

The Challenges that Society Brings to Engineering Designs...

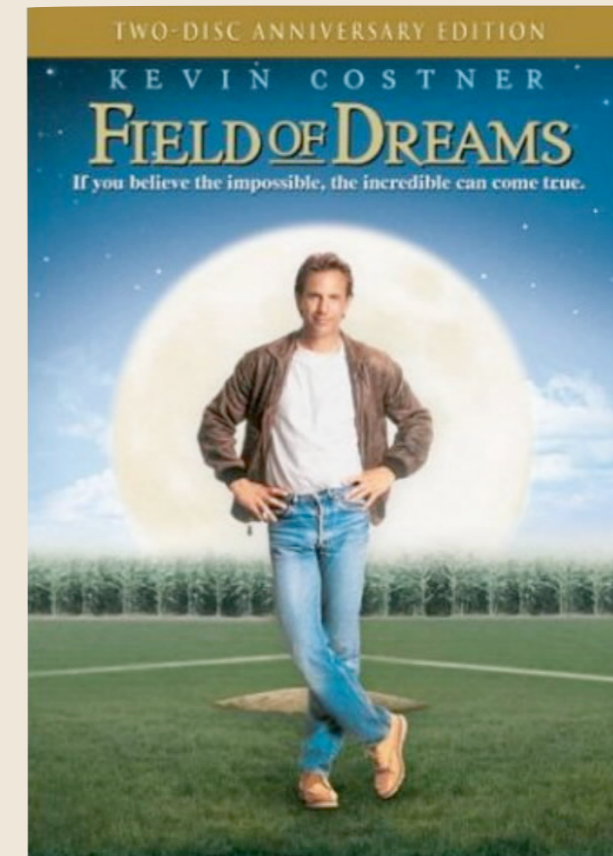
...and the games they play...



Jason R. Marden

Department of Electrical and Computer Engineering
University of California, Santa Barbara
(ECE 149 - Game Theory)

Field of Dreams...



if you build it, they will come...



if you build it, they will come...

Field of Dreams...

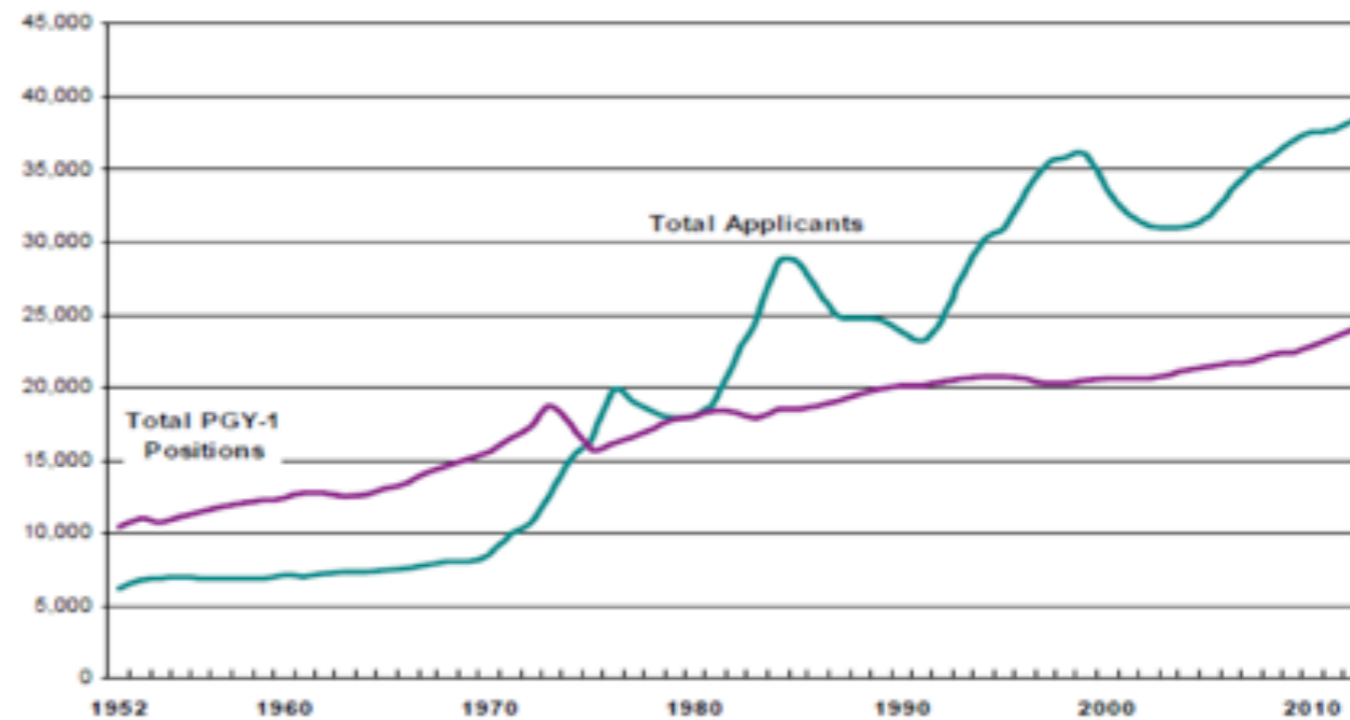


if you build it, they will come...



Residency Positions v. Applicants

Figure 1 Applicants and 1st Year Positions in The Match, 1952 - 2012

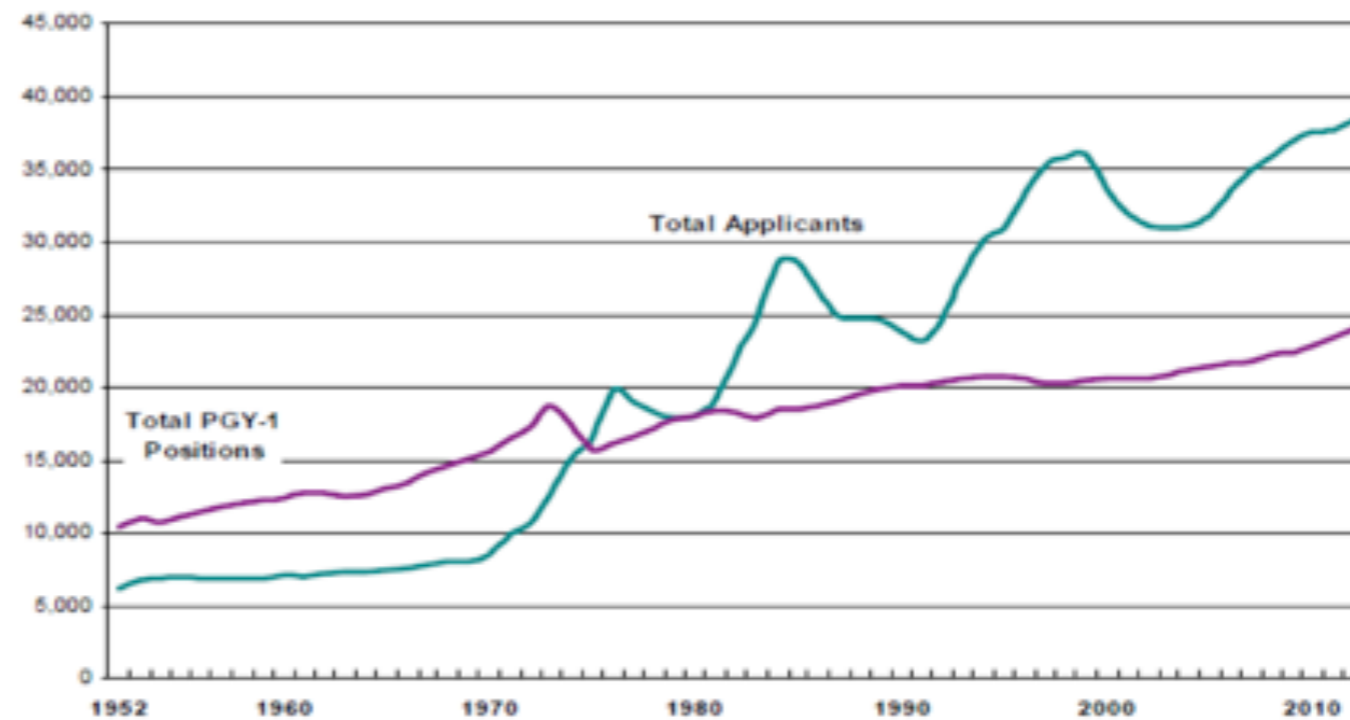


if you build it, they will come...



Residency Positions v. Applicants

Figure 1 Applicants and 1st Year Positions in The Match, 1952 - 2012



if you build it, they will come...

but will they use it efficiently?

Experiment: Beauty contest

Goal: Determine "most" beautiful contestant

Toni Casner

Meet the six lovely candidates for Miss Rheingold 1957, chosen by a panel of famous judges that included Bob Cummings, Irene Dunne, Joan Fontaine, Ida Lupino, Ed Sullivan and William Perfing and George Seaton.

Now you become the final judge
Your vote—and the votes of your friends—will help elect Miss Rheingold 1957.

Prize and fortune for the winner
The girl who wins the title wins a contract worth \$50,000, expense-paid trips to Hollywood and Europe, plus all the fun and fame of starring in next year's Rheingold advertising.

Time to fill those ballot boxes
You can help your favorite candidate. Just look for the Miss Rheingold Election Ballot Box at any Rheingold store or tavern. And cast your vote—today or any day through September 28.

Kathleen Wallace

Beverly Christensen

Which will You elect Miss Rheingold 1957?

Pick the girl who'll win a contract worth \$50,000! Vote at any Rheingold store or tavern!

Maggie McNulty

Every vote counts
All ballots are checked and tabulated by an independent research organization that certifies the accuracy of the final tally.

To join in the fun of choosing a new Miss Rheingold—cast your ballot along with the millions of people who've made this the second-largest election in America.

And join those same millions in enjoying the best Miss Rheingold represents. It's always been so here about taste. And your approval of Rheingold Extra Dry has made it the largest-selling beer in the East!

Rheingold EXTRA DRY

Master brewers for more than 115 years
Brew. Co., Columbia, Missouri, Inc., St. Louis, Mo., U.S.A.

Diane Baker

From research of the John W. Therman Center for Sales, Advertising and Marketing Theory, Ohio University

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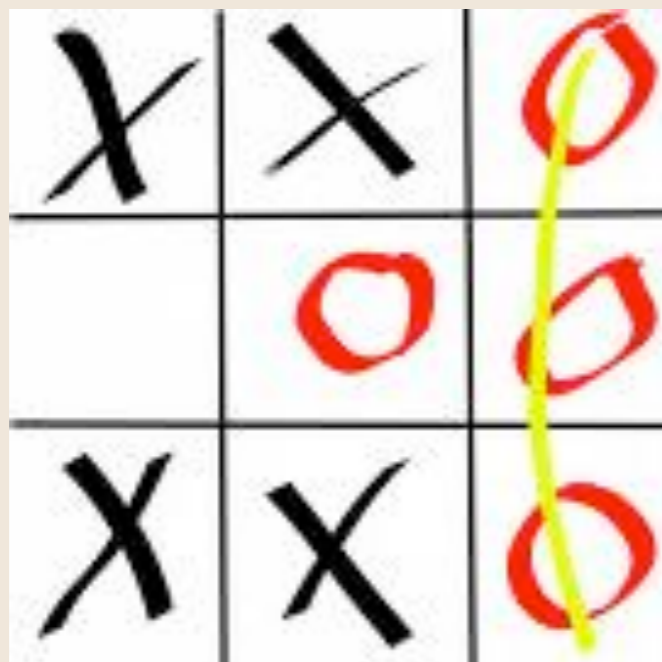
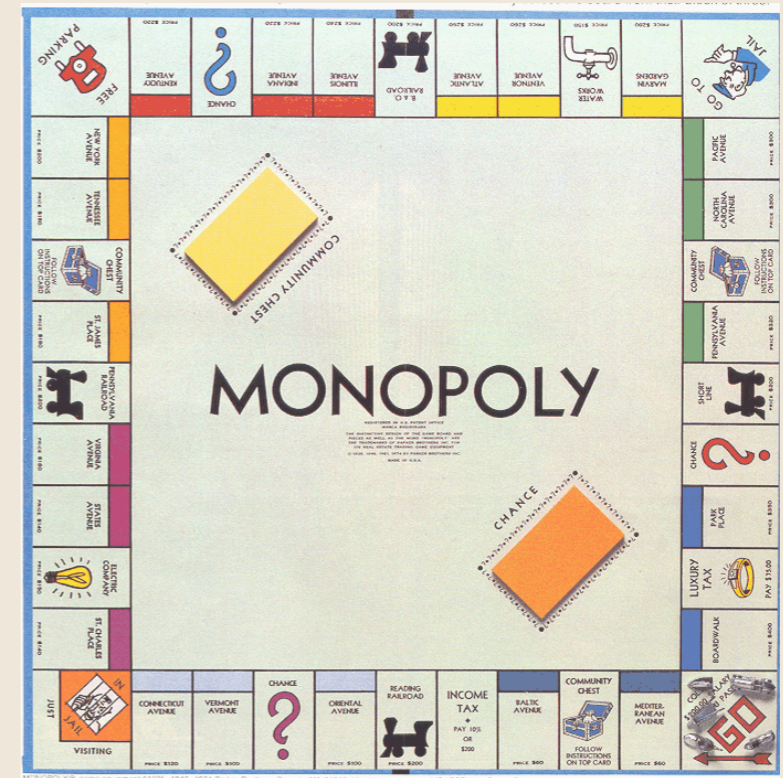
Rheingold EXTRA DRY

Master brewers for more than 117 years
1874-1928, Columbia Bottling Co., 1928-1948, B. G.

Photo courtesy of the John W. Sherman Center for Sales, Advertising and Marketing Theory, Ohio University

Game Theory = Study/Influence Social Behavior

Game theory: Popular perception

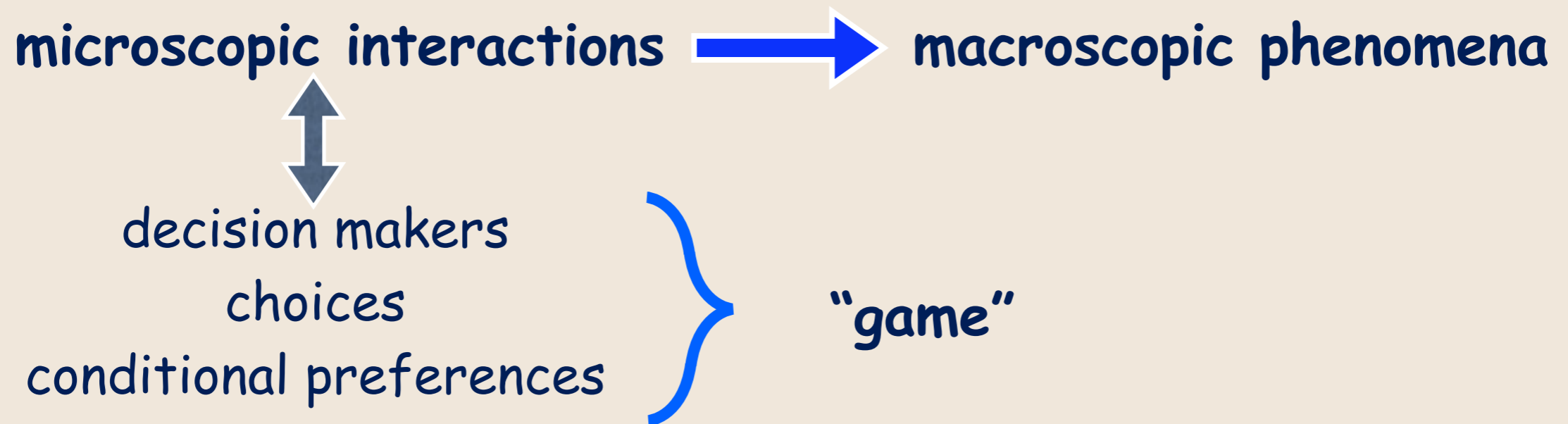


Game Theory = Analysis/Influence Social Behavior

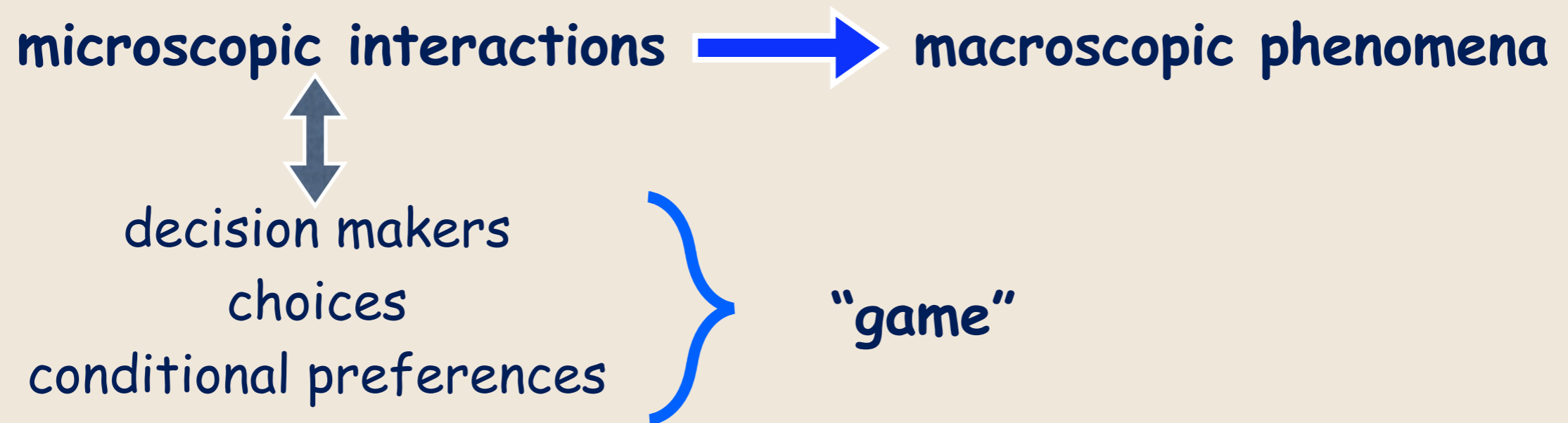
microscopic interactions  **macroscopic phenomena**



Game Theory = Analysis/Influence Social Behavior

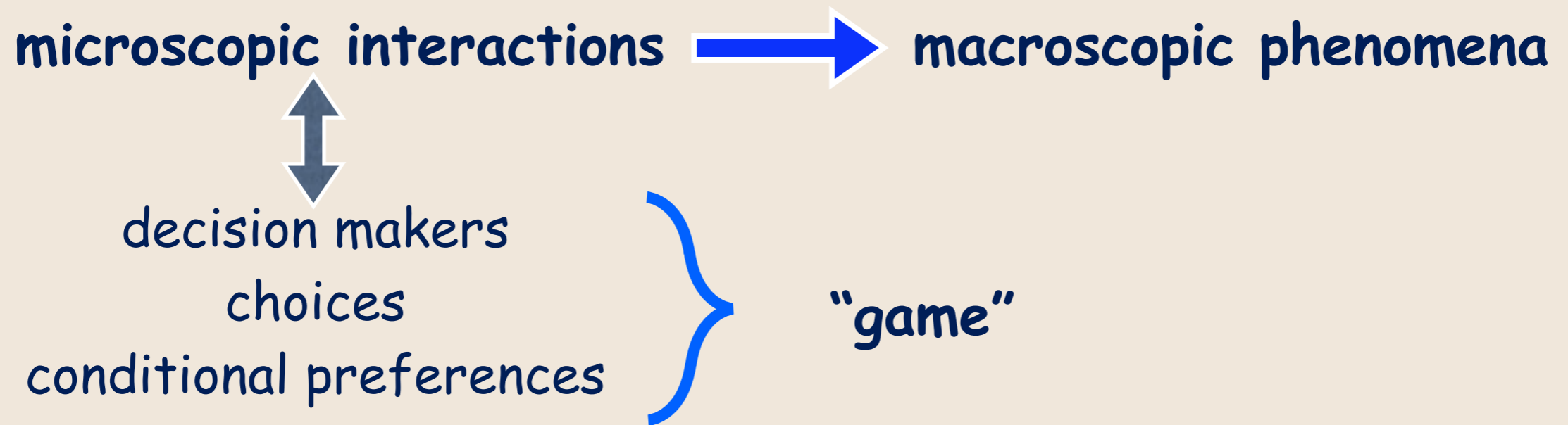


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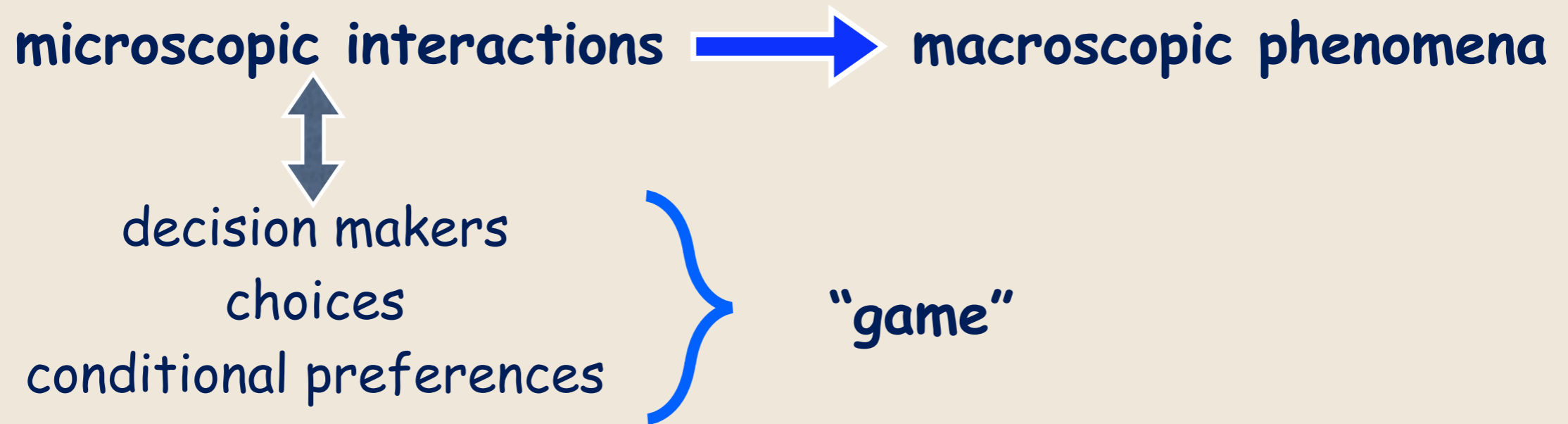
DMs = white/black
choices = moves
preferences = win

Game Theory = Analysis/Influence Social Behavior



DMs = drivers
choices = routes
preferences = minimize time

Game Theory = Analysis/Influence Social Behavior



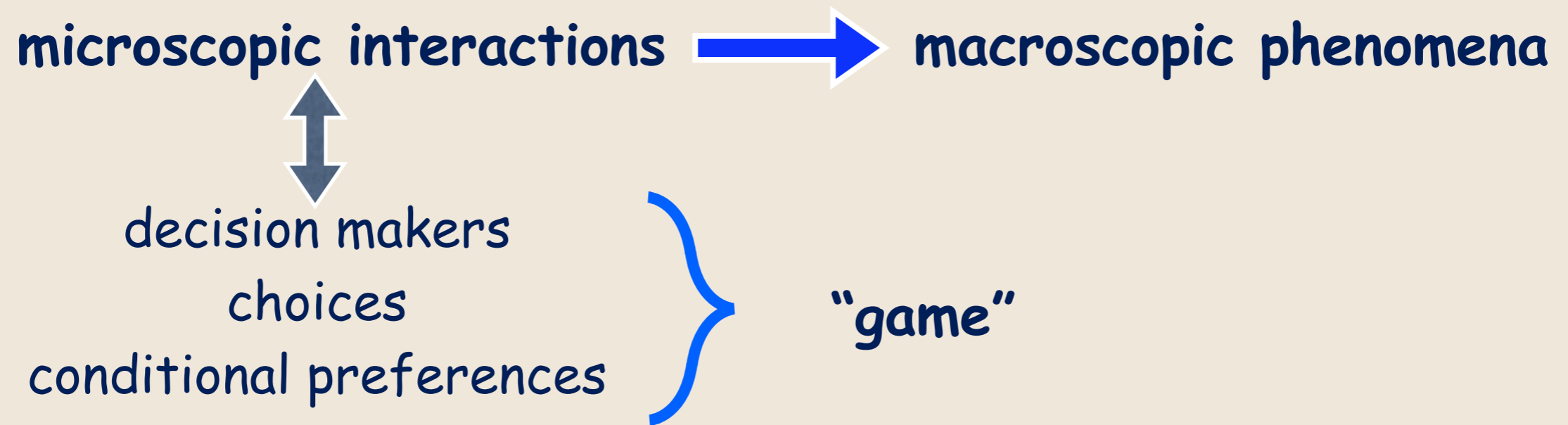
Social Norms?

QWERTY vs DVORAK

traditional
keyboard

optimized
keyboard

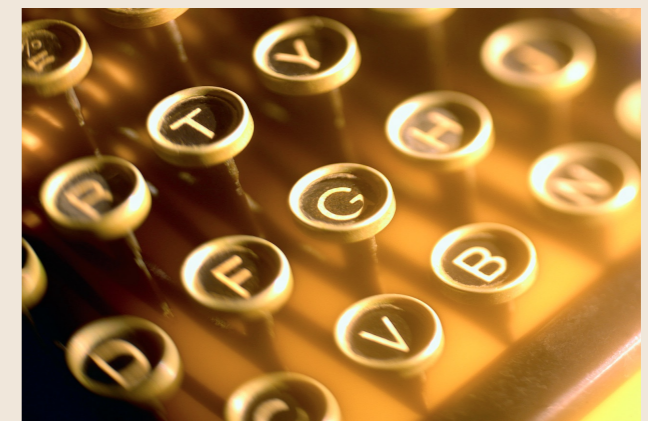
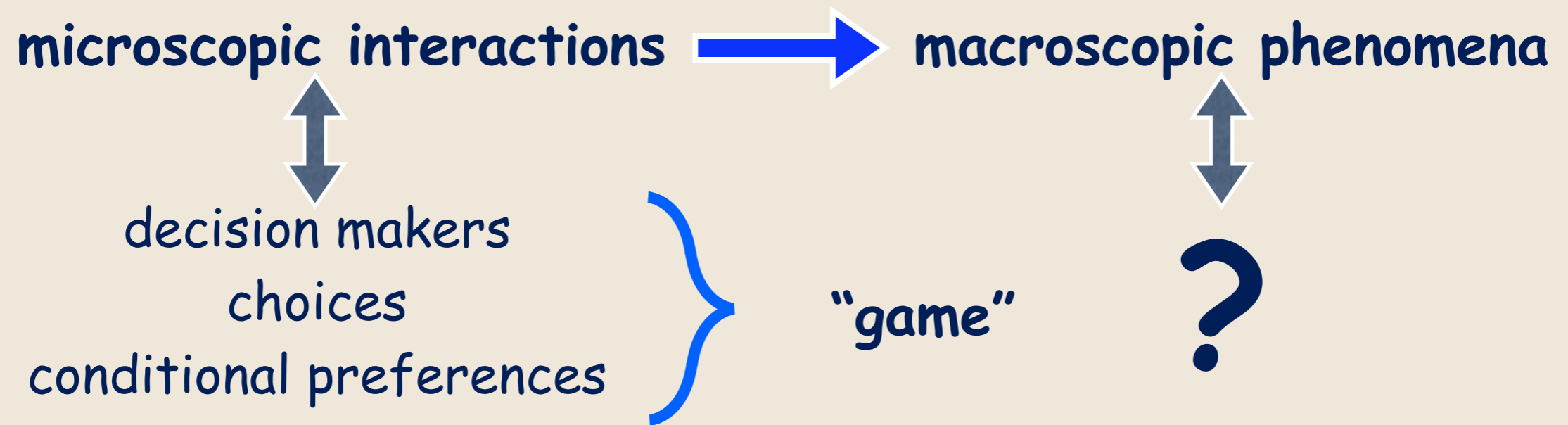
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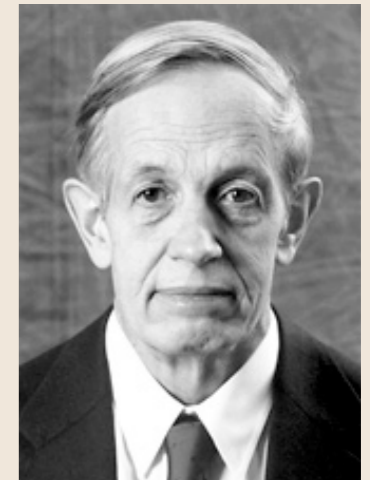
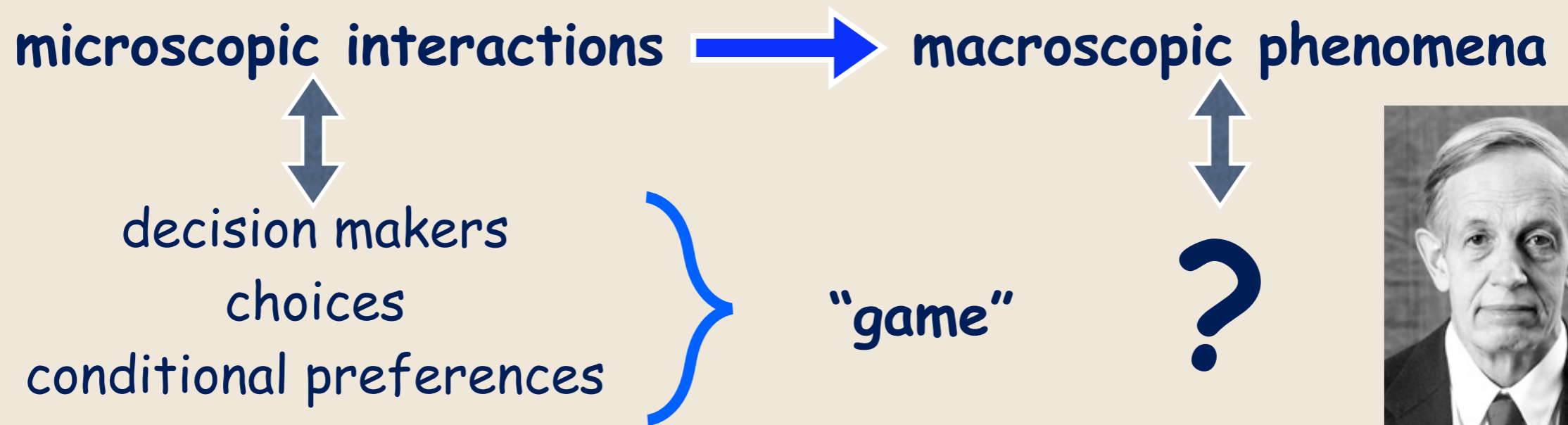
eBay



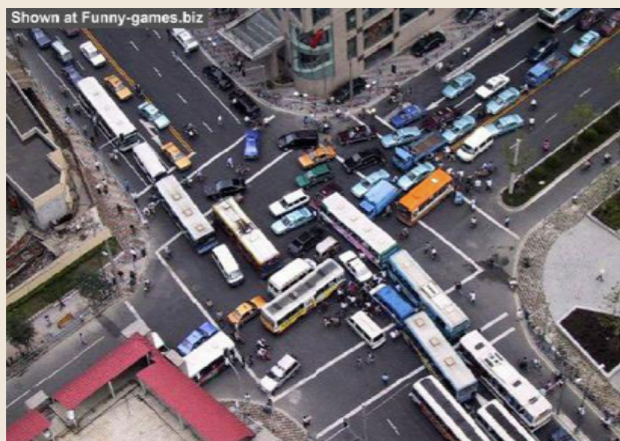
Game Theory = Analysis/Influence Social Behavior



Game Theory = Analysis/Influence Social Behavior



John Nash
(Nobel Prize 1994)



A Beautiful Mind



microscopic interactions

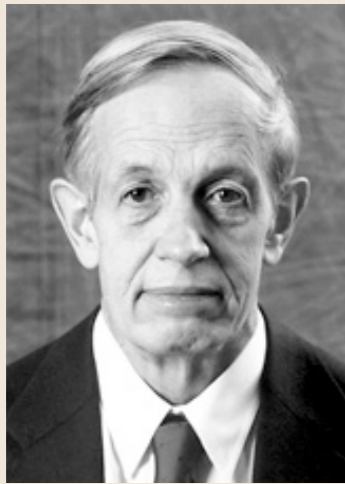


macroscopic phenomena

decision makers
choices
preferences

emergent behavior?
efficient?
coordination?

emergent behavior?
efficient?
coordination?



John Nash
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“Nash equilibrium”

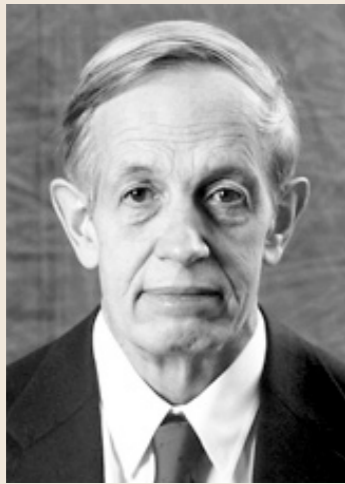
Emergent behavior = Conditionally optimal choices
(i.e., best choice given choices of other DMs)



emergent behavior?

efficient?

coordination?



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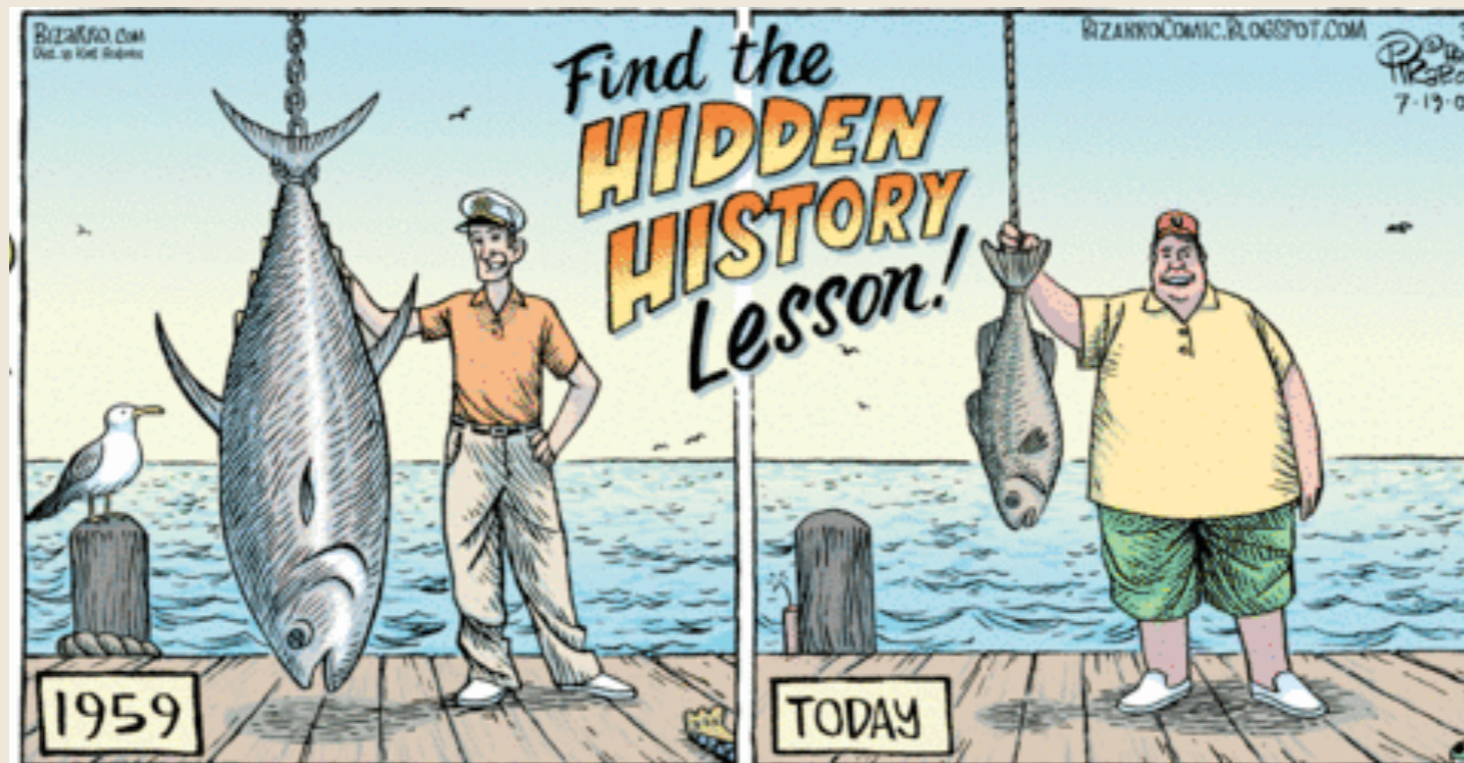
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emergent behavior?
efficient?
coordination?

Grand Banks Fisheries

- 1950s: Endless supply of cod fish
- 1960-1970: Advancements in fishing technology
- 1990s: Collapse due to low cod populations

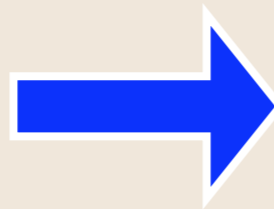


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Social Norms



society could adopt
inferior convention

emergent behavior?
efficient?
coordination?

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Social Norms

Transportation Systems



uninfluenced traffic
can be suboptimal
(tolls not necessarily for \$)

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Social Norms

Transportation Systems



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Not Efficient Behavior!

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Not Efficient Behavior!

emergent behavior?
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coordination?

There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior



(auctions)



(overbooked flights)



(school assignments)



There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior

success story



(auctions)



A STAR ALLIANCE MEMBER



(overbooked flights)



(school assignments)





100



150



250



choices = how much \$ to bid

preference = win tickets at lowest possible cost

Auctions



100



150

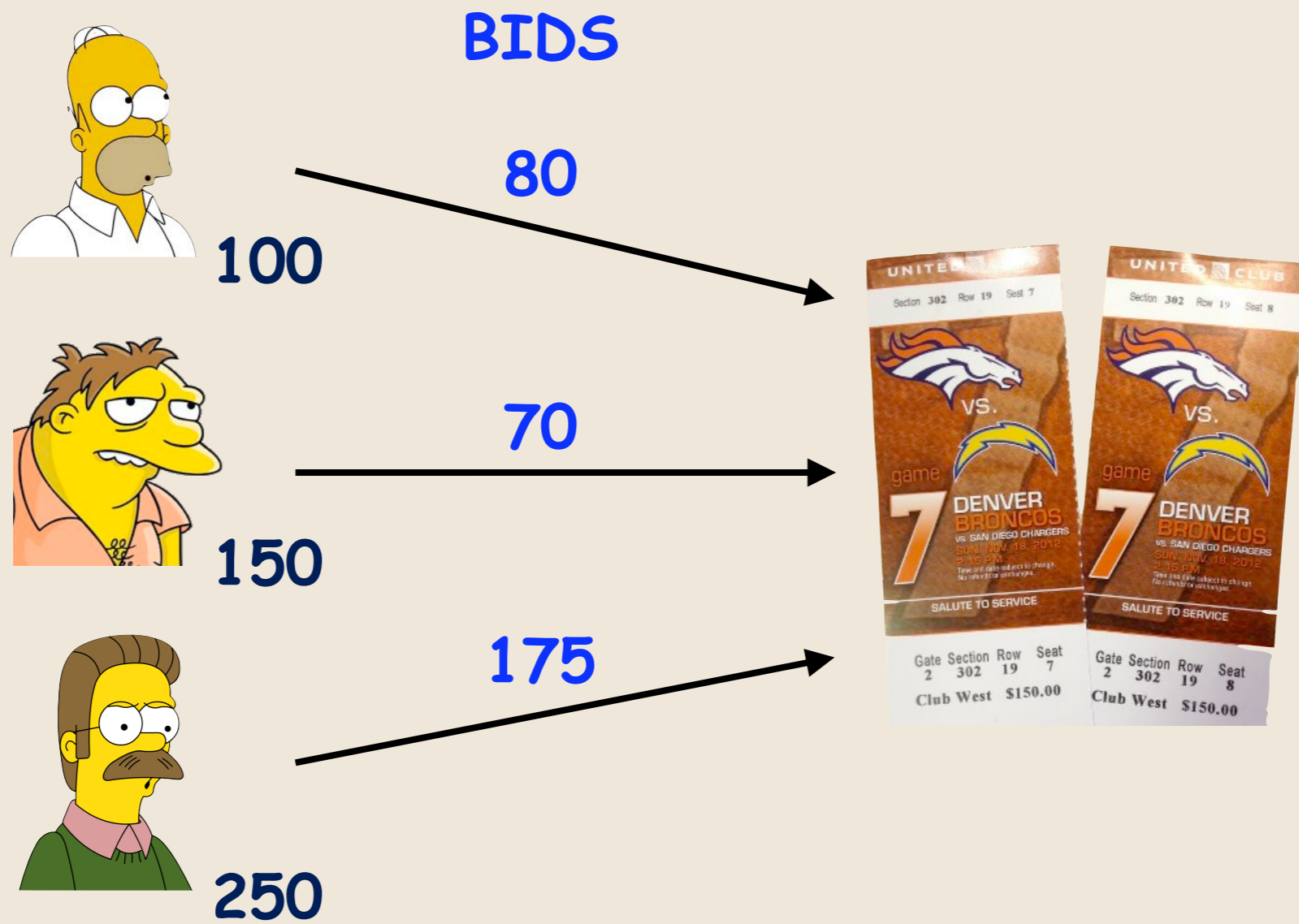


250

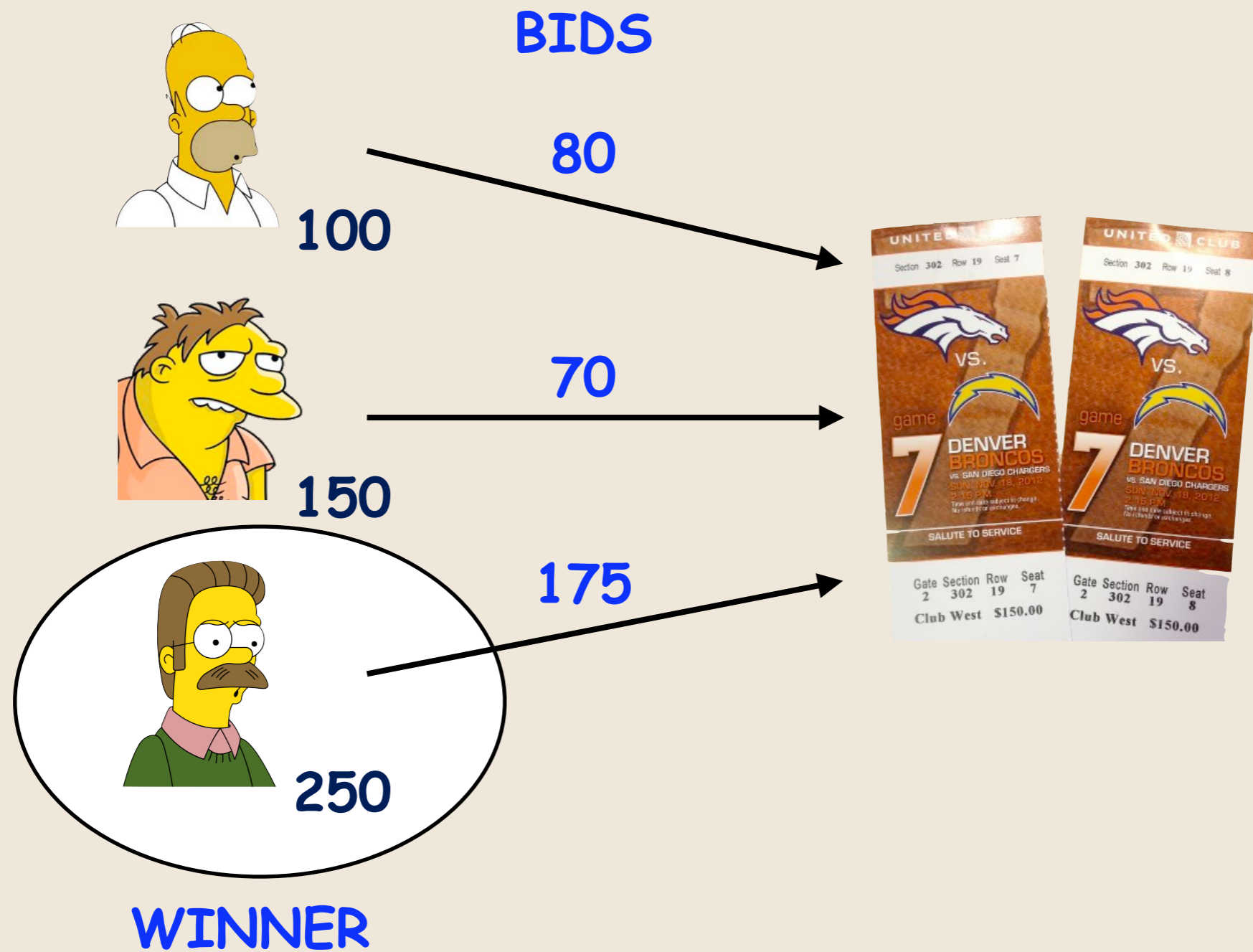


objective = optimize surplus or revenue (uncertainty)
system choice = report? who wins? payments?

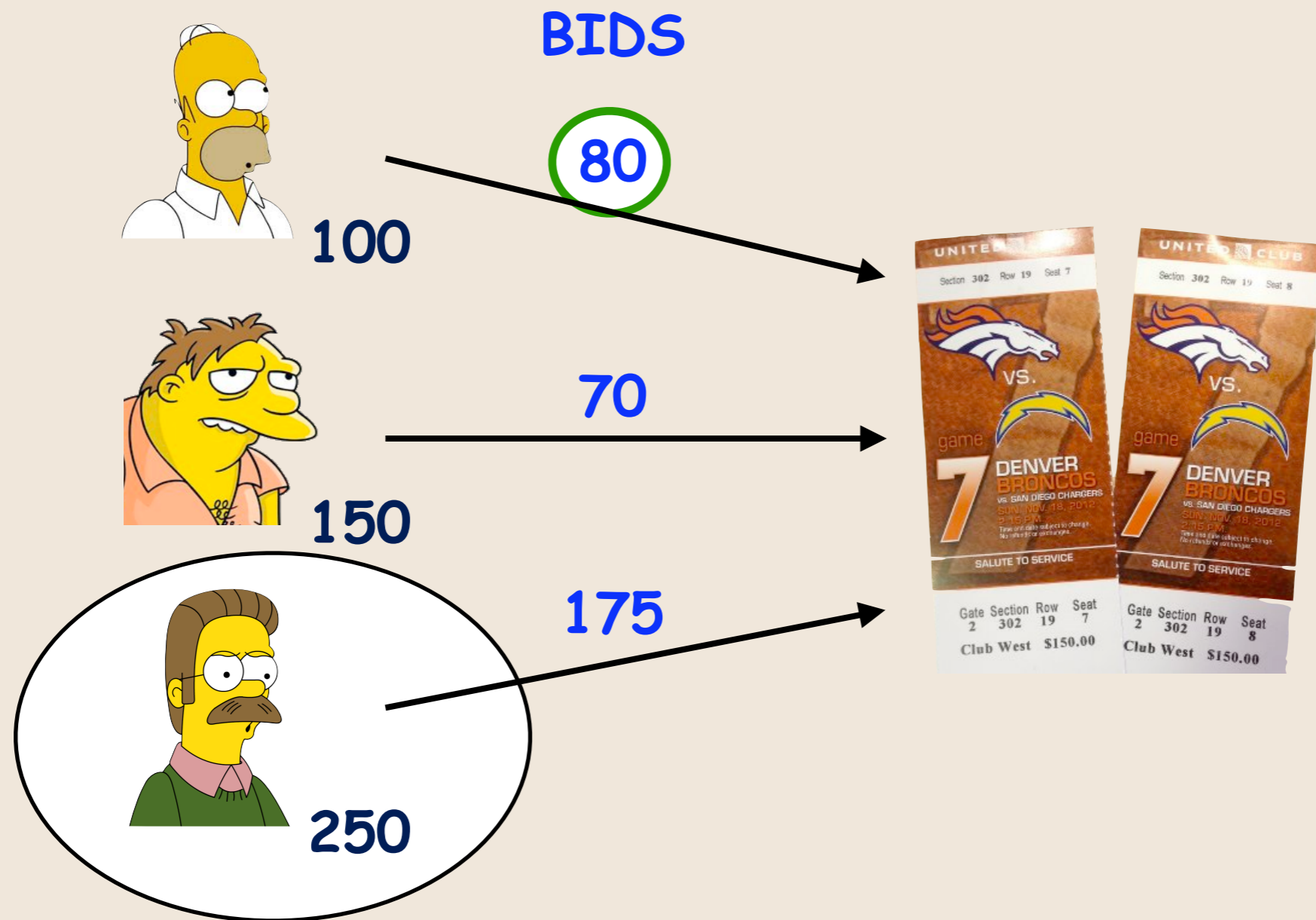
Auctions



Auctions

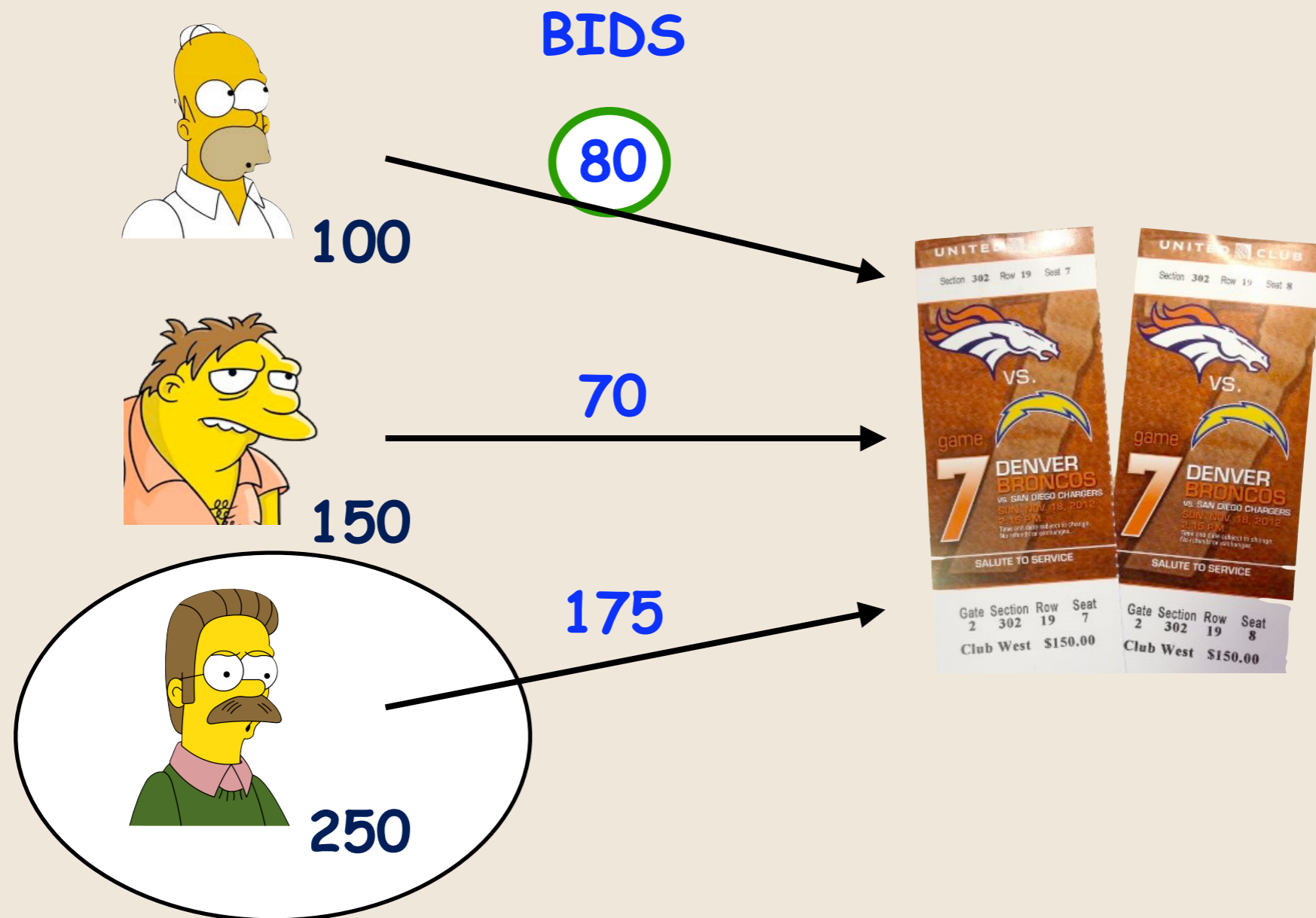


Auctions



WINNER

PAYS: \$80 (second highest price)



WINNER

PAYS: \$80 (second highest price)

Why not have Ned pay his bid \$175?

There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior



(auctions)

success story

- (i) optimizes social surplus
- (ii) optimal to bid true value

William Vickrey (1961)
(Nobel Prize 1996)

There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior



(auctions)

OPEN
Enrollment



(school assignments)



(i) not efficient for BVSD

(ii) not efficient for parents

There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior



(auctions)



(overbooked flights)



(school assignments)

There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior



United Airlines

There are many mechanisms you are exposed to on a daily basis that are in place to influence your behavior



United's way of bumping 'is very inefficient,' says auction expert

By [Ethan Wolff-Mann](#)

[m.yahoo.com](#) — United's way of bumping 'is very inefficient,' says auction expert Yahoo Finance Wednesday, April 12, 2017 Ethan Wolff-Mann With a proper auction, there is no such thing as involuntary bumping. Source: AP After a viral video emerged this week of United Airlines (UAL) dragging a paying customer off a plane, some outraged consumers attacked the airline industry's practice of overbooking. Not all airlines overbook, with JetBlue (JBLU) being a notable exception.

3 MONTHS AGO [f](#) | [in](#) | [t](#) | [Who shared?](#)

[Wrong byline?](#)



microscopic interactions



macroscopic phenomena

decision makers
choices
preferences

emergent behavior?
efficient?
coordination?

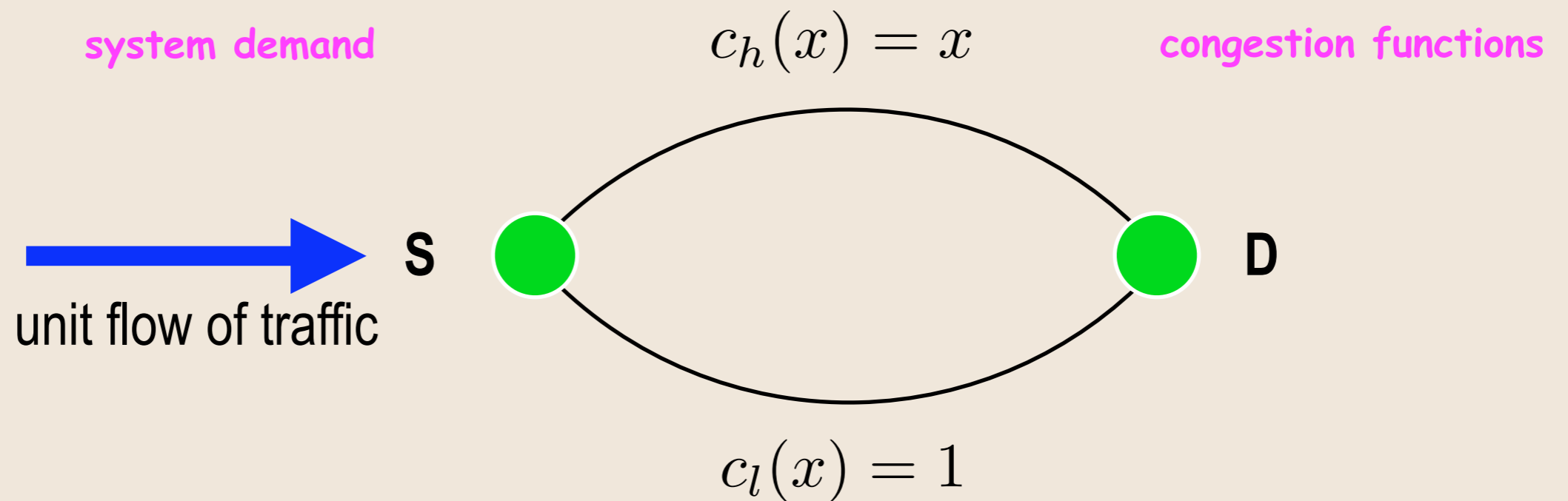


simplifying assumptions
transportation network
driver behavior models

emergent behavior?
efficient?
coordination?

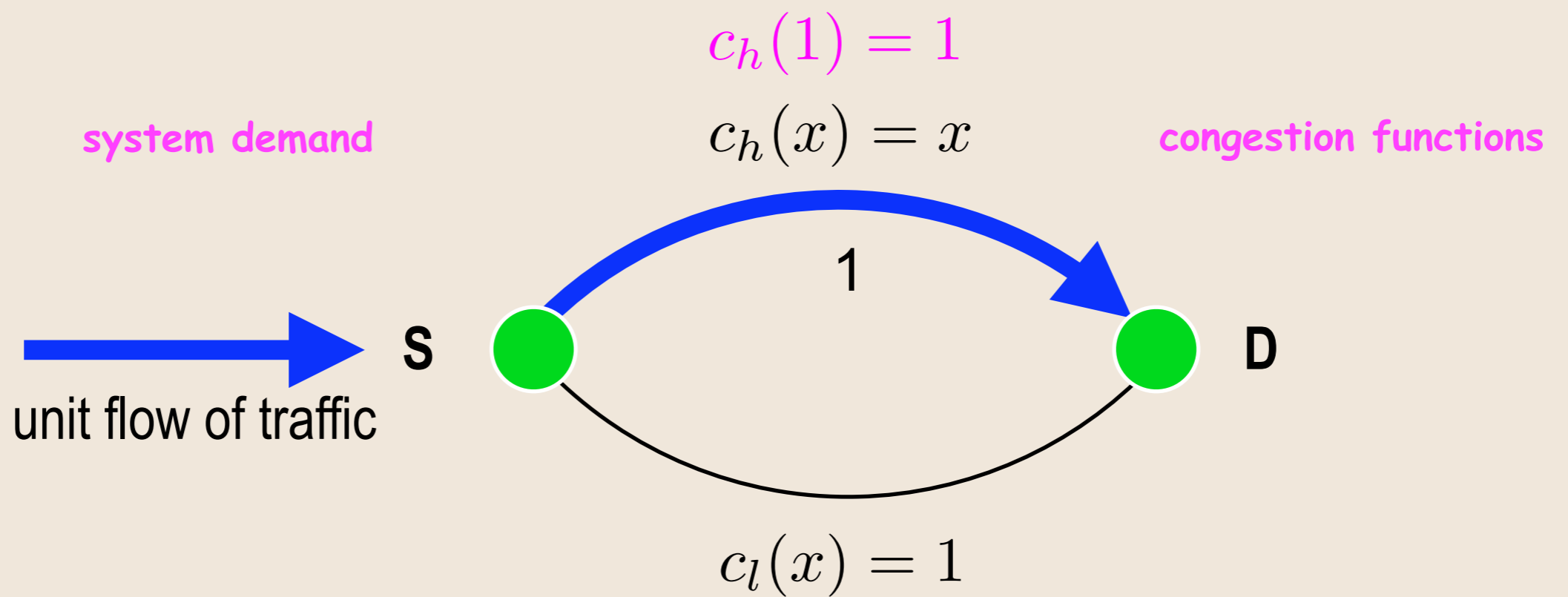


simplifying assumptions
transportation network
driver behavior models



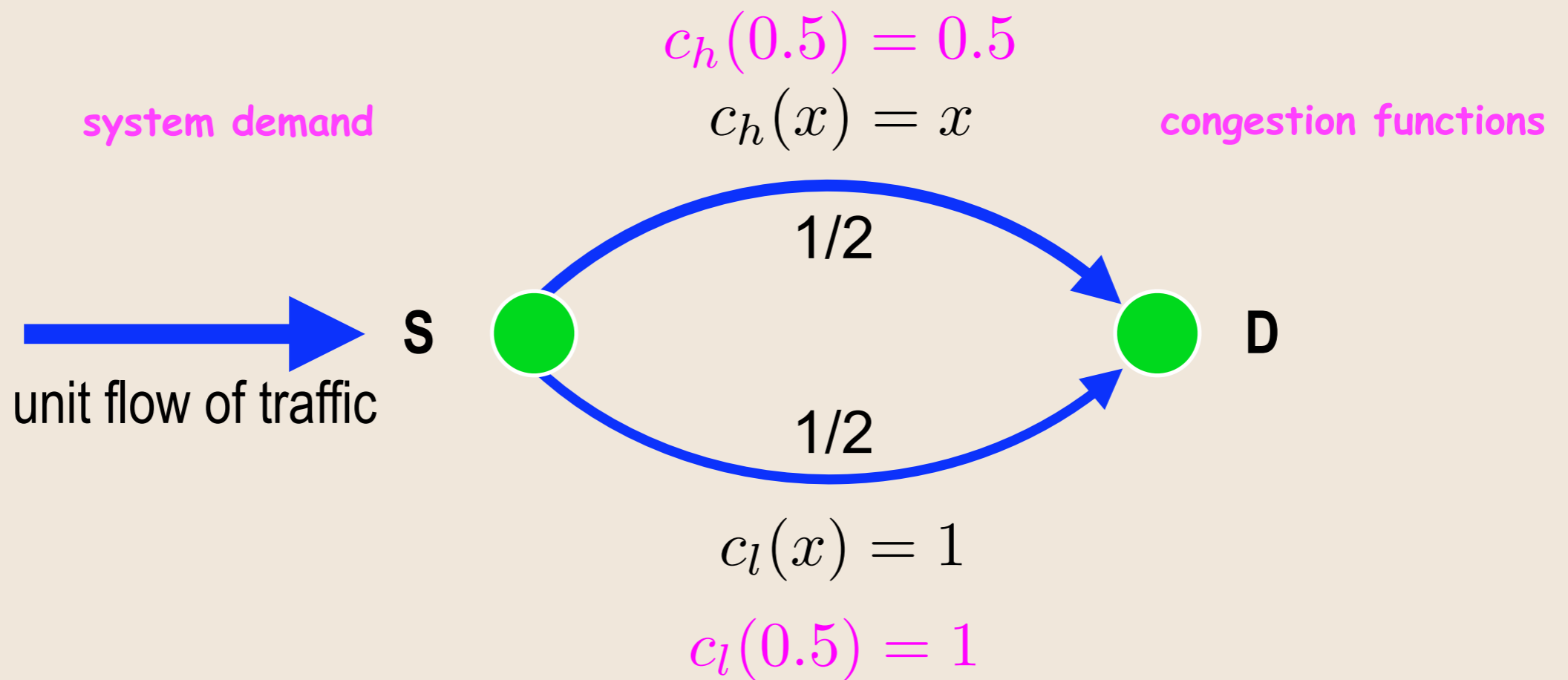


simplifying assumptions
transportation network
driver behavior models





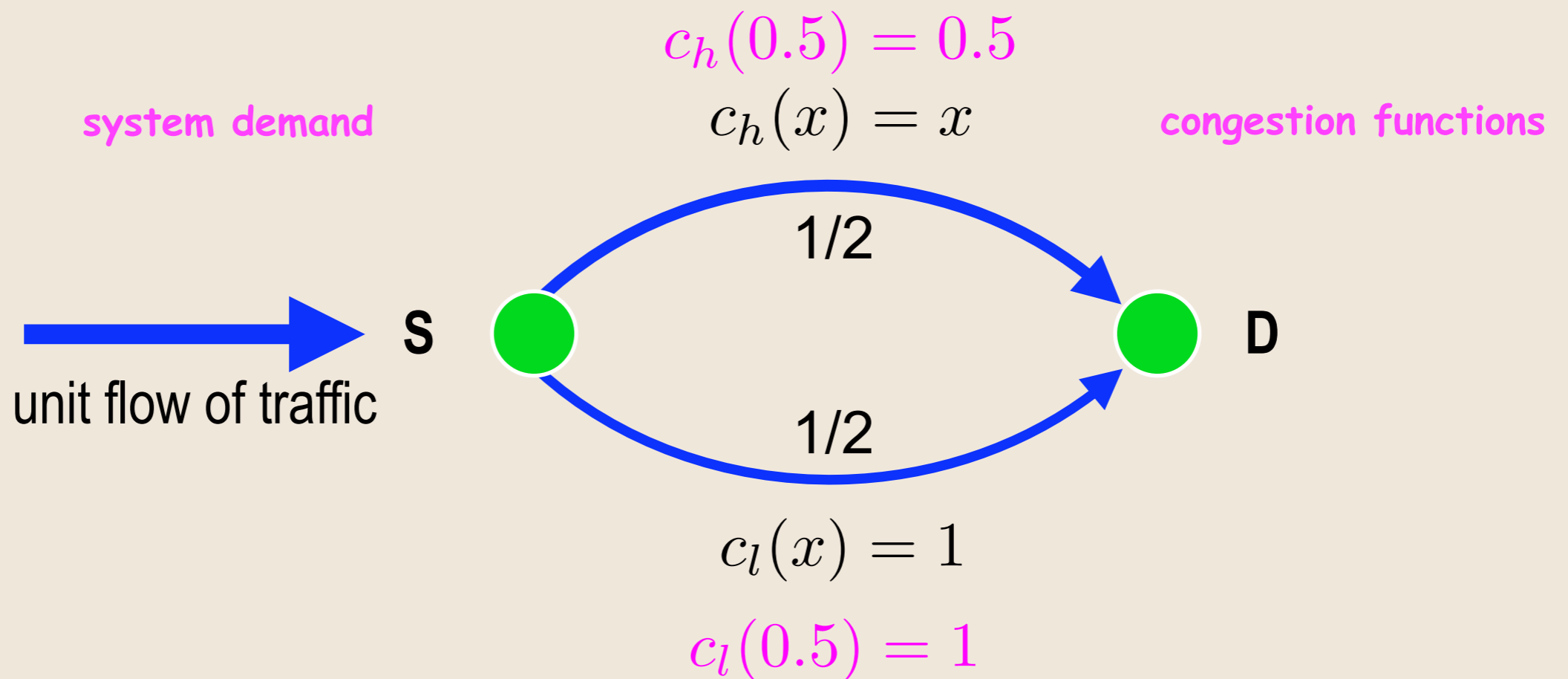
simplifying assumptions
transportation network
driver behavior models





simplifying assumptions
transportation network
driver behavior models

drivers seek to minimize
own experienced congestion

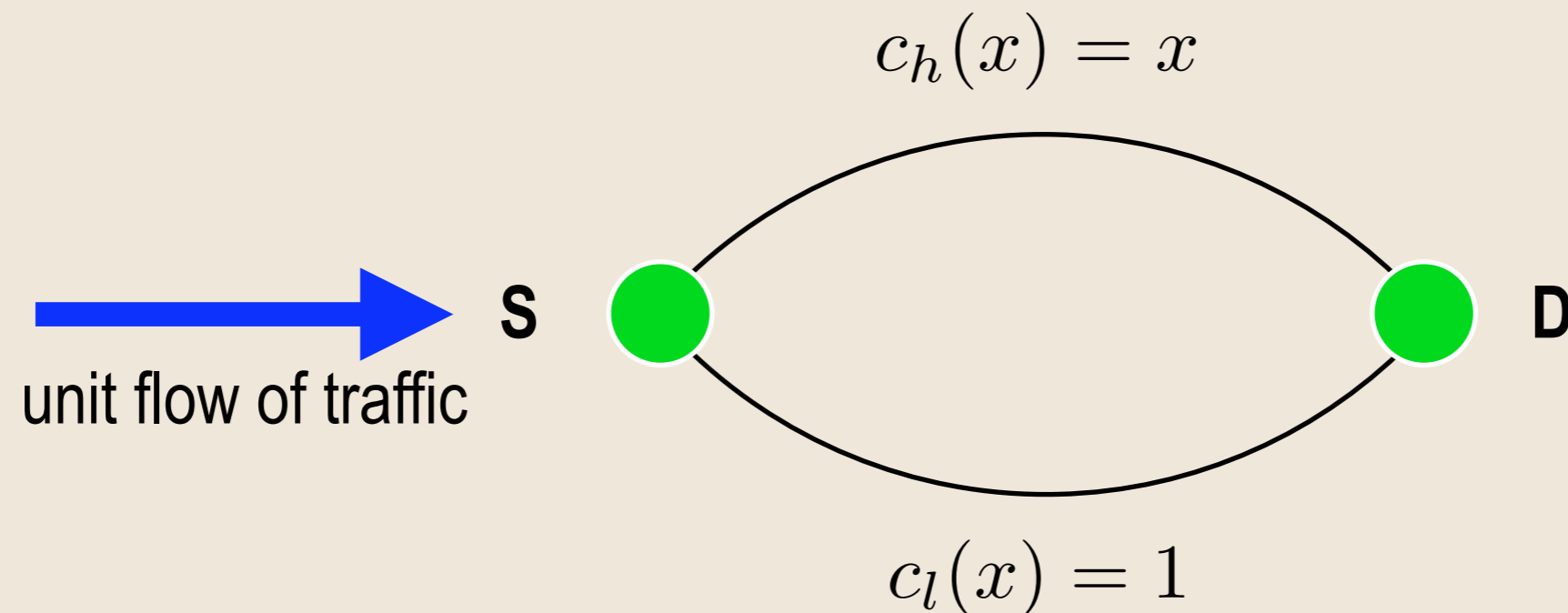


Motivation:

- Uninfluenced systems often exhibit poor system behavior

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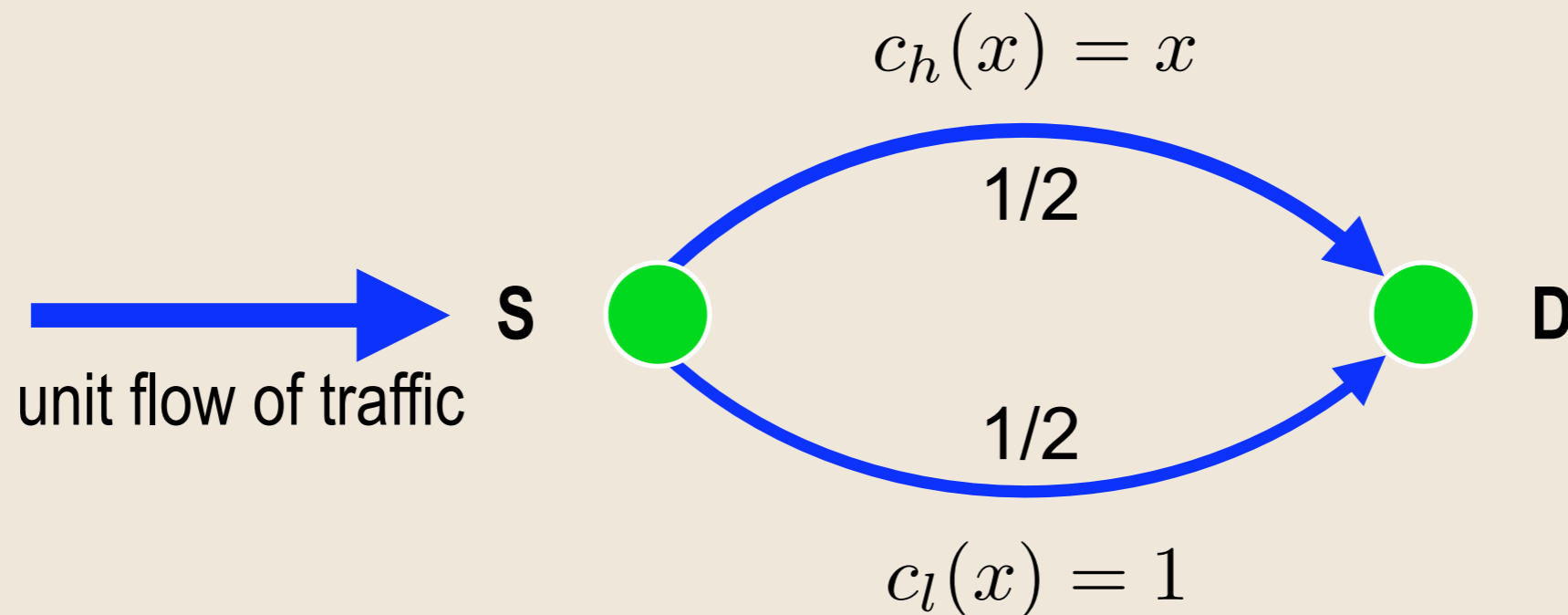
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system optimal outcome **vs.** self-interested outcome

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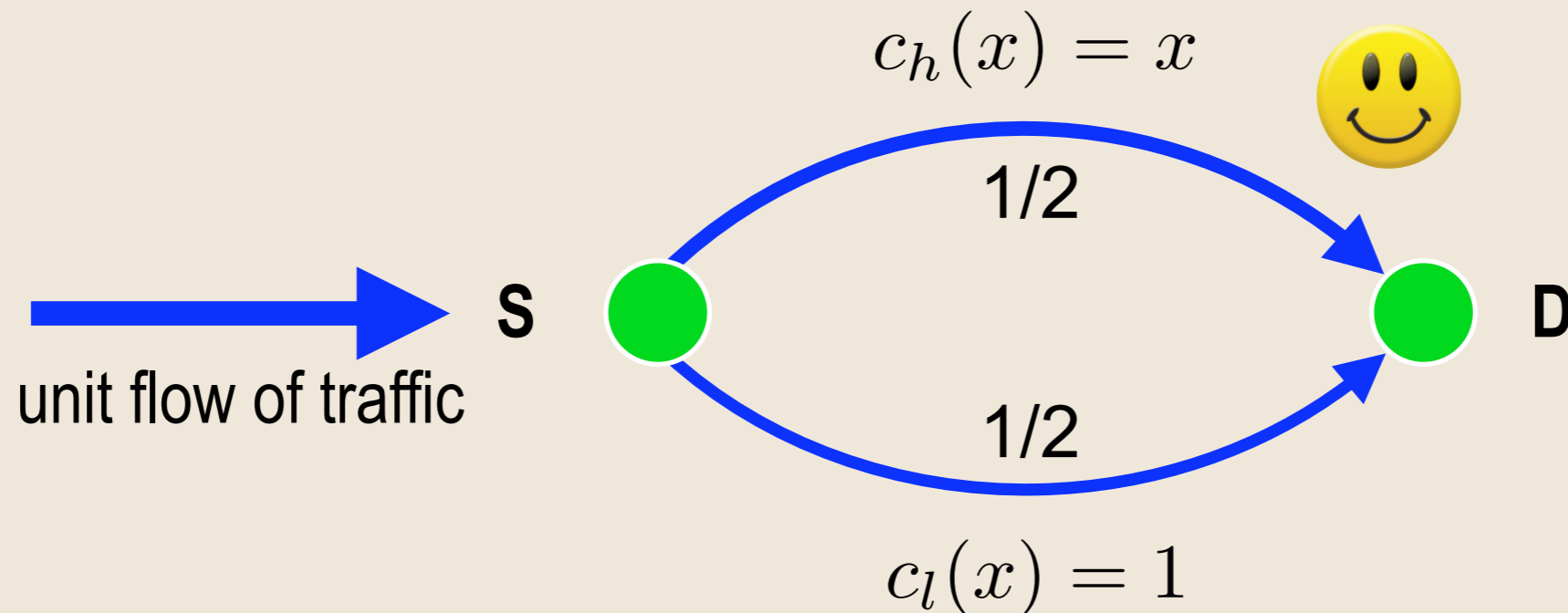


system optimal outcome vs. self-interested outcome

3/4

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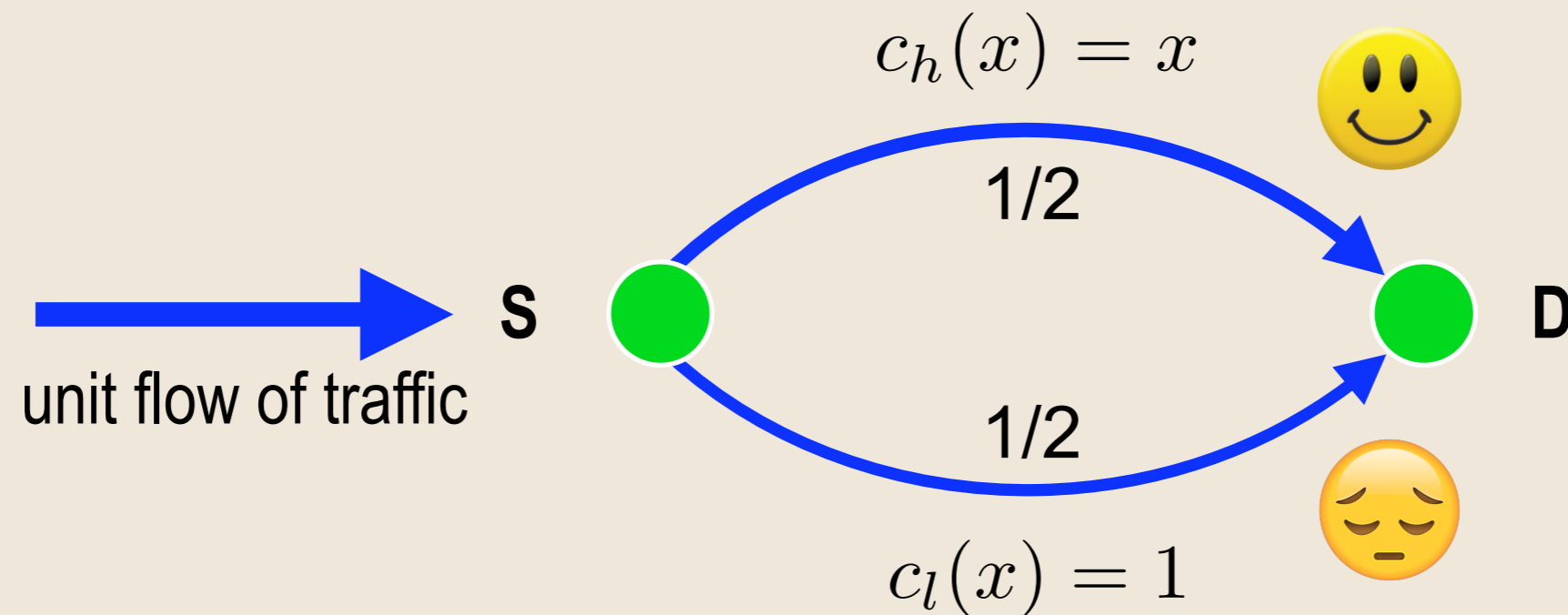


system optimal outcome vs. self-interested outcome

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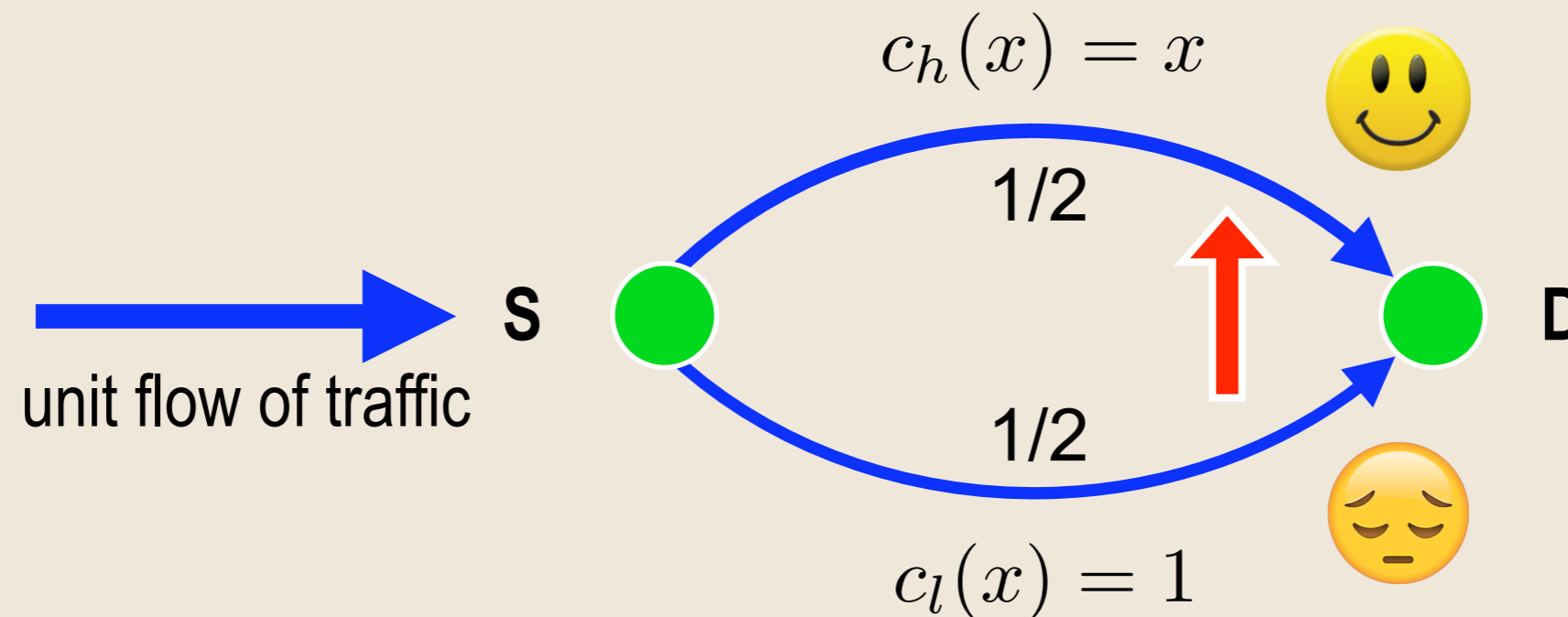


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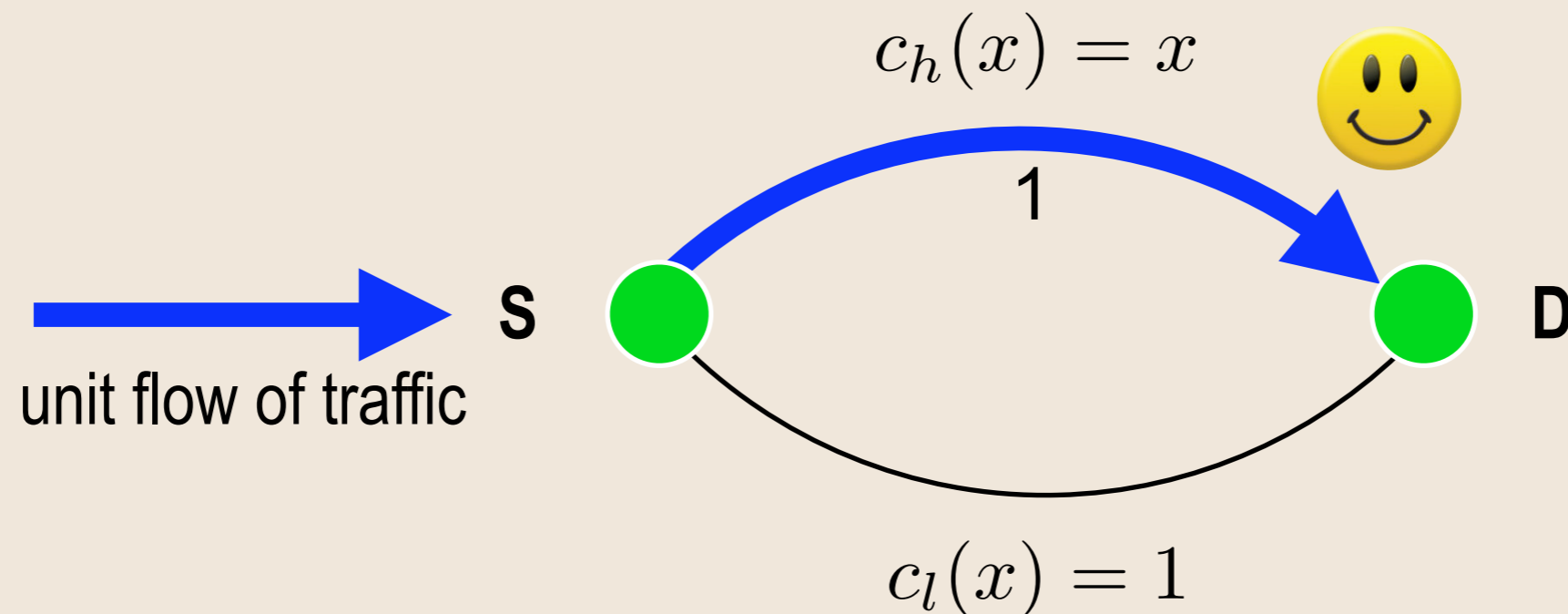


system optimal outcome vs. self-interested outcome

\swarrow
3/4

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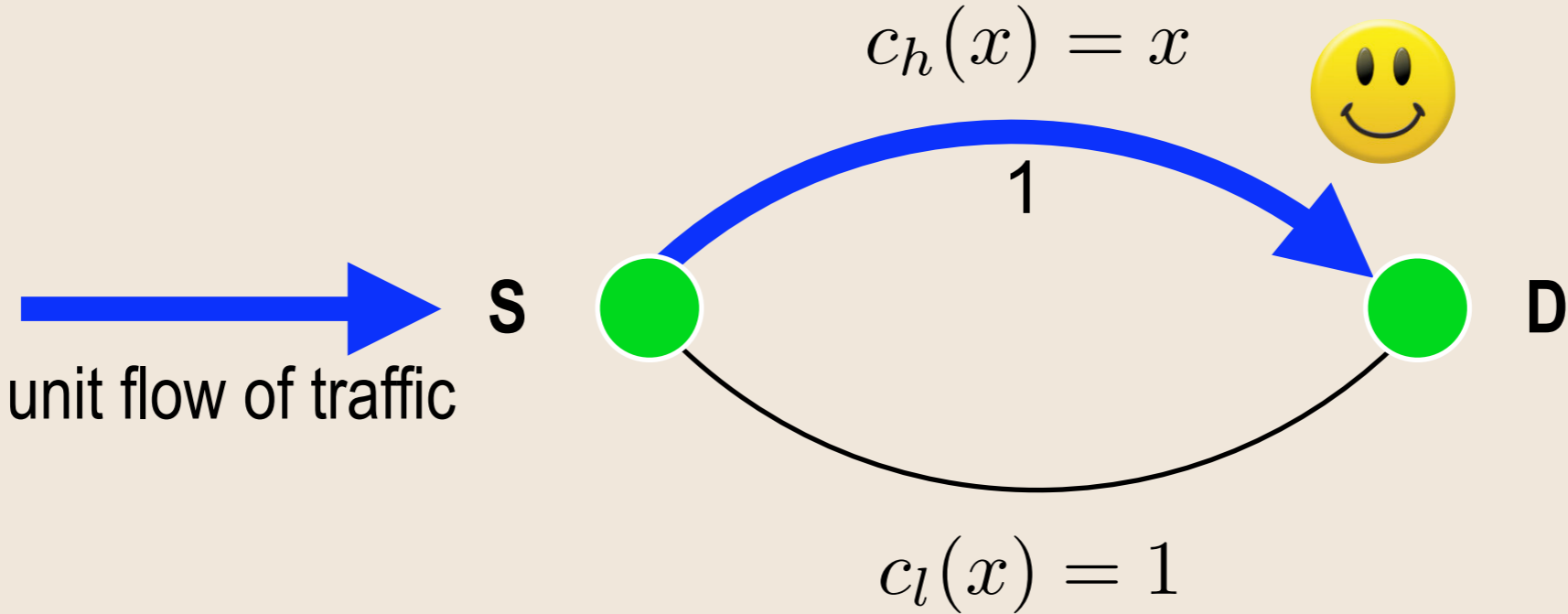
system optimal outcome vs. self-interested outcome

3/4

1

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system optimal outcome vs. self-interested outcome

3/4

self-interested outcome
33% worse than optimal outcome

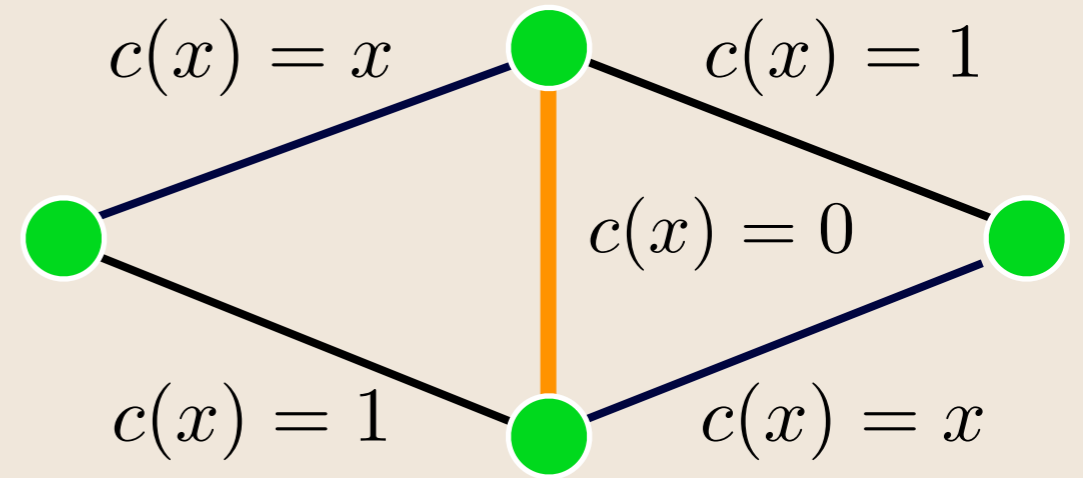
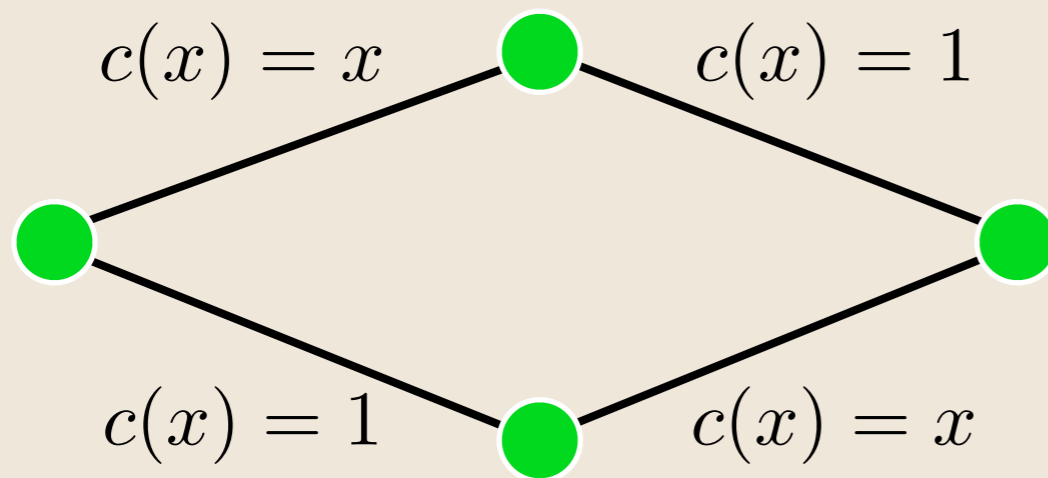
1

Motivation:

- Uninfluenced systems often exhibit poor system behavior
- Natural influencing mechanisms need not lead to intuitive outcomes

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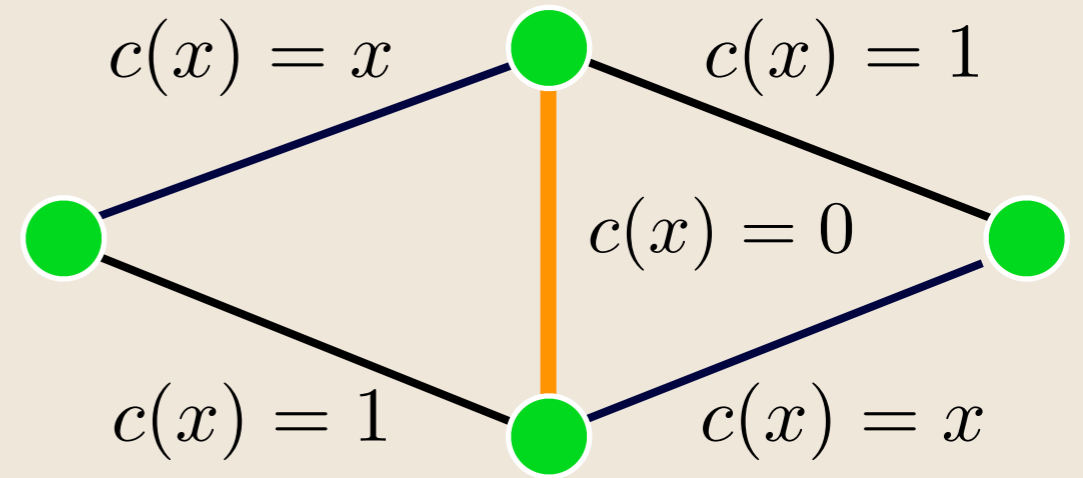
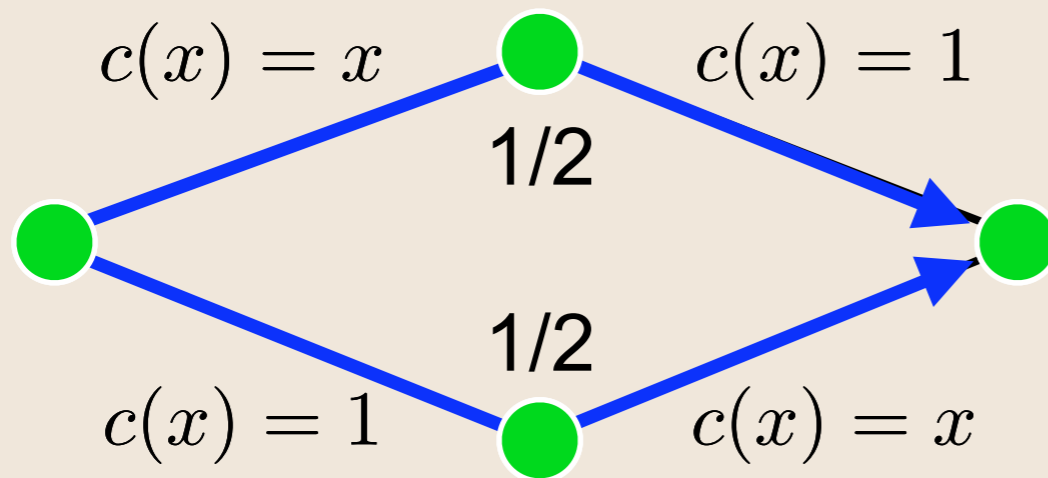
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original network **vs.** original network + extra edge

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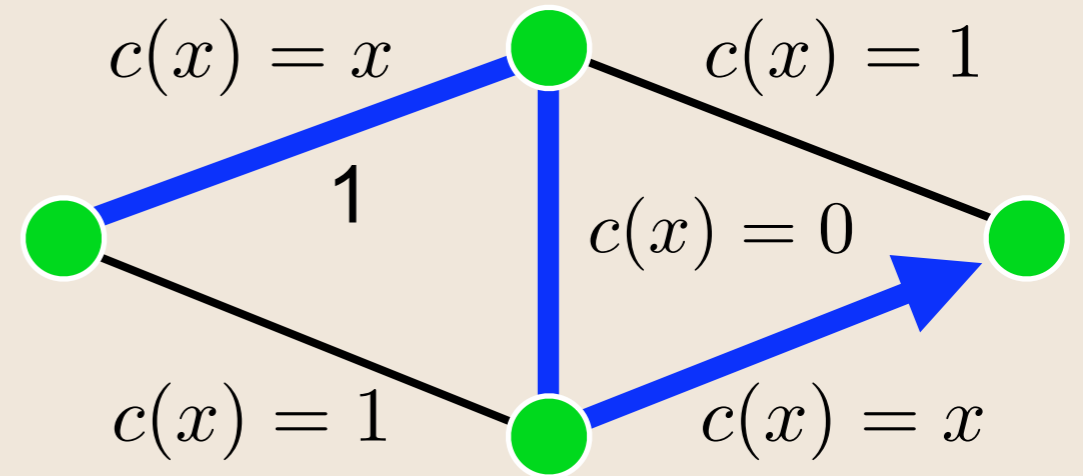
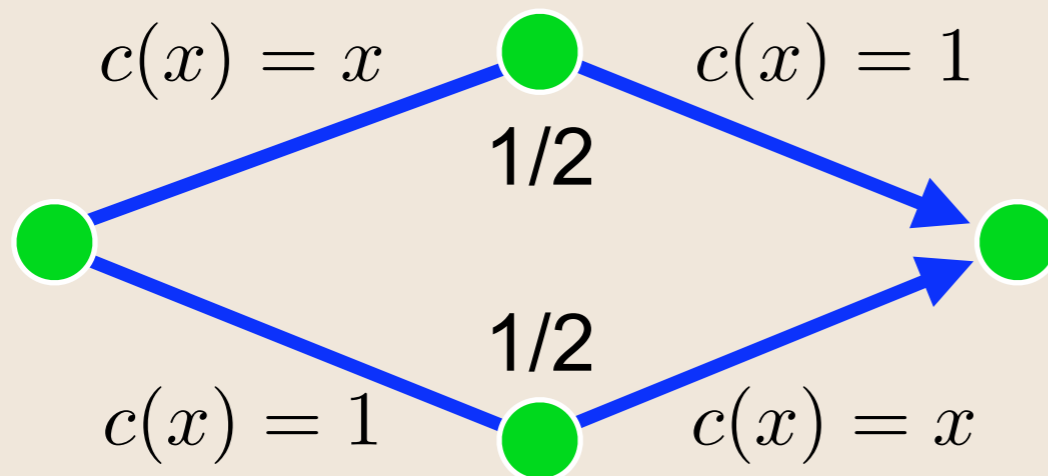


original network vs. original network + extra edge

1.5

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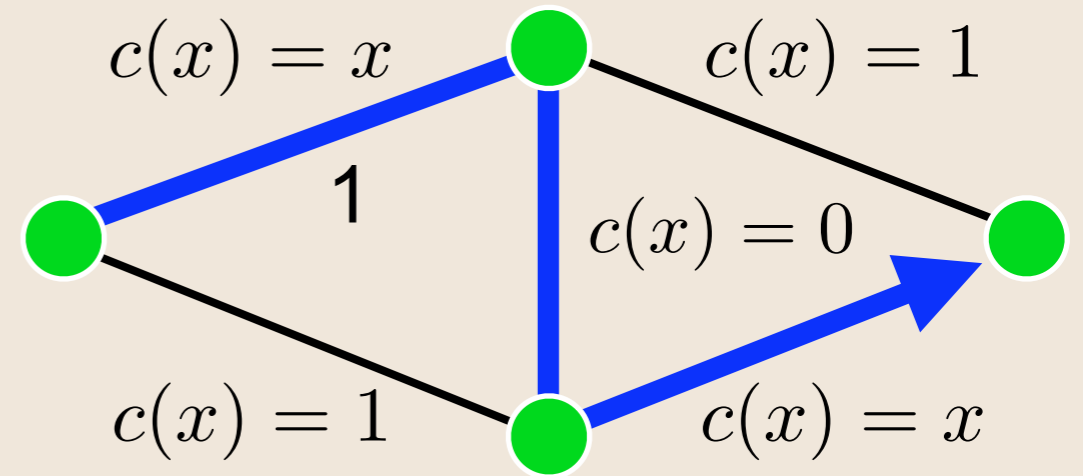
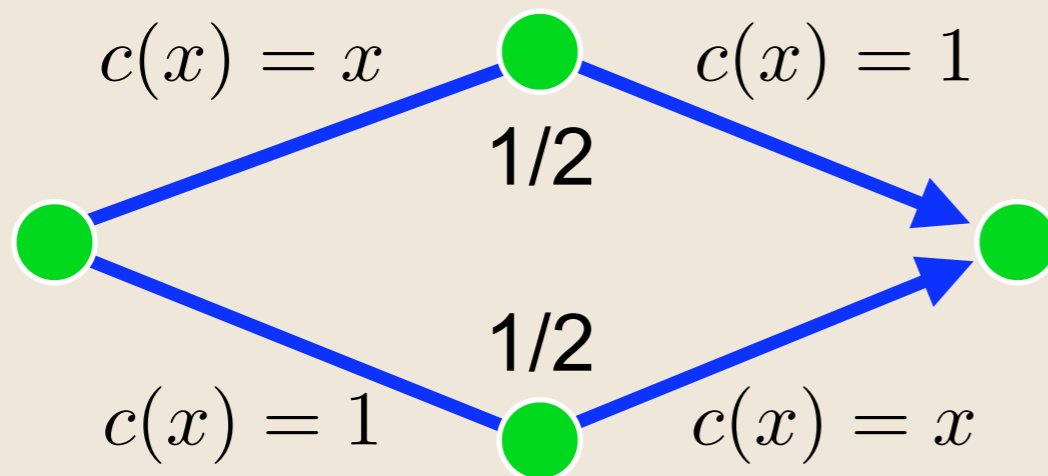
original network vs. original network + extra edge

1.5

2

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original network vs. original network + extra edge

1.5

additional resources resulted
in 33% worse system performance

2

Motivation:

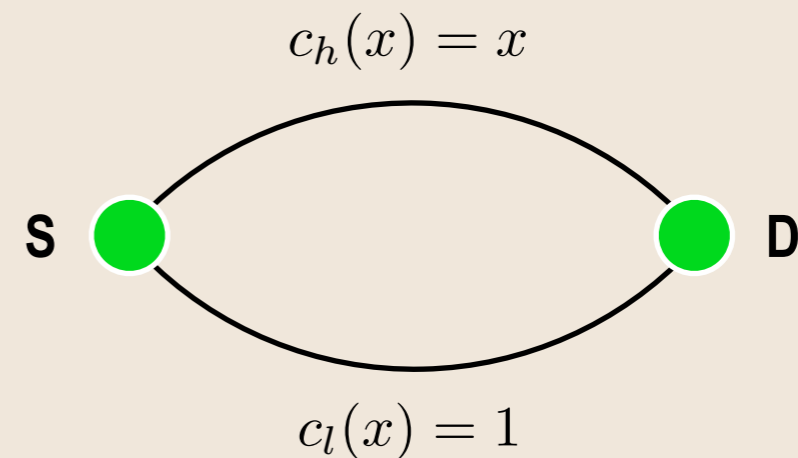
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Research Thrust: Develop methodologies for robust social coordination to improve system-level performance (taxes)

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Research Thrust: Develop methodologies for robust social coordination to improve system-level performance (taxes)

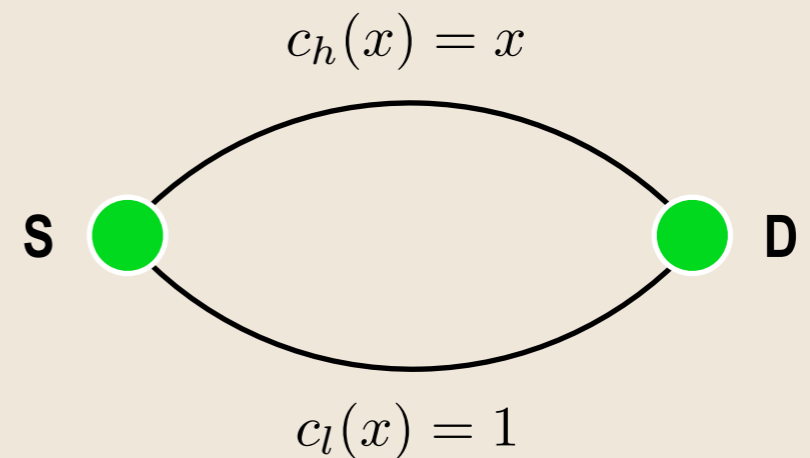
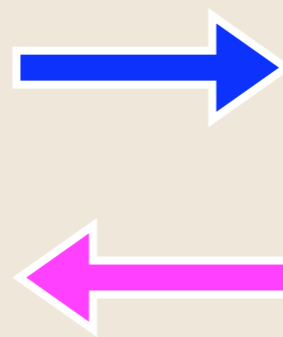


simplified models provide us insight to challenges and opportunities in realistic setting

Motivation:

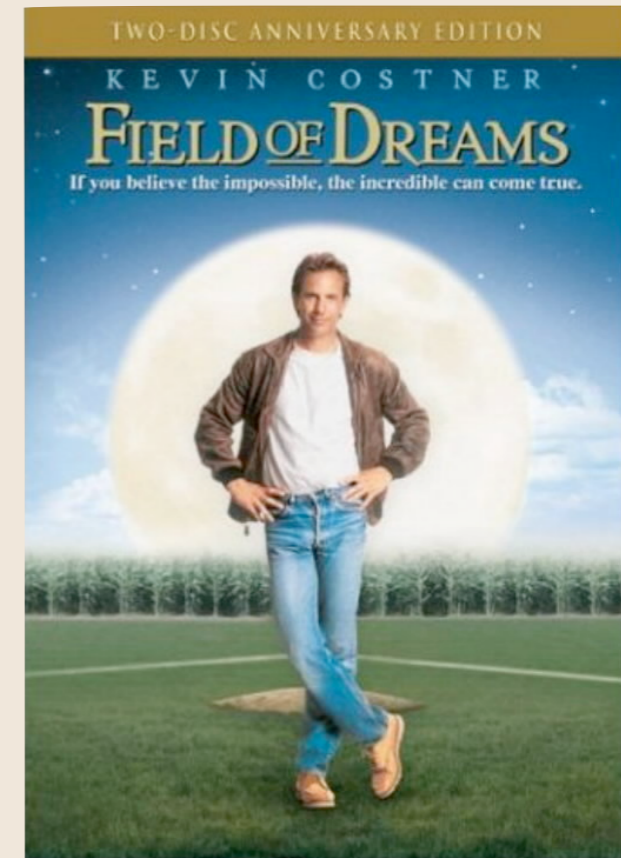
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Research Thrust: Develop methodologies for robust social coordination to improve system-level performance (taxes)



identify salient features of
robust coordinating mechanisms

Field of Dreams...



if you build it, they will come...

but will they use it efficiently?



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Field of Dreams...



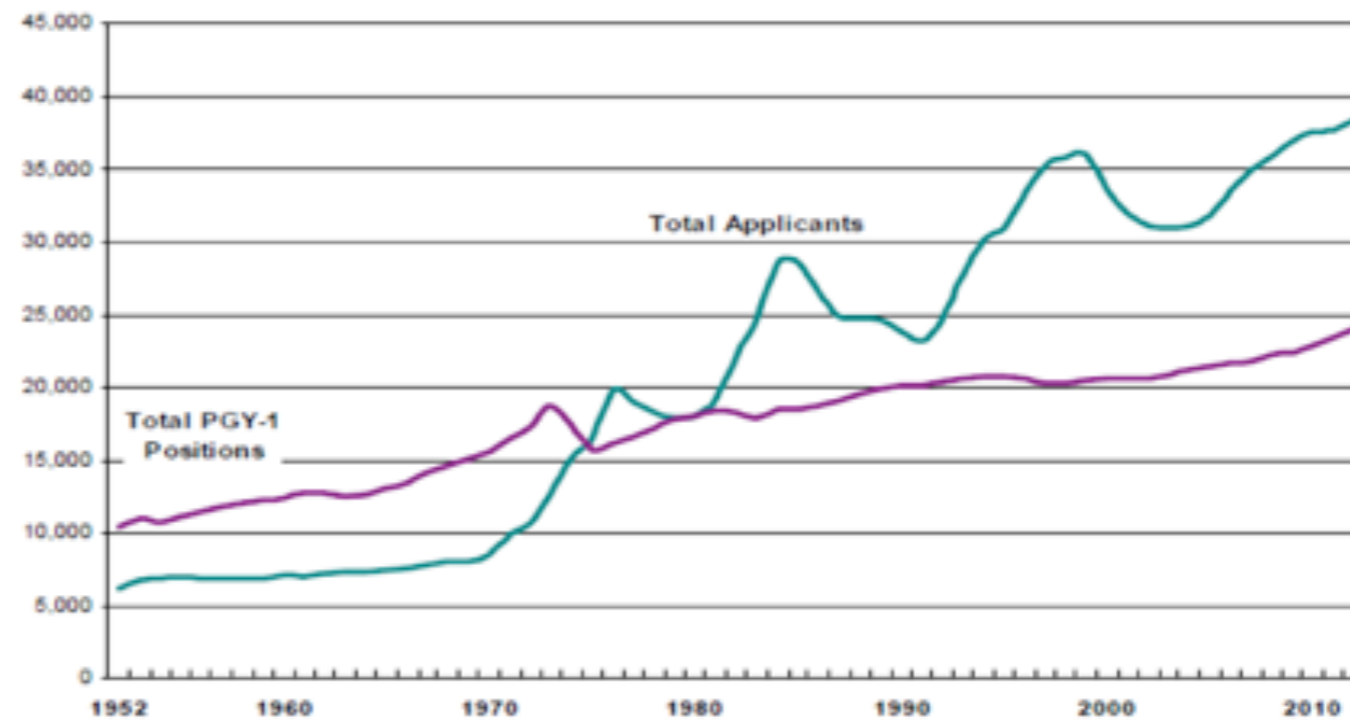
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Figure 1 Applicants and 1st Year Positions in The Match, 1952 - 2012

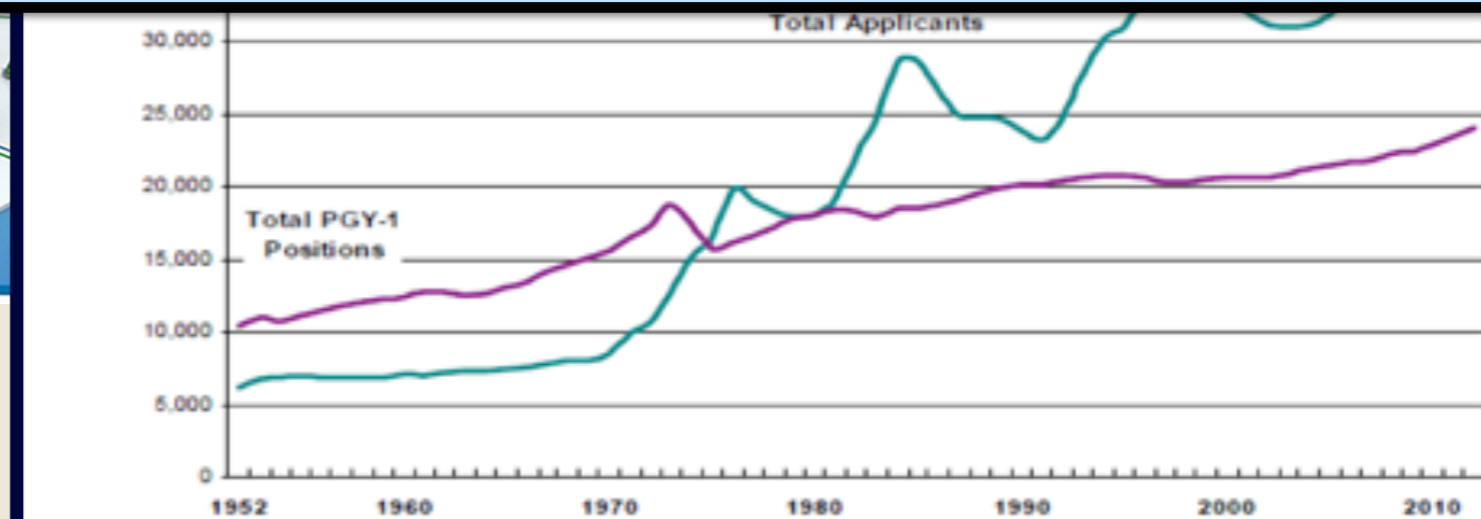


if you build it, they will come...

but will they use it efficiently?

Take away points:

- Ensuring "systems" utilized efficiently is challenging
- Natural choice need not be good choice
- Deriving mechanism requires thorough theoretical analysis
- Game theory is instrumental in the design of good mechanisms
- Engineers need awareness of Game Theory to design such systems



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(avoid situations like this)

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i never realized i
was a player in a game

Thank You

