

# SOCIAL|evolution

The formation,

maintenance

and transformation

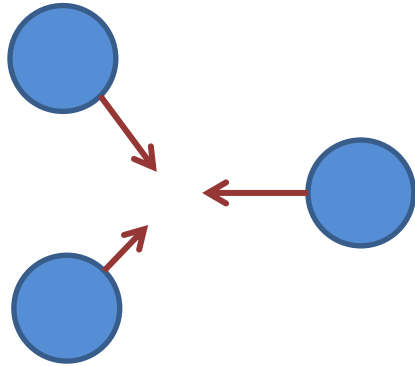
of groups

are all underpinned by strategic interactions



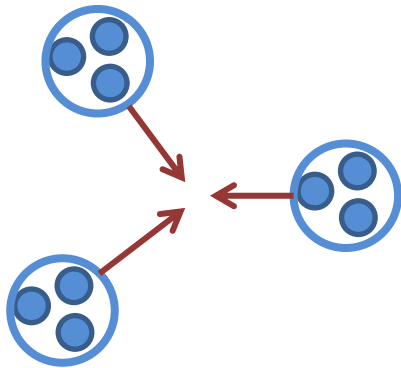
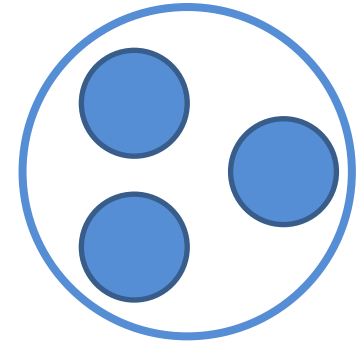
What features of the environment can explain variation in behaviour?





Formation

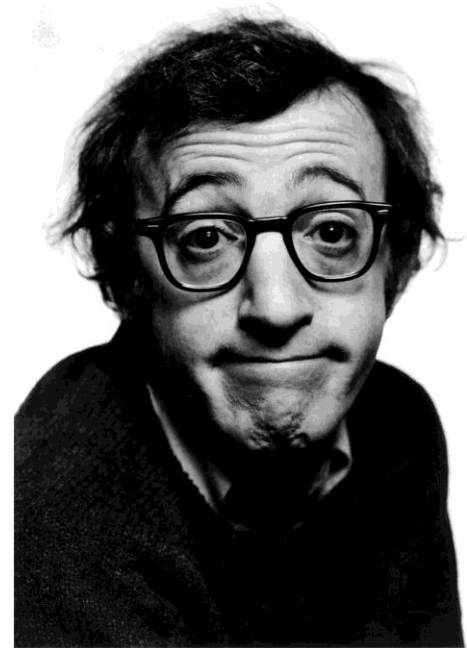
Maintenance



Transformation

# Social relationships...

They're totally crazy, irrational, and absurd, but we keep going through it because we need the eggs.



# LEARNING aims

---

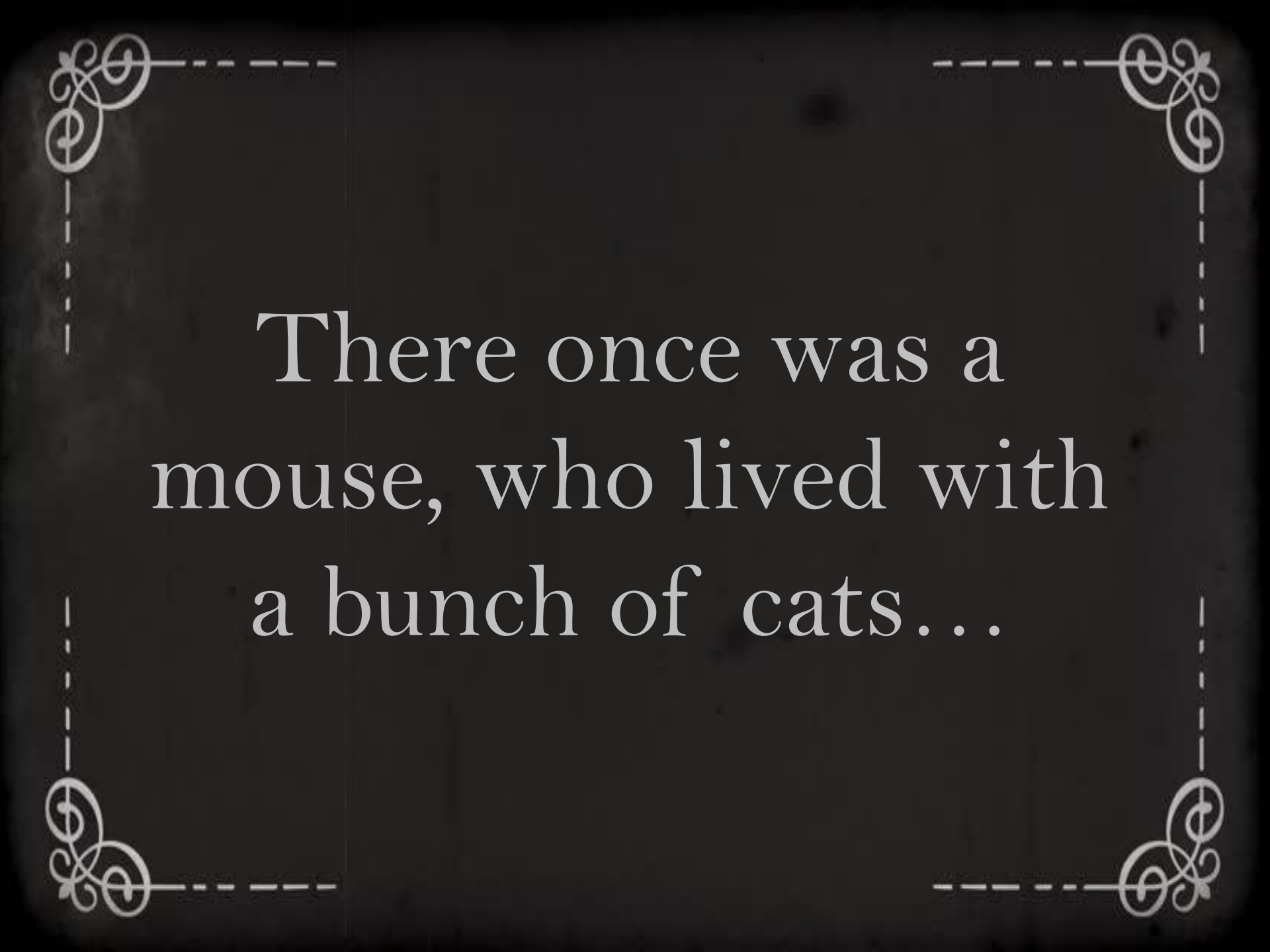
- How to think strategically
- How to place strategic thinking within an ecological context

# THINKING|strategically

Social behaviour involves the interaction of several individuals, and the best thing to do depends on what others are doing.

ITCHY & SCRATCHY  
*in*  
"PORCH PALS"





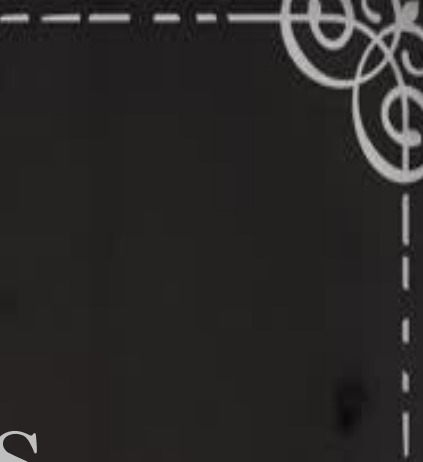



There once was a  
mouse, who lived with  
a bunch of cats...







Population



Individual/Agent



The mouse was  
hungry, and wanted  
some food.



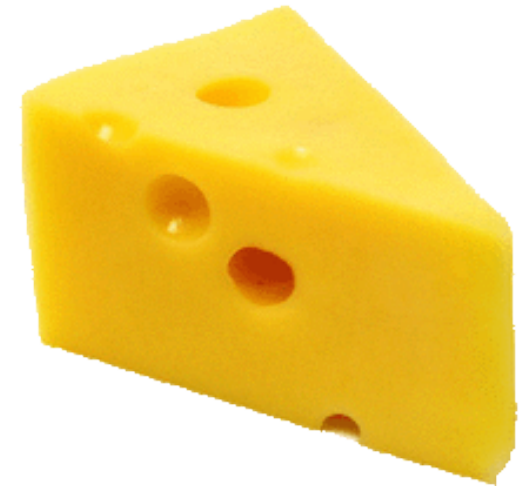
The mouse can improve his **payoff** by taking a particular **action**.

Payoffs are a proxy for fitness consequences



**Payoff** **+1**

**Action: Take Cheese**



**Payoff** **0**

**Action: Ignore Cheese**

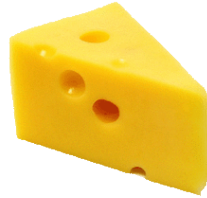


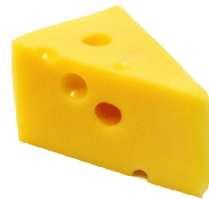


A hungry cat  
approaches...

... and complicates  
things.



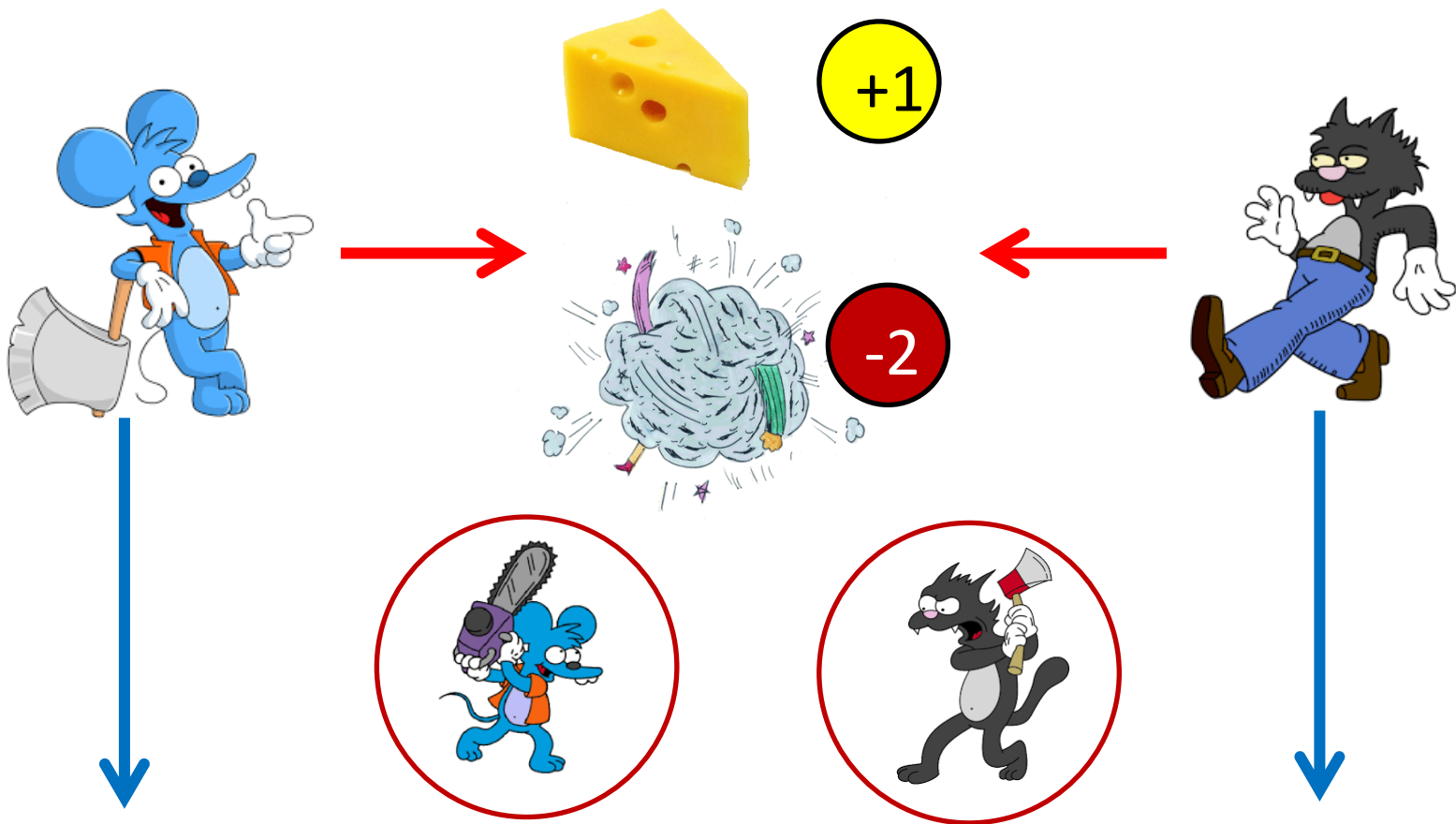


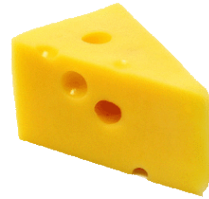


+1

0





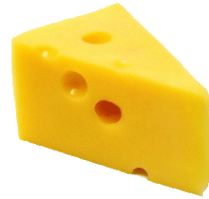


0

0







0

+1





0

0

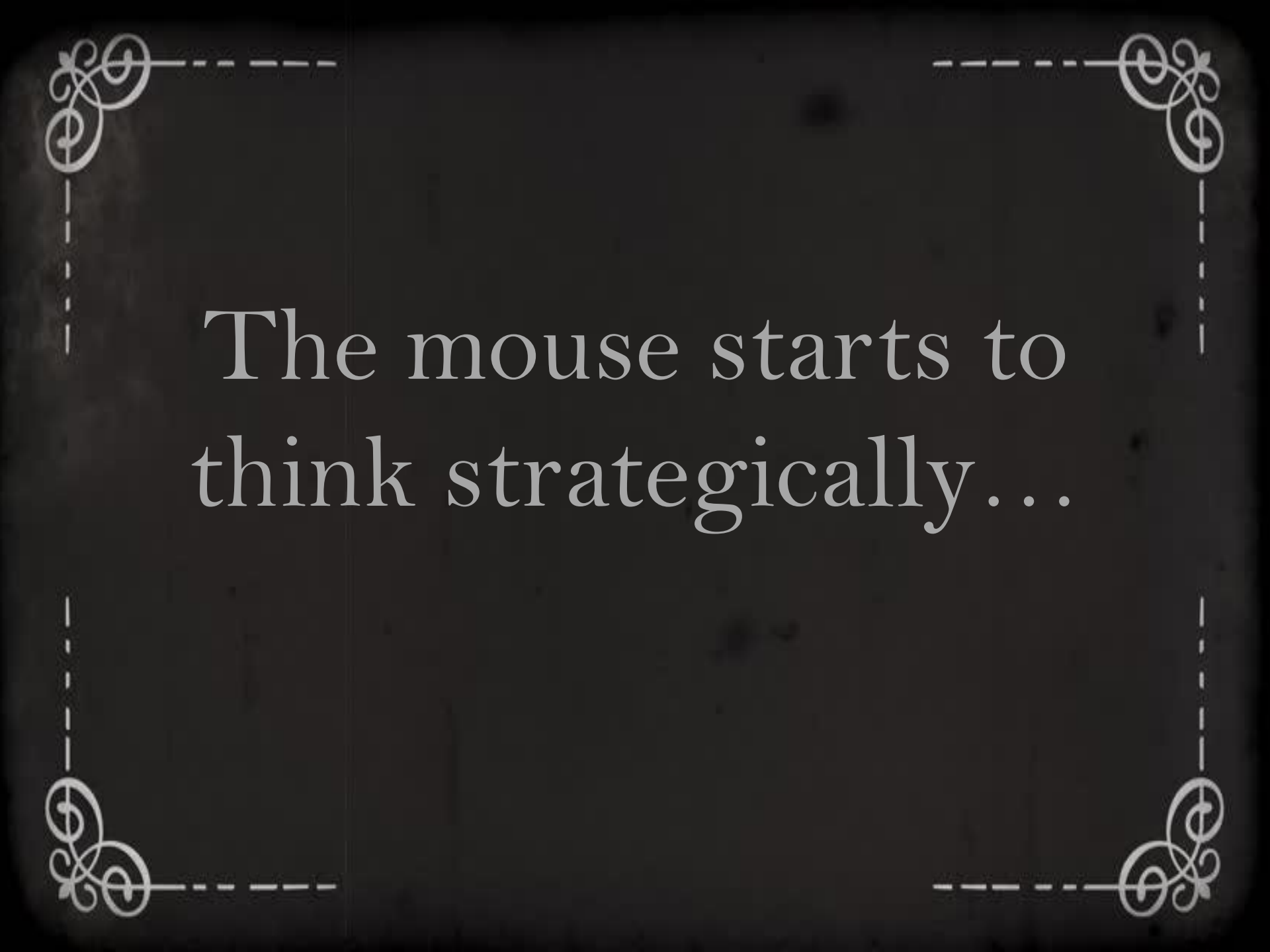
Best behaviour depends on  
what others are doing.



+1

+1

-2



The mouse starts to  
think strategically...

# Strategy

A complete plan that specifies the actions to take under every possible situation

**Strategy 1: Always take the cheese**

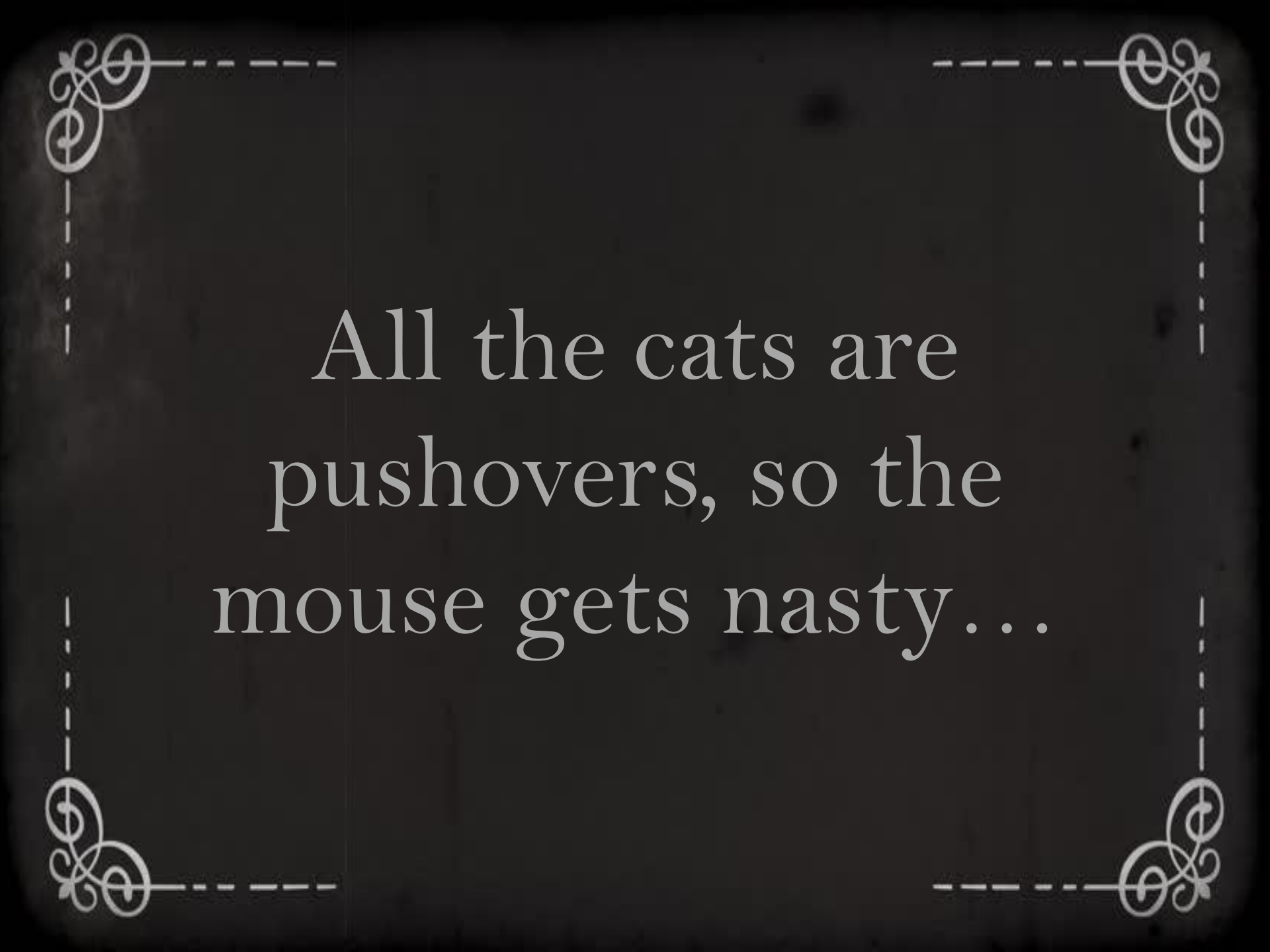


**Strategy 2: Always ignore the cheese**



**Strategy 3: Take the cheese only if the cat ignores it**





All the cats are  
pushovers, so the  
mouse gets nasty...

# Strategy

Always Take

Always Ignore

Mix it Up Somehow...

---



0

**Selection acts on  
strategies, not  
actions.**

# Strategy

Always Take

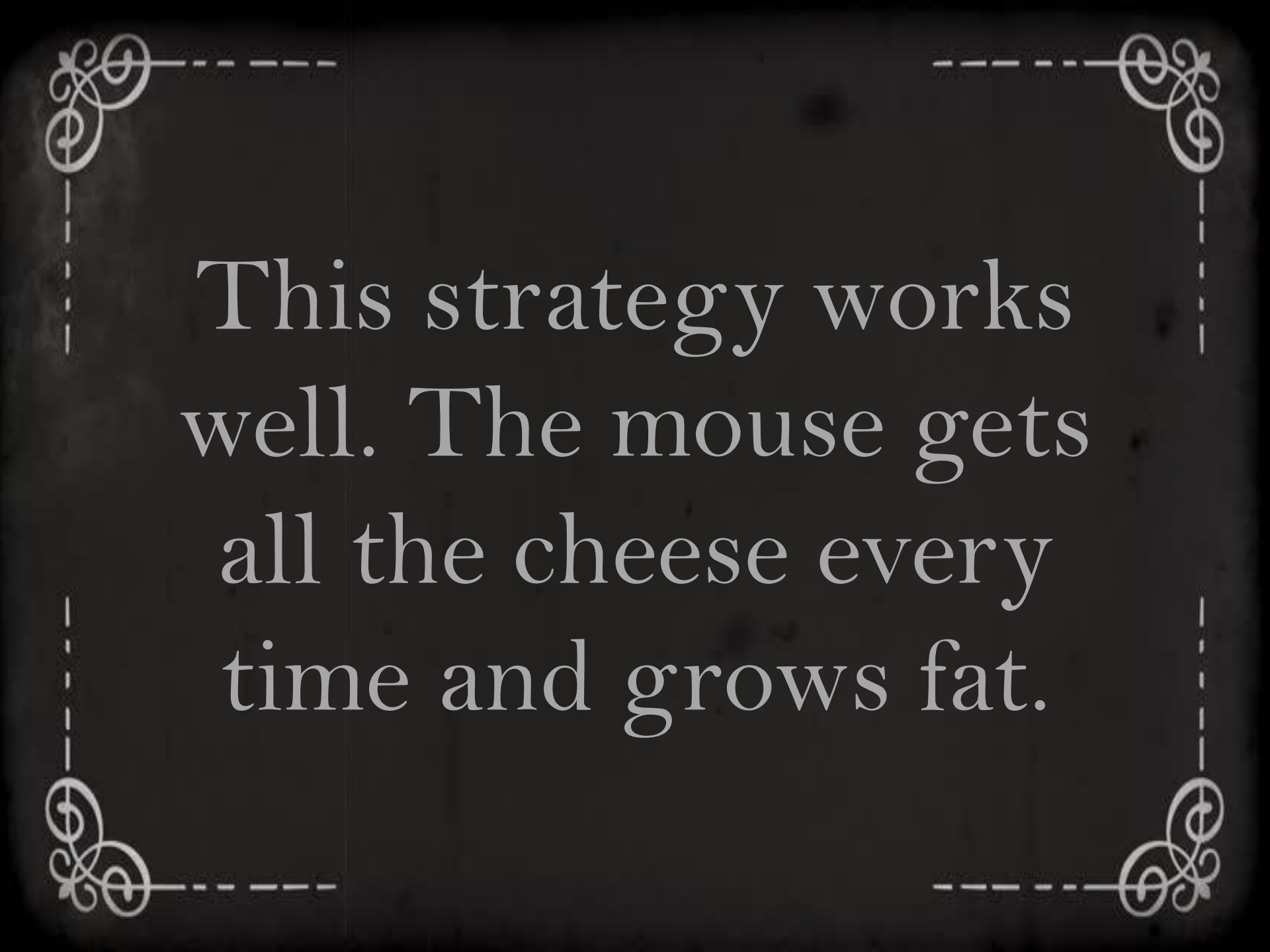
Always Ignore

Mix it Up Somehow...



+1





0







This strategy works well. The mouse gets all the cheese every time and grows fat.







But then the cats get  
sick of being pushed  
around...



# Strategy

Always Take



+1

Always Ignore



0

Mix it Up Somehow...

# Strategy

Always Take

Always Ignore

Mix it Up Somehow...



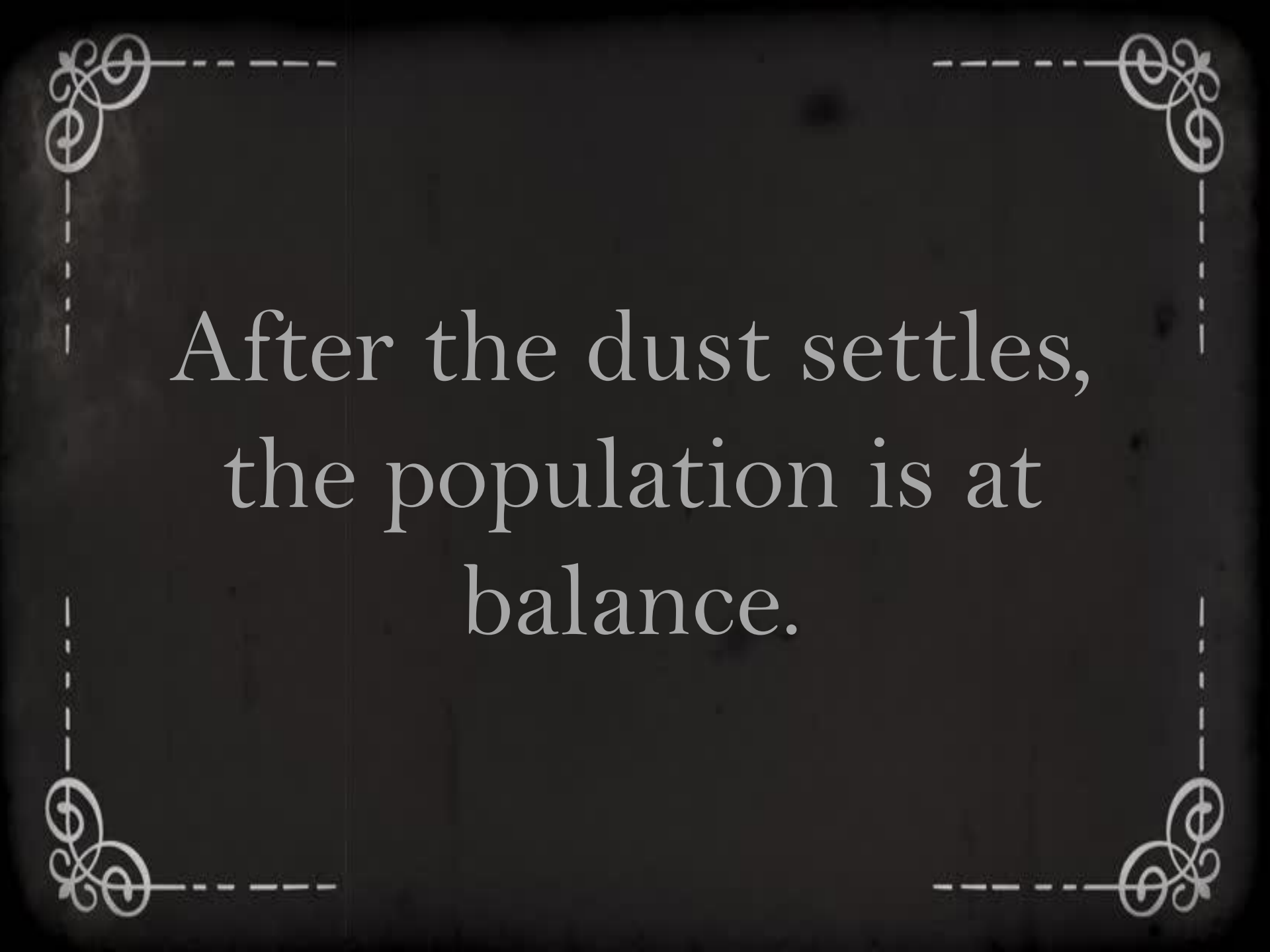
-1



0



A strategy's success depends on the distribution of strategies in the population



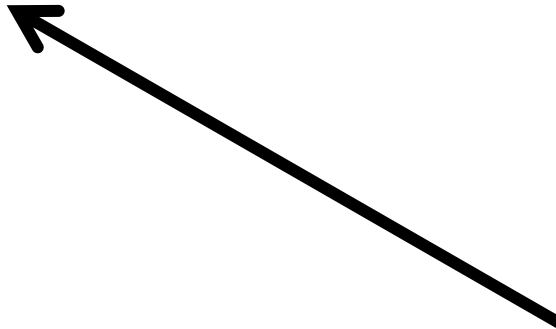
After the dust settles,  
the population is at  
balance.

# Strategy

Always Take

Always Ignore

Mix it Up Somehow...



+1

0

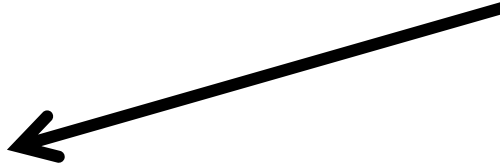
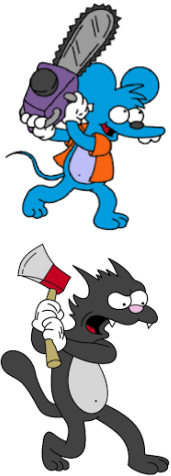
# Strategy

Always Take

Always Ignore

Mix it Up Somehow...

---



0

0

# Strategy

Always Take

Always Ignore

Mix it Up Somehow...

---



-1



0

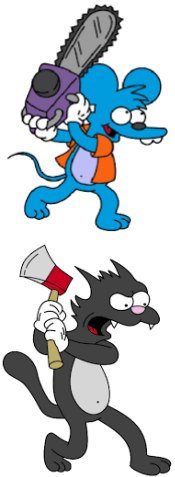


# Strategy

Always Take

Always Ignore

Mix it Up Somehow...



0

0

# Strategy

Always Take

Always Ignore

Mix it Up Somehow...

---



+1

0

# Strategy

Always Take

Always Ignore

Mix it Up Somehow...

---



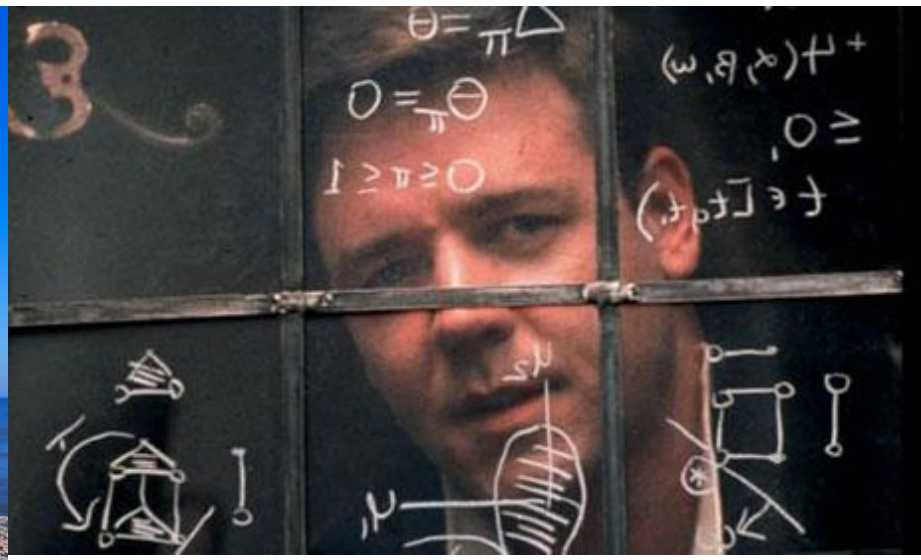
**At equilibrium, no individual can improve their situation by changing their strategy**

0

0

# NASH | equilibria

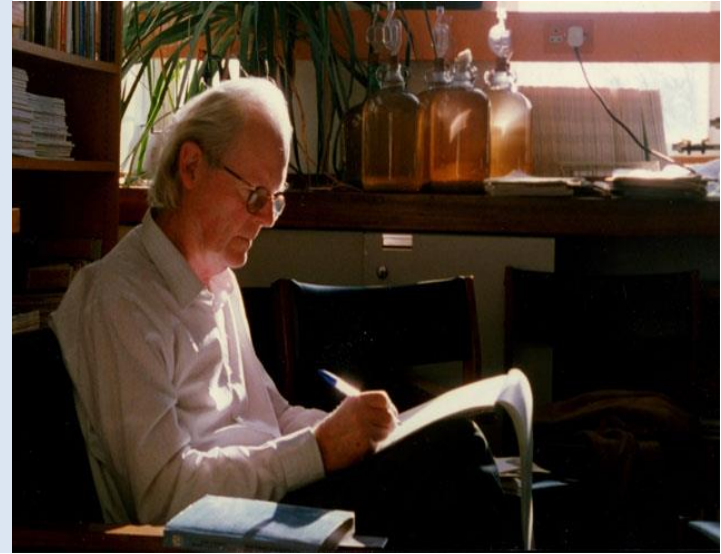
An individual **can not improve their payoff by changing their strategy**, given the strategy of their opponent



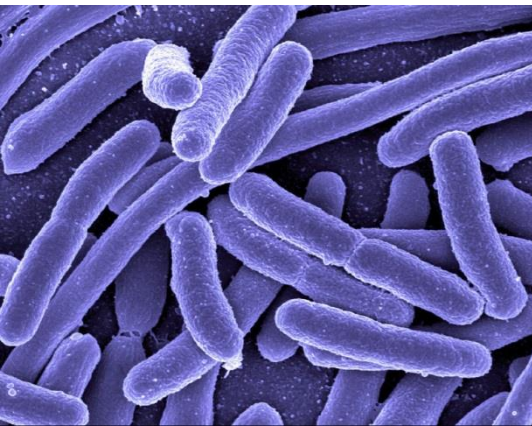
# Evolutionary Stable Strategies

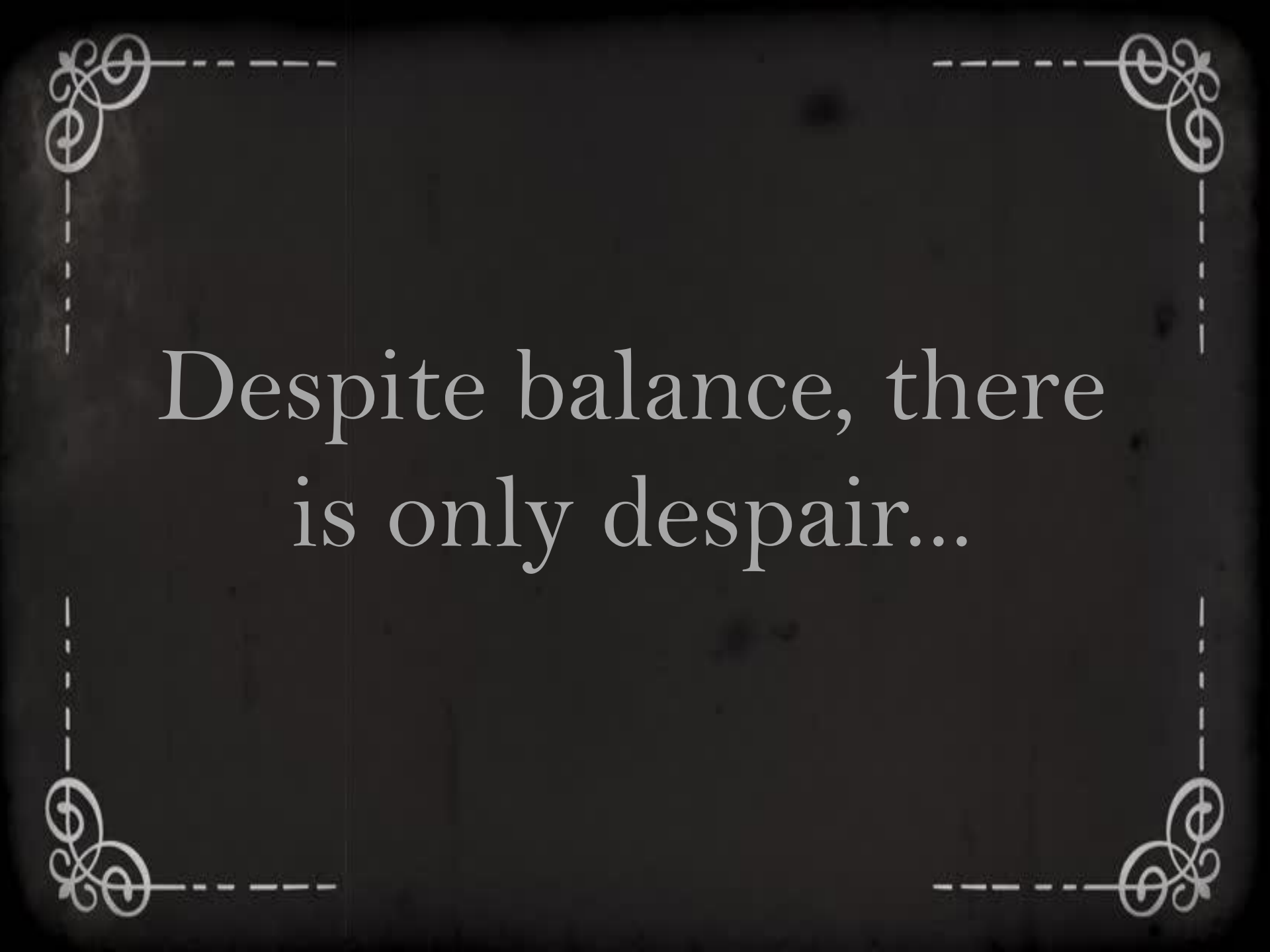
There is reproduction and natural selection.

Novel strategies can arise through mutation or mistakes.



**Not all Nash equilibria are evolutionarily stable.**







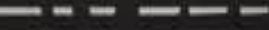



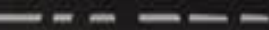

Despite balance, there  
is only despair...



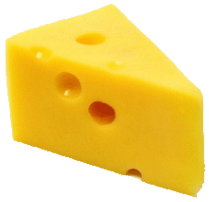
... an endless cycle of  
violence...







... and no better off  
than before.



Kicks ass when no resistance



At equilibrium, the expected payoff is 0. Same as if there were no cheese at all.

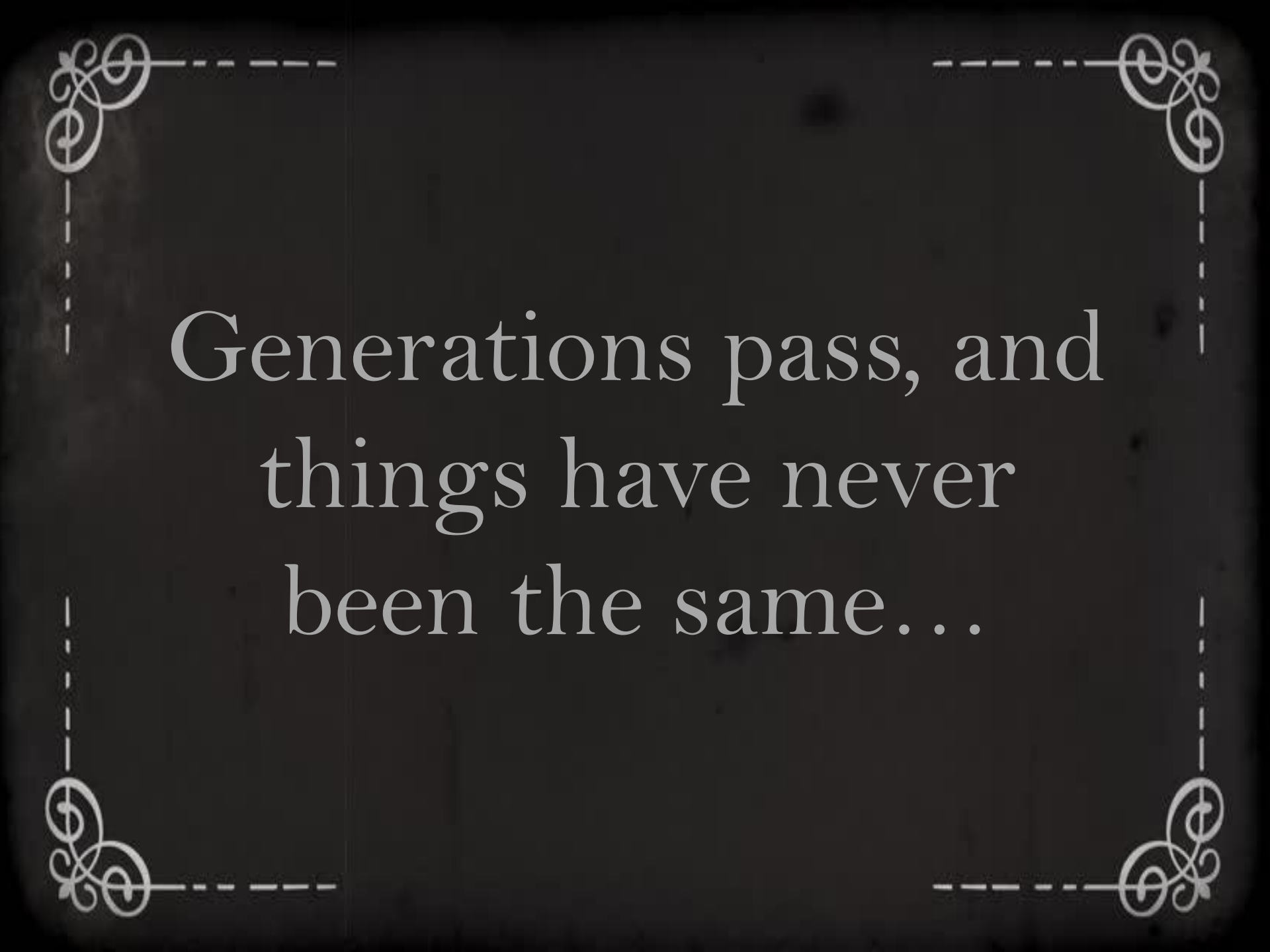


But too much fighting when everyone does it



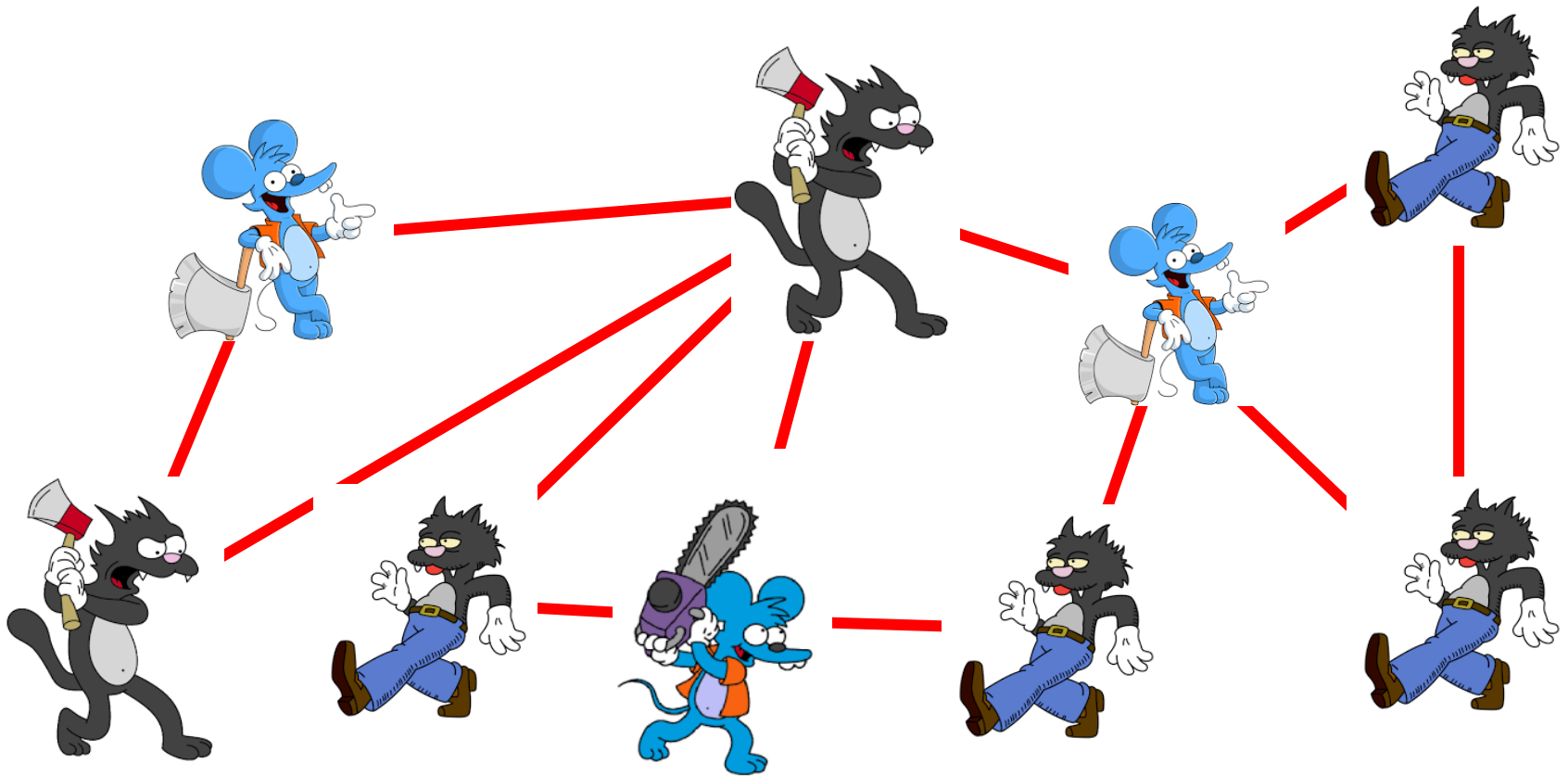
Individual payoffs are not necessarily maximised at an equilibrium.

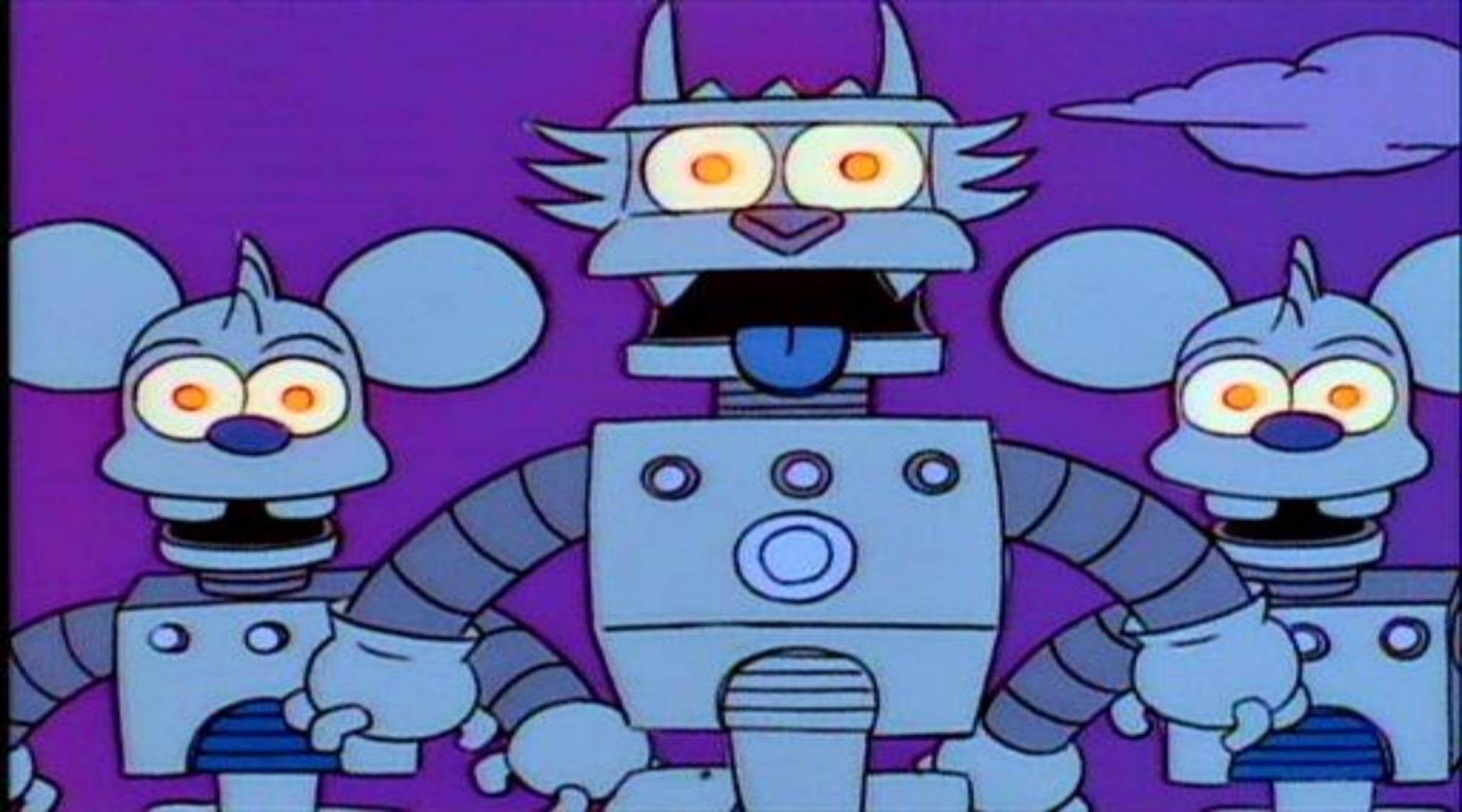
So don't look for optimal fitness. Look for an ESS.



Generations pass, and  
things have never  
been the same...

The population can be mapped onto a network of strategic interactions.





Social interactions are finely tuned by natural selection to be infallible strategic calculations that maximise fitness (in theory).

# RATIONALITY



If an individual knows

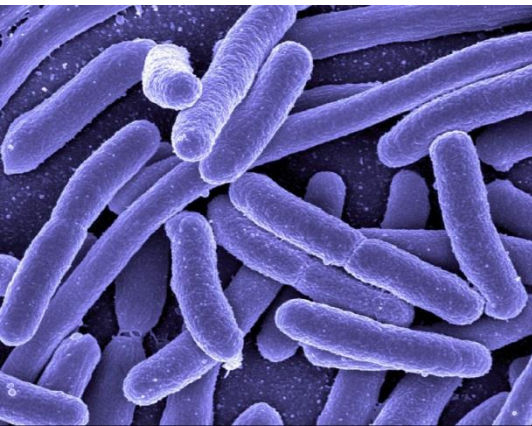
- How their opponent will act
- All the relevant payoffs
- The structure of the game
- What the outcome of their strategy will be

Then their strategy will reflect a Nash equilibrium.



# QUASI rationality

- All ESS correspond with a Nash equilibrium
- Therefore, the end point of evolution is a rational response even if individuals have no cognition or awareness of the situation
- **Natural selection shapes strategies to imitate rationality**



# DEEP ECOLOGICAL rationality

- Conditions of rationality are not met in nature!
  - Constant uncertainty
  - Things external to the game
- Differences between rationality and reality are helpful





*Fin*

619

**TOOL  
TIME**

# **TOOL TIME**

**Individuals and  
Populations**

**Strategies**

**Equilibrium**

**Payoffs**



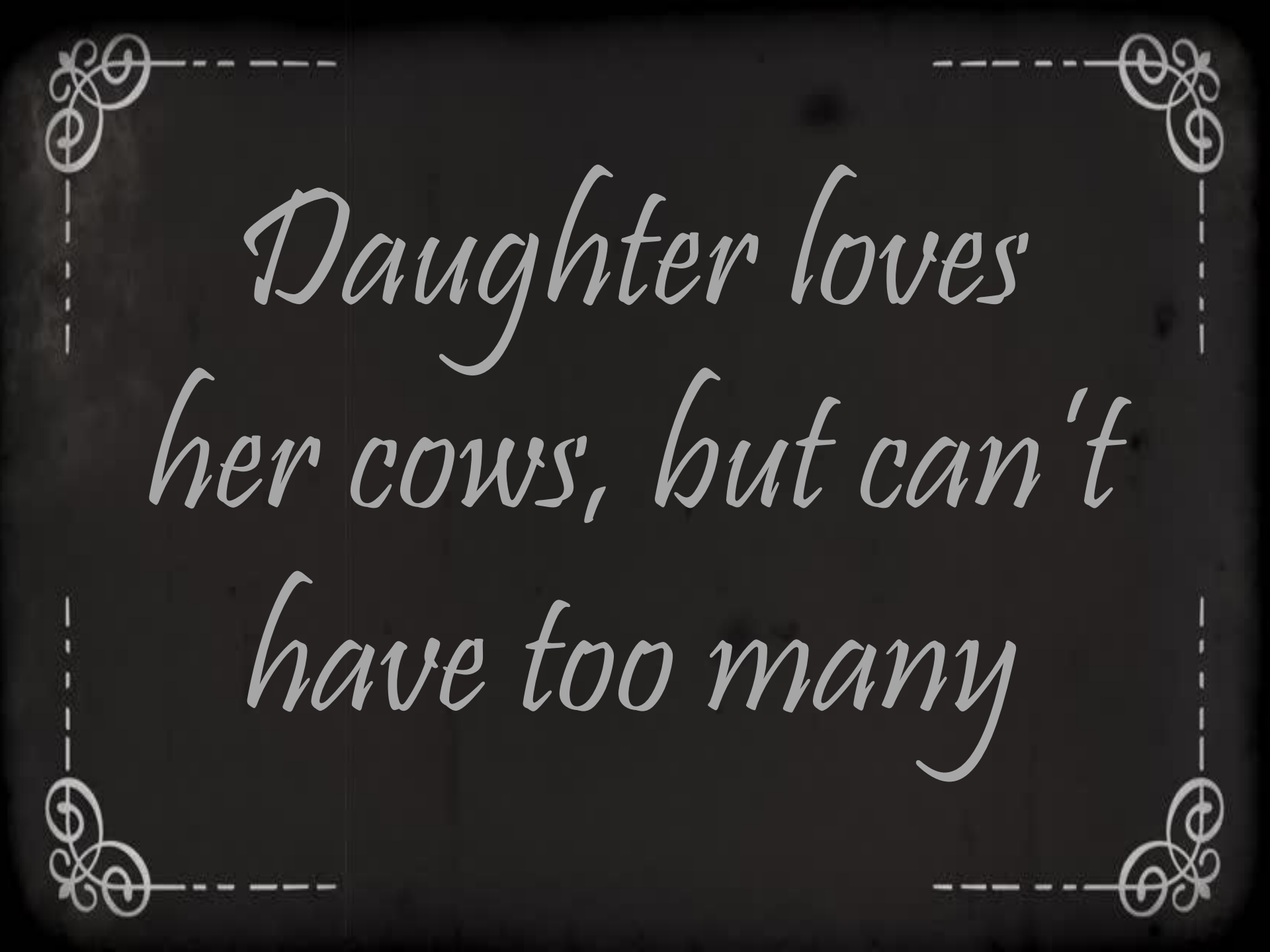
*THE  
FARMER'S  
DAUGHTER*

© 1954 E. W. BENTLEY, JR. ALL RIGHTS RESERVED

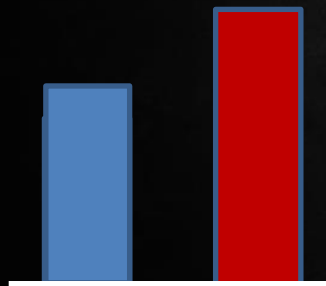




*A Tragedy in  
ye Commons!*

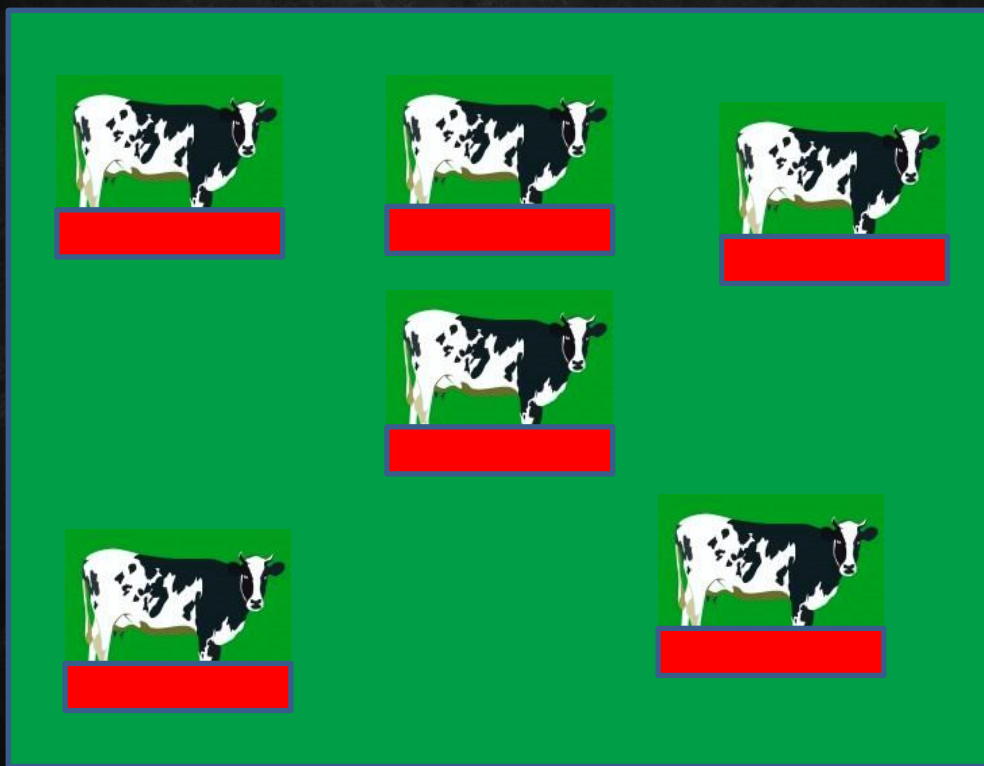



Daughter loves  
her cows, but can't  
have too many



+

-



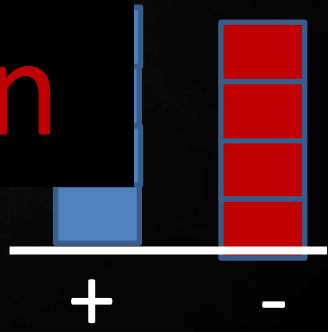
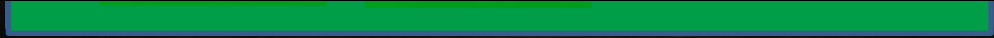


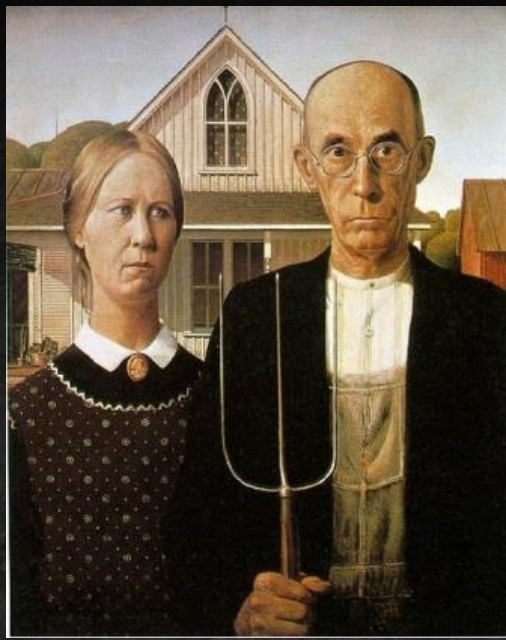
*A dastardly  
neighbour comes to  
ruin things...*





What is best for the individual is not always best for the population





+ - Fitness

Own field

+ - Fitness

Common field

Individual fitness is not always maximised at equilibrium

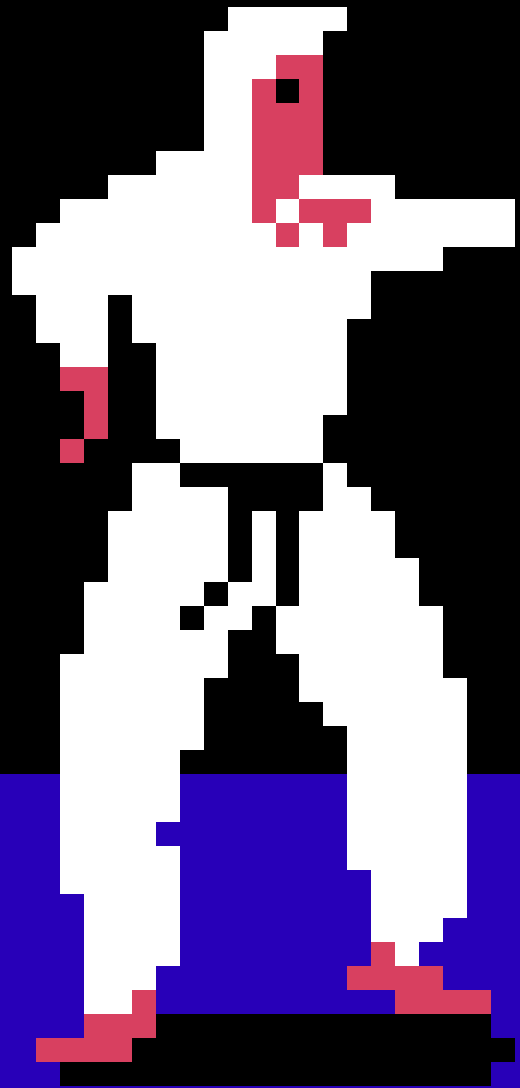


NO

SIGNAL

00:00

00-00-00



**CLASSIFICATION** | **game**

# We classify life



We must also classify interactions



The first step is to identify the players and their actions.



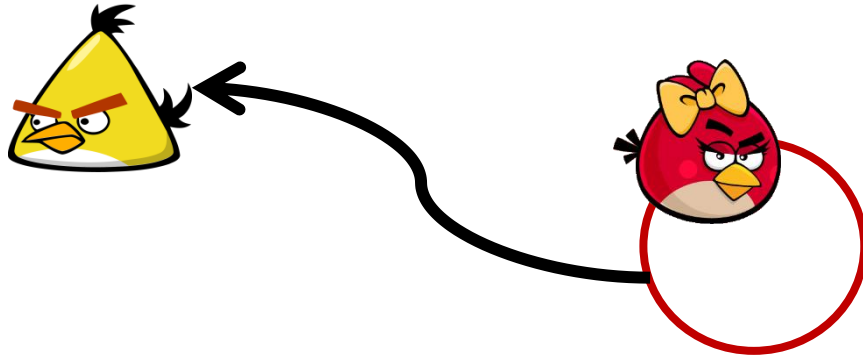
To care,  
or not to care...





We then determine who exactly is playing the game, and how often they play it.

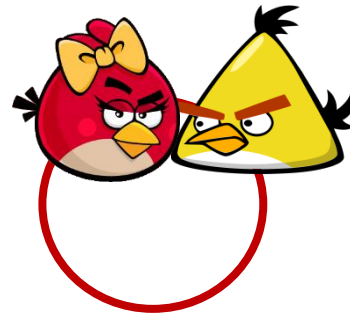
## Who Plays?



If the game is only played once, then there is no need to care about future repercussions

We then determine who exactly is playing the game, and how often they play it.

## Who Plays?

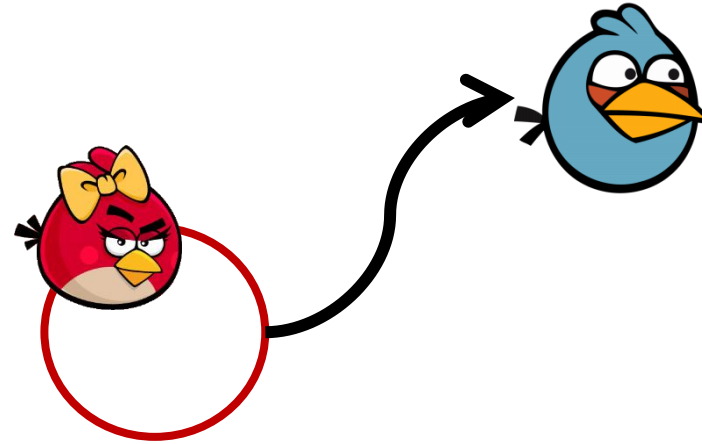


If the game is played many times, then current actions can have consequences in the future. Individuals can build reputations.

More equilibria are available.

We then determine who exactly is playing the game, and how often they play it.

## Who Plays?



But if it's a stranger each time, then things are the same as if the game is just being played once.



It may be the same individuals playing the same game over and over throughout their lives...



... or it may be the same game being played by thousands of generations.

Next step is to think about  
the payoffs for different  
combinations of actions, and  
ask

## What is the Shared Interest?

Fully divergent

Fully convergent

---

Next step is to think about the payoffs for different combinations of actions, and ask

## What is the Shared Interest?

Fully divergent

Fully convergent



Rock, paper, scissors  
(constant sum games)



	Rock	Paper	Scissors
Rock	0 0	-1 1	1 -1
Paper	1 -1	0 0	-1 1
Scissors	-1 1	1 -1	0 0

Next step is to think about the payoffs for different combinations of actions, and ask

# What is the Shared Interest?

Fully divergent

Fully convergent



Rock, paper, scissors  
(constant sum games)



Dinner

Movies

Dinner

1 1

0 0



Movies

0 0

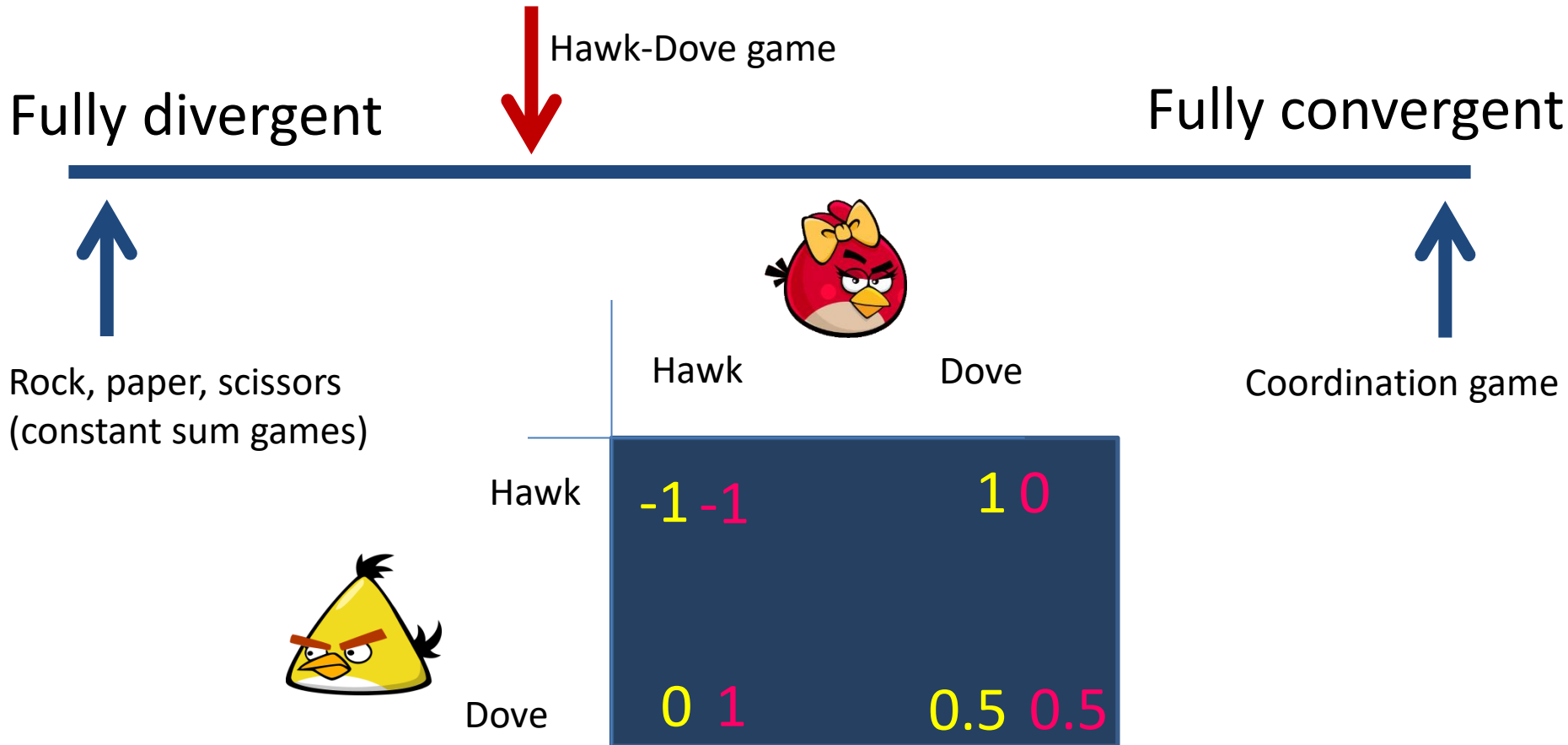
1 1



Coordination game

Next step is to think about the payoffs for different combinations of actions, and ask

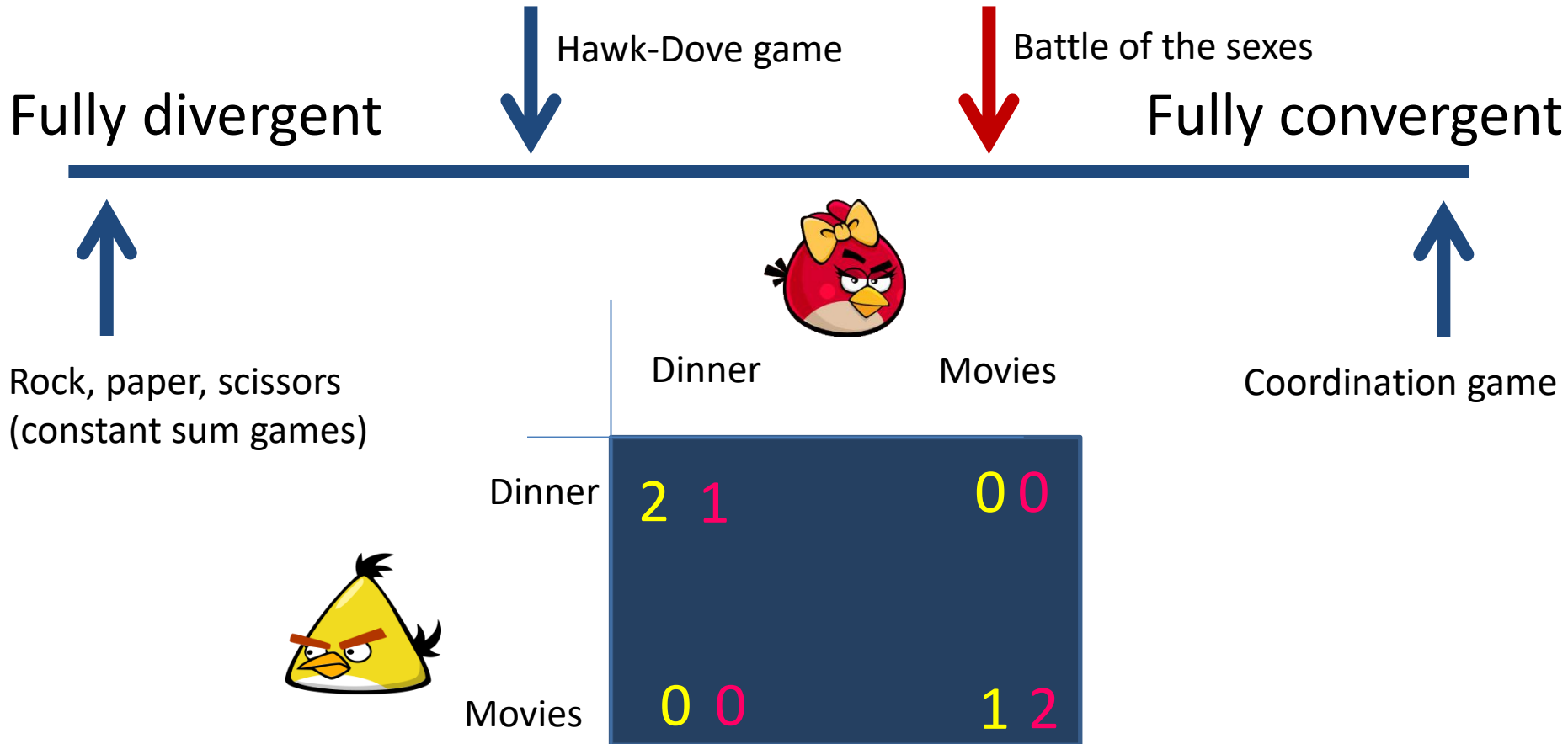
# What is the Shared Interest?





Next step is to think about the payoffs for different combinations of actions, and ask

# What is the Shared Interest?

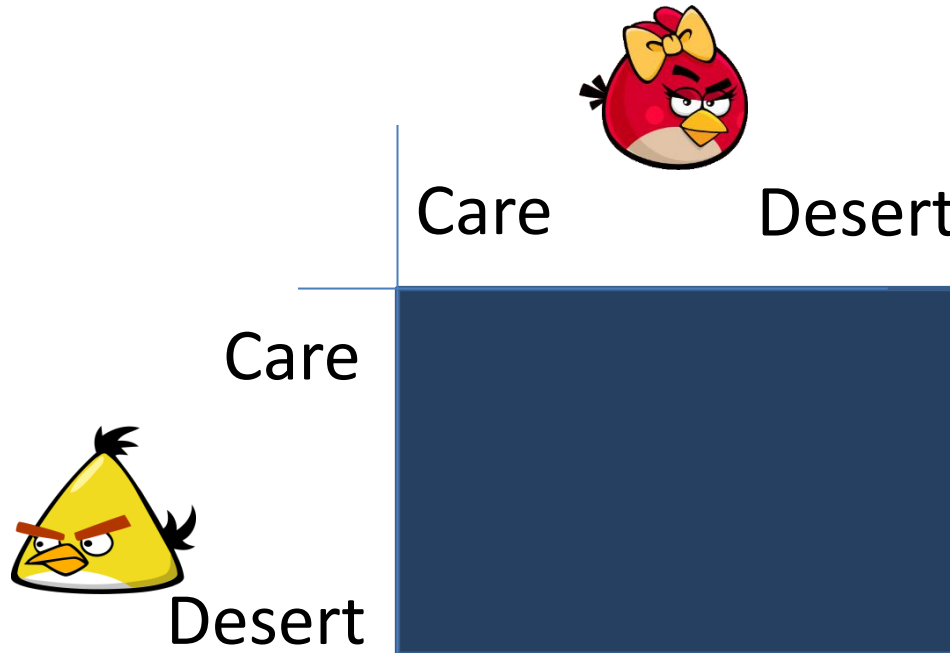


Next step is to think about the payoffs for different combinations of actions, and ask

## What is the Shared Interest?

Fully divergent

Fully convergent



Next step is to think about the payoffs for different combinations of actions, and ask



## What is the Shared Interest?

Fully divergent



Caring Game

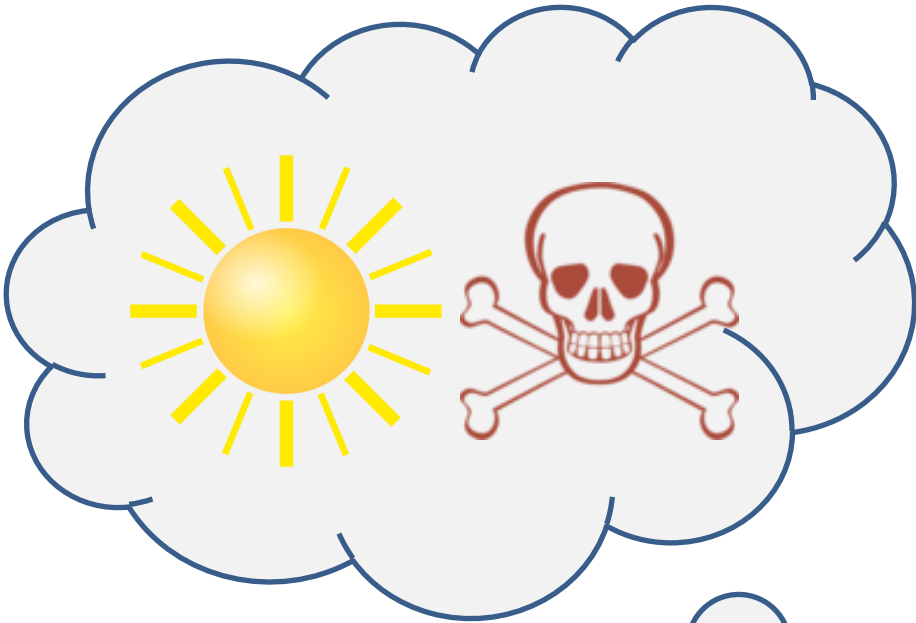
Fully convergent



		Caring Game	
		Care	Desert
Yellow Bird	Care	2 2	1 3
	Desert	3 1	0 0

The next question deals with the nature of information in the game.

## Who Knows What?



**External Uncertainty:**  
*Is it even a good year for breeding?*

**Strategic Uncertainty:**  
*What's this guy gonna do?*



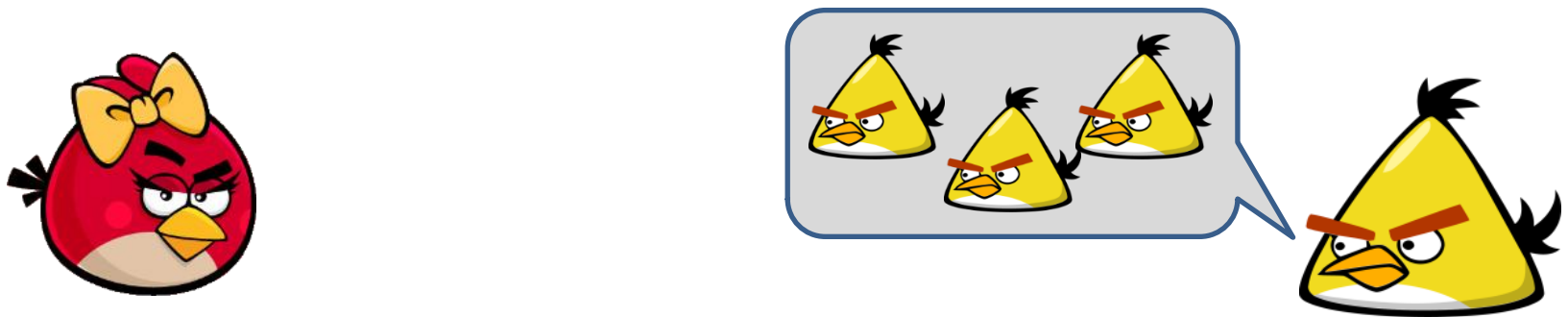
The next question deals with the nature of information in the game.

## Who Knows What?

Different individuals can have different information



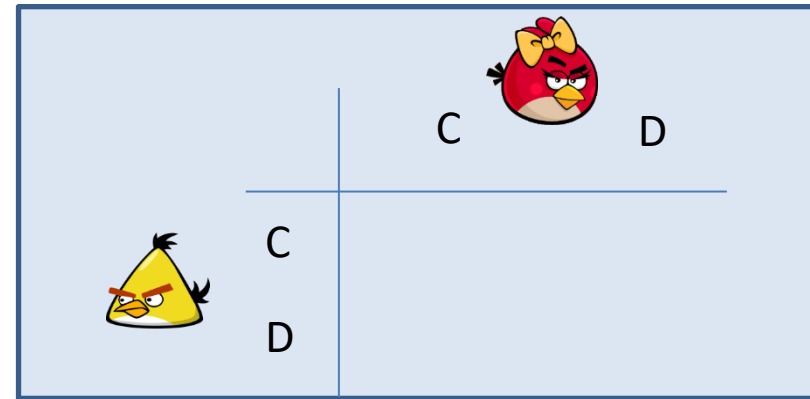
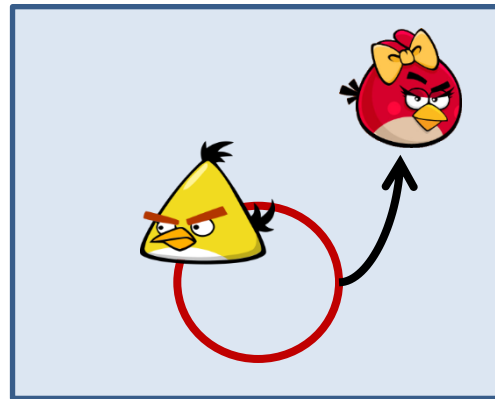
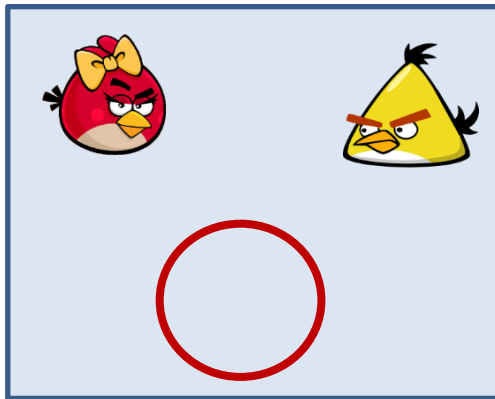
They may attempt to infer, conceal or convey information



The next question deals with the nature of information in the game.

## Who Knows What?

Can anyone act on their information?

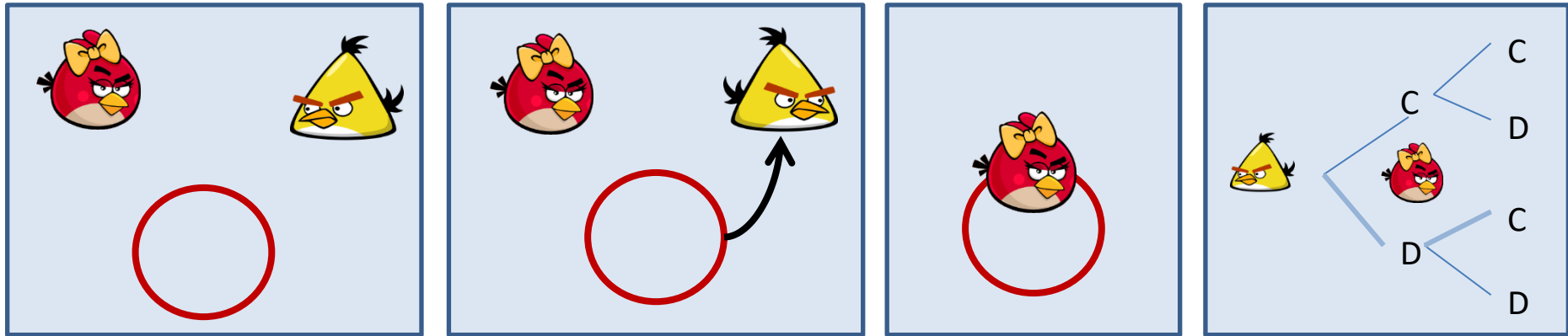


Players must act without knowledge of what other players are doing, or what their reactions will be.

The next question deals with the nature of information in the game.

## Who Knows What?

Can anyone act on their information?

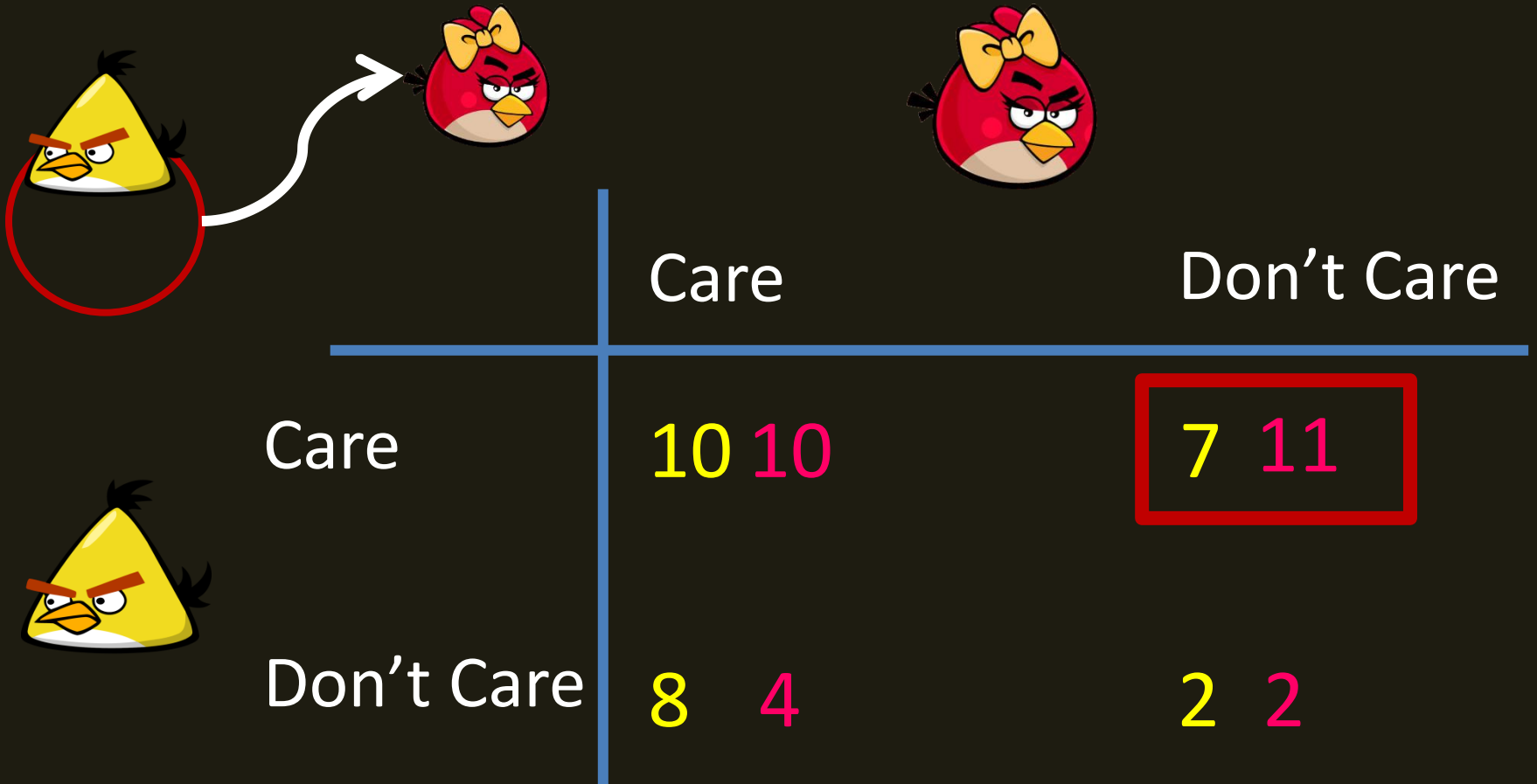


An individual can act first to provide their partner with information.

Note that this information is a burden to the female in this case!

Let's give it a try...

## Classifying the Care Game

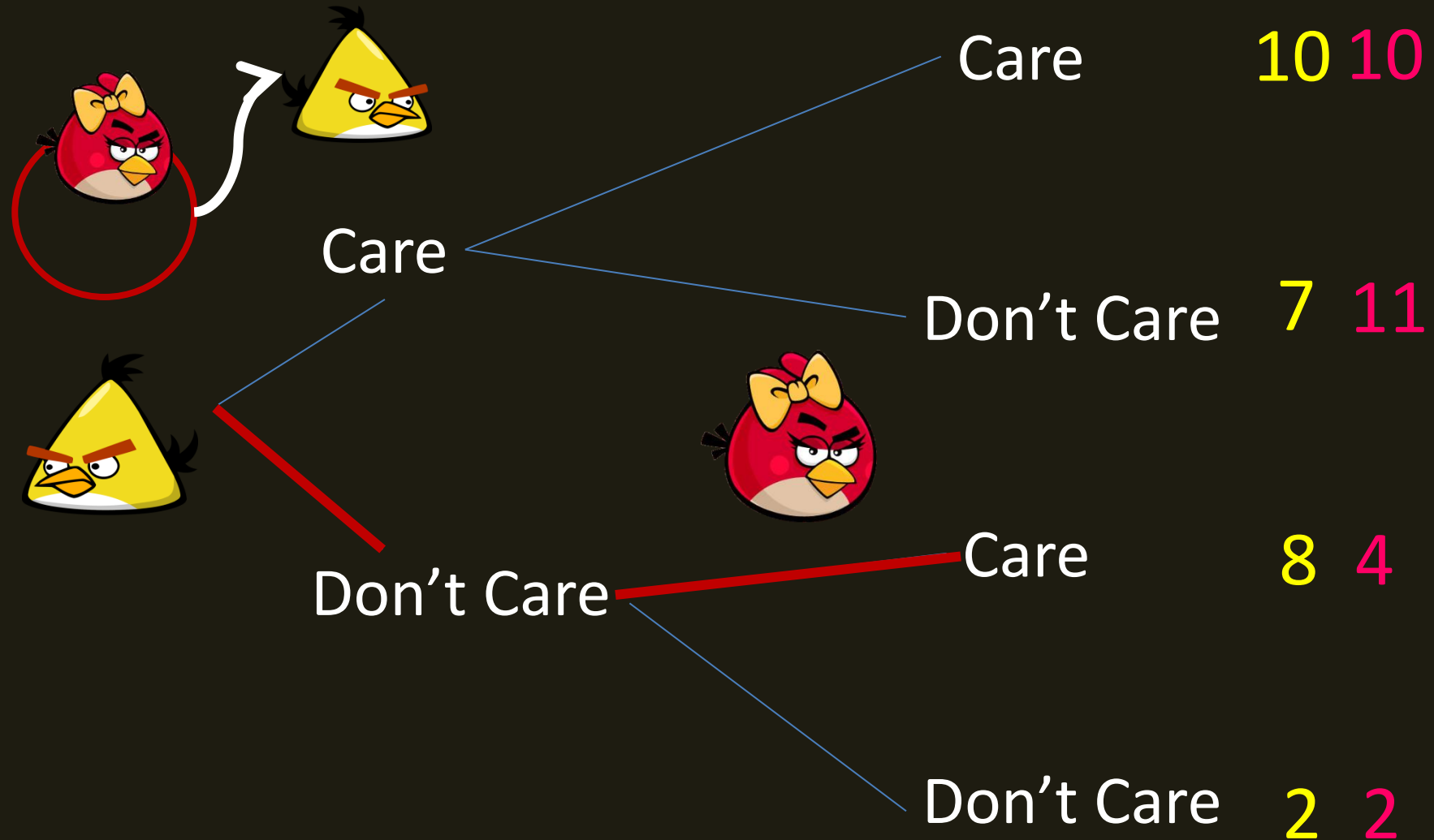


	Care	Don't Care
Care	10 10	7 11
Don't Care	8 4	2 2



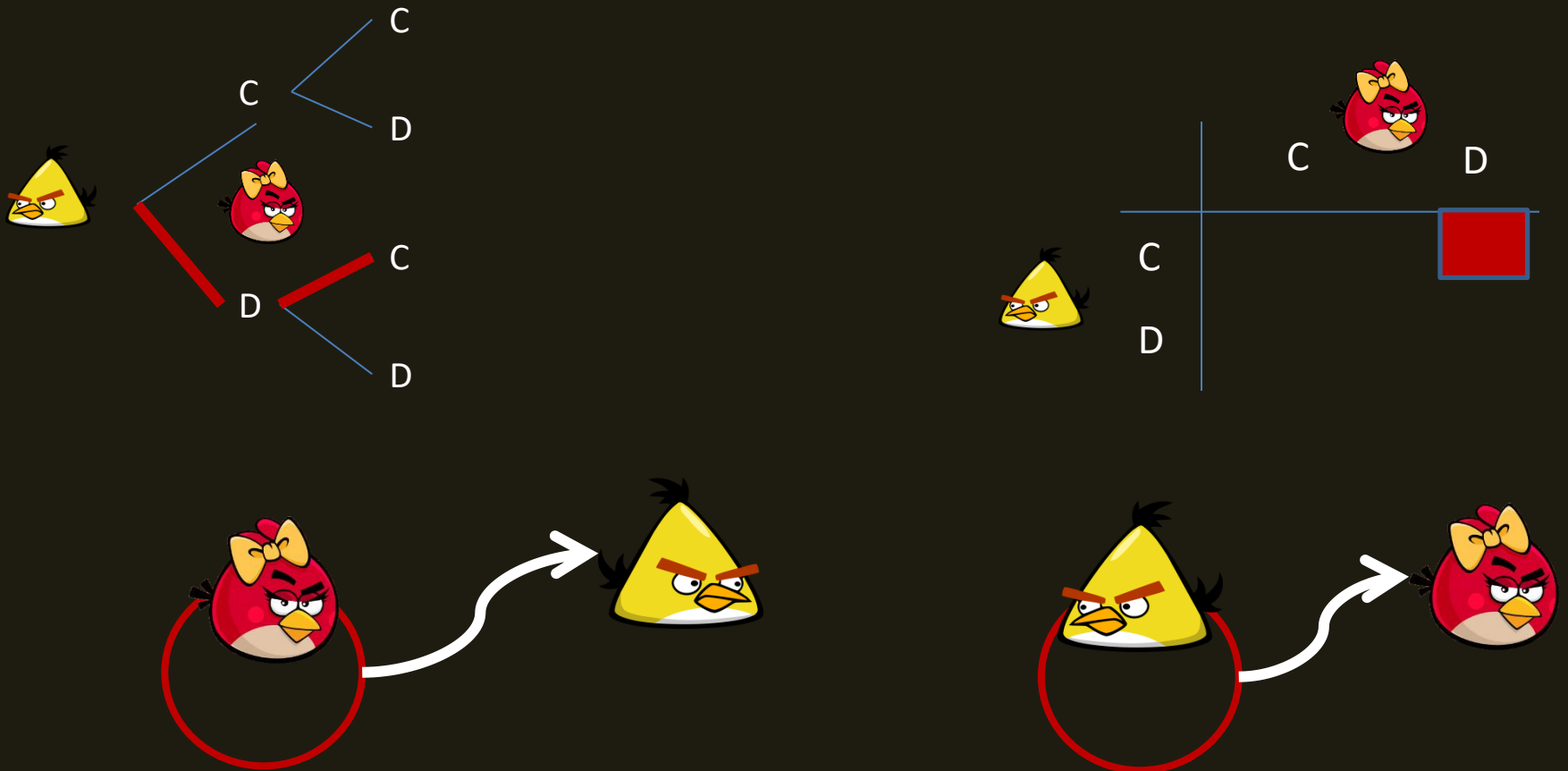
Let's give it a try...

## Classifying the Care Game



Hmm... We get different outcomes depending on what type of game we consider.

Here we see the importance of burdening a social partner with information.



# ***TOOL***

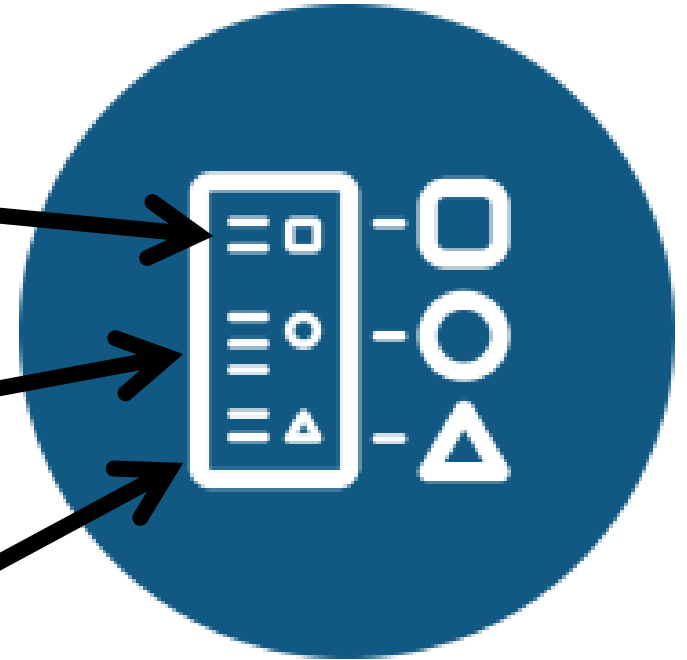


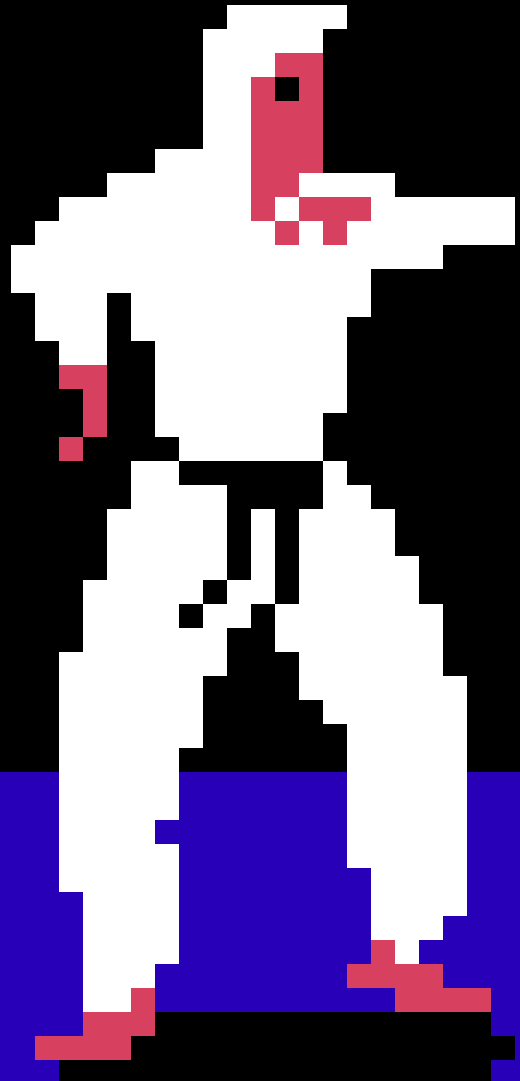
# ***TIME***

**Who Knows What?**

**Who Plays?**

**What are the Shared  
Interests?**





**INFORMATION** | **transfer**



Sharing, hiding and gathering information can affect strategic uncertainty...

... but what keeps the information reliable (i.e. talk is cheap)?



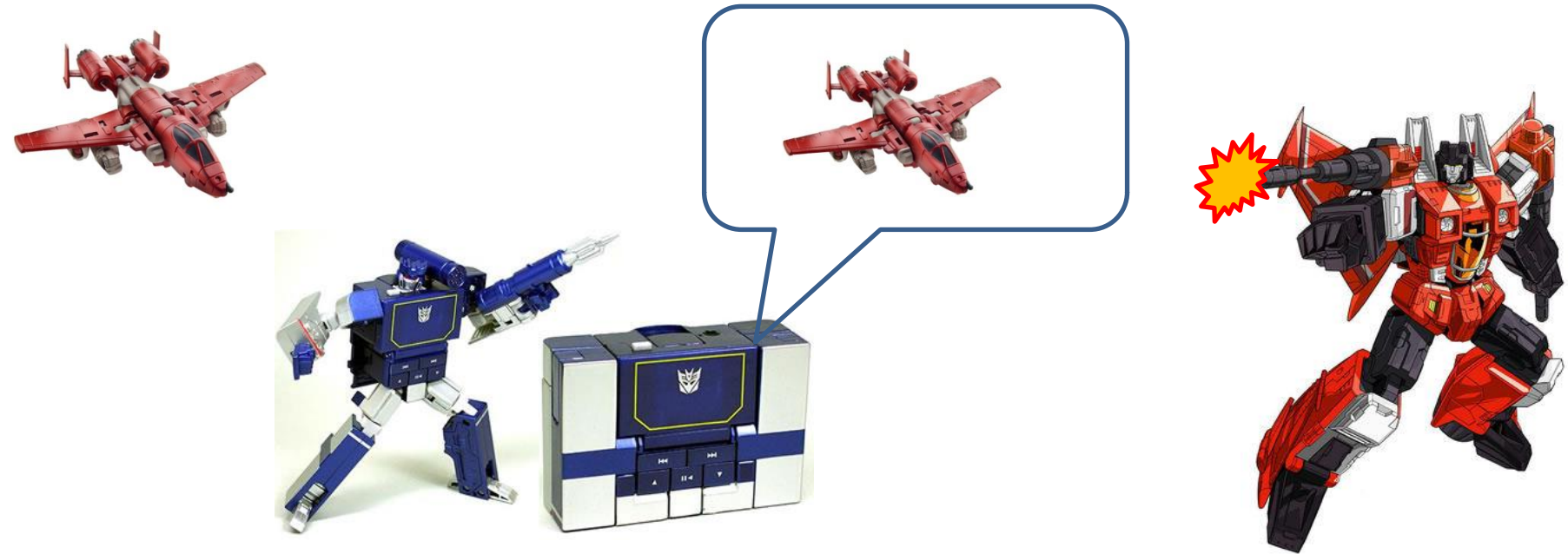
A sender has information ....

... and does something...

... that is tracked by...

... a receiver...

... who acts.



**SENDER**

**communication**

**RECEIVER**



# Cues



Something can convey information about the **sender**, but it's not evolved for this purpose.

The **receiver** is better off for knowing, but the **sender** may want to keep certain things a secret.





# Signals



Benefits the signaller to convey the information.  
Benefits the receiver to respond to the information.

Evolve because they have this influence.

**But what stops the sender from exploiting their influence on the receiver?**



# Index

Some acts or structures  
are impossible to fake





## Handicaps

The signal is costly,  
and only honest  
senders can pay the  
cost.

# Punishment

There are costs to making a false signal.



# Common Interest

Sender and receiver  
have the same  
interests, and a  
dishonest signal is  
mutually costly.





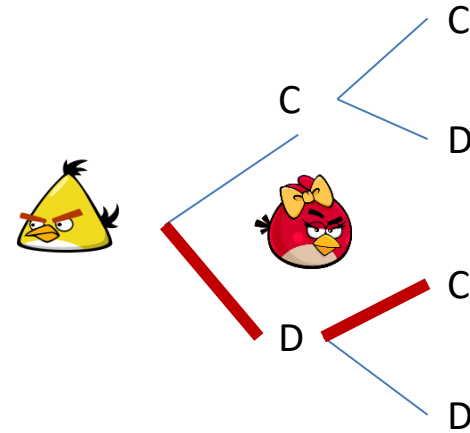
**Reputation**  
Cheaters can be  
remembered and  
recognised.





# Binding

The signaller commits themselves to a course of action



# **TOOL**

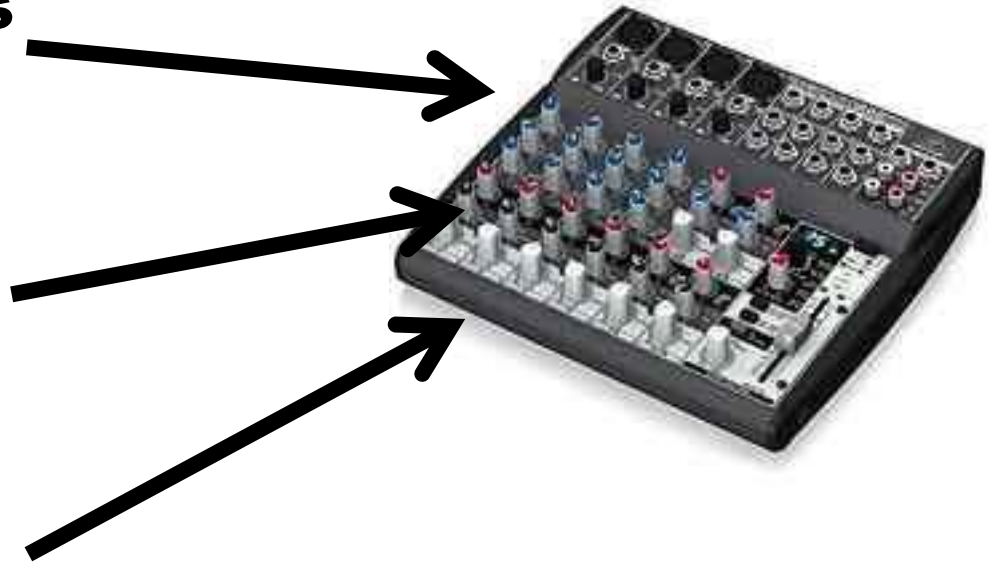
# **TIME**



**Senders and Receivers**

**Signals and Cues**

**Reliability**





**THINKING** | **strategically**

It is not individual actions that have central focus,  
it is the 'program' specifying what actions to  
take under specific circumstances

The central question to ask is:

**How does selection act on strategies?**

We can relate this to the central question provided at the  
start of the lecture...



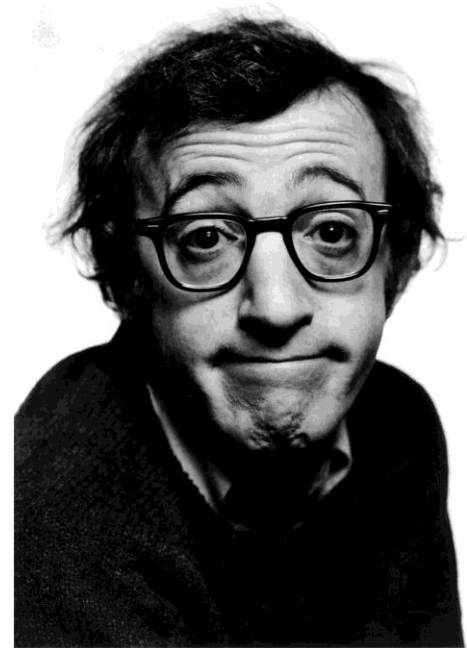
What features of the environment can explain variation in behaviour?

How does the evolutionary stable strategy vary depending on the environment?



# Social relationships...

They're totally crazy, irrational, and absurd, but we keep going through it because we need the eggs.



# Discussion

If evolution through natural selection is a game,  
what are the players,  
teams,  
rules,  
objectives  
and outcomes?