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An application of TOPSIS for ranking internet web browsers

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ABSTRACT

Web browser is one of the most important internet facilities for surfing the internet. A good web browser must incorporate literally tens of features such as integrated search engine, automatic updates, etc. Each year, ten web browsers are formally introduced as top best reviewers by some organizations. In this paper, we propose the implementation of TOPSIS technique to rank ten web browsers. The proposed model of this paper uses five criteria including speed, features, security, technical support and supported configurations. In terms of speed, Safari is the best web reviewer followed by Google Chrome and Internet Explorer while Opera is the best web reviewer when we look into 20 different features. We have also ranked these web browsers using all five categories together and the results indicate that Opera, Internet explorer, Firefox and Google Chrome are the best web browsers to be chosen.

1. Introduction

Internet plays an important role on today's business and life style. People prefer to read news and access to required information through web browsers. Therefore, it is important task to use reliable web reviewers to access the necessary information more efficiently. There are literally various web browsers on the internet where people could simply switch from one to another one. When a web browser is implemented, it should be capable of handling the required web address. The other important required feature is the security of the web browsers and many people prefer to use only the most reliable one in terms of security especially for financial affairs such as internet banking. Making web selection is normally a multi criteria decision making problem since there are more than one single criteria involved in making appropriate decisions.

For over thirty years, there have been tremendous efforts on having efficient techniques proposed to rank various alternatives including data envelopment analysis (DEA) (Charnes et al., 1978, 1994; Andersen et al., 1993), analytical hierarchy process (AHP) (Saaty, 1992), Entropy and **T**echnique for **O**rder **P**reference by **S**imilarity to **I**deal **S**olution (TOPSIS). Some of the techniques requires decision

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maker (DM) to express his/her insights to rank preferences, for example AHP and some others do not such as classical DEA. When we want to prevent direct communication with DM, we normally look for other methods for ranking different alternatives and there are growing interests to use methods for decision making processes, which rely on both financial and non-financial criteria (Kaplan & Norton, 1992; Kaplan, & Norton, 1996).

TOPSIS, originally developed by Hwang and Yoon in 1981, is a simple but sophisticated ranking methodology used in many information technology applications of science and engineering (Chang et al., 2010). Traditional TOPSIS method selects alternatives, which concurrently maintain the shortest distance from the positive ideal solutions and the longest distance from the negative-ideal solutions. TOPSIS makes full use of attribute data, provides a cardinal ranking of alternatives, and does not ask attribute preferences to be independent. To use this technique, attribute values must be numeric, monotonically increasing or decreasing, and have commensurable units (Chen and Hwang, 1992; Yoon & Hwang, 1995).

There are various applications of TOPSIS adopted in many areas of scientific societies and there are different extensions of TOPSIS such as fuzzy TOPSIS where, we consider uncertainty with input parameters. This extension is more realistic since in today's world, uncertainty is an inevitable part of incidents (Aiello et al., 2009). Amiri (2010), for instance, attemped project selection for oil-fields development by implementing the combined AHP and fuzzy TOPSIS methods. Athanasopoulos et al. (2009) proposed a decision support system for coating selection based on fuzzy logic and multi-criteria decision making. Awasthi et al. (2011a) implemented an application of fuzzy TOPSIS in evaluating sustainable transportation systems. Awasthi et al. (2011b), in an another work, proposed a hybrid approach based on SERVQUAL and fuzzy TOPSIS to make an assessment on transportation service quality. Performance measurement is another TOPSIS implementation and its extentions such as fuzzy TOPSIS. Krohling and Campanharo (2011) used fuzzy TOPSIS for group decision making for a case study of accidents with oil spill in the sea. Thomaidis et al. (2008) implemented TOPSIS for the wholesale natural gas market prospects in the energy community treaty countries.

Aydogan (2011), in other work, performed a study for performance measurement model in Turkey by looking into Turkish aviation firms using the rough-AHP and TOPSIS methods under fuzzy environment. Chamodrakas et al. (2009) studied customer evaluation for order acceptance using a novel class of fuzzy methods based on TOPSIS. Kelemenis et al. (2011) investigated on support managers' selection using an extension of fuzzy TOPSIS.

TOPSIS has been also used in internet services, for instance, Cheng et al. (2011) used TOPSIS for Web service selection problems. Sun and Lin (2009) implemented fuzzy TOPSIS method for assessing the competitive advantages of shopping websites. Yu et al. (2011) performed ranking of e-commerce websites in an e-alliance using Fuzzy TOPSIS.

2. The proposed model

The proposed model of this paper considers ten well-known web browsers including Google Chrome, Fire Fox, Internet Explorer, Opera, Safari, Maxthon, Rockmelt, Seamonkey, Deepnet Explorer and Avant Browser and uses TOPSIS based on five major criteria including speed, features, security, technical support and supported configurations. Next, we explain details of classical TOPSIS method used in this paper. Let x_{ij} be the inputs for matrix of priorities where there are $i = 1, \cdots, m$ alternatives and $j = 1, \cdots, n$ criteria. There are six steps associated with the implementation of TOPSIS as follows,

Step 1. Construct normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ij}^2}} \tag{1}$$

Step 2. Construct the weight normalized matrix

$$v_{ij} = w_i r_{ij}, i = 1, \cdots, m \quad j = 1, \cdots, n \tag{2}$$

Step 3. Determin the positive and negative ideal solutions

$$\begin{aligned} A^+ &= \left\{v_1^+, \cdots, v_n^+\right\}, \text{ where } v_j^+ = \left\{\max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J'\right\} \\ A^- &= \left\{v_1^-, \cdots, v_n^-\right\}, \text{ where } v_j^* = \left\{\min(v_{ij}) \text{ if } j \in J; \max(v_{ij}) \text{ if } j \in J'\right\} \end{aligned} \tag{3}$$

Step 4. Calculate seperation (positive and negative) measures for each alternative

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_j^+ - v_{ij})^2}, S_i^- = \sqrt{\sum_{j=1}^{n} (v_j^- - v_{ij})^2}, i = 1, \cdots, m \tag{4}$$

Step 5. Calculate the relative closness to the ideal solution

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+}, 0 < C_i^+ < 1, i = 1, \cdots, m \tag{5}$$

3. The results

There are five criteria for measuring the performance of different web browsers and they are adopted from the yearly report of http://www.toptenreviews.com.

3.1. Web browser startup and navigation

The first criterion is associated with time required to launch a web browser as well as navigation. Table 1 shows three factors influencing speed, which is the first factor involved in web browsers assessment.

Table 1
Ranking web browsers in terms of speed

Web browser	Initial Startup Time	Average Startup Time	Navigation Time	Rank	Efficiency
Safari	4.2	3.7	3.8	1	0.8258
Google Chrome	4	4.3	4.4	2	0.6929
Internet Explorer	4.3	4	4.5	3	0.6842
Seamonkey	5.7	4.5	3.8	4	0.6351
Opera	5.1	4.4	4.5	5	0.5946
Deepnet Explorer	4.1	3.5	6.3	6	0.5763
Maxthon	8	5.9	3.2	7	0.5551
Fire Fox	6.3	6.3	5.7	8	0.3318
Avant Browser	6.6	5.4	6.4	9	0.2907
Rockmelt	9.5	4.3	11.1	10	0.2020

For the implementation of TOPSIS, we have assigned equal weights for all three factors shown in Table 1. According to our survey, Safari is number one website followed by Google Chrome and Internet Explorer.

3.2 Web browser features

The second criterion is related to different features provided by various web browsers. Table 2 demonstrates twenty factors impacting features as the second factor involved in web browsers

assessment. For the implementation of TOPSIS, we have assigned equal weights for all factors shown in Table 2.

Table 2
Ranking web browsers in terms of web features

Web browser	Tabbed Browsing	Integrated Search Engine	Autofill	Save Tabs	Customization Options	Bookmarks	RSS Feeds	Automatic Updates	Password Manager	Find-On Page Function	Zoom	Add-ons	Spell Check	Open-Source Development	Seamless Download Manager	Thumbnail Preview	Synchronize	Parental Controls	Mouse Gestures	Voice Interaction	Rank	Efficiency
Opera	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0.6404
Fire Fox	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	2	0.5224
Chrome	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	3	0.4984
IE	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	0	0	4	0.4573
Rockmelt	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	5	0.3645
Seamonkey	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	0	6	0.3537
Maxthon	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	1	0	1	1	0	7	0.3378
Safari	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	0	8	0.2679
Deepnet Explorer	1	1	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	1	0	9	0.2177
Avant Browser	1	1	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	1	0	10	0.2177

According to the results of Table 2, Opera maintains the highest efficiency in terms of the number of features and capabilities, followed by Fire Fox, Chrome and Internet Explorer (IE).

3.3 Web browser Security

The Third criterion is associated with security and Table 3 shows six factors influencing security, which is the third factor involved in web browsers assessment.

Table 3
The results of ranking different web browsers based on security features

Web browser	Pop-up Blocker	Anti-Spyware	Anti-Virus	Anti-Phishing	Clear Data	Private Mode	Rank	Efficiency
Chrome	1	1	1	1	1	1	1	1.0000
Fire Fox	1	1	1	1	1	1	1	1.0000
Internet Explorer	1	1	1	1	1	1	1	1.0000
Safari	1	1	1	0	1	1	2	0.6517
Opera	1	1	1	1	1	0	3	0.5563
Maxthon	1	1	1	0	1	0	3	0.5563
Seamonkey	1	1	1	1	1	0	3	0.5563
Rockmelt	1	1	1	1	1	0	4	0.4437
Deepnet Explorer	1	0	0	1	1	0	5	0.3483
Avant Browser	1	0	0	0	1	0	6	0

As we can observe from the results of Table 3, three web browsers of Chrome, Firefox and Internet Explorer are considered the safest web reviewers. This could be the most important attribute that many people prefer to consider specially those who wish to do their online banking transactions. Note that these days, many hackers penetrate to people's financial accounts through the existing bugs in web browsers and there has been a growing concerns on having secure and reliable web browser in the internet.

3.4 Web browser Technical Help/Support

The Fourth criterion is related to Technical Help/Support. Table 4 shows Six factors influencing Technical Help/Support, which is the Fourth factor involved in web browsers assessment.

Table 4
The results of ranking different web browsers based on Technical Help/Support

Web browser	Online Knowledgebase	Tutorials	User Manual	FAQs	User Forums	Email Support	Telephone Support	Rank	Efficiency
Internet Explorer	1	1	1	1	1	1	1	1	1.0000
Fire Fox	1	1	1	1	1	1	0	2	0.4545
Maxthon	1	1	1	1	1	1	0	2	0.4545
Opera	1	1	1	1	1	1	0	2	0.4545
Safari	1	1	1	1	1	0	0	3	0.4021
Chrome	1	1	1	1	1	0	0	3	0.4021
Deepnet Explorer	1	0	1	1	1	1	0	3	0.4021
Avant Browser	1	0	0	1	1	1	0	4	0.3583
Rockmelt	1	0	1	0	0	0	0	5	0.2201
Seamonkey	1	0	0	0	1	0	0	6	0.2094

In terms of Technical support, Internet Explorer is number one web reviewer and it seems to have much more features compared with other competitors.

3.5 Web browser Supported Configurations

Table 5 demonstrates the priorities of different web browsers based on various operating systems. It is clear from the results of Table 5 that the first five web browsers are available on all both Microsoft Windows as well as Apple's operating system and obviously are attractive for more users.

Table 5
Ranking different browsers based on various operating systems

Web browser	Windows 7	Windows Vista	Windows XP	Mac OS	Rank	Efficiency
Google Chrome	1	1	1	1	1	1
Fire Fox	1	1	1	1	1	1
Opera	1	1	1	1	1	1
Safari	1	1	1	1	1	1
Seamonkey	1	1	1	1	1	1
Internet Explorer	1	1	1	0	0	0
Maxthon	1	1	1	0	0	0
Rockmelt	1	1	1	0	0	0
Deepnet Explorer	1	1	1	0	0	0
Avant Browser	1	1	1	0	0	0

Table 6
Ranking different browsers based on all factors with equal weights

Browser	Opera	Internet Explorer	Fire Fox	Google Chrome	Safari	Maxthon	Seamonkey	Rockmelt	Deepnet Explorer	Avant Browser
Efficiency	0.5790	0.5674	0.5319	0.5108	0.3888	0.3874	0.3718	0.3498	0.3074	0.2593
Rank	1	2	3	4	5	6	7	8	9	10

Finally, we have considered all 40 features together and as we can observe from the results of Table 6, the first four browsers including Opera, Internet explorer, Firefox and Google Chrome have close efficiencies and they stay in the first four best web browsers according to our proposed method.

4. Conclusion

In this paper, we have presented an empirical study to rank ten best internet web browsers based on the implementation of TOPSIS. Our implementation indicates has considered five exclusive categories with equal weights and rank these ten web browsers individually. In terms of speed, Safari is the best web reviewer followed by Google Chrome and Internet Explorer while Opera is the best web reviewer when we look into 20 different features. We have also ranked these web browsers using all five categories together and the results indicate that Opera, Internet explorer, Firefox and Google Chrome are the best web browsers to be chosen.

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