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First paper on cooperation published in 1980.

Book (left) published in 1984 to wide acclaim.

Best known for this and related work; still active in this area and publishing new research.

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# Iterated Prisoner's Dilemma

Two players

Prisoner's Dilemma played  
repeatedly

History of previous  
interactions remembered  
by each player

No other outside knowledge



# Contest #1

Call for entries to game theorists

All entrants told of preliminary experiments

15 strategies =  
14 entries + 1 RANDOM

Round-robin tournament against all other players and “twin”

Each game 200 iterations

Games run 5 times against each strategy

Scores averaged over all games

Anatol Rapoport	4	504.5
Nicholas Tideman & Paula Chieruzzi	41	500.4
Rudy Nydegger	23	485.5
Bernard Grofman	8	481.9
Martin Schubik	16	480.7
William Stein & Amnon Rapoport	13	477.8
James Friedman	13	473.4
Morton Davis	6	471.8
James Graaskamp	63	400.7
Leslia Downing	33	390.6
Scott Feld	6	327.6
Johann Joss	5	304.4
Gordon Tullock	18	300.5
Name withheld	77	282.2
RANDOM	5	276.3

# And, the winner is...

## TIT FOR TAT

“Cooperate on first move,  
thereafter reciprocate  
opponent’s previous  
action”

Shortest program  
submitted

By psychologist, Anatol  
Rapoport

### Oxford English Dictionary

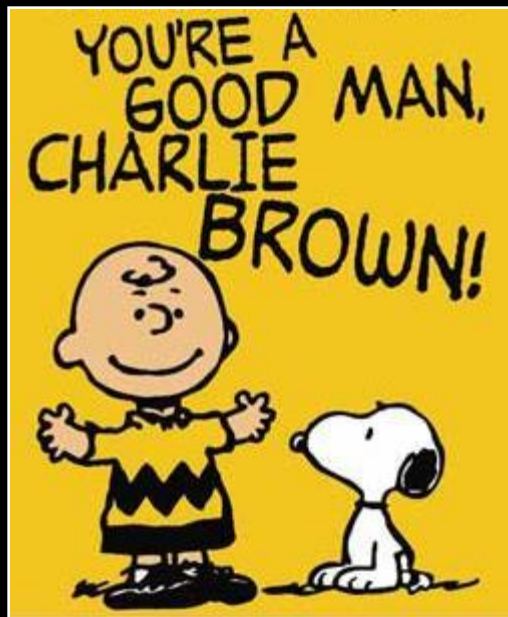
1. In phr. **tit for tat** [app. a variation of *tip for tap*, known a century earlier: see [TAP](#) *n.*<sup>2</sup>, [TIP](#) *n.*<sup>2</sup>, and cf. prec. But perh. wholly or partly onomatopœic.] One blow or stroke in return for another; an equivalent given in return (usually in the way of injury, rarely of benefit); retaliation. Also used as rhyming slang for ‘hat’. Cf. [TITFER](#).

The whole phrase is used sometimes as a *n.*, sometimes as *adj.* or *adv.*; also, elliptically or as *int.*

1556 [J. HEYWOOD](#) *Spider & F.* xxxvii. 26 That is tit for tat in this altricacion. 1586 [J. HOOKER](#) *Hist. Irel. in Holinshed* II. 94/1 That they would not sticke to set his seruants at libertie, so he would redeliuer them the youth of the citie, which was nothing else in effect, but tit for tat. 1710 [ADDISON](#) *Tatler* No. 229 ¶3, I was threatened to be answered Weekly Tit for Tat. 1809 [J. QUINCY](#) in *Life* 181, I shall .give. what politicians call a Rowland for their Oliver, and what the ladies term tit for tat. 1881 [SAINTSBURY](#) *Dryden* iv. 80 A fair literary tit-for-tat in return for the *Rehearsal*. 1891 *Daily News* 16 July 5/1 Fair Traders, Reciprocity men, or believers in the tit-for-tat plan of dealing with other nations. 1905 [H. A. VACHELL](#) *The Hill* viii, Tit for tat. If I do this for you, will you do something for me? 1925 [FRASER & GIBBONS](#) *Soldier & Sailor Words & Phrases* 285 *Tit for tat*, hat. (Rhyming slang). 1930, 1937 [see [TITFER](#)].

# Analysis: “Nice” Guys Finish First

Top 8 strategies never defect first.



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# Other Interesting Strategies

## TIT FOR TWO TATS

- Retaliate only if previous two are D's
- Could have won tournament, if entered

## NICE DOWNING

- Like DOWNING, but start with C's
- Could have won tournament, if entered

## Variations on TIT FOR TAT

- Did well, but none beat TIT FOR TAT

# Contest #2

Same set up as Contest #1, except...

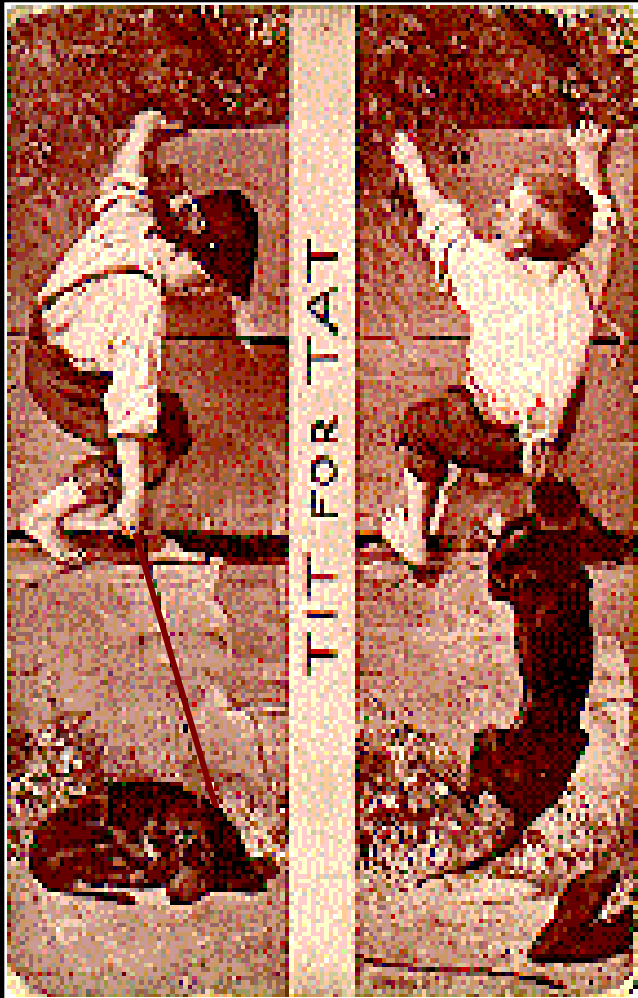
Entries from first-round contestants as well as open call in magazine

63 strategies =  
62 entries + 1 RANDOM

Each game iterated an uncertain number of iterations, with probability 0.00346 of ending

The Contestants					
Rank	Name	Country (if not U.S.)	Discipline (if faculty)	Language (FORTRAN or BASIC)	Length of Program*
1	Anatol Rapoport	Canada	Psychology	F	5
2	Danny C. Champion			F	16
3	Otto Börfesen	Norway		F	77
4	Rob Cave			F	20
5	William Adams			B	22
6	Jim Grauskamp & Ken Katzen			F	23
7	Herb Weiner			F	31
8	Paul D. Harrington			F	112
9	T. Nicolaus Tideman & P. Chieruzzi		Economics	F	38
10	Charles Kluepfel			B	59
11	Abraham Getzler			F	9
12	Francois Leyvraz	Switzerland		B	29
13	Edward White, Jr.			F	16
14	Graham Fatherley	Canada		F	12
15	Paul E. Black			F	22
16	Richard Hufford			F	45
17	Brian Yamauchi			B	32
18	John W. Colbert			F	63
19	Fred Mauk			F	63
20	Ray Mikkelsen		Physics	B	27
21	Glenn Rowsam			F	36
22	Scott Appold			F	41
23	Gail Grisell			B	10
24	J. Maynard Smith	United Kingdom	Biology	F	9
25	Tom Almy			F	142
26	D. Ambuelh & K. Kickey			F	23
27	Craig Leathers			B	48
28	Bernard Grofman		Pol. Science	F	27
29	Johann Joss	Switzerland	Mathematics	B	74
30	Jonathan Pinkley			F	64
31	Rudy Nydegger		Psychology	F	23
32	Robert Pebley			B	13
33	Roger Jalk & James Langsted			B	117
34	Nelson Weideman		Computer Sci.	F	18
35	Robert Adams			B	43
36	Robyn M. Dawes & Mark Batell		Psychology	F	29
37	George Lefevre			B	10
38	Stanley F. Quayle			F	44
39	R. D. Anderson			F	44
40	Leslie Downing		Psychology	F	33
41	George Zimmerman			F	36
42	Steve Newman			F	51
43	Martyn Jones	New Zealand		B	152
44	E. E. H. Shurmann			B	32
45	Henry Nussbacher			B	52
46	David Gladstein			F	28
47	Mark F. Batell			F	30
48	David A. Smith			B	23
49	Robert Leyland	New Zealand		B	52
50	Michael F. McGurran			F	78
51	Howard R. Hollander			F	16
52	James W. Friedman		Economics	F	9
53	George Hufford			F	41
54	Rik Smoody			F	6
55	Scott Feld		Sociology	F	50
56	Gene Snodgrass			F	90
57	George Duisman			B	6
58	W. H. Robertson			F	54
59	Harold Rabbie			F	52
60	James E. Hall			F	31
61	Edward Friedland			F	84
62	RANDOM			F	(4)

And, the winner is...



TIT FOR TAT, again!

(Again, by Anatol Rapoport)



# Analysis: Contest #1

## Lessons Validated

14 of top 15 strategies  
never defect first.

14 of bottom 15  
strategies were not  
“nice”.

Forgiveness important.

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3	Otto Norfsen	Norway		F	77
4	Bob Cave			F	20
5	William Adams			B	22
6	Jim Grauskamp & Ken Katzen			F	23
7	Herb Weiner			F	31
8	Paul D. Harrington			F	112
9	T. Nicolaus Tideman & P. Chieruzzi		Economics	F	38
10	Charles Kluepfel			B	59
11	Abraham Getzler			F	9
12	Francois Leyvraz	Switzerland		B	29
13	Edward White, Jr.			F	16
14	Graham Fetherley	Canada		F	12
15	Paul E. Black			F	22
16	Richard Hufford			F	45
17	Brian Yamauchi			B	32
18	John W. Colbert			F	63
19	Fred Mauk			F	63
20	Ray Mikkelsen		Physics	B	27
21	Glenn Rowsam			F	36
22	Scott Appold			F	41
23	Gail Grisell			B	10
24	J. Maynard Smith	United Kingdom	Biology	F	9
25	Tom Almy			F	142
26	D. Rothwell & K. Kiekey			F	23
27	Craig Feathers			B	48
28	Bernard Grofman		Pol. Science	F	27
29	Johann Joss	Switzerland	Mathematics	B	74
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37	George Lefevre			B	10
38	Stanley F. Quayle			F	44
39	R. D. Anderson			F	44
40	Leslie Downing		Psychology	F	33
41	George Zimmerman			F	36
42	Steve Newman			F	51
43	Martyn Jones	New Zealand		B	152
44	E. E. H. Shurmann			B	32
45	Henry Nussbacher			B	52
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47	Mark F. Batell			F	30
48	David A. Smith			B	23
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50	Michael F. McGurran			F	78
51	Howard R. Hollander			F	16
52	James W. Friedman		Economics	F	9
53	George Hufford			F	41
54	Rik Smoody			F	6
55	Scott Feld		Sociology	F	50
56	Gene Snodgrass			F	90
57	George Duisman			B	6
58	W. H. Robertson			F	54
59	Harold Rabbin			F	52
60	James R. Hall			F	31
61	Edward Friedman			F	84
62	RANDOM			F	(4)

# Analysis: Be Retaliatory

Some entrees tried to take advantage of “nice” strategies:

TRANQUILIZER – cooperate first, if other cooperates, too, throw in a few defections.

TESTER – defect first, if other doesn’t retaliate, cooperate twice, then alternate defection and cooperation. If other ever defects, do TIT FOR TAT.

Strategies that were unresponsive to defections get taken advantage of.

Top strategies retaliate quickly.

# Analysis: Sneakiness Doesn't Pay

Entrees that try to take advantage of “nice” strategies, don’t gain as much as they lose.

TRANQUILIZER – 27<sup>th</sup> place in tournament.

TESTER – 46<sup>th</sup> place in tournament (out of 63).

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# General Lessons

Be nice. (Don't defect first.)

The best way to do well is to cooperate with others who are also nice.

Retaliate swiftly.

Or, others will take advantage.

Forgive.

Feuds are costly. Defections shouldn't prevent cooperation later on.

Don't be *too* clever.

Too much cleverness looks RANDOM.

# TIT FOR TAT and Ethics

Mahabharata (~3000 BC)

“One should not behave towards others in a way which is disagreeable to oneself. This is the essence of morality. All other activities are due to selfish desire.”

Hammurabi's Code (~1750 BC)

“If a man put out the eye of another man, his eye shall be put out. If he break another man's bone, his bone shall be broken.”

The Golden Rule (~30 AD)

“Do unto others as you would have them do unto you.”

Kant's Categorical Imperative

“Act so that the maxim of action may be capable of becoming a universal law.”

Garrett Hardin (“The Tragedy of the Commons”, 1968)

“Conscience is self-eliminating.”

Thank you!