

Modeling & Simulating Cooperation in Organizations

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Introduction

- Stress has a significant effect on performance of organizations
- Approx. 75 % of employees regularly experience psychic and somatic symptoms of stress
- In 2014, the cost of stress to US economy has been estimated as 300 billion USD

Stress and performance

- Most commonly, the relationship between task performance and stress is understood as \cap -shaped
- However, many empirical studies showed that the relationship may be either positively or negatively linear, or even no relationship at all.
- To study this phenomena, we have decided to develop a model and perform *in silico* studies that allow to eliminate effects of sample, context, selected methodology or other effects that are present in *in vivo* studies

The model

- Laboratory of Search and Dialogue, Masaryk University
- NetLogo Environment for modeling and simulations of complex systems
- Multi-variable agent-based model using spatialized prisoner's dilemma game

Prisoner's dilemma game

- Standard setting from game theory to study aspects of cooperation
- Can cooperation be a logical choice even for rational agent?
- To cooperate or to defect?
- Short term vs. long term



		Alice	
		confess	silent
Bob	confess	5 5	0 10
	silent	10 0	1 1

PDG in our model

- Employees exchange certain part of their work
- Whether the work is delivered as promised is a subject to PDG
- Employees use strategies that are well known in the PDG context

Strategy	Label	Description
Defect	D	Always defects
Cooperate	C	Always cooperates
Tit for Tat	T	Repeats partner's last move.
Tit for two Tats	T2	Defects if defected in both last 2 rounds, otherwise cooperates.
Tit for Tat – Naïve	nT	Repeats partner's last move. There is a probability for cooperation if defected.
Peacemaker		Initiates with cooperation. Then repeats last own action when won and switches action when lost last round.
Pavlov	P	Once defected by a partner, always defects. Otherwise cooperates.
Unforgiving	U	

Stress

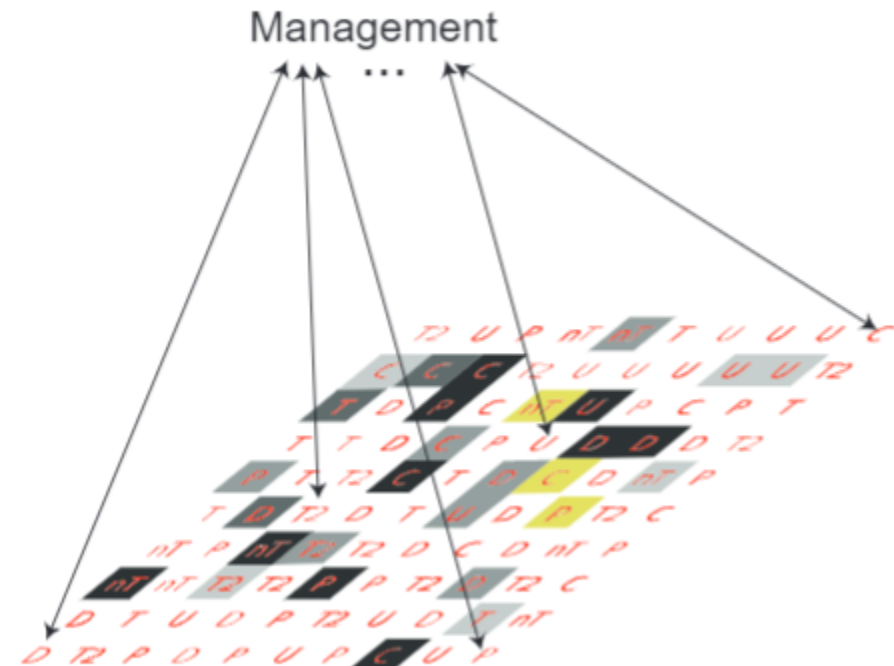
- 3 sources of employees' stress:
 - PDG
 - Effort
 - Management evaluation
- Stress regeneration

Management Module

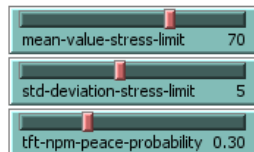
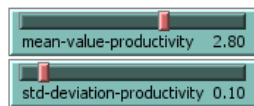
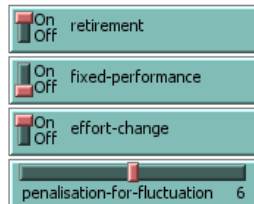
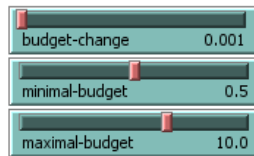
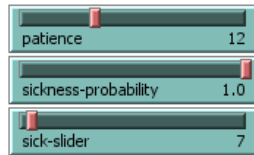
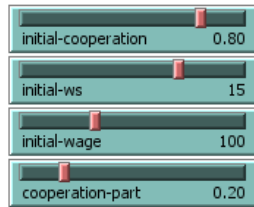
- Management evaluates employees on monthly basis
 - Insight into cooperation
 - Insight into performance
 - What to prefer
 - Intensity of reaction

Visualization of the model

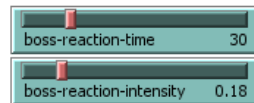
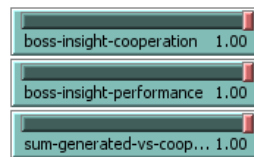
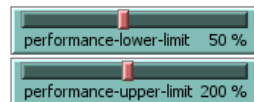
T2	U	P	nT	nT	T	U	U	U	C
C	C	C	T2	U	U	U	U	U	T2
T	D	P	C	nT	U	P	C	P	T
T	T	D	C	P	U	D	D	D	T2
P	T	T2	C	T	D	C	D	nT	P
T	D	T2	D	T	U	D	P	T2	C
nT	P	nT	T2	T2	D	C	D	nT	P
nT	nT	T2	T2	P	P	T2	D	T2	C
D	T	U	D	P	T2	U	D	T	nT
D	T2	P	D	P	U	P	C	U	P



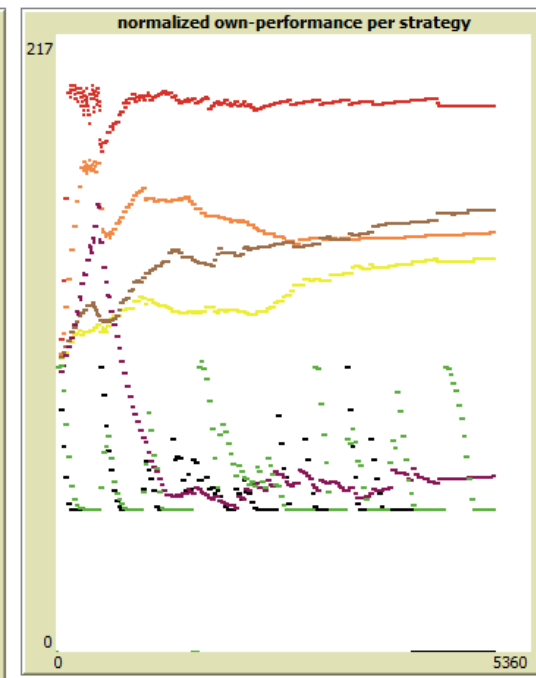
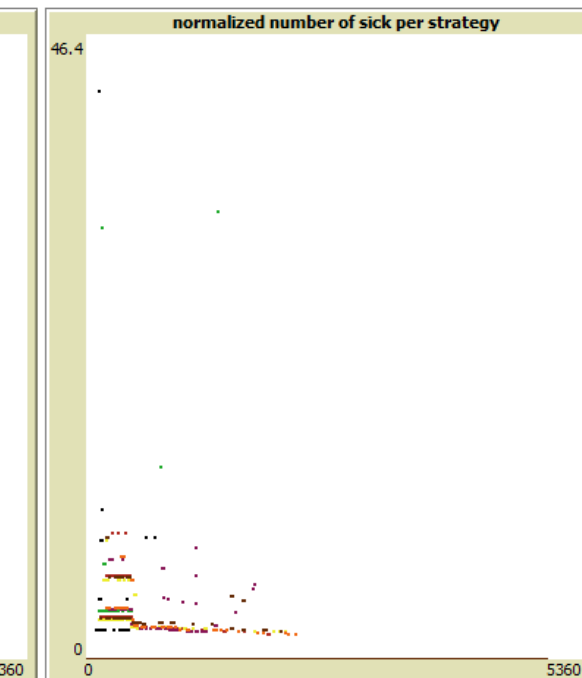
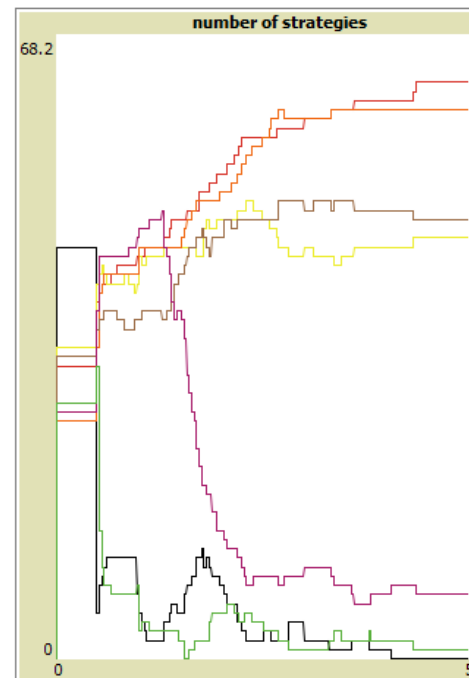
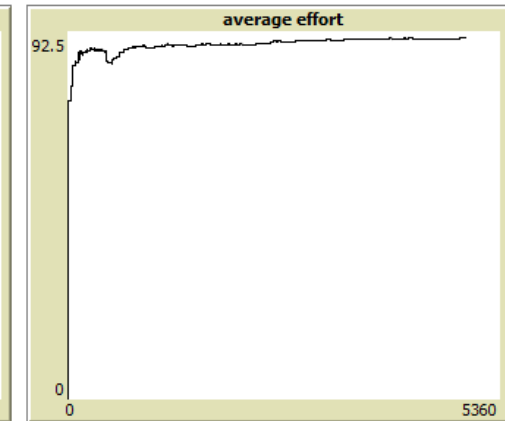
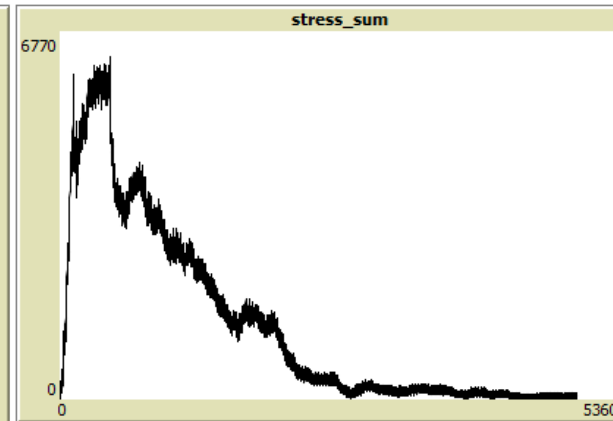
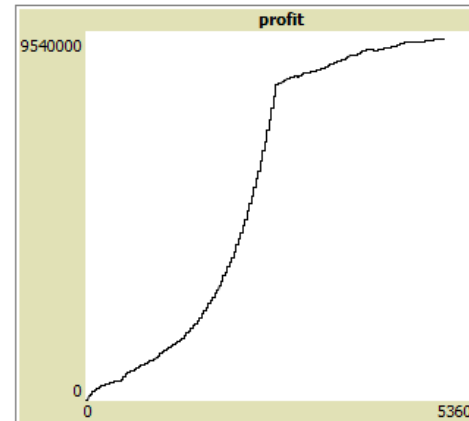
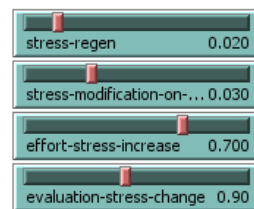
The model interface



T2 C T2 nT T2 C T T2 T2 C T T2 T2 P nT
 nT T T nT nT nT C T2 T nT nT T nT nT T2
 nT nT T2 nT C T T2 P C T C nT C C nT
 nT T2 C T2 C T nT T T2 T2 C nT nT T nT
 nT C C nT C nT T nT C C nT nT P T2 T2
 C T T2 nT T T T T2 T2 T2 T C T nT T2
 C T nT C T2 nT C T2 nT C C nT T2 nT C
 T2 nT C C T2 C C T2 C T T T nT T nT
 C C C U T2 C C nT T T C C nT T
 T2 C T T C T T T2 C T C nT T T2 T
 nT T C nT nT C C nT T C nT C T2 nT T2
 T2 T2 C T T2 T2 nT C T2 T2 T nT P nT T2
 T T nT nT T T2 T2 T2 P nT T2 C nT C C
 nT nT nT P C T nT nT C C T2 C T C nT
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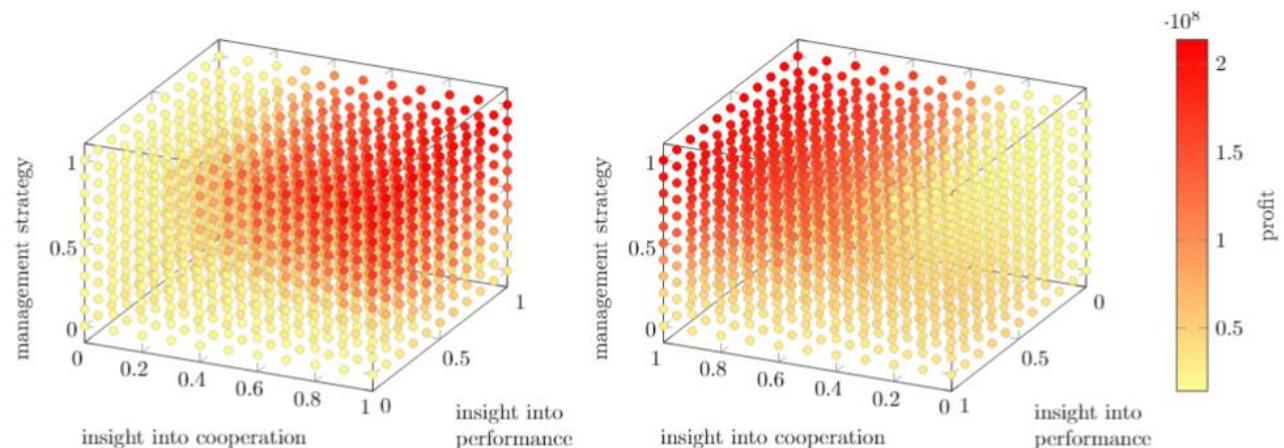


black = defect
 red = coop
 yellow = TFT
 orange = TFT-npm
 brown = TF2T
 lila = pavlov
 green = unforgiving



Results from pilot experiments

- Focus on cooperativeness performs better than focus on performance
- Focus on performance never exceed 40% of performance, when compared to best setting
- Lowest performance is observed when employees are rewarded randomly



Future work

- Social network model
- Growth model
- Improving fluctuation algorithm
- Improving employees' productivity
- Field study to set parameters closer to reality