



Web-page Optimization to Reduce Web-page Load-time

Omkar Sawant*

Department of Computer Engineering,
Sinhgad Academy of Engineering,
University of Pune, Maharashtra, India

Sachin Godse

Department of Computer Engineering,
Sinhgad Academy of Engineering,
University of Pune, Maharashtra, India

Abstract— *In the era of Internet, webpage load time is one of the most critical issues the users are facing as it directly affects the user's satisfaction. A recent study has proposed the concept of 'Web Page Complexity' which eventually affects the web page load time. Webpage complexity can be measured using certain metrics. Though there have been extensive study regarding websites and its performance, little work has been done to understand how the complexity of an individual website can be measured and manipulated to improve the user's experience and reduce webpage load time. This paper tries to fill this gap by utilizing the concept of 'Complexity of website' and the metrics proposed by prior studies to measure and analyse the complexity of a website. In order to do so an Analyzer tool is proposed which will help determine the complexity of a website in terms of the complexity metrics. The analyzer tool will generate a report containing information regarding the nature of complexity of a website. According to recent studies there is the need to explore more systematic tools and mechanisms to improve webpage load time. Extending this line, this paper also aims to study the impact of optimization mechanisms to reduce the complexity of a website thereby reducing the page load time. However, this needs to be done by balancing the trade-off between webpage load time and the complexity of a website because measures taken to reduce page load time should not affect the user's experience and web publisher's revenue.*

Keywords— *Webpage Complexity, Webpage Load time, MIME Types, Non-origin Contribution, Webpage ptimization*

I. INTRODUCTION

The traditional character of every field in the life of mankind has been touched and changed significantly by the World Wide Web. With continuous upgradations to adapt to the changing situations and user's requirements WWW is becoming more and more complex. Web 1.0 which represented simple, static and text based information has now changed to the web 3.0 that characterises rich client and dynamic data processing [1]. However, with the changing nature of World Wide Web, many unprecedented demands and requirements have been arising from both from the users as well as the system.

Complete system of World Wide Web stands upon the entity called Web site. During the evolution of the Web, nature and orientation of websites has significantly changed. Though, these changes have added several new features to improve the performance of websites, they at the same time have caused the websites to become more and more complex and created several other challenges that need to be reflected upon and dealt with to move towards the next phase of the evolution in the Web.

Probably, one of the most important of these challenges is the increasing complexity of websites. Complex websites ultimately causes increase in load time of the website. Webpage load time is the time taken by the browser to render the complete page requested by the client. Once a website grows more and more complex its page load time increases at the same time[2]. This ultimately deteriorates user's experience and satisfaction. As user's experience and satisfaction are the essential parameters that determine the success of any technology, they must be considered with highest priority.

Complexity of Webpage:

Recently a study has proposed the concept of webpage complexity [2]. Complexity of webpage represents the complex nature of the web page in terms of certain parameters. These parameters are as follows.

1. Number and type of objects requested to load a webpage
2. Number of servers contributed to load a webpage

Based on these factors; complexity of website can be determined in terms of certain metrics. These metrics are as follows.

1. Number of objects
2. MIME type of objects
3. Number of servers used to load the page
4. Non-origin contribution to load the webpage

Thus it is the complexity of a website that ultimately determines the webpage load time [2]. This paper introduces some optimization mechanisms that if implemented appropriately, will reduce the webpage load time. The study will help millions of websites that are becoming more and more complex to increase the user's experience at the cost of loading time. Today's need is to increase the user's experience of the website without increasing the loading time of the webpage. Secondly, this paper proposes an optimization system that optimizes the complexity of a website to reduce the loading time. The system will be helpful in determining the nature of the content, structure and orientation of a website which are the factors that need to be considered if optimization mechanisms are to be implemented. It will be note worthy that optimization is not a straight forward task and hence it may differ depending upon the nature and type of the website.

Following are the optimizations this paper considers:

1. Moving scripts to footer
2. Loading JS from Google libraries
3. Deferring the parsing of JavaScript files
4. Removing query strings
5. Lazy loading the images
6. Loading CSS asynchronously
7. Minify all CSS styles.

II. LITERATURE SURVEY AND PROBLEM DEFINITION

A. Background

Website and related issues have been studied for long by web developers and analyzers. Many techniques have been suggested to increase the performance of a website or a web-service. Some of the important literatures that we found to be giving new insights into the problem of reducing web-page load time are described below.

B. Web page post backs and jQuery & Ajax calls

In his thesis, Rohit Dhand, described how Webpage post back calls causes increase in the bandwidth utilisation and thereby page load time of the website [3]. He has also proposed the importance of jQuery and Ajax call to reduce the web page post backs.

By using the asynchronous loading strategy Ajax calls significantly reduce the loading time of the page. But the technique cannot be implemented in all cases as the applicability of asynchronous loading is limited to specific type of content on the webpage.

C. Rich Client Web Architecture Based on HTML5 (RCWABH)

With the development of HTML5 many new strategies to increase the performance of website emerged. CHEN Li-li and LIU Zheng-long proposed the concept of rich client web architecture based on the HTML5 – an HTML5 based framework to increase the performance of websites [4].

The significance of this architecture is that it improves client performance by incorporating advance features of HTML5 to replace traditional notions in HTML4. They have also focused on the need to increase the user's experience and client performance without increase in the web page load time. The study helped us find new techniques to balance the trade-off between client performance and users experience in today's web environment.

D. Web Pre-fetching

Another concept we found was about web-prefetching which was proposed by Monti Babulal Pal and Dinesh Chandra Jain; in there thesis [5]. Web-prefetching is used to utilize the cache efficiently to increase the performance and effectiveness of web services. The notion of Web caching to improve the performance of Web based system has been discussed in elaborately in by them. The concept of 'Web caching' involves keeping 'Web objects' that are likely to be used in the near future in location closer to user. The Web caching mechanisms is considered at three levels: client level, proxy level and original server level.

E. Web Page complexity

The concept of web-page complexity has been proposed in a recent study by Michael Butkiewicz, Harsha V. Madhyastha, and Vyas Sekar [2]. The term webpage complexity represents the nature of complexity of an individual website in terms of different parameters. Various metrics for quantifying the complexity of a website have been proposed. Moreover, the term web page complexity has been divided into two parts viz. Content level complexity and service level. Another aspect of webpage complexity is its impact on webpage load time. In the thesis, it has been ascertained that the concept of Web Page Complexity is purely new notion in the field of Web and it needs to be considered to analyze its impact on the page load time and improve client performance by implementing various optimization techniques to reduce webpage load time.

F. Evaluation

Among the works described above the one which deals with the concept of web-page complexity and its impact on the web-page load-time has been found to be the most appropriate for this study. Though there has been extensive study

regarding websites and related issues the web-page complexity is the concept that deals with individual website. This is the reason why it has been taken as the foundation for this study.

III. PROPOSED SYSTEM

With the help of advanced technologies websites are becoming more and more complex. This increases the user's experience and makes the website more attractive. However, the increasing complexity on the other hand also increases the time required to load the web-page. Thus more complex websites tend to become slower. This fact undermines the user's experience and eventually affects the web-publisher's revenue.

The system we are proposing is the optimization tool that will optimize the complexity of a website to reduce its webpage load time

Optimization system

The system analyzes the complexity of a website and generates a report regarding it. This generated report could be used to later to determine which set of optimization mechanisms are best suited to reduce the web page load time.

The system works upon specific indices to determine the nature of complexity of a website. These indices are NumberOfObject, TypeOfObjet, NumberOfServers, NonOriginContribution. The content level complexity is determined by the former two while the later two are used to represent service level complexity. It is by analyzing these indices that system would ultimately decide another two indices namely ContetComplexity and ServiceComplexity that represent the measurement of the two types of complexities. The values of these indices are to be used to decide the set of optimizations to be carried out.

Input to the system is a website whose webpage load time is to be reduced. System accepts the code for the website as an input and by considering all the indices mentioned above determines the nature of the complexity of the website. The output of the analyser tool is passed as an input to the next stage i.e. Optimization.

Optimization

This section describes some of the optimization mechanisms to reduce web page load time of complex websites. We have selected optimization techniques that may produce larger impacts on the Web page load time of complex structured websites.

A. Moving Java Scripts files to footer

Java Scripts are small executable modules that are intended to run at client side to increase the interactivity of a website. If all the Java Script files are moved to the footer of a page then all the scripts will be executed only after the page gets loaded.

B. Loading scripts from Google libraries

It is recommended to use CDN copy of script file, while using the 3rd party script files such as jquery. Google is considered to be one of the popular CDN providers used to host popular scripts libraries. Many times, these files are already present in the browser through cache. So, these cache versions of the files can be used instead of requesting them from the server. This reduces the roundtrip time and thus increases the speed of the loading.

C. Deferring the parsing of JavaScript files

As Javascripts are small executable modules that are intended to run at client side, deferring the execution of JavaScript files can help reduce the page load time of the webpage. A Java Scripts can be executed only when it is needed.

D. Removing query strings

If query parameter or version parameter are passed to the included script then that will make unique copy of url which cannot be considered valid to be loaded from the local cache of the client. So, each time, client needs to request the new copy of the script from the server. By removing query string from url client can use same copy of script in the cache multiple times.

E. Lazy loading the images

By lazy loading we mean loading of the images only in the visible portion of the page whereas non-visible portion of the page gets loaded once user starts scrolling the page. This significantly reduces the loading time.

F. Loading CSS or JavaScripts asynchronously

By loading CSS files asynchronously reduces the waiting time of the browser to load the complete page. This technique is used where the content can be loaded in the background without having user's interaction.

G. Minifying CSS

Minifying involves compression of the CSS selectors to reduce the size of the CSS file. Compression is done by removing comments and white-spaces and creating local reference of the image paths.

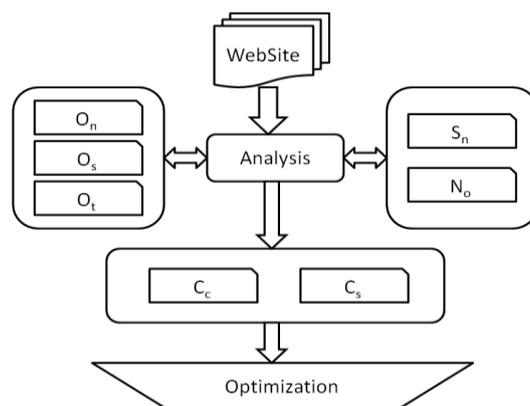


Fig.1 Overall structure of the system

O_n = Number of Objects requested to load the page
 O_s = Size of Objects requested to load the page
 O_t = Type of Objects requested to load the page

S_n = Number of Servers used to load the page
 N_o = Non-origin contribution to load the page
 C_c = Content-level Complexity
 C_s = Service-level Complexity

IV. CONCLUSION

Webpage complexity is the new concept that needs to be studied further to get new insights into the issues related to the Web performance. This paper tries to present different optimization mechanisms that can be implemented on a website to reduce the webpage load time by analyzing its complexity with the help of the proposed Analyzer tool. It is also found that optimization is not a straight-forward task and needs to be implemented by considering nature of the complexity of the website under consideration. For this purpose the proposed Analyzer tool can play a significant role by determining the nature of the complexity of a website so that appropriate optimizations can be carried out to mitigate the ill-effects of the complexity on the webpage load time.

ACKNOWLEDGMENT

We wish to thank our P.G. Co-ordinator – Prof. S. N. Shelke and Head of the Department – Prof. B. B. Gite, for their guidance and support. We shall forever remain grateful for the constant support and guidance extended by them. We would also like to thank all the staff-members of Department of Computer Engineering, Sinhgad Academy of Engineering, Kondhwa, Pune. Without their support and motivation, this work would not have been materialised.

REFERENCES

- [1] Keshab Nath, Sourish Dhar and Subhash Basishtha, "Web 1.0 to Web 3.0 - Evolution of the Web and its Various Challenges" 978-1-4799-2995-5/14 20 14 IEEE.
- [2] Michael Butkiewicz, Harsha V. Madhyastha, and Vyas Sekar, "Characterizing Web Page Complexity and Its Impact", IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 22, NO. 3, JUNE 2014.
- [3] Rohit Dhand, "Reducing web page post backs through jQuery Ajax calls in a Trust based Framework", 978-0-7695-4817-3/12 2012 IEEE.
- [4] CHEN Li-li and LIU Zheng-long, "Design of Rich Client Web Architecture Based on HTML5", 978-0-7695-4789-3/12 2012 IEEE
- [5] Monti Babulal Pal and Dinesh Chandra Jain, "Web Service Enhancement Using Web Pre-Fetching By Applying Markov Model", 978-1-4799-3070-8/14 2014 IEEE