



LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN

STRATEGIC MINDS: THE GAME THEORY OF COOPERATION, COORDINATION AND COLLABORATION

THE PROBLEM OF COOPERATION

CAN IT PAY OFF TO FORGO A PAYOFF?

Adrian Haret
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April 15, 2024

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*does not include situations where
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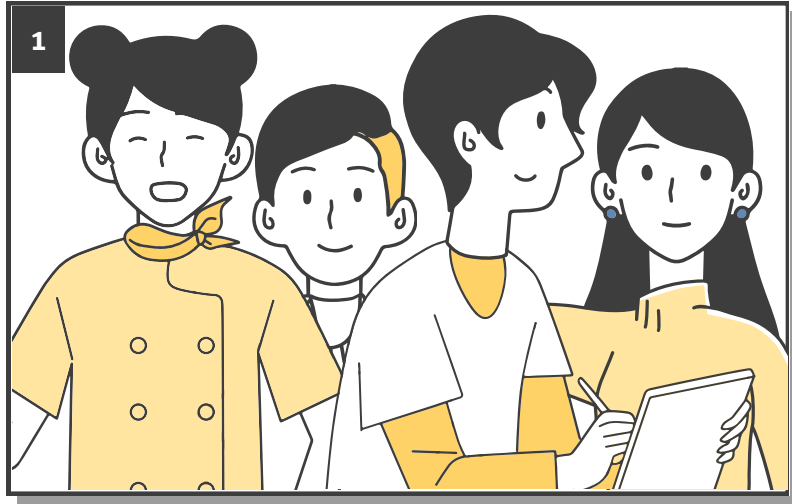
Sometimes also called *altruism*.

Though it need not involve conscious action...

Why is this a *problem*?

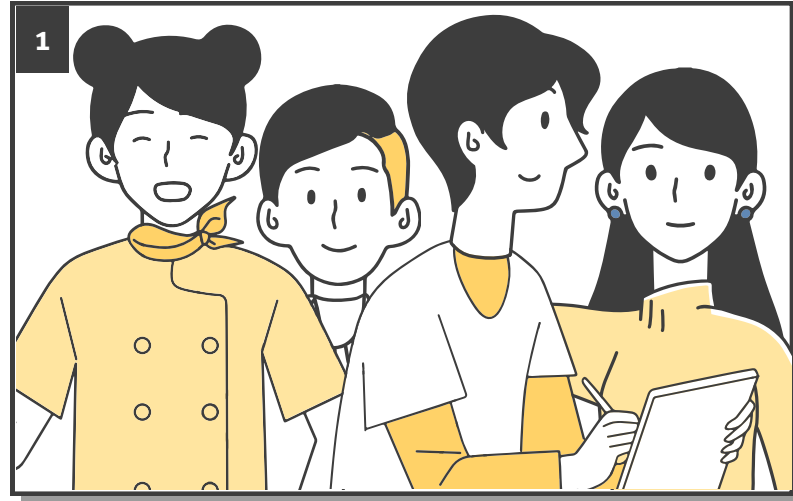
It's not clear if cooperation can survive in a world of self-interested individuals.

The Story of Cooperation

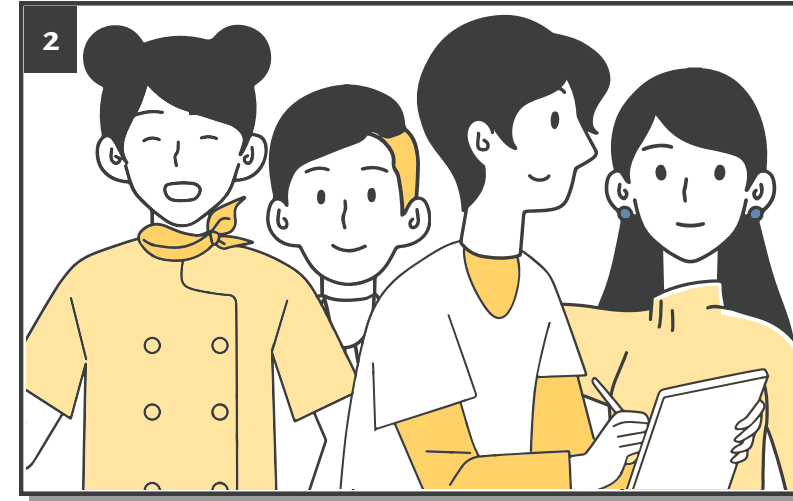


Cooperation is everywhere among living things.

The Story of Cooperation

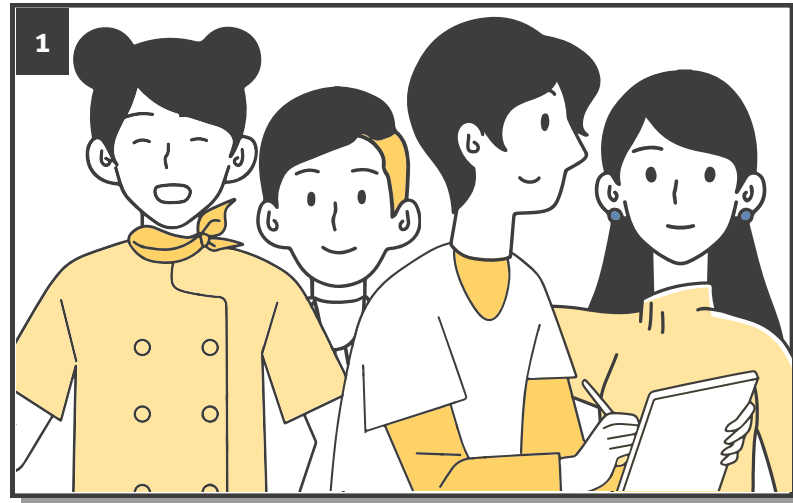


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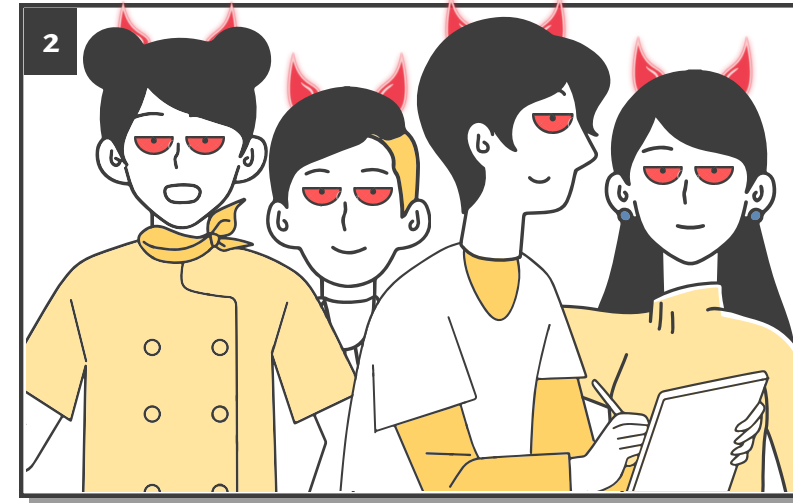


???
But how, when everyone is in it only for themselves?

The Story of Cooperation

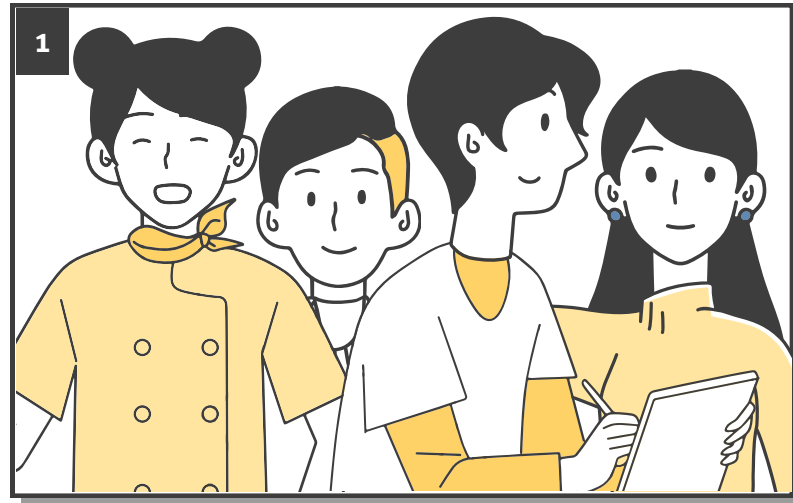


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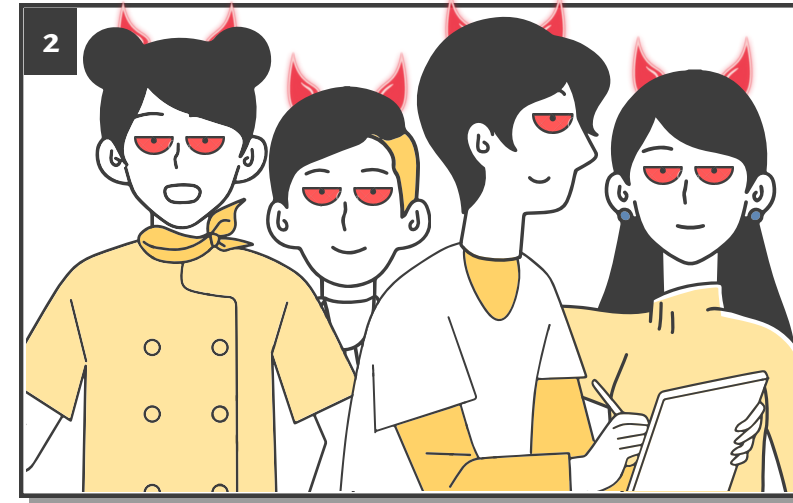


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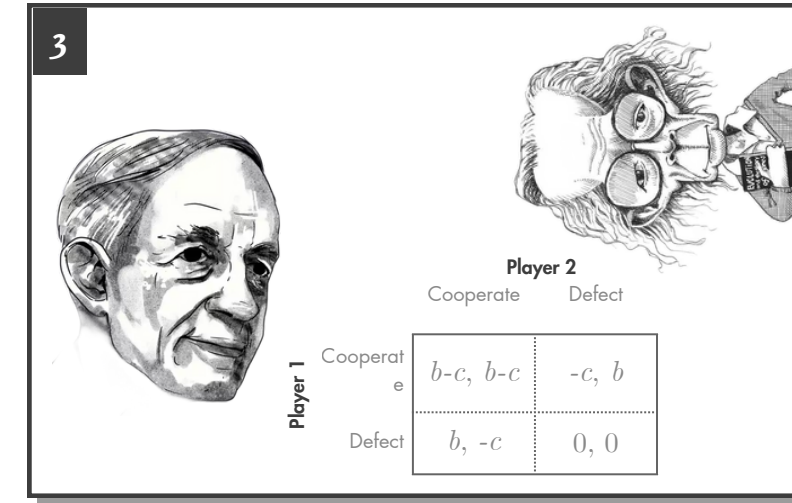
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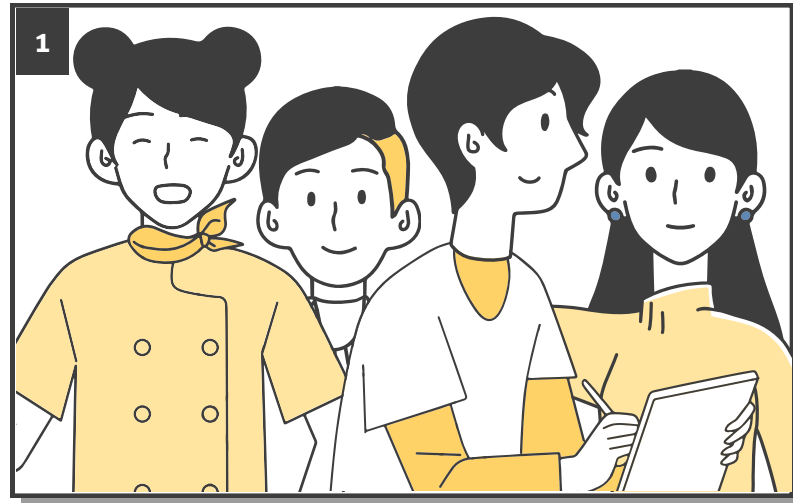


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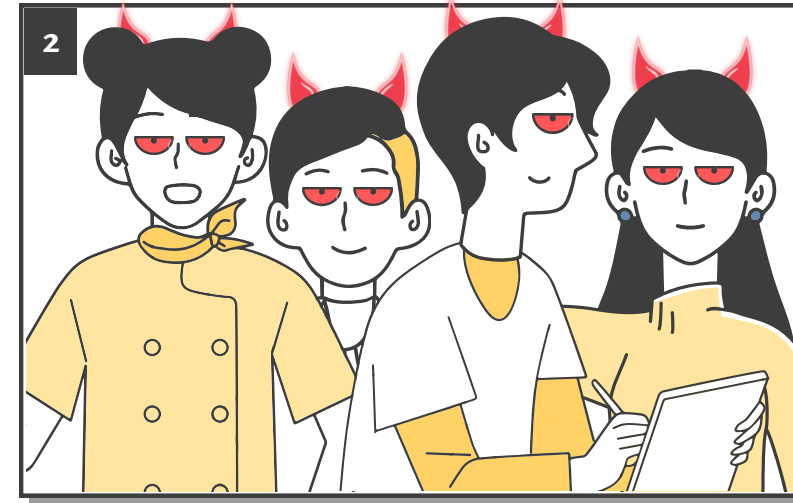


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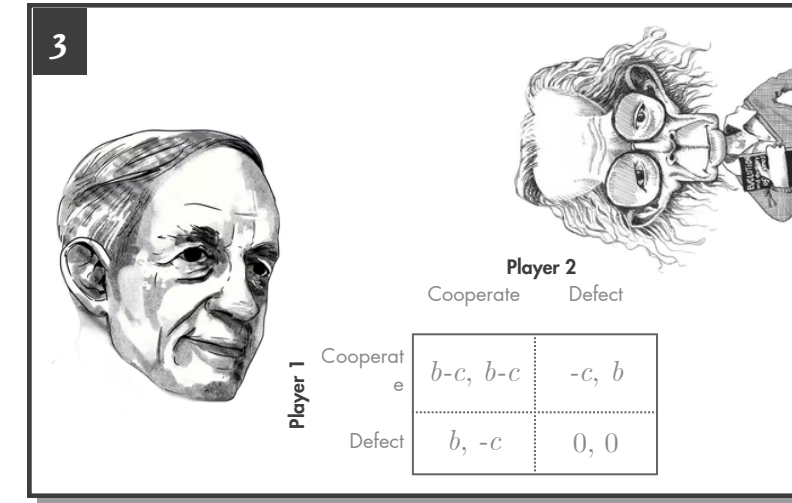
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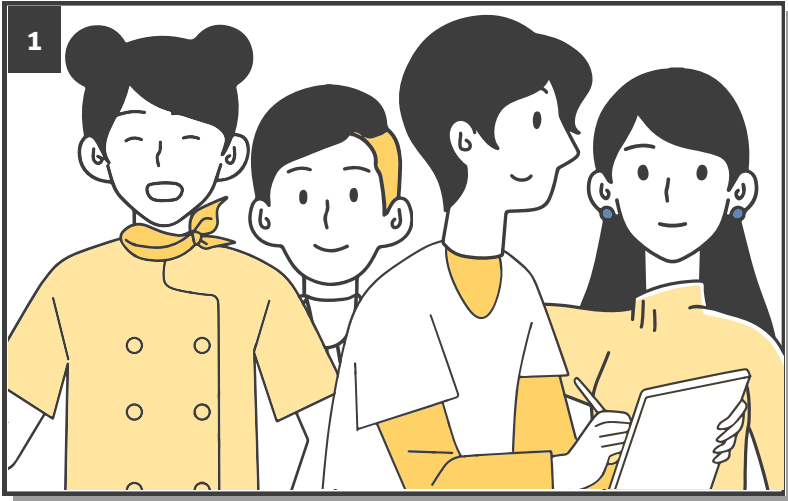


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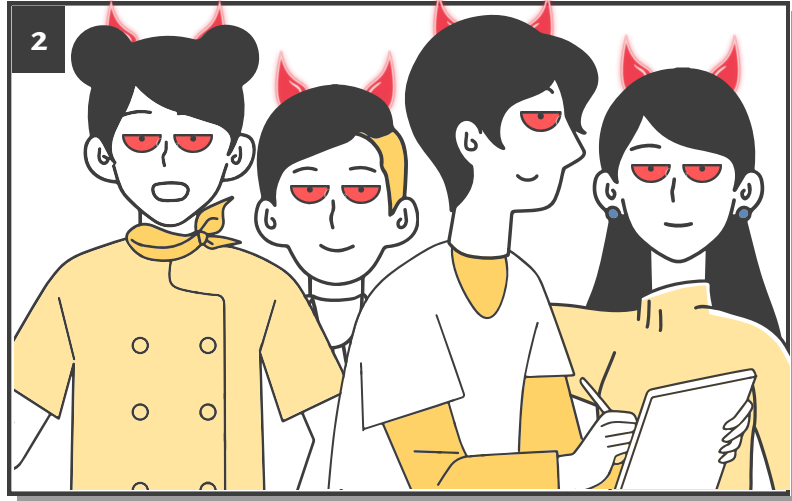


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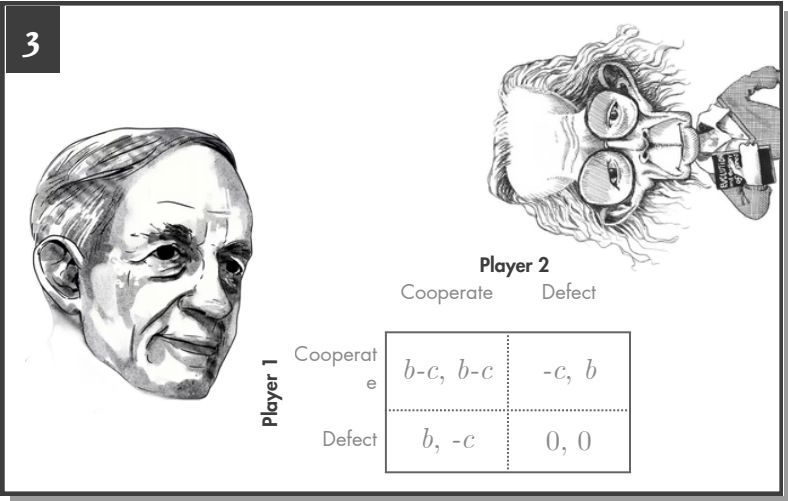
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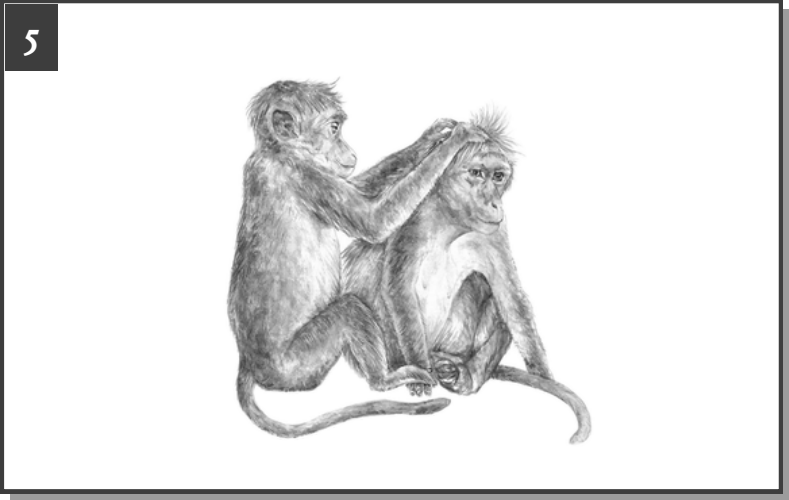
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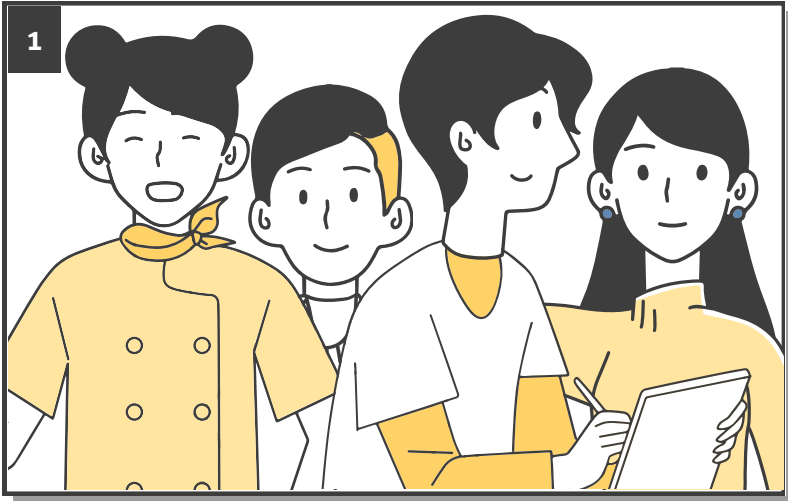


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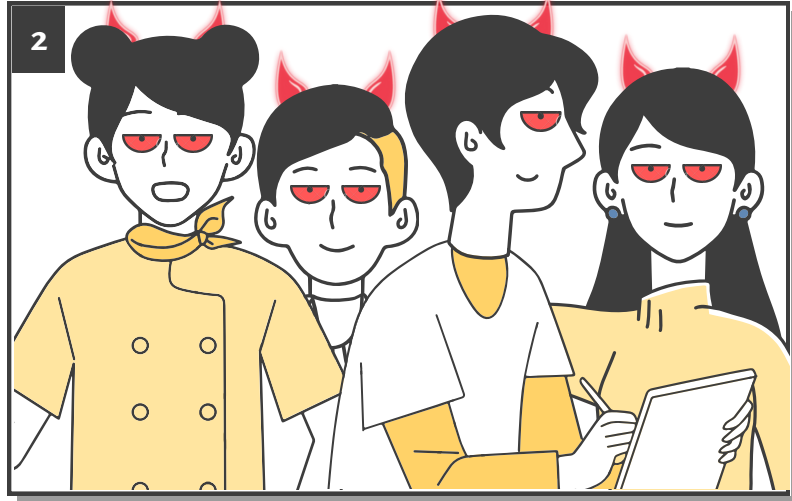


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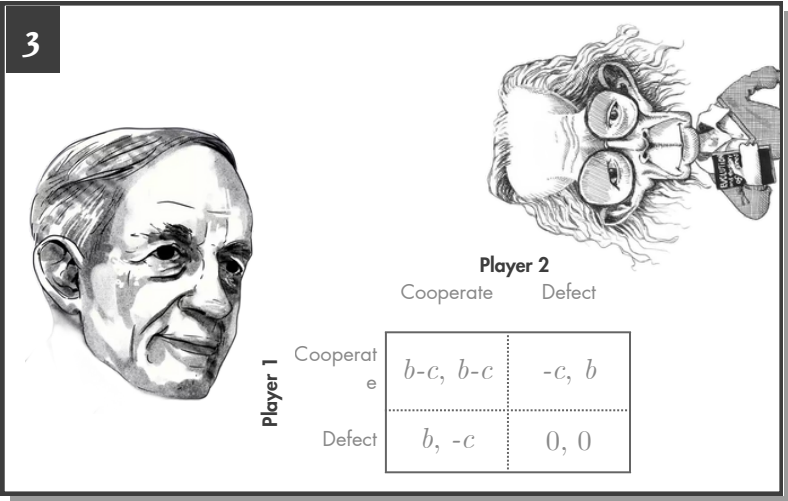
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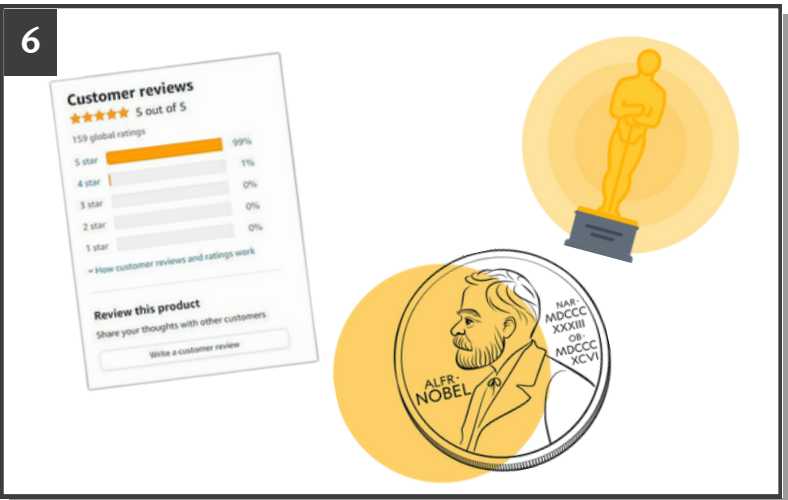
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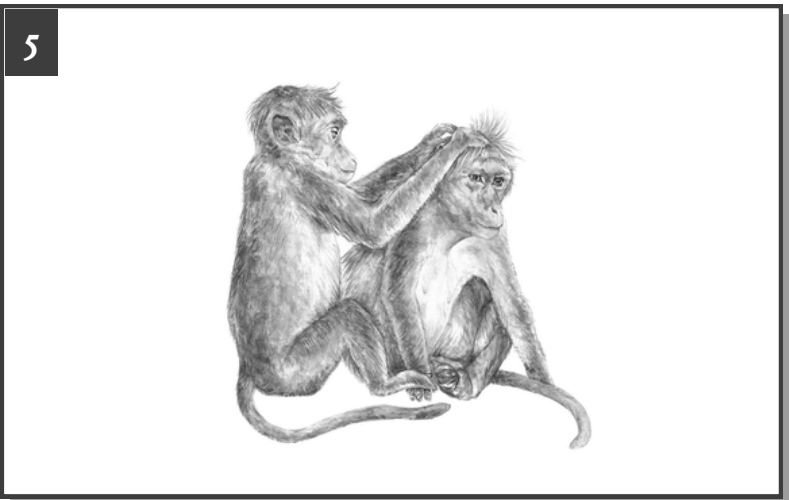
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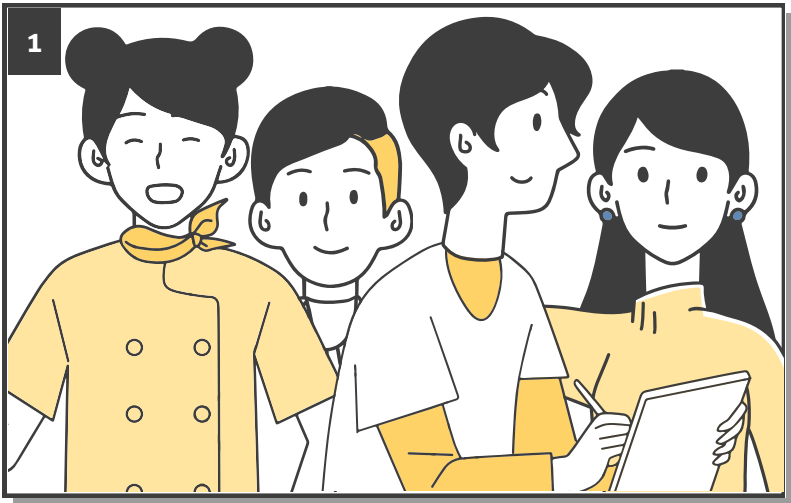


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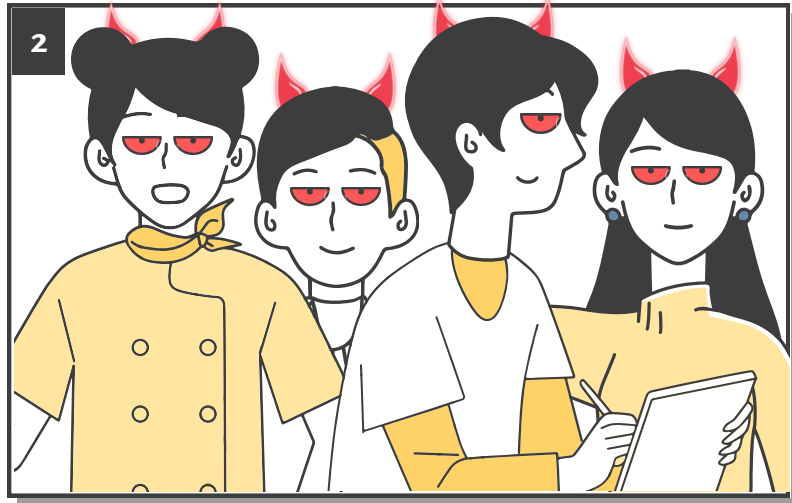


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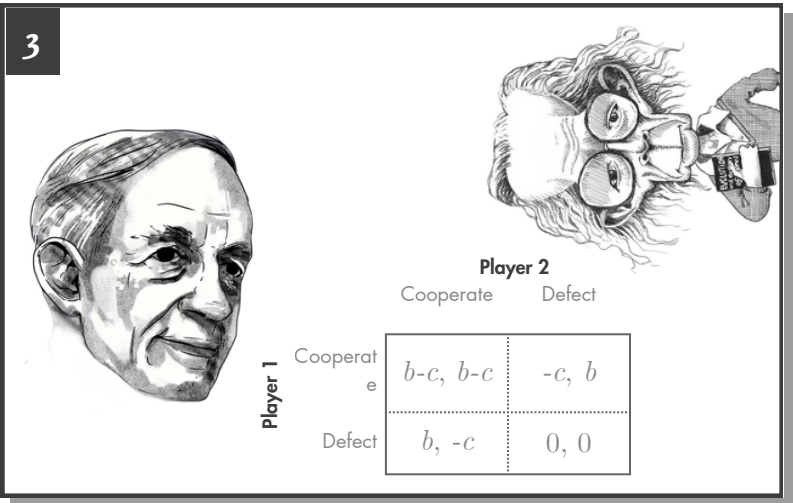
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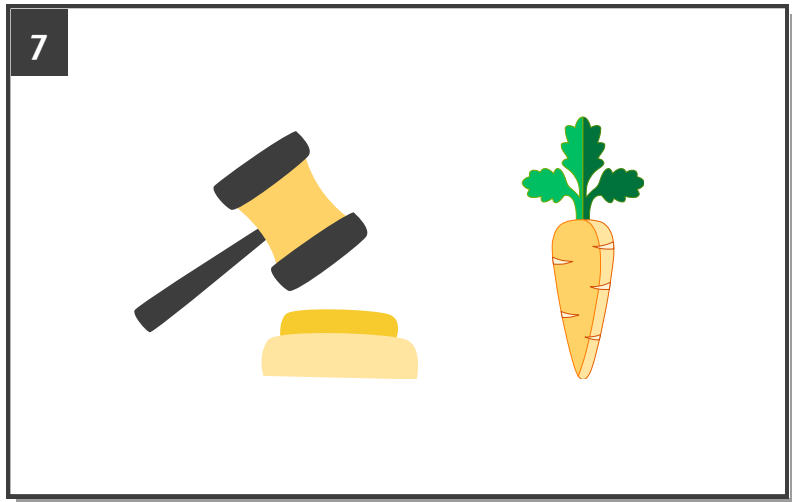
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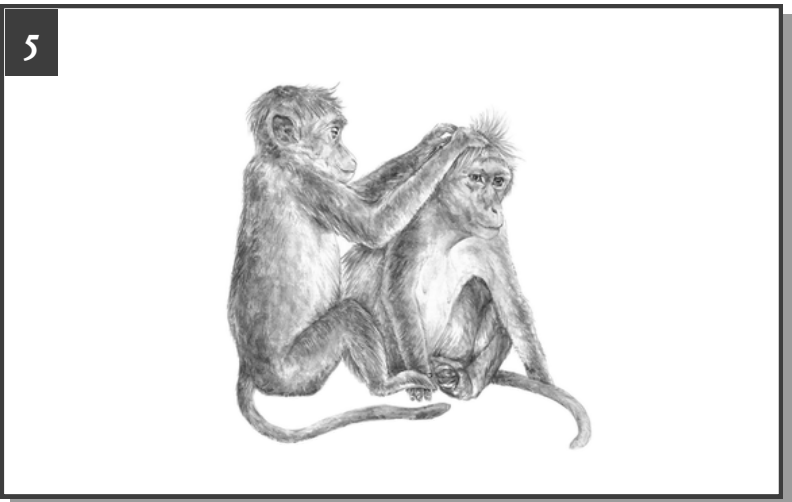
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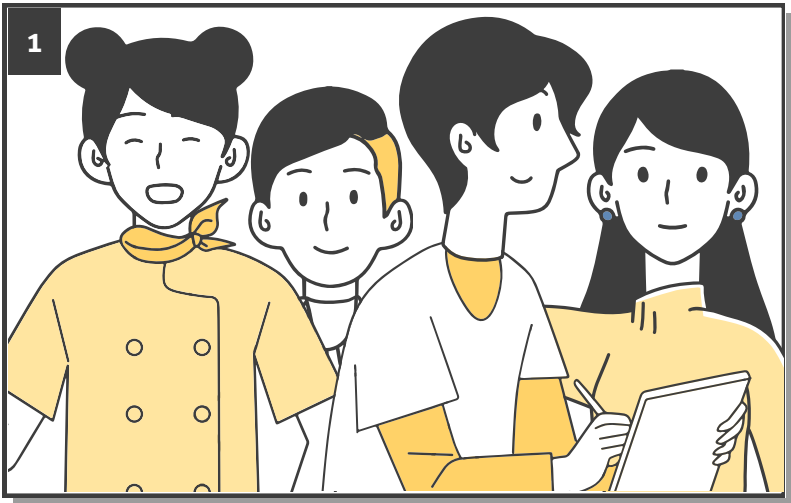


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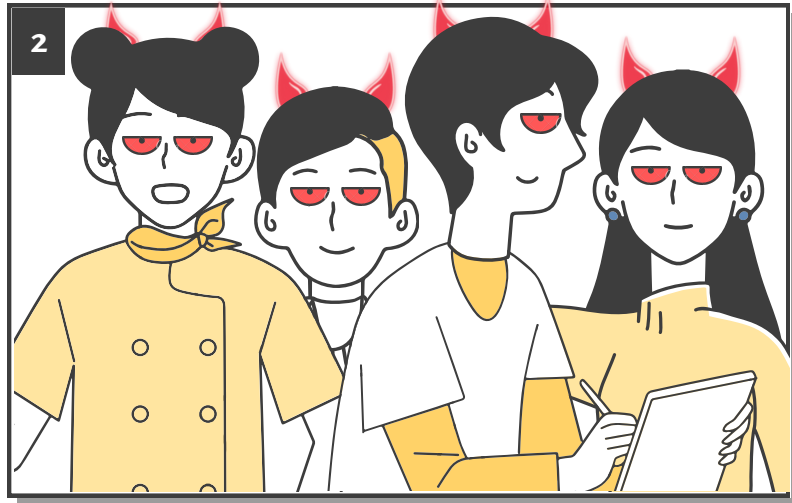


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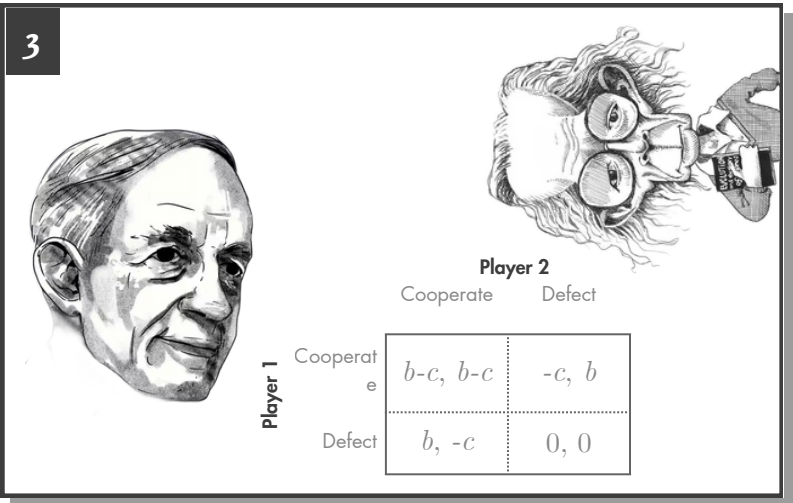
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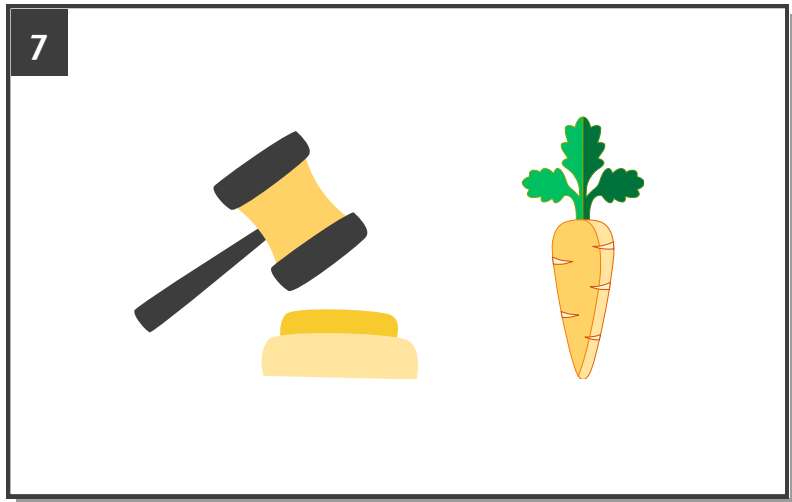
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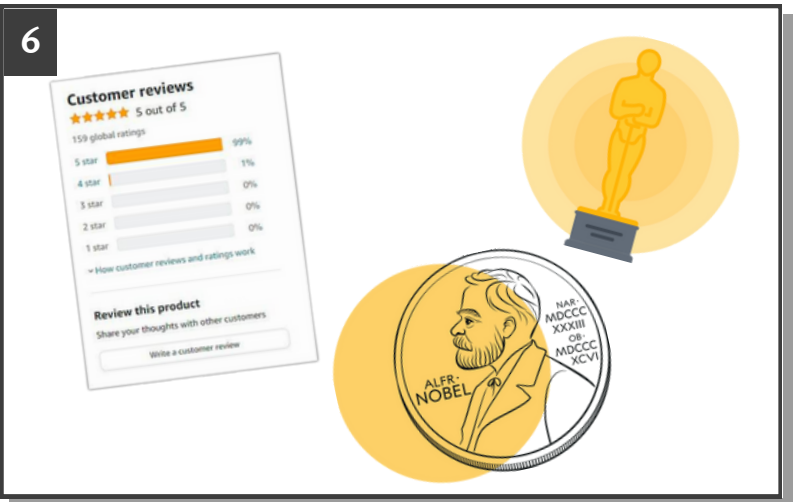
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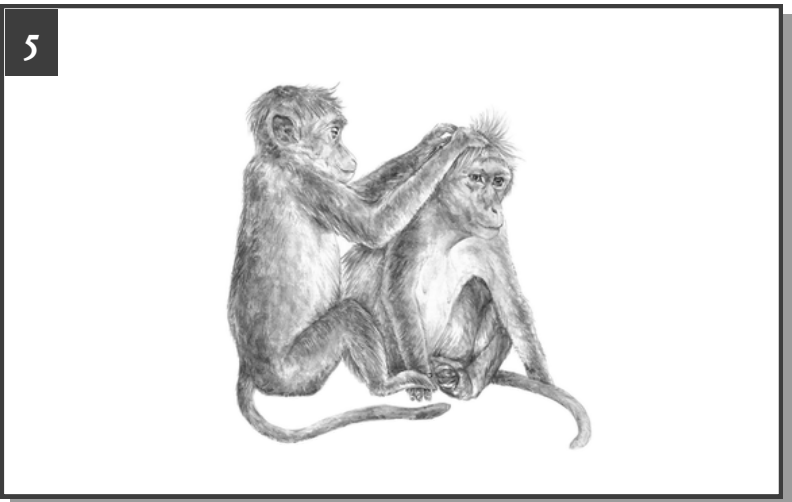
8 or selection based on kinship and group membership.



7 punishments and rewards...



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Where does cooperation occur?

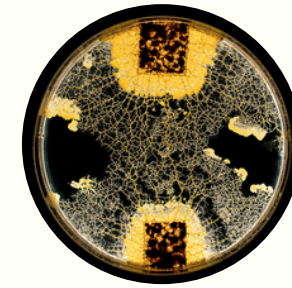
Where does cooperation occur?

Let's see some examples.



SLIME MOLDS

SLIME MOLD ELDER
Slime molds are single-celled organisms, amoebas living in the ground.



When resources are scarce, slime molds group together to form stalks with bulbs (fruiting bodies) at one end.

The fruiting body contains spores that end up producing other slime mold cells.

Meanwhile the cells in the stalk die, having 'sacrificed' themselves.



Solman, P. (2012, April 5). *Slime Molds: No Brains, No Feet, No Problem*. *PBS NewsHour*.

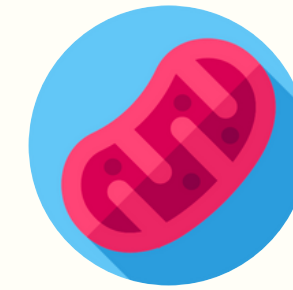
Kin, K., & Schaap, P. (2021). Evolution of Multicellular Complexity in The Dictyostelid Social Amoebas. *Genes*, 12(4).



MITOCHONDRIA & CELLS

MITOCHONDRIA ELDER

Legend has it that about 1.8 billion years ago an early cell swallowed a bacterium—but instead of digesting it, it kept the bacterium around inside its body.



The bacterium went on living and reproducing inside its host cell.

This arrangement proved somehow useful, and managed to stay on, perpetuating itself.

what were the tradeoffs involved?

The two entities evolved into the eukaryotic cells with mitochondria that make up all y'all bodies to this day.



LYNN MARGULIS

The details of this process are still subject to much debate. 

Margulis, L. (1970). *Origin of Eukaryotic Cells*. Yale University Press.

Martin, W., Hoffmeister, M., Rotte, C., & Henze, K. (2001). An overview of endosymbiotic models for the origins of eukaryotes, their ATP-producing organelles (mitochondria and hydrogenosomes), and their heterotrophic lifestyle. *Biological Chemistry*, 382(11), 1521–1539.

Hummert, S., Bohl, K., Basanta, D., Deutsch, A., Werner, S., Theissen, G., Schroeter, A., & Schuster, S. (2014). Evolutionary game theory: cells as players. *Molecular bioSystems*, 10(12), 3044–3065.

Lane, N. (2018). *Power, Sex, Suicide: Mitochondria and the Meaning of Life (Second Edition)*. Oxford University Press.

PBS Eons (2018). [How Two Microbes Changed History](#). YouTube.

LEAFCUTTER ANTS



E. O. WILSON



Leafcutter ants have complex, highly organized societies.

With very defined roles: a (single) queen, males, workers.

And caste-based division of labor: some ants forage for food (leaf fragments), others handle the foraged food back at the nest.

Remarkably, leafcutter ants farm a special type of fungus, which they use as food.

how does such specialization arise?



Holldobler, B., & Wilson, E. O. (2010). *The Leafcutter Ants: Civilization by Instinct (Illustrated edition)*. Norton & Company.



VAMPIRE BATS

VAMPIRE BAT ELDER

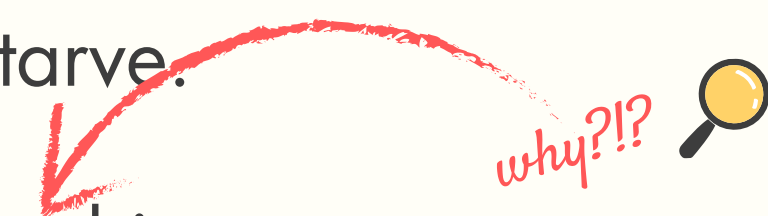
We live in crowded caves, but need to go out every night to procure food. 🩸



But sometimes we're unlucky, don't find any food, and return to the roost hungry.

If this happens three days in a row we starve.

Fortunately, luckier mates are willing to share food in case of need.



Wilkinson, G. S. (1984). Reciprocal food sharing in the vampire bat. *Nature*, 308(5955), 181–184.

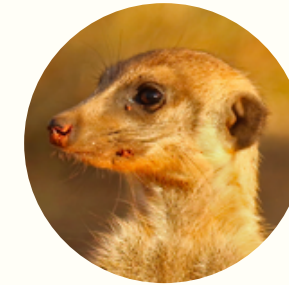
Carter, G. G., Farine, D. R., Crisp, R. J., Vrtilik, J. K., Ripperger, S. P., & Page, R. A. (2020). Development of New Food-Sharing Relationships in Vampire Bats. *Current Biology*, 30(7), 1275–1279.



MEERKATS

MEERKAT ELDER

It is a truth widely acknowledged that in every group there must be a dominant male and female.



Dominants do most of the breeding: about 90% of the pups are born to the dominant female.

By the natural ordering of things, subordinates help the dominants raise their offspring.



For instance, if a subordinate finds a scorpion, common sense dictates they will deliver it to the children of the dominants.



mmm scorpions... 😊

Griffin, A. S., Pemberton, J. M., Brotherton, P. N. M., McIlrath, G., Gaynor, D., Kansky, R., & Clutton-Brock, T. H. (2003). A genetic analysis of breeding success in the cooperative meerkat (*Suricata suricatta*). *Behavioral Ecology*, 14(4), 472–480.





PEOPLE

GEORGE FREDERIC WATTS

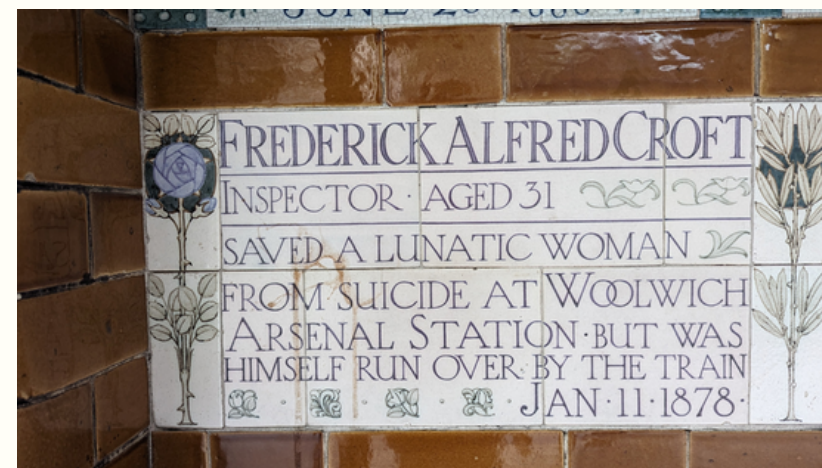
People sometimes engage in amazing acts of altruism.



You can see a glimpse of this at the *Memorial of Heroic Self-Sacrifice* in Postman's Park, London.

(that I set up)

*is there anything in it for them?
does that even matter?*



There are many example of humans being altruistic.

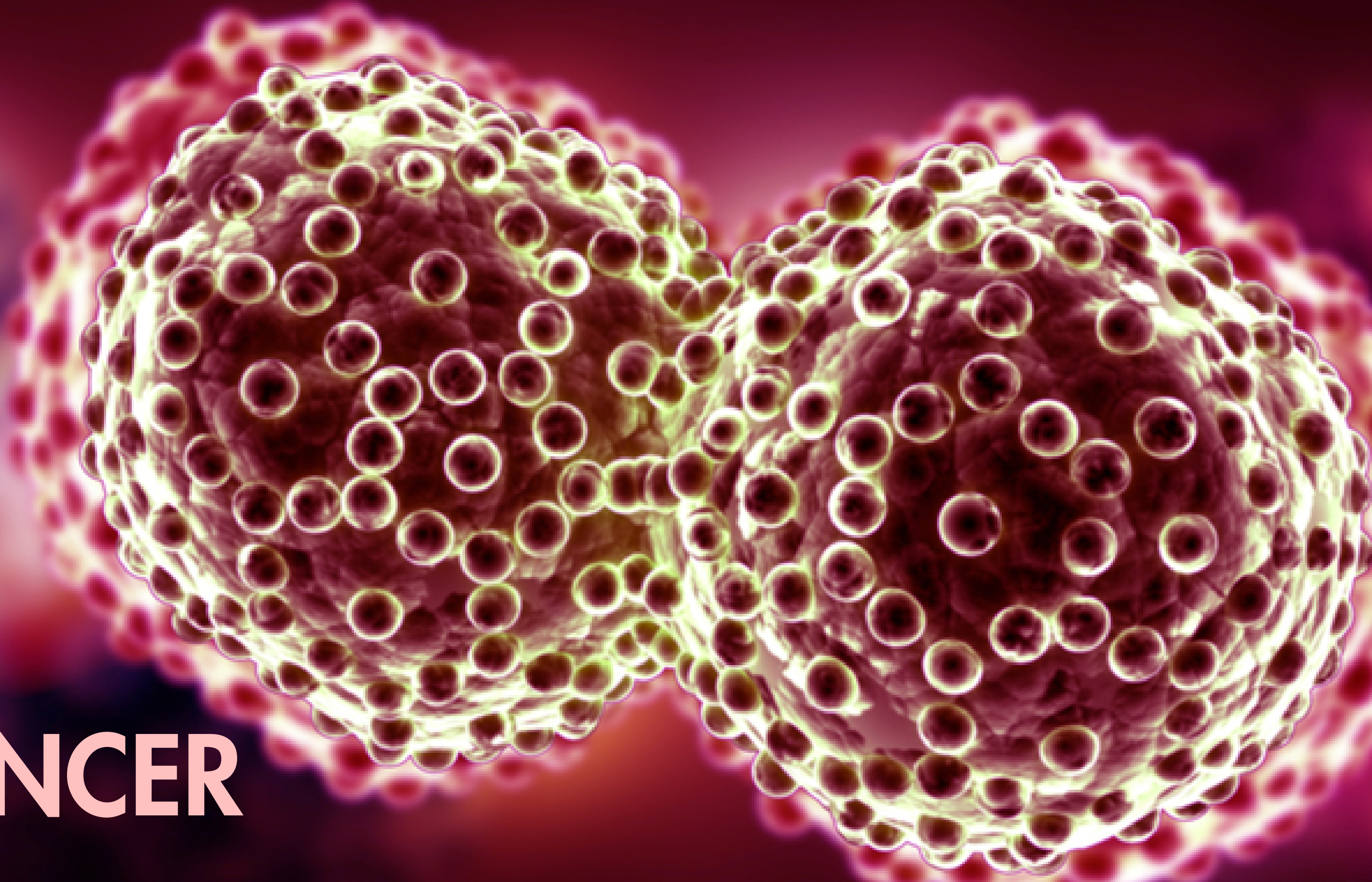
But these are anecdotes.

How altruistic are people *really*?



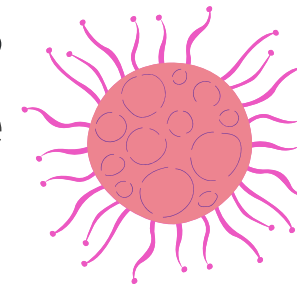
Let's also look at some *failures*
of cooperation.

CANCER



CANCER CELL ELDERS

In a normally functioning organism, cells are cooperative: liver cells do liver stuff, skin cells do skin stuff.



But sometimes, as result of mutation, cells go rogue and start multiplying uncontrolled, syphoning off resources from other cells.

Also known as cancer.

what keeps 'normal' cells in check?



ANARCHIST BEES



BEE ELDER
With our distant cousins the ants, workers are usually sterile.



But worker bees *can* lay eggs—just that normally they leave this task to the queen.

There is, however, a mutation that turns worker bees into anarchists that keep laying eggs (even when there is a queen).

When this mutation occurs, workers become more interested in making babies than in working for the colony.

As the mutation becomes more prevalent, the colony itself becomes less productive.

ok, but why aren't all bees anarchists?





CORRUPTION



Corruption is an abuse of entrusted power for private gain.

Transparency International. *Long Methodological Brief*, p.2.

DON CORLEONE

The way I like to think about it is, you take things from this big pot lying around, and you put it into the pockets of your family.

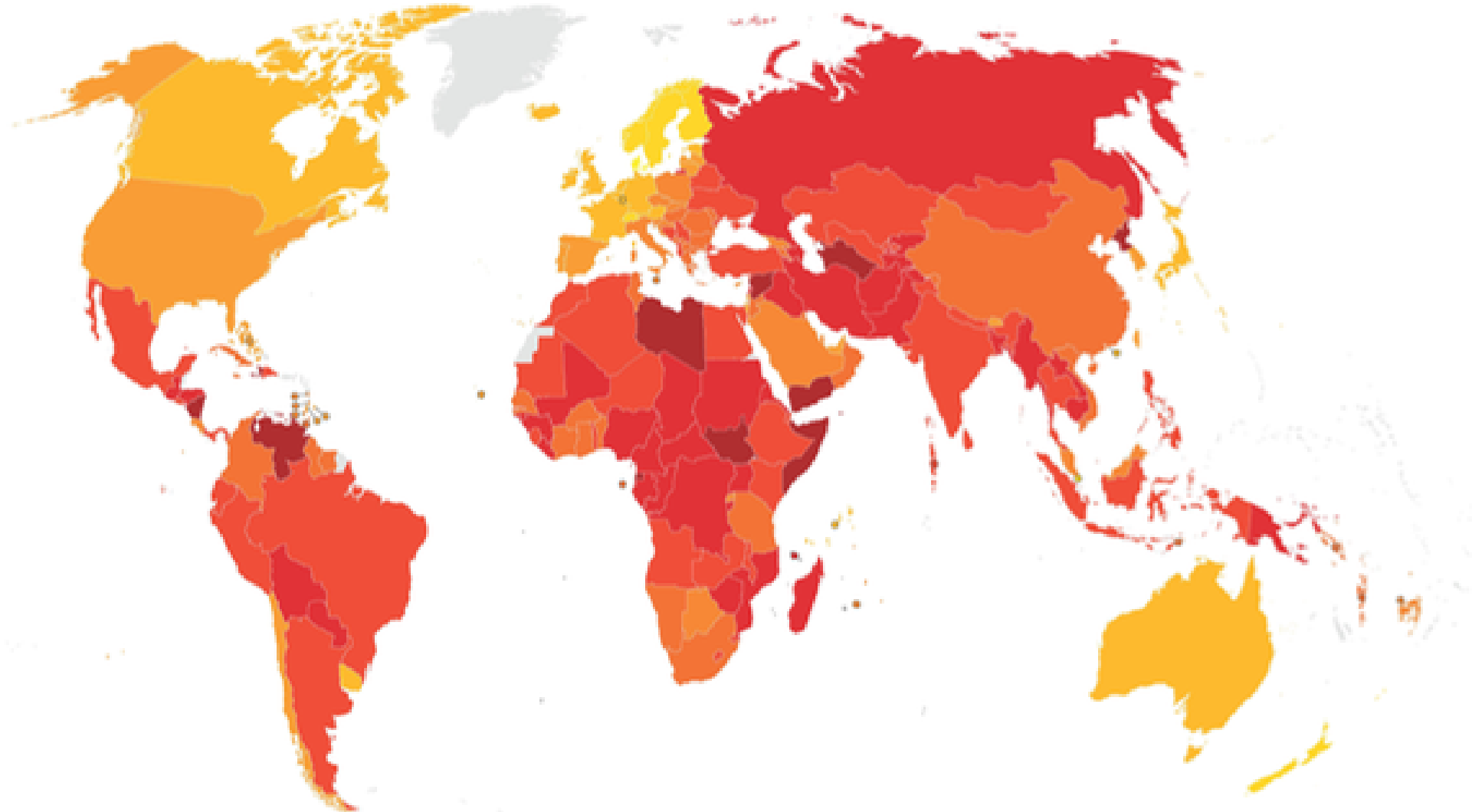


I don't see anything wrong with that.

aren't we all supposed to look after our families?

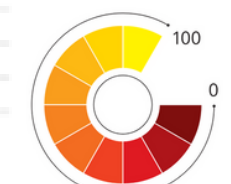
CORRUPTION PERCEPTIONS INDEX 2023

The perceived levels of public sector corruption in 180 countries/territories around the world.



Notice anything?

SCORE	COUNTRY/TERRITORY	SCORE	COUNTRY/TERRITORY	SCORE	COUNTRY/TERRITORY	SCORE	COUNTRY/TERRITORY	SCORE	COUNTRY/TERRITORY	SCORE	COUNTRY/TERRITORY
90	Denmark	68	United Arab Emirates	52	Fiji	42	Moldova	36	Ukraine	29	Bolivia
87	Finland	67	Taiwan	52	Saudi Arabia	42	North Macedonia	35	Bosnia and Herzegovina	29	Pakistan
85	New Zealand	66	Chile	51	Malta	42	Trinidad and Tobago	35	Dominican Republic	29	Papua New Guinea
84	Norway	64	Bahamas	51	Mauritius	41	Burkina Faso	35	Egypt	28	Gabon
83	Singapore	64	Cabo Verde	50	Croatia	41	Kosovo	35	Nepal	28	Laos
82	Sweden	63	Korea, South	50	Malaysia	41	South Africa	35	Panama	28	Mali
82	Switzerland	62	Israel	49	Greece	41	Vietnam	35	Sierra Leone	28	Paraguay
79	Netherlands	61	Lithuania	49	Namibia	40	Colombia	35	Thailand	27	Cameroon
78	Germany	61	Portugal	48	Vanuatu	40	Côte d'Ivoire	34	Ecuador	26	Guinea
78	Luxembourg	60	Latvia	46	Armenia	40	Guyana	34	Indonesia	26	Kyrgyzstan
77	Ireland	60	Saint Vincent and the Grenadines	46	Jordan	40	Suriname	34	Malawi	26	Russia
76	Canada	60	Spain	46	Kuwait	40	Tanzania	34	Philippines	26	Uganda
76	Estonia	60	Botswana	46	Montenegro	40	Tunisia	34	Sri Lanka	25	Liberia
75	Australia	59	Qatar	46	Romania	39	India	34	Turkey	25	Madagascar
75	Hong Kong	58	Czechia	45	Bulgaria	39	Kazakhstan	34	Angola	25	Mozambique
73	Belgium	57	Dominica	45	Sao Tome and Principe	39	Lesotho	33	Mongolia	25	Nigeria
73	Japan	56	Italy	44	Jamaica	39	Maldives	33	Peru	24	Bangladesh
73	Uruguay	56	Slovenia	43	Benin	38	Morocco	33	Uzbekistan	24	Central African Republic
72	Iceland	55	Costa Rica	43	Ghana	37	Argentina	33	Niger	24	Iran
71	Austria	55	Saint Lucia	43	Oman	37	Belarus	32	El Salvador	24	Lebanon
71	France	54	Poland	43	Senegal	37	Ethiopia	31	Kenya	24	Zimbabwe
71	Seychelles	54	Slovakia	43	Solomon Islands	37	Gambia	31	Mexico	23	Azerbaijan
71	United Kingdom	53	Cyprus	42	Timor-Leste	37	Zambia	31	Togo	23	Guatemala
69	Barbados	53	Georgia	42	Bahrain	36	Algeria	30	Djibouti	23	Honduras
69	United States	53	Grenada	42	China	36	Brazil	30	Eswatini	23	Iraq
68	Bhutan	53	Rwanda	42	Hungary	36	Serbia	30	Mauritania	22	Cambodia



THE CPI USES A SCALE FROM 0 TO 100
100 is very clean and 0 is highly corrupt

DON CORLEONE

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I don't see anything wrong with that.



JOE HENRICH

Most of the least corrupt countries seem to be WEIRD...

Coincidence?

*Western, Educated, Industrialized,
Rich, Democratic*

Henrich, J. (2020). *The WEIRDest People in the World: How the West Became Psychologically Peculiar and Particularly Prosperous*. Farrar, Straus and Giroux.

+1.2°C 2.16°F

CLIMATE ACTION

+1.0°

+0.8°

+0.6°

+0.4°

+0.2°

0°

-0.2°

1880

1915

1950

1985

2021

Source: NASA GISS & NOAA NCEI global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910). Data as of 1/13/2022.

CLIMATE  CENTRAL

Cyclone Freddy

In 2023, around 500,000 people were estimated to have been affected by floods, mudslides and wind damage following the passage of Tropical Cyclone Freddy in southern Malawi.



JOSEPH STIGLITZ

Poor countries should be provided with \$300bn a year from the International Monetary Fund to finance their fight against the climate crisis.



It will probably be impossible to get this through the US Congress in its current deadlocked state though...

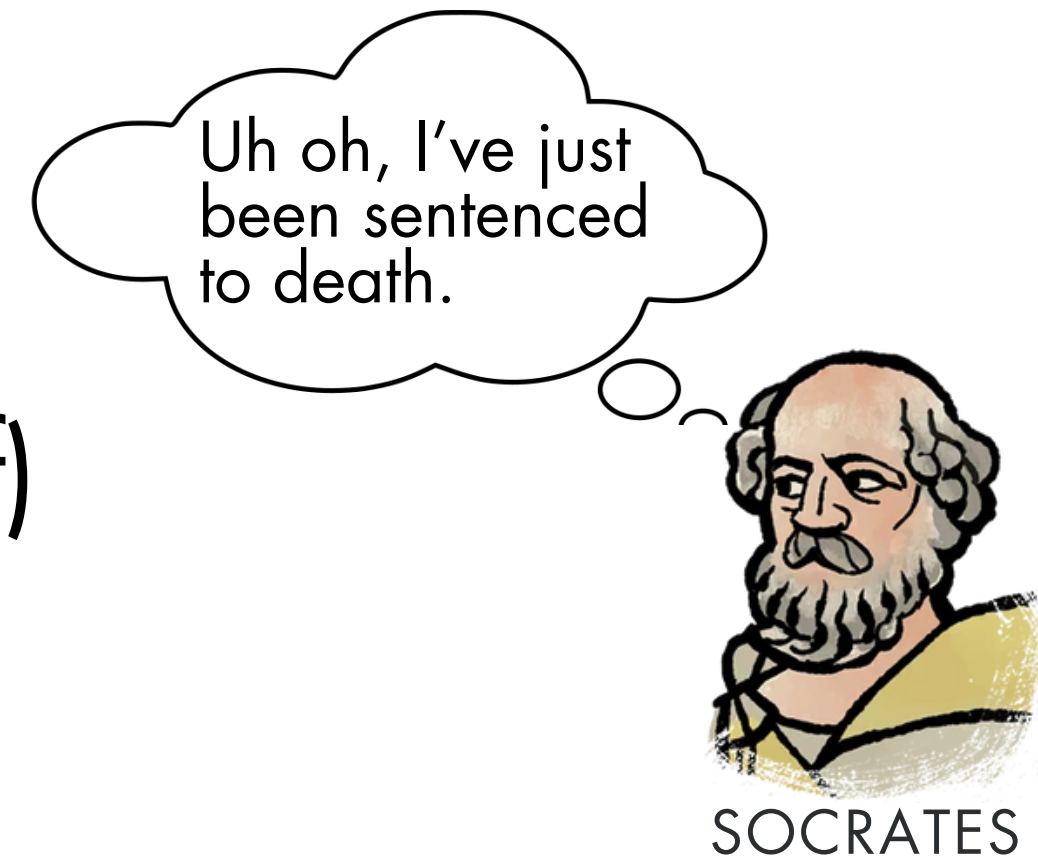
why wouldn't the US want to help poorer countries?

Elliott, L. (2023, October 13). IMF should give poor countries \$300bn a year to fight climate crisis, says Joseph Stiglitz. *The Guardian*.

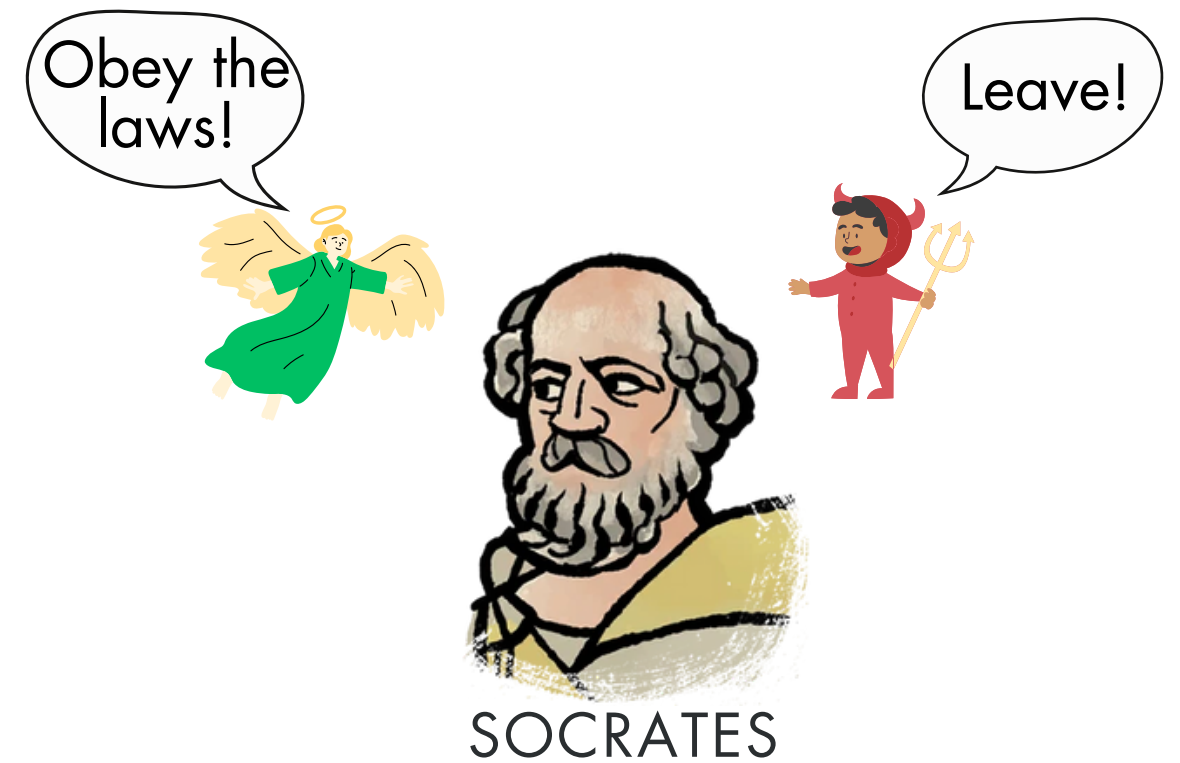
A cell, a worker bee, a person, a US congressman: why should they cooperate with others?

We've said that there's a cost to cooperation: there's the rub.

Cooperation: the age-old conflict between self-interest vs (some version of) the common good.



Cooperation: the age-old conflict between self-interest vs (some version of) the common good.



We can make this drama more precise.

With a little detour through...

GAME THEORY