KINSHIP VERIFICATION AND GENEALOGY VALIDATION FOR MERANAW FAMILIES.

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CERTIFICATE OF PANEL APPROVAL

The thesis attached hereto, entitled “KINSHIP VERIFICATION AND GENEALOGY VALIDATION ALGORITHM FOR MERANAW FAMILIES”, prepared and submitted by NORFAIDZ M. IBRAHIM and YASSIN A. AGUAM in partial fulfillment of the requirements for the degree BACHELOR OF SCIENCE IN COMPUTER SCIENCE, is hereby recommended for approval.

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CHAPTER I

INTRODUCTION

1.1 Background of the Study

Genealogy is the study of lineage and family history. It holds significant value for the Meranaw people who traditionally record their family lineages using *Salsila*. The *Salsila*, derived from the Arabic term "Silsilah" meaning chain or link is a handwritten genealogical record that serves not only to track ancestral connections and preserve cultural identity but also as a tool for resolving family disputes, understanding family histories, and maintaining strong family ties. Central to genealogy is kinship, which defines social and familial relationships within clans and acts as a cornerstone of the Meranaw social structure and cultural identity**. Kinship** plays a vital role in traditional practices such as marriage, inheritance, and conflict resolution, ensuring the continuity of family bonds across generations. However, despite the importance of *Salsila* and Kinship, The traditional manual methods of verifying and validating family lineages face significant challenges, including data loss, inaccuracies in handwritten entries, and unauthorized access to sensitive family information.

Digitization of genealogical records has gained global attention as a means to address challenges associated with traditional manual record-keeping. A study titled *"Reexamining Technological Support for Genealogy Research, Collaboration, and Education"* by Fei Shan and Kurt Luther discusses the impact of new technologies on genealogy practices. The research highlights how emerging genealogy websites have transformed traditional research methods but also notes the challenges posed by technological dependencies. However, online genealogy platforms depend heavily on stable internet connections, which are often unavailable in many areas of Lanao del Sur. The lack of internet connectivity presents a significant challenge to utilizing traditional online genealogy platforms. This gap limits the accessibility and applicability of these technologies for Meranaw families in remote areas.

A study by Ruogu Fang, Kevin D. Tang, Noah Snavely, and Tsuhan Chen explored kinship verification by classifying face image pairs as "related" or "unrelated" using advanced feature extraction and selection methods. First, they conducted a controlled online search to gather frontal face images of 150 pairs of celebrities and their parents or children. Next, they proposed and evaluated a set of low-level image features for kinship classification. By selecting the most discriminative inherited facial features, they achieved a classification accuracy of **70.67%** on a test set using K-Nearest-Neighbors. Lastly, they compared their algorithm's performance with human accuracy on the same task.

Salsila is typically documented in a standard tree structure, following a hierarchy that begins from ancestor and branching out to descendants. While this structure is simple, searching for relatives or tracing lineage can be slow and challenging particularly for large families with extensive networks. The inefficiency of traditional tree structures comes from **“linear traversal methods”** which become increasingly time consuming as the dataset grows.

To address these challenges, the researchers propose the development of a **Kinship Verification and Genealogy Validation Algorithm**, designed to work independently. The proposed algorithm is an ancestral tree structure type algorithm, simplifying the process of verifying kinship relationships by focusing on a manageable subset of data. By integrating hashing and bitwise encryption for genealogy validation, the algorithm ensures data integrity and security, reducing the risks associated with the “*rido”* conflict and unauthorized access. The ancestral tree structure enhances search efficiency by narrowing the focus to immediate and relevant ancestry. For instance, starting from an individual and moving to their ancestors which provides a clear and concise view of familial connections.

The algorithm represents a significant step towards preserving Meranaw cultural identity by addressing the limitations of manual record-keeping. By bridging the gap between tradition and technology, the research offers a practical and sustainable approach on managing genealogical records while aligning with the **United Nations Sustainable Development Goal (SDG) 11.4**, which aims to protect and safeguard the world’s cultural and natural heritage. Furthermore, the integration of modern technologies supports the broader SDG agenda by promoting inclusive, sustainable, and secure solutions for cultural preservation and social harmony.

1.2 Statement of the Problem

Current kinship verification methods are inefficient due to their complex structures, such as deep graphs with variants, and lack of security, failing to address critical Meranaw cultural concerns like ***rido*** (clan conflicts), which hinder accurate genealogy validation and may create family tensions.

1.3 Research Objectives

1.3.1 General Objective

To develop a Kinship Verification and Genealogy Validation Algorithm for Meranaw families, enhancing the efficiency, accuracy, and security of managing *Salsila* records and verifying kinship relationships.

1.3.2 Specific Objectives

1. To design hashing structures with bitwise encryption which ensure data integrity and secure sensitive family information while supporting decryption.
2. To develop an algorithm that optimizes the ancestral tree structure for efficient kinship verification.
3. To validate the algorithm's efficiency in improving kinship verification and preventing unauthorized access to familial data.

1.4 Significance of the study

This research is significant as it aims to develop Kinship Verification and Genealogy Validation algorithm specifically for Meranaw families. By addressing the limitations of traditional methods, the proposed algorithm seeks to enhance accuracy, efficiency, and security while also preserving cultural heritage and strengthening family connections. The research aligns with **SDG 11.4**, contributing to the preservation of Meranaw cultural heritage by providing a sustainable, offline solution that bridges tradition and technology.

This research is particularly significant for the following beneficiaries:

1. **Meranaw Families**

   Meranaw families will benefit from a secure and efficient system for preserving and accessing genealogy records, ensuring the continuity of their cultural identity and kinship traditions.

2. **Future Generations**

   The *salsila* will serve as a resource for community elders to verify family histories, strengthen kinship ties, and mitigate *rido* conflicts and will also provide future generations of Meranaws with access to their ancestral records, fostering a sense of pride in their heritage and enabling the intergenerational transmission of knowledge.

3. **Cultural Institutions and Scholars**

   Scholars and cultural institutions will gain access to a well-organized digital archive of genealogical data, facilitating the study and preservation of meranaw cultural heritage and enabling further research into their rich traditions and history.

1. 5 Scope and Limitation of the study

This study focuses on the design and development of **Kinship Verification and Genealogy Validation Algorithm** tailored for Meranaw families. It uses an ancestral tree structure combined with hashing and bitwise encryption to ensure secure and efficient kinship verification. The algorithm is limited only to **five generations** to maintain cultural relevance and computational efficiency, as relationships beyond this point become less significant and increasingly distant.

However, the study is limited to testing in controlled offline settings and does not include public assessment, scalability testing, or integration with networked or existing systems. The algorithm’s scope is confined to five generations, prioritizing efficiency over deeper genealogical exploration.

CHAPTER II

REVIEW OF RELATED LITERATURES

This chapter synthesizes existing literature to provide a comprehensive understanding of kinship verification and genealogy validation, with a focus on Meranaw culture. Key topics include the significance of **Salsila** as a cultural artifact, the challenges of maintaining and validating genealogical records in complex family structures, and the impact of **rido** on lineage continuity. Methodological advancements such as dynamic programming algorithms, visualization techniques, and hashing methods are explored to address these challenges. The results highlight critical gaps in existing approaches, particularly the need for culturally adaptive and computationally efficient solutions tailored to the Meranaw context.

2.1 Meranaw Culture and Kinship System

2.1.1 Meranaw Culture

The Maranaos are one of the biggest cultural minorities in the island of Mindanao, Philippines and also, they are known to be the most conservative Muslim groups in the country. They settle peacefully in the provinces of Lanao del Sur and Lanao del Norte (Velasco, 2017). The Meranaw culture when it comes to marriage(*kawing*) also practices polygamy. Macabangon (2022) defined polygamy as a "marriage or union in which a partner of either sex may have more than one mate at the same time". A study of Daud (2024) in *The Role of Cultural Beliefs in Shaping Marital Practices: A Study of Mëranao Families* define polygyny as a significant cultural practice among the Meranaw, it is defined as a man being married to two or more women simultaneously. Deeply embedded in Maranao culture, this practice is permitted under Shari'ah or Islamic law. In technological side of the culture, there is a generation gap between today’s generation and from ancestors. On the article by Johnson S. (2023) from *The impact of technology on family relationships* stated that The adoption of technology in family life has opened up new opportunities, but it has also raised challenges and concerns. From dependence on digital devices to the generation gap, it is essential to explore comprehensively how technology has impacted family relationships from different perspectives (Johnson, 2023).

As Meranaw families continue to expand due to cultural practices, it becomes increasingly essential to develop systems that can accurately trace and verify familial ties. Our research aims to address the growing issue of Meranaw genealogical family tree by leveraging modern technologies, such as **algorithm-based kinship verification systems**, to ensure that Meranaw families maintain a clear and accurate record of their lineage.

2.1.2 Meranaw Genealogy

The Salsila or the Family tree from the Arabic "Silsilah" is the written genealogy of the Tausug nobility. It contains heroic deeds and significant events. It is jealousy kept by the Sulu nobility and is written in the jawi (Arabic) (Tuban & Kiram, 2012).

According to the study of Sohayle M. Hadji Abdul Racman on *The Lanao Sultanate Leadership Legitimacy: Its Bases from Islamic Principles on Leadership, Maranao Traditions, Salsilas and Historical Claims* there is a limited research on the Lanao Sultanate legitimacy in the areas of Islamic principles on leadership, Maranao traditions, *salsilas* (scholarly chain of genealogy), and historical claims. Their study explores the bases of legitimacy of Lanao Sultanate from Islamic principles on leadership, Maranao traditions, *salsilas*, and historical claims perspectives (Hadji Abdul Racman, 2022). This study proves that the *salsilas* of the Meranaw culture assures the kinship system.

This study recommends us to investigate more about the other areas in Lanao and Meranaw community such as the *salsilas*.

2.1.3 Family Feud or *Rido* on Meranaw

According to Orozco (2022), *Rido* or clan feud among Meranaos has been known as one of the most common problems that hinder individual and social development. Parents and children vary in their experiences and the consequences they faced. In their study on *The Lived Experiences of Rido: The Meranao Case* they aim to investigate the nature of *rido*, describe the impact of it on parents and children on mental and physical health, and identify their coping mechanisms. 20

responded through snowball sampling in Lanao del Sur. Their study revealed that the most common *rido* experience by the respondents are politics. The respondents stated that they suffered from grief, anxiety, and depression. Children lost a sense of belongingness and interest from frequent changes of residence and school. Respondents' families suffered from a common physical ailment that varies from mild to severe condition. Both parents and children are coping through pangni (prayers), but children are more likely to resort to retaliation (Orozco, 2022).

There are various types of Rido. According to Oki (2014), Rido cases are resolved, remain unresolved, or recur. In this study, in our proposed algorithm, *rido* is considered an hindrance to kinship verification. Because it might trigger an unresolved or reoccur a resolved *rido* once a kinship is verified.

This study will serve as basis on our study focusing on managing conflicts and family feud (*rido*).

2.2 Kinship Verification and Genealogy Validation

In early days lineages were transmitted orally, and each generation passed this information to the next. The Japanese *kataribe*; the celtic *shanachy* and the Germanic *scop* all shared a common task: to record, recite and preserve the ancestry of chieftains and heads of state (Hadis, 2002).

2.2.1 Genealogical Challenges

In the study by McGuffin & Balakrishnan (2005) on *Interactive Visualization of Genealogical Graphs*, they mentioned the dual-trees visualization and presented a software prototype that would implement this scheme. According to them the depiction of relationships in a large family is challenging, as is generally the case with large graphs. In the same article by McGuffin & Balakrishnan (2005) genealogical graphs are commonly referred to as family trees, in which misleading. Every individual has a tree of ancestors, as well as a tree of descendants

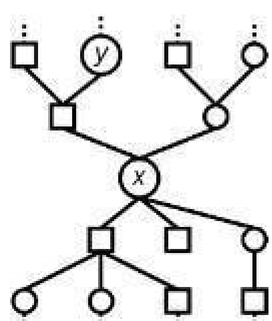

Figure 1. Graph showing individual X has tree of ancestors and tree of descendance from the article

It is more challenging, however, to also show the descendants of y, or worse still, to show the descendants of every ancestor of x, and the ancestors of every descendant of x.

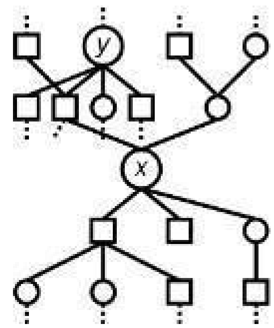

Figure 2. Graph showing the descendants of induvial y on the tree of ancestors of individual x from the article *Interactive Visualization of Genealogical Graphs*

The study mentioned will be used as basis for our study on Validating Meranaw genealogy (*salsila*) on analyzing effective algorithms.

Genealogical practices are crucial for understanding familial relationships and tracing ancestral lines, but they come with several inherent challenges. One of the primary obstacles is managing and visualizing large family trees, especially in communities with extensive and interconnected lineages. As families grow and branch out, maintaining an accurate record of individuals and their relationships becomes increasingly difficult. The sheer scale of these genealogies can be computationally demanding, as traditional tools may struggle to handle such complex data, leading to inefficiencies in how the information is stored and presented (McGuffin & Balakrishnan, 2005). Furthermore, many genealogies in cultures worldwide have been passed down orally, which introduces another significant challenge: transitioning oral histories into written genealogical records. Oral accounts, rich in cultural nuances, may not always be accurately captured when transcribed, leading to discrepancies or omissions in the final written genealogies. This is particularly evident in cultures where oral traditions are central to preserving family histories (Hadis, 2002). In addition to these technical and cultural challenges, family feuds, or *rido*, complicate genealogical practices even further. These conflicts disrupt the continuity of family lineages, as individuals may alter or contest genealogical records for personal or political reasons. As a result, different versions of family histories may emerge, adding ambiguity to the genealogical data. Such conflicts make it difficult to create an objective and accurate genealogical record, as certain family branches might intentionally obscure or challenge the inclusion of specific individuals or relationships (Orozco, 2022). Thus, genealogical practices face a range of challenges, from the technical difficulties of managing large datasets to the cultural and social factors that influence the accuracy of family histories. Addressing these issues requires advanced computational tools, careful translation of oral traditions, and strategies to resolve family conflicts in order to maintain the integrity of genealogical records.

2.2.2 Algorithmic Solutions

Various algorithmic solutions have been developed to address the challenges of verifying kinship in genealogical data. One such solution is Felsenstein's pruning algorithm, which efficiently handles large genealogies by reducing computational complexity through dynamic programming, particularly in phylogenetic tree construction. This algorithm operates in linear time, O(n), where n is the number of nodes in the tree. Another approach is Bayesian networks, which model the probabilistic relationships between individuals, helping infer likely kinship based on available data while handling uncertainty and missing information. The time complexity of Bayesian networks is O(n^2), as it involves iterative probabilistic inference. Graph theory algorithms, on the other hand, use nodes to represent individuals and edges to represent relationships, enabling the validation of kinship and identification of inconsistencies in family connections. The time complexity for graph-based methods is O(V + E), where V is the number of vertices (individuals) and E is the number of edges (relationships).

Maximum Likelihood Estimation (MLE) algorithms estimate the most probable kinship by analyzing genealogical data, especially when the data is incomplete. These algorithms typically require cubic time complexity, O(n^3), due to the combinatorial nature of the problem. DNA matching algorithms, such as Longest Common Subsequence (LCS) and Hamming Distance, verify kinship through genetic data comparison. The time complexity for LCS is O(n*m), where n and m are the lengths of the sequences, while Hamming Distance runs in linear time, O(n). Relational database models utilize algorithms to store, retrieve, and query genealogical data, assisting in kinship verification by linking individuals in the database. Queries in balanced databases generally have a logarithmic time complexity, O(log n). Lastly, fuzzy logic algorithms handle uncertainties in genealogical data by using fuzzy sets, allowing for flexible kinship verification when relationships may be unclear or approximate. These algorithms operate with a time complexity of O(n^2), as they evaluate multiple possible matches.

Algorithmic Solutions	Description	Time Complexity
Felsenstein's Pruning Algorithm	Efficiently handles large genealogies by reducing computational complexity through dynamic programming, particularly in phylogenetic tree construction.	**O(n)**
Bayesian Networks	Models the probabilistic relationships between individuals to infer likely kinship based on genealogical data, handling uncertainty and missing information.	**O(n^2)**
Graph Theory Algorithms	Uses graph-based methods to validate kinship, where nodes represent individuals	**O(V + E)** where V is the number of vertices (individuals) and

	and edges represent relationships. Can identify inconsistencies in family connections.	E is the number of edges (relationships)
Maximum Likelihood Estimation (MLE)	Estimates the most probable kinship by analyzing genealogical data, especially when data is incomplete. It uses statistical methods for inference.	**O(n^3)**
DNA Matching Algorithms	Utilizes algorithms like Longest Common Subsequence (LCS) and Hamming Distance to verify kinship through genetic data comparison.	**LCS: O(n*m),** **Hamming: O(n)**
Relational Database Models	Uses relational database algorithms to store, retrieve, and query genealogical data, assisting in kinship verification by linking individuals in the database.	**O(log n)** for queries in balanced databases
Fuzzy Logic	Handles uncertainties	**O(n^2)**

Algorithms	in genealogical data using fuzzy sets, allowing flexible kinship verification where relationships may be unclear or approximate.	

Table 1. Possible Algorithmic solutions found relevant to the study on kinship verification

2.3 Research Gaps

Several gaps exist in the study and application of genealogy and kinship systems, particularly in the context of the Meranaw people. One key issue is the lack of focused research on Meranaw-specific genealogy, which often overlooks the unique cultural practices, beliefs, and family structures of the community. This absence of tailored studies leads to misinterpretations when applying standard genealogical models. Additionally, the practice of polygamy in Meranaw culture results in complex family trees with numerous nodes and branching patterns, making it difficult for traditional algorithms to accurately model and validate kinship and lineage. Moreover, the cultural impact of family conflicts, such as *rido*, further complicates genealogical data, as disputes can disrupt the continuity and accuracy of family records.

To address these issues, there is a need for more robust, scalable algorithms that are specifically designed for the complexities of Meranaw genealogies. Existing algorithms often fail to account for non-Western kinship systems, polygamous structures, and the influence of family conflicts, highlighting the necessity for culturally sensitive solutions. Developing tailored algorithms will ensure that genealogical data is accurate, culturally appropriate, and able to handle the complexities inherent in Meranaw kinship systems, ultimately leading to better preservation and validation of family histories.

Summary

This chapter explores the complexities of kinship verification and genealogy validation, specifically within the Meranaw culture. It highlights the significance of the Salsila (family tree) in preserving familial ties and cultural history, emphasizing challenges such as polygamy, family conflicts (rido), and the impact of modern technology on these traditional practices. The chapter also discusses the technical difficulties in managing large genealogies, particularly with the use of algorithms to verify kinship in complex family structures. Various algorithmic solutions, such as Felsenstein's pruning algorithm, Bayesian networks, and DNA matching methods, are examined, noting their strengths and limitations in handling the intricacies of Meranaw genealogies. The need for more culturally tailored computational solutions to address these unique challenges is underscored.

THEORETICAL FRAMEWORK

Based on existing literature understanding Meranaw culture, the role and research gap of *salsila* in Meranaw identity, the conflict management, and the challenges in validating large family trees. The researchers aim to address the gaps using following theories from cultural, validation, and considering secure concerns specifically on family feuds and conflict.

4.1 Cultural Heritage Theory

Cultural Heritage Theory is our framework of thought which preserves, manage, and examines the cultural heritage. *A Theory of Cultural Heritage* provides a structured and comprehensive picture of the concept of cultural heritage (CH) and its theoretical and practical derivatives (Munoz-Vinas, 2023).

Salsila comes from an Arabic word *Silsilah* which means scholarly chains of transmission or genealogical links. Salsila is written on karatas (paper) in Arabic script, called kirim, written usually in Maranao language with Malay or Arabic terms. It has been handed down through the generations as jealously guarded secrets by the pananalsilas (genealogy experts) (Rachman, 2018).

4.1.1 Impact of Salsila in Trading

It is within this context that traditions, cultural values, beliefs and practices distinguish the Maranao from all other Muslim ethnic groups. The Maranao trade, strategize and decide on their business based on ilial and community bond- often fueled by maratabat (family pride). It is the central value and personality trait that imparts the tone in the day-to-day relationships between Maranao individuals. Maranao trading has a long history. The historical records of the present-day Maranao are found in salsila or oral traditions detailing about the Kingdom of Bumbaran, the ancestors of the present-day Maranao (Bidad & Mision, 2015)

4.1.2 Conflict Resolution Theory

This theory is similar to the study of Orozco (2022), their study is anchored to Maslow's Hierarchy of Needs and Ecological Models of Human Development. This theory emphasizes need that activates the human behavior. This theory is in a particular order like in a pyramid. Mention in the theory was the psychological need. Esteem needs as emphasized by Maslow is relevant on Meranaw's cultural view of Maratabat (pride) which influences their behavior on rido.

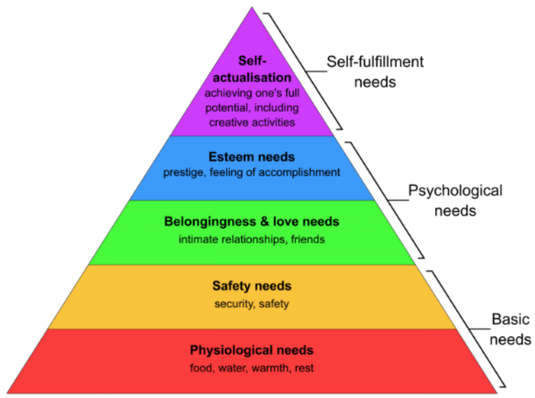

Figure 3. Maslow's Hierarchy of Needs and Ecological Models of Human Development

4.2 Verification Theory

Verification theory is our principle that ensure the accuracy and reliability of the data collected and ensure the data was properly used.

Genealogy with large graphs and trees with many nodes is a hassle to track. In the study of McGuffin & Balakrishnan (2005) they represent large graphs and shows the traditional genealogical graph, or a simple family tree with the focus on descendants' lineage. The problem with traditional family tree is there is no limit on the descendants' lineage of the flow of the tree.

This study introduces a hierarchy method on verifying kinship within a meranaw family. The researchers focus more on the ancestors with only two nodes (parents) and limit it to level 5 of the family tree. This study proposes an array-to-array approach in comparing ancestors with 2 meranaw individuals when verifying kinship. An array is a linear data structure where the elements or items are arranged in sequence. It is a collection of elements with the same data type.

To achieve the array-to-array approach, the algorithm will extract a linear list of ancestors from an individual and compare it to another array of ancestors from different individuals.

Unlike the traditional family tree, the number of nodes in a binary tree with only 5 levels for this study is $N = 2^n$ where N is the number of nodes and n is the number of levels. To compute it, $N = 2^5 = 32$, which is the possible maximum number of iterations and will resolve the time complexity of the proposed algorithm. The traversal algorithm the researchers used in this study is Depth-First algorithm. Depth-First algorithm is a process where it starts at the root node and explores as far as possible along each branch of the tree before backtracking.

4.3 Hashing Theory and Bitwise cryptography

The researchers used theory involving hashing techniques to process and transform the data into a set of characters. This will be achieved using Bitwise cryptography as our hash function design.

For validation process, if two different individuals have a matched ancestor (refer to figure 4) the name and date of birth of the ancestor transforms into shorter value. This process is called **Hashing**.

Hashing is a process of transforming a string of characters into a shorter and fixed-length value that can represent original data with significantly reduced runtime or storage consumption. This transformation can be achieved by using hashing functions (Chi & Zhu, 2017). In this study, the researchers used Bitwise encryption after the hashing of the matched ancestors. According to the article *Understanding Bitwise Operations in Python: Cryptography, Hashing, and Real-World Applications* by Woon (2024) Bitwise operations allow manipulation of individual bits of an integer in binary form. They stated that bitwise operators give an efficient method in manipulating the data at the bit level, which can be profoundly applied in cryptography, hashing, and hardware-level programming. For security purposes, this study applied security questions and bitwise encryption for efficient manipulation of the hashed value of ancestor, ensuring that every value can be toggled and control in every correct answer of security questions.

Summary

The **Theoretical Framework** for this study integrates multiple theories to address the research gaps in validating Meranaw genealogies, focusing on cultural heritage, conflict resolution, verification, and secure data handling. The **Cultural Heritage Theory** emphasizes the importance of preserving the Salsila, the Maranao family tree, as a critical cultural artifact that links generations and informs key aspects of Maranao identity and business practices, influenced by family pride or *maratabat*. **Conflict Resolution Theory**, grounded in Maslow's Hierarchy of Needs, highlights how rido (family feuds) affects behavior, particularly concerning esteem needs and pride in Meranaw culture. **Verification Theory** is applied to ensure the accuracy and reliability of genealogical data, proposing an array-to-array comparison method for efficiently verifying kinship within Meranaw families, using a hierarchy to limit the tree depth to five levels. Finally, **Hashing Theory and Bitwise Cryptography** address security concerns by transforming genealogical data into shorter, fixed-length values, allowing efficient storage and manipulation while ensuring data privacy through encryption and security questions.

CHAPTER V

CONCEPTUAL FRAMEWORK

This study aims to verify kinship and validate Meranaw Genealogy (*salsila*) using a hashing design function with bitwise cryptography. To understand the study, conceptual frameworks will be developed. This chapter shows the diagram explaining the process of adding data to the binary tree, comparing the array of ancestors, and encrypting and decrypting of ancestors for genealogy validation. This will present a structured set of the concepts by specifying the variables, measuring the instruments, data collection procedures, and data analysis techniques.

5.1 Data encoding of Salsila Binary Tree

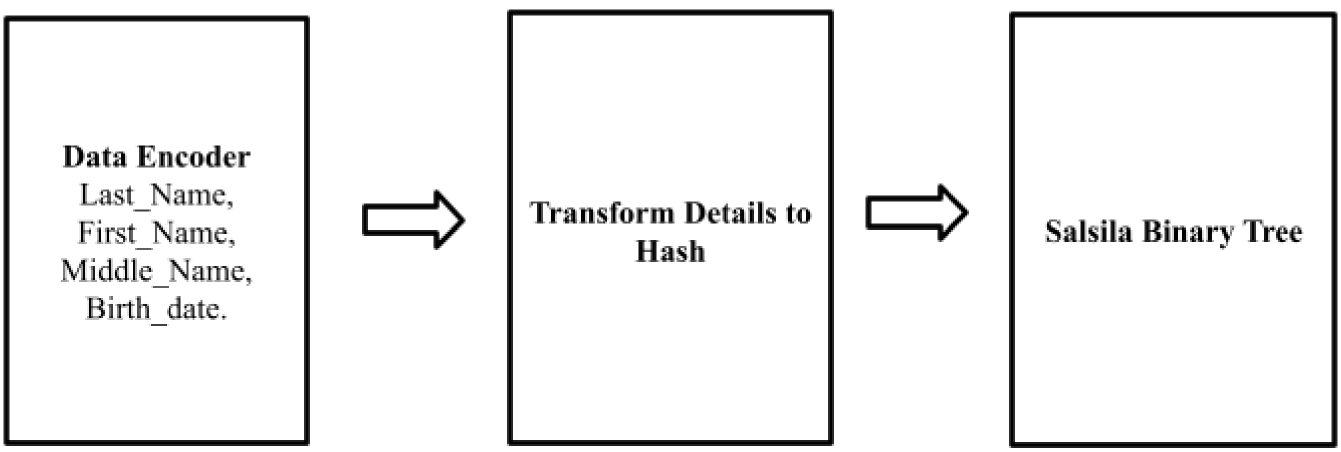

Figure 4. Process when inputting data on Salsila Binary Tree

For databases on the mobile platform, the user will input the data with information such as last name, first name, middle name, and date of birth. To achieve an efficient comparison of ancestors, the data will transform into a hash code that represents the ancestor's whole details and proceed to add onto the user's salsila binary tree that shows the information entered by the user in every node of the tree. Figure 4.1 shows the sample Salsila binary tree.

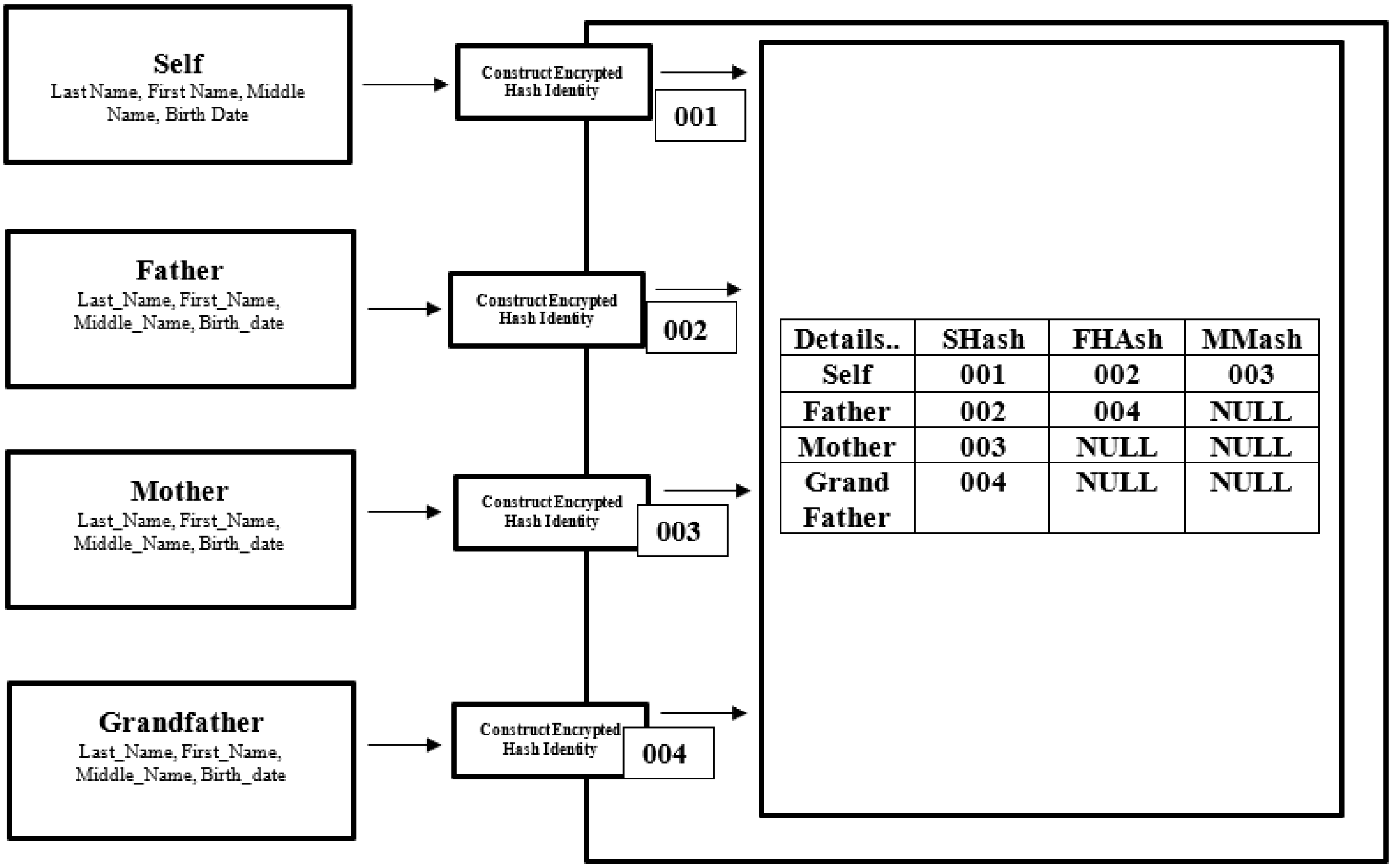

Figure 4.1. Sample output of user X's Salsila Binary Tree after adding the data with hash codes

The figure above shows sample data that the user adds to the binary tree. Every node has plus button that means that the tree will accept new data and connect it to that node. The plus button will not be visible if the node is already connected to two nodes. The hash code is not visible to the user.

5.2 Array-to-Array comparison and Kinship Verification process

For kinship verification, comparing ancestors is necessary. To achieve this, the Array-to-Array approach will be used. Figure 5 shows the first array with a list of ancestors that get extracted from individual X and compare to an array of ancestors of individual Y. This will be achieved using traversal algorithm like Depth-First search. The search will start from the root and to the deepest node. If the comparison fails, the traverse will backtrack and proceed to the second array of ancestors.

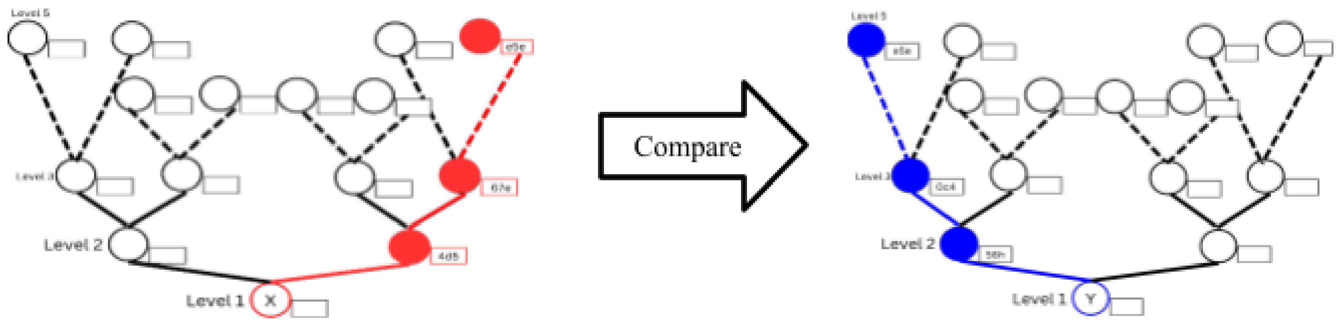

Figure 5. Traversing the individual X's array of ancestors and gets compared to individual Y's array of ancestors

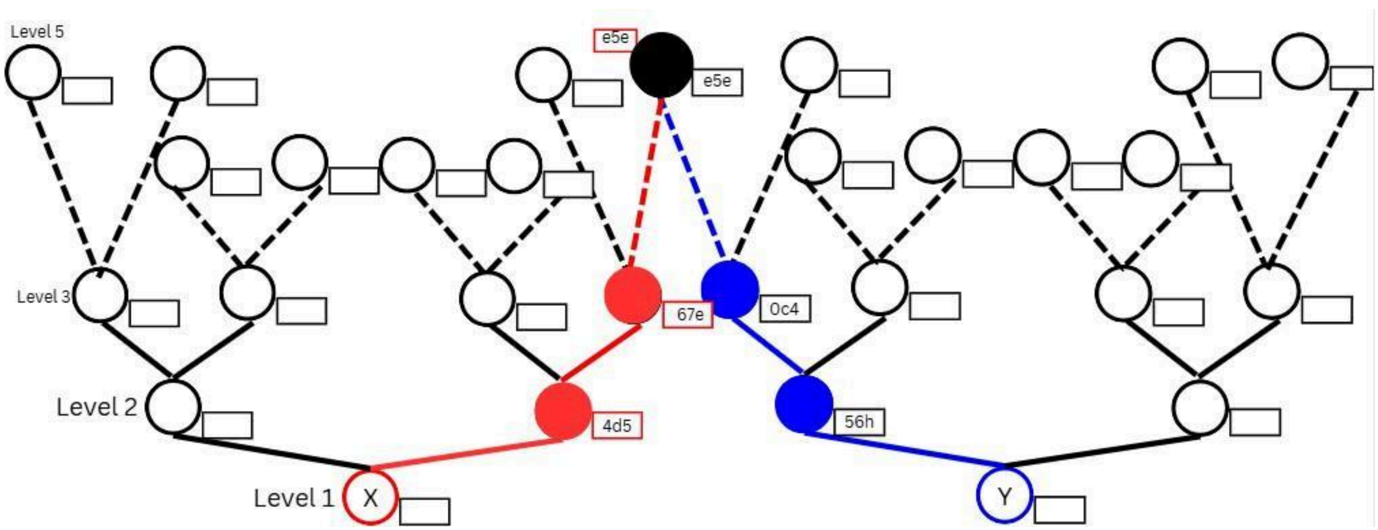

Figure 5.1 Showing two individual X and Y sharing the same ancestor (black color) with same hash code

5.3 Genealogy Validation of the matched ancestor

Validation of the genealogical lineage requires the matched ancestors of the two individuals. X as seeker who asked Y to verify their kinship. The matched ancestor will proceed on the validation. This includes the hashing of the last name, first name, middle name, and date of birth separately, applying bitwise encryption to the hash codes using the check digit extracted randomly from the information of the ancestor, applying security questions to decrypt the back to the hash code if answered correctly, and revealing the information to the seeker who asked the question. As shown in the figure 6, this process will repeat until all encrypted hash codes are decoded and reveal the full information of the ancestor.

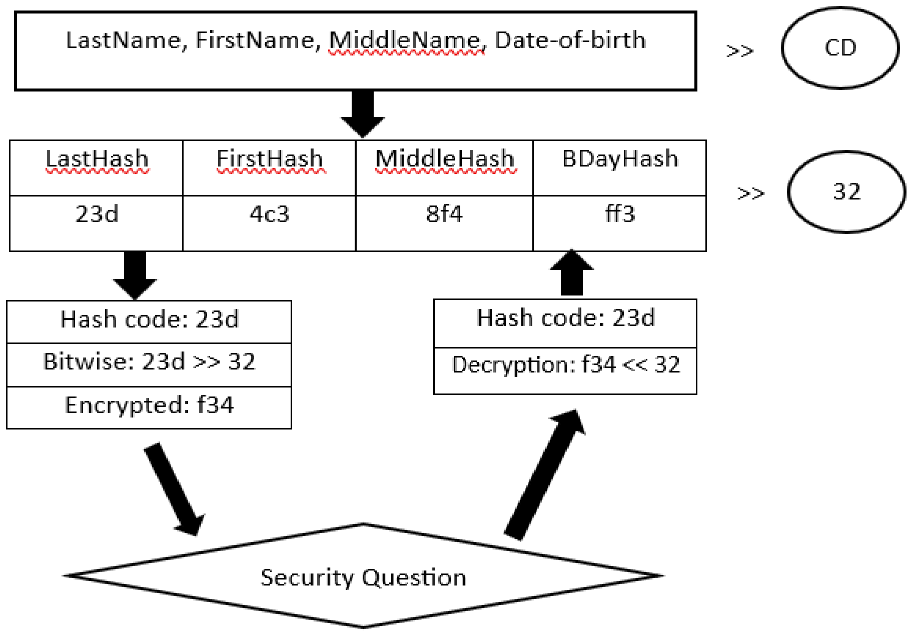

Figure 6. Hashing, Encryption, an
d Decryption of the matched
ancestor

5.4 Salsila Binary Tree Algorithm

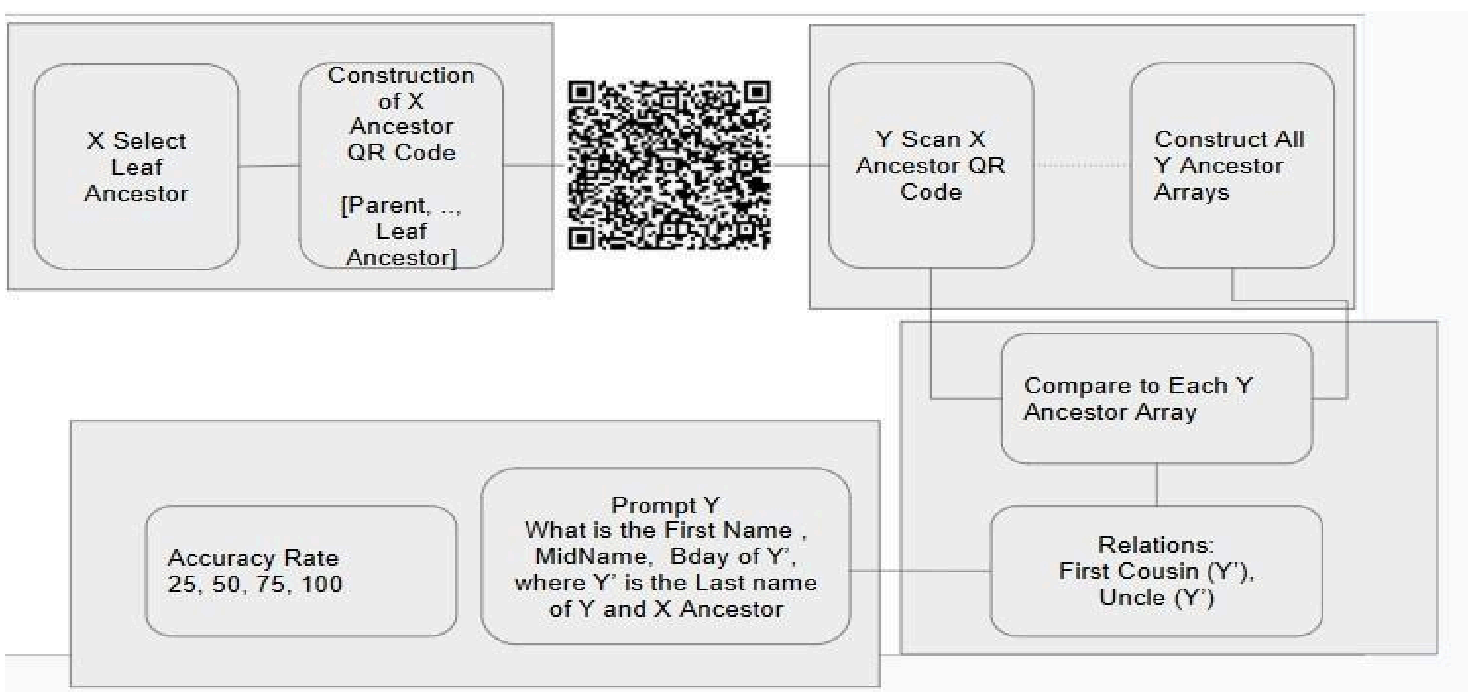

Figure 7. Showing the whole framework of Salsila Binary Tree Algorithm

Summary

The conceptual framework for this study focuses on verifying kinship and validating Meranaw genealogy using a Salsila Binary Tree and hashing techniques. The process begins with encoding data (such as last name, first name, middle name, and birth date) into a binary tree structure, where these details are transformed into unique hash codes. The binary tree allows users to add and manage genealogical data nodes systematically. The Array-to-Array comparison is then employed, utilizing traversal algorithms (like Depth-First Search) to compare arrays of ancestors from two individuals and identify shared ancestors through matching hash codes.

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