Prisoner's Dilemma

Frederik Mallmann-Trenn
6CCS3AIN

The Prisoner's Dilemma

(Wolf Films/NBC)

The Prisoner's Dilemma

Two suspects are collectively charged with a crime and held in separate cells, with no way of meeting or communicating.
They are told that:

- *if one confesses and the other does not, the confessor will only get one year, and the other will be jailed for four years;*
- *if both confess, then each will be jailed for three years.*

Both prisoners know that if neither confesses, then they will each be jailed for two years.

The Prisoner's Dilemma

- Payoff matrix for prisoner's dilemma:

		j: confess	j: lie
i	confess	3, 3	4, 1
	lie	1, 4	2, 2

  Numbers are payoffs to players, not years in jail.

- What should each agent do?

What Should You Do?

- You can minimise the jail time by picking confess (at most 3 years)
- But you trust your partner, then you can get away with 2 years ...

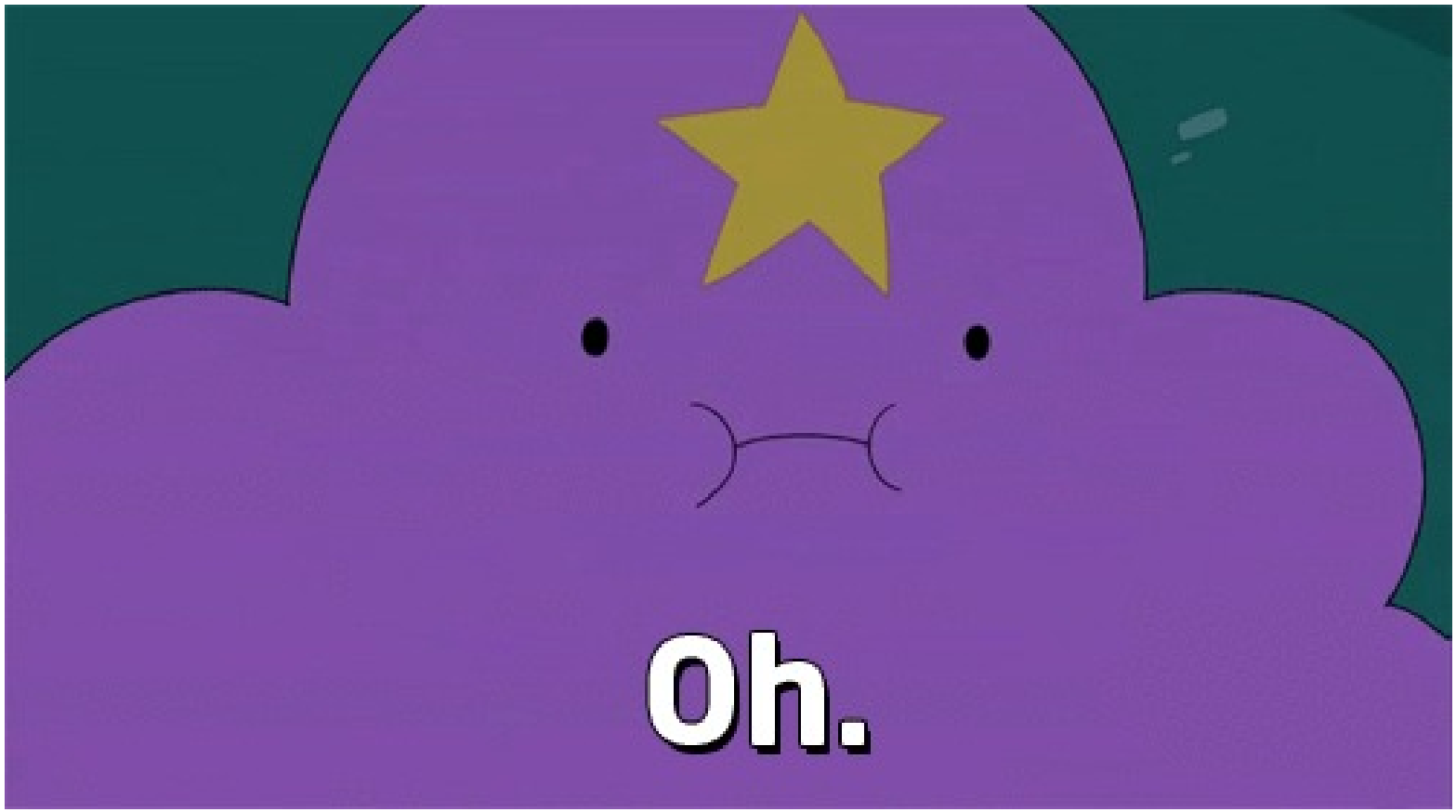
Solution Concepts

- Payoff matrix for prisoner's dilemma:

		j: confess	j: lie
i	confess	3, 3	1, 4
	lie	4, 1	2, 2

- There is no Nash equilibrium.
- All outcomes except $(confess, confess)$ are Pareto optimal.
- (lie, lie) maximises social welfare.

Oh!



(Pendleton Ward/Cartoon Network)

Prisoner's dilemma

- Real world examples:
  - nuclear arms reduction/proliferation
  - free rider systems — public transport, file sharing;
  - in the UK — television licenses.
  - climate change — to reduce or not reduce emissions
  - doping in sport
  - ...
- The prisoner's dilemma is ubiquitous.
- Can we encourage cooperation?

The Shadow of the Future

- *Play the game more than once*.
  If you know you will be meeting your opponent again, then the incentive to confess appears to evaporate.
  - If you confess, you can be punished (compared to the co-operation reward.)
  - If you get tricked, then what you lose can be amortised over the rest of the iterations, making it a small loss.
- Cooperation is (provably) the rational choice in the infinitely repeated prisoner's dilemma.
- Experiments with real prisoners in Germany show that this is not what happens though ...

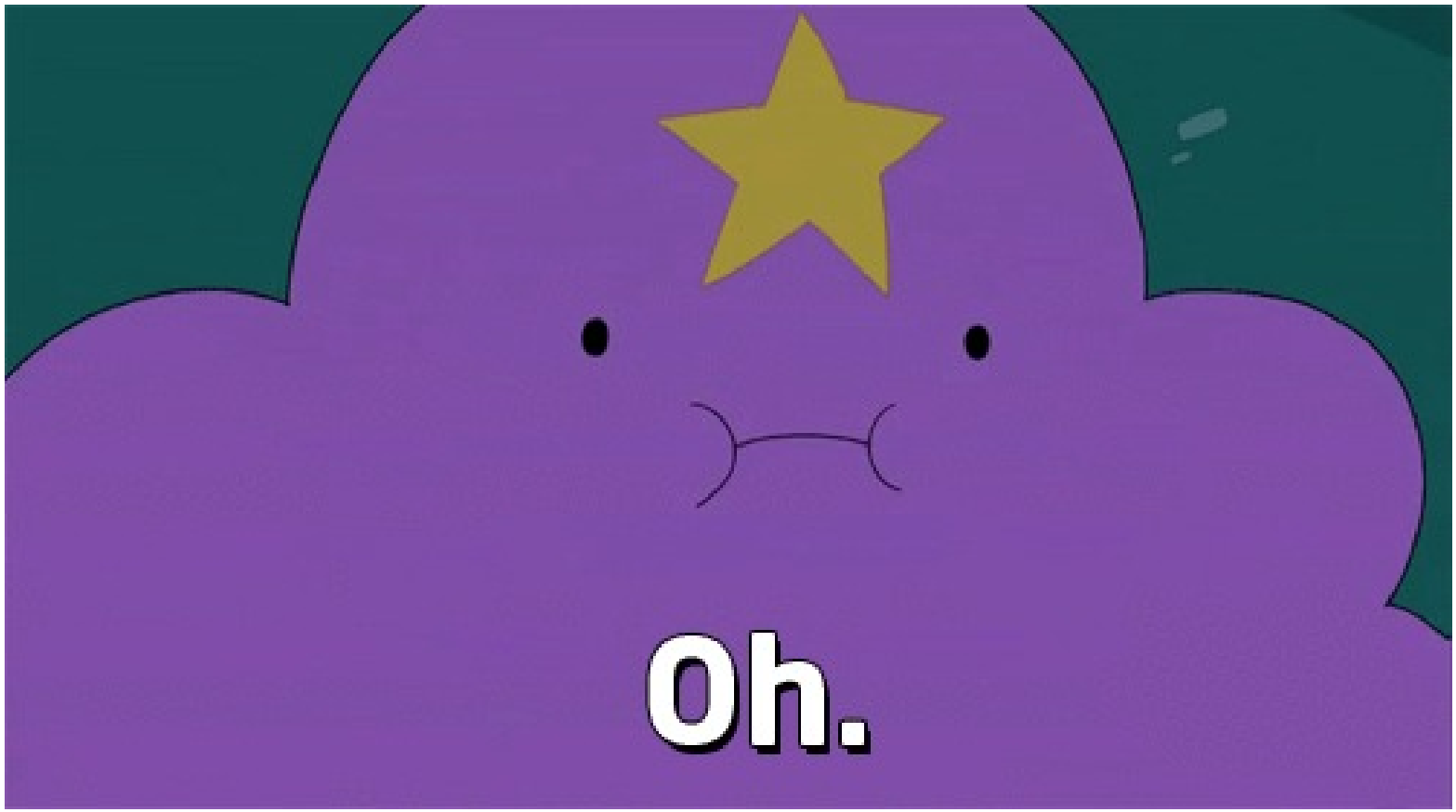
The Shadow of the Future

- But what if there are a finite number of repetitions?

Backwards Induction

- Suppose you both know that you will play the game exactly n times.
  On round n, you have an incentive to defect, to gain that extra bit of payoff.
  But this makes round $n - 1$ the last "real" round, and so you have an incentive to defect there, too.
  This is the backwards induction problem.
- Playing the prisoner's dilemma with a fixed, finite, pre-determined, commonly known number of rounds, confessing is the best strategy.
- That seems to suggest that you should never lie (cooperate with partner).

Oh!



(Pendleton Ward/Cartoon Network)

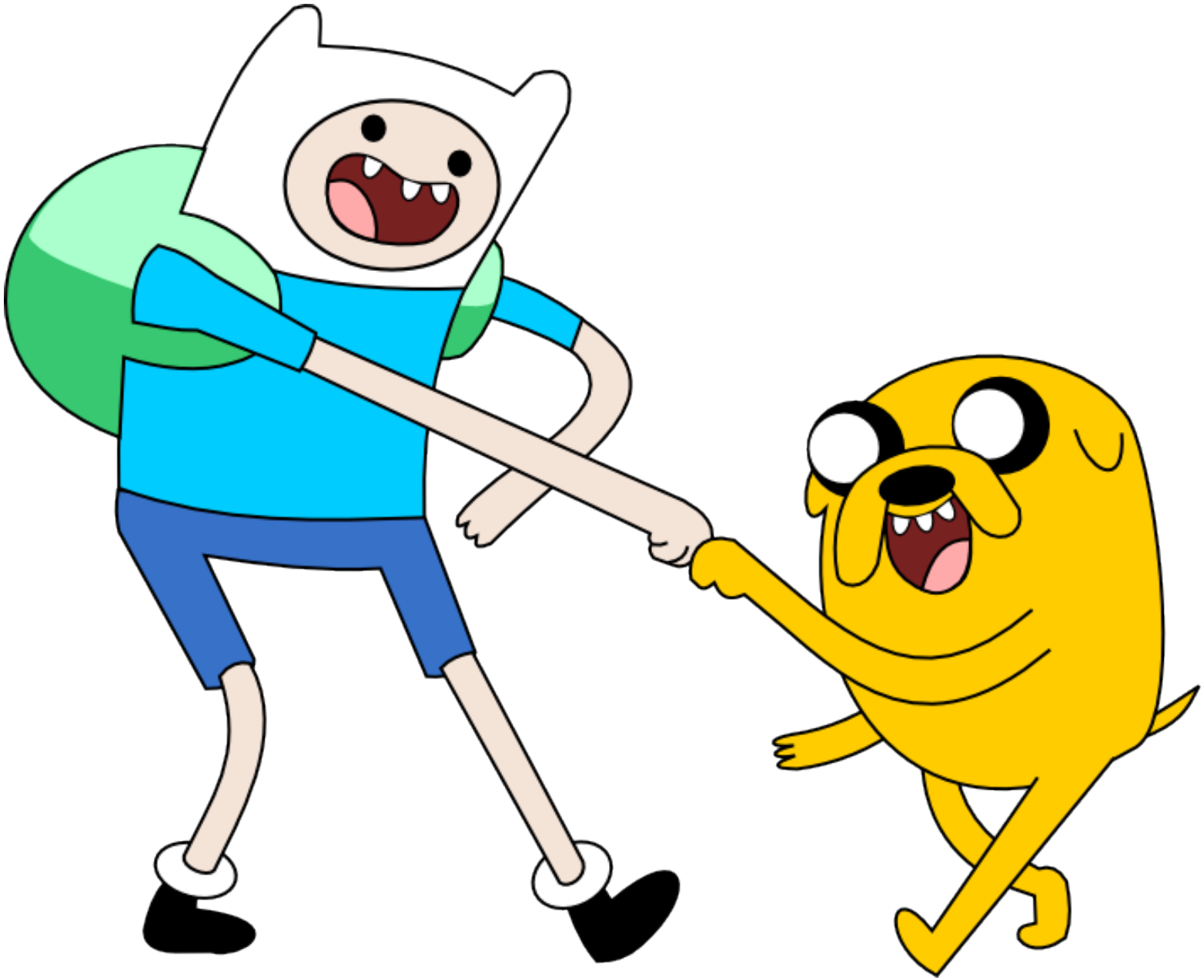
But

- So how does cooperation arise? Why does it make sense?
- After all, there does seem to be such a thing as society, and even in a big city like London, people don't behave so badly.
- Or, maybe more accurately, they don't behave badly all the time.

But

- Turns out that. . .
- As long as you have some probability of repeating the interaction, co-operation can have a better expected payoff.
- As long as there are enough co-operative folk out there, you can come out ahead by co-operating.

Mathematical!



Summary

- Have looked at strategic reasoning in the presence of other agents.
- Covered some ideas from game theory and discussed what it can do for us.
- Lots more we haven't covered...
- Game theory helps us to get a handle on some of the aspects of cooperation between self-interested agents.
- Rarely any definitive answers.
- Given human interactions, that should not surprise us.