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Counteracting destructive information influences based on the game approach

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Abstract

The problem of counteracting destructive influences on the example of ensuring information security of society during the rapid structural changes in the television industry is considered. To solve this problem we propose a nonlinear model that is based on multiple-choice in the context of information counteraction. Based on the study of the election campaign, the simulation of processes affecting security was conducted. A case in which, due to certain circumstances, some TV channels that political parties engage in for the purpose of agitation stop broadcasting has been investigated. The model considered the following objects: the first group of TV channels with common interests, the second group of TV channels - antagonists of the first, the third group - TV channels whose activities are insignificant in terms of impact on the first group, but in the simulation they are considered to belong to the second group. The dependence of the efficiency of information influence on certain parameters of the model is shown. The conditions that ensure the preservation of the coalition in the conditions of information counteraction have been identified with the help of the game approach.

Keywords: public security, multiple-choice model, informational influence, game approach, coalition conditions

Developments in the modern world clearly highlight the important role of such a trend as the use of cyberspace and informational influence to achieve certain goals. The example of many countries shows how one state tries to influence and influences the information agenda of another. There have been more and more cases where a certain media outlet is shut down because it spreads desinformation and also tries to influence the life of a country in order to satisfy the interests of another country. Therefore, in the light of modern realities of information confrontation, the question of a competent policy in the field of information security arises.

One of the areas where security is critical is political processes within any country. Indeed, politics and information influence, which takes the form of propaganda, information intrusions, the creation and exacerbation of certain information drives, etc., are quite intertwined. In this case, the simulation of processes that take place using cyberspace, is proposed to conduct, taking as the main example of the election campaign. [1], [2]

For agitation, political parties try to attract as many TV channels as possible in order to reach not only the largest possible audience, but also to further influence certain segments of the population. Over time, some TV channels become the mouthpiece of certain political forces. In addition, agents of influence from another country help to promote narratives that benefit them.

In general, TV channels have a more or less established audience. That is why such serious changes are taking place, or the latest broadcasts are being created. Consider the case when, as a result of certain actions, some channels stop broadcasting. In this case, existing broadcasters have the opportunity to increase their own audience at the expense of a free audience of closed TV channels. During building a model, we will consider certain parameters as variables from the beginning of the closing of channels to the moment of transition of their viewers to the audience of other TV channels. At the end of this transition process, we will consider the parameters stable and analyze the resulting model to create a coalition to preserve the information agenda in the face of the threat of further closure of television broadcasters.

Let, N - it is the number of viewers, covered by the broadcast of a certain group of TV channels. Suppose, that the value of $N = const$. The specified number of viewers is divided into $(m+1)$ group, where m - it is the number of TV channels, and the last group - is a set of viewers of that TV channel, which stopped broadcast. Denote $N_1, ..., N_m$ - groups of viewers, who watch mainly the first, second or $i-th$ channel, respectively, and as C denote that viewers, who remained without the broadcast theirs TV channels. In such case TV channels, that are present on the air, are faced with the task with help of informational impact during the time $[0, T]$ win favour another group of viewers, moreover first the impact should be directed at the group C. Note that the time T is determined by the condition $C(T) = \varnothing$.

Fix the number of each of the groups at the beginning of the information company, as $N_1(0), ..., N_m(0), C(0)$, moreover $N_j(0) > 0, C(0) > 0$.

Now we have, $N = N_1(t) + ... + N_m(t) + C(t)$. Denote normalized share of the number of each group to the total number of spectators through

$$n_1(t) = \frac{N_1(t)}{N}, ..., n_m(t) = \frac{N_m(t)}{N}, c(t) = \frac{C(t)}{N}.$$

Now, we can write the variable $c(t)$ as follows:

$$c(t) = 1 - n_1(t) - ... - n_m(t) \tag{1}$$

Denote probability of the viewer of a particular TV channel will react to the information agenda of the $i-th$ channel through $b_i(t), i = 1,..,m$. Then we introduce the coefficient of the information impact $a_{ij}(t)$, which shows, how many viewers of the $i-th$ TV channel will go to the audience of the $j-th$ TV channel, moreover $a_{ii}(t) = 0$. The coefficients $a_{0j}(t)$ belong to group C. Note, that $\sum_{j=1}^{m} a_{ij} \leq 1, j = 1,..,m$. Consider the dynamic of the number of the groups $C(t)$ and $N_i(t)$ in the normalized form:

$$\frac{dc(t)}{dt} = -c(t)a_{01}(t)b_1(t) - c(t)a_{02}(t)b_2(t) - ... \quad (2)$$

$$... - c(t)a_{0m}(t)b_m(t)$$

$$\frac{dn_i(t)}{dt} = c(t)a_{0i}(t)b_i(t) - n_i(t)\sum_{j=1}^{m} a_{ij}(t)b_j(t) + \quad (3)$$

$$+b_i(t)\sum_{j=1}^{m} a_{ji}(t)n_j(t)$$

Now move on to the system of equations, using (2) and (3) equations :

$$\begin{cases} \frac{dc(t)}{dt} = -c(t)\sum_{j=1}^{m} a_{0j}(t)b_j(t) \\ \frac{dn_1(t)}{dt} = c(t)a_{01}(t)b_1(t) - n_1(t)\sum_{j=1}^{m} a_{1j}(t)b_j(t) + \\ b_1(t)\sum_{j=1}^{m} a_{j1}(t)n_j(t) \\ ... \\ \frac{dn_i(t)}{dt} = c(t)a_{0i}(t)b_i(t) - n_i(t)\sum_{j=1}^{m} a_{ij}(t)b_j(t) + \\ +b_i(t)\sum_{j=1}^{m} a_{ji}(t)n_j(t) \\ ... \\ \frac{dn_m(t)}{dt} = c(t)a_{0m}(t)b_m(t) - n_m(t)\sum_{j=1}^{m} a_{mj}(t)b_j(t) + \\ b_m(t)\sum_{j=1}^{m} a_{jm}(t)n_j(t) \\ c(t) = 1 - n_1(t) - ... - n_m(t) \end{cases} \quad (4)$$

The value $c(t)a_{0i}(t)b_i(t)$ means, what normalized share the channel i receives from group $C(t)$. Another expression $n_i(t)sum_{j=1}^{m}a_{ij}(t)b_j(t)$ shows what normalized share is lost because of information impact from other channels and the expression $b_i(t)\sum_{j=1}^{m} a_{ji}(t)n_j(t)$ reflects the share of viewers who have joined the audience of the $i-th$ channel. It would be logical to assume that information impact of any TV channel also depend on the size of its audiences. In this case we make an assumption, that $b_i(t) = n_i(t)$. Thus, the we rewrite the equation (3) for $i-th$ channel in such a way:

$$\frac{dn_i(t)}{dt} = c(t)a_{0i}(t)n_i(t) - n_i(t)\sum_{j=1}^{m} a_{ij}(t)n_j(t) +$$

$$+n_i(t)\sum_{j=1}^{m} a_{ji}(t)n_j(t)$$

And system (4) takes the next form:

$$\begin{cases} \frac{dc(t)}{dt} = -c(t)\sum_{j=1}^{m} a_{0j}(t)n_j(t) \\ \frac{dn_1(t)}{dt} = c(t)a_{01}(t)n_1(t) - n_1(t)\sum_{j=1}^{m} a_{1j}(t)n_j(t) + \\ n_1(t)\sum_{j=1}^{m} a_{j1}(t)n_j(t) \\ ... \\ \frac{dn_i(t)}{dt} = c(t)a_{0i}(t)n_i(t) - n_i(t)\sum_{j=1}^{m} a_{ij}(t)n_j(t) + \\ (4)n_i(t)\sum_{j=1}^{m} a_{ji}(t)n_j(t) \\ ... \\ \frac{dn_m(t)}{dt} = c(t)a_{0m}(t)n_m(t) - n_m(t)\sum_{j=1}^{m} a_{mj}(t)n_j(t) + \\ b_m(t)\sum_{j=1}^{m} a_{jm}(t)n_j(t) \\ c(t) = 1 - n_1(t) - ... - n_m(t) \end{cases} \quad (5)$$

We subtract the general factor and give similar terms. We will receive:

$$\begin{cases} \frac{dn_1(t)}{dt} = n_1(t)\,(c(t)a_{01}(t) + \\ +\sum_{j=1}^{m}(a_{j1}(t) - a_{1j}(t))n_j(t)... \\ \frac{dn_i(t)}{dt} = n_i(t)\,(c(t)a_{0i}(t) + \\ +\sum_{j=1}^{m}(a_{ji}(t) - a_{ij}(t))n_j(t)... \\ \frac{dn_m(t)}{dt} = n_m(t)\,(c(t)a_{0m}(t) + \\ +\sum_{j=1}^{m}(a_{jm}(t) - a_{mj}(t))n_j(t) \end{cases} \quad (6)$$

Let the process, which is described by (6), approached the moment $t = T$, when $C(T) = \varnothing$. In this case, the coefficients $a_{ij}(t)$ become constant, namely, $a_{ij}(t) = a_{ij}(T)$, where $T = const$. Then the system (6) takes the following form:

$$\begin{cases} \frac{dn_1(T)}{dT} = n_1(T)\sum_{j=1}^{m}(a_{j1}(T) - a_{1j}(T))n_j(T) \\ ... \\ \frac{dn_i(T)}{dT} = n_i(T)\sum_{j=1}^{m}(a_{ji}(T) - a_{ij}(T))n_j(T) \\ ... \\ \frac{dn_m(T)}{dT} = n_m(T)\sum_{j=1}^{m}(a_{jm}(T) - a_{mj}(T))n_j(T) \\ c(T) = 1 - n_1(T) - ... - n_m(T) \end{cases} \quad (7)$$

Consider the whole list of TV channels. Let's select the first group, that contain that channels, which have common ideological principles and let their number be p channels. The second group consists of antagonists of the first. The third group includes all others, not taking into account their activities. In order for the first group to have an opportunity have an advantage in the information space, it is necessary for the first group to consider all other TV channels as representatives of the second group. We suppose that each group is a coalition, so the corresponding coefficients of information impact $a_{ij}(t) = 0$. So, $p + k = m$, where k - the number of TV channels of the second group. Let's rewrite the system (5):

$$\begin{cases} \frac{dn_1(T)}{dT} = n_1(T)\sum_{j=p+1}^{m}(a_{j1}(T) - a_{1j}(T))n_j(T) \\ ... \\ \frac{dn_p(T)}{dT} = n_p(T)\sum_{j=p+1}^{m}(a_{jp}(T) - a_{pj}(T))n_j(T) \\ ... \\ \frac{dn_{p+1}(T)}{dT} = n_{p+1}(T)\sum_{j=1}^{p}(a_{j(p+1)}(T) - \\ -a_{(p+1)j}(T))n_j(T)... \\ \frac{dn_m(T)}{dT} = n_m(T)\sum_{j=1}^{p}(a_{jm}(T) - a_{mj}(T))n_j(T) \end{cases} \quad (8)$$

Let's consider the structure of matrix of coefficients information impact:

$$\begin{pmatrix} 0 & \dots & 0 & a_{1(p+1)} & \dots & a_{1m} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & \dots & 0 & a_{p(p+1)} & \dots & a_{pm} \\ a_{(p+1)1} & \dots & a_{(p+1)p} & 0 & 0 & a_{1m} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{m1} & \dots & a_{mp} & 0 & \dots & 0 \end{pmatrix}$$

Analyzing the matrix, it is easy to see, the information impact, for example, of the first TV channel is depended on the difference of the sum of elements of the first column and the sum of the first row. If this difference is positive then the first TV channel prevails in the information counteraction. The situation is similar in other channels of the first group.

Also note that the number of differences $(a_{ij} - a_{ji})$ is $m \cdot n$, and the number of equations of the system (6) is $m + n$. In this case, calculations are performed at k points to be performed such a condition: $k \cdot (m + n) \geq m \cdot n$, redundant equations are discarded, and then the values are $(a_{ij} - a_{ji})$ calculated.

Suppose we have the following data on four channels at four points in time, time forecast $t = 4.01$ and normalized data:

	channel1	channel2	channel3	channel4
t_1	36023	271423	843992	121971
t_2	31061	133926	664489	142423
t_3	37065	862442	408419	275139
t_4	33555	223311	173384	239864
$t_{4.01}$	33406	202459	171468	237712
$t^*_{4.01}$	0.017	0.1001	0.085	0.118

It should be noted that the first group consists of the first and second channels, and the second - the third and fourth. Calculate the values of z_1, z_2, z_3, z_4, where $z_1 = a_{31} - a_{13}$, $z_1 = a_{31} - a_{13}$, $z_2 = a_{41} - a_{14}$, $z_3 = a_{32} - a_{23}$, $z_4 = a_{42} - a_{24}$. After calculations we get: $z_1 = -1.336 \cdot 10^-5$, $z_2 = 7.701 \cdot 10^-6$, $z_3 = -8.668 \cdot 10^-5$, $z_4 = 1.882 \cdot 10^-5$.

Let's analyze the obtained data. The parameters z_1 and z_2 belong to the first channel, z_3 and z_4 - to the second channel. Since z_1 and z_3 have negative values, then the first and second channels should pay attention to strengthening the resistance to the information impact of the third channel, as it controls the parameters a_{13} and a_{23}.

Let's pay attention to one more aspect. So, let's consider the probable development of events [3], when there may be a situation of possible closure of the channels of the first group. Let's use a game approach to solve the following problem. Let there be hidden provocateurs among the experts invited to air, the purpose of which is to make statements of this kind, which would lead, at least, to a temporary cessation of broadcasting. We believe that they can be detected only on one of the channels within the coalition. Then the provocateur's pure strategy is to get on the air, and his gain is to stop broadcasting, which, in turn, forces a certain audience to switch to other channels. The coalition's pure strategy is to choose a channel to check for a provocateur, and its gain is to retain its viewers. Renumber $n_i(T)$, $i = 1,..,p$, so that such a inequality holds: $n_1(T) > n_2(T) > ... > n_p(T)$. We present the matrix game in the form of the following table, where x_i - the strategy of the provocateur, and y_i- the strategy of the coalition.

	y_1	y_2	y_3	...	y_p
x_1	0	$n_1(T)$	$n_1(T)$	...	$n_1(T)$
x_2	$n_2(T)$	0	$n_2(T)$	...	$n_2(T)$
x_3	$n_3(T)$	$n_3(T)$	0	...	$n_3(T)$
...	...	...	...	...	...
x_p.	$n_p(T)$	$n_p(T)$	$n_p(T)$	...	0

Find the price of the game:

$$\begin{cases} \sum_{i=1}^{p} x_i n_i(T) - x_1 n_1(T) = v_1 \\ ... \\ \sum_{i=1}^{p} x_i n_i(T) - x_p n_1(T) = v_1 \end{cases}$$

From here we get:
$x_1 n_1(T) = x_2 n_2(T) = ... = x_p n_p(T) = \alpha$ Then:
$\sum_{i=1}^{p} x_i n_i(T) - x_1 n_1(T) = ... = \sum_{i=1}^{p} x_i n_i(T) - x_p n_p(T) = \alpha(n-1)$
As $\sum_x i = 1$ and $\forall i x_i = \frac{\alpha}{n_i(t)}$ then we have that:

$$\sum_{i=1}^{p} \frac{\alpha}{n_i(T)} = 1 => \alpha \sum_{i=1}^{p} \frac{1}{n_i(T)} = 1 => \alpha = \frac{1}{\sum_{i=1}^{p} \frac{1}{n_i(T)}}$$

In this case $v_1 = \frac{p-1}{\sum_{i=1}^{p} \frac{1}{n_i(t)}}$. Similarly, we calculate v_2. It's easy to see that $v_1 = v_2 = V_p$. Find the condition under which the following condition will be satisfied $V_{k+1} < V_k$, $k + 1 \leq p$.

$$\frac{k}{\sum_{i=1}^{k} \frac{1}{n_i(T)} + \frac{1}{n_{k+1}(T)}} < \frac{k-1}{\sum_{i=1}^{k} \frac{1}{n_i(T)}}$$

$$k \cdot \sum_{i=1}^{k} \frac{1}{n_i(T)} < (k-1) \cdot \sum_{i=1}^{k} \frac{1}{n_i(T)} + (k-1) \cdot \frac{1}{n_{k+1}(T)}$$

$$\sum_{i=1}^{k} \frac{1}{n_i(T)} < (k-1) \cdot \frac{1}{n_{k=1}(T)}$$

$$n_{k+1}(t) < \frac{k-1}{\sum_{i=1}^{k} \frac{1}{n_i(T)}} = V_k$$

Therefore, if the value $n_{k+1}(t)$ becomes less than V_k, then the next price, calculated together with $n_{k+1}(t)$, decreases and it makes no sense to focus on checking the channels $k+1, ..., p$.

Conclusions

This paper considers two situations of structural changes in the television industry that pose a threat to information security of society. The first of them is the closure of TV channels and, thus, the change of the information agenda on TV. The second is the neutralization of actions aimed at closing or temporarily suspending the channel's broadcasting. To study the first situation, when part of the audience is left without a certain broadcaster, models describing the election race were used. Based on them, a generalized model of multiple-choice was developed. Using it, we modelled the process of transition of unused TV audiences to other channels. In addition, a coalition was formed from a group of TV channels and the factors that determine the significance of its influence in the context of information confrontation were identified. in the second situation, a game approach was used to prevent destructive information influences on the activities of certain coalition TV channels. The conditions under which it is possible to minimize the negative impact on the functioning of the entire group of television broadcasters that are part of the coalition are identified. A computer experiment was performed to calculate the above situations. Thus, it is confirmed that the developed model and the proposed game approach allow their practical use to solve real problems.

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