

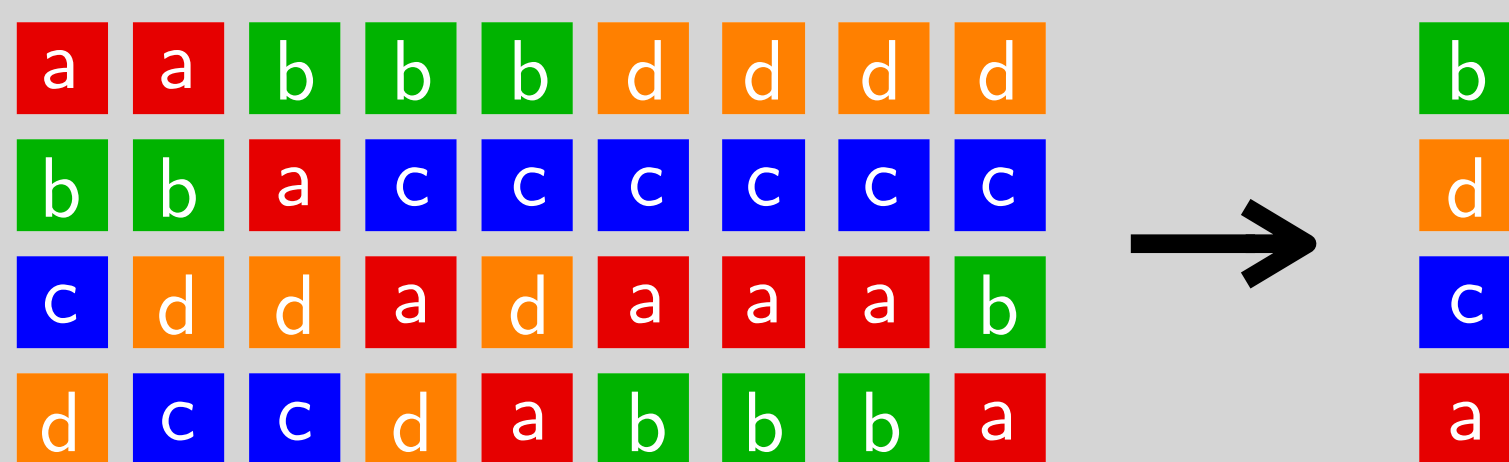
Rank Aggregation Using Scoring Rules

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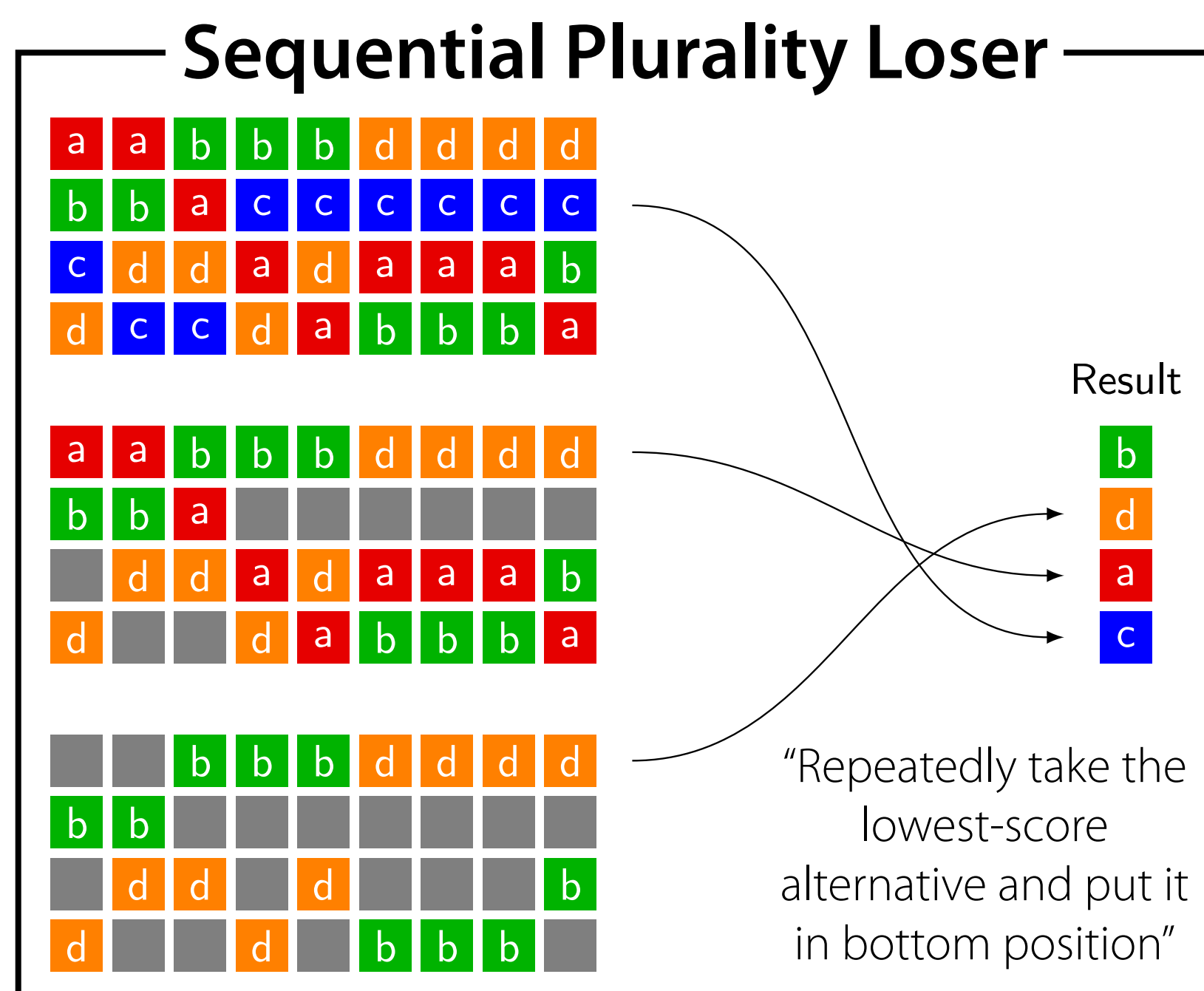
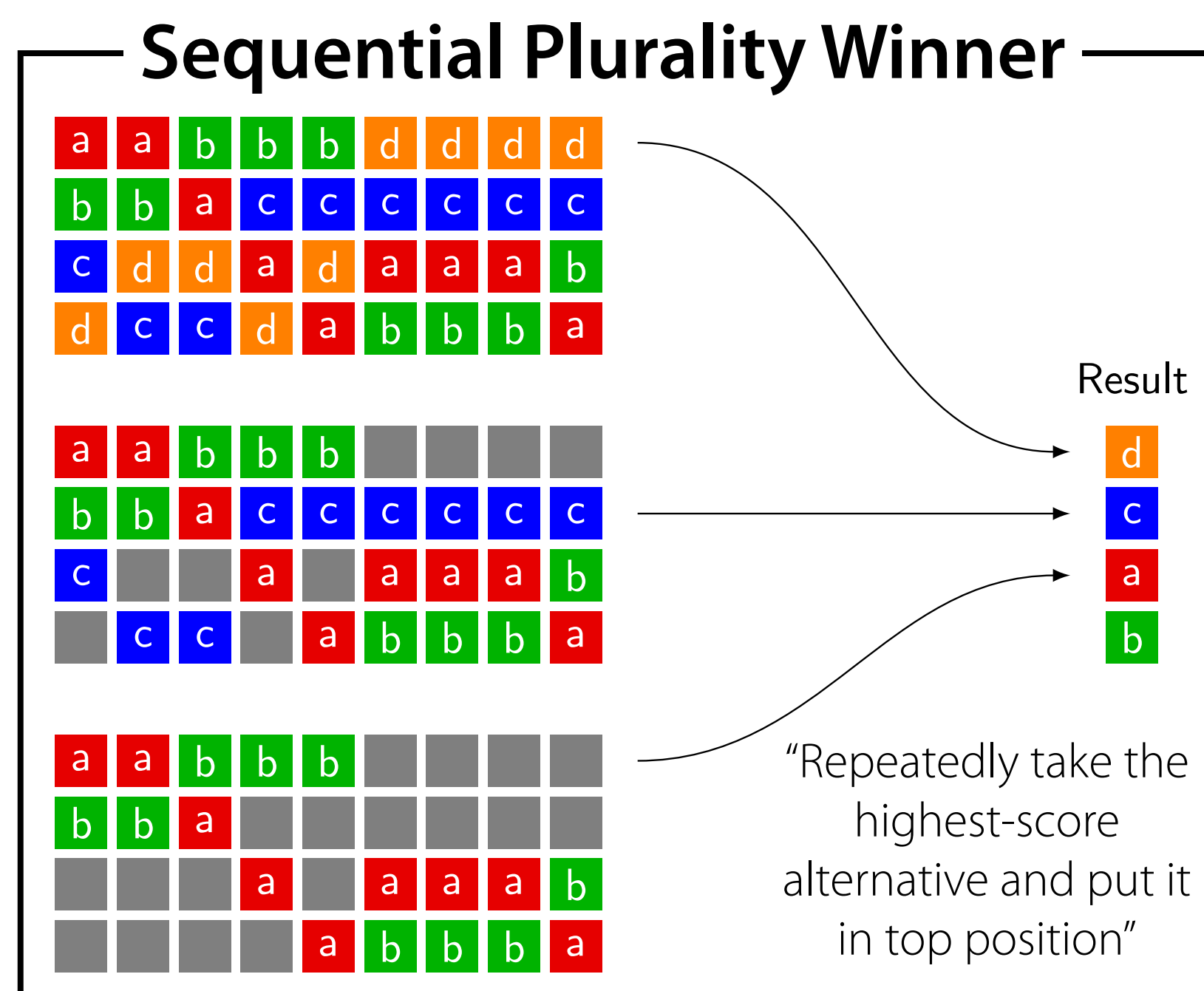
Task: Rank aggregation
combining several rankings
into one summary ranking



Benchmark method: Kemeny
take the ranking that minimizes
total swap distance to the inputs
but: hard to compute, hard to explain output

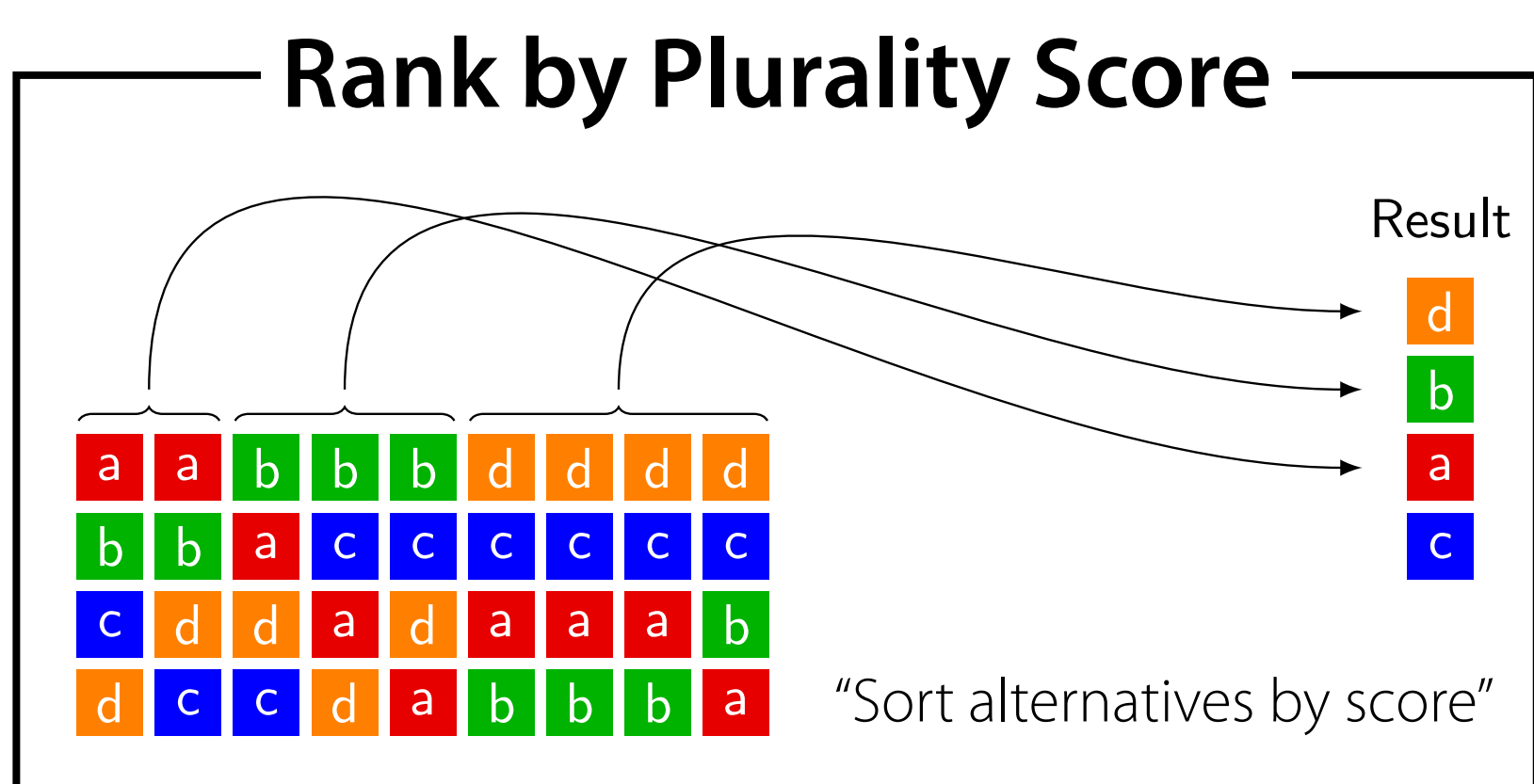
Our paper: Simple methods using Scoring Rules
based on how often an alternative is ranked top
(plurality), or its average rank (Borda), or
number of times it is ranked bottom (veto)

Three schemes of scoring-based rank aggregation rules:



Applications

- Sequential Winner** (no prior literature?)
 - order to make job offers
 - party lists for elections
- Sequential Loser**
 - well-known in voting theory: = instant runoff voting used in Australian elections.
 - Variants: Baldwin, Coombs
- Rank by Score**
 - Eurovision Song Contest
 - "ARTU" aggregated university rankings
 - rank by Olympic medals
 - participatory budgeting



Axiomatic Analysis

Some of our rules get "axiomatically close" to the Kemeny rule.

	Score	Sequential-Winner			Sequential-Loser					
	Kemeny	Plurality	Veto	Borda	Plurality	Veto	Borda	Plurality	Veto	Borda
Independence at the top	✓	×	×	×	✓	✓	✓	×	×	×
Independence at the bottom	✓	×	×	×	×	×	×	✓	✓	✓
Reinforcement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reinforcement at the top	×	✓	✓	✓	✓	✓	✓	×	×	×
Reinforcement at the bottom	×	✓	✓	✓	×	×	×	✓	✓	✓
Condorcet winner at top	✓	×	×	×	×	×	×	×	×	✓
Copy majority	✓	×	×	×	✓	×	×	×	✓	×
Independence of clones	×	×	×	×	×	×	×	✓	×	×

Complexity Analysis

Due to tie-breaking, it's hard to decide which alternatives can rank highly.

Decision problem: can candidate c appear in the top k positions?

	parameter number of candidates	parameter number of voters			
	n	k	$n+k$	m	
Sequential-Plurality-Winner	NP-c.	W[1]-h., XP	W[1]-h., XP	FPT	FPT
Sequential-Veto-Winner	NP-c.	FPT	W[2]-h., XP	FPT	FPT
Sequential-Borda-Winner	NP-c.	NP-h. for $n=8$	W[1]-h., XP	?	FPT

3 similar rules, but different parameterized complexity!

our most technically challenging results

Decision problem: can candidate c appear in the top position? (aka winner determination)

	n	m
Sequential-Plurality-Loser (STV)	NP-c. ^[known]	FPT
Sequential-Veto-Loser (Coombs)	NP-c. ^[known]	W[1]-h., XP
Sequential-Borda-Loser (Baldwin)	NP-c. ^[known]	NP-c. for $n=8$

was known (2009) but proof omitted

proof technique based on McGarvey's theorem

Dependence 2^m , comes with ETH lower bound

