

## **COGNITIVE MODELLING APPLICATION FOR SOCIAL TENSION STUDY**

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**Abstract.** This article describes the construction of a cognitive map for the problem domain of the social tensions. Simulation experiments are conducted. Dining solutions obtained.

**Keywords:** model, cognitive approach, cognitive dissonance, graph, vertices, arcs, simulation experiment.

### **1. Introduction**

Society is a social system. It can be in a steady state, if the social expectations of individuals correspond to reality. Social tensions arise otherwise. It is reflected in the mood, judgment and behavior of individuals. Social tension is concerned with insecurity, aggression and other negative reactions. Social tensions experienced individuals who can not adapt to social changes due to high prices and low incomes, fear of losing their jobs due to the inability to change the current picture of the world. Such individuals experience cognitive dissonance. Cognitive dissonance is the state of a potential participant of social conflicts.

The purpose of the paper is the fixation and analysis of cognitive dissonance, the study of its causes and manifestations.

### **2. Methodology**

The task of the research conducted is the multifaceted study of cognitive dissonance with the cognitive approach application. The cognitive approach includes cognitive information structuring using graph theory, the construction of the cognitive matrix in linear algebra, carrying out simulation experiments to find significant controlling factors. Scientists all over the world are making a great contribution to the development of models of unstable social processes.

Perov E.V. used cognitive approach to the study of social tensions of society. He made up the circuit in the form of a cognitive map, which identifies factors gain of conflicts of society. The cognitive map is applied to determine the cause of social tension strengthening [1].

Belyaeva N.A. offered the method for social tensions measuring by income differentiation. [2].

Radko K.S., Ivanova M.I., Moshchenko I.N. conducted the factor analysis of the social tensions of society. They made up the images of emotional attitudes towards the existing political order. The semantic differential method was used for the processing of empirical information [3].

Proshin E.N., Zhuravleva N.A., Martynov V.V. created an information model for the description of social tension. They made up a mathematical model for social tensions calculation [4].

Dolomatov M.U. and other researchers have created an information system Assessment of the level of social tension. They offered two models. One model describes the distribution of income. The second model calculates a comprehensive assessment of social tensions based on the entropy approach [5].

Orlik L.K. constructed a predictive model. Empirical studies and a mathematical model are used to predict the probability of aggression among students [6].

Abramovich E.S. and Gryzlov I.N. used mathematical statistics to measure social tension [7, 8].

Shvedovskii V.A. developed mathematical model-building groups with the use of differential equations. Population groups are divided into supporters and opponents. The model describes the dynamic behavior of groups. He built the system of Makrosotsium and defined the oscillation period of socio-political tensions in the Caucasus with its help [9].

García-Barrios L.E., Speelman E.N., Pimm M.S. developed a simulation system to generate options for the development of the object, which would suit the conflicting parties [10].

Juska A., Woolfson C. dedicated their work to clarification of the structure and causes of social conflicts in the specific examples [11, 12]. M. Lobo analyzed the causes of conflicts between ethnic groups [13]. Professional aspects of social tensions highlighted Kepplinger H.M. [14]. Aggressiveness is investigated in the work of C. Nathan De Wall, Craig A. Anderson, Brad J. Bushman [15] and others.

### **2.1. Self-esteem and aggressive mood**

Human activity has been studied with the help of the computer metaphor of the brain. This approach is currently inadequate. It is necessary to study mood and other people's emotions [16].

We applied the cognitive approach. It allows you to intensify the process of knowledge, understanding and explaining the information. We make extensive use of schematization. Schematization — these are different ways of individuals considerations about possible cause-and-effect relationships between the objects of the problem area. The conclusion is based on limited information in this case [17].

A person has self-esteem, his own attitude to communication, behavior, activities, experiences. It is influenced by the estimation of the society. Self-esteem may be optimal and non-optimal. We conducted experiments to determine the self-esteem of students of the university. Low self-esteem has 30-40 points. Average

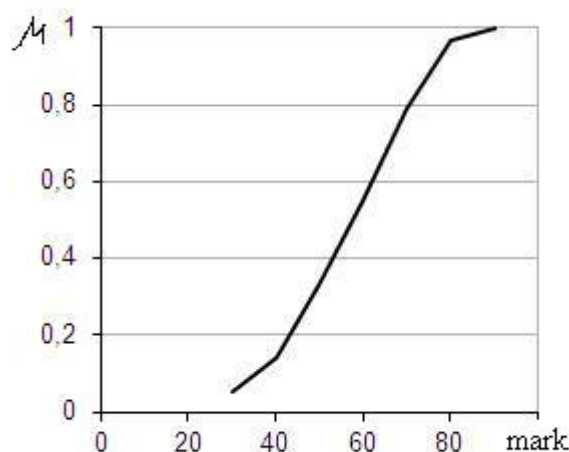


Figure 1. Fuzzy set of self-esteem

self-esteem has 50-60 points. High self-esteem has 70-90 points. Fuzzy set of self-esteem is shown in Figure 1. It shows the degree of property by points.

In the experiment conducted the students were offered statements. The responses showed their propensity for conflict or compromise in conflict situations. Responses were divided into three groups. The first group was choosing a compromise in conflict situations. The second group had an interim choice. The third group was choosing conflict in any situation. We used the correlation coefficient to characterize the relationship between self-esteem and aggressive mood. The correlation coefficient had the value of minus 0.18 (weak feedback). The analysis showed that 11% of students with high self-esteem, and 4% — the average self-esteem, and 3% — low self-esteem, tend to conflict. Half of the students chose a compromise in one case, and in another one — a conflict, regardless of self-esteem. High self-esteem may be the cause of aggressive mood. High self-esteem destroys self-government, self-control and idealizes one's own image.

Aggressive mood of a person has destructive and constructive direction. The constructive direction vector is oriented against processes of the entropy.

## 2.2. The example of entropic processes in society

The causes of social tension are: unemployment, poor quality of life, low incomes, the inability to get a good education and good health care, as well as an increase in crime. We examined the information on the growth of crime in the regions of the Russian Federation and the country as a whole. The data are available on the website of the Federal State Statistics Service.

Violation of the law is a socially dangerous act. It is contrary to the rule of law. Crime can be regarded as a subsystem with the position of system analysis. Subsystem has a behavior and can change the state. The behavior is a function of the subsystem:

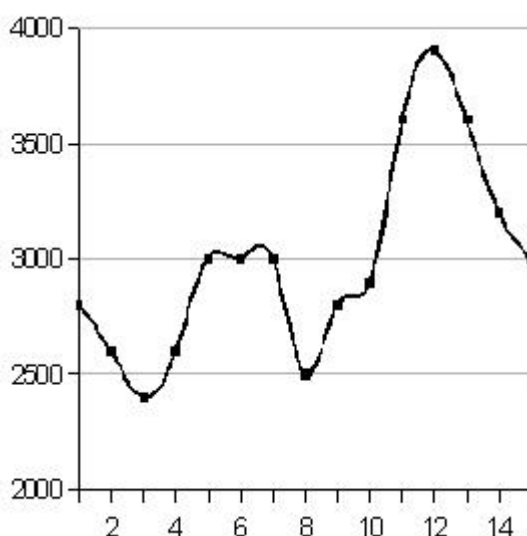


Figure 2. The number of registered crimes

$$c(t) = [c(t-1), y(t), x(t)],$$

$c(t)$  — the state of the subsystem at the moment of the time  $t$ ,  $y(t)$  — control actions,  $x(t)$  — disturbing influences.

In our research work the behavior of the subsystem is defined by the values of recorded crimes (Fig. 2). The numbers on the x-axis correspond to the time interval from 1995 to 2009. Number 1 — 1995. Number 2 — 1996. And etc. The numbers of reported crimes are on the y-axis.

*Discussion.* The behavior of the subsystem has cyclical nature. System laws can not be undone. They can not be prohibited. Any system must be managed in accordance with the laws of the system to produce a positive decision. The cyclical nature should be used for the successful management. During the periods of crime recession it is necessary to accumulate the resources for effective decision in the growth.

The properties of multidimensional systems are difficult to investigate. They have a large number of variables. The scientists have used the method of reduction for simplification. A large number of differential equations is reduced to a smaller number. Reduced system of equations is called the base system. It contains two equations for the variables  $x$  and  $y$ :

$$dx/dt = A \cdot P(x, y); dx/dt = B \cdot Q(x, y),$$

$A$  and  $B$  — coefficients;  $P(x, y)$  and  $Q(x, y)$  — non-linear functions. This method is the method of the phase portrait construction.

The baseline data are presented as a table. The values in the cells of the table show the number of crimes according to years and species. They are on the website of the Federal State Statistics Service [18].

Table 1. Number of reported crimes in the Russian Federation (in thousands)

	1	2	3	4	5	6	7	8
1990	15,6	14	15	83,3	16,5	913,1	16,3	96,3
...								
2009								

The first column shows the number of murders and attempted murders. The second column shows the intentional infliction of harm. The third one is abuse or attempt to abuse. The fourth one is robbery. The fifth one — brigandage, the sixth — theft, the seventh — crimes connected with unlawful narcotic circulation, the eighth — breaking of traffic rules and transportation exploitation.

The values are non-linear functions in the cells of the table. They are used for charting. The subsystem of crime is divided into three groups according to the years: 1990-1995; 1995-2000; 2000-2005 (Fig. 3, 4, 5).

*Discussion.* The markers indicate the status of the crimes subsystem at different times in the graphs. The data on crimes increase were plotted on the y-axis. The number of crimes is plotted along the x-axis in the normalized form. Markers are numbered in accordance with the types of crimes on the charts (Table). What do you see on the charts? The crimes subsystem varies. The distance between the markers either increases or decreases. The markers fill charts occasionally. We limit some area. The convex curve surrounds the markers (Fig. 5). The entropy  $S(t)$  can be determined by Ya. Sinaya's formula [19]:

$$S(t) = k \cdot \ln(G(t)/G_0),$$

$k$  — Boltzmann constant,  $G_0$  — the unit cell of the phase space.

Each time the interval coincides with the crimes subsystem state. Three states of the crimes subsystem are shown in fig. 3, 4, 5. The markers are closer or farther apart. Ongoing processes correspond to an increase or decrease of entropy in the subsystem of the crime.

Crime rates comparison. We have compared the crime rates in the Russian Federation as a whole and in the region of the Omsk region. The lines are marked in accordance with the normalized data on crimes in the Russian Federation. The dotted lines are marked in reference to the normalized data on crimes in the Omsk region (Fig. 6). We studied the periods from 1995-1998 to 2007-2010 (4 years correspond to 4-axis in Fig. 6).

Crime has become lower in the Omsk region in 2007-2010. Its normalized values are smaller than in the Russian Federation as a whole.

*Discussion.* Disorder is the system regularity of closed systems. The law enforcement system needs to restore order. The entropy of closed systems can not decrease. The system openness is one of the factors of entropy decrease. The system can increase the degree of its organization and reduce the entropy by entropy transmission into the environment.

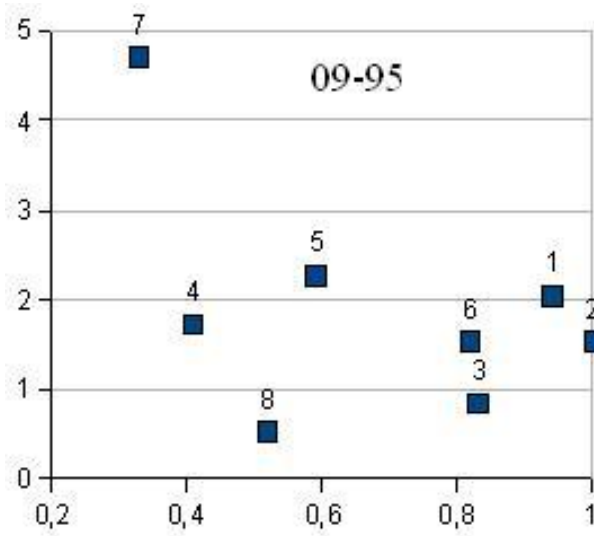


Figure 3.

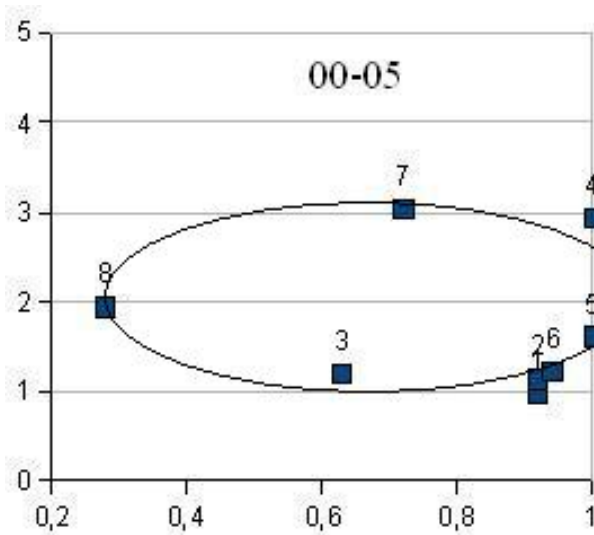


Figure 4.

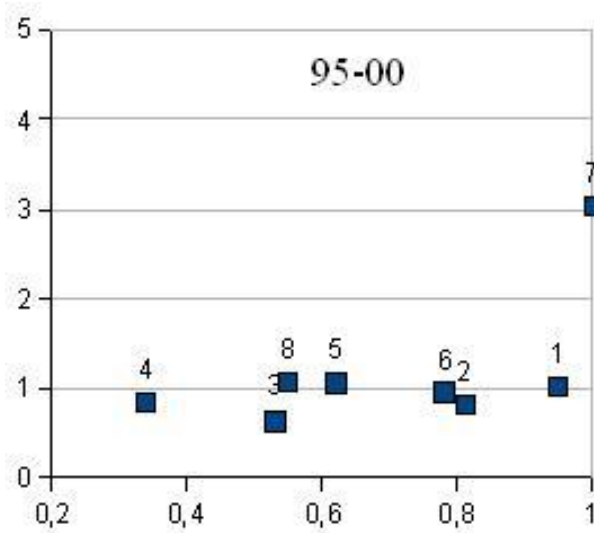


Figure 5.

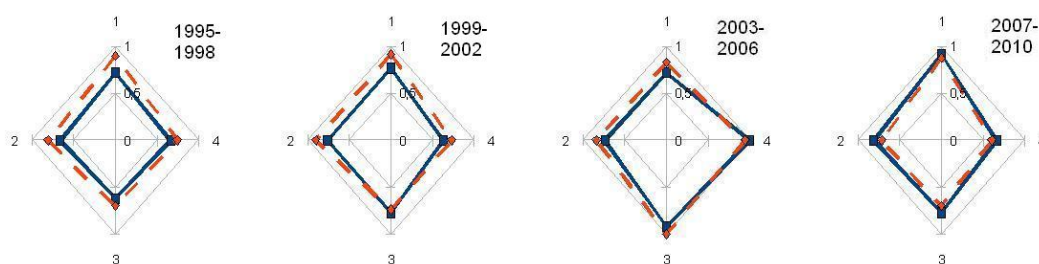


Figure 6. The number of reported crimes during the 4-years period  
(Line — Russian Federation, dotted — Omsk region)

We can operate the system in accordance with the objective laws and to have positive results. We must learn to control the amplitude and frequency of entropy oscillation to ensure the stability of the system [20].

### 2.3. The study of cognitive personality dissonance

Cognitive dissonance is an unpleasant mood. Unmet needs are reasons for such situations. To satisfy needs fully is impossible. There is a barrier of discontent, after which there is an explosion. We want to find the measure of discontent, or the amount of cognitive dissonance.

The construction of a cognitive map. We applied schematization and constructed cognitive maps to identify new points of view concerning the problem. We analyze cognitive schemes of our own and others' to improve the decisions. Every person has a set of mental models. He uses it to analyze the causes and solutions variants.

*Discussion.* The first researcher chose the mood as the target factor. Mood and health are two interrelated concepts. If health is poor, the mood is bad (direct relationship). The mood can be improved by the high quality of medical services or entertainments (inverse relationship). Both ways require good incomes (direct relationship). Good incomes can improve mood (direct dependence) (Fig. 7).

The second researcher chose the degree of cognitive dissonance as a target factor. Establishing of relationships leads to the construction of a cognitive map 2 (Fig. 8).

If the health of the individual is bad, then the degree of cognitive dissonance will be high (inverse relationship). He is seeking to reduce its level. He addresses a medical or entertainment institution. The degree of cognitive dissonance will be high, it means that medical services or entertainments are necessary (direct dependence) (Fig. 8). These means require good incomes. High incomes help to reduce the degree of cognitive dissonance (inverse relationship). The quality of medical service is high, the health is better (direct relationship). The better the health the more success at work (direct relationship).

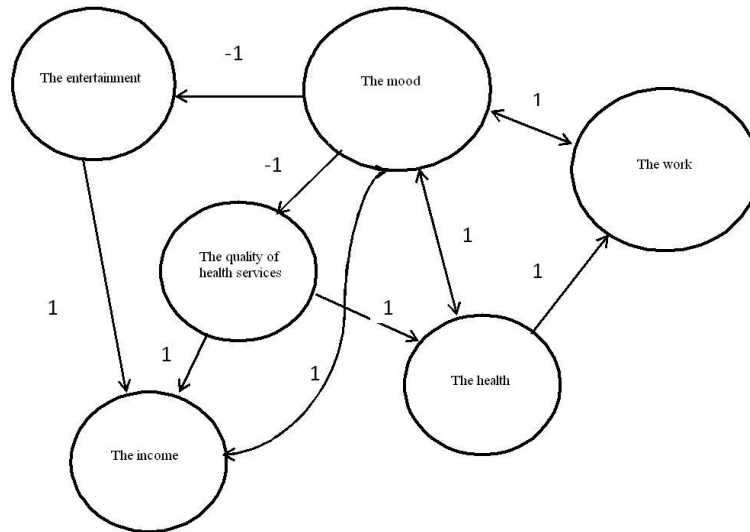


Figure 7. Cognitive map 1 "Mood depends on various factors"

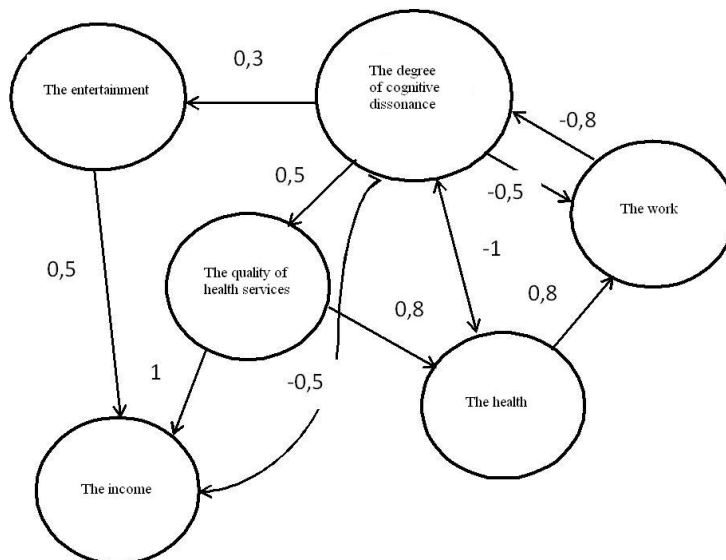


Figure 8. Cognitive map 2 "Cognitive dissonance depends on various factors"



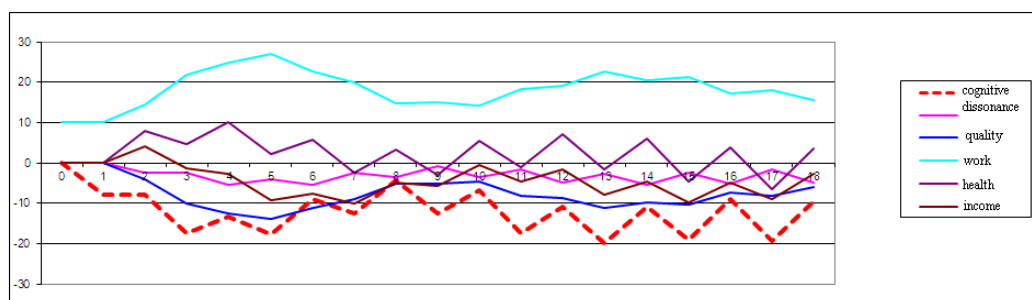


Figure 9. The dotted line is the degree of cognitive dissonance when increasing the factor of work by 10 conventional units

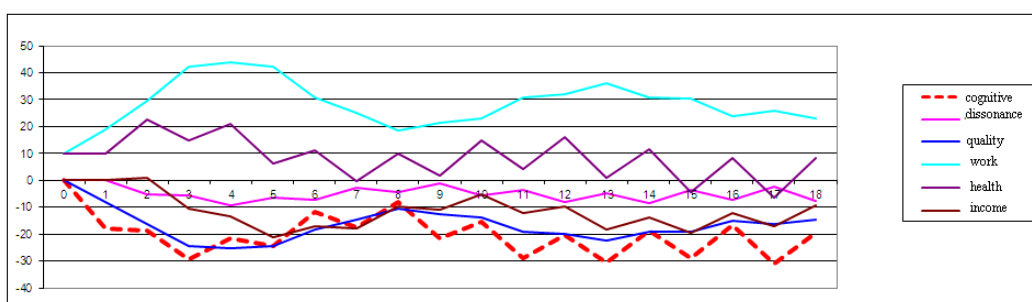


Figure 10. The dotted line is the degree of cognitive dissonance when increasing the factors of work and health by 10 conventional units

## 2.4. Discussion of research

We have two cognitive maps. The mood concepts and degree of cognitive dissonance can not be interchangeable because they have different relationships with other concepts. Let us compare the mood and the degree of cognitive personality dissonance. The mood is better, the degree of cognitive dissonance is lower (inverse relationship).

Simulation experiments were performed using the procedure [21, 22, 23]. We have developed a software tool [24, 25]. We used the actions:

- construction and transposition of cognitive matrix;
- perturbations were introduced in the nodes a of the graph;
- disturbance was introduced on the ways of graph.

*Change in the control factors.* Figures 9 and 10 show the change in the target and control factors on 18 steps. Work factor was increased by 10 conventional units. The factor degree of cognitive dissonance (dotted line) reaches 20 conventional units in this case. The minus sign indicates an inversely proportional relationship between the factors.

The results of simulation experiments are presented on 18 steps with an increase in factors of work and health by 10 conventional units given on the fig. 10. The factor degree of cognitive dissonance has 30 conventional units. These results are consistent with common sense: the better the work and health, the lower the

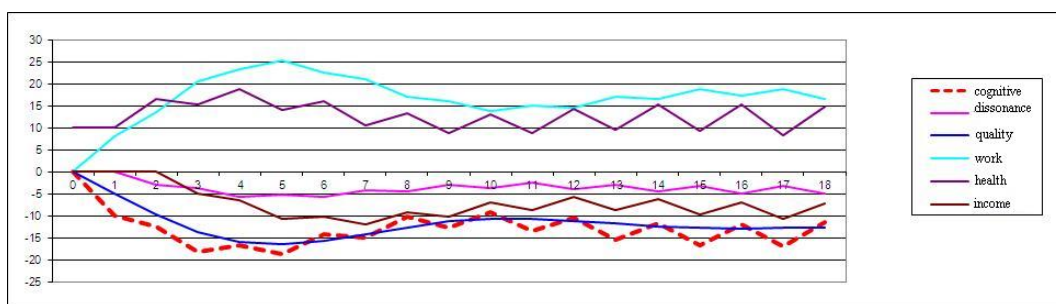


Figure 11. Dotted cognitive dissonance is about 20 conventional units. (The relationship of quality of medical services and health are constant, equal to 0.8); the relationship of health and quality of medical services is  $-0.5$  (weight of the arc)

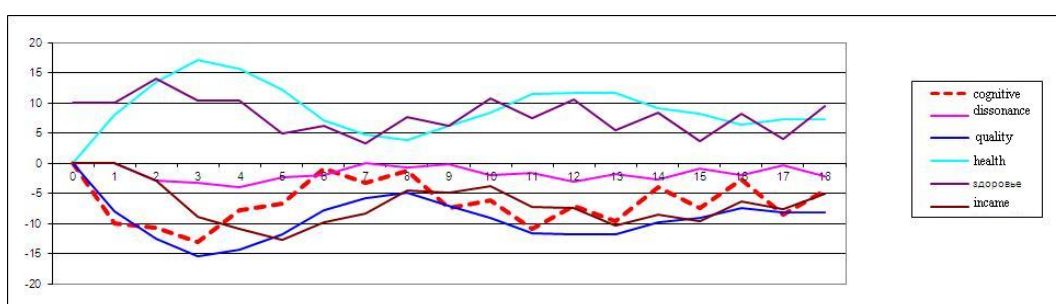


Figure 12. Dotted cognitive dissonance is about  $-1$  of conventional units. (The relationship of quality of medical services and health are constant, equal to 0.8); the relationship of health and quality of medical services is  $-0.8$  (weight of the arc)

degree of cognitive dissonance.

*Changing the values of relationships.* The results of simulation experiments are shown in Figures 11, 12. The relationship between factors of health and quality of medical services are not constant. (The relationship of quality of medical services and health are constant, equal to 0.8). The relationship of health and quality of medical services is  $-0.5$  (weight of the arc).

The degree of cognitive dissonance increases, if the relationship between the factors of health and quality of medical services are reduced.

## Conclusion

Cognitive approach allows to conduct the following research work:

- Various factors are analyzed and the relationships are analyzed too;
- Consequences have no single cause, and the reasons have the nonlinear structure;
- A new view point concerning the problem;
- The stability of the system could be researched on the basis of consonance and dissonance characteristics.

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## ПРИЛОЖЕНИЯ КОГНИТИВНОГО МОДЕЛИРОВАНИЯ ДЛЯ ИЗУЧЕНИЯ СОЦИАЛЬНОЙ НАПРЯЖЁННОСТИ

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**Аннотация.** Эта статья описывает построение когнитивной карты для задачи изучения социальной напряжённости. Проведён компьютерный эксперимент. Получено решение.

**Ключевые слова:** модель, когнитивный подход, когнитивный диссонанс, граф, вершины, дуги, компьютерное моделирование.