Creating Color Fashion Trends through Autonomous Behavior using Multi-Agent Systems

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Abstract. People are being influenced by several means to purchase different products or services, e.g., targeted advertisements that are generated by computer systems. Agents in these systems are known as the *influencers of the environment*. In this work, it is proposed an architecture based on a Multi-Agent System to show autonomous behaviors with social implications. The social behaviors observed are used to analyze the influence of suppliers and the trend of products or services in commercial markets. The study case in this paper uses the color based fashion trends.

Keywords: MAS, agents, autonomous behavior, fashion trends.

1 Introduction

Technological advances in computer science offer different opportunities to create collaborative systems. In order to fulfill its purposes, these kind of systems require coordination and sharing capabilities. Artificial Intelligence (AI) and Intelligent Distributed Systems are two principal contributors to the development of these environments.

Traditional AI systems are based on a centralized model and its components have the purpose of not affecting other elements. Modern AI proposes an approach based on agents: entities that perceive their environment through sensors, and respond or act in such an environment through effectors.

As Damazeau et al. [3] mentioned, Multi-Agent Systems' (MAS) approach attempts to decentralize control and reuse modules. These two characteristics are essential to implement coordination of agents and communication protocols between them. The objective is to integrate ubiquitous computing, communication with other entities, intelligence, and behaviors in a coherent system. MAS's applications include: network management, simulation of dynamical systems, provision of services on demand, electronic commerce (e-commerce), etc.

In this work, it's proposed a MAS based architecture for the study of fashion trends, e.g., clothes' color. The approach taken initially works with a single solid color and, later, with the combination of two different colors.

2 Related Works

There are several techniques to deploy agents' systems, but it is necessary to consider an appropriate software architecture to assure the effective performance of the system. The most important aspect is how agents interact with each other to achieve the objective of the system. This interaction depends on the organizational structure that represents the relationship of the agents inside the system, and the coordination mechanism to control the sequences of interaction and conflict management among agents [4].

The problem of how to design architectures based on agents can be stated in terms of the form of organizational structures between agents and how to coordinate the interactions between them. For example, Sánchez implemented an agent-based system for the simulation of epidemiological behavior of influenza AH1N1[7]. The architecture included the following components: environment, agents, activities, and behavior specification. The environment is the representation of the interaction between agents. Agents are the representation of individuals in the population, and they can have behaviors and develop activities. Responses are created as the result of agent's activities when interactions occur.

The architecture used in e-commerce systems, according to Zeng [9], is comprised of different actors: an Interface which serves to communicate system and client to collect and analyze customer needs; a Buyer seeking merchandise from various suppliers; Deals, an expert actor, provides support for decision-making; an Evaluator focuses on comparing products to make a selection based on attributes; and a Collaborator which analyzes consumer's needs to reduce the time of interaction between system and user (see Fig. 1).

In a similar design, Aragón's [1] proposal highlights three kinds of agents: Recommender, suggesting a range of products tailored to consumer's preferences; Comparator, bargain hunters that allow consumers find the best deals among providers; and Negotiators, called action agents, and have varying degrees of human intervention (see Fig. 2).

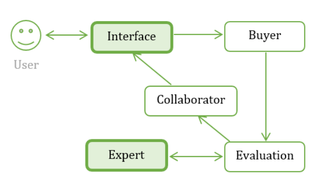

Fig. 1. Architecture proposed by Zeng

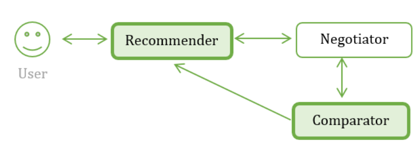

Fig. 2. Architecture proposed by Aragón

3 MAS Architecture for Color Tendencies

3.1 Architecture of an Agent

The architecture of an agent is an essential element by itself. It allows to decompose a system into smaller components and determine how is the relationship between them and, therefore, how they should interact with each other and with the environment. It can be found various kinds of architectures for the modeling of agents, e.g., deliberative, cognitive, reactive, and hybrid architectures. In particular, Muller [5] enumerates the characteristics that a cognitive agent architecture should include:

- *Tasks:* refers to what the agent can do, and what other agents may know he does. Some of these tasks might be communication's functions, agent selection for a particular task, retrieval of internal or system information, etc.
- *Beliefs:* subjective knowledge or set of opinions that the agent has about himself and other agents. It might begin as a review or initial experience, and then change through the actions and performance of each of the agents including himself when the system is running.
- *Knowledge base:* is the representation of what each agent knows and the knowledge acquired in past experiences. It serves to find solutions or select actions to be taking at any time. Knowledge enables the agent to understand the world, what others agents try to tell and their internal arguments and explain their ideas and decisions to others agents.
- *Goals:* are the set of desirable states in the environment in which an agent operates. An agent cannot reach or decide such goals according to the benefits that they represent. In an MAS, a global or primary goal should be achieved with the cooperation of all actors in the system. This overall objective can be divided into sub-goals, which are assigned to the system's agents, according to some organizational policy.
- *Communication:* mechanism that allows agents to interact with each other for solving a common problem, coordinating or synchronizing actions, solve conflicts with resources, participate in a negotiation, or just to send information. Communication protocols are a representation of the possible communication patterns and are modeled using Agent Communication Language (ACL) [2]. In this case, it is used an Interaction Protocol proposed by the Foundation for Intelligent Physical Agents (FIPA) [4].

3.2 General Architecture

This work relies in the features independently provided by Zeng and Aragon's architecture. On the one hand, Zeng's architecture gives especial importance to the user: its agents have well-defined tasks to interact between user and system. On the other hand, this architecture is based on personalized search towards similar preferences of the customer, and this is a disadvantage in our case: the aim is to influence other agents, or to be influenced by the environment, and not to reinforce our own preference of color.

Aragón's architecture has the advantage that it incorporates agent's recommendations. Moreover, this architecture implements two business models, direct and indirect, which are used in e-commerce to find a customer or notify a user that the recommendations are directed at him. However, agents in this architecture are intended to seek bids according to preferences or customer profiles. That intention is not desirable for the proposal in this work.

After analyzing the strengths and weaknesses of both architectures, a hybrid architecture is proposed which consists of the following agents: Interface or Environment, Color, Comparator, Expert and Recommender (see Fig. 3).

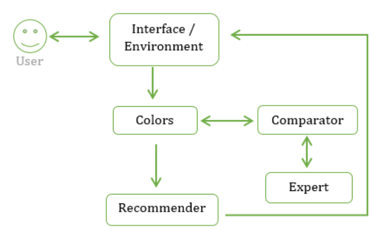

Fig. 3. Proposed Architecture based in MAS

Interface or Environment. It is the intermediary between user and system. It will be the means by which the user can enter data, and feedback, into the system. Furthermore, it will broadcast to other agents to announce the task requested by the user, and one of them will accept the task, according to its abilities, skills and knowledge.

Color. In this system there will be only three such agents, each defined by a color: red, green and blue. These colors represent the trends that will be handled. They will be responsible for influencing neutral populations. However, the belief of these agents cannot change because the agents are"providers" of a color.

Comparator. The function of this agent is to perform, after a certain period, and if any of the officers of color accept the task, to contact the expert agent to solve the task in progress. Once this agent has the solution, it should make a broadcast to officers of color to apply the solution.

Expert. This agent is tasked to respond to Comparator. When Color agents are not able to handle user's requests, this entity knows how to create all shades from three color agents. Expert can say how to fix the problem. This agent has a preliminary knowledge base on RGB colors.

Recommender. His goal is to present the proposals obtained by the agents of color, this is made directly with the agent Environment.

4 Experiments

The simulation tool NetLogo Framework was used to implement the proposed architecture. NetLogo is a programming language that allows the specification of the behavior of each patch (plots), turtles (agents) and execution control. The language is simple, expressive and functional. Each agent in NetLogo offers perception of its environment and acts on it, carries its thread of control and it is autonomous [6].

The simulation included three suppliers agents which were defined according to the BDI (Beliefs-Desires-Intentions) architectural model [8]. According to the model, each agent has as belief the tendency of a color (red, green or blue), and that there is no population trend. Supplier agents cannot be converted to a different trend. The desires of each supplier are that there is the greatest number of agents in the trend with its provided color. Finally, their intentions are to share its color to the neighbor agent.

The population without trend, as simulation's time progress, will know the existence of agents with a trend (suppliers). In each encounter with suppliers, individual agents will increase their belief in this trend. After some threshold, five in this simulation, they will adopt the preference for that color, i.e., their beliefs have changed.

The algorithm was implemented for transmission of beliefs from initials agents to acquirers agents. Provider agents move randomly in the environment and, consequently, there will be a time to converge of two or more agents as neighbors. Transfer of beliefs is made to a purchaser agent when the other agent is a Color or a purchaser that has only the belief of a trend at the time. However, not necessarily the first convergence will transfer the belief by the supplier.

What happens when the percentage of belief of two trends are equivalent? This gives place to a new generation trends. However, this agent is not able to share this new trend to other agents so, if it is feasible that in a future iteration it become part of the group of agents that share, but only one of the three initial trends will be used.

In Fig. 4, an initially de-trended population are influenced by three supplier agents. After some time, it is observed how the agent with blue trend has been most successful compared to the other two supplier agents (red and green). In the graph located on the right side of Fig. 4, x-axis represents time, and y-axis represents the population for each trend. It is easy to observe the generated tendencies, and the result of the influence of suppliers.

The fact that most of the population tendency is blue does not prevent the other two agents to continue to pursue their objective. This generates a greater number of collisions between them which develops a new trend.

5 Results

Several simulations were performed, each one consisted of four runs, but the value of population's variable was changed among them. Results are shown below with

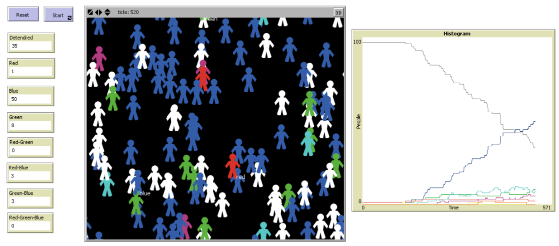

Fig. 4. NetLogo simulation of purchaser and supplier agents generating new trends.

the population size and time (ticks) as indicated. Four runs were needed in order to introduce new trends (colors).

In Table 1, it can be observed a test performed with a population of 30 agents. After 300 ticks, it appeared that the population with no tendency is reduced in each run, but in small amounts. In Fig. 5, it can be seen more clearly the percentage of the population that has no tendency after four runs, and the influence of providers agents on the population. The fact that the population is small affects the appearance of new trends.

People = 30	Time(Ticks)=300			
Detendred	28	25	19	14
Red	1	2	5	6
Green	1	3	6	8
Blue	0	0	0	2
Red-Green	0	0	0	0
Red-Blue	0	0	0	0
Green-Blue	0	0	0	0
Red-Green-Blue	0	0	0	0

Table 1. Results after 4 runs with a population of 30 agents

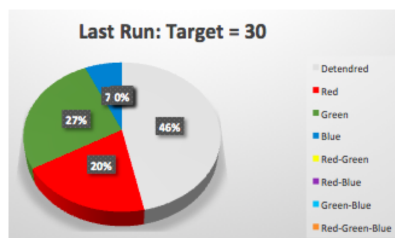

Fig. 5. Population trends after 4 runs

Subsequently, a second test was performed with the results given at Table 2. With an increase in the population to 50 agents without tendency, similar results to that obtained in the first test behavior are observed, taking into account that the increase of the population is minimal.

People = 50	Time(Ticks)=300			
Detendred	47	34	18	12
Red	0	0	0	0
Green	2	10	22	26
Blue	1	6	9	8
Red-Green	0	0	0	0
Red-Blue	0	0	0	0
Green-Blue	0	0	1	4
Red-Green-Blue	0	0	0	0

Table 2. Results after 4 runs with a population of 50 agents

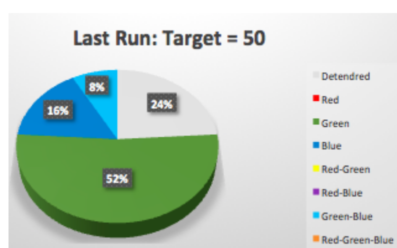

Fig. 6. Population trends after 4 runs

In a third test, population size was doubled. The results of 100 agents can be seen in Table 3. This time, the agents detrended have disappeared, hence, have been influenced by the provider agents. Similarly, in Fig. 7, it can been seen how the agent with blue trend has grabbed almost all of the population at the end of the fourth run. It was the first to obtain enough "supporters" and, consequently, to influence the other agents without tendency. Also, in this test, it can be seen the first emergence of new trends.

People = 100	Time(Ticks)=300			
Detendred	78	12	2	0
Red	2	3	1	0
Green	0	3	1	1
Blue	20	80	93	98
Red-Green	0	0	0	0
Red-Blue	0	2	2	1
Green-Blue	0	0	1	0
Red-Green-Blue	0	0	0	0

Table 3. The result after 4 runs is displayed, with a population of 100 agents

Fig. 7. Population trends after 4 runs

Finally, population was increased to 500 agents. The results can be seen in Table 4 and in Fig. 8. The behavior of agents has slight variations. But in this time, there is greater number of objectives, and acquirer's beliefs are more volatile. Some changes in trends are also noted at the first run in population without trend. The variation of the subsequent runs has no radical changes, that is, it was stabilized, thereby achieving coexistence of virtually all color shades.

People = 500	Time(Ticks)=300			
Detendred	31	12	7	6
Red	179	185	174	177
Green	180	188	207	212
Blue	42	33	30	27
Red-Green	45	51	50	47
Red-Blue	9	4	4	4
Green-Blue	7	14	15	17
Red-Green-Blue	7	13	13	10

Table 4. The result after 4 runs is displayed, with a population of 500 agents

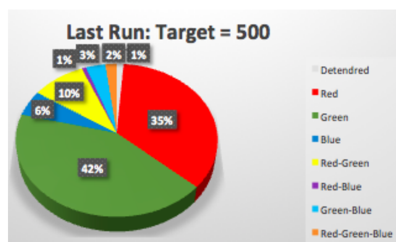

Fig. 8. Population trends after 4 runs

6 Conclusions

Social tendencies are a complex pattern to analyze and to create predictions about them. Nonetheless, current technology and algorithms permit us to create simplified models with acceptable time constraints. The simulated models are useful for creating inferences and some insights might be achieved.

This is the case in this study. By creating an artificial environment in which people (autonomous agents) live, it was possible to simulate the capabilities of influencers (specialized agents) that are introducing a fashion trend (a color).

The resultant data enable us to analyze the pattern that was needed in order to people to change its color preferences.

As the results shown, with a small population, it's harder to introduce a trend. The reasoning might be that interaction of people is not big enough in order to exchange information about their preferences. As population increase, interactions became more common, and trends started to appear. This was not only the result of the influencers, but also of agents that already have a color preference and they share that information.

Initial tests show tendencies for a single different color. But another interesting pattern emerged when population was considerable greater than the initial one. Trends for a mix of two colors started to appear in the population. This was the result of similar interactions, in quantity, with different influencers. And as time went by, agents created a trend that was composed of a couple of colors.

This research represents the initial phase of a work in progress that aims at understanding social tendencies. In future work, it is desired to introduce more variables to get closer to complexity of the decision-making procedure of real people.

References

1. Salvador Aragón. Agentes software y comercio electrónico, 1999.
2. Juan A. Botia. The fipa request interaction protocol, October 2007.
3. Yves Damazeau, Machael Pechoucek, Juan M. Corchado, and Javier Bajo Pérez. *Advances on Practical Applications of Agents and Multiagent Systems*. Springer, 2011.
4. The Fundation for Intelligent Physical Agents. Interaction protocol, January 2014.
5. J. P. Muller. The design of intelligent agents. *Springer*, 2012.
6. Ilias Sakellariou, Petros Kefalas, and Ioanna Stamatopoulou. Enhancing netlogo to simulate bdi communicating agents. *Springer*, pages 263–275, 2008.
7. J. C. Sánchez. *Generación de comportamientos epidemiológicos de influenza AH1N1 en una población dentro de un ambiente urbano, empleando momodel basados en agentes inteligentes.* PhD thesis, Universidad Autónoma del Estado de México, Facultad de Ingeniería, 2013.
8. Milind Tambe. Beliefs, desires, intentions (bdi). In *Introduction to Artificial Intelligence*, 2010.
9. Ziming Zeng. An agent-based online shopping system in e-commerce. *Computer and Information Science*, 2(4):14–19, November 2009.