Transfer in multi-theme opinion dynamics of Deffuant et al

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Abstract: Monte Carlo simulations mix the opinion dynamics of Deffuant et al with the cultural transfer model of Axelrod, using ten discrete possible opinions on ten different themes. As Jacobmeier’s simulations of the pure Deffuant case, people preferably agree on nearly all or nearly no theme.

Keywords: Monte Carlo simulation, Axelrod model, Deffuant model, sociophysics.

Opinion dynamics has been simulated with various models, including the “negotiators” of Deffuant et al [1]. Such opinions can be expressed on a variety of themes, as in the Axelrod model of cultural transfer [2]; see [3] for a review. Deffuant et al let people negotiate with each other repeatedly until they may have reached an agreement. Axelrod lets everyone accept fully the opinion of somebody else on one theme. The set of people with whom we talk is restricted to those who do not differ too much from our own opinion.

The present work combines the negotiation iterations of Deffuant et al with the transfer process of Axelrod, that means at each meeting of two people they follow Axelrod with probability $p$ and Deffuant et al with probability $1 - p$. Since people usually are not located on regular lattices, we let them sit on directed Barabási-Albert networks [4], which may [4] or may not [5] be a good approximation for social networks [6]. Then for Deffuant negotiators, Jacobmeier [7, 8] found for ten themes and ten possible opinions for each theme, that usually two people agree on very few or on nearly all themes, but rarely on half of the themes. We now check how this result for $p = 0$ is affected if we introduce Axelrod transfer, i.e. for $p > 0$.

Initially, the opinions are distributed randomly. Then, at each iterations, each person $i$ selects randomly a partner $j$. If the total differences in the opinions $O$, summed over all ten themes, is not larger than some threshold
Figure 1: Histogram for the overlap in the opinions of all pairs of people; this overlap can vary from zero (agreement on none of the ten themes) to ten (agreement in all themes.) The plus signs correspond to the previous case of $p = 0$ \cite{7, 8}, the other signs to nonzero $p$ (admixture of Axelrod transfer); $\Delta = 30$.

$\Delta$, some interaction takes place. Thus with opinions $O_{ik}$ of person $i$ on theme $k$, people $i$ and $j$ ignore each other if

$$\sum_k |O_{ik} - O_{jk}| > \Delta .$$

An interaction means that one of the ten themes is selected randomly; if both agree on this theme, nothing happens. Otherwise, with probability $p$ person $i$ takes over the opinion of person $j$ (Axelrod case), while with probability $1 - p$ they follow the Deffuant opinion dynamics: $O_{ik}$ shifts towards $O_{jk}$ and $O_{jk}$ shifts towards $O_{ik}$ by a (rounded) amount $\sqrt{0.1|O_{jk} - O_{ik}|}$. (If the two opinions differ by only one unit, one of the two people takes over the opinion of the other one.)

As in \cite{8} we summed over 5000 samples, each of which consisting of 1000
Figure 2: Variation of overlap with $\Delta$; 1000+3 sites.

agents surrounding a fully connected core of three people. Each agent added to the Barabási-Albert network selects three people to whom the new agent will seek contact later, and the selection probability for each of the three is proportional to the number of previous agents who had selected these people as future contacts. The simulations were stopped when nobody changed opinion, but at the latest after one million iterations.

Our Fig.1 shows that the previous results are not changed much if a small probability $p$ to disobey Deffuant et al and to obey Axelrod is introduced: Again most of the pairs of people either agree in the majority of the themes or in none or one of them; seldomly there is agreement in three of the ten themes. Also the variation with $\Delta$ at $p = 0.2$ in Fig.2 is about the same as at $p = 0$. [8], and this is true also for 5000+3 sites at $p = 0.1, \Delta = 30$.

In all these cases the simulations stopped before the maximum limit of $10^6$ updates per site for the observation time were reached. (For $p = 0.4$ and 0.9 this time was reached sometimes or always, respectively.) For opinion dynamics, $10^6$ discussions for each person may be unrealistically many; Fig.3
Figure 3: Variation of overlap with observation time growing from 1 to $10^6$ in powers of ten; 5000 samples for 1000+3 sites, $\Delta = 30$, $p = 0.2$ and 0.0.

shows that for shorter times instead of a minimum we find a maximum at intermediate overlaps. Again the results for $p = 0$ and 0.2 are nearly the same.

All the above results sum over 1000 or 5000 samples; if only one sample is followed one may see as in Fig.4 a Gaussian distribution shifting with increasing time from agreement in very few to agreement in many themes.

In summary, the addition of a little bit Axelrod transfer to Defuant opinion dynamics changed the results not much in these simulations.

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Figure 4: Variation of overlap with observation time 1, 10, ..., 10 million; 1000+3 sites, $\Delta = 30$, $p = 0.5$.

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