Collective Decision-making: Arguing & Voting

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Purpose of this talk

☐ **Provide a light-weighted introduction to** Argumentation Theory **in the context of Collective Decision-Making**

☐ **Put forth a number of research topics at the interface of the** Theory of Aggregation, Argumentation theory, **and** Rational Dynamics

☐ **... put together techniques from** Social Choice, Artificial Intelligence, Logic **(and** Game theory**)**

☐ **Watch a good movie!**

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Voting

Preference & Judgment Aggregation

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Majority voting on two issues

Theorem (May, 1952) If the number of voters is odd, and the number of issues is two, then pairwise majority voting is the only rule which is anonymous, neutral, monotonic and resolute.

☐ The theorem is a PA theorem, but has an obvious counterpart in JA when voting on any number of *logically unrelated* propositions.

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Majority voting on more issues (i)

Marie. J. A. N. de Caritat (1785) "Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité de voix"

$\{x, y\}$	$\{y, z\}$	$\{x, z\}$
$y \prec x$	$z \prec y$	$z \prec x$
$y \prec x$	$y \prec z$	$x \prec z$
$x \prec y$	$z \prec y$	$x \prec z$
$y \prec x$	$z \prec y$	$x \prec z$

- **Intransitivity of collective judgment in pairwise majority voting**

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Majority voting on more issues (ii)

p	$p \rightarrow q$	q
$\models$	$\models$	$\models$
$\models$	$\not\models$	$\not\models$
$\not\models$	$\models$	$\not\models$
$\models$	$\models$	$\not\models$

- **The collective judgment is impossible (<u>under Propositional Logic</u>)**

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Majority voting on more issues (ii)

p	q	$p \wedge q$
$\models$	$\models$	$\models$
$\models$	$\not\models$	$\not\models$
$\not\models$	$\models$	$\not\models$
$\models$	$\models$	$\not\models$

- **The collective judgment is impossible (<u>under Propositional Logic</u>)**

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Majority voting on more issues (ii)

p	q	$p \vee q$
$\nvDash$	$\nvDash$	$\nvDash$
$\vDash$	$\nvDash$	$\vDash$
$\nvDash$	$\vDash$	$\vDash$
$\nvDash$	$\nvDash$	$\vDash$

- **The collective judgment is impossible (<u>under Propositional Logic</u>)**

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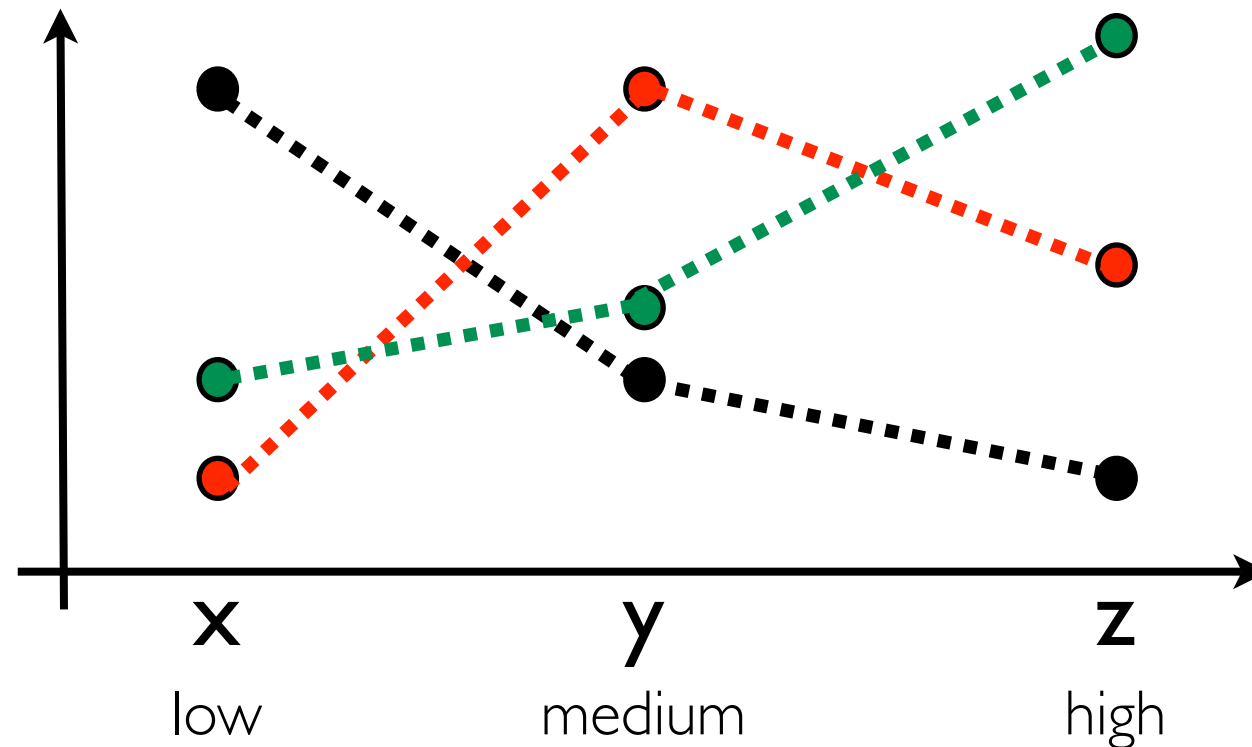# Majority voting on more issues (iii)

K. Arrow (1950) "A Difficulty in the Concept of Social Welfare", Journal of Political Economy, 58(4): 328-346

Theorem (Arrow, 1950) There exists no preference aggregation function which satisfies unanimity, independent of irrelevant alternatives and non-dictatorship for more than two issues.

C. List and P. Pettit (2002) "Aggregating Sets of Judgments: An Impossibility Result", Economics and Philosophy 18: 89-110

Theorem (List and Pettit, 2002) There exists no judgment aggregation function which satisfies systematicity and anonymity if the set of issues includes p, q and one of their Boolean compounds.

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"Well-behaved" preferences (i)

A preference profile $\mathfrak{p} = (\preceq_1, \ldots, \preceq_n)$ of total preorders on $\mathtt{Iss}$ is *single-peaked* if there exists a total order $\preceq^*$ on $\mathtt{Iss}$ s.t. $\forall i \in \mathtt{Agn}$:

$$y \preceq_i x \ \& \ B(x, y, z) \quad \Rightarrow \quad z \prec_i y$$

where B is the betweenness relation induced by $\preceq^*$.

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"Well-behaved" preferences (ii)

Theorem (Black, 1948) If the number of voters is odd, and the domain of the aggregation function is restricted to single-peaked profiles, then there always exists a Condorcet winner.

☐ Since we restrict the domain of aggregation, majority becomes "non-resolute" in some problematic cases.

☐ Is such "non-resoluteness" the rationale of pre-voting deliberation?

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Unanimity

$$v(C) = \begin{cases} 1 & \text{if } |N| = |C| \\ 0 & \text{otherwise} \end{cases}$$

☐ Unanimity on more than two issues is a special case of majority under single-peakedness

☐ Unanimity is undertedermined also when voting on two issues.

☐ Is requesting a vote by unanimity a way to foster deliberation?

Deliberating/Arguing

Argumentation Theory

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Arguing

☐ *The Economist:* "Berlusconi is unfit to lead Italy because he is involved in several trials"

☐ *Mr. Berlusconi:* "Berlusconi is actually the fittest to lead Italy because he is the most successful Italian entrepreneur"

The Uses of Argument (1958)

"What things about the form and merits of our arguments are *field-invariant* and what things about them are field-dependent? [...] The various phases [of assessment of an argument] may be encountered equally whether our argument is concerned with a question of physics or mathematics, ethics or law, or an everyday matter of fact. [...] The *force* of the conclusion [...] is the same regardless of fields: the criteria or sorts of grounds required to justify such a conclusion vary from field to field" [Toulmin,1958]

☐ Abstract argumentation theory studies the field-invariant aspects of argumentation, i.e., what is common to arguing in any context

Abstract argumentation (i)

e   b
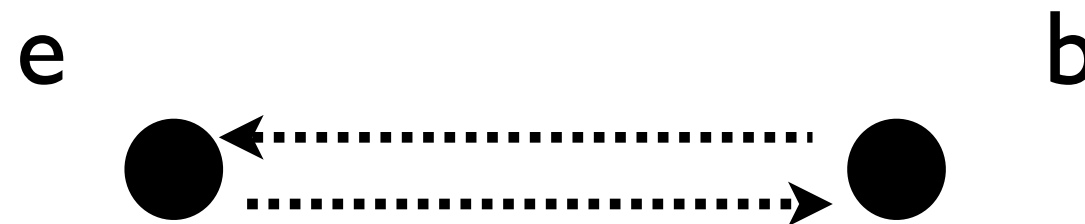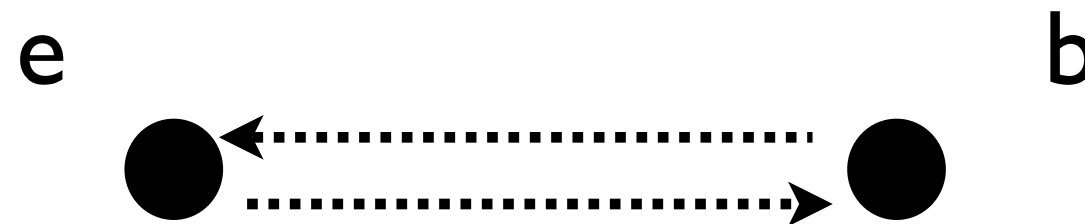
- Abstract argumentation is about arguments (points) and attacks (relations): $(A, \rightarrow)$

- The question is, given an argumentation framework, which (sets of) arguments should be considered "justified", or "acceptable" (justification-based 'semantics')?
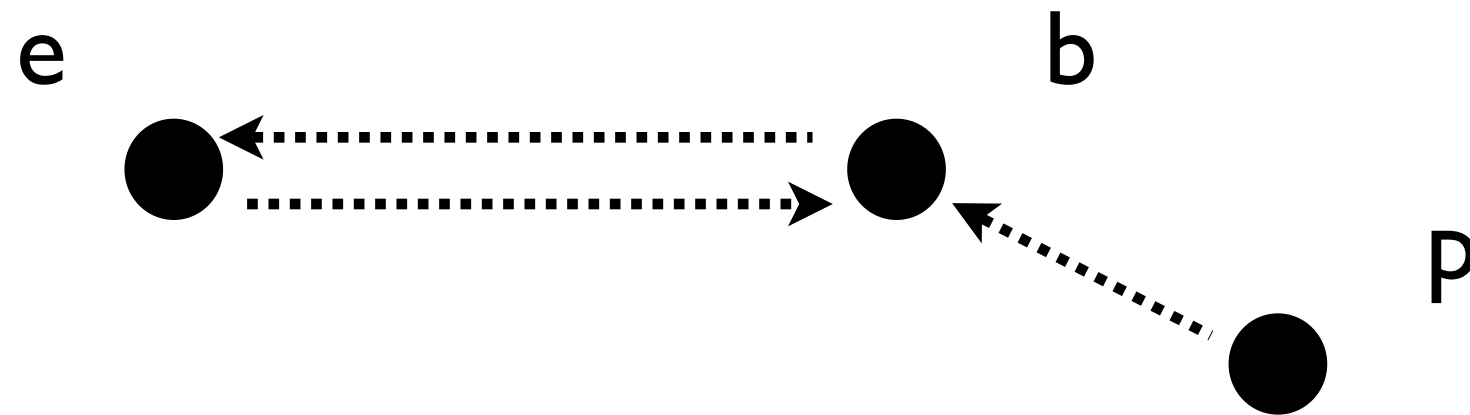
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Abstract argumentation (ii)

GroundedSet	$\emptyset$	Least fixpoint of "attacking all attackers"
PreferredSets	$\{e\}, \{b\}$	Maximal conflict-free post-fixpoint of "attacking all attackers"
StableSets	$\{e\}, \{b\}$	Fixpoint of "all attackers are out"

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Abstract argumentation (iii)

GroundedSet	$\{e, p\}$	Least fixpoint of "attacking all attackers"
PreferredSets	$\{e, p\}$	Maximal conflict-free post-fixpoint of "attacking all attackers"
StableSets	$\{e, p\}$	Fixpoint of "all attackers are out"

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Conclusions

Research questions

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Deliberating & Arguing

☐ In the simplest case of deliberation (e.g. before casting a vote under Unanimity rule), the position of the group on a certain issue will be the set of "justified" or "acceptable" arguments put forth by the agents.

☐ So, each agents contributes to building an argumentation framework, then by applying a justification-based semantics, a collective conclusion is reached.

☐ This works for unanimity in PA or JA. How would such argument-based deliberation work in changing a profile of preferences to a single-peaked one (thus enabling Black's theorem)?

Deliberation as profile transformation (Umberto)

☐ Take "deliberation" to be a function from profiles to singlie-peaked profiles.

☐ What are the intuitive axioms they should satisfy?

☐ What are the properties of existing argument-based deliberation procedures (e.g. formal verification of parliamentary procedures)?

Form vs. Formality (Johan)

"It now appears that arguments must not just have a particular shape, but must be set out and presented in a sequence of steps conforming to certain basic rules of procedure. In a word, rational assessment is an activity necessarily involving *formalities* [...] we must ask how far the formal character of sound arguments can be thought of more geometrico, as a matter of their having the right sort of shape, and how far it needs to be thought of, rather, in procedural terms, as a matter of their conforming to the formalities which must be observed if any rational assessment of arguments is to be possible" [Toulmin,1958]

☐ If arguing happens according to some "rules of the game", can we deploy game-theory to study the strategic aspects of deliberation via arguing (e.g. in trials)?

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Deliberation in DEL (Fernando)

☐ Can we use the DEL-machinery to model the type of changes in the epistemic attitudes of agents engaged in a deliberation and influencing each other's opinions? Does (van Benthem, 2008) suffice?

☐ Can argumentation frameworks be used to "update" DEL models so to capture the epistemic changes of agents engaged in a deliberation process?

"12 Angry Men"

Sydney Lumet, 1957

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