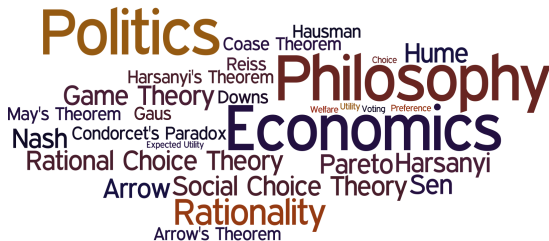


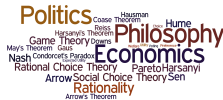
PHIL309P

Methods in Philosophy, Politics and Economics

Eric Pacuit
University of Maryland



Pure Strategy Nash Equilibrium



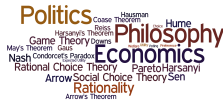
Let $\langle N, \{A_i\}_{i \in N}, \{u_i\}_{i \in N} \rangle$ be a strategic game

For $a_{-i} \in A_{-i}$, let

$$B_i(a_{-i}) = \{a_i \in A_i \mid u_i(a_{-i}, a_i) \geq u_i(a_{-i}, a'_i) \forall a'_i \in A_i\}$$

B_i is the **best-response** function.

Pure Strategy Nash Equilibrium



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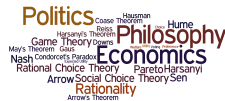
B_i is the **best-response** function.

$a^* \in A$ is a **Nash equilibrium** iff $a_i^* \in B_i(a_{-i}^*)$ for all $i \in N$.

In zero-sum games

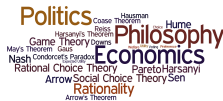
- ▶ There exists a mixed strategy Nash equilibrium
- ▶ There may be more than one Nash equilibria
- ▶ Security strategies are always a Nash equilibrium
- ▶ Components of Nash equilibria are interchangeable: If σ and σ' are Nash equilibria in a 2-player game, then (σ_1, σ'_2) is also a Nash equilibrium.

Battle of the Sexes



		Bob	
		B	S
Ann	B	2, 1	0, 0
	S	0, 0	1, 2

Battle of the Sexes



		Bob	
		B	S
Ann	B	2, 1	0, 0
	S	0, 0	1, 2

(B, B) , (S, S) , and $([2/3 : B, 1/3 : S], [1/3 : B, 2/3 : S])$ are Nash equilibria.

In an arbitrary (finite) games (that are not zero-sum)

- ▶ There exists a mixed strategy Nash equilibrium
- ▶ Security strategies are not necessarily a Nash equilibrium
- ▶ There may be more than one Nash equilibrium
- ▶ Components of Nash equilibrium are not interchangeable.
- ▶ Why *should* players play a Nash equilibrium?

Let $G = \langle N, \{S_i\}_{i \in N}, \{u_i\}_{i \in N} \rangle$ be a finite strategic game (each S_i is finite and the set of players N is finite).

A **strategy profile** is an element $\sigma \in S = S_1 \times \cdots \times S_n$

σ is a **Nash equilibrium** provided for all i , for all $s_i \in S_i$,

$$u_i(\sigma) \geq u_i(s_i, \sigma_{-i})$$

		Everyone Else	
		C1	C2
Me	C1	2, 2	0, 4
	C2	4, 0	1, 1

- ▶ Athletes using performance-enhancing drugs

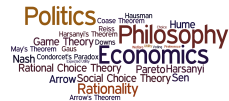
- ▶ Athletes using performance-enhancing drugs
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- ▶ Two people meet and exchange closed bags, with the understanding that one of them contains money, and the other contains a purchase. Either player can choose to honor the deal by putting into his or her bag what he or she agreed, or he or she can defect by handing over an empty bag.

- ▶ Athletes using performance-enhancing drugs
- ▶ Two competing companies deciding advertising budgets
- ▶ Nation-states deciding to restrict CO2 emissions
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- ▶ <http://www.radiolab.org/story/golden-rule/>

Prisoner's Dilemma



		Bob	
		C	D
Ann	C		
	D		

Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3	1
	D	4	2

Ann's preferences

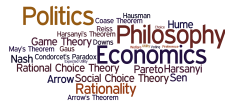
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3	4
	D	1	2

Bob's preferences

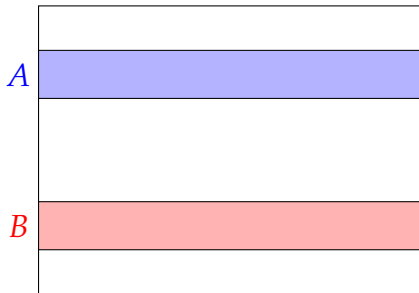
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

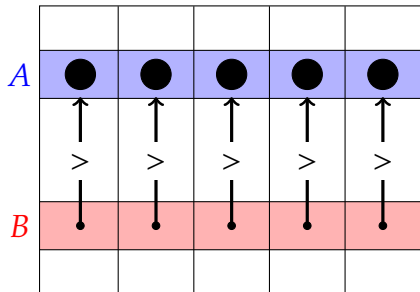
What should Ann (Bob) do?

Dominance Reasoning



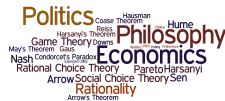
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Dominance Reasoning



Dominance reasoning is appropriate only when probability of outcome is *independent of choice*.

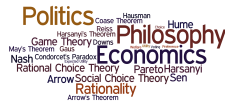
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

What should Ann (Bob) do?

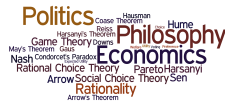
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

What should Ann (Bob) do? *Dominance reasoning*

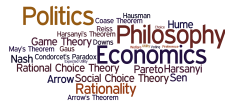
Prisoner's Dilemma



		Bob	
		C	D
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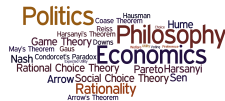
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

What should Ann (Bob) do? *Dominance reasoning* is not **Pareto**!

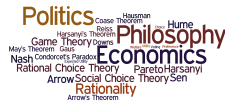
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3	2.5
	D	2.5	2

What should Ann (Bob) do? *Think as a group!*

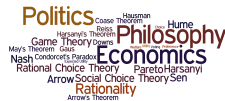
Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

What should Ann (Bob) do? *Play against your mirror image!*

Prisoner's Dilemma



		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

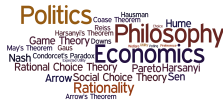
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A word cloud featuring names of economists and political theorists, and their associated theories. The words are arranged in a circular pattern. The most prominent words are 'Politics' (top left, large orange), 'Philosophy' (top right, large dark red), and 'Economics' (center, large dark blue). Other visible words include 'Hume', 'Hausman', 'Coase', 'Theorem', 'Reiss', 'Harsanyi's', 'Game Theory', 'Downs', 'May's Theorem', 'Gaus', 'Nash', 'Condorcet's Paradox', 'Rational Choice Theory', 'Pareto', 'Harsanyi', 'Arrow', 'Social Choice Theory', 'Sen', 'Rationality', and 'Arrow's Theorem'. The colors of the words vary, including shades of orange, red, blue, and grey.

Ann

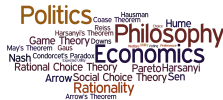
What should Ann (Bob) do? *Change the game...*

Nozick: Symbolic Utility



“Yet the symbolic value of an act is not determined solely by *that* act.

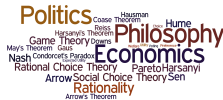
Nozick: Symbolic Utility



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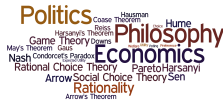
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Nozick: Symbolic Utility



“Yet the symbolic value of an act is not determined solely by *that* act. The act’s meaning can depend upon what other acts are available with what payoffs and what acts also are available to the other party or parties. What the act symbolizes is something it symbolizes when done in *that* particular situation, in preference to *those* particular alternatives. If an act symbolizes “being a cooperative person,” it will have that meaning not simply because it has the two possible payoffs it does

Nozick: Symbolic Utility



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R. Nozick. *The Nature of Rationality*. Princeton University Press, 1993.

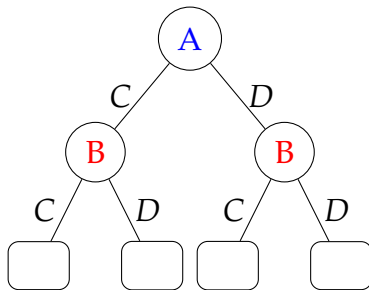
		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

What should/will Ann (Bob) do?

		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

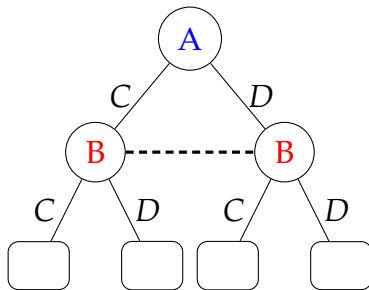


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

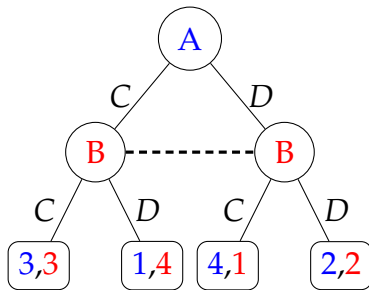


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

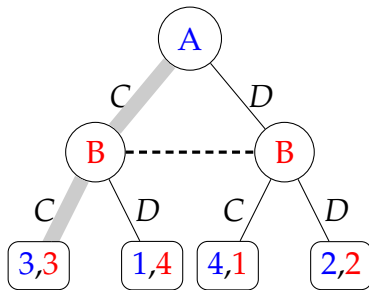


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

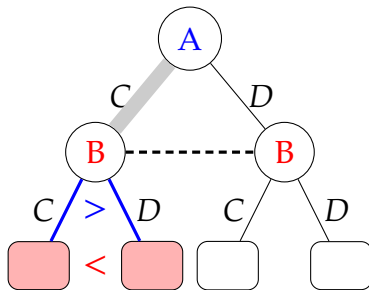


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

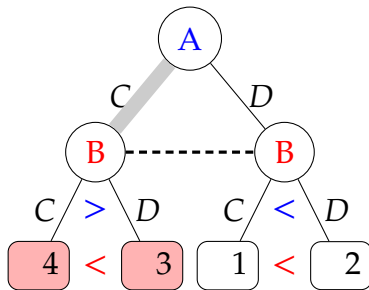


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

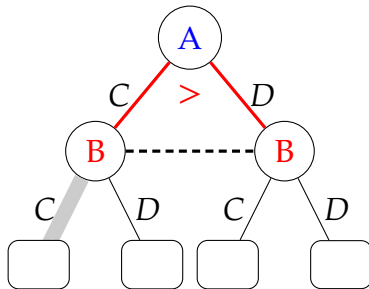


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

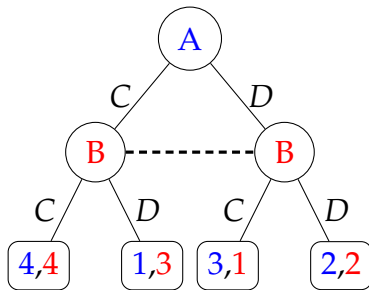


What should/will Ann (Bob) do?

Bob

		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma



What should/will Ann (Bob) do?

		Bob	
		C	D
Ann	C	3,3	1,4
	D	4,1	2,2

Prisoner's Dilemma

		Bob	
		C	D
Ann	C	4,4	1,3
	D	3,1	2,2

Assurance Game

What should/will Ann (Bob) do? *Change the game* (eg., Symbolic Utilities)

“Game theorists think it just plain wrong to claim that the Prisoners’ Dilemma embodies the essence of the problem of human cooperation.

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“Game theorists think it just plain wrong to claim that the Prisoners’ Dilemma embodies the essence of the problem of human cooperation. On the contrary, it represents a situation in which the dice are as loaded against the emergence of cooperation as they could possibly be. If the great game of life played by the human species were the Prisoner’s Dilemma, we wouldn’t have evolved as social animals! No paradox of rationality exists. Rational players don’t cooperate in the Prisoners’ Dilemma, because the conditions necessary for rational cooperation are absent in this game.” (pg. 63)

K. Binmore. *Natural Justice*. Oxford University Press, 2005.

Nozick's intuition is right. Just because the payoffs are the same—the games look the same in their strategic form—they may nevertheless be different games in their extensive form....In a game, everything of normative relevance for choice—“even the structure of the decision tree itself”—is part of the consequence domain. The utility at the terminal nodes sums up all the normatively relevant considerations. (G, pp. 115, 116)

Iterated Prisoner's Dilemma



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

Iterated Prisoner's Dilemma



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

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

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

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

Iterated Prisoner's Dilemma



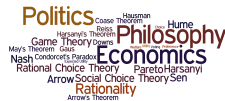
	C	D
C	3,3	0,4
D	4,0	1,1

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

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

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

Iterated Prisoner's Dilemma



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

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

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

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

Iterated Prisoner's Dilemma



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

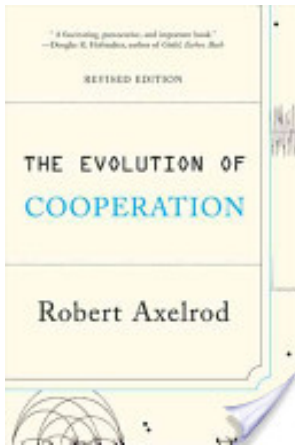
	C	D
C	3,3	0,4
D	4,0	1,1

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

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

...



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	<i>C</i>	<i>D</i>		<i>C</i>	<i>D</i>		<i>C</i>	<i>D</i>		<i>C</i>	<i>D</i>	...
<i>C</i>	3,3	0,4		<i>C</i>	3,3	0,4		<i>C</i>	3,3	0,4		
<i>D</i>	4,0	1,1		<i>D</i>	4,0	1,1		<i>D</i>	4,0	1,1		

[illegible]

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