Rationality

Lecture 16

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December 16, 2010

Group Rationality Constraints

- Defining a group's preferences and beliefs:
  - Even if all the agents in a group have rational preferences, the groups preference may not be rational.
  - Even if all the agents in a group have rational beliefs, the groups beliefs may not be rational.
- Different normative constraints on group decision making are in conflict.
  - Arrow's Theorem
  - Sen's Liberal Paradox
  - Puzzles of Fair Division
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Main Question: Given a group of people faced with some decision, how should a central authority combine the individual opinions so as to best reflect the "will of the group"?

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How should we compare the different methods?

Reflecting the will of the people

# voters	3	5	7	6
	a	a	b	c
	b	c	d	b
	c	b	c	d
	d	d	a	a

Brams and Fishburn. *Voting Procedures*. Handbook of Social Choice and Welfare (2002).

Reflecting the will of the people

# voters	3	5	7	6
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a is the simple majority winner.

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But a **stronger** majority ranks *a* last.

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Condorcet Winner: c beats each candidate in a pairwise comparisons.

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Borda: Take into account the *entire* ordering: all voters rank b and c either first, second or third.

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Voting Procedures

- *Roughly* three different types of procedures: ranked, non-ranked, multi-stage.

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- Each procedures specifies a type of vote, or **ballot**, that is recognized as admissible by the procedure and a method to **count** a vector of ballots (one ballot for each voter) and select a winner (or winners).

Many Examples

Plurality (Simple Majority)

- Each voter selects one candidate (or none if voters can abstain)
- The candidate(s) with the most votes wins.

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Negative Voting

- Every voter can select one candidate to voter for or against.
- The candidate(s) with the most votes wins.

(Equivalent to either giving one vote to a single candidate or one vote to everyone but one candidate)

Many Examples

Approval Voting

- Each voter selects a proper subset of candidates (empty set means the voter abstains)
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Cumulative Voting

- Every voter is given k votes which can be cast arbitrarily (several votes for the same candidate are allowed)
- The candidate(s) with the most votes wins.

Many Examples

Plurality with runoff

- Use plurality voting to select the winner(s)
- If two or more candidate tie for the win, they move on to round two. If there is a unique winner in round 1, that candidate and the second place winner(s) move on to round two.
- Use plurality vote on this smaller set of candidates.

(More generally, alternative rules can be used to determine who moves on to the next round)

Many Examples

Pairwise Elimination

- In advance, voters are given a schedule for the order in which pairs of candidates will be compared.
- In the above order, successively eliminate the candidates preferred by a minority of votes.
- The winner is the candidate who survives.

Many Examples

Borda Count

- Each voter provides a linear ordering of the candidates.
- The candidate(s) with the most **points** wins, where points are calculated as follows: if there are n candidates, $n-1$ points are given to the highest ranked candidates, $n-2$ to the second highest, and so on.

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The Hare System

- Each voter provides a linear ordering of the candidates.
- Repeatedly delete the candidate or candidates with the least first-place votes. The last group to be deleted is tied for the win.

Comparing Voting Procedures

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- Is the procedure **monotonic**? More votes should always be better!

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- A **Condorcet winner** is a candidate that beats every other candidate in pairwise contests. A voting procedure is Condorcet provided it selects the Condorcet winner, if one exists.
- Is the procedure **monotonic**? More votes should always be better!
- How susceptible is the procedure to *manipulation*?

Failure to elect the Condorcet candidate

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Plurality: a is the plurality winner.

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# voters	3	5	7	6
3	a	a	b	c
2	b	c	d	b
1	c	b	c	d
0	d	d	a	a

Borda:

- $BC(a) = 3 \times 3 + 3 \times 5 + 0 \times 7 + 0 \times 6 = 24$
- $BC(b) = 2 \times 3 + 1 \times 5 + 3 \times 7 + 2 \times 6 = 44$
- $BC(c) = 1 \times 3 + 2 \times 5 + 1 \times 7 + 3 \times 6 = 29$
- $BC(d) = 0 \times 3 + 0 \times 5 + 2 \times 7 + 1 \times 6 = 20$

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Condorcet: c beats each candidate in a pairwise comparisons.
Plurality: a is the plurality winner.
Borda: b is the Borda winner.

Scoring Rules

Fix a nondecreasing sequence of real numbers

$$s_0 \leq s_1 \leq s_1 \leq \cdots \leq s_{m-1}$$

with $s_0 < s_{m-1}$

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Voters rank the candidates, giving s_0 points to the one ranked last, s_1 to the one ranked next to last, and so on. A candidate with the maximal total score is elected.

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Theorem (Fishburn) There are profiles where the Condorcet winner is never elected by **any** scoring method.

AV is more flexible

Fact There is no fixed rule that always elects a unique Condorcet winner.

# voters	2	2	1
	a	b	c
	d	d	a
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# voters	2	2	1
	a	b	c
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The unique Condorcet winner is *a*.

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# voters	2	2	1
	a	b	c
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Vote-for-1 elects $\{a, b\}$, vote-for-2 elects $\{d\}$, vote-for-3 elects $\{a, b\}$.

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# voters	2	2	1
	a	b	c
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$(\{a\}, \{b\}, \{c, a\})$ elects a under AV.

AV is more flexible

Fact Condorcet winners are always AV outcomes, but a Condorcet looser may or may not be an AV outcome.

The Spoiler Effect

# voters	35	33	32
	a	b	c
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# voters	35	33	32
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Plurality and Borda both pick *a*.

The Spoiler Effect

# voters	35	33	32
	a	b	c
	c	a	b
	b	c	a

Candidate c is a spoiler.

The Spoiler Effect

# voters	35	33	32
	a	b	x
	x	x	b
	b	c	a

Without c, both Plurality and Borda both pick b.

Failure of Monotonicity

# voters	6	5	4	2
	a	c	b	b
	b	a	c	a
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The profiles are monotonic (in a).

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	b	a	x	a
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The profiles are monotonic (in a).

a wins the first election.

c wins the second election.

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No-show Paradox

Totals	Rankings	H over W	W over H
417	B H W	417	0
82	B W H	0	82
143	H B W	143	0
357	H W B	357	0
285	W B H	0	285
324	W H B	0	324
1608		**917**	**691**

Fishburn and Brams. *Paradoxes of Preferential Voting*. Mathematics Magazine (1983).

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B: $417 + 82 = 499$

H: $143 + 357 = 500$

W: $285 + 324 = 609$

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H Wins

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Suppose two more people show up with the ranking B H W

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W Wins!

Multiple Districts

Totals	Rankings	East	West
417	B H W	160	257
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1608		**588**	**1020**

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B would win both districts!

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# voters	35	33	32
	a	b	c
	c	a	b
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The order: 1. a vs. b; 2. the winner vs. c elects c

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The order: 1. a vs. c; 2. the winner vs. b elects b

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The order: 1. b vs. c; 2. the winner vs. a elects a

The Danger of Manipulation

Setting the Agenda:

# voters	1	1	1
	b	a	c
	d	b	a
	c	d	b
	a	c	d

The order: 1. a vs. b; 2. the winner vs. c; 3. the winner vs. d elects d

The Danger of Manipulation

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The Danger of Manipulation

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	d	b	a
	c	d	b
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The order: 1. a vs. b; 2. a vs. c; 3. c vs. d elects d, but **everyone** prefers b to d.

The Danger of Manipulation

"Insincere Voting":

# voters	3	3	1
	a	b	c
	b	a	a
	c	c	b

The Danger of Manipulation

"Insincere Voting":

# voters	3	3	1
	a	b	c
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BC will elect *a* with 10 points (*b* gets 9 points and *c* gets 2 points).

The Danger of Manipulation

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	c	a	b

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The Danger of Manipulation

"Failure of IIA":

# voters	3	2	2
	a	b	c
	b	c	a
	c	a	b

The Danger of Manipulation

"Failure of IIA":

# voters	3	2	2
	a	b	c
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	c	a	b

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The new BC ranking is: c (13) $>$ b (12) $>$ a (11) $>$ x (6)

Conclusions

- Many different types of voting methods: Plurality, Plurality with runoff, AV, BC, Hare system (STV), Copeland, Dodgson, Condorcet, etc.
- Many different dimensions to compare the procedures.
- No voting methods is perfect....

Concluding Remarks

Rationality

What does it mean to be *rational* or *reasonable* as opposed to *irrational* or unreasonable?

Rationality: Key Issues

Theoretical vs. Practical Rationality

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Theoretical vs. Practical Rationality

- what is rational for an agent to believe (accept, know, etc.)
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Normative vs. Descriptive

Rationality: Two Themes

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Rationality is a matter of *reliability*:

- A rational belief is one that is arrived at a through a process that reliably produces beliefs that are true.
- A act is rational if it is arrived at through a process that reliably achieves specified goals.

Rationality: Two Themes

"Neither theme alone exhausts our notion of rationality. Reasons without reliability seem emtpy, reliability without reasons seems blind. In tandem these make a powerful unit, but how exactly are they related and why?" (Nozick, pg. 64)

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Accuracy and rationality are linked, they are not the same: a fool may hold a belief irrationally — as a result of a lucky guess or wishful thinking — yet it might happen to be correct. Conversely, a detective might hold a belief on the basis of a careful and exhaustive examination of all the evidence and yet the evidence may be misleading, and the belief may turn out to be wrong.

Theoretical Reasoning

Rational beliefs are those that arise from **good thinking**, whether or not that thinking was successful in latching on to the truth.

But, what is **good thinking**?

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But, what is **good thinking**?

- classical logic (modus ponens, modus tollens, etc.)
- non-monotonic/default logic
- closed-world reasoning
- induction (induction from examples)
- Bayesian inference
- case-reasoning/reasoning by analogy
- fast and frugal heuristics

Rational Constraints on Beliefs

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Conceptions of Beliefs

- **Binary**: "all-out" belief. For any statement p, the agent either does or does not believe p. It is natural to take an *unqualified* assertion as a statement of belief of the speaker.

- **Graded**: beliefs come in degrees. We are *more confident* in some of our beliefs than in others.

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- Deductive cogency: an ideal rational agent's beliefs should be *consistent* and *deductively closed*. (Preface Paradox, Lottery Paradox, Problems with Closure)

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- Maximize expected utility
- Dominance reasoning

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3. I ought to go to the bar. *belief*

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What does it *mean* for a choice/belief/action to be *rationally* criticizable?

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What happens when rational agents *interact*?

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Group Rationality
What does it mean for a *group* to be *rational*?

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- How do we make sense of the fact that deliberative reflection can directly give rise to action?
- Which norms for the assessment of action are binding on us as agents? What about *moral norms*?
- Which normative attitude is "primary"? (ought, reason)

Instrumental Rationality

Instrumental Rationality: Ann's action α is instrumentally rational iff Ann chooses α because she soundly believes it is the best prospect to achieve her goals, desires, tastes, etc.

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- *Instrumental rationality* is a fundamental account of "rationality", but it is not necessarily the "whole of rationality"

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- Utility is not a sort of "value", but simply a representation of one's ordering of options based on one's underlying values, ends and principles.

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- We need an account of which distinctions are relevant and which are not...what justifies a preference.
- Utility theory is a way to formalize and model rational action, but it is not itself a complete theory of rational action.

J. Pollock. *Rational Choice and Action Omnipotence*. The Philosophical Review, Vol. 111, No. 1 (2002), pgs. 1 - 23.

Rationality in Interaction: Game Theory

"We wish to find the mathematically complete principles which define 'rational behavior' for the participants." (pg. 31)

J. von Neumann and O. Morgenstern. *Theory of Games and Economic Behavior*. Princeton University Press, 1944.

Game Theory: Key Questions

- What should the players *do* in a game-theoretic situation and what should they expect? (Assuming everyone is **rational** and recognize each other's rationality)

- What are the assumptions about rationality and the players' knowledge/beliefs underlying the various solution concepts? *Why* would the agents' follow a particular solution concept?

Normative/Descriptive

The point of view of this model is not normative; it is not meant to advise the players what to do. The players do whatever they do; their strategies are taken as given.

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R. Aumann. *Irrationality in Game Theory*. in: *Aumann's Collected Papers, Volume 1*, Chapter 35, 1992.

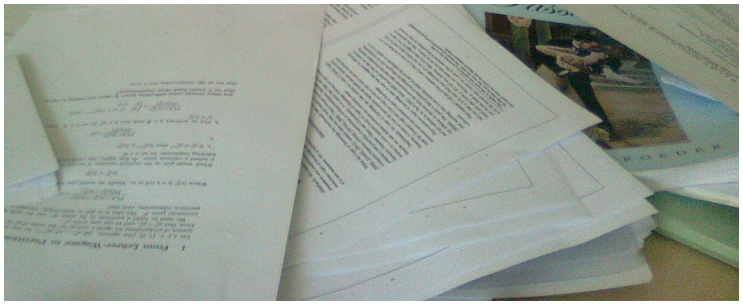
Focal Points

"The basic intellectual premise, or working hypothesis, for rational players in this game seems to be the premise that some rule must be used if success is to exceed coincidence, and that the best rule to be found, whatever its rationalization, is consequently a rational rule."

(Thomas Schelling)

Game Theory: Classifying Social Interactions

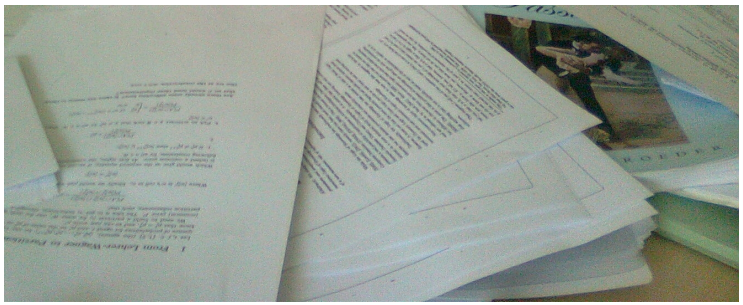
	C	D
C		
D		



Game Theory: Classifying Social Interactions

Problem of Cooperation.

	C	D
C	3,3	0,4
D	4,0	1,1



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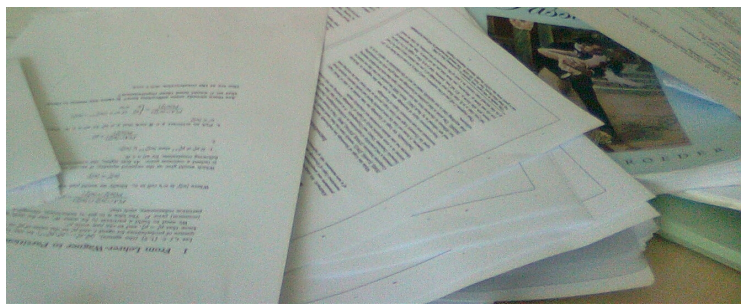
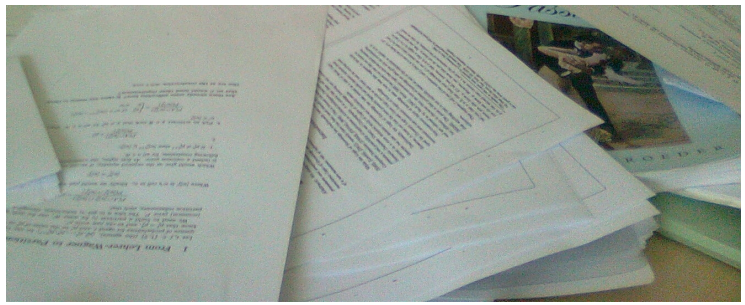


Game Theory: Classifying Social Interactions

	C	D
C		
D		

Intuitively, we solve these problem by working together.
This is the question of collective agency.



Different contexts of agency

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- Individual decision making and individual action against nature.
  - Ex: Gambling.

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- Individual decision making and individual action against nature.

- Individual decision making in interaction.
  - Ex: Playing chess.

Different contexts of agency

- Individual decision making and individual action against nature.
- Individual decision making in interaction.
- Collective decision making.
  - Ex: Carrying the piano.

Different contexts of agency

- Individual decision making and individual action against nature.
- Individual decision making in interaction.
- Collective decision making.

Group Rationality Constraints

- Defining a group's preferences and beliefs:
  - Even if all the agents in a group have rational preferences, the groups preference may not be rational.
  - Even if all the agents in a group have rational beliefs, the groups beliefs may not be rational.
- Different normative constraints on group decision making are in conflict.
  - Arrow's Theorem
  - Sen's Liberal Paradox
  - Puzzles of Fair Division
- Many proposed group decision methods (voting methods) with very little agreement about how to compare them.

Final Paper Due February 16, 2011 (send email or put it in my pigeon hole)