Reviving, reproducing, and revisiting Axelrod's second tournament

QUT

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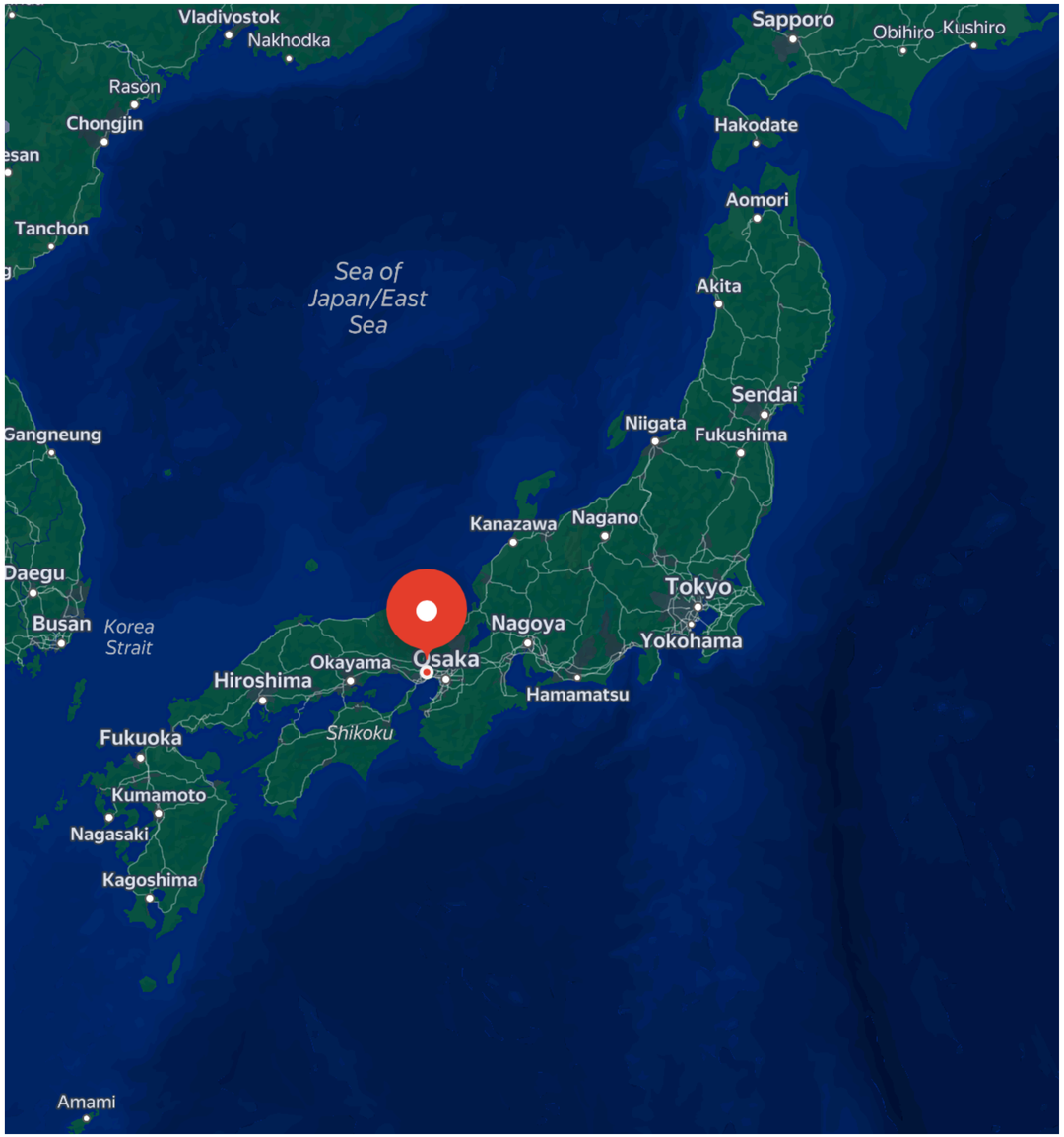
PRIFYSGOL CAERDYDD

RIKEN

R-CCS

iTHEMS



Social Behavior

Understand Cooperation

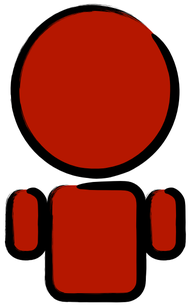
Analysing Scientific Collaboration

Mathematical Analysis

Agent Based Simulations

Data Analysis

Introduction to repeated games



$$\begin{array}{c} \\ C \\ D \end{array} \begin{array}{c} \begin{array}{cc} C & D \end{array} \\ \begin{pmatrix} 3 & 0 \\ 5 & 1 \end{pmatrix} \end{array}$$

Nash Equilibrium

$$T > R > P > S$$

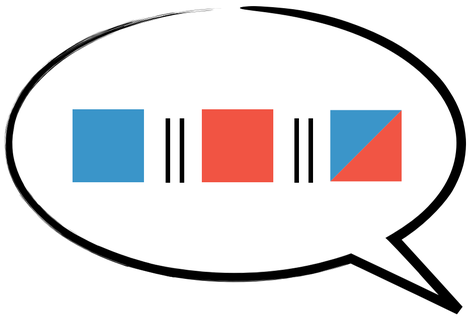
Reciprocity

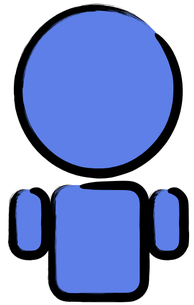
$$\begin{array}{cccccccccccc} \boxed{1} & C & D & \boxed{2} & C & D & \boxed{3} & C & D & \boxed{n-1} & C & D & \boxed{n} & C & D & \boxed{n+1} & C & D \\ C & r & s & C & r & s & C & r & s & C & r & s & C & r & s & C & r & s \\ D & t & p & D & t & p & D & t & p & D & t & p & D & t & p & D & t & p \end{array} \quad \infty$$

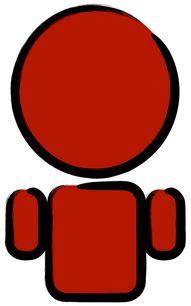
$$C \quad D \quad C \quad \cdots \quad C \quad C$$

$$D \quad C \quad C \quad \cdots \quad D \quad C$$

Introduction to repeated games







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Nash Equilibrium

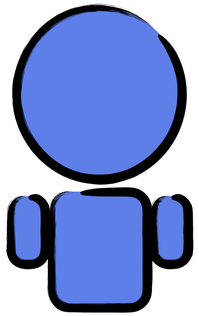
$$T > R > P > S$$

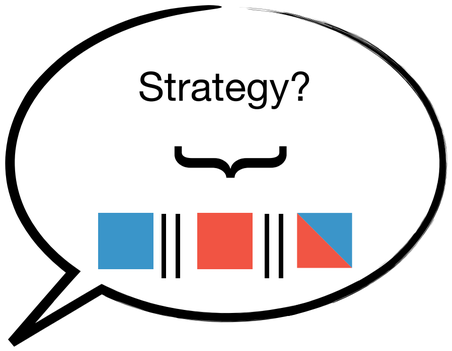
Strategies

1	C	D	2	C	D	3	C	D	$n-1$	C	D	n	C	D	$n+1$	C	D	∞
C	r	s	C	r	s	C	r	s	C	r	s	C	r	s	C	r	s	
D	t	p	D	t	p	D	t	p	D	t	p	D	t	p	D	t	p	

$C \quad D \quad C \quad \cdots \quad C \quad C \quad C/D$

$D \quad C \quad C \quad \cdots \quad D \quad C$





Computer tournaments

Robert Axelrod

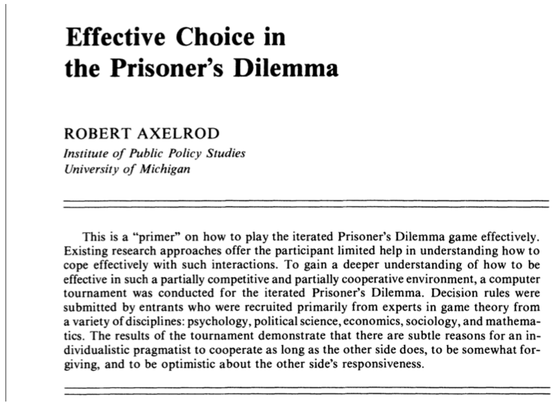
What strategy should Blue play to be successful?

Which is the best strategy in the repeated prisoner's dilemma

Axelrod's First

RULES

- Strategies are submitted as computer code.
- Each strategy plays a match against every other strategy, a copy of itself, and the Random strategy.
- Each match consists of 200 rounds.
- The tournament is repeated five times.
- The strategy with the highest average payoff across all matches is declared the winner.

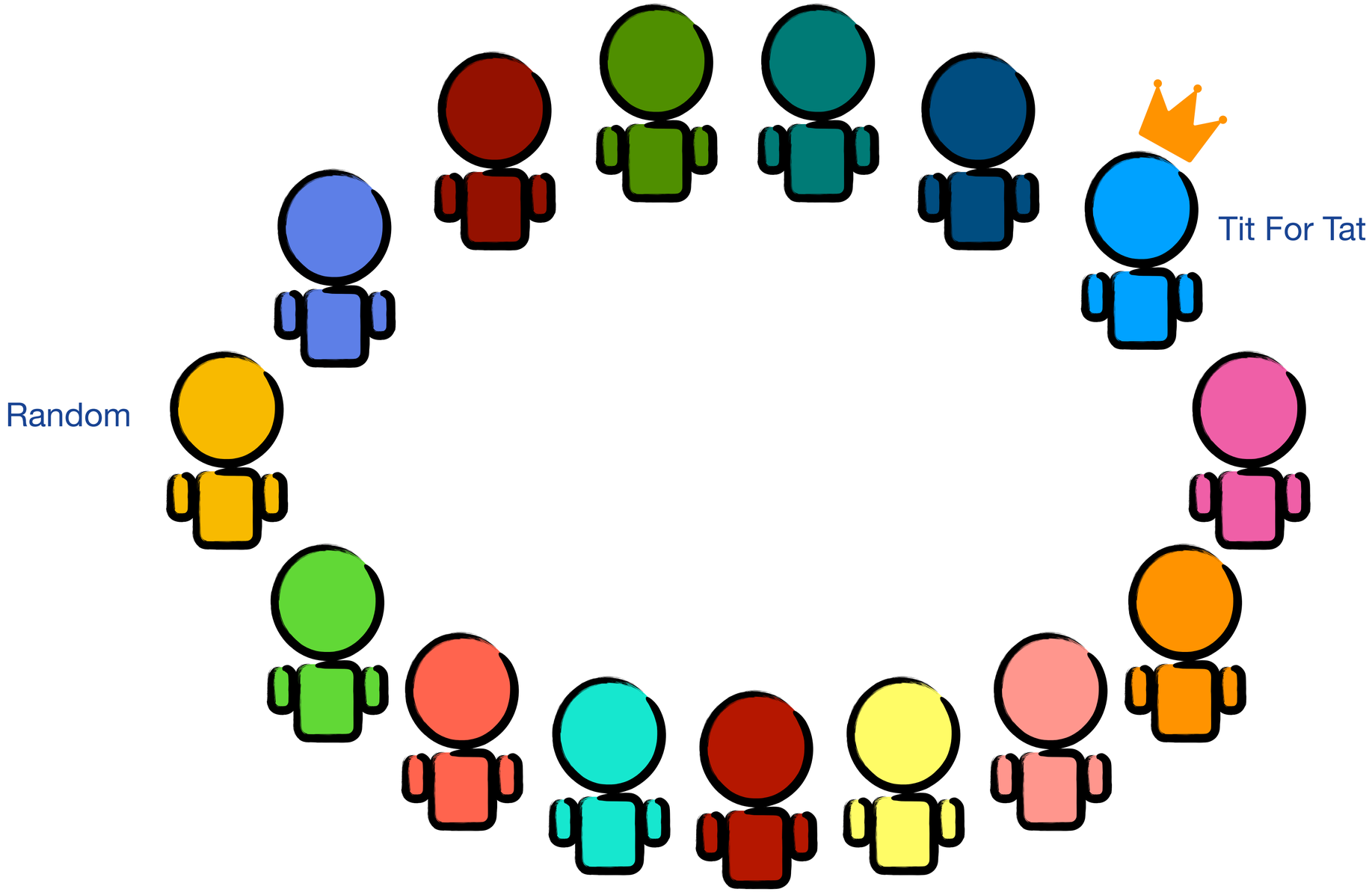


Effective Choice in the Prisoner's Dilemma

ROBERT AXELROD
Institute of Public Policy Studies
University of Michigan

This is a "primer" on how to play the iterated Prisoner's Dilemma game effectively. Existing research approaches offer the participant limited help in understanding how to cope effectively with such interactions. To gain a deeper understanding of how to be effective in such a partially competitive and partially cooperative environment, a computer tournament was conducted for the iterated Prisoner's Dilemma. Decision rules were submitted by entrants who were recruited primarily from experts in game theory from a variety of disciplines: psychology, political science, economics, sociology, and mathematics. The results of the tournament demonstrate that there are subtle reasons for an individualistic pragmatist to cooperate as long as the other side does, to be somewhat forgiving, and to be optimistic about the other side's responsiveness.

Axelrod’s First



Axelrod's Second

SECOND TOURNAMENT RULES

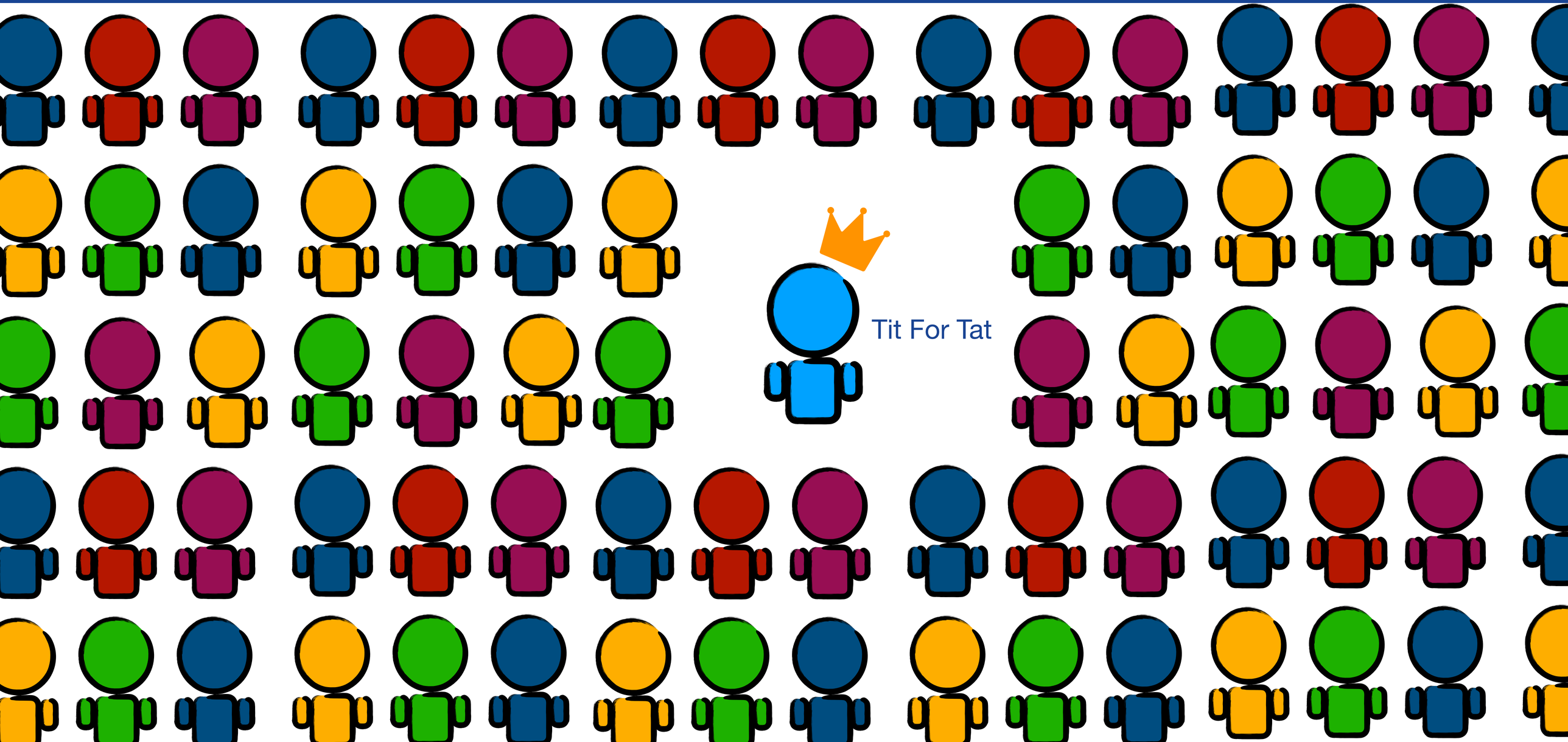
- Strategies are submitted as computer code.
- Each strategy plays a match against every other strategy, a copy of itself, and the Random strategy.
- Each match consists of  rounds.
- The tournament is repeated five times.
- The strategy with the highest average payoff across all matches is declared the winner.

More Effective Choice in the Prisoner's Dilemma

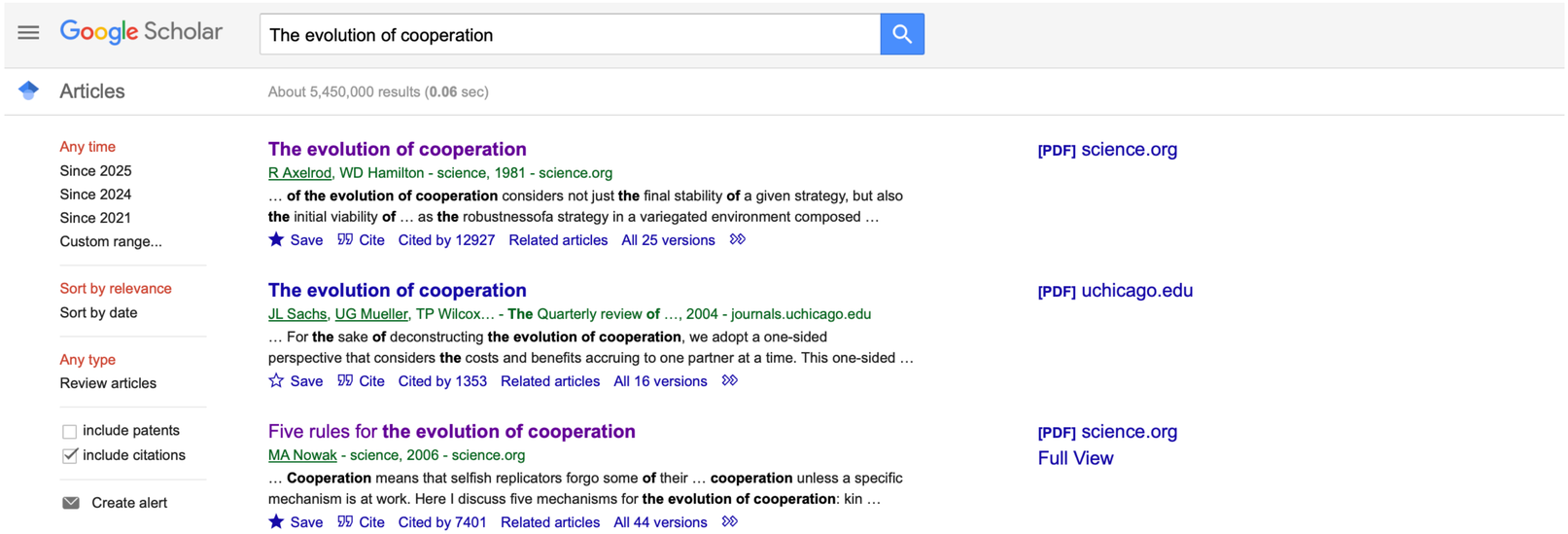
ROBERT AXELROD
Institute of Public Policy Studies
The University of Michigan

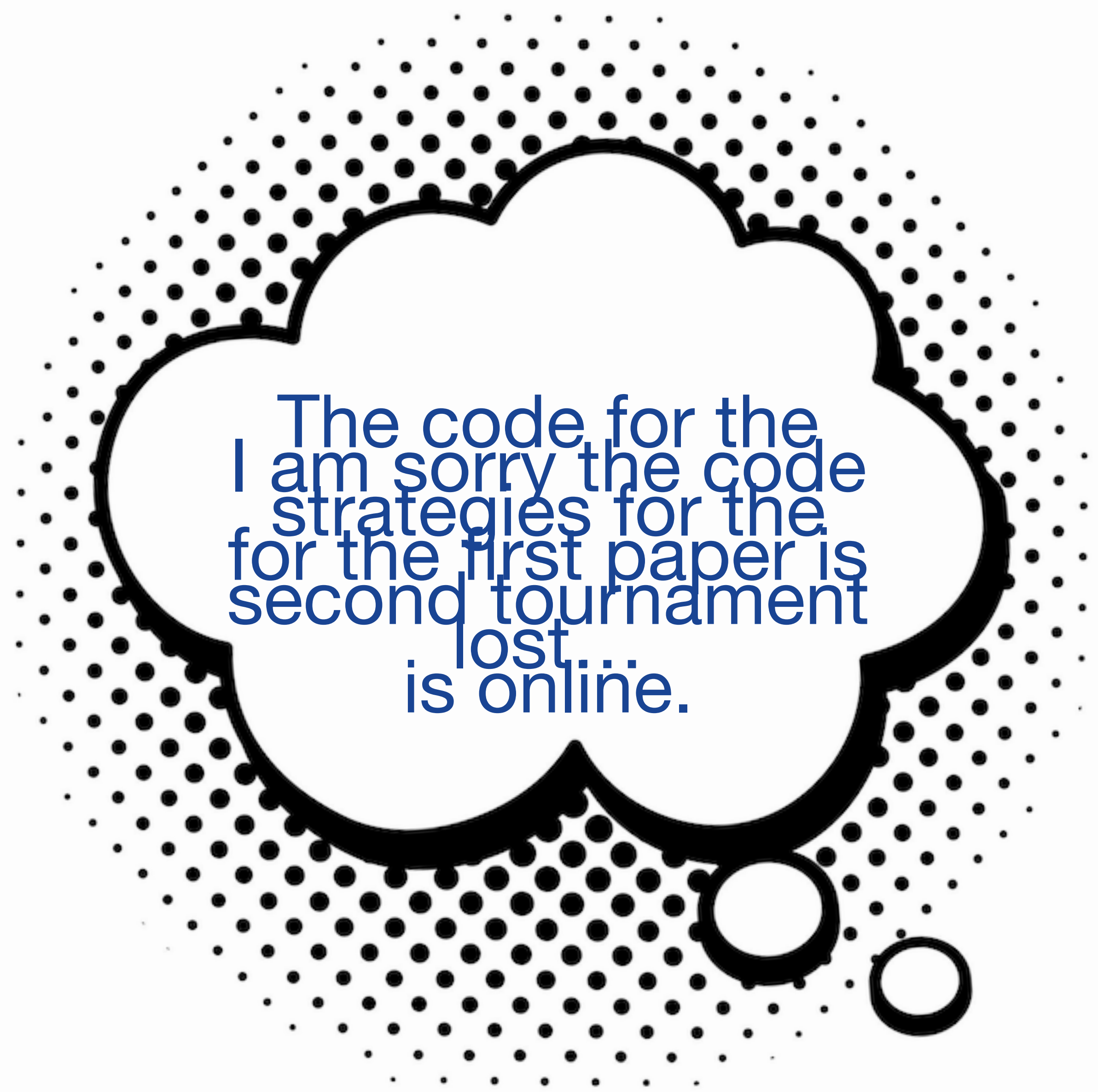
This study reports and analyzes the results of the second round of the computer tournament for the iterated Prisoner's Dilemma. The object is to gain a deeper understanding of how to perform well in such a setting. The 62 entrants were able to draw lessons from the results of the first round and were able to design their entries to take these lessons into account. The results of the second round demonstrate a number of subtle pitfalls which specific types of decision rules can encounter. The winning rule was once again TIT FOR TAT, the rule which cooperates on the first move and then does what the other player did on the previous move. The analysis of the results shows the value of not being the first to defect, of being somewhat forgiving, but also the importance of being provocable. An analysis of hypothetical alternative tournaments demonstrates the robustness of the results.

Axelrod's Second

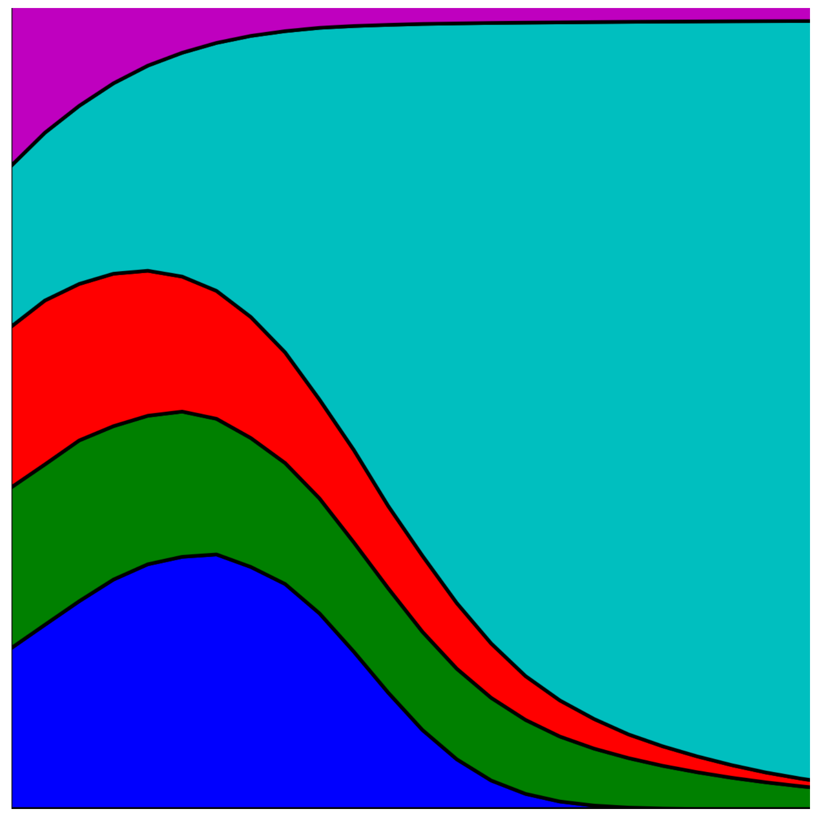


Axelrod's Work

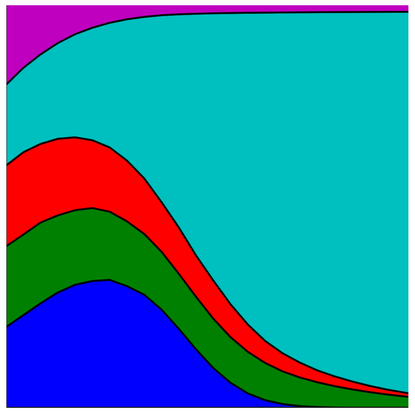



The code for the strategies for the second tournament is online.
I am sorry the code for the first paper is lost...


I have your code?



Axelrod-Python



https://
axelrod.readthedocs.io/en/
stable/

Help desk

Reviving, reproducing, and revisiting Axelrod's second tournament

The code for the strategies for the second tournament is online.

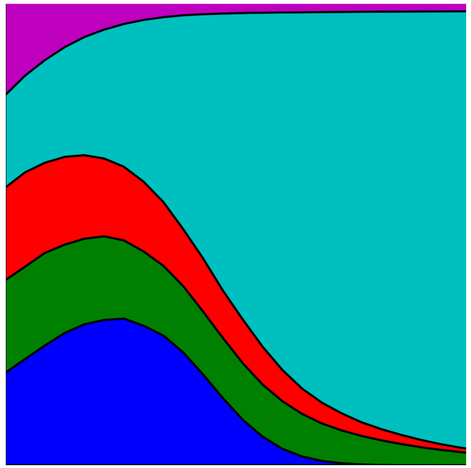
Can we re-run the original tournament?

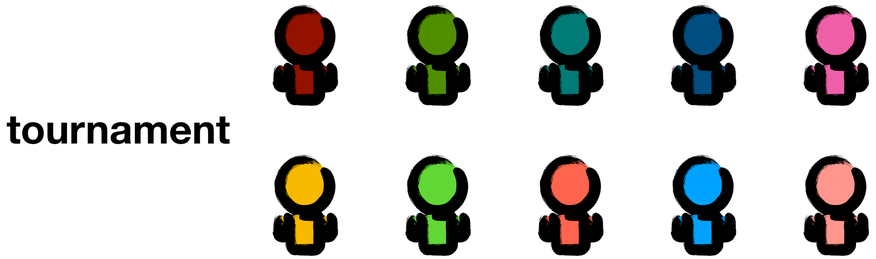
Reviving the tournament

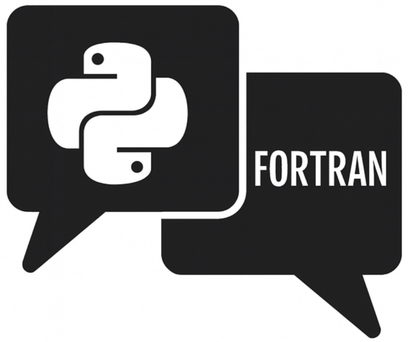
```
      FUNCTION K92R(J,M,K,L,R,JA)
C BY ANATOL RAPOPORT
C TYPED BY AX 3/27/79 (SAME AS ROUND ONE TIT FOR TAT)
c replaced by actual code, Ax 7/27/93
c  T=0
c   K92R=ITFTR(J,M,K,L,T,R)
      k92r=0
      k92r=j
c test 7/30
c   write(6,77) j, k92r
c77   format(' test k92r. j,k92r: ', 2i3)
      RETURN
      END
```

- J: Opponent's previous move (0 = cooperate, 1 = defect),
- M: Current turn number (starting at 1),
- K: Player's cumulative score,
- L: Opponent's cumulative score,
- R: Random number between 0 and 1 (for stochastic strategies),
- JA: Player's previous move.

Reviving the tournament





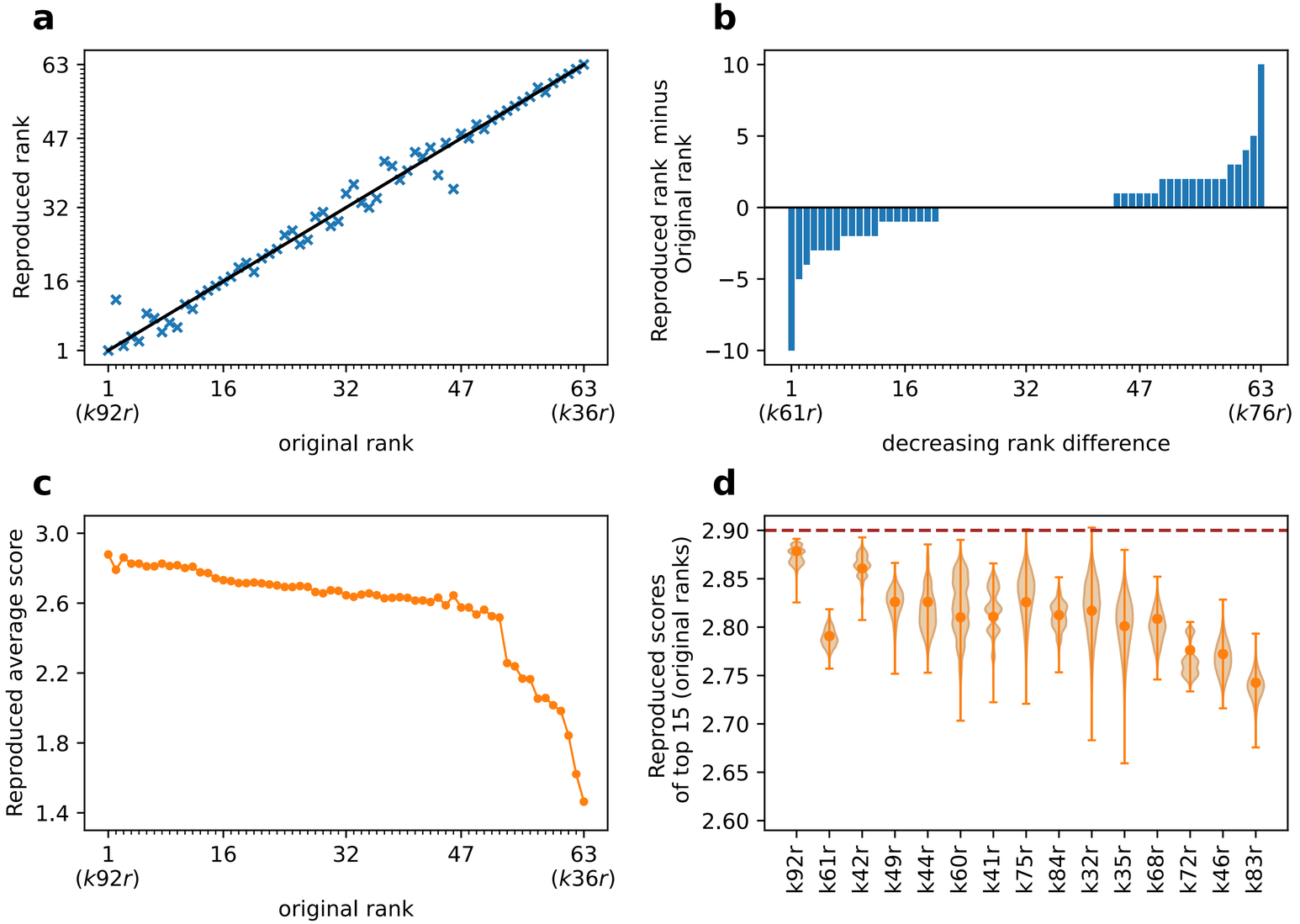


Reviving the tournament

"As announced in the rules, the length of the games was determined probabilistically with a .00346 chance of ending with each given move. This parameter was chosen so that the expected median length of a game would be 200 moves. In practice, each pair of players was matched five times, and the lengths of these five games were determined once and for all by drawing a random sample. The resulting random sample from the implied distribution specified that the five games for each pair of players would be of lengths 63, 77, 151, and 308 moves. Thus the average length of a game turned out to be somewhat shorter than expected at 151 moves."

25,000

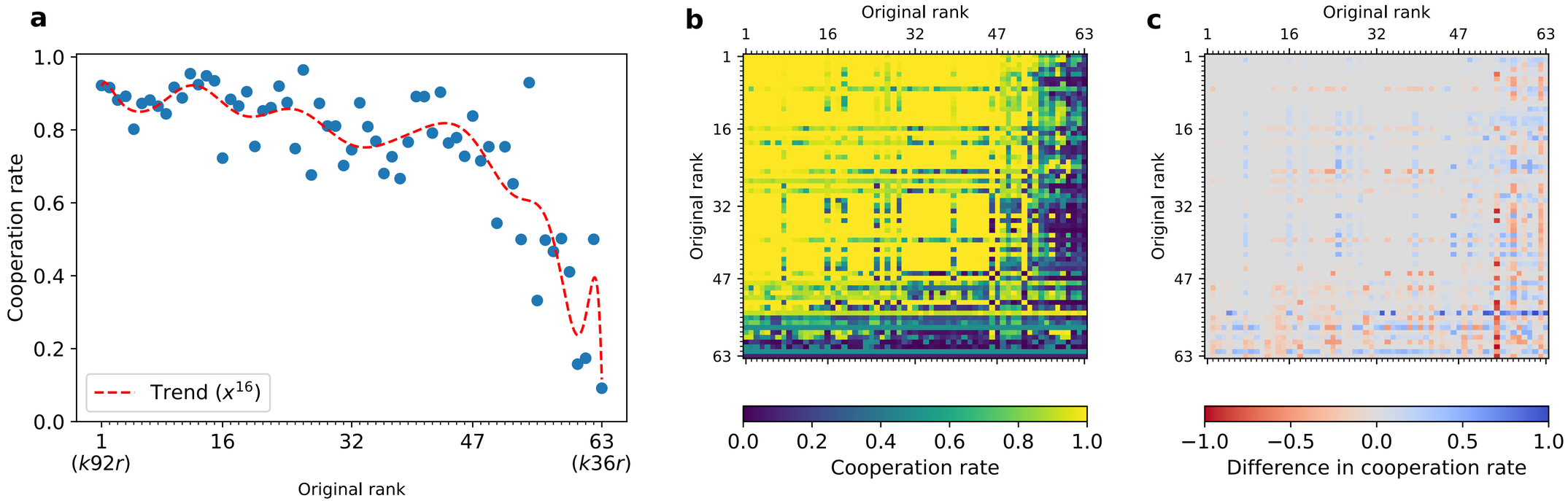
Reproducing the tournament



Reproducing the tournament

```
      FUNCTION K61R(ISPICK,ITURN,K,L,R, JA)
C BY DANNY C. CHAMPION
C TYPED BY JM 3/27/79
      k61r=ja     ! Added 7/27/93 to report own old value
      IF (ITURN .EQ. 1) ICOOP = 0   ! Added 10/8/2017 to fix bug for multiple runs
      IF (ITURN .EQ. 1) K61R = 0
      IF (ISPICK .EQ. 0) ICOOP = ICOOP + 1
      IF (ITURN .LE. 10) RETURN
      K61R = ISPICK
      IF (ITURN .LE. 25) RETURN
      K61R = 0
      COPRAT = FLOAT(ICOOP) / FLOAT(ITURN)
      IF (ISPICK .EQ. 1 .AND. COPRAT .LT. .6 .AND. R .GT. COPRAT)
     +K61R = 1
      RETURN
      END
```

Reproducing the tournament



Revisiting

1. Extra invitations (209 strategies)
2. A noisy tournament
3. Stewart and Plotkin tournament
4. Axelrod-Python tournament
5. Axelrod-Python tournament 1% Noise
6. Axelrod-Python tournament 5% Noise

Revisiting

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	1 New (N = 209)	2 New (N = 21736)	3 New (N = 1499784)	4 New (N = 77238876)
k32r	0.00000	0.00000	0.00001	0.00079
k41r	0.00000	0.00000	0.00001	0.00000
k42r	0.14833	0.26941	0.36640	0.21723
k44r	0.00000	0.00023	0.00057	0.00461
k49r	0.00000	0.00014	0.00035	0.00023
k60r	0.00478	0.01118	0.01882	0.00451
k75r	0.00000	0.00051	0.00245	0.00086
k92r	0.84689	0.71747	0.60814	0.75412
Sum	1.00000	0.99894	0.99674	0.98235

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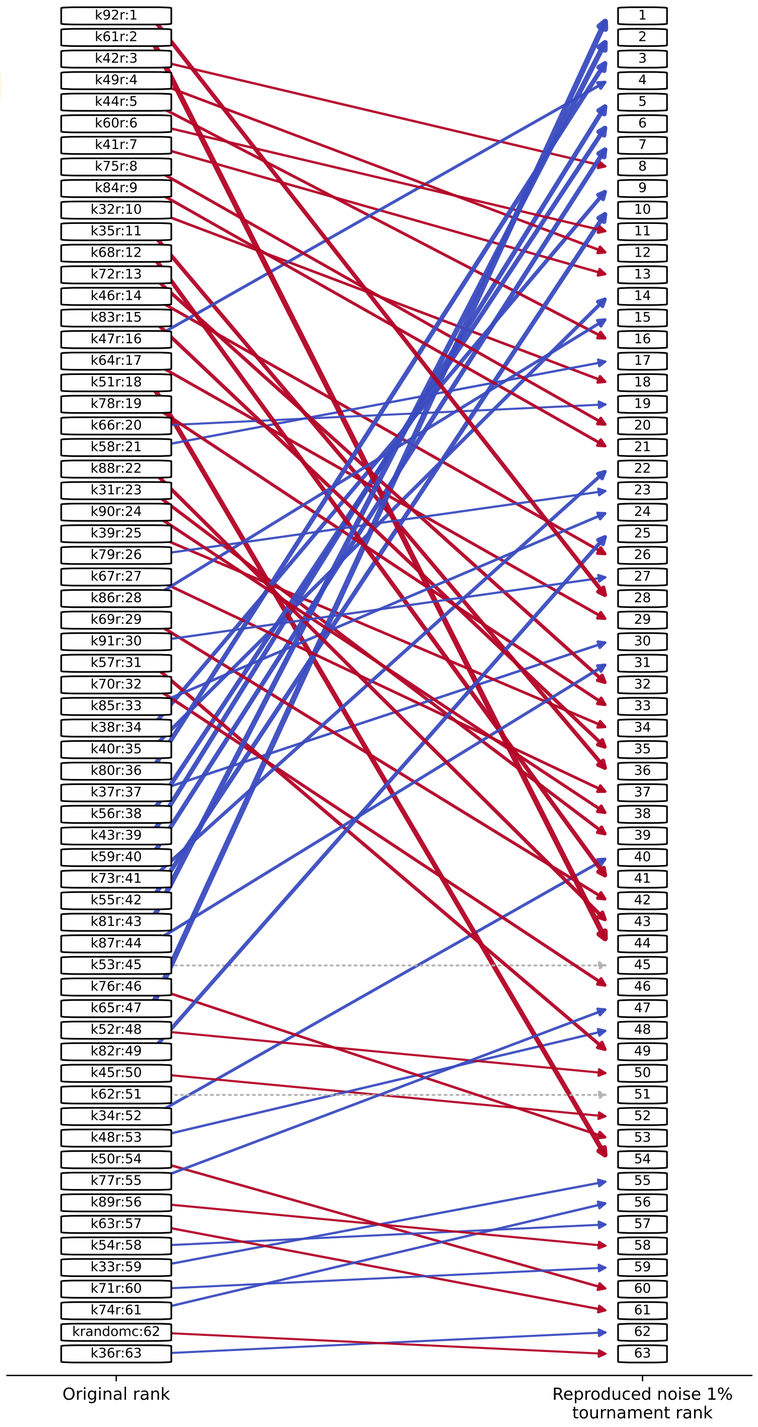

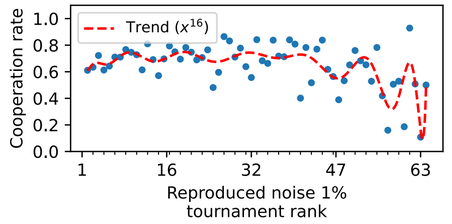

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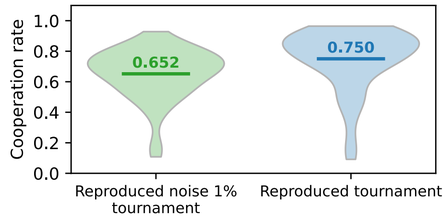

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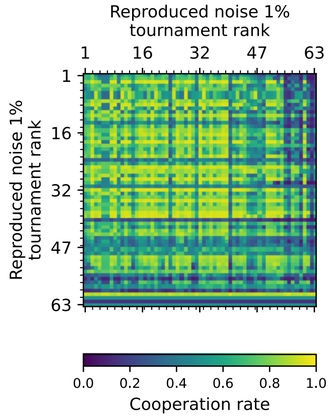

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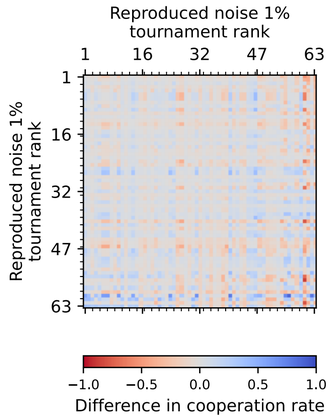

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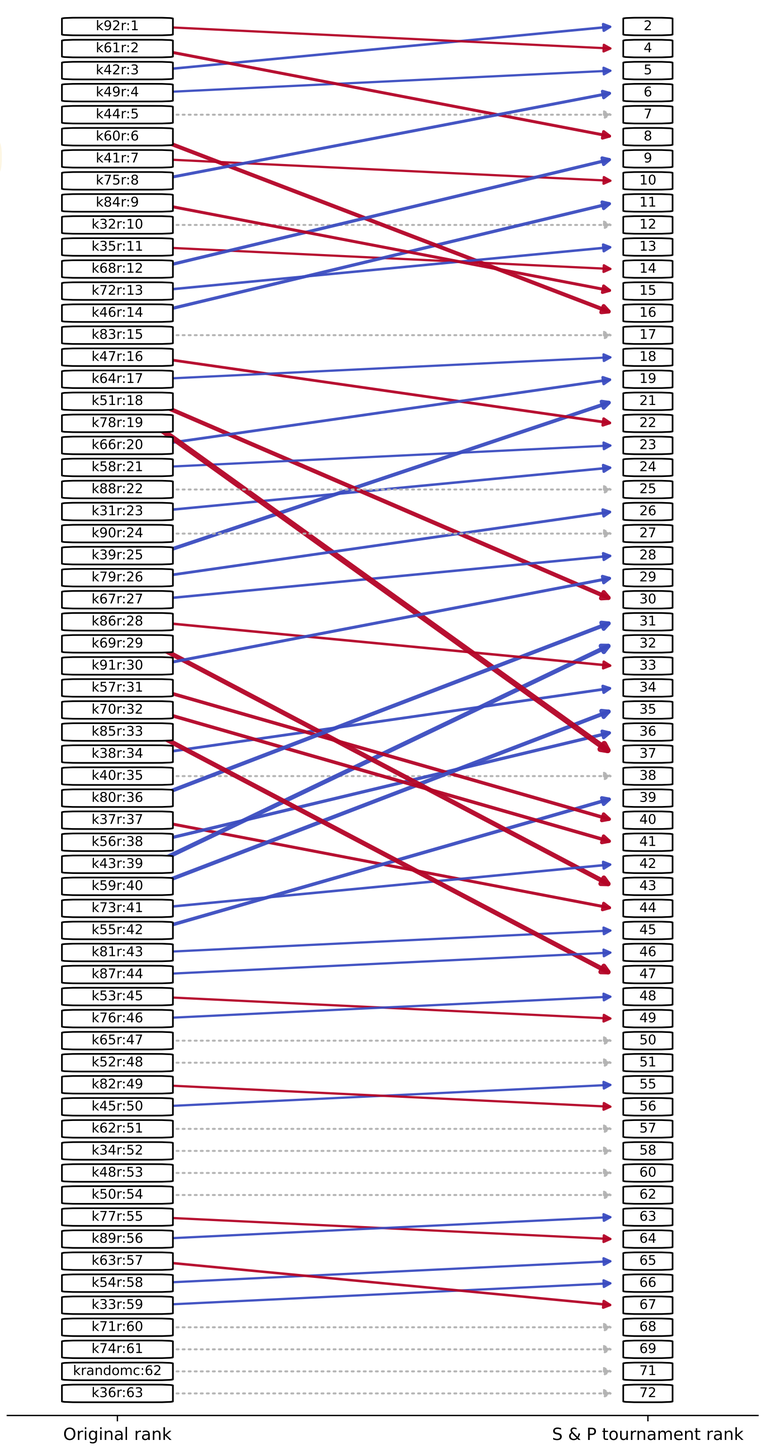

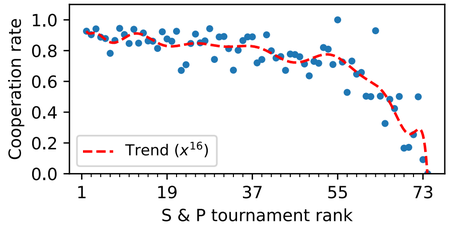

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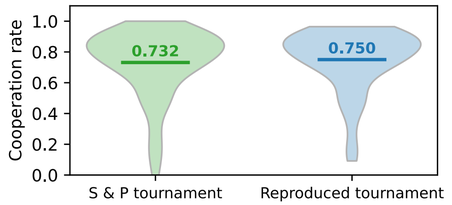

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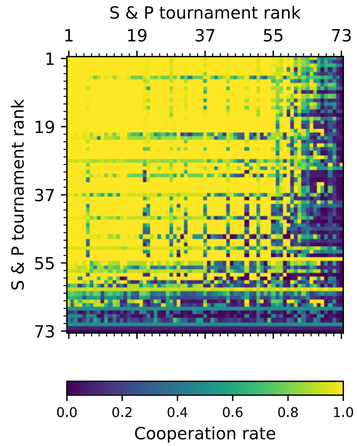

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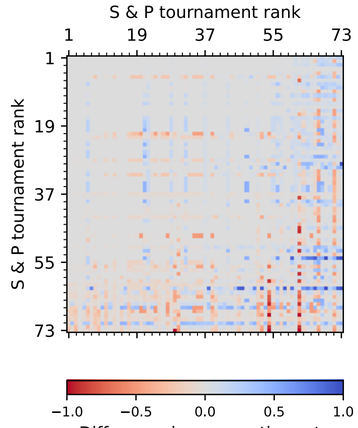

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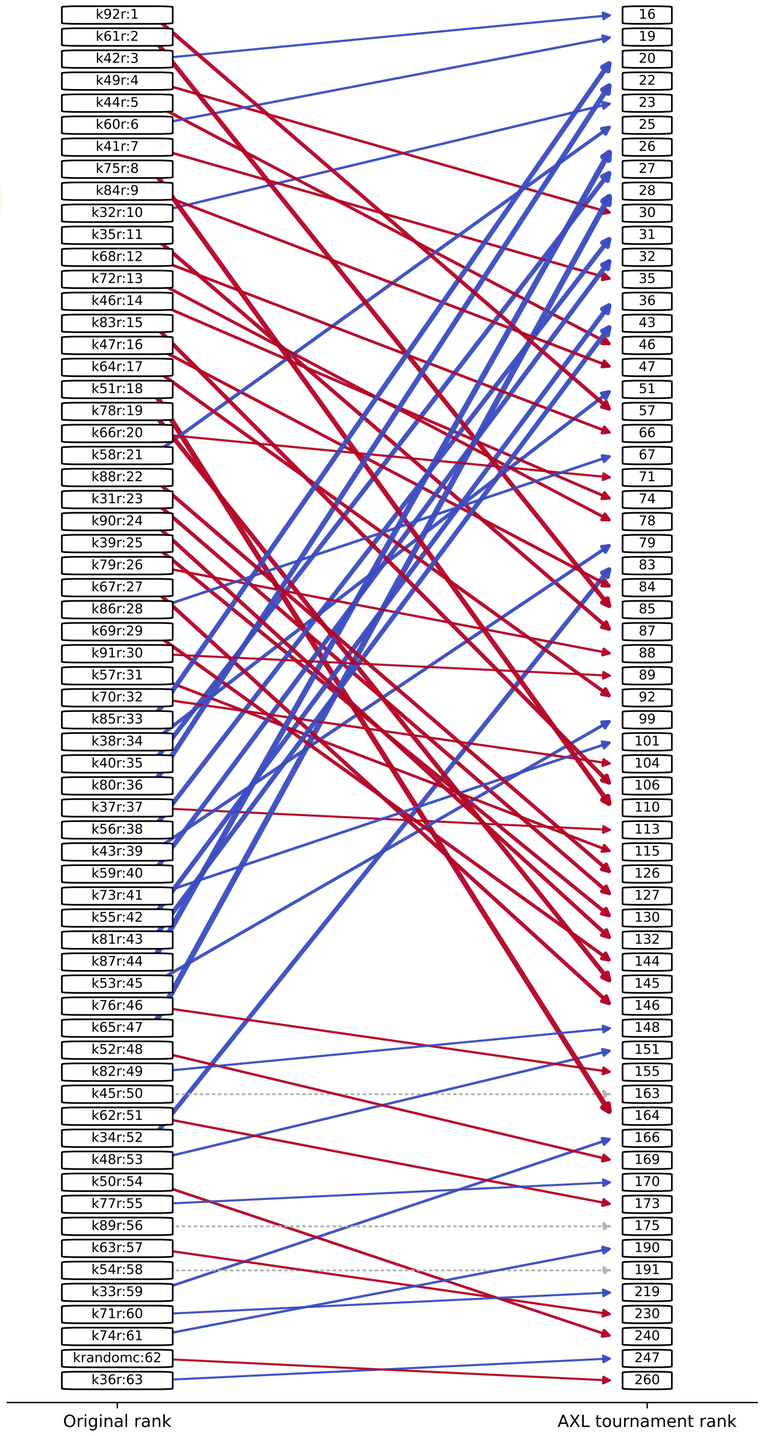

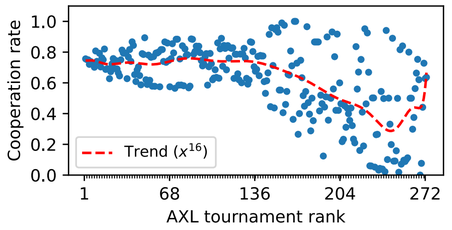

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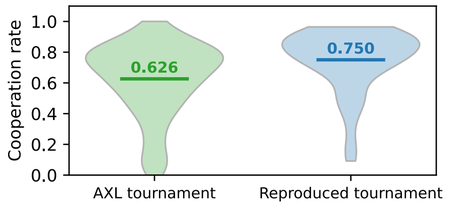

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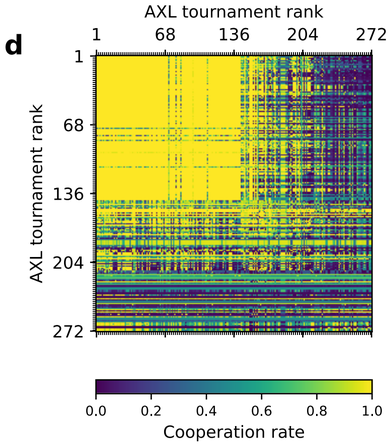

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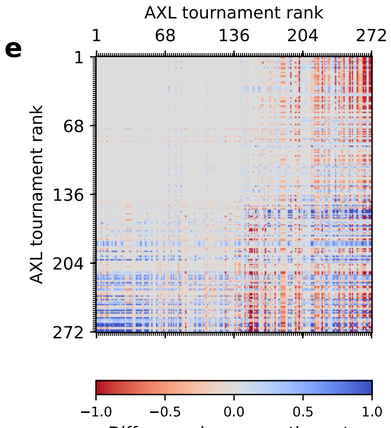

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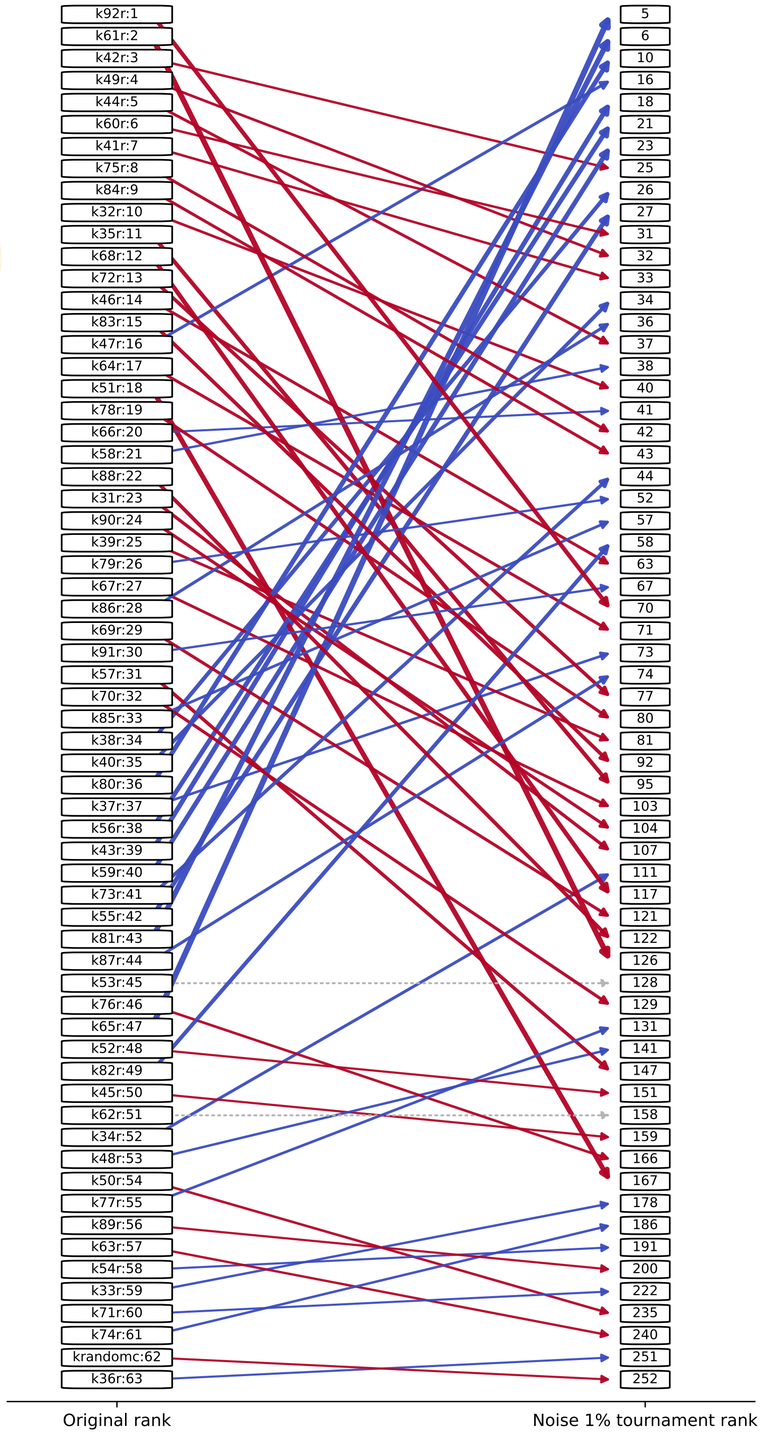

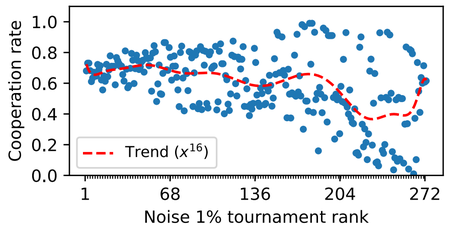

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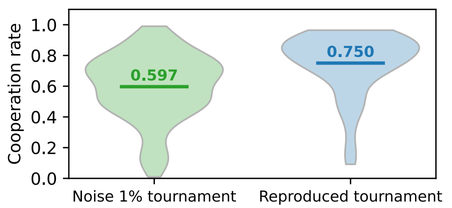

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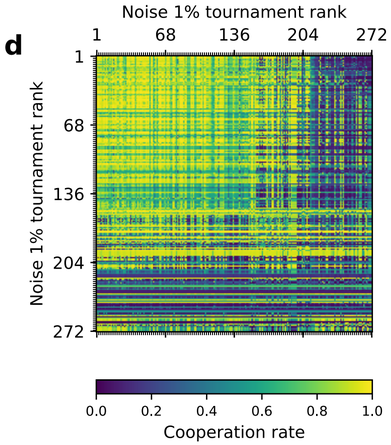

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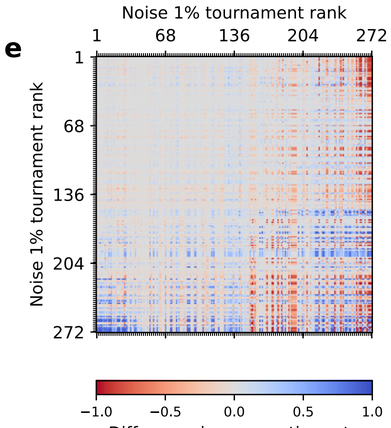

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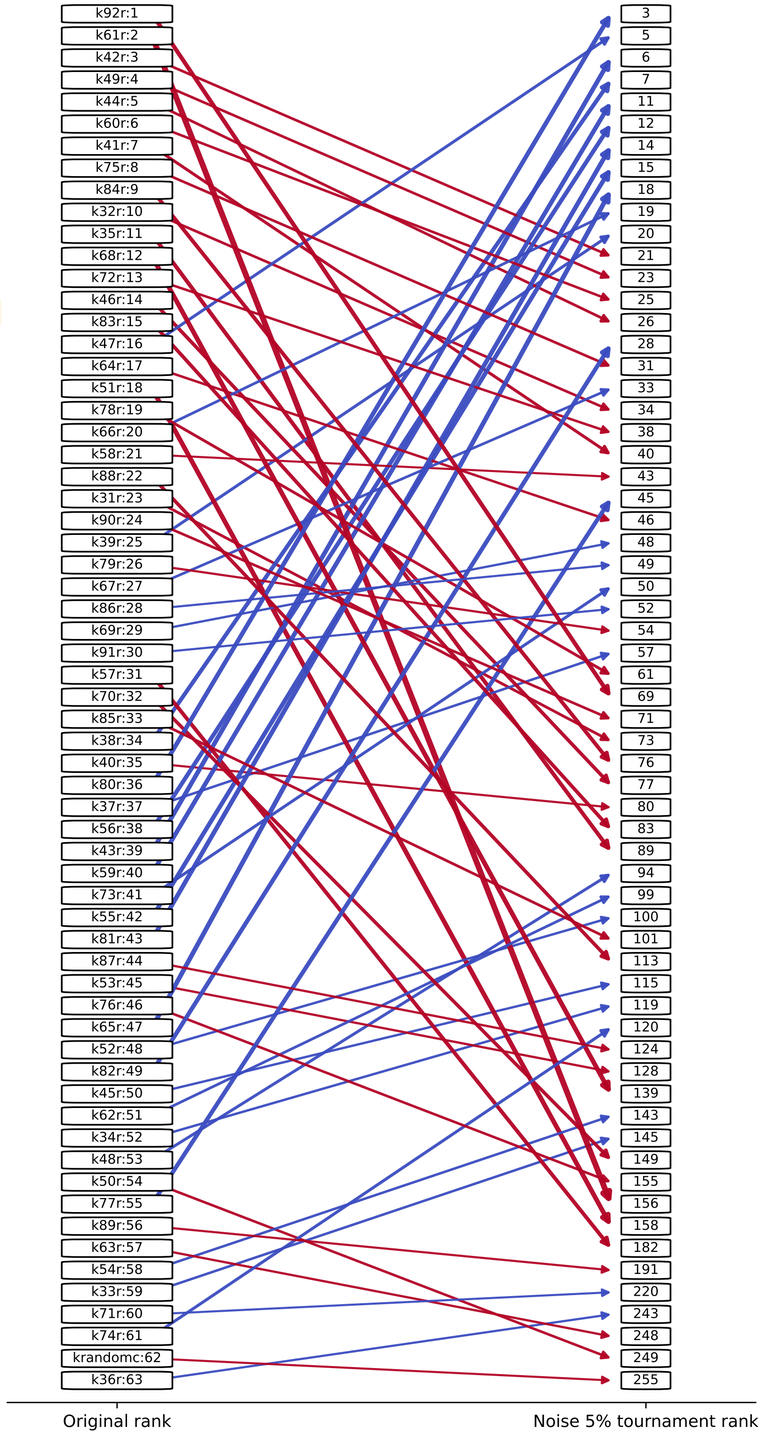
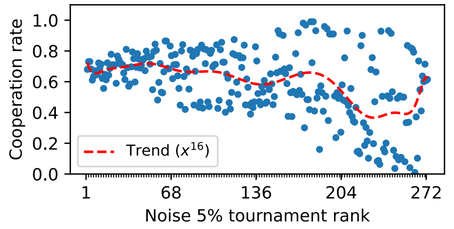
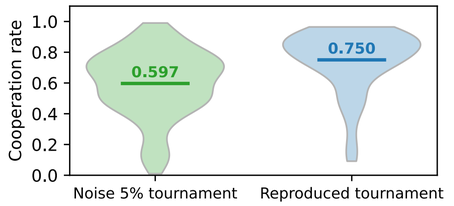
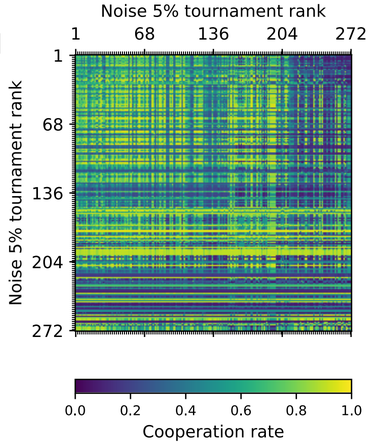




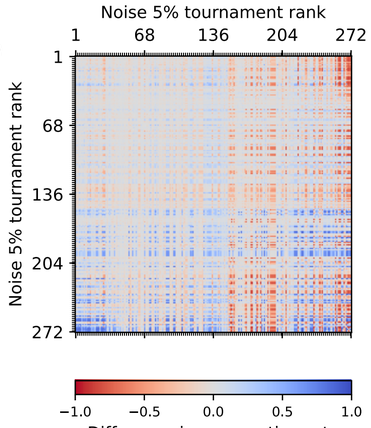
c



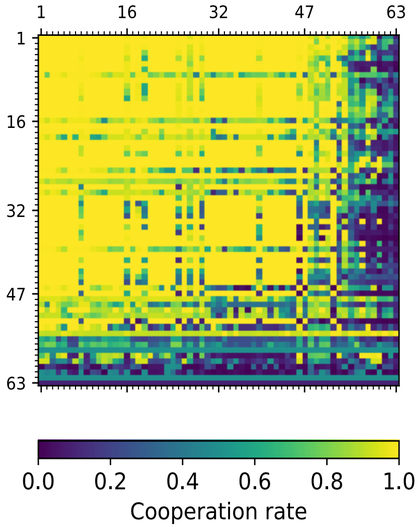
d

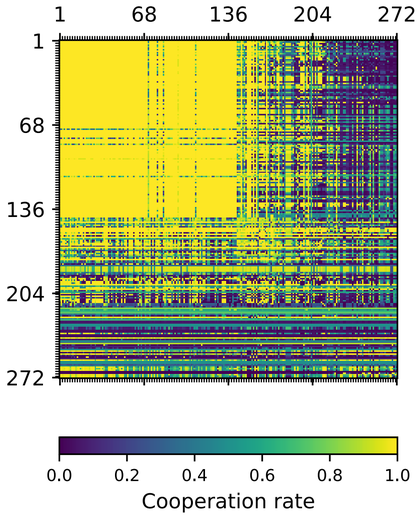


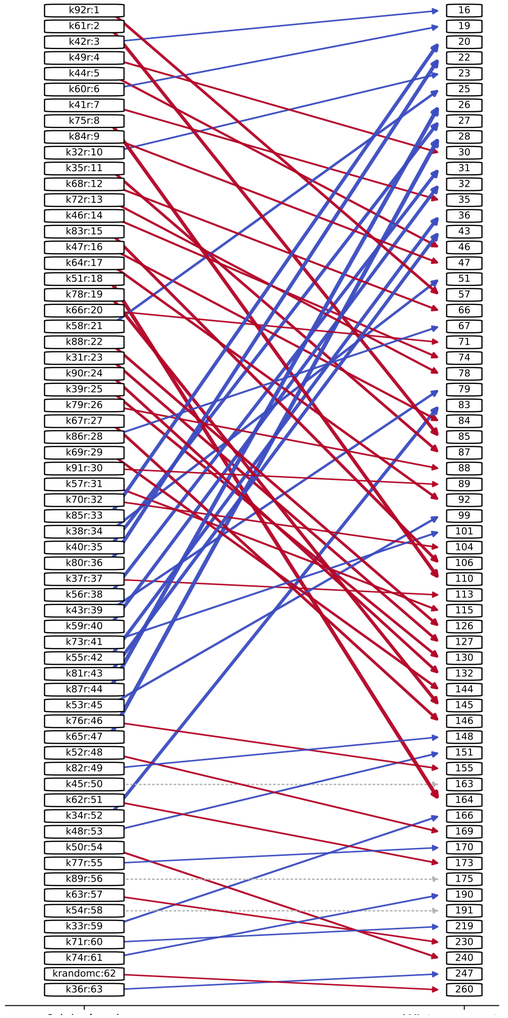
e



Summary







Nikoleta-v3

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THANK YOU!