The Leviathan model

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The Leviathan model

It simulates a group of agents holding opinions on each other. During dyadic meetings, they propagate their opinions of each other and of some other agents (gossip). Highly valued agents are more influential. Listeners decrease their opinion about the speaker when feeling undervalued and increase it when feeling overvalued. Various dynamic opinion structures emerge in the group: absolute dominance, hierarchy of opinions, crisis, equality and elite.

Dynamic of simulated agents

Influence and vanity due to direct contact

Face-to-face(i,j)

if $a_{ii} = nil$, $a_{ii} \leftarrow 0$

if $a_{ij} = nil$, $a_{ij} \leftarrow 0$

$a_{ii} \leftarrow a_{ii} + \rho p_{ij}(a_{ji} - a_{ii} + \text{Random}(-\delta, +\delta))$

$a_{ij} \leftarrow a_{ij} + \rho p_{ij}(a_{jj} - a_{ij} + \text{Random}(-\delta, +\delta))$

$\quad + \omega(a_{ji} - a_{ii} + \text{Random}(-\delta, +\delta))$

i is influenced by what j tells about i and j with the coefficient ρ

If i perceives the opinion of j about herself (i) higher than her own opinion of self, i increases her opinion of j (she rewards the compliment-giver allowing j to be more influential on herself). Else i decreases her opinion of j (punishment of the perceived despiser making j less influential on her). Reward or punishment are weighted by ω

For x iterations:
  Repeat $N/2$ times :
    Choose randomly a couple (i,j)
    Face-to-face(i,j)
    Face-to-face(j,i)
    Gossip(i,j)
    Gossip(j,i)

At the beginning, i and j don't know each other and all their opinions are nil. They are changed when they meet or heard about them for the first time.

Influence about opinions of acquaintances

j propagates to i her opinions about k agents randomly chosen among her acquaintances

Gossip(i, j) - Repeat k times:

Choose randomly z with $a_{jz} \neq$ nil, $z \neq j$

If $a_{iz} = nil$, $a_{iz} \leftarrow 0$

$a_{iz} \leftarrow a_{iz} + \rho p_{ij}(a_{jz} - a_{iz} + \text{Random}(-\delta, +\delta))$

i modifies her opinion about an the agent z applying the coefficient p_{ij} weighted by ρ to the perceived (with noise) difference between what j told about z and what she thinks of z.

Influence is a matter of esteem

The coefficient $p_{i,j}$ of influence suppose that if i has a high opinion of j, j is more influential

$$p_{ij} = \frac{1}{1 + \exp\left(-\dfrac{a_{ij} - a_{ii}}{\sigma}\right)}$$

difference between the opinion of i about j (a_{ij}) and the opinion i about herself ($a_{i,i}$)

σ defines the slope of the function close to $a_{ij} - a_{ii} = 0$
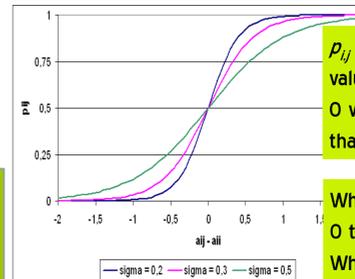
p_{ij} tends to 1 when a_{ij} - a_{ii} is close to 2 (i values j higher than herself), and tends to 0 when it is close to -2 (i values j lower than herself).

When σ is small, p_{ij} rapidly changes from 0 to 1
When σ is large, this change is progressive

Emergent dynamic structures of the population

Dominance

All agents share a similar opinion about every other agent, but a single agent has a high reputation while most of the other agents have a very low reputation.
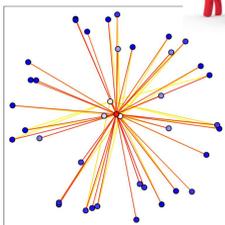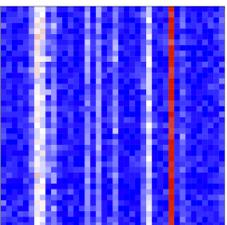
Consensus on opinion about an agent, varies in number of levels and differences between levels
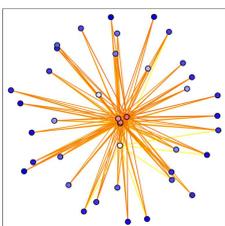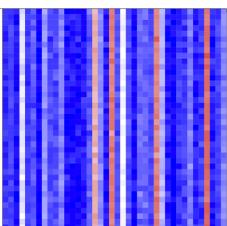
Hierarchy

All agents share a similar opinion about every other agent (called reputation) and the reputations are widely spread between -1 and +1. There are more agents of low reputation than of high reputation: this gives the image of a classical hierarchy with a wide basis and progressively shrinking when going up to the top.

Readable on columns: opinions each one has of someone (ie reputations)

Readable on lines: opinions someone have on the others
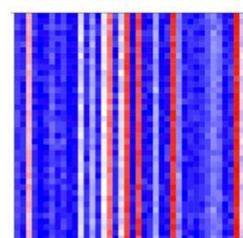
From dark red (+1) to dark blue (-1)

Network: link between two agents only when at least one of them has a positive opinion of the other.

Representation in a 2D space :
- The **distance** between agents (= nodes) indicates how negative they are on each other (large when they have negative opinions of each other; small if they are positive; medium when the sum of their opinions is close to 0) ;
- The **colour** of the links is yellow when the link is close to 0 and it gets close to red when the value of the link is close to 1.
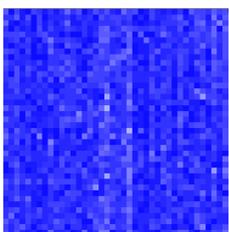
Crisis

Each agent has a very negative opinion of all the others and of herself.
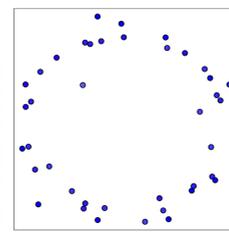
Equality

Each agent has a positive opinion about herself, she is connected by strong positive mutual opinions with a small set of agents and has very negative opinions about all the others. All agents have a similar number of positive (and negative) links.
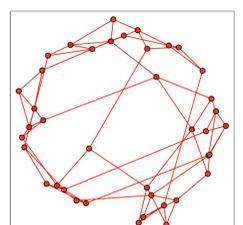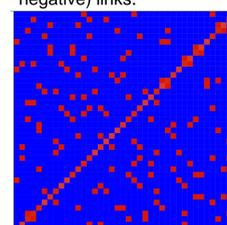
No consensus, structure based on individuals privileged relations
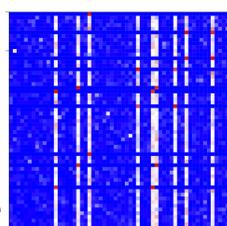
Elite

It shows two categories of agents: the elite and second category agents. The elite agents have a positive self-opinion and are strongly supported by a friend, but they have a very negative opinion of all the other elite agents and of all the second category agents. The second category agents have a very negative self-opinion, they have a very negative opinion of all the other second category agents and their opinion about the elite agents is moderate.

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- **Deffuant, Carletti, Huet 2013**, JASSS
- Huet 2014 (study of gossip)
- Huet, Deffuant 2014 (negativity or positivity of the population)
- Huet, Shtiliyanova 2014 (communication apprehension)