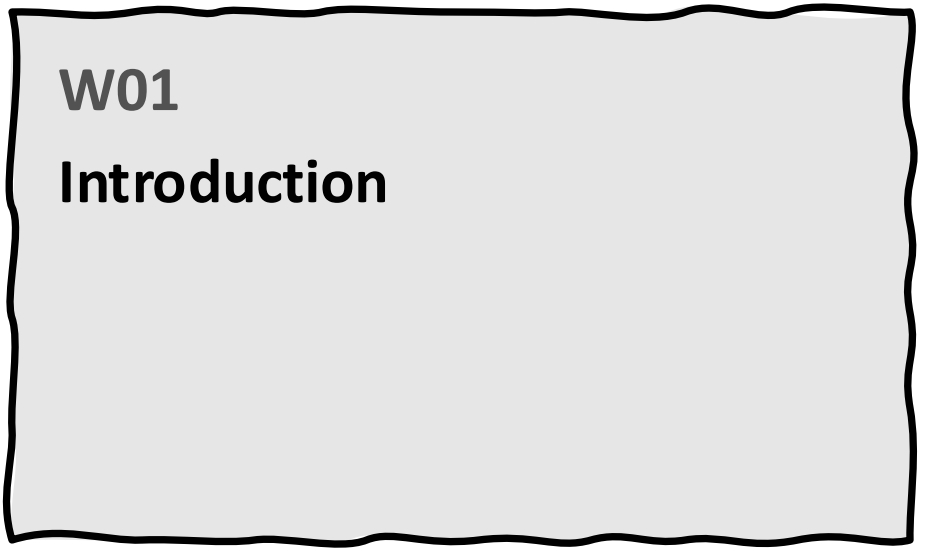
Fall '25

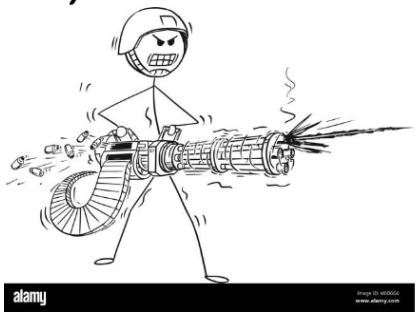
Conflict In CyberSpace

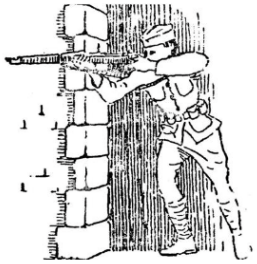


Anton Sobolev

Office Hours: TR~~U~~ 7-10pm

Cyber Criminals

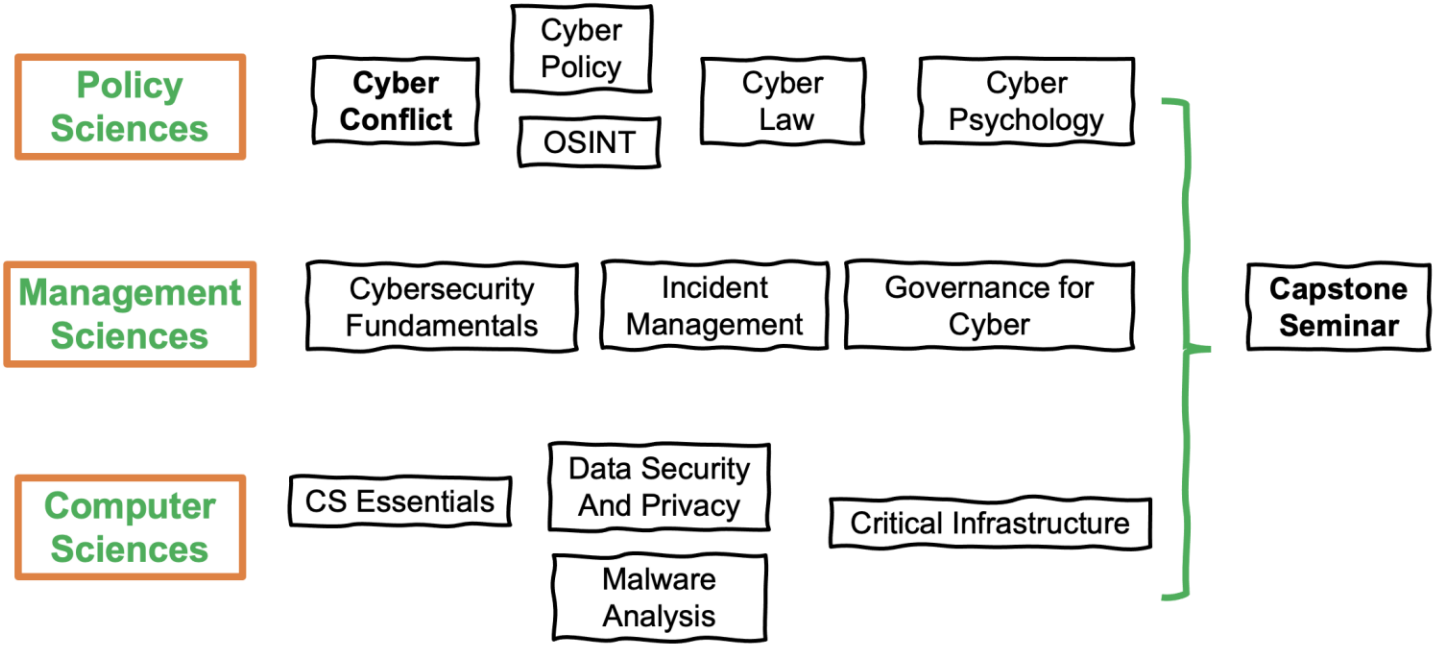




IT Security Team

Class Role

Classes



Class Map

F'24

I enjoyed the entire class. Even when we had no idea what it was we were meant to learn in that session's lecture, Dr. Sobolev would do his best to adjust his lecture to help us better understand it. He rewired our brains to think differently which was an incredibly difficult goal. However, once I understood that to be the goal, I began to understand everything he was teaching!

What is this class?

Roadmap

W01 Introduction and Logistics
W02 Strategic Behavior with Game Theory
W03 Statistical Analysis of Strategic Behavior – 1
W04 Statistical Analysis of Strategic Behavior – 2
W05 Computational Analysis of Strategic Behavior
W06 Counterfactual Analysis of Strategic Behavior
W07 Understanding Conflict. Midterm Preview
W08 Midterm Exam (in-class)
W09 Brief History of Communications / What is Cyberspace / Technology Steps In
W10 How Cyberspace Transforms Conflicts
W11 Cyberspace & Military Operations
W12 Domestic Conflicts
W13 Cyberspace & New Types of Conflict
W14 No Class — Fall Break / Thanksgiving
W15 Final Exam
W16 Review of Final Exam / Conclusions: What will cyberconflict look like tomorrow?

[gpt4 - strong AI?]

Assignments
Quiz

Week 04, 09/15 - 09/19: Statistical Analysis of Strategic Behavior – 2

In-Class Quiz 03
- Bueno de Mesquita & Fowler, Ch. 1, *Thinking Clearly in a Data-Driven Age*
- Yang, Y., Grandel, S., Balasubramanian, D., Huang, Y., & Leach, K. (2025). Cognitive Biases in Web Application Security." *Proceedings of HotSoS '25*. AC

Assignment due 03: Statistics in R

Assignments DataCamp

RANK	NAME	EMAIL	COURSES COMPLETED	CHAPTERS COMPLETED	LAST XP	XP EARNED
	Anton Sobolev	anton.sobolev@utdallas.edu	0	0		0

Active Assignments

Filter By

Search assignments...

TITLE	ASSIGNED TO	STATUS	DUE DATE TYPE	CREATED AT	EXPIRES AT
Introduction to Data Visualization with ggplot2 Course	Organization	Active	Fixed	Aug 25, 2025 09:11 CDT	Sep 23, 2025 14:00 CDT
Introduction to Data Visualization with ggplot2 Course	Organization	Active	Fixed	Aug 25, 2025 09:10 CDT	Sep 21, 2025 14:00 CDT
Introduction to AI Agents Course	Organization	Active	Fixed	Aug 25, 2025 08:29 CDT	Dec 02, 2025 12:00 CST
Introduction to					Nov 30,

Assignments DataCamp

Understanding the EU AI Act	1250
Social Media Data in R	4700
Data Privacy	2550
Inference in R	4000
Demystifying Decision Science	2500
Understanding GDPR	3200
Communicating Data Insights	2600
Probability Puzzles in R	3750
Statistics in R	4250
Data Visualization 1	4300
Data Visualization 2	4300
Introduction to R	6200
Total	**43 600**

Assignments

Component	%
Participation	15
Attendance	15
In-Class Quizzes (11)	44
Home Assignments in R (13)	42
Midterm Exam	15
Final Exam	20
Total	151

Participation (15)

You are expected to contribute regularly to class discussions, drawing from the assigned readings and integrating lessons from earlier meetings.
Active participation demonstrates preparation, critical thinking, and engagement with course material.

Attendance (15)

Attendance is mandatory. Students are expected to be present at each class session.
Consistent attendance is essential to keep up with discussions, in-class activities, and collaborative learning.

In-Class Quizzes (11) (44)

Closed-book quizzes will be administered at the beginning of almost every class. They are designed to ensure students arrive prepared to engage with readings and team activities. Each quiz consists of multiple-choice questions, is time-limited, and must be completed individually in one sitting. Quizzes cannot be paused, retaken, or discussed with others.

Home Assignments (13) (15)

There will be 13 mandatory assignments completed in R. Late submissions will not be accepted without prior permission. Students may discuss the problems together, but each must independently produce and submit solutions.

Midterm Exam (15)

The midterm is a closed-book, individual written exam designed to test students' understanding of key concepts from the first half of the course. It will consist of a combination of short-answer and essay-style questions, requiring synthesis, critical thinking, and application of theories learned in readings and lectures.
The midterm will be conducted during class time and must be completed within the allotted time frame.

Speaking of attendance

Let’s Try

Typical Class

- **Quiz on Home Assignment** □ Readings (1st)
- **Last Week Quiz Review**
  - **Discussion: Last Week Topic**

    □ Readings □ Problem-Solving □ Coding
    - **Lecture: Intro to the Topic / TBC**

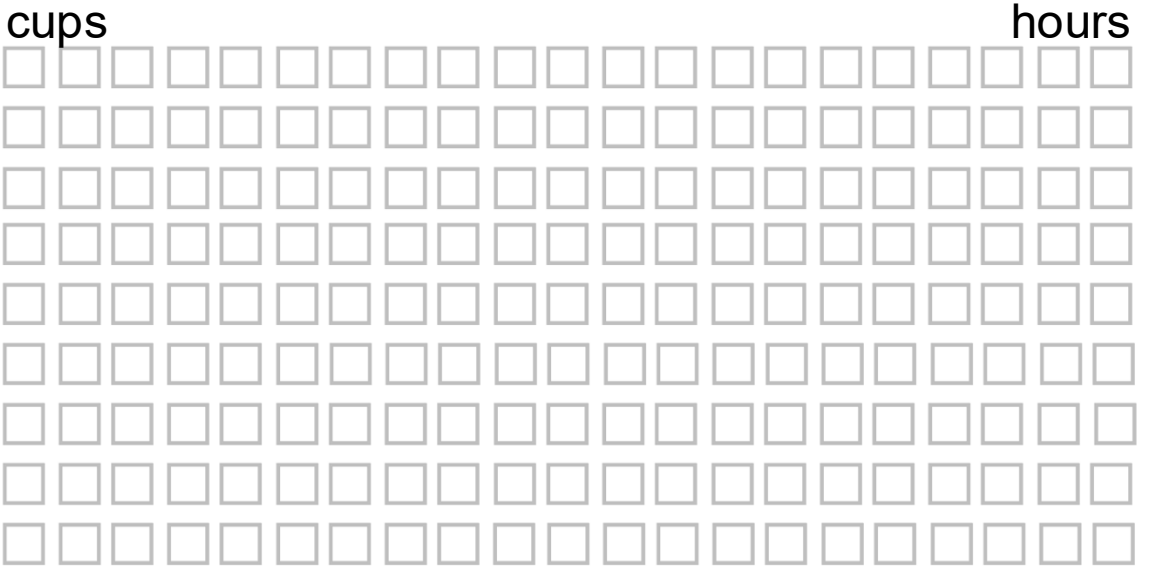
The most useful in this class

Do not be afraid to reasoning

Keep focus

ICEBREAKER QUESTION

1 How many hours do you usually sleep on a weekday?
2 How many cups of coffee or energy drinks do you usually have per day?



Fall '25

Conflict In CyberSpace

W01

Game Theory ?

[Private goods]

Anton Sobolev

What strategy is

What is different

What strategy is

Story 1. “Secret weapon and leaked information” (D-Day deception). Before the Normandy landing, the Allies carried out Operation Fortitude. They created a fake army under General Patton, with inflatable tanks and false radio traffic. All of this was designed so that the Germans would “accidentally” intercept the information and believe it. As a result, the Germans kept their main forces near Calais instead of Normandy.

Setup:
Britain broke the *Enigma* code, knew U-boat positions.
Could not save every convoy, or Germans would realize the code was compromised.
Strategy:
Selective intervention — sometimes let ships be lost to protect the secret.
Game-theory lens (repeated game with incomplete information):
Short-term loss vs. long-term informational advantage.
Equilibrium logic: *look irrational locally, win strategically globally.*
Outcome:
Preserving the secret code break ensured long-term Allied superiority at sea.

What strategy is

Story 2. “Enigma and the convoys.” Britain managed to break the Enigma code and knew the positions of German U-boats. But they could not save every convoy, because if they did, the Germans would quickly realize that the code had been compromised. Sometimes the British deliberately allowed ships to be lost in order to protect the secret. This was a repeated game with incomplete information: a short-term loss was traded for a long-term informational advantage. Preserving the secrecy of the code break ensured lasting Allied superiority at sea.

Setup:

Allies built a *fake army* under General Patton: inflatable tanks, dummy camps, fake radio traffic.

Designed so Germans would “accidentally” intercept and believe.

Outcome:

Germans kept main forces near Pas-de-Calais.

Normandy landing succeeded.

Game-theory lens (signaling game):

Sender: Allies choose whether to send a costly, credible-looking signal.

Receiver: Germany must decide — believe or not?

Payoffs: Massive Allied advantage if deception works.

Let’s practice

📝 ***Group Project***

In a group of three people, everyone must write a joint report. Each person decides whether to work hard or slack off. If everyone works, the project gets a high grade.
If someone slacks off while others work hard, the project is submitted, but the burden falls on the diligent ones. If everyone slacks off, the project fails.

📝 ***Fake News Post***

Two users on social media are deciding whether to share a sensational but unverified post. If both share it, the post spreads quickly, but later it turns out to be false, and both lose reputation. If only one shares it, that person gains likes and attention. If neither shares, everyone stays safe.

📝 ***Parking Spot***

Two drivers approach the same free parking spot at the same time.Each can choose to drive fast or drive slow. If both drive fast, they crash (bad outcome). If one drives fast and the other drives slow, the fast driver gets the spot. If both drive slow, one of them eventually gets the spot, but without an accident.

Game Theory

What is Game Theory?

□ A branch of **mathematics** and **economics** that studies strategic decision-making
□ Focuses on situations where outcomes depend on the actions of **multiple agents**
□ Originally developed to understand **military strategy**
□ Widely used today in **politics, cybersecurity, biology, business, and AI**

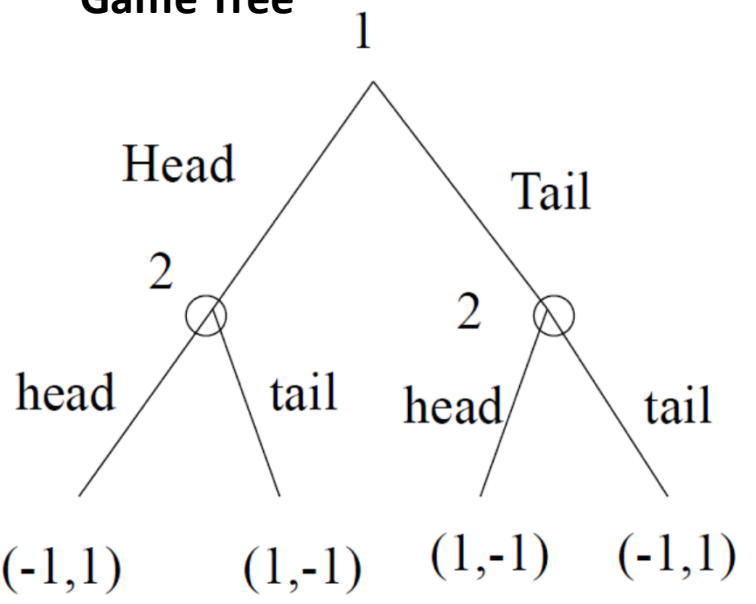
Core Elements of a Game [`Simplifiable`]:

□ **Players** — decision-makers in the game
□ **Strategies** — the options available to each player
□ **Payoffs** — the outcome (or utility) resulting from each combination of strategies
□ **Information** — what players know when they make decisions
□ **Rules** — whether players move simultaneously or sequenti

🎲 **Matching Pennies (Payoff Matrix)**

	Player B: Heads	Player B: Tails
Player A: Heads	A: +1, B: –1	A: –1, B: +1
Player A: Tails	A: –1, B: +1	A: +1, B: –1

Game Tree



Let’s practice

Game 1. Battle of the Sexes

Two people, traditionally called Player A and Player B, are trying to decide how to spend an evening together. They both want to be at the same event, but they each have a different personal preference. Player A prefers to go to the opera. Player B prefers to go to the football game.

They cannot communicate before making their choices, and each must independently decide which event to attend. If they end up at different places, neither of them enjoys the evening they both receive a payoff of 0. If they both go to the opera, Player A is happy and receives 2, while Player B is content but less satisfied, receiving 1. If they both go to the football game, Player B gets 2 and Player A gets 1.

Game 2. Rock–Paper–Scissors

Two players, Player A and Player B, are engaged in a competitive game where each must simultaneously choose one of three actions: rock, paper, or scissors. The rules are simple: rock beats scissors, scissors beats paper, and paper beats rock. If one player wins the round, they receive a payoff of +1, and the other receives –1. If both players choose the same action, it is a tie, and both receive a payoff of 0. This is a zero-sum game, meaning one player’s gain is always the other’s loss.

Let's practice

Game 3. Chicken
Two drivers, Player A and Player B, are driving toward each other on a narrow road. Each must independently decide whether to swerve or stay straight, with no opportunity to communicate beforehand. If both players stay straight, they crash and each receives a payoff of 0. If one player swerves and the other stays straight, the one who swerves is seen as a "chicken" and receives a payoff of 1, while the one who stays straight is seen as bold and receives a payoff of 2. If both swerve, they avoid the crash but neither "wins," so both receive a payoff of 1.

Game 4. Sequential Cake-Cutting [Useless Power?]
Two players must divide a single cake between them. Player A is assigned the role of cutter and must divide the cake into two slices in any way they choose. Player B, the chooser, then observes the two slices and selects one of them to take. Player A receives the remaining slice. Both players receive a payoff equal to the proportion of the cake they end up with (e.g., 0.5 for half, 0.7 for seventy percent). Player A must anticipate that Player B will always choose the larger piece, and therefore has an incentive to cut the cake as evenly as possible.

Game 5. Coordination without Conflict
Two engineers, called Player A and Player B, are finishing their workday at a newly built factory. The building has two identical exits, Exit 1 and Exit 2, and the engineers must independently decide which exit to use. Both players want to leave through the same exit so they can walk together to the parking lot, but they have no personal preference for which exit it is. If both choose same exit, each receives a payoff of 2 otherwise 0.

Matrix

Players – Actions -- Outcomes

	b_1	b_2	b_3
a_1	6; 5	3; 6	3; 9
a_2	7; 7	3; 0	4; 1

Best Response – Strategy -- Eqm

	b_1	b_2	b_3
a_1	6; 5	3; 6	3; 9
a_2	7; 7	3; 0	4; 1

	b_1	b_2	b_3	b_4
a_1	2; 7	3; 2	7; 5	5; 6
a_2	1; 9	2; 8	5; 4	3; 0

Weekly Dominated Strategy

	b_1	b_2	b_3	b_4
a_1	2; 7 *	3; 7 *	7; 5	5; 6
a_2	1; 9	2; 8	5; 4	3; 0

Elimination of Strongly Dominated Strategies

	b_1	b_2	b_3
a_1	6; 5	3; 6	3; 9
a_2	7; 7	3; 0	4; 1

Exclusion of Weekly Dominated Strategies

	b_1	b_2
a_1	5; 5	5; 5
a_2	5; 5	5; 5

Keynesian Beauty Contest

Strategy: Complete Set of responses of 1st to 2nd

Is this all?

Strongly Dominated Strategy

	b_1	b_2	b_3
a_1	6; 5	3; 6	3; 9
a_2	7; 7	3; 0	4; 1

	b_1	b_2	b_3	b_4
a_1	2; 7	3; 2	7; 5	5; 6
a_2	1; 9	2; 8	5; 4	3; 0

Weekly Dominated Strategy

	b_1	b_2	b_3	b_4
a_1	2; 7 *	3; 7 *	7; 5	5; 6
a_2	1; 9	2; 8	5; 4	3; 0

Elimination of Strongly Dominated Strategies

	b_1	b_2	b_3
a_1	6; 5	3; 6	3; 9
a_2	7; 7	3; 0	4; 1

Exclusion of Weekly Dominated Strategies

	b_1	b_2
a_1	5; 5	5; 5
a_2	5; 5	5; 5

Keynesian Beauty Contest

Strategy: Complete Set of responses of 1st to 2nd

equilibrium:

A stable state

Assuming all other players' strategies remain the same

	b_1	b_2
a_1	$5; 5$	$5; 5$
a_2	$5; 5$	$5; 5$

Stable Equilibrium

Unstable Equilibrium

equilibrium:

A stable state

Assuming all other players' strategies remain the same.

The Prisoner's Dilemma

Two suspects are arrested for a crime. The police have enough evidence to convict them of a minor offense (1 year), but not the major one — unless one confesses. Each prisoner is held in isolation and offered the same deal:

If you confess and your partner stays silent, you go free, and your partner gets 10 years.
If you both confess, you each get 5 years.
If you both stay silent, you each get 1 year.

equilibrium:

A stable state

Assuming all other players' strategies remain the same.

War of Attrition

Two rival hacking groups are targeting the same vulnerable government system. Both groups want to exploit the vulnerability and plant a backdoor — but only one will succeed. The longer each group waits before launching an attack, the lower the chance of detection, but the higher the cost (more time, resources, risk of patching). If both launch attacks at the same time, the system detects both and blocks access. If one waits longer, they win exclusive access, but both pay the cost of waiting.

	Attack at t=1	**Attack at t=2**
Attack at t=1	Both blocked (–2, –2)	Group A loses (–1, 3)
Attack at t=2	Group B loses (3, –1)	Both pay cost of waiting (1,1)

equilibrium:

A stable state

Assuming all other players' strategies remain the same.

War of Attrition

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Attack at t=2	Group B loses (3, –1)	Both pay cost of waiting (1,1)

Takeaways

- Social Action >> Strategy
- Simplification: Raw Data (Text) -> Setting -> Model
- Unexpected Results of Expected Behavior
- Private Goods

Fall '25

Conflict In CyberSpace

W02

Game Theory ?

[Public Goods

Vs

Private Goods]

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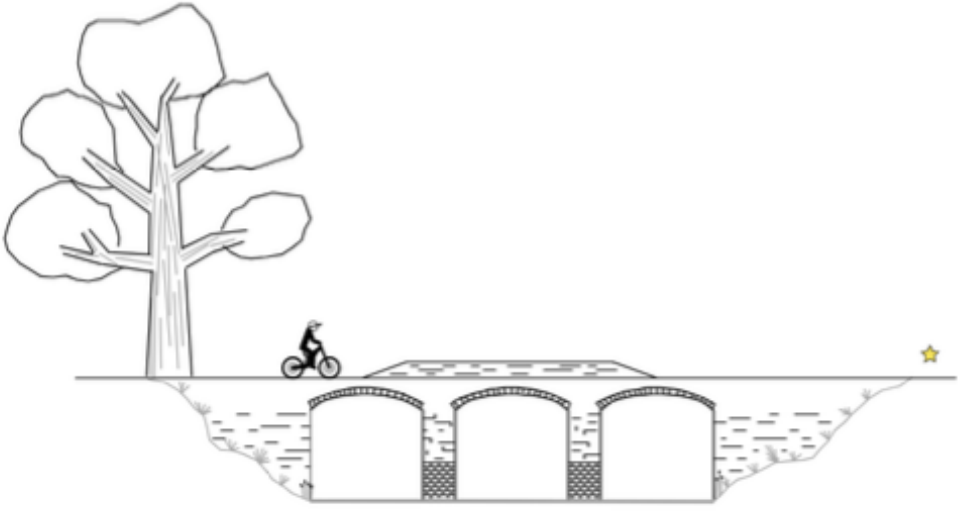
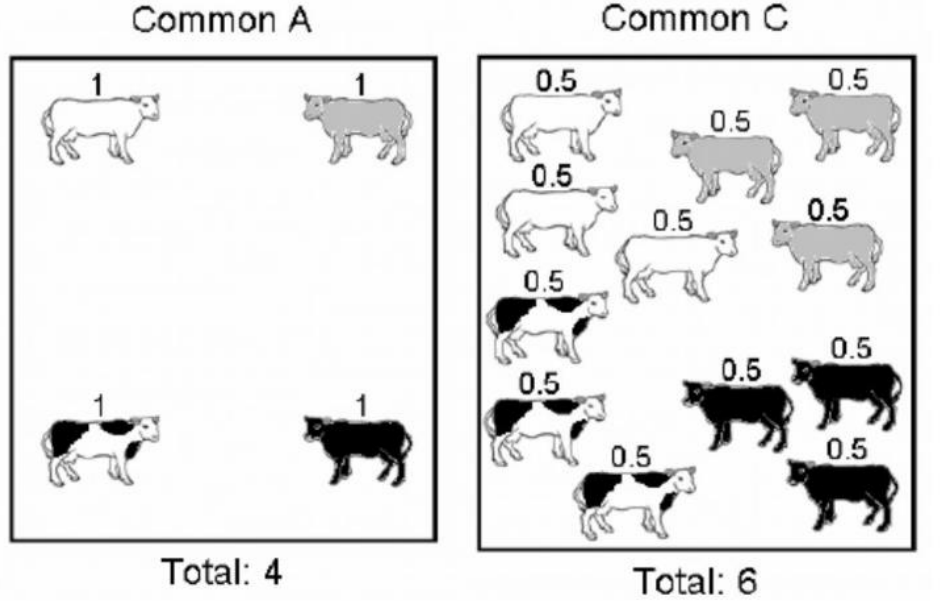
Public Good?
Ideas

Public Goods & Tragedy of Commons



If so hard,
How/Why do PG exist?



The Prisoner's Dilemma Revisited

Two suspects are arrested for a crime. The police have enough evidence to convict them of a minor offense (1 year), but not the major one — unless one confesses. Each prisoner is held in isolation and offered the same deal:

If you confess and your partner stays silent, you go free, and your partner gets 10 years.
If you both confess, you each get 5 years.
If you both stay silent, you each get 1 year.

Additional mafia penalty of 6 years, regardless of the police deal.

	B: Stay Silent	B: Confess
A: Stay Silent	–1, –1	–10, –6
A: Confess	–6, –10	–11, –11

Action – ‘Tactics’ -- Strategy -- Policy

Public Goods

State solves cooperation problem

- **State:** Problem-Solver or Problem-Maker
- **Price**
  - Non-Pareto Solution (not maximizes public wealth)
  - Cost of the state service
  - Cost of the Redistribution
- **Coercion replaces coordination**
- **Conflict!**

Spontaneous Coordination Focal Points

- Game
- Role of Societal Factors

Fall '25

Conflict In CyberSpace

W01

Game Theory ?

[Private goods]

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Conflict In CyberSpace

W01

Game Theory ?

[Private goods]

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Conflict In CyberSpace

W01

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