A Comparative Analysis on Data Pre-processing Tools

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Abstract - Data pre-process is one of the activities in Data mining. It will cover 80% of the processes involved in knowledge extraction. The study has applied a systematic approach and found WEKA, R- Programming, and Microsoft Excel as familiar tools for pre-processing of data. These tools have better functionality to study the relationship between data. Microsoft Excel is not an efficient data analytics tool, but able to a large volume of data without any complexity. It is a flexible tool to perform manual pre-process of complex data. The aim of the study is to compare the tools and reveal their merits and demerits. WEBKB dataset and weblogs were used in the study to evaluate the performance of tools.

Keywords - Microsoft Excel, Data Pre-process, WEKA, R-Programmer, Data Pre – process

I. INTRODUCTION

Data Mining (DM) is a set of techniques to extract knowledge from large volume of Data[1][2][3]. Data Pre – process (DP) is the backbone of DM techniques. Many researchers have proved that a better DP can lead to a better knowledge extraction. Data cleansing, Data Integration, Data discretization, and Data Transformation are the major activities of DM. DP is a set of Data processing activities that help DM technique to produce useful patterns from data corpus.

A. Data Cleansing - It is a process of removing unwanted data from data corpus. Removal of outliers will help to fix the boundary to dataset[4]. Replacement of missing value is also an important task in data cleansing activity[5][6]. Decision tree and Bayesian rules are handy for the replacement of missing values. The final step in data cleansing is the correction of inconsistent data. Careful studies on data provide solution to correct inconsistent data.

B. Data Integration - It is a process of combining data from different sources and store as a single set. It will give confidence to user that the data is reliable. It will make a global schema to store heterogeneous data[7][8]. The mapping unit will map heterogeneous data with global schema.

C. Data Transformation - It is an important phase in DP. Data has to be transformed into a computable format. DM technique have different logic to process data[9][10]. Data normalization, aggregation, and generalization are the activities involved in data transformation.

D. Data Reduction - It is a process of reducing the size of dataset without losing valuable information. Techniques

such as Binning, Clustering, and Aggregation are use to minimize the size.

E. Data Discretization - It is a subset of Data Reduction. It will use nominal values in the place of numerical attributes. Data will be more generalized and too specific with the help of Data Reduction.

The objective of the study is to compare the familiar pre processing tools and evaluate the performance using datasets[11][12][13].

The structure of the study is as follows: The following section will provide details about the selection procedures for DP tools. The section 3 will give details about Microsoft Excel, R - programming, and Waikato Environment for Knowledge Analysis (WEKA) tools. Experiments and results will be discussed in section 4. Finally section 5 will conclude the study.

II. SELECTION PROCEDURES FOR DP TOOLS

Systematic approach was followed in the study to select the familiar DP tools. Keywords such as "Data Pre - process", "Data Mining", "Knowledge Extraction", "Pattern Recognition", and "Data Cleansing" are used to collect literatures on Data pre – process.

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Figure 1: Collection Procedure - Google Scholar

IEEE Exploreⁱ, Springer, and Google Scholar were the prime portals for the collection of research materials related to keywords. A total of 30 research articles were collected from the portals. The period of publication for the research articles were from year 2013 to 2018. The research also gave importance for number of citations for the research. If a research fell before the mentioned period and having high number of citations then the research was included in the

study. After applying these criteria, 10 articles were excluded from the initial collection and 5 articles were included into the collection and made a reasonable total of 25 articles. Table 1 shows the details of research articles after applying criteria.

	Table	1:	Details	of	research	articles
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S.No.	Portals	Citation	No. of Articles
1	Google Scholar	>12	7
2	IEEE Explore	>20	10
3	Springer	>20	8

III. DP TOOLS

A. Microsoft Excel (Excel) - It is a handy tool to work with data. The application is offering many useful features to preprocess data. User can write code to control data[15][16][17]. The code will be stored as macro. The macro can be triggered at any time and level. Visual Basic for Application (VBA) is the language used for developing macro.

Statistical Package for Social Science (SPSS) is a most powerful tool comparing to Excel. User cannot employ SPSS to pre – process data. Excel will offer many functions to format data into desirable form.

It is a basic level to pre – process complex data for Machine Learning (ML) algorithms. Many advanced tools have existed but Excel is more preferable for data scientist. A new stable version of Excel was released on February 12, 2019.

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Figure 2: Microsoft Excel – Data Pre-process

B. R – **Programming** - **R** is a statistical computing tool. It is widely used for extraction of knowledge from data. It is a freeware, which is under GNU General Public Licenceⁱⁱ. It has secured 15^{th} rank in the assessment of popular programming language.

The programming environment is providing a command line interface to execute functions in R. User has to learn the functionalities and commands to excel in R. It will support

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all kinds of programming such as procedural and object oriented with generic functions[19][20][21][22]. User canⁱⁱⁱ create their own packages in Java, C and C++. The fig. 3 will show the R – studio and fig. 4 shows the R – programming environment. The latest version of R is version 3.5.2. (Eggshell Igloo).

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Figure 3: R-Studio



Figure 4: R-Programming Environment

C. WEKA - It is a freeware, developed by University of Waikato. It is offering a graphical interface for users to analyze data[23][24][25]. WEKA model was implemented in Java and thus operate on different platforms.

ML techniques like clustering, classification, and regression can be implemented in WEKA model without any difficulties[26][27]. Dataset has to be loaded as a single file into WEKA for the analysis. Visualization model will help

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to understand the relationship between data. DT can be performed by WEKA. The latest version is 3.8.3 released on September 4, 2018. Fig. 5 shows the interface of WEKA.



Figure 5: WEKA interface

IV. EXPERIMENTS AND RESULTS

In order to show the ability of DP tools, a variety of datasets were used in the study. World

Web Knowledge base (WEBKB) dataset of Carnegie Melon University (CMU)^{iv} comprises of 4 Universities Cornell, Texas, Washington, and Wisconsin data. 20 Newsgroups dataset is also from CMU contains 20,000 online messages from different news groups. And, finally a weblog of <u>www.rahablog.com</u> (rahablog) was also used in the study. Fig. 6 shows the screenshot of rahablog.



Figure 6: rahablog

Fig. 7 illustrates the flowchart of the experimented, which was conducted in the study. The study has used the raw data of WEBKB and matched with classified dataset of CMU. Rahablog data was pre – processed and classified into three

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users such as Synthetic, Potential, and Normal users. The raw data was cleaned with specific rules according to the ML technique. The process of tokenization will help to label the tokens and lead to DT. After DT, data will be in a computable format for ML technique. The following section will show the results generated by the study.



Table 2 shows the details of pre – processing of University dataset. CMU column in the table indicates the data provided by University. They have pre – processed the data and classified into different categories mentioned in the table 2. The fig. 8 shows the relevant graph of table 2. The graph indicates that all tools have reached the optimum level like CMU.

Table 2: WEBKB - University Dataset

Classification / Tools	CMU - Tool	Excel	WEKA	R
Student	1641	1583	1602	1610
Faculty	1124	1134	1201	1194
Staff	137	102	145	109
Department	182	214	165	225
Course	930	1045	908	927
Project	504	490	512	520
Other	3764	3714	3749	3697



Figure 8: WEBKB - University Dataset Comparison

Table 3 shows the details of pre – processing 20,000 messages of 20 News groups. 20 News groups data are clustered into 6 different categories. C1 is "Politics", C2 is " Entertainment",C3 is " Social Welfare", C4 is "Education" C5 is "Health", and C6 is "Miscellaneous".

The results have proved that Excel is deviated from WEKA and R. Excel has limited functionalities, so accuracy level is not like other tools. Formation of Rules is difficult and complex in Excel. The computation time of Excel is more comparing to WEKA and R. The performance of Excel was better in University dataset because of rules formation.

Table 4 shows the weblog details of rahablog. The weblogs are pre – processed into 3 different categories [18]. The fig. 10 shows the relevant graph of Table 4.

Table 3: 20 Newsgroups Dataset							
Classification / Tools	Excel	WEKA	R				
C1	1400	2148	2700				
C2	5064	5384	4900				
C3	4700	5300	4989				
C4	1789	1314	1142				
C5	4132	3850	3947				
C6	2814	1980	2045				



Figure 9: Comparison of DP tools - 20 News groups

Classification / Tools	Excel	WEKA	R
Synthetic	450	752	587
Normal	1487	1854	1754
Potential	1785	1356	1524



Figure 10: Comparison of DP tools -Rahablog weblog

Finally, Table 5 shows the comparative analysis of pre-processing tools. Different attributes were taken into consideration to derive the performance of DP tools

Table 5	: Comparative	analysis	of DP	Tools
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Tools / Attribu tes	Efficienc y	User Interf ace	Analy tic Level	Programmi ng Knowledge	DP	DT
Excel	Medium	High	Medi	Low	Medi	Med
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R	High	Medi	High	High	High	Med
		um				ium
WEKA	High	Medi	High	High	High	High
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V. CONCLUSION

Pre-process of data is a part of the process in the extraction of data. The study has followed a systematic way to find familiar pre-process tools

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in data mining. Excel, WEKA, and R are familiar tools to perform data analysis. WEBKB datasets of Universities and 20 newsgroups were used in the study for the evaluation of the performance of data pre-process tools. In addition, a weblog of rahablog was also employed in the study. The study has found the following facts. Excel has achieved an approximate of 90 % of accuracy in University and 20 newsgroups dataset. WEKA has reached 96% and R has achieved 97%. Excel is basically a spreadsheet program, not having a good functionality like WEKA and R. The computation time is also more in Excel. A user need not to have better programming skills in Excel. In the case of WEKA, and R, the user should have good programming knowledge to derive a relationship in a large amount of data.

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