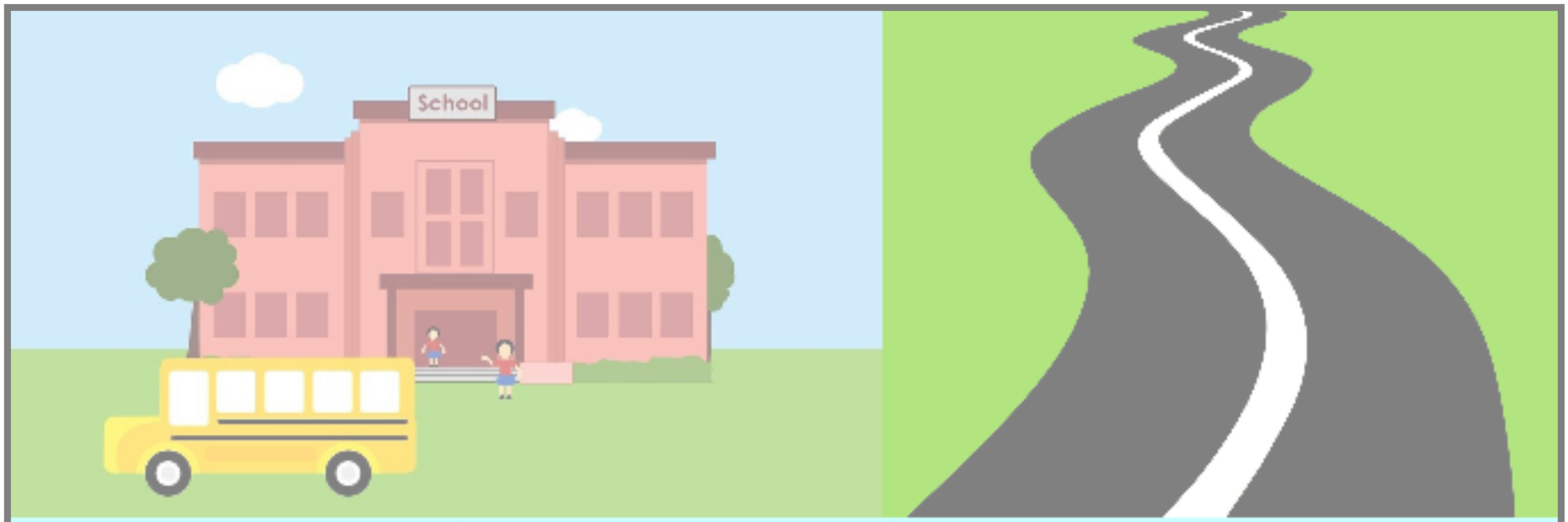

Deliberation for Social Choice

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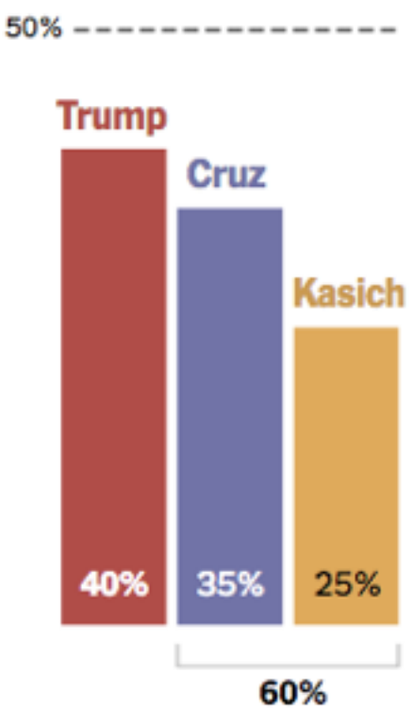
Voting in Complex Spaces

- What if:
  - The space of outcomes is large?
  - No preference structure is known a priori?
- We can always run plurality vote, but…

The Failure of Plurality

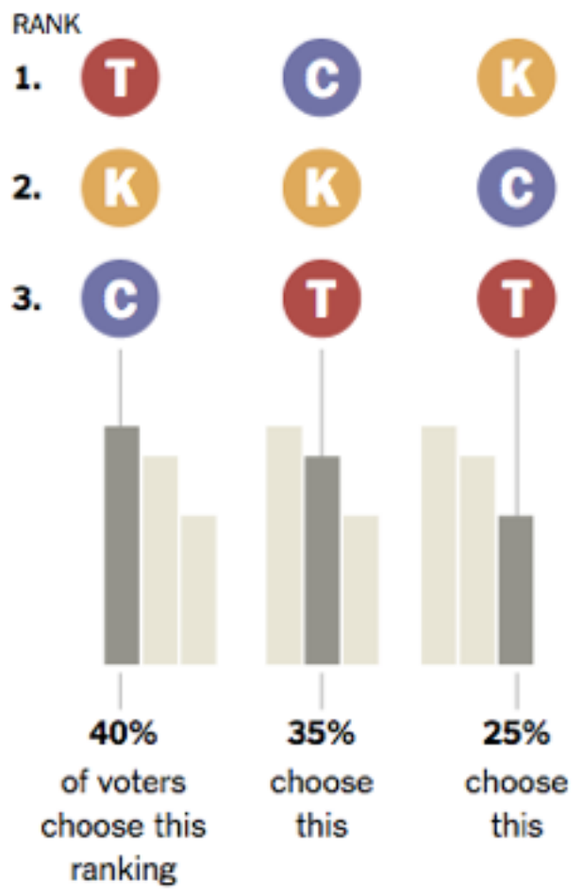
Two Ways to Pick a Winner

By the top choice
In this hypothetical result, Trump wins, even though he falls short of a majority. A plurality is all that is needed.



Combined, Trump's two opponents draw a majority of the vote.

By voters ranking the candidates
In the same hypothetical vote, Trump loses and Kasich wins if voters prioritize the candidates in this order of preference:



How the winner is picked
Trump is ranked above the others by only 40 percent of voters.

Cruz is ranked above Trump by 60 percent of voters.

But Kasich is ranked above Trump by 60 percent of voters . . .

. . . and above Cruz by 65 percent.

With majorities favoring him over both other candidates, **Kasich wins.**

By Bill Marsh/The New York Times

Goals

- Desiderata:

  A. The algorithm (mechanism) designer does not need to understand the decision space.

  B. We can prove guarantees on the quality of outcomes under analytical models.

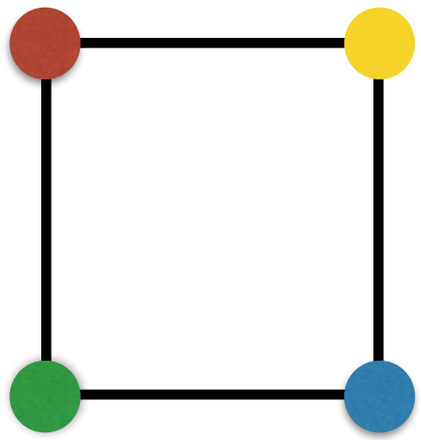
  C. In particular, we should beat random dictatorship.

Sequential Deliberation

- *N* := set of agents. Initialize o^0 <— Favorite outcome of a random agent.
- For rounds from t=1 to t=T:
  - u^t ~ Uniform(*N*) and v^t ~ Uniform(*N*)
  - o^t <— Bargain($\{u^t, v^t\}$, o^{t-1})
- Output o^T.

Median Graphs

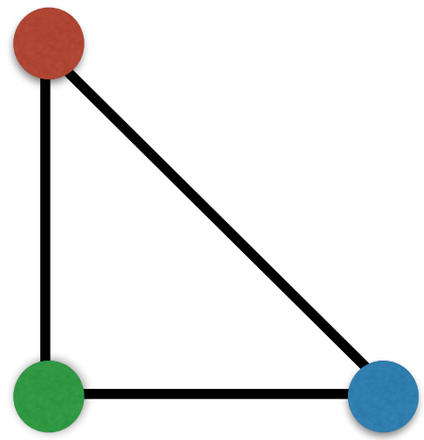
Median Graph



- Trees
- Hypercubes
- Grids

Has a Condorcet winner

Not Median Graph



- Triangles
- Disconnected

Results

1. On a median graph, Nash bargaining between agents u and v with bliss points p_u and p_v using disagreement outcome o finds the median of p_u, p_v, o.

2. We can analytically compute bounds on approximating the social cost minimizer by embedding onto the hypercube.

3. All agents bargaining truthfully representing their bliss point is a subgame perfect Nash equilibrium of the extensive form game defined by sequential bargaining.

Bounds

	Welfare Approximation	Random Dictatorship	Random Deliberation	Sequential Deliberation
Upper Bound	2	1.316	1.208	
Lower Bound	2	1.316	1.125	

Acknowledgements

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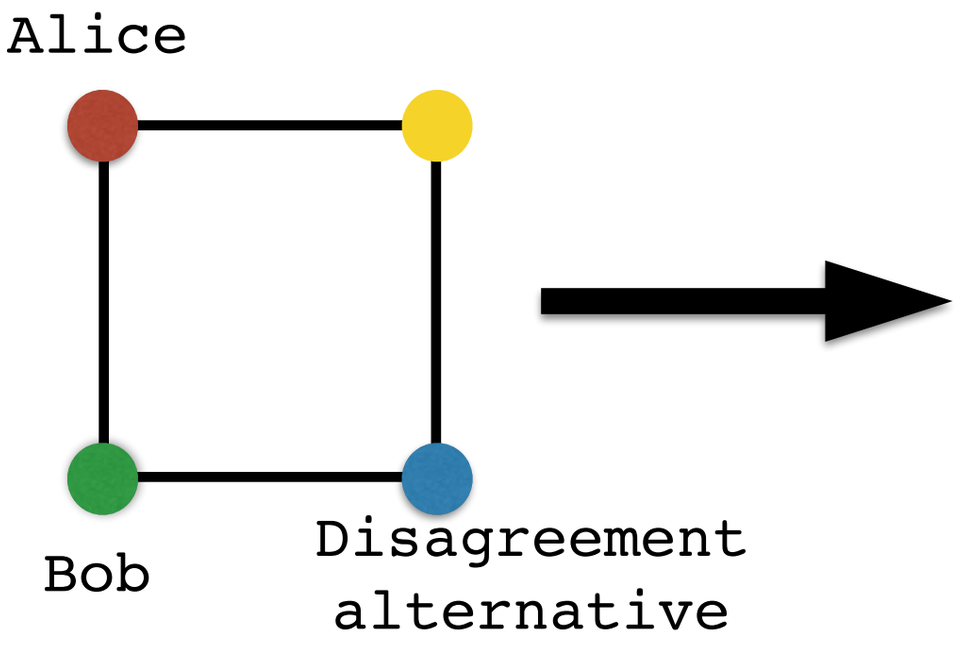
Thanks!

- Questions?

Deliberation



	Red	Yellow	Blue	Green
Dist. to Alice	0	1	2	1
Dist. to Bob	1	2	1	0

	Red	Yellow	Blue	Green
Red	(0, 1)	(2, 1)	(2, 1)	(2, 1)
Yellow	(2, 1)	(1, 2)	(2, 1)	(2, 1)
Blue	(2, 1)	(2, 1)	(2, 1)	(2, 1)
Green	(2, 1)	(2, 1)	(2, 1)	(1, 0)

```
Bargain({Alice,Bob}, Blue)
        = Green
```