PoSITeams - Positive Systems Intelligent Teams

an Agent-Based Simulator for Studying Group Behaviour

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- **Background:**
  - Systems intelligence
  - Positivity
- **Simulation:**
  - describe social behaviour in teams
  - test the effects of behavioural assumptions
  - test the effects of behavioural changes
- **Optimization:**
  - help teams to flourish
  - find better structures
  - find better personal behaviour
- **Web-based implementation:**
  - allows easy distribution of the application

Systems Intelligence

- Ability to act intelligently within complex systems involving interaction and feedback.
- A systems intelligent person perceives the system as a whole and recognizes herself as an active part of the system, who is both able to affect the state of the system and is reciprocally influenced herself by the system.

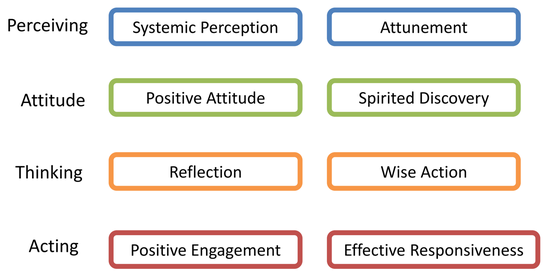
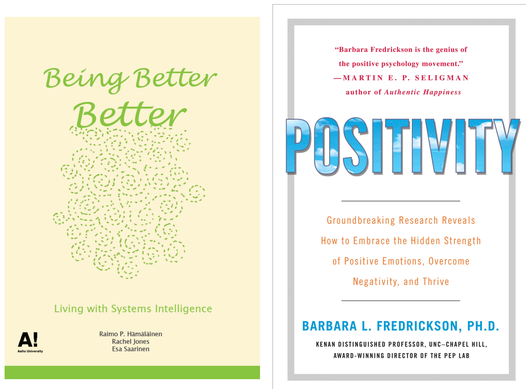


Figure 1: The eight dimensions of systems intelligence.



Positivity

- **Positive emotions:**
  - build cognitive, social, psychological, emotional and physical resources.
  - increase the ability to cope with negativity
  - can become a positive feedback loop towards emotional well-being
- **High positivity ratios:**
  - increase the performance of social groups and individuals
  - increase the number of strong connections in the team

Purpose

- Engage the user in reflective thought-processes and facilitate seeing the system as a whole and let the user recognize herself as an active part of the system.
- Demonstrate systemic effects of different behavioural and structural changes that can occur in organizations.
- Support systems intelligent behaviour in organizations.
- A tool for developing systems intelligence.

Improving team behaviour

- Optimization of model parameters with simulated annealing.
- Simulator can suggest systems intelligent actions.
- The user can add constraints to model parameters.
- Costs can be assigned to changing the behavioural parameters.

Using PoSITeams

- Agents and their connections can be added, removed and modified.
- The behaviour of an agent can be adjusted by:
  - General positivity, P/N in the uninfluenced steady state.
  - Extroversion ε_j
  - Emotional sensitivity δ_j
  - Negativity bias β_j
  - Social connection strengths $\alpha_{i,j}$
- The whole group or its subgroups can be optimized.
- Allowed parameter ranges and costs of changing behaviour can be specified.

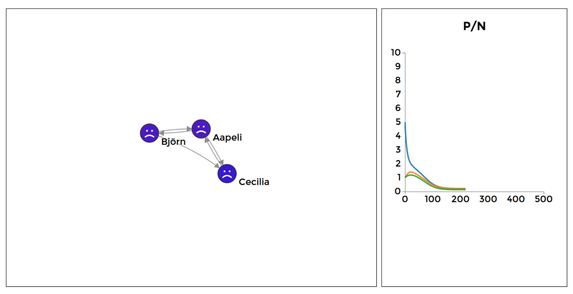
Future work

- Testing the simulator in a real-world organization.
- Validation of the emotional contagion model.
- Evaluate if SI can be improved in real life by PoSITeams.
- Further development of the simulator software.

Try the simulator at

http://systemsintelligence.aalto.fi/positeams

Improve personal behaviour



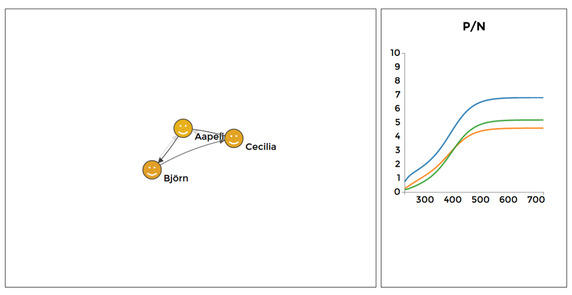
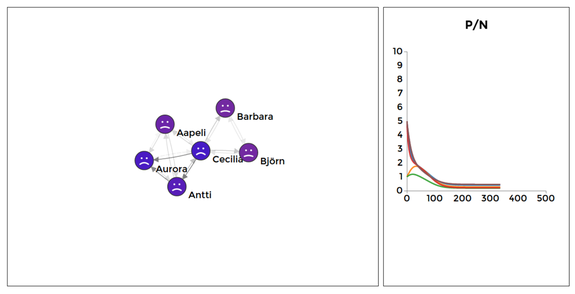


Figure 2: The team after optimizing the behaviour of Aapeli, emotional sensitivity: 0.8 ⇒ 0, extroversion: 0.8 ⇒ 1.

Improve team structure



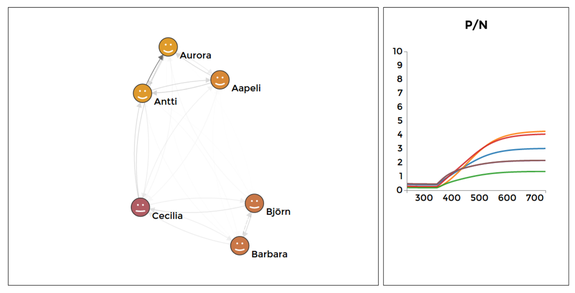
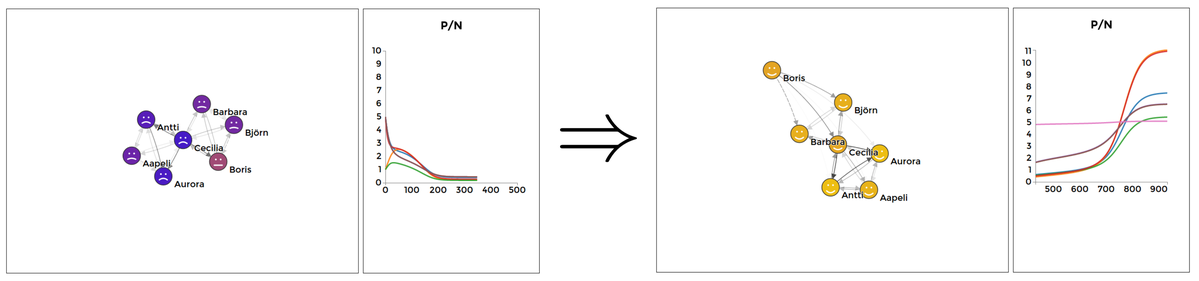


Figure 3: The team with an optimized structure.

Adding a new team member



Model

Emotional contagion

$$P_j(t+1) = aP_j(t) + b + \sum_{i \neq j} I^P_{i,j}(t)$$
$$N_j(t+1) = cN_j(t) + d + \sum_{i \neq j} I^N_{i,j}(t)$$

Influence functions

$$I^P_{i,j}(t) = \gamma_{i,j}(1-\beta_j)P^{rel}_i(t)$$
$$I^N_{i,j}(t) = \gamma_{i,j}\beta_j N^{rel}_i(t)$$

Relative positivity

$$P^{rel}_j = 1 - N^{rel}_j = \frac{P_j}{P_j + N_j}$$

- P_j, N_j level of positivity and negativity
- β_j negativity bias
- $\gamma_{i,j} = \varepsilon_i \alpha_{i,j} \delta_j$ emotional contagion strength between agents i and j, where
  - ε_i how strongly the agent i expresses its level of emotion
  - $\alpha_{i,j}$ social connection strength between agents i and j
  - δ_j how easily the emotions of agent j are affected by the emotions of others

Broaden-and-build extension

- Increases connectivity and ability to cope with negativity as P/N increases.

$$\delta_j(t) = P^{rel}_j(t-1)(\delta^{max}_j - \delta^{min}_j) + \delta^{min}_j$$
$$\varepsilon_j(t) = P^{rel}_j(t-1)(\varepsilon^{max}_j - \varepsilon^{min}_j) + \varepsilon^{min}_j$$
$$\beta_j(t) = P^{rel}_j(t-1)(\beta^{min}_j - \beta^{max}_j) - \beta^{min}_j + 1$$

References

[1] S. G. Barsade. The ripple effect: Emotional contagion and its influence on group behavior. *Administrative Science Quarterly*, 47(4):644–675, 2002.

[2] T. Bosse, R. Duell, Z. A. Memon, J. Treur, and C. N. Van Der Wal. A multi-agent model for emotion contagion spirals integrated within a supporting ambient agent model. In *Principles of Practice in Multi-Agent Systems*, pages 48–67. Springer, 2009.

[3] T. Bosse, R. Duell, Z. A. Memon, J. Treur, and C. N. Van Der Wal. A multi-agent model for mutual absorption of emotions. In *Proceedings of the 23rd European Conference on Modelling and Simulation, ECMS*, pages 212–218. Citeseer, 2009.

[4] B. L. Fredrickson. The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American psychologist*, 56(3):218, 2001.

[5] B. L. Fredrickson. Updated thinking on positivity ratios. *American Psychologist*, 68:814–822, 2013.

[6] J. M. Gottman. *What predicts divorce?: The relationship between marital processes and marital outcomes*. Psychology Press, 1994.

[7] R. P. Hämäläinen, R. Jones, and E. Saarinen. *Being Better Better - Living with Systems Intelligence*. Aalto University Publications, CROSSOVER 4/2014, 2014.

[8] M. Hoogendoorn, J. Treur, C. N. Van Der Wal, and A. Van Wissen. Agent-based modelling of the emergence of collective states based on contagion of individual states in groups. In *Transactions on computational collective intelligence III*, pages 152–179. Springer, 2011.

[9] M. Losada and E. Heaphy. The role of positivity and connectivity in the performance of business teams a nonlinear dynamics model. *American Behavioral Scientist*, 47(6):740–765, 2004.

[10] P. Rozin and E. B. Royzman. Negativity bias, negativity dominance, and contagion. *Personality and social psychology review*, 5(4):296–320, 2001.

[11] E. Saarinen and R. P. Hämäläinen. Systems intelligence: Connecting engineering thinking with human sensitivity. *Systems intelligence in leadership and everyday life*, pages 51–78, 2007.