A Multiagent System for Modeling Democratic Elections

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Abstract

We address the problem of simulate democratic elections via a set of competing agents. We propose a logical model based on a set of non-cooperative agents which compete for attracting a maximum number of votes from a population. Each agent builds a set of strategies (formed by the promises, actions and proposals of the agent) used to convince to the potential voters.

Introduction

In the area of AI, the application of intelligent agents has provoked a great commercial interest, and they have been useful for making decisions (Carmel and Markovitch 1996).

We propose a novel logical model which tries to capture some important aspects of the process of a political election through of a simulation system of the political behavior of certain sectors of voters in agreement with the changes of strategies that the candidates go carrying out during their political campaign .

The Multi-Agent Competitive System

Let $\mathcal{A} = \{A_1, A_2, \ldots, A_n\}$ be a set of n intelligent agents. $A_i \in \mathcal{A}$ represents one of the prospectuses competing for a position or, in political terms, competing for winning a political election (Li, Giampapa, and Sycara 2003).

In our logical model, there is a set of profiles which are the resources used by the agents in order to influence to the voters. Similarly, the same profiles are used for characterizing the different sectors of the population. We represent the list of profiles via a discrete set $\mathcal{P}\int = \{P_1, \ldots, P_m\}$.

Each agent is certain to possess (or offers to the voters) a certain amount of those profiles. The amount of a profile $P_i \in \mathcal{P}\int$ that an agent believes to have is represented by a weight w_i.We call to each program of an agent a *strategy* of the agent to be used for competing with the other agents in order to attract to the voters.

Thus, a strategy s_i of A_i is a set of pairs: $s_i = \{(P_1, w_{i1}, (P_2, w_{i2}), \ldots, (P_m, w_{im})\}$, where each weight $w_{ij}, j = 1, \ldots, m$ is the amount of the profile P_j that the agent A_i determines to apply into one of his political program (s_i). Let $S(A_i) = \{s_{i1}, s_{i2}, \ldots, s_{in_i}\}$ be the set of different strategies that the agent $A_i \in \mathcal{A}$ can apply for attracting voters.

When all agents choose one of their strategies $s_i \in S(A_i)$, $i = 1, \ldots, n$, a state (an action in the multi-agent system) is formed $e = (s_1, \ldots, s_n) \in S(A_1)X \ldots XS(A_n)$. Let $\mathcal{S} = \{e_1, \ldots, e_o\}$ be the set of different states formed by the multi-agent system.

Then, a state $e_j, j = 1, \ldots, o$ is one of the possible configurations of the multi-agent system, and according with the strategies applied by the agents, they obtain a certain number of votes. As the agents change their strategies in order to obtain more votes, they conform interactively new states into the multi-agent system.

In our congestion network (Feldmann, Röglin, and Vöcking 2008), several agents (or players) simultaneously aim at allocating sets of resources (profiles). The cost of a resource (one edge of this network) is given by a function of the congestion (Lipton, Markakis, and Mehta 2003), i.e. the number of agents allocating the same resource. Each agent $A_i \in \mathcal{A}$ chooses a strategy forming a state $e = (s_1, \ldots, s_n)$ and the cost function is computed for all limited resource and according with the state e.

So, we are modeling the selection of a representative as a non-cooperative game, where there are limited quantities of each profile which represent the limited resources of a congestion network (Li, Giampapa, and Sycara 2003).Thus, while more agents use the same profile the influence of such profile in the voters tend to decrease.

Characterizing to the voters

Let $Pot = \{Z_1, Z_2, \ldots, Z_k\}$ be a population of voters distributed in k sectors, where Let $WZ_i = |Z_i|$ be the number of voters of the sector Z_i. We assume that the cardinalities $WZ_i, i = 1, \ldots, k$ are known values.

A weight wz_{ij} is given to each profile $P_j \in \mathcal{P}\int$ which is part of the characterization of a sector $Z_i \in Pot$. wz_{ij} represents the minimum value that a voter must to have on the profile P_j in order to be considered part of the sector Z_i. If for Z_i, a profile P_j is not relevant then $wz_{ij} = 0$, and if a profile P_j is too important for identifying the members from Z_i then wz_{ij} has to be a greater value than the weights of the other profiles characterizing Z_i.

We order the minimum weights used for characterizing a sector Z_i via a vector VZ_i containing m weights, being

$VZ_i[j] = wz_{ij}, j = 1, \ldots, m$. Then, the sector Z_i is made up by the voters holding all the profiles with weights greater than those established by the vector VZ_i.

Each vector $VZ_i, i = 1, \ldots, k$ operates like a 'sieve' which selects the main features of the members of each sector Z_i. In some way, each $VZ_i, i = 1, \ldots, k$ codify the AND of the minimum weights on the profiles that an agent has to hold in order to influence to the members of the sector Z_i. Simulating so, the heterogeneity of a sector via the collective political preferences of their members.

We can order the elements of the vector which characterizes a sector Z_i as a row of the matrix $MPot$ that contains the minimum weights to be held over each profile in order that a voter could be considered part of a sector, as well as those weights are the minimum values that any agent should offer to a sector to influence in its members.

Example

According with an investigation carried out in a town of México city in 1996 (Fernandez 1997), the following sectors were analyzed:

Table 1: List of sectors and its population

	Name	WZ_i
Z_1 :	$Retired$	1000
Z_2 :	$Housewives$	1100
Z_3 :	$Public\ Sector$	3500
Z_4 :	$Unemployed$	2000
Z_5 :	$Students$	3000
Z_6 :	$Private\ Sector$	2500
Z_7 :	$Micro\ entrepreneurs$	1000

The importance of the following profiles were recognized for characterizing each one of the previous sectors (Table 2).

Table 2: List of profiles and its description

Profile Description
P_1 : $First\ Job$
P_2 : $Credit\ for\ Women$
P_3 : $Elimination\ of\ Car\ Ownership\ Tax$
P_4 : $Education\ Scholarships$
P_5 : $Freezing\ of\ salaries$
P_6 : $Support\ marginalized\ groups$
P_7 : $War\ against\ drugs$
P_8 : $Reduce\ Communication\ Tax$

We determine the minimum weights which characterize each sector $Z_i, i = 1, \ldots, 7$. In this scenario, we want to model the competence among three political forces represented by three agents; A_1, A_2, A_3 which represent the respective candidates of the main political parties (or political alliances) of México.

For each strategy $s_i = (w_{i1}, \ldots, w_{i8})$ chosen by an agent A_i, the factor of abstention (represented by the variable $abstention$) was modeled by the following rules:

1. If $(w_{i1} + w_{i2}) < 40$ then abstention=$[(w_{i1} + w_{i2})/8] + abstention$
2. If $(w_{i3} < 20)$ then abstention=$[20 - w_{i3}] + abstention$
3. If $(w_{i7} > 27)$ then abstention=$[32 - w_{i7}] + abstention$

The value obtained for the previous rules represents a factor which decrease the total number of votes obtained by each agent $A_i \in \mathcal{A}$ which holds anyone of the rules.

Notice that given a state e, there is an agent who obtains the maximum number of votes, we call to such agent *the candidate of the state* e, denoted as $Candidate(A, e)$, which is the agent $A \in \mathcal{A}$ who obtains the maximum number of votes in the state e, that is,

$$\#Votes(A, e) = max\{\#Votes(A_l, e), l = 1, \ldots, n\} \tag{1}$$

Although, to change a strategy of one agent (even if the candidate does not change his strategy) makes a change in the state from e to e' and the agent who obtains the candidacy could change too. A *pure Nash equilibrium* in this congestion game is an assignment of strategies to the n agents, in such a manner that the potential function does not increase its value, by changing a strategy for any one of the agents.

Thus, this competition game consists in changing the agent's strategies in order to obtain a better number of votes and looking for obtaining a maximal value for the potential function $Total\_\#Votes$. The game finishes when none of the agents can change his strategy and improve the value for $Total\_\#Votes$.

Conclusions

We have designed a logical model for attacking the problem of selecting a representative from a democratic system. In our proposal, we assume that each prospectus determines a finite set of strategies.

Our system can be adapted for modeling democratic elections on the condition of knowing the sectors and their sizes, the profiles which characterize to the voters on the sectors and the different strategies used for the prospectus who compete in the election.

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