Achieving cooperation in Social Networks through peer punishment

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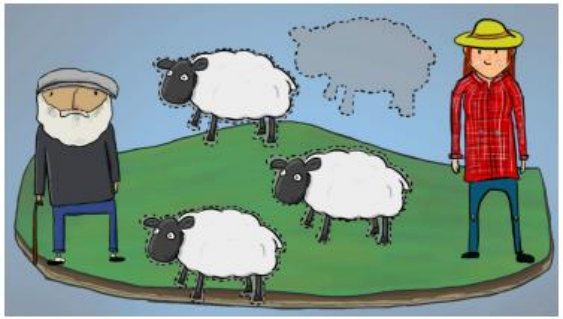
Escaping the Tragedy of the Commons

- A shared-resource
- Individual users acting independently according to their own self-interest
- This leads to depletion or spoiling of that resource through their collective action
  - Non renewable resources
  - Deforestation, overfishing
  - Public Goods Game



Networks and Communities

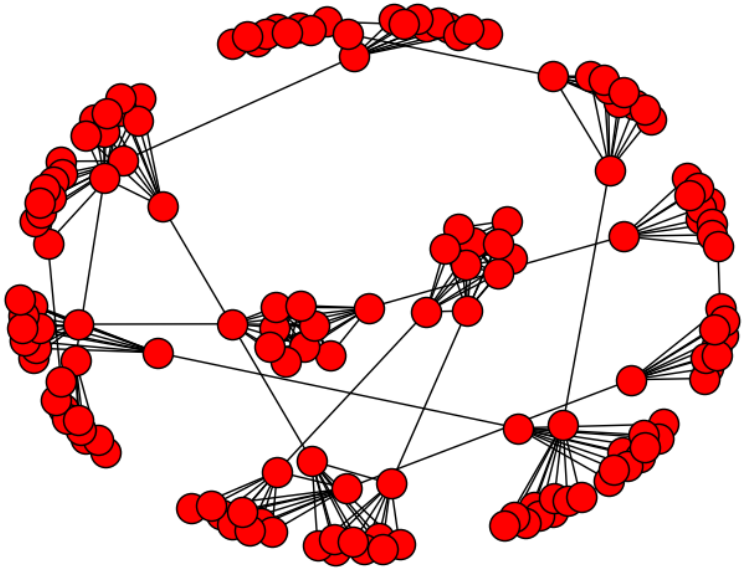
- How did we escape it initially?

  Punishment = Lowering potential payoff of defectors

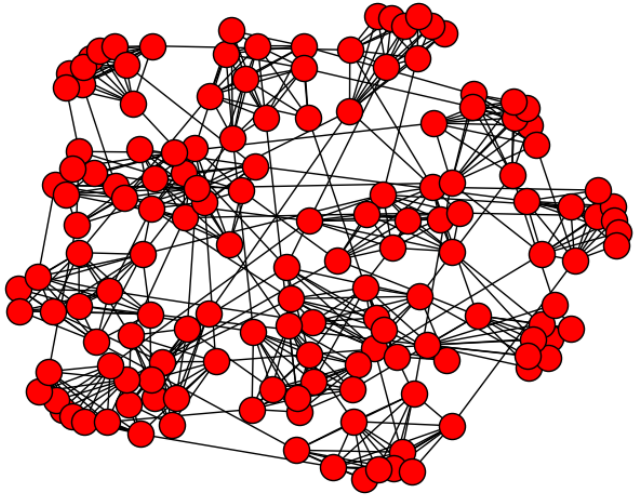
- Real world has topology

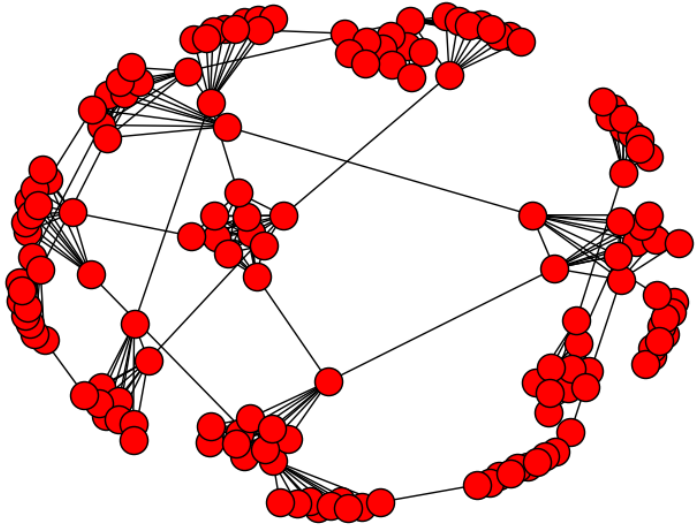
- Modular (Community/Cluster) Structure

Caveman Networks



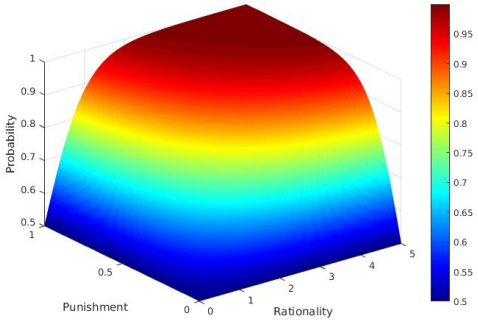
Relaxed Caveman Networks

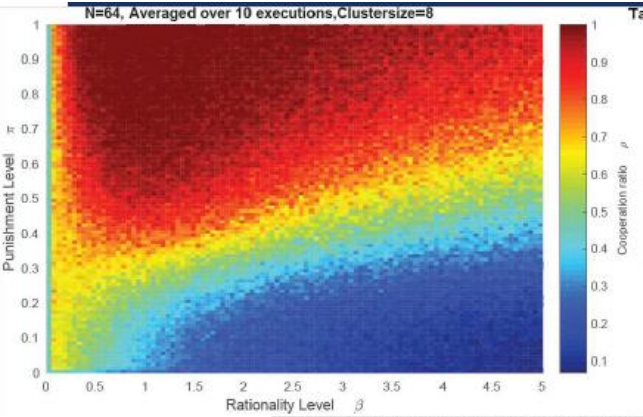


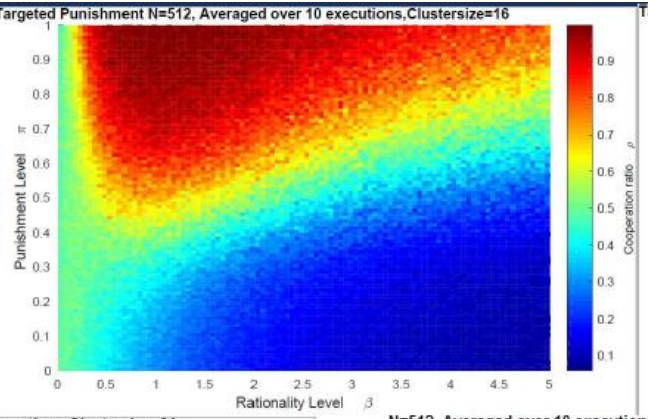


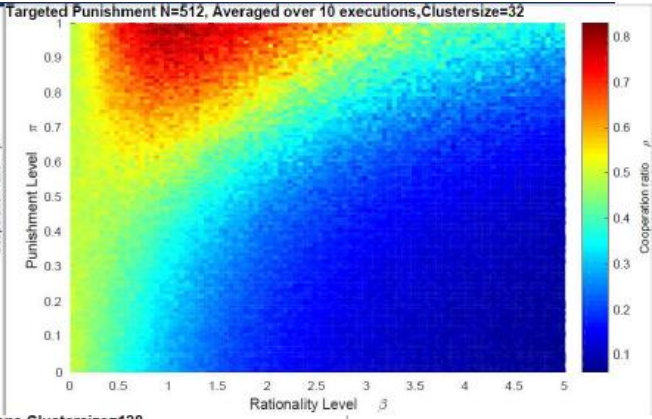
Baseline Model

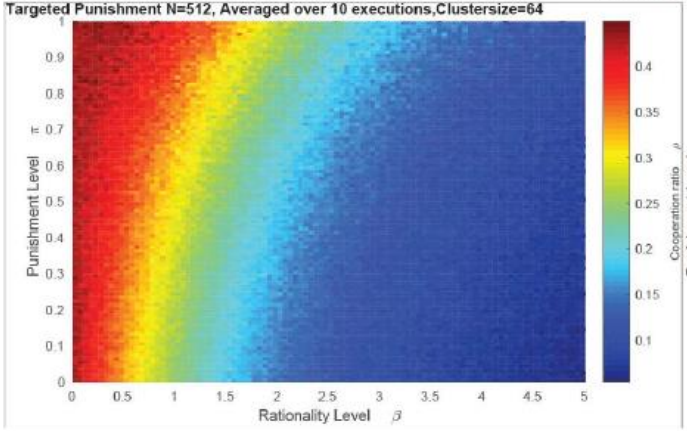
- Probabilistic cooperation $P_i = \frac{1}{2}[\tanh(\beta H_i) + 1]$
- System inherently against cooperation
- Cooperators can lower the payoff of their defector neighbours by equally splitting their allocated punishment
- Cooperators can be defined recursively as an increasing sequence of sets

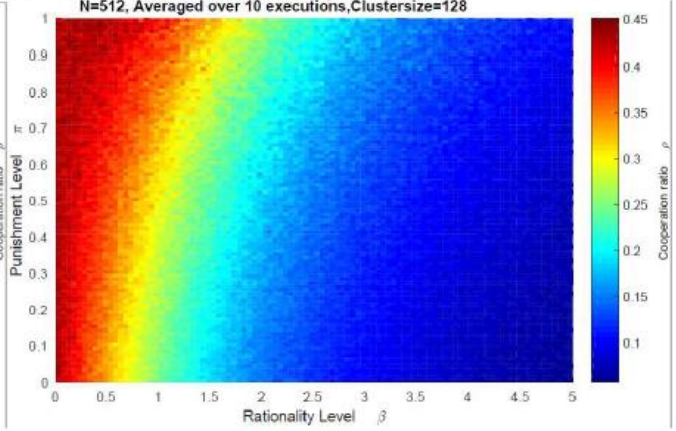



N=64, Averaged over 10 executions,Clustersize=8
Punishment Level π
Rationality Level β
Cooperation ratio ρ

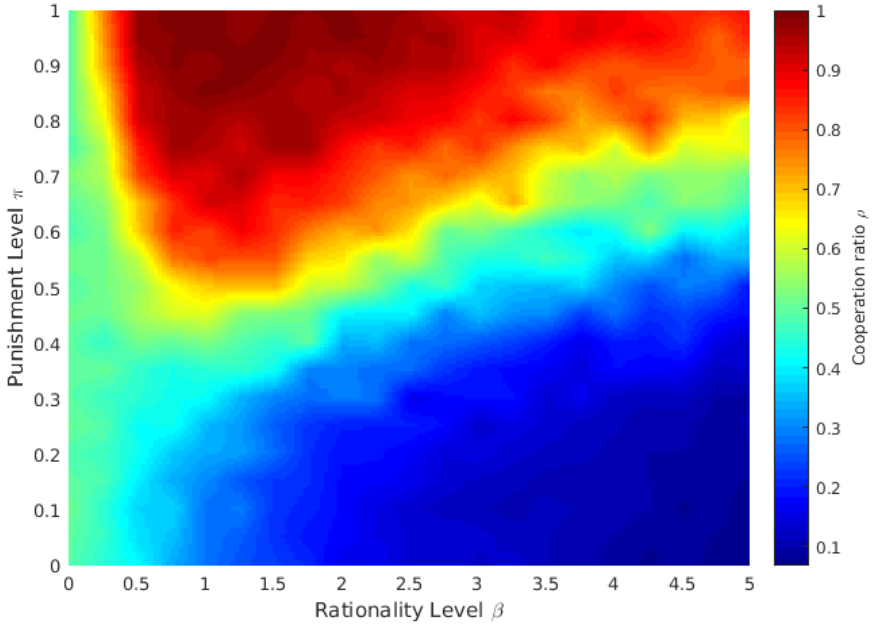

Targeted Punishment N=512, Averaged over 10 executions,Clustersize=16
Punishment Level π
Rationality Level β
Cooperation ratio ρ


Targeted Punishment N=512, Averaged over 10 executions,Clustersize=32
Punishment Level π
Rationality Level β
Cooperation ratio ρ

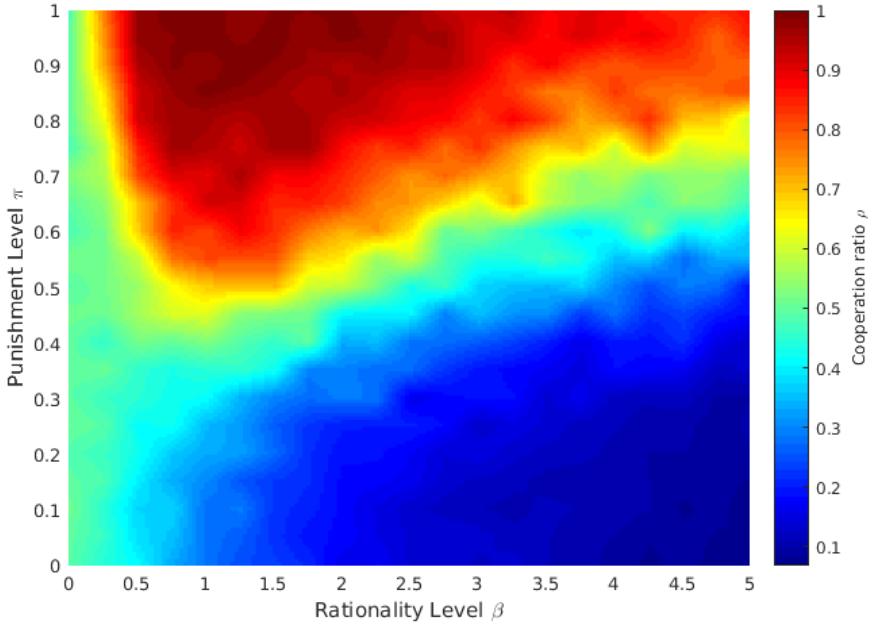

Targeted Punishment N=512, Averaged over 10 executions,Clustersize=64
Punishment Level π
Rationality Level β
Cooperation ratio ρ


N=512, Averaged over 10 executions,Clustersize=128
Punishment Level π
Rationality Level β
Cooperation ratio ρ

Results


Punishment Level π
Rationality Level β
Cooperation ratio ρ
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Results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Cooperation ratio ρ
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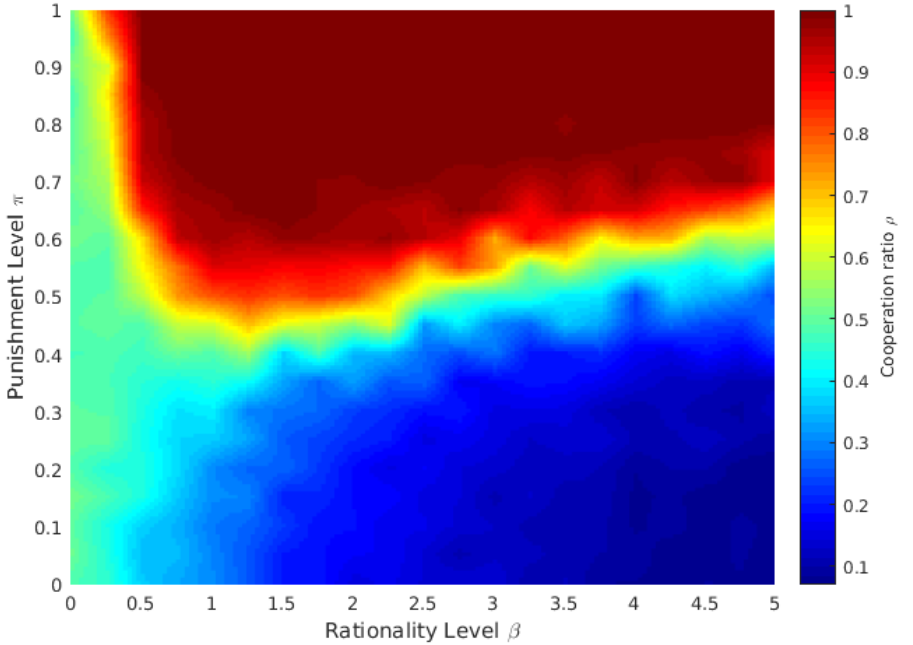
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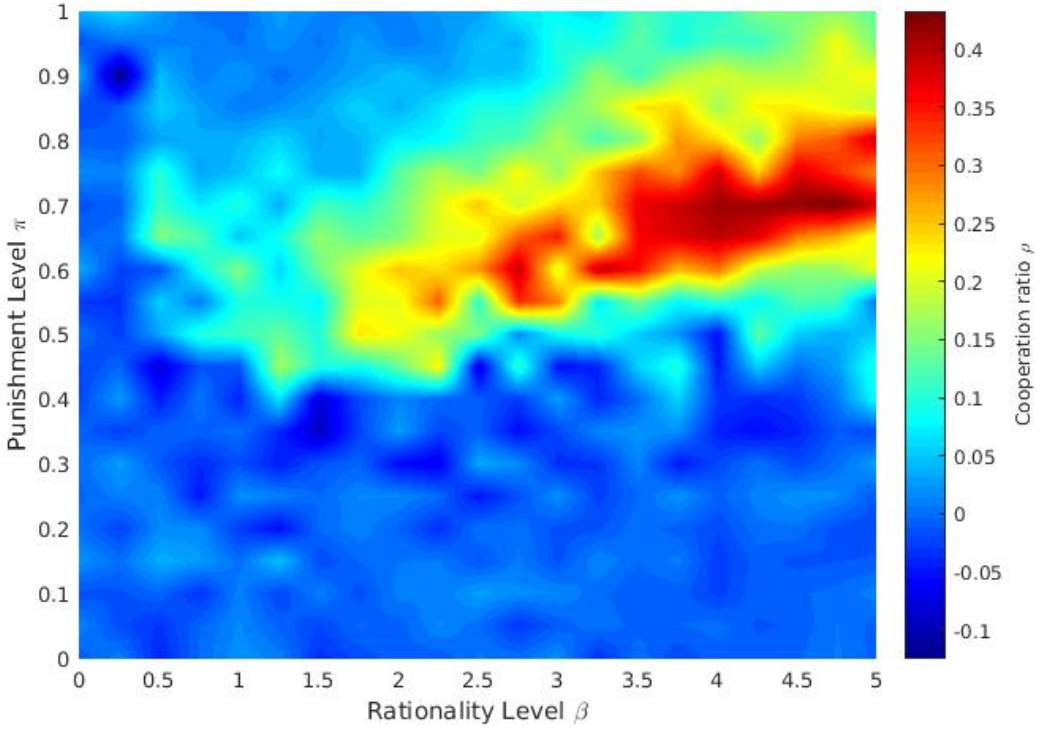
Results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Cooperation ratio ρ
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0.5
0.6
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0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1

Further work

- Forward looking agents
- Probabilistic end of the game
- Account for multi-level interaction
  - Multilayer networks

Main References

- Sam Johnson, Warwick – Escaping the Tragedy of the Commons through Targeted Punishment – Open Royal Science (2015)

- David Jimenez Gomez, Becker Friedman Institute – Social Pressure in Networks Induces Public Goods Provision