IPD for Species

A competition to design a species
that plays IPD

Aim

- To investigate the coevolution of cooperation, at the level of species
- Specifically, what strategies should a successful IPD-playing species use to maximise species survival (i.e. Try not to go extinct)

IPD = Iterated Prisoner's Dilemma

	C	D
C	3,3	0,5
D	5,0	1,1

- Players play repeated rounds of the game above
- A traditional model to study conditions for cooperation between selfish players
- Example strategy: Tit-for-tat (TFT) = cooperate at first, then play your opponent's previous move

Motivation

- Individuals within a species may do well by exploiting their cousins, but that may cause the extinction of their species!
- In an earlier IPD competition, the winners used a master/slave strategy
  - Submit a Master entry
  - Submit lots of Slave entries
  - The Slaves deliberately lose to the Master
- But, this wouldn’t work in Nature – or would it??

Rules

- Competitors design a species of IPD player
  - Players can play IPD
  - Players know the species of their opponents
  - Clone and mutate operations
- Implemented as Java classes conforming to a given API
- Two divisions:
  - Restricted: additional rules ensure Darwinian evolution and restricted information sharing
  - Unrestricted: no additional rules

Rules

- 100 simulation runs
- In each run
  - Start with equal numbers of each species
  - Play round-robin IPD tournament to determine fitness
  - Use fitness proportionate selection to determine composition of next generation
  - Repeat for 1000 generations
- Winner is the species that survives 1000 generations most often (mean survival time used to break ties).

Entries

- 4 entries received
- Only 1 qualified as “restricted” => only the unrestricted competition has been run
- None used evolution (i.e. No mutation used)
  - Why?

Entries

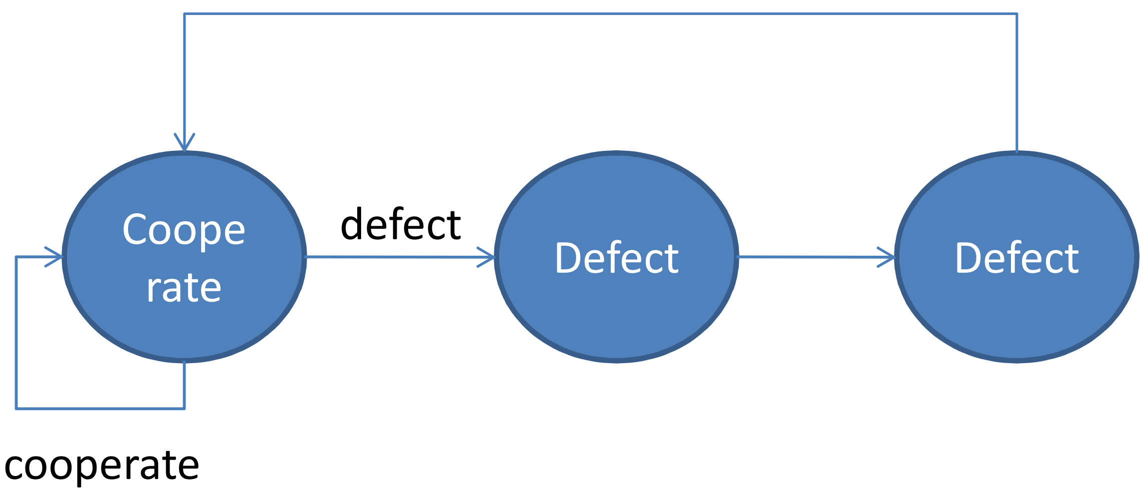
JWL_GXK : Michael (Jiawei Li) and Graham Kendall, Nottingham University

First 6 moves	TFT			
Kin	Cooperate			Clique
Non-kin	Majority	Defect		Clique
	Minority	Cooperative	TFT	Adaptive Pavlov
		All defect	Defect	Adaptive Pavlov
		STFT	TFTT	Adaptive Pavlov
		Other	Defect	Adaptive Pavlov

Based on Adaptive Pavlov (Li)

Entries

LearnCooperation : Alin Russu, The Alexandru Ioan Cuza University of Iași, Romania



A “lighter” version of Gradual

Entries

The Sunay Ritual Exchange of the Llama Herders of the Ayacucho Basin in the Andes mountains of Peru: Bob Reynolds, Khalid Kattan and Thaer Jayyousi, Wayne State University, Detroit

Entry based on the custom that someone in need can ask a successful herder for a Llama:

- With kin: the top x% of individuals donate points to the bottom y% (by allowing them to defect without retaliating). Otherwise, cooperate.
- With non-kin:
  - Type 1 : defect
  - Type 2 : grim (cooperate until opponent defects, then defect)
- x and y evolved using a Cultural Algorithm (Reynolds)

Results:

Survival Rates				
N	A	B	C	D
10	0	100	0	0
20	0	100	0	0
30	0	100	0	0
40	0	100	0	0
50	0	100	0	0
100	0	100	0	0

Survival Times				
N	A	B	C	D
10	7.22	1000	10.31	10.54
20	8.74	1000	11.3	11.15
30	10.74	1000	11.7	11.88
40	12.16	1000	12.12	12.01
50	12.49	1000	12.17	12.31
100	13.98	1000	12.96	13.06

Equal 3rd place:

Survival Rates				
N	A	B	Sunay1	Sunay2
10	0	100	0	0
20	0	100	0	0
30	0	100	0	0
40	0	100	0	0
50	0	100	0	0
100	0	100	0	0

Survival Times				
N	A	B	Sunay1	Sunay2
10	7.22	1000	10.31	10.54
20	8.74	1000	11.3	11.15
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40	12.16	1000	12.12	12.01
50	12.49	1000	12.17	12.31
100	13.98	1000	12.96	13.06

2nd place:

Survival Rates				
N	LearnC	B	Sunay 1	Sunay 2
10	0	100	0	0
20	0	100	0	0
30	0	100	0	0
40	0	100	0	0
50	0	100	0	0
100	0	100	0	0

Survival Times				
N	LearnC	B	Sunay 1	Sunay 2
10	7.22	1000	10.31	10.54
20	8.74	1000	11.3	11.15
30	10.74	1000	11.7	11.88
40	12.16	1000	12.12	12.01
50	12.49	1000	12.17	12.31
100	13.98	1000	12.96	13.06

The winners:

Survival Rates				
N	LearnC	JWL_GXK	Sunay 1	Sunay 2
10	0	100	0	0
20	0	100	0	0
30	0	100	0	0
40	0	100	0	0
50	0	100	0	0
100	0	100	0	0

Survival Times				
N	LearnC	JWL_GXK	Sunay 1	Sunay 2
10	7.22	1000	10.31	10.54
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Afterthoughts

- Very small fitness differences lead quickly to extinction – could this be changed by
  - Less selection pressure
  - Larger population
  - Occasional “migration”
- Evolution not used by competitors: too slow? too costly?
  - See above
  - More generations
- Information sharing within species successful
  - Further investigation on “cultural evolution”?