposed his own voting method in 1801.

The Borda Count

The Borda count was used by the French Academy of Sciences to elect its members for about two decades, until Napoleon Bonaparte imposed his own voting method in 1801.

Similar systems were developed independently several times, as far back as 1433, when the German philosopher Nicholas of Cusa proposed it as a method to elect Holy Roman Emperors.

The Borda Count

The Borda count was used by the French Academy of Sciences to elect its members for about two decades, until Napoleon Bonaparte imposed his own voting method in 1801.

Similar systems were developed independently several times, as far back as 1433, when the German philosopher Nicholas of Cusa proposed it as a method to elect Holy Roman Emperors.

Today it is used in many academic and private institutions, and (with variations) even in a few political jurisdictions.

The Borda Count

Advantages:

The Borda Count

Advantages:

- Tends to favor candidates who are more broadly acceptable to voters.

The Borda Count

Advantages:

- Tends to favor candidates who are more broadly acceptable to voters.
- Somewhat less vulnerable to tactical manipulation by strategic ranking than other common methods.

The Borda Count

Advantages:

- Tends to favor candidates who are more broadly acceptable to voters.
- Somewhat less vulnerable to tactical manipulation by strategic ranking than other common methods.

Disadvantages:

The Borda Count

Advantages:

- Tends to favor candidates who are more broadly acceptable to voters.
- Somewhat less vulnerable to tactical manipulation by strategic ranking than other common methods.

Disadvantages:

- It is possible that a candidate who is the first choice of a majority of voters is not the winner.

The Borda Count

Advantages:

- Tends to favor candidates who are more broadly acceptable to voters.
- Somewhat less vulnerable to tactical manipulation by strategic ranking than other common methods.

Disadvantages:

- It is possible that a candidate who is the first choice of a majority of voters is not the winner.
- How to count ballots where not all candidates are ranked?

The Borda Count

Advantages:

- Tends to favor candidates who are more broadly acceptable to voters.
- Somewhat less vulnerable to tactical manipulation by strategic ranking than other common methods.

Disadvantages:

- It is possible that a candidate who is the first choice of a majority of voters is not the winner.
- How to count ballots where not all candidates are ranked?
- Highly susceptible to a form of tactical manipulation called *teaming* or *cloning*.

The Borda Count

Example: Suppose that there are two factions, the Alphas and the Betas. The Alphas are very popular, with about 60% of the voters supporting them. The main candidates are the Alpha candidate A and the Beta candidate B.

The Borda Count

Example: Suppose that there are two factions, the Alphas and the Betas. The Alphas are very popular, with about 60% of the voters supporting them. The main candidates are the Alpha candidate A and the Beta candidate B.

In a standard election between these two candidates—or even a plurality election including one or two candidates with about 1% or 2% support each—A would win with more than 50% of the vote.

The Borda Count

Example: Suppose that there are two factions, the Alphas and the Betas. The Alphas are very popular, with about 60% of the voters supporting them. The main candidates are the Alpha candidate A and the Beta candidate B.

In a standard election between these two candidates—or even a plurality election including one or two candidates with about 1% or 2% support each—A would win with more than 50% of the vote.

Now say that the Betas decide to run a second, much less popular candidate C, who will receive about 10% of the Beta vote. Then the ballots might be cast as follows. (Again, assume there are 100 voters.)

The Borda Count

Ordered preferences	Votes
(A, B, C)	54
(A, C, B)	6
(B, C, A)	36
(C, B, A)	4

The Borda Count

Ordered preferences	Votes
(A, B, C)	54
(A, C, B)	6
(B, C, A)	36
(C, B, A)	4

Candidate	Total points
A	
B	
C	

The Borda Count

Ordered preferences	Votes
(A, B, C)	54
(A, C, B)	6
(B, C, A)	36
(C, B, A)	4

Candidate	Total points
A	$(54 \times 3) + (6 \times 3) + (36 \times 1) + (4 \times 1) = 220$
B	
C	

The Borda Count

Ordered preferences	Votes
(A, B, C)	54
(A, C, B)	6
(B, C, A)	36
(C, B, A)	4

Candidate	Total points
A	$(54 \times 3) + (6 \times 3) + (36 \times 1) + (4 \times 1) = 220$
B	$(54 \times 2) + (6 \times 1) + (36 \times 3) + (4 \times 2) = 230$
C	

The Borda Count

Ordered preferences	Votes
(A, B, C)	54
(A, C, B)	6
(B, C, A)	36
(C, B, A)	4

Candidate	Total points
A	$(54 \times 3) + (6 \times 3) + (36 \times 1) + (4 \times 1) = 220$
B	$(54 \times 2) + (6 \times 1) + (36 \times 3) + (4 \times 2) = 230$
C	$(54 \times 1) + (6 \times 2) + (36 \times 2) + (4 \times 3) = 150$

The Borda Count

Ordered preferences	Votes
(A, B, C)	54
(A, C, B)	6
(B, C, A)	36
(C, B, A)	4

Candidate	Total points
A	$(54 \times 3) + (6 \times 3) + (36 \times 1) + (4 \times 1) = 220$
B	$(54 \times 2) + (6 \times 1) + (36 \times 3) + (4 \times 2) = 230$
C	$(54 \times 1) + (6 \times 2) + (36 \times 2) + (4 \times 3) = 150$

Even though C takes votes *away* from B, the mere presence of C in the election allows B to defeat A.

Condorcet's theory

Condorcet's theory

In 1785, the French Mathematician Marquis Nicolas de Condorcet published a treatise called *Essay on the Application of Analysis to the Probability of Majority Decisions*, which includes the following major ideas:

Condorcet's theory

In 1785, the French Mathematician Marquis Nicolas de Condorcet published a treatise called *Essay on the Application of Analysis to the Probability of Majority Decisions*, which includes the following major ideas:

- **Condorcet's jury theorem:** If each member of a voting group is more likely than not to make a correct decision, then the probability that the highest vote of the group is the correct decision increases as the number of group members increases.

Condorcet's theory

In 1785, the French Mathematician Marquis Nicolas de Condorcet published a treatise called *Essay on the Application of Analysis to the Probability of Majority Decisions*, which includes the following major ideas:

- **Condorcet's jury theorem:** If each member of a voting group is more likely than not to make a correct decision, then the probability that the highest vote of the group is the correct decision increases as the number of group members increases.
- **Condorcet's paradox:** With 3 or more candidates, majority preferences can become intransitive: The electorate may prefer A to B, B to C, and C to A. (This is called a *Condorcet cycle*.)

Condorcet's theory

The treatise also outlines the **Condorcet method**, which is designed to simulate all pairwise elections between all candidates.

Condorcet's theory

The treatise also outlines the **Condorcet method**, which is designed to simulate all pairwise elections between all candidates.

If some candidate would win all pairwise elections with all other candidates, that candidate is called the *Condorcet winner*. (But the existence of Condorcet cycles means that a Condorcet winner may not exist!)

Condorcet's theory

The treatise also outlines the **Condorcet method**, which is designed to simulate all pairwise elections between all candidates.

If some candidate would win all pairwise elections with all other candidates, that candidate is called the *Condorcet winner*. (But the existence of Condorcet cycles means that a Condorcet winner may not exist!)

Condorcet disagreed strongly with Borda's method, because it can fail to elect the Condorcet winner (if there is one).

Instant Runoff Voting (IRV)

Instant Runoff Voting (IRV)

Also known as “single-winner ranked choice voting,” “preferential voting,” or “transferable vote.”

Instant Runoff Voting (IRV)

Also known as “single-winner ranked choice voting,” “preferential voting,” or “transferable vote.”

This algorithm was proposed in 1871 by the American architect William Robert Ware:

Instant Runoff Voting (IRV)

Also known as "single-winner ranked choice voting," "preferential voting," or "transferable vote."

This algorithm was proposed in 1871 by the American architect William Robert Ware:

- Each voter ranks the list of candidates in order of their preference.

Instant Runoff Voting (IRV)

Also known as "single-winner ranked choice voting," "preferential voting," or "transferable vote."

This algorithm was proposed in 1871 by the American architect William Robert Ware:

- Each voter ranks the list of candidates in order of their preference.
- In the first round, all 1st place votes are counted. If no candidates receives over 50% of the vote, the candidate with the fewest votes is eliminated.

Instant Runoff Voting (IRV)

Also known as "single-winner ranked choice voting," "preferential voting," or "transferable vote."

This algorithm was proposed in 1871 by the American architect William Robert Ware:

- Each voter ranks the list of candidates in order of their preference.
- In the first round, all 1st place votes are counted. If no candidates receives over 50% of the vote, the candidate with the fewest votes is eliminated.
- In the second round, all ballots whose 1st place candidate has been eliminated are reassigned to their 2nd place candidates.

Instant Runoff Voting (IRV)

Also known as "single-winner ranked choice voting," "preferential voting," or "transferable vote."

This algorithm was proposed in 1871 by the American architect William Robert Ware:

- Each voter ranks the list of candidates in order of their preference.
- In the first round, all 1st place votes are counted. If no candidates receives over 50% of the vote, the candidate with the fewest votes is eliminated.
- In the second round, all ballots whose 1st place candidate has been eliminated are reassigned to their 2nd place candidates.
- The procedure is repeated until some candidate has over 50% of the vote, and then that candidate wins the election.

Instant Runoff Voting (IRV)

In an election with 3 candidates, this system is equivalent to a plurality vote with a runoff, but without the need to actually hold a second election.

Instant Runoff Voting (IRV)

In an election with 3 candidates, this system is equivalent to a plurality vote with a runoff, but without the need to actually hold a second election.

With 4 or more candidates, this system can produce different results from a standard runoff election.

Instant Runoff Voting (IRV)

This system is gaining in popularity as an alternative to the plurality system:

Instant Runoff Voting (IRV)

This system is gaining in popularity as an alternative to the plurality system:

- IRV has been used for the Australia's House of Representatives elections since 1919.

Instant Runoff Voting (IRV)

This system is gaining in popularity as an alternative to the plurality system:

- IRV has been used for the Australia's House of Representatives elections since 1919.
- In the U.K., the Labour Party and the Liberal Democrats use IRV to elect party leaders.

Instant Runoff Voting (IRV)

This system is gaining in popularity as an alternative to the plurality system:

- IRV has been used for the Australia's House of Representatives elections since 1919.
- In the U.K., the Labour Party and the Liberal Democrats use IRV to elect party leaders.
- Several U.S. cities (e.g., San Francisco, Minneapolis, and Portland, Maine) use IRV in mayoral elections.

Instant Runoff Voting (IRV)

This system is gaining in popularity as an alternative to the plurality system:

- IRV has been used for the Australia's House of Representatives elections since 1919.
- In the U.K., the Labour Party and the Liberal Democrats use IRV to elect party leaders.
- Several U.S. cities (e.g., San Francisco, Minneapolis, and Portland, Maine) use IRV in mayoral elections.
- In November 2019, New York City voted to adopt IRV for primary and special elections for several city offices.

Instant Runoff Voting (IRV)

- In 2016, voters in Maine approved a referendum to implement (single-winner) ranked-choice voting—i.e., IRV—for statewide elections. The state Supreme Court first ruled that this system violated the state constitution, but then reversed itself in April 2018. It was used for the first time in June 2018 in Maine's primary election.

Instant Runoff Voting (IRV)

- In 2016, voters in Maine approved a referendum to implement (single-winner) ranked-choice voting—i.e., IRV—for statewide elections. The state Supreme Court first ruled that this system violated the state constitution, but then reversed itself in April 2018. It was used for the first time in June 2018 in Maine's primary election.
- Maine voters also affirmed in June 2018 (55% to 45%) that the state will continue using IRV, effective immediately, and it was used again in the general election for Maine's U.S. Congressional House and Senate seats in November 2018.

Instant Runoff Voting (IRV)

Style No.

State of Maine Sample Ballot
Republican Primary Election, June 12, 2018
for

Instructions to Voters

To vote, fill in the oval like this ●

To rank your candidate choices, fill in the oval:

- In the 1st column for your 1st choice candidate.
- In the 2nd column for your 2nd choice candidate, and so on.

Continue until you have ranked as many or as few candidates as you like.

Fill in no more than one oval for each candidate or column.

To rank a write-in candidate, write the person's name in the write-in space and fill in the oval for the ranking of your choice.

Governor	1st Choice	2nd Choice	3rd Choice	4th Choice	5th Choice
Fredette, Kenneth Wade Newport	0	0	0	0	0
Mason, Garrett Paul Lisbon	0	0	0	0	0
Mayhew, Mary C. China	0	0	0	0	0
Moody, Shawn H. Gorham	0	0	0	0	0
Write-in	0	0	0	0	0

Rep. to the Legislature District 75	1st Choice	2nd Choice	3rd Choice	4th Choice
Morris, Joshua K. Turner	0	0	0	0
Pape, John Alexander Turner	0	0	0	0
Terreri, Angelo Turner	0	0	0	0
Write-in	0	0	0	0

Turn Over for Additional Contests

Instant Runoff Voting (IRV)

Advantages:

Instant Runoff Voting (IRV)

Advantages:

- Reduces the impact of "spoiler" candidates, while still allowing voters to show support for minor candidates without "wasting" their vote.

Instant Runoff Voting (IRV)

Advantages:

- Reduces the impact of "spoiler" candidates, while still allowing voters to show support for minor candidates without "wasting" their vote.
- Easy to explain to voters, legislators, judges.

Instant Runoff Voting (IRV)

Advantages:

- Reduces the impact of "spoiler" candidates, while still allowing voters to show support for minor candidates without "wasting" their vote.
- Easy to explain to voters, legislators, judges.
- Relatively resistant to tactical manipulation by strategic ranking.

Instant Runoff Voting (IRV)

Advantages:

- Reduces the impact of "spoiler" candidates, while still allowing voters to show support for minor candidates without "wasting" their vote.
- Easy to explain to voters, legislators, judges.
- Relatively resistant to tactical manipulation by strategic ranking.
- May inspire more positive campaigning, as candidates aim to become voters' second and third choices instead of attacking their opponents.

Instant Runoff Voting (IRV)

Disadvantages:

Instant Runoff Voting (IRV)

Disadvantages:

- Candidates who have broad support as a 2nd place choice may be eliminated early, as in our runoff example.

Instant Runoff Voting (IRV)

Disadvantages:

- Candidates who have broad support as a 2nd place choice may be eliminated early, as in our runoff example.
- It is possible that a candidate who would win all head-to-head contests among the candidates (i.e., a Condorcet winner) may not win the election.

Instant Runoff Voting (IRV)

Disadvantages:

- Candidates who have broad support as a 2nd place choice may be eliminated early, as in our runoff example.
- It is possible that a candidate who would win all head-to-head contests among the candidates (i.e., a Condorcet winner) may not win the election.
- When some voters do not rank all candidates and their ballots become "exhausted," it is possible that the eventual winner still does not receive a majority of votes cast.

Instant Runoff Voting (IRV)

Disadvantages:

- Candidates who have broad support as a 2nd place choice may be eliminated early, as in our runoff example.
- It is possible that a candidate who would win all head-to-head contests among the candidates (i.e., a Condorcet winner) may not win the election.
- When some voters do not rank all candidates and their ballots become "exhausted," it is possible that the eventual winner still does not receive a majority of votes cast.
  - In 2018, Jared Golden won Maine's 2nd Congressional District election with 49.18% of votes cast.

Instant Runoff Voting (IRV)

Disadvantages:

- Candidates who have broad support as a 2nd place choice may be eliminated early, as in our runoff example.
- It is possible that a candidate who would win all head-to-head contests among the candidates (i.e., a Condorcet winner) may not win the election.
- When some voters do not rank all candidates and their ballots become "exhausted," it is possible that the eventual winner still does not receive a majority of votes cast.
  - In 2018, Jared Golden won Maine's 2nd Congressional District election with 49.18% of votes cast.
  - In 2018, London Breed won a special election for San Francisco mayor with 46.2% of votes cast.

Instant Runoff Voting (IRV)

Disadvantages:

- Candidates who have broad support as a 2nd place choice may be eliminated early, as in our runoff example.
- It is possible that a candidate who would win all head-to-head contests among the candidates (i.e., a Condorcet winner) may not win the election.
- When some voters do not rank all candidates and their ballots become "exhausted," it is possible that the eventual winner still does not receive a majority of votes cast.
  - In 2018, Jared Golden won Maine's 2nd Congressional District election with 49.18% of votes cast.
  - In 2018, London Breed won a special election for San Francisco mayor with 46.2% of votes cast.
- Tallying must be centralized and requires ALL ballots before declaring a winner.

Instant Runoff Voting (IRV)

A cautionary tale: The 2009 Burlington, VT mayoral election

Instant Runoff Voting (IRV)

A cautionary tale: The 2009 Burlington, VT mayoral election

The 2009 mayoral election of Burlington, VT was conducted by IRV and featured 3 main candidates:

1. Kurt Wright (Republican)
2. Andy Montroll (Democrat)
3. Bob Kiss (Progressive, and the incumbent)

Instant Runoff Voting (IRV)

Excluding minor candidates who did not affect the vote, the ballot count was as follows:

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

Instant Runoff Voting (IRV)

Excluding minor candidates who did not affect the vote, the ballot count was as follows:

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

First round tally: Wright 3297, Kiss 2982, Montroll 2554.
So Montroll is eliminated.

Instant Runoff Voting (IRV)

Excluding minor candidates who did not affect the vote, the ballot count was as follows:

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

First round tally: Wright 3297, Kiss 2982, Montroll 2554.
So Montroll is eliminated.

Second round tally: Kiss 4314, Wright 4064.
So Kiss is elected.

Instant Runoff Voting (IRV)

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

But this seems a little bit strange! In head-to-head matchups:

Instant Runoff Voting (IRV)

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

But this seems a little bit strange! In head-to-head matchups:

- 4067 voters preferred Montroll to Kiss, while 3477 preferred Kiss to Montroll.

Instant Runoff Voting (IRV)

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

But this seems a little bit strange! In head-to-head matchups:

- 4067 voters preferred Montroll to Kiss, while 3477 preferred Kiss to Montroll.
- 4597 voters preferred Montroll to Wright, while 3668 preferred Wright to Montroll.

Instant Runoff Voting (IRV)

Ranking	Votes	Ranking	Votes	Ranking	Votes
(M, K, W)	1332	(K, M, W)	2043	(W, M, K)	1513
(M, W, K)	767	(K, W, M)	371	(W, K, M)	495
(M)	455	(K)	568	(W)	1289

But this seems a little bit strange! In head-to-head matchups:

- 4067 voters preferred Montroll to Kiss, while 3477 preferred Kiss to Montroll.
- 4597 voters preferred Montroll to Wright, while 3668 preferred Wright to Montroll.

So Montroll was the Condorcet winner – but he was eliminated in the first round!

Instant Runoff Voting (IRV)

So we have the following strange situation:

Instant Runoff Voting (IRV)

So we have the following strange situation:

- With a plurality vote, Wright would win.

Instant Runoff Voting (IRV)

So we have the following strange situation:

- With a plurality vote, Wright would win.
- With head-to-head matchups, Montroll would win.

Instant Runoff Voting (IRV)

So we have the following strange situation:

- With a plurality vote, Wright would win.
- With head-to-head matchups, Montroll would win.
- With IRV, Kiss would—and did!—win.

Instant Runoff Voting (IRV)

So we have the following strange situation:

- With a plurality vote, Wright would win.
- With head-to-head matchups, Montroll would win.
- With IRV, Kiss would—and did!—win.

Incidentally, a Borda count (assuming ties for candidates not ranked) gives
Montroll 18,425.5, Kiss 17,496, Wright 17,076.5.

Instant Runoff Voting (IRV)

So we have the following strange situation:

- With a plurality vote, Wright would win.
- With head-to-head matchups, Montroll would win.
- With IRV, Kiss would—and did!—win.

Incidentally, a Borda count (assuming ties for candidates not ranked) gives
Montroll 18,425.5, Kiss 17,496, Wright 17,076.5.

Aftermath: In 2010, Burlington repealed IRV by a vote of 52% to 48%.

Arrow's Theorem

So, if all of these methods have problems, could there possibly be a better way that takes all of this into account?

Arrow's Theorem

So, if all of these methods have problems, could there possibly be a better way that takes all of this into account?

In his 1951 Ph.D. thesis, Kenneth Arrow proved the following theorem, which helped earn him the 1972 Nobel Prize in Economics:

Arrow's Theorem

Arrow's Theorem: Consider the following conditions on a voting system:

Arrow's Theorem

Arrow's Theorem: Consider the following conditions on a voting system:

1. Each voter's rankings of the candidates forms a complete, strict, transitive ranking.

Arrow's Theorem

Arrow's Theorem: Consider the following conditions on a voting system:

1. Each voter's rankings of the candidates forms a complete, strict, transitive ranking.
2. *Pareto condition:* If all voters share the same ranking of a pair of candidates, then the common ranking should be consistent with the election outcome.

Arrow's Theorem

Arrow's Theorem: Consider the following conditions on a voting system:

1. Each voter's rankings of the candidates forms a complete, strict, transitive ranking.
2. *Pareto condition:* If all voters share the same ranking of a pair of candidates, then the common ranking should be consistent with the election outcome.
3. *Independence from irrelevant alternatives:* If every voter's preference between A and B remains unchanged, then the group ranking of A and B should remain unchanged, even if preferences involving other candidates (e.g., A vs. C) change.

Arrow's Theorem

Arrow's Theorem: Consider the following conditions on a voting system:

1. Each voter's rankings of the candidates forms a complete, strict, transitive ranking.
2. *Pareto condition:* If all voters share the same ranking of a pair of candidates, then the common ranking should be consistent with the election outcome.
3. *Independence from irrelevant alternatives:* If every voter's preference between A and B remains unchanged, then the group ranking of A and B should remain unchanged, even if preferences involving other candidates (e.g., A vs. C) change.

The only procedure that satisfies these conditions is dictatorship.

Ordinal vs. Cardinal methods

Arrow's Theorem applies to any **ranked voting system**, where voters must rank the candidates in order. Such a system is also called an **ordinal system**.

Ordinal vs. Cardinal methods

Arrow's Theorem applies to any **ranked voting system**, where voters must rank the candidates in order. Such a system is also called an **ordinal system**.

An alternative is a **cardinal system**, where voters give each candidate an independent rating or grade.

Approval Voting

The simplest cardinal method is called **approval voting**. This system was developed in 1971 by Robert Weber as part of his Ph.D. thesis.

Approval Voting

The simplest cardinal method is called **approval voting**. This system was developed in 1971 by Robert Weber as part of his Ph.D. thesis.

Each voter votes for as many candidates as they choose, with no ranking of candidates, and the candidate with the most votes wins.

Approval Voting

- Approval voting has been used since the mid-1980's by the American Mathematical Society and the Mathematical Association of America in their elections.

Approval Voting

- Approval voting has been used since the mid-1980's by the American Mathematical Society and the Mathematical Association of America in their elections.
- Approval voting is used for internal elections by the Green Party in Texas and Ohio, the Libertarian Party in Texas, and the U.S. Modern Whig Party.

Approval Voting

- Approval voting has been used since the mid-1980's by the American Mathematical Society and the Mathematical Association of America in their elections.
- Approval voting is used for internal elections by the Green Party in Texas and Ohio, the Libertarian Party in Texas, and the U.S. Modern Whig Party.
- In 2018, Fargo, ND adopted approval voting for its future elections for city officials.

Approval Voting

Advantages:

Approval Voting

Advantages:

- Avoids the spoiler effect of plurality elections while still being quick and easy to calculate.

Approval Voting

Advantages:

- Avoids the spoiler effect of plurality elections while still being quick and easy to calculate.
- Like Borda count, tends to favor candidates with broad appeal.

Approval Voting

Advantages:

- Avoids the spoiler effect of plurality elections while still being quick and easy to calculate.
- Like Borda count, tends to favor candidates with broad appeal.
- Gives minor parties greater visibility and may help them grow in support.

Approval Voting

Advantages:

- Avoids the spoiler effect of plurality elections while still being quick and easy to calculate.
- Like Borda count, tends to favor candidates with broad appeal.
- Gives minor parties greater visibility and may help them grow in support.
- Allows a voter to be more expressive by choosing how many candidates to vote for.

Approval Voting

Disadvantages:

Approval Voting

Disadvantages:

- As with IRV, it is possible that the winning candidate receives less than 50% approval, and so lacks a perceived mandate.

Approval Voting

Disadvantages:

- As with IRV, it is possible that the winning candidate receives less than 50% approval, and so lacks a perceived mandate.
- Vulnerable to tactical manipulation by, e.g., bullet voting (i.e., only voting for one candidate), where it essentially reduces to plurality voting if enough voters do this.

Score/STAR Voting

Score voting is a more nuanced cardinal method, where voters can rate each candidate on an integer scale, typically from 0 to 5 or 0 to 9. The candidate with the highest total score wins.

Score/STAR Voting

Score voting is a more nuanced cardinal method, where voters can rate each candidate on an integer scale, typically from 0 to 5 or 0 to 9. The candidate with the highest total score wins.

A variation called **STAR (Score Then Automatic Runoff)** has two steps:

Score/STAR Voting

Score voting is a more nuanced cardinal method, where voters can rate each candidate on an integer scale, typically from 0 to 5 or 0 to 9. The candidate with the highest total score wins.

A variation called **STAR (Score Then Automatic Runoff)** has two steps:

1. Use score voting to identify the top two candidates.

Score/STAR Voting

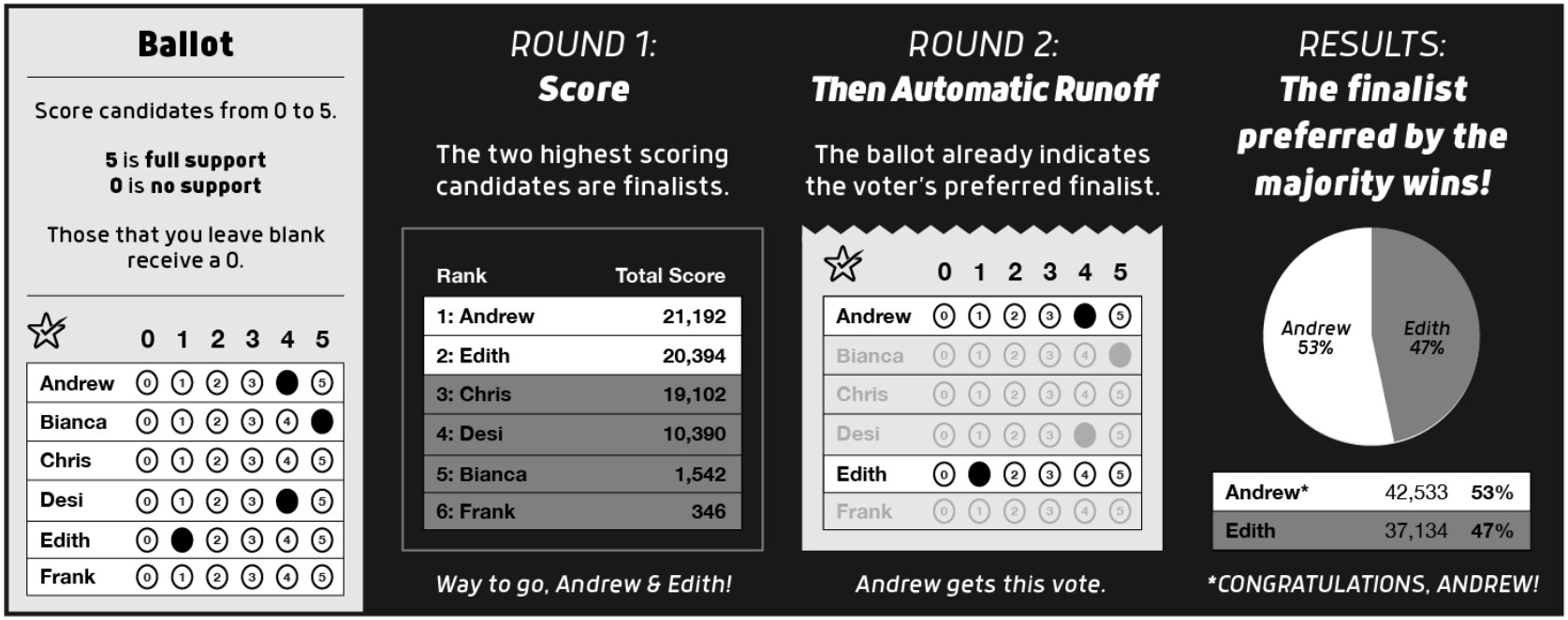
Score voting is a more nuanced cardinal method, where voters can rate each candidate on an integer scale, typically from 0 to 5 or 0 to 9. The candidate with the highest total score wins.

A variation called **STAR (Score Then Automatic Runoff)** has two steps:

1. Use score voting to identify the top two candidates.
2. Of these two candidates, the one who is preferred by most voters wins the election.

How does STAR Voting work?

Voters rate candidates, and ballots are counted in a two step process: **Score, Then Automatic Runoff. [STAR]**



www.starvoting.us

Score/STAR Voting

STAR voting was first proposed in October 2014 by Mark Frohnmayer.

Score/STAR Voting

STAR voting was first proposed in October 2014 by Mark Frohnmayer.

The runoff step was introduced in order to reduce strategic incentives in ordinary score voting, such as bullet voting.

Score/STAR Voting

STAR voting was first proposed in October 2014 by Mark Frohnmayer.

The runoff step was introduced in order to reduce strategic incentives in ordinary score voting, such as bullet voting.

A ballot measure to introduce STAR voting in Lane County, Oregon narrowly failed in November 2018 (47.6% yes vs. 52.4% no). Supporters hope to try again in 2020.

Score/STAR Voting

Advantages:

Score/STAR Voting

Advantages:

- Many of the same advantages as approval voting, and gives voters the ability to be even more expressive.

Score/STAR Voting

Advantages:

- Many of the same advantages as approval voting, and gives voters the ability to be even more expressive.
- The runoff step reduces some of the strategic incentives in ordinary score voting.

Score/STAR Voting

Advantages:

- Many of the same advantages as approval voting, and gives voters the ability to be even more expressive.
- The runoff step reduces some of the strategic incentives in ordinary score voting.

Disadvantages:

Score/STAR Voting

Advantages:

- Many of the same advantages as approval voting, and gives voters the ability to be even more expressive.
- The runoff step reduces some of the strategic incentives in ordinary score voting.

Disadvantages:

- STAR voting is a very new method, and its pros and cons are still being debated. For more info, see https://www.equal.vote/

Score/STAR Voting

While approval and score methods are not subject to Arrow's Theorem, they remain subject to **Gibbard's Theorem**, which states that **any** deterministic decision process must satisfy at least one of the three following properties:

Score/STAR Voting

While approval and score methods are not subject to Arrow's Theorem, they remain subject to **Gibbard's Theorem**, which states that **any** deterministic decision process must satisfy at least one of the three following properties:

1. The process is dictatorial, i.e., there exists a distinguished agent who can impose the outcome.

Score/STAR Voting

While approval and score methods are not subject to Arrow's Theorem, they remain subject to **Gibbard's Theorem**, which states that **any** deterministic decision process must satisfy at least one of the three following properties:

1. The process is dictatorial, i.e., there exists a distinguished agent who can impose the outcome.
2. The process limits the possible outcomes to two options only.

Score/STAR Voting

While approval and score methods are not subject to Arrow's Theorem, they remain subject to **Gibbard's Theorem**, which states that **any** deterministic decision process must satisfy at least one of the three following properties:

1. The process is dictatorial, i.e., there exists a distinguished agent who can impose the outcome.
2. The process limits the possible outcomes to two options only.
3. The process encourages agents to think strategically: Once an agent has identified their preferences, they have no action at their disposal that would best defend their opinions in every situation.

Multi-winner elections

Multi-winner elections

Boulder City Council elections are conducted by **plurality-at-large voting**.

Multi-winner elections

Boulder City Council elections are conducted by **plurality-at-large voting**.

In this system, all candidates run against each other for some number N of positions, and each voter may select up to N candidates on the ballot.

Multi-winner elections

Boulder City Council elections are conducted by **plurality-at-large voting**.

In this system, all candidates run against each other for some number N of positions, and each voter may select up to N candidates on the ballot.

The N candidates with the most votes (who may or may not receive votes on a majority of the ballots) are elected.

Multi-winner elections

This system is problematic for a number of reasons:

Multi-winner elections

This system is problematic for a number of reasons:

- Like ordinary plurality voting, it is particularly vulnerable to tactical voting.

Multi-winner elections

This system is problematic for a number of reasons:

- Like ordinary plurality voting, it is particularly vulnerable to tactical voting.
- Parties or factions are incentivized to nominate exactly the same number of candidates as the number of seats in order to avoid vote-splitting.

Multi-winner elections

This system is problematic for a number of reasons:

- Like ordinary plurality voting, it is particularly vulnerable to tactical voting.
- Parties or factions are incentivized to nominate exactly the same number of candidates as the number of seats in order to avoid vote-splitting.
- It strongly disfavors minority representation: A typical result is that the most popular party or faction wins all the seats.

Multi-winner elections

Example: Back to the Alphas and Betas! Suppose that there are 6 seats up for election, and the Alphas (with 60% voter support) run exactly 6 candidates $A_1, ..., A_6$.

Multi-winner elections

Example: Back to the Alphas and Betas! Suppose that there are 6 seats up for election, and the Alphas (with 60% voter support) run exactly 6 candidates $A_1, ..., A_6$.

Assuming that all (or even most) of the Alpha voters vote for all 6 candidates, there is no strategy for the Betas to win even a single seat, regardless of how many candidates they run.

Multi-winner elections

Example: Back to the Alphas and Betas! Suppose that there are 6 seats up for election, and the Alphas (with 60% voter support) run exactly 6 candidates $A_1, ..., A_6$.

Assuming that all (or even most) of the Alpha voters vote for all 6 candidates, there is no strategy for the Betas to win even a single seat, regardless of how many candidates they run.

So the Betas have 40% voter support, but they gain no representation.

Multi-winner elections

Once again, this is not a theoretical problem!

Multi-winner elections

Once again, this is not a theoretical problem!

The city of Lowell, MA chooses its City Council by plurality-at-large voting. In 2017, the city was sued by minority voters who claimed that this system of voting violates their voting rights by preventing minority representation on the Council.

Multi-winner elections

Once again, this is not a theoretical problem!

The city of Lowell, MA chooses its City Council by plurality-at-large voting. In 2017, the city was sued by minority voters who claimed that this system of voting violates their voting rights by preventing minority representation on the Council.

The community is over 40% Asian and Hispanic, but there have only been 2 people of color elected to the 9-member City Council in the last 20 years.

Multi-winner elections

In 2019, Lowell agreed to change its election method for City Council, and in November 2019 voters were asked to choose between two options:

Multi-winner elections

In 2019, Lowell agreed to change its election method for City Council, and in November 2019 voters were asked to choose between two options:

1. One that uses **single transferable vote (STV)**, a multi-winner version of ranked choice voting, or

Multi-winner elections

In 2019, Lowell agreed to change its election method for City Council, and in November 2019 voters were asked to choose between two options:

1. One that uses **single transferable vote (STV)**, a multi-winner version of ranked choice voting, or
2. A hybrid system that uses a combination of districts and at-large seats.

Multi-winner elections

An extensive analysis of both options was performed by the Metric Geometry and Gerrymandering Group at Tufts University; the full report may be found at https://mggg.org/uploads/Lowell-Report.pdf.

Multi-winner elections

An extensive analysis of both options was performed by the Metric Geometry and Gerrymandering Group at Tufts University; the full report may be found at https://mggg.org/uploads/Lowell-Report.pdf.

Their primary conclusions were that:

Multi-winner elections

An extensive analysis of both options was performed by the Metric Geometry and Gerrymandering Group at Tufts University; the full report may be found at https://mggg.org/uploads/Lowell-Report.pdf.

Their primary conclusions were that:

- Because the Asian and Latino populations are fairly dispersed throughout the city, it would be difficult to draw districts that would result in significant representation for people of color; even with optimally drawn districts, minority representation would likely be at most 1-2 seats.

Multi-winner elections

An extensive analysis of both options was performed by the Metric Geometry and Gerrymandering Group at Tufts University; the full report may be found at https://mggg.org/uploads/Lowell-Report.pdf.

Their primary conclusions were that:

- Because the Asian and Latino populations are fairly dispersed throughout the city, it would be difficult to draw districts that would result in significant representation for people of color; even with optimally drawn districts, minority representation would likely be at most 1-2 seats.
- They estimated that an STV system would likely produce minority representation of 2-4 seats, even with low voter turnout.

Multi-winner elections

Voters were asked to express their preferences for or against both systems; the final decision of which system to adopt will be made by the current City Council in December.

Multi-winner elections

Voters were asked to express their preferences for or against both systems; the final decision of which system to adopt will be made by the current City Council in December.

Voters clearly preferred the hybrid system, with 60% in favor and 40% opposed.

Multi-winner elections

Voters were asked to express their preferences for or against both systems; the final decision of which system to adopt will be made by the current City Council in December.

Voters clearly preferred the hybrid system, with 60% in favor and 40% opposed.

Voters opposed the STV system, with 49% in favor and 51% opposed. The director of the Cambodian Mutual Assistance Association said that the system "was too complex, even for people who vote year after year."

Multi-winner elections

Example: Now suppose that the election for 6 seats is conducted by STV. Suppose that the Alphas and Betas each run 6 candidates, and all voters for each party rank the candidates in the same way. (Again, we assume 100 voters for simplicity.)

Multi-winner elections

Example: Now suppose that the election for 6 seats is conducted by STV. Suppose that the Alphas and Betas each run 6 candidates, and all voters for each party rank the candidates in the same way. (Again, we assume 100 voters for simplicity.)

The vote threshold to win a seat is $\frac{1}{6+1} = \frac{1}{7}$ of votes cast, so it takes 15 votes to win a seat.

Round 1:

Ordered preferences	Votes
$(A_1, A_2, A_3, A_4, A_5, A_6)$	60
$(B_1, B_2, B_3, B_4, B_5, B_6)$	40

Round 1:

Ordered preferences	Votes
$(A_1, A_2, A_3, A_4, A_5, A_6)$	60
$(B_1, B_2, B_3, B_4, B_5, B_6)$	40

- In the first round, A_1 has the most first-place votes (60), so A_1 is elected. This election uses up 15 votes, and the 45 remaining Alpha ballots are transferred to their next-favorite candidate.

Round 2: A_1 already elected.

Ordered preferences	Votes
$(A_2, A_3, A_4, A_5, A_6)$	45
$(B_1, B_2, B_3, B_4, B_5, B_6)$	40

Round 2: A_1 already elected.

Ordered preferences	Votes
$(A_2, A_3, A_4, A_5, A_6)$	45
$(B_1, B_2, B_3, B_4, B_5, B_6)$	40

- In the second round, A_2 has the most first-place votes (45), so A_2 is elected. This election uses up 15 votes, and the 30 remaining Alpha ballots are transferred to their next-favorite candidate.

Round 3: A_1 and A_2 already elected.

Ordered preferences	Votes
(A_3, A_4, A_5, A_6)	30
$(B_1, B_2, B_3, B_4, B_5, B_6)$	40

Round 3: A_1 and A_2 already elected.

Ordered preferences	Votes
(A_3, A_4, A_5, A_6)	30
$(B_1, B_2, B_3, B_4, B_5, B_6)$	40

- In the third round, B_1 has the most first-place votes (40), so B_1 is elected. This election uses up 15 votes, and the 25 remaining Beta ballots are transferred to their next-favorite candidate.

Round 4: A_1, A_2, and B_1 already elected.

Ordered preferences	Votes
(A_3, A_4, A_5, A_6)	30
$(B_2, B_3, B_4, B_5, B_6)$	25

Round 4: A_1, A_2, and B_1 already elected.

Ordered preferences	Votes
(A_3, A_4, A_5, A_6)	30
$(B_2, B_3, B_4, B_5, B_6)$	25

- In the fourth round, A_3 has the most first-place votes (30), so A_3 is elected. This election uses up 15 votes, and the 15 remaining Alpha ballots are transferred to their next-favorite candidate.

Round 5: A_1, A_2, B_1, and A_3 already elected.

Ordered preferences	Votes
(A_4, A_5, A_6)	15
$(B_2, B_3, B_4, B_5, B_6)$	25

Round 5: A_1, A_2, B_1, and A_3 already elected.

Ordered preferences	Votes
(A_4, A_5, A_6)	15
$(B_2, B_3, B_4, B_5, B_6)$	25

- In the fifth round, B_2 has the most first-place votes (25), so B_2 is elected. This election uses up 15 votes, and the 10 remaining Beta ballots are transferred to their next-favorite candidate.

Round 6: A_1, A_2, B_1, A_3, and B_2 already elected.

Ordered preferences	Votes
(A_4, A_5, A_6)	15
(B_3, B_4, B_5, B_6)	10

Round 6: A_1, A_2, B_1, A_3, and B_2 already elected.

Ordered preferences	Votes
(A_4, A_5, A_6)	15
(B_3, B_4, B_5, B_6)	10

- In the sixth round, A_4 has 15 votes and so wins the last seat.

Round 6: A_1, A_2, B_1, A_3, and B_2 already elected.

Ordered preferences	Votes
(A_4, A_5, A_6)	15
(B_3, B_4, B_5, B_6)	10

- In the sixth round, A_4 has 15 votes and so wins the last seat.

Final result: A_1, A_2, B_1, A_3, B_2, and A_4 are elected, in that order. So the Alphas win 4 seats and the Betas win 2 seats.

Advantages of STV:

Advantages of STV:

- Tends to provide approximately proportional representation; in particular, it significantly improves minority representation.

Advantages of STV:

- Tends to provide approximately proportional representation; in particular, it significantly improves minority representation.
- Reduces "wasted" votes, both for losing candidates and for surplus votes for winning candidates.

Multi-winner elections

Advantages of STV:

- Tends to provide approximately proportional representation; in particular, it significantly improves minority representation.
- Reduces "wasted" votes, both for losing candidates and for surplus votes for winning candidates.

Disadvantages of STV:

Multi-winner elections

Advantages of STV:

- Tends to provide approximately proportional representation; in particular, it significantly improves minority representation.
- Reduces "wasted" votes, both for losing candidates and for surplus votes for winning candidates.

Disadvantages of STV:

- Most of the same issues as IRV.

Multi-winner elections

Advantages of STV:

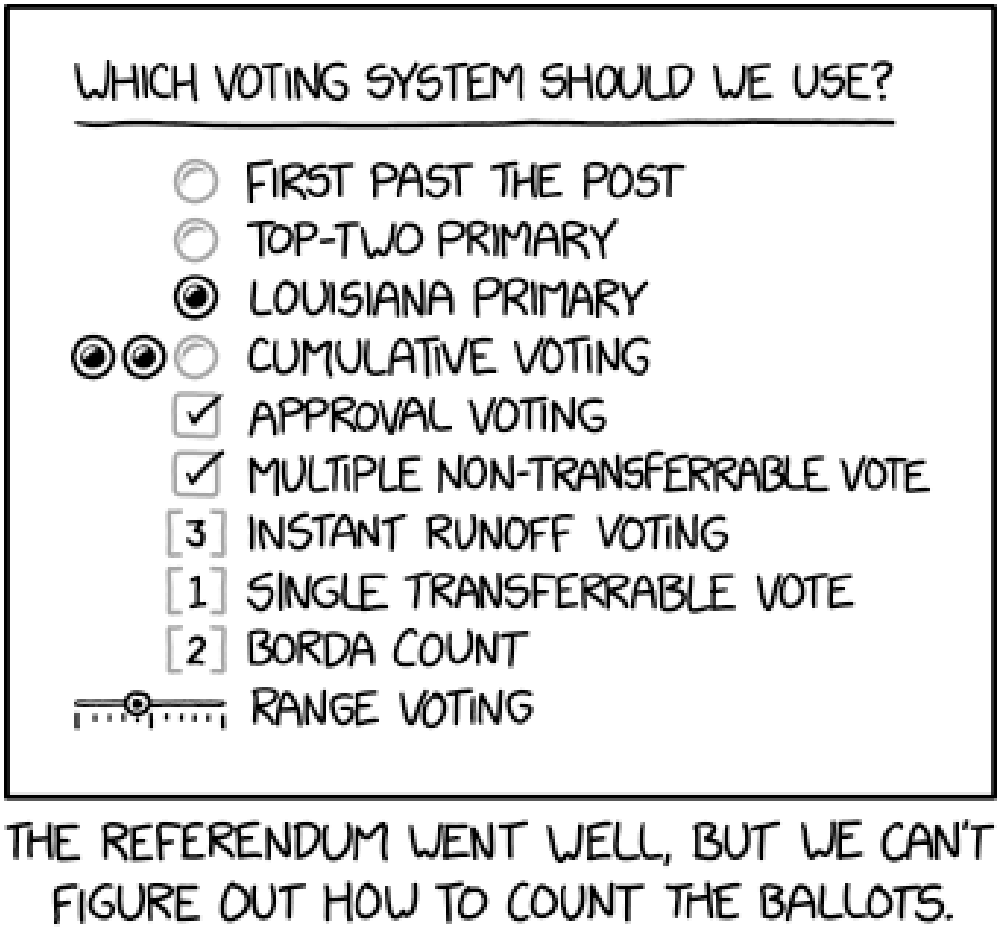
- Tends to provide approximately proportional representation; in particular, it significantly improves minority representation.
- Reduces "wasted" votes, both for losing candidates and for surplus votes for winning candidates.

Disadvantages of STV:

- Most of the same issues as IRV.
- The counting method is complicated and difficult to explain to voters.

Where do we go from here?

Where do we go from here?



(Credit: https://xkcd.com/2225/)

Where do we go from here?

Since we can't have everything, we have to make non-mathematical choices about what factors to prioritize.

Where do we go from here?

Since we can't have everything, we have to make non-mathematical choices about what factors to prioritize.

- Simplicity: Is the method transparent to voters, legislatures, and courts?

Where do we go from here?

Since we can't have everything, we have to make non-mathematical choices about what factors to prioritize.

- Simplicity: Is the method transparent to voters, legislatures, and courts?
- Who are the winners and losers?

Where do we go from here?

Since we can't have everything, we have to make non-mathematical choices about what factors to prioritize.

- Simplicity: Is the method transparent to voters, legislatures, and courts?
- Who are the winners and losers?
- What do we want to achieve: Is the election of more moderate candidates with broad (but perhaps less passionate) support desirable?

Where do we go from here?

Since we can't have everything, we have to make non-mathematical choices about what factors to prioritize.

- Simplicity: Is the method transparent to voters, legislatures, and courts?
- Who are the winners and losers?
- What do we want to achieve: Is the election of more moderate candidates with broad (but perhaps less passionate) support desirable?
- What is politically practical to implement?

Where do we go from here?

Since we can't have everything, we have to make non-mathematical choices about what factors to prioritize.

- Simplicity: Is the method transparent to voters, legislatures, and courts?
- Who are the winners and losers?
- What do we want to achieve: Is the election of more moderate candidates with broad (but perhaps less passionate) support desirable?
- What is politically practical to implement?

Don't let the perfect be the enemy of the good!

For further reading:

- Donald Saari, *Chaotic Elections! A Mathematician Looks at Voting*
- Jordan Ellenberg, *How Not to Be Wrong: The Power of Mathematical Thinking*, Chapter 17: "There is no such thing as public opinion"
- Jonathan Hodge and Richard Klima, *The Mathematics of Voting and Elections: A Hands-On Approach*
- George G. Szpiro, *Numbers Rule: The Vexing Mathematics of Democracy, from Plato to the Present*