Entropy conditions for human factor conflicts development

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Abstract. The paper considers the possibility of the quantitative estimation for the conflicts with the help of the subjective entropy paradigm realized in the Entropy Conflict Theory through the formulated Subjective Entropy Maximum Principle. It is proposed to evaluate the subjective entropy though the subjective risk estimation. Uncertainty degree assessment with the use of the entropy in the style of the well-known Jayne's Principle allows quantitative models developments, which take into account subjective effectiveness functions similar to the Bayesian risk. Conflict management in the situations stipulated by the subjective risks alternatives uncertainties requires the models for the subjective preferences optimal distributions. It is proposed to use one of the possible schemes for the subjective entropy dependence upon the subjective risk in the view of the logistic curve. Another important factor, which needs its formalization, considered in the presented report, is the criterion for the conflict sharpness quantitative evaluation that could describe, for example, the social tension value to some extent. The other category of conflicts it is the type of conflicts related with the alternatives and uncertainty of the way for the subjective intensions realization. The discussed approach seems to be prospective to the war and peace optimal distribution dilemma and its applications.

1. Introduction

The presented paper is devoted to the application of the entropy methods to the conflict theory. Conflicts in the human and societies lives play more and more increasing role. Often, it relates not only with the life organization but also with the safety issues. Entropy methods in the conflict theory can be significantly helpful as it seems.

Last decades, the elaborations have been dealing with the certain variational principles implemented into the sphere of psychology. The results of that activity are presented in the view of several monographs and more than a hundred paper publications. The entropy concept in psychology was also the topic of many scientific conferences reports.

2. Research of existing problems

First of all it is necessary to make a few remarks to the connections between the entropy and conflict theory. The content of this paper follows publications [1-16]. Especially [13-16]: where, at some moment, it became absolutely clear that the entropy approach is adequate to the theory of conflicts.

The mathematical apparatus is analogous to the entropy formalism from theoretical physics [14-16]. And it gives plausible results shown in [13, 17-20].

3. In the subjective entropy maximum principle application

Let us consider the condition of

$$H^*_{Sub} = f\left(R_{Sub}\right), \tag{1}$$

where H^*_{Sub} is entropy of the decision making (or transition the conflict from the "cold" phase into the "hot" one); R_{Sub} is subjective risk, [13]. This condition corresponds with an additional supposition of the entropy principle mentioned in [13]. It means that the higher the risk the higher the level of uncertainty for the decision making. In accordance with this, entropy threshold H^*_{Sub} is an increasing function of the subjective risk. On the other hand

$$H^*_{Sub} < H_{\max} = \ln N\,. \tag{2}$$

Subjective risk R_{Sub} in some cases can be expressed with the function inverse to (1):

$$R_{Sub} = f^{-}\left(H^*_{Sub}\right). \tag{3}$$

And this function should be of the logistics type. Condition (1) is an additional supposition about the properties of psych. We can define an unbearable risk, for example, 15 ° role for the marine fleet, as a role of panic. It is an external parameter set from the elsewhere out. One of the possible schemes for H^*_{Sub} upon R_{Sub} dependence is shown in figure 1, [13].

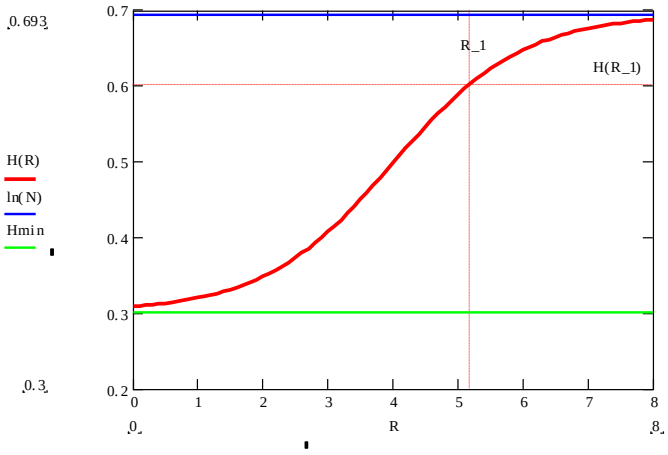

Fig. 1. Supposed dependence of the entropy threshold upon risk, [13].

At $R_{Sub} \le R^*_{Sub}$ the risk does not create an influence upon the entropy threshold H^*_{Sub}. But at $R_{Sub} > R^*_{Sub}$ the impact of the risk leads to the increase of H^*_{Sub}, it cannot be more than $H_{\max} = \ln N$ although. Social justice is provided if $\left|\mathrm{K}_{jp}\right| < \mathrm{K}^*_{jp}$; where K_{jp} – criterion of the conflict sharpness; j – number of the subject; p – number of the conflict type; K^*_{jp} – allowed social tension criterion value.

Conflict tension in the group of subjects $j \in \overline{1\ldots M}$:

$$Conf(G)=\sum_{j=1}^{M}\sum_{p=1}^{P}\left|\mathrm{K}_{jp}\right| \quad \text{or} \tag{4}$$

$$Conf(G)=\sum_{j=1}^{M}\sum_{p=1}^{P}\left|\mathrm{K}^{*}_{jp}-\mathrm{K}_{jp}\right|. \tag{5}$$

The borders of K^{*}_{jp} – can correspond to the moments of the transitions of the cold conflict into the hot one. The "hot" conflict is understood not only as a military conflict but also as a contradiction situation related to the threat for human lives. Let $M=1$ and $P\geq 1$, then

$$Conf(G)=Conf(j\in M)=\sum_{p=1}^{P}\left(\mathrm{K}^{*}_{jp}-\mathrm{K}_{jp}\right). \tag{6}$$

Let us introduce a criterion of the conflict sharpness at the set of ways $(\sigma_1,\sigma_2,\ldots,\sigma_N)$.

Then, the entropy of the ways preferences will be described with the formula

$$H\left[\pi(\sigma_1,\sigma_2,\ldots,\sigma_N)\right]=H\left[\pi(\sigma_1)\right]+H\left[\pi(\sigma_2|\sigma_1)\right]+H\left[\pi(\sigma_3|\sigma_1,\sigma_2)\right]+\ldots+H\left[\pi(\sigma_N|\sigma_1,\sigma_2,\ldots,\sigma_{N-1})\right]. \tag{7}$$

For the Markovian ways this will be as follows:

$$H\left[\pi(\sigma_1,\ldots,\sigma_N)\right]=H\left[\pi(\sigma_1)\right]+H\left[\pi(\sigma_2|\sigma_1)\right]+H\left[\pi(\sigma_3|\sigma_2)\right]+\ldots+H\left[\pi(\sigma_N|\sigma_{N-1})\right]. \tag{8}$$

And for the corresponding alternatives of *A* and *B*, such entropy approach realization result will get the view of, [13]:

$$H\left[\pi(A,B)\right]=H\left[\pi(A)\pi(B|A)\right]=H\left[\pi(B)\pi(A|B)\right]=\pi(A)\pi(B|A)\ln\left[\pi(A)\pi(B|A)\right]=$$

$$=\pi(A)\pi(B|A)\left\{\ln\left[\pi(A)\right]+\ln\left[\pi(B|A)\right]\right\}=\pi(A)\pi(B|A)\ln\left[\pi(A)\right]+\pi(A)\pi(B|A)\ln\left[\pi(B|A)\right]=$$

$$=\pi(B|A)H\left[\pi(A)\right]+\pi(A)H\left[\pi(B|A)\right]. \tag{9}$$

If there are two or more conflicts that exist simultaneously, then such situations are very important part of the general entropy conflict theory. We call such situations complex conflict situations. At this, the interaction of these conflicts existing at the same time and theoretical background for determination the moments and conditions of the conflicts transitions from one type into the other would be a significant portion of the theory. In the presented paper, due to the restrictions of the space, we do not consider these questions. We intend to deliver this material in further publications.

Herewith, as an example, we consider a case of two simultaneously existing and interacting conflicts. At this, the mutual influence is realized not only through the normalizing conditions but also via the conditional functions of the preferences distributions. So, let there are two preferences distributions at the sets of alternatives *A* and *B*, which could have not empty set in conjunction.

$$\sigma_i\in A_{\sigma}, \qquad i\in\overline{1,N_{\sigma}}, \tag{10}$$

$$\eta_j\in B_{\eta}, \qquad j\in\overline{1,M_{\eta}}. \tag{11}$$

If these conflicts (between or in the preferences distributions) exist in parallel (at the same time), then the following formulas are justified

$$\pi(\sigma_i, \eta_j) = \pi(\sigma_i)\pi(\eta_j|\sigma_i), \tag{12}$$

$$\pi(\sigma_i, \eta_j) = \pi(\eta_j)\pi(\sigma_i|\eta_j). \tag{13}$$

The entropy of the conjoint distribution

$$H_\pi[\pi(\sigma_i, \eta_j)] = H_\pi[\pi(\sigma_i)\pi(\eta_j|\sigma_i)] = -\sum_i \sum_j \pi(\sigma_i)\pi(\eta_j|\sigma_i)\ln[\pi(\sigma_i)\pi(\eta_j|\sigma_i)] =$$

$$= -\sum_i \sum_j \pi(\sigma_i)\pi(\eta_j|\sigma_i)\{\ln[\pi(\sigma_i)] + \ln[\pi(\eta_j|\sigma_i)]\} =$$

$$= -\sum_i \sum_j \{\pi(\sigma_i)\pi(\eta_j|\sigma_i)\ln[\pi(\sigma_i)] + \pi(\sigma_i)\pi(\eta_j|\sigma_i)\ln[\pi(\eta_j|\sigma_i)]\} = H[\pi(\sigma_i)] + \sum_i \pi(\sigma_i)H[\pi(\eta_j|\sigma_i)].$$

(14)

Analogously for condition (13)

$$H_\pi[\pi(\sigma_i, \eta_j)] = H_\pi[\pi(\eta_j)\pi(\sigma_i|\eta_j)] = -\sum_i \sum_j \pi(\eta_j)\pi(\sigma_i|\eta_j)\ln[\pi(\eta_j)\pi(\sigma_i|\eta_j)] =$$

$$= -\sum_i \sum_j \pi(\eta_j)\pi(\sigma_i|\eta_j)\{\ln[\eta_j] + \ln[\pi(\sigma_i|\eta_j)]\} =$$

$$= -\sum_i \sum_j \{\pi(\eta_j)\pi(\sigma_i|\eta_j)\ln[\pi(\eta_j)] + \pi(\eta_j)\pi(\sigma_i|\eta_j)\ln[\pi(\sigma_i|\eta_j)]\} = H[\pi(\eta_j)] + \sum_j \pi(\eta_j)H[\pi(\sigma_i|\eta_j)].$$

(15)

4. Conflict development in the war and peace categories

In recent publications [13], the concept of the entropy paradigm psychological implementation has been developed. As that was shown, this concept is widely applicable to the variety of social and psychological spheres in the study and control of active systems. Psychological aspects of "War and Peace" issues are based upon the so called "Entropy Conflict Theory".

Below, we are going to present some main categories and facts of the Entropy Conflict Theory. Two types of preferences are introduced: **"Object"** preferences and **"Subject"** preferences. Correspondent distributions are supposed to be normalized. Those distributions are not probabilistic. The mentioned distributions are determined at the set of the attainable alternatives. The algebra of the alternatives has been developed in [13]. Also, the notions of **"Problem"** and **"Aim"** have been introduced there.

The degree of the uncertainty of the preferences at the set of the alternatives is characterized in the given theory by the subjective entropies:

$$H_\pi = -\sum_{i=1}^{N} \pi(\sigma_i)\ln\pi(\sigma_i), \tag{16}$$

$$H_\xi = -\sum_{j=1}^{M} \xi(j)\ln\xi(j). \tag{17}$$

The presented theoretical approach idea [13] proposes the conflict theory problem settings, in particular, classification of conflicts, transitions of conflicts from one kind into another (cold into hot), inner (internal) conflict into external and reverse etc. Definitions of **"Vital"** and **"Lethal"** resources are considered. Conditions of decision making, alternative (strategy) choice, conflict beginning and exodus are also discussed.

The notions of **"Psychological"** or **"Emotional"** temperatures are specified similarly to the thermodynamics Gibbs' temperature.

Development of active system theory [13] based upon the use of Subjective Entropy Maximum Principle is proposed. This principle, from formal mathematical point of view, coincides with the Jaynes' principle [14-16].

The system "aircraft-pilot-environment" is an example of an active system. The pilot is an active part of that system.

Further on we will name an active element "actor" or "subject" of an active system.

Development of the entropy theory of an active system is an actual task of the subjective analysis theory [13]. The mentioned principle, Subjective Entropy Maximum Principle, significantly differs from the Jaynes' principle; and being applied to the psych manifestations could be considered as a new independent principle.

There are some necessary suppositions [13]:

1. The only bearer of all categories used here is an individual's psych.
2. There are two kinds of preferences: object preferences (preferences) and rating preferences (ratings); quantitative measure of the first kind of the preferences (preferences) and quantitative measure of the second kind of the preferences (ratings); both can be normalized in some way.
3. In general case preferences and ratings are not probabilities because not always we can imagine the existence of the general population.
4. As the factors of an uncertainty, entropies of (16) and (17) are taken.
5. The main position of the principle sounds like the following assertion: "Distributions of the mentioned above preferences provide maximum to the preferences and ratings entropies under some constraints; and the distributions are the solutions of the optimization problems. The so-called cognitive functions, which reflect internal and external influences on the decision making – choice of alternatives are considered.
6. The individual's psych can realize aggregated preferences. In this case we should presuppose a possibility of an information exchange between the subjects as well as some models of the information transition.
7. The entropy space has a structure. It is divided into several areas with some thresholds. For example, let us put that H_π^* is such a level that passage through this level from above to down corresponds with the beginning of a possibility of making a decision, because if $H_\pi > H_\pi^*$, then the alternatives are hardly distinguished. So, the necessary conditions of the decision making are

$$H_\pi \le H_\pi^*; \qquad \frac{dH_\pi}{dt} < 0; \qquad q = \left|\frac{dH_\pi}{dt}\right| < q^*; \qquad H_\pi^* = f\left(R_{SB}^*\right) < \ln N. \tag{18}$$

8. Along with the said above, we have to introduce the so-called subjective risk. From the formal point of view it is very similar to the Bayes' risk. It deals with the object preferences, as well as the rating ones. It depends upon the measures of uncertainties and may be subjective probabilities. It is a real supposition that the entropy threshold is a function of the Bayes' risk.
9. The preferences distributions obtained on the basis of the principle are optimal. They, in some cases, coincide with the distributions of Gibbs'; thus, we may state the social temperature, also an individual's and group temperatures.

Conclusions

The background of the entire presented theory (1-18) is the **"Subjective Entropy Maximum Principle"** [13]. The well-known from the theoretical physics kinetic theory Jaynes' principle [14-16] has been adopted. As a result, psychological branch of science gets a possibility of the quantitative estimation of the preferences distributions as well as numerical solutions to many problems dealing with conflicts.

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