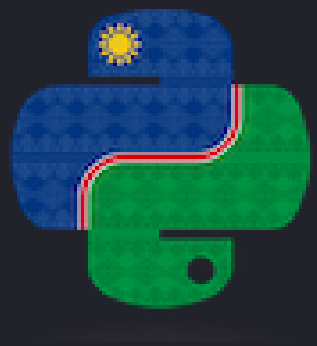
Understanding responses to environments for the Prisoner's Dilemma: A meta analysis, multidimensional optimisation and machine learning approach

Nikoleta E. Glynatsi

Dr Vincent Knight & Dr Jonathan Gillard

International Conference on Social Dilemmas



International Conference
on Social Dilemmas

Software Sustainability Institute - Collaborations Workshop

SoapBox Science Cardiff

Enriching Student Life Award

SIAM-IMA Chapter Treasurer & President

Published

1. Reinforcement learning produces dominant strategies for the Iterated Prisoner's Dilemma. Marc Harper, Vincent Knight, Martin Jones, Georgios Koutsovoulos, **Nikoleta E. Glynatsi**, Owen Campbell - PLOS One - Preprint arXiv:1707.06307

2. An evolutionary game theoretic model of rhino horn devaluation. **Nikoleta E. Glynatsi**, Vincent Knight, Tamsin Lee. Ecological Modelling - Preprint arXiv:1712.07640

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4. An open framework for the reproducible study of the Iterated prisoner's dilemma. Vincent Knight, Owen Campbell, Marc Harper et al - Journal of Open Research Software

Under review

1. A bibliometric study of research topics, collaboration and influence in the field of the Iterated Prisoner's Dilemma. **Nikoleta E. Glynatsi** and Vincent A. Knight - Palgrave Communications - Preprint arXiv:1911.06128

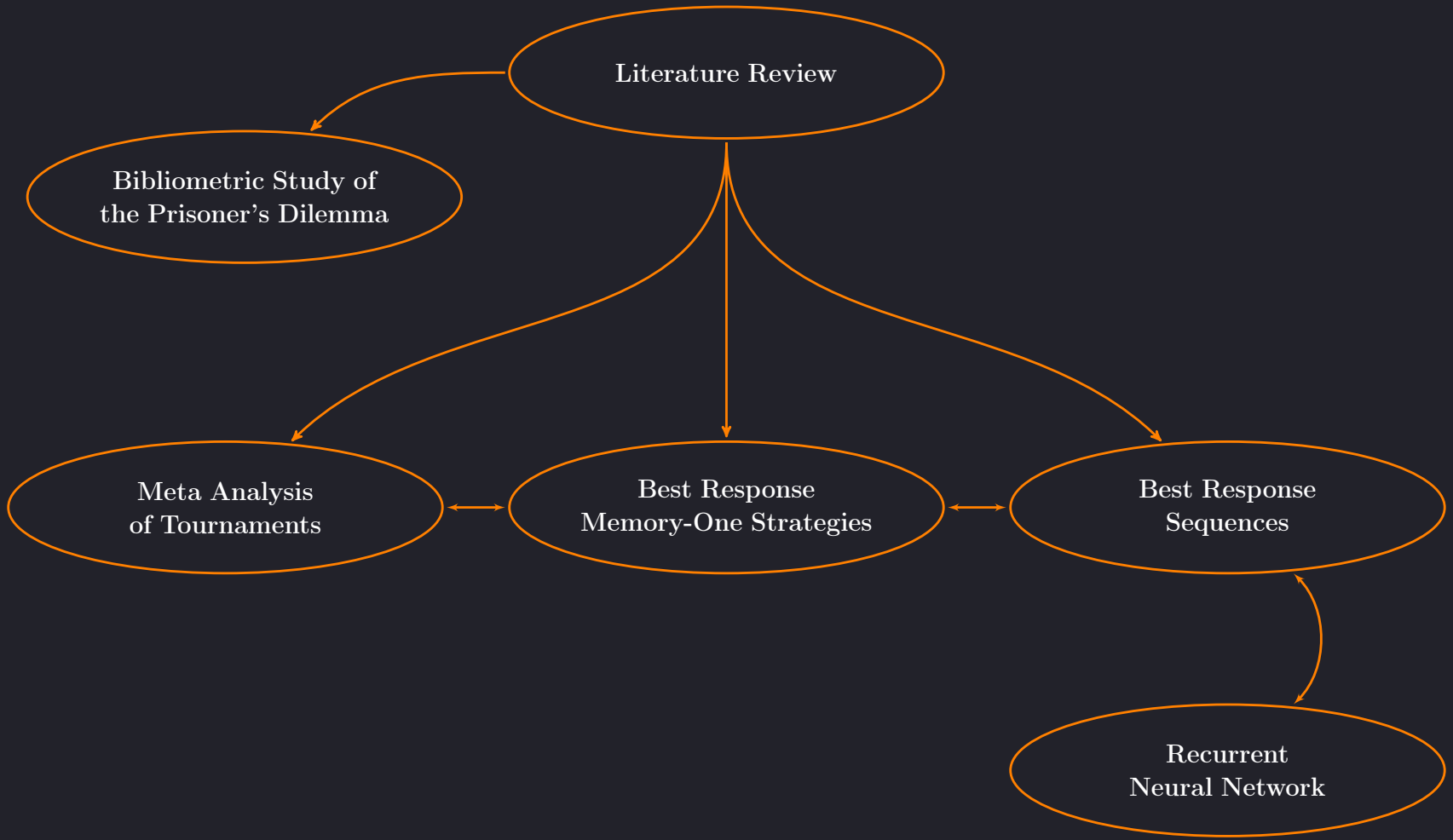
2. Game Theory and Python: An educational tutorial to game theory and repeated games using Python **Nikoleta E. Glynatsi** and Vincent A. Knight - Journal of Open Source Education Nikoleta-v3/Game-Theory-and-Python

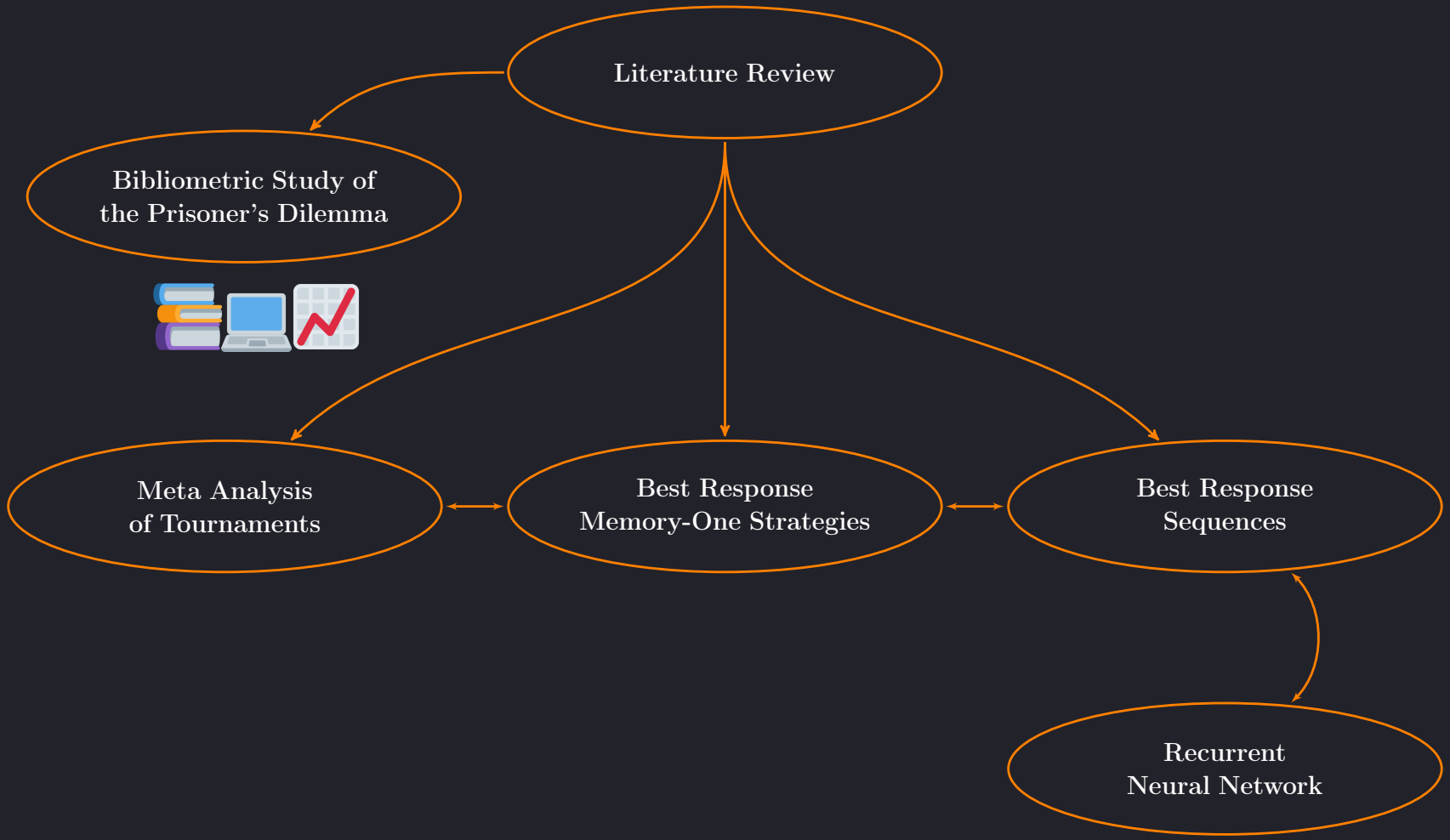
3. A theory of mind: Best responses to memory-one strategies. The limitations of extortion and restricted memory. **Nikoleta E. Glynatsi** and Vincent A. Knight - Scientific Reports - Preprint arXiv:1911.12112

In preparation

1. Properties of Winning Iterated Prisoner's Dilemma Strategies. **Nikoleta E. Glynatsi**, Vincent A. Knight and Marc Harper - Preprint arXiv:2001.05911

2. Recognising and evaluating the effectiveness of extortion in the Iterated Prisoner's Dilemma. Vincent Knight, Marc Harper, **Nikoleta E. Glynatsi**, Jonathan Gillard - Preprint arXiv:1904.00973


Literature Review
Bibliometric Study of the Prisoner's Dilemma
Meta Analysis of Tournaments
Best Response Memory-One Strategies
Best Response Sequences
Recurrent Neural Network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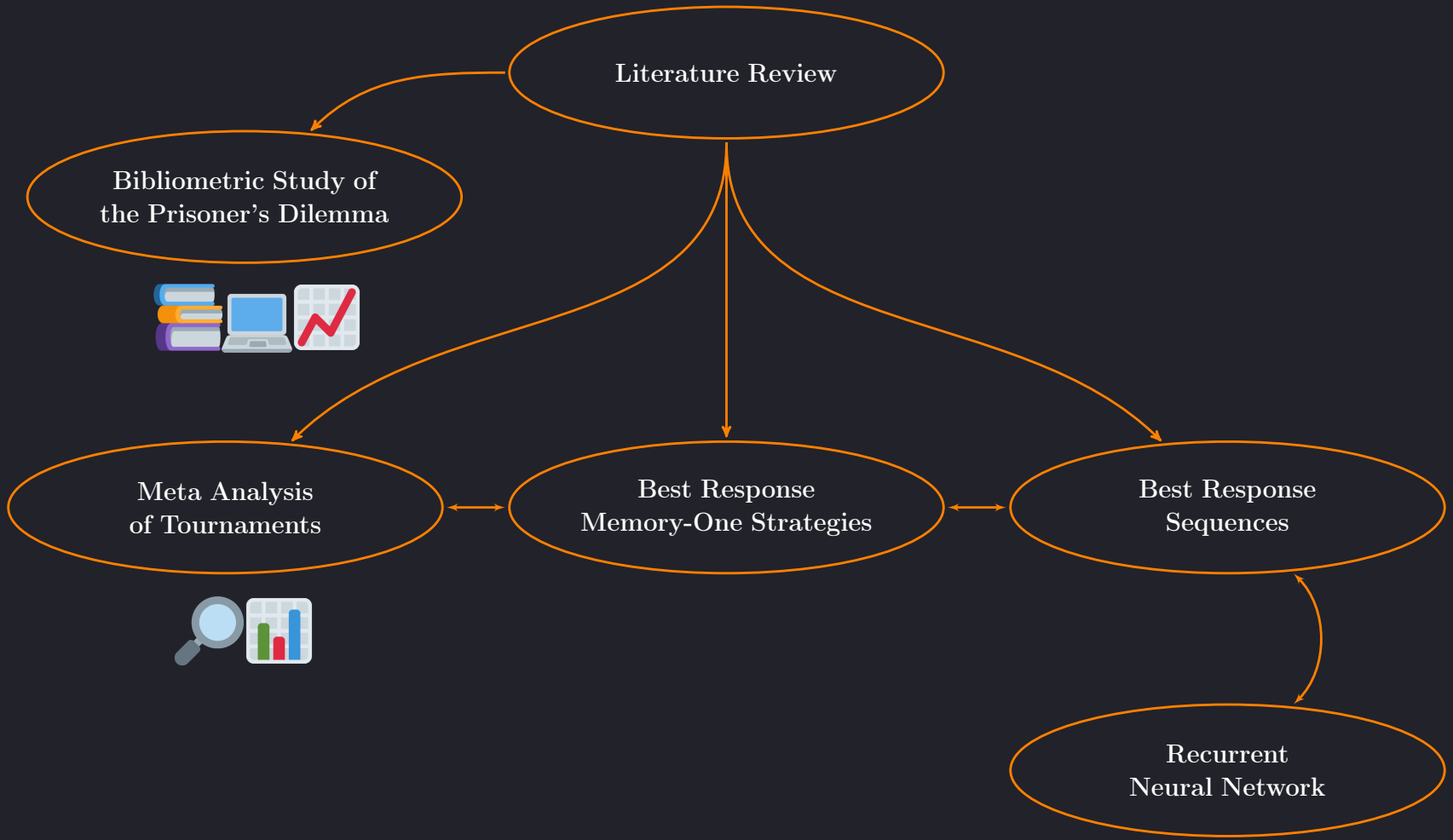
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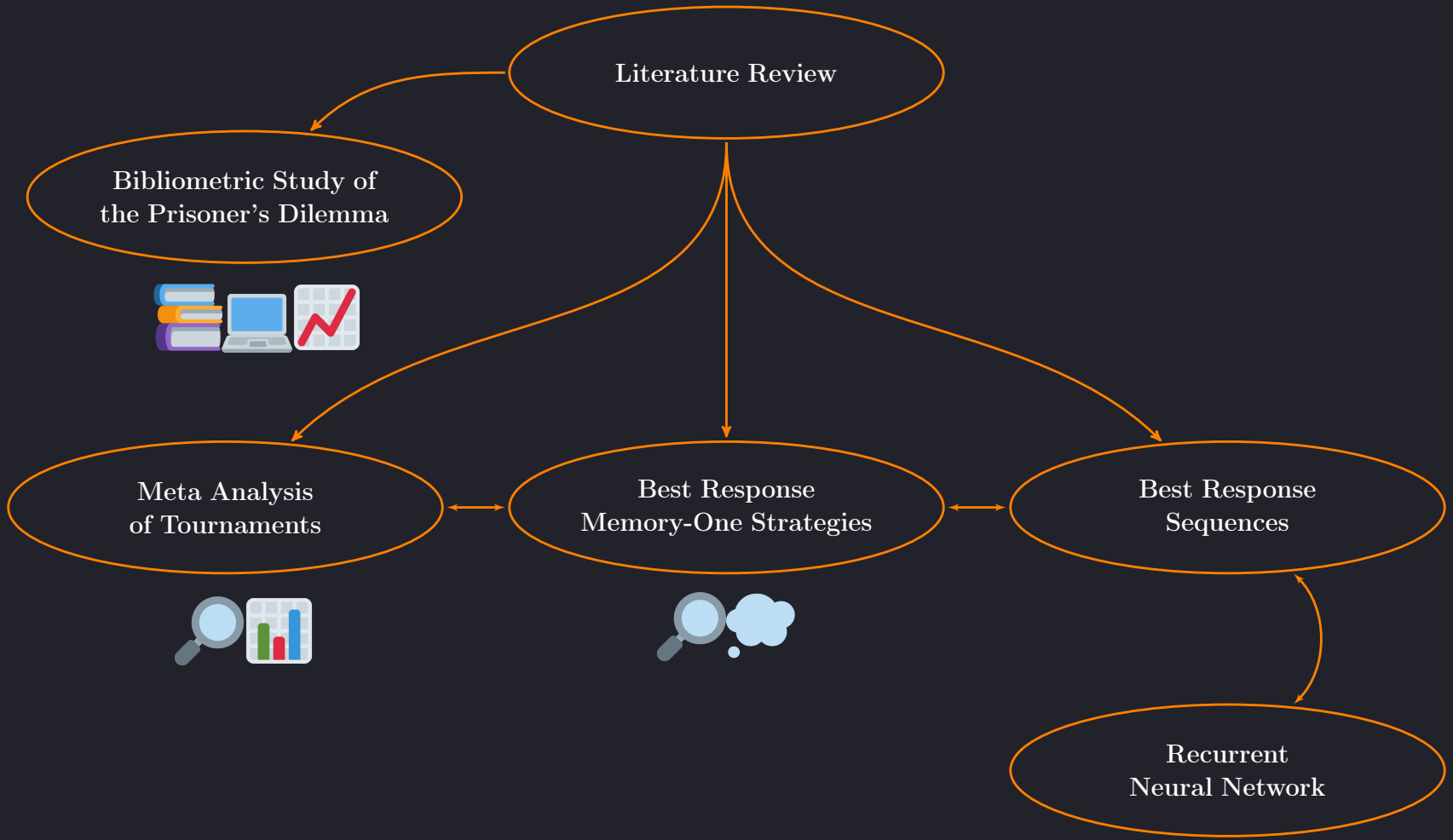
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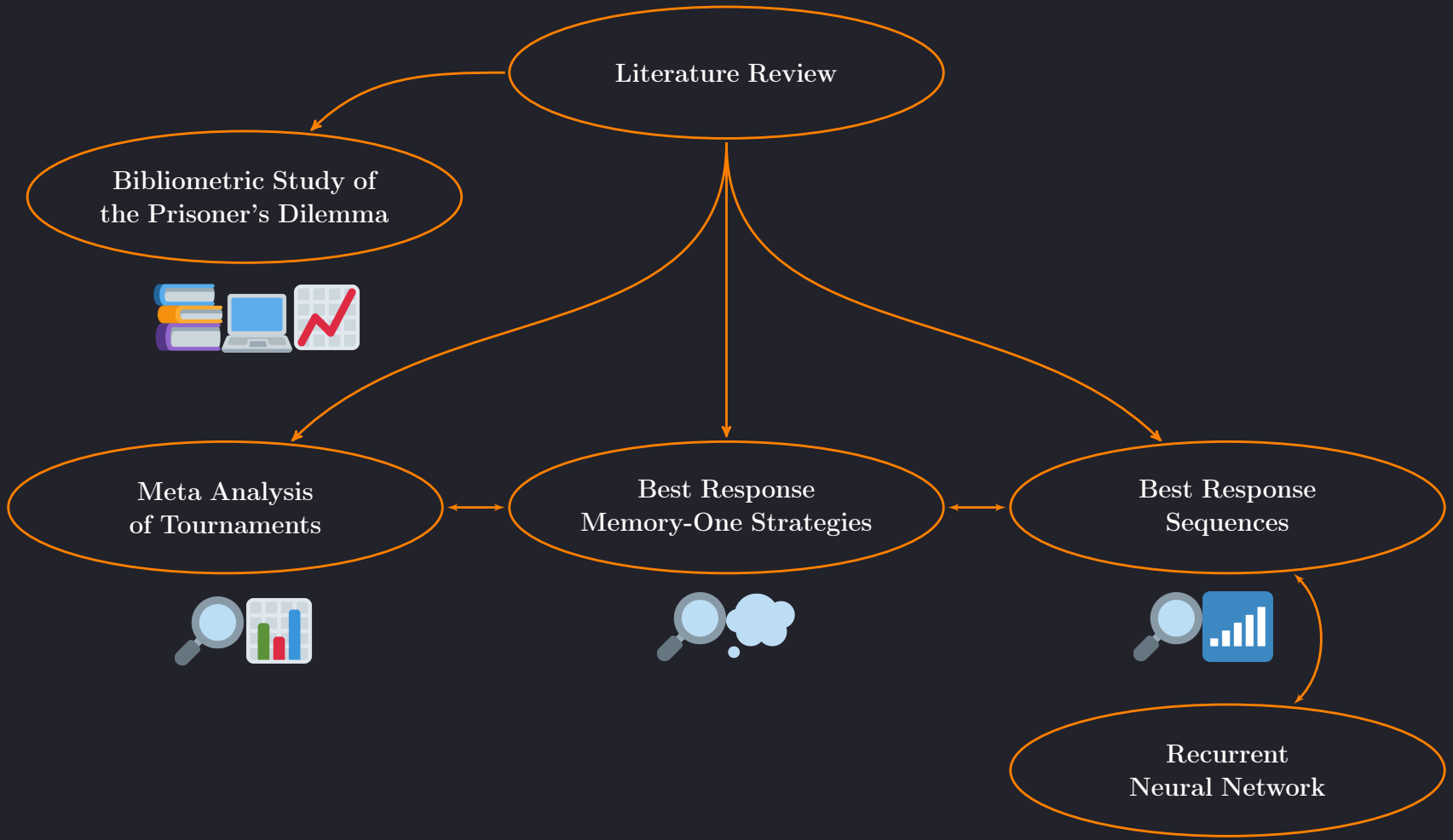
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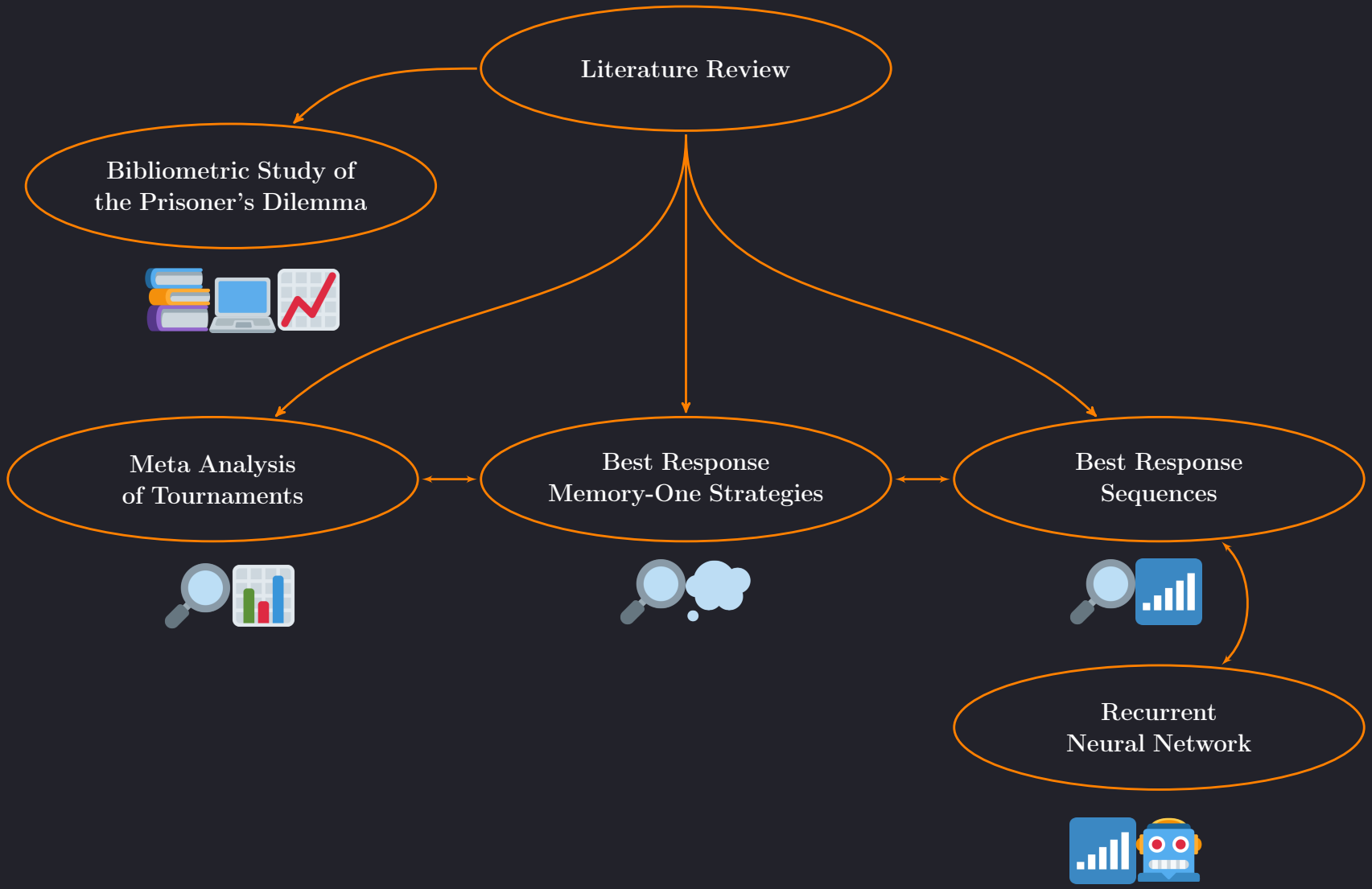
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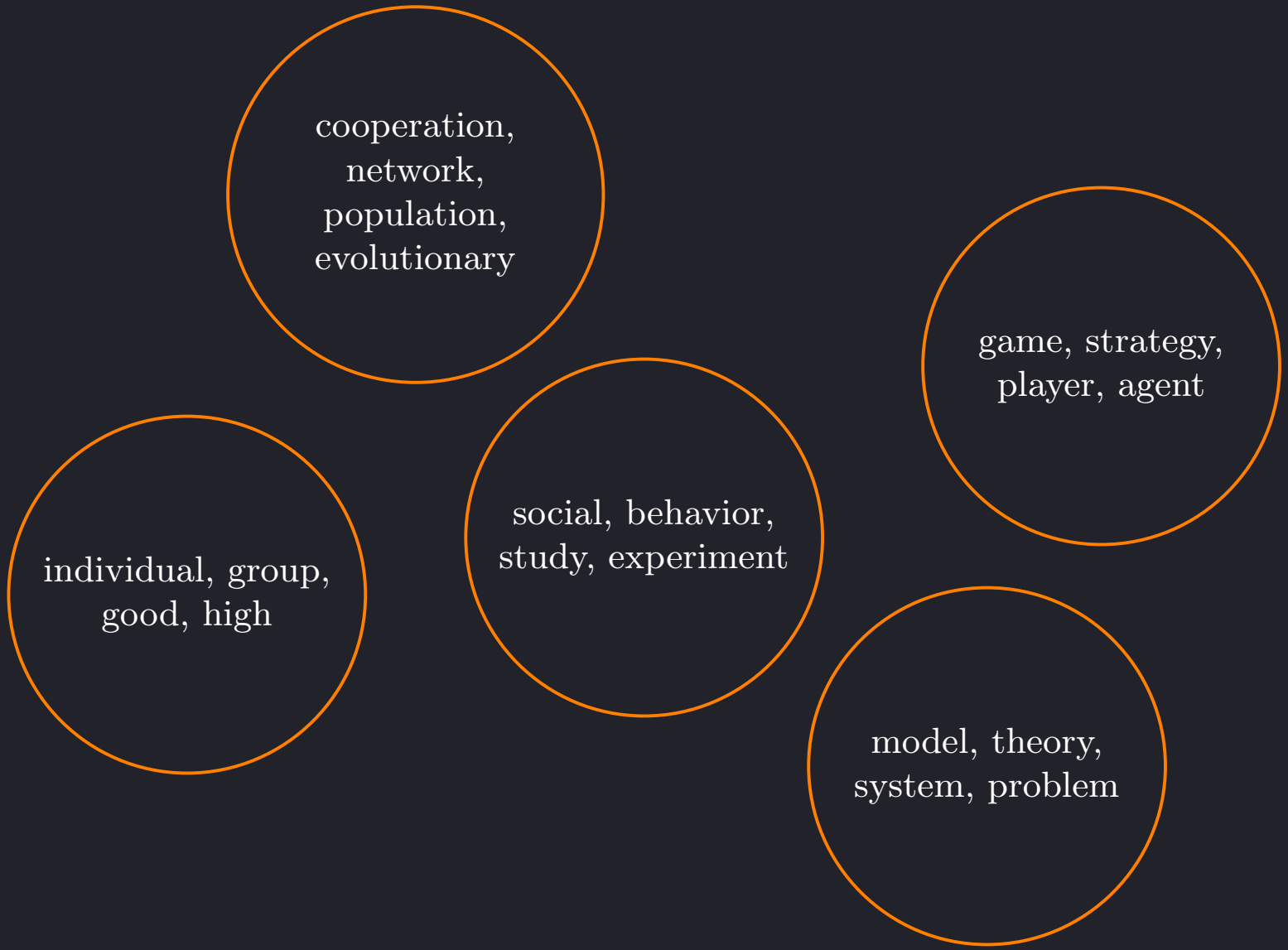
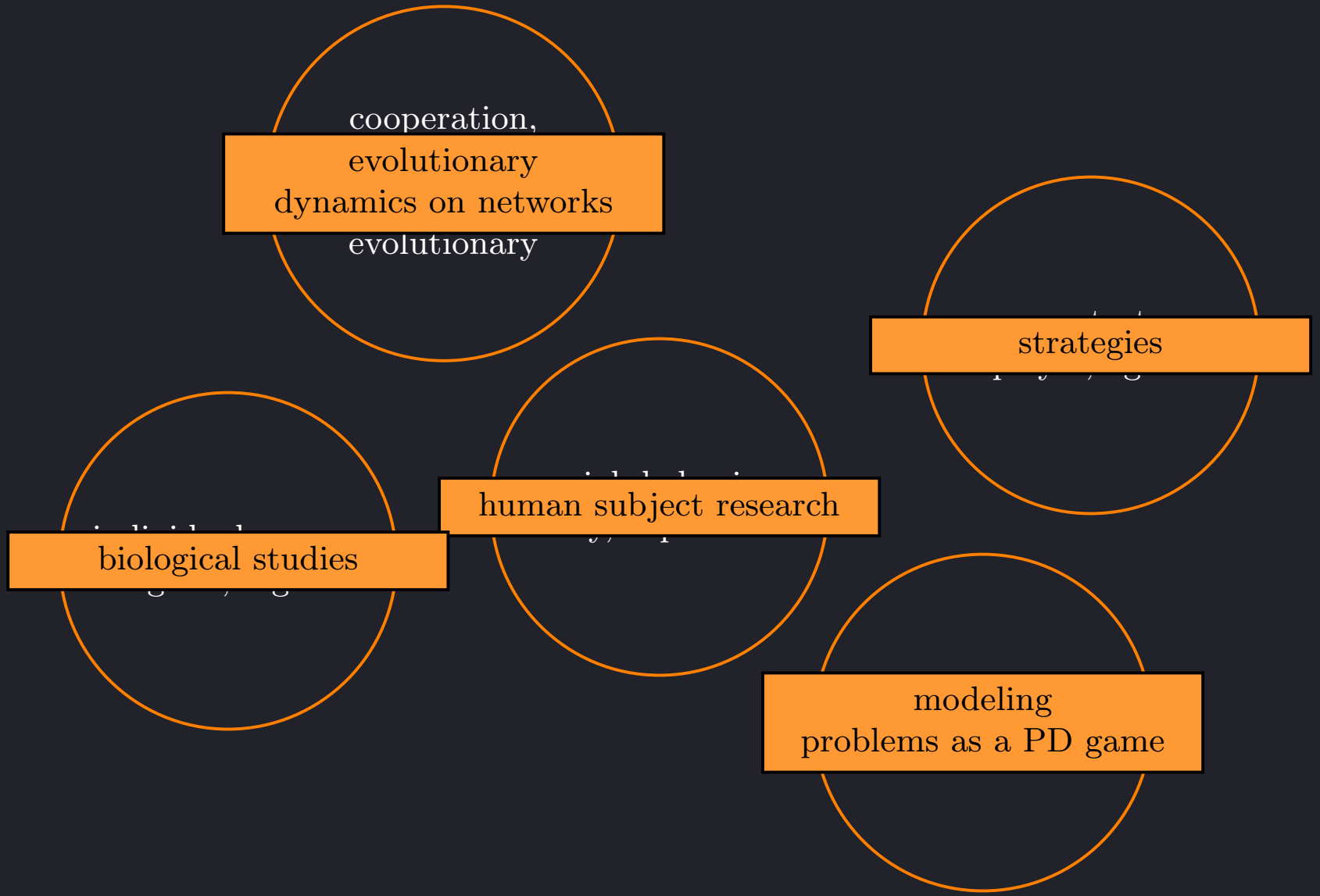
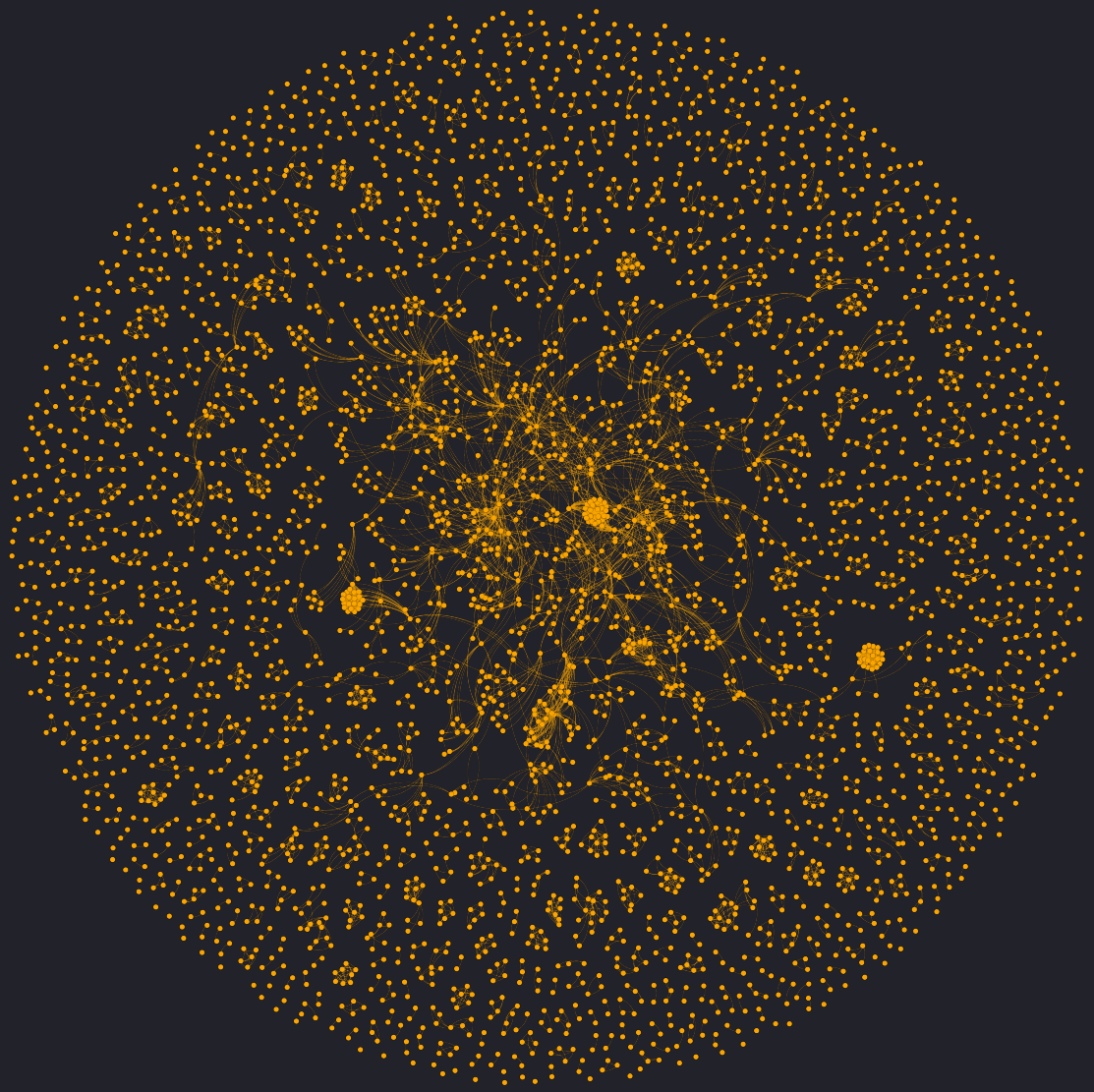
arxiv.org/abs/1911.06128

Under review: Palgrave Communications


cooperation, network, population, evolutionary
game, strategy, player, agent
individual, group, good, high
social, behavior, study, experiment
model, theory, system, problem


cooperation,
evolutionary
dynamics on networks
evolutionary
strategies
human subject research
biological studies
modeling
problems as a PD game



Highlights & Challenges

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- ARCAS

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- ARCAS
- Large data set

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- Natural Language Processing

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- Concrete insights from textual data

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- Large data set
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- Concrete insights from textual data
- Understanding journals protocols
- Cleaning data

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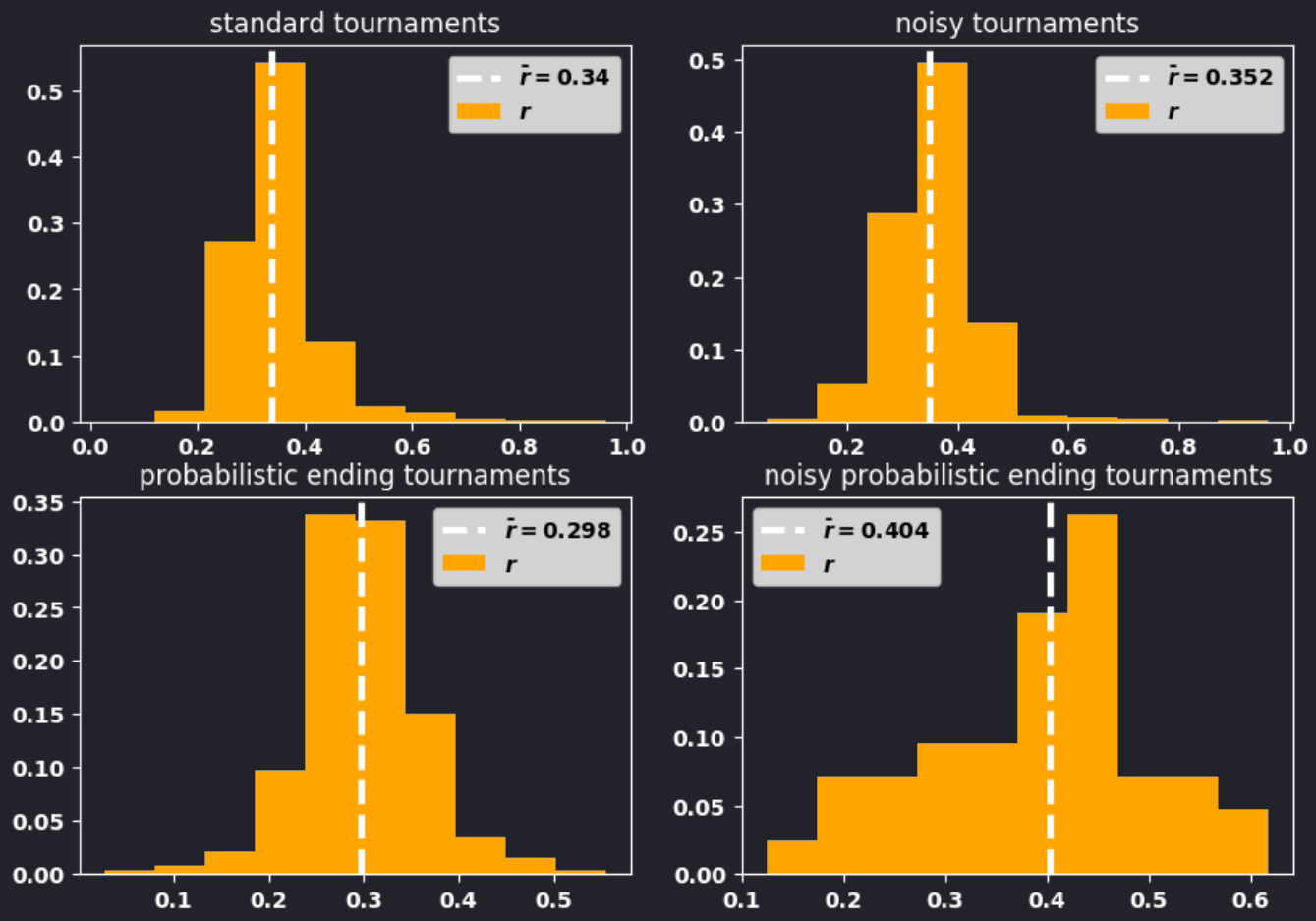
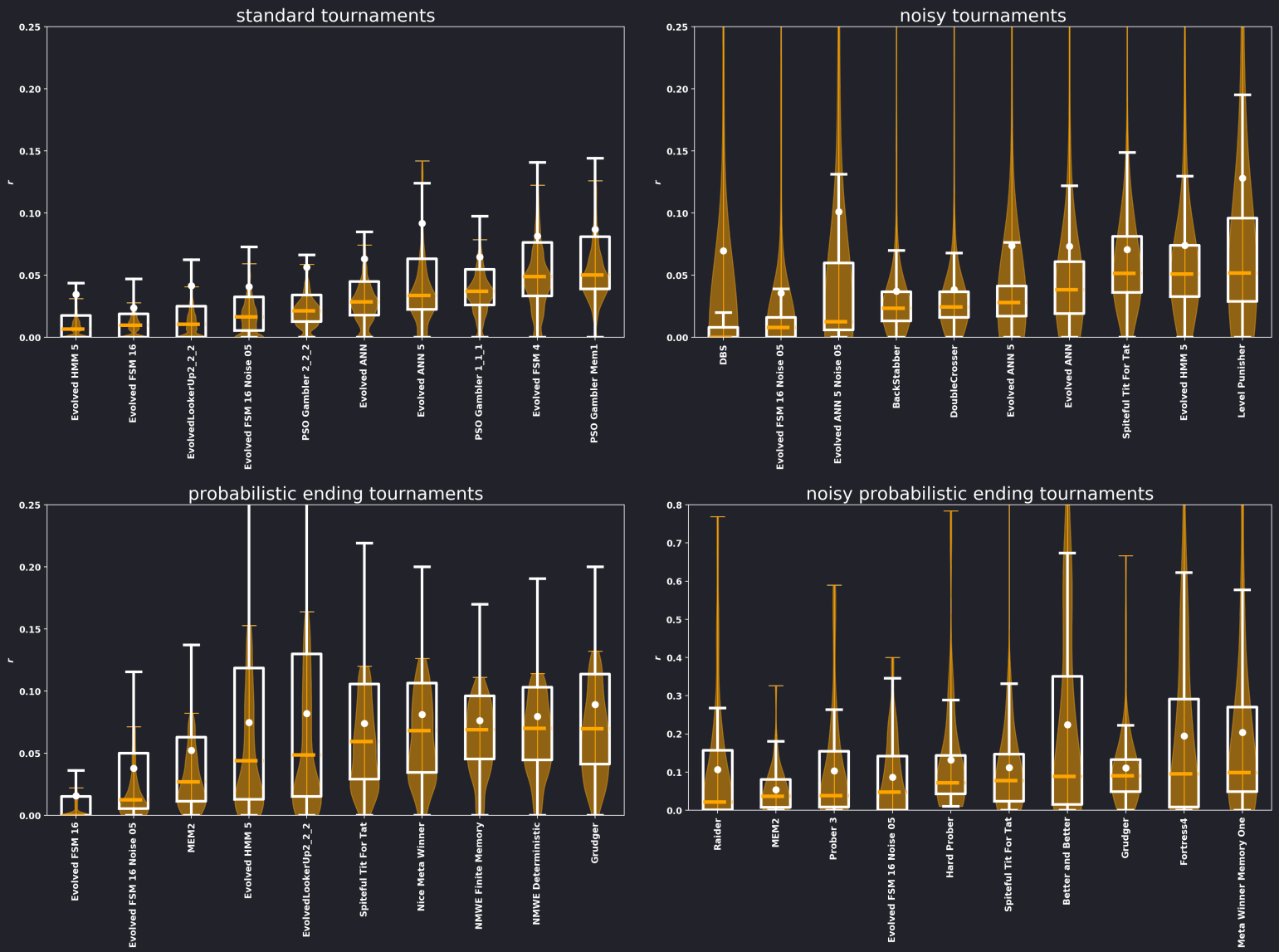
arXiv:2001.05911

data: DOI:10.5281/zenodo.3516652

Tit For Tat Normalised Rank




standard tournaments
noisy tournaments
probabilistic ending tournaments
noisy probabilistic ending tournaments
r
Evolved HMM 5
Evolved FSM 16
EvolvedLookerUp2_2_2
Evolved FSM 16 Noise 05
PSO Gambler 2_2_2
Evolved ANN
Evolved ANN 5
PSO Gambler 1_1_1
Evolved FSM 4
PSO Gambler Mem1
DBS
Evolved FSM 16 Noise 05
Evolved ANN 5 Noise 05
BackStabber
DoubleCrosser
Evolved ANN 5
Evolved ANN
Spiteful Tit For Tat
Evolved HMM 5
Level Punisher
Evolved FSM 16
Evolved FSM 16 Noise 05
MEM2
Evolved HMM 5
EvolvedLookerUp2_2_2
Spiteful Tit For Tat
Nice Meta Winner
NMWE Finite Memory
NMWE Deterministic
Grudger
Raider
MEM2
Prober 3
Evolved FSM 16 Noise 05
Hard Prober
Spiteful Tit For Tat
Better and Better
Grudger
Fortress4
Meta Winner Memory One

Highlights & Challenges

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- Largest collection of strategies

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- Largest collection of strategies
- Largest number of computer tournaments

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- Largest number of computer tournaments
- Diverse type of computers tournaments

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- Diverse type of computers tournaments
- Generalised results

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- Largest collection of strategies
- Largest number of computer tournaments
- Diverse type of computers tournaments
- Generalised results
- Handling big data

“A theory of mind: Best responses to memory-one strategies. The limitations of extortion and restricted memory”

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arXiv:1911.12112

Under review: Scientific Reports

$$u_q(p) = \frac{\frac{1}{2}pQp^T + cp + a}{\frac{1}{2}p\bar{Q}p^T + \bar{c}p + \bar{a}}$$

$$\frac{1}{N}\sum_{i=1}^{N} {u_q}^{(i)}(p)$$

Highlights & Challenges

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- New theorem on the utility of a memory-one strategy

Highlights & Challenges

- New theorem on the utility of a memory-one strategy
- New mathematical approach for the limitations of memory-one strategies

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- New theorem on the utility of a memory-one strategy
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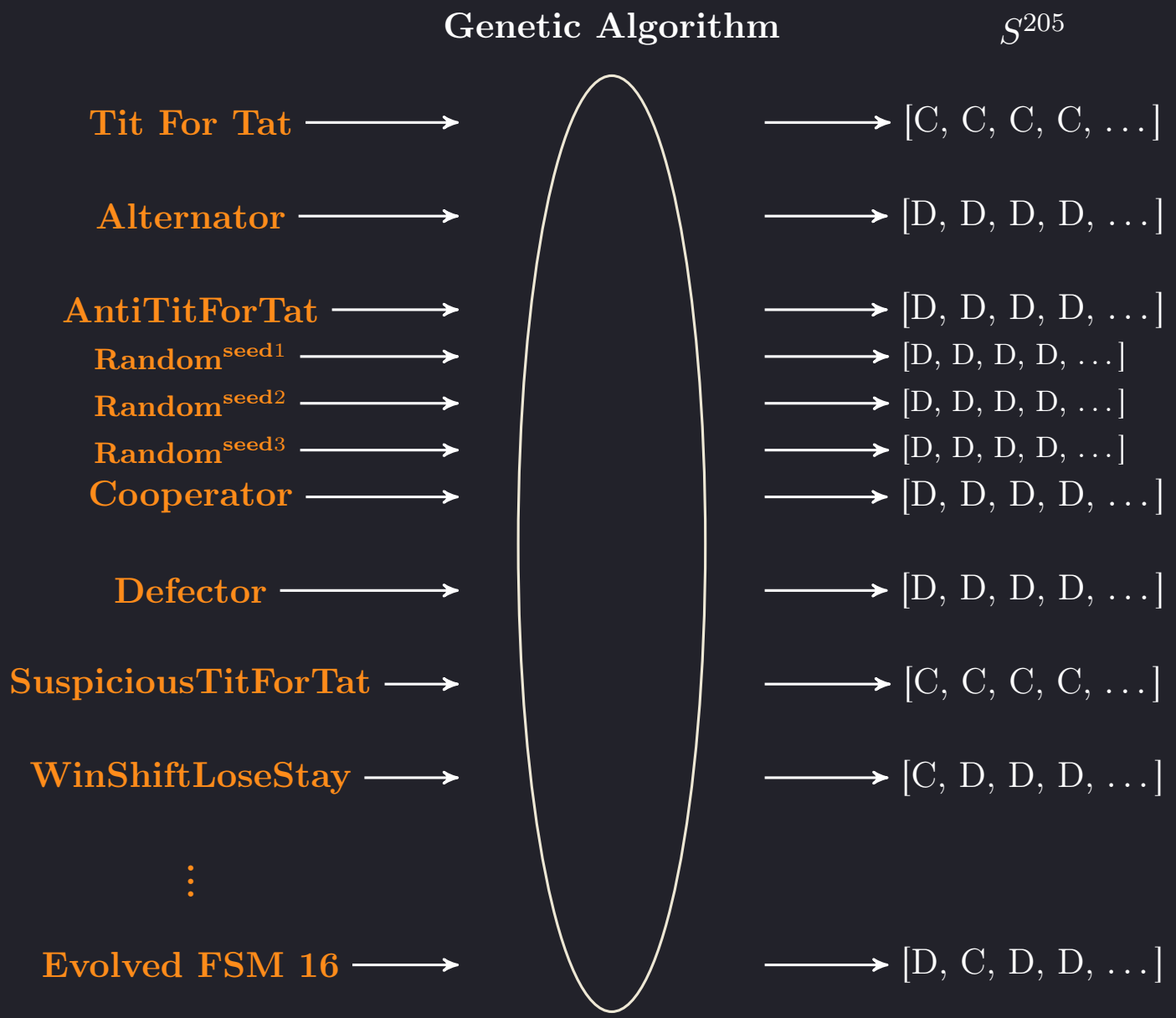
- Resultant theory

Highlights & Challenges

- New theorem on the utility of a memory-one strategy
- New mathematical approach for the limitations of memory-one strategies
- Resultant theory
- Non convexity of utility function

“Training long short-term memory networks produces successful Prisoner’s Dilemma strategies”

data: DOI:10.5281/zenodo.3685251


Genetic Algorithm
S^{205}
Tit For Tat
Alternator
AntiTitForTat
Random^seed1
Random^seed2
Random^seed3
Cooperator
Defector
SuspiciousTitForTat
WinShiftLoseStay
Evolved FSM 16
[C, C, C, C, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
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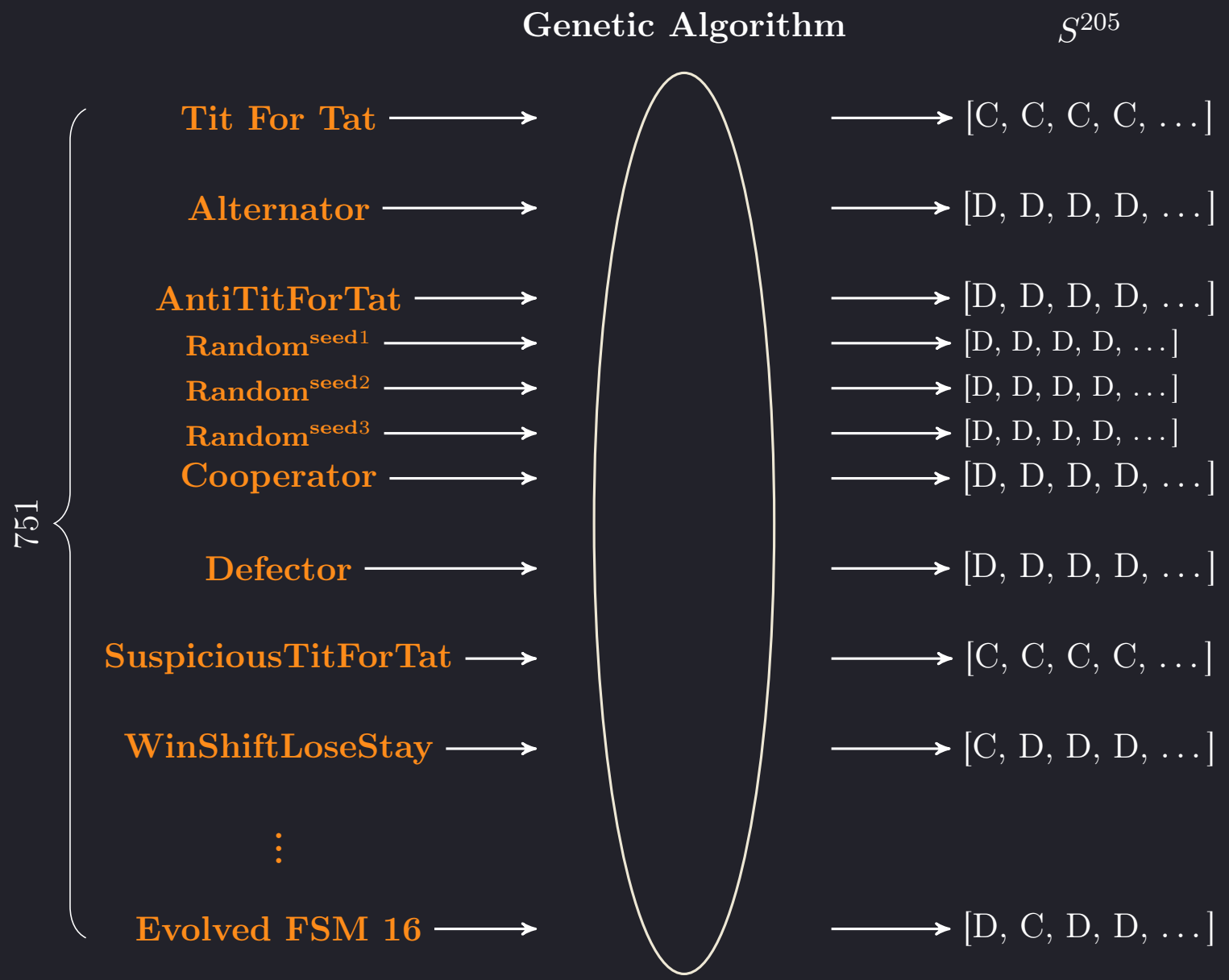
Genetic Algorithm
S^{205}
751
Tit For Tat
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Cooperator
Defector
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WinShiftLoseStay
Evolved FSM 16
[C, C, C, C, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
[D, D, D, D, . . .]
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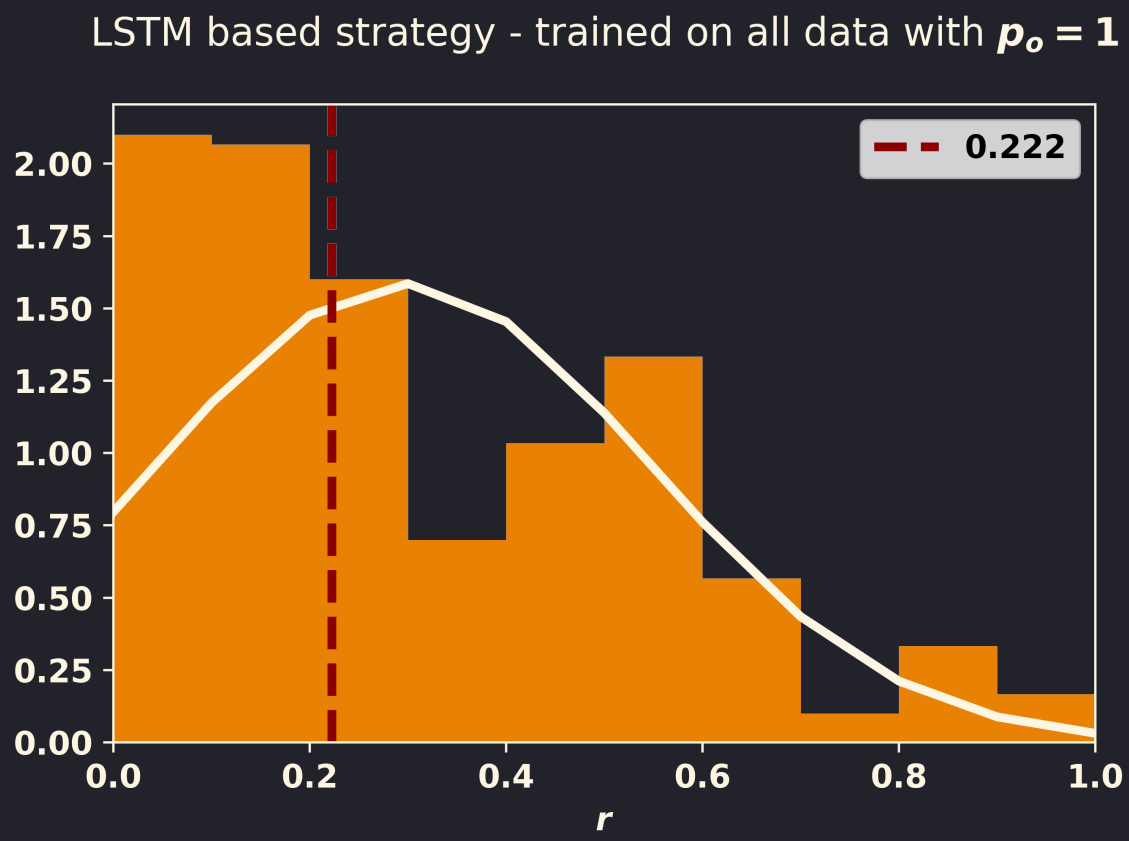
LSTM based strategy - trained on all data with $p_o = 1$
0.222
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.0
0.2
0.4
0.6
0.8
1.0
r

Highlights & Challenges

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- Best response sequences using heuristics

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- Best response sequences using heuristics
- Artificial neural networks
- Long short-term memory

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- Best response sequences using heuristics
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- Best response sequences using heuristics
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- High computational cost

Be nice & Open with cooperation

Be nice & Open with cooperation

Be a little envious & Be complex

Be nice & Open with cooperation

Be a little envious & Be complex

Adapt to the environment & Longer memory

CORRECTNESS [ko - rektnas]

[noun]

1. the quality or state of being free from error; accuracy.

Data sets

doi.org/10.5281/zenodo.3406544
doi.org/10.5281/zenodo.3406542
doi.org/10.5281/zenodo.3406536
doi.org/10.5281/zenodo.3516652
doi.org/10.5281/zenodo.3753498
doi.org/10.5281/zenodo.3402179
doi.org/10.5281/zenodo.3685251
doi.org/10.5281/zenodo.3831431
doi.org/10.5281/zenodo.3841932

Software Archive

doi.org/10.5281/zenodo.1127684
doi.org/10.5281/zenodo.3766344
doi.org/10.5281/zenodo.3533146
doi.org/10.5281/zenodo.3829971

Software Development

github.com/ArcasProject/Arcas
github.com/Nikoleta-v3/meta-analysis-of-prisoners-dilemma-tournaments
github.com/Nikoleta-v3/Memory-size-in-the-prisoners-dilemma
github.com/Nikoleta-v3/Training-IPD-strategies-with-RNN

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