A brief intro to
social dilemmas ... and how
bacteria and humans solve them

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o Social dilemmas: interplay between individual "rational" actions and collective dynamics

o To cooperate means that the donor pays a cost and the recipient gets a benefit

o In evolution, cost and benefit are measured in terms of reproductive success

o Bacteria could help us identify principles that lead from competition to cooperation in specific biological settings

○ The payoff matrix of Game Theory

My move

A   B

Your move

A   a   b

B   c   d

Your payoff

o Imagine this payoff matrix; what would you do?

My move

A B

Your move

A   3   0

B   5   1

Your payoff

Two individuals can cooperate (C) or defect (D)

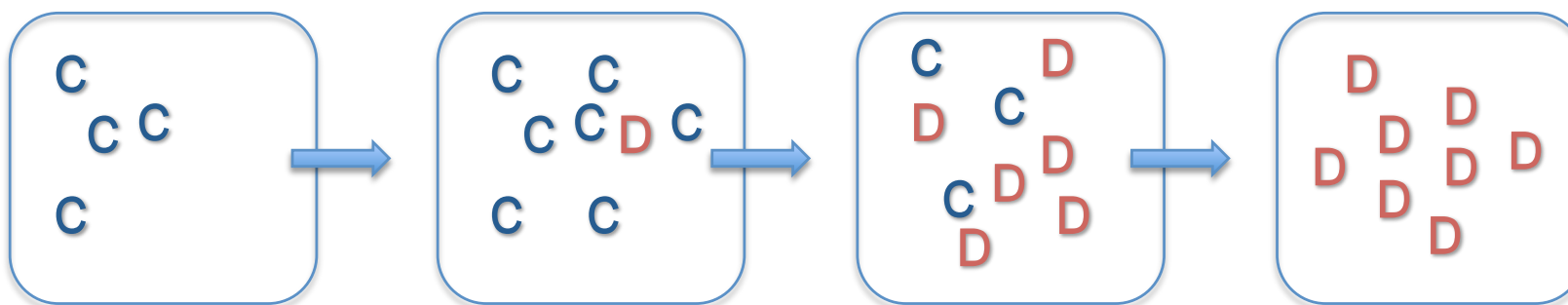They want to maximize their respective payoff

My move

	C	D
C	b-c	-c
D	b	0

Your move

Your payoff;
$b>c>0$

The Prisoner's Dilemma
"rationality" leads to D

Evolution of defection

D's always a higher payoff

Defectors outcompete cooperators;
natural selection favors defection

Imagine now that the game is <u>repeated</u> m times

Two strategies: GRIM (cooperate on the 1st move and then cooperate as long as the opponent does not defect; if she defects once GRIM switches permanently to defection) or always defect (allD)

My move

Direct reciprocity stabilizes cooperation

GRIM allD

Your move

GRIM $3m$ $0 + (m\text{-}1)$

allD $5 + (m\text{-}1)$ m

Your payoff

Is GRIM an ideal strategy for the repeated Prisoner's Dilemma?

Tit-for-tat (TFT): start cooperating and then do whatever the opponent did in the previous round; TFT can thus resume cooperation if the opponent cooperate (unlike GRIM)

However, TFT cannot correct mistakes!

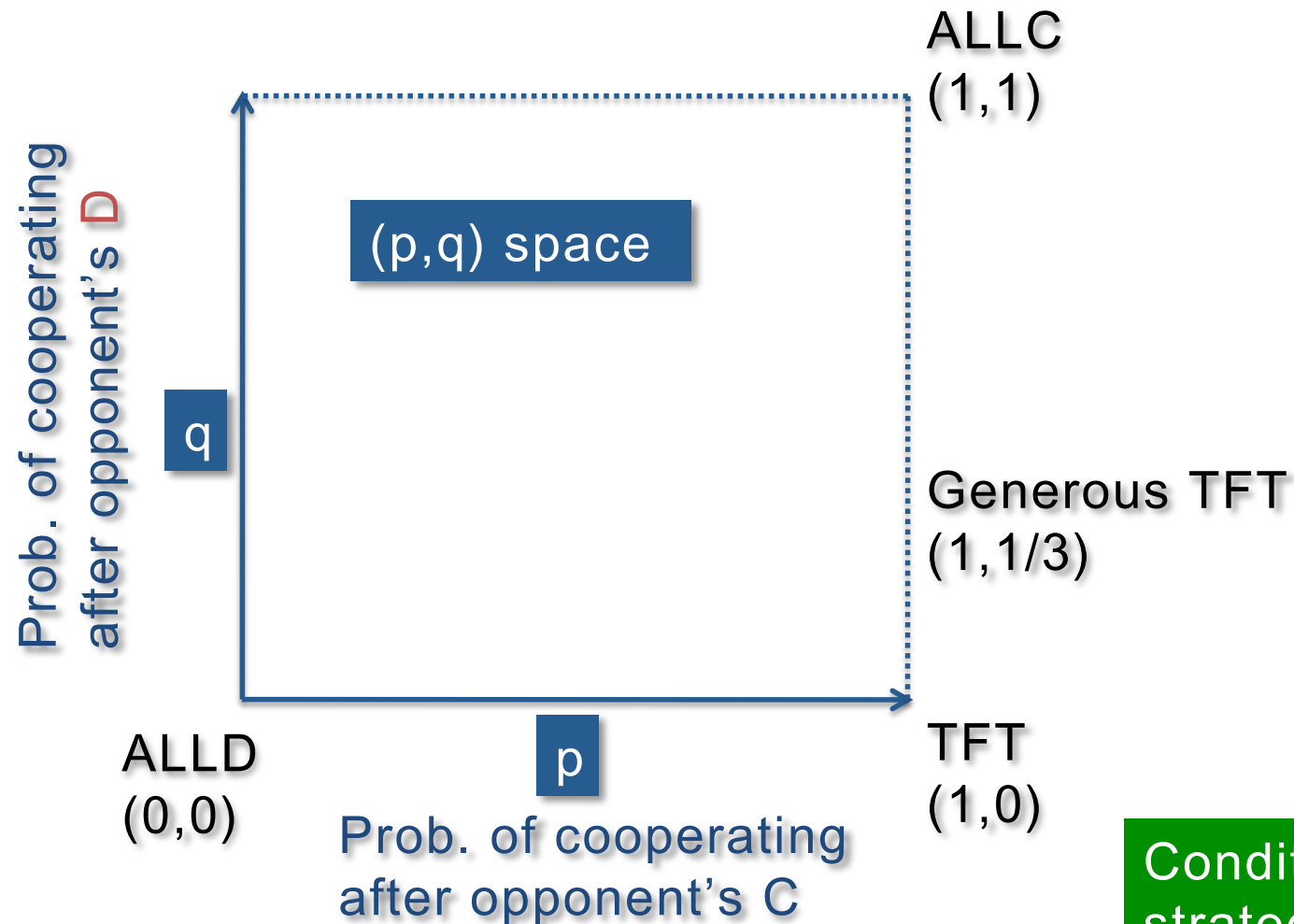TFT: C C C D C D C D D D ...

TFT: C C C C D C D D D D ...

o Three simple strategies in the PD, ALLC, ALLD, TFT

My move

TFT   allC (allD)

Your move

TFT

allC
(allD)

Payoffs?

Your payoff
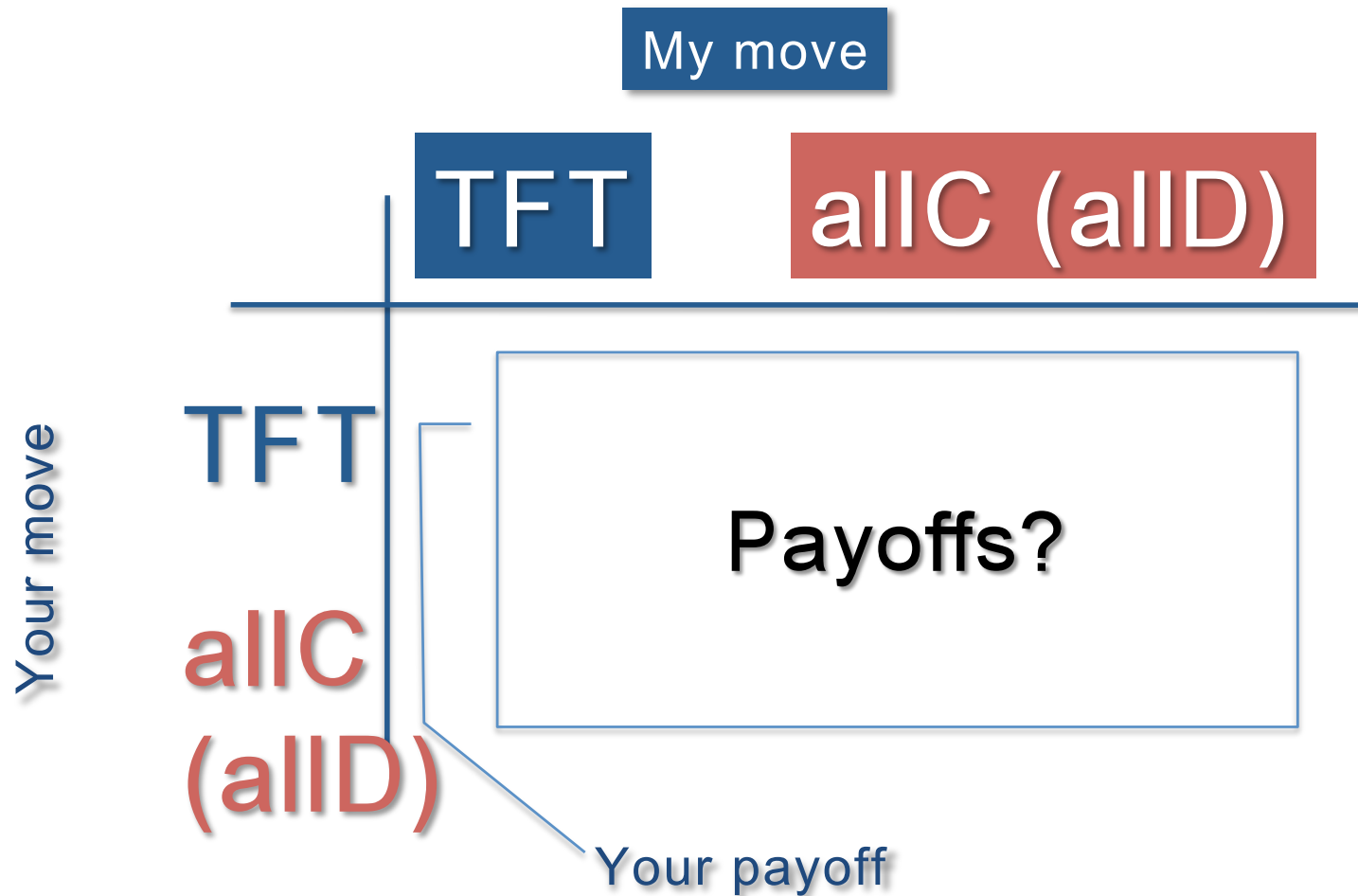
We could imagine the use of <u>reactive</u> strategies that cooperate *conditional* to the opponent previous strategy (cooperation or defection)

ALLC
(1,1)

(p,q) space

Prob. of cooperating after opponent's D

q

Generous TFT
(1,1/3)

ALLD
(0,0)

p

TFT
(1,0)

Prob. of cooperating after opponent's C

Conditional (reactive) strategies

If I cooperate I pay a cost

Watch out for the free-riders!

It is always better to interact more than once with the same people

She sometimes cooperates when the opponent has defected, she is a generous tit-for-tater!

References

- The evolution of cooperation (revised edition). Axelrod R, Perseus Books (2006)
- Evolutionary dynamics. Nowak MA, Harvard Upress (2006)