

Usability Prediction of ‘Live Auction’ Using Multistage Fuzzy System

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Abstract: In the recent decade, usability prediction has become a relevant research field. It is also helpful in enhancing the software quality. This study is an extension of the research done by the same researchers. In this study, we are predicting the total usability of a web application using multistage fuzzy system. To reduce the total number of fuzzy rules, the fuzzy system can be multistage by grouping the usability factors. In this research, initially a dataset for ‘Live Auction’ web application is created and made it publicly available, then the total usability is predicted for the same using multistage fuzzy system. The ranking of players has been implemented using SOWIA-MOORA method in the created dataset.

Key words: Usability prediction, fuzzy system, SOWIA-MOORA, live auction, dataset, initially

INTRODUCTION

During the last decade, the need of the quality software systems is exponentially increased. Software usability prediction has been recognized as an essential factor in improving the software product quality and the latest literature shows that the success and failure of a software system depends on its usability prediction. According to ISO. (1998), usability is defined as “the extent to which a product can be used by specified users to achieve specified goals with efficiency, effectiveness and satisfaction in a specified context of use”. The number of usability attributes have been identified in their usability model by different researchers (Abran *et al.*, 2003; Bevan and Macleod, 1994; Molich and Nielsen, 1990; Nielsen and Loranger, 2006; Nielsen, 1993; Wharton *et al.*, 1994; Gulati and Dubey, 2012).

Several studies have shown the advantages of incorporating usability prediction in the process of software development. Therefore, usability evaluation has become a significant and relevant research area. Usable software systems are much more successful as they are more accurate, safe, efficient and effective. However, there is a lack of commonly used standard dataset of usability. A number of usability models have been proposed by various standards and researchers but none of them defined the usability dataset for usability prediction. In lucid language, usability is the ease of use, learnability and remembrance of a human-made object. The object can be a website, software application, tool, book, machine, process or anything a human interacts with. A usability study must be conducted as a primary job by usability analyst or as a secondary job by designers, marketing

personnel, technical writers and others. In this research, we initially create a standard dataset for the ‘Live Auction’ web portal and then predicts its usability using multistage fuzzy system. This study is an extension of the (Gupta and Ahlawat, 2016) of same researchers, (Deepak and Anil, 2016) proposes the multistage fuzzy system for determining the usability of a website or software product, if the values of the seven factors are known.

MATERIALS AND METHODS

Multistage fuzzy system: According to Gupta and Ahlawat (2016), the usability can be easily determined for a software product using multistage fuzzy system. The fuzzy system accepts the seven inputs or usability factors and generates the total usability of the software product. Multistage fuzzy system consists of 7 factors representing a specific facet of usability; these factors are decomposed into a total of 23 attributes which are further divided into 42 characteristics. The factors, attributes and the characteristics are related to each other in a hierarchical manner. The 7 factors include efficiency, satisfaction, effectiveness, memorability, productivity, security and universality. Based on these factors, the 23 attributes are quantifiable which consist of either a fuzzy rule or countable data.

The multistage fuzzy system consists of membership function of each input (7 factors) and output (usability). For each member function, linguistic values are defined ranging 0-9 and certain fuzzy rules are defined and on the basis of these values and rules the fuzzy logic controller generates the desired output.

Fuzzy system: Considers all the usability factors together to generates too many rules and additionally it is difficult for the experts to consider all formulates rules with proper emphasis, since, each input parameter has 3 linguistic values (low, medium and high). Therefore, we have decomposed the factors into sub-categories just to minimize a huge number of rules. To reduce the total number of fuzzy rules, the fuzzy logic controller can be multistage by grouping the 7 factors as given:

- Software related group consists of effectiveness, security, universality and productivity
- End user related group consists of efficiency, memorability and satisfaction

Total six Fuzzy Interface System (FIS) namely 1-3, end-user and US have been created in Matlab using a fuzzy logic toolbox. Consequently, input/output variables, their membership functions and fuzzy control rules have also been created for each FIS. The input/output of each FIS can be seen from (Gupta and Ahlawat, 2016). Figure 1 shows a fully functional the fuzzy logic model.

‘Live auction’ web application: Auction is a process of bidding war for an item, valuable or service between interested auctioneers/parties. In the present scenario, it would be undesirable to ask an individual to leave his/her comfort zone and be available at a common location for bidding. It would also not be apt to ask individuals to involve in the process of auction by physical gestures when same can be achieved by click of a mouse. Thus, live auction (ISO., 1991) takes this plight of bidding individuals into consideration and makes the process automated. This not only allows the individuals to easily get involved in the process of the auction but also makes the process visually more informative and attractive. The server controlled by auction administrator, displays all the information needed by the administrator for proper conduction of the process. The client, used by individuals engaging in bidding war, enables them to be well informed about the player that is up for the auction, including all the stats available on the player and helps them make a much more.

The live auction web application has been designed and created using Java and NetBeans and the ranking of players have been implemented using a mathematical multiple criteria based performance evaluation model consisting of SOWIA (Subjective and Objective Weight Integrated Approach) and MOORA (Multiple Objective Optimizations on the basis of Ratio Analysis) methods (Das *et al.*, 2013). Sowia-MOORA method is choosen as it helps to determine the relative importance of criteria, understanding of different experts in the form of subjective weight, ranking of players, stable, less

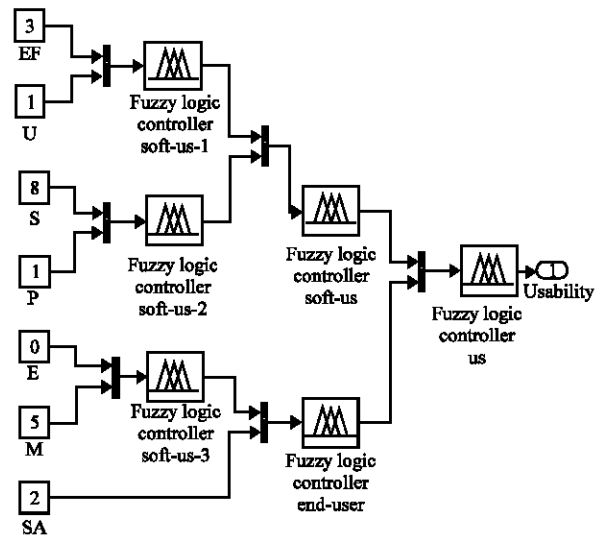


Fig. 1: Multistage fuzzy system for usability prediction

computational time, minimum mathematical calculations involved. The input of SOWIA-MOORA approach is the IPL_Records consisting of number of matches, runs, strike rate, average, fifties, hundreds and the output is rank of each player. The input and output snapshot can be seen in Fig. 2 and 3, respectively. Thus, the live auction application have been designed successfully.

RESULTS AND DISCUSSION

Evaluating dataset: The collection of related, discrete items of related data called dataset. It may be accessed individually or in combination or managed as a whole entity. In this study, we will discuss the methodology of the dataset creation on the basis of the 7 usability factors, i.e., efficiency, satisfaction, effectiveness, memorability, productivity, security and universality and their 23 attributes (Gupta *et al.*, 2014). The attributes of these three factors are given in Table 1.

Aim and objective: The aim of this research is to investigate the usability attributes in the valuation of the usability of a ‘Live Auction’ web application. The specific objectives for the research are:

- To ask usability experts and students to give the answers of the questions given to them related to ‘live auction’ web application
- To use the answers given by usability experts and students, compute the values of usability attributes (weights)
- To use the weights of usability attributes and probability theory, compute the total weights of usability factors

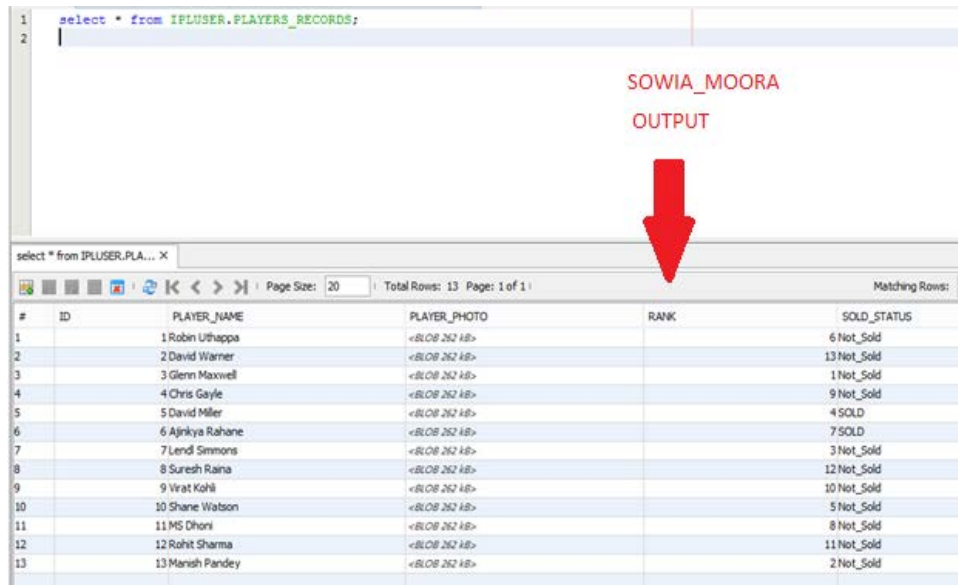


Fig. 2: Input of SOWIA-MOORA approach

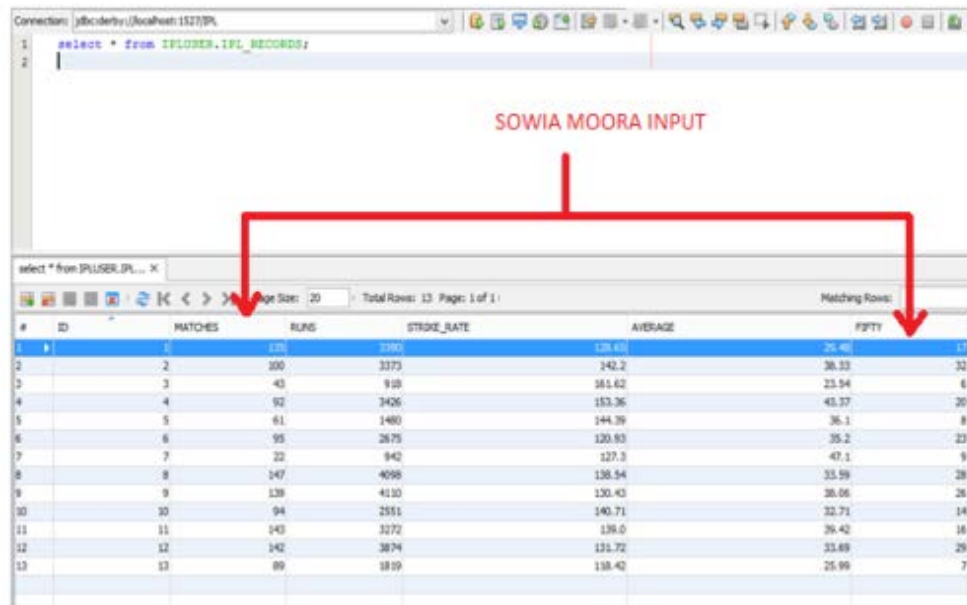


Fig. 3: Output of SOWIA-MOORA approach

Table 1: Attributes associated with the usability factors

Usability factors	Attributes
Efficiency	Resource, time, user effort, economic cost
Effectiveness	Task accomplishment, operability, extensibility, reusability, scalability
Satisfaction	Likeability, convenience, aesthetics
Memorability	Learnability, memorability of structures, Comprehensibility, consistency in structures
Security	Safety, error tolerance
Universality	Approachability, utility, faithfulness, cultural universality
Productivity	Useful user task output

- Usability factors are used as an input to multistage fuzzy system and computes the final usability value

Participants/sample: The participants in this study were usability experts, faculties from engineering background and some undergraduate students enrolled as engineering students (B.Tech.) related to two branches (Computer Science and Engineering and Information Technology). The total number of participants were 596, the number of males was 399 while the number of females was

197 (Table 2). The 407 provided usable responses. Demographic information concerning the students is shown in Table 2. The students in each batch carried out the procedure on live auction web portal. The web portal was evaluated by six classes (three batches from each branch) (Fig. 4).

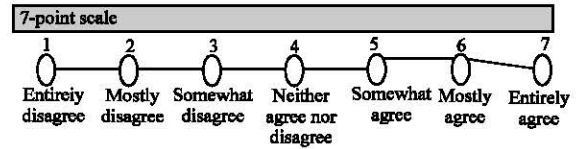


Fig 4: Likert 7-point scale

Procedure: All data collection sessions followed the same procedure. Data were gathered using the survey in India where all experts, faculties and students had access to the internet. The session began with the researcher welcoming the all and explaining the objectives of the study; the web application that would be evaluated; the number of survey that needed to be filled in and participant’s right to withdraw from the session at any time. The participants were then asked to fill in the pretest questionnaire in order to obtain information regarding their background and experience. Then, the participants were asked to provide their perceptions of the usability attributes (weights) using the survey.

On the basis of the survey conducted and the response collected by various experts and users, all the 23 attributes are assigns a value on the likert 7-point scale as seen in Table 3.

Table 2: Demographic information of the research participants

Variable	Branches		
	CSE	IT	Total
Sex			
Female	185	93	278
Male	73	56	129
Computer experience			
<1 year	5	16	23
From one to			
3 years	194	154	348
>3 years	15	23	38
Internet experience			
<1 year	20	18	38
From one to three years	125	72	197
>3 years	77	75	142
Frequently use of internet			
Daily	93	39	132
Weekly	59	43	102
Monthly	43	77	120
By Semester	6	17	23
Yearly	0	0	0

Table 3: Values of each attribute for the live auction

Factors/Attributes	Explanation	Live auction
Efficiency		
Resource	It is a measure of following resource related attributes for successful completion of tasks by user	6
Time	It reflects capability of software product in term of time investment for activities includes in performing actions by users, response time by system, time spent on errors and memory Load	7
Economic cost	It involves following expenses required for software	5
User effort	It reflects capability of software product for producing desired results with respect to physical and mental efforts that user invests	6
Effectiveness		
Task accomplishment	It is a measure of software product in which user can perform his task with successful accomplishment of his goals	6
Operability	It is a measure of software product which helps user to perform required functionalities in tasks with accuracy	6
Extensibility	It is a measure of adaptation of software product with respect to changing needs of user	4
Reusability	It is a measure with which software product can be reused in another application	5
Scalability	It is the ability of software product to continue to function well when it is changed in size or volume in order to meet a user need	4
Satisfaction		
Likeability	It is measure of software system to maintain the attention of all kinds of user	5
Convenience	It is a measure of software product that builds strong attitude of user towards its design	5
Aesthetics	It is a measure of software system to attract its user in sensorial terms (visual, olfactory)	5
Memorability		
Learnability	It is a measure with which user can easily learn the software system in minimum amount of time	7
Memorability of structures	It is that property of software system that helps the user to remember structure, elements and functionality of software system	6
Comprehensibility	It is a measure with which software system has clarity to the user i.e. clarity of elements/structure/functioning	6
Consistency in structures	It is that property of software system that develops uniformity in system	5
Security		
Safety	It is defined as capacity of software system so that risks can be avoided	5
Error tolerance	It is a measure with which software system can withstand in error occurring environment	4
Universality		
Approachability	It is a measure of software system which can be defined by usage of large numbers of users regardless of any physical and psychic features (disabilities, age etc)	5
Utility	It is a measure of software system which helps the users when they don't remember about usage of the system	5
Faithfulness	It is a measure of faithfulness of software product that is delivered to its user	5
Cultural universality	It is a measure of software product with which user can use the system but from different viewpoint due to their cultural backgrounds	4
Productivity		
Useful user task output	It is a measure of useful output that is produced from interaction of user with software product	7

Table 4: Values of each attribute for the ‘live auction’ web application with final usability using multistage fuzzy system (IEEE, 1990)

Factors	Live auction	Soft-us-1	Soft-us-2	Soft-us-3	Soft-us	End-user	us
Effectiveness	6.42						
Universality	6.10	5.499					
Security	5.78		4.5		5.499		
Productivity	9.00						5.4998
Efficiency	6.42			5.5		5.5	
Memorability	7.71						
Satisfaction	6.42						

Usability prediction of ‘live auction’ using multistage fuzzy system: The intuition of chance and probability develops at very early ages (Piaget and Inhelder, 1976). However, a formal, precise definition of the probability is elusive. The probability of an event tells that how likely the event will happen. Using the probability theory, the values of the three usability factors can be mapped on the scale of 0-9 as shown in Table 4. The Factor value can be computed by finding the probability using the following equation:

$$\text{Factor}_{\text{value}} = \left(\frac{\sum \text{attributes value in a factor} * \text{Max}_{\text{value}}}{\text{Total number of attributes} * \text{Max}_{\text{value-of-likert-scale}}} \right)$$

Where:

Factor_{value} = The value generated for each factor of a live auction

Max_{value-of-likert-scale} = The maximum value of the scale, i.e., 7

Max_{value} = The maximum value of the scale, i.e., 9 as we are mapping it in scale of 0-9

The final usability value of the created dataset for live auction web application comes out to be 5.4998.

CONCLUSION

In this study, initially, we have created the ‘live auction’ web application using SOWIA-MOORA approach for ranking of players, then some questions have been generated related to ‘live auction’ and collect the responses from the usability experts, faculties and students. The ‘live auction’ dataset has been created successfully. We have successfully predicted the usability of the ‘live auction’ web application using multistage fuzzy system and it comes out to be 5.4998.

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