Modelling support for political agendas among altruistic, cooperative and individualistically-oriented agents: do negotiation styles matter?

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Introduction

Societal challenge

Illustrated vividly by the case of Cambridge Analytica [1], micro-targeting of voters powered by psychological profiling and large-scale data collection can lead to catastrophic consequences for the integrity of democratic elections, aggravating social polarisation and atomisation [2], as well as gravely violating citizens' autonomy [3]. In light of this, the power of modelling political processes accurately and comprehensively can hardly be overstated. Whereas voter profiling is riddled with legal-ethical dilemmas as a practice, statistical modelling of anonymised voter movement avoids endangering both institutional integrity and the autonomy and privacy of the individual voter. One of the approaches to modelling voter movement are deterministic epidemiological models [4], [5]. Such models are built on the assumption of a population of a constant size divided into a number of parties and a voting class, with the parties exerting unilateral influence over the voters. Both Misra [4] and Bañuelos et al.[5] account for the cases of party members changing their affiliation. The core question of party membership dynamics and voter-party interactions is then subject to differential analysis of the recruitment rates. Misra models the influence of two political parties on a voter class and each other through nonlinear ecological-type equations; Bañuelos et al. adopts the same approach, extending the model to 3 parties. A slightly different perspective is offered by Balatif et al. [6] who accounts for 6 distinct classes and analyses voter movement through the lens of optimal control. At the time of this paper, the epidemiological model in the context of voting behaviour has not been previously implemented in the NetLogo environment, nor elaborated in the context of negotiation theory.

Research questionsand corresponding hypotheses

Assuming a three-party model with mutual influenceability and agents belonging to one of three negotiator types, this paper aims to examine the following research question: '*Is there a relationship between the party that surpasses the voter threshold first and the negotiator proportions of its demographics?'* The primary hypothesis for the experiment is that there is a significant correlation between the negotiator proportions and the winning party. For instance, considering that the conditionality of altruist support is less strict, it is fair to assume that this group may be the main driver behind political projects.

Model description and choices

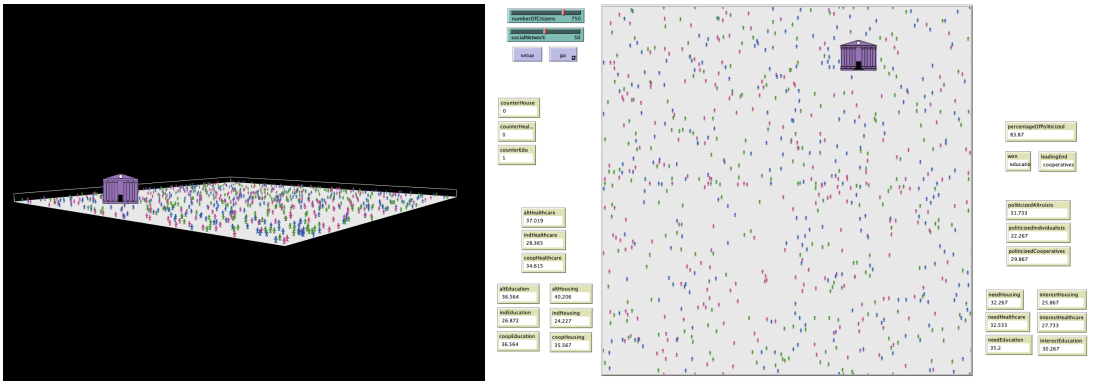

Figure 1. 3D view of the NetLogo model and the model's interface.

Conceptualisation

The model setup contains a number of structural differences compared to the models by Bañuelos et al., Balatif et al. and Misra, since the rules for agent behaviour per negotiator type are elaborated to be dependent on personal interest, political affiliation and social network membership. The three parties assume titles reflecting arbitrarily chosen political interests: education, housing and healthcare. Party membership is defined intrinsically through the political interest of the individual. Additionally, each individual possesses a personal interest corresponding to a broader political goal. These interests are formalised as follows: "apply to uni", "find housing", "see a doctor". The cognitive aspect of agent behaviour is constituted by the division of agents between negotiator types. As discussed by Alfredson and Cungu [7], behavioural approach to negotiation claims the existence of four different negotiator classes, based on the actor's investment in interpersonal relations (altruistic and individualistic types) and outcomes (cooperative and competitive types). With the primary motivation guiding agent behaviour in the current model being their ability to persuade or be persuaded in the context of adopting political views, the competitive negotiator type is considered irrelevant to the environment due to its adversarial attitude to other agents. The rest of the negotiator types are conceptualised as discrete properties indicating the probability of convincing an agent, on a decreasing scale from altruistic to cooperative to individualistic. Lastly, altruists and individualists have the capacity to grow a social network of a limited size, which is discussed further in the section about agent rules. In choosing the value range for the social network size, one could argue for the appropriateness of Dunbar's number, which is often used to refer to the maximum size of a social network; however, Lindenfors et al. [8] emphasises that confidence intervals differ dramatically among the studies aimed at validating it. Consequently, the model is set to accommodate user input for the social network size, with its value ranging between 1 and 100% of the population.

Model assumptions and randomness

The model operates under two assumptions, namely, the initial degree of politicised agents and the voter threshold both being set to 30% of the population. The initial degree of politicised agents reflects the number of agents with a political interest; at the start of each run, such agents are randomly selected and randomly assigned a political affiliation. This leads to a small variability in the percentages of party members per each run, with the initial membership values averaging at 10% per party after a large number of repetitions, according to the Law of Large Numbers. The primary reason for injecting a degree of randomness into the system is to reduce the gap between real-life processes and their abstraction in NetLogo. The voter threshold limits the duration of voter movement and is instrumental for measuring and comparing parameter influence. Once it is reached, a building representing the win of the corresponding party is placed on the map, and the model stops running. Choosing a different threshold may yield vastly different results and provide more extensive insight into the trends behind voter movement. The scope of measurements in this experiment, however, remains limited to the time needed for one party to grow its membership from 10% to 30%. Agent interactions are enabled through turtle movement across the field, with the modelling approach to movement taken from Assignment 2. Last but not least, the opportunity for agent interaction is limited to the area of one patch. As such, a politicised agent may attempt to exert influence over somebody else only when they are on the same patch; likewise, an agent only becomes a member of another's social network if they share a patch at the same moment in time.

Agent behaviour

While it could be presumed that altruistic agents are susceptible to any kind of influence, and individually-oriented ones are immune to it, to avoid having unrealistic behaviour, all agents were set to operate within arbitrary social bounds. Altruistically-oriented agents can be influenced by anyone, as long as it is an agent they already know. Cooperative agents agree with anyone whose proposal matches their personal interest, and individualistically-oriented agents can be convinced to adopt a political affiliation if the agent proposing it is known to them and the political interest itself matches with their personal one.

Experiment

The experiment shall be run on nine permutations of parameter values, with the general population assuming the size of 250, 500 and 750 agents and social network sizes constituting 25%, 50% and 75% of each population size respectively. The research question shall be answered through collecting data on negotiator proportions within the parties and their results (win/lost) per run, applying a linear probability model to each party to examine whether there is a linear relation between the outcome and the negotiator composition. The experimental setup contains 14 main and 10 secondary reporter functions placed to the left and right of the interface respectively; all data necessary for the analysis are gathered using

the main reporter functions. The dependent variable is taken to be whether a party has won or not and formalised as a counter assuming 1 or 0; the 3 independent variables are numeric and represented by the percentages of each negotiator type comprising the party at the end of the experiment run. The experiment is repeated 100 times per each value permutation via BehaviorSpace in NetLogo 6.3.0. Considering that there is a small degree of randomness present, for reproducibility purposes the random seed has been added to BehaviorSpace setup to repeat every 9 permutations.

Results

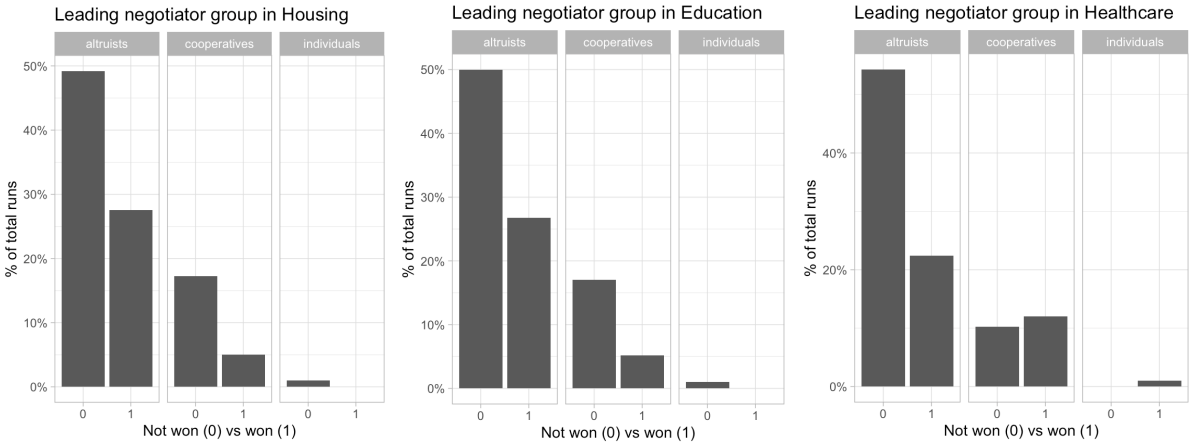

Figure 1. Leading negotiator groups (by the end of the simulation) per political party.

Based on the experiment, altruists constitute the majority of supporter demographics among all parties irrespective of their win status (Fig. 1). The proportional breakdown is almost identical for Education and Housing; however, there are a few notable differences when it comes to Healthcare. Firstly, this is the only group that has a case of win with individuals being the leading group. Secondly, there are more cases of cooperatives being the majority supporter group when the party won rather than lost; the opposite was true for Education and Housing. In light of similar indifinitive results among the parties, it appears that the negotiator proportions of the party's supporters do not have an influence on the speed with which it reaches the voter threshold. Notably, none of the political parties dominated the landscape, with only negligible differences in win percentages.

Discussion

When running a linear probability model, an error signifying perfect multicollinearity between two of the predictor values arose; upon investigating correlation between all possible pairs of values, the root of the error was not found. Hence, the analysis took form of 9 linear probability models run on each pair of independent variables for each political party. Based on comparison of p-values in R, the pair of variables that were statistically significant for the outcome for each of the tree parties were the percentages of individuals

and cooperatives, resulting in three final models. The model equations and the corresponding statistics are represented in Figure 2 and Figure 3 respectively.

Healthcare: $counterHealth = 1.375 - 0.011 * indHealthcare(\%) - 0.02 * coopHealthcare\ (\%)$

Housing: $counterHouse = 1.578 - 0.022 * indHousing\ (\%) - 0.019 * coopHousing\ (\%)$

Education: $counterEdu = 2.556 - 0.034 * indEducation(\%) - 0.037 * coopHousing\ (\%)$

Figure 2. Linear equations for party results based on the percentages of individualists and cooperatives.

Party	Multiple R-squared	P-value
Healthcare	0.03067	8.567e-07
Housing	0.04797	2.665e-10
Education	0.1014	< 2.2e-16

Figure 3. Main statistics for the linear model of each party.

Despite extremely small p-values that fall under the significance threshold of $\alpha = 0.05$, the values of multiple R-squared for all models lie extremely low compared to even a medium standard of 0.5. Ideally, if the negotiator percentages were good predictors, the value should have reached about 0.8 - 0.9. The results observed here indicate that the hypothesis stating there is a significant relationship between the negotiator proportions and the party's win is false.

Limitations

It is possible that rule for agent movement has had an effect on the speed of interactions, and hence, the speed of agent politicisation in general. The probability of encountering another agent was assumed to be the same for all turtles, whereas it might not have been in practice. Seeing as the model described here includes two parameters capable of affecting party membership dynamics, namely, the population size and the size of the agent's social network, the questions of their influence may also be relevant to this analysis. The social network size, in particular, may have a considerable effect on this relationship, considering that it is a factor for both altruistic and individualistic behaviour.

Conclusion

Research question revisited

According to the results of the experiment, there is no significant correlation between the party that surpassed the voter threshold first and the negotiator proportions of its demographics. The negotiator percentages are poor predictors of the outcome for all parties when using a linear probability model. The fact that win percentages between the parties are

similar (Fig. 1) may also indicate that the equal-ratio division of negotiator types between parties has rendered the effects of negotiator types irrelevant to the inter-party competition.

Future work

The model is simplified in one essential aspect, compared to other deterministic epidemiological models. It does not account for agents dynamically joining and leaving the system and, hence, assumes that all agents are eligible to participate in the process. Incorporating entry and exit rates would significantly boost the model's practical applicability. Another prospective development would be to analyse the model differentially on a more complex framework of electoral behaviour, as examined by Balatif et al., and model it as a problem of optimal control. It might be also useful to investigate the effect of different voter thresholds and the initial degree of politicised agents on the model.

Self-reflection

1. I have learned to conceptualise, model and analyse social processes on a small scale through Netlogo and to conduct statistical tests on the hypotheses I formulate using R.
2. I anticipated for the course to bridge the gap between the theory of multi-agent interaction and its practical applications. Admittedly, I did not expect the first two weeks of assignments to be as challenging as they were; however, they have laid the foundation necessary for me to confidently utilise Netlogo for my project. Throughout the course I developed both technical and academic skills, as well as freely explored and modelled a socially important topic of my own choice, which is something I did not imagine happening but am really grateful for.
3. I would like to spend some free time to eliminate some of my model's limitations, like implementing random agent movement, and to pose and study different research questions. Moreover, once I finish my Calculus, Linear Algebra and Discrete Mathematics courses, I would like to reproduce the work by Bañuelos et al. in Netlogo, with a full understanding of the mathematics behind party membership dynamics.
4. I have studied Netlogo extensively and implemented procedures outside of what has been discussed in assignments and lectures. I have also attempted to use more complex statistical techniques like multiple logistic regression before deciding in favour of a linear probability model. I believe I have also familiarised myself with how to perform a proper research cycle.
5. I would have devoted more time to studying the methods of statistical analysis depending on the type of information being analysed; as well as the ways to analyse the effect of randomness in models. It would have also been great if I inspected other Netlogo models before embarking on creating my own, since it could have provided me with a different perspective on modelling and better coding practices.

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