

# CS540 Introduction to Artificial Intelligence

## Lecture 23

Young Wu

Based on lecture slides by Jerry Zhu, Yingyu Liang, and Charles Dyer

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## ID

- Enter the last two digits of your campus ID (or you can use two random digits too).
- Write this number down somewhere

^  
as last 2 digits of  
Zoom name.

Cat 88

## Due Dates

Thurs + Fri 1:00 - 2:30
 <sup>d</sup>  
Fri 5:30 - 8:30

- M12 and P4 to P5 before midnight Sunday: I have to submit the grades on Monday.
- Group discussions before midnight Sunday.
- M8 to M11 before midnight Wednesday.
- Sharing solutions before midnight Wednesday.
- Double-check exam grading and your grades on Canvas and email me before midnight Sunday.
- Questions? ←

$$\left[ \begin{aligned}
 & 10\% \max(M, X) + 10\% \max(Q, X) + 10\% \max(\underline{D}, X) \\
 & + 30\% X + 40\% P
 \end{aligned} \right.$$

89

# Split or Steal Game

- Watch the video and guess the outcome of the game (the action of the person on the left, the action of the person on the right).

- A : (Steal, Steal)

- B : (Steal, Split)

- C : (Split, Steal)

- D : (Split, Split)

NE

rationalizable

# Prisoner's Dilemma

- The general form of a PD game is ( $C$  stands for Cooperate (Deny) and  $D$  stands for Defect (Confess)):

—	$C$	$D$
$C$	$(x, x)$	$(0, y)$
$D$	$(y, 0)$	$(1, 1)$

- The game is PD is  $y > x > 1$ .

# Prisoner's Dilemma Example

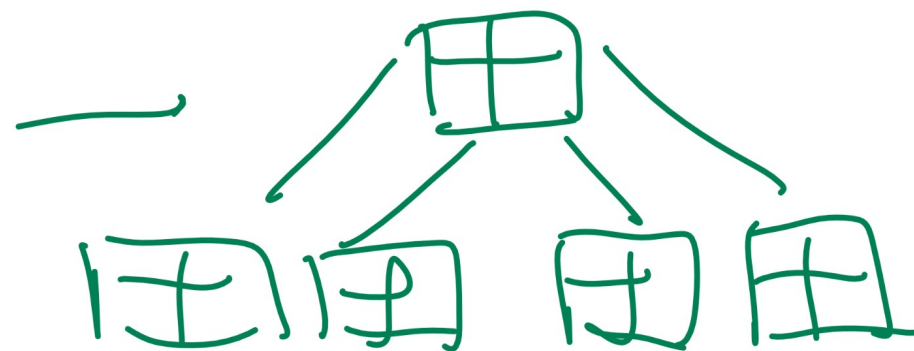
Q7 - Q10

- We will repeat this 3 times. If the last digit of your ID is an odd number, you are the row player (choose A or B), otherwise, you are the column player (choose C or D).

-	C	D	row	col
A	(2, 2)	(0, 3)	2	2
B	(3, 0)	(1, 1)	2	2
.	.	.	?	?

(Handwritten annotations: A red bracket on the left labels the rows as 'row'. A red bracket below labels the columns as 'col'. Blue circles highlight the payoffs (2,2), (0,3), (3,0), and (1,1). Blue text 'not available' and 'NB' is written next to the (1,1) payoff.)

# Repeated Games



- Repeated games are sequential games with simultaneous move stages (rounds).
- The stage games do not need to be the same.
- A solution of a repeated game (also called Subgame Perfect Equilibrium) does not require the actions to form a Nash equilibrium in each stage.

# Repeated Prisoner's Dilemma Example 1

- Stage 1 (C for Cooperate, D for Defect):

—	C	D
C	(2, 2)	(0, 3)
D	(3, 0)	(1, 1)

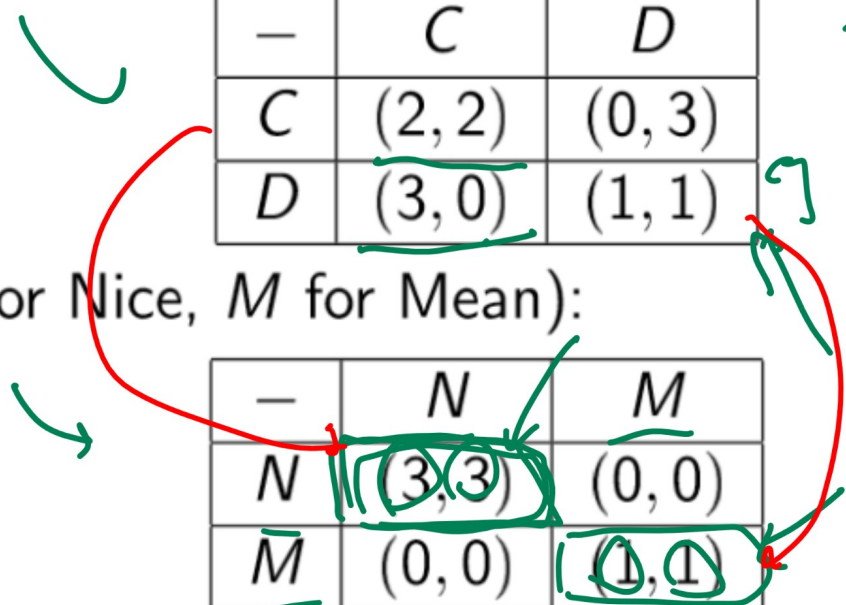
- Stage 2 (N for Nice, M for Mean):

—	N	M
N	(3, 3)	(0, 0)
M	(0, 0)	(1, 1)

NE  
play: if C  
if D

NE

	C	D
N	(5, 5)	1, 4
D	4, 1	(2, 2)





# Repeated Prisoner's Dilemma Example 2

- Stage 1 (*C* for Cooperate, *D* for Defect):

—	<i>C</i>	<i>D</i>
<i>C</i>	(2, 2)	(0, 3)
<i>D</i>	(3, 0)	(1, 1)

- Stage 2 (*C* for Cooperate, *D* for Defect):

—	<i>C</i>	<i>D</i>
<i>C</i>	(2, 2)	(0, 3)
<i>D</i>	(3, 0)	(1, 1)

# Infinite Repeated Prisoner's Dilemma

- If there are infinite number of stages, there are trigger strategies that can be solutions given sufficiently large discount factors.
- For example,  $(D, D)$  if any player played  $D$  in the previous stages and  $(C, C)$  otherwise is an SPE if the discount factor  $\delta$  satisfy:

$$\left[ \begin{array}{l} \frac{x}{1-\delta} \geq y + \frac{\delta}{1-\delta} \\ \delta \geq \frac{y-x}{y-1} \end{array} \right.$$

$D$  if you played  $D$  at least once

$C$  if you always played  $C$ .

NE trigger

# Infinite Repeated Prisoner's Dilemma Derivation

–	$C$	$D$
$C$	$(x, x)$	$(0, y)$
$D$	$(y, 0)$	$(1, 1)$

# Coordination Games

- Coordination games:

- ① Battle of Sexes. ←
- ② Stag Hunt (same as the exam question posting game).
- ③ Matching Penny (dis-coordination game).
- Anti-Coordination Games
 

	H	T
H	1, -1	-1, 1
T	-1, 1	1, -1
- ① Game of Chicken.
- ② Highway (crowding game). ←
- ③ El Farol Bar (same as the vaccination and pollution game on X5). ↙

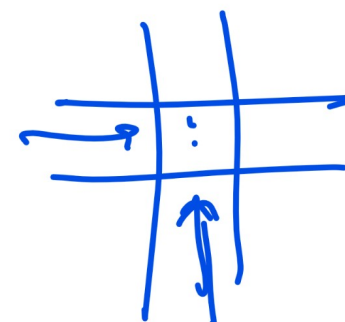
# Game of Chicken

Q10.

- If the last digit of your ID is an odd number, you are on car 1, otherwise, you are on car 2.
- Two cars heading towards each other on a single lane, if both keep going or both yield, there will be a crash; otherwise, both cars are safe.
- A : You are on car 1, keep going.
- B : You are on car 1, yield.
- C : You are on car 2, keep going.
- D : You are on car 2, yield.



# Game of Chicken



- Traffic lights are coordination devices.
- An equilibrium that relies on a random coordination devices (called signal) is called a correlated equilibrium.

$$\left[ \begin{array}{c} \frac{1}{2} (A, B) \\ \text{green} \end{array} , \begin{array}{c} \frac{1}{2} (B, A) \\ \text{red} \end{array} \right]$$

# El Farol Bar Game

- If less than 60 percent of you go to the El Farol Bar, bar is more fun.
- If more than 60 percent of you go to the bar, staying home is more fun.
- A : stay home.
- B : go to the bar.

Q1

✓ formula sheet

✓ PS soln bugs.

Canvas grades



midnight

tonight

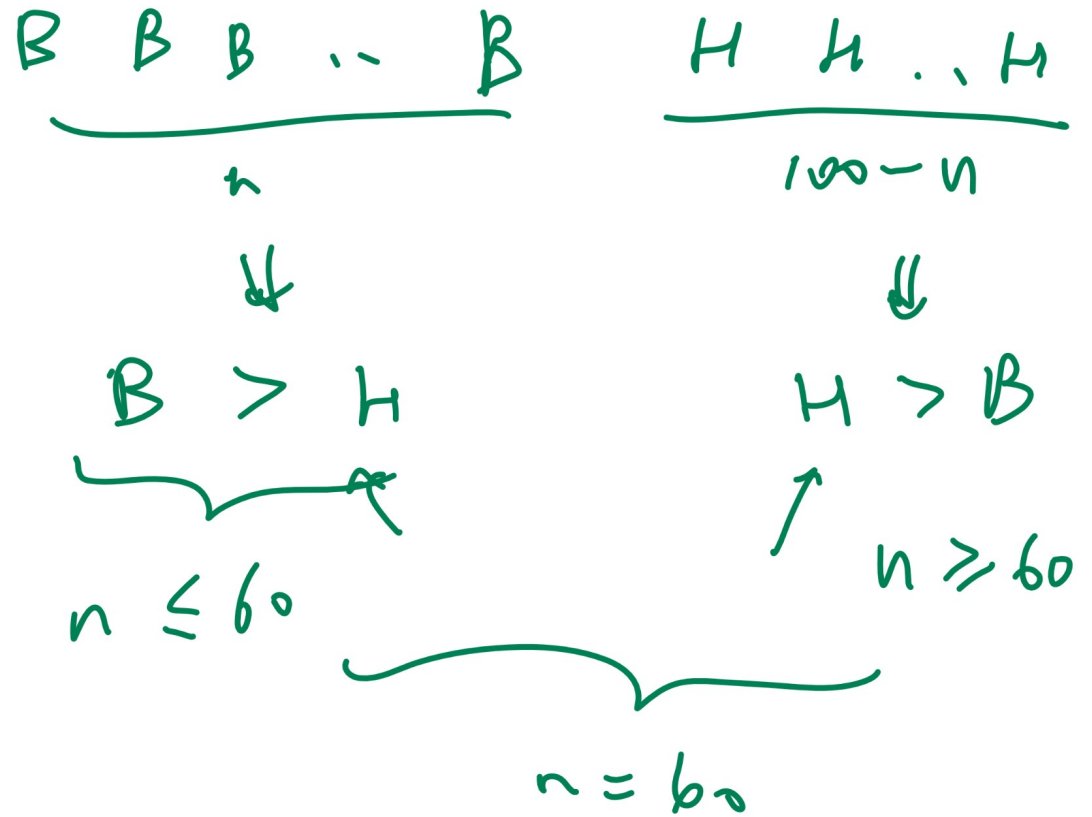
M8-11

D4-6

XF1 . XF2 , XF3

# Highway, Vaccination, and Pollution

- Questions see X7.





# Coordination Mechanisms

- Ways to coordinate:
  - 1 Mixed strategy. ←
  - 2 Repeated games. ←
  - 3 Focal point. ←
  - 4 Communication. ←

# Coordination Focal Point Example

- Select the most popular choice.
- A : A
- B : B
- C : C — focal point
- D : D
- E : E

Q2

## Anti-Coordination Focal Point Example

- Select the least popular choice.
- A : *A*
- B : *B*
- C : *C*
- D : *D*
- E : *E*

Q3

# Crime Reporting



- On March 13, 1964, Kitty Genovese was stabbed outside the apartment building. There are 38 witnesses, and no one reported. Suppose the benefit of reported crime is 1 and the cost of reporting is  $c < 1$ .
- Suppose every witness uses the same mixed strategy of not reporting with probability  $p$  and reporting with probability  $1 - p$ . Then the mixed strategy Nash equilibrium is characterized by the following expression.

MILQ10

$$p^{37} \cdot 0 + (1 - p^{37}) \cdot 1 = 1 - c \Rightarrow p = c^{1/37}$$

or (else) I reported  
 if I want to mix then I am indifferent  
 indifference condition  
 $R = N$

no one reports  
 if I want to mix then I am indifferent

# Donation Game



- Q29 on the exam: You will receive 4 points for this question and you can choose to donate  $x$  points (a number between 0 and 4). Your final grade for this question is the points you keep plus twice the average donation (sum of the donations from everyone in your section divided by the number of people in your section, combining both versions). Enter the points you want to donate (an integer between 0 and 4).

Friday

29

+2 bugs

4

None.

8

PD

Piazza

# Generative Adversarial Network

- Generative Adversarial Network (GAN):
    - 1 Generative part: input random noise and output fake images.
    - 2 Discriminative part: input real and fake images and output labels real or fake.
    - 3 The two parts compete with each other.
- Handwritten notes:*  
- A blue box around the first two items contains the word "game".  
- "face is real?" with arrows pointing to "real" and "fake".  
- "Pr.  $x$ " and " $y \sim f(x)$ ".  
- "zero-sum game" with "zero-sum" underlined and crossed out with a blue line.  
- "game." written below "zero-sum game".  
- "game." written below "The two parts compete".  
- "game." written below "The two parts compete" with a blue underline.