UNIVERSITY of ROCHESTER

Separating & Collapsing Electoral Control Types

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JOINT WORK WITH
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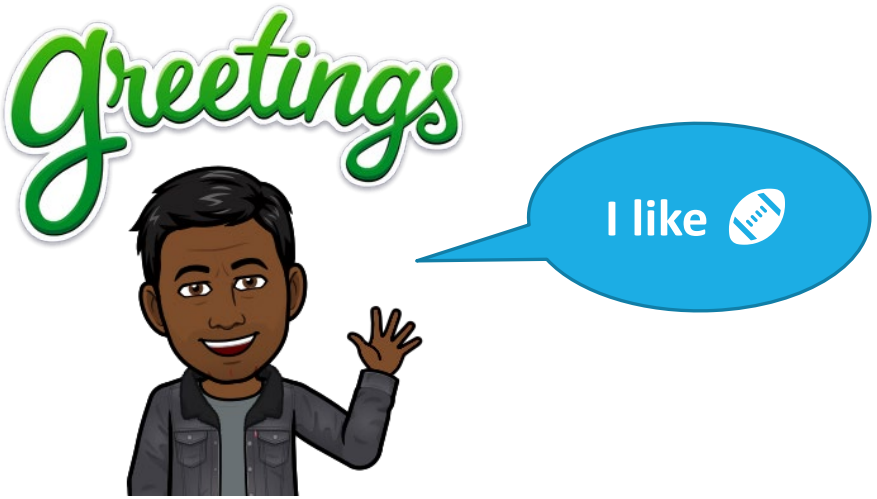
Example: Picking a Favorite Sport

Candidates (C):	🏐, 🏈, 🏓

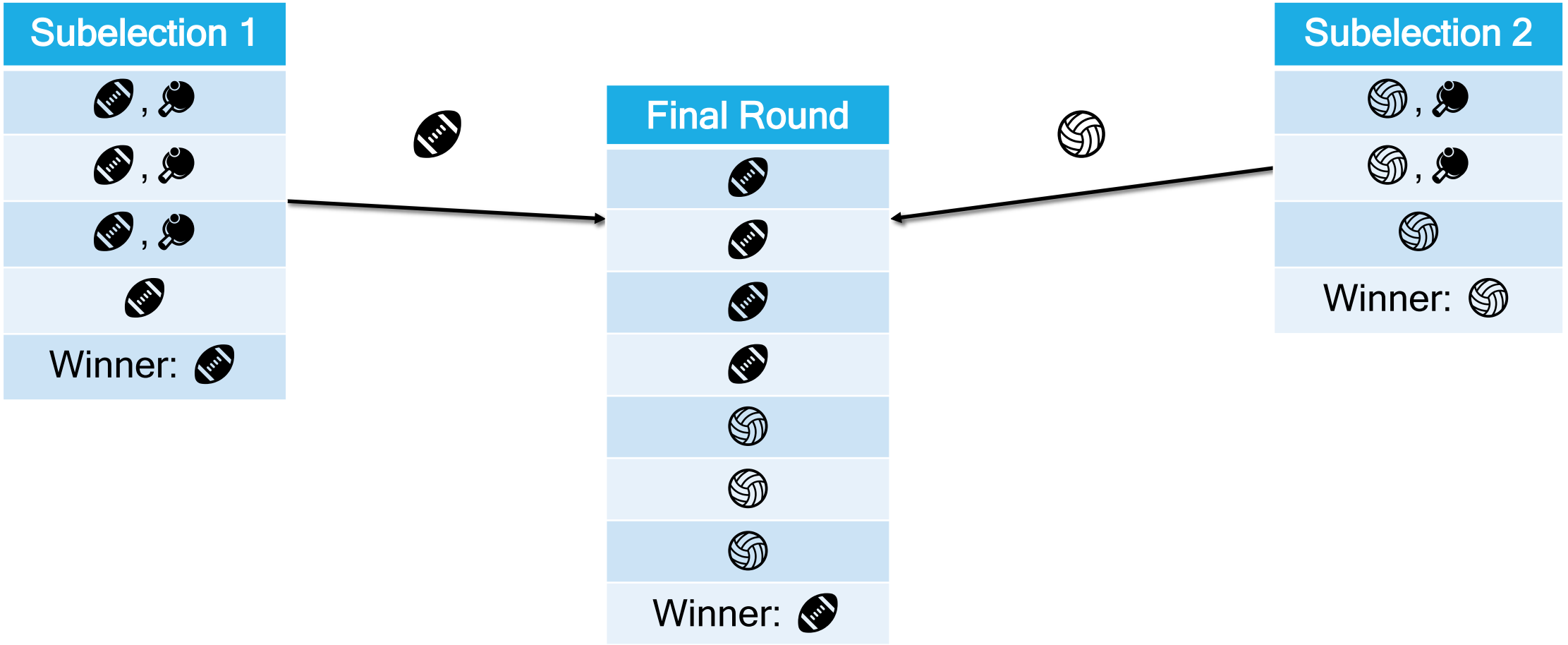
Election System/Voting Rule: Approval

Votes (V)
🏈, 🏓
🏈, 🏓
🏈, 🏓
🏈
🏐, 🏓
🏐, 🏓
🏐
Winner: 🏓



Election Chair

Control by Partition of Voters (using Approval)



Electoral (Partition) Control Types

End-Goal	• Constructive (CC) • Destructive (DC)
Action	• Partition of Voters (PV) • Partition of Candidates (PC) • Run-off Partition of Candidates (RPC)
Tie-Handling	• Ties Eliminate (TE) • Ties Promote (TP)
Winner Model	• Unique Winner (UW) • Nonunique Winner (NUW)

24 different partition control types!

The Other Electoral Control Types

End-Goal	• Constructive (CC) • Destructive (DC)
Action	• Unlimited Adding Candidates (UAC) • Adding Candidates (AC) • Adding Votes (AV) • Deleting Candidates (DC) • Deleting Votes (DV)
Winner Model	• Unique Winner (UW) • Nonunique Winner (NUW)

20 other control types!

Are Control Types Inherently Different?

When are two control types equal (collapse) and when are they different (separate)?

Our model

- Decision Model

- For control type Approval-CC-PV-TP-UW
  - **Inputs:** set of candidates C, set of votes V, distinguished candidate p.
  - **Question:** Is there a partition (V_1, V_2) of V such that p is a winner of the two-stage election where the winners* of (C, V_1) compete against the winners* (C, V_2) (using votes V)?

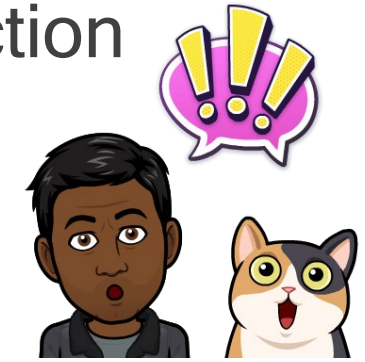
- Using our toy example, (C, V, ) ∈ Approval-CC-PV-TP-UW.

Why Does it Matter?

- Provably Less Work
- New Research Landscape
- Deepens Understanding of Control
- Applicable to Multiple Models

General Collapses

- Hemaspaandra et al. (2020) showed that for any election system $\mathcal{E}$
  - $\mathcal{E}$-DC-RPC-TE-UW = $\mathcal{E}$-DC-PC-TE-UW = $\mathcal{E}$-DC-RPC-TE-NUW = $\mathcal{E}$-DC-PC-TE-NUW
  - $\mathcal{E}$-DC-RPC-TP-NUW = $\mathcal{E}$-DC-PC-TP-NUW



- We ask: Are there more collapses?
  - In the general case, no.
  - But if we look at concrete systems, yes.

Our Results

Election System	Collapses	Separations	Open
General	7	1 + 314	0
Plurality	7	315	0
Veto	7+1	314	0
Approval	7+14	301	0

For Reference:
Plurality: Each candidate gets 1 point per vote that ranks them first.

Veto: Each candidate receives 1 point for each vote, unless they're ranked last.

Approval: Each candidate gets 1 point for each vote that approves them.

Key
Prior work (Hemaspaandra et al., 2020)
Our work (Carleton et al., 2022)

How Do We Show Separations?

$C = \{a, b, c, d, e, f, g, h\}$ and

$V = \{\{a, c, d, e, f\}, \{a, c, d, e, f\}, \{a, b, c\}, \{b, h\}, \{b, h\}, \{d, h\}, \{e, g, h\}, \{f, g, h\}, \{a, c, d, e, f, g\}, \{a, b, d, e, f, g\}\}$

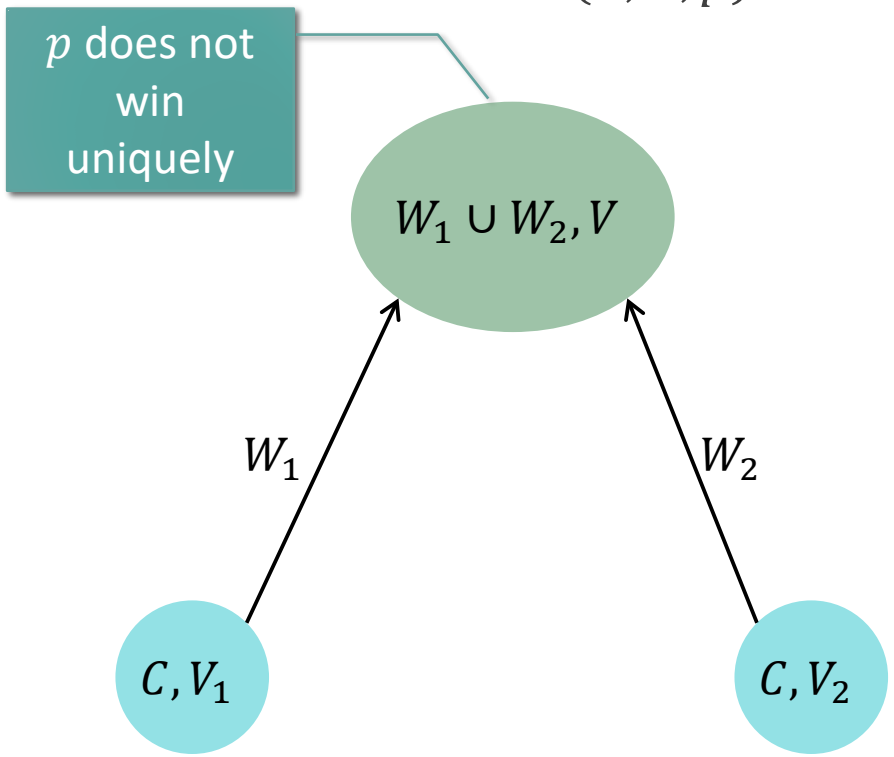
- $(C, V, a) \in \text{Approval}-\text{CC}-\text{PV}-\text{TP}-\text{UW}$
- Also, $(C, V, a) \notin \text{Approval}-\text{CC}-\text{PV}-\text{TE}-\text{UW}$

- $\therefore$ For approval, $\mathbf{CC-PV-TP-UW} \neq \mathbf{CC-PV-TE-UW}$
  - More precisely, "$\not\subseteq$"

How do we show collapses?

Claim: In approval, $\mathrm{DC{-}PV{-}TE{-}UW} = \mathrm{DC{-}PV{-}TE{-}NUW}$.

Proof Sketch: Let $(C, V, p) \in \mathrm{DC{-}PV{-}TE{-}UW}$ via partition (V_1, V_2).



General Idea: Construct partition that demonstrates that p is not a final-round winner, i.e., $(C, V, p) \in \mathrm{DC{-}PV{-}TE{-}NUW}$.

Case 1: $p \notin W_1 \cup W_2$ → Done

Case 2: $p \in W_1 \cup W_2$, then there is $d \in W_1 \cup W_2$ and $score_V(p) \leq score_V(d)$. So, use partition $(V, \emptyset)$.

This shows $\subseteq$, and $\supseteq$ is trivial

But can we be more general?

Yes!

We give some axiomatic-sufficient conditions of the form:

If election system $\mathcal{E}$ satisfies Unique-WARP, then $\mathcal{T}_1 = \mathcal{T}_2$.

A first step towards characterizing collapses; helps us deepen our understanding of control types.

Other Contributions

Immunity results

General-case containments

Programs to automatically find separations

Hierarchy of incomparability

Explicit solution conversions

Future work & Open Directions

- Additional Model Extensions
- Study Additional Election Systems
- Axiomatic Characterizations
- Further Refinements

Thank You

Location: Le Morne, Mauritius

Poster #29