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## Mixed and Behavioral Strategies

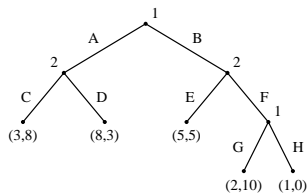
Game Theory Course:  
Jackson, Leyton-Brown & Shoham

# Randomized Strategies



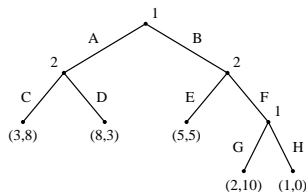
- There are two meaningfully different kinds of randomized strategies in imperfect information extensive form games
  - mixed strategies
  - behavioral strategies
- **Mixed strategy:** randomize over pure strategies
- **Behavioral strategy:** independent coin toss every time an information set is encountered

# Randomized strategies example



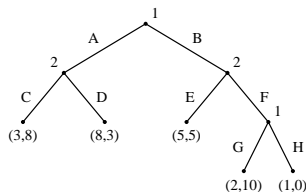
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  - $A$  with probability  $.5$  and  $G$  with probability  $.3$

# Randomized strategies example



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- Example of a mixed strategy that is not a behavioral strategy:
  - $(.6(A, G), .4(B, H))$  (why not?)

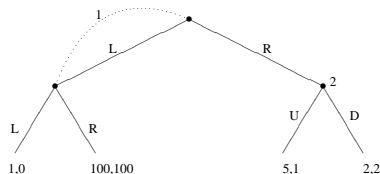
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- Example of a mixed strategy that is not a behavioral strategy:
  - $(.6(A, G), .4(B, H))$  (why not?)
- In this game every behavioral strategy **corresponds to** a mixed strategy...

# Games of imperfect recall

Imagine that player 1 sends two proxies to the game with the same strategies. When one arrives, he doesn't know if the other has arrived before him, or if he's the first one.



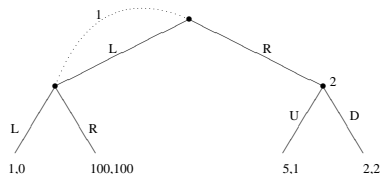
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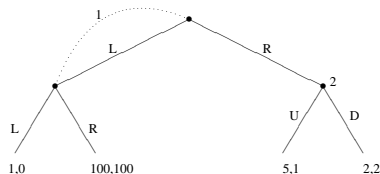
cooperative payoff utility  
Bayesian Normal-form auctions  
tragedy of the commons  
equilibrium class players  
Nash equilibria  
predator  
strategies  
zero-sum probability  
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action



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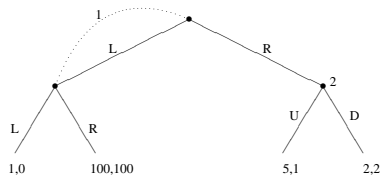


- What is the space of pure strategies in this game?
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- What is the mixed strategy equilibrium?

Game Theory Online

cooperative payoff utility Bayesian Normal-form auctions tragedy of the commons Nash equilibria class players strategies zero-sum probability



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- What is the space of pure strategies in this game?
  - 1:  $(L, R)$ ; 2:  $(U, D)$
- What is the mixed strategy equilibrium?
  - Observe that  $D$  is dominant for 2.  $R, D$  is better for 1 than  $L, D$ , so  $R, D$  is an equilibrium.

Game Theory

Bayesian Normal-form auctions

equilibrium

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Online

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risky

choice

maximizes

paper

Extensive-form

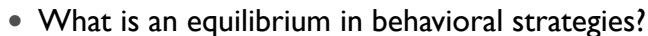
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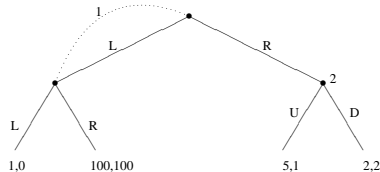
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theory



# Games of imperfect recall



Game Theory Online

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- What is an equilibrium in behavioral strategies?
  - again, D strongly dominant for 2
  - if 1 uses the behavioural strategy  $(p, 1 - p)$ , his expected utility is  $p2 + 100p(1 - p) + 2(1 - p)$
  - simplifies to  $-99p^2 + 98p + 2$
  - maximum at  $p = 98/198$
  - thus equilibrium is  $(98/198, 100/198), (0, 1)$
- Thus, we can have equilibria in behavioral strategies that are different from equilibria in mixed strategies.