A Systematic Model of Big Data Analytics for Clustering Browsing Records into Sessions Based on Web Log Data

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Abstract: This paper presents a systematic model of big data analytics for clustering browsing records into sessions based on the web log data. With the rapid development of the Internet and World Wide Web technologies, the behavior of web users becomes more and more complicated. The analysis on web log data may reveal some hint at the browsing behavior of web users. Since the information of browsing sessions has a great impact on the effectiveness of analysis on web log data, especially in the precision of describing the behavior of web users, this motivates our work in developing a systematic model of clustering browsing sessions. First, we present a five-phase architecture that we develop for big data analytics. We have built a computing environment with the architecture, and we have implemented a few methods of big data analytics with such an architecture. Then, we propose the new systematic model, called EDCP model, of big data analytics for clustering browsing records into sessions based on the web log data. Since the analysis on the web log data with various goals may pose distinct criteria for clustering browsing records into sessions, the design of EDCP model allows simple adaption for the distinct criteria in order to meet the need of various goals. We demonstrate the application of EDCP model with the session criteria given by a research group in the tourism and recreation area. We present the experiments of applying EDCP model on the web log data from the official web site provided by Taiwan Tourism Bureau with a goal of clustering the browsing sessions for the web users of 2018 Taiwan Lantern Festival. As a summary, we have a total of 344,963,578 browsing records in the web log data, and we find 55,318,326 records among them are related to 2018 Taiwan Lantern Festival. Our systematic model successfully clusters the records into 307,154 browsing sessions, as a result.

Key words: Big data analytics, network user behavior, web log mining.

1. Introduction

Due to the rapid development in the Internet and World Wide Web (WWW) technologies, web log data is one of the fastest growing user generated contents in cloud computing era [1], and the behavior of web users becomes more and more complicated [2]. The technical papers reporting their efforts in analyzing the behavior of web users by mining the web log data include [2]-[11].

Web mining can be classified into three types: *web content mining*, *web usage mining*, and *web structure mining* [12], and web log mining is usually viewed as part of web usage mining [1], [2]. In general, the

process of web log mining includes four phases: *data processing*, *session recognition*, *pattern found*, and *pattern analysis* [2]. Taking a detailed investigation on the phases, we observe that the information of browsing sessions has a great impact on the effectiveness of analysis on web log data, especially in the precision of describing the behavior of web users. This motivates our work in developing a systematic model of big data analytics for clustering browsing records into sessions in order to provide more precise and meaningful browsing sessions for the behavior analysis of web users.

The systematic model of big data analytics that we develop for clustering browsing records into sessions includes four phases: the extracting phase, the defining phase, the clustering phase, and an optional post-processing phase. We called it as EDCP model. Since the analysis on the web log data with various goals may pose distinct criteria for clustering browsing records into sessions, the design of EDCP model allows simple adaption for each distinct criterion in order to meet the need of various goals. We demonstrate the application of EDCP model with the session criteria given by a research group in the tourism and recreation area [12].

We present the experiments of applying EDCP model on the web log data from the official web site provided by Taiwan Tourism Bureau with a goal of clustering the browsing sessions for the web users of 2018 Taiwan Lantern Festival in the spanning time from November 1st, 2017 to March 11th, 2018. As a summary, we have a total of 344,963,578 browsing records in the web log, and we find 55,318,326 records among them are related to 2018 Taiwan Lantern Festival. Our systematic model successfully clusters the records into 307,154 browsing sessions, as a result.

The rest of this paper is organized as follows. Section 2 briefly describes the related work to this paper. In section 3, we present a five-phase architecture that we develop for big data analyses with web log data. We propose, in section 4, a new systematic model of big data analytics for clustering browsing records into sessions based on web log data. Section 5 presents our experiments on applying the proposed model to the web log data collected from the official website of Taiwan Tourism Bureau. At last is a brief conclusion.

2. Related Work

In literature, there are abundant technical papers reporting their efforts in analyzing the behavior of web users by mining the web log data, including [2]-[11]. Here we briefly describe the work by by Sisoldia *et al.* [3], by Yu and Korkmaz [4], and by Bayir *et al.* [5].

In [3], the principle objective of web user sessions clustering by Sisodia *et al.* is to maximise the intra-group while minimizing the inter-group similarity, when the web users are already clustered into groups in advance. Their method includes four phases: web logs pre-processing, vector space representation of web use sessions, computing page relevance in web user sessions, and clustering augmented web user sessions.

In [4], Yu and Korkmaz investigate web pages structure and find the most evident groups of users and web pages. They note that facing huge amount of web logs, it is not always necessary to group all the users in a web log dataset into different clusters, and sometimes finiding out the major dominant user groups and the corresponding web pages is more important. They propose a new way to search the most evident co-clusters of users and the corresponding web pages in the web log data using the frequent super-sequence mining technique.

In [5], Bayir *et al.* propose a session model based on a page view, and develop a new session construction method called Smart-SRA, accordingly. Different from the conventional session models, they propose that a session is a set of paths traversed in the web graph that corresponds to a user navigation by following the links on the web pages.

3. An Architecture of Big Data Analytics with Web Log Data

In this section, we present the architecture of big data analytics with web log data. The architecture, first proposed by Yung in 2015 [1], includes five phases as shown in Fig. 1.

1. *User Data Generation* phase: This phase includes all the activities of generating user data. In addition to web log data, we may also include the generation of other needed data, such as location data of RFID devices and GPS devices.
2. *Data Acquisition* phase: In this phase, we collect all the data needed for big data analytics. Note that the needed data may be stored in various data repositories of different owners.

Fig. 1. An architecture of big data analytics with web log data.

3. *Integration* phase: This phase integrates all the needed data and transforms data when necessary so that the integrated data can be easily processed by the big data analysis algorithms.
4. *Analysis* phase: One or more analysis algorithms of big data analytics may be chosen for implementation in this phase.
5. *Decision Making* phase: The final phase is the decision making based on the analysis results of big data analytics. Note that in most of the cases, the ultimate purpose of designing big data analysis is the support of making better decisions.

The five-phase architecture is actually implemented and applied to the experiments presented in this paper.

4. A New Model of Big Data Analytics for Clustering Browsing Records into Sessions

In this section, we propose a systematic model of big data analytics, called EDCP model, for clustering browsing records into sessions based on web log data. Please note that EDCP model is applied in the analysis phase of our five-phase architecture of big data analytics with web log data. In other words, our model assumes that all the needed data is collected and integrated into the integrated environment, as

shown in Fig. 1.

There are four phases in EDCP model, shown in Fig. 2.

1. The *extracting* phase: The first phase extracts objective records from the massive web log data. Excluding the uninterested records may expedite the procession in the following phases.
2. The *defining* phase: The second phase defines the criteria for clustering browsing sessions from the web log data. There are two popular ways for defining the session criteria: applying the data mining algorithms to discover the sessions purely from data, or applying the definition of session criteria given by the domain experts. In this paper, our demonstration uses the second one.
3. The *clustering* phase: The third phase clusters browsing records into sessions according to the criteria defined in the previous phase.

Fig. 2. Phases in the systematic model of big data analytics for clustering browsing records into sessions.

4. The *post-processing* phase: An optional fourth phase manipulates the procession needed after the sessions are recognized, such as transforming data for the use of follow-up analyses, and extracting the complete data of records if an abbreviated version is used in the previous phases for simplicity.

We call the proposed model as EDCP for the four phases in the model. Note that EDCP model is *systematic* since we can develop a software program for each phase, and all the programs integrate into a solid software system for clustering browsing records into sessions based on web log data.

5. Experiments

In this section, we present our experiments for verifying the validity of EDCP model in clustering browsing records into sessions. We integrate the programs developed in all the phases into an EDCP software system. All programs are developed in C++ programming language. In phase 2, we apply the definition of session criteria given by Li, *et al.* [12], which may be stated as follows.

If the time difference of two consecutive browsing records of a web user is less than sixty minutes, the

two records belong to the same browsing session.

In other words, if the time difference of two consecutive browsing records of a web user is greater than or equal to sixty minutes, the two records belong to different browsing sessions.

We experiment on the EDCP software system when applied to the web log data collected between November 1st of 2017 and March 11th of 2018 from the official web site of Taiwan Tourism Bureau [13]. The web log data is integrated into a database system implemented in a MariaDB server [14] before applying the analysis for clustering browsing records into sessions.

```
MariaDB [2018lantern]> select * from relantern limit 1000;
```

id	date	time	c_ip	cs_uri_stem
1	2017-11-01	00:08:45	66.249.77.23	/2018taiwanlantern/0000161.html
2	2017-11-01	00:09:52	66.249.77.25	/2018taiwanlantern/0000141.html
3	2017-11-01	00:10:27	66.249.79.156	/2018taiwanlantern/EN/News
4	2017-11-01	00:12:41	66.249.79.152	/2018taiwanlantern/TH/0000004.html
5	2017-11-01	00:13:15	66.249.79.156	/2018taiwanlantern/EN/0000112.html
6	2017-11-01	00:23:39	126.245.10.40	/2018taiwanlantern
7	2017-11-01	00:23:39	126.245.10.40	/2018taiwanlantern/
8	2017-11-01	00:23:39	126.245.10.40	/2018taiwanlantern/common/css/reset.css
9	2017-11-01	00:23:39	126.245.10.40	/2018taiwanlantern/common/js/jquery-migrate-3.0.0.min.js
10	2017-11-01	00:23:39	126.245.10.40	/2018taiwanlantern/common/css/common.css
11	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/common_rwd.css
12	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/index.css
13	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/index_rwd.css
14	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/jquery-3.2.1.min.js
15	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/1/stylesheet.css
16	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/plugins/slick.css
17	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/plugins/colorbox.css
18	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/plugins/jquery.mmenu.all.css
19	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/plugins/footable.core.css
20	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/css/plugins/jquery.mCustomScrollbar.css
21	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/common.js
22	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/index.js
23	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/skrollr.min.js
24	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/zh-tw/google.js
25	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/imgLiquid.min.js
26	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/jquery.mmenu.all.min.js
27	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/slick.min.js
28	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/jquery.colorbox.min.js
29	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/footable.js
30	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/jquery.easing.compatibility.js
31	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/jquery.easing.1.3.js
32	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/jquery.mCustomScrollbar.concat.min.js
33	2017-11-01	00:23:40	126.245.10.40	/2018taiwanlantern/common/js/plugins/jquery-ui.min.js
34	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/P1010417.jpg
35	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/morning-3.jpg
36	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/images/video/video.mp4
37	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/json/GetDayNight
38	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/20170323_高跟鞋點燈DSC_9493.jpg
39	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/morning-5.jpg
40	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/morning-8.jpg
41	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/night-7.jpg
42	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/images/weather/02.svg
43	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/night-3.jpg
44	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/UserFiles/night-4.jpg
45	2017-11-01	00:23:41	126.245.10.40	/2018taiwanlantern/images/chiaiyi_map.png

Fig. 3. Extracted objective browsing records from web log data.

We include a few figures to show the snapshots of executing the EDCP software system. Fig. 3 presents the extracted objective browsing records after the extracting phase. Fig. 4 shows the two phases in clustering browsing records into sessions: Fig. 4(a) shows the numbering of the visited web pages as the first part of the clustering phase, and Fig. 4(b) shows the messages in the process of clustering browsing records into sessions as the second part of the clustering phase. And, Fig. 5 lists the clustered sessions.

We summarize the experiment with the numbers collected, shown in Table 1. The original web log data has a total of 344,963,578 browsing records, from which the EDCP software system extracts 55,318,326 objective browsing records that are relevant to 2018 Taiwan Lantern Festival. According to the definition of session criteria given by Li *et al.*, the EDCP software system clusters the objective browsing records into 307,154 browsing sessions. Hence, in average, there are 180.10 browsing records and 5.64 web pages per browsing session. The overall process takes about 4 hours and 45 minutes for the EDCP software system to complete the clustering of browsing records into sessions based on web log data, executed on a desktop system with an Intel i7 CPU and 8 gigabytes RAM.


```

1 ----- /2018taiwanlantern/
10 ----- /2018taiwanlantern/0000068.html
100 ----- /2018taiwanlantern/0000149.html
1000 ----- /2018taiwanlantern/kr/0000261.html
1001 ----- /2018taiwanlantern/th/0000261.html
1002 ----- /2018taiwanlantern/tw/0000053.html
1003 ----- /2018taiwanlantern/News/tw/
1004 ----- /2018taiwanlantern/tw/News/
1005 ----- /2018taiwanlantern/th/0000063.html
1006 ----- /2018taiwanlantern/0000066.html
1007 ----- /2018taiwanlantern/0000302.html
1008 ----- /2018taiwanlanternNew/News/0000028.html
1009 ----- /2018taiwanlanternNew/0000053.html
101 ----- /2018taiwanlantern/0000202.html
1010 ----- /2018taiwanlanternNew/Sitemap.html
1011 ----- /2018taiwanlanternNew/0000064.html
1012 ----- /2018taiwanlanternNew/News/0000024.html
1013 ----- /2018taiwanlanternNew/News/0000027.html
1014 ----- /2018taiwanlanternNew/News/0000026.html
1015 ----- /2018taiwanlanternNew/0000071.html
1016 ----- /2018taiwanlanternNew/0000072.html
1017 ----- /2018taiwanlanternNew/0000073.html
1018 ----- /2018taiwanlantern/kr/News/0000030.html
1019 ----- /2018taiwanlantern/EN/News/0000044.html
102 ----- /2018taiwanlantern/0000161.html
1020 ----- /2018taiwanlantern/jp/News/0000036.html
1021 ----- /2018taiwanlantern/en/News/0000036.html
1022 ----- /2018taiwanlantern/0000385.html
1023 ----- /2018taiwanlantern/jp/0000062.html
1024 ----- /2018taiwanlantern/kr/0000062.html
1025 ----- /2018taiwanlantern/kr/0000416.html
1026 ----- /2018taiwanlantern/AACxDSx/a02.html
1027 ----- /2018taiwanlantern/the/0000416.html
1028 ----- /2018taiwanlantern/kr/0000426.html
1029 ----- /2018taiwanlantern/0000024.html
103 ----- /2018taiwanlantern/0000126.html
1030 ----- /2018taiwanlantern/TH/0000367.html

```

(a) Numbering visited web pages

```

1 -----[have itemset]----->> 1
10 -----[have itemset]----->> 1
100 -----[have itemset]----->> 1
1000 -----[have itemset]----->> 1
10000 -----[have itemset]----->> 7 58
100000 -----[have itemset]----->> 1
100001 -----[have itemset]----->> 1 50 15
100002 -----[have itemset]----->> 1
100003 -----[have itemset]----->> 1
100004 -----[have itemset]----->> 1
100005 -----[have itemset]----->> 1
100006 -----[have itemset]----->> 1
100007 -----[have itemset]----->> 1
100008 -----[have itemset]----->> 1
100009 -----[have itemset]----->> 18
10001 -----[have itemset]----->> 15
100010 -----[have itemset]----->> 18
100011 -----[have itemset]----->> 1
100012 -----[have itemset]----->> 51
100013 -----[have itemset]----->> 32 7 41 34
100014 -----[have itemset]----->> 1
100015 -----[have itemset]----->> 2 9 41 16 7 31
100016 -----[have itemset]----->> 1
100017 -----[have itemset]----->> 30 40 7 18
100018 -----[have itemset]----->> 1
100019 -----[have itemset]----->> 1
10002 -----[have itemset]----->> 52 80 7 1 15
100020 -----[have itemset]----->> 1
100021 -----[have itemset]----->> 34 39 35 41 9 16 2
100022 -----[have itemset]----->> 1
100023 -----[have itemset]----->> 1
100024 -----[have itemset]----->> 1
100025 -----[have itemset]----->> 1
100026 -----[have itemset]----->> 1
100027 -----[have itemset]----->> 1
100028 -----[have itemset]----->> 9 39 2
100029 -----[have itemset]----->> 1 46 39 4
10003 -----[have itemset]----->> 1
100030 -----[have itemset]----->> 1
100031 -----[have itemset]----->> 9 1

```

(b) Clustering browsing records into sessions

Fig. 4. Two phases in clustering browsing records into sessions.

終端機	檔案(F)	編輯(E)	檢視(V)	搜尋(S)	終端機(T)	求助(H)
34625	2017-11-01	00:39:21	1.171.20.182	/2018TaiwanLantern/images/p02.png		
35591	2017-11-01	00:39:37	1.171.20.182	/2018TaiwanLantern/images/video/video.mp4		
43057	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/swing.svg		
43058	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/temperature.png		
43059	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/icon_sun_c.svg		
43060	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/icon_moon.svg		
43062	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/icon_share.svg		
43063	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/parallax_1.png		
43064	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/parallax_2.png		
43065	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/logo.svg		
43067	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/		
43069	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/icon_sitemap.svg		
43072	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/P1010417.jpg		
43073	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/morning-3.jpg		
43074	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/icon_sun.svg		
43075	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/icon/icon_share.svg		
43076	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/bk_news.jpg		
43077	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/logo.svg		
43078	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/main_logo.png		
43079	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/temperature.png		
43083	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/night-7.jpg		
43085	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/morning-5.jpg		
43086	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/morning-8.jpg		
43087	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/json/GetDayNight		
43088	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/20170323_高跟鞋點燈DSC_9493.jpg		
43090	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/night-4.jpg		
43091	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/UserFiles/night-3.jpg		
43092	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/chilayi_map.png		
43093	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/map.jpg		
43094	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLanternManager/UserFiles/2018qr.jpg		
43095	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/p02.png		
43099	2017-11-01	00:48:00	163.27.14.162	/2018TaiwanLantern/images/logo.svg		
43110	2017-11-01	00:48:01	163.27.14.162	/2018TaiwanLantern/images/parallax_2.png		
43113	2017-11-01	00:48:01	163.27.14.162	/2018TaiwanLantern/images/bk_bridge.png		
43114	2017-11-01	00:48:01	163.27.14.162	/2018TaiwanLantern/images/p06.jpg		
43115	2017-11-01	00:48:01	163.27.14.162	/2018TaiwanLantern/images/parallax_1.png		
43897	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern		
43909	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/		
43910	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/reset.css		
43911	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/common_rwd.css		
43912	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/jquery-migrate-3.0.0.min.js		
43913	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/common.css		
43914	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/index.css		
43915	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/index_rwd.css		
43916	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/1stylesheet.css		
43917	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/plugins/slick.css		
43918	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/jquery-3.2.1.min.js		
43919	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/plugins/colorbox.css		
43920	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/plugins/footable.core.css		
43921	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/common.js		
43922	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/plugins/jquery.mCustomScrollbar.css		
43923	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/css/plugins/jquery.mmenu.all.css		
43924	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/index.js		
43925	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/zh-tw/google.js		
43926	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/plugins/skrollr.min.js		
43927	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/plugins/tmgLiquid-min.js		
43928	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/plugins/slick.min.js		
43929	2017-11-01	00:49:23	221.114.241.113	/2018TaiwanLantern/common/js/plugins/jquery.colorbox-min.js		

Fig. 5. Clustered browsing sessions.

Table 1. The Summary of the EDCP Experiment

Item	Amount	Unit
Original web log data	344,963,578	Records
Objective web log data	55,318,326	Records
Cluster sessions	307,154	Sessions
Average records per session	180.10	Records
Average web pages per session	5.64	Pages

6. Conclusion

In this paper, we present a systematic model of big data analytics for clustering browsing records into sessions based on the web log data. We, first, present a five-phase architecture that we develop for big data analytics. Then, we propose a systematic model of big data analytics for clustering browsing records into sessions, called EDCP model. EDCP model consists of four phases: the extracting phase, the defining phase, the clustering phase, and an optional post-processing phase. We demonstrate the application of EDCP model with the session criteria given by a research group in the tourism and recreation area.

For verifying the validity, we experiment on applying the EDCP model to the web log data from the official web site provided by Taiwan Tourism Bureau with a goal of clustering the browsing sessions for the web users of 2018 Taiwan Lantern Festival in the spanning time from November 1st, 2017 to March 11th, 2018. As a summary, we have a total of 344,963,578 browsing records in the web log data, and we find 55,318,326 records among them are related to 2018 Taiwan Lantern Festival. Our systematic model successfully clusters the records into 307,154 browsing sessions, as a result.

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