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Designing a Framework for Improving Container Scheduling and Load Balancing Using Deep Reinforcement Learning

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Abstract: Duplication of records refers to the situation when a specific record appears in the database more than once. The record matching technique is utilized to determine which records correspond to the same real-world object. This is the biggest and trickiest assignment of the day. Duplicates in the database will needlessly lengthen the time it takes to perform queries and need additional power resources, among other things. Records deduplication is done in order to prevent these problems and their effects.This study proposes an efficient algorithm that matches records using a rough set approach. We treat these datasets using our records deduplication computing methodology. Ultimately, the dataset collection made up of distinct record entries is produced by the algorithm. We proposed two algorithms namely Compute Distinguishability Matrix (CDM) and Rough Sets based Record Deduplication (RSRD). The former is used to compute a matrix that is used in the latter for record deduplication. Subsequently, the findings of the experiment are offered which are prepared using common datasets, and the effectiveness is examined.

Keywords: *Duplicate detection, Record linkage, Data deduplication, Data integration, Records matching, rough sets.*

1. Introduction

These days, there is a massive increase in the amount of data that is dynamically created from several online or query sources. This is mostly shown in an ad hoc manner. Therefore, extracting meaningful information from massive amounts of data—which might exist as electronic archives, digital libraries, or e-commerce data—has proven to be a challenging task for data managers worldwide.Currently, developing a system that can carry out the following tasks is a major difficulty - Concatenate and integrate several accessible datasets.Carry out the matching process between several sets of records that are accessible, which can reflect the same real-world object.Many studies on records deduplication have been conducted in a variety of fields, including text mining, databases, artificial intelligence, and data mining. The solutions need further technical work to address the records deduplication issue [1], [2]. The presence of unstructured and irrelevant material in the repositories may have the following effects: (1) increased computing time and expense; (2) performance deterioration; (3) increased knowledge space dimensionality; and (4) increased processing power requirements.Deduplication and record matching are necessary to prevent these effects [3], [4], [5], [6]. If an algorithm for de-duplicating records finds more copies through record matching, it is considered efficient.The necessity for record deduplication is growing quickly in the modern world, namely in data mining and database applications. Our objective in this research is to provide an approach that can carry out the data deduplication procedure more effectively. To sum up, this paper's primary contributions are as follows. Described our suggested approach for efficiently carrying out the records deduplication procedure. Our suggested approach makes use of the Rough set as a tool in the computational model for data deduplication. Released the user from the burden of deriving any sophisticated optimization strategy to carry out the records matching process, which may involve exponential time computational complexity. The remaining portions of this document are arranged as follows.Section 2 reviews literature on prior works. Some necessary preliminary work has been covered in section 3. The proposed framework is presented in Section 3. Section 4 contains the experiment outcomes. Section 5 provides conclusions and offers suggestions for further research.

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2. Related Work

This section reviews literature on prior works linked to rough sets based deduplication methods. S. Lawrence and colleagues [7] [8] suggested computational methods, such as edit distance, phrase match, and so on, for matching citations from various sources. Approximation techniques for computing the LCS have been presented by Kuo-Si Huang et al. [9]. A fuzzy logic match approach was presented by Surajit Chaudhuri et al. [10]; in order to improve the process, tests were conducted on real datasets. A solution for the text categorization problem has been provided by Y. Li et al. [11]. "Soccer (Source Conscious Compiler for Entity Resolution)" is a notable method for locating optimal matching in record datasets, as demonstrated by Shen et al. [12]. [13] A better technique for duplication identification in record datasets and websites was presented by Elhadi et al. [14] in 2009. Weifeng Su et al. [15] have suggested an unsupervised duplication detection (UDD) technique to meet the difficult record matching problem. Genetic programming was suggested by Moises G. et al. [16] as a method for detecting record duplication. Procedural performance analysis is provided for a variety of user online reviews and questions in the study by Madusubram et al. [17]. A modified "particle swarm optimization" approach for global optimizes of broad inverse problematic situations was published by Shafi Ullah Khan et al. [18] in 2015. De-duplication on encrypted communication messages is developing as a promising topic in the scientific community in today's client-cloud server situations. [19] A solution named "HEDup (Homomorphic Encryption Deduplication)" was presented by Rodel Miguel et al. [20] for secure storage scenarios that also provide data deduplication.Yang et al. [21] suggested method provides excellent user-defined access control and secure deduplication, protecting data confidentiality and successfully fending off threats. Prajapati and Shah [22] discussed safe deduplication techniques for cloud storage that boost storage effectiveness while protecting data confidentiality and integrity.Heo et al. [23] Storage optimization solutions—which fall into three categories: content-based, redaction, and replication—are required due to the increase in blockchain transactions. Challenges with these systems include security, decentralization, and scalability. Grzegorowski et al. [24] by combining comparable data bits, granulation of information improves machine learning performance and facilitates feature selection for Big Data jobs. Cheng et al. [25] suggested a duplicated storage adaptive migration technique that maximizes space savings and service flexibility. It reduces the cost of additional space and enhances data availability by utilizing heuristics and ILP.Vidhya and Geetha [26] entered data integration are resolved using entity resolution, or ER. By reducing thorough pairwise comparisons, blocking increases productivity. The efficacy and efficiency of the rough set approach are improved. He et al. [27] suggested safe encrypted deduplication method for cloud storage ensures efficiency and security by enabling deduplication without the help of a third party. Wang et al. [28] improved user happiness and interaction success rate, the Cloud Services Trust Evaluation Model (CSTEM) integrates weights and gray correlation analysis. Through simulation trials, it combines reputation, recommended trust, and direct trust to provide a thorough trust evaluation. Zhang et al. [29] for JointCloud storage, the Secure and Efficient data Deduplication (SED) strategy is suggested, which improves security, functionality, and efficiency. Vidhya and Geetha [30] increased precision without compromising recall, a hybrid recommendation system for healthcare makes use of rough set pruning. From the review of literature, it is observed that there is need for an efficient framework for deduplication of records using rough sets.

3. Preliminaries

The following are some prerequisitesneeded for record matching and duplication detection using rough sets. Any web records matching method's performance is mostly determined by the computing model that is employed. The RS hypothesis is one such approach. Reductt selection is a key idea in RST. Eliminating superfluous features might aid in determining the crucial, efficient, and non-redundant categorization viewpoints. A decision table, often referred to as a data table, is a system of the kind S = (U, C d), where d is the decision attribute and C is the collection of conditional attributes. The words "Upper Approximation" and "Lower Approximation" are part of the set approximation vocabulary in rough set theory (RST).If X is a notion in the approximation space S = (U, R), then the lower approximation is RlowerX = $\{x \in U \,|[x] \subseteq X\}$ upper approximation is RupperX = $\{x \in U \,|[x] \cap X \;/\!= \emptyset\}$ When the equivalency class [x], which has element e, is referred to. Assume that S = (U, C $\wedge$ {d}) is a decision system that comprises the entire universe of objects. If POSR(d) = POSC(d), then a subset R of conditional attributes (C) is a reduct. It is well known that computing the reduct is an NP-hard issue, and processing the reduct for large datasets requires a very powerful computer environment.

4. Proposed System

Our suggested approach for records deduplication using rough set theory is presented in this section. Figure 1 below depicts the general computational paradigm of our suggested approach. There are two stages to the suggested technique for records deduplication based on rough sets and logical reasoning. We demonstrated how to construct the discernibility matrix using rough sets in phase 1 and in phase 2 actual deduplication mechanism is carried out.

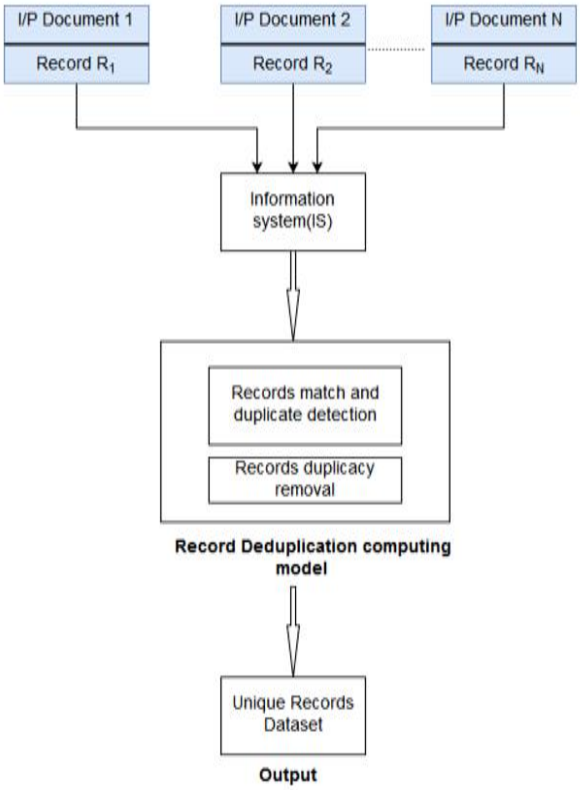

Fig 1: Proposed framework for record deduplication

As presented in Figure 2, each record in the system considered is nothing but a document linked to an information system. The proposed record deduplication model is employed (comprising of two algorithms) to detect duplicate records and remove them so as to ensure that the storage infrastructure holds only one unique copy and it may be used with different references. The framework is based on discernibility matrix and also the procedure used for actual deduplication. The framework is based on the concept of rough sets which has potential to leverage performance in detection of duplicates. We proposed two algorithms namely Compute Distinguishability Matrix (CDM) and Rough Sets based Record Deduplication (RSRD). The former is used to compute a matrix that is used in the latter for record deduplication.

Algorithm 1: Compute Distinguishability Matrix (CDM)
Input: Set of documents D (D={d1, d2, d3, …, dn) where $d_i \forall 1 \le i \le n$

1. Begin
2. Initialize a map M
3. Combine documents $d_i \forall 1 \le i \le n$
4. Each set has {R1, R2, R3,…, Rn}
5. For each set of documents s in D
6. IS has the datasets of different size
7. dm←ComputeDisMatrix(IS)
8. Add IS and dm to M
9. End For
10. For each entry e in M
11. Concatenate dm
12. End For
13. Return dm
14. End

Algorithm 1: Compute Distinguishability Matrix (CDM)

As presented in Algorithm 1, the proposed framework shown in Figure 1 is realized by computing discernibility matrix and then using the same in Algorithm 2 for automatic detection and removal of duplicate records.

Algorithm 2: Rough Sets based Record Deduplication (RSRD)

1. Begin
2. Create perceptibility table using record set pairs using rough sets theory and dm
3. Perform indexing
4. Use logical reasoning for entries in table
5. Add resultant entries in new column denoted as DV
6. Search for duplicate entries
7. Mark duplicate entries for deletion
8. Delete marked entries from IS
9. Update dataset
10. End

Algorithm 2: Rough Sets based Record Deduplication (RSRD)

As presented in Algorithm 2, the proposed framework shown in Figure 1 is realized by reusing discernibility matrix computed in Algorithm 1 and then using the same in Algorithm 2 for automatic detection and removal of duplicate records. We provide a deduplication approach for records that builds a discernibility matrix. Every record object case row in the discernibility matrix construction process requires m comparisons. Where m is the discernibility matrix's dimension or the total number of object cases in a text. Thus, the total amount of comparisons needed is $|m| \times |m|$. Therefore, $O(|m||m|)$ is the complexity for the construction of the discernibility matrix.

4. Experimental Results

Our experimental study, which was carried out on the real-time recordings data set, is presented in this part. The subsections that follow will provide further information about the data set. The Java environment has been our primary tool for implementation. Below are the specs of our system: Ubuntu 16.04 LTS, 64-bit operating system; Java version: 1.8.0 111; RAM capacity: 4 GB; Processor: Intel Core i3 4030U CPU @1.90GHz x 4.

4.1. Dataset Creation

We have gathered many dataset documents for our experiment, each of which has multiple records. These files consist of citation information gathered from several sources for a variety of research articles. Every document, which is made up of citation records, has certain properties such as a title, author details, journal or conference data, volume number, month, and year. After that, a single set named D is created by concatenating all document sets di ∀ 1 ≤ i ≤ n. D is made up of several separate records, R1, R2, R3,..., Rm. The information from the aforementioned records is then shown in an information table (IS) as knowledge. Each row in this created information table represents a single record, and each column represents a distinct attribute vector. We have gathered 410 records for our experiment from several websites. Six attributes have also been taken into consideration. Thus, 410 x 6 is the size of our input IS table.

4.2 Results

The initial stages of algorithmic execution aim to match records, detect duplicates, and eliminate duplication. Our input for the method consists of several records with a 410 6 dimension size of IS. The discernibility matrix for the specified IS is computed. Following the creation of a perceptibility table with record set pairings, indexing is carried out using logical statements.Row record pairs are later on in this procedure found to be duplicate record pairs. The detected records are ultimately removed from IS. Following completion of the procedure, record duplication is eliminated, and the suggested RDCM model produces an output of a records data set with every record entry being unique.

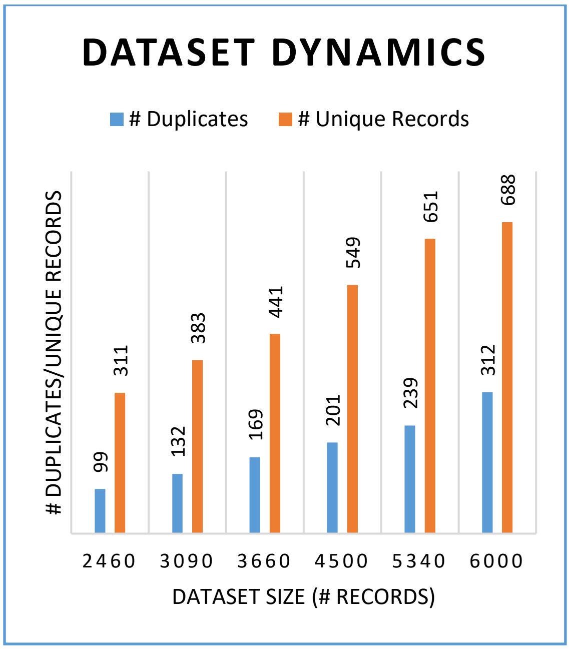

Fig 2: Dataset details

As presented in Figure 2, experiments are made with different datasets of varied size. For each dataset, there is specific experiment to observe execution time for record deduplication process.

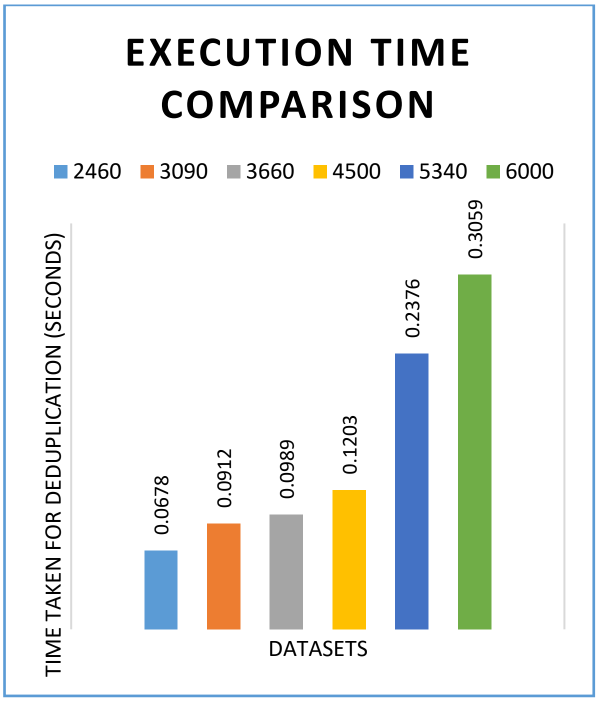

Fig 3: Time taken for record deduplication with datasets of different size

As presented in Figure 3, the dataset size has its impact on the execution time required by the proposed deduplication method. The following are the primary benefits of RS theory, which is applied in our suggested system paradigm for records deduplication. Rough sets are a new, sophisticated mathematical tool used in the RS-based records deduplication strategy for feature selection and reduce discovery. In order for subsequent categorization to become more precise and effective. It doesn't require any further data, such as probabilistic data occurrence or other statistical data.It removes unnecessary characteristics from the records data set knowledge in order to achieve dimensionality reduction.We have suggested an algorithmic model for Records deduplication utilizing RS and logical reasoning that requires less average execution time than existing techniquesassumed significance in distributed environments.

5. Conclusion and Future Work

We suggest an effective approach for performing the records deduplication procedure. Our framework and two algorithms were evaluated and found to be efficient in deduplication of records. We proposed two algorithms namely Compute Distinguishability Matrix (CDM) and Rough Sets based Record Deduplication (RSRD). The former is used to compute a matrix that is used in the latter for record deduplication. The Roughest is a tool in our suggested data deduplication computer architecture. The experiment's findings demonstrate how much faster our method is in de-duplicating records while requiring a less amount of computing power. In the future, we want to conduct our tests with our record deduplication computing process with larger datasets, including as those from Reuters, Cora, Amazon book reviews, hotel ratings, movie reviews, etc. We will thereafter examine the accuracy of the tests and the typical execution time needed for various configuration machines.

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