# We, Agents!

## Complexity out of Simplicity.

Uzay Çetin

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# About Me

interested in computational aspects of social systems.

PhD in Computer Engineering, 2017

- Boğaziçi University
- Area of research: Complex Systems

MS in Artificial Intelligence, 2009

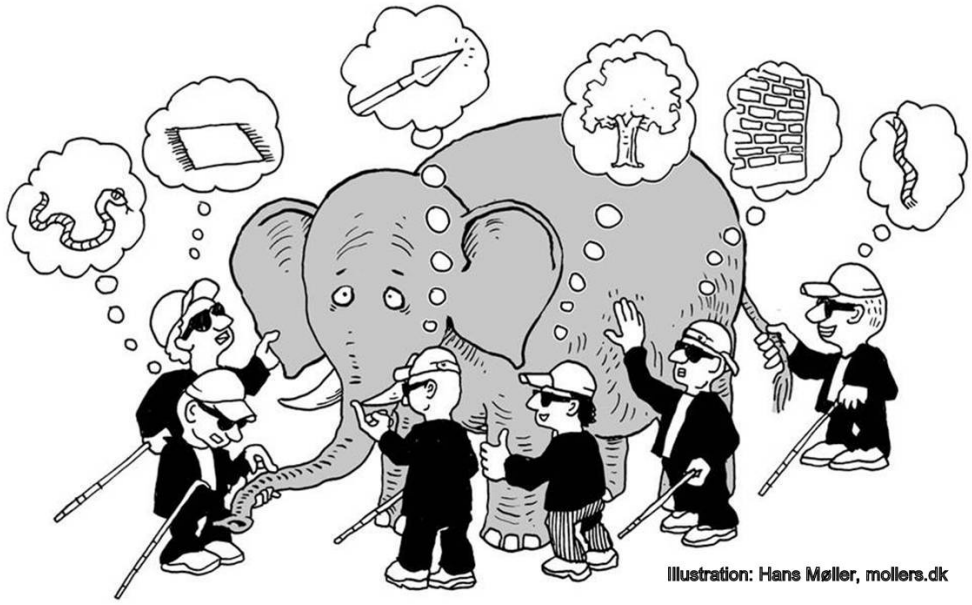
- Pierre-et-Marie Curie University (Paris VI)

BS in Computer Engineering, 2007

- Galatasaray University

# Outline



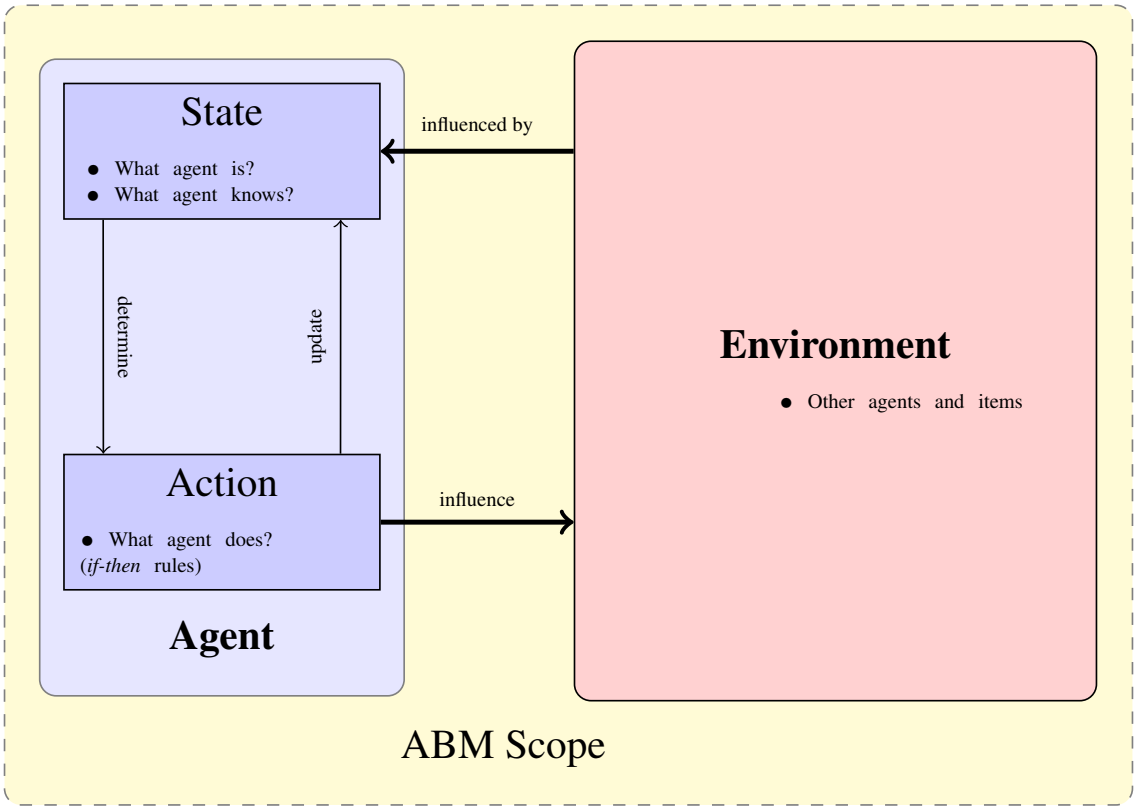



The parable of the blind men and the elephant

# An Agent

## is an *autonomous* computational unit

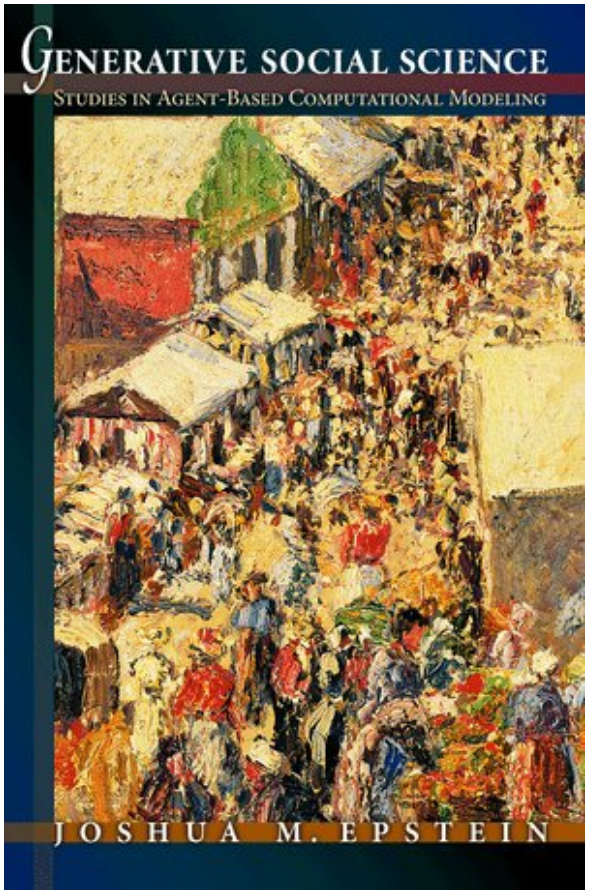
Relationships are primary, agents are secondary!!



# Agent-Based Modeling (ABM)

Emergent complex features *grow* from *bottom-up*.

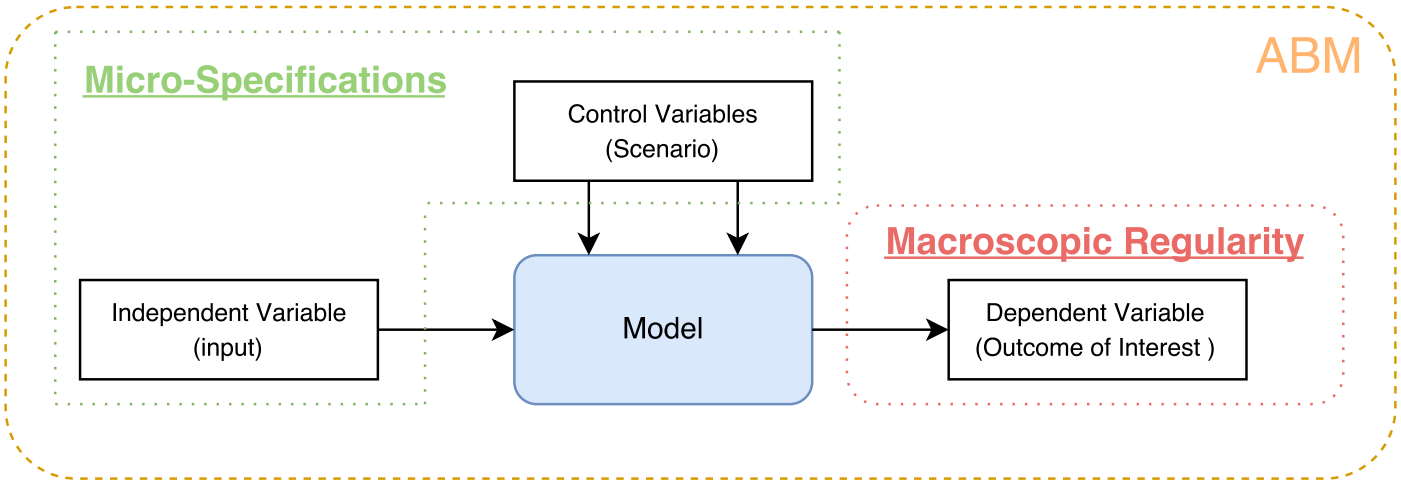
Structure generates behavior!!




ABM resembles French impressionist paintings.

# Generative Social Science

Are the given microspecifications sufficient to generate a macrostructure of interest?




## Micro-to-macro mapping

We get macro-surprises despite complete micro-knowledge.

# Cooperation is a Dilemma

## How selfish beings manage to cooperate?

Cooperation involves a cost to benefit others. The cost makes cooperation vulnerable to defection.

Nonetheless, we see cooperation everywhere.

# Prisoners Dilemma Game

Payoff Matrix:

| | C | D |
|---|---|---|
| C | R = 3 | S = 0 |
| D | T = 5 | P = 1 |

Conditions:

- $S < P < R < T$
- $S + T < 2R$

Dilemma

- (Individual) Rationality leads to defection.
- Mutual cooperation is better than mutual defection.

# Threat Game

## Co-evolution of Memory and Cooperation

*What is the effect of increasing level of threat on the co-evolutionary dynamics of memory and cooperation?*

# Model

A population of $N$ agents, who have limited memory size $M$, will play Prisoner's Dilemma Game iteratively.

## Agent representation

- Memory ratio $\mu = \frac{M}{N} \in [0, 1]$.
- Defection rate $\rho \in [0, 1]$.

## Selective attention

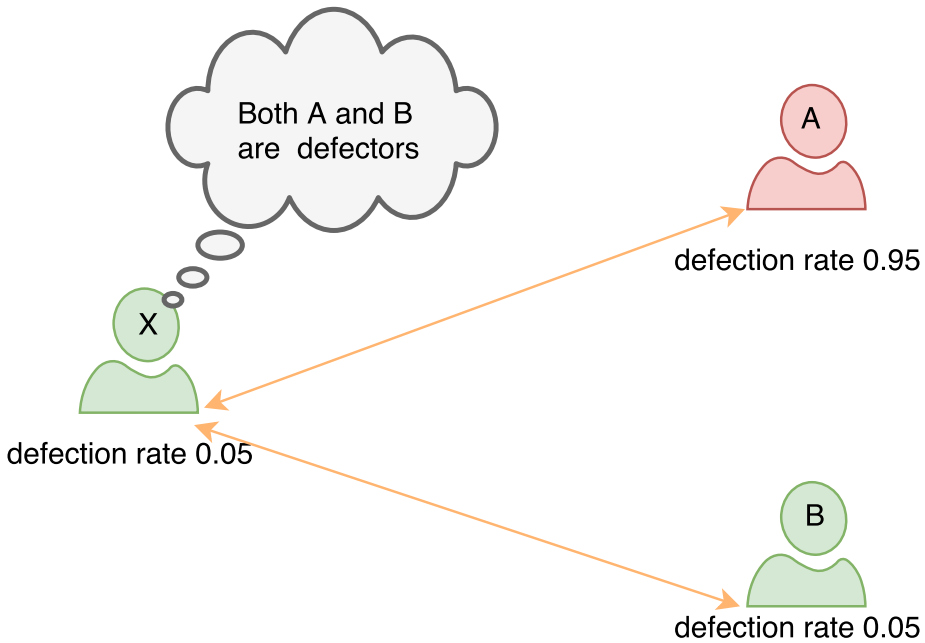
- Agents are "hard-wired" to pay attention to defectors.

## Interaction rule

- Agents are reciprocal and refuse to play with defectors.

# Misperceptions

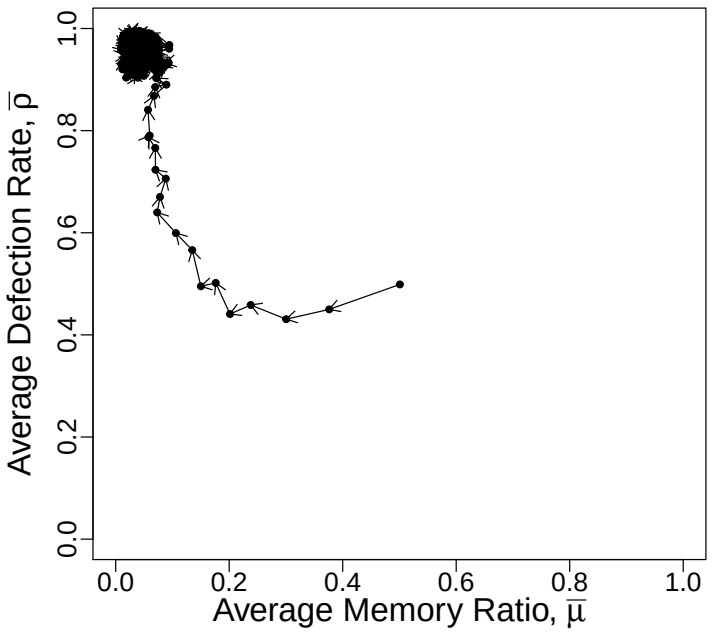
## due to small sample size of interactions




Suppose both A and B defected in their very first rounds with X. What is the conclusion of X?

# Memory Barrier

## Memory blocks interactions that would bring positive payoffs.



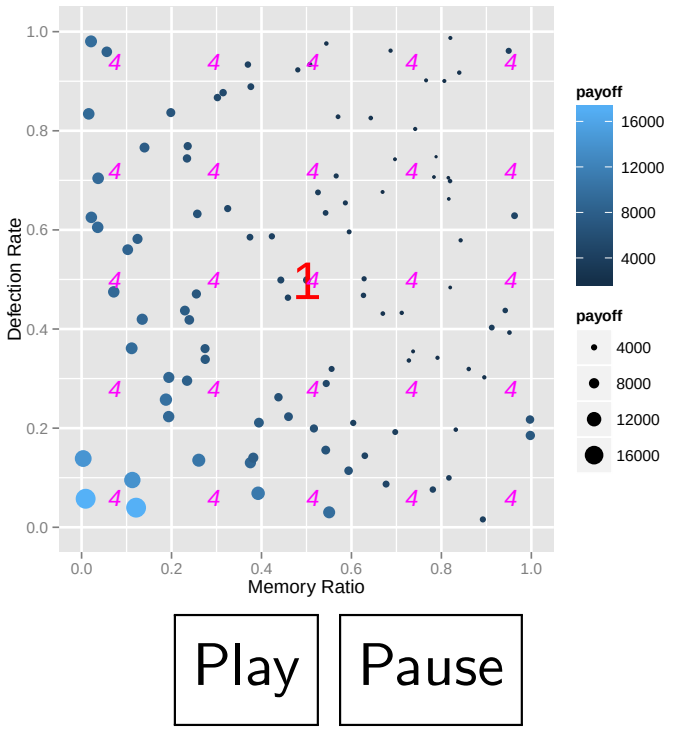
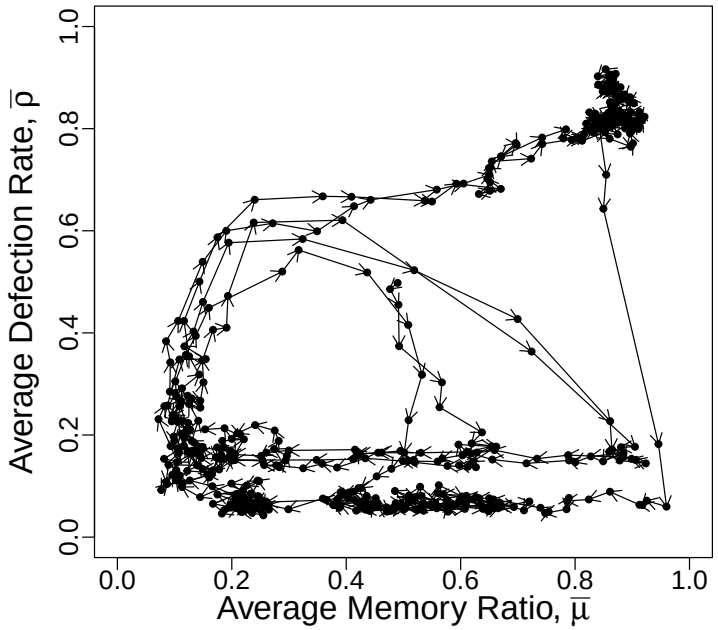




Figure: Single realisation for $(S, P, R, T) = (0, 1, 3, 5)$.

# Memory Dilemma

## maintain self-protection vs avoid self-isolation



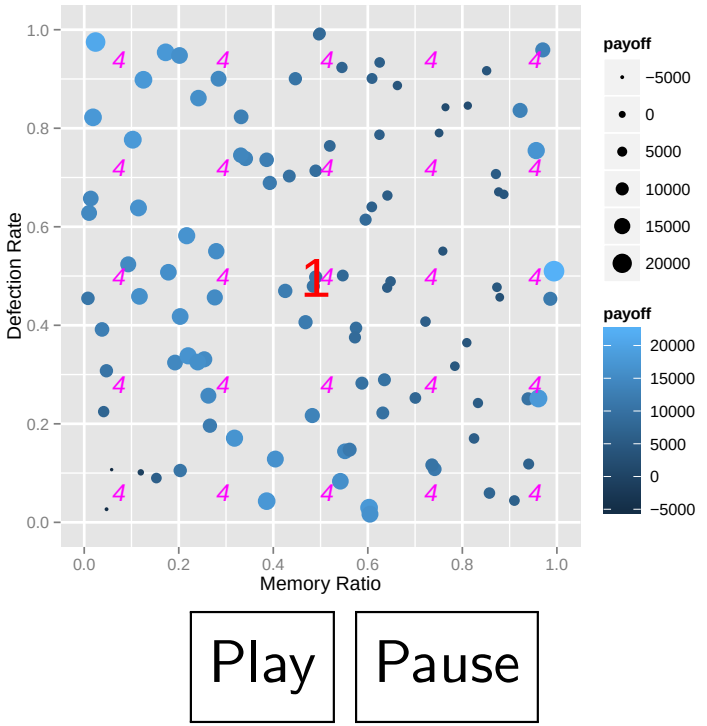




Figure: Single realisation for $(S, P, R, T) = (-5, -4, 4, 5)$.

# Presence of Threat

## Emergence of Immunity Against Defection.

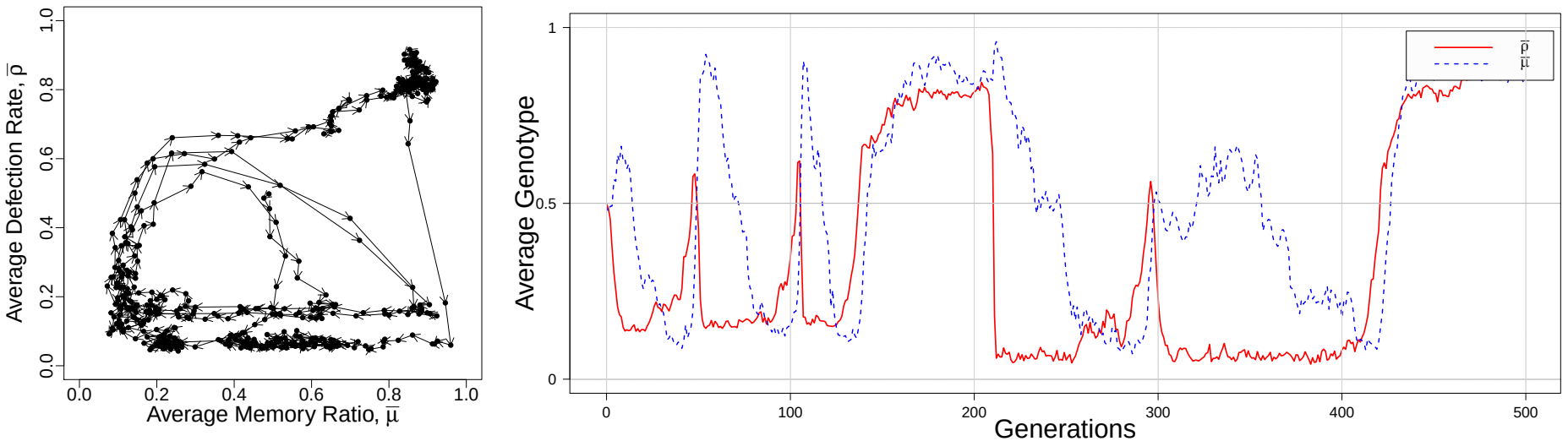



Figure: Co-evolution for $(S, P, R, T) = (-5, -4, 4, 5)$.

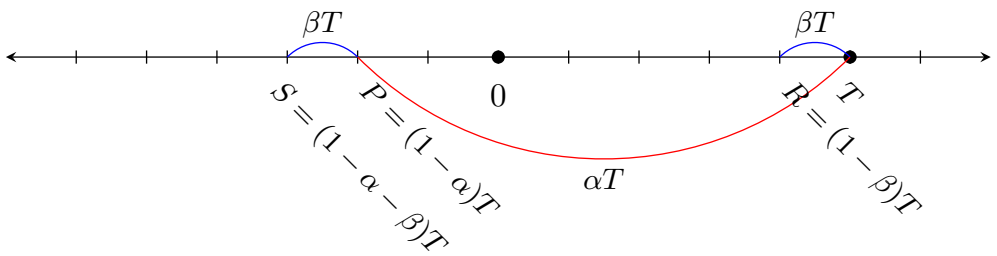
# Reformulation of Prisoners Dilemma Game

## The Effect of Payoff Matrix

| | **C** | **D** |
|---|---|---|
| **C** | $R$ | $S$ |
| **D** | $T$ | $P$ |

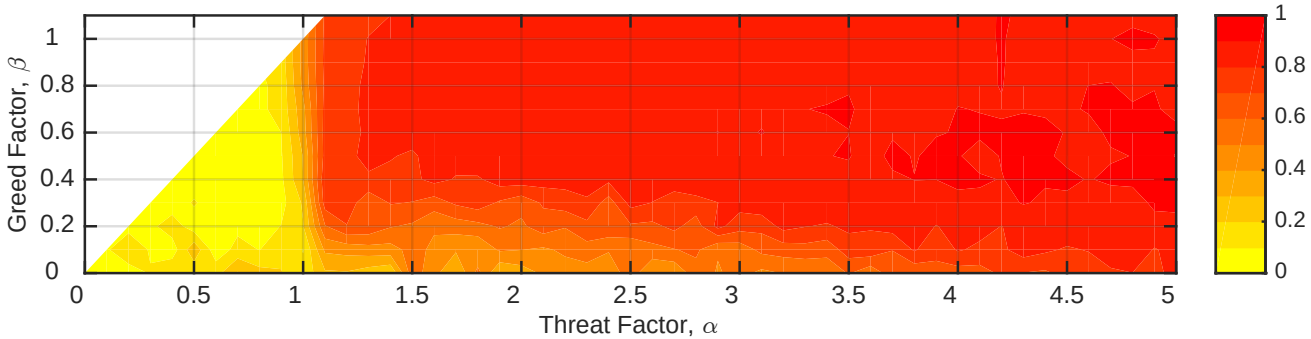
Greed $\beta T$
(benefit for defection)

Threat $\alpha T$
(cost for receiving a defection)

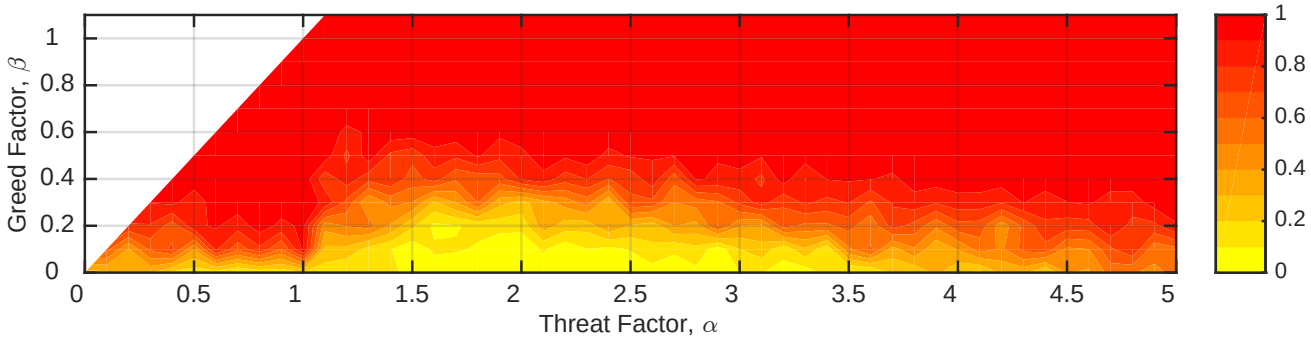


# Results

## The effect of ecology on the co-evolution of Memory and Cooperation

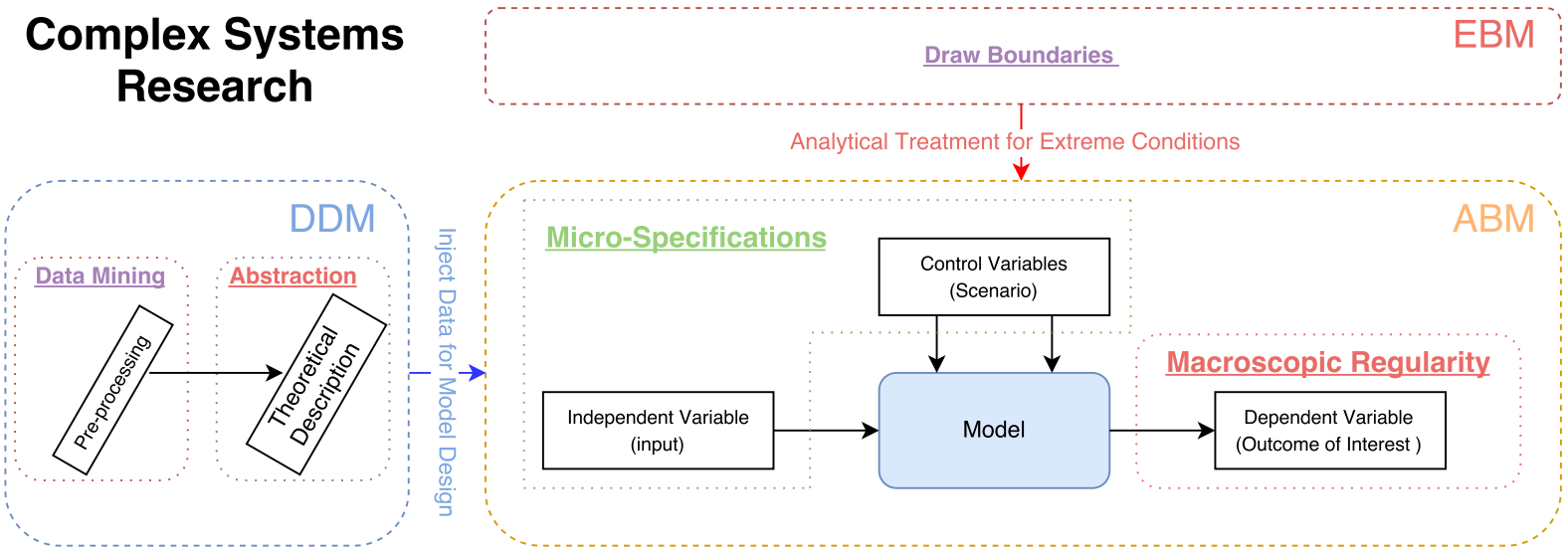



(a) Average memory ratio $\overline{\mu}$ as a result of threat & greed factors.

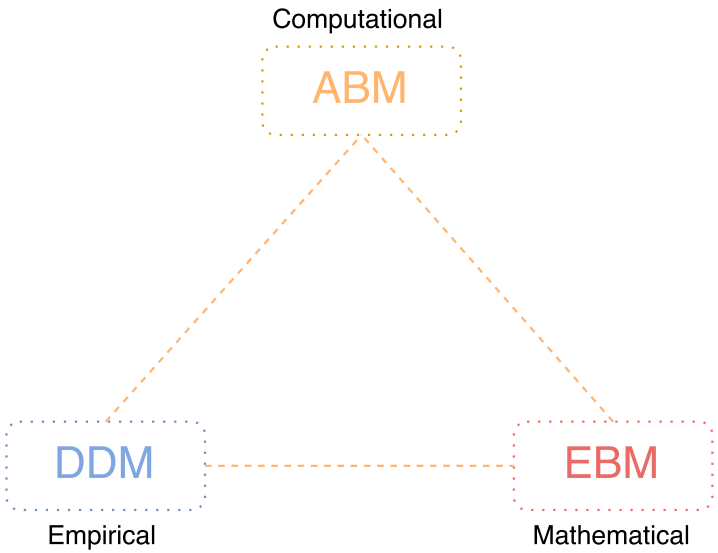



(b) Average defection rate $\overline{\rho}$ as a result of threat & greed factors.

# Complex Systems Research



# Complex Systems Research




https://uzay00.github.io/kahve/

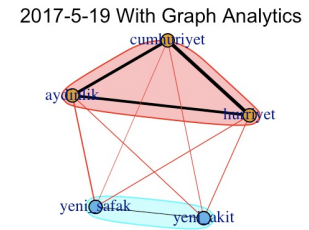
# Ongoing Projects

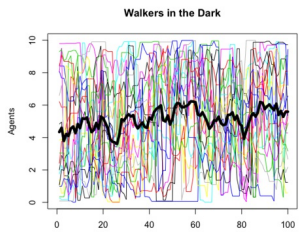
## ABM

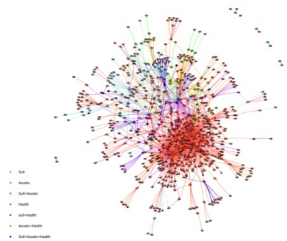
- The formation and spread of religious communities
- Agent-Based Prediction Competition

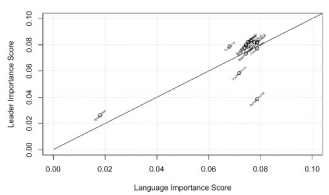
## DDM

- Text Analysis, of Turkish Newspapers, Using Complex Networks
- A cross lingual analysis of Wikipedia.
- Prestige and Quality in Bipartite Networks





# Courses

## Undergraduate

- Into Programming
- Object Oriented Programming
- Data Structures and Algorithms
- Database Systems
- Discrete Mathematics
- Intro Software Engineering
- Statistical Thinking
- Intro Computational Science and Modeling

## Graduate

- Complex Systems
- Complex Networks
- Agent-Based Modeling
- Multi-Agent Systems
- Computational Social Science
- Pattern Recognition
- Data Science

# List of Publications

## Threat Game

(1) Uzay Cetin and Haluk O. Bingol, The Dose of the Threat Makes the Resistance for Cooperation, Advances in Complex Systems, DOI: 10.1142/S0219525916500156, 2017, SCI-E.

## Attention Game

(2) Uzay Cetin and Haluk O. Bingol, Iterated Prisoners Dilemma with limited attention, Condensed Matter Physics, vol. 17, No. 3, 33001:1-8, DOI:10.5488/CMP.17.33001, 2014, SCI-E.

## Fame Game

(3) Uzay Cetin and Haluk O. Bingol, Attention competition with advertisement, Phys. Rev. E, DOI: 10.1103/PhysRevE.90.032801, 2014, SCI.