

Impact of text entropy on the human emotional state

Sergey Gennadyevich Fadyushin, Alexandra Sergeevna Lobodenko, Catherine Evgen'evna Milyaeva

Far Eastern Federal University, Sukhanova str., 8, Vladivostok, 690950, Russian Federation

Abstract. The subject of this article is the impact of entropy of a text message on the emotional state of a person who is reading the text. The results of the experimental test have been represented. While making an experiment the news posted on the web-pages have been used as text messages. When reading the news the human emotional state was assessed by measuring the parameters of the galvanic skin response. The entropy of a text message has been calculated and compared with the evaluation parameters of the galvanic skin impedance. The statistical analysis has been carried out according to the test data. The relation between the entropy of a text message and the electrodermal activity has been detected.

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Introduction

A modern person is surrounded by the information "ocean". Nowadays information is as necessary, as the air, water and food. The information relevance and impact on a person, a society and the nature have been reflected in the scientific works, such as [1, 2]. But this definition has not been unanimous yet and the information impact on a person has been insufficiently studied.

The word "information" has a double meaning. On the one hand, it is a various information (messages, data), regardless of its representation form. In this view, the information outlines a concept of something for a person, and the amount of the information could be compared with a number of characters in a text message. Assuming that one character is one byte, then upon such approach the amount of the information will be equal to a number of characters in bytes. Here, in terms of a character the information is expressed as a substance.

On the other hand, the information is the immaterial essence, a reflection of the material world in the form of signals and signs, a property of the matter. From this perspective, the definition "information" does not fit in the traditional human beliefs and therefore, is uncertain in nature. In turn, the information uncertainty allows comparing it with the entropy as a measure of uncertainty. Such probabilistic approach to the information has been invented in the works by C. Shannon [3, 4]. In this case the information is expressed through entropy as an accident.

In our research work the following postulates have been taken as a basis:

1. An information is a reflection (an accident) of the probabilistic behaviour of any system, expressed by entropy.

2. The emotional state of a person who is reading the text depends on the degree of the information richness of the text message.

3. The degree of the information richness is determined by the entropy of the character sequence in the text message.

We have made an attempt to put the arguments for the listed postulates in our scientific research. However, we fully agree with the reader's right to have his own point of view on this subject.

Study data and methods

Let's get down to the works cited. According to C. Shannon, "Entropy is a statistical parameter, which to a certain extent, measures the average amount of the information per one letter of a language text" [5]. Assuming, that the letters in the text sequence are independent, then entropy and hence, the amount of the information could be calculated using the formula:

$$H = - \sum_{i=1}^n p_i \log_2 p_i$$

where H – is the entropy of p_i probabilities set; p_i – is the probability of i character.

The variable H is taken for a measure of the information amount and measured in bits per one character [3]. In the conducted study H impact on the recipient, i.e. a person, who receives (reads) the text message, has been investigated.

The following criteria have been used in order to assess the degree of the information richness of a text message (the information amount):

1. A number of characters n (no spaces).
2. The entropy of a text message H.

The recipient's emotional status has been determined through the statistical analysis of the evaluation parameters of the galvanic skin response (GSR). Tracing GSR and measuring the evaluation parameters have been carried out using the dual-channel hardware-software complex "DIANEL 11S-iON" [6]. This method is widely used in many research fields [7, 8, 9, 10, 11]. Comparing the GSR parameters with the criteria of a text message allows assessing the entropy impact, and therefore, the information one on the recipient's emotional state. The human emotions are plotted on the GSR graph as isolated responses (emotional responses). The emotional response is primarily characterized by increasing the amplitude of the galvanic skin impedance character [12, 13].

In our study the GSR- activity has been used as a mean value of the total activation throughout the test and the main evaluation parameter of the emotional responses [14]:

$$TA = \frac{\sum a_i}{n},$$

where TA – is the GSR-activity, cNp /response; a_i – is the amplitude of the i-th response activation, cNp (the activation increment for the i-th response); n – is the number of responses. cNp – is the santineper (the metric unit of the galvanic skin impedance [15]).

The GSR-activity variable is obtained as a mean value of the isolated phasic GSR amplitudes per the test time, expressed in cNp per one response. This parameter is the integrated index of the dynamic processes of the human energy consumption per one emotional response. The GSR- activity is some kind of assessing the psychophysiological costs for regulating the psychophysiological and psychoemotional human states. [14]

The degree of the entropy impact on the recipient's emotional state has been assessed by the linear regression dependence $TA=f(H)$ and the approximation accuracy factor.

Study results and its discussion

The impact of the text entropy on the recipient's emotional state has been investigated by making the experiments. Let's consider one of these experiments as an example. The news on the Far Eastern Federal University site from the Premier News section have been used as text messages [16]. Seven news have been used during the experiment, as more news could result in the recipient's fatigue and cause errors. The recipient was connected to the "DIANEL 11S-iON" device sensors, and then he was

asked to read out the site news. During the test, the galvanic skin impedance of a person, who was reading the text, was tracing. The emotional responses were recorded in santinepers according to the change in the amplitude of the galvanic skin impedance character.

The test results are represented in Table 1.

Table 1. Test results

Text Message	Entropy, H Bit/Character	Number of Characters, n	GSR-Activity, TA cNp/Response
Bit of News # 1	4.411	1841	7.06
Bit of News # 2	4.442	1681	6.25
Bit of News #. 3	4.393	1505	5.53
Bit of News # 4	4.438	2205	5.59
Bit of News # 5	4.447	945	6.61
Bit of News # 6	4.403	1907	6.04
Bit of News # 7	4.427	2329	5.17

According to the Table 1 data (Figure 1), the graph of the GSR-activity dependence on the entropy of a text message has been constructed. The variables C_E and C_{TA} have been plotted on the abscissa and ordinate respectively for the ease of analysing. The variable C_E is the relation of the current entropy values to the initial value $C_E=H_i/H_1$. The variable C_{TA} – is the relation of the GSR-activity current values to the initial value $C_{TA}=TA_i/TA_1$. As such, the graph shows the dependence of increment of the GSR activation amplitude on the excess entropy of the text message.

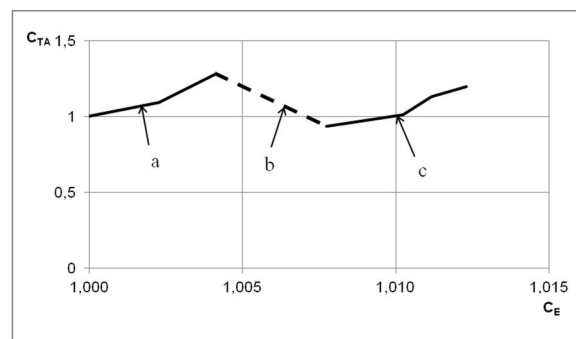


Figure 1: Dependence of increment of the GSR activation amplitude on the excess entropy of the text message

The statistical analysis of the experimental data (ref. Table 1, Fig. 1) indicates as follows. The excess entropy of a text message results in increment

of the GSR- activity, i.e. the higher the degree of the text information richness is, the higher the GSR-activity is, respectively. At the same time, there is a good correlation dependence between these parameters. However, the GSR- activity increases up to a certain limit (the section a) and by 1.3-1.5 times as compared with the initial value of the activation amplitude. Then the GSR- activity reduces to approximately the level of the initial value (the section b), and during the further increase of entropy it starts to increase again (the section c).

The relation between a number of characters in the text message and the recipient's emotional state has not been detected. During the test, the recipients were offered the messages which differed by the degree of relevance and novelty. The relation between these different text messages and the recipient's emotional state has not been also detected.

Thus, the following main conclusion could be drawn from the conducted research. First of all the entropy of a text message (the informational richness) has an emotional impact on a person, who is reading.

The results obtained could be used while analysing the quality of the information richness of text messages of various forms, such as web-site pages in the Internet. Analysing the quality of the information richness of text messages means assessing the degree of the emotional impact of the text message entropy on a person.

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Corresponding Author:

Dr.Fadyushin Sergey Gennadyevich
Far Eastern Federal University
Sukhanova str., 8, Vladivostok, 690950, Russian Federation

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