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## Hybrid Technique for Arabic Text Compression

By Arafat Awajan & Enas Abu Jrai

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**Abstract-** Arabic content on the Internet and other digital media is increasing exponentially, and the number of Arab users of these media has multiplied by more than 20 over the past five years. There is a real need to save allocated space for this content as well as allowing more efficient usage, searching, and retrieving information operations on this content. Using techniques borrowed from other languages or general data compression techniques, ignoring the proper features of Arabic has limited success in terms of compression ratio. In this paper, we present a hybrid technique that uses the linguistic features of Arabic language to improve the compression ratio of Arabic texts. This technique works in phases. In the first phase, the text file is split into four different files using a multilayer model-based approach. In the second phase, each one of these four files is compressed using the Burrows-Wheeler compression algorithm.

**Keywords :** *text compression, multilayer model text compression, morphological analysis, word-based compression, burrows-wheeler algorithm.*

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# Hybrid Technique for Arabic Text Compression

Arafat Awajan<sup>α</sup> & Enas Abu Jrai<sup>σ</sup>

**Abstract-** Arabic content on the Internet and other digital media is increasing exponentially, and the number of Arab users of these media has multiplied by more than 20 over the past five years. There is a real need to save allocated space for this content as well as allowing more efficient usage, searching, and retrieving information operations on this content. Using techniques borrowed from other languages or general data compression techniques, ignoring the proper features of Arabic has limited success in terms of compression ratio. In this paper, we present a hybrid technique that uses the linguistic features of Arabic language to improve the compression ratio of Arabic texts. This technique works in phases. In the first phase, the text file is split into four different files using a multilayer model-based approach. In the second phase, each one of these four files is compressed using the Burrows-Wheeler compression algorithm. Different compression techniques were investigated and tested at the level of each one of the four files. The integration of the multilayer model with the Burrows-Wheeler technique was found to be suitable for all text files in terms of compression ratio.

**Keywords:** *text compression, multilayer model text compression, morphological analysis, word-based compression, burrows-wheeler algorithm.*

## I. INTRODUCTION

Data compression is important for data transmission and data storage. It aims at reducing the size of data in order to improve the speed of transmission and reduce the size that is needed for the storage. Data compression techniques can be classified into two general categories: Lossy and Lossless techniques. Lossless techniques themselves can be classified into two main categories: statistical compression techniques and dictionary compression techniques [1], [2].

Text compression is a subfield of data compression. It focuses on compressing natural language texts as they occur in the real world. Text compression uses mainly the different features of natural languages to improve the compression ratio and performance. Research papers concerning natural language text compression have been published during the past three decades. Their main concern were European languages such as English, French and German [3], [4] [5]. Other languages such as Japanese

and Chinese were subjects of this type of research, too [6]. Few studies and published research papers focused on the compressing of Arabic text.

Each type of compression technique has advantages and disadvantages. Dictionary-based techniques are fast, but they give smaller compression ratios. On the other hand, statistically based techniques provide high compression ratios but ignore the specificities of natural language texts. Arabic and other Semitic languages are complex and rich in terms of morphological features, where tens or hundreds of words can be derived from the same root. These morphological features can be exploited to improve the compressing ratio of Arabic texts [7]. In 2008, Stujbe [8] showed that utilizing multiple compression techniques is a superior alternative to the classic single-compressor approach. Thus hybrid approaches that combine several of these techniques in order to obtain better compression ratio have been proposed.

Studies on Arabic text compression were limited despite the fact that Arabic is one of the major international languages. This work aims at developing new compression techniques based on the exploitation of morphological and grammatical features of Arabic language to present a hybrid paradigm that will be able to improve the compression ratio and performance and to produce a new representation of text that can be more appropriate for other applications such as information retrieval.

## II. FEATURES OF ARABIC LANGUAGE

An Arabic word is a series of alphabet letters and diacritical marks. Thirty-six characters are used in Modern Standard Arabic (MSA): 28 basic letters and eight diacritical marks. The diacritical marks, called TASHKEEL, are optional and in general are added above or below Arabic letters. Table 1 shows the different vowelization states of the Arabic word: fully vowelized, partially vowelized and unvowelized.

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Table 1 : The vowelization states of Arabic text

Vowelization States	Examples
Fully vowelized words	مُعْتَمِد - مُسْتَقِيم
Partially vowelized words	مُعْتَمِد - مُسْتَقِيم
Unvowelized words	مُعْتَمِد - مُسْتَقِيم

In Arabic language, a word may be derivative or non-derivative. A derivative word is generated from a basic Arabic root according to a predefined palette or template called morphological balances. Figure 1 shows an example of some words that are derived from the root كـتـب k-t-b which represent

the concept 'writing'. The non-derivative words are mainly functional words and nouns borrowed from foreign languages.

كتب، كاتب، مكتبة، كتب، مكاتب،  
اكتب، استكتب، مكتوب، كتاتيب  
كتبة، أكتب، اكتب، كتبوا، مكتب،

Figure 1 : Some words derived from the same root كـتـب k-t-b

Stop words are words that have little semantic meaning. However, they are used to explain grammatical relationships between the words within a sentence. This class of words includes pronouns, prepositions, conjunctions and interjections. The number of stop words is limited, but their frequency is very high in natural texts. They represent nearly 40% of the total number of words in a text [9]. Table 2 shows the frequency of these words in real-world text that contains one million words taken from a collection of articles from newspapers and magazines.

The morphological analysis is one of the most important techniques used in natural language

processing. Its objective to analyze words in order to decompose them into their original morphemes and identify their internal structure. In the case of Arabic words, a word may be decomposed into suffix, prefixes, root or stem. In the case of derivative words, the morphological analyzers may generate the morphological pattern used for the creation of the word in addition to the other components listed before. It is a key step for many applications of natural language processing systems [10], [11], [12].

Table 2 : Frequency of some stop words [9]

Partially vowelized stop words		Unvowelized stop words	
Word	Frequency	Word	Frequency
في	292,396	من	322,239
من	269,200	في	301,895
و	120,060	أي	132,635
على	108,252	و	130,809
ما	89,027	على	119,639
عن	83,027	إذا	115,842

### III. RELATED WORK

Three approaches to research on Arabic text compression can be found in the literature. The first approach considers general-purpose compression techniques and does not take into account the features of Arabic languages. Some of these techniques proceed at the level of characters [13]. They use the frequency of

characters in order to replace the most frequent characters by short codes. Therefore, they are called statistical compression methods and are developed based on the Huffman compression technique and its variants. Other techniques look at strings in the text and put pointers to strings or substrings that have already appeared [14]; these techniques are called dictionary-based techniques and are developed in general based

on the Lempel-Ziv technique (LZ). The third category consists of techniques that work at the frequency of the character and its neighbouring characters to decide how a character will be encoded. Examples of the last category are Burrows-Wheeler Transform (BWT) and Prediction by Partial Matching (PPM). In 2005, Khafagy [15] presented a study analyzing the results of a variety of data compression techniques applied to both English and Arabic texts. The best compression ratio had been obtained by neural compression, followed by PPM and LZW variations and Huffman-based techniques. RLE gave the worst results.

The second approach to research on Arabic text compression uses the features of Arabic language to develop new compression techniques. These techniques use either the statistical features of the languages, such as the most frequent N-grams, or the morphological features and linguistics of the language to achieve a shorter representation of the text [16], [17]. The results of these techniques are in general very limited.



Figure 2 : Steps of the Burrows-Wheeler Compression Algorithm

The first step performs the Burrows-Wheeler transform (BWT), which is done by reading blocks of text with predefined size from input and processing each block to make it easier to code the data with a simple coder. The second step implements the Move to Front transformation (MTF) to transform the characters into a list of numbers. This technique does not compress data; its aim is to decrease the redundancy of letters. The third step applies RLE on the new text that has been produced in the previous step. RLE is one of the simplest compression techniques dealing with consecutive recurrent symbols [21], which are encoded as a pair: the length of the string and the symbol itself. After these steps, we can apply and identify the compression technique. Usually arithmetic coding or adaptive Huffman technique is used. We have suggested the adaptive Huffman technique to apply in our work.

#### b) Burrows-Wheeler Algorithm And Arabic Language

Arabic language is rich in morphology. Several surface forms may be generated from the same root according to a predefined template pattern. The order of letters may change inside the derived words. For example, the word "أَرَق" - "read" may change to "أَرَقِي" - "read," "قَارِ" - "reader" or "قَارِمْ" - "readable." This is unlike the English language, in which the origin of the word remains unchanged and the derivations are limited to adding suffixes at the end or the beginning of the word, for example, "read," "reads," "reader," "the reader" [22].

The third approach to research on Arabic text compression are hybrid techniques that use the features of Arabic language in addition to general-purpose data compression techniques such as Huffman in order to achieve better results. The combinations of these techniques leads to better results as shown in [18], [19].

## IV. BURROWS-WHEELER COMPRESSION

Several studies have proved that the compression technique based on BWT provides good results in comparison with general-purpose compressors [20]; it achieves good compression ratios combined with high speed [21].

### a) Burrows-Wheeler Algorithm

The BWT technique was invented by Michael Burrows and David Wheeler in 1994. It converts the original blocks of data into a format that is extremely well suited for compression, through a sequence of steps [1]. Figure 2 describes the steps of the BWT technique.

The BWT technique is very sensitive to the structure of the word, so derivative words are not suitable for compression by this technique. Therefore, we have suggested using one of the morphological analyzers as a pre-processing step to implement (BWT) on derivative words, using the root-pattern dictionaries technique guided by the proposed method of [23], [19]. The main idea of this technique is to replace derived words with index values for their roots and their standard pattern as shown in Figure 3. Then BWT technique is applied to these components to compress the text.

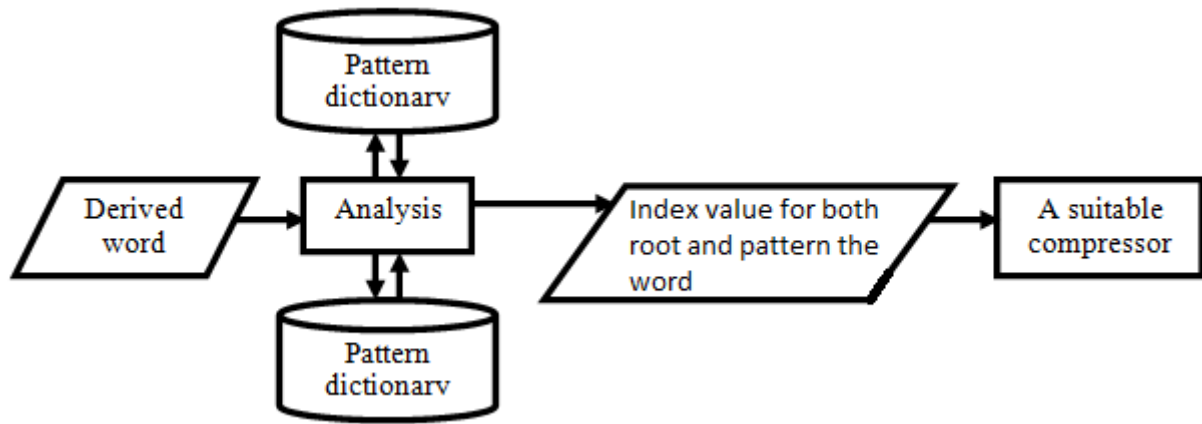


Figure 3 : The morphological analyzers

## V. MULTILAYER MODEL

Awajan [19] provided a multilayer model for the analysis of fully vowelized, non-vowelized and partially vowelized Arabic text. It classifies the text into three categories of words: derived, functional words and other words (i.e. non-derivative words and words that the system fails to classify into one of the categories). His approach depends on searching to determine if the word is functional or not, and using two techniques to determine the derived word; the first technique applies the pattern-based algorithm, and the second uses the dictionary for patterns and roots. This approach attaches all prefixes and suffixes to the dictionary of patterns to decrease the duration of the morphological analysis.

Our aim in this work is to integrate more than one technique to compress Arabic texts, by taking advantage of the morphological features of Arabic language. The most important characteristic of a multilayered model from other analyzers is that it deals

with all categories of texts and all categories of Arabic words including symbols and punctuation marks.

## VI. HYBRID COMPRESSION TECHNIQUE

The proposed compression technique consists of two phases, as shown in Figure 4. In the first phase, the multilayer model has been selected to analyze the text. This model employs several procedures to partition the incoming text into three layers that represent three categories of Arabic words: functional, derivative and non-derivative words. The first layer is used to store the index of the stop words instead of the original word. The second layer is used to store the index of the roots and the patterns instead of derivative words. The third layer represents the words that the system failed to classify into either of the first two layers. The fourth layer, called the mask, is used during the decoding stage, to reconstruct the original text from the decoding of other layers. Suitable compression techniques were applied to the different layers in order to maximize the compression ratio.

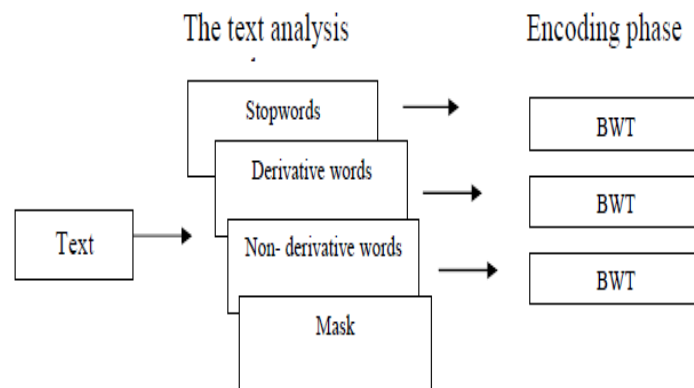


Figure 4 : The main steps of the hybrid compression approach

In the second phase, the encoding phase, the BWT technique is applied for each layer. The mask layer contains the number "zero" to indicate the position of

the word in the first layer. If it contains the number "one," this means the current word in the second layer; if it contains the number "two," this means the word in the



stories, holy text from the Qur'an and articles from BBC Arabia news. Compression ratio, defined as the ratio of the size of the compressed text to the size of the original text, is considered to evaluate the performances of the proposed compression technique.

Three tables are used. One for storing the stop words contained 127 of the most frequently occurring stop words extracted from a corpus representing the BBC and CNN Arabic news [24]. The other two tables were constructed to represent the roots and patterns. The roots table included 4,095 of the most commonly used three-letter words, where 376,167 word types are derived from the three-letter roots [9]. The patterns table consists of the 13,600 most used patterns [25]. The later table has two entries for each pattern. One entry represents the list of consonants (LC), and the other entry represents the list of diacritics (LD) as shown in Table 3.

A set of different categories of Arabic texts (vowelized, partially vowelized, unvowelized) was collected from multiple Internet sources. They represent

Pattern	List of Consonants (LC)	List of Diacritical Marks (LD)
استفعل	است** *	َ َ َ َ َ
استفعل	است***	َ َ َ َ َ َ َ
استفعل	است*** *	َ َ َ َ َ َ َ َ

of encoded data and size of the compressed files using LZW and BWT. These results have shown that the compression ratios are better when BWT is used with the multilayer model. On the other hand, the proposed hybrid technique for compressing Arabic texts achieved good results compared to single text data compression.

Algorithm	First Layer	Second Layer	Third Layer
LZW	0.83	0.75	0.49
BWT	0.50	0.54	0.41

Text Category	BWT	LZW	Multilayer with LZW	Multilayer with BWT
Vowelized	0.31	0.30	0.24	0.23
Unvowelized	0.35	0.32	0.23	0.26
Partially Vowelized	0.33	0.32	0.30	0.25
Average	0.33	0.31	0.26	0.25

A hybrid technique for compressing Arabic texts has been developed. It integrates the multilayer model of Arabic texts with BWT. This technique relies on

exploiting the morphological features of Arabic language to improve the performance of BWT, where the multilayer model was integrated with BWT. This approach gives a better compression ratio than

integrating the same model with other traditional compression techniques such as LZW and Huffman compression.

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## Big Data Analysis: Ap Spark Perspective

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**Abstract-** Big Data have gained enormous attention in recent years. Analyzing big data is very common requirement today and such requirements become nightmare when analyzing of bulk data source such as twitter twits are done, it is really a big challenge to analyze the bulk amount of twits to get relevance and different patterns of information on timely manner. This paper will explore the concept of Big Data Analysis and recognize some meaningful information from some sample big data source, such as Twitter twits, using one of industries emerging tool, known as Spark by Apache.

**Keywords :** *big data analysis, twitter, apache spark, apache hadoop, open source.*

**GJCST-C Classification :** *D.2.11, H.2.8*



*Strictly as per the compliance and regulations of:*



# Big Data Analysis: Ap Spark Perspective

Abdul Ghaffar Shoro<sup>α</sup> & Tariq Rahim Soomro<sup>σ</sup>

**Abstract-** Big Data have gained enormous attention in recent years. Analyzing big data is very common requirement today and such requirements become nightmare when analyzing of bulk data source such as twitter twits are done, it is really a big challenge to analyze the bulk amount of twits to get relevance and different patterns of information on timely manner. This paper will explore the concept of Big Data Analysis and recognize some meaningful information from some sample big data source, such as Twitter twits, using one of industries emerging tool, known as Spark by Apache.

**Keywords:** big data analysis, twitter, apache spark, apache hadoop, open source.

## I. INTRODUCTION

In today's computer age, our life has become pretty much dependent on technological gadgets and more or less all aspects of human life, such as personal, social and professional are fully covered with technology. More or less all the above aspects are dealing with some sort of data; due to immense increase in complexity of data due to rapid growth required speed and variety have originated new challenges in the life of data management. This is where Big Data term has given a birth. Accessing, Analyzing, Securing and Storing big data are one of most spoken terms in today's technological world. Big Data analysis is a process of gathering data from different resources and then organizing that data in meaning full way and then analyzing those big sets of data to discover meaningful facts and figures from that data collection. This analysis of data not only helps to determine the hidden facts and figures of information in bulk of big data, but also it provides with categorize the data or rank the data with respect to important of information it provides. In short big data analysis is the process of finding knowledge from bulk variety of data. Twitter as organization itself processes approximately 10k tweets per second before publishing them for public, they analyze all this data with this extreme fast rate, to ensure every tweet is following decency policy and restricted words are filtered out from tweets. All this analyzing process must be done in real time to avoid delays in publishing twits live for public; for example business like Forex Trading analyze social data to predict future public trends. To analyze such huge data it is required to use some kind of analysis tool. This paper focuses on open source tool Apache Spark. Spark is a cluster computing system from Apache with incubator status; this tool is specialized at making data analysis faster, it

is pretty fast at both running programs as well as writing data. Spark supports in-memory computing, that enables it to query data much faster compared to disk-based engines such as Hadoop, and also it offers a general execution model that can optimize arbitrary operator graph [1]. This paper organized as follows: section 2 focus on literature review exploring the Big Data Analysis & its tools and recognize some meaningful information from some sample big data source, such as Twitter feeds, using one of industries emerging tool, Apache Spark along with justification of using Spark; section 3 will discuss material and method; section 4 will discuss the results of analyzing of big data using Spark; and finally discussion and future work will be highlighted in section 5.

## II. LITERATURE REVIEW

### a) Big Data

A very popular description for the exponential growth and availability of huge amount of data with all possible variety is popularly termed as Big Data. This is one of the most spoke about terms in today's automated world and perhaps big data is becoming of equal importance to business and society as the Internet has been. It is widely believed and proved that more data leads to more accurate analysis, and of course more accurate analysis could lead to more legitimate, timely and confident decision making, as a result, better judgment and decisions more likely means higher operational efficiencies, reduced risk and cost reductions [2]. Big Data researchers visualize big data as follows:

#### i. Volume-wise

This is the one of the most important factors, contributed to emergence of big data. Data volume is multiplying to various factors. Organizations and governments has been recording transactional data for decades, social media continuously pumping steams of unstructured data, automation, sensors data, machine-to-machine data and so much more. Formerly, data storage was itself an issue, but thanks to advance and affordable storage devices, today, storage itself is not a big challenge but volume still contributes to other challenges, such as, determining the relevance within massive data volumes as well as collecting valuable information from data using analysis [3].

#### ii. Velocity-wise

Volume of data is challenge but the pace at which it is increasing is a serious challenge to be dealt with time and efficiency. The Internet streaming, RFID

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tags, automation and sensors, robotics and much more technology facilities, are actually driving the need to deal with huge pieces of data in real time. So velocity of data increase is one of big data challenge with standing in front of every big organization today [4].

### iii. *Variety-wise*

Rapidly growing huge volume of data is a big challenge but the variety of data is bigger challenge. Data is growing in variety of formats, structured, un-structured, relational and non-relational, different files systems, videos, images, multimedia, financial data, aviation data and scientific data etc. Now the challenge is to find means to correlate all variety of data timely to get value from this data. Today huge numbers of organizations are striving to get better solutions to this challenge [3].

### iv. *Variability-wise*

Rapidly growing data with increasing variety is what makes big data challenging but ups and downs in this trend of big data flow is also a big challenge, social media response to global events drives huge volumes of data and it is required to be analyzed on time before trend changes. Global events impact on financial markets, this overhead increase more while dealing with un-structured data [5].

### v. *Complexity-wise*

All above factors make big data a really challenge, huge volumes, continuously multiplying with increasing variety of sources, and with unpredicted trends. Despite all those facts, big data much be processed to connect and correlate and create meaningful relational hierarchies and linkages right on time before this data go out of control. This pretty much explains the complexity involved in big data today [5].

To precise, any big data repository with following characteristics can be termed big data. [6]:

- Accessible — highly available commercial or open source product with good usability.
- Central management and orchestration
- Distributed redundant data storage
- Extensible — basic capabilities can be augmented and altered
- Extremely fast data insertion
- Handles large amounts (a petabyte or more) of data
- Hardware agnostic
- Inexpensive (relatively)
- Parallel task processing
- Provides data processing capabilities

### b) *Big Data Analysis Tools*

The following are brief introduction of some of selected big data analysis tools along with brief overview of Apache Spark and finally justification of apache spark with other competitors to distinguish and justify use of Apache Spark.

#### i. *Apache Hive*

Hive is a data warehousing infrastructure, which runs on top of Hadoop. It provides a language called Hive QL to organize, aggregate and run queries on the data. Hive QL is similar to SQL, using a declarative programming model [7]. This differentiates the language from Pig Latin, which uses a more procedural approach. In Hive QL as in SQL the desired final results are described in one big query. In contrast, using Pig Latin, the query is built up step by step as a sequence of assignment operations. Apache Hive enables developers specially SQL developers to write queries in Hive Query Language HQL. HQL is similar to standard query language. HQL queries can be broken down by Hive to communicate to MapReduce jobs executed across a Hadoop Cluster.

#### ii. *Apache Pig*

Pig is a tool or in fact a platform to analyze huge volumes of big data. Substantial parallelization of tasks is a very key feature of Pig programs, which enables them to handle massive data sets [7]. While Pig and Hive are meant to perform similar tasks [8]. The Pig is better suited for the data preparation phase of data processing, while Hive fits the data warehousing and presentation scenario better. The idea is that as data is incrementally collected, it is first cleaned up using the tools provided by Pig and then stored. From that point on Hive is used to run ad-hoc queries analyzing the data. During this work the incremental buildup of a data warehouse is not enabled and both data preparation and querying are performed using Pig. The feasibility of using Pig and Hive in conjunction remains to be tested.

#### iii. *Apache Zebra*

Apache Zebra is a kind of storage layer for data access at high level abstraction and especially tabular view for data available in Hadoop and relief's users of pig coming up with their own data storage models and retrieval codes. Zebra is a sub-project of Pig which provides a layer of abstraction between Pig Latin and the Hadoop Distributed File System [9]. Zebra allows a Pig programmer to save relations in a table-oriented fashion (as opposed to flat text files, which are, normally used) along with meta-data describing the schema of each relation. The tests can be run using J Unit or a similar Java testing framework [10].

#### iv. *Apache H Base*

Apache H Base is a data base engine built using Hadoop and modeled after Google's Big Table. It is optimized for real time data access from tables of millions of columns and billions of rows. Among other features, H Base offers support for interfacing with Pig and Hive. The Pig API features a storage function for loading data from an H Base data base, but during this work the data was read from and written to flat HDFS files, because the data amounts were too small to necessitate the use of H Base [11].



v. *Apache Chu kwa*

A Map Reduce based data collection and monitoring system called Chu kwa has been developed on top of Hadoop. Chu kwa is mainly aimed at processing log files, especially from Hadoop and other distributed systems [11]. Because Chu kwa is meant mostly for the narrow area of log data processing, not general data analysis, the tools it offers are not as diverse as Pig's and not as well suited for the tasks performed in this work.

vi. *Apache Storm*

A dependable tool to process unbound streams of data or information. Storm is an ongoing distributed system for computation and it is an open source tool, currently undergoing incubation assessment with Apache. Storm performs the computation on live streams of data in same way traditional Hadoop does for batch processing. Storm was originally aimed at processing twitter streams, and now available as open source and being utilized in many organizations as stream processing tool. Apache spark is quick and reliable, scalable, and makes sure to transform information. It is also not very complex to be deployed and utilized [1].

vii. *Apache Spark*

Apache Spark is a general purpose cluster computing engine which is very fast and reliable. This system provides Application programming interfaces in various programming languages such as Java, Python, Scala. Spark is a cluster computing system from Apache with incubator status, this tool is specialized at making data analysis faster, it is pretty fast at both running programs as well as writing data. Spark supports in-memory computing, that enables it to query data much faster compared to disk-based engines such as Hadoop, and also it offers a general execution model that can optimize arbitrary operator graph. Initially system was developed at UC Berkeley's as research project and very quickly acquired incubator status in Apache in June 2013 [9]. Generally speaking, Spark is advance and highly capable upgrade to Hadoop aimed at enhancing Hadoop ability of cutting edge analysis. Spark engine functions quite advance and different than Hadoop. Spark engine is developed for in-memory processing as well a disk based processing. This in-memory processing capability makes it much faster than any traditional data processing engine. For example project sensors report, logistic regression runtimes in Spark 100 x faster than Hadoop Map Reduce. This system also provides large number of impressive high level tools such as machine learning tool M Lib, structured data processing, Spark SQL, graph processing tool Graph X, stream processing engine called Spark Streaming, and Shark for fast interactive question device. As shown in Figure-2-1 below.

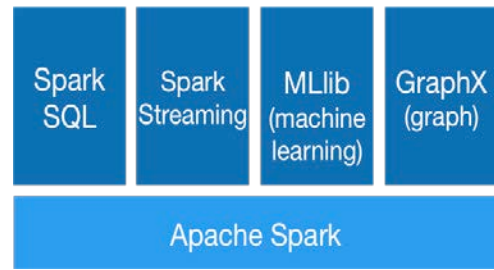


Figure-2-1 : Apache Spark

c) *Why Apache Spark?*

Following are some important reasons why Apache Spark is distinguished amongst other available tools:

- Apache Spark is a fastest and general purpose engine for large-scale data processing [1].
- Apache Spark is a data parallel general purpose batch processing engine
- Workflows are defined in a similar and reminiscent style of Map Reduce, however, is much more capable than traditional Hadoop Map Reduce.
- Apache Spark is a full, top level Apache project
- Simple to Install
- Spark is implemented in Scala, which is power full object oriented languages and with ample resources [10]
- Spark is relatively much junior compared to Storm but it achieved incubator status with few months of its first production to Share through in early 2013 [9].
- Both Map R's distributions and Cloudera's Enterprise data platform support Spark Streaming. Also, very large company known as Databricks provides support for the Spark stack, including Spark Streaming.
- Spark Reliability can be judged from Intel recommendation for spark to be used in healthcare solutions [12].
- Open source contributors, Cloudera, Databricks, IBM, Intel, and Map R has openly announced to support and fund standardization of Apache Spark as Standard general purpose engine for big data analysis [1].
- Host on works, the first company to provide support for Apache storm recommends Apache Spark as Data Science tool [11].
- One of the favorite features of Spark is the ability to join datasets across multiple disparate data sources.

d) *When Not to Use Apache Spark*

Apache Spark is fastest General purpose big data analytics engine and it is very suitable for any kind of big data analysis. Only following two scenarios, can hinder the suitability of Apache spark [13].



- Low Tolerance to Latency requirements: If big data analysis are required to be performed on data streams and latency is the most crucial point rather anything else. In this case using Apache Storm may produce better results, but again reliability to be kept in mind.
- Shortage of Memory resources: Apache Spark is fasted general purpose engine due to the fact that it maintains all its current operations inside Memory. Hence requires access amount of memory, so in this case when available memory is very limited, Apache Hadoop Map Reduce may help better, considering huge performance gap.

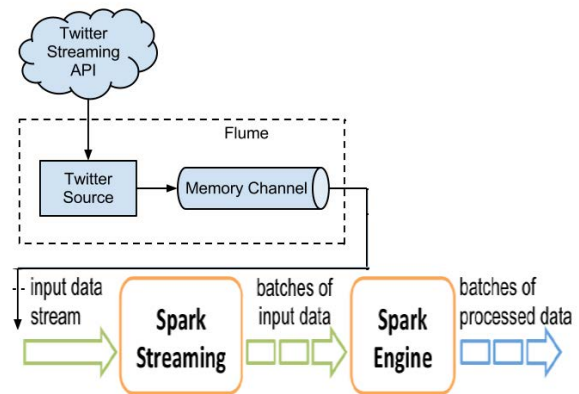


Figure-3-1: Apache Spark data processing

### III. MATERIAL AND METHODS

The nature of this paper is to cope with huge amount of data and process / analyze huge volume of data to extract some meaningful information from that data in real time. The big data is modern day technology term that have changed the way world have looked at data and all of methods and principles towards data. The Data gather of big data is totally different than our traditional ways of data gathering and techniques. Coping with big data specially analyzing in real time has become almost impossible with traditional data warehousing techniques. This limitation have resulted a race of new innovations in data handling and analyzing field. Number of new technologies and tools have emerged and claiming to resolve big data analyzing challenges. So technically speaking, Twitter streaming API is used to access twitter's big data using Apache Spark.

#### a) Research Instrument

- Twitter Stream API: The Streaming APIs provide push deliveries of Tweets and other events, for real-time or low-latency applications. Twitter API is well known source of big data and used worldwide in numerous applications of a number of objectives. In fact there are some limitation in free Twitter API that should be considered while analyze the results.
- Apache Spark: As an open source computing framework to analyze the big data. Though apache spark is claiming to be fastest big data analyzing tool in market, but the trust level and validation of results will still be subject to comparison with some existing tools like Apache storm, for example.

In this paper the data processing is happening using Twitter streaming API and Apache Spark as shown in Figure-3-1 bellow.

### IV. RESULTS

This section illustrates and analysis the data collected for the experiment purpose by Apache Spark using twitter streaming API. The amount of data processed for each scenario, processing time and results are given in tabular as well as graphical format. Following scenarios were executed for experiment purpose on live streams of twits on twitter.

1. Top ten words collected during a particular period of time. (10 minutes)
2. Top ten languages collected during a particular period of time. (10 minutes)
3. Number of times a particular "word" being used in twits, twitted in a particular period of time.

*Scenario 1:* Top ten words collected in last 10 minutes  
Statistics:

- The total number of tweets analyzed during this time=23865
- The total number of unique words =77548
- The total number of words=160989
- Total time duration=10 minutes (600 seconds).
- See Table 4-1 for top ten words in tabular form.
- See Figure 4-1 for top ten words shown graphically in charts

Table 4-1 : Top ten words in last 10 minutes

S. No.	Word	Frequency
1	Lady	24005
2	Today	20056
3	https	26558
4	عدي	2619
5	Love	86288
6	Что	29002
7	م ملل ا	34406
8	2014	43101
9	Mtvstars	99449
10	Как	90619

### Top Ten Words Twited

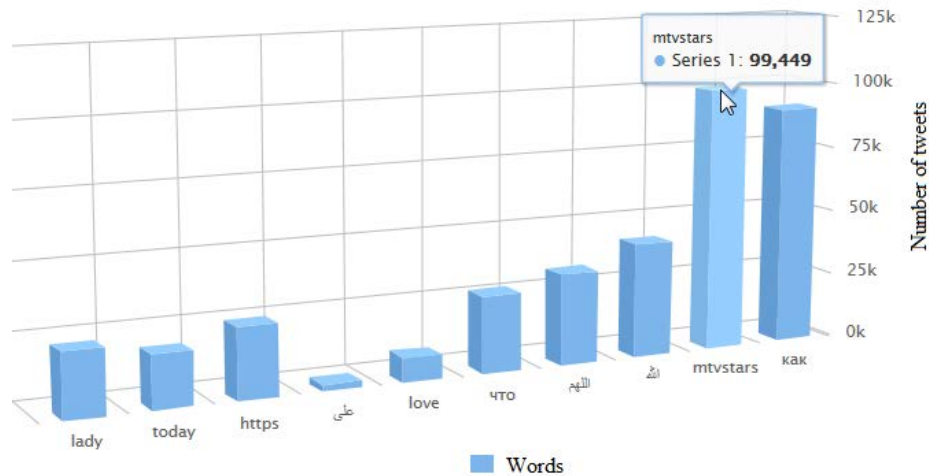


Figure 4-1: Top ten words in last 10 minutes

*Scenario 2:* Top ten languages collected in last 10 minutes.

Statistics:

- The total number of tweets analyzed during this time=23311
- The total number of unique languages=42
- Total time duration=10 minutes (600 seconds).
- See Table 4-2 for top ten languages in tabular form
- See Figure 4-2 for top ten languages shown graphically in charts

Table 4-2 : top ten languages in last 10 minutes

S. No.	Language	Frequency
1	Thai	359
2	Korean	426
3	French	435
4	Turkish	491
5	Indonesian	621
6	Spanish	1258
7	Arabic	1560
8	Russian	2109
9	Japanese	6957
10	English	8114

### Top Ten Languages Twitted

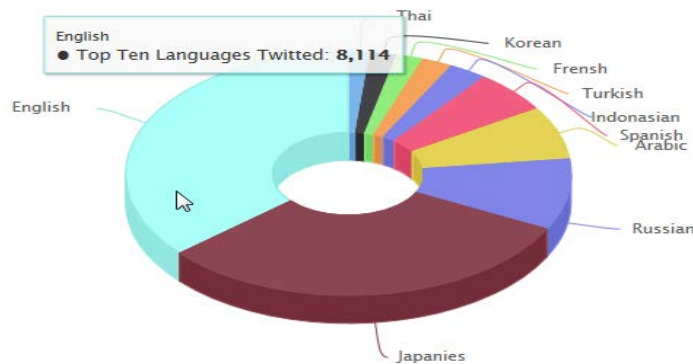


Figure 4-2 : Top ten languages in last ten minutes

Scenario 3: Number of times “mtvstars” being used in tweets twitted in last 10 minutes.

Statistics:

- Search String = mtvstars
- Time duration = 10 minutes
- Number of tweets = 42119
- See Table 4-3 for number of tweets posted using word “mtvstars” in tabular form
- See Figure 4-3 for number of tweets posted using word “mtvstars” shown graphically in charts

Table 4-3 : Number of tweets “mtvstars” used to post a tweet in last 10 minutes

Twits frequency	Time duration in seconds	Twits frequency	Time duration in seconds	Twits frequency	Time duration in seconds
405	15	15051	215	29158	415
100	22	15401	221	29589	421
1444	29	15557	227	30017	427
2031	35	16281	233	30374	433
2876	41	16689	240	30939	442
3570	47	17104	246	31601	448

4100	53	17584	252	31945	454
4526	59	18010	258	32577	460
4999	65	18631	264	32879	466
5225	71	19214	270	33491	472
5986	77	19699	276	34014	479
6002	83	20040	282	34405	485
6633	89	20564	288	34789	491
7102	95	21004	294	35010	497
7469	101	21525	300	35345	503
8011	107	22322	306	35699	509
8291	113	22435	312	36258	515
8406	119	22699	318	36585	521
8801	125	23050	324	37008	527
9265	131	23323	330	37548	533
9515	137	24009	336	37898	539
10016	143	24310	342	38228	545
10205	149	24904	348	38998	551
10784	155	25407	355	39479	557
11108	161	25899	361	40184	563
11579	167	26106	367	40629	569
12009	173	26436	373	40836	575
12588	179	27007	379	41307	581
13391	185	27389	385	41520	587
14009	191	27884	391	41679	593
14261	197	28256	397	41806	600
14501	203	28559	403		
14831	209	28807	409		

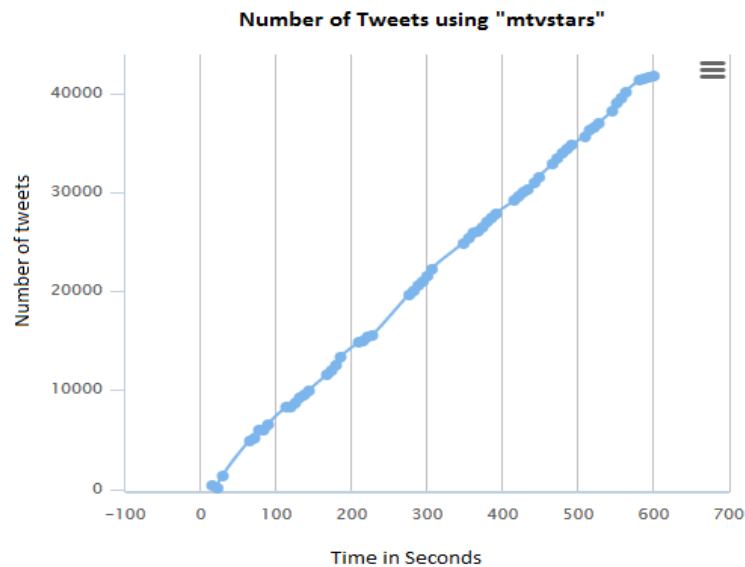


Figure 4-3 : number of twits using “mtvstars” in last minutes

## V. DISCUSSION & FUTURE WORK

As not many organizations share their big data sources. So study was limited to twitter free feed API and all limitations of this API, such as amount of data per request and performance etc. and that directly impact the results presented. Also a common laptop was used to analyze tweets as compare to dedicated Server. As a result of this study, following Scenarios were considered and analyzed and their results were presented in previous section.

1. Top ten words twitted during last specific period of time.
2. Top ten languages used to twit during specific period of time.
3. A list of twitted items matching a given search keyword.

Considering the above mentioned limitations, Apache Spark was able to analyze streamed tweets with very minor latency of few seconds. Which proves that, despite being big general purpose, Interactive and flexible big data processing engine, Spark is very competitive in terms of stream processing as well. During the process of analyzing big data using spark, couple of improvement areas were identified as of utmost importance should be persuaded as future work. Firstly, like most open source tools, Apache Spark is not the easiest tool to work with. Especially deploying and configuring apache spark for custom requirements. A flexible, user friendly configuration and programming utility for apache spark will be a great addition to apache spark developer community. Secondly, analyzed data representation is poor, there is a very strong need to have powerful data representation tool to provide powerful reporting and KPI generation directly from Spark results, and having this utility in multiple languages will be a great added value.

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# Usability Evaluation of Learning Management Systems in Sri Lankan Universities

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**Keywords :** *usability evaluation, learning management systems, open and distance learning.*

**GJCST-C Classification :** *H.5.1, I.1.3*



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# Usability Evaluation of Learning Management Systems in Sri Lankan Universities

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**Abstract-** As far as Learning Management System is concerned, it offers an integrated platform for educational materials, distribution and management of learning as well as accessibility by a range of users including teachers, learners and content makers especially for distance learning. Usability evaluation is considered as one approach to assess the efficiency of e-Learning systems. It is used to evaluate how well technology and tools are working for users. There are some factors contributing as major reasons why the LMS is not used effectively and regularly. Learning Management Systems, as major part of e-Learning systems, can benefit from usability research to evaluate the LMS ease of use and satisfaction among its handlers. Many academic institutions worldwide prefer using their own customized Learning Management Systems; this is the case with Moodle, an open source LMS platform designed and operated by most of the universities in Sri Lanka. This paper gives an overview of Learning Management Systems used in Sri Lankan universities, and evaluates its usability using some pre-defined usability standards. In addition it measures the effectiveness of LMS by testing the Learning Management Systems. The findings and result of this study as well as the testing are discussed and presented.

**Keywords:** *usability evaluation, learning management systems, open and distance learning.*

## 1. INTRODUCTION

E-learning has a well-developed approach to the creation and sequencing of content-based, single learner, self-paced learning objects (Dalziel, 2003). Open learning is defined as a student-centered approach for education that eliminates all barriers to access while providing a high degree of learner autonomy (Maxwell, 1995). Nowadays the way of delivering a course of study through some electronic media is dramatically increased. Here in this way of delivery the majority of communication between teachers and students occurs in non-continuous fashion. Computer based systems increase the efficiency and reduces the risks involved in any mode of activity (Thuseethan, 2014). Further in technologically mediated educational process, an efficient two-way communication between teachers and students is extremely important. During the last ten years, many universities and higher educational institutions have started offering distance education courses for their on-

campus students because of the following reasons (Ay bay et al., 2002).

- Online course development: The University gains more experience on it
- Establishment: Gains more experience on the management of online programs and this perhaps leads to the establishment of an institute
- Quick response from the students involving online courses respond quickly
- Staff development: Train sufficient number of teaching staff who are qualified in evolving distance educations

Most of the modern institution providing higher education desires a Learning Management System (LMS) to handle teaching and learning activities. Somehow it is essential to offer electronic lecture materials for students to access via the internet anywhere at any time. Bearing in mind the significance of all these needs, and believing that distance education will become more important in the education system, all universities in Sri Lanka initiate the practice of learning management systems. Learning management systems are essential for content development and management of online programs (Ay bay et al., 2002). One of the most important features of LMS is to provide an environment for learning and teaching without the restrictions of time or distance (Epping, 2010). Most of the researches concentrate on performing comparative or evaluation studies on learning management system technical or pedagogical issues. Even though a few number of researches have been done by concern these systems accessibility or usability. In this sense usability is one of the major term in Human-Computer Interaction, defined as the ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component [IEEE Std.610.12-1990]. In the context of Learning Management System usability testing concentrate on learning about the understanding of the user engaged in it.

Due to the complexity of human nature and individual differences, objective and systematic assessment of human behavior and performance remains highly difficult (Bellott et al., 2013). But conducting usability evaluations have been taken as a crucial quality assessment technique in evaluating learning management systems. Numerous usability evaluation methods have been developed and materialized in research and practice in the field of

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usability engineering. Presently, usability is becoming a significant concern for e-learning and for learning management systems development and most practitioners perceive usability as a crucial factor in e-learning applications planning and usage (Inversini et al., 2006). Evaluating the usefulness and effectiveness of learning management system can benefit both academic institution and students as well.

In this paper we discuss on the findings of usability evaluation in Sri Lankan Universities and deliberate their implications.

## II. LITERATURE REVIEW

### a) *Learning Management Systems in Sri Lankan Universities*

The rapid development of ICT infrastructures in Sri Lanka motivates every educational institution to make use of the internet as a medium of communication among the students. The effective and efficient access to learning materials achieved by the concepts and methodologies of technology-based learning. Increasing use of e-learning materials becomes a crucial resource for institutions. LMS has been widely used in higher education due to various advantages including flexible learning times and boundless distance education (Hamuy et al., 2009).

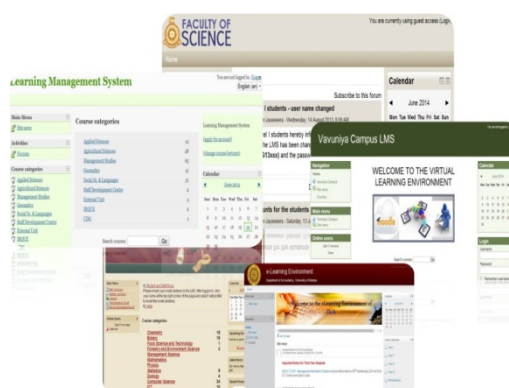


Figure 1 : Sample LMS home pages in Sri Lankan Universities (Courtesy: All universities in Sri Lanka)

In most Sri Lankan state universities, Moodle open source platform is used as LMS. Figure 1 shows some of the learning management system interfaces of Sri Lankan state universities which are currently in use. The universities in Sri Lanka are expecting at-least the following functionalities from well-organized Moodle learning management systems:

- The registration of teachers and students in the educational portal
- Planning and scheduling the course and the way of structuring it
- Provide the way of delivery or making the course accessible for registered users
- Track the students' progress as well as producing automatic reports of students' performance
- Communicating students with each other through forums, mails, file sharing and chatting applications
- Teacher and student evaluation

### b) *Why Moodle in Sri Lanka*

Modular Object Oriented term Developmental Learning Environment (Moodle) is a course management system through the Internet, also recognized as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It is a free web learning environment that educators can use to model effective online learning platforms. In this sense, it can

be used to model effective online learning programs. One of the major advantage is it is an open source, which can be used by any users, modifying with programming knowledge and adapt the environment according to their own desires. It can be installed at any number of servers without any cost and there is no maintenance costs required to pay for upgradings. This learning platform has worldwide users such as universities, societies, schools, teachers, courses, instructors and even in businessmen. Likewise Sri Lankan universities also adapt to this. The design of Moodle is totally based on socio-constructivist pedagogy (Brandl, 2005). This means its goal is to give a set of tools that backing an inquiry- and discovery-based approach to online learning process.

The great success of Moodle is due to the fact that it satisfies the guidelines for best LMS. The best LMS solution is defined in this study as one in which all LMS components are considered within the total learning infrastructure of universities such that maximum student success is ensured from both an institutional and System perspective (Randal, 2010). Aspects of these components in terms of students' perspective success were assessed by the following attributes:

- Interoperability and Flexibility
- Cost effectiveness

- Support and Training
- Ease of Use
- Scalability
- Sustainability

In reality, for instance Moodle gives a more sophisticated and structured environment. It looks more like a set of tools that share an efficient learning environment. These are some strong reasons behind the wide range of usage in Sri Lankan context.

#### c) Usability and Learning Management Systems

Web usability arose as a research field at the very beginning of the Internet era (Rukshan et al., 2011). To enhance the usability of learning management systems, human computer interaction holds a major role in attaining the goal of improving user performance (Sung et al., 2012). Many past researches in human computer interaction have offered beneficial information on how users fit to perform and think about the system to use it easily. Research in this area offers significant insight for technology usability and consideration of the user for the design element of human computer interaction (De Lera et al., 2010). Based on the International Organization for Standardization, the term usability refers that users can effectively use a tool or system to accomplish a task with satisfaction and ease (ISO 9241-11, 1998). In user's perspective, the use of Learning Management System is constrained by the human's

perceptual and cognitive abilities (Thuseethan et al., 2014). The better human computer interaction that offers the learning management systems users, the easier of use and greater satisfaction users will have within systems or tools they involved. Usability can improve the learning experience for students (Tselios et al., 2008) as well as academic performance. Therefore, a sensible design of human computer interaction with usability study is one of the crucial components in the design and development of learning management systems.

Based on the Shackle's proposal usability can be viewed in terms of four major operational criteria, those are effectiveness; learn ability, flexibility and attitude. This study involves the testing of all four operational criteria on learning management system.

- Effectiveness – The performance in accomplishment of tasks by some percentage of the users within the system
- Learn ability – The degree of learning to accomplish tasks. Learning also includes the time taken to learn and relearn the system.
- Flexibility – The adaptation to variation in tasks and environments which can be accommodated by the design.
- Attitude – The user satisfaction with the system whether to continue use the system or enhance their use of the system

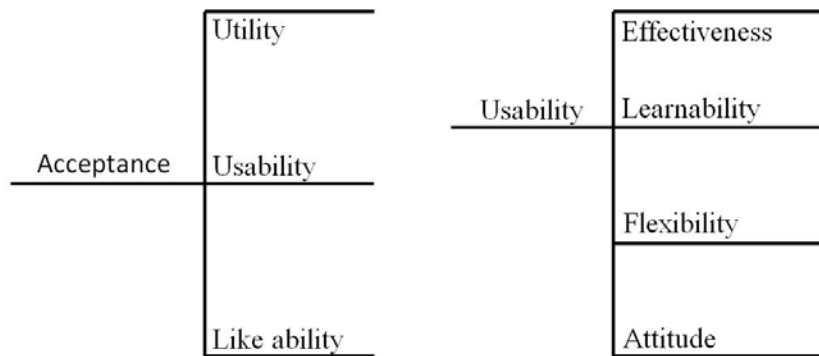


Figure 2 : Shackle's definition of Usability (1991)

### III. EVALUATION METHODOLOGIES

We used different approaches to do the usability evaluation. Most studies on learning management system focus on the technical parts of the systems. These kinds of studies are rarely assessing the effectiveness and user satisfaction in learning management systems in terms of users. The techniques used for evaluating the usability of learning management systems have varied from simple checklists to more complicated standardized questionnaires. Many research studies have been conducted to evaluate the usability of existing learning management systems. Selection of right technique for

evaluation depends on the complexity and functionality of the learning management systems and sometimes on goal that system has.

#### a) Approach 1

The purpose of this approach is to present some first findings of the usability of learning management systems among a selected group of students with advanced computer proficiency. This study took place in seven different universities in Sri Lanka and more than two hundred students taken from computer science based departments to answer the evaluation questionnaires. We did this survey during the

last few day of semester. Because in last few days of the semester the usage of learning management is high comparing with normal days, during that time students used to submit the assignments, ask questions and clearing their doubts in the discussion boards, download course materials and handouts, check notices and complete online quizzes.

In this approach we used two standard questionnaires for the evaluation. In both questionnaires five-scale Likert scale (Strongly Agree {4}, Strongly Disagree {0}) were used to mark the students' response:

1. The SUS (System Usability Scale)(see Appendix A), a mature questionnaire constructed by John Brooke in 1986. This questionnaire comprises 10 statements and it is very robust and has been widely used and adapted to evaluate usability.
2. Other new questionnaire was constructed based on two standard questionnaires which are: Usability and User Satisfaction Questionnaire (Zins et al., 2004) and the Web-based Learning Environment Instrument (Chang, 1999). The newly generated questionnaire LMS Usability Questionnaire

consisted of 10 questions picked from both questionnaires.

Questions picked from these two standard questionnaires assess the following areas of usability in learning management systems (see Appendix B):

- System layout design
- System functionality
- Ease of use
- Learnability
- Satisfaction
- Outcome/future use
- System usefulness.

#### b) Approach 2

This approach involves the testing on the effectiveness of the learning management system as the major study. During this phase, the candidates are given with tasks list and questionnaire to observe the responses. Defined task list is translated into scenarios based activities with some specific goals. Based on the Shackel's (1991) four factors on usability four questions were used to evaluate usability. Figure 3 shows the research methodology framework used to evaluate the usability of learning management system which is classified into four factors in the areas of study.

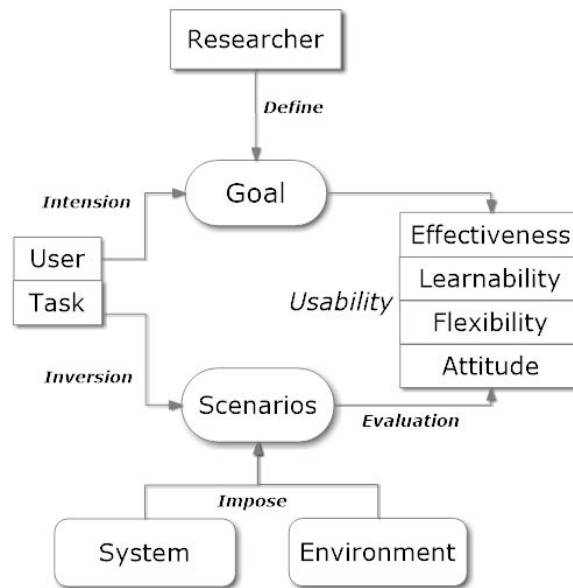


Figure 3 : The Research Theoretical Framework

Definition of the goal is done by the researcher which has been intended by users. The user accomplishes the task by doing the inverted scenarios; one single task structured into one or many scenarios. Scenarios depend on the system and environmental state, where the system is the computer system and environment comprises physical aspects such as proper heating, lighting, layout, operating conditions as well as psychological facets such as the provision of help, training, customer care and socio-political features such as the organizational environment in which the interaction happens. Finally the relationship between

usability of desired goal and achieved goal get compared and analyzed. The acceptance of learning management systems is measured by the usability factors such as effectiveness, flexibility, learnability and attitude in particular environment and system. Real-time evaluation is probably one of the most demanding types of evaluation practice, requiring not only a wide range of skills from evaluators but also a tightly focused professional approach in order to meet the time demands (Clarke et al., 1997). This testing approach involves students or users of the learning management system to work on typical tasks using the real system

and in real time. In real-time evaluation of learning management systems, four major tasks were formulated by dividing those into sub tasks based on the three main features or functions of the system (see Appendix C). All the tasks should be completed within fifteen minutes. After completing every section of the task the subject has to give comments. Real time results can be used by designers to make changes on the system design (Genise, 2002; Sriharan, 2014). The final result from this real-time test can be used to illustrate how the user interface, speed, quality and the overall of the learning management system can supports the users in their learning process.

#### IV. RESULTS AND DISCUSSIONS

Figure 4 displays the overall response of 201 students to each question in SUS questionnaire as average response which varies from 0 to 4. The average students' response to the positive statements 1,3,5,7 and 9 were above midpoint which means that the students found the current learning management systems easy to use and its functionalities were designed properly and well integrated. In the meantime, the responses to the negative statements 2, 4, 6 and 8 discovered that even though the current learning management was user friendly and easy to use, it still has some inconsistency, complexity and irregular actions in its functionalities.

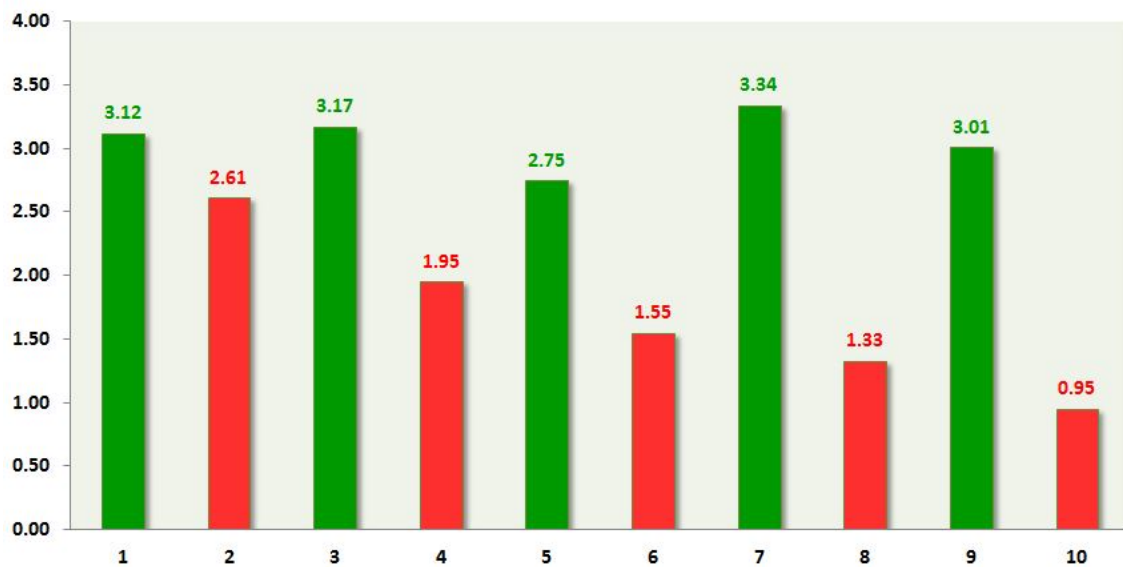


Figure 4 : Average score of students' response for each question in SUS

Further we analyzed the users respond to negative questions positively to find the reason behind their response. By considering the response to statement number 2 shows that even though they like to use present learning management systems they found some kind of complexity while using it. Another important negative statement is number 4, even though most of the students were familiar with using computers, web and other information systems, yet some of them found the learnability of the system was in the border line and require help from specialized person.

On the other hand next questionnaire consisted of 10 question spicked from both the Usability and User Satisfaction Questionnaire and the Web-based Learning Environment Instrument. The result is somehow related to the findings of SUS questionnaire, however with more insights about the level of satisfaction practiced in learning management systems. Figure 5 shows the overall response of the students to the selected statements from the Usability and User Satisfaction Questionnaire. Responses to statements other than 1, 5, 6 and 8 were above midpoint. According to those four

low response statements most of the users found problems in interfaces, appropriate error messages, recovery mechanisms and location of online materials. Apart from this we must comment that most students indicate some significant functional and technical issues in it.

- The malfunction of the search feature
- The post organization in the forum and discussion board
- The inconsistency in downloading course materials



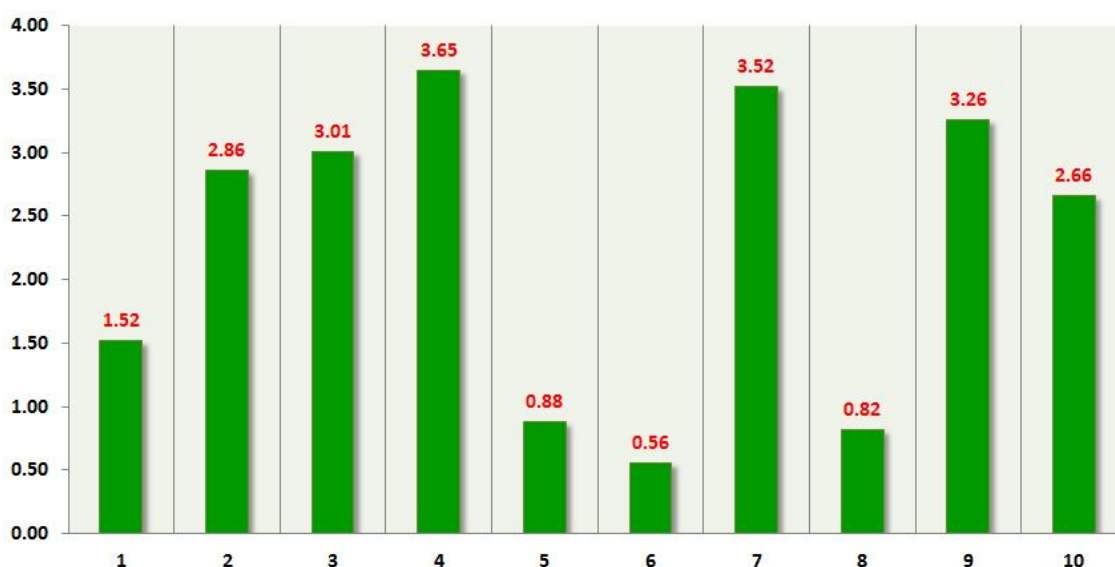


Figure 5 : Average score of students' response for each question in combined questionnaire

According to the user feedback we found some major issues in present learning management systems with evidence.

#### a) Lack in First Impression

Most of the users have reported about the bad login user interface. For the very first time users are overloaded with information when logging into learning

management systems. At that time they lose their focus on goal. Some information could be omitted in the first time use such as old and read news, course details and e-mail messages. Users also demanded the ability to maximize each sub window on the welcome page, in addition to a search function. Some users prefer search function as a crucial means of navigation. Figure 6 shows one evident for bad login design.

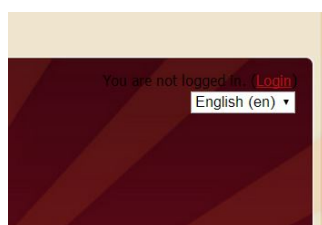


Figure 6 : Evidence for bad login design reported by users

#### b) Visual inconsistencies

Moodle allows the teachers' or source creators to integrate own material which is likely to result in visual inconsistencies because of different styles they used. One teacher appends with one visual style and the other teacher is likely to have deployed a totally different style. Therefore, in this case two or more different styles lead

to inconsistencies in learning management systems. This inconsistency is not a major issue but it does, however, give the user the impression of chaos and lack of professionalism in design. Figure 7 shows the usage of different size of fonts in present learning management systems.



Figure 7 : Evidence for usage of fonts in different sizes for same category

Figure 8 indicates that the maintainers of present learning management systems have been sloppy in designing hyperlinks. A well-structured

hyperlink is characterized by the fact that the system user immediately knows to click on the link without time delay. It is a convention that hyperlinks should be



underlined and preferably be in blue colour. But in present learning management systems one is blue coloured, one is black coloured and one is in grey. Some are hyperlinked and remaining is not underlined.



Figure 8 : Evidence for different kinds of hyperlinks

Another main problem is colour usage in interfaces. Use few colours would provide the user interface a solid sense of consistency and uniformity in look and style. The combination of green and blue (analogous colors) were used in some present learning management systems. Red and orange is also used (complementary colors). In some parts yellow is also used. Red, yellow and blue encompass a complex triadic color scheme. The students found it tough to group these overlapping color schemes. The users would probably perceive the system as more consistent if fewer colors were used. The lack of consistency not only creates a problem in accessing information in these very complex systems but also increases operational and training costs to the users.

Another major issue is each course instructor is responsible for configuring the menu, title, backgrounds, fonts and the folder structure for each course. A better solution would probably be a standardized menu, title,

The maintainers should have reduced the number of hyperlink styles to one unique style to maintain consistency.

backgrounds and folder structures. A standardized structure would allow students to more easily orient themselves and reuse their knowledge from one course to another without retraining. Most of the learning management systems support one locale which is English. The internationalization capability in presenting one does not match the rapid increase in internationalization at universities.

#### c) Lack of error prevention and recovery

Reliable operation of a computing system depends on both error detection and error recovery (Horning et al., 1974). Some users found some appropriate presentation of error messages. Figure 9 shows one evident for bad error presentation without colour or warning sound. Some users reported that there are insufficient back buttons in interfaces. Sometimes in some interfaces there is unnecessary placement of back buttons.

## Log in



Figure 9 : Evidence for bad error presentation

#### d) Icon recognition or eye candy

A pictogram is a stylized figurative drawing that is used to convey information of an analogical or figurative nature directly to indicate an object or to express an idea (Charles et al., 2007). Icons are widely used in present learning management systems; it's an

enhanced way of presentation than text. Icons can be used together with text as a visual substitute to do tasks. Because the reading is cognitively more challenge than well-integrated icons. Users found two major mistakes as use of same icons for different operations and use of different icons for same operation in different interfaces.



Figure 10 : Evidence for inconsistency in using icons

Figure 10 shows the inconsistency in using icons. Same icon used for students' login help and free time slot option. On the other hand two different icons used for calendar option in different interfaces.

## V. CONCLUSION AND FUTURE WORK

The outcome of this work indicates the overall level of the effectiveness of learning management system constructed in students' perspective. The results found that most of the students liked present system and find it very easy to access. However, it suffers from some functional, design and technical problems in its usability. Further some of the major findings through this study are 1) It is useful that the system is trying to do much more than is required by user 2) Currently it is hard to use some important functions like login and assignment submission 3) Teachers should be given with proper guidelines or less freedom while uploading or organizing the system 4) Maintainers are not efficient and not maintaining the components according to HCI standards. We conclude that each and every revision of present systems should be undergone or proofread by an expert or central authority to maintain the consistency.

Since this research is a preliminary stage study on learning management system, it is supposed that it provides some awareness into the usability of current system. Furthermore usability studies can be lead to evaluate adapting other existing usability evaluation techniques. In future usability studies can be conducted to refine the existing HCI standards through users' feedback and further virtual reality can be included inside the current system.

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#### *Appendix A*

List of System Usability Scale (SUS) questions (John Brooke, 1986)

No.	Question
1	I think that I would like to use LMS frequently
2	I found LMS unnecessarily complex
3	I thought LMS was easy to use
4	I think that I would need the support of a person with technical knowledge to be able to use LMS
5	I found the various functions in LMS were well integrated
6	I thought there was too much inconsistency in this system
7	I would imagine that most people would learn to use LMS very quickly
8	I found LMS very cumbersome to use
9	I felt very confident using LMS
10	I needed to learn a lot of things before I could get going in browsing LMS

#### *Appendix B*

List of question items picked from Usability and User Satisfaction Questionnaire (Zins et al., 2004) and the Web-based Learning Environment Instrument (Chang, 1999)

No.	Question
1	I liked using the interface of LMS system
2	Overall, this system was easy to use
3	It was easy to learn to use the system
4	I believe I could become productive using this system
5	The system gave error messages
6	Whenever I made a mistake using the system, I could recover easily and quickly
7	I can access the learning activities at times convenient to me
8	The online material is available at locations suitable for me
9	LMS enables me to interact with other students and the tutor asynchronously
10	I am confident in using this technology

#### *Appendix C*

List of tasks inverted into scenarios to scale usability in real-time.

Task	Scenario
1	Step 1. Select one of the course that you have selected Step 2. Click on the quizzes button LMS Step 3. Answer the test within five minutes Step 4. Submit the result Step 5. Comment on task 1
2	Step 1. Click 'My Courses' button Step 2. Find a course material Step 3. Display your result Step 4. Search the course material within 3 minute Step 5. Comment on task 2
3	Step 1. Use the login system Step 2. Change the password within 2 minute Step 3. View the activity log Step 4. Comment on task 3
4	Step 1. Choose any subject Step 2. Post one message asking the doubt from your tutor Step 3. Send the response to one of your friend's Step 4. Do both subtasks in 5 minutes Step 5. Comment on task 4

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## Dynamic Permutations

By Dr. Saleh N. Abdullah & Dr. Sharaf A. Alhomdy

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**Abstract-** The confidentiality, integrity and authentication of an electronic document are necessary in many application systems. The security of confidentiality, integrity and authentication of an electronic document are based on nonlinear functions, in which there is no direct relationship between the inputs and the outputs. This means that the inputs cannot be extracted from the outputs.

Indeed, all modern cyphers are based on the concept of substitution transposition. In data encryption standard algorithm, DES, which consists of many functions, only one nonlinear function is used in the algorithm, called substitution boxes, and all other functions are linear, one of these linear functions is called IP, initial permutation function, which performs static permutations. The permutations are replaced by transpositions, based on predefined positions, and the permutation function is used several times in DES algorithm.

**Keywords :** *confusion, diffusion, linear function, nonlinear function, static permutations, dynamic permutations, one-way functions, hash table and complexity.*

**GJCST-C Classification :** *G.2.1*



DYNAMIC PERMUTATIONS

*Strictly as per the compliance and regulations of:*



# Dynamic Permutations

Dr. Saleh N. Abdullah<sup>a</sup> & Dr. Sharaf A. Alhomdy<sup>a</sup>

**Abstract-** The confidentiality, integrity and authentication of an electronic document are necessary in many application systems. The security of confidentiality, integrity and authentication of an electronic document are based on nonlinear functions, in which there is no direct relationship between the inputs and the outputs. This means that the inputs cannot be extracted from the outputs.

Indeed, all modern cyphers are based on the concept of substitution transposition. In data encryption standard algorithm, DES, which consists of many functions, only one nonlinear function is used in the algorithm, called substitution boxes, and all other functions are linear, one of these linear functions is called IP, initial permutation function, which performs static permutations. The permutations are replaced by transpositions, based on predefined positions, and the permutation function is used several times in DES algorithm.

The permutation is an essential factor in many security systems or cryptosystems. That is because of the fact that every language has its own structure; the language structures disappear via the permutation factors.

In this paper, we will try to develop dynamic permutations instead of static permutations, nonlinear factors, which in turn enhance the security system.

**Keywords:** confusion, diffusion, linear function, nonlinear function, static permutations, dynamic permutations, one-way functions, hash table and complexity.

## I. INTRODUCTION

In any cryptosystem or message integrity and authentication, the nonlinear functions are the cornerstones because the inputs to the nonlinear functions cannot be extracted from the outputs. In linear function it is possible to obtain the output if both the inputs & the operation are known; also the second input can be obtained if one input & output are known (e.g. XOR function).

A function is called nonlinear if one solution can be reached from several inputs; in other words, if the operations and the outputs of a function are known, and the inputs to a function are not known, the function is called nonlinear. Moreover, if such outputs are produced via nonlinear functions, it becomes difficult to obtain the inputs to the nonlinear functions in a suitable time. For example, the operation *mod* acts as nonlinear function,

because  $20 \bmod 6 = 2$ , also  $20 \bmod 9 = 2$ , and  $20 \bmod 3 = 2$ . The value 2 comes from  $20 \bmod 6$ ,  $20 \bmod 9$ , and  $20 \bmod 3$ . So, if we know one of the inputs and the output along with the operation '*mod*', we cannot know the second input.

In this paper, section two provides details about literature review. Section three describes our proposal technique to enhance the security in the confidentiality, integrity and authentication. The conclusion and future works will be found in section four.

## II. LITERATURE REVIEW

In any cryptography systems, permutation (transposition) is an essential element to remove the relations between the alphabets which formulate the sentences because every language has its own characteristics.

Permutation: refers to mapping a block of length  $L_1$  into a block of length  $L_1$  [1].

Definition: Permutation denotes  $\Pi_p$ .

$\Pi_p: \{1, \dots, L_m\} \rightarrow \{1, \dots, L_m\}$  is a permutation,

where  $L$  and  $m$  are positive integers.

Shannon [2, 3] suggests two methods for frustrating statistical cryptanalysis: Diffusion and Confusion. In diffusion, the statistical structure of the plaintext is dissipated into a long range statistics of the cipher text. On the other hand, confusion seeks to make the relationship between the statistics of the cipher text and the value of encryption key as complex as possible. Confusion can be achieved by the use of a complex substitution algorithm via using substitution boxes [1]. For example, if we have the following inputs: 10101101 01001110 10000100 10101111.

The corresponding values in hexadecimal system are AC4E84AF. So every value will take a predefined position as shown in table 1.

Table 1: Shows the Values and Indexes

1	2	3	4	5	6	7	8	← Index input
A	C	4	E	8	4	A	F	
4	8	C	A	E	F	4	A	
3	5	2	7	4	8	6	1	← Index output

The first 4-bit input will be transferred into position 8 of output, and so on.

In DES algorithm [3, 4] the function is called IP initial permutation acts. This function performs static

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permutations; the permutations are replaced by transpositions, based on predefined positions as showed in Table (2) and Table (3).

Table 2 : Inputs to Function IP

V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>8</sub>
V <sub>9</sub>	V <sub>10</sub>	V <sub>11</sub>	V <sub>12</sub>	V <sub>13</sub>	V <sub>14</sub>	V <sub>15</sub>	V <sub>16</sub>
V <sub>17</sub>	V <sub>18</sub>	V <sub>19</sub>	V <sub>20</sub>	V <sub>21</sub>	V <sub>22</sub>	V <sub>23</sub>	V <sub>24</sub>
V <sub>25</sub>	V <sub>26</sub>	V <sub>27</sub>	V <sub>28</sub>	V <sub>29</sub>	V <sub>30</sub>	V <sub>31</sub>	V <sub>32</sub>
V <sub>33</sub>	V <sub>34</sub>	V <sub>35</sub>	V <sub>36</sub>	V <sub>37</sub>	V <sub>38</sub>	V <sub>39</sub>	V <sub>40</sub>
V <sub>41</sub>	V <sub>42</sub>	V <sub>43</sub>	V <sub>44</sub>	V <sub>45</sub>	V <sub>46</sub>	V <sub>47</sub>	V <sub>48</sub>
V <sub>49</sub>	V <sub>50</sub>	V <sub>51</sub>	V <sub>52</sub>	V <sub>53</sub>	V <sub>54</sub>	V <sub>55</sub>	V <sub>56</sub>
V <sub>57</sub>	V <sub>58</sub>	V <sub>59</sub>	V <sub>60</sub>	V <sub>61</sub>	V <sub>62</sub>	V <sub>63</sub>	V <sub>64</sub>

Table 3 : Output to Function IP

V <sub>58</sub>	V <sub>50</sub>	V <sub>42</sub>	V <sub>34</sub>	V <sub>26</sub>	V <sub>18</sub>	V <sub>10</sub>	V <sub>2</sub>
V <sub>60</sub>	V <sub>52</sub>	V <sub>44</sub>	V <sub>36</sub>	V <sub>28</sub>	V <sub>20</sub>	V <sub>12</sub>	V <sub>4</sub>
V <sub>62</sub>	V <sub>54</sub>	V <sub>46</sub>	V <sub>38</sub>	V <sub>30</sub>	V <sub>22</sub>	V <sub>14</sub>	V <sub>6</sub>
V <sub>64</sub>	V <sub>56</sub>	V <sub>48</sub>	V <sub>40</sub>	V <sub>32</sub>	V <sub>24</sub>	V <sub>16</sub>	V <sub>8</sub>
V <sub>57</sub>	V <sub>49</sub>	V <sub>41</sub>	V <sub>33</sub>	V <sub>25</sub>	V <sub>17</sub>	V <sub>9</sub>	V <sub>1</sub>
V <sub>59</sub>	V <sub>51</sub>	V <sub>43</sub>	V <sub>35</sub>	V <sub>27</sub>	V <sub>19</sub>	V <sub>11</sub>	V <sub>3</sub>
V <sub>61</sub>	V <sub>53</sub>	V <sub>45</sub>	V <sub>37</sub>	V <sub>29</sub>	V <sub>21</sub>	V <sub>13</sub>	V <sub>5</sub>
V <sub>63</sub>	V <sub>55</sub>	V <sub>47</sub>	V <sub>39</sub>	V <sub>31</sub>	V <sub>23</sub>	V <sub>15</sub>	V <sub>7</sub>

### III. DYNAMIC PERMUTATIONS

So far all the processes of any permutations are static, i.e, the permutations are replaced by transpositions, based on predefined positions. However, in this paper we will suggest a new method "dynamic permutations" to enhance the security in cryptosystems. The main idea for the new method is as follows:

- Constructing a suitable hash table along with suitable hash key.
- Dividing the binary data into groups, each group consists of 8-bits; and each 8-bits can take values from 00 to FF in hexadecimal system.
- Each group should be hashed into the corresponding value; this value is used as an index to store the group in the hash table. Since the values stored in the hash table are based on random indexes, each group will take dynamic position.

In this case, the permutations of the inputs are dynamic permutations but not static. Figure (1) shows the suggested method for the construction of the hash table.

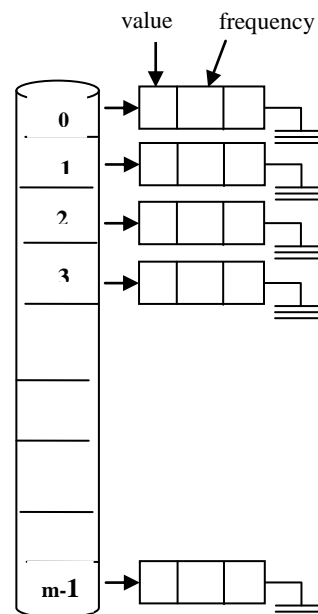


Figure1 : Shows the Construction of the Hash Table

Example: if we have the following inputs 10101101 01001110 10000100 10101111. The corresponding values in hexadecimal system are AC, 4E, 84, AF. So, every value will take a position in the hash table. If there is more than one value equals, the first one will take the correct position in the hash table and the others will increase the frequency field by 1, and so on, without taking extra positions in the hash table. If

there are more than one values hashed to the same index, the second value stays in another node with the same index in the hash table, and so on.

The length of the hash table is directly proportional to the S. That means,  $L \propto S$  (1)

such that S is the number of characters in the block simultaneously permuted and L is the length of the hash table.

The following equation:

$$pi = (pi - 1 + xi) \% m \quad (2)$$

Maybe used to produce the hash key, such that  $p_0 = 7$ , pi is the index position in the hash table,  $x_0 = 11$ , xi is the value to be hashed, and m is prime number points to the size of the hash table.

The following is a sample of values hashed to the some indexes.

index	value	index	value	index	value	index	value
94	199	123	206	173	8	32	225
181	152	186	4	93	164	12	88
140	254	194	90	67	60	7	169
28	125	175	231	17	174	168	136
150	89	56	112	70	110	95	166
23	140	105	147	149	160	70	124
92	7	8	56	94	113	30	87
182	46	181	52	72	183	108	164
53	142	195	64	42	201	151	126
162	225	0	26	132	160	129	118
144	68	167	249	33	46	177	162
103	183	167	55	51	254	145	232
11	213	202	58	152	14	157	140
28	214	11	163	88	234	5	248
62	194	88	187	156	9	201	204
114	247	43	26	162	108	38	38
109	222	53	153	78	117	88	51
93	234	108	122	11	5	190	246
121	210	61	215	11	218	130	88
191	15	170	72	155	39	116	113
57	152	67	216	95	117	48	21
209	220	23	42	165	185	26	163
148	1	100	232	186	183	109	10
206	92	7	109	210	150	108	28
76	49	142	179	1	197	131	23
160	172	58	126	67	13	78	113
38	31	160	202	152	247	142	228
156	126	61	114	46	97	95	186
6	24	174	35	67	91	49	90
34	152	125	129	20	72	94	20
55	59	48	151	201	50	175	41
63	83	132	132	76	109	182	30
131	253	27	100	47	112	89	67
126	31	171	125	147	239	136	126
118	165	66	171	178	62	203	93
6	252	7	14	24	226	210	92
83	206	21	241	171	121	8	115
152	0	171	254	133	204	136	228
168	234	77	161	136	50	68	67
150	214	177	185	99	40	166	198
198	187	100	134	171	46	186	206
111	58	181	207	78	228	111	182
187	218	209	82	140	101	199	220
83	128	67	114	182	228	123	238
137	50	157	28	206	134	148	119

208	13	122	250	40	127	171	170
185	132	85	220	198	111	207	109
123	219	18	99	113	255	80	169
121	227	202	239	199	183	9	209
104	247	149	204	60	35	79	177

#### a) Complexity Measurements

Complexity means studying each of execution time, input-data, language difficulties, mass storage required by the algorithm etc.

In this study we concentrate on complexity from only three points:

##### i. Data complexity.

The amount of data needed as input to the attack.

##### ii. Processing complexity.

The time needed to perform the attack. This is often called the work factor.

##### iii. Storage requirements.

The amount of memory needed to do the attack [6].

#### b) Complexity of Algorithms

An algorithm's complexity is determined by the computational power needed to execute the algorithm itself. The computation of an algorithm is often measured by two variables: T (for Time Complexity), and S (for Space Complexity). In general, the computational complexity of an algorithm is expressed in what is called "big O" notation: the order of magnitude of the computation complexity.

Generally, algorithms are classified according to their time or space complexity:

- An algorithm is a constant if its time complexity is independent of  $n$ :  $O(1)$ .
- An algorithm is linear, if its time complexity is  $O(n)$ .
- An algorithms can also be quadratic, cubic, and so on. Like those algorithms, their complexity are polynomial i.e.  $O(n^m)$ , where  $m$  is a constant.

Algorithms whose complexities are  $O(c f(n))$ , where  $c$  is a constant and  $f(n)$  is more than a constant but less than linear, are called "Supper polynomial"[6].

The suggested algorithm will take extra process more than static algorithm as the following:

- The process of conversion from binary to decimal  $O(n)$ .
- The computation of indexes  $O(m)$ .
- It needs also extra storage corresponding to the hash table.

## IV. CONCLUSION AND FUTURE WORK

The permutation is an essential factor in many security cryptosystems. Therefore, we developed a new method that uses dynamic permutation for enhancing the security of the system in a way better than using static permutations.

The future work, dynamic permutation can be used to produce one way hash function.

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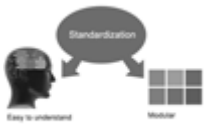
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- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

**You can use your own standard format also.**

### Author Guidelines:

1. General,
2. Ethical Guidelines,
3. Submission of Manuscripts,
4. Manuscript's Category,
5. Structure and Format of Manuscript,
6. After Acceptance.

### 1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

### Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

## 2. ETHICAL GUIDELINES

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- 2) Drafting the paper and revising it critically regarding important academic content.
- 3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

**Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.**

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## 3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.



To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

#### 4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications.

Research letters: The letters are small and concise comments on previously published matters.

#### 5. STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also. Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

**Papers:** These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

- (a) Title should be relevant and commensurate with the theme of the paper.
- (b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.
- (c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.
- (d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.
- (e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.
- (f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;
- (g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.
- (h) Brief Acknowledgements.
- (i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.



The Editorial Board reserves the right to make literary corrections and to make suggestions to improve brevity.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

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*Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.*

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than  $1.4 \times 10^{-3} \text{ m}^3$ , or 4 mm somewhat than  $4 \times 10^{-3} \text{ m}$ . Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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*Abstract, used in Original Papers and Reviews:*

### Optimizing Abstract for Search Engines

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A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art. A few tips for deciding as strategically as possible about keyword search:



- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

*Acknowledgements: Please make these as concise as possible.*

## References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

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*Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.*

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Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

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**1. Choosing the topic:** In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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**16. Use proper verb tense:** Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

**17. Never use online paper:** If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

**18. Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

**19. Know what you know:** Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

**20. Use good quality grammar:** Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

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**22. Never start in last minute:** Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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**24. Never copy others' work:** Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

**25. Take proper rest and food:** No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

**26. Go for seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.



**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

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**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

## INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

### Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

### Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.



Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

### **General style:**

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

- Adhere to recommended page limits

Mistakes to evade

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- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

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- Keep on paying attention on the research topic of the paper
- Use paragraphs to split each significant point (excluding for the abstract)
- Align the primary line of each section
- Present your points in sound order
- Use present tense to report well accepted
- Use past tense to describe specific results
- Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives
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### **Title Page:**

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.



### Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript-- must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

### Approach:

- Single section, and succinct
- As an outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

### Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from an abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

### Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.



- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

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This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

#### **Materials:**

- Explain materials individually only if the study is so complex that it saves liberty this way.
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- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

#### **Methods:**

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

#### **Approach:**

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

#### **What to keep away from**

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

#### **Results:**

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently. You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.





## Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

### What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

### Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

### Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

### Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

### Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.



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<b>Methods and Procedures</b>	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
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<b>References</b>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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