

Game THEORY

The background of the slide is a photograph of a wooden table. Scattered on the table are several game cards. Some cards are red with a blue border and the text 'Jungle Speed' in a stylized font. One card is black with a green border and the same text. Another card is white with a black border and features three red octagons. A stack of cards is visible in the center. In the bottom right corner, there is a white lined notebook with 'Office DEPOT' printed on the left edge. A black pen and a black marker are lying on the notebook.

Nicolas Dudebout

What is game theory?

What is game theory?

How do we study it?

What is game theory?

How do we study it?

Where is research headed?

What?

The study of interacting decision makers

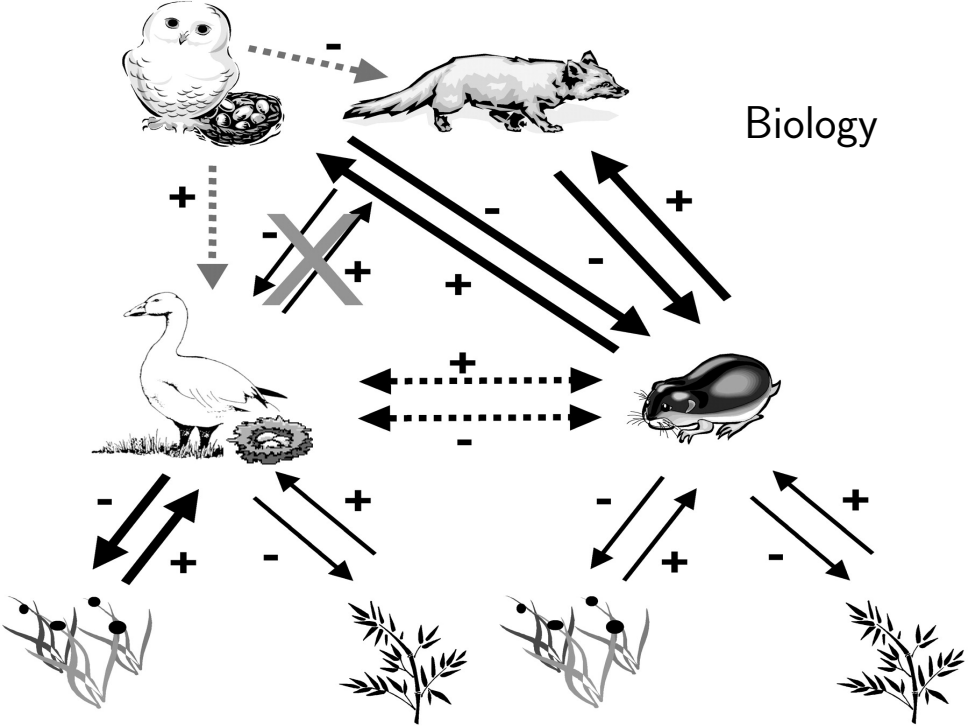




Economy



Biology



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Sociology

Sign Up

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Last Name:

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Re-enter Email:

New Password:

I am: **Select Sex:**

Birthday:

Month: **Day:** **Year:**

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www.google.com/search?hl=en&biw=1458&bih=947&q=google+ads&aq=f&aqi=g4g-s1g5&aqi=f&oq=

Web Images Videos Maps News Shopping Gmail more

Sign in

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google ads Search

About 53,100,000 results (0.07 seconds) Advanced search

Instant is off

Everything

Images

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News

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More

Atlanta, GA
Change location

Any time

Latest

Past 24 hours

Past 2 days

Past week

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Custom range...

More search tools

Something different

adSense ads

affiliate links

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text ads

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How Google AdWords Works
Benefits of Google AdWords

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Submit a new application	How do I add more sites to my account?
AdSense Tour	Google AdSense Case Study
AdSense reports	How do I change my email address ...

More results from google.com »

Welcome to Google Advertising Programs

Allows you to buy advertising on the **Google** search engine, or on other sites through its **AdSense** program. Includes a tour and FAQ.
www.google.com/ads/ - Cached

Google AdWords - Online Advertising by Google

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Welcome to Google Advertising Programs

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Ads

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See your ad here »

Computer Science

Engineering



Different agendas



What?

What?

- ▶ study of interacting decision makers

What?

- ▶ study of interacting decision makers
- ▶ interdisciplinary field

What?

- ▶ study of interacting decision makers
- ▶ interdisciplinary field
- ▶ different agendas

How?

Decision maker

Decision maker

- ▶ choices, C

Decision maker

- ▶ choices, C
- ▶ preferences, \succeq

Decision maker

- ▶ choices, C
- ▶ preferences, \succeq
utility function, $u : C \rightarrow \mathbb{R}$

$$c_1 \succeq c_2 \iff u(c_1) \geq u(c_2)$$



$$C = \{L, R\}$$



$$C = \{L, R\}$$



$$u : C \rightarrow \mathbb{R}$$

$$L \mapsto 0$$

$$R \mapsto 1$$

$$C = \{L, R\}$$

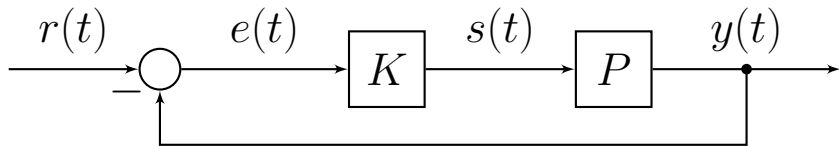


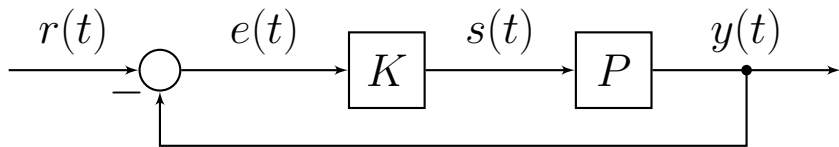
$$u : C \rightarrow \mathbb{R}$$

$$L \mapsto 0$$

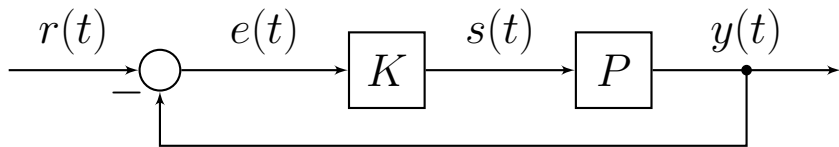
$$R \mapsto 1$$

	u
L	0
R	1





► $C = \{\text{stabilizing controller } K\}$



- ▶ $C = \{\text{stabilizing controller } K\}$
- ▶ $u(K) = -\tau_r(K)$

Optimality

Decision maker:

- ▶ choices, C
- ▶ utility function, u

Optimality

Decision maker:

- ▶ choices, C
- ▶ utility function, u

Goal of decision maker:

$$\max_{c \in C} u(c)$$

Game Theory

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- ▶ players, $\{i\}$

Game Theory

- ▶ players, $\{i\}$
- ▶ choices for player i , C_i

Game Theory

- ▶ players, $\{i\}$
- ▶ choices for player i , C_i
- ▶ joint choices, $C = \prod_i C_i$
 $c \in C = (c_i, c_{-i})$

Game Theory

- ▶ players, $\{i\}$
- ▶ choices for player i , C_i
- ▶ joint choices, $C = \prod_i C_i$
 $c \in C = (c_i, c_{-i})$
- ▶ utility function for player i , $u_i : C \rightarrow \mathbb{R}$

Optimality?

Goal of decision maker i :

$$\max_{c \in C} u_i(c_i, c_{-i}) \left(\neq \max_{c \in C} u_i(c_i) \right)$$

Example: Prisoner's dilemma

	C	D
C	2, 2	-1, 3
D	3, -1	0, 0

Example: Prisoner's dilemma

	C	D
C	2	-1
D	3	0

Example: Prisoner's dilemma

	C	
C	2	
D	3	

Example: Prisoner's dilemma

	C	
C	2	
D	3	

Best response, $BR_i : C_{-i} \Rightarrow C_i$

Example: Prisoner's dilemma

	C	
C	2	
D	3	

Best response, $BR_i : C_{-i} \Rightarrow C_i$

► $BR_1(C) = \{D\}$

Example: Prisoner's dilemma

		D
C		-1
D		0

Best response, $BR_i : C_{-i} \Rightarrow C_i$

► $BR_1(C) = \{D\}$

Example: Prisoner's dilemma

	D
C	-1
D	0

Best response, $BR_i : C_{-i} \Rightarrow C_i$

► $BR_1(C) = \{D\}, BR_1(D) = \{D\}$

Example: Prisoner's dilemma

	C	D
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Best response, $BR_i : C_{-i} \Rightarrow C_i$

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Example: Prisoner's dilemma

	C	D
C	2, 2	-1, 3
D	3, -1	0, 0

Best response, $BR_i : C_{-i} \Rightarrow C_i$

- ▶ $BR_1(C) = \{D\}, BR_1(D) = \{D\}$
- ▶ $BR_2(C) = \{D\}, BR_2(D) = \{D\}$

Nash equilibrium

$a^* = (a_i^*, a_{-i}^*)$ is a Nash equilibrium:

Nash equilibrium

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- ▶ $\forall i, a_i^*$ is a best response to a_{-i}^*

Nash equilibrium

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- ▶ no unilateral deviation is profitable

Nash equilibrium

$a^* = (a_i^*, a_{-i}^*)$ is a Nash equilibrium:

- ▶ $\forall i, a_i^*$ is a best response to a_{-i}^*
- ▶ no unilateral deviation is profitable
- ▶ $\forall i, \forall a_i \in A_i,$

$$u_i(a_i^*, a_{-i}^*) \geq u_i(a_i, a_{-i}^*)$$

Existence of Nash equilibria

Every n -player game has a Nash equilibrium.

Extensions

Extensions

- ▶ history-dependent strategy

Extensions

- ▶ history-dependent strategy
- ▶ imperfect information

Extensions

- ▶ history-dependent strategy
- ▶ imperfect information
- ▶ cooperation

Extensions

- ▶ history-dependent strategy
- ▶ imperfect information
- ▶ cooperation
- ▶ large populations

Back to the agendas

Back to the agendas

- ▶ descriptive

Back to the agendas

- ▶ descriptive
- ▶ predictive

Back to the agendas

- ▶ descriptive
- ▶ predictive
- ▶ manipulative

How?

How?

- ▶ interacting decision maker

How?

- ▶ interacting decision maker
- ▶ best response

How?

- ▶ interacting decision maker
- ▶ best response
- ▶ Nash equilibrium

Where?

Learning

Controls \Rightarrow Game Theory:

Learning

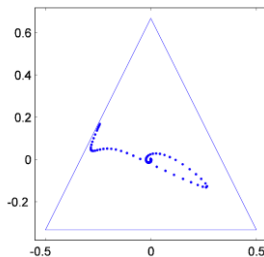
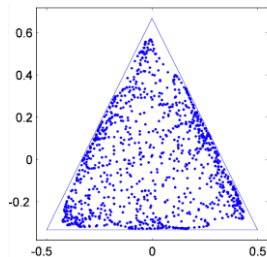
Controls \Rightarrow Game Theory:

- ▶ stability and robustness

Learning

Controls \Rightarrow Game Theory:

- ▶ stability and robustness
- ▶ derivative control



Decentralized control

Game Theory \Rightarrow Controls:

Decentralized control

Game Theory \Rightarrow Controls:

- ▶ network formation

Decentralized control

Game Theory \Rightarrow Controls:

- ▶ network formation
- ▶ communication limitations

Dynamic Games

Dynamic Games

- ▶ network security

Dynamic Games

- ▶ network security
- ▶ learning in repeated games

Where?

Where?

- ▶ learning

Where?

- ▶ learning
- ▶ decentralized control

Where?

- ▶ learning
- ▶ decentralized control
- ▶ dynamic games

Questions?

Comments?