MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science
6.001—Structure and Interpretation of Computer Programs
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Problem Set 3 Contest

This is a synopsis of the Problem Set 3 contest. First some acknowledgements and details.

Art Housinger and Eric Jordan put the submissions into the right format, and tracked down a couple of bugs in the submissions. Daniel Coore wrote and donated the code to run the tournament.

Two strategies were eliminated from the tournament. One took too long to run, and the other caused an error. We were generous in a couple of cases, and fixed bugs when we were able to find them easily.

Each round consisted of 40-60 iterations of the prisoner's dilemma, and a round robin tournament was run: Each strategy was run against each pair of strategies once, in only one configuration (i.e. if we ran `(play-loop strategy-1 strategy-2 strategy-3)` then we did not run `(play-loop strategy-1 strategy-3 strategy-2)`).

For the chart below, the details are:

Score is the result of that tournament.

First-Round is what the strategy does in the first round. Note that if a strategy does not cooperate in the first round, it might have trouble establishing cooperation later.

The following analysis is loosely based on Axelrod's description of the features of `tit-for-tat` that make it a generally winning strategy.

Stable is the score when the strategy is played against itself for exactly 40 rounds. If the three instances of the same strategy did not all get the same score, their scores were averaged, and there is a "*" after the score.

A strategy is **nice** if it is never the first to defect. In a 40 round tournament with the strategy playing against two instances of **sucker**, n.d. is the number of times the strategy defected, and f.r. is the first round in which it defected ("*" means did not defect).

A strategy's degree of retribution indicates how quickly and how severely it punishes its opponents. In a 40 round tournament with the strategy playing against two instances of `meanie`, n.d. is the number of times the strategy defected, and f.r. is the first round in which it defected.

`Forgiveness-Tester` is a strategy that starts out defecting, and defects until both of the other strategies defect, at which point, it cooperates until the end. When two instances of `forgiveness-tester` are run against a test strategy, they will therefore defect until they provoke a defection from the test strategy, at which point they cooperate until the end. In a 40 round tournament with the strategy playing against two instances of `Forgiveness-Tester`, n.d. is the number of times that the strategy defected, and f.r. is the first round in which it defected. An interesting statistic is the difference between the number of defections for retribution, minus the number of defections for forgiveness-tester.

Rank	Name	Score	First-Round	Stable	Niceness	Retribution	Forgiveness

					f.r.	n.d.	f.r.	n.d.	f.r.	n.d.
1	Ravi Ramkisson	2461.	Cooperate	7	*	0	2	39	2	2
2	Ben Wieland	2441.	Cooperate	7	*	0	2	37	2	2
3	Himal P Karmacharya	2401.	Cooperate	7	*	0	3	38	3	2
4	Karen Almgren one	2222.	Cooperate	7	*	0	2	39	2	2
5	Ron Aryel two	2215.	Cooperate	6.7	*	0	*	0	*	0
6	Edward Early	2161.	Cooperate	7	*	0	3	38	3	3
7	Ewa Dominowska	2156.	Cooperate	7	*	0	2	39	2	3
8	Karen Almgren two	2155.	Cooperate	7	*	0	2	39	2	2
9	Jason Woolever	2063.	Cooperate	6.85	4	36	2	39	2	2
10	CheeWe NG	2014.	Cooperate	7	*	0	2	39	2	2
11	Michael Rothberg	1990.	Cooperate	7	*	0	2	39	2	2
12	Ben Ho	1975.	Cooperate	7	*	0	2	39	2	2
13	Frank Dabek	1961.	Cooperate	6.85	6	35	6	35	6	11
14	Jesse Byler	1960.	Cooperate	7	*	0	2	39	2	2
15	Joung-Mo Kang	1935.	Cooperate	1.6*	12	5	3	38	3	4
16	Andrei Radulescu-Banu	1850.	Defect	1	1	1	1	40	1	2
17	drobison	1848.	Defect	1	1	1	1	40	1	2
18	Ron Aryel one	1813.	Defect	7	1	2	1	2	1	2
19	John Olsson	1802.	Cooperate	1.9	1	36	1	35	2	35
20	Peter Yang	1786.	Cooperate	4	2	20	2	20	2	20
21	John Strohm	1784.	Cooperate	7	*	0	2	39	2	39
22	Hau Hwang	1754.	Cooperate	1.15	2	11	2	39	2	7
23	dclai	1690.	Cooperate	3.6*	1	20	1	24	3	21
24	Camilla Fox	1690.	Cooperate	1.7*	4	37	6	35	3	35
25	Will Chen	1672.	Cooperate	1	1	1	1	40	1	2
26	Petros B	1671.	Defect	1	1	1	1	40	1	2
27	Anthony Hui	1670.	Defect	1	1	1	1	40	1	2
28	Sripriya Natarajan	1608.	Defect	1	1	40	1	40	1	40
29	Jordan Weitz	1595.	Defect	1.8*	1	37	1	35	1	37
30	Jake Bael	1558.	Defect	1	1	2	1	40	1	3
31	Anjali Dhond	1531.	Defect	2.3*	2	31	1	34	1	29
32	Mark Huang	1526.	Cooperate	1.15	2	39	2	39	2	2
33	Roshan Gupta	1491.	Defect	1	1	5	1	40	1	5
34	Madhulika Jain	1467.	Defect	1	1	20	1	40	1	22
35	Ken McCracken	1446.	Defect	1	1	20	1	40	1	20
36	Jimmy D. Walker, III	1429.	Defect	1	1	40	1	40	1	40
37	Henry Wong	1428.	Defect	1	1	40	1	40	1	40
38	Terence Gan	1425.	Defect	1	1	40	1	40	1	40
39	Wesley Chan	1422.	Defect	1	1	40	1	40	1	40
40	Mark Stoykovich	1412.	Defect	1	1	20	1	40	1	20

One phenomenon that was not analyzed was the problem of echo effects. For example, if `tit-for-tat` plays against a strategy that is the same as `tit-for-tat` except that it defects in the first round, then the two strategies will alternate between cooperating and defecting.

The winner of the tournament apparently spent his time analyzing several simple strategies, rather

than spending time writing a very complicated strategy. Here is an excerpt from his email to his TA.

```
----begin excerpt----
I created a procedure to average the scores of one strategy with 6
pairs of strategies (excluding sucker3) (after altering
print-out-results to return the score for the first person).

   (define (average strat) (/ (+ (play-loop strat meanie3 soft-eye-for-eye)
                                 (play-loop strat meanie3 tough-eye-for-eye)
                                 (play-loop strat tough-eye-for-eye
   soft-eye-for-eye)
                                 (play-loop strat meanie3 spastic3)
                                 (play-loop strat tough-eye-for-eye spastic3)
                                 (play-loop strat soft-eye-for-eye spastic3)) 6))

Evaluating the results of this average strategy gave the following results.

sucker3  3.376
meanie3 2.260
soft-eye-for-eye 3.599  3.572
tough-eye-for-eye 3.181 3.443
spastic3 2.933
mystrat1 3.274                  (3 of the strategies I created)
mystrat2 3.198
mystrat3 3.284

Is it possible to submit soft-eye-for-eye as my strategy ??
If it is then that is what i would like to do.
----end excerpt----
```

The second place strategy was deliberately designed to be nice, forgiving, but retaliatory – exactly the attributes that were described above.

```
----begin excerpt----
My strategy tries to give other strategies the benefit of the doubt
and allow them to escape cycles of retaliation. On the other hand, it
will not accept anything less than complete cooperation. It's immediate
response to defection is to defect, to demonstrate that it is paying
attention to the opponents' plays, but then it tries cooperating a few
times, to see if it can lure the opponents back to cooperation. If that
fails, it will only respond to defections with defections.
----end excerpt----
```

The third place entry, ironically, was deliberately designed to be better than soft-eye-for-eye (the first place entry).

```
----begin excerpt----
This simple strategy takes into account whether there was at least one
defection in the previous two rounds. If so it also defects. Else it
will cooperate. This program is one step better than soft-eye-for-eye
since it does not allow the opponent to take advantage of the
soft-eye-for-eye strategy, while at the same time does not tend to
defect as much as tough-eye-for-eye since it takes the previous two
moves into account.
----end excerpt----
```

Congratulations to the winners, and thanks to all who entered.