Web Page Interface Optimization Based on Nature-Inspired Algorithms

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ABSTRACT

This article describes how the conversion rate of a web page depends on the interface usability degree. Optimization of existing interfaces as the matter of improving their usability faces a number of difficulties. In the first place, the unified objective function selection method for such optimization is not set up; that is resulting in necessity of qualified experts’ participation for its implementation. In the second place, the corresponding optimization problem will have a high dimension, which makes the classical optimization methods unsuitable for the problem solution. Nature-inspired algorithms have undeniable advantages in comparison with classical optimization algorithms for solving high-dimensional problems, such as for example the optimization of web interfaces by their usability criterion. In this article, new web page interface optimization methods based on nature-inspired algorithms are proposed. In particular, genetic algorithms (GAs), artificial bee colony algorithms (ABC), and charged system search algorithms (CSSs) were analyzed. The conducted experiments revealed the advantages of these algorithms for posed problem solutions and showed research prospects in this direction.

KEYWORDS

Artificial Bee Colony Algorithm, Charged System Search Algorithm, Genetic Algorithm, Interface Heat Maps, Usability Optimization, User Experience, Web Interface

1. INTRODUCTION

The Internet is rapidly developing and the number of various internet resources is increasing nowadays. Daily users deal with various unique web pages with different interfaces. A lot of people spend time in searching the necessary information in the Net, comparing internet-store prices etc. In addition, being on a new page, users often display conservative attitude, which means leaving the page within first minutes due to unwillingness to waste time and feel mental workload of studying new interface. That can be reflected in the reduction of resource audience and hence financial losses for its owners.

This problem can be solved by such web page interface usability optimization that would allow users to avoid discomfort and annoyance. According to this, developers need not to create whatsoever interface but to develop the interface, which would (because of its high usability) attract as many potential clients as possible. Moreover, modern search systems are ranking search results on the basis of evaluating of user behavior which additionally increase high-quality interfaced resources traffic value (Bakaev, 2017). Generally, high-quality interface cannot be created in the first attempt, a
qualitative result can be reached only by a number of iterations. At the same time, interface optimization challenges some main difficulties.

Firstly, by reason of unified approach to quantitative measurement of interface usability and concerned with its usage mental workload (Paas & Van Merrienboer, 1993; Alfimtsev & Sakulin & Levanov, 2016; Grabish, 2006) absence, a need of objective function defensible choice for such optimization arises. Secondly, because of big amount if possible parameters and respectively, interface implementation variations (Alfimtsev & Sakulin & Levanov, 2016; Grabish, 2006), corresponding optimization problem will have high dimension. As a result, classical methods are not suitable for web page interface optimization. Thirdly, the people providing this optimization must have deep knowledge and experience in web interface development and modification which is often unapproachable. Due to this, a question of the development of web interface optimization methods which would let overcoming described difficulties or reduce their influence on the result becomes actual.

One way to implement such methods is using nature-inspired algorithms since they are preferable to classical ones in high-dimensional problems solution (Yang, 2014; Simon, 2013). The present paper is devoted to usage of such algorithms for web page interface optimization. Further paper has the following structure. In section 2, a review of literature from the fields of interface usability optimization, web page users’ behavior journaling, visualization and analysis is given; works devoted to nature-inspired algorithms usage for web page optimization problems solution are considered; a review of this algorithms and its practical application is given. In section 3 defined method implementation based on applying genetic algorithm (GA), artificial bee colony algorithm (ABC), and charged system search (CSS) algorithm is considered. As the optimization objective we chose interface approximation to the template which was pre-selected by heat maps corresponding to DOM-interface models. In section 4 based on defined algorithms interface optimization experiments are described and the obtained results are given. In section 5 conclusion based on experiments results is given and further research directions are proposed.

2. RELATED WORK

Different technologies of journaling, visualization and analysis of users’ behavior for evaluating interface usability are applied. In particular, leading search systems (Yandex, Google) provide journaling facilities of users’ behavior on web pages (Bakaev, 2017). Graphical representation of data in form of heat maps (Deu-Pons & Schroeder & Lopez-Bigas, 2014) allows showing with color mouse activity, mouse clicks, page scrolling, and path of user view movement on the page. For representing and analyzing of heat maps there can be used specialized toolset such as Crazy Egg and Heat Map (Babicki & Arndt & Marcu & Liang & Grant & Maciejewski & Wishart, 2016). Moreover, methods of objective data and expert knowledge display on the same heat map are developed (Danilov & Shulga & Frolova & Melnikova & Vagarina & Pchelintseva, 2016).

Data analysis for compliance with usability criteria and decision making about necessary interface correction are carried out on basis of checking recommendations related to usability (Dingli & Cassar, 2014). For instance, among such recommendations there are: web page usability user criteria (Alfimtsev & Sakulin & Levanov, 2016; Grabish, 2006), graphics and text proportion (Lin & Yeh & Wei, 2013), correspondence to design recommendations (Aizpurua & Harper & Vigo, 2016), taxonomy of menu properties (Bailly & Lecolinet & Nigay, 2016), interface optimization criteria such as efficiency of actions and responsiveness of the system (Feit & Bachynskyi & Sridhar, 2015) etc. However, this approach is restricted by the requirement of experts’ participation and the influence of certain subject field specificity on its result. In addition, every interface redesigning which complies with decisions made takes significant amount of time.

As it was mentioned, classical optimization algorithms are hardly suitable for solving high-dimensional problems. In this regard, to optimize the interfaces based on the data received from users
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