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On the Characterization Strategy of a Voter Transition Method and Its Influence on Social Choice

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***Abstract*—Digital social networks are used to share information in a group. The collective knowledge of the group in the shared subjects can be greater than the individual information a single member of the group has. It is not clear if this accumulation of data can be used by the group to answer questions better as a common entity than as a sum of individuals. One way a group can answer questions is with delegation of answering by selecting a leader who in turn will decide the answer. In this paper we propose an experiment where a leader is decided by a group by simple majority to answer a questionnaire with questions with a clear correct answer. The sum of the answers by the chosen leader is then compared with the average of the group to see if a significant improvement is reached. The result of the experiment corroborates the hypothesis as the chosen leader has a better result 1.99 standard deviations from the average results of the experts consulted.**

I. Introduction

Digital social networks are changing the way people collect information as a group. Big volumes of information are gathered and shared and group opinions emerge as this information is spread. The option of taking a collective choice by means of this information gathering is possible but not frequently used.

We can consider that a Digital Social Network is the digital space where multiple agents interact. We define an agent as a participant capable of performing actions independently for its own benefit (devising what needs to be done to meet its design goals, rather than constantly being told to do step by step). The main point about agents is that they are autonomous: capable of acting independently, having control of their own internal process. Therefore, an agent is a person or system of autonomous action in some environment that seeks to satisfy its own objectives or its owners. However, here arises a natural concern: what happens when several agents want to communicate with each other?, What language do they use to have the right coordination? Is it valid to take general conclusions as a group based on the opinion of every agent? In response to these questions there are concepts such as centralized and decentralized systems. Centralized system solutions can either demand overhead to the network or require a lot of coordination among agents. When a gregary opinion is made in one of these systems, we can use Social Choice theory to check the validity of the opinion made. Social choice theory deals with making collective decisions based on individual preferences within a society. One of the biggest trends in social groups is coalitions. The decision-making balance in a group is a major factor in the democratic decision-making to improve efficiency. Social groups consist of three levels: social norms, specific social groups, and rules and procedures of particular groups or organizations [1]. Constantly we all make decisions based on our experiences but when we face complex decisions that may affect others we need to consider the possibility of getting help from an expert, that sometimes may not have enough experience, common sense or intuition. The question arises whether we should continue acting and making decisions based only on our intuition or in those who are considered experts or, on the contrary, should we use methods that allow us to add a contribution to the intuition of mathematical logic.

Consider a set of social alternatives and a society where individuals have preferences about that set. We denote these preferences based on binary relations on the set of alternatives; Keep in mind those individuals may have different views on social alternatives. Social choice theory studies the process of individual aggregation preferences into a social preference. [2]. The collective decisions, then, will be taken from the binary social relationship that has been obtained by adding individual preferences. More formally, given a set of social alternatives, a social welfare function will assign to each opinion state a binary relationship.

Some properties that have the social aggregation processes may be: (i) Social welfare function: if individual preferences are total preorders, then the social preference should also be a total preorder. (ii) Universal Domain: any individual preference is legitimate. (iii) Pareto Principle: If there is unanimity in considering an alternative better than another one, then the

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social preference should place the best alternative ahead of the worst [3]. (iv) Independence of irrelevant alternatives: a social arrangement between two alternatives only depends on the individual orderings of the two alternatives and not the way in that they order other ones [4]. Arrow showed that these conditions are not compatible with each other, even they seem reasonable from the social point of view, i.e., there is no general social relationship that meets the conditions simultaneously. Note that the result of the incompatibility remains before the easing of some of the axioms or before the consideration of a set with less axioms.

In a democratic system, every member can cast their vote to select among different options in multiple facets. Even though the idea is clear, the way to implement it is subject to discussion. Two solutions for this problem are direct and indirect democracy. In a direct democracy, every decision should be consulted with every possible voter to have a selection made. This presents some difficulties, both in the organization of adding up consensus and on the voting agents, who have to be consulted on every menial decision making option who will saturate every agent on the voting process. The classic solution to avoid both problems is indirect democracy, in which a representative is chosen among some candidates. This representative will be in charge of the decision making process, on behalf of the agents who selected him. This solution is effective to a point. And it is the preferred solution in societies where agents with similar decision power have to make multiple choices. But a really important problem arises from this perspective: The number of candidates to be the elected representative is finite, and when taking into account the multiple dimensions where choices will be made, not all agents will find one who represents them in every aspect, so compromises will have to be taken. Taking advantage of current network technologies and social networks, we propose a new way for social choice making that takes into account both the overload of choice making a single agent can have, and the multiple dimensions where the choices take place.

We describe the organization of the rest of the paper. In Section 2, we present related work. Section 3 we show the experimental setup. Section 4 discusses results and discussion including a case of study. Finally, conclusions are given in Section 5.

II. Related work

Social choice takes a set of individual preferences and try to add them to form what it would be the order of collective preferences that characterizes the group of individuals. In [5] the concept of distributed artificial intelligence is developed for users with common preference profiles. Coordination and cooperation are key concepts in this multi-agent issue. However, each agent is designed for specific tasks of its own. A voting system is composed of a set of candidate agents, which reveal their profiles and preferences and have equal influence on the voting process. There may be coalitions in the group that may be prone to misrepresent the global perspective. An agent can only gain profit by taking an active part on the voting process. They use the concept of laws of social traffic among autonomous agents. Kojima et al. deals coalition methods to balance coalition power in a group based on democracy. The authors establish a binary relationship to determine the influence of a coalition. Extremely decentralized decision-making process: a value is selected for each of the characteristics that describe an alternative, and then the result of the collective decision is the alternative defined jointly by these independently selected values. The authors describe a coalition balance of power with a binary relationship. It describes contexts in which strategic manipulations of collective decision rules can be avoided even when feasibility restrictions have to be considered. This constitutes a blockability relations for social choice. [2]. Besides, the authors in [6] analyze score functions with maximum satisfaction, study the case theoretically and then validate the approach empirically. They are based on having an approach where it can be automatically optimized according to the needs of the agents. They explain that the need for voting or social choice can also lie in the restriction of communication between the agents of a system. To quantify the quality of a function of social choice is used a notion of distortion. It is analyzed the worst case of a social satisfaction of an optimal alternative. As a consequence, they use valuation functions on alternatives. These social choice models and individual profiles work well in computational economics, algorithmic mechanisms, and e-commerce. In [7] they study the computational complexity of voting rules and analyze the problem as a NP (nondeterministic polynomial) time algorithm, from the point of view of a two-step process for leader selection (computational manipulation for a double voting stage). The metrics studied are: weightless votes with a small number of manipulators, manipulation of votes with weight, coalition of manipulators, small number of candidates. Stone et al., in [8] expose the decision-making which is based on a decision, it focused on tourism consumer behavior studies. Generally, in the specific case of travelers, decisions fall on a person. Thus making it a binary decision, either agree or disagree. Then, this is known as to delegate decision. The authors establish terms of delegation of decision: social surrogate (casual relationship) and social influence. In addition, they expose the decision-making process [9]: problem recognition, external search for alternatives, evaluation of alternatives, and the purchase process. Xia [10] et al. expose the using of social choice mechanisms with machine learning. They explain specific mechanisms such as: the multi-objective nature of social choice, incentives of agents, and computational considerations.

The design criteria to choose among being feasible resource allocations is one of the most regulatory topics because it involves the choice of utility levels of different individuals. Tennenholtz et al. [11] provide a dynamic study of voting in e-commerce and e-marketing with respect to a set of alternatives. The ratings are based on taking several candidates from a given election instead of comparing them together. The Internet is an example that displays variety of feedback worldwide and preference aggregation methods. In [12], Stirling resembles a real cybernetic network where vertices are individuals and edges are the links that model communication relationships. There is a coordinated and collaborative performance work between the agents. This expresses in graphs the relations of preferences among individuals of a network and the way in which they relate to each other through links. A central authority forms committees and each committee has a specific task. A coordination function is proposed to obtain a social order and a coordination ranking is achieved. The author describes positive and negative coordination. Bade et al. [3] rank from the low to the highest inequality of preferences among agent profiles. They use a permissive notion of Pareto optimality and analyze robust matching mechanisms for a delimited rational behavior. Shen et al. [13], show to us another perspective on the problem with non-binary social choice with certain constraint conditions. They are based on collective decision making when such decisions are made by a group of individuals with heterogeneous preferences (e.g. society). Thus, this idea was born on the concept of the condition of independence of irrelevant alternatives. The authors in [6] express a utilitarian perspective on social choice which gives the same weight on the usefulness of each individual, regardless of the status of each in the social scale. The authors develop a case study where there are neutral distributional models. In addition, they express the measure of happiness in monetary terms of utility in order to maximize the social welfare. Decisions of individuals are modeled on social choice functions and optimized as needed.

III. Experimental Setup

An experiment to obtain empirical evidence of the capacity of a Digital Social Network to pick better choices as a group that individually is presented. A form containing a questionnaire of 10 categories spread on different ambits of general culture was designed.

The questionnaire contained 10 questions on each category for a total of 100 questions. For each knowledge area, an expert on the subject was selected. The expert was then, requested to fill the complete form. The categories chosen for the experiment where: History, Laws, Nutrition, Philosophy, Motor racing, Geography, Technology, Mathematics, Arts and Sports. The categories where chosen randomly from a selection of general knowledge categories. The number of 10 categories was chosen to have an ample variety of questions. A consideration was taken to avoid having multiple categories in the same field of knowledge, to avoid one person to dominate all the spectrum, but without being too specific to be impossible to answer by a knowledgeable person.

The answer of the experts where recorded but the participants were not informed of the results of the experts. The participants were then given the choice to pick one expert to be his delegate to answer the questionnaire for them. We define the set A as the set of choice making agents who form the population.

$$A = \{a_1, a_2, a_3, \cdots, a_v\}$$

We make a set C of the categories described before, and choose an expert from a set E, having an expert for each category.

$$C = \{c_1, c_2, c_3, \cdots, c_{10}\}$$

$$E = \{e_1, e_2, e_3, \cdots, e_{10}\}$$

Where the person e_i is expert on the subject c_i. Also,

$$Q = \{q_1, q_2, q_3, \cdots, q_{100}\}$$

are the 100 questions asked to the experts. where q_{10*i+j} is the jth question from the c_i category. Every question had an objectibly correct answer and an objectibly wrong answer, and every expert on the subject answered all the questions, so we can define the function R as the answer of an expert to a question and assign 1 if it was correct, and 0 if it was wrong:

$$R : E, Q \rightarrow \{1|0\}$$

We define the set of solutions S as a function of E,

$$s_i = \sum_j a_{i,j}$$

where:

$$a_{i,j} = R(e_i, q_j)$$

The experiment made every element of A to choose a member of E they thought had the maximum value on the set S.

$$F_r : A \rightarrow C$$

The member of E who had the maximum number of votes (by simple majority) was considered the delegate of the group. The solution S_d of the delegate was considered a significative answer if the distance between S_d and the mean of the set S was more than one standard deviation.

IV. Results

We chose 10 experts in each of the areas to answer the entire test thoroughly. Subsequently, we conducted a survey with 108 participants, where voters should choose a single expert that they consider would be the one who would have the best score on the test, after having fully answered it, including their area of expertise. The figure 1 shows the percentage of voters leaning on each of the experts. We observe that the most accepted expert is the mathematics one, with 30.6%, thus becoming the delegate of the group.

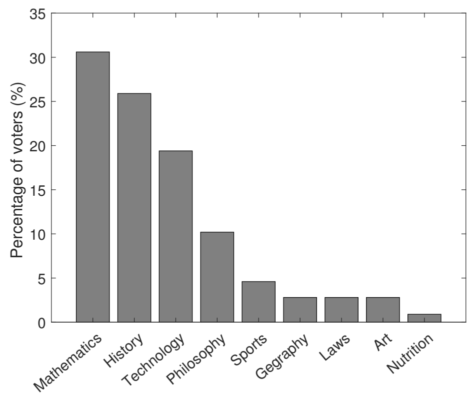

Fig. 1. Percentage of voter per each expert.

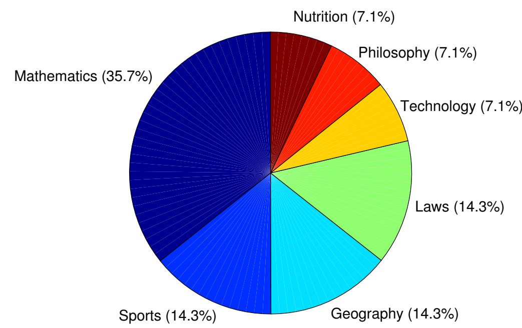

Fig. 2. Number of areas in which an expert exceled.

Table I describes the actual results of the test carried out by the experts. This corroborates the hypothesis established by the people who conducted the survey. The table shows the order of best and lowest average of the experts to answer the exam completely. The results confirm that a Digital Social Network cumulative information can obtain a better result as a group than every person by separate. In this way we can confirm the foundations of a Digital Social Network.

TABLE I
BEST SCORES OF THE EVALUATED EXPERTS.

Best rank	Expert	
1	Mathematics	62
2	Technology	50
3	Laws	48
4	Geography	45
5	Art	43
6	History	41
7	Automotive	41
8	Philosophy	36
9	Sports	34
10	Nutrition	34

Eventhough the experts were chosen accordingly to their studies, some experts in other categories answered the part of other categories better than the experts in that category. This was hidden from the agents of the Digital Social Choice as part of the implicit information of the test. The Figure 2 represents a pie chart with the percentages of expertise of each of the experts, confirming that the expert in mathematics, also chosen by the voters, is the one who answered the best exam. It was expected for each expert to be better in its field, but it was not always the case in the experiment.

The best delegate the group could have chosen was in our results, the chosen expert: the Mathematics Expert, with a result of 62. The mean of the solutions of every expert was 43.11 and the standard deviation of the solutions was 9.49 That means the solution of the group was 1.99 standard deviations above the mean of the solutions. This makes the collective choice a very significative improvement over the average choice of each member.

V. Conclusion

Taking advantage of modern methods of data gathering using Digital Social Networks, every agent can make their preferences known, and have a direct impact on the election of a solution to a problem, using any range of dynamic methods of choice selections. Even when using typical methods, like simple majority, the collective knowledge gathered inside a Digital Social Network is enough to make a better decision as a group than the average decision of a group member. Even if that agent decides to surrogate its decision, it doesn't follow that the surrogation process has to happen to the same leader for every dimension or category of problems, and in fact, it would be better if that was not the case, because it would mean that every agent individuality is represented in its individual mapping of choice and leader preferences. This open a window of oportunity of Digital Social Network for better direction and option decision to benefit the whole group. Every agent of the group can benefit by sharing its knowledge and accept decision making to delegates chosen by its expertise. More research is needed to find the sweet spot where agents can delegate decisions or choose by themselves without saturating every agent with a decision making problem. The problem of agent saturation where asked repeatedly for its opinion, can be attacked using an agregation method of delegating options without the agent loosing control and conserving its autonomy.

References

[1] A. Wang, Y. Luo, and Y. Li, "A research of institution design based on social choice," in *Advanced Computational Intelligence (IWACI), 2011 Fourth International Workshop on*. IEEE, 2011, pp. 693–696.

[2] K. Kojima and T. Inohara, “A method for comparison of coalition influence on social choice function,” in *Systems, Man, and Cybernetics (SMC), 2011 IEEE International Conference on*. IEEE, 2011, pp. 3471–3475.
[3] S. Bade, “Pareto-optimal matching allocation mechanisms for boundedly rational agents,” *MPI Collective Goods Preprint*, p. 2010/47, 2010.
[4] K. J. Arrow, *Social choice and individual values*. Yale university press, 1963, no. 12.
[5] E. Ephrati and J. S. Rosenschein, “Deriving consensus in multiagent systems,” *Artificial Intelligence*, vol. 87, no. 1-2, pp. 21–74, 1996.
[6] C. Boutilier, I. Caragiannis, S. Haber, T. Lu, A. D. Procaccia, and O. Sheffet, “Optimal social choice functions: A utilitarian view,” *Artificial Intelligence*, vol. 227, pp. 190–213, 2015.
[7] N. Narodytska and T. Walsh, “Manipulating two stage voting rules,” in *Proceedings of the 2013 international conference on Autonomous agents and multi-agent systems*. International Foundation for Autonomous Agents and Multiagent Systems, 2013, pp. 423–430.
[8] M. J. Stone, “Deciding not to choose: Delegation to social surrogates in tourism decisions,” *Tourism Management*, vol. 57, pp. 168–179, 2016.
[9] J. F. Engel, “The study of human behavior,” *Consumer Behavior: Selected Readings*, pp. 2–17, 1968.
[10] L. Xia, “Designing social choice mechanisms using machine learning,” in *Proceedings of the 2013 international conference on Autonomous agents and multi-agent systems*. International Foundation for Autonomous Agents and Multiagent Systems, 2013, pp. 471–474.
[11] M. Tennenholtz, “Transitive voting,” in *Proceedings of the 5th ACM Conference on Electronic Commerce*. ACM, 2004, pp. 230–231.
[12] W. C. Stirling, “Social choice on networks,” in *Systems, Man, and Cybernetics (SMC), 2015 IEEE International Conference on*. IEEE, 2015, pp. 161–166.
[13] H. Shen-ze and C. Xiang-jun, “Non-binary social choice preference profile’s properties and its application,” in *E-Business and E-Government (ICEE), 2011 International Conference on*. IEEE, 2011, pp. 1–5.