The iterated Prisoner's dilemma

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The prisoner's dilemma

- Ernie & Bert have comitted a crime
- They are caught, sparse evidence
- They are separately interrogated
- Either confess or deny

4 possible outcomes

- Both confess (defect!) $\Rightarrow$ Both get punished
- Both deny (cooperate!) $\Rightarrow$ Both get light punishment (evidence!)
- Ernie denies, Bert confesses $\Rightarrow$ Ernie free, Bert punished hard
- Vice versa

The prisoner's dilemma payoff matrix

Ernie \ Bert	*Cooperate*	*Defect*
Cooperate	Reward Reward	S payoff T payoff
Defect	T payoff S payoff	Penalty Penalty

- T = Tempation payoff
- R = Cooperation reward
- P = Punishment
- S = Sucker's payoff
- $T > R > P > S$

Optimal strategy: defect!

Problem: No communication...

The iterated prisoner's dilemma (IPD)

- Play an unknown number of rounds; accumulate reward "points"
- A strategy can choose based on past moves of either player

Example strategies:

- Saint: Always cooperate
- Defector: Always defect
- Random: 50/50 random choice
- Grim Trigger: Cooperate until oponent defects; from then on defect always
- Tit for Tat: Cooperate in the first round; then always do what the opponent did in the previous round
- Tit for Two Tats: As TFT, but allow two defections

Axelrod's tournament

R. Axelrod, late 1970s

- Invited game theorists to submit strategies
- Most were more complicated...

And the winner is:

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Key attributes

- Nice: Do not start defecting
- Retaliating: Don't be a sucker
- Forgiving: Return to cooperation if appropriate
- Non-envious: Don't try to outscore your opponent

Accidents happen...

- Random noise

  $\Rightarrow$ occasionally invert player's decision

- Bad for TFT

  $\Rightarrow$ Endless cycle of recrimination

TFT1	C	C	C	C	d	C	d	C	d	C	...
TFT2	C	C	C	d	C	d	C	d	C	d	...

Accident

Chinese Embassy, Belgrade

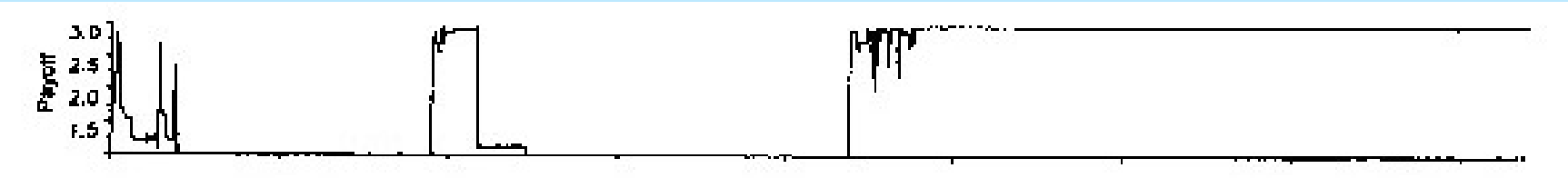
Favors more forgiving strategies: Tit for N Tats

Note: [$\lim_{N\to\infty}$ Tit for N Tats] $=$ Saint

Societal collapse and order

Nowak & Sigmund 1990s

- Population of strategies
- Reward: Offspring $\Rightarrow$ adjust proportions



- Plenty of defection
- TFT eliminates defectors
- With few defectors, noise favors TFNT with increasing N
- These near Saints are vulnerable to exploitation by defectors...

Pavlov's Victory

In the long run societies are often dominated by Pavlov

- Start by cooperating
- win-stay, loose-switch, i.e. Change choice if I get a "sucker's payoff" or "punishment"
- If by accident it gets away with exploitation, it does so!

What makes Pavlov strong?

- It does not police as well as TFT
- But, as TFNT get soft, Pavlov ruthlessly exploits near Saints
- Yet, Pavlov is perfectly cooperative with copies of itself

Conclusions

- Altruism is NOT the opposite of selfishness
- Communication vital for establishing cooperation
- In the IPD, stay nice, simple, retaliating and yet forgiving
- Noise complicates life!
- Defectors are bad and so are Saints
- TFT needed for policing, Pavlov needed to weed out Saints