International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

# The Chaotic Influence of Convinced Elements on Routing Collective Opinion and Appearance of Butterfly Effect

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***Abstract*—The study touches on the impact of the presence of convinced opinion for some of intelligent agents during the voting on formation the final collective opinion in a community G consists of autonomous agents, every intelligent agent have his opinion 0 or 1 On a thoughtful topic, between these agents happening an interaction[1], by entering into a collective debate[2], this interaction we will call 'voting', especially in the community, when the number of elements that have opinion 0, convergent compared with the number of elements that have different opinion 1 during the voting where this state of society is close to an unstable equilibrium point, this state will change during voting process, to close to one of two stability points 0 or 1 according to a previous study, presence convinced opinion intelligent agents, would later lead to a chaotic change in the final result of the voting[3], this chaotic change is called the "Butterfly Effect"[4,5], this influence can occur in many fields, market movements and economics, social life, mathematical problems, technological topics, movement of a driverless or ;***

***Index Terms*—Chaotic Influence; Convinced Elements; Butterfly Effect; voting; collective opinion; a set of intelligent agents; majority;***

## INTRODUCTION

Contemporary life depends in many aspects on collective opinion and the factors influencing it, and trying to direct or control it, to reach a specific goal or so-called state of stability, which in turn is an important pillar of every aspect of economic life, technological, biological, political, social, etc.

The formation of collective opinion is subject to a number of mathematical factors and probabilistic laws , that restrict its formation by approximate probability equations, depending on the nature of the elements in a society G, relations the and interactions between it.

The elements in a society are divided into three types [6, 7]:

1- The commoners: constitute the vast majority, which interact greatly between them, they are easily docile or influenced
2- Conscious or readers: they are the elements that have a better aware than commoners, those with some degree of education, and close to commoners and sometimes affect them.
3- Leaders or convinced: They are the lowest percentage of the elements, possess intelligence, qualities of leadership capable of influencing the former two types of elements, and bring a great deal of changes in their attitudes, despite the small number, they rarely change their views, despite their presence in the majority of dissenting opinion.

The third type is the one that we study its impact on the formation and direction of collective opinion during voting and decision-making in society G.

We will study the formulation of collective opinion and show the effect of convinced elements according to the following steps:

1- Formulate the approximate mathematical form for collective opinion who contains convinced intelligent agents in the next moment $t = 1$
2- Formulate the analytical equation of the opinion collective who contains convinced intelligent agents in every moment t+1.
3- Assessment of the chaotic effect of convinced intelligent agents on voting results.

1- Formulate the approximate mathematical form for collective opinion who contains convinced intelligent agents in the next moment $t = 1$

Based on the results of a previous study, it's known that when deriving the approximate form for collective opinion of the obtained for all elements of a group G who contain k intelligent agents, s of them having opinion 1 in initial time t=0, the following expression is valid[8]:

$$\mu(1) = \Phi(\mu_0) = \mu_0 + \frac{1}{k}[(1-\varepsilon)\sum_{s>\frac{k}{2}} C_k^s \mu_0^s (1-\mu_0)^{k-s}(1-\frac{s}{k}) + \varepsilon\sum_{s\le\frac{k}{2}} C_k^s \mu_0^s (1-\mu_0)^{k-s}(1-\frac{s}{k}) -$$

$$-(1-\varepsilon)\sum_{s<\frac{k}{2}} C_k^s \mu_0^s (1-\mu_0)^{k-s}(\frac{s}{k}) - \varepsilon\sum_{s\ge\frac{k}{2}} C_k^s \mu_0^s (1-\mu_0)^{k-s}(\frac{s}{k})].....(1)$$

$\mu(0) = \mu_0$ _ Share of autonomous intelligent agents, which have opinion 1 at the initial time t=0; $0 \le \mu_0 \le 1$

**Revised Manuscript Received on October 30, 2019.**
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$\mu(1)$ _ Average value of the fraction of intelligent agents which in state 1 at the next instant of time t=1; $0 \le \mu(1) \le 1$

$\Phi(\mu_0)$ _ Function that considers the proportion of all intelligent agents, that are at the time t=0 in the state 1 in our process;

$C_k^s \mu_0 (1-\mu_0)^{k-s}$ _ Binomial distribution [9] that give a probability for group of k autonomous intelligent agents which contains s intelligent agents in the state 1;

$\varepsilon$ – is a voting error;

Form (1) is an approximate form describing the voting process in the next moment t = 1 when we randomly choosing intelligent agent to vote, who will choose his opinion depending on majority of others agents [10] , in a group of k agents, containing s agents with opinion 1 in moment t.

Since we're talking about convinced agents, who don't change their opinions in voting by the majority, this means, the intelligent agents group S which include k elements divides to two groups: $S_k = S_n + S_c$;

Where:

$S_n$_Normal intelligent agents _ it's agents whose change their opinions in voting by the majority, with percent (1-$\varepsilon$);

$S_c$_convinced intelligent agents_ it's agents whose never don't change their opinions in voting by the majority, with percent (1-$\varepsilon$);

Accordingly $\mu_0$ will be divided also to two groups $\mu_0 = \mu_{0n} + \mu_{0c}$.

Where: $\mu_{0n}$ – A Share normal intelligent agent in the group consists of k agents;

$\mu_{0c}$ – A Share convinced intelligent agents in the group consists of k agents,

So the approximate equation (1) describing the voting process in the next moment (t + 1) has the following form:

$$\mu(1) = \Phi(\mu_0) = \Phi(\mu_{0n} + \mu_{0c}) = (\mu_{0n} + \mu_{0c}) + \frac{1}{k}[(1-\varepsilon)\sum_{s>\frac{k}{2}} C_k^s (\mu_{0n} + \mu_{0c})^s (1-\mu_{0n} - \mu_{0c})^{k-s} (1-\frac{s}{k}) +$$

$$+ \varepsilon \sum_{s\le\frac{k}{2}} C_k^s (\mu_{0n} + \mu_{0c})^s (1-\mu_{0n} - \mu_{0c})^{k-s} (1-\frac{s}{k}) - (1-\varepsilon)\sum_{s<\frac{k}{2}} C_k^s (\mu_{0n} + \mu_{0c})^s (1-\mu_{0n} - \mu_{0c})^{k-s} (\frac{s}{k}) -$$

$$- \varepsilon \sum_{s\ge\frac{k}{2}} C_k^s (\mu_{0n} + \mu_{0c})^s (1-\mu_{0n} - \mu_{0c})^{k-s} (\frac{s}{k})]; \ldots\ldots(2)$$

2- Formulate the analytical equation of the opinion collective who contains convinced intelligent agents in every moment t+1

Form (1) is an approximate form describing the process the next moment t =1, to get the analytical equation for collective opinion in every moment t, we divide elements of group M to groups, in each group 3 elements, voting is done by majority in each group separately, so when we change k=3 in form (1) and solve the equations we get the analytical equation which explain how the collective opinion changing in every moment t [8]:

$$\mu(t+1) = -\frac{2}{3}(1-2\varepsilon)\mu^3(t) + (1-2\varepsilon)\mu^2(t) + \frac{2}{3}\mu(t) + \frac{\varepsilon}{3} \quad \ldots\ldots\ldots(3)$$

$0 \le \mu(t) \le 1$

In our case, and for convinced intelligent agents $\mu(t)$ divides to $\mu_n(t)$ and $\mu_c(t)$

$\mu(t) = \mu_n(t) + \mu_c(t)$;

Therefore, to get the analytical equation of the opinion collective that contains convinced intelligent agents in every moment t+1 we will change $\mu(t) = \mu_n(t) + \mu_c(t)$ in equation (3)

$$\mu(t+1) = -\frac{2}{3}(1-2\varepsilon)(\mu_n(t) + \mu_c(t))^3 + (1-2\varepsilon)(\mu_n(t) + \mu_c(t))^2 + \frac{2}{3}(\mu_n(t) + \mu_c(t)) + \frac{\varepsilon}{3}$$

$$\mu(t+1) = -\frac{2}{3}(1-2\varepsilon)\mu_n^3(t) + (-2\mu_c(t)+1)(1-2\varepsilon)\mu_n^2(t) + [2(1-2\varepsilon)(\mu_c^2(t) + \mu_c(t)) + \frac{2}{3}]\mu_n(t) +$$

$$+ [-\frac{2}{3}(1-2\varepsilon)\mu_c^3(t) + (1-2\varepsilon)\mu_c^2(t) + \frac{2}{3}\mu_c(t)] + \frac{\varepsilon}{3} \ldots\ldots(4)$$

$$\mu_c(t) = c \text{ Const.} \quad 0 \le c \le 1$$

3- Assessment of the influence of convinced intelligent agents on voting results.

To determine the extent to which convinced intelligent agents affect voting results, the following example is given

**RESULTS:**

**Example:**

Let us suppose that there are a group G of intelligent agents include 300 autonomous agents, suppose we have a voting between the elements of this group about using clean energy, elements that have an opinion 1 support the use of clean energy, elements that have an opinion 0 do not support the use of clean energy, at the beginning of the voting we had share of agents which favoring the idea $\mu_0 = 49.49\%$, and the error while voting $\varepsilon = 0.05$, voting takes 150 times, one time in every second. The processes takes place, and as a result of voting and during calculate $\mu(t)$, we note that, the collective opinion for elements group G approaches to stationary value $\mu(t) = 1$, This means that Most elements after the vote They became supportive of the idea of using clean energy, Fig.1.

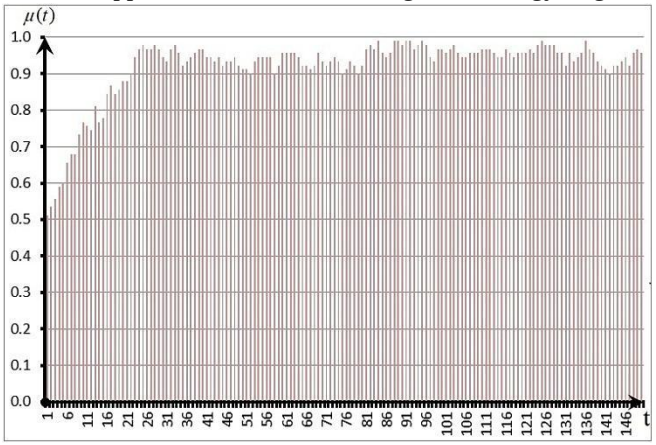


**Fig. 1**

We will use the same data as before to vote again, with an additional condition is, There are convinced elements within the group G $\mu_{0c}$ =5.05% , After re-voting we note the big difference in the results between votes without convinced agents and if they exist, when they exist, they changed the result, the convinced agents were able to significantly change the opinions of the commoners in the group, thus, most elements of the group are against the use of clean energy.Fig2.

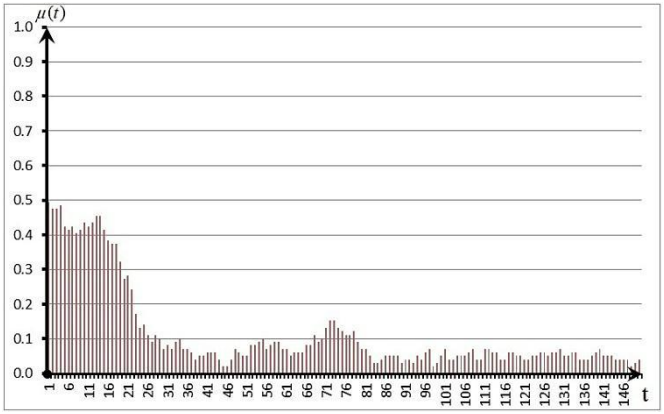


**Fig. 1**

This dramatic change in results can be explained by chaos theory, exactly "butterfly effect" which can explain these big changes in final results, its reports that small changes in initial conditions lead to much different and unexpected results in the final results.

Conclusion:

The presence of convinced elements in a group or community, can lead to significant change, in the group or community opinion, when they make a collective decision about a subject, therefore, to control the group's decision it is enough to influence them with convinced elements, and direct them to a certain direction, instead of steer all elements, this helps us to save time and effort money, get quick and useful results.

That's exactly what happens when you domestication of wild animals [11], we put them in the cage with other animals of the same species, they were born in the cage and knows no wildlife, to learn wild animals ways to live and adapt to a new life, in genetics, scientists remove or add some elements to cell genes to become stronger and able to resist diseases, there are many other examples in our daily lives.

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