Cloning

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  - A' is just slightly less popular than A

Cloning

- Cloning is the introduction of a new candidate A' that is similar to candidate A
  - A' is just slightly less popular than A
  - Effect is that people will place A' just under A on a list of preferences

Cloning

- In a plurality vote, what happens when a candidate is cloned?

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  - Vote splitting

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  - Vote splitting
  - The candidate should receive about half as many votes as before
  - This is why political parties hold primaries
  - Plurality is said to be **cloning negative**

Cloning

- In an instant runoff, what happens when a candidate is cloned?

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  - Example: consider the following list of preferences:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	A
3^{rd} **choice**	C	A	B

Cloning

- In an instant runoff, what happens when a candidate is cloned?
  - Example: consider the following list of preferences:

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  - Who wins (using instant runoff)?

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    - A

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3^{rd} **choice**	C	A	B

  - Who wins (using instant runoff)?
    - A
  - Now suppose that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

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  - Who wins (using instant runoff)?
    - A
  - Now suppose that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

  - Who wins (using instant runoff)?
    - Still A

Cloning

- Suppose instead that C is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	C'
3^{rd} **choice**	C	C'	A
4^{th} **choice**	C'	A	B

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- Suppose instead that C is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	C'
3^{rd} **choice**	C	C'	A
4^{th} **choice**	C'	A	B

- Who wins (using instant runoff)?

Cloning

- Suppose instead that C is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	C'
3^{rd} **choice**	C	C'	A
4^{th} **choice**	C'	A	B

- Who wins (using instant runoff)?
  - Still A

Cloning

- Suppose instead that C is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	C'
3^{rd} **choice**	C	C'	A
4^{th} **choice**	C'	A	B

- Who wins (using instant runoff)?
  - Still A
- In an instant runoff, the clone will be eliminated immediately

Cloning

- Suppose instead that C is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	C'
3^{rd} **choice**	C	C'	A
4^{th} **choice**	C'	A	B

- Who wins (using instant runoff)?
  - Still A
- In an instant runoff, the clone will be eliminated immediately
- Plurality is said to be **cloning neutral**

Cloning

- When using the Borda method, what happens when a candidate is cloned?

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2^{nd} **choice**	B	C	A
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  - Who wins (using the Borda method)?
    - A gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points

Cloning

- When using the Borda method, what happens when a candidate is cloned?
  - Example: consider the following list of preferences:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	A
3^{rd} **choice**	C	A	B

  - Who wins (using the Borda method)?
    - A gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
    - B gets $10 \cdot 3 + 11 \cdot 2 + 8 \cdot 1 = 60$ points

Cloning

- When using the Borda method, what happens when a candidate is cloned?
  - Example: consider the following list of preferences:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	A
3^{rd} **choice**	C	A	B

  - Who wins (using the Borda method)?
    - A gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
    - B gets $10 \cdot 3 + 11 \cdot 2 + 8 \cdot 1 = 60$ points
    - C gets $8 \cdot 3 + 10 \cdot 2 + 11 \cdot 1 = 55$ points

Cloning

- When using the Borda method, what happens when a candidate is cloned?
  - Example: consider the following list of preferences:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	C	A
3^{rd} **choice**	C	A	B

  - Who wins (using the Borda method)?
    - A gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
    - B gets $10 \cdot 3 + 11 \cdot 2 + 8 \cdot 1 = 60$ points
    - C gets $8 \cdot 3 + 10 \cdot 2 + 11 \cdot 1 = 55$ points
    - B wins

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 1 = 78$ points

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 1 = 78$ points
  - B gets $10 \cdot 4 + 11 \cdot 3 + 8 \cdot 2 = 89$ points

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 1 = 78$ points
  - B gets $10 \cdot 4 + 11 \cdot 3 + 8 \cdot 2 = 89$ points
  - B' gets $10 \cdot 3 + 11 \cdot 2 + 8 \cdot 1 = 60$ points

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 1 = 78$ points
  - B gets $10 \cdot 4 + 11 \cdot 3 + 8 \cdot 2 = 89$ points
  - B' gets $10 \cdot 3 + 11 \cdot 2 + 8 \cdot 1 = 60$ points
  - C gets $8 \cdot 4 + 10 \cdot 2 + 11 \cdot 1 = 63$ points

Cloning

- Now suppose that B is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	B	B'	A
3^{rd} **choice**	B'	C	B
4^{th} **choice**	C	A	B'

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 1 = 78$ points
  - B gets $10 \cdot 4 + 11 \cdot 3 + 8 \cdot 2 = 89$ points
  - B' gets $10 \cdot 3 + 11 \cdot 2 + 8 \cdot 1 = 60$ points
  - C gets $8 \cdot 4 + 10 \cdot 2 + 11 \cdot 1 = 63$ points
  - Still B (by a larger margin)

Cloning

- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

Cloning

- Suppose instead that A is cloned:

Number of Voters	11	10	8
1^{st} choice	A	B	C
2^{nd} choice	A'	C	A
3^{rd} choice	B	A	A'
4^{th} choice	C	A'	B

- Who wins (using the Borda method)?

Cloning

- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points

Cloning

- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points
  - A' gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points

Cloning

- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
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4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points
  - A' gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
  - B gets $10 \cdot 4 + 11 \cdot 2 + 8 \cdot 1 = 70$ points

Cloning

- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points
  - A' gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
  - B gets $10 \cdot 4 + 11 \cdot 2 + 8 \cdot 1 = 70$ points
  - C gets $8 \cdot 4 + 10 \cdot 3 + 11 \cdot 1 = 73$ points

Cloning

- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points
  - A' gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
  - B gets $10 \cdot 4 + 11 \cdot 2 + 8 \cdot 1 = 70$ points
  - C gets $8 \cdot 4 + 10 \cdot 3 + 11 \cdot 1 = 73$ points
  - A is now winning

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- Suppose instead that A is cloned:

Number of Voters	**11**	**10**	**8**
1^{st} **choice**	A	B	C
2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points
  - A' gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
  - B gets $10 \cdot 4 + 11 \cdot 2 + 8 \cdot 1 = 70$ points
  - C gets $8 \cdot 4 + 10 \cdot 3 + 11 \cdot 1 = 73$ points
  - A is now winning
- Given enough clones, almost any candidate can win (so long as someone prefers them)

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- Suppose instead that A is cloned:

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2^{nd} **choice**	A'	C	A
3^{rd} **choice**	B	A	A'
4^{th} **choice**	C	A'	B

- Who wins (using the Borda method)?
  - A gets $11 \cdot 4 + 8 \cdot 3 + 10 \cdot 2 = 88$ points
  - A' gets $11 \cdot 3 + 8 \cdot 2 + 10 \cdot 1 = 59$ points
  - B gets $10 \cdot 4 + 11 \cdot 2 + 8 \cdot 1 = 70$ points
  - C gets $8 \cdot 4 + 10 \cdot 3 + 11 \cdot 1 = 73$ points
  - A is now winning
- Given enough clones, almost any candidate can win (so long as someone prefers them)
- The Borda method is said to be **cloning postive**

The Borda Method

- Suppose there are two voters with true preferences:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	B	C
3^{rd} **choice**	C	A
4^{th} **choice**	D	D

The Borda Method

- Suppose there are two voters with true preferences:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	B	C
3^{rd} **choice**	C	A
4^{th} **choice**	D	D

- If both vote their true preferences, who will win (using the Borda method)?

The Borda Method

- Suppose there are two voters with true preferences:

	Voter 1	**Voter 2**
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2^{nd} **choice**	B	C
3^{rd} **choice**	C	A
4^{th} **choice**	D	D

- If both vote their true preferences, who will win (using the Borda method)?
  - B

The Borda Method

- Suppose there are two voters with true preferences:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	B	C
3^{rd} **choice**	C	A
4^{th} **choice**	D	D

- If both vote their true preferences, who will win (using the Borda method)?
  - B
- Can Voter 1 change their vote so that A wins?

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}\,C$	C
3^{rd} **choice**	$\cancel{C}\,D$	A
4^{th} **choice**	$\cancel{D}\,B$	D

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}C$	C
3^{rd} **choice**	$\cancel{C}D$	A
4^{th} **choice**	$\cancel{D}B$	D

- Who will win (using the Borda method)?

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}C$	C
3^{rd} **choice**	$\cancel{C}D$	A
4^{th} **choice**	$\cancel{D}B$	D

- Who will win (using the Borda method)?
  - A and C tie (don't know how to deal with ties)

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}C$	C
3^{rd} **choice**	$\cancel{C}D$	A
4^{th} **choice**	$\cancel{D}B$	D

- Who will win (using the Borda method)?
  - A and C tie (don't know how to deal with ties)
- One more attempt:

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}\,\cancel{C}\,D$	C
3^{rd} **choice**	$\cancel{C}\,\cancel{D}\,C$	A
4^{th} **choice**	$\cancel{D}\,B$	D

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}\,\cancel{C}\,D$	C
3^{rd} **choice**	$\cancel{C}\,\cancel{D}\,C$	A
4^{th} **choice**	$\cancel{D}\,B$	D

- Who will win (using the Borda method)?

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}\cancel{C}D$	C
3^{rd} **choice**	$\cancel{C}\cancel{D}C$	A
4^{th} **choice**	$\cancel{D}B$	D

- Who will win (using the Borda method)?
  - B

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}\cancel{C}D$	C
3^{rd} **choice**	$\cancel{C}\cancel{D}C$	A
4^{th} **choice**	$\cancel{D}B$	D

- Who will win (using the Borda method)?
  - B
- An example of **strategic voting**

The Borda Method

- Voter 1 can alter their preferences to:

	Voter 1	**Voter 2**
1^{st} **choice**	A	B
2^{nd} **choice**	$\cancel{B}\,\cancel{C}\,D$	C
3^{rd} **choice**	$\cancel{C}\,\cancel{D}\,C$	A
4^{th} **choice**	$\cancel{D}\,B$	D

- Who will win (using the Borda method)?
  - B
- An example of **strategic voting**
- This is called **burying** a candidate

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney
  - 2% prefer Johnson

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney
  - 2% prefer Johnson
- Suppose everyone voting Democrat or Republican voted strategically

% of Voters	**51**	**47**	**2**
1^{st} **choice**	Obama	Romney	Johnson
2^{nd} **choice**	Johnson	Johnson	Romney
3^{rd} **choice**	Romney	Obama	Obama

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney
  - 2% prefer Johnson
- Suppose everyone voting Democrat or Republican voted strategically

% of Voters	**51**	**47**	**2**
1^{st} **choice**	Obama	Romney	Johnson
2^{nd} **choice**	Johnson	Johnson	Romney
3^{rd} **choice**	Romney	Obama	Obama

  - Obama gets $51 \cdot 3 + 49 \cdot 1 = 202$ points

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney
  - 2% prefer Johnson
- Suppose everyone voting Democrat or Republican voted strategically

% of Voters	**51**	**47**	**2**
1^{st} **choice**	Obama	Romney	Johnson
2^{nd} **choice**	Johnson	Johnson	Romney
3^{rd} **choice**	Romney	Obama	Obama

  - Obama gets $51 \cdot 3 + 49 \cdot 1 = 202$ points
  - Romney gets $47 \cdot 3 + 2 \cdot 2 + 51 \cdot 1 = 196$ points

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney
  - 2% prefer Johnson
- Suppose everyone voting Democrat or Republican voted strategically

% of Voters	51	47	2
1^{st} **choice**	Obama	Romney	Johnson
2^{nd} **choice**	Johnson	Johnson	Romney
3^{rd} **choice**	Romney	Obama	Obama

  - Obama gets $51 \cdot 3 + 49 \cdot 1 = 202$ points
  - Romney gets $47 \cdot 3 + 2 \cdot 2 + 51 \cdot 1 = 196$ points
  - Johnson gets $2 \cdot 3 + 98 \cdot 2 = 202$ points

Strategic Voting

- Suppose that the U.S. presidential election used the Borda method
  - 51% prefer Obama
  - 47% prefer Romney
  - 2% prefer Johnson
- Suppose everyone voting Democrat or Republican voted strategically

% of Voters	51	47	2
1^{st} **choice**	Obama	Romney	Johnson
2^{nd} **choice**	Johnson	Johnson	Romney
3^{rd} **choice**	Romney	Obama	Obama

  - Obama gets $51 \cdot 3 + 49 \cdot 1 = 202$ points
  - Romney gets $47 \cdot 3 + 2 \cdot 2 + 51 \cdot 1 = 196$ points
  - Johnson gets $2 \cdot 3 + 98 \cdot 2 = 202$ points
  - Election is a nail-biter between Obama and Johnson

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  - The manipulator prefers the outcome of the second list

Manipulating an Instant Runoff

- Suppose a preference list was as follows:

Number of Voters	**2**	**2**	**1**
1^{st} **choice**	A	C	B
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- Can one of the first voters alter their vote to get a more preferential outcome?

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- Suppose one of the first voters altered their preferences as follows:

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- So the instant runoff is manipulable

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