The strategic advantages of micro-targeted campaigning: A proof of principle Bayesian Agent-Based Model

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Abstract

Predicting the effect of persuasion campaigns is difficult, as belief changes may cascade through a network. In recent years, political campaigns have adopted micro-targeting strategies that segment voters into fine-grained clusters for more specific targetting. At present, there is little evidence that explores the efficiency of this method. Through an Agent-Based Model, the current paper provides a novel method for exploring predicted effects of strategic persuasion campaigns.

The voters in the model are rational and revise their beliefs in the propositions expounded by the politicians in accordance with Bayesian belief updating through a source credibility model.

The model provides a proof of concept and shows strategic advantages of micro-targeted campaigning. Despite having only little voter data allowing crude segmentation, the micro-targeted campaign consistently beat stochastic campaigns with the same reach. However, given substantially greater reach, a positively perceived stochastic candidate can nullify or beat a strategic persuasion campaigns.

Keywords: Agent-Based Model; Persuasion; Strategic campaigns; Politics; Voting simulation

Introduction

Persuasion is paramount in political campaigns, and source credibility is a key component of a successful campaign. It influences a range of human cognitive phenomena related to reasoning, argumentation, and judgement and decision-making. It influences the reception of persuasive messages (Petty & Cacioppo, 1984; Chaiken & Maheswaran, 1994), plays a vital part in the development of children's perception of the world (Harris & Corriveau, 2011), impacts juror decision making (Lagnado et al., 2012), increases adherence with persuasion strategies (Cialdini, 2007), and influences how people are seen in social situations (Fiske et al., 2007; Cuddy et al., 2011). The specific normative function of source credibility in argumentation, however, is still debated. For example, the dual-process-based Elaboration-Likelihood Model (Petty, 1981) assigns message source to heuristic rather than analytic cues (Briñol & Petty, 2009) whilst recent Bayesian models integrate credibility in revising beliefs when given evidence from a source (Bovens & Hartmann, 2003; Hahn et al., 2012; Harris et al., 2015).

Trustworthiness is an important factor in politics. It increases public policy compliance (Ayres & Braithwaite, 1992), influences candidate choice (Citirin & Muste, 1999), increases *intention* of voting (Householder & LaMarre, 2014, though not necessarily actual voting, see Dermody et al., 2010), increases societal cooperation (Fukuyama, 1995), and lack of trust may instigate civic participation (see Levi & Stoker, 2000 for a discussion of this). The current paper expands upon these findings by showing how source credibility influences the convincingness of an argument for a proposed candidate.

In political literature, credibility factors include integrity, competence, fairness, flip-flopping, honest, equitable, and being responsiveness to public needs (Citrin & Muste, 1999; Levi & Stoker, 2000). Collating these, Mayer and colleagues identify credibility as ability, benevolence, and integrity (Mayer et al., 1995; Mayer & Davis, 1999). Empirical exploration of management corroborates such a definition (Colquitt et al., 2011 for a review) while social psychology partitions reliability in two main spheres: warmth and competence (Fiske et al., 2006; 2007; Cuddy et al., 2011). Further studies in management literature differ in whether they identify two (Jarvenpaa et al., 1998) or three credibility traits (Mayer et al., 1995).

The model employed in the paper is in line with the factors identified in the above studies. Specifically, we divide credibility into two factors: expertise (the capability to provide accurate information) and trustworthiness (the willingness to provide accurate information).

Micro-targeted campaigns

Political campaigns attempt to persuade voters that they should support and vote for a particular candidate or political position. Unsurprisingly, the competitive nature of electoral campaigns has led to the development of strategies regarding belief updating and behaviour changes, in particular through the use of data and voter segmentation (O'Neil, 2016). Typically, an election campaign is divided into two phases: a persuasion phase that focuses on changing the minds of the voters and a "get-out-the-vote" phase that focuses on making sure the voters do indeed turn out for the election. While the former phase typically lasts for the duration of the entire campaign, the latter is typically implemented in the final 3-4 days (see Green & Gerber, 2008). In the current paper, we focus on the element of political campaigns concerned with changing the minds of the voters (i.e. the persuasion phase). Specifically, we explore the potential strategy advantages of knowing the voters' attitudes towards the persuader (the politician).

Companies increasingly accrue data on their customers. Given potential access to and purchase of large-scale data sets about voters, recent years have seen the development of specifically targeted political campaigns, known as micro-targeted campaigns (MTCs, see Issenberg, 2012). While traditional campaigns use rough voter segmentation such as by gender, income, or place of habitation, individual voter models allow for fine-grained segmentation (e.g., upper-middle class, Caucasian, suburban, father, Prius-owner, Seattleite; as well as top-five travel destinations, frequented news sites, etc.). Such data allows for highly specified models of the individual voter concerning political leaning, policy priorities, and voting likelihood. The models allow for targeted political adverts that address specific political issues in a way that is tailored to the individual in question.

There is currently little academic research conducted on the effect and strategic administration of micro-targeted campaigns in elections. First, micro-targeted models are a recent element in election campaigns (Issenberg, 2008). As such, most models actually used in campaigns are subject to non-disclosure agreements and are kept by the responsible companies. Second, it is difficult to assess the quality of campaigns; partly due to the aforementioned secrecy regarding the exact models, and partly due to the complexity of campaigns, given the number of free parameters and the uniqueness of each campaign.

The current paper focuses on changes of electorate beliefs and not on the likelihood of voting (at the end of the simulation (i.e. campaign period), all voters vote with a probability of 1). Election campaigns unfold over time, where campaigns can contact voters and attempt to persuade them. As such, the persuasion attempt of the politician is a successive campaign designed to convince the electorate that the voters should support the persuader in question.

While we do not test specific campaign models, the paper provides a proof concerning the potential effect of micro-targeted campaign strategies through Agent-Based Model simulation of interactions between politicians and voters. We stress the exploratory nature of the study, as the model is necessarily simplified. Rather than testing the predictive power of a specific voter model, we explore the strategic potential of MTCs through a Bayesian source credibility model, which has been developed and tested in previous studies. In the following, we present Agent-Based Models as a technique for exploring the development of aggregate patterns (such as changes in beliefs in a population) across time. Aside from testing the potential effectiveness of MTCs, the paper presents Agent-Based Models (ABMs) as a novel method for simulating the predicted effect of persuasion campaigns.

A Bayesian source credibility model

Bayesian approaches to reasoning and belief revision take point of departure in subjective, probabilistic degrees of beliefs in propositions where Bayes' theorem captures the posterior degree of belief given a prior belief in the hypothesis and some new evidence (Oaksford & Chater, 2007). The approach has been applied to argumentation theory (Hahn & Oaksford, 2006; 2007) where findings suggest that Bayesian reasoning may account for crucial elements of human information integration in practical reasoning. Most relevant to the current model, researchers have used Bayesian approaches to describe how humans integrate uncertain information from more or less reliable sources (Bovens & Hartmann, 2003). The model has been tested empirically (Harris et al., 2015; Madsen, 2016) and enjoys a good fit with observed responses.

Taking point of departure from the Bayesian source credibility model, credibility is defined as a combination of trustworthiness and expertise (Hahn et al., 2009; Harris et al., 2015; see Fig. 1). In order to implement this model and to facilitate communication between persuaders (politicians) and persuadees (voters) and to capture the desired belief updating process, the members of the electorate have subjectively estimated beliefs about the credibility of each persuader.

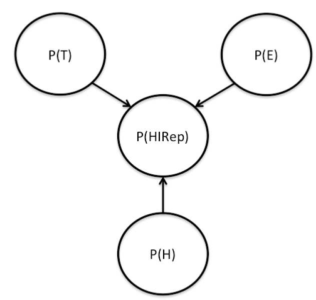

Fig. 1: A Bayesian source credibility model[1]

Expertise refers to whether or not the persuader is **capable** of providing accurate and relevant information. For example, a politician may know the legislative framework connected with a policy proposal (thus increasing the chances of providing legislation that is legal and within constitutional law), a doctor may be more qualified to diagnose an illness compared with a layperson and so forth. Conversely, *trustworthiness* refers to the **intention** of providing accurate information. Regardless of the expertise of the source, the speaker might wish to misinform, lie, or otherwise deceive the listener. Expertise and trustworthiness are orthogonal and independent in the model (see Fig. 1) such that a person can be inexpert and yet intend to represent her available information as accurately as possible or a person can be highly expert within a field, but wish to misinform the listener. The source credibility model used in the current paper has previously been tested on appeals to political authority, which suggests that the model captures

[1] P(E) = perceived expertise (0-1); P(T) = perceived trust (0-1); Rep is the represented statement (e.g., Hypothesis = 1)

part of how voters update their beliefs when politicians publically endorse or critique a policy (Madsen, 2016).

As explained later, the persuaders in the model contact the voters and provide either a positive or a negative statement concerning a hypothesis. To calculate the expected posterior belief in the likelihood of the hypothesis (e.g. the goodness of the candidate), we apply the source credibility model. The equation used to calculate the posterior is an expanded version of Bayes' theorem that incorporates trustworthiness and expertise within the theorem. It is taken from Harris et al. (2015) and relies on advances made in Bovens and Hartmann (2003) and Hahn et al. (2009) on the concept of source reliability (Hahn et al., 2012).

$$P(H \mid e) = \frac{P(H)P(e \mid H)}{P(H)P(e \mid H) + P(\neg H)P(e \mid \neg H)}$$

where p(h|rep) represents the probability that the hypothesis is true (h) given a confirming statement (rep). P(h) represents the prior belief in the hypothesis, and p(rep|h) and p(rep|¬h) represent the conditional probability that the source would provide a positive statement if indeed the hypothesis was true or false. Trustworthiness and expertise are integrated within p(rep|h) and p(rep|¬h) through the combination of these conditionals[2].

To parameterise the model, p(exp) and p(trust) represent prior beliefs in expertise and trustworthiness. Conditional probabilities (see footnote 1) represent the epistemic relationship between model parameters and the likelihood of providing true or good advice. For example, p(rep|h, exp, trust) refers to the likelihood that a speaker declares a hypothesis to be true when the speaker has complete and perfect knowledge of the topic and is unequivocally trustworthy in a world where the hypothesis happens to be true regardless of the statement of the speaker.

The model allows for parameter-free belief revision such that the agent makes use of its estimation of the persuader's source credibility to update its belief when the persuader contacts the voter with a persuasive statement.

Agent-Based Modelling

Traditional equation-based models typically take point of departure in cognitive functionality in isolation (e.g. belief revision given new information) or in dyads (e.g. prisoners' dilemma). However, when agents can interact and influence each other through time, across space and between multiple agents, behaviour may become dynamic and adaptive. If this happens, patterns may become computationally intractable, making predictions difficult or impossible with isolated or dyadic models, as the system becomes complex (see Parunak et al., 1998). ABMs allow for simulations of interactions between agents and their environment and between multiple agents (Epstein & Axtell, 1996). In the paper, we use this method to simulate a campaign with interactions between politicians and voters. Each round in an ABM is called a tick. Here, each tick represents a campaign day. For the current model, the ABM requires agents and links between agents.

Agents

Agents are the actors in the simulated model world. The cognitive make-up of each agent may consist of any rules constrain or enable relevant behaviours within the simulated world. By applying the relevant cognitive rules, agents can revise their beliefs about the model world by interacting with the environment. Further, agents can have physical rules such as metabolism, energy consumption, and age. This allows for simulated life-spans in which agents can live, learn, generate progeny, and die. The physical and cognitive rules allow for heterogeneity, as agents may differ in essential characteristics. This allows for dynamic models of heterogeneous populations.

In the ABM presented in this paper, there are three types of agents: voters, strategic persuaders and stochastic persuaders. The persuaders' aim to convince the voters to support them in an election. Politicians engage with voters by providing a statement, supporting one candidate or the other (H = 0 or 1). Voters update their belief in the goodness of each candidate on the basis of the prior beliefs (p(h)) and their perception of the candidate (using the above Bayesian source credibility model).

Links

While agents have cognitive rules that apply to agents in isolation, ABMs allow for interactivity. Links represent connections between agents that may be encoded with functional capacities. These can be any and all social links that inform and influence behaviour. Links can be direct (e.g., providing information to another agent, fighting with another agent) or indirect (e.g., some agents might prefer to be in the vicinity of other types of agents). In the current model, only direct links are employed, as the persuaders contact voters directly.

In the current model, politicians establish links by seeking out voters. Stochastic candidates engage randomly with voters while MTC candidates only engage with voter that has a positive attitude towards the candidate (using the 'signal factor' described in the following section). There are no links between voters in the current model. Introducing social structure will be a natural development in future work. Indeed, we strongly suspect that MTC candidates would be more efficient in social structures, as they can target 'community leaders' and important social nodes.

Simulating Micro-targeted campaign strategies

In order to tentatively explore the effect of MTCs, we simulate the span of an election campaign through an ABM in which the politicians (the persuaders) can interact with the voters (the persuadees). Though exploratory in nature, the model has two aims. First, to our knowledge, although

[2] p(rep|h) = p(rep|h, exp, trust) * p(exp) * p(trust) + p(rep|h, ¬exp, trust) * p(¬exp) * p(trust) + p(rep|h, ¬exp, ¬trust) * p(¬exp) * p(¬trust) + p(rep|h, exp, ¬trust) * p(exp) * p(¬trust), mutatis mutandis for p(rep|¬h)

some models have explored opinion chance in politics (e.g. Duggins, 2016), ABMs have not been used to directly explore campaign strategies. The paper consequently provides a new method for exploring the efficiency of persuasion campaign strategies. Second, by implementing a simplified voter and strategy model, the efficiency of minimal voter knowledge is explored. As the strategic potential of MTCs increases given higher voter complexity (e.g. if voters have prioritised political beliefs), the simplified model explores the efficiency of MTCs in situations where they are expected to be least effective. As such, the model explores a conservative modelling scenario. In the following, we present the Agent-Based Model.

Agents The model consists of three types of agents: Voters, Micro-target persuader (MTC), and stochastic persuader (non-MTC). The physical space plays no role in the current model (as the interactions between the persuader and the persuadee may be likened to sending out pamphlets or generating cold-calls). Consequently, voters are randomly distributed across simulation space. All voters were outfitted with the Bayesian source credibility model to inform their belief revision process. To operationalise the model, each voter generates an expertise and trustworthy score for each candidate from a normal distribution (as described later, we manipulate the means in the two simulations, such that mean = 0.5 or = 0.6, *SD* = 0.25). To fully parameterize the model, agents are given conditional probabilities:

H	H	H	H	¬H	¬H	¬H	¬H
T, E	T, ¬E	¬T, E	¬T, ¬E	T, E	T, ¬E	¬T, E	¬T, ¬E
80.38	58.21	34.63	18.04	22.59	42.3	59.90	71.26

Table 1: Conditional probability table

These are taken from Madsen (2016), as this study applies the model to political belief revision. This allows for belief revision given persuader statements (with no free parameters) and further allows for agent heterogeneity, as some agents will rate one candidate highly while another will rate the same candidate poorly.

To provide a 'signaling' factor for the MTC candidate, voters average trustworthiness and expertise scores to generate a 'credibility score'. Each voter generates a prior belief from a normal distribution (mean = 0.5, *SD* = 0.25, bounded between 0.01 and 1), representing a voter's initial (prior) likelihood of voting for either candidate. This introduces the eventual decision (voting) rule: If a voter has p(candidate) < 0.5, it favours the non-MTC candidate; if p(candidate) > 0.5, it favours the MTC candidate. The campaign runs for 50 days (50 ticks). At the end of the simulation, voters vote for their favoured candidate. There are 10,000 voters in the simulation.

Both persuaders' aim to persuade voters to shift their p(candidate) towards their own position. In order to do so, they establish connection with voters and make opposite claims. In accordance with the source credibility model, the non-MTC candidate represents p(candidate) = 1 while the MTC candidate represents p(candidate) = 0. This gives full implementation of the Bayesian source credibility model where the voter updates the prior belief given representation by a (more or less) credible source. After each connection, the contacted voter takes P(candidate|rep) - i.e. the posterior - as their new value for p(candidate)[3].

For each tick, the candidate can establish contact with X voters, defined as 'candidate reach'. In the simulations, the MTC candidate has a reach of 20 while we manipulate the reach of the non-MTC candidate to test the efficiency of the MTC strategy. In Fig. 2 below, the reach ratio is the reach of the non-MTC divided by the reach of the MTC.

Central to the model, the MTC and non-MTC campaigns differ in their contact selectivity. The non-MTC is fully stochastic and thereby corresponds to a blind campaign that distributes leaflets or conducts cold-calls with no knowledge of the electorate. The MTC segments voters and will only contact voters with a favourable impression of the credibility of the candidate (voters with a signaling factor > 0.5). This selection process does not take into account the voter's prior belief in the candidate. As such, the underlying source credibility factors determine whether the voter is "open" to the candidate's message (i.e. will update in the desired manner). Of the sub-group of (desirable) voters who fit this criterion, a random selection (the amount based on "reach") are selected for contacting. Both campaigns may contact the same voter multiple times during the simulation, but not more than once on a single "day".

In sum, voters entertain prior beliefs about each candidate, rate each candidate for trustworthiness and expertise, and have a signaling factor. When a candidate contacts the voter, the voter updates the belief in p(candidate) in accordance with the Bayesian source credibility model. Candidates are either stochastic (non-MTC) or use the signaling factor to identify favourably disposed voters. Each candidate can reach a fixed number of voters each click. There are 10.000 voters and 2 candidates, and the campaign lasts for 50 days (ticks). At the end of each simulation, voters cast their vote for the candidate they find most favourable.

Main findings

We conduct two main manipulations. First, we manipulate the mean credibility rating of each candidate by altering voter perception of candidate trust and expertise (mean = .5 or mean = .6, *SD* = .25), providing a 2x2 simulation. Second, for each of the credibility combinations, the reach ratio of the non-MTC is between 1-10 (1 represents simulations where the non-MTC and MTC have identical reach; 10 represents simulations where the non-MTC can reach 10 times as many voters per tick). The reach of the MTC candidate is always 20. Fig. 2 illustrates the percentage of voters who supported the non-MTC on the y-axis and the reach ratio of the non-MTC on the x-axis.

[3] While it is not possible in the current model, this enables negative campaigning, as candidates could provide a negative representation (e.g., p(candidate|¬rep)) and attacks designed to undermine the trustworthiness or expertise of the opposing candidate. Intentionally, the model is built compartmentally to allow for increasingly complex persuasion campaigns.

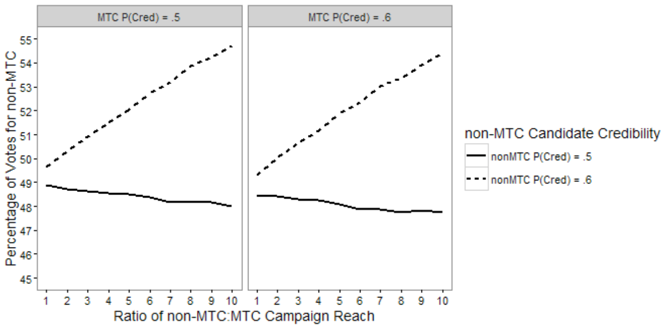

Fig. 2: Election outcome (p(cred) = .5; p(cred) = .6)

The simulations point to two main conclusions. First, a non-MTC with mean credibility rating of .5 is inefficient when run stochastically. As opinions about the candidate are equally divided, a stochastic strategy will necessarily engage with an equal number of supporters and adversaries. As such, blind strategies only work in when the campaign expect general voter estimation of the candidate to be > .5. If the candidate is seen as distrustful, a blind campaign will be ineffective or detrimental and will be beaten by campaigns with simple winnowing strategies.

Second, though MTCs provide a distinct advantage in terms of persuasion strategies, the stochastic campaign can beat the strategic campaign through brute force if the average p(cred) of the stochastic candidate is > 0.5. If the reach of the non-MTC is roughly double, the effect of the MTC is cancelled out. If the reach ratio > 2, the non-MTC edges out the strategic campaign. This is an interesting finding, as the MTC is effective, but can be beaten. Given the possibility of simulating and calculating a tipping point where a stochastic candidate (with credibility rating > .5 among the voters) beat strategic campaigns, it is possible to conduct cost-benefit analyses to determine the best available strategy given a limited campaign budget. In general, though highly simplified, the simulations show that it is methodologically possible to estimate the expected effect of a strategic (or stochastic) persuasion campaign by applying cognitive rules to the persuaders and persuadees in a dynamic environment.

Discussion and future developments

The current model provides an important proof of concept that MTCs have a non-trivial advantage in a limited world where the voters revise their beliefs in the same manner and where the candidates can only advocate their position in a simplified way. We believe the paper provides a novel method for simulating and analysing electoral strategies using Agent-Based Models. However, as a proof of concept, this leaves room for further model developments.

First, real-life voters may exhibit individual differences concerning moral foundation (Haidt, 2012) or reasoning strategies (Lodge & Taber, 2013). Voters in the current model are cognitively homogenous (though epistemically heterogenous) who revise their beliefs by the same process. Future work could integrate cognitive voter heterogeneity, which would allow for exploration of strategic choices. Adding personality profiles would make the model more realistic and interesting in terms of testing election strategies for actual elections. Further, real-life campaigners do not have a perfect signal from each voter. Consequently, noise needed to be added to voter signalling.

Second, in the model, voters consider one proposition whereas elections often consist of a multitude of attitudes, beliefs, and desires. The present framework may easily be extended to include multiple policy beliefs, preference rankings, and multiple candidates.

Third, the MTC only considers the favourability of the candidate. Given additional data about complex voters (e.g., policy preference, personality, etc.), a sophisticated MTC may target voters more strategically. For example, an MTC could differentiate between swing and secure voters. Additionally, some voters are more likely than others to vote regardless of their political conviction. This is essential for strategic implementation of get-out-the-vote strategies.

Fourth, in the model, voters cannot communicate with each other. To allow for greater belief diffusion and for a more dynamic simulation of an electorate, it is reasonable to assume voter interaction where voters can share beliefs and persuade each other through their individual networks. Models that explore the role of hierarchy in opinion dynamics would be particularly relevant to explore this function (see e.g., Quattrociocchi et al 2014; Watts & Dodds, 2007). Some voters might be communal leaders and have more impact than others. Given weighted network structures of the electorate, it would be possible to simulate complex persuasion strategies. This would simulate the relative efficiency of MTCs in highly complex, highly dynamic, and highly adaptive elections.

We predict that models with more complex voter belief systems, individual voter differences, and with interaction between voters will yield much higher benefits to MTCs. That is, we predict a positive correlation between available electorate data and the efficiency of an MTC. Concurrently, we also predict a positive correlation between the complexity of the electorate and the cost of running an MTC, as complex segmentation requires more data and sophisticated models.

By applying a cognitive updating rule in an Agent-Based Model, the paper presents a new methodology for simulating dynamic persuasion campaigns and for estimating their expected effect. We show a strategic advantage of MTCs. In the simulations, non-MTCs require double reach to cancel out this advantage. Despite having only simple voter data that allows for crude segmentation and a very crude selection strategy, the MTC consistently bested stochastic a candidate with the same reach (even when the opponent had a greater average credibility). However, given greater reach, a positively perceived stochastic candidate can beat a strategic candidate.

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