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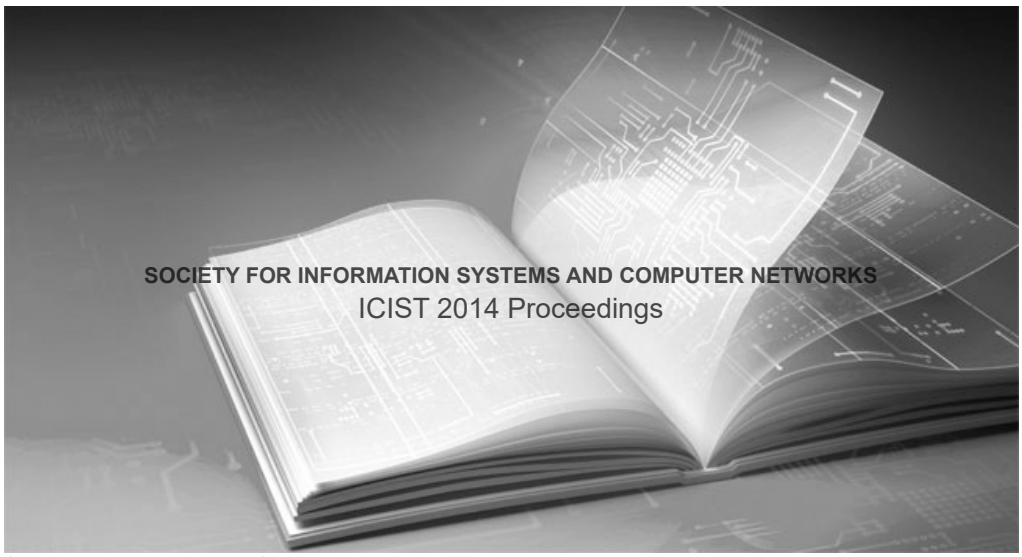

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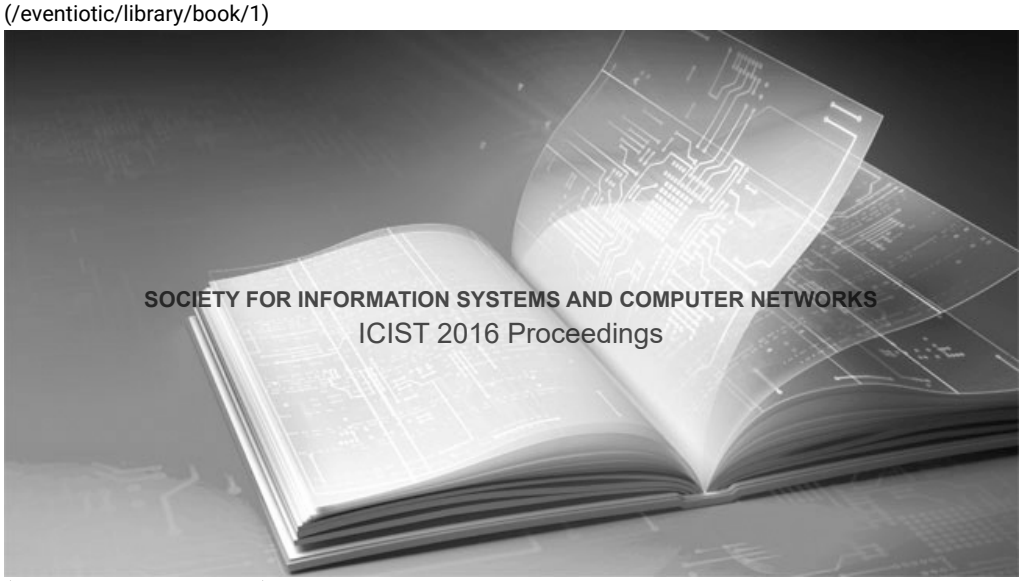

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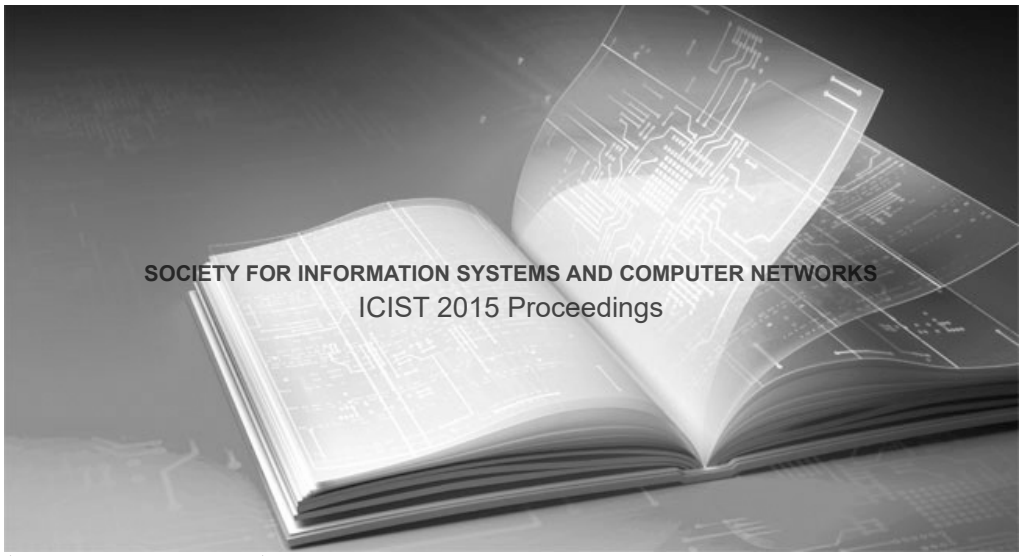

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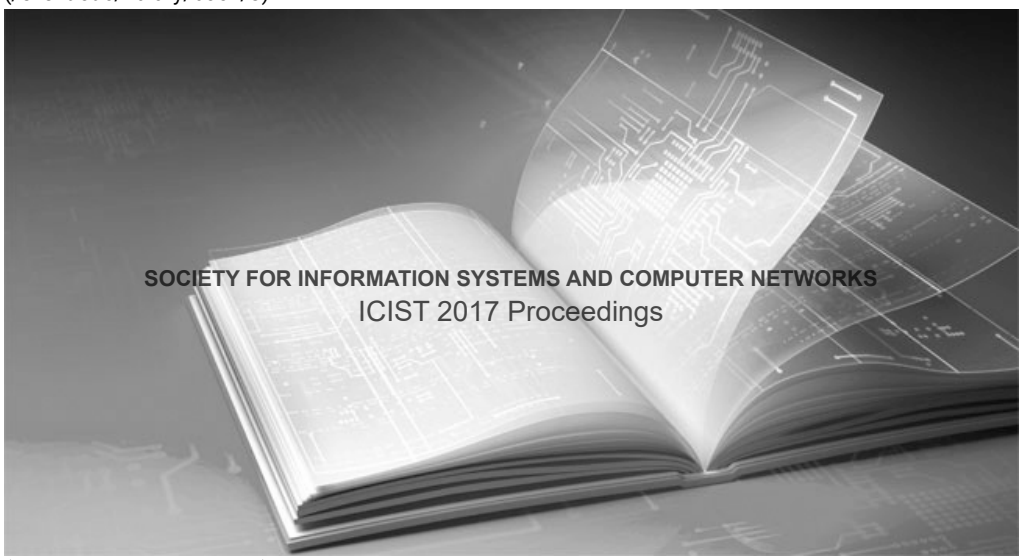

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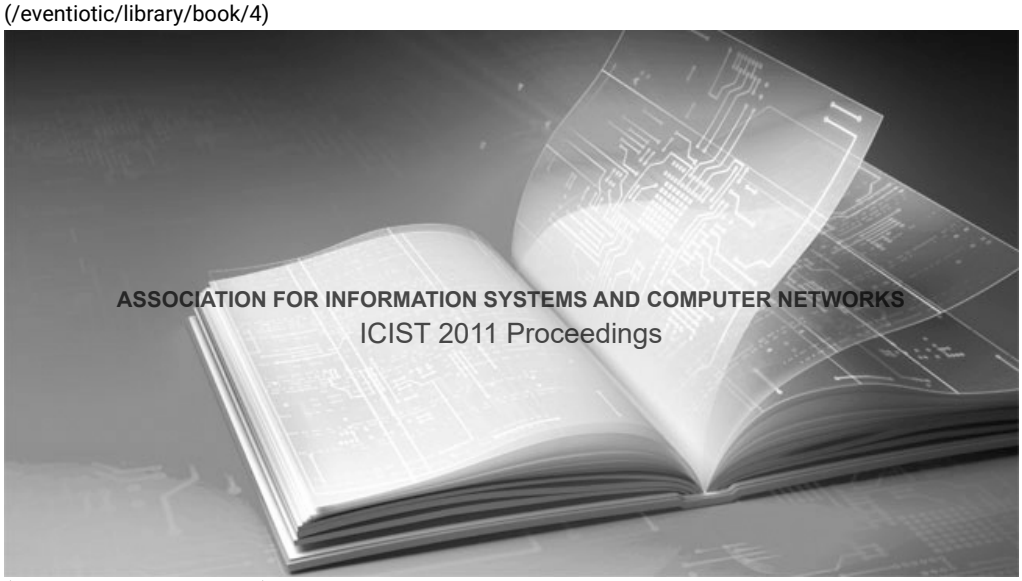

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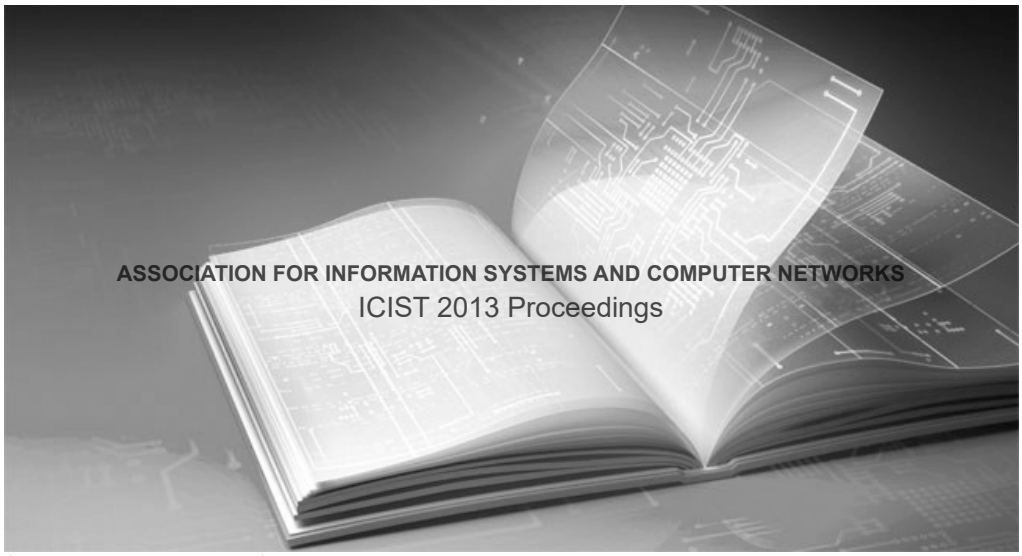

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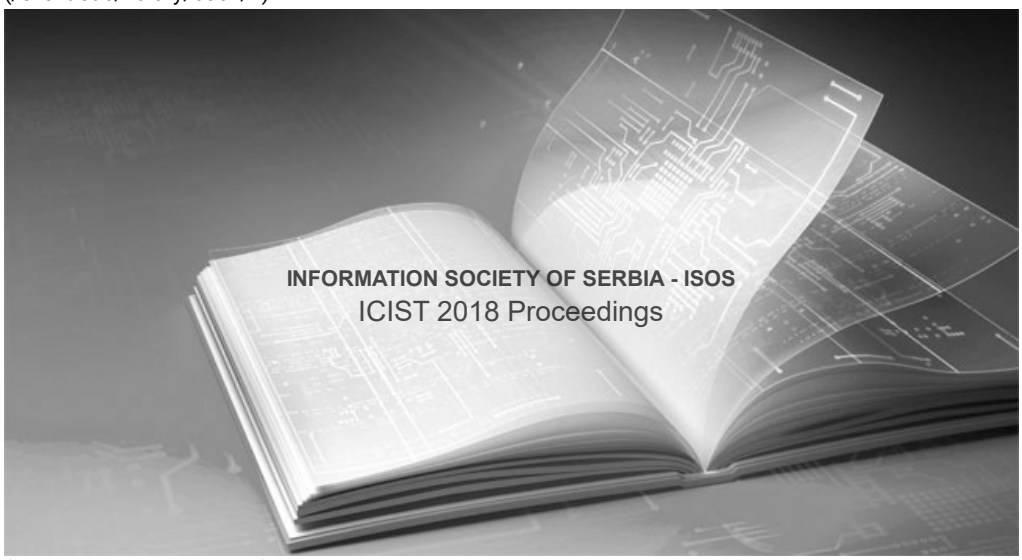

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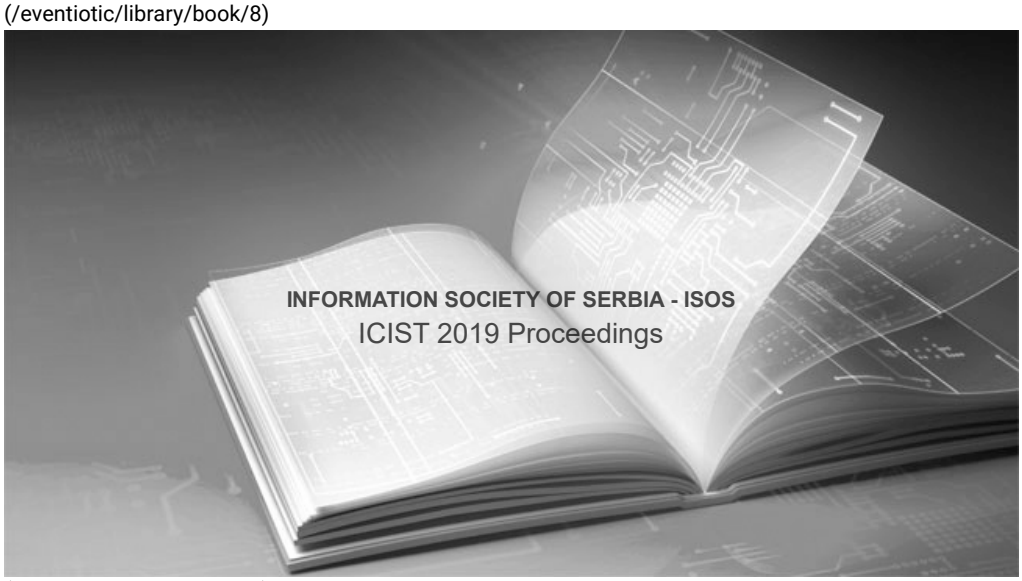

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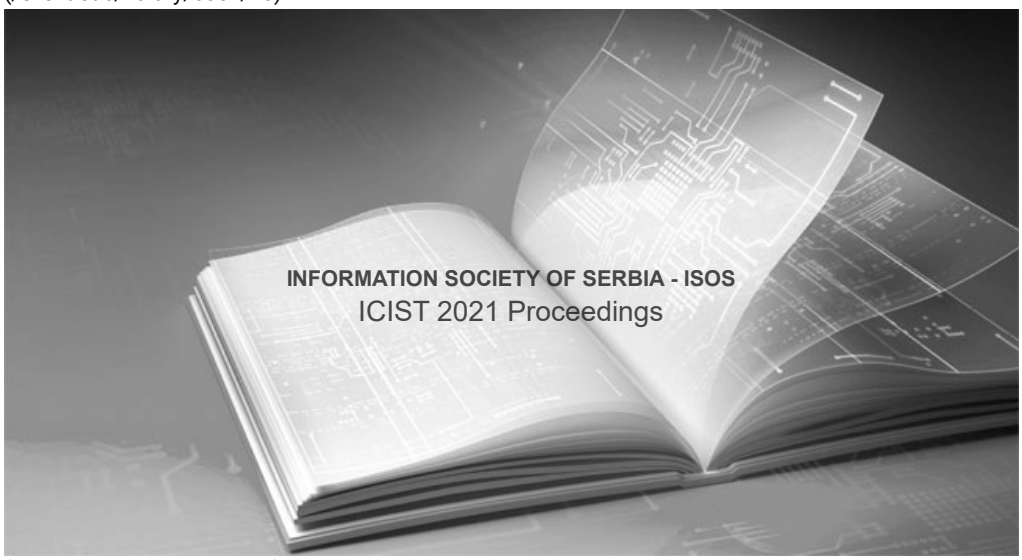

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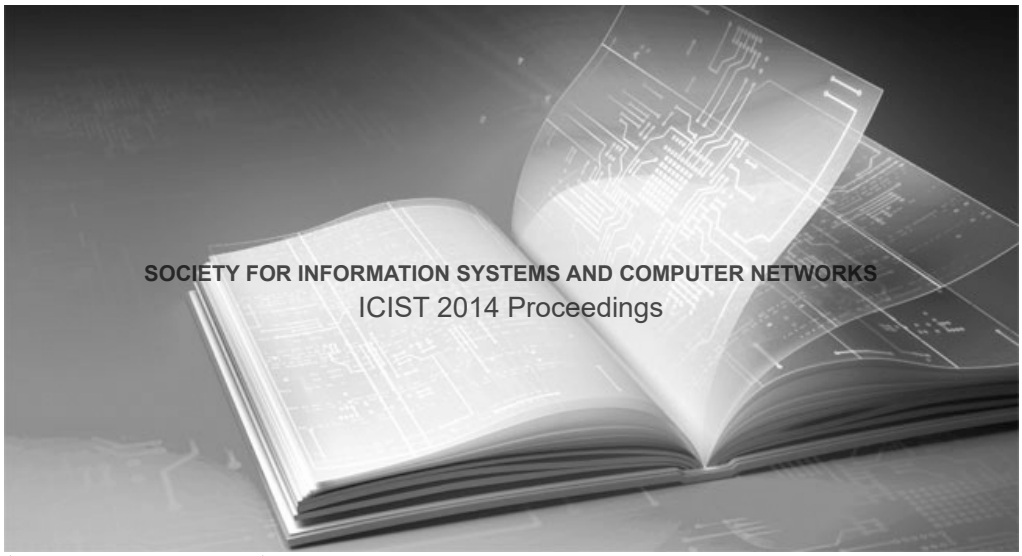

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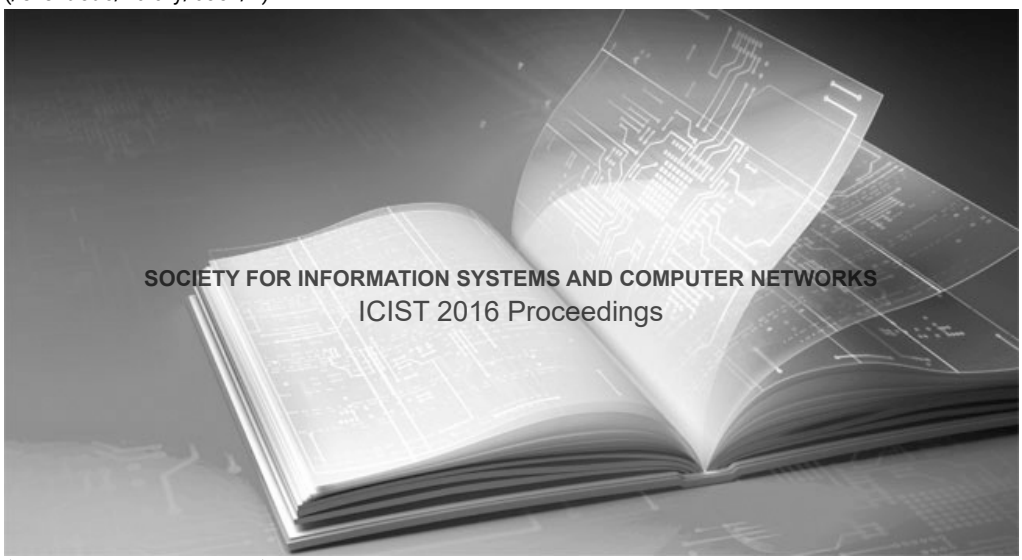

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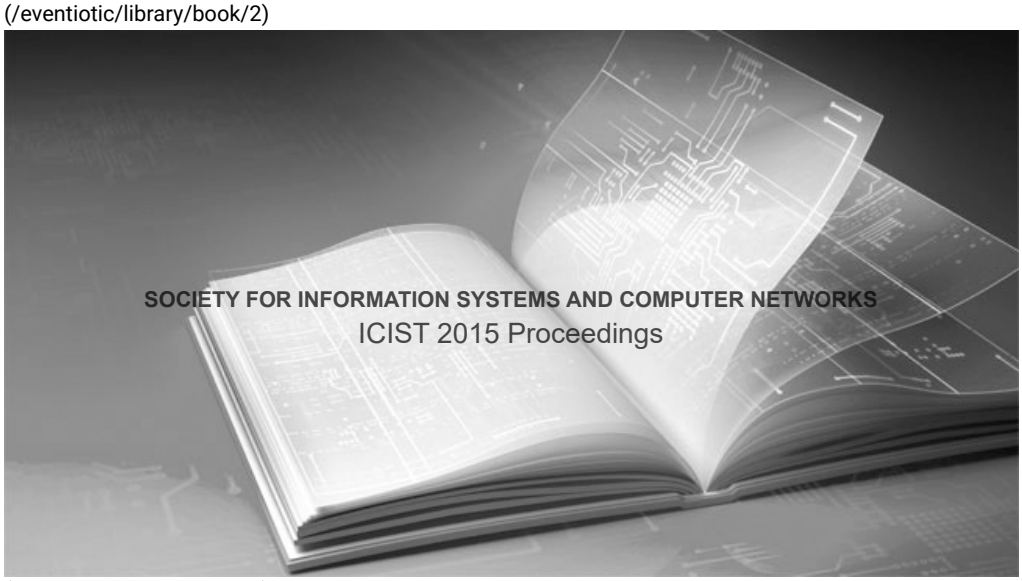

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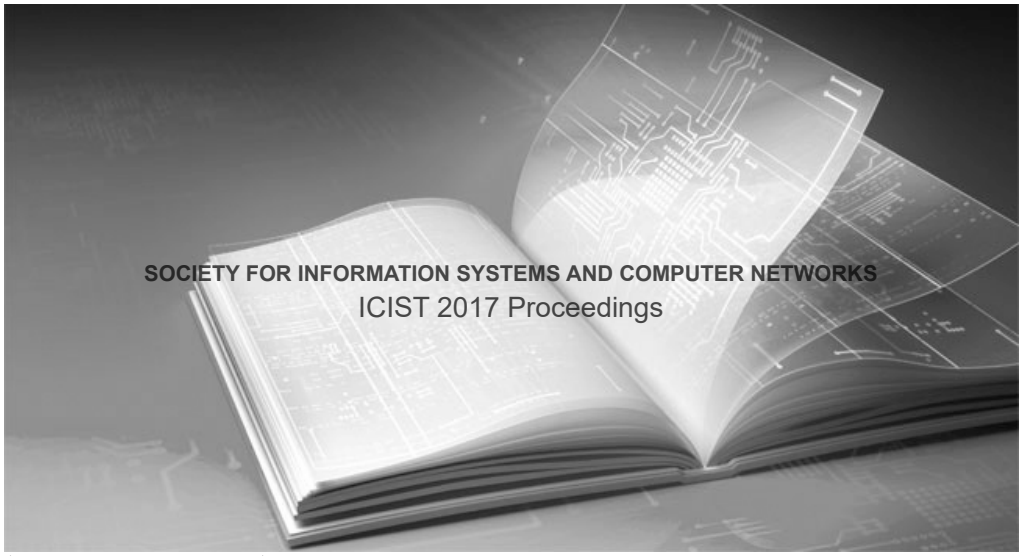

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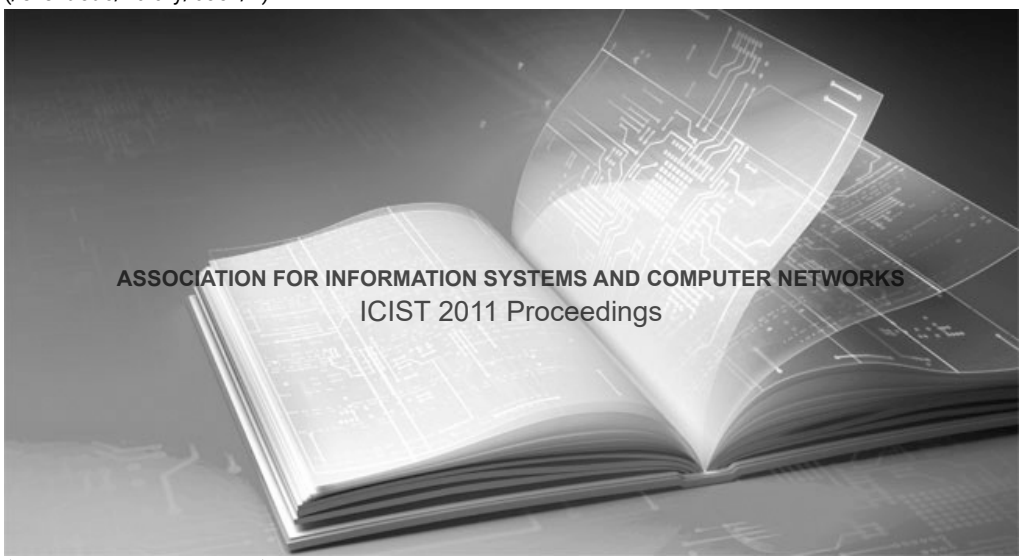

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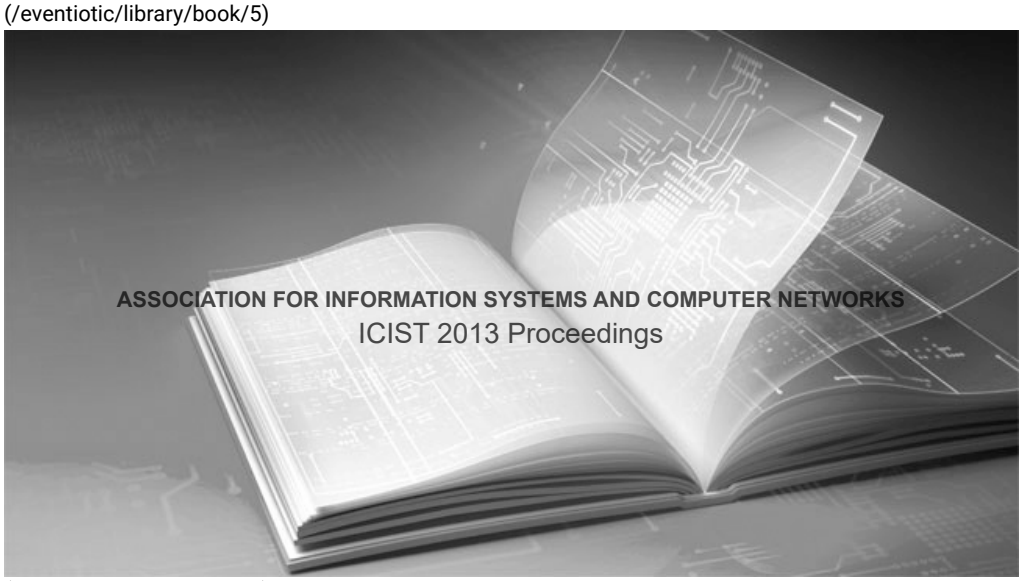

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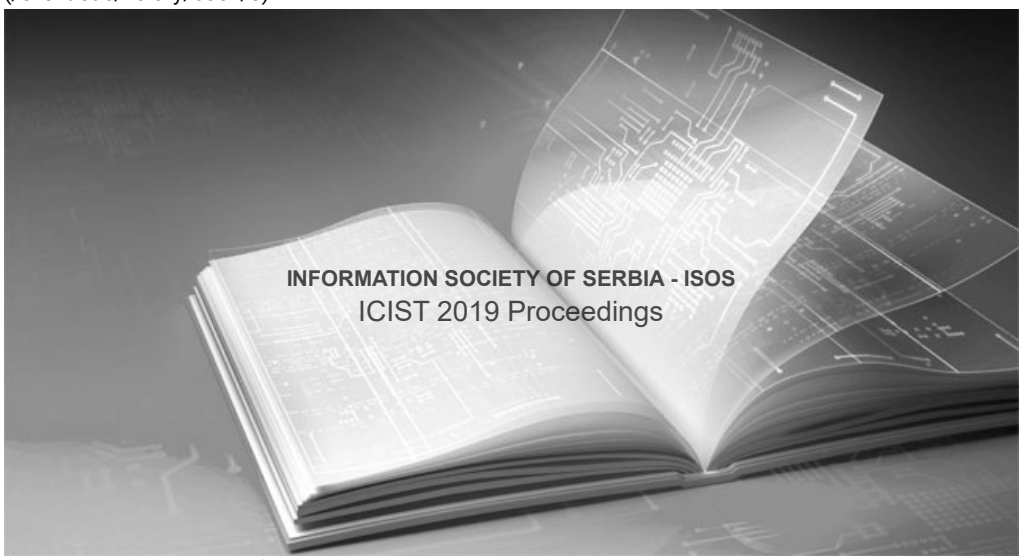

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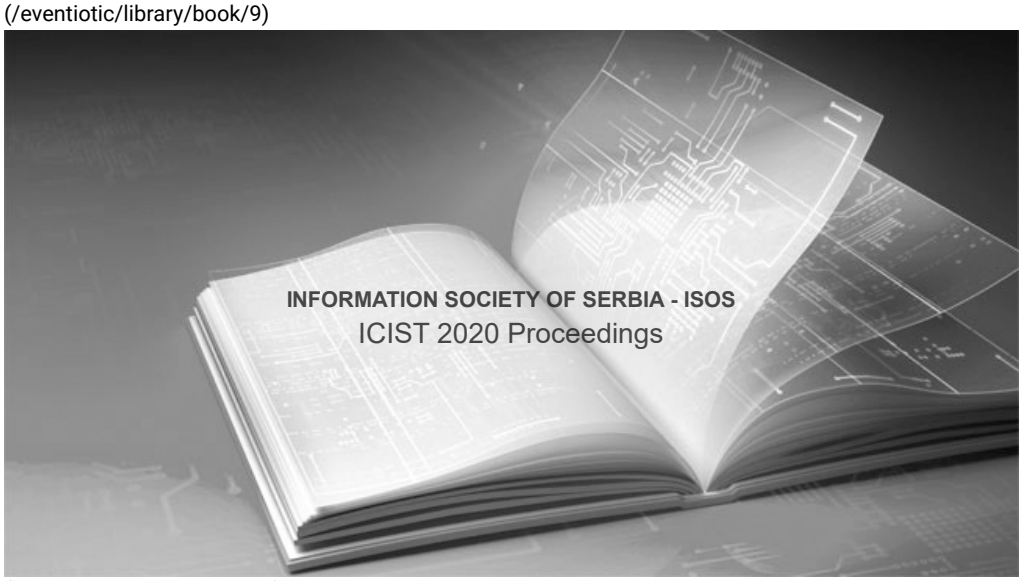

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Automation of psychological testing of stressful situations in the Serbian language

Ulfeta Marovac*, Adela Ljajić*, Aldina Avdić*, Anida Fazlagić*
* State University of Novi Pazar, Vuka Karadžića bb, 36300 Novi Pazar
umarovac@np.ac.rs
acrnisanin@np.ac.rs
apljaskovic@np.ac.rs
anvrcic@np.ac.rs

***Abstract*— People are increasingly exposed to stress today, hence the care for their mental health is even more significant. The lack of time often does not allow that people discuss with professionals about stressful situations, but the answers to these problems are searched through the Internet such as the experiences of other people. Definition of a stressful situation is the first question. People react differently to certain stressful situations depending on the moment in which they are happening and their psychological state. The perception of a situation as stressful can be an indicator of the existence of a problem. This paper presents the model of the crowdsourcing platform that serves to gather information of stressful situations, individual reaction to the given situation, the comment of professionals on the problem, as well as the assessment of the psychological state of the user through a psychological test. Such a platform is a unique platform of this type in the Serbian language. The users of this platform get information about the relationship between the stressful situation and the corresponding psychological state. For the purposes of this paper, the platform is developed for the case of postpartum depression.**

I. INTRODUCTION

Studies of traditional psychology are based on various techniques for data collection. The collecting of data is usually done through psychological tests, with a defined scale of assessment. The problem of the validity of psychological tests is the objectivity of a respondent. Psychological analysis is more complete if it is done through a structured or semi-structured interview. A large number of people are trying to solve their problems through electronic social networks. Many psychologists research electronic media in order to capture available data and analyze them from the perspective of clinical and medical psychology. The application of information technologies in health systems is known as e-health and it increases the efficiency of the standard health care systems [1]. Creating a system that automatically processes psychological tests and interviews will be of great benefit to everyone. This system cannot replace psychologists and psychiatrists, but it can direct people with potential problems to seek professional help.

In this paper, we will present a model of the system for providing support to women during and after the pregnancy that may have some specific psychological problems. The current statistics show that stressful situations in this period accelerate the current psychological state of women that in 10% of cases leads to postpartum depression. The practical aim of this study is to discover this form of depression through an online crowdsourcing platform to support pregnant women and mothers in stressful situations. There are standardized psychological tests to determine this type of depression, but they are not completely reliable due to non-objective respondents. By using information technology, alternative ways of diagnosing these problems can be found. Free text that is available in various forums can sometimes be a better indicator of whether a person really has a problem. The processing of free text is a great challenge. The presented platform should process a free text, and by using text similarity, it will give some answers to the problem. In order to make text-based conclusions more precise, it is necessary to have as large a sample of texts already associated with a certain diagnosis. The presented model is based on crowdsourcing and is specific because it was made for the Serbian language.

II. SYSTEMS FOR AUTOMATED DATA COLLECTION

The term crowdsourcing is a method for collecting data based on users who volunteer in the process. This method provides collecting a large amount of data for a short time.

The basic idea behind this principle is the goodwill of a group of people to take on some business and volunteer for it or for some fee. Therefore, crowdsourcing is a modern way of using collective intelligence, whose advantages are recognized in many areas, such as problem-solving, decision making, etc. [2].

Applications based on crowdsourcing are used in the implementation of voting systems (eg. Amazon Mechanical Turk, [3]), information sharing systems (Quora, [4]), games (Google Image Labeler) and creative systems (TopCoder [5]), etc.

III. SYSTEMS FOR SELF-DIAGNOSIS OF MENTAL DISEASES

Self-diagnosis is a conclusion about your health based on a medical questionnaire. This conclusion can be made anywhere and at any time in an electronic healthcare platform. Examples of such programs are described below.

CPSK [6] is a self-examination program for elementary school students, designed to detect possible mental problems in the early stages. AMPK [7] is a test for measuring the level of care, anxiety, violence, and obsession among young people aged 12 to 18. PSS [8] is a test used to measure the level of stress over a period of one month. SBK-R [9] is a test to determine whether the patient is suicidal. Chiang et al. [10] described the criteria

for measuring the level of depression based on crowdsourcing and within the framework of a smart healthcare platform. The disadvantage of these programs is that they do not support automation and are not intended for the language spoken in our area.

IV. PROPOSED MODEL OF SYSTEM FOR SELF-DIAGNOSIS OF PSYCHOLOGICAL PROBLEMS

Tests are psychological measuring instruments. They consist of various questions, tasks or claims. When a person performs a psychological test, their answers are compared with the values obtained on the population, thus determining the position of the individual and analyzing possible deviations. Such tests, where there are clearly defined limits for which the psychiatrist makes conclusions, are often available on the Internet. With these tests, the subject can come to the conclusion, but this is by no means an end to diagnosis, but simply an indication of the existence of a particular psychological problem. The second type of psychological instruments are interviews, which make a qualitative analysis of the answers and evaluate the unique characteristics of the person, using responses to the questions asked. The analysis of these tests is difficult for automatic processing and is very important. The significance of the interview is reflected in the objectivity of the interviewee himself. Predictability of outcomes in solving appropriate psychological tests leads to nonobjectivity, that can be a major problem in solving tests.

The proposed solution is based on crowdsourcing with the aim to detect postpartum depression and give some helpful information. Online crowdsourcing platform should be the mediator between people who have the same interests and problems.

The goal is to motivate the critical population to leave their experience as a significant source of new information and to mark the appropriate data in some way through psychological tests in self-diagnosis.

One of the tasks of this platform is to motivate users to leave their experience in the form of free text as a significant source for research. Through the psychological test, users give the link of the psychological state which they described with their results of the test. So free text data would be marked with the degree of depression.

Participants of this crowdsourcing are pregnant women and mothers. Considering the great obligations women have in this period, they often ask for a quick solution to the problem on social networks. Identification with the group and the experience of women who found themselves in the same situation is important to support women who are in a new situation and often with psychological problems. The platform solves the usual psychological problems that arise and determines the correlation of problems with postpartum depression.

In order to solve the problem of automating the analysis of the psychological state in stressful situations, the crowdsourcing platform allows users to enter information about the stressful situation they have experienced and describe their feelings in the form of free text and to do a psychological test (which is automatically processed). The classification of free text that describes the stressful situation and feelings leads to the connection of the corresponding reactions on the stress with the results of psychological tests. The system will display an example of the diagnosis of postpartum depression.

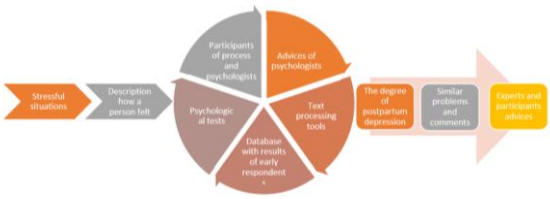

Figure 1. The conceptual model for the proposed solution

The picture represents the conceptual model of the crowdsourcing platform. The input is stressful situations of the respondents, as well as the problems or feelings caused by this situation.

Objectivity is very important in this process so that the part in which the user presents the problem is on the beginning before the psychological test makes a potential influence on it and reduces the objectivity of answering. The next step is the psychological test that automatically processes and estimates postpartum depression based on the Edinburgh scale of postpartum depression (EPDS) [11]. The system finds the most similar situations and feelings that follow them and provides the advice to appropriate users given by psychologists. The advice is based on input data, and also provides an overview of the relationship between the described psychological state and postpartum depression.

Problems that arise when performing crowdsourcing tasks are related to the human factor and platform. Understanding the human motivation and behavior of a related group of people is important in order to motivate the participants to do a good job. That's why the platform itself has to be designed to attract the attention of participants providing additional information. There is no similar portal dealing with self-diagnosis of postpartum depression in Serbian language, so the significance of this platform is even greater.

V. SYSTEM ALGORITHM

Figure 2 shows a detailed algorithm of the system for self-diagnosis of psychological problems for pregnant women and mothers. As shown in figure 2, the participants of this system are pregnant women and mothers, as well as psychologists who provide expert advice based on the information provided and the results of the test.

Psychologists do not respond to each individual situation but start with those that are at least similar to situations that have already been processed. In this way, expert assistance is effectively used. Each user also performs a psychological test and gets the test results for postpartum depression.

A. Processing psychological tests

Psychological tests are processed automatically. To determine postpartum depression, the Edinburgh scale is used, with a score greater than 12 indicating the postpartum depression. EPDS is one of the most

commonly used scales for assessing depressive symptoms for women who have given birth. The respondent estimates the weight for ten different depressive symptoms in the past seven days on a scale of 0 to 3 [11]. The possible range of results is from 0 to 30, where higher scores refer to more difficult symptomatic. The items on the scale refer to the assessment of the possibility of experiencing joy, concern, guilt, sorrow, then self-harming, etc.

This scale evaluates mainly the psychological symptoms of depression while interpreting physiological symptoms through one item related to the assessment of sleeping ability. The authors found that with the critical result, the 12/13 sensitivity of the scale was 86%, the specificity was 78%, and the total positive predictive validity was 73%. The EPDS scale is validated and translated into a number of countries and is actively used to screen and diagnose postpartum depression.

It should be noted that this is a screening instrument that is rarely used for the purpose of diagnosing elevated depression. In the research by Fazlagić [12], through this instrument on a random sample, the postpartum depression rate was found to be above 12% for 29% of mothers.

In addition to the results obtained using the test, the patient receives additional advice from a psychologist if there is a similar situation in the database and the accompanying psychological condition caused by this situation. If it does not exist, the user is given examples of how others felt in the given situations and how much this condition is related to the results of a psychological test.

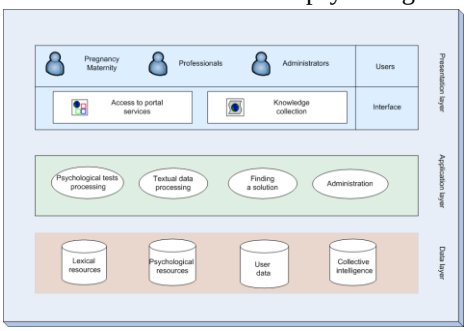

Figure 2. The architecture of the Proposed System

B. *Processing textual data*

Text data inputs are in raw format and are necessary to be preprocessed to be ready for machine processing. Preprocessing is performed in several steps (Figure 3):

- Tokenization - separating on tokens, discrete parts of the text (words, numbers, punctuation marks) and removing redundant characters
- Removing stop words - words that do not carry meaning (adverbs, prepositions, pronouns, ...)
- Reducing different forms of the word on its root (stem or n-gram) [13]
- Splitting text to sentences
- Extracting key terms
- Representing documents in the form of a word-vector.

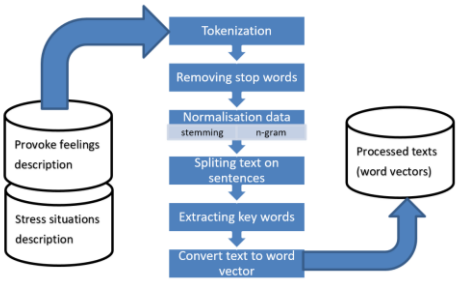

Figure 3. Textual data processing

C. *Data reduction*

In order to shorten the process of obtaining the most adequate response, the size of the data should be reduced. Appropriate input texts (descriptions of stressful situations or description of induced reactions and feelings). In order to reduce the size of the text while preserving the meaning, the text will be presented using a word vector. Words that carry the essence of the meaning of the text should have more weight than other terms. Therefore, the text will be transformed into word vectors with associated weight <term, weight>. The *f_tw* function for calculating the weight of a word will be defined as follows in (1).

$$f\_tw: term \rightarrow term\_weight$$
$$f\_tw(t)\begin{cases} 0, & t\text{-}stopword \\ tfi\text{-}df, & t\text{-}keyword \\ a*tfidf, & else. \end{cases} \quad (1)$$

Stop words (adverbs, prepositions, conjunctions, exclamations, words, pronouns) are words that do not carry the essence meaning in a text and therefore they will be removed from the text. After removing the stop word, text transformation is done in the vector word with the associated frequency. In order to extract words that carry the essential meaning of the text, coefficients *tf* (term_frequncy) and *idf* (inverse document frequency) are calculated. These coefficients serve to create words based on a corpus of similar texts in a document appearing in it with a higher expectation than is usual. *Tf* is calculated as given in (2) and equation for *idf* is (3).

$$tf = \frac{\text{frequency of a term in the text}}{\text{total number of terms in the text}} \quad (2)$$

$$idf = \log\left(\frac{\text{total numer of texts}}{\text{the number of texts with term}}\right) \quad (3)$$

For keyword, one can choose words with tf-idf> 1 or a certain number of words in which tf-idf is the largest. When comparing, only the keywords can be considered (in this case a = 0) or all words but with the associated weight (0 <a <1).

D. *Similarity search*

The algorithm for comparing stressful situations (or feelings) by similarity includes the following steps:

1. Select a stressful situation for comparison;
2. Compares the current description of the stressful situation with descriptions of all other stressful situations from the knowledge base in the following way:
    a. Normalize the descriptions of stressful situations
    b. Create a word vector from the selected description of the stressful situation
    c. Compare the word vectors describing the stressful situations by similarity, using the cosine similarity algorithm
    d. If the result of the comparison of the selected and current vector of stressful situations is greater than zero, give the current name of the stressful situation to a series of similar names of stressful situations.
3. Repeat step 2 to describe stress situations.

Evaluating similarity between word vectors (stressful situation descriptions) is done by cosine similarity algorithm [14]. Figure 4 shows the pseudocode of evaluating the similarity between word vectors of stress situations.

```
Algorithm 1: SituationSimilarity(Situation s1, Situation s2)
1: SumTwS12=0;
2: ProductTwS12=1;
3: TwS11=0;
4: TwS22=0;
5: foreach Word ∈ s1
6:     begin
7:     TwS12=f_tw(Word,s1)* f_tw(Word,s2);
8:     SumTwS12+=TwS12;
9:     TwS11+=f_tw(Word,s1)* f_tw(Word,s1);
10:    TwS11+=f_tw(Word,s2)* f_tw(Word,s2);
11:    end;
12: ProductTwS12=sqrt(TwS11)* sqrt(TwS22);
13: if (ProductTwS12!=0)
14:    CosSimS12= SumTwS12/ ProductTwS12;
15: else
16:    CosSimS12=-1;
17: return CosSimS12
```

Figure 4. Evaluating similarity of stressful situations

VI. CONCLUSION

The paper presents the model of online crowdsourcing platform that enables efficient provision of psychological assistance and self-diagnosis of psychological problems for pregnant woman and mothers. Providing such specific support is very important for platform users, but also for creating collective knowledge that can serve to detect these problems in social networks, for example.

There is no similar portal dealing with self-diagnosis of postpartum depression in Serbian language, so the significance of this platform is greater.

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ACKNOWLEDGMENT

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