

50-50 Stalemate model with Doubt

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Abstract

The 50-50 Stalemate Model with Doubt State is an extended version of the classic voter model in computational sociology and computer science. This model not only includes binary opinions ("Yes" or "No") but also incorporates a third state of doubt.

1 Introduction

In our life and world our thoughts, at least during opinion formation, are not only between "yes" and "no". Sometimes, an intermediate state of "doubt" is present that can be either permanent or temporal, until the moment of vote. This new state can interact and be influenced by the others so the 50-50 Stalemate model can be improved by adding it. Figure 1 shows a real case which can be modeled by using this "50-50 Stalemate model with doubt" about the results of a repeated poll asking about the Brexit.

2 Model description

The model consist of a 2 dimensional lattice which N agents. Each agent i has an opinion $o_i = -1, 0, 1$, or "yes", "doubt" and "no", respectively. In every time step, each agent (speaker) interacts with one of its random neighbors (listener) and the following cases can apply:

- If the speaker has and "doubt" opinion, nothing changes
- If the speaker has a decided opinion:

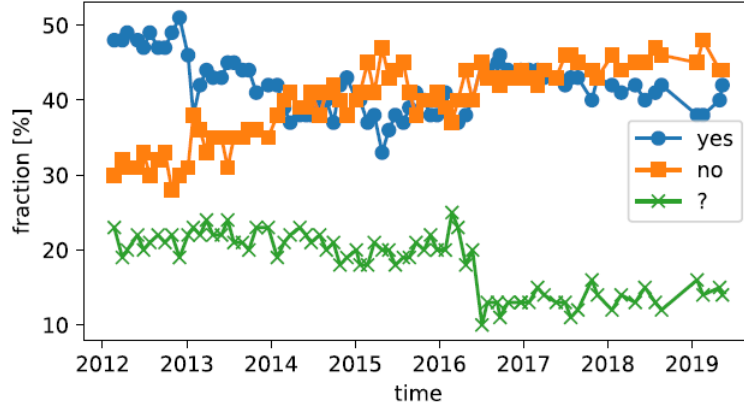


Figure 1: Survey conducted by "You Gov" between 2012 and 2019 regarding how the British people would vote in a referendum to leave the EU.

- if the listener doubts, it is convinced by the speaker with probability p_{conv} or repelled with probability $p_{conv} \cdot q_{repel}$. That means that, with probability $1 - p_{conv} - p_{conv} \cdot q_{repel}$, its opinion does not change.
- if the listener has an opposite decided opinion, it changes to doubt with probability $p_{conv} \cdot q_{doubt}$. With probability $1 - p_{conv} \cdot q_{doubt}$ the opinion does not change.
- if the listener has the same opinion, it can change to doubt with probability $p_{conv} \cdot q_{doubt} \cdot q_{repel}$. With probability $1 - p_{conv} \cdot q_{doubt} \cdot q_{repel}$ the opinion remains the same.

Note that the different probabilities have, on the one hand be greater than 0 and less than 1, and, in the other hand, fulfill the relationships $1 - p_{conv} \cdot q_{doubt} \cdot q_{repel} \geq 0$ and $1 - p_{conv} - p_{conv} \cdot q_{repel} \geq 0$.

3 Complexity explorable

In order to understand the dynamics of the model, it has been programmed as a complexity explorable. There, the parameters of convince, repel and doubt can be modified to observe the model development under different conditions. The default values are $p_{conv} = 0.5$, $q_{repel} = 0.2$ and $q_{doubt} = 0.1$. Also, the initial distribution of agents with decided opinion "yes" and "no" have been set to the 40% , and the "doubt" agents to the 20%.

4 Results

The analysis of the model was done by modifying the probability parameters and observing the dynamics of the different opinions as described in section 2. The most remarkable fact is the phase transition observed at $q_{repel} = \frac{1}{3}$. For $q_{repel} < \frac{1}{3}$, after a long time run, one of the decided opinions dominates, as show in Figures 2 and 3, where the state of "yes" or "no" dominates, respectively.

50-50 Stalemate model -

This explorable illustrates dynamics and spatio-temporal patterns in the formation of two different opinions in controversial debate.

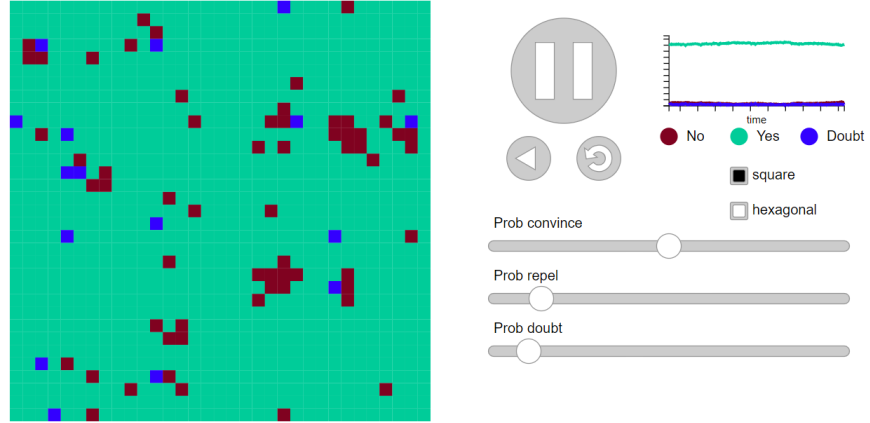


Figure 2: Dynamics of the model with $q_{repel} < \frac{1}{3}$, where the state of "yes" finally dominates

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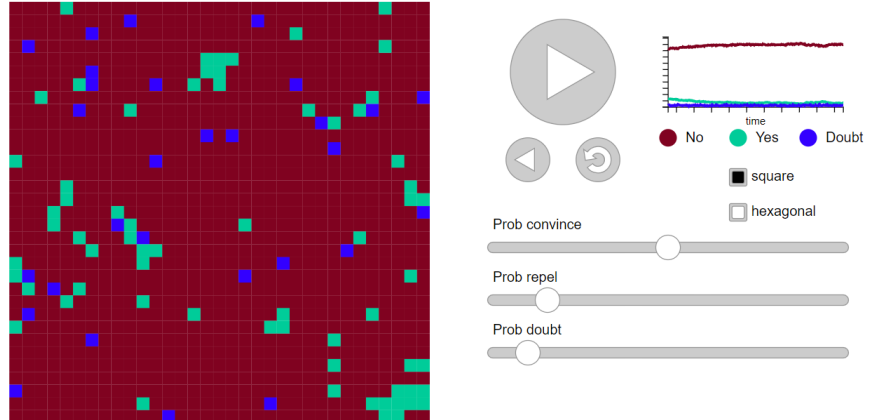


Figure 3: Dynamics of the model with $q_{repel} < \frac{1}{3}$, where the state of "no" finally dominates

On the other hand, for $q_{repel} > \frac{1}{3}$, a stalemate of "yes" and "no" happens and any of them strictly dominates, as show in Figure 4.

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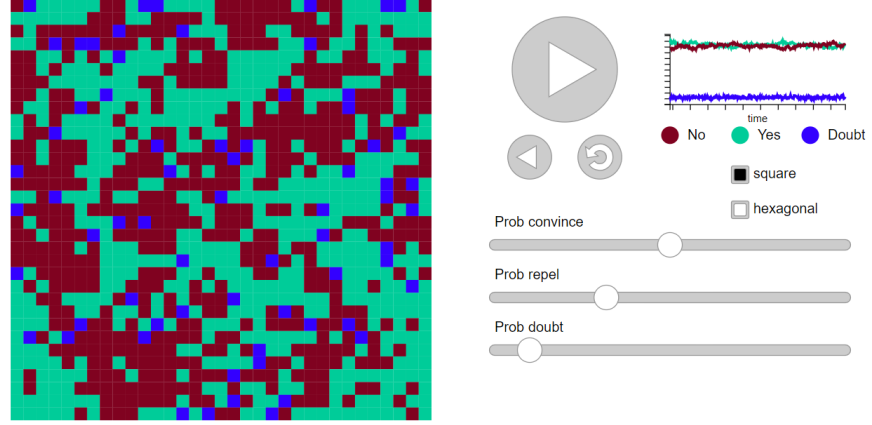


Figure 4: Dynamics of the model with $q_{repel} > \frac{1}{3}$, where the states of "yes" and "no" compete and mutually coexist

The proportion of agents in the state of "doubt" can be of course be controlled by changing q_{doubt} . Increasing the value leads to an increase of the proportion of "doubt" agents, as can be seen in Figure 5.

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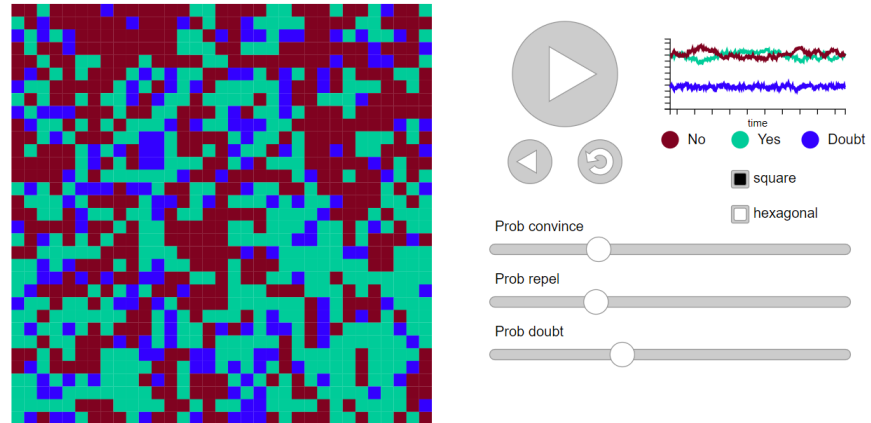


Figure 5: Dynamics of the model increasing q_{doubt} , showing a higher proportion of "doubt" agents

Coming back to the repeated poll asking about the Brexit in Figure 1, it can be reproduced using this model by changing q_{doubt} at certain time, that realistically

corresponds to a referendum held in 2016. This similar representation is shown in Figure 6. Note that the decrease of the proportion of "doubt" agents also leads to a higher competition between the other states.

50-50 Stalemate model -

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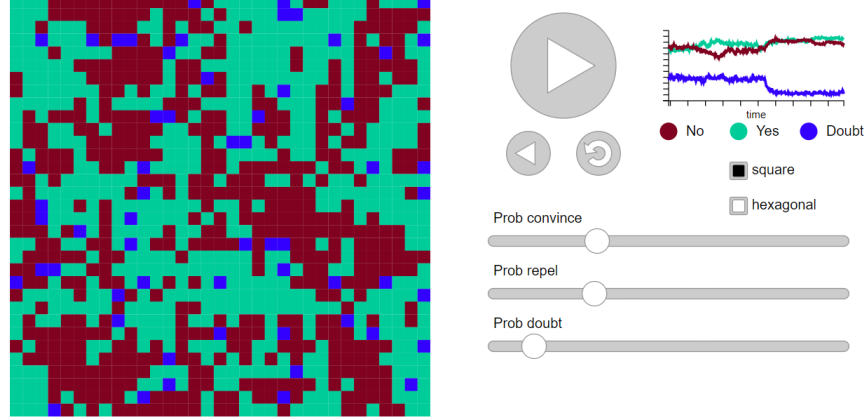


Figure 6: Dynamics of the model decreasing q_{doubt} at certain time in order to reproduce the real case of the survey conducted by "You Gov" between 2012 and 2019 regarding how the British people would vote in a referendum to leave the EU

5 Conclusion

The 50-50 Stalemate Model with Doubt State provides a better representation of opinion formation by introducing a third state of "doubt" alongside the traditional binary choices of "Yes" and "No", showing different states of equilibrium and phase transitions. This extension of the classic model acknowledges the complexity of real-world decision-making processes, where individuals may not always commit to a definitive stance immediately. By incorporating this intermediate state, the model enhances our understanding of how opinions evolve and how uncertainty can influence the outcome of collective decisions.

References

- [1] Krause SM, Weyhausen-Brinkmann F, Bornholdt S. Repulsion in controversial debate drives public opinion into fifty-fifty stalemate. *Phys Rev E*. 2019 Oct;100(4-1):042307. doi: 10.1103/PhysRevE.100.042307. PMID: 31770906.