Social Sorting

Apply social biases to complex systems

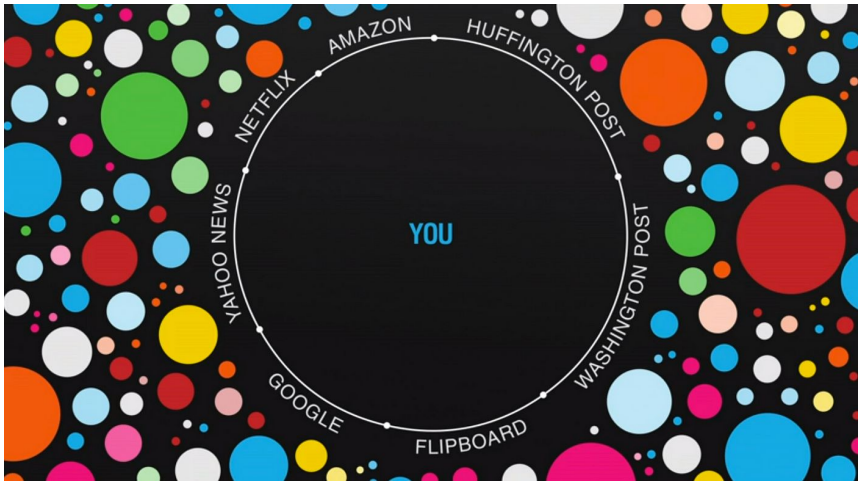
Social Media, Bubbles and Echo-Chambers

The modern era is characterised by the existence of online platforms that allow us to connect potentially to millions of people and gain information from many different sources.

But we can also observe the emergence of different communities in conflict, from distrust to open hate, that interact aggressively and make it look like they cannot communicate between them.

Social Media, Bubbles and Echo-Chambers

A popular explanation for this phenomenon is the **Bubble**: the idea that online platforms filter in some way the information that reaches you because you read news only from specific platforms and hear discussion only with specific people who see the world as you do.



Social Media, Bubbles and Echo-Chambers

Inside these closed communities of people with the same ideology, if they discuss a topic, their opinion only becomes stronger because nobody introduces new ideas or counterarguments encouraging the development of extremism and dogmatic assumptions.

But is this true?

Social Sorting, an Alternative explanation to extremes ideas

New studies have observed interactions among people on social media proving that today you are more connected than ever to thousands of people with different opinions distant from what you think.

The real reason why ever more people are developing extreme ideas is not because online platforms hide pieces of information but because something deep down inside our brain guides an important part of our behaviour.

Social Sorting, an Alternative explanation to extremes ideas

Social Sorting: the idea that if someone is really similar to you is very likely safe to be trusted because, of course, you are a “good person” and you can be trusted.

At the same time people too different from you are suspect because, since they don't share the ideology that you have they are not similar to something you can trust and, therefore, can’t be trusted.

Social Sorting, an Alternative explanation to extremes ideas

Social Sorting dates back to ancient times when humans were still divided into many small tribes and having a united community was safer than a divided one.

So our brains learned to trust what was close to us and since it came from the same local culture, was also similar.

Social Sorting, an Alternative explanation to extremes ideas

Our brains care to feel safe inside a tribe, but today through social media we are exposed to an enormous amount of disagreement, and it can't be all processed by a single person.

Sou our brain selects for us sources that it thinks can be trusted **concentrating more on how much they look like us** rather than who they are or what they are saying.

Social Sorting applied to Complex Systems

It is possible to study social sorting with a complex system?

And how it changes the behaviour of known social models with the introduction of this bias?

The tools

Python 3:(on Google Collab Notebook) was used to implement the data structure and the algorithm run for the experiments

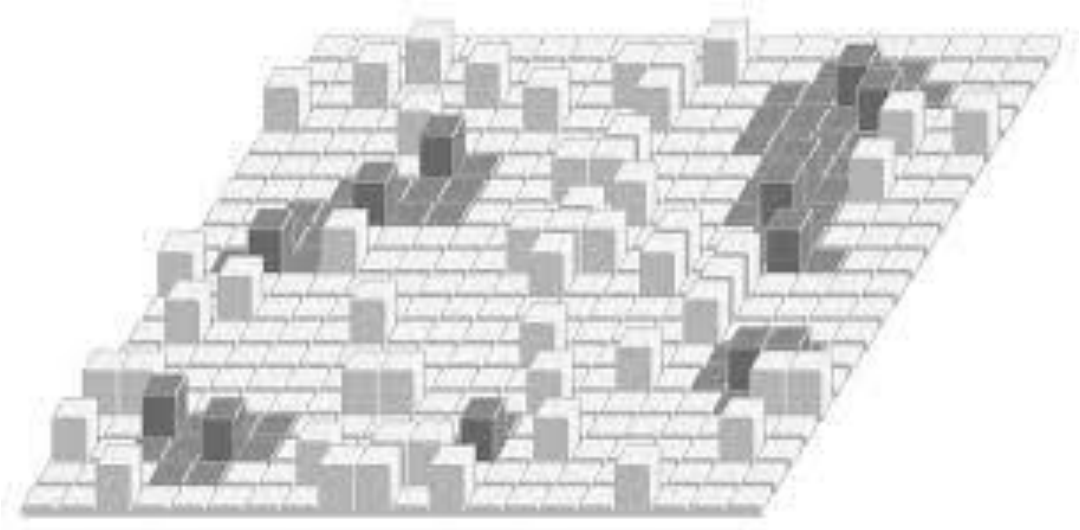
Networkx 3.3: a Python library for graph analytics with many functions and models already implemented.

Pandas 2.2.2: a Python library for data science used to collect and study data during the execution of the algorithms

The starting model

Nowak Lewenstein cellular automata for public opinion: the starting models modified for this study were created to emulate the polarization on complex automata.

It was used as a starting point for developing a new model for this experiment.



The modified model

Nowak Lewenstein model for Public Opinion: the starting models modified for this study were created to emulate the polarization on cellular automata.

Each element has 3 attributes:

- **Level of Conviction**: a positive value that indicates how much an element is convinced about his ideology.
- **Force of Persuasion**: a positive value that can assume only certain values that indicate how much an element is good at influencing the idea of its neighbours.
- **Tribe**: the tribe of membership of the element, two tribes, one for and one against a topic.

The modified model

The model can iterate and at each step each node changes its value based on the force of persuasion of its neighbors.
The change function is as follows, and it changes the level of conviction:

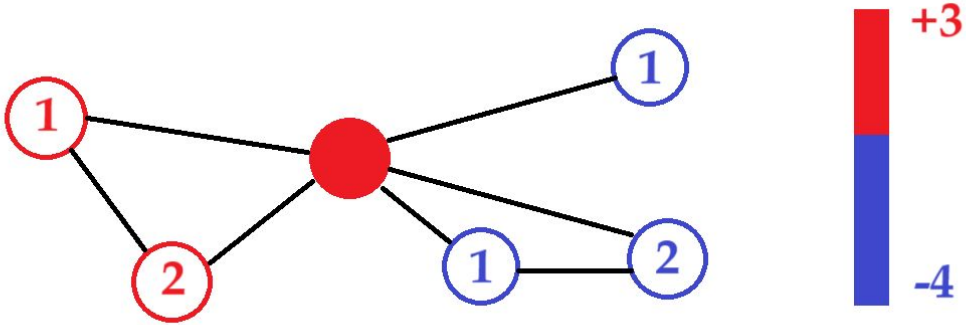
$$LoC_i^{t+1} = LoC_i^{t} + \Sigma_{j \in nst} FoP_j - \Sigma_{j \in ndt} (ss * FoP_j) \quad i = 1 \ldots n$$

The modified model

nst = neighbours of an element that are in the **same** tribe
ndt = neighbours of an element that are in the **different** tribe
ss $\in$ [0,1] indicates how much a tribe discard the influence of the other tribes
LoC$_i^t$ = level of conviction of an element i at step t
FoP$_j$ = Force of Persuasion of element j

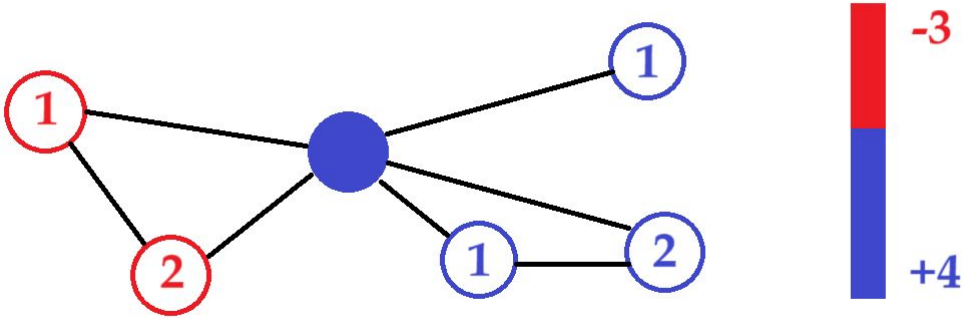
$$LoC_i^{t+1} = LoC_i^t + \Sigma_{j \in nst} FoP_j - \Sigma_{j \in ndt} (ss * FoP_j) \quad i = 1 \ldots n$$

The modified model



The total force of persuasion on the central node is -1, if an iteration has a level of conviction of 9 at the next step it will be equal to 8.

The modified model



After enough iterations the node's level of conviction drops below zero, and then the node will become a member of the opposite tribe with a level of conviction equal to 0.

The modified model

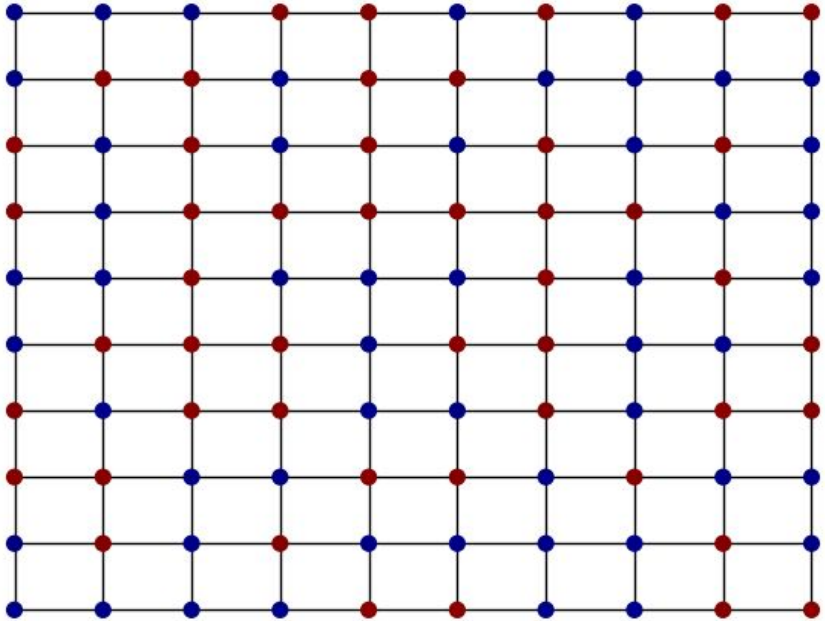
For the experiment conducted, we have:

- Two different topologies were used to simulate 2 different systems:
  - A **Cellular Automata** emulated with a 2d grid network with Von Neumann neighbourhood.
  - A **Power Low Network** to simulate the shape of the connections between people on social media with the presence of **hubs**.
- **Force of Persuasion** is set integer in [1,2]
- Network size is setted to 2500 nodes with 4 arcs for each node (in the power law network with **preferential attachment** based on number of links)

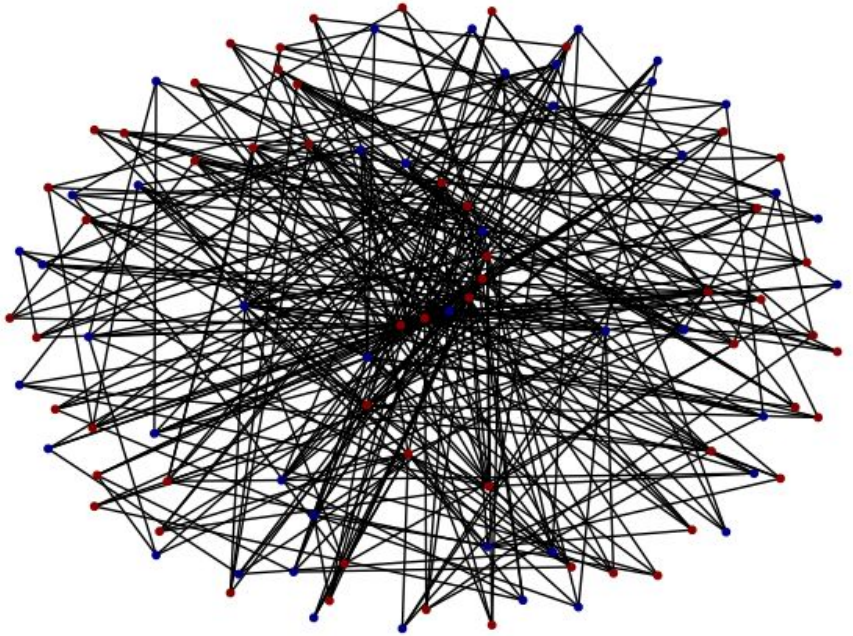
The members of one tribe, that will be considered as the pro faction, are coloured red while the other elements are coloured blue.
The **intensity** of the color it's **proportional** to the **Level of Conviction** of an element to help visualize the presence of extreme ideology.

The modified model

2D Grid Network

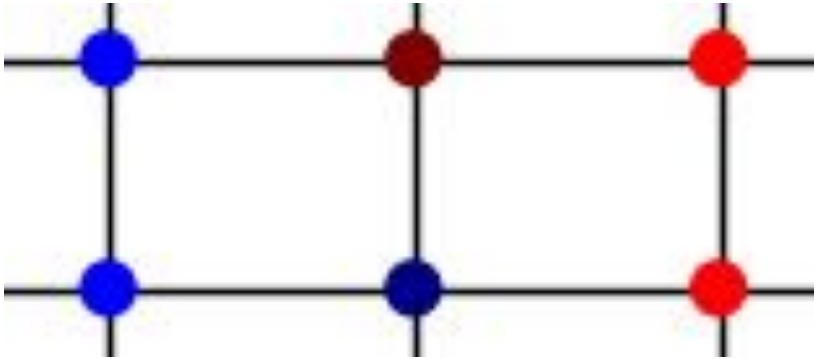


Power Law Network



The modified model

Different Level of conviction among two tribes:



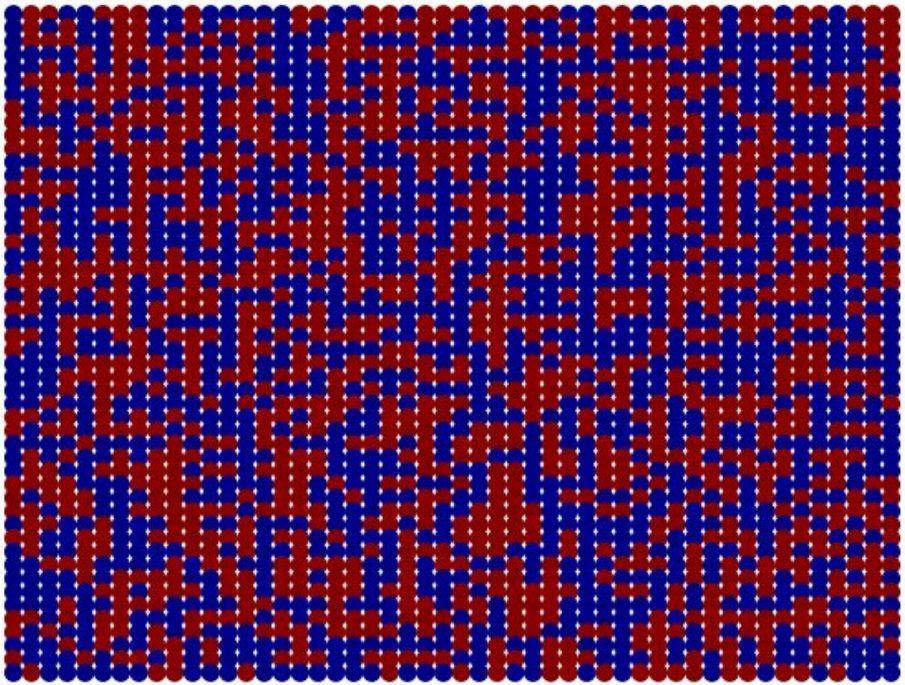
Cellular Automata vs Power Law Network

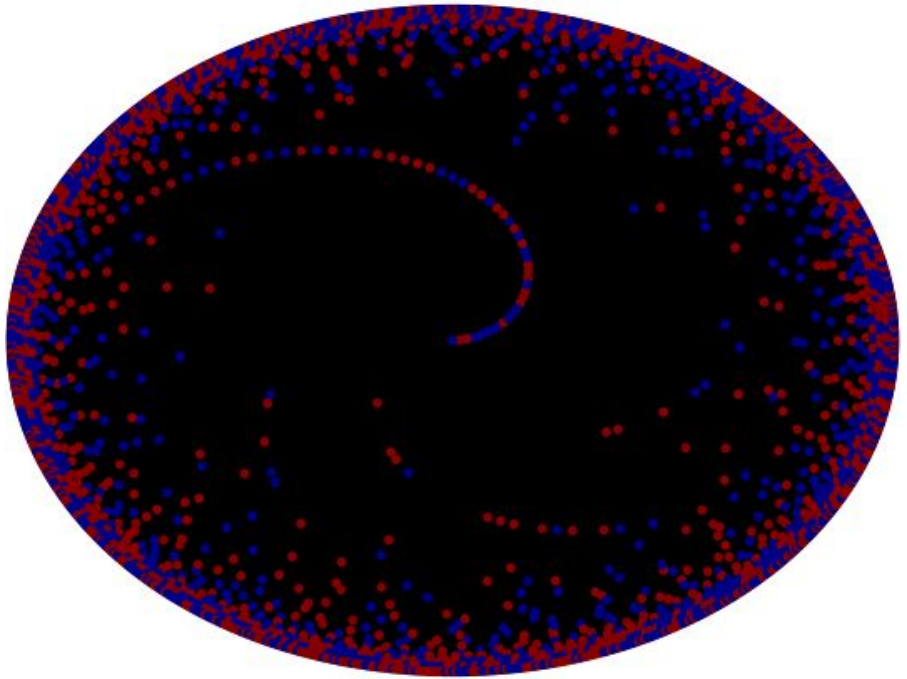
In the first experiment, we consider the two network topologies with the same number of nodes and edges and monitor how the systems change in different ways.

Note: in the plot of the Power Low Network the more a node is closer to the center, the more links it has.

Cellular Automata vs Power Law Network

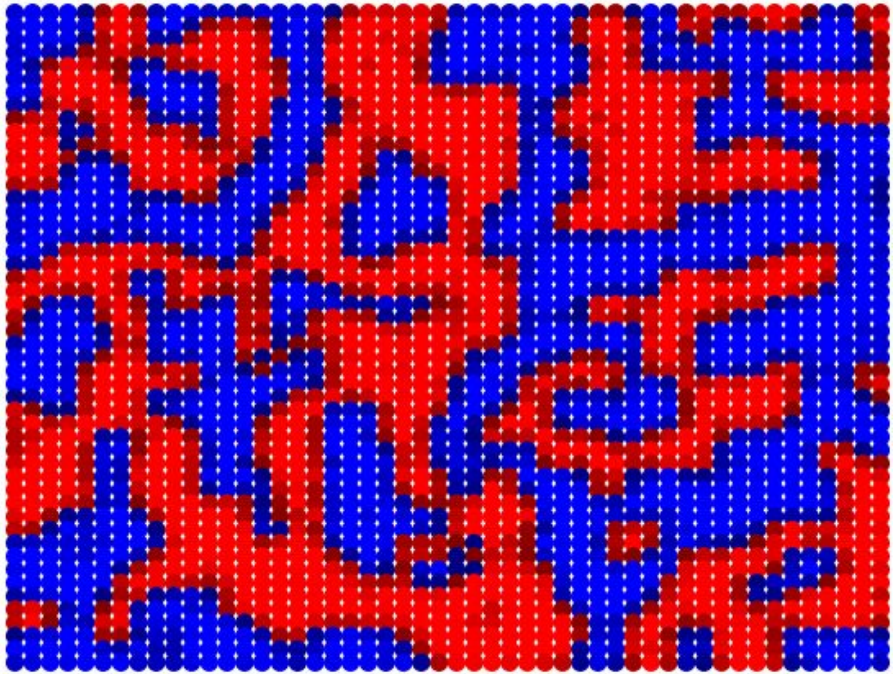
Iterations count = 0

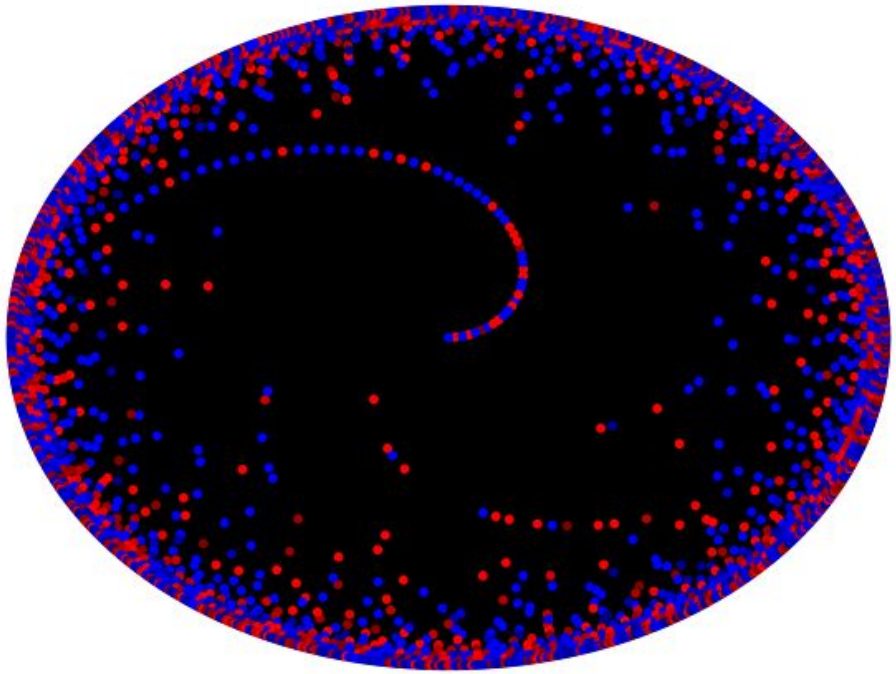




Cellular Automata vs Power Law Network

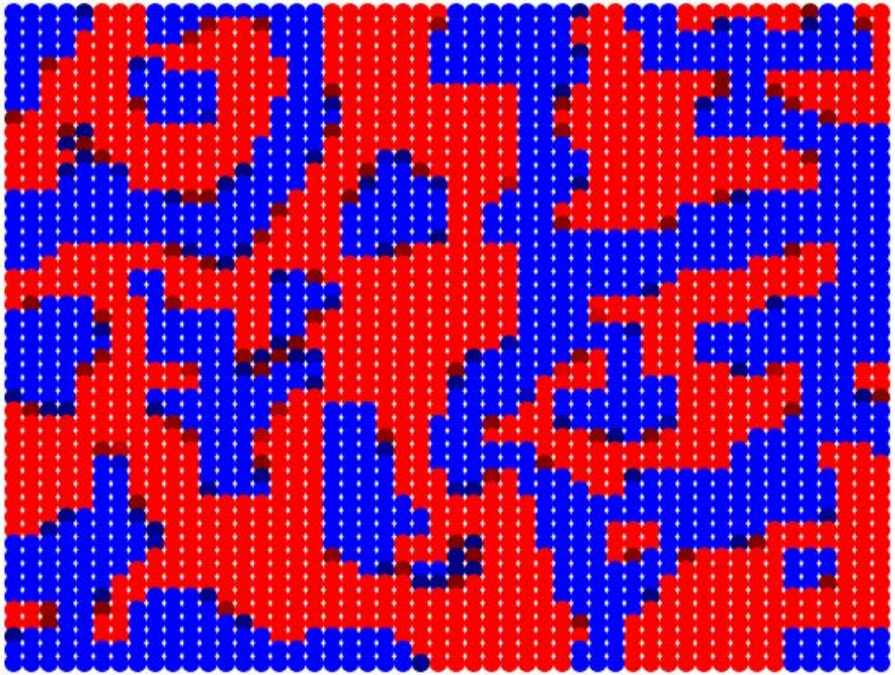
Iterations count = 100

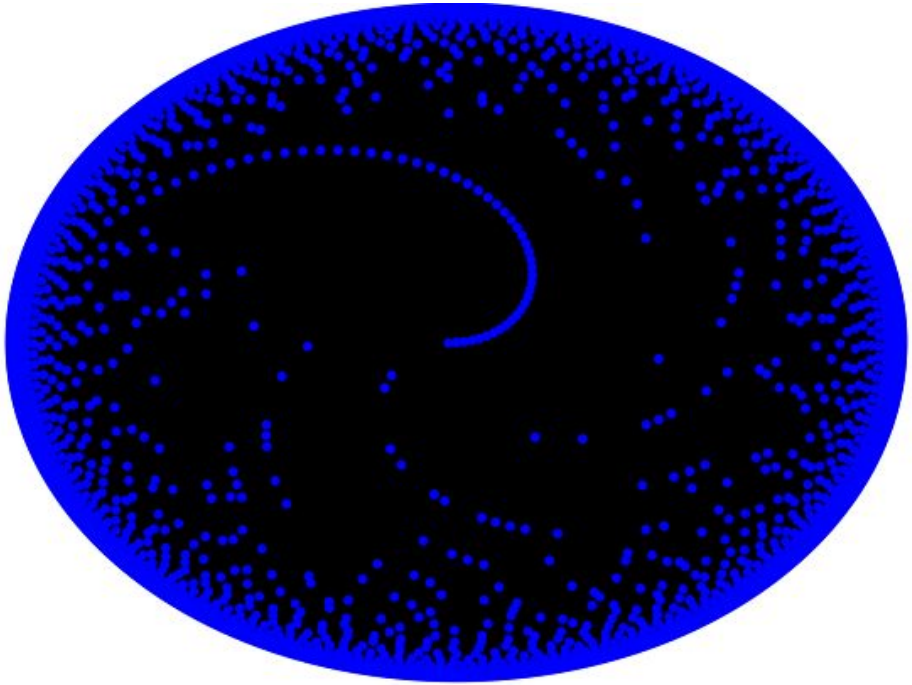




Cellular Automata vs Power Law Network

Iterations count = 1000

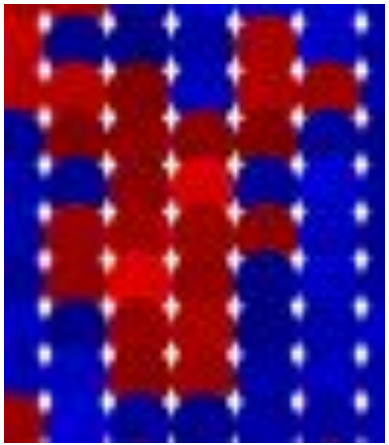


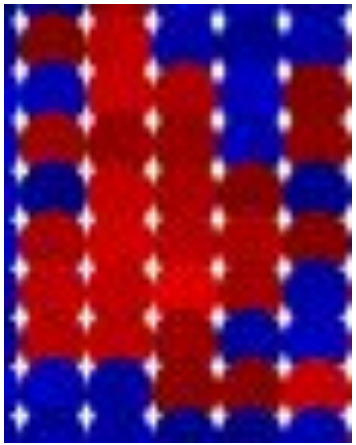


Cellular Automata vs Power Law Network

In the 2d grid network, we observe immediately the formation of structures similar to the ones in the Nowak Loewenstein model, like fortresses or towers, and after some iterations, we can see the formation of pockets of the same colour that grow bigger until an equilibrium between the 2 tribes is reached.

Some structures formed after 5 iterations.





Cellular Automata vs Power Law Network

In the Power Law Network the different structures make slowly one tribe grow stronger than the other until one of the 2 tribes is completely whipped out.

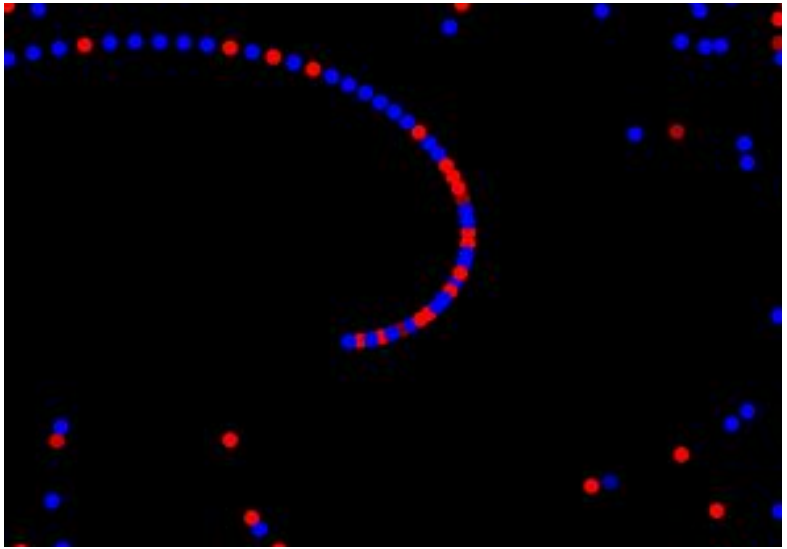
This happens because in the first network, all the nodes (except for the ones in the margin of the grid) are equivalent and one will influence only 4 neighbours.

In a Power Law Network a node could occupy a central position linking many different nodes and being able to influence a greater portion of the network.

As a result the tribe that can “convince” more hubs gains an advantage over the other.

Cellular Automata vs Power Law Network

We can observe how after 100 iterations most of the central nodes are in the blue tribe.



Social Sorting applied to the model

Now let’s focus on Social Sorting and how it changes the behaviour of the system: we can observe two fundamental changes in both the network type

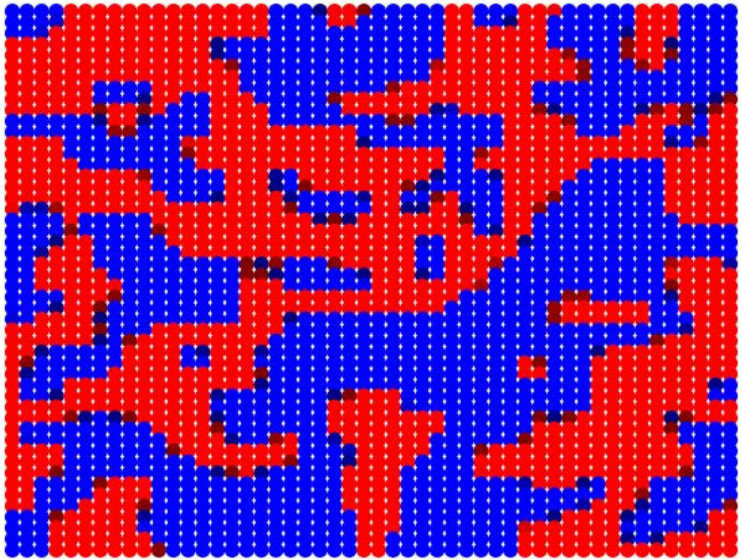
The **number of times** an element **change tribe** drops to zero faster if the social sorting is active.

A **final phase is reached faster** that with social sorting, and as a consequence the average Level of Confinement reaches the maximum value allowed more quickly.

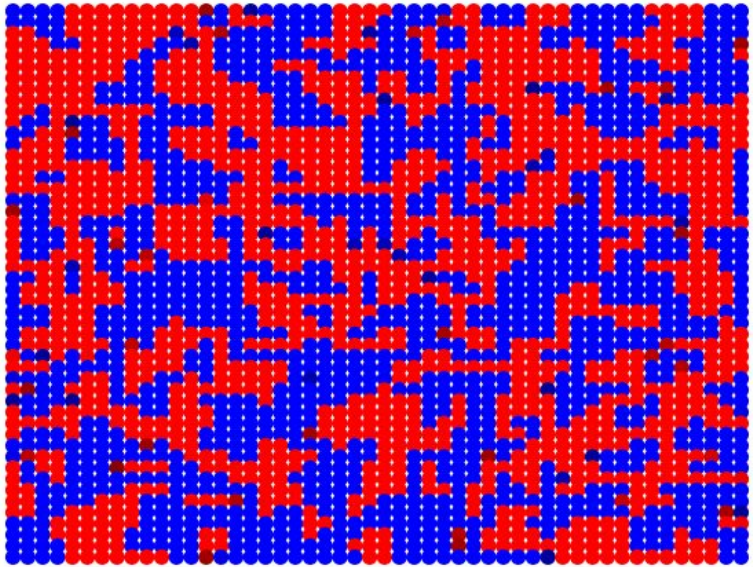
Social Sorting on Cellular Automata

Iterations count = 1000 ; Social Sorting Weight = 0.3

Without Social Sorting

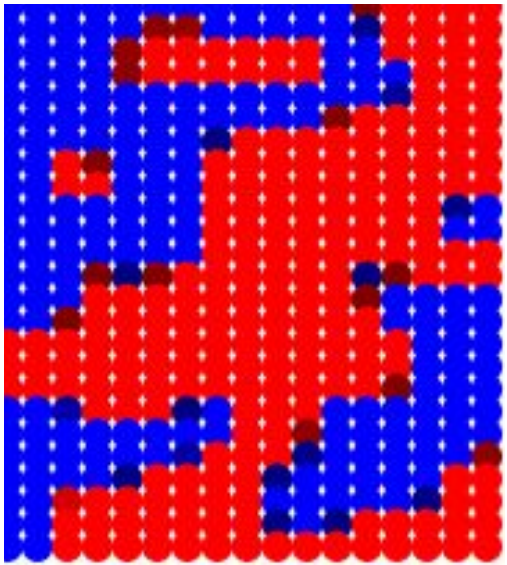


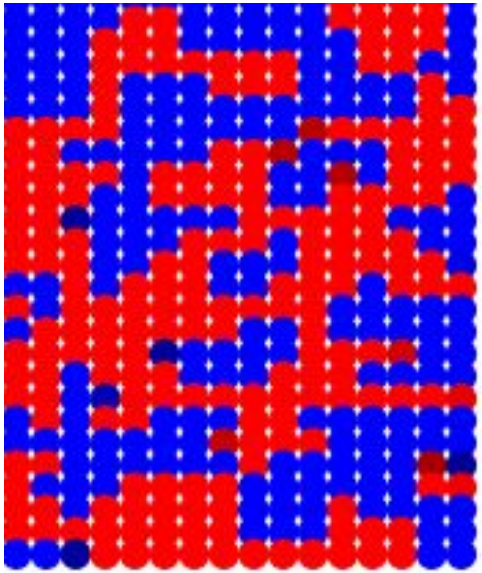
With Social Sorting



Social Sorting on Cellular Automata

In the cellular automata the social sorting makes the system converge faster to a state of equilibrium but with smaller and much more sparse pockets.

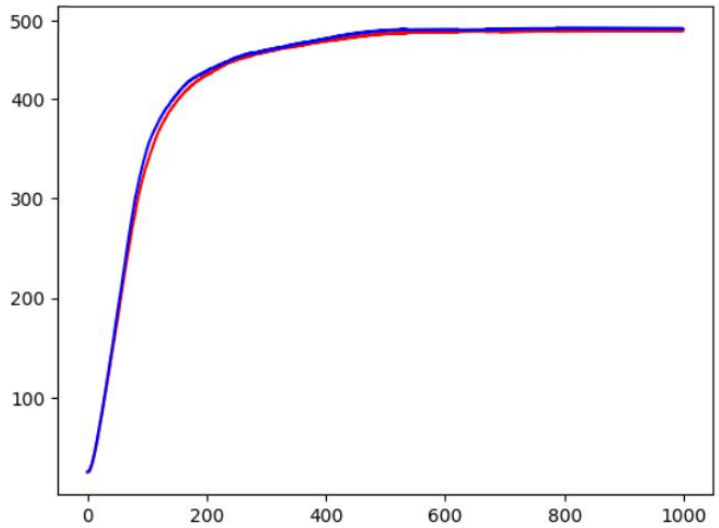




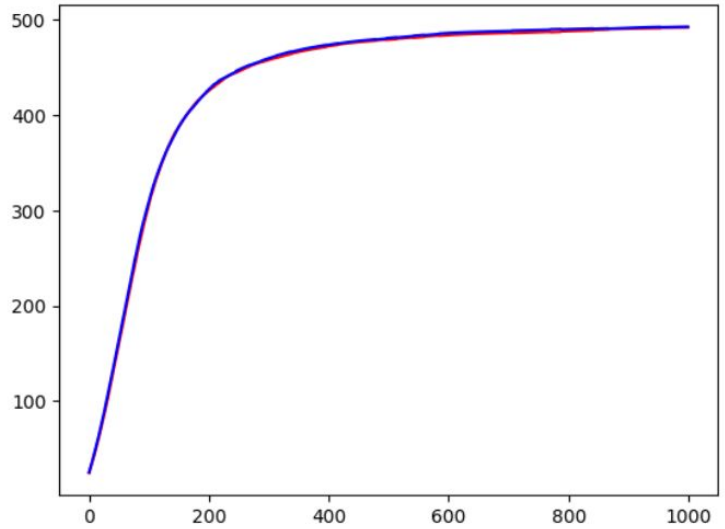
Social Sorting on Cellular Automata

Average Level of Conviction 2D Grid Network:

Without Social Sorting



With Social Sorting

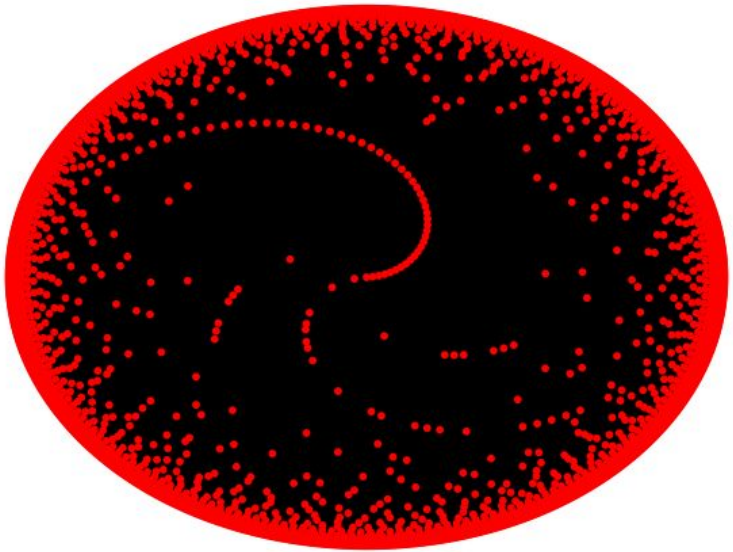


Red line = tribe pro
Blue line = tribe against

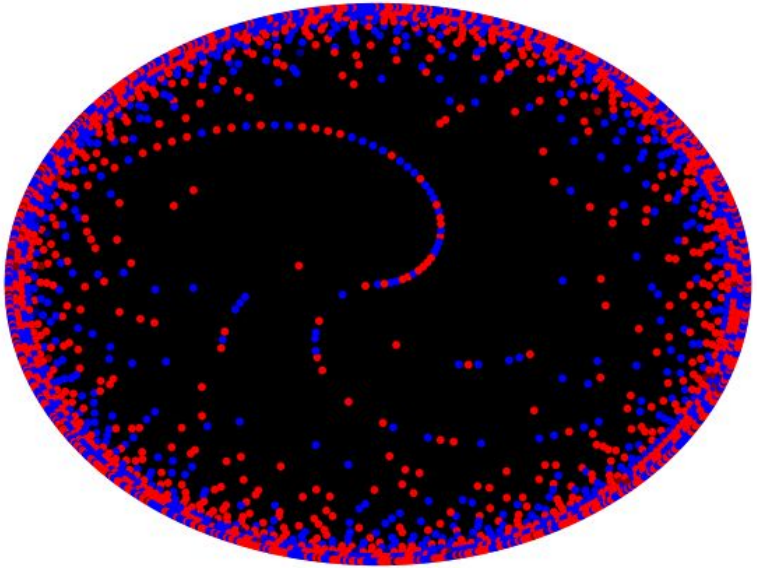
Social Sorting on Power Law Network

Iterations count = 1000 ; Social Sorting Weight = 0.3

Without Social Sorting



With Social Sorting

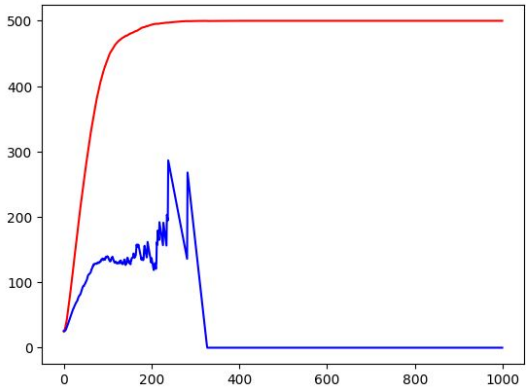


Social Sorting on Power Law Network

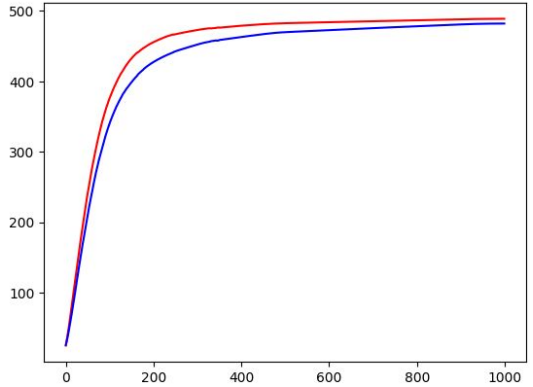
The effect on the Power Law Network is even more evident: when the social sorting is active one tribe can survive even if it is at a disadvantage while without the filter it gets removed from the other tribe.

Average Level of Conviction Power Law Network:

Without Social Sorting



With Social Sorting



Red line = tribe pro
Blue line = tribe against

Constant change in Cellular Automata

One difference that isn’t influenced by the presence of social sorting between the cellular automata and the power law network is that in the first system a small number of nodes keep changing state; even during the final equilibrium phase.

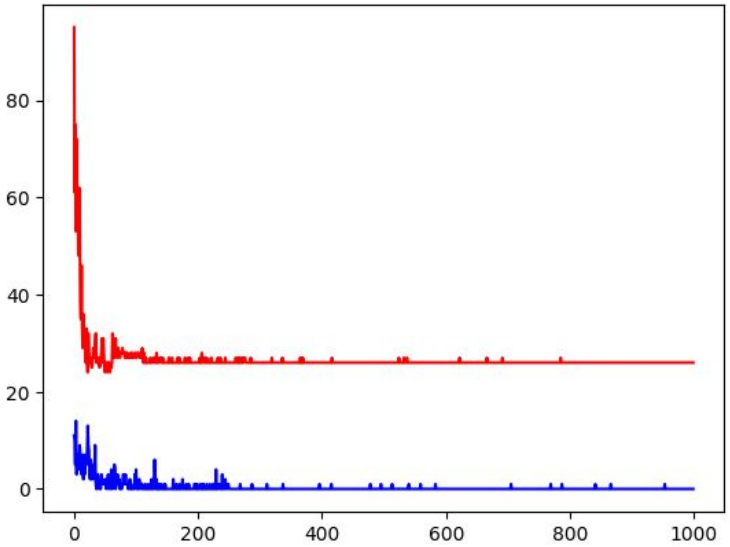
This happens to some of the elements in areas between two tribes that keep fluctuating between the two factions.

In the power law graph instead when an equilibrium is reached no matter how many steps are going to be taken; no nodes will ever change their tribe again.

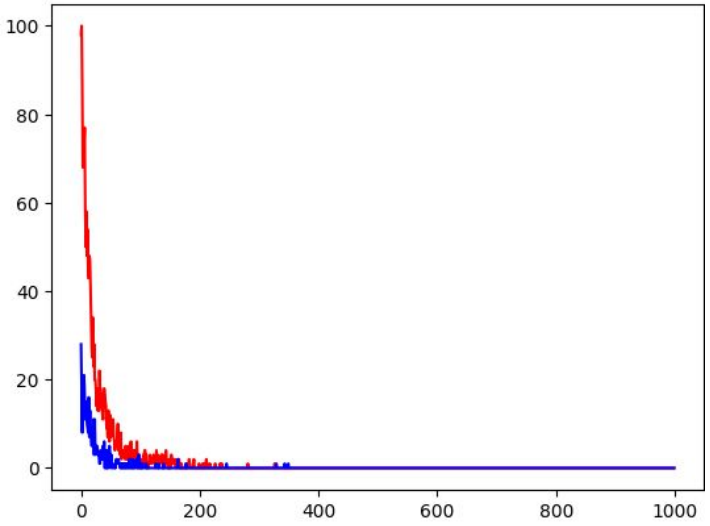
Constant change in Cellular Automata

Number of changes of tribe in both networks

2D Grid Network



Power Law Network



Red line = social sorting not active
Blue line = social sorting active

Conclusions

Two relevant observations can be taken from the experimentation on this model:

1. The shape of the structure of a system can change drastically its behaviours.
2. Social sorting has the power to promote the growth of conviction level on an idea or a topic; accelerating the development of extreme ideologies and preventing nodes to change state.

Source and Insights

- Petter Tornberg - How digital media drive affective polarization through partisan sorting:

  https://www.pnas.org/doi/epdf/10.1073/pnas.2207159119

- Modeling Social Change with Cellular Automata:

  https://link.springer.com/chapter/10.1007/978-94-015-8686-3_14

- Kurzgesag - In a nutshell - “The internet is worse than ever ?” :

  https://www.youtube.com/watch?v=fuFIMtZmvY0&t=476s

Code

Notebooks with the code:

https://github.com/JiacomoPassero/project-social-sorting-on-complex-system