LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

MAY 5, 2025

REAL LIFE GAMES:
HOW GAME THEORY SHAPES HUMAN DECISIONS

GAME THEORY 101

Adrian Haret
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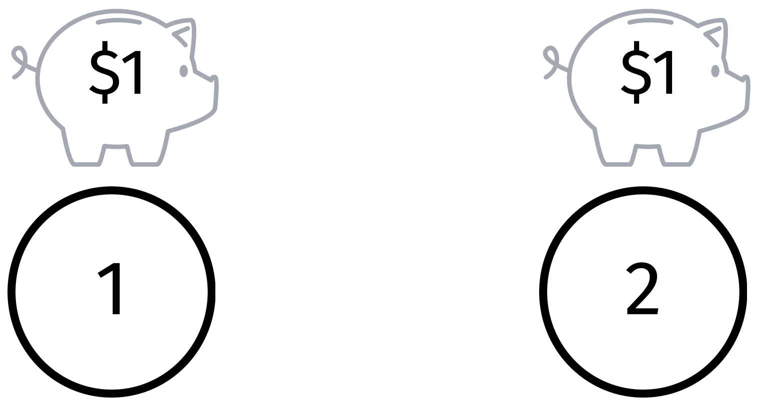
Let’s play a game!

The Trust Game

Two players, with initial endowment of 1 each.

payoffs



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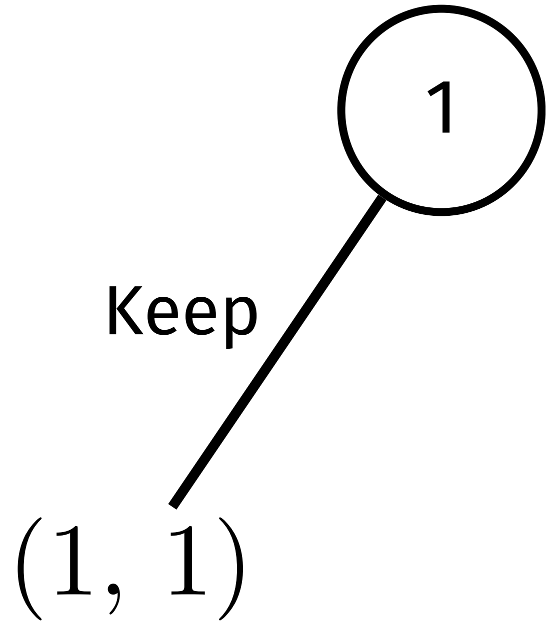

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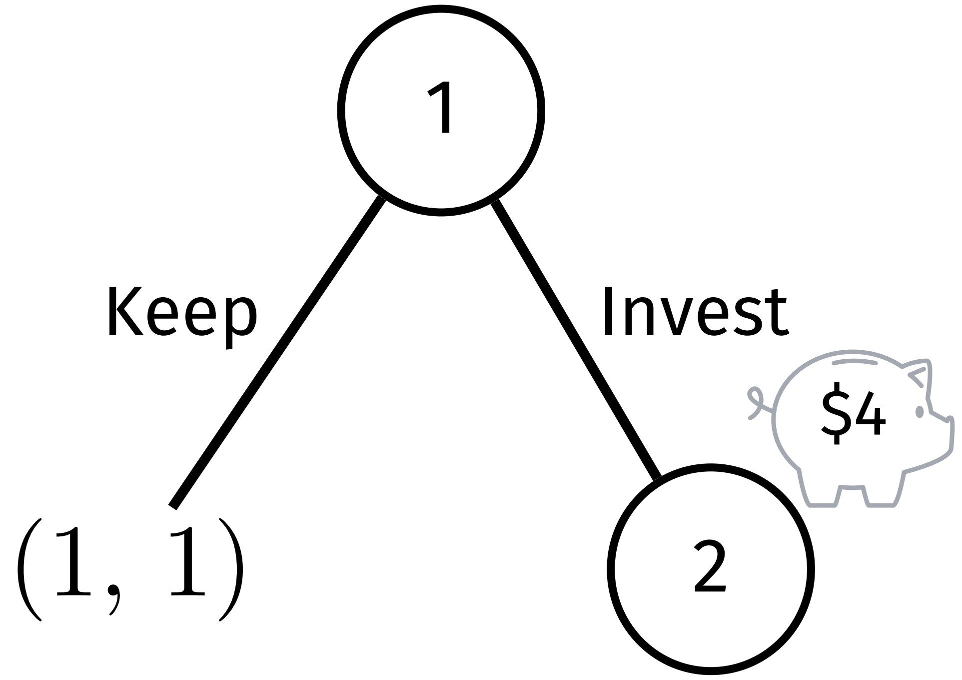

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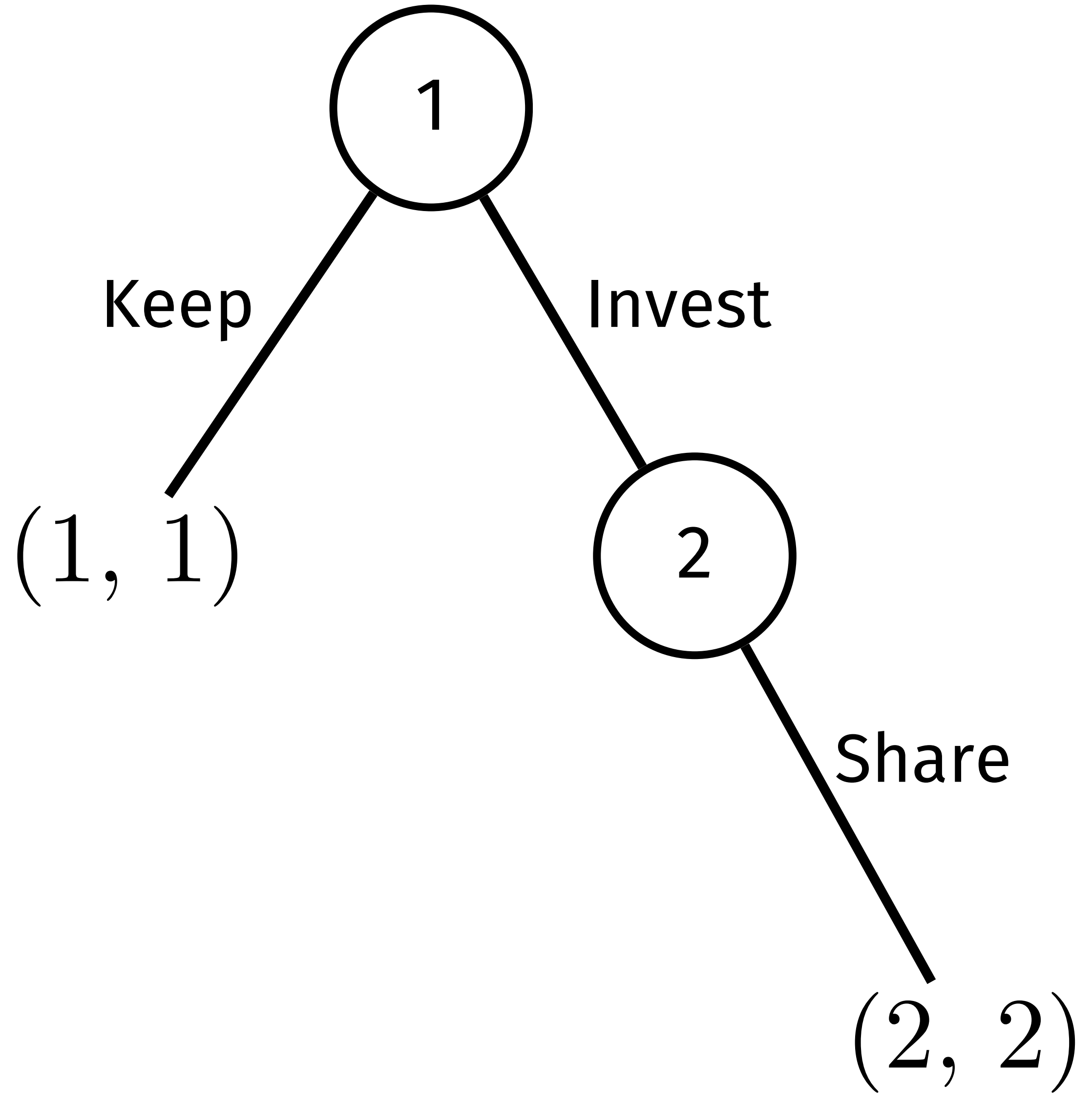

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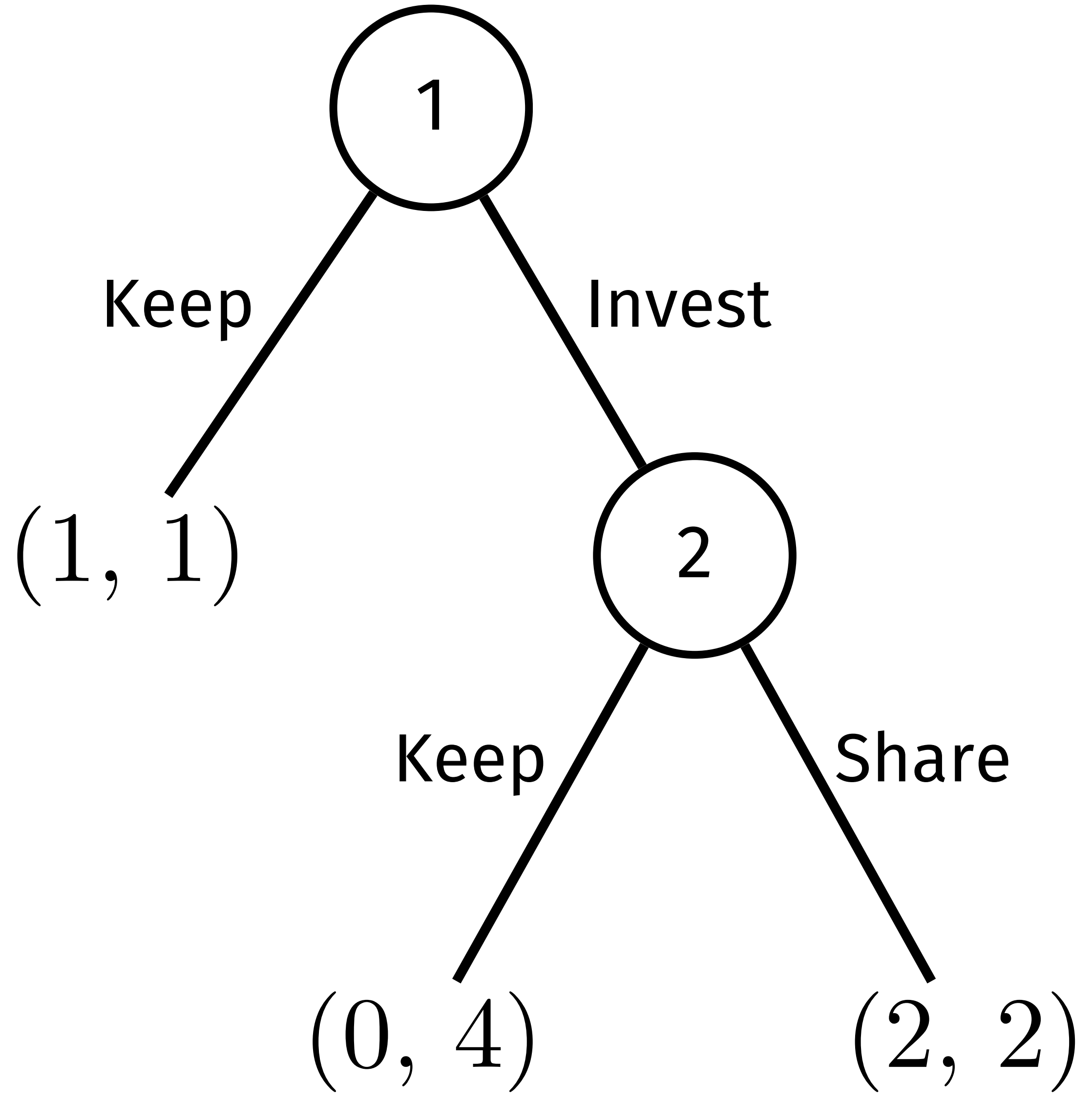
Player 2 can either divide the sum equally, or keep everything.



Did you trust your co-player?

Did you trust your co-player? Do people trust each other across the world?

THE TRUST GAME IN EXPERIMENTS

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Player 1 could send any amount between $0 and $10. Player 2 could return anything between $0 and $20.

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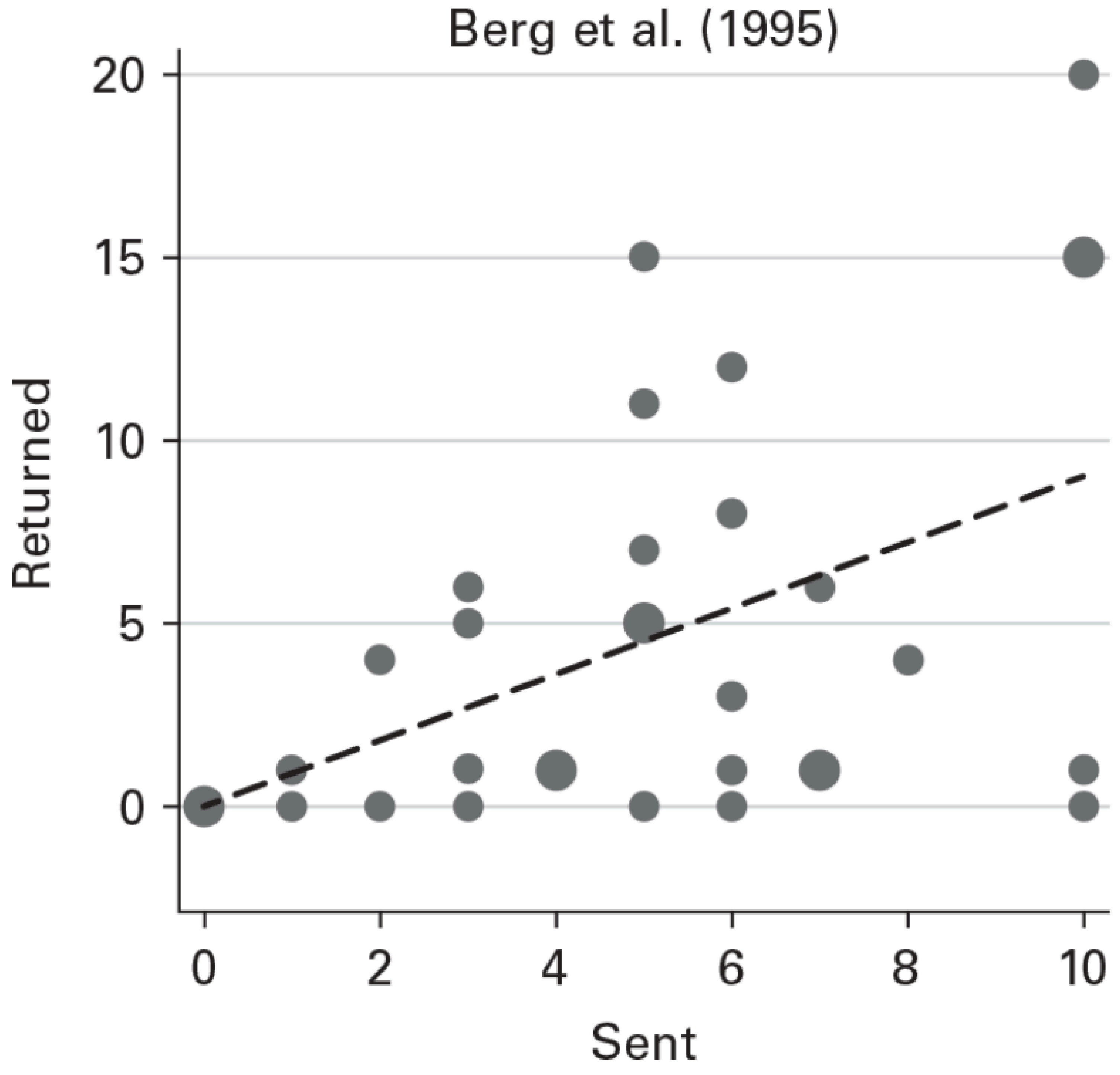

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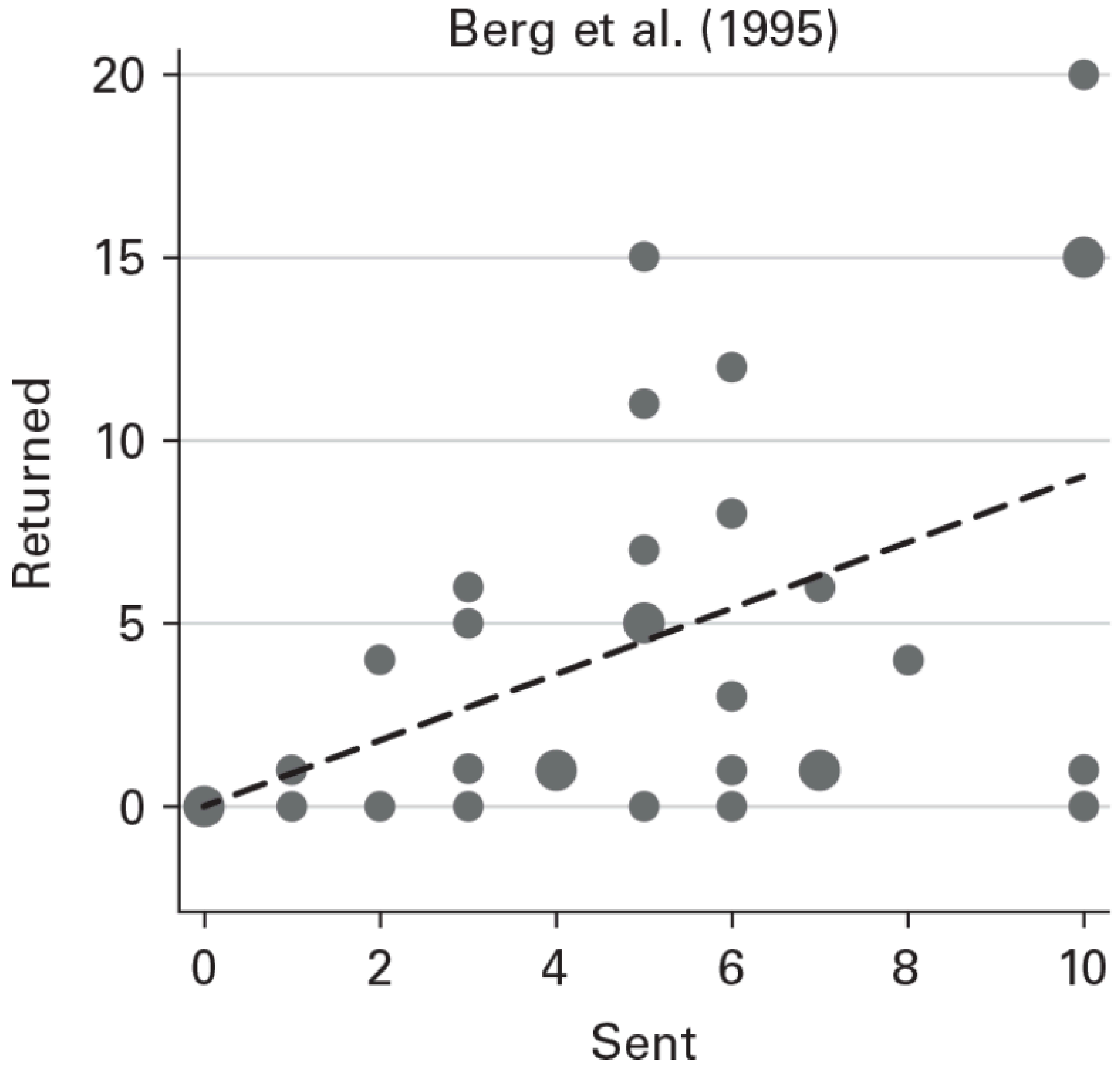
Average amount sent by Player 1 was \$5,16.

Average amount returned by Player 2 was \$4,66.



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RESULTS FROM A META-STUDY

These results have been replicated across many other instances and cultures.

Variable name	Obs.	Sum N	Mean
Panel A: Sent fraction (trust)			
All regions	161	23,900	0.502
North America	46	4579	0.517
Europe	64	9030	0.537
Asia	23	3043	0.482
South America	13	4733	0.458
Africa	15	2515	0.456
Panel B: Proportion returned (trustworthiness)			
All regions	137	21,529	0.372
North America	41	4324	0.340
Europe	53	7596	0.382
Asia	15	2361	0.460
South America	13	4733	0.369
Africa	15	2515	0.319

Johnson, N. D., & Mislin, A. A. (2011). Trust games: A meta-analysis. *Journal Of Economic Psychology*, 32(5), 865–889.

The Trust Game is a workhorse for the study of prosocial traits, e.g., trust in others.

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CAN PEOPLE BE TRUSTED?

Countries ranked by proportion agreeing that ‘most people can be trusted’.

Country/area	Share agreeing "Most people can be trusted" percent • 2022
Denmark	73.9%
Norway	72.1%
Finland	68.4%
China	63.5%
Sweden	62.8%
Iceland	62.3%
Switzerland	58.5%
Netherlands	57.0%
New Zealand	56.6%
Austria	49.8%
Australia	48.5%
Canada	46.7%
United Kingdom	43.3%
Germany	41.6%
Macao	41.4%

Interpersonal trust vs. GDP per capita. (n.d.). Our World in Data. Retrieved May 4, 2025.

CAN PEOPLE BE TRUSTED?

Countries ranked by proportion agreeing that ‘most people can be trusted’.

Country/area	Share agreeing "Most people can be trusted" percent • 2022
Zimbabwe	2.1%
Albania	2.8%
Trinidad and Tobago	3.2%
Peru	4.2%
Nicaragua	4.3%
Colombia	4.5%
Indonesia	4.6%
Ghana	5.0%
Philippines	5.3%
Ecuador	5.8%
Brazil	6.5%
Cyprus	6.6%
Egypt	7.3%
Greece	8.4%

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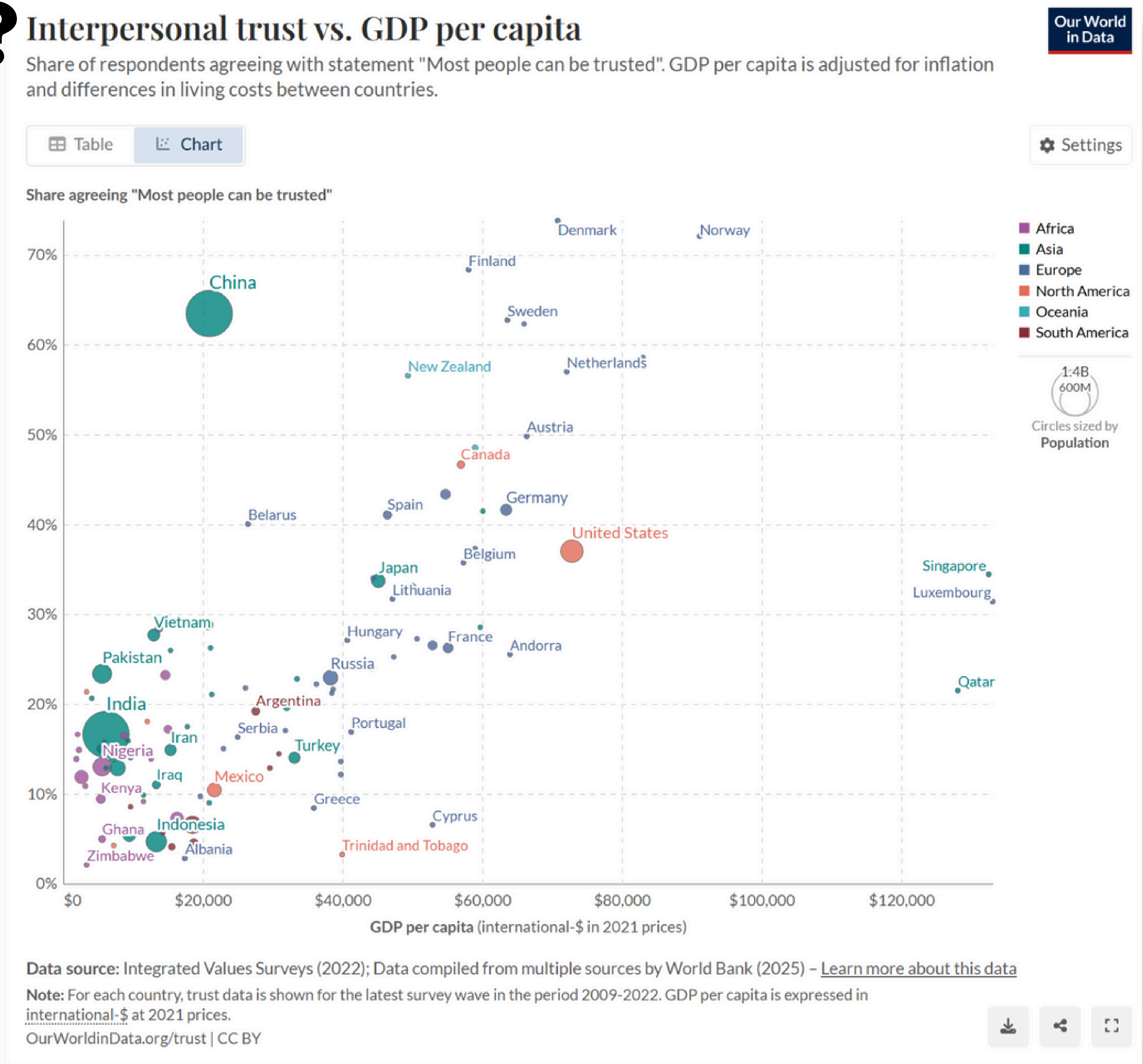
Countries ranked by proportion agreeing that ‘most people can be trusted’.

Turns out there is a correlation between levels of trust and GDP per capita.*



*There is a similar correlation between trust and levels of inequality.

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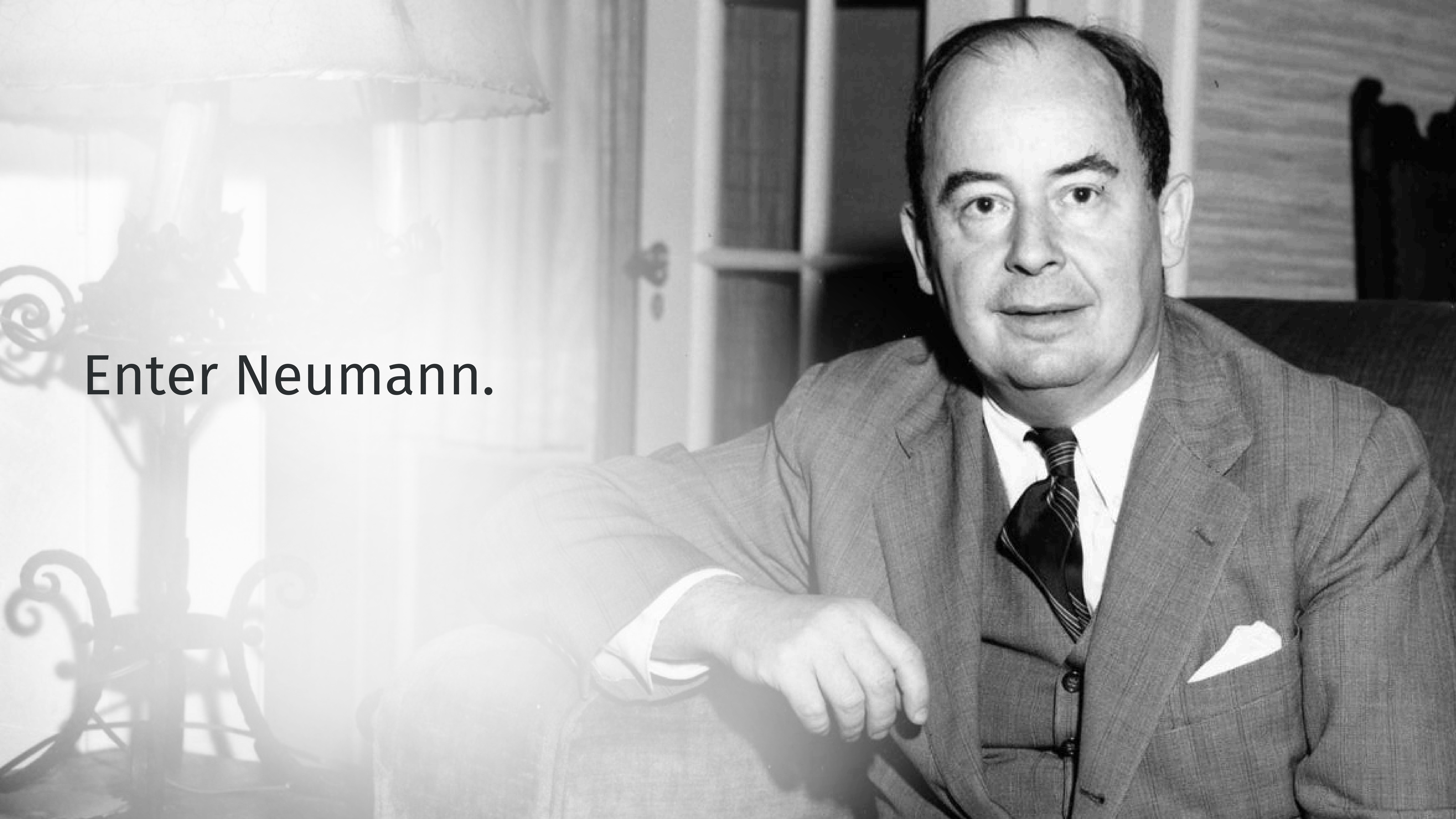
How do we think about interactive decision situations like these, more generally?


Enter Neumann.

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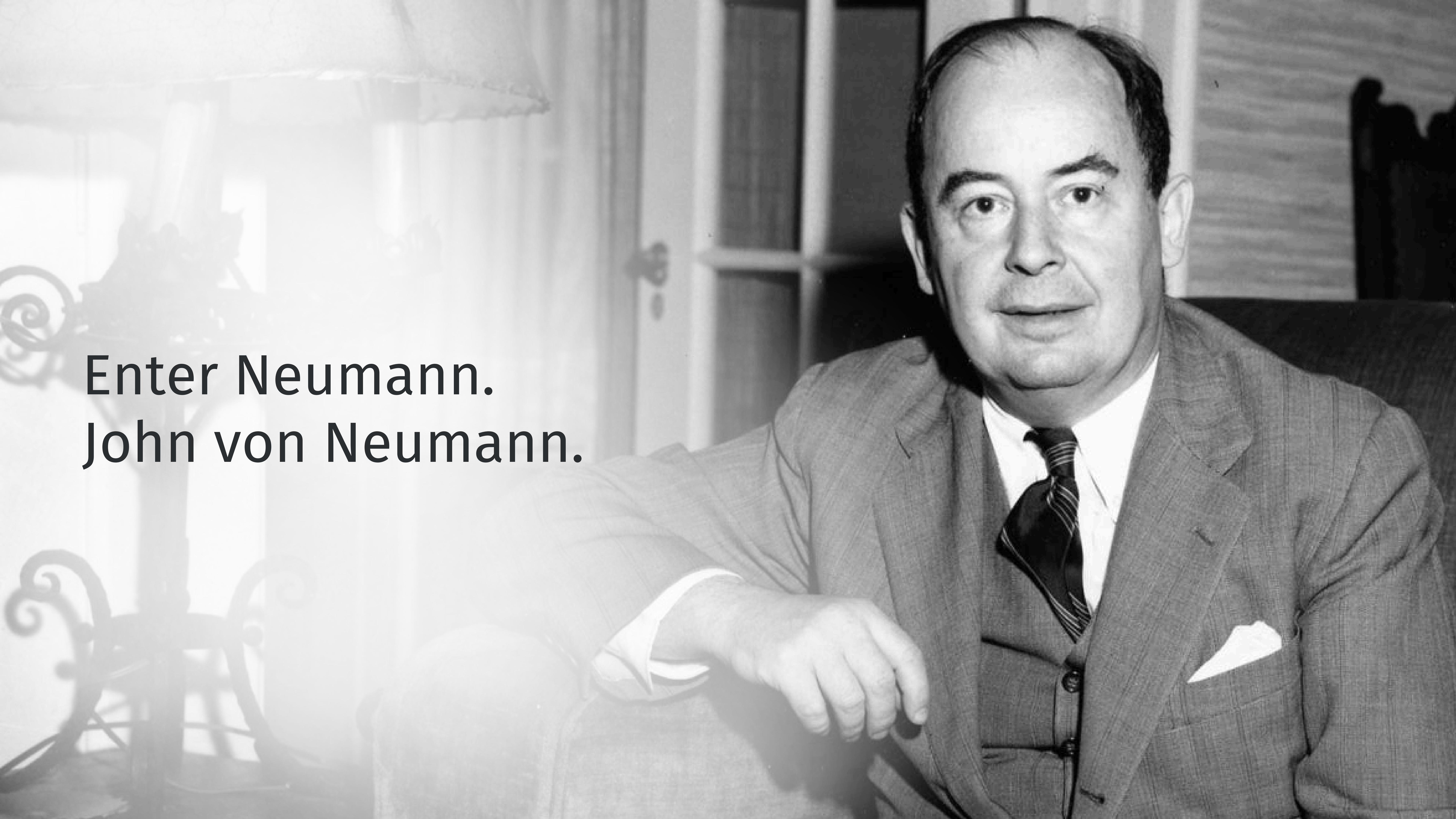
John von Neumann.



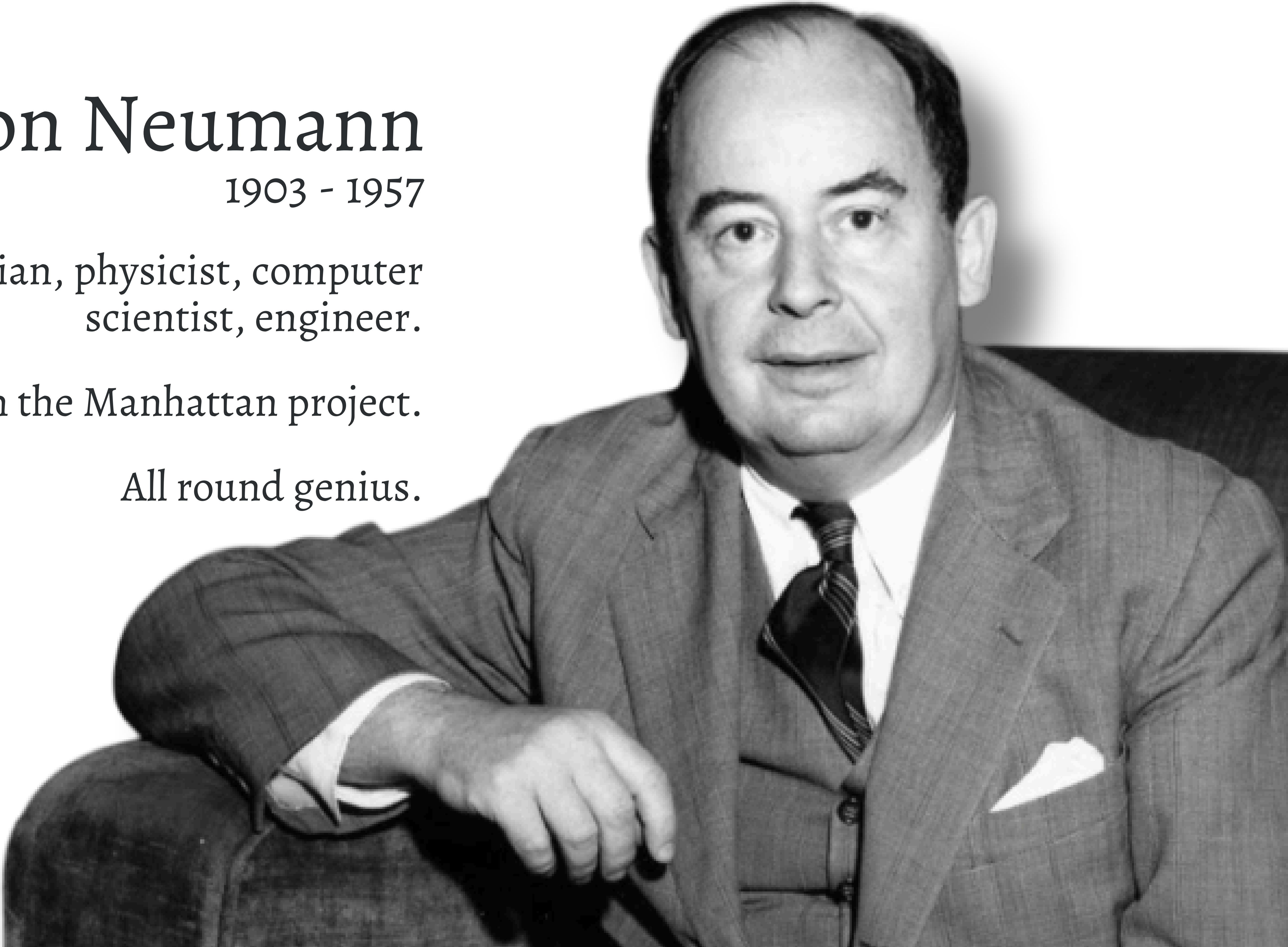
John von Neumann

1903 - 1957

Mathematician, physicist, computer scientist, engineer.

Instrumental in the Manhattan project.

All round genius.



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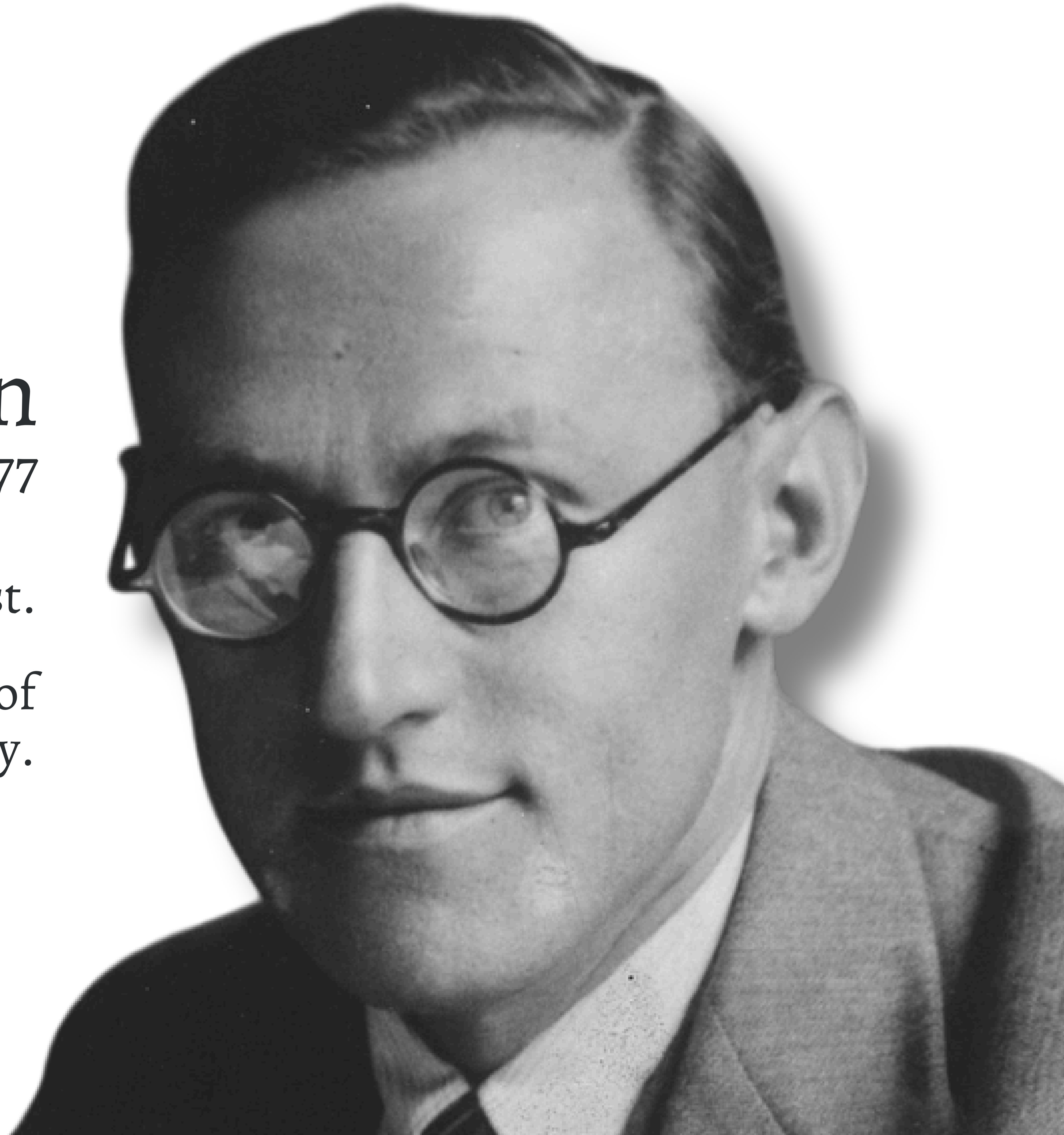
Oskar Morgenstern

1902 - 1977

Economist.

Together with von Neumann, founder of game theory.



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OSKAR MORGENSTERN

And economics!

von Neumann, J., & Morgenstern, O. (1953). *Theory of Games and Economic Behavior.* Princeton University Press.

What do all these situations have in common?

What do all these situations have in common? Let's start with the most basic type of game: games in *normal form*.

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The basic ingredients of a game in normal form are the *players*, their *strategies* and the *utility* each player derives from a combination of strategies.

NOTATION

players	$N = \{1, \ldots, n\}$
strategy of player i	s_i
profile of strategies	$\boldsymbol{s} = (s_1, \ldots, s_n)$
utility of player i with strategy profile $\boldsymbol{s}$	$u_i(\boldsymbol{s}) \in \mathbb{R}$
strategy profile $\boldsymbol{s}$ without s_i	$\boldsymbol{s}_{-i} = (s_1, \ldots, s_{i-1}, s_{i+1}, \ldots, s_n)$
$\boldsymbol{s}$, alternatively	$\boldsymbol{s} = (s_i, \boldsymbol{s}_{-i})$

When there are only two players, we can represent the game using a table.

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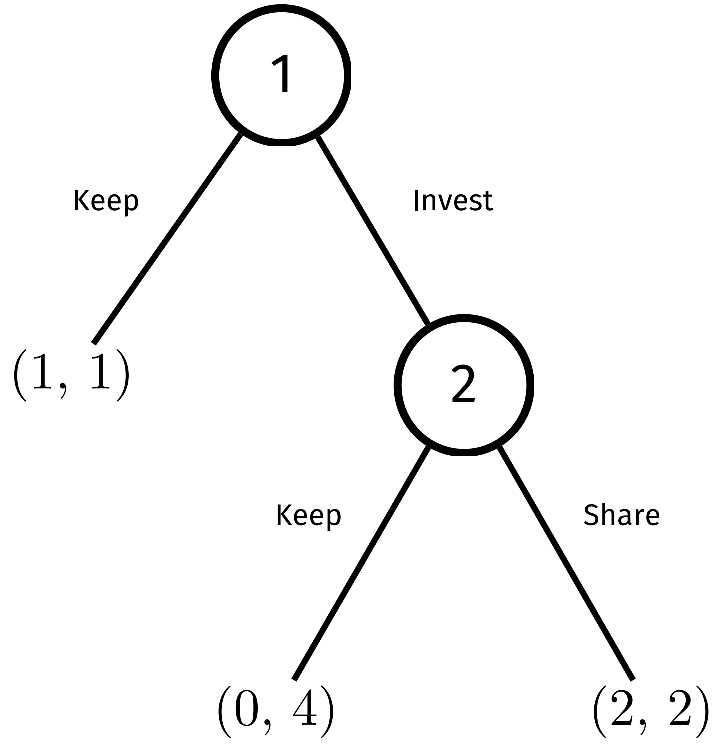
Player 2 can either divide the sum equally, or keep everything.

payoffs



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payoff table (matrix)

	Keep	Share
Keep	1, 1	1, 1
Invest	0, 4	2, 2

players

1 and 2.

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strategy profiles

(Keep, Keep), (Keep, Share), (Invest, Keep), (Invest, Share).

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payoffs

$u_1(\text{Keep}, \text{Keep}) = 1$, $u_2(\text{Invest}, \text{Keep}) = 4, \ldots$

WE TYPICALLY ASSUME...

... that Player 1 is the row player...

Player 1		Keep	Share
	Keep	$1, 1$	$1, 1$
	Invest	$0, 4$	$2, 2$

WE TYPICALLY ASSUME...

... that Player 1 is the row player...

... Player 2 is the column player...

Player 2

	Keep	Share
Keep	$1,\ 1$	$1,\ 1$
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WE TYPICALLY ASSUME...

... that Player 1 is the row player...

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... a *strategy* consists in choosing one available action and playing it with 100% probability.*

		Player 2	
		Keep	**Share**
Player 1	Keep	$1,\ 1$	$1,\ 1$
	Invest	$0,\ 4$	$\boxed{2,\ 2}$

*For now.

WE TYPICALLY ASSUME…

… that Player 1 is the row player…

… Player 2 is the column player…

… a *strategy* consists in choosing one available action and playing it with 100% probability.*

Oh, and players want to maximize their payoffs, given the other player's strategy.

		Player 2	
		Keep	Share
Player 1	Keep	$1, 1$	$1, 1$
	Invest	$0, 4$	$2, 2$

*For now.

Now we know what a game (in normal form) is. What do we do with it?

FROM UTILITIES TO STRATEGIES

If we knew what strategies players would play,
we could compute utilities, etc.

Player 2

Player 1		Keep	Share
	Keep	$1,\ 1$	$1,\ 1$
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FROM UTILITIES TO STRATEGIES

If we knew what strategies players would play, we could compute utilities, etc.

But we're assuming players have to figure out what to do without knowing what the others are doing, but assuming that the others are also maximizing their own payoffs.

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For instance, if it becomes known that Player 2 shares, then Player 1 wants to invest.

Player 2

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For instance, if it becomes known that Player 2 shares, then Player 1 wants to invest.

But if Player 1 invests, then Player 2 wants to switch to keeping.

We need to reason the other way around: from utilities to strategies.

		Player 2	
		Keep	Share
Player 1	Keep	$1,\ 1$	$1,\ 1$
	Invest	$0,\ 4$	$2,\ 2$

We need to reason about *solution concepts*.

We need to reason about *solution concepts*. These describe the strategies we can expect players to play.


Enter Nash.


Enter Nash. John Nash.

John Forbes Nash Jr.

1928 - 2015

Mathematician.

In 1994, won the Nobel prize in Economics.

JOHN NASH

In a Nash equilibrium no one has an incentive to change their strategy, given the other players' strategies.

BEST RESPONSE & NASH EQUILIBRIUM

DEFINITION (BEST RESPONSE)

Player i's *best response* to the other players' strategies $\boldsymbol{s}_{-i} = (s_1, \ldots, s_{i-1}, s_{i+1}, \ldots, s_n)$ is a strategy s_i^* such that $u_i(s_i^*, \boldsymbol{s}_{-i}) \geq u_i(s_i, \boldsymbol{s}_{-i})$, for any strategy s_i of player i.

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DEFINITION (PURE NASH EQUILIBRIUM)

A strategy profile $\boldsymbol{s}^* = (s_1^*, \ldots, s_n^*)$ is a *pure Nash equilibrium* if s_i^* is a best response to $\boldsymbol{s}_{-i}^*$, for every player i.

In other words, $\boldsymbol{s}^*$ is a pure Nash equilibrium if there is no player i and strategy s_i' such that $u_i(s_i', \boldsymbol{s}_{-i}^*) > u_i(s_i^*, \boldsymbol{s}_{-i}^*)$.

profitable deviation

And now for the moment we’ve all been waiting for.

The Prisoner’s Dilemma

You and a friend are at the police station. You are the main suspects in a string of Oktoberfest beer thefts.

You are interrogated at the same time, in separate rooms.

If both of you stick to the common story (Cooperate), you get off with a smallish fine.

But if you tell on your friend (Defect) you get off free, while they get a hefty fine.

Your friend faces the same situation.

If you rat each other out, you split the large fine.

payoff table

	Cooperate	Defect
Cooperate	-20, -20	-100, 0
Defect	0, -100	-50, -50

pure Nash equilibria

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The Prisoner's Dilemma

You and a friend are at the police station. You are the main suspects in a string of Oktoberfest beer thefts.

You are interrogated at the same time, in separate rooms.

If both of you stick to the common story (Cooperate), you get off with a smallish fine.

But if you tell on your friend (Defect) you get off free, while they get a hefty fine.

Your friend faces the same situation.

If you rat each other out, you split the large fine.

payoff table

	Cooperate	**Defect**
Cooperate	-20, -20	-100, 0
Defect	0, -100	-50, -50

pure Nash equilibria

- ✗ (Cooperate, Cooperate)
- ✗ (Cooperate, Defect)
- ✗ (Defect, Cooperate)
- ✓ (Defect, Defect)

At equilibrium both players rat each other out!

At equilibrium both players rat each other out! What about the Trust Game?

The Trust Game

Two players, with initial endowment of 1 each.

Player 1 makes the first move, by deciding whether to invest in a joint venture.

If Player 1 makes no investment, the game is over and both players retain their endowments.

If Player 1 invests, a surplus is generated and Player 2 ends up with $4.

Player 2 now has to decide how to allocate the available sum of $4.

Player 2 can either divide the sum equally, or keep everything.

payoff table

	Keep	Share
Keep	$1, 1$	$1, 1$
Invest	$0, 4$	$2, 2$

pure Nash equilibria

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pure Nash equilibria

(Keep, Keep)

At equilibrium there's no trust!

Let's look at an example with more than two players.

Let’s look at an example with more than two players. Why do people endure the discomfort of high heels?

NOT JUST FOR WOMEN BTW

For men at the court of Louis XIV high heels were a marker of status and importance.

Louis XIV, by Hyacinthe Rigaud (1701)

NOT JUST FOR WOMEN BTW

For men at the court of Louis XIV high heels were a marker of status and importance.

Loui

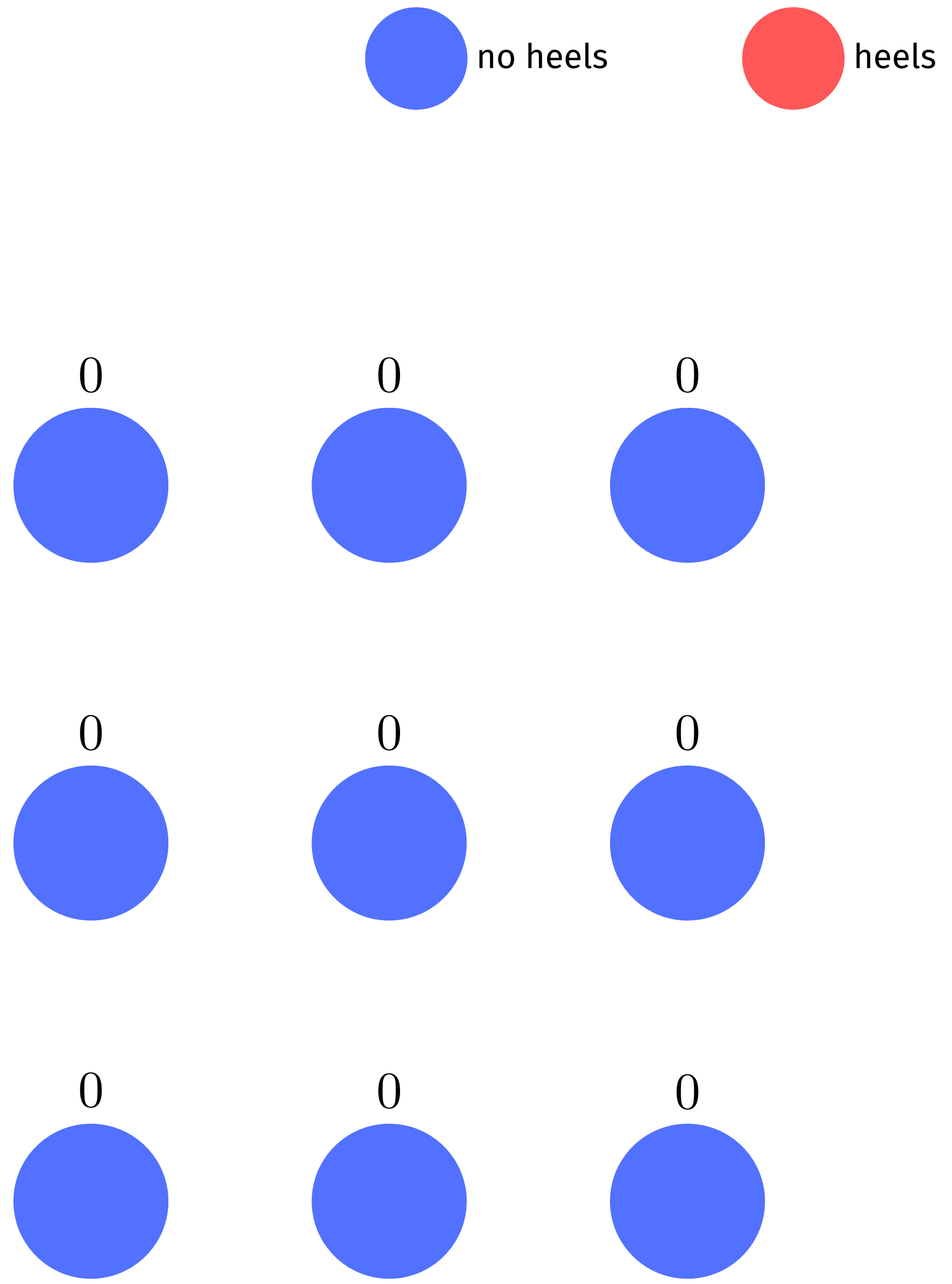
JANE AUSTEN

[Marianne], in having the advantage of height, was more striking [than her sister].

Austen, J. (1811). *Sense and Sensibility.*

THE DILEMMA OF HIGH HEELS

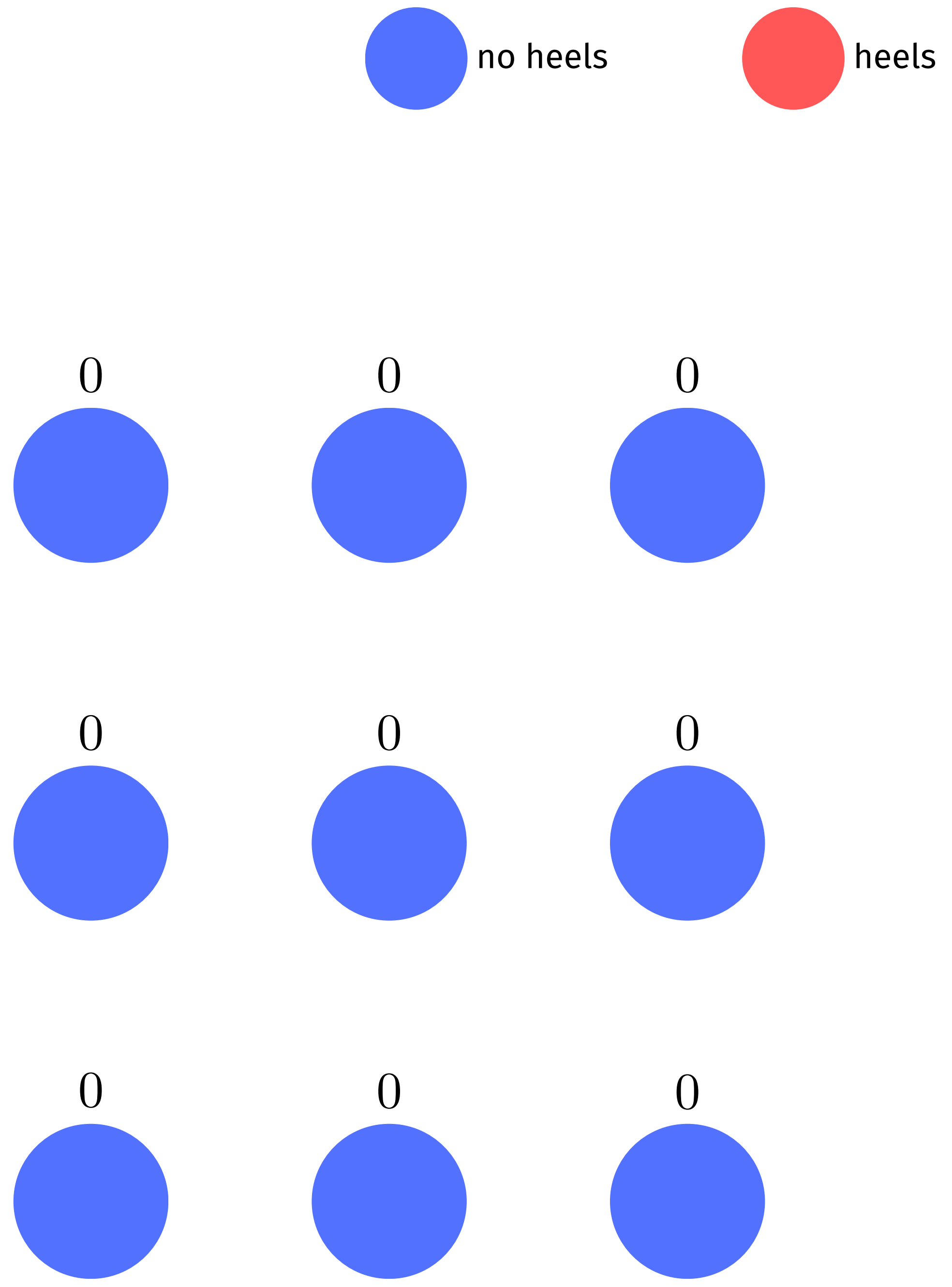
Let’s assume that a height advantage makes one more attractive (+3), and a disadvantage is bad (-3).



THE DILEMMA OF HIGH HEELS

Let’s assume that a height advantage makes one more attractive (+3), and a disadvantage is bad (-3).

And that this boost overweights the discomfort of wearing heels (-2).



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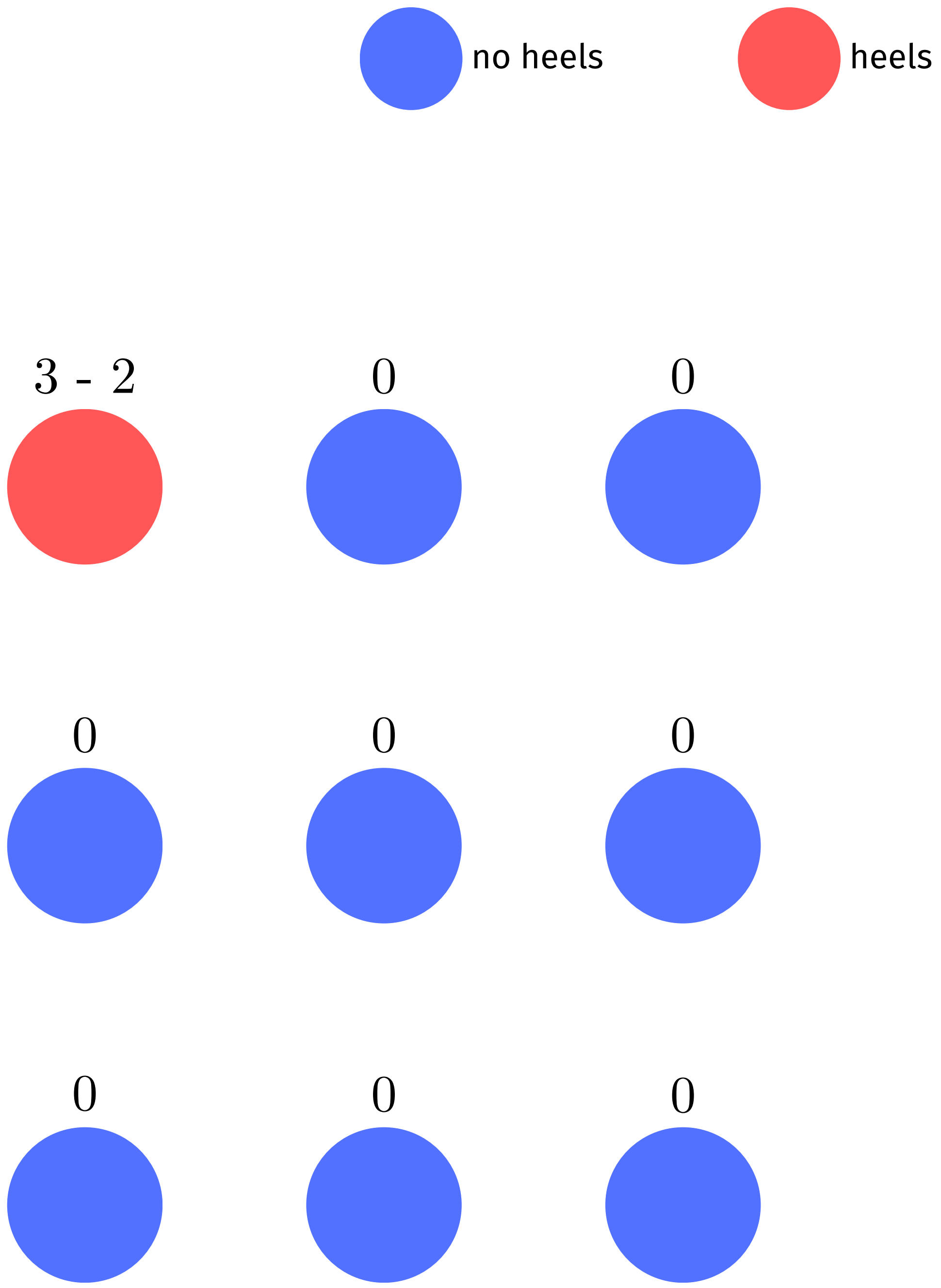

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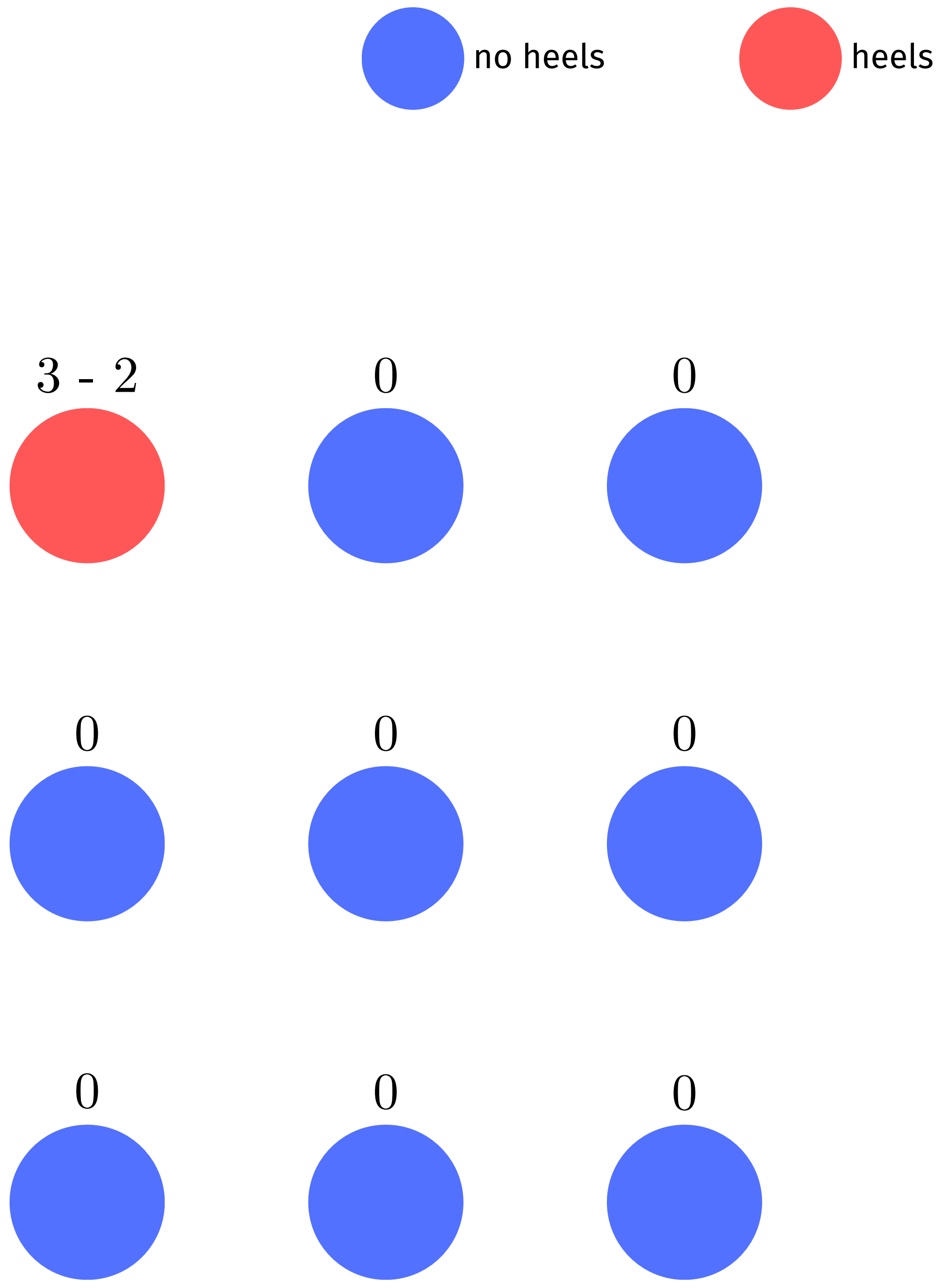
So everyone adopts high heels.



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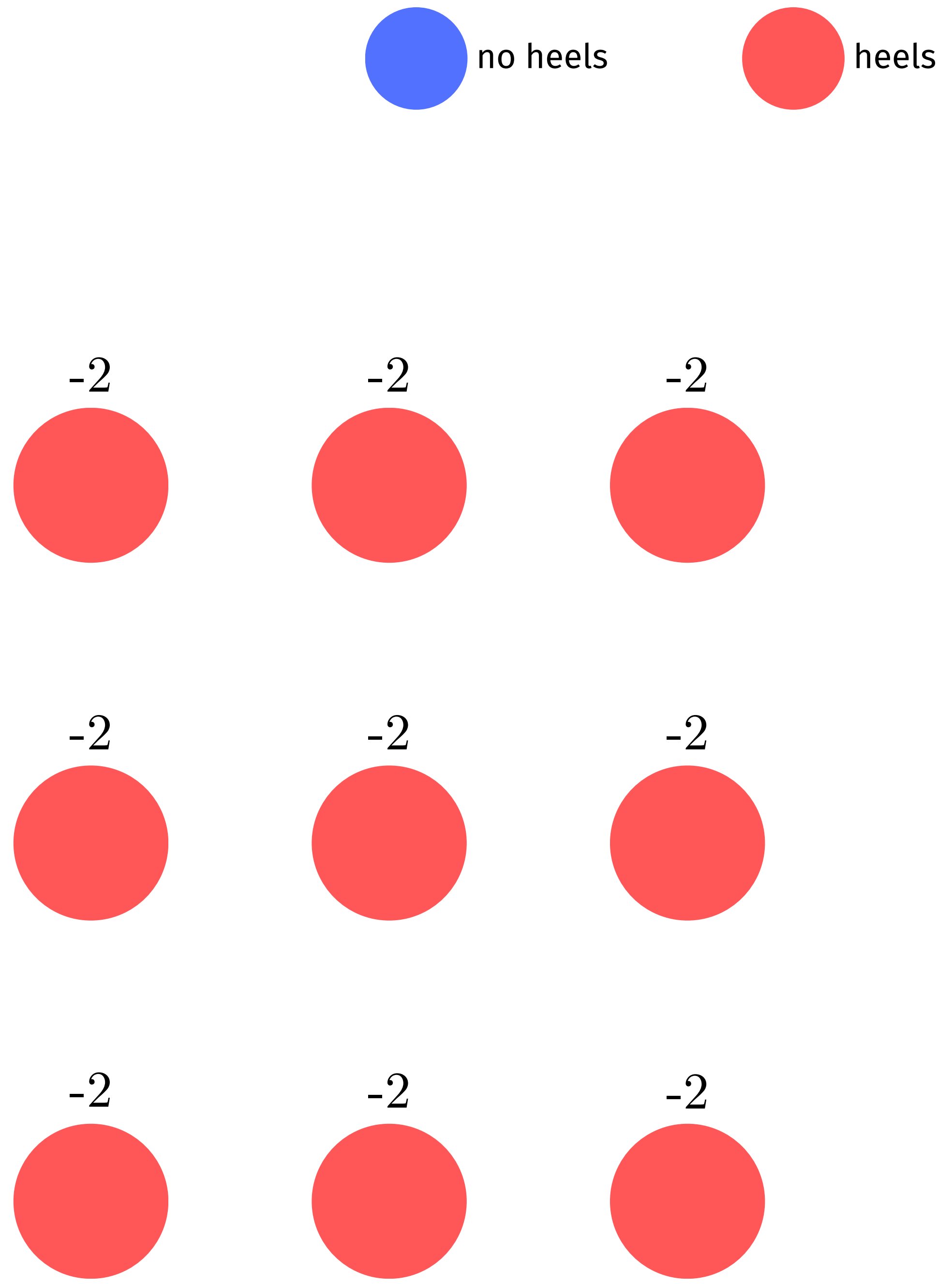

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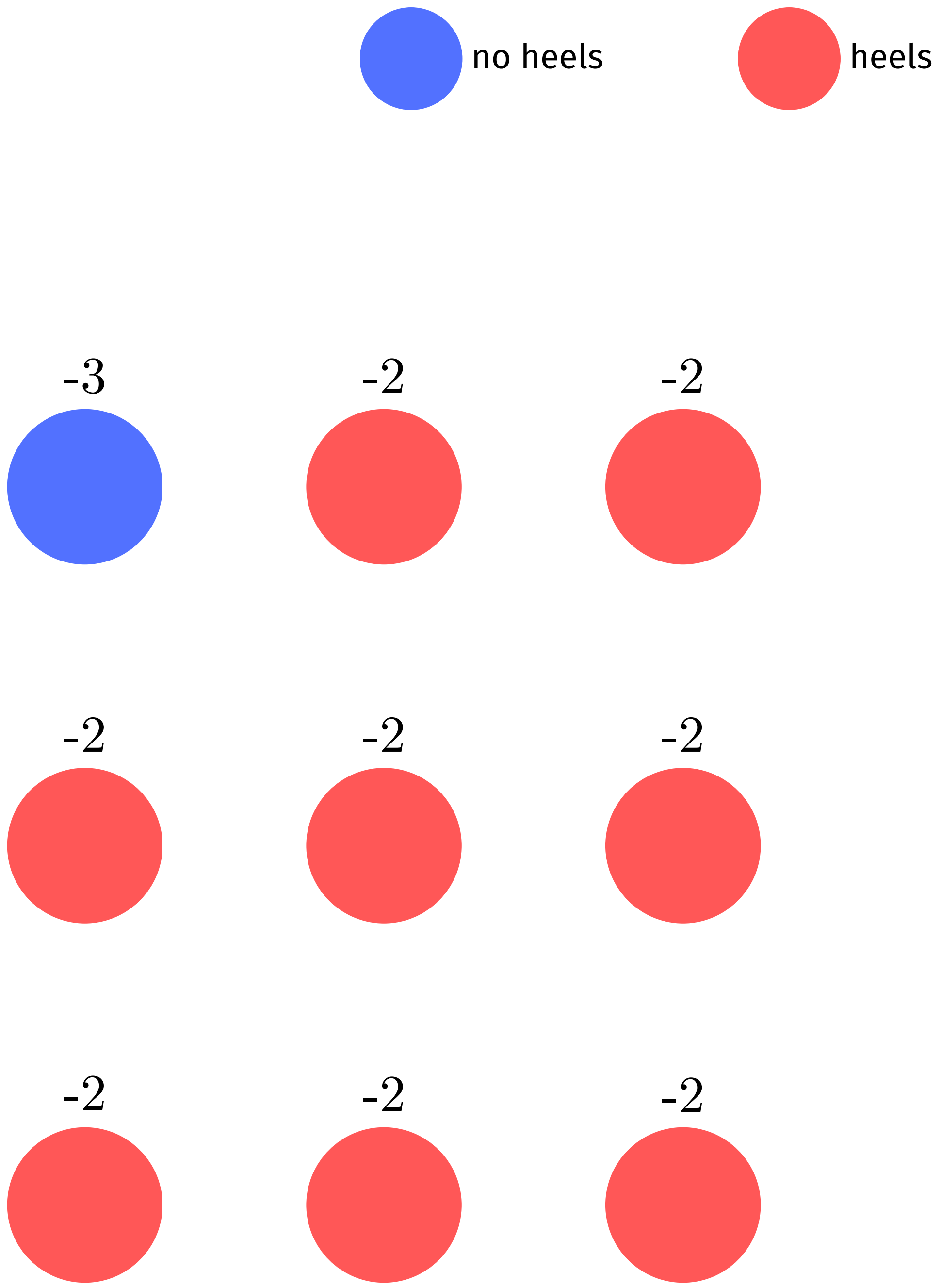
In a world of high heels, showing up without them puts one at a disadvantage.



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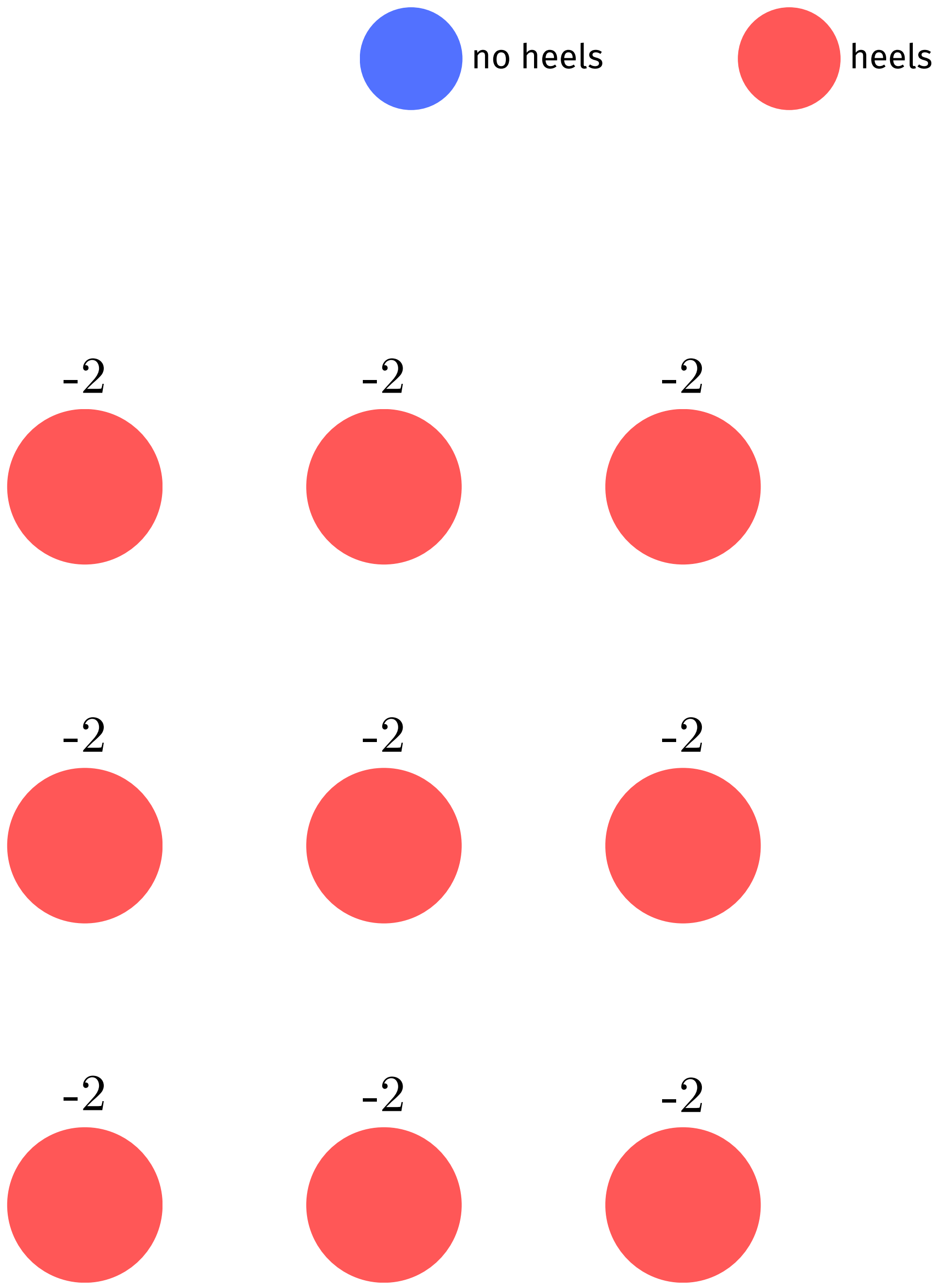

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In a world of high heels, showing up without them puts one at a disadvantage.

At the Nash equilibrium, everyone puts up with the discomfort... even though the height advantage is gone!

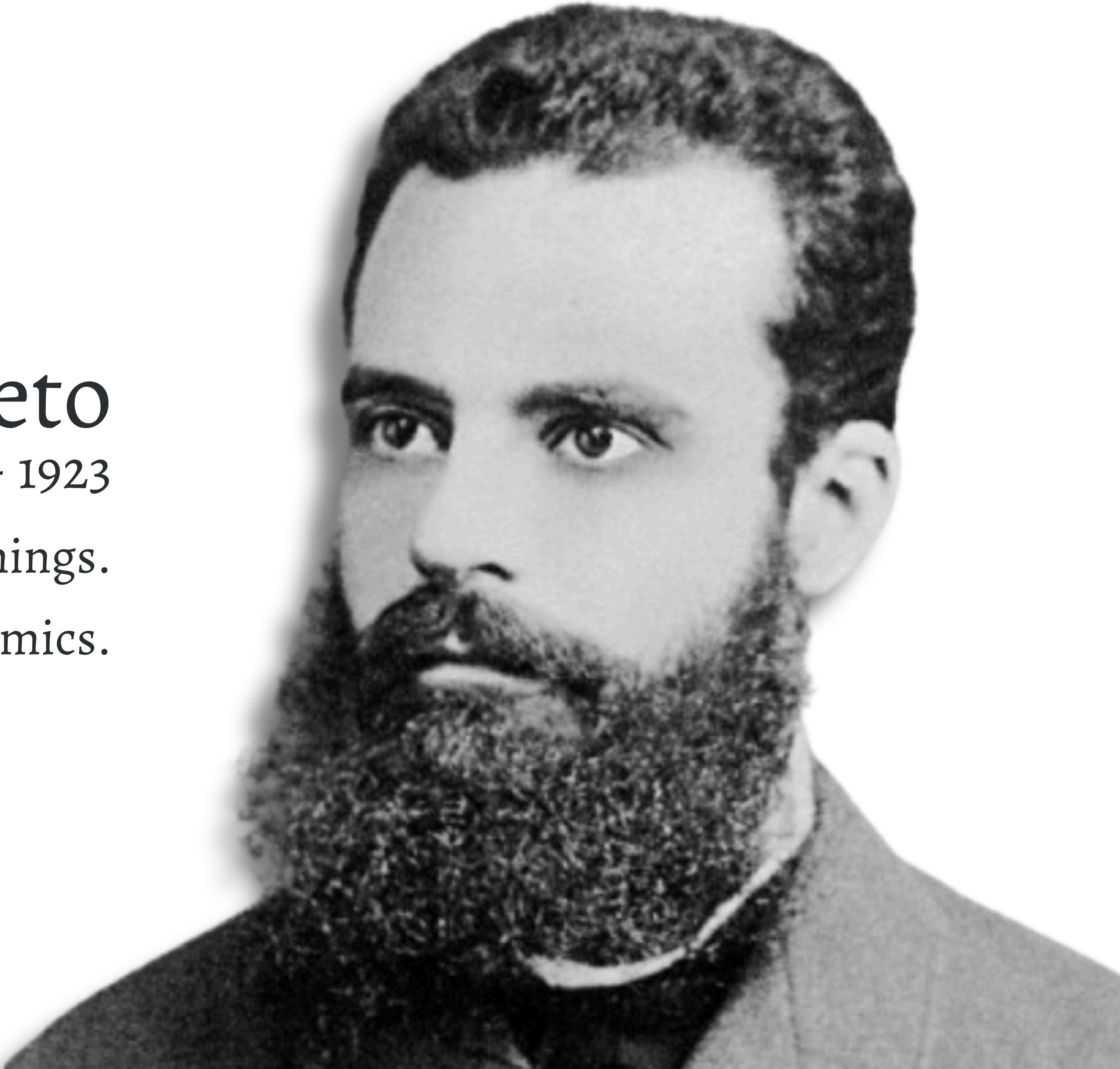
There’s something weird about all these situations: everyone hates the equilibrium, and would prefer a different outcome.

Vilfredo Pareto

1848 - 1923

Mathematician and many other things.

In 1994, won the Nobel prize in Economics.



VILFREDO PARETO

How about we look at outcomes where people are (jointly) as well-off as they can be.

VILFREDO PARETO

How about we look at outcomes where people are (jointly) as well-off as they can be.

In a Pareto optimal outcome no one can be made better off without making someone else worse off.

PARETO DOMINATION & OPTIMALITY

DEFINITION (PARETO DOMINATION)

A strategy profile $\boldsymbol{s}$ *Pareto dominates* strategy profile $\boldsymbol{s}'$ if:

(i) $u_i(\boldsymbol{s}) \geq u_i(\boldsymbol{s}')$, for every agent i, and

(ii) there exists an agent j such that $u_j(\boldsymbol{s}) > u_j(\boldsymbol{s}')$.

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DEFINITION (PARETO OPTIMALITY)

A strategy profile $\boldsymbol{s}$ is *Pareto optimal* if there is no (other) strategy profile $\boldsymbol{s}'$ that Pareto dominates $\boldsymbol{s}$.

PARETO OPTIMALITY IN THE PRISONER'S DILEMMA

What dominates what in the Prisoner's Dilemma?

payoff table

	Cooperate	Defect
Cooperate	-20, -20	-100, 0
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pure Nash equilibria

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Pareto optimal outcomes

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(Defect, Defect) is Pareto dominated by (Cooperate, Cooperate).

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PARETO OPTIMALITY IN THE PRISONER'S DILEMMA

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Everything *but* the Nash equilibrium is Pareto optimal!

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2/2

PARETO OPTIMALITY IN THE TRUST GAME

What dominates what in the Trust Game?

payoff table

	Keep	Share
Keep	$1,\ 1$	$1,\ 1$
Invest	$0,\ 4$	$2,\ 2$

pure Nash equilibria

(Keep, Keep)

Pareto optimal outcomes

PARETO OPTIMALITY IN THE TRUST GAME

What dominates what in the Trust Game?

(Keep, Keep) and (Keep, Share) are dominated by (Invest, Share).

(Invest, Keep) and (Invest, Share) are not dominated by anything.

payoff table

	Keep	Share
Keep	1, 1	1, 1
Invest	0, 4	2, 2

pure Nash equilibria

(Keep, Keep)

Pareto optimal outcomes

(Invest, Keep)

(Invest, Share)

All these games are examples of *social dilemmas*.

SOCIAL DILEMMAS

DEFINITION

A *social dilemma* is a situation in which individual incentives are at odds with group incentives. Individual rationality leads members of a group to an outcome that is suboptimal.

Carpenter, J., & Robbett, A. (2022). *Game Theory and Behavior*. MIT Press.

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More formally, a social dilemma is a game in which the equilibria are Pareto dominated by some other outcome.

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Social dilemmas show up a lot.

Social dilemmas show up a lot. They’re the reason we can’t have nice things.

LANCE ARMSTRONG

Sports people face a social dilemma when deciding whether to take performance enhancing drugs.

Schneier, B. (2006, August 10). Drugs: Sports’ Prisoner's Dilemma. *Wired*.

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VAMPIRE BAT ELDER

We face a similar dilemma when having to decide whether to give up some of our food to feed hungry colleagues.

Can’t we just expect that players will gravitate towards a Pareto-optimal outcome?

PARETO IS FRAGILE

Supposing players end up in a situation where both cooperate, they each have a strong incentive to defect.

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Pareto optimal outcomes

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PARETO IS FRAGILE

Supposing players end up in a situation where both cooperate, they each have a strong incentive to defect.

Pareto-optimal outcomes may not survive, in the long run.

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Nash equilibria are not necessarily *good*.

Nash equilibria are not necessarily *good*. They're just hard to escape, if end up in them.