PoSITeams
Positive Systems Intelligent Teams
an Agent Based Simulator for Studying Group Behaviour

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Agent based Social Simulation

• Agent simulations are very actively growing field
  – So far most activity in computer science and artificial intelligence

• Applications, e.g.:
  – Information diffusion in social networks
  – Emergence of social phenomena
  – Crowd behaviour – disasters, evacuation – fire
  – Analysis of markets

• Operations Research – the Science of Better – could also benefit from the agent approach in improving the performance of social systems

• We developed a web-based organisational social simulator, that focuses on the effects of positivity
Simulating the effects of emotions in teams

• **Simulating positive and negative affect**
  – Helps study how they influence people and groups
  – Illustrates/visualises behaviours
  – Supports personal decision making: 
    *How can I best adjust my behaviour to have a positive impact on my group?*

• **Bridging Positivity Research and Operations Research**
  – Analysis and “optimization” of social behaviour in groups and organizations
Positivity research in psychology

• Barbara Fredrickson (2004)
  – Ratio of positive to negative affect (P/N) influences behaviour (high P/N people “flourish”)
  – **Broaden-and-Build theory**: higher P/N
    • broadens awareness
    • builds personal resources
Positive affect between people

• John Gottman (2005)
  – **Mathematics of Marriage**: A non-linear dynamic model to describe the effects of a Married couple’s positive and negative interaction
  – Can predict the dynamics and success of marriage

• Marcial Losada (2005)
  – **Dynamics of teamwork**: A higher average P/N in communication in team work predicts higher team performance
Social agent models

- Tibor Bosse et al (2009)
  - Contagion of emotions in agent models, see e.g. 
    A Multi-Agent Model for Mutual Absorption of Emotions

- Mark Hoogendoorn at al (2010)
  - Using the Broaden-and-Build theory to study the interplay of information and emotions, with an application to evacuation planning, see 
    An Agent-Based Model for the Interplay of Information and Emotion in Social Diffusion
Our approach

• We introduce the **Systems Intelligence** lens (Hämäläinen and Saarinen 2004)
  – Focus: The structure of the system/organisation and the agents’ ability to act intelligently in a system
  – Seeing and using leverage points

• **We use the B-and-B theory in an interactive framework to study and illustrate the behaviour of agents in organizations**
  – User makes initial assumptions of the structure of the organization and the agents’ initial states
  – User can play around with the scenario and parameters easily
The model in PoSI Teams

• Agent’s emotions
  – State variables: amount of positivity/negativity received \( P(t) / N(t) \)
  – Decay over time: old inputs become less significant
  – The ratio \( P(t)/N(t) \) defines the agent’s interaction style
  – “Build”: a high P/N causes negativity to have less effect

• Interactions
  – Simulated as a two-dimensional space where agents connect with the nearest other agents
  – “Broaden”: a high P/N causes the agent to increase the number of connections with other agents
Equations

\[ C_i(t) = \{\text{set of agents interacting with agent } i \text{ at time } t\} \]

\[ b_i(t) = 0, \text{ if } P_i(t)/N_i(t) < 3 \]
\[ = 0.05, \text{ if } 3 \leq P_i(t)/N_i(t) < 4 \]
\[ = 0.15, \text{ if } 4 \leq P_i(t)/N_i(t) < 5 \]
\[ = 0.25, \text{ if } 5 \leq P_i(t)/N_i(t) \]

\[ d_i(t) = 0, \text{ if } P_i(t)/N_i(t) < 0.9 \]
\[ = 1, \text{ if } 0.9 \leq P_i(t)/N_i(t) < 3 \]
\[ = 3, \text{ if } 3 \leq P_i(t)/N_i(t) < 4 \]
\[ = 4, \text{ if } 4 \leq P_i(t)/N_i(t) < 5 \]
\[ = 5, \text{ if } 5 \leq P_i(t)/N_i(t) \]

\[ u_i(t) = P_i(t)/(P_i(t) + N_i(t)) \]

\[ P_i(t + 1) = 0.95P_i(t) + \sum_{j \in C_i(t)} u_j(t) \]

\[ N_i(t + 1) = 0.95N_i(t) + \max(0, \sum_{j \in C_i(t)} (1 - u_j(t)) - b_i(t)) \]
Web-based implementation

• For **ease of use** and **easy distribution**
  – HTML5 and Javascript
  – Supports all modern web browsing devices

• **Effective and transparent visualisation**
  – Agents’ states shown as “smileys” on the screen
Demonstration

http://salserver.org.aalto.fi/sim/positeams/
The PoSITeams interface
Kimmo

Juha

Juuso

Minna

Perttu

Ahti

Kai

Jussi

Raimo

Ilkka

Jirka

Arttu

Harri
Developing the system further

• **Improving the simulation model**
  – Enriching the models for emotion and interaction
  – Possibility for the user to decide his own agent’s behaviour and make assumptions of the team members’ behaviour

• **Computational support** to find the most effective action and agent when the goal is to optimise team positivity
  – Solving the simulation with e.g. a Monte Carlo approach?
  – Simulator could suggest the best course of action
Future research

• **What would a systems intelligent team look like?**
  – Robust against the effects of negativity
  – Support the development of positivity
  – What number of negative agents can be accommodated?

• **Behavioural testing by experiments**
  – Let people study their team’s performance interactively by changing their own responses
References

• B. Fredrickson: The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions, American psychologist 2001
• B. Fredrickson & M. Losada: Positive affect and the complex dynamics of human flourishing, American Psychologist 2005
• J. Gottman & al: Mathematics of Marriage, MIT Press 2005
• E. Saarinen & R. Hämäläinen, Systems Intelligence: Connecting Engineering Thinking with Human Sensitivity 2004
• J. Luoma, R. Hämäläinen & E. Saarinen, Perspectives on Team Dynamics: Meta Learning and Systems Intelligence, Systems Research and Behavioral Science 2008
• T. Bosse & al, A Multi-Agent Model for Mutual Absorption of Emotions 2009
• M. Hoogendoorn & al, An Agent-Based Model for the Interplay of Information and Emotion in Social Diffusion 2010
• http://salserver.org.aalto.fi/sim/positeams/