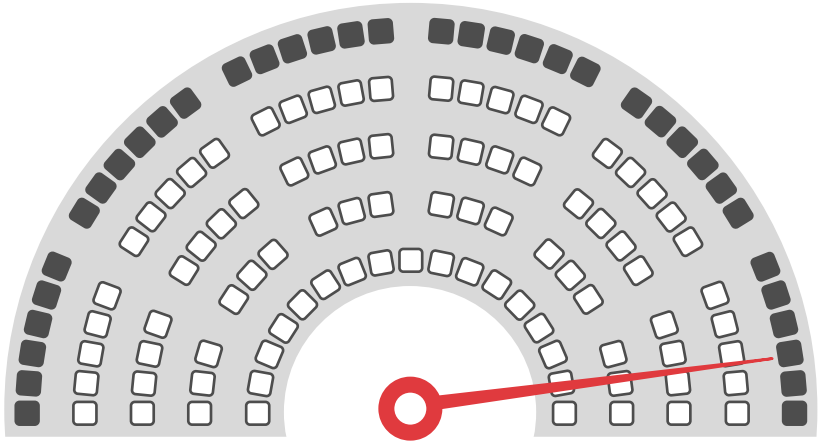


Optimized Democracy

Spring 2022 | Lecture 0

Course Overview

Ariel Procaccia | Harvard University

Pia Mancini

“Politics is solving today's problems with yesterday's tools.”

Objective

Provide students with a rigorous perspective on, and a technical toolbox for, the design of better democratic systems.

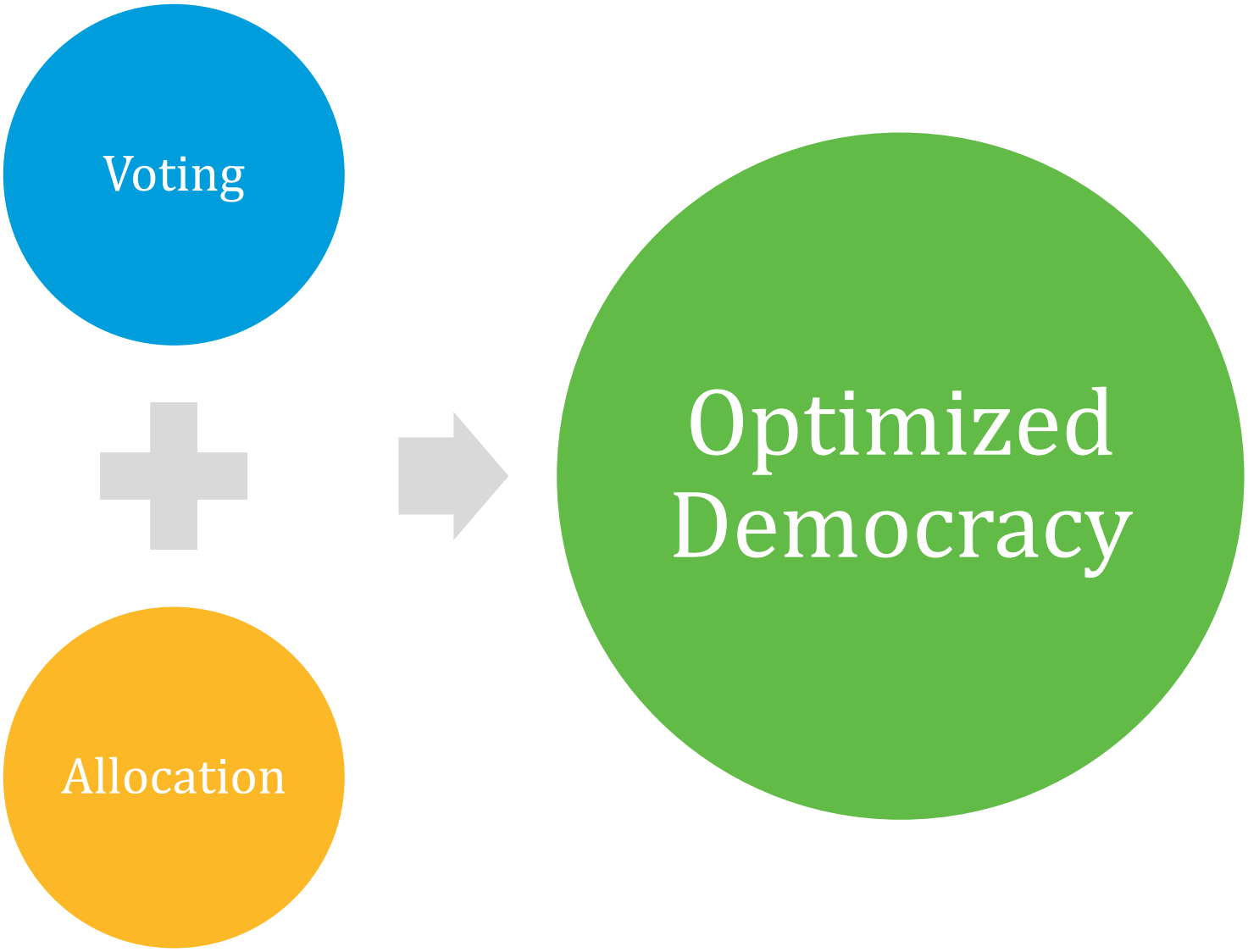
UNDERGRAD VS. GRAD

Undergrad

Understand existing ideas and apply them

Grad

Creativity required, generate new ideas


Voting
Allocation
Optimized Democracy

SYLLABUS

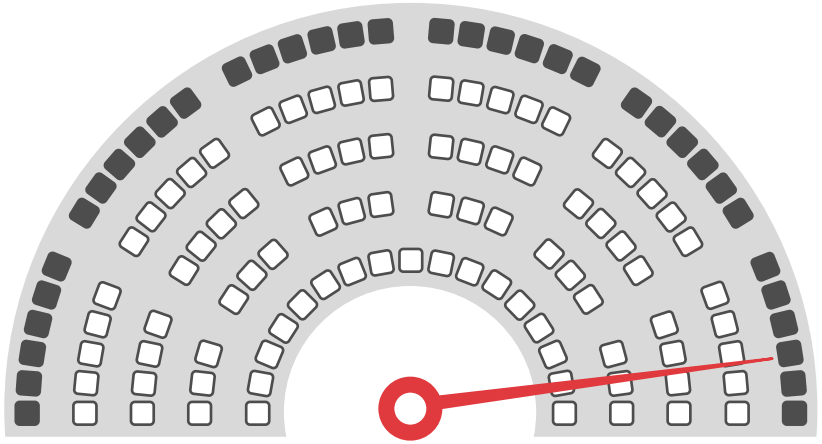
Voting	Allocation
Voting Rules	Cake cutting
The axiomatic approach	Rent division
Strategic manipulation	Indivisible goods
Restricted preferences	Random assignment
Electoral competition	Sortition
The epistemic approach	Apportionment in the 19th century
Liquid democracy	Apportionment in the 20th century
Committee elections	Redistricting as cake cutting
Participatory budgeting	Identifying gerrymandered maps
	The Electoral College

REQUIREMENTS

- Four theoretical homework assignments ($10\% \times 4 = 40\%$)
- Participation (15%), in the sense of active participation in class
- Research project (45%), which should raise novel technical questions and provide some nontrivial answers

LOGISTICS

- Sign up for Ed through the course website
- TFs: Daniel Halpern and Haneul Shin
- My office hours by appointment
- We will of course accommodate difficulties related to Covid
- All lectures are recorded
- If you are enrolled and "shopping," please decide by the end of the week to allow other students to enroll (currently 103 petitions)



Optimized Democracy

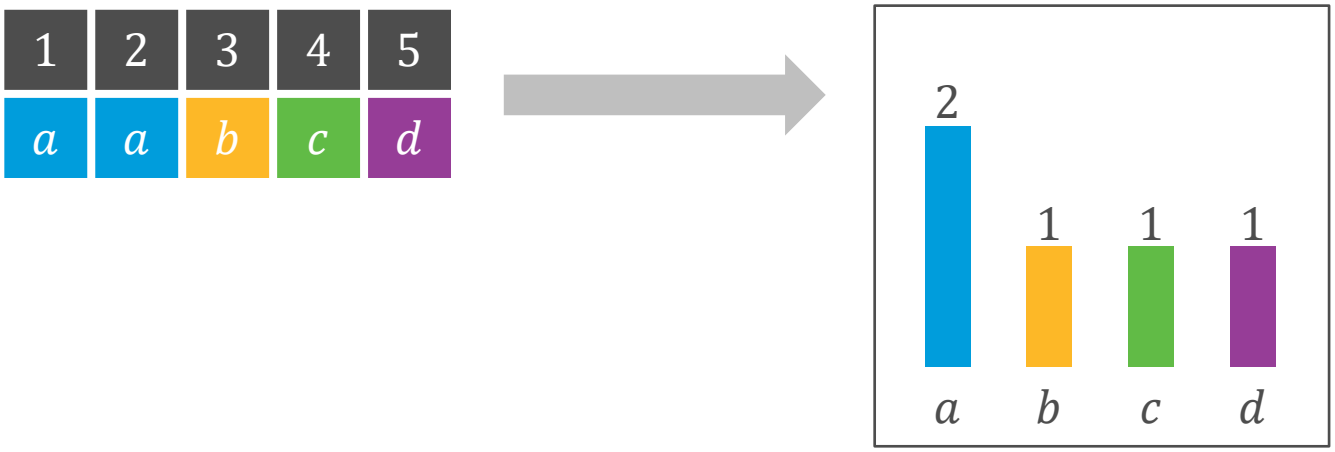
Spring 2022 | Lecture 1

Voting Rules

Ariel Procaccia | Harvard University

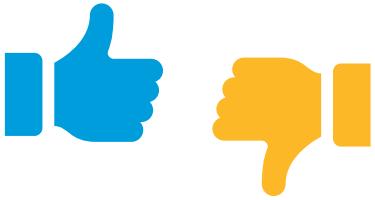
PLURALITY

- 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

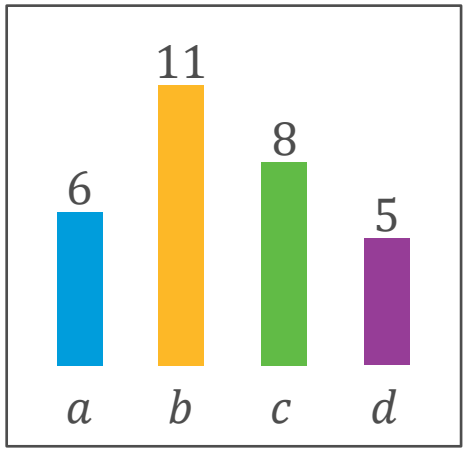
1733–1799

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

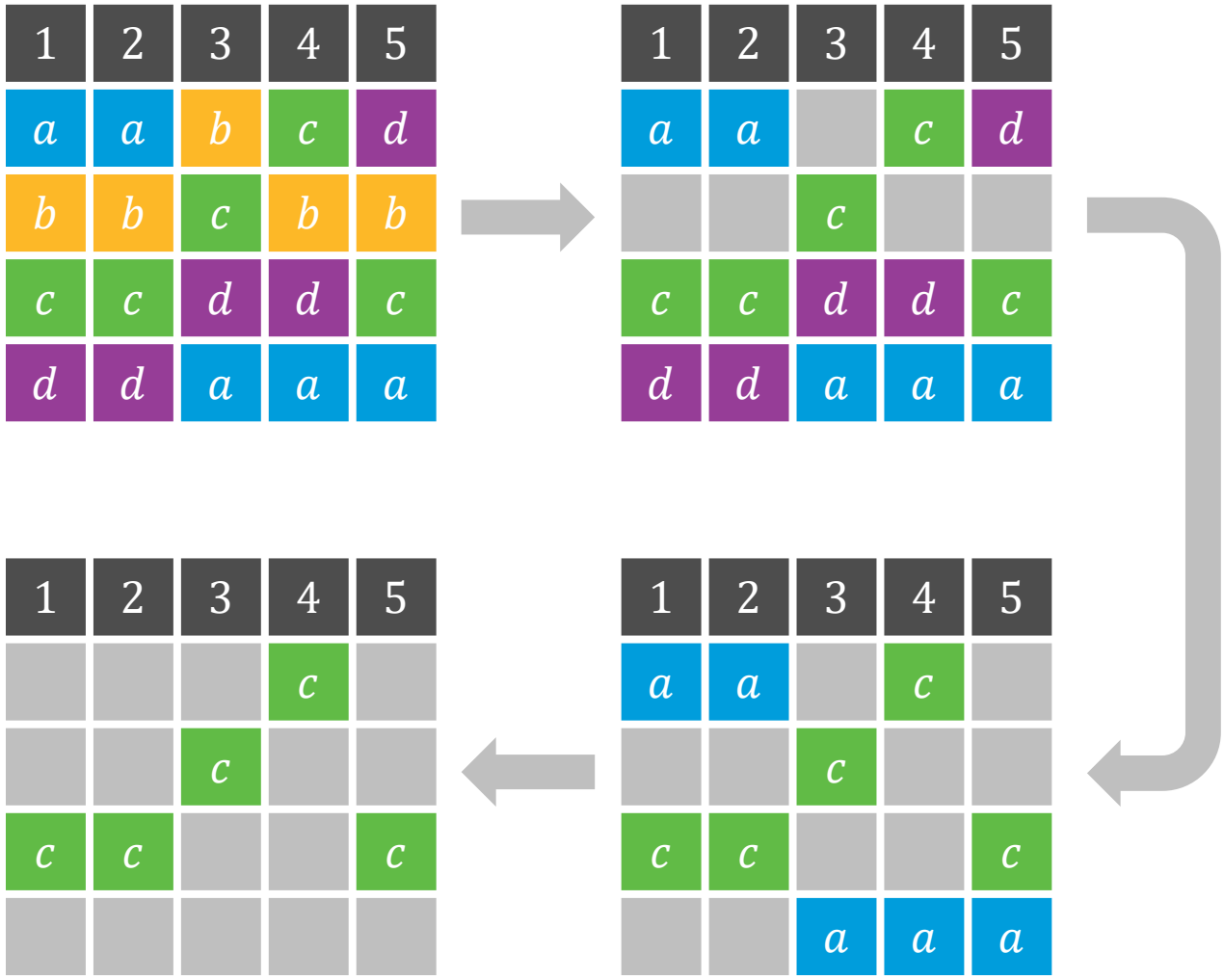
1	2	3	4	5
a	*a*	*b*	*c*	*d*
b	*b*	*c*	*b*	*b*
c	*c*	*d*	*d*	*c*
d	*d*	*a*	*a*	*a*



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

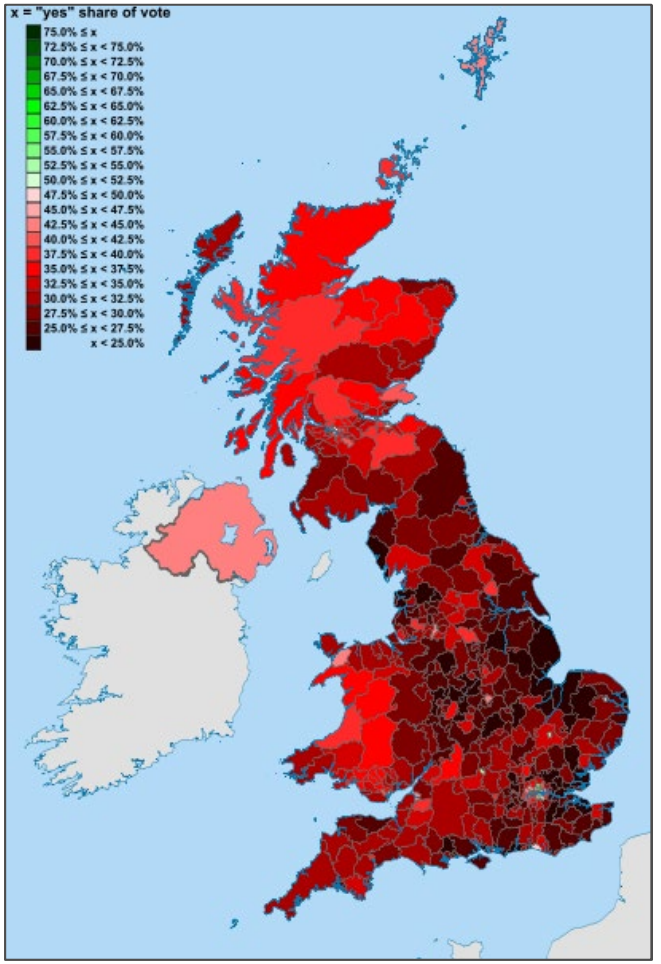
Canada
Used in Ontario for municipal elections

Australia
Used for parliamentary elections

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

BARRIERS TO ADOPTION

- 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



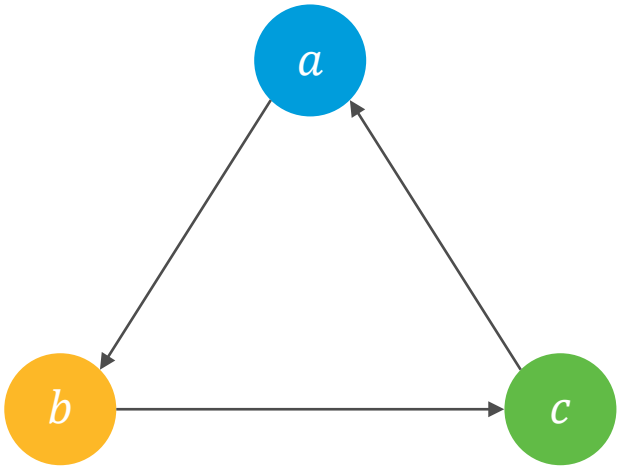
Marquis de Condorcet

1743–1794

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

THE CONDORCET PARADOX

1	2	3
a	c	b
b	a	c
c	b	a



The preferences of the majority may be cyclical!

CONDORCET CONSISTENT RULES

- A Condorcet winner is an alternative that defeats every other alternative in a head-to-head comparison
- A rule is Condorcet consistent if it always selects a Condorcet winner whenever it is presented with a profile that contains one

Poll

Which rule is Condorcet consistent?

- Plurality
- Borda Count
- Both rules
- Neither one

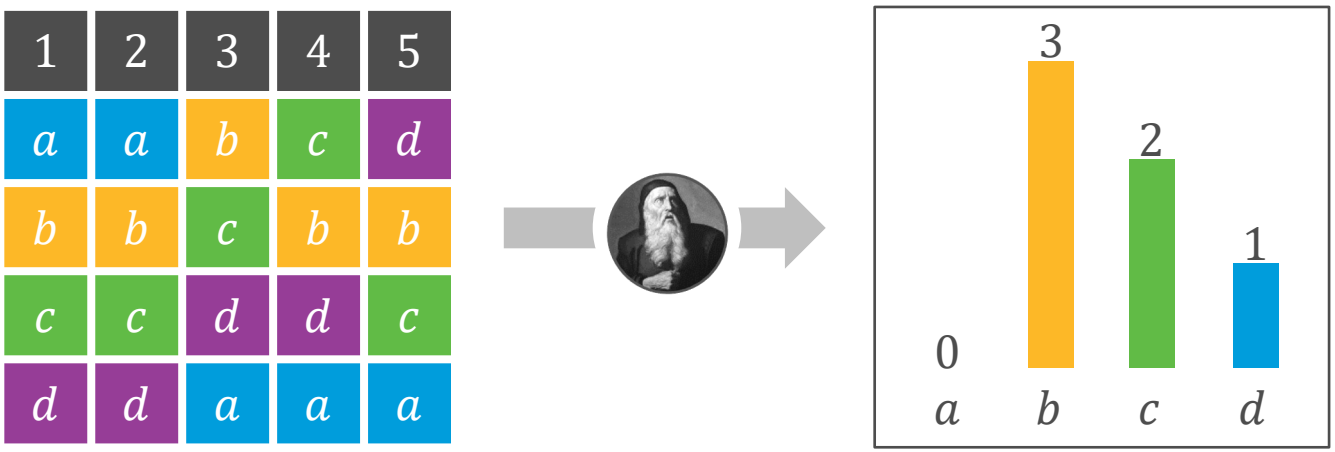
Ramon Llull

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

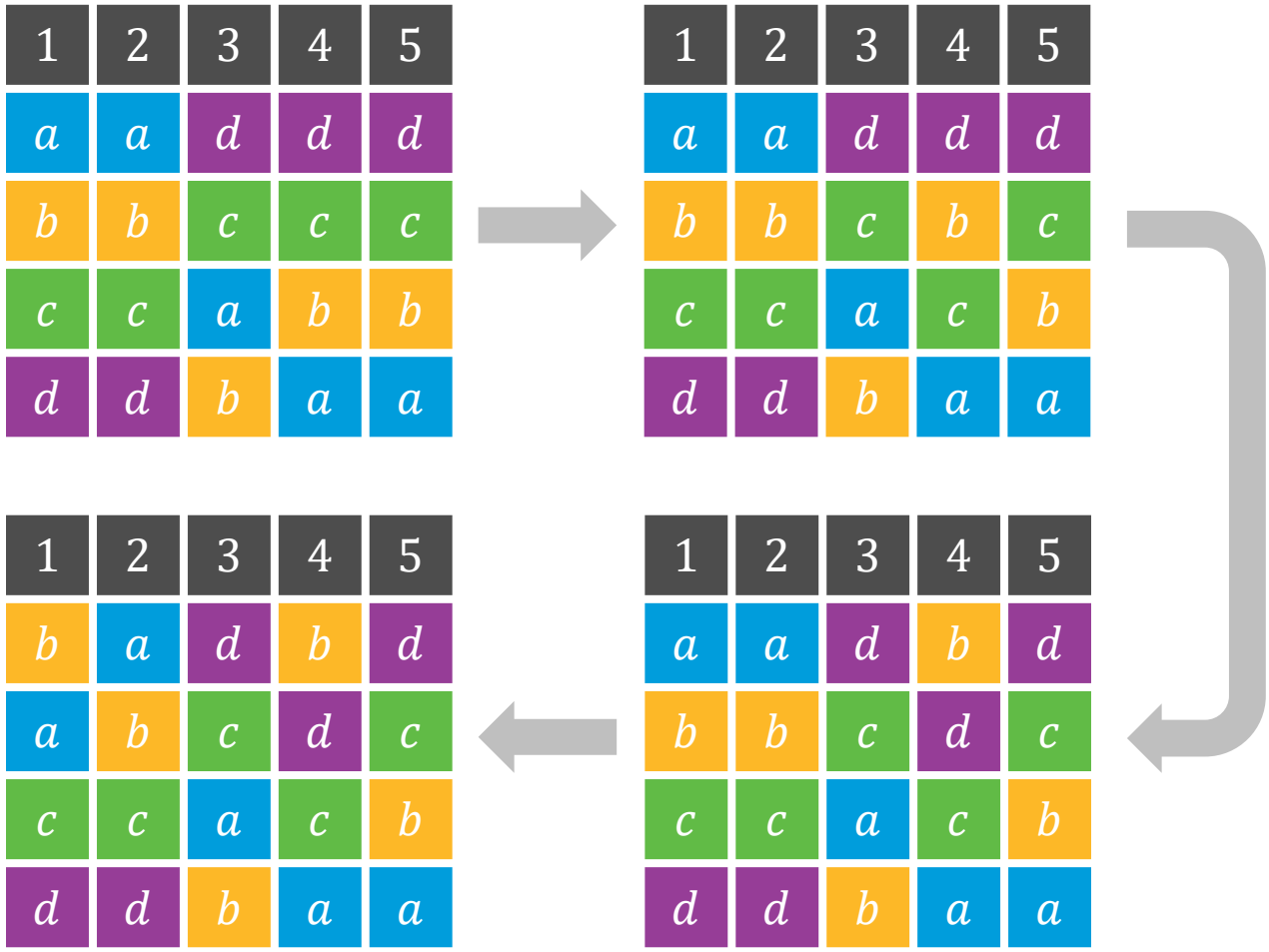
Professor of mathematics at Oxford, pioneer photographer, and beloved author. Also known for not plagiarizing Condorcet's work.

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 [Bartholdi et al. 1989]

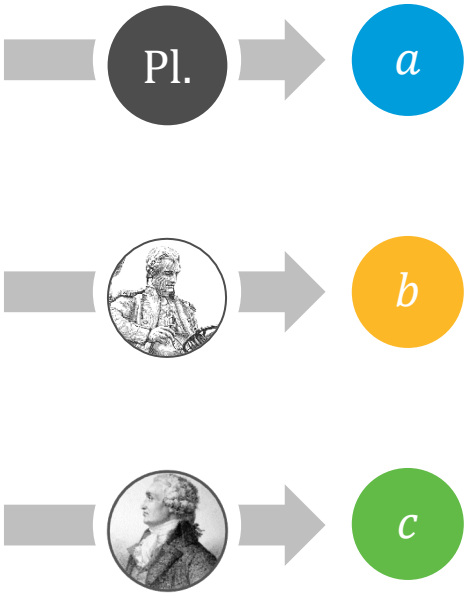
DODGSON'S RULE

What is the Dodgson score of b?



AWESOME EXAMPLE

33 voters	16 voters	3 voters	8 voters	18 voters	22 voters
a	*b*	*c*	*c*	*d*	*e*
b	*d*	*d*	*e*	*e*	*c*
c	*c*	*b*	*b*	*c*	*b*
d	*e*	*a*	*d*	*b*	*d*
e	*a*	*e*	*a*	*a*	*a*




One rule
to rule
them all?