Politicophysics: A new model of opinion dynamics and its possibility of an application to politics/political science

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Abstract

In the Bounded Confidence Model of opinion dynamics, which assumes the value of opinion as a continuous value, we present an opinion dynamics model named Trust-Distrust Model that takes agreement and repulsion of opinion into account simultaneously. The former derives from trust and the latter from distrust. Trust and distrust are defined as whether a coefficient set for a relationship between people is positive or negative. This opinion dynamics model can be applied to many social science areas, especially political science, because the model can be used to state various aspects of political phenomena. For example, the model can be used to state how political leaders with charismatic popularity gain support from people, how the leaders' actions deepen social division and cause political/social crises.

Introduction

The opinion dynamics model treats an opinion with a continuous value is known as the Bounded Confidence Model. [1,2,3] However, the Bounded Confidence Model implicitly assumes consensus will be built as a result. In this model, a coefficient was treated as a convergence factor. Ishii and Kawahata [4] proposed a new model of opinion dynamics where the coefficient is reinterpreted as the coefficient of trust: when this convergence factor is negative, it is considered a relationship of distrust. This new model has been further improved and developed by Ishii [5]. In this paper, we named this new model as Trust-Distrust Model.

In Trust-Distrust Model (TDM), charismatic people are assumed to be trusted by all society [6]. Conversely, a calculation of a person whom all the people distrust was conducted too [7,8]. How opinions of people change due to media advertising was also modeled and calculated [9,10]. As we introduced distrust among people into the model, the opinion dynamics model [11,12]. Using this opinion dynamics model, phase transition phenomena can be understood as connections between people within societies, where consensus is formed when trusts are 55% or more [13].

This paper summarizes our prior studies' results where number of people in society is 300 and the coefficient of trust is decided by random number. The way of calculation is described in detail in Ref.5 and Ref.12. We shows that Trust-Distrust seems to be valid. We also claim that the model can be reasonably applied to political science.

Trust-Distrust Model

For a fixed agent, say i, where $1 \leq i \leq N$, we denote the agent's opinion at time t by $I_i(t)$. The meaning of the coefficient D_{ij} in the bounded confidence model as the trust coefficient in TDM. $D_{ij} > 0$ if there is a trust relationship between the two persons, and $D_{ij} < 0$ if there is a distrusting relationship between them.

The equation of TDM can be expressed as follows [5]:

$$\Delta I_i(t) = c_i A(t)\Delta t + \sum_{j=1}^{N} D_{ij} f(I_i, I_j)(I_j - I_i)\Delta t$$

where f is the sigmoid type of smooth cut-off function for opinion. D_{ij} and D_{ji} are independent. Usually, D_{ij} is an asymmetric matrix; $D_{ij} \neq D_{ji}$. Moreover, D_{ij} and D_{ji} can have different signs.

Results of Previous works

Charismatic person

Think of a charismatic person who gathers all the trust from an entire society. In other words, the whole society has a high positive value of D_{ij} for the charismatic person. In this case, as we can see in Fig.1, many people's opinions rally around the charismatic person. If there are two charismatic leaders, many people's opinions will gather around those two people. Therefore, we can handle cases such as a US presidential election or a French presidential election using the model with charismatic leaders.
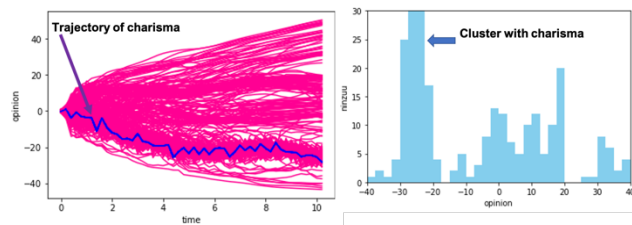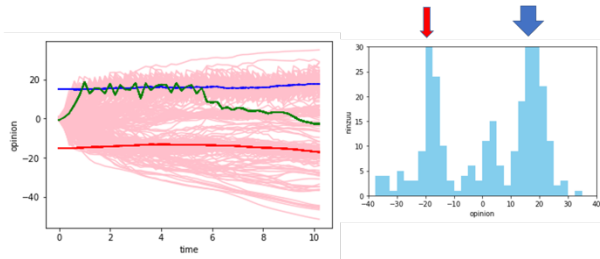

Fig.1. These figures show the opinion trajectory of people in a society and also show opinion distribution when a charismatic person exists. Number of people is 300. D_{ij} is between -1 to 1. The charismatic person gets $D_{ij} = 10$.

What would happen when a charismatic person suddenly disappears due to resignation, retirement, or death? The resignation

of Nixon should be such a case. Such a simulation is also feasible to see what happens to those who are in agreement with the charismatic person.

Conflict of two charismatic persons

Think of a charismatic person who gathers all the trust from an entire society. In other words, the whole society has a high positive value of D_{ij} for the charismatic person. If there are two charismatic leaders, most people's opinions will gather around the two people [8] as shown in Fig.2. Therefore, based upon such a supposition, we can simulate cases such as a U.S. presidential election or a French presidential election.

Fig.2. These figures show opinion trajectory for people in a society and also show opinion distribution when two charismatic persons exist.

Opinion Dynamics under advertisement

Trust-Distrust Model includes the impact of advertising. With this new model, we can calculate the case where all people in society are affected the same by advertising. Also, the case where each person reacts differently to advertising can be calculated [9,10]. Therefore, it is possible to simulate the cases where each supporters' group in a given election is affected differently by the mass media. In Fig.3, we show the dynamics of social opinions by intense advertisement effect.
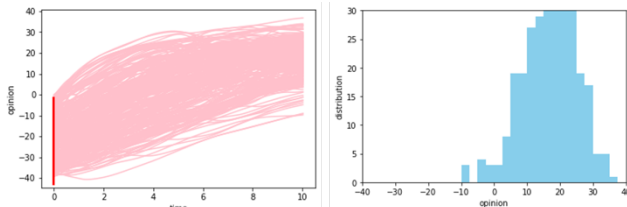
Fig.3. These figures show opinion trajectory for people in a society and also show opinion distribution for a case of immense advertisement by mass media [12].

Social Division

In many cases, societies are divided. A good example is the U.S. society after the 2016 presidential election. We calculated the cases when a society is divided into two groups with different opinions and the groups are distrustful of each other. Additionally, we dealt with the case when the groups have different affinity for other groups [11,12].

Alternatively, if there is a charismatic person who is trusted by both of the two opposing groups, how the presence of the charismatic person affects the conflict is also an interesting question, which can be calculated with Trust-Distrust Model.

Conclusion

As described in this paper, Ishii's opinion dynamics model can handle charismatic leaders who gather most opinions. The model can also handle the effects of how media advertising affects people in various ways. Finally, the model can handle divided societies and complex factional conflicts with distrust among people into account. Therefore, Ishii's opinion dynamics can be applied reasonably to politics and political science. We dare say the application could be denominated as "politicophysics".

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