

The Prisoner's Dilemma

File transfer game:

- Alice has a file desired by Bob and vice versa
- simultaneously decide whether to upload or not
- benefit of download = 3
- cost of upload = 1

Equivalent: Prisoner's Dilemma.

Payoff matrix:

		Bob's choice	
		upload	no upload
Alice's choice	upload	2, 2	-1, 3
	no upload	3, -1	0, 0

outcome from collective optimization (2, 2)

outcome from individual optimization (0, 0)

Question: better to upload, or not? special case of "Nash equilibrium"

- for the individual: dominant strategy to not upload \Rightarrow zero payoffs
- for the collective: better to upload ((2, 2) "Pareto dominates" (0, 0))

Repeated Prisoner's Dilemma

Model #1: Alice, Bob play Prisoner's Dilemma n times (payoffs add).
- action in a stage i can depend on outcomes of stages $1, 2, \dots, i-1$.

Note: at stage n , dominant strategy to defect.

\Rightarrow continuing backward, only justifiable behavior in model is to always defect.
"backward induction"

Model #2: After each stage, game ends with some probability p .

Claim: if p is small enough, cooperation is justified.

	C	D
C	2, 2	-1, 3
D	3, -1	0, 0

The Tit-for-Tat Strategy

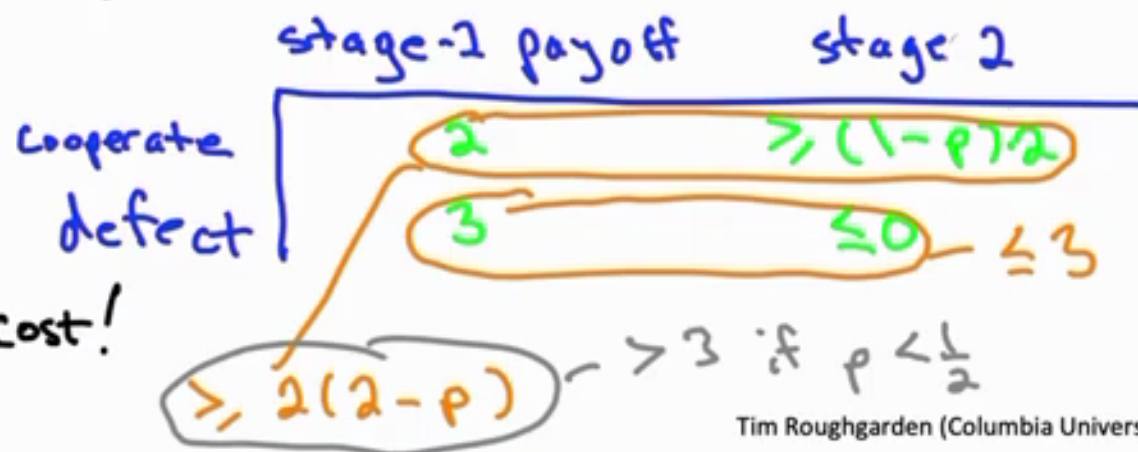
Setting: repeated Prisoner's Dilemma, each stage the last with probability p .

Tit-for-Tat: (1) in stage 1, cooperate
 (2) in stage $i \geq 2$, do whatever other player did in stage $i-1$.

Claim: if $p \leq \frac{1}{2}$ and Alice plays tit-for-tat, Bob should cooperate.

Reason: Consider stage 1.

\Rightarrow if $p < \frac{1}{2}$, short-term gain of defection outweighed by long-term cost!



Tit-for-Tat in BitTorrent

BitTorrent: dominant paradigm in P2P file distribution.

Strategy: - break big file into many pieces (e.g., 10MB each)

- users exchange file pieces

⇒ transforms single-shot Prisoner's Dilemma into repeated Prisoner's Dilemma!

Default client: (ignoring bootstrapping)

- broadcast which files you have

- request download from all peers with relevant file pieces

- split upload capacity equally across s peers
(e.g., $s=4$)

- chosen using Tit-for-Tat! (reward others' uploads)