

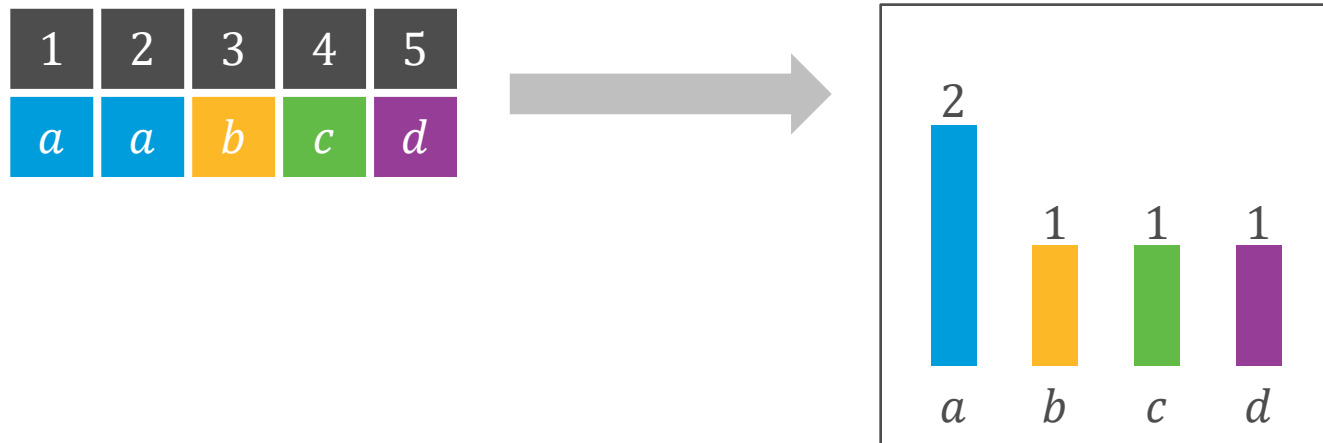
Fall 2022 | Lecture 12

Social Choice

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PLURALITY

- Each person votes for a single alternative, and the alternative with most points wins
- A highly problematic voting rule!



SOME BALLOT TYPES



Rankings



Approvals



Scores/stars

We will focus on rankings!



Jean-Charles de Borda

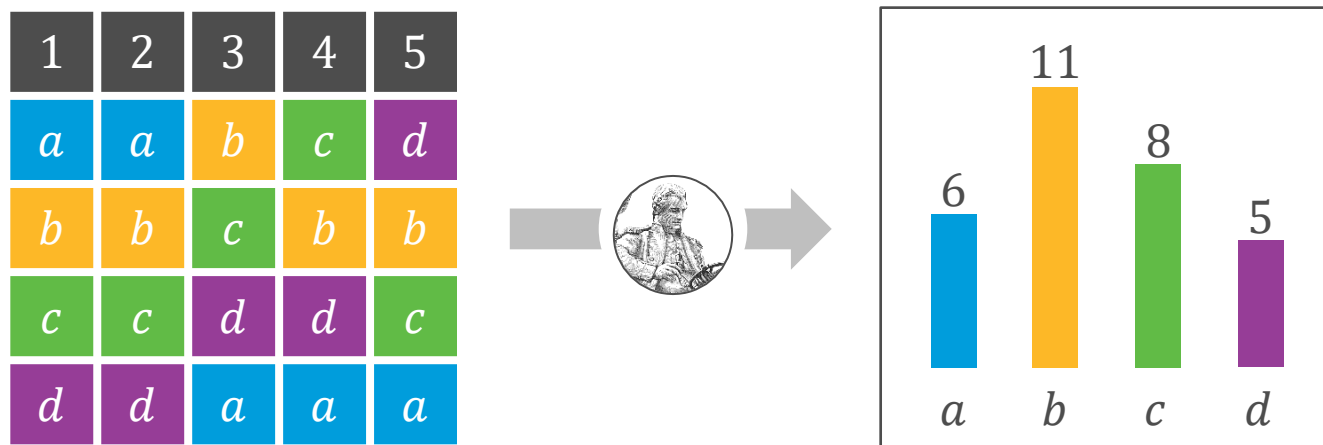
1733–1799

Mathematician, engineer, and naval officer. Also remembered as an instigator of the metric system.



BORDA COUNT

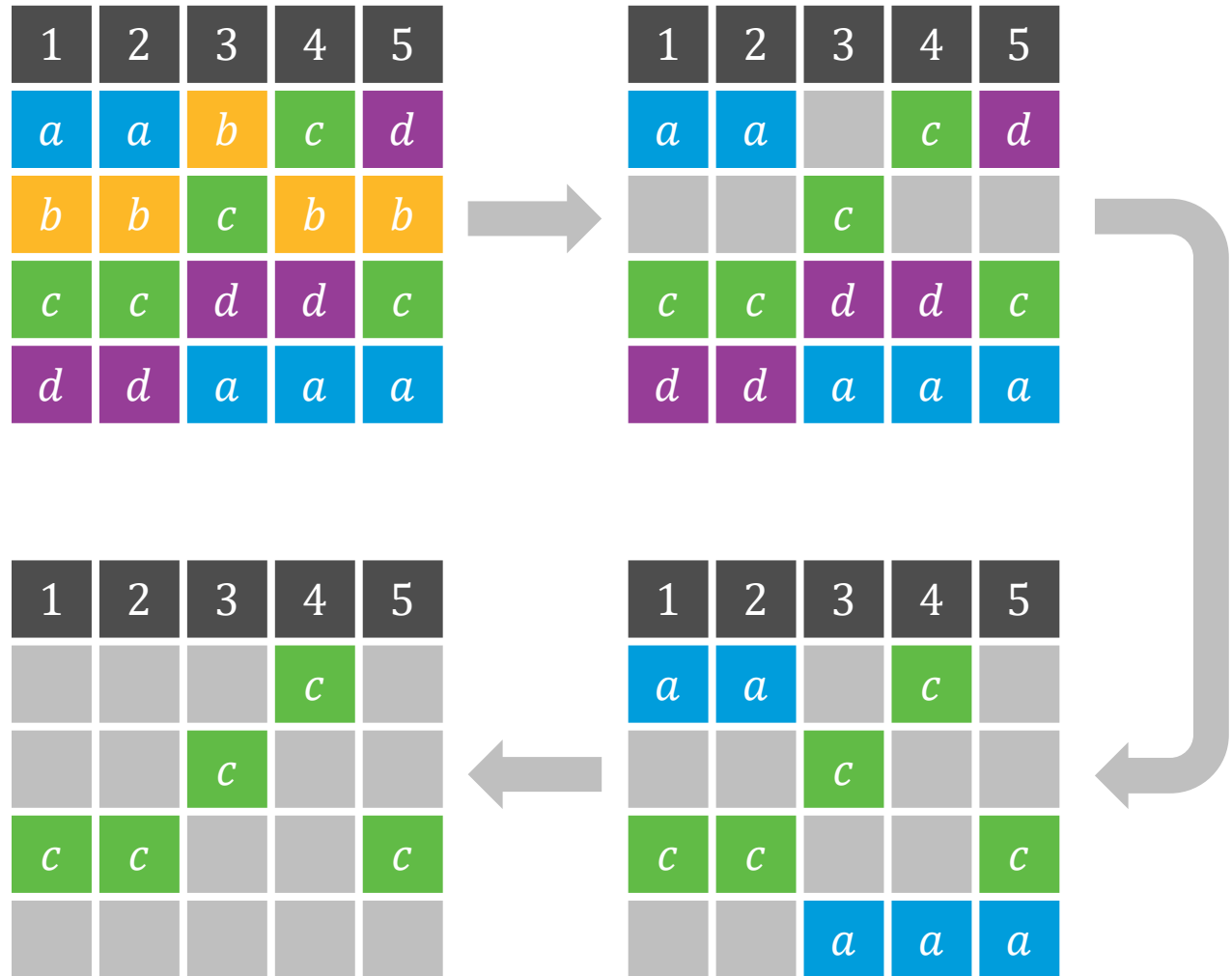
- Each voter awards $m - k$ points to the alternative placed in the k 'th position, where m is the number of alternatives



SINGLE TRANSFERABLE VOTE

- Also known as “alternative vote,” “instant-runoff voting” and (misleadingly) “ranked-choice voting”
- Votes are tabulated in rounds, where in each round the alternative with the lowest plurality score is eliminated; last alternative left standing is the winner

SINGLE-TRANSFERABLE VOTE



STV AROUND THE WORLD



■ Ireland

Used for all public elections

■ Canada

Used in Ontario for municipal elections

■ Australia

Used for parliamentary elections

■ USA

Used for statewide elections in ME and AK, and in cities like Cambridge, MA



Marquis de Condorcet

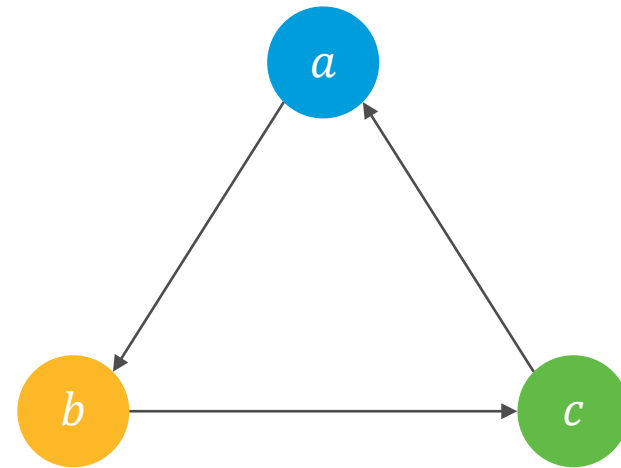
1743–1794

Philosopher, mathematician,
enlightened nobleman. Also known
for dying mysteriously in prison.



THE CONDORCET PARADOX

1	2	3
<i>a</i>	<i>c</i>	<i>b</i>
<i>b</i>	<i>a</i>	<i>c</i>
<i>c</i>	<i>b</i>	<i>a</i>



The preferences of the majority may be cyclical!

CONDORCET CONSISTENCY

- A **Condorcet winner** is an alternative that defeats every other alternative in a head-to-head majority comparison
- A rule is **Condorcet consistent** if it always selects a Condorcet winner whenever it is presented with a profile that contains one
- **Poll 1:** Which rule is Condorcet consistent?
 - Plurality
 - Borda count
 - Both rules
 - Neither one



Ramon Llull

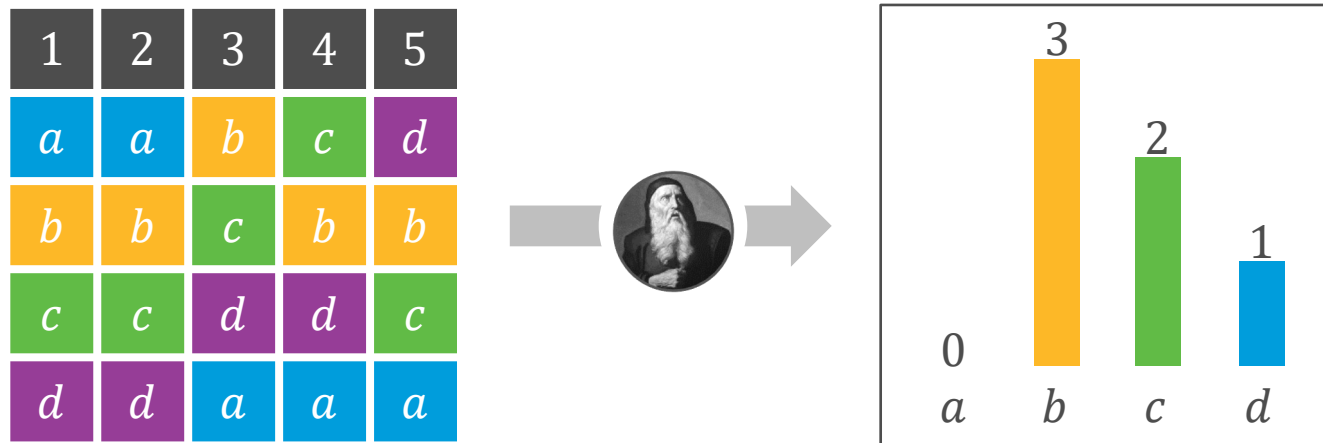
c. 1232–1315

Monk, missionary, and philosopher; one of the most influential intellectuals of his time. Also remembered for publishing a medieval parenting guide.



LLULL'S RULE

- Each alternative receives one point for each head-to-head comparison it wins (as well as for tied comparisons)



- Llull's rule is Condorcet consistent



Charles Lutwidge Dodgson

1832–1898

Professor of mathematics at Oxford,
pioneer photographer, and beloved
author. Also known for not plagiarizing
Condorcet's work.

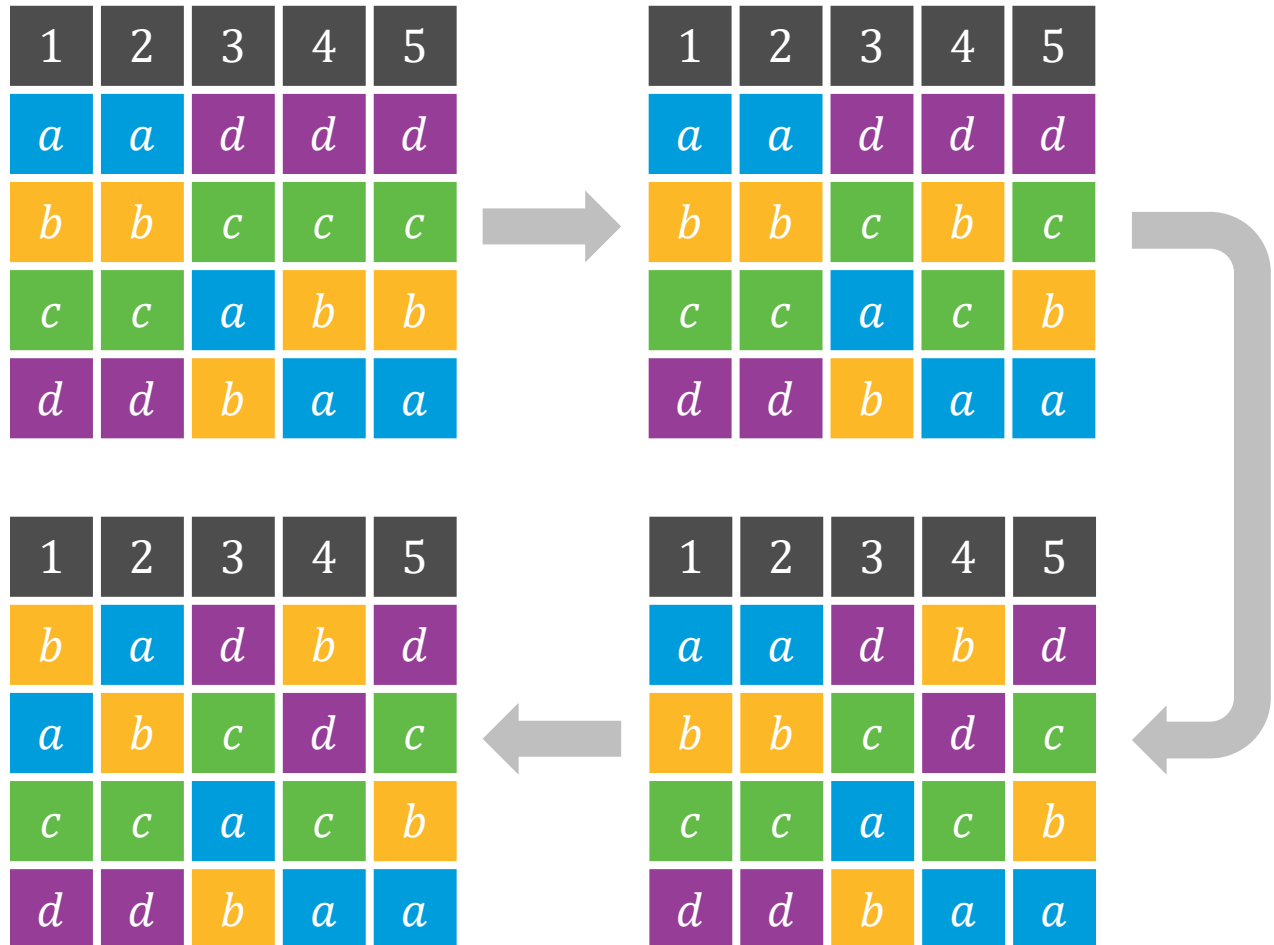


DODGSON'S RULE

- The **Dodgson score** of an alternative x is the minimum number of swaps between adjacent alternatives needed to make x a Condorcet winner; select an alternative with minimum score
- Dodgson's rule is Condorcet consistent
- Dodgson's rule is NP-hard to compute!

DODGSON'S RULE

What is the Dodgson score of b ?



1934 ELECTION: OREGON GOVERNOR



Charles H. Martin
Dem.
116,667 votes



Peter Zimmerman
Ind. (Rep.)
95,519 votes



Joe E. Dunne
Rep.
86,923 votes

INDEPENDENCE OF CLONES

- A subset of alternatives K is a set of **clones** if no voter ranks any alternative outside of K between two alternatives of K
- In the following profile, a and b are clones:

1	2	3	4	5
a	a	b	c	d
b	b	a	b	c
c	c	d	a	b
d	d	c	d	a

INDEPENDENCE OF CLONES

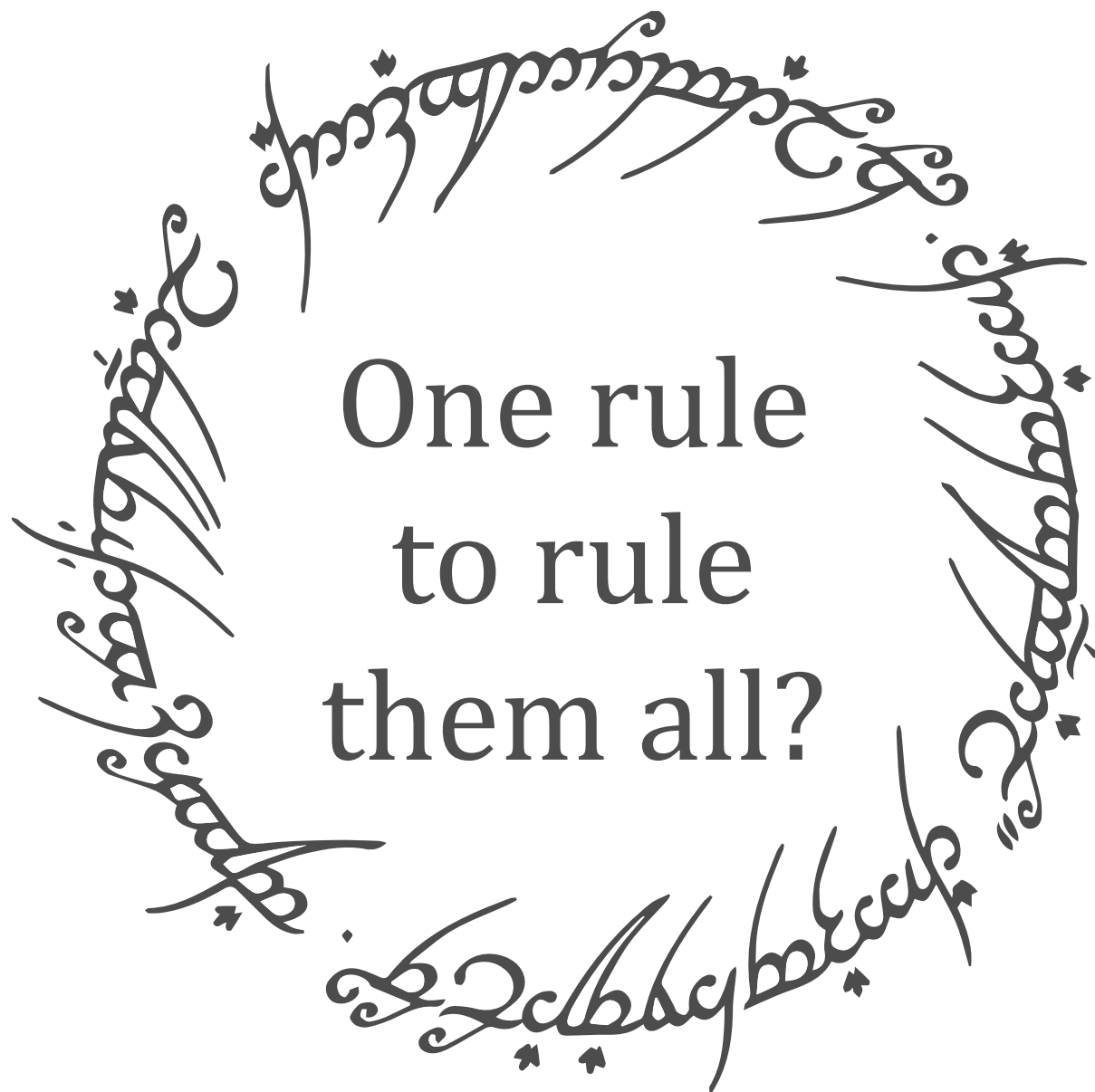
1	2	3	4	5	6	7
<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>	<i>c</i>	<i>c</i>	<i>c</i>
<i>b</i>	<i>b</i>	<i>c</i>	<i>c</i>	<i>a</i>	<i>a</i>	<i>a</i>
<i>c</i>	<i>c</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>

1	2	3	4	5	6	7
<i>a</i>	<i>a</i>	<i>d</i>	<i>d</i>	<i>c</i>	<i>c</i>	<i>c</i>
<i>d</i>	<i>d</i>	<i>a</i>	<i>a</i>	<i>d</i>	<i>a</i>	<i>a</i>
<i>b</i>	<i>b</i>	<i>c</i>	<i>c</i>	<i>a</i>	<i>d</i>	<i>d</i>
<i>c</i>	<i>c</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>

Under plurality, cloning a candidate may prevent them from winning

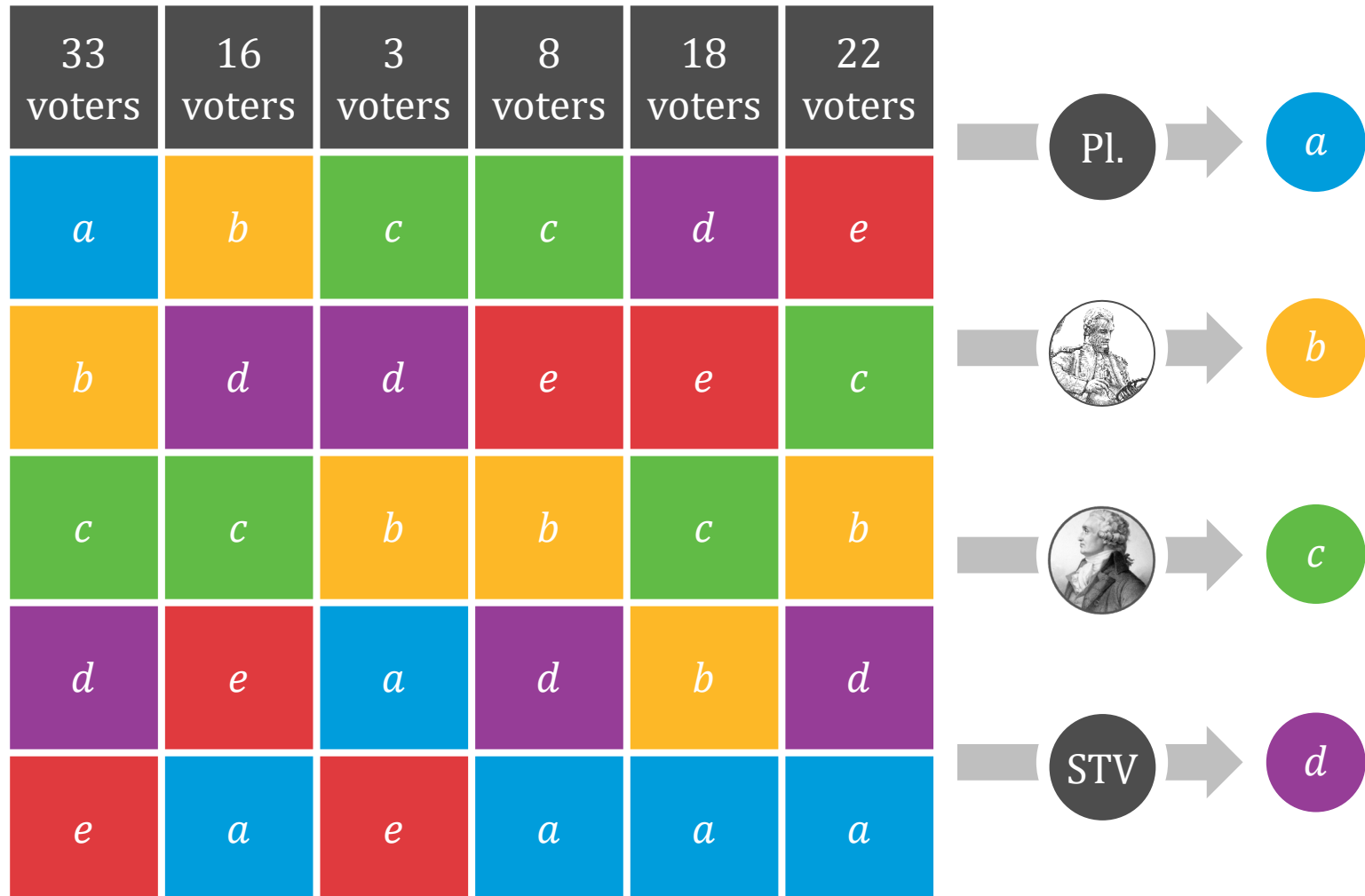
INDEPENDENCE OF CLONES

- A voting rule is **independent of clones** if and only if it satisfies the following two conditions:
 1. An alternative that is a member of a set of clones wins if and only if some member of that set of clones wins after a member of the set is eliminated
 2. An alternative that is not a member of a set of clones wins if and only if that same alternative wins after any clone is eliminated
- **Poll 2:** Which rule is independent of clones?
 - Single-transferable vote
 - Borda
 - Llull
 - None of the above



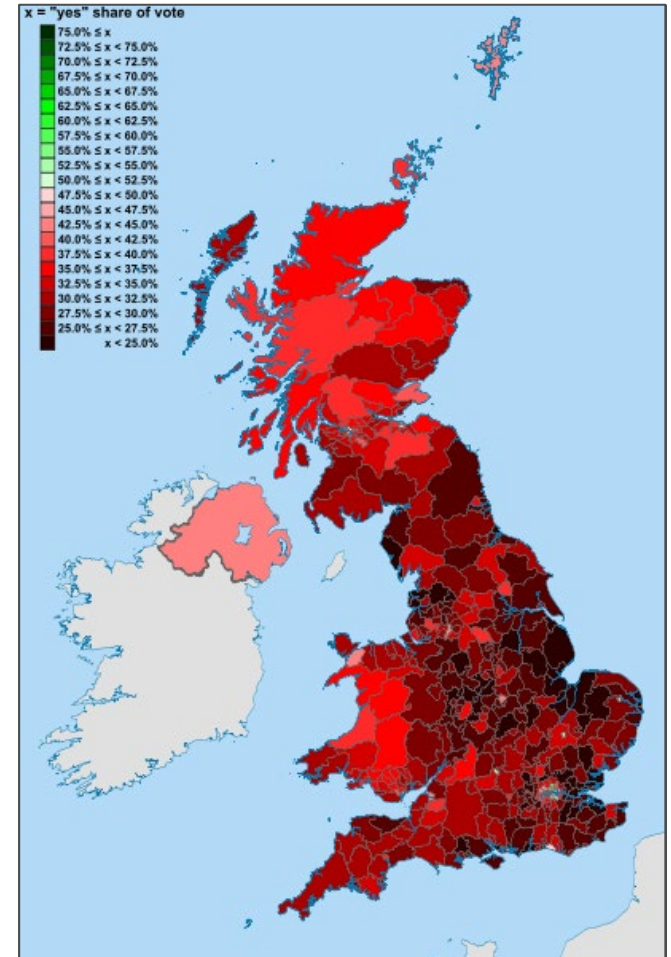
One rule
to rule
them all?

AWESOME EXAMPLE



IS SOCIAL CHOICE PRACTICAL?

- UK referendum (2011): Choose between plurality and STV as a method for electing MPs
- Academics agreed STV is better
- But STV was seen as beneficial to a particular politician



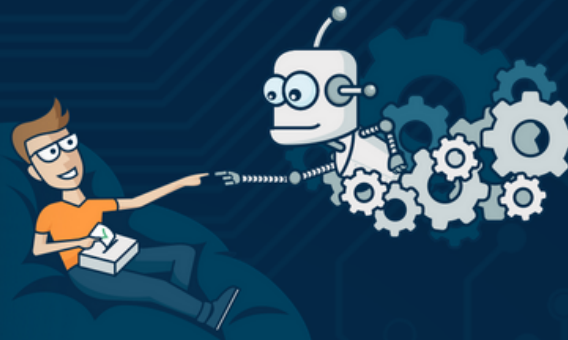
COMPUTATIONAL SOCIAL CHOICE

However, in emerging paradigms of democracy and tools for group decision making, the designer is free to choose any voting rule!



AI-Driven Decisions

RoboVote is a free service that helps users combine their preferences or opinions into optimal decisions. To do so, RoboVote employs state-of-the-art voting methods developed in artificial intelligence research. [Learn More](#)



Poll Types

RoboVote offers two types of polls, which are tailored to different scenarios; it is up to users to indicate to RoboVote which scenario best fits the problem at hand.



Objective Opinions

In this scenario, some alternatives are objectively better than others, and the opinion of a participant reflects an attempt to estimate the correct order. RoboVote's proposed outcome is guaranteed to be as close as possible — based on the available information — to the best outcome. Examples include deciding which product prototype to develop, or which company to invest in, based on a metric such as projected revenue or market share. [Try the demo.](#)



Subjective Preferences

In this scenario participants' preferences reflect their subjective taste; RoboVote proposes an outcome that mathematically makes participants as happy as possible overall. Common examples include deciding which restaurant or movie to go to as a group, which destination to choose for a family vacation, or whom to elect as class president. [Try the demo.](#)

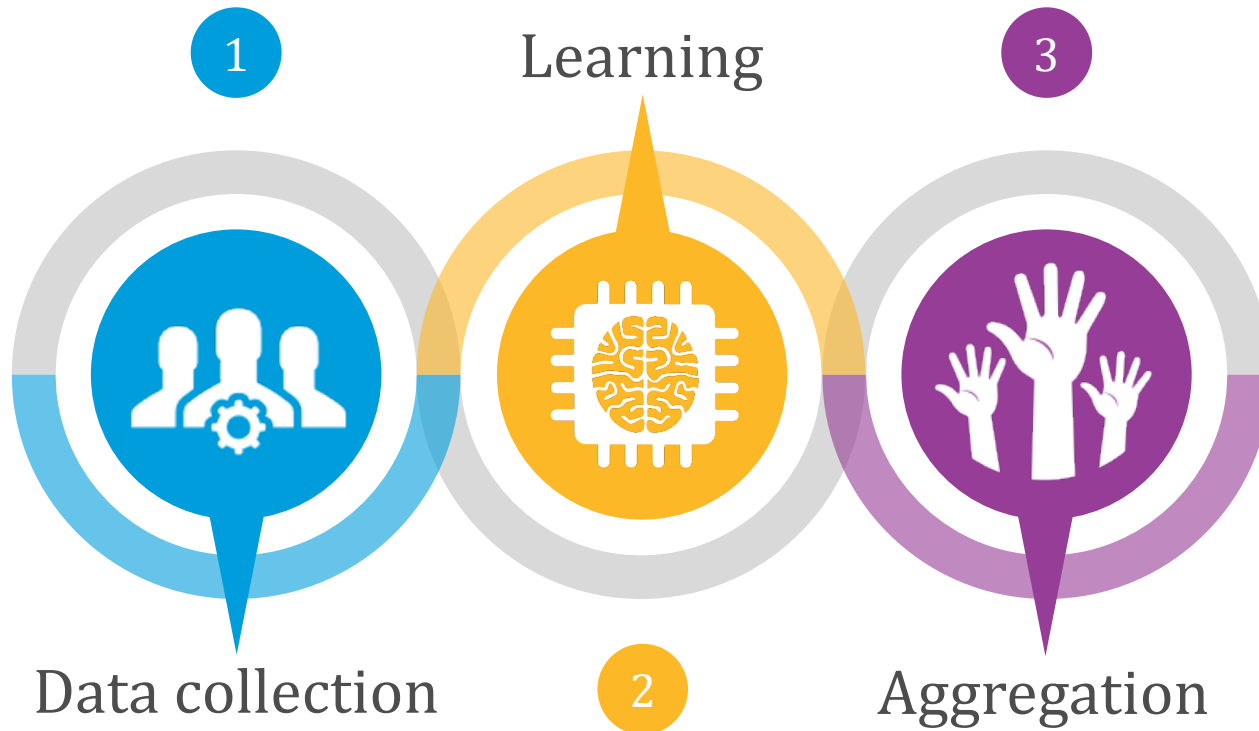
Ready to get started?

[CREATE A POLL](#)



Panelot

VIRTUAL DEMOCRACY



VIRTUAL DEMOCRACY

Nonprofit partner

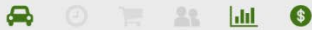
Hide recommendations

or

Choose

Recommendations:

1 ACHA – Robert J. Corbett Apartments



2 Matilda Theiss Health Center



3 AHG – EB McNitt



4 Meals on Wheels – Bethel Park



5 Veteran's Leadership Program – Strip District



More recommendations

1 ACHA – Robert J. Corbett Apartments

5 minute drive

Show details

2 weeks ago

Med food access

20 people

High poverty rate

Low income level

Weekly Rescues:



Hours:

24 hours a day

Choose this nonprofit

