

# Diagnosis of Internet-dependent Human Behavior in the Information Aspect

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**Abstract**—The paper gives a substantiation of the diagnostic criterion and the methodology of the primary evaluation of Internet-dependent human behavior in the information aspect. As a diagnostic criterion, the entropy of key words and expressions used by a person when searching for information on the Internet is considered. The study is relevant due to the fact that nowadays for many people the Internet has turned into a pernicious habit, which can be got rid of by timely diagnosis and adoption of appropriate psychotherapeutic measures. The purpose of the study is to substantiate the diagnostic criterion and methodology for the initial evaluation of Internet-dependent human behavior. Research methods: the method of calculating the amount of information, developed and laid down in the theory of information by K. Shannon; author's technique for assessing the sense of a text message, based on a comparative analysis of the source text with its probabilistic representation by random permutation of words. The survey of 50 Internet users confirmed the main hypothesis of the conducted research on the possibility of using word entropy to diagnose Internet addiction. The materials of the paper can be of practical and theoretical interest for psychologists and sociologists dealing with issues of addictions in the field of information technology, linguists and developers of artificial intelligence.

**Keywords**—Addiction, Internet addiction, Sense, Entropy, Information, Semantic connection, Probabilistic model of meaning.

## I. INTRODUCTION

From the point of view of the founder of the psychological studies of the Internet addiction phenomenon, a clinical psychologist K. Young, Internet addiction should be considered as a real clinical phenomenon, one of the types of mental disorders and diseases [1]. However, the term "Internet addiction" does not yet appear in official medical reference books, such as ICD-10 and DSM-5. But, at present, the problems of Internet psychology have become so widespread that many psychologists and psychiatrists tend to consider Internet addiction as a real diagnosis. So, according to a survey conducted by the independent sociological service Foundation "Public Opinion", 40% of respondents under the age of 30 believe that Internet addiction exists.

The reasons for the dependence on the Internet are not yet fully understood. Recently, researchers of the psychology of the Internet have a tendency to search for links between

Internet addiction and the flow experience [2, 3]. Some authors believe that experiencing the flow on the Internet can lead to addiction [4].

To date, a large number of methodologies and measurement scales have been proposed for the evaluation of Internet-dependent behavior. But, so far none of them has become widespread, with the exception of the CIAS methodology [5].

The main goal of this research is to substantiate the criterion and method of diagnosing Internet-dependent behavior at the initial level, based on the information nature of this phenomenon. In order to establish a definitive diagnosis, the use of psychodiagnostic methods is not excluded.

## II. METHODS

One of the main signs of Internet addiction is that a person spends too much time on the Internet. "... the researchers tried first of all to quantify the number of hours that need to be spent online to be recognized as dependent" [6]. According to statistics, almost 61% of dependent people apply for psychological help because of excessive use of the Internet [7]. Nevertheless, this approach to diagnosing Internet addiction is problematic, because the time of using the Internet grows exponentially.

This research is based on the author's method of estimating the sense of a text message developed according to the data of primary sources [8, 9, 10, 11]. The main provisions of the methodology are described in "Probabilistic estimation of sense" [12]. In this paper, for the quantitative evaluation of the sense it is proposed to use the differential entropy ( $H(\Delta H)$ ) as a psychometric criterion  $M$ :  $M = H(\Delta H)$ . Earlier, it was established in [13, 14, 15, 16, 17, 18] that the greater the differential entropy of the exponential distribution of the random variable  $\Delta H$  (the Shannon entropy difference [19] of two adjacent words throughout the text), the greater the sense, and vice versa. The peculiarity of the conducted research is that a text message is understood as a set of words and phrases for searching information on the Internet.

The main hypothesis of the study is as follows. If one spends a lot of time on the Internet and concentrate on one topic (several similar topics), one can immerse himself/herself

in the state of experiencing the flow - the passion for the topic. Gradually, the flow experience can be transformed into addiction. Therefore, when searching for information on the Internet, the "dependent" person will obviously use a standard one-type set of search queries for a particular topic. Hence, it follows that, according to the level of meaningfulness, the set of words and phrases of the search queries of the "dependent" person ("user text") will differ from the set of words and phrases of search queries according to the search engine ("machine text"). In this case, the machine text will represent the average "norm", and the user text will be an individual "anomaly". Comparing the meaningfulness of these texts, one can quantify the deviation from the norm, i.e. Internet addiction.

Thus, when assessing the Internet relationship, the values of  $M_i$  and  $M_m$  of the user and machine texts are compared and analyzed, respectively:

if  $M_i \geq M_m$ , then, Internet addiction is most probably absent;

if  $M_i < M_m$ , then, Internet addiction is most probably present.

Decreasing the level of differential entropy of search queries of an individual ( $M_i$ ) in comparison with the level according to the data of the search engine ( $M_m$ ), with unmotivated unlimited increase of time on the Internet ( $T_i$ ) will indicate the development of Internet addiction:

$$M_i < M_m, T_i \rightarrow 24 \text{ hours.}$$

### III. RESULTS AND DISCUSSION

To test the methodology, 50 students of our university (FEFU) were interviewed. In the questionnaires, respondents were asked to answer the question about the time spent on the Internet and indicate the topics, keywords and expressions used in the information search. The data for the machine text were obtained using the service *Search of Words* by a search engine Yandex [20].

Results of the survey:

- the time spent on the Internet by one person was 8.8 hours;

- between the amount of time spent on the Internet and the psychometric criterion  $M$ , an inverse correlation established with the correlation coefficient  $R = -0.3$ , i.e., with the increase of time, the meaningfulness of Internet requests is reduced;

- of those surveyed, approximately 20% have signs of Internet-dependent behavior.

As the examples, the authors give the results of calculations and their graphical representation for cases of correspondence between "norm" and "anomaly." For the first case ("norm"), it turned out:  $M_i = 0.52035$ ,  $M_m = 0.2807$ . According to the data from the questionnaire,  $T = 9$  hours with an average statistical value of  $T = 8.8$  hours. With these values, the diagnostic criterion is as follows:  $M_i > M_m$ ,  $T_i = 9$  hours. For the second case ("anomaly"):  $M_i = -0.28292$ ,  $M_m = 0.28071$ .  $T = 24$  hours (also, according to the data from the questionnaire). Diagnostic criterion:  $M_i < M_m$ ,  $T_i = 24$  hours.

In Fig. 1 and 2, there are graphs of probability density functions of the entropy difference (according to Shannon) for the user and machine texts in cases of "norm" and "anomaly." In both figures, the solid line means the graph of the probability density function of the machine text, the dashed line indicates the user probability density.

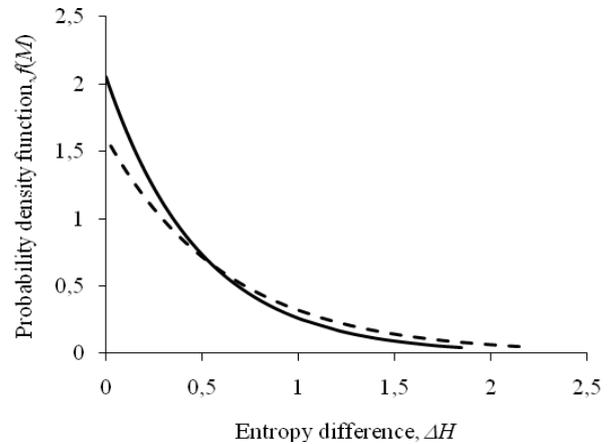


Fig. 1. Probability density function graphs for "norm".

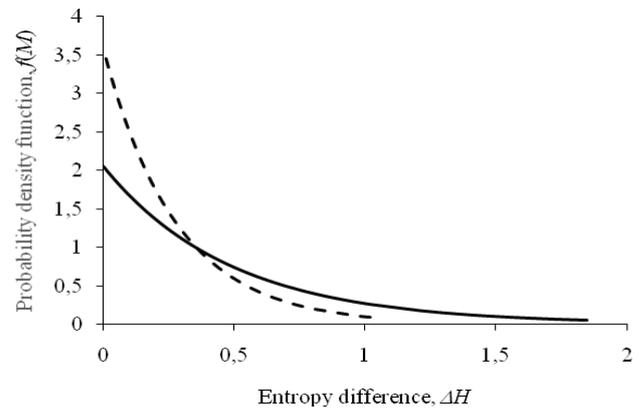


Fig. 2. Probability density function graphs for "anomaly".

The graphs in Fig. 1 and 2 displaying probability density functions of the exponential distribution of the random variable  $\Delta H$  show that in the case of the "norm" the probability of "short" (small in the difference of letters and entropy between words) semantic links for the user text is less than in the case of "anomalies". The probability of "long" semantic links for the user text, on the contrary, in the case of "norm" is greater than in the case of "anomaly".

The result indicates that in the state of Internet addiction, a person makes search queries from the same type words, similar in size (number of letters). To compose a text containing "long" semantic connections, a greater tension of thought and creativity is required, which is impossible in a state of addiction.

The results of calculations and analysis of the graphs are confirmed by a list of search topics indicated in the questionnaires. In the case of "norm", the respondent pointed

out the following topics as important: science, programming, music, cinema, education, video, news, family, computer technology, social networks, work. In the case of "anomaly": funny videos, integrals, games.

Thus, the control examples confirm the hypothesis of the research: when searching the Internet, the "dependent" person will most often refer to one obviously specific search topic(s), as a result of which the user text will be less than the machine text in terms of the level of meaningfulness. It follows that the criterion and methodology proposed in this paper can be used as a diagnostic criterion for the initial evaluation of Internet-dependent human behavior.

#### IV. CONCLUSION

Thus, in the context of the information aspect to the assessment of Internet addiction, it has been found that as a diagnostic criterion it is possible to use the differential entropy of a set of key words and phrases of search queries on the Internet. The decrease in the level of entropy (meaningfulness) of the search requests of an individual ( $M_i$ ) in comparison with the entropy level of search queries based on the search engine ( $M_m$ ) data with an unmotivated, unlimited increase in the time on the Internet ( $T_i$ ) will indicate the development of an Internet addiction in a person. In order to establish a definitive diagnosis it is necessary to use the appropriate methods of psychodiagnosics.

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