Behavioral Social choice

u_1, u_2	**L**	**M**	**R**
T	1, 1	4, 6	4, 1
B	3, 5	2, 3	5, 8

Minicourse outline

- Class 1: A crash course in Behavioral Economics

- Class 2: Applying behavioral insights to social choice theory

- Class 3: Experiments in social choice

Disclaimer

Goal

- To know behavioral economics

- To know how human voters behave

- To know how to run experiments

Goal

- ~~To know behavioral economics~~
- A glimpse to the immense literature on behavioral economics

- ~~To know how human voters behave~~
- Understand how *some* behaviors can be modelled

- ~~To know how to run experiments~~
- Understand some of the challenges and benefits of experiments

Class 1: A crash course in Behavioral Economics

The economic reasoning template

Some interaction among agents → Explicitly model incentives → Write as a game → Find equilibrium

For example, Plurality voting over {a,b,c}

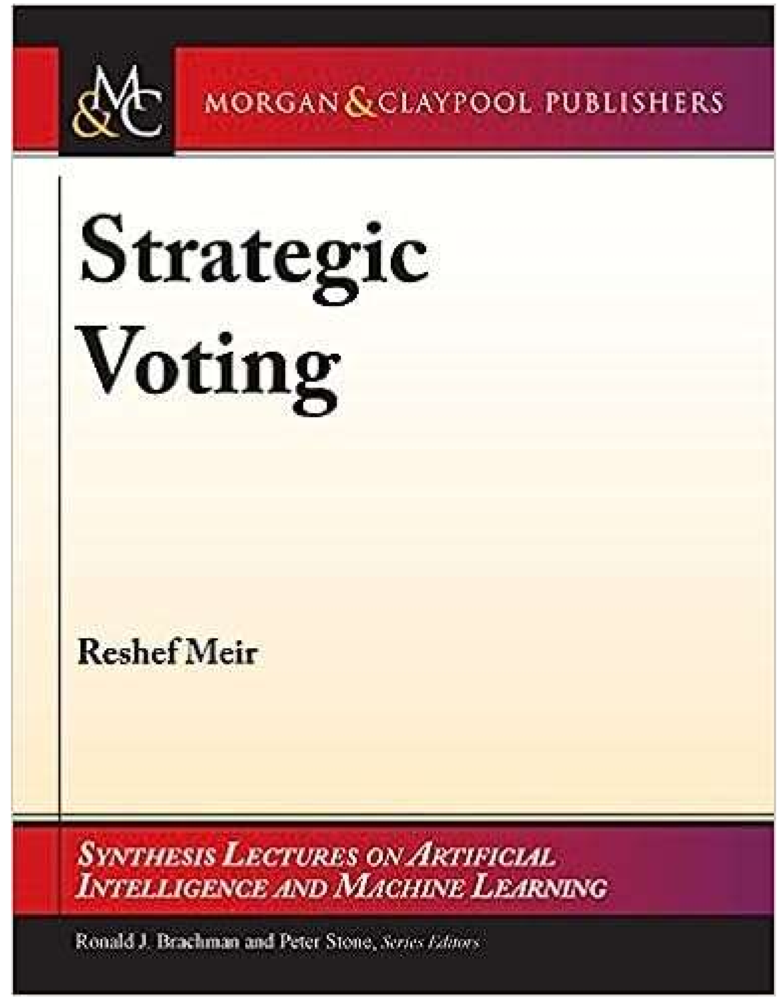
A voter has a linear preference order
$L_1: c \succ b \succ a$
$L_2: b \succ c \succ a$

A voting rule is a game form:

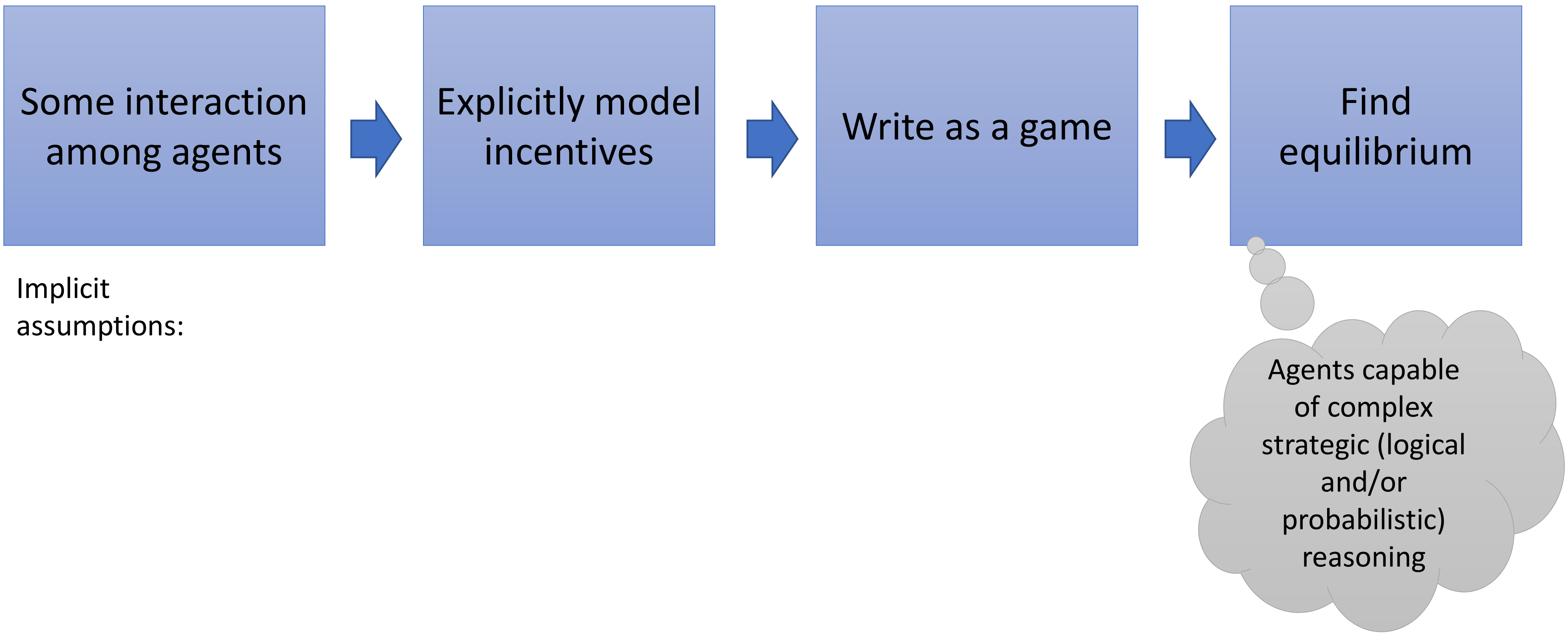
g	a	b	c
a	a	a	a
b	a	b	b
c	a	b	c

$\langle g, L \rangle$	a	b	c
a	3, 1	3, 1	3, 1
b	3, 1	2, 3	2, 3
c	3, 1	2, 3	1, 2

- Second book you should read if interested in strategic voting
  - The Handbook is the first
- Links economic and computational approaches
- 80% “rational behavior”
- We will touch some the other 20% in class 2



The economic reasoning template



Implicit assumptions:

Think fast:

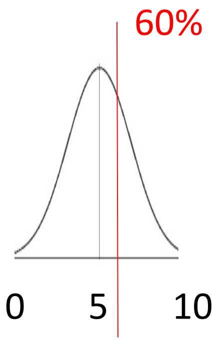
Play Kahoot!
(will work until August 15)

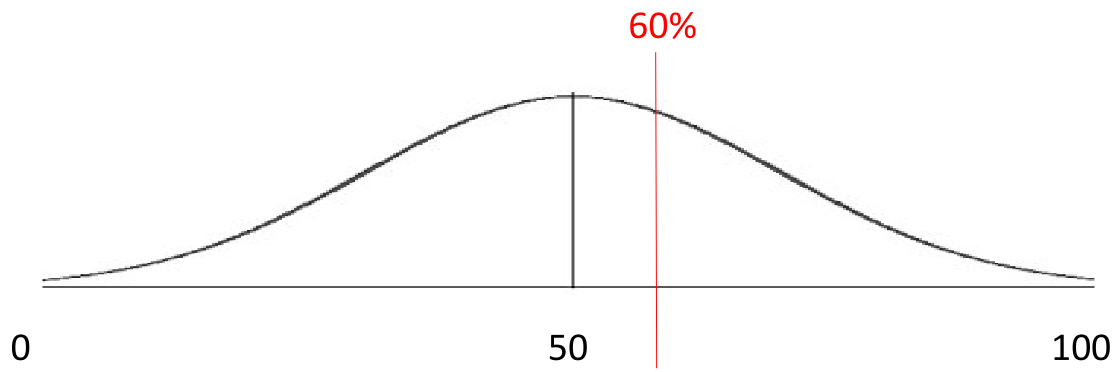
Each hospital rings the bell every day there are >60% girls among newborns

~10 births per day

~100 births per day

Our intuition

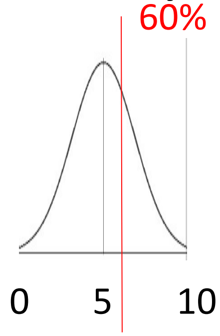


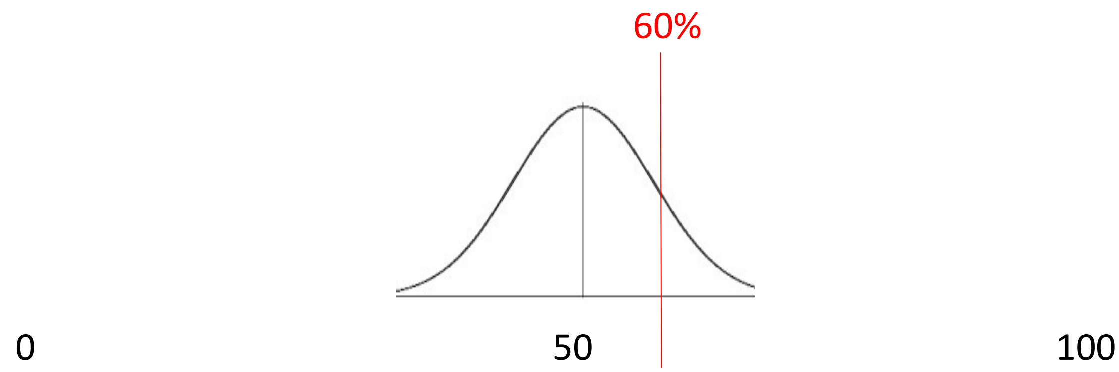


~10 births per day

~100 births per day

Reality





~10 births per day

~100 births per day

Availability heuristics

Kangaroo
Know

Ya**k**
Li**k**e

Much more **available**

X2 more frequent

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. science, 185(4157), 1124-1131.

Anchoring

- In the lack of valid cues, people use invalid cues

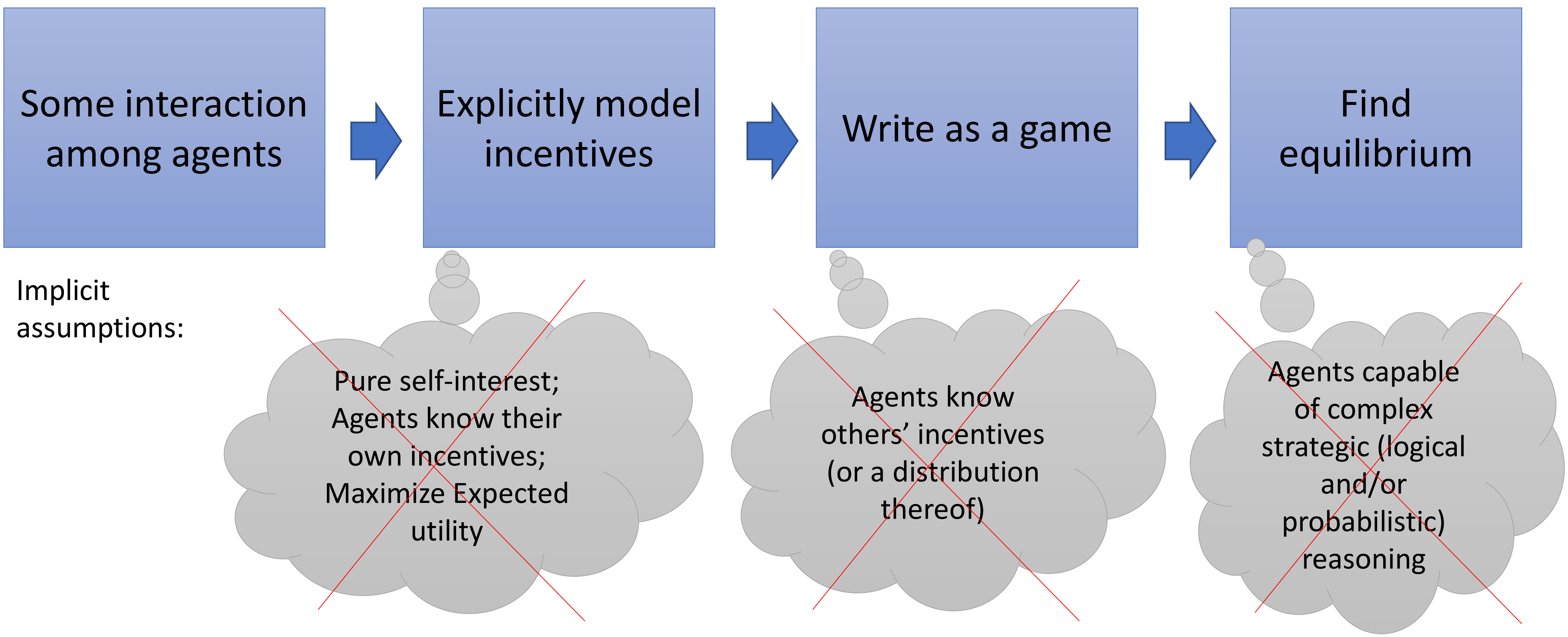
Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. science, 185(4157), 1124-1131.

Problem!

- We can't even answer a simple question correctly

- How can we solve a complicated game?

The economic reasoning template



Bounded rationality

Limitations:

- Limited available information
- Limited representation
- Limited computation time

…

- Apply both for people and machines

Cognitive biases:

- Risk aversion
- Loss aversion
- Present-bias
- Altruism/spite

…

- Apply only to people ?

Background

1950’s: Herbert Simon

"a kind of rational behavior that is compatible with the **access to information** and the **computational capacities** that are actually possessed … in environments”

Agents use **heuristics** instead of optimal decision rules, ***Satisficing***

1970’s-1990’s: Kahnemann and Tversky

A series of experiments show a wide range of behaviors that contradict rational decisions

List a number of “**biases**”, suggest models to reconcile them

Other important figures:

- A. Rubinstein
- G. Gigerenzer
- M. Rabin
- D. Luce
- C. Camerer
- R. Thaler

Approaches to bounded rationality

Modifying the **representation**

- Simplified representation
- Biased/simplified utility function
- Suitable for capturing a wide range of biases
- Can still apply standard game theoretic tools like Nash equilibrium

Modifying the **solution**

- Relax assumptions on optimizing the utility
- Heuristic strategies
- Different types of equilibria
- Alternatives to equilibria

Utility modifications

Monetary payoffs

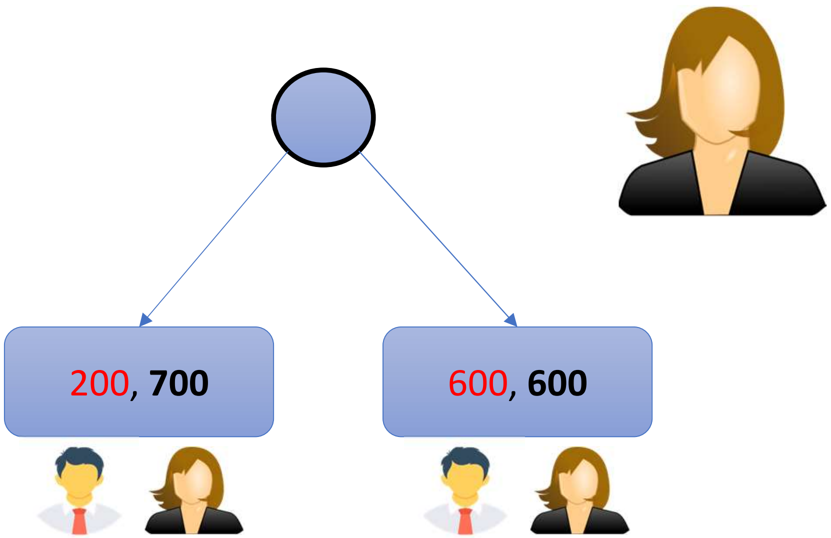
v_1, v_2	C	D
C	8 , 16	0 , 20
D	10 , 0	2 , 4

- Observation: People often cooperate rather than defect
- $u_i(a) = v_i(a) + 0.5 \cdot v_{-i}(a)$

- Result: Hadi?

Utility modifications

- The Dictator game
- Always better (for black) to go left
- Most people go right!
- Why?



Utility modifications

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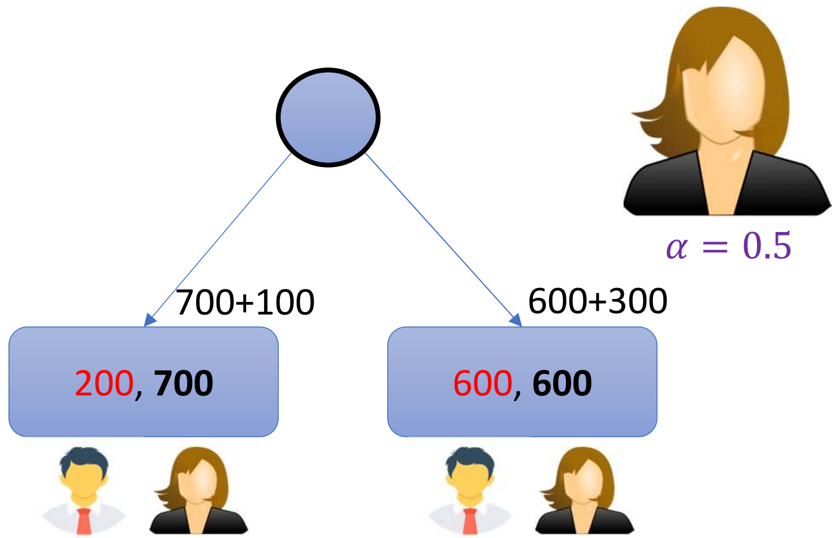
- Why?

- One explanation: "Social" utility

$u_i(a) = v_i(a) + \alpha_i \cdot v_{-i}(a)$

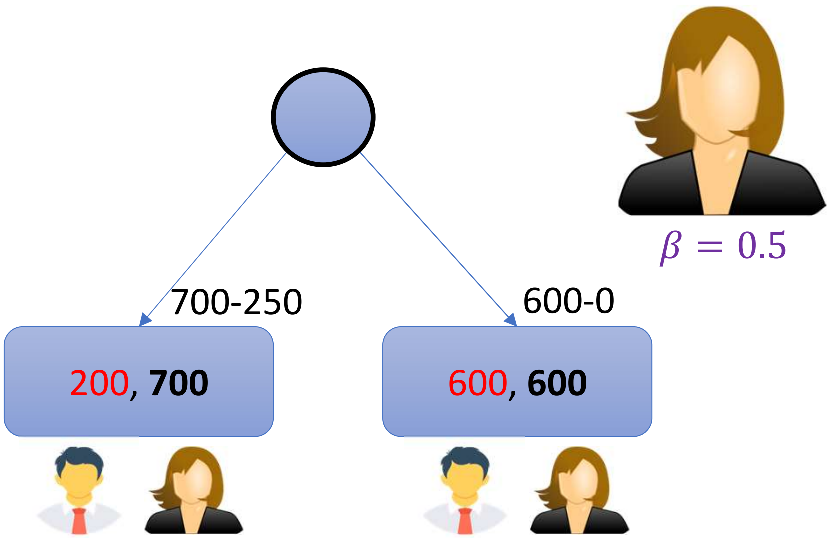


*Charness, Gary and Matthew Rabin. "Understanding Social Preferences with Simple Tests.", QJE, 2002.

Utility modifications

- The Dictator game
- Always better (for black) to go left
- Most people go right!
- Why?

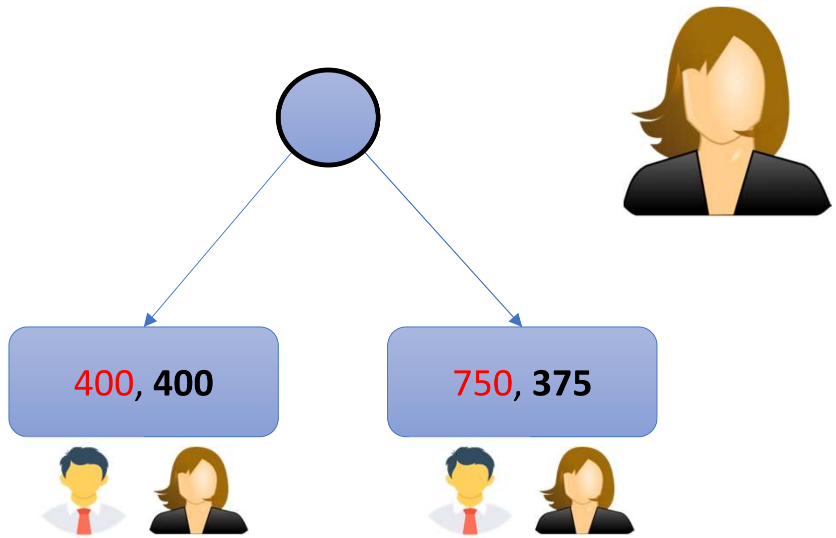
- One explanation: "Social" utility
$u_i(a) = v_i(a) + \alpha_i \cdot v_{-i}(a)$
- Another explanation: avoid inequality
$u_i(a) = v_i(a) - \beta_i \cdot |v_i(a) - v_{-i}(a)|$



*Charness, Gary and Matthew Rabin. "Understanding Social Preferences with Simple Tests.", QJE, 2002.

Utility modifications

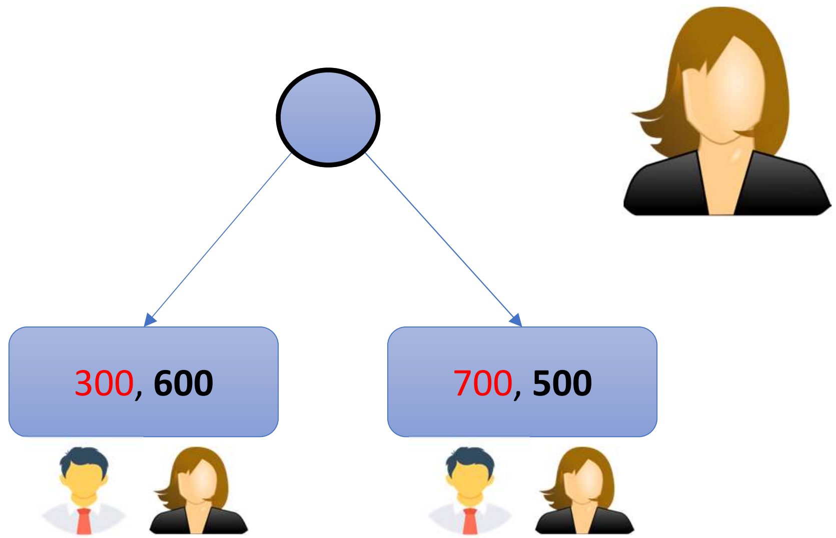
- What about now? about half/half



Utility modifications

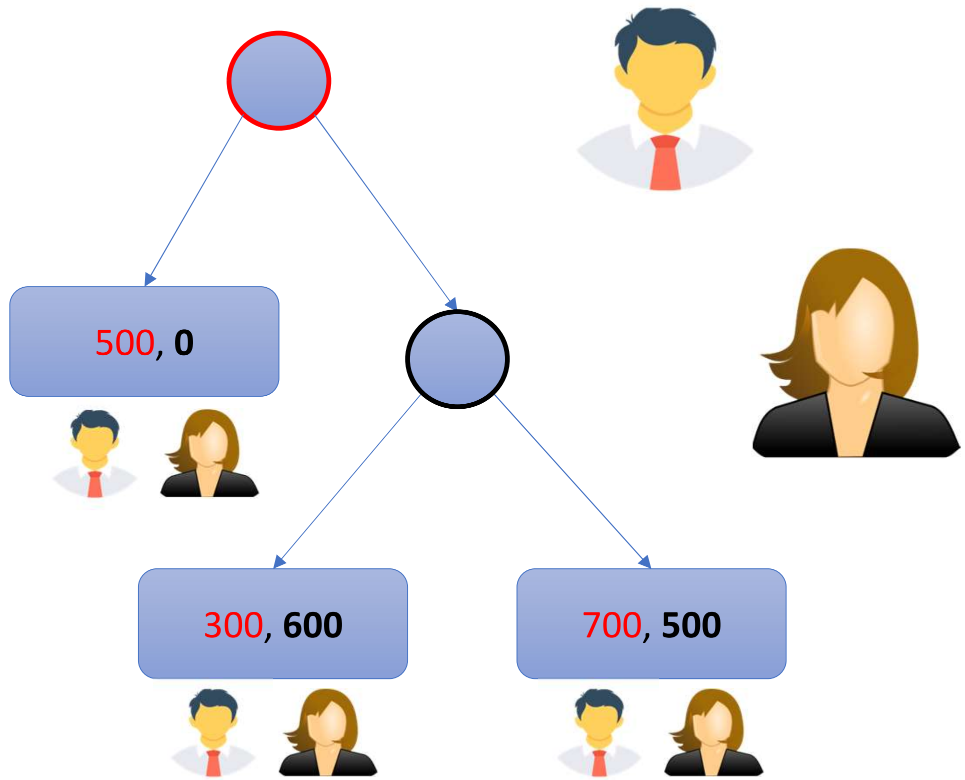
- What about now?
- And now?

about a third go right



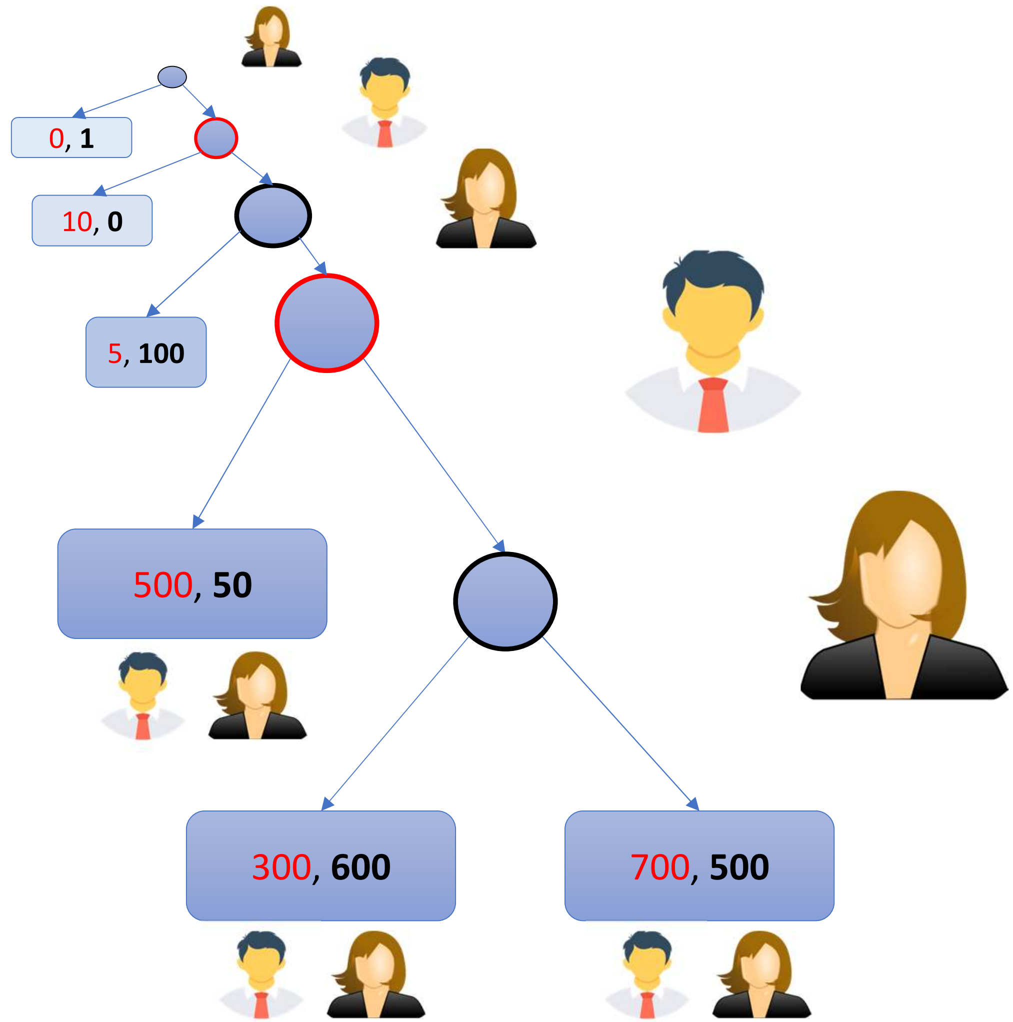
Utility modifications

- What about now?
- And now?
- And now?
  (trust game)



Utility modifications

- What about now?
- And now?
- And now?
  (trust game)
- And now?
  (centipede game)



What affects people's utility?

- Self interest v_i
- Social welfare? $+\sum_j v_j$
- Egalitarian welfare? $+\min_j v_j$
- Inequality? $-|\max_j v_j - \min_j v_j|$
- Competition? $-\max_{j \neq i} v_j$
- Reciprocity? $+v_j$ if j played in my favor
- …

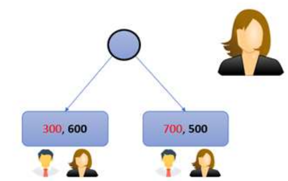
How to distinguish?

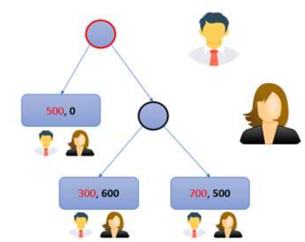
Experiments

- Behavioral psychologists design careful experiments trying to isolate effects

	Two-person dictator games	Left	Right
Berk29 (26)	B chooses (400,400) vs. (750,400)	.31	.69
Barc2 (48)	B chooses (400,400) vs. (750,375)	.52	.48
Berk17 (32)	B chooses (400,400) vs. (750,375)	.50	.50
Berk23 (36)	B chooses (800,200) vs. (0,0)	1.00	.00
Barc8 (36)	B chooses (300,600) vs. (700,500)	.67	.33
Berk15 (22)	B chooses (200,700) vs. (600,600)	.27	.73
Berk26 (32)	B chooses (0,800) vs. (400,400)	.78	.22

	Two-person response games—B's payoffs identical	Out	Enter	Left	Right
Barc7 (36)	A chooses (750,0) or lets B choose (400,400) vs. (750,400)	.47	.53	.06	.94
Barc5 (36)	A chooses (550,550) or lets B choose (400,400) vs. (750,400)	.39	.61	.33	.67
Berk28 (32)	A chooses (100,1000) or lets B choose (75,125) vs. (125,125)	.50	.50	.34	.66
Berk32 (26)	A chooses (450,900) or lets B choose (200,400) vs. (400,400)	.85	.15	.35	.65





*Charness, Gary and Matthew Rabin. "Understanding Social Preferences with Simple Tests.", QJE, 2002.

Experiments (cont.)

- Some factors provide a perfect explanation to some games…
  - But fail to explain others ☹

- On the >2000 observations in [Charness&Rabin'02], **social welfare** explains 93%-94% of the data!
  - Other models not so successful
  - Is that good?
  - Danger: overfitting ("lack of predictive power")
  - In the paper: they do some more sophisticated analysis

Explanation and prediction

- For a single decision maker:
  - Is there a parameter that explains all/most of the decisions of a person?
  - Is there a reasonable **distribution** of parameters that explains decisions of the population?
- For a game:
  - Are there individual parameters that explain the observed outcome as **equilibrium**?
  - Same for distribution of parameters in the population
- What about overfitting?
  - In modern work: **cross-validation**
  - Fit parameters on one dataset, predict on another

Utility modifications

Monetary payoffs

v_1, v_2	C	D
C	4 , 4	-10 , 10
D	10 , -10	-6 , -6

- Example: Altruism
- $u_i(a) = v_i(a) + 0.5 \cdot v_{-i}(a)$

u_1, u_2	C	D
C	4+2=6 , 4+2=6	-10+5=-5, 10-5=5
D	10-5=5, -10+5=-5	-6-3=-9 , -6-3=-9

- Result: Hadi?

Matt Rabin's "recipe"

- Pick a Greek letter (say, "Deppa" Þ)
- Modify the utility function $u'_i(a) = u(a\ , \text{Þ}_i)$
  - For some value of Þ_i (typically 0,1 or ∞) we get the original unbiased utility
- Analyze the game with the modified utilities
- Consider empirical and experimental data:
  - Are results better explained by the modified model?
  - For what values of Þ_i ?
  - What is the distribution of Þ_i in the population?

Another example: Present bias

- People buy gym subscription, and then rarely use it
- Set alarm clock for 6:00am, then go back to sleep

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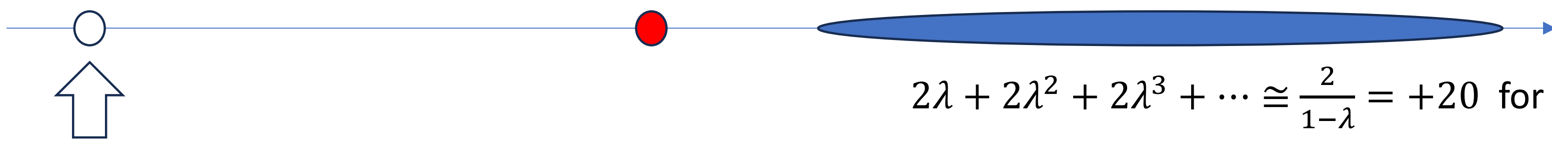

$$2\lambda + 2\lambda^2 + 2\lambda^3 + \cdots \cong \frac{2}{1-\lambda} = +20 \text{ for } \lambda = 0.9$$

⇨ The long term-benefit of being fit is higher than the inconvenience of training

- Even with moderate exponential discounting

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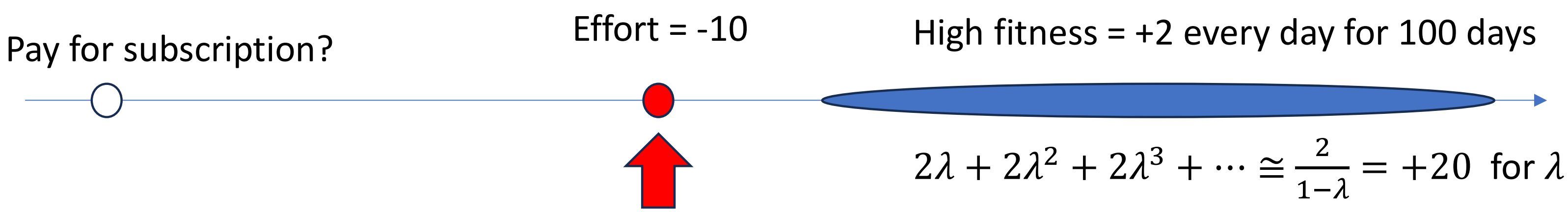

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The long term-benefit of being fit is higher than the inconvenience of training

- Even with moderate exponential discounting

But going to the gym is **now**, and benefit is **later**

Another example: Present bias

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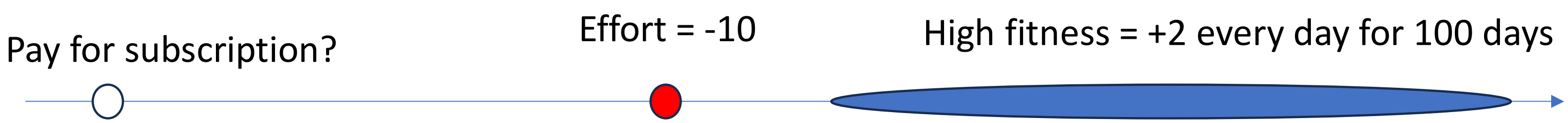


$$u_i(a,t) = v_i(a^t) + \beta_i \cdot \sum_{k=1\ldots} \lambda^k \cdot v_i(a^{t+k})$$

$u_i(buy, t^0) = \beta_i(-10 + 20) > 0$ (both effort and gain are in the future)

$u_i(go, t^1) = -10 + \beta_i(20) < 0$ (effort is now)

O'Donoghue, Ted, and Matthew Rabin. "Doing it now or later." American economic review 89.1 (1999): 103-124.

Problems with modified utility

- Contradictory observations
- Still assumes “rational” or “optimal” decision making
- Parameters depend on context

Some common alternative models

- Cognitive hierarchy
- Prospect theory
- Learning from experience
- Choice heuristics
- Quantal Response

These are just examples!

(grossly oversimplified)

Cognitive Hierarchy

The "Beauty contest" game:

Pick the number in [1…100] closest to 70% of the average

- Each player assumes others are *simple*
  - "everyone picks [1…100] **uniformly at random**" — A "level 0" strategy
  - Then best strategy is $0.7 \cdot 50 = 35$ — A "level 1" strategy = best response to level 0
  - Assume that everyone plays 35? — A "level 2" strategy
- Full rationality = everyone is level ∞
  - Assume everyone else is too
- Mixture model: assume a distribution over lower levels
  - E.g.: 60% level 0 and 40% level 1 (best response is $0.7 \cdot (0.4 \cdot 35 + 0.6 \cdot 50) \cong 31$)

Camerer, Colin F., Teck-Hua Ho and Juin-Kuan Chong. "A Cognitive Hierarchy Model of Games". The Quarterly Journal of Economics, August 2004
Wright, James, and Kevin Leyton-Brown. "Beyond equilibrium: Predicting human behavior in normal-form games." AAAI 2010.

Cognitive Hierarchy Equilibrium?

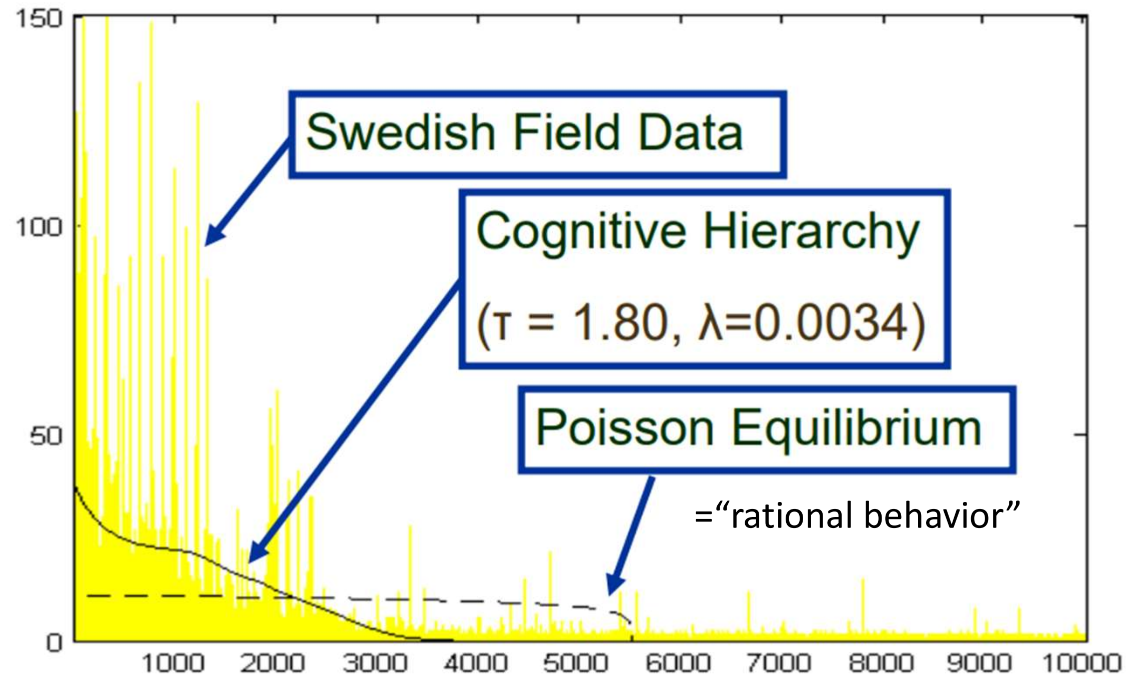
The "Beauty contest" game:

Pick the number in [1…100] closest to 70% of the average

- Can often explain empirical observations
  - E.g. strategy profile in the Beauty contest game can be explained by players' beliefs
- Not in equilibrium!
- If we play again, "sophistication" increases
  - In Beauty contest, average goes down towards 0

CH and the Swedish Lottery

Lowest Unique Positive Integer game:
- Pick the number in [1…10000]
- Lowest unique number wins



Östling, Robert, et al. "Testing game theory in the field: Swedish LUPI lottery games." American Economic Journal: Microeconomics 3.3 (2011): 1-33.

Prospect Theory

PROBLEM 11: In addition to whatever you own, you have been given 1,000. You are now asked to choose between

R: (1,000, .50), and S: (500).

$N = 70$

Risk aversion

COMSOC School

Prospect Theory

PROBLEM 11: In addition to whatever you own, you have been given 1,000. You are now asked to choose between

R: (1,000, .50), and S: (500).

$N = 70$ [16] [84]*

(80%)

PROBLEM 12: In addition to whatever you own, you have been given 2,000. You are now asked to choose between

R': (−1,000, .50), and S': (−500).

$N = 68$

(66%)

Utility is 1000 or 2000 with equal probability

Utility is 1500

Risk aversion

Inconsistent!

Risk seeking

Kahneman, Daniel, and Amos Tversky. "Prospect theory: An analysis of decision under risk." Handbook of the fundamentals of financial decision making: Part I. 2013. 99-127.

COMSOC School

It gets worse

S1: Win $240 for sure

R1: Win $1000 w.p. 0.25 (0 otherwise)

84% participants choose S1 **(88%)**

S2: Lose $750 for sure

R2: Lose $1000 with probability 0.75 (0 otherwise)

87% participants choose R2 **(35%)**

S1 + R2

(25% for 240, 75% for -760)

^

(25% for 250, 75% for -750)

R1 + S2

Tversky, Amos, and Daniel Kahneman. "Rational choice and the framing of decisions.", 1989.

It gets worse

S1:

R1:

S2:

R2:

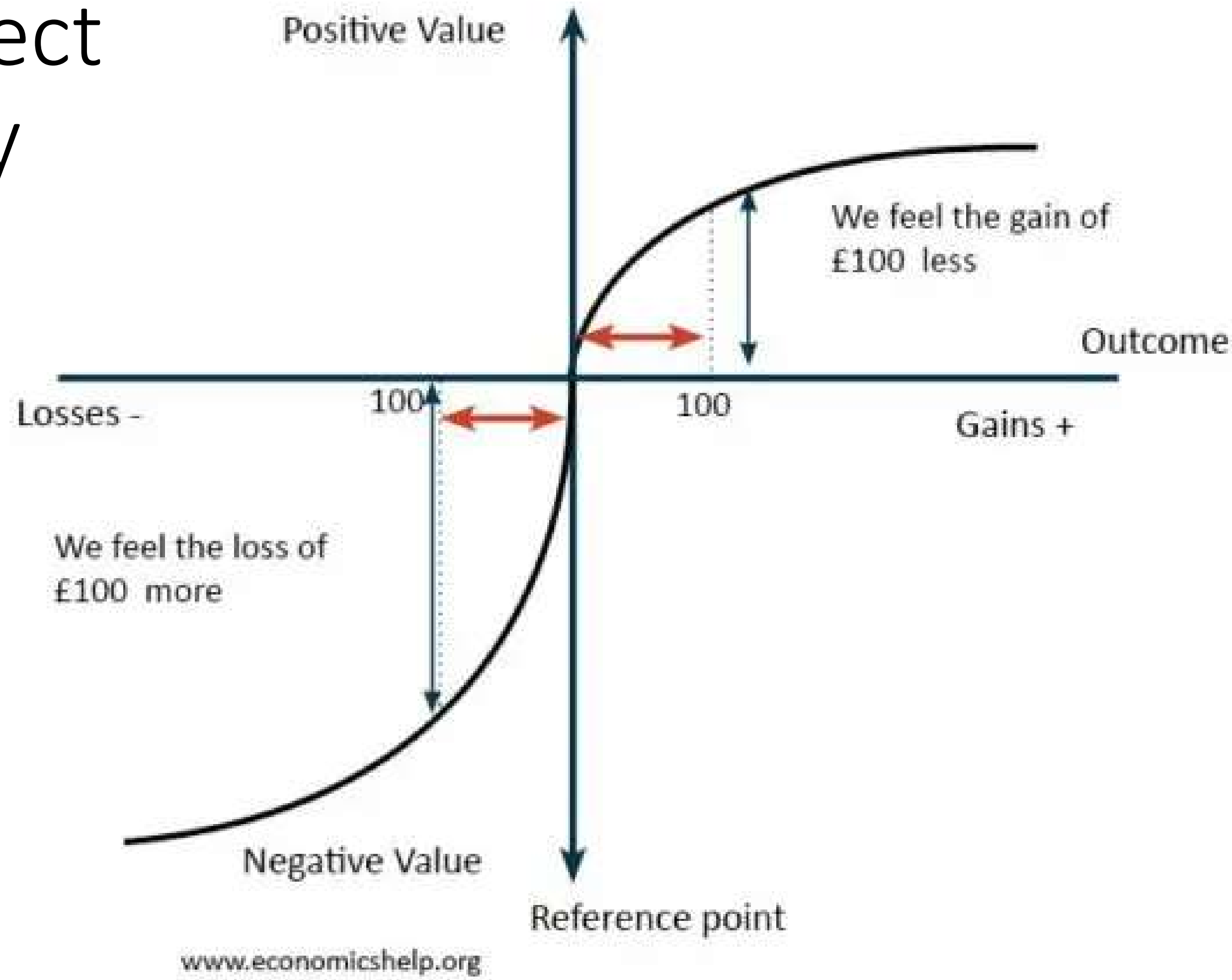
A+D = (25% for 240, 75% for -760)

^ ^

B+C = (25% for 250, 75% for -750)

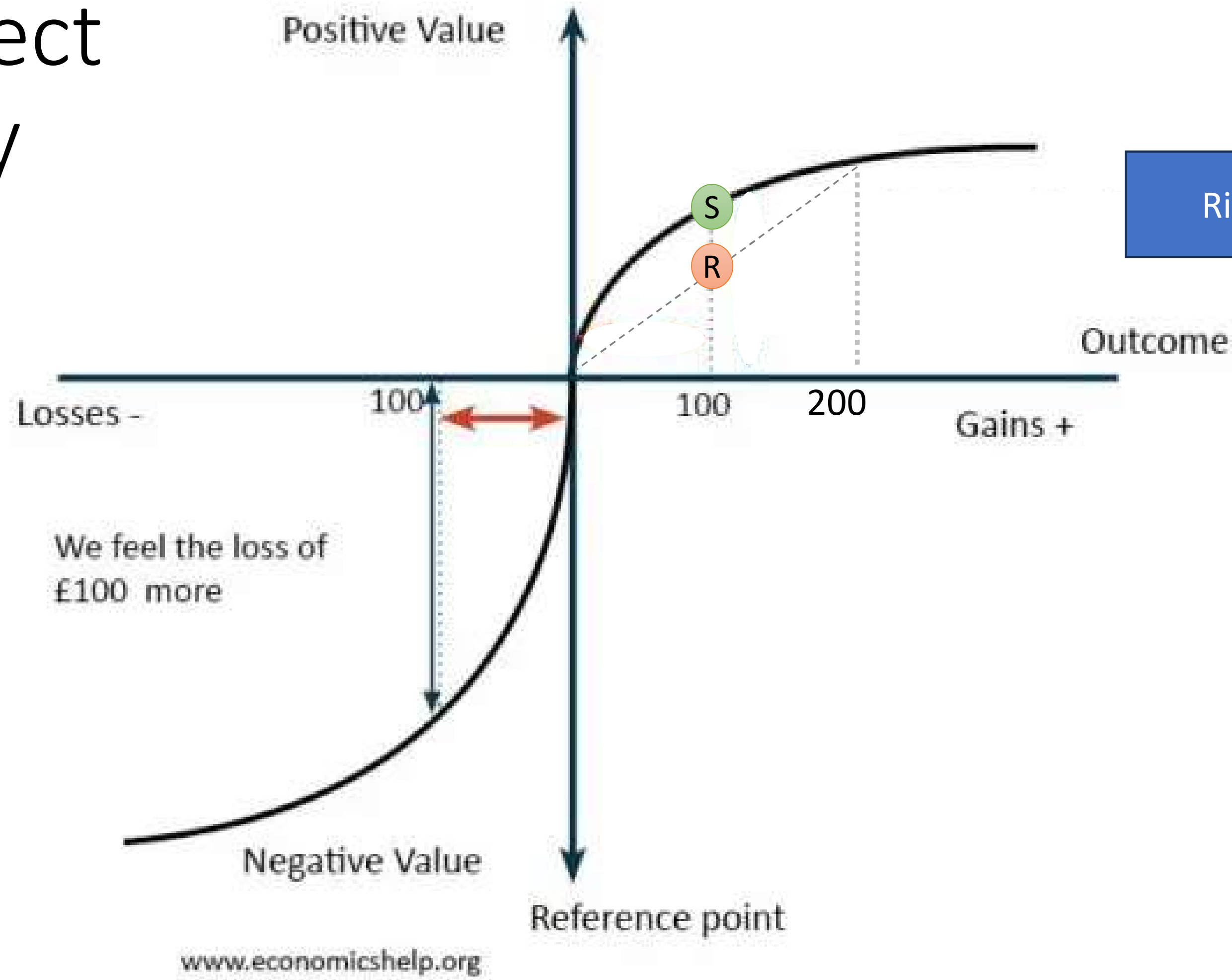
Tversky, Amos, and Daniel Kahneman. "Rational choice and the framing of decisions.", 1989.

Prospect theory



Kahneman, Daniel, and Amos Tversky. "Prospect Theory: An Analysis of Decision under Risk." Econometrica 47.2 (1979): 263-292.

Prospect theory



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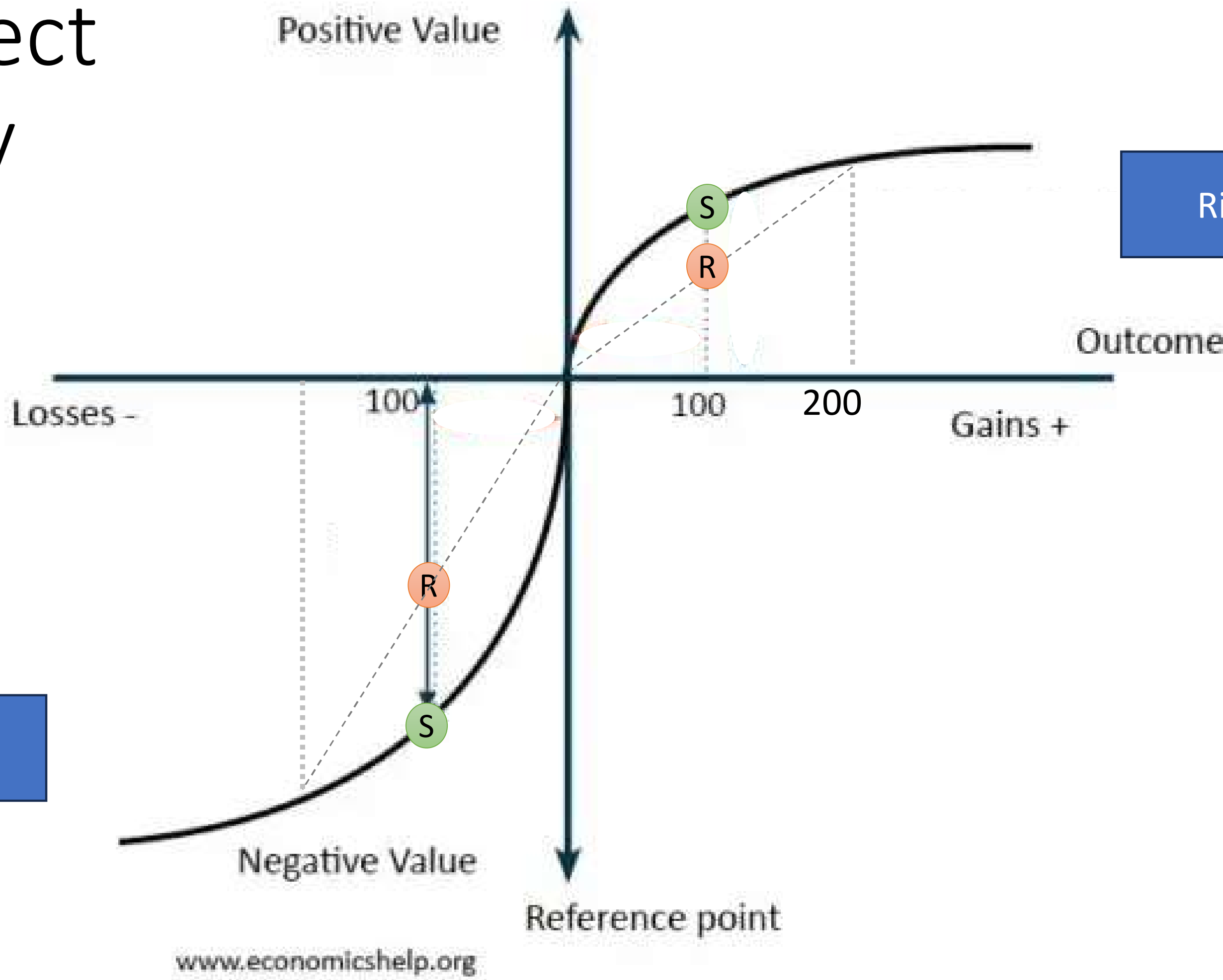


Risk aversion!

Risk seeking!

Kahneman, Daniel, and Amos Tversky. "Prospect Theory: An Analysis of Decision under Risk." Econometrica 47.2 (1979): 263-292.

Overweighting rare events

S1: Win 1 for sure

R1: **Win 20** with probability .05 (0 otherwise)

Most participants choose R1

“Lottery ticket”

S2: Lose 1 for sure

R2: **Lose 20** with probability .05 (0 otherwise)

Most participants choose S2

“Insurance”

- Contradicts Prospect Theory
  - Also not robust

Erev, Ido, et al. "From anomalies to forecasts: Toward a descriptive model of decisions under risk, under ambiguity, and from experience." *Psychological review* 124.4 (2017): 369.

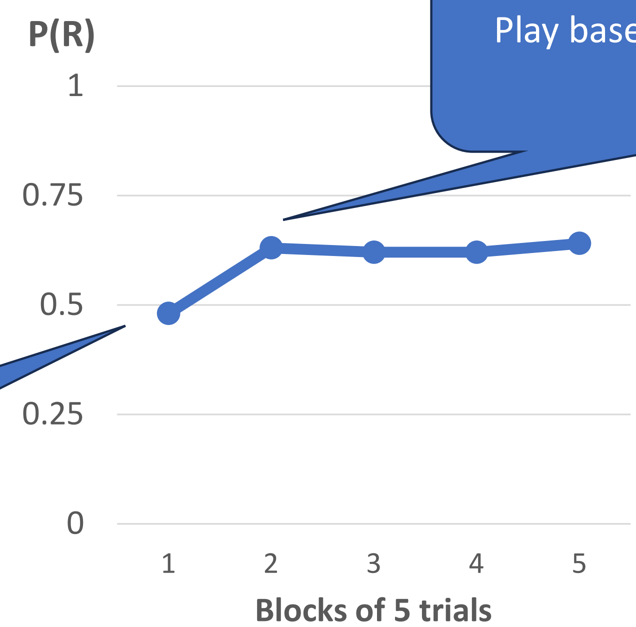
Feedback reverses weighting of rare events

Choose between

S2: Lose 1 for sure

R2: Lose 20 with probability .05

Play based on **experience**

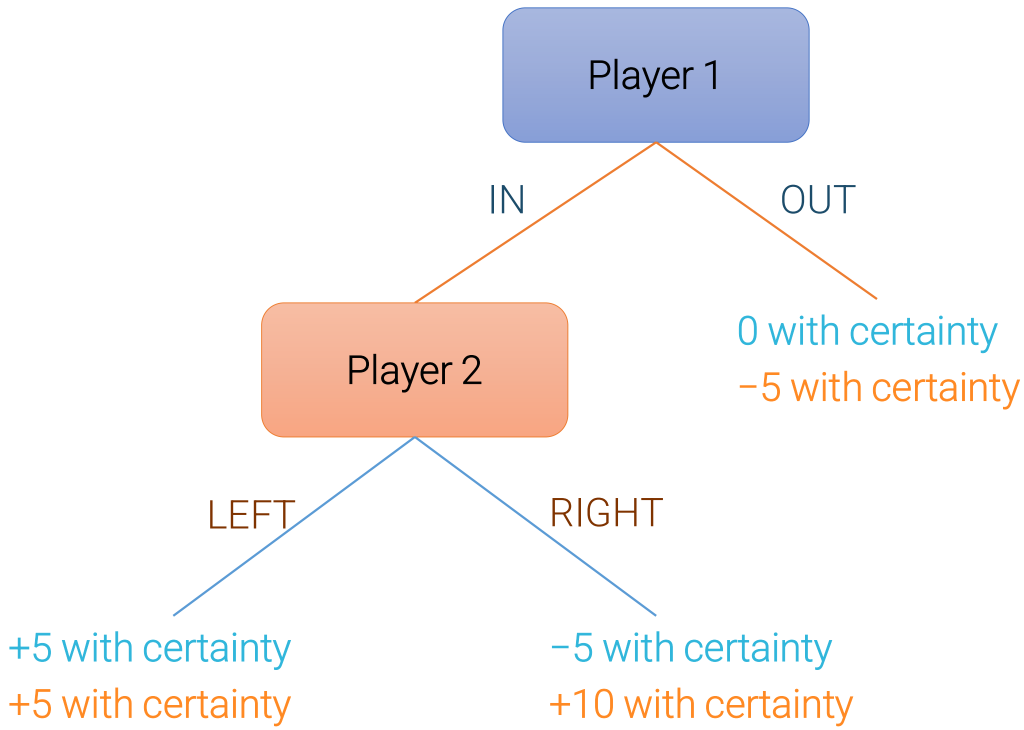


Play based on **description**
Various biases affect decision

Erev et al., 2017

Slides: curtesy of Ori plonsky

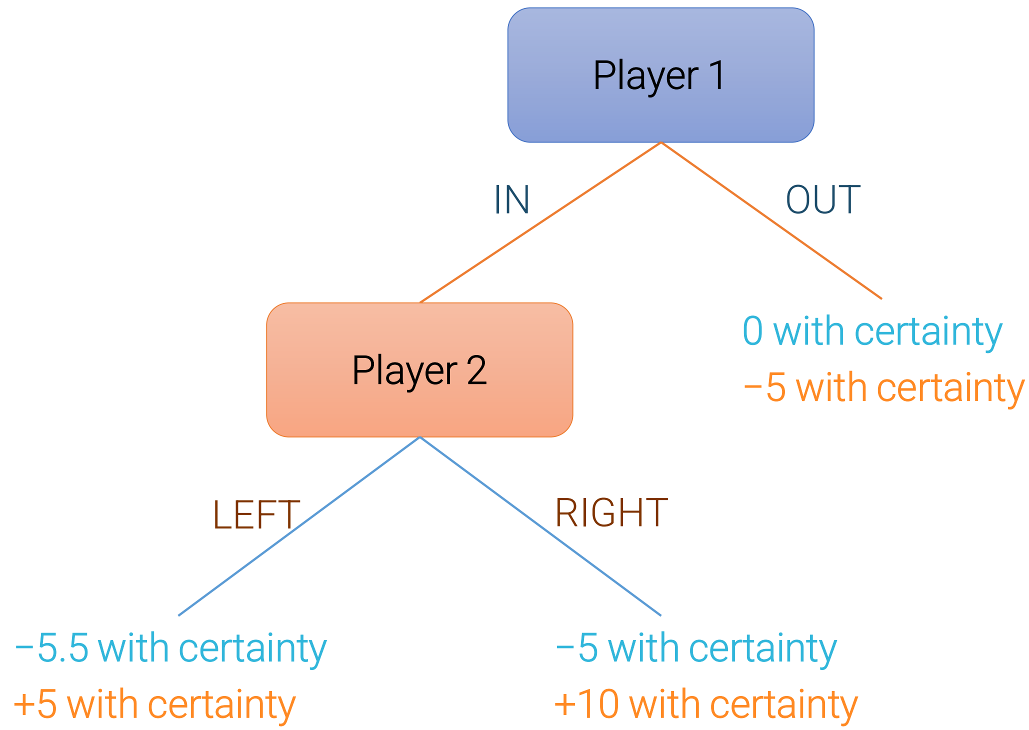
What about a strategic interaction?



“Trust game”

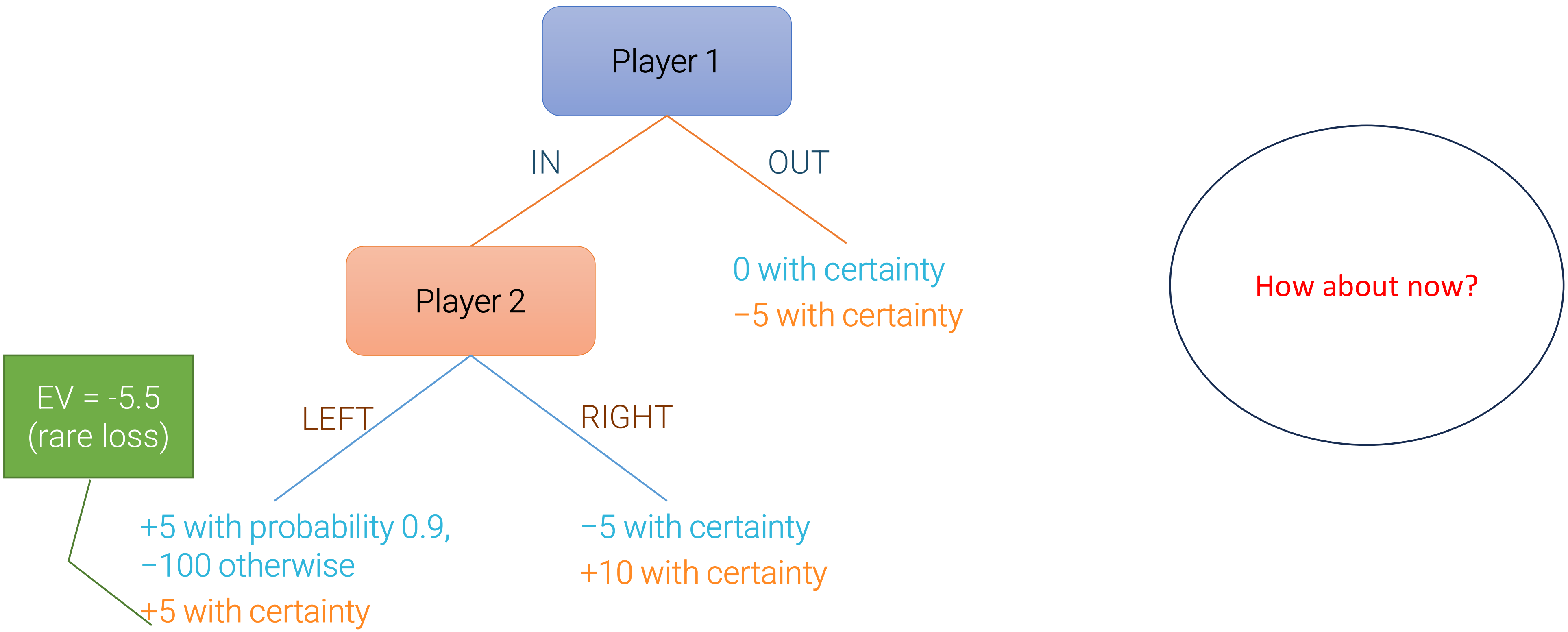
Slides: curtesy of Ori plonsky

What about a strategic interaction?



Not a trust game.
Player 1 has **no reason** to play IN

Slides: curtesy of Ori plonsky



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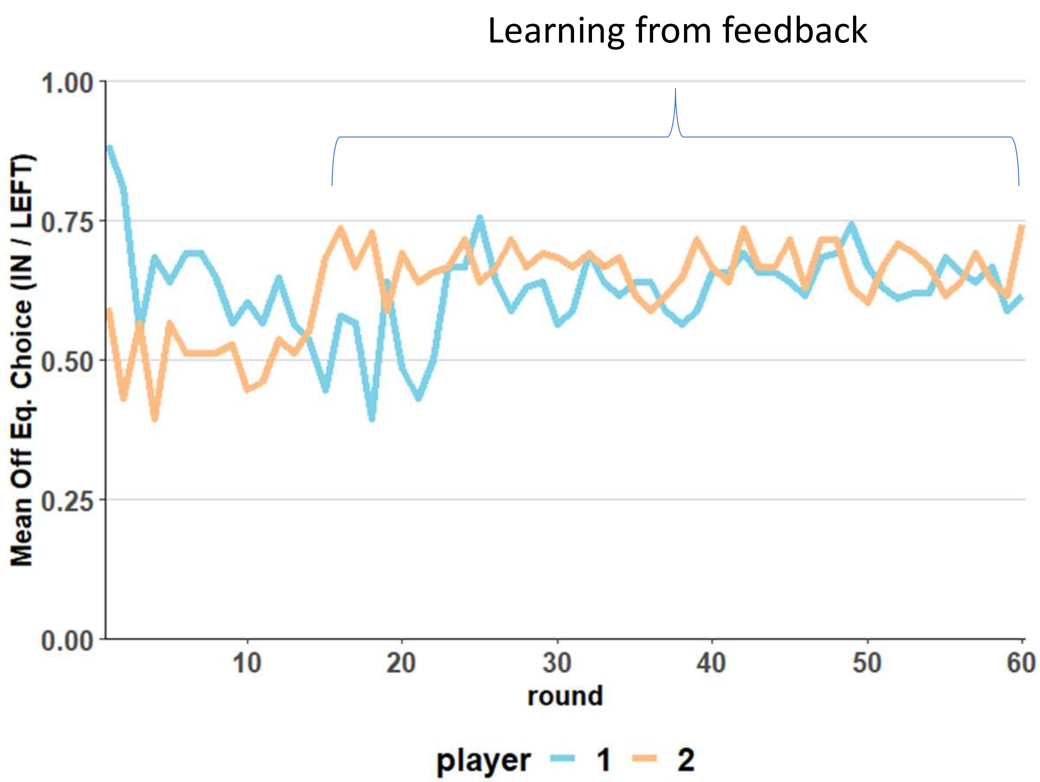
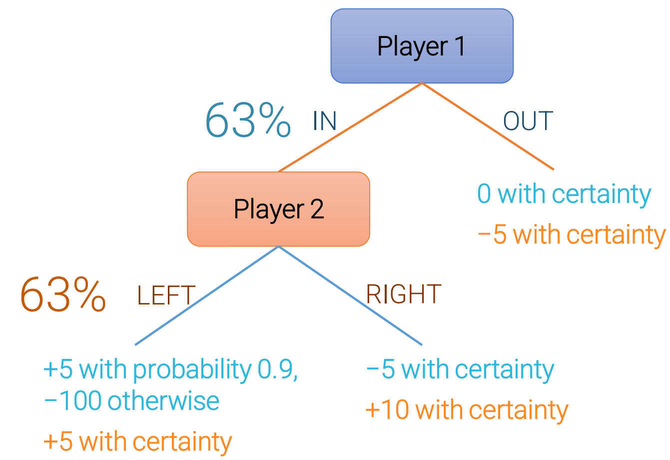
Results

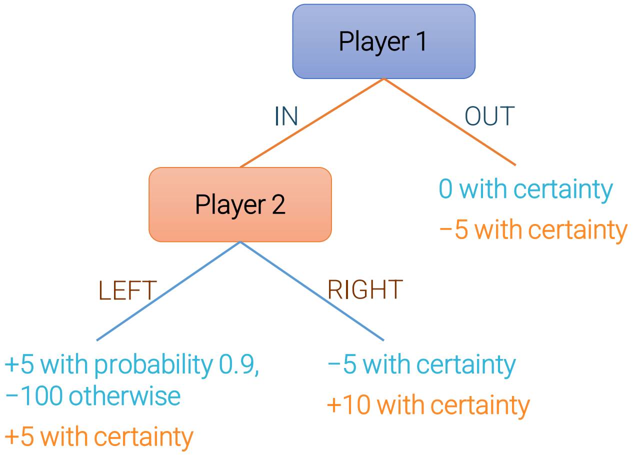




Slides: curtesy of Ori plonsky

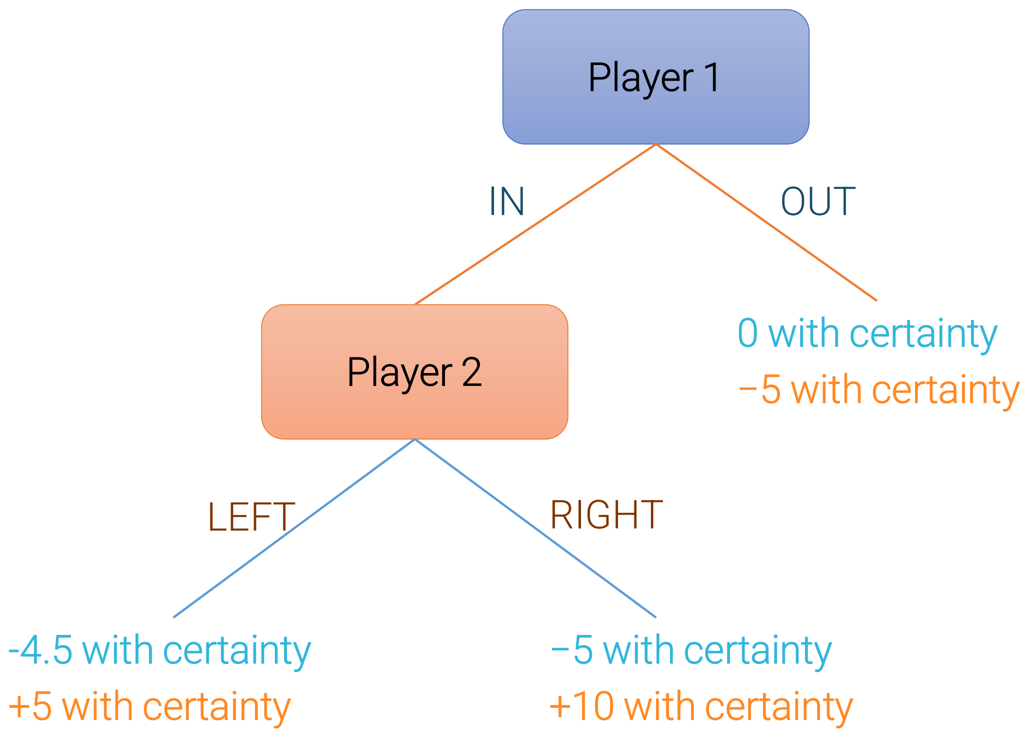
Reaction to rare loss

Observed payoff of IN			% IN choice at round *t* (n)
at *t*-3	at *t*-2	at *t*-1	
5	5	-100	91.8% (49)
5	-100	5	93.2% (44)
-100	5	5	97.6% (41)
5	5	5	96.6% (551)

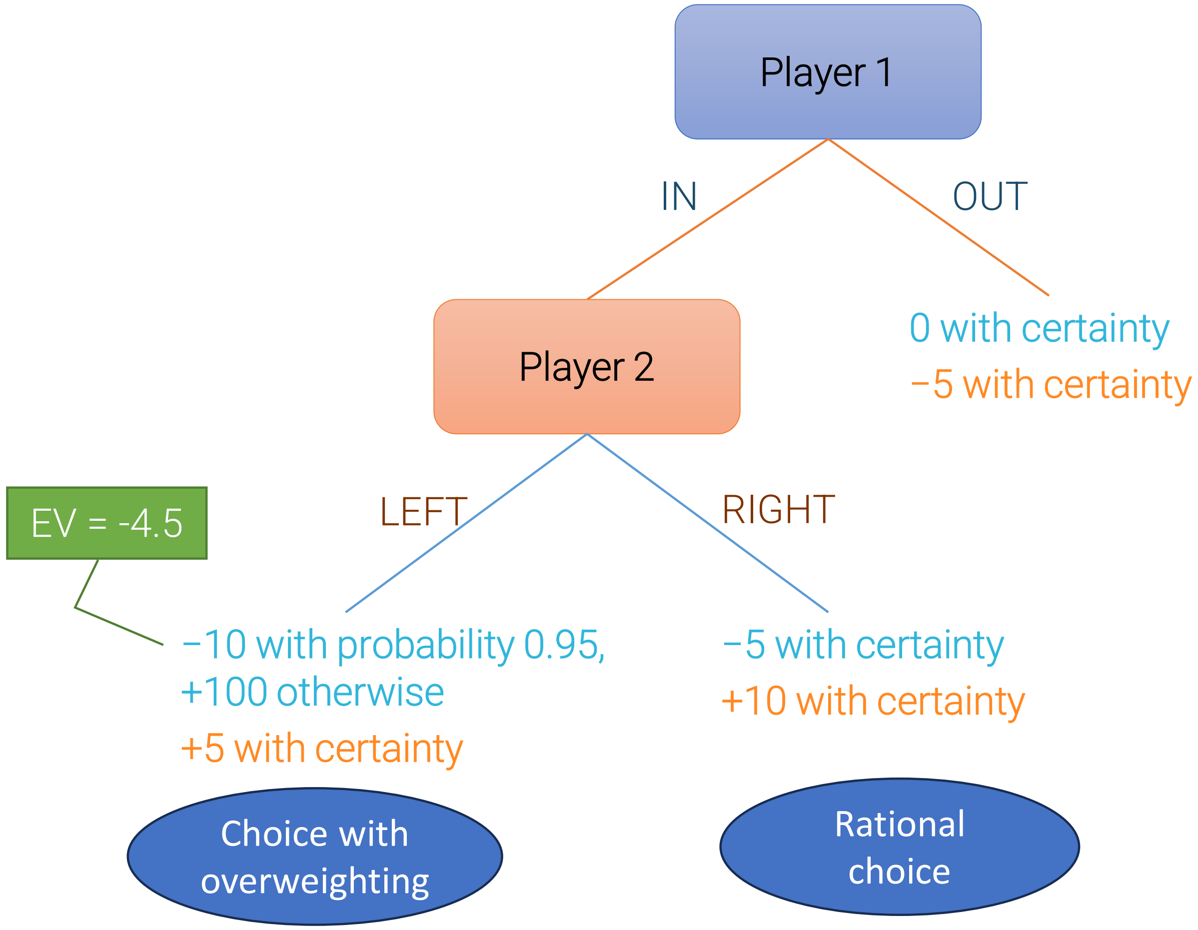


Slides: curtesy of Ori plonsky

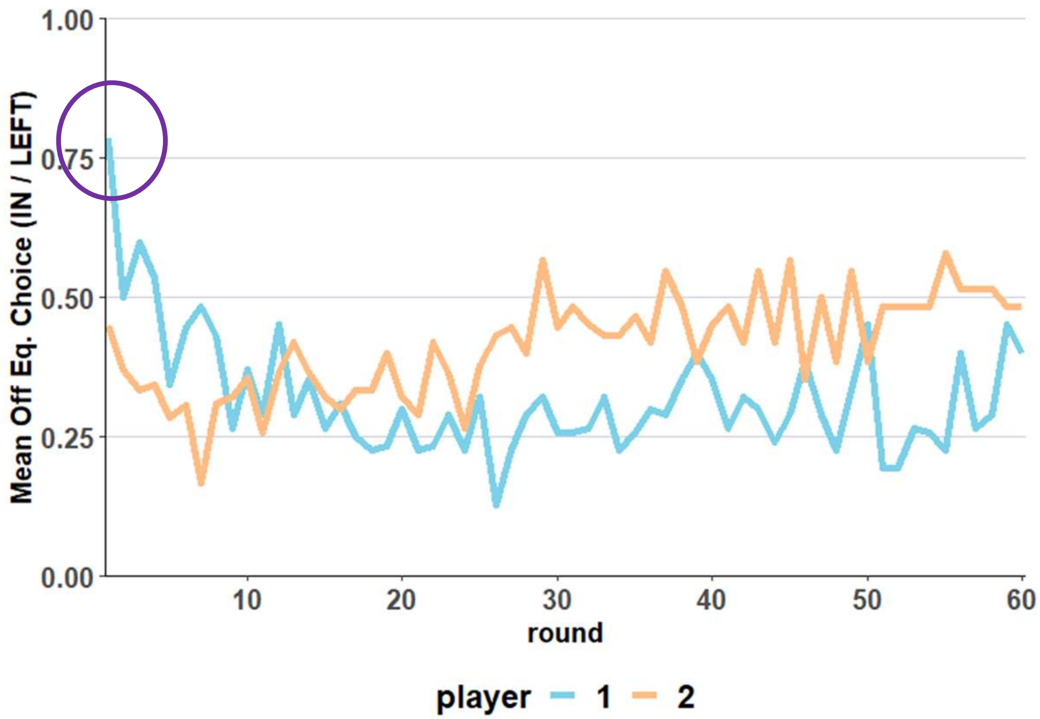
What about a strategic interaction?

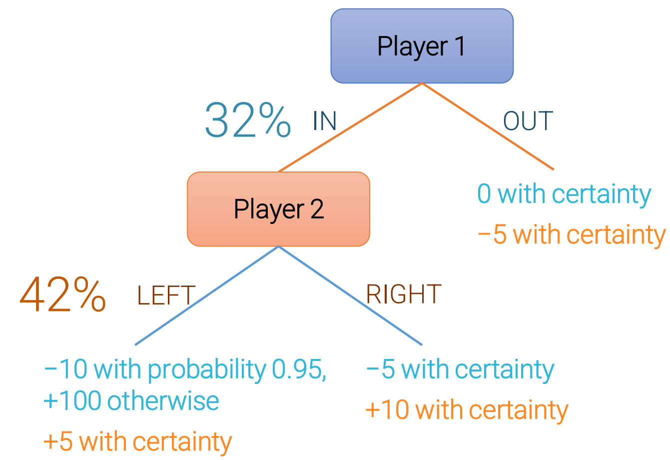


What about a strategic interaction?



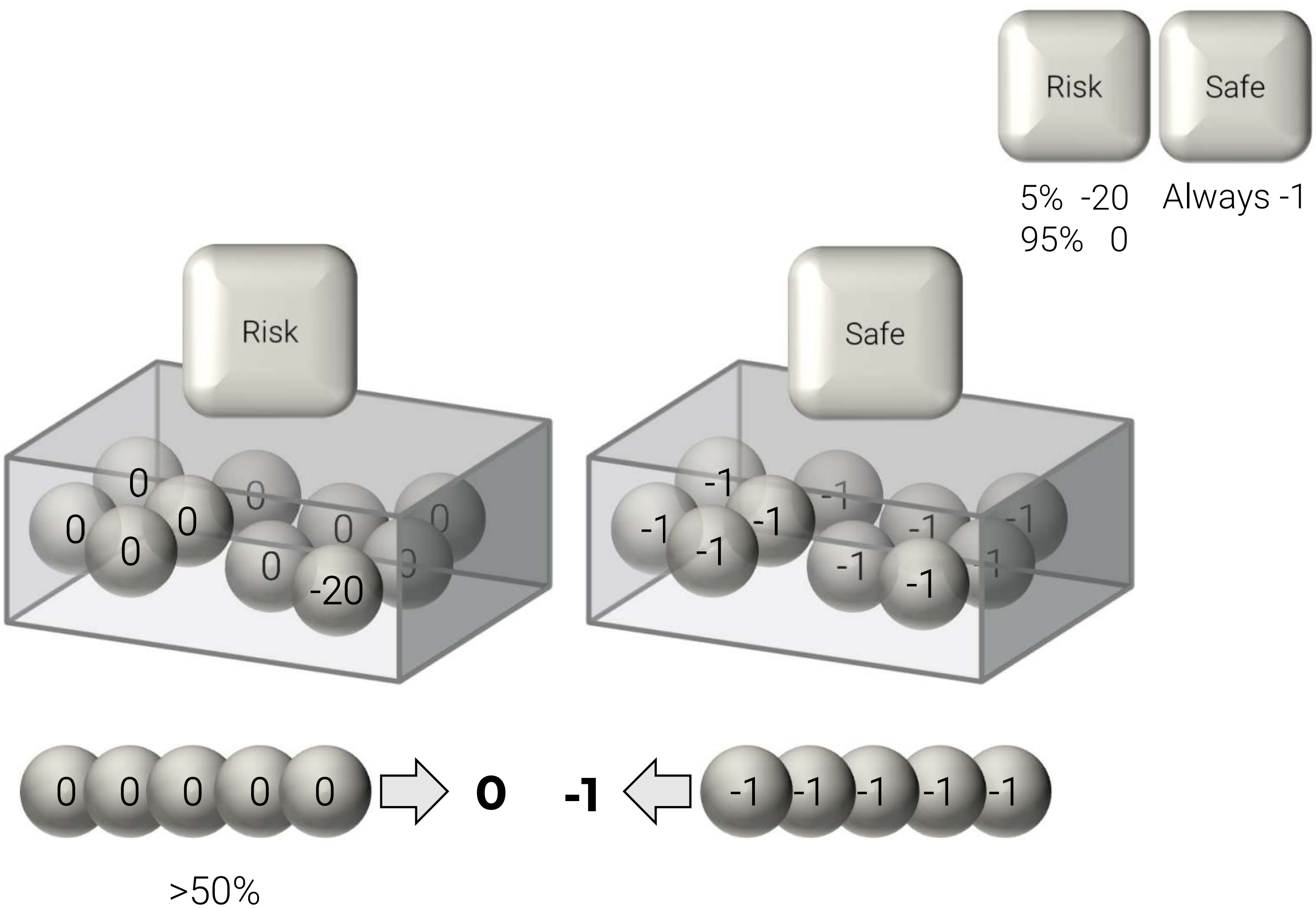
Results


1.00
0.75
0.50
0.25
0.00
Mean Off Eq. Choice (IN / LEFT)
10
20
30
40
50
60
round
player 1 2


Player 1
32% IN
OUT
0 with certainty
−5 with certainty
Player 2
42% LEFT
RIGHT
−10 with probability 0.95,
+100 otherwise
+5 with certainty
−5 with certainty
+10 with certainty

Reliance on small samples

Sample size 5



Which city has larger population?

Play Kahoot!
(will work until August 15)

World-knowledge on importance of these features

	Hamburg	Cologne
National capital	-	-
Soccer team in major league	+	+
Intercity train	+	+
State capital	+	-
University	+	+
License plate	-	+
…		

“rational” decision making: integrate relative importance, account for interdependencies, priors, etc…

	Bonn	Wiesbaden
National capital	-	-
Soccer team in major league		-
Intercity train	+	+
State capital	-	+
University	+	
License plate	-	-
…		

	Munich	Berlin
National capital	-	+
Soccer team in major league	+	-
Intercity train	+	+
State capital	+	+
University	+	+
License plate	+	+
...		

Which city has larger population?

World-knowledge on importance of these features

	Hamburg	Cologne
National capital	-	-
Soccer team in major league	+	+
Intercity train	+	+
State capital	+	-
University	+	+
License plate	-	+
…		

"satisficing"

Take-the-Best heuristic: Sort by relative frequency
Pick **first** feature where cities differ

Gigerenzer, Gerd, and Daniel G. Goldstein. "Reasoning the fast and frugal way: models of bounded rationality." Psychological review 103.4 (1996): 650.

Are heuristics really suboptimal?

- Common view of behavioral economics:
  - Bounded rationality is a descriptive theory
  - Maintains the normative/prescriptive view of “rational reasoning”

- Gigerenzer makes a stronger claim:
  - applying heuristics often leads to **better** judgement
  - What experiment can show that?
    - Simulations! No need for real people
  - Explanation: Much of the data we get from the environment is **redundant**

- Evolutionary justification

What about decisions?

What about decisions?

FIGURE B

DIFFERENT DECOY PLACEMENT STRATEGIES[a]

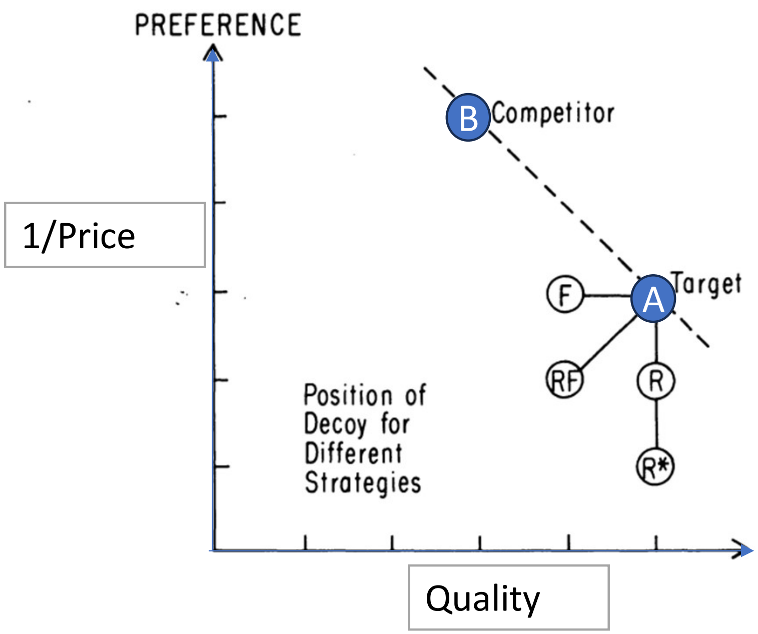


TABLE 1

EXAMPLES OF CHOICE SETS FOR DIFFERENT STRATEGIES

	Price/ sixpack	Quality rating
Range increasing (R)		
Target	$1.80	50
Competitor	$2.60	70
Added decoy	$1.80	40
Extreme range increasing (R*)		
Target	$1.80	50
Competitor	$2.60	70
Added decoy	$1.80	30
Frequency increasing (F)		
Target	$1.80	50
Competitor	$2.60	70
Added decoy	$2.20	50
Range-frequency (RF)		
Target	$1.80	50
Competitor	$2.60	70
Added decoy	$2.20	40

A becomes more popular by introducing a decoy

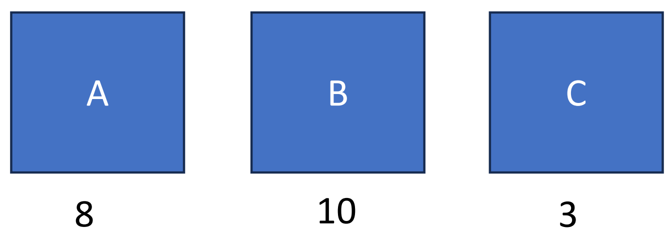
Violates IIA!

Huber, J., Payne, J. W., & Puto, C. (1982). Adding asymmetrically dominated alternatives: Violations of regularity and the similarity hypothesis. Journal of consumer research, 9(1), 90-98.

Luce, R. Duncan, and Howard Raiffa. Games and decisions: Introduction and critical survey. Courier Corporation, 1989.

Quantal Response

- People make mistakes



Full rationality: Always choose B

McKelvey, Richard; Palfrey, Thomas (1995). "Quantal Response Equilibria for Normal Form Games". Games and Economic Behavior. 10: 6–38.

Quantal Response

- People make mistakes
- The chance for a "large" mistake is smaller
  - Parameter $\lambda > 0$

A	B	C
8	10	3

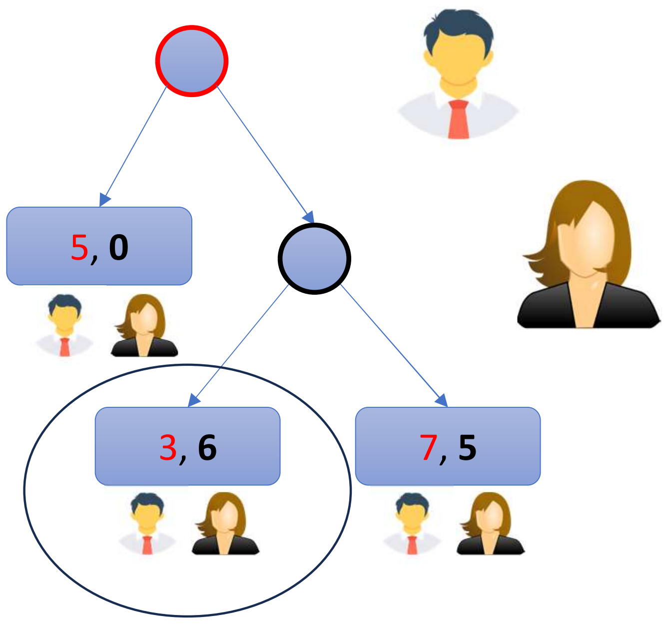
Try it!

Full rationality: Always choose B

Quantal response: Choose w.p. $\propto$ $e^{\lambda \cdot 8}$ $e^{\lambda \cdot 10}$ $e^{\lambda \cdot 3}$

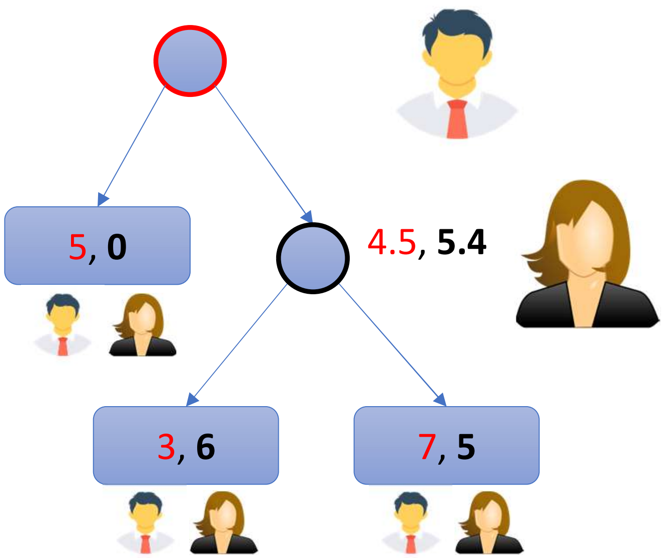
McKelvey, Richard; Palfrey, Thomas (1995). "Quantal Response Equilibria for Normal Form Games". Games and Economic Behavior. 10: 6–38.

Quantal Response Equilibrium (QRE)



Quantal Response Equilibrium (QRE)

Suppose $\lambda_1 = \lambda_2 = 0.5$



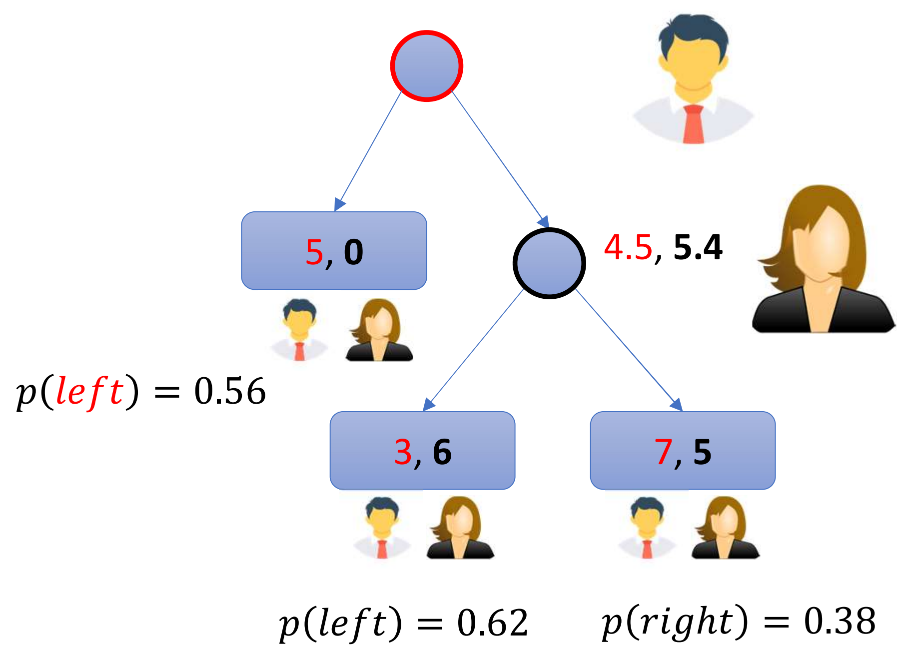
$p(left) = 0.62$ $p(right) = 0.38$

Quantal Response Equilibrium (QRE)

Suppose $\lambda_1 = \lambda_2 = 0.5$

Everyone assumes other playing the same QRE

Parameters (or their distribution) must be commonly known



Recap

- Take-the-Best (and other decision heuristics) explain how people make **similar** decisions among options that are **difficult** to compare

- Quantal response explains how people make **different** decisions among options that are **easy** to compare

In general, behavioral economics theories try to reconcile existing (decision/game) theory with empirical findings

Experiments continue to show new deviations from theory

So what is a good behavioral theory?

- Is ecologically reasonable: May result from many different processes
  - Limitations, heuristics, lack of information…

- Can explain **many** behavioral phenomena
  - Individual choice, games
  - Including (seemingly) contradicting phenomena

- Can **predict** behavior

Choice prediction competition by plonsky and Erev
https://arxiv.org/abs/1904.06866