



**NAMIBIA
UNIVERSITY
OF SCIENCE AND
TECHNOLOGY**

Proverb Representation using Semantic Technologies: A case study of Nigerian Yoruba Proverbs

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**Thesis presented in partial fulfillment of the requirements for the degree of Master
of Computer Science at the Namibia University of Science and Technology**

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October 2020

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Declaration

I, Victor Adelakun Omolaoye, born on the 12th of October 1993 hereby declare that the work contained in the thesis report for my Master of Computer Science project, entitled:

“Proverb representation using semantic technologies: a case study of Nigerian Yoruba proverbs”

Is my work and that I have not previously in its entirety or in part submitted it at any university or other higher education institute for the award of a degree.

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Abstract

Indigenous Knowledge (IK) is the unique, traditional, local knowledge existing within and developed around the specific condition of women and men indigenous to a particular geographic area. Forms of expressing IK include folklores, songs, stories, festivals, outfit and proverbs. Proverbs are grounded upon years of experience and close observation of life and natural phenomena. Some research posed proverbs to be the bedrock of civilization of a society. By implication, almost all societies have proverbs or a form of it. The Nigerian Yoruba society is endowed with enormous proverbs which serve pivotal roles. The significance of proverbs to society and in particular Yoruba society cannot be overemphasised. Thus, attempts have been made to archive them both digitally and in print.

However, present users with simple lists of proverbs to browse. These forms of representation also pay no attention to proverbs' applicability to daily challenges; they are hard-coded and unfriendly. Thus, reducing proverbs to passive text rather than active wisdom. Due to the proliferation of intelligent linguistic agents, they can serve as media of communicating proverbs. However, agents need more than text to attain a level of intelligence whereby they respond to queries (complaints) with relevant indigenous proverbs. Hence, Yoruba proverbs are yet to be represented and preserved with technologies that maximise their usefulness. Thus, this study aimed to design a semantic proverb representation that allows linguistic AI applications to apply indigenous proverbs to domain contexts (complaints).

Employing research through design methodology, minimum metadata about proverbs required to explain, interpret and apply best fitting proverb(s) to a domain context from a pool of proverbs were identified by reviewing literature. Case study based data was elicited through interview. The data gathered corroborated literature standpoint that the meaning of a proverb is context-dependent. By implication, the context of application affects the meaning of proverbs. After thematic analysis, there are four main factors that determine proverbs' relevance to contexts, namely proverb intrinsic-attributes, proverb user attributes, context attributes and audience attributes. Subsequent to these findings, a generic computer understandable representation of proverb was designed.

Notwithstanding, it must be ascertained that this representation is robust enough for intelligent agents to use when responding to complaints or query. Hence, a simple complaint-response app and a chatbot were developed by active coding. The chatbot was tested by seven users with a

complaint each. The users passed comments and corrections were made. Subsequently, it was tested and 31 complaint-response pair were recorded. These responses were given to 20 evaluators to rate their suitability to complaints on a scale of 1 to 5. The average rating was 3.12 rounded off to 3.0 implying the advice is sensible, acceptable to the listener, useful to some extent but might be general. I ascribe this limitation (over generalisation) to the application layer where models are not accurate and not the representation itself. I conclude that the representation is adequate for the purpose it was designed, but its veracity and efficacy are dependent on the accuracy of the application layer.

Retention and Use of Thesis

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Acknowledgement

To the only true and wise God who gives life through His Son and sustains it by His Spirit do I give all glory, honour and praise for the gift of life, sound health, spiritual and physical family, wonderful supervisor, consistent sponsor and supportive colleagues.

The German Academic Exchange Service fully funded this research from June 2018 to June 2020. Therefore, many thanks to all taxpayers in Germany for their support throughout my stay in Namibia as a student working on this project. I also acknowledge everyone that participated in the interviews and workshops I held to gather data. I am grateful.

My heartfelt gratitude also goes to my supervisor for her support and interest in my idea and progress. Many thanks, Prof. Heike. I also acknowledge the support of Deeper Life Campus Fellowship for spiritual and moral support given. Our Patron, Prof. Reju, I really appreciate you. My beloved “Namibian Next of Kin” Katjana John, I appreciate you. Benjamin, thanks for your support.

To everyone that companied me online while away from home Temidayo, Happiness, Akinbola, Bori, Esther Amhenrior, Kenadex, Peteru and others, thank you all.

Finally, to my Dad and Mum, many thanks to you for keeping my back always.

Dedication

This work is dedicated to God, the giver of inspiration.

Glossary

Metadata	Metadata is data about data (Cruz & Xiao, 2005)
Agent	A computer program capable of intelligently interacting with human. Used interchangeable with machine
Paremiology	The study of proverbs
Perlocution	An act of speaking or writing which has an action as its aim but which in itself does not effect or constitute the action
Synset	An NLTK python class containing words and their synonyms
Wordnet	A large lexical database of English Noun, verbs, adjectives and adverbs

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List of Abbreviations

ACID	-	Atomicity, Consistency, Isolation and Durability
AGI	-	Artificial General Intelligence
AI	-	Artificial Intelligence
AIML	-	Artificial Intelligence Markup Language
AJAX	-	Asynchronous JavaScript and XML
APCI	-	Artificial Psychological and cultural intelligence
ATLAS	-	A Taste of Language at School
CRIN	-	Cocoa Research Institute of Nigeria
CRUD	-	Create Retrieve Update Delete
CSS	-	Cascade Style Sheet
HTML	-	HyperText Markup Language
IFRA	-	Institute of African Studies
IK	-	Indigenous Knowledge
JSON	-	JavaScript Object Notation
LSA	-	Latent Semantic Analysis
LSTM	-	Long Short Term Memory
ML	-	Machine Learning
NISER	-	Nigeria Institute of Social and Economic Research
NLP	-	Natural language processing
NLTK	-	Natural Language Toolkit
NoSQL	-	Not only SQL
ODDL	-	Open Data Description Language
OPM	-	Object Process Paradigm
PARADISE	-	PARAdigm for DIalogue System Evaluation
POS	-	Part of Speech
PWS	-	Possible World Semantic
RDF	-	Resource Description Framework
SDT	-	Self Determination Theory
SQL	-	Structured Query Language
SRH	-	Sexual and Reproductive Health
UCL	-	University College London

- UML - Universal Markup Language
- XML - Extensible Markup Language

Chapter 1

Introduction

1.1. Introduction

Greiner (1998) defined Indigenous Knowledge (IK) as the unique traditional and local knowledge existing within and developed around the specific condition of women and men indigenous to a particular geographic area. He asserted that IK development covers every aspect of life, including management of the natural environment and it is pivotal to the survival of the people. Similarly, Warren (1991) defined IK by pointing out its attributes as local, unique to every culture and society and a basis for local-level decision making in all areas of life including but not limited to agriculture, health care, food preservation and preparation. IK provides problem-solving strategies for communities, and it is dynamic, continuously evolves and innovates (Sharma, 2014).

The fact that IK predates recorded history (Nelson, 2008) makes it conveyed down generations orally. IK is shared and communicated by specific examples and through culture. It is stored in people's memories and activities, expressed in stories, songs, folklore, dances, myth, cultural values, beliefs, rituals, community laws, local language and taxonomy, agricultural practices, equipment, materials, plant species, animal breed and proverbs (Greiner, 1998).

IK has received diverse kinds of attention from different viewpoints over the last decades; thus, its digitisation is pursued on all continents by numerous agencies (Winschiers-Theophilous, Rodil, & Jensen, 2012). Findings of several studies (Nelson, 2008; Bolaji & Kehinde, 2017) have ventured into its analysis, application, documentation and digitisation. However, IK has a different epistemology, which poses a significant set-back to its digitization and proper representation (Bidwell & Winschiers-Theophilus, 2015).

Furthermore, Winschiers-Theophilous et al., (2012) suggested the engineering of an indigenous oriented scientific driven system for representing IK which current technologies do not support efficiently; they claimed current technologies support only some of the features of IK. However, the 'self-containing' attribute of proverbs as reported by Dabaghi, Pishbin, & Niknasab (2010) reveals that an ideal proverb requires determinable metadata needed for its understanding and application. Fundamentally, such metadata can be stored as text. These attributes make proverbs to

fall into the few forms of expressing IK or features of IK which current technologies can support with little modifications.

Proverbs, being short, generally known sentences of folk contain truth, wisdom, morals and traditional views in a metaphorical, fixed and memorisable form. They are handed down from generation to generation and used to treat socio-psychological problems (Dabaghi et al., 2010) . Proverbs also guide actions and thoughts, help in giving advice, and express general truth (Bolaji & Kehinde, 2017) . Although proverbs are indigenous, they have not lost their relevance in present-day societies. Corroborating that fact, Ademowo & Balogun (2014) applied some Nigerian Yoruba proverbs to the prevalent challenges in their society and deduced solutions to the problems.

The significance of IK to the society and in particular, Yoruba society, remains undeniable. Thus, there exist several successful attempts to archive and safeguard indigenous knowledge, including proverbs. The result of these attempts are books such as “Owe in Yoruba fun Ile-Eko Giga”, “Owe L’esin Oro”, “Yoruba Proverbs – their meaning and usage” and many others. Technological advancement has not left this process unaffected; an example is “Yoruba Proverbs: The Good Person” (Oyekan, 2004) . Nevertheless, researchers like (Khalala, Makitla, Botha, & Alberts, 2014; Sarkhel, 2016) decried the underutilisation of IK, including proverbs, especially towards solving severe problems as Nakata (2002) pointed out. Digitisation remains the only significant effort aimed at preserving proverbs. Thus, the digital representations of the data available on Yoruba proverbs do not encourage using them for problem-solving and decision making either by human or agents.

1.2. Problem Statement

The significance of proverbs to societies and in particular, Yoruba society, remains indispensable. Thus, attempts have been made to compile these proverbs and to archive them both digitally and in print. However, the present technologies used to preserve these proverbs and the format of digitizing them are not efficient. They present users with simple lists of proverbs to browse. These forms of representation pay no attention to proverbs’ applicability to everyday situations; they are hard-coded, static, non-incremental, time-consuming, frivolous and unfriendly. Thus, reducing proverbs to passive text rather than active wisdom. Due to the proliferation of intelligent linguistic agents, they can serve as media of communicating proverbs which if learnt, can be used consciously or subconsciously for problem-solving by humans.

Nevertheless, intelligent agents need more than text to attain the level of intelligence, whereby they respond to queries (complaints) with pertinent indigenous proverbs. The intelligent agents desired

requires that digitised proverbs exceed simple listings. Hence, Yoruba proverbs are yet to be represented and preserved with technologies that maximise their usefulness.

Representing Yoruba proverbs as simple listings make them dormant and seemingly useless. It obscures their relevance and applicability to social problem solving and has limited their general usage. However, when adequate information like “definition of terms”, “explanation of metaphoric meanings” and “context of applicability” are provided, Yoruba proverbs proves to be more useful and relevant to solving social problems (Bolaji & Kehinde, 2017) . Therefore, representing indigenous proverbs in formats encapsulating definition of terms, explanation of metaphoric meanings and context of application would considerably increase proverbs’ usefulness and applicability to social problem solving and decision making in present-day society. It will also avail linguistic machines the ability to use proverbs, thereby improving human-computer interaction.

1.3. Research Aim and Objectives

The main research objective is to design a semantic proverb representation that allows linguistic AI applications to apply indigenous proverbs to contexts (complaints).

1.3.1. Research Objectives

The research sub-objectives are to:

- Identify minimum metadata about proverbs required to identify, explain, interpret and apply best fitting proverb(s) to a domain context from a pool of proverbs.
- Design an appropriate semantic representation of proverbs given the metadata identified in the first objective
- Develop an application to test the usability of the representation by linguistic applications and agents.
- Evaluate the suitability of proverbs applied to context by linguistic application based on this representation.

1.4. Significance and Contribution

There are several campaigns by the United Nations, the World Bank and other bodies towards safeguarding Indigenous knowledge. This study contributes to safeguarding IK by representing proverbs in a form that reveals their prowess. The study will aid in solving social problems by

employing the wisdom contained in proverbs and applying them to context or situation in order to have an indigenous point of view. The outcome of the study indirectly teaches users of computer applications that leverage this formalism, indigenous knowledge.

Finally, the study would bring about means of proverb digitisation that makes them useful and more relevant to day-to-day contexts or situations.

1.5. Ethics

Anderson, Johnson, Gotterbarn, & Perrolle (1993) discussed fundamental ACM code of ethics and professional conduct regarding intellectual property, privacy, confidentiality, quality of professional work, fairness and discrimination, liability and unreliability, software risk, conflicts and interest, unauthorized access. They gave sample scenarios these ethics must hold and the duty of a professional. In addition to professional conduct, there are moral imperatives expected of a professional or researcher. It is expected of a researcher to contribute to society and human wellbeing; avoid harm to others, be honest and trustworthy; be fair and take action not to discriminate, honour property right including copyrights and patents, give proper credit to intellectual property and respect the privacy of others.

These and Yoruba societal ethics fundamentally respect and honour were strictly adhered to while interacting with the knowledge holders during interviews and workshops. Yorubas expect a younger person to accord them due respect and honour. The definition of young can be extended to mean deficiency. A person in need is expected to accord due respect to whosoever is helping even if the helper is comparatively juvenile. In this case, I am younger than all participants because I need their help. This cultural norm was duly followed. In return, they all obliged to respond to my call whenever I need their help in future.

Furthermore, institutional ethical clearance requires that participants give their consent to participate in the workshop, retain their right to stay and leave at any point in the workshop, use their data for research purpose and the findings would be published. Ideally, the participants were to sign a document, but they were called via phone, details of the workshop articulated to them in Yoruba language, which is their mother tongue. Those that participated were intimated the content of the ethical clearance. They subsequently signed a participation form to indicate their voluntary participation.

1.6. Scope

This study focuses only on Nigerian Yoruba proverbs (Southwest, Nigeria) and the linguistic applications developed are experimental, sole for the sake of research. However, most of the component need little customisation to be production-ready.

Chapter 2

Literature Review

This chapter seeks to inform, establish and remind the reader of some computer science concepts, application software, frameworks and paremiology principles used in the course of this study. The review starts from the definition of indigenous knowledge, specifies proverbs as a form of IK and culminates in human language processing - a field in computer science.

2.1. Indigenous Knowledge

Warren (1991) stated that IK is local knowledge, emphasising that it is knowledge unique to a given culture or society. Morris (2010) prefers to define IK as the knowledge that ordinary people have of their immediate locality. In concordance with Senanayake (2006), Morris asserts that IK is rooted in a particular place, shared, based on experience, empirical, practical, pragmatic, informal and dynamic. ARTIC COUNCIL (2018) defined IK from a psychological perspective as a systematic way of thinking and knowing, rightly applicable to biological, physical, cultural and linguistic systems. These definitions presuppose IK is an instrument of civilization in societies.

Of interest is the definition Chinsebu et al. (2015) gave to IK as the ‘dynamic information base of a society facilitating communication and decision making’, therefore considering IK as a psychological tool that facilitates decision making. Whereas a body of IK is local, IK as a concept is nonetheless universal, in that every locality has IK peculiar to her. Senanayake (2006) accentuated this claim by comparing IK in different cultures and concluded that IK is “different knowledge of similar things, different knowledge of different things, different ways of organising knowledge and different ways of preserving and transferring knowledge”.

2.2. IK’s Relevance to Problem-Solving

Most writers agree that IK is all-inclusive, touching virtually every aspect of life as revealed in the definitions above. They are used in pastoral societies to meet health, agricultural, psychological, political, environmental and social needs to mention but few. It is interesting that researchers of contemporary societies have proposed and applied IK to unravel and solve social problems. In this

vein, Mawere (2015) discussed the importance of IK to public education in sub-Saharan African. He viewed IK as a tool to “deracialise” African educational system. Arguing from Mazrui (1978) standpoint, he opined that IK could be efficient in reducing heavy dependency current African education has on colonial cultures. He also reasoned along with Busia (1964) that IK is efficacious in solving community problems. Among other efficacies of IK to learning as identified by Mawere (2015) are “promoting innovative thinking, evaluating the effectiveness of conventional science, motivate and generate interest in Learners, instil a sense of self-consciousness and cultural identity, promote the dissemination of development and promote interpersonal relationship”.

Although Senanayake (2006) proposed IK solutions as alternatives to failed scientific agricultural approach, Agrawal (2014) argued that indigenous knowledge has been overly exaggerated as a viable alternative to failed scientific agricultural approach and thus needs to be balanced by scientific knowledge. He pointed out agricultural conditions might warrant a corroborative relationship and application of both scientific knowledge and IK. Though IK might be overly exaggerated as opined by Agrawal (2014), however, he admitted the latter’s relevance to agriculture and natural resource management. Beyond criticism of exaggerated relevance towards achieving several development goals, many private organisations and researchers have realised that adapting indigenous knowledge to solving shared problems is cheap and locally adaptable when blended with scientific knowledge (Mundy & Compton, 1991) . Thus, much effort and resources have been devoted to safeguarding and exploring IK, though with many challenges.

2.3. Challenges and limitation of IK digitisation

Transfer of IK is majorly oral, and in some cases as lessons or culture or skill. Also, indigenous education is mostly informal and does not have a specific structure. Some IK distinguishes a group of people that is, some forms of IK are communal. For example, knowledge of herbs peculiar to a community might be their heritage and means of livelihood. These and some other characteristics differentiate IK from scientific knowledge. Although IK is communal, Okorafor (2010) posited that some are individualistic. He claimed that the inherent nature of IK, coupled with some external factors constitutes challenges to digitising them. He identified improper coordination and cooperation, the authenticity of IK and copyright protection to be paramount factors inhibiting IK

digitisation. Despite these challenges, advances towards archiving or safeguarding various forms of IK with the aid of available technologies abound.

Ortony (1980) appraised the role of information communication technologies in gathering, storing and disseminating IK and found ICT to be viable. Following Ortony's conclusion, Verran, Christie, Anbins-King, Van Weeren, & Yunupingu (2007) proposed safeguarding Aboriginal Australian IK with ICT. They observed the parents and grandparents with rich IK were favourable to the idea of harnessing ubiquity of computer systems to conserve their knowledge so that coming generations can access their local wisdom. In the same vein, Kapuire & Blake (2011) said the elders they worked with approved videos, digital images, texts and other data formats as reliable means of storing their knowledge. In the two research instances, a deal of rapport was crucial to success. By implication, digitizing IK is dependent on the holders and requires emotional investment which might be expensive.

Whereas, storing and safeguarding are important; access, dissemination and usefulness should not be neglected. Otherwise, the resources devoted to storage might be a waste if such IK ends up irrelevant in future societies. It might be justifiable to document a body of indigenous knowledge so that heritage will be appreciated, however, if such knowledge is useless to solving problems as was at the time of documentation, such effort is not complete. Knowledge should not just be appreciated; preferably, it should be applied; this must be considered while safeguarding pragmatic IK like proverbs.

2.4. Proverbs

Noteworthy are the means of expressing IK, which Grenier (1998) identified to include but not limited to folklores, songs, stories, festivals, outfit and proverbs. While body languages and other sign languages which text cannot accurately capture might be pivotal to demystifying most means of expressing IK, proverbs tend to be documentable in text format without losing much meaning. The claim is valid because proverbs are perlocutionary, meaning proverbs derive their meanings based on hearer's experience and exposure. Thus, this research will focus on proverbs which Akbarian (2012) reported to sum up situations and give advice in short, terse phrases.

Morphologically, proverbs take different forms like common sentences, namely simple, compound, complex, and compound-complex. Also, as in common sentences, proverbs can be declarative, interrogative, imperative, or exclamatory (Mac Coinnigh, 2015)

The importance of proverbs, both in indigenous and modern societies, cannot be overemphasized (Ademowo & Balogun, 2014). Akbarian (2012) claimed that proverbs are grounded upon years of

experience, close observation of life and natural phenomena, and through metaphoric language, may caution, warn, reprimand or advice by drawing attention to moral or ethical consequences of human behaviour. Bolaji & Kehinde (2017) accentuated that proverbs are the bedrock of civilization of a society. They situated the importance of proverbs in councils, homes, farms and many other spheres of life. Corollarily, Dabaghi *et al.* (2010) underlined proverbs' aptness to literary works. These and several reasons make proverb digitization compelling.

2.4.1. Proverb digitisation and their limitations

Many Nigerian Yoruba proverbs have been documented and analysed in print. Adebayo's (1979) "Owe in Yoruba fun Ile Eko giga" is a compendium of Yoruba proverbs for higher learning. Others include "Owe l'esin oro" and "Yoruba proverbs: Their meaning and usage". Another comprehensive compilation is "Yoruba Proverbs" (Oyekan, 2004). It contains more than five thousand (5000) Yoruba proverbs in print. The proverbs are grouped into themes with translation in English. Ademowo & Balogun, 2014; Bolaji & Kehinde (2017) and several other researchers have analysed some of these proverbs, thereby preserving them indirectly.

Furthermore, there are early digital preservations of Yoruba proverbs. Nigeria Institute of Social and Economic Research (NISER), Institute of African Studies (IFRA), Cocoa Research Institute of Nigeria (CRIN) and several others have contributed towards preserving Indigenous Knowledge (IK) including proverbs (Adeyemo & Adebayo, 2017). Adeyemo and Adebayo's study revealed that traditional file system and relational databases are the prominent technologies used to store proverbs and other IK.

Also, in an attempt to broaden language horizon of students, University College London developed ATLAS (A Taste of Language at School). ATLAS includes Nigerian Yoruba language proverbs and as such, documented on the platform. Being a platform aimed at giving a taste of the language, it does not contain a considerable amount of proverbs.

Despite numerous digitisation, shortcomings abound because they were not designed to aid problem-solving. One of such is 'The good person', an expert from the book "Yoruba Proverbs" by Dr Oyekan Owomoyela at the University of Nebraska - Lincoln (University College London (UCL)). He classified proverbs based on virtues and vices they address, namely humility, self-control, self-knowledge, self-respect, self-restraint, perspicaciousness (good judgment, perceptiveness), reasonableness, sagacity, savoir-faire, wisdom, worldly wisdom, caginess, caution, moderation, patience, prudence, perseverance, industry, resilience, self-confidence, self-reliance, resourcefulness, daring, fortitude, invulnerability, consistency, honesty, openness, plain-

speaking, reliability, consideration, kindness, and thoughtfulness. Each section or theme has proverbs with direct or first meaning and grouped into alphabetic headings (Oyekan, 2004) . However, proverbs are empirical knowledge, and their documentation should aid their practicability. Though the documentation by Oyekan is robust, locating appropriate proverb for a context might be difficult.

Another robust storage is Matti Kuusi international database of proverb type. The database classifies proverbs into international types. The resulting types are enormous for daily application, but suitable for educational purpose. The project was started by Matti Kuusi, a Professor of Finnish and Comparative Folk Poetry Studies (today called folkloristics) at the University of Helsinki from 1959 to 1977 (Lauhakangas, 2001) . He compiled many cross-cultural proverbs and created a card reference system for them. He aimed at revealing the relationship between proverbs from different cultures. The card index system being manual had a very significant shortcoming, and managing such a vast data is difficult until he got to know about paradox – a database management system. Academia Scientiarum Fennica and his daughter furthered the project. The outcome of the project is a system which classifies proverbs into “universal types” and reveals proverbs with equivalent meanings but from different cultures (Lauhakangas, 2001) . Matti’s documentation is inherent with Oyekan’s documentation limitations.

Beyond documentation, Maayan, Prebor & Bloch (2017) developed an RDF based proverb ontology to aid retrieval. This approach improves keyword search despite the metaphoric nature of proverbs. Metaphors limit keyword search because the meaning of a word in proverb might be different from its direct meaning. For example, “cast not stone into the well that gives you water” connotes “gratitude”. However, a search for “gratitude” would not include this proverb in its result. Maayan’s ontology resolves this challenge. Notwithstanding, the ontology would result in boundless and possible duplicate keywords or concepts as proverbs increase. Beyond ontology, apposite proverb retrieval and usage requires processing, and since proverbs are documented in natural languages, computation of such data is fundamental.

2.5. Natural Language Processing.

“Natural language processing (NLP) is a field of computer science, artificial intelligence, and linguistics concerned with the interactions between computers and human (natural) languages.” (Bruno, Nielsen, Sakhibat, Smythe, & Woods, 2017) . As against conventional structured data which are meaningful to computer applications, this field of computer science manipulates unstructured data majorly in text and audio format, in order to get information (Socher, Lin,

Manning, & Ng, 2011) . Due to enormous unstructured data in text data format and because information capable of improving business performance reside in those data, NLP has been a field of interest.

Moreover, NLP is pivotal to accurate information retrieval system development, language translation systems, text-to-speech and speech-to-text systems, automated customer servicing and many other business-critical technologies. There are fundamental processes that NLP entails, which include morphological analysis, parsing, semantic analysis, pragmatic analysis, or other types of analysis directed to understanding textual content (Goldberg, 2017) . More often than never, when data is in audio format, such are converted to a text format document before manipulation.

Since proverbs are digitised as text in local languages and are full of applicable wisdom if well processed; natural language processing is fundamental to achieve the aim of this study. NLP algorithms may be directly applied to indigenous texts or resulting translation or transcription. While translation would inevitably lead to considerable information loss, the available indigenous text might be biased or insufficient to train machine or deep learning models. Subsequent sections are devoted to briefly discussing various processes in NLP and the methods of implementing them.

2.5.1. Morphological Analysis

Morphology is the study and description of word formation (such as inflexion, derivation, and compounding) in a language (Merriam-Webster, n.d.). The barest unit of a language is the morpheme, which can be free or bound. Bound morphemes do not have meaning without an associating free morpheme (Azuma, 1996) . Most computational analytic tools do not consider morpheme analysis. Morphological analysis thence entails analysis of the components of a sentence, including words and punctuation, in order to determine part of speech associated with words (Brill, 1992). This process is called part of speech (POS) tagging. Upon tagging, words are associated with any of adjective, adverb, verb, noun, pronoun, determinant, preposition, conjunction or punctuation. This classification varies based on NLP toolkit. In the scope of this research, morphological analysis is useful in processing user contexts. The linguistic systems developed takes a user's context as input, processes it and gives a proverb as output. The processing requires a level of morphological analysis to determine part of speech of words. In addition, the underlying database stores some keywords and the corresponding part of speech. Every word is associated with a keyword depending on its part of speech. Morphological analysis can be done either by rules or statistically. However, the statistical approach is state of the art. In addition to

sentence component analysis, structural analysis, also called syntactic analysis, is imperative to understanding expressions.

2.5.2. Syntactic analysis

When a corpus is parsed, the structure of constituent sentences is determined, validating grammars and other language rules. This analysis mediates between linguistic expression and meaning as the complexity of sentences are determined and meaning derived (Bruno *et al.*, 2017) . A syntactic analysis breaks sentences into the subject (performer of an action), predicate (the action performed) and the object (the recipient of the action performed) if the sentence is simple. In the case of complex, compound or compound-complex sentences, the division might be much more. Employing chunking and chunking operations can further elicit information about sentences structure. The goal of sentence analysis is to capture its meaning. Thus, morphological and syntactic analysis is preparatory to semantic analysis.

2.5.3. Semantic Analysis

Semantics deals with the meaning of words and hence extendable to the meaning of sentences and or a whole body of text (Huntley, 1984) . Thus, a semantic analysis aims at deriving the meaning of a body of text such that computer application can act appropriately. This task is a major and daunting one because of the ambiguous nature of human language (Socher et al., 2011) . Semantic analysis can be carried out using latent semantic analysis (LSA), a well-known approach which partially addresses polysemy and synonym challenge (Hofmann, 2013) . However, Hofmann (2013) challenged the theoretical foundation of LSA and proposed probabilistic latent semantic analysis. Advances in artificial intelligence have led to semantic analysis based on contextual information; typical is word2vec model which represent words as vectors in a given space (Mikolov, Chen, Corrado, & Dean, 2013). While the meaning assigned to an expression by a reader is important, grasping the intention of the speaker is much more important to decipher appropriate response the speaker desires; hence pragmatic analysis.

2.5.4. Pragmatic Analysis

Mey (1993) defines pragmatics as a subfield of linguistics and semiotics that studies the contribution of context to meaning. Bruno et al. (2017), in other words, describes pragmatic analysis as a process of deducing the intended meaning of a speaker. Thus, for appropriate responses, pragmatic analysis is essential. Otherwise, users interacting with applications powered by NLP computations would barely be satisfied. These analyses aim to solving every day NLP tasks like question and answer, information retrieval, sentiment analysis, named entity recognition, machine translation and chatbot. A chatbot, for example, predicts the task the user intends through pragmatic analysis of the context and other features available in a text. Regarding this study, when a user inputs a complaint, proverb retrieval is dependent on accurate prediction of possible lessons the user needs.

In summary, natural language processing entails morphological, structural, semantic and pragmatic analysis in order to decipher the meaning of a sentence and the intention of the speaker. But the algorithms that perform these analyses are complex and tedious to engineer; therefore, developers and researchers, reuse existing programs and applications. Related programs are packaged together and called toolkits.

2.5.5. NLP toolkits

Google defines a toolkit as a set of software tools. NLP toolkit, by extension, is a set of software commonly used for natural language processing packaged in a module. Example of such is Natural Language Toolkit (NLTK), Spacy and AllenNlp. NLTK is best for teaching and researching while spacy for agile development of natural language applications. In addition, NLTK is a platform for building natural language programs in Python programming language. It is available on Windows, Mac OS X and Linux. As said earlier, it eases and speeds up research and education in NLP as a field of study. By issuing python's import command, several programs are leveraged to perform the analysis earlier mentioned and even more. Also, NLTK comes with corpora for immediate learning. It is free, open-source and community-driven (Bird, Klein, & Loper, 2009) . A famous and robust module of NLTK is the wordnet. Wordnet houses words with their synonyms in a python class called synset.

On the other hand, Spacy was developed and continuously maintained for commercial applications; however, it is also felicitous for research because of speed. It supports more than 52 languages, requires less coding, has pre-trained word vectors, and it is easily adaptable to numerous AI

frameworks (“Industrial-strength: Natural language processing” 2020) . Toolkits are built to ease application development; such is NLP toolkits. Succeeding section discusses some NLP applications

2.5.6. NLP Applications

Some NLP applications were mentioned earlier including machine translation like Google translate; conversation-capable applications like Siri, ELIZA, Google assistant; information retrieval systems like google search engine, domain expert systems like MYCIN and DENDRAL; question and answer systems like IBM Watson and many more. Due to enormous information and accompanying rigour of retrieving apposite information, natural language processing is of interest, especially conversation capable systems otherwise known as chatbots. Chatbots resolve diverse challenges in different domains. For example, Ukpabi, Aslam, & Karjaluoto (2019) applied chatbot, a form of NLP application to ease tourism services. It is important to note that chatbots run on several hidden NLP applications for them to function acceptably.

2.5.6.1. Chatbots

Goh, Wong, Fung, & Depickere (2006) defines a chatbot as a computer program that can imitate human attribute of conversation. With the introduction of ELIZA in 1966, a deal of effort, both mental and financial, has been devoted to chatbot development and still ongoing. However, despite the enormous resources and effort directed towards this area of NLP, no chatbot has passed the turning test (Deshpande, Shahane, Gadre, Deshpande, & Joshi, 2017) . Notwithstanding, considerable accomplishments in chatbot development inform the prolific use of chatbots by several organizations to automate monotonous duties.

Early chatbots mostly employ regular expression to search and match patterns in user input upon which they respond with designated responses (Deshpande et al., 2017) . For example, a chatbot might be programmed to match the word ‘hello’ and give ‘hi’ as a response. These kind of chatbots are not versatile in conversing but are acceptable notwithstanding. An improvement on regular expression matching is parsing, which converts users’ input to a set of words with features that enable the parser to determine the grammatical structure of the sentence (Ukpabi et al., 2019) . It subsequently checks for words available in its dictionary and gives responses.

Contrary to parser-driven chatbots that function on predefined keywords, Markov chain model generates responses probabilistically. The approach is famous for its ability to generate sentences when there is no programmed response (Deshpande et al., 2017) . To further improve

understanding, ontology plays a crucial role. Some chatbots use ontology to infer meaning and generate responses (Cahn, 2017) .

A popularly known language to developing chatbots is the Artificial Intelligence Markup Language (AIML). It is an extension of XML. An AIML script is fundamentally a list of rules. Cahn (2017) claims that AIML accrues power to itself because of its recursive abilities. However, chatscript has succeeded AIML; the former focuses on improved scripting and maintenance. Whereas, there are several frameworks for evaluating chatbots, Cahn (2017) discussed PARAdigm for Dialogue System Evaluation (PARADISE), a framework for evaluating bot's clarity, naturalness, friendliness, robustness regarding misunderstandings, willingness to use again. It further quantifies bot's effectiveness based on some parameters.

Chatbots have been deployed on institutional webpages to replace frequently asked questions; financial institutions have used it for interactive banking and commercial platforms for interactive sales. It has also been used for tourism purposes. In an attempt to achieve one of United Nations' Sustainable Development Goals, where language plays a crucial role, AI models have been taught some indigenous languages going to extinction and chatbots built on them (Cooper & Kruglikova, 2019). This project is the closest to the ideology of linguistic applications using proverbs as their direct response or rationale for their responses. Before this chapter is concluded, it is imperative to discuss data storage technologies which serve as long-term memory to computer applications, including chatbots. Contemporary and versatile database of interest built on NoSQL technologies is the graph database.

2.6. Graph database

The previous section mentioned semantic network or ontological approach to developing chatbots. This section discusses graph databases and their relevance to knowledge representation. Since the inception of stored-program architecture, the need for data storage abounds. Structured Query Language databases gained prominence until conferences on NoSQL (Not only SQL) were organised in 2009 and 2010 (Sharma & Dave, 2012). SQL supports CRUD (Create, Read, Update and Delete) operations and uphold ACID (Atomicity, Consistency, Isolation and Durability) principle. Whereas ACID principles are efficacious to many management or user requirements, it inhibits efficiency as data scales up exponentially (Vicknair et al., 2010) . Thus, the need for more robust technologies to handle escalating data generated as a result of ubiquitous computing. This gave rise to NoSQL databases that evade the limitations imposed on SQL databases by the principle of consistency.

NoSQL databases are implemented as any of Key-value, columnar, document stores or graph database (Vicknair et al., 2010). A graph has vertices and edges (Ruohonen, 2013) . Where in application or implementation, vertices are nodes and edges are relationships. Also, robust graph operations tend to be more efficient than complex set operations fundamental to relational databases (Vicknair et al., 2010); besides, medical research reveals that human memory is a graph of linked neurons which makes graph databases paramount to knowledge (indigenous knowledge inclusive) representation. As evidence to the efficacy of NoSQL, big-data-driven applications like Twitter and Facebook utilise graph databases. Common NoSQL databases include MongoDB, CouchDB, Oracle NoSQL Database, Cassandra DB and many others. AllegroGraph, Amazon Neptune, ArangoDB, Neo4j and Microsoft SQL server are examples of graph databases built on NoSQL.

2.7. Summary

Proverbs are forms of IK which this study aims to represent using “schemaless” semantic technologies in order to capture robust information about proverbs. This suggests that NoSQL technologies will best to implement the design; graph databases being an example. In addition, natural language processing entails deducing meaning from language and generating responses in the form of human language. Of the many processes that constitute NLP are morphological, syntactic, semantic and pragmatic analysis. Consequent to these processes, an application should be cable of deducing meaning from human language expressions. Typical NLP application is a chatbot, a conversational application capable of engaging human in a discussion. These concepts and technologies were integrated in order to achieve the research aim.

Chapter Three

Methodology

This chapter discusses the overarching methodology taken to achieve the study's aim. It also describes the methods of accomplishing the sub-objectives. The overall approach to this study is research through design. The propounder of the methodology asserts that knowledge gathering occurs and research conducted as designs take place (Zimmerman, Forlizzi, & Evenson, 2007) . This methodology falls under experimental research (Ayash, 2014) .

3.1. Overview of design paradigms

Computer science has its root in mathematics, engineering and science (Monteiro, Da Silva, & Capretz, 2016) . Its vast domain of application influences its dynamics of evolution. Thus, the field uses principles from psychology, economics, sociology, chemistry and other fields to substantiate claims. However, mathematics, science and engineering still have a massive influence on computer science (Demeyer, 2011); this is substantiated by the fact that important computer science concepts like Turing machine (halting problem), algorithmic complexity, compilers (Chomsky hierarchy), Databases, logical augmentation all emerged from mathematics (Dodig-Crnkovic, 2002) . Thus, methods used in conducting researches in computer science tend to be science and engineering-oriented.

Demeyer (2011) classified dominant views on research methods into scientific and double-blind methods. The scientific method he explained, entails forming a hypothesis about a phenomenon, design of experiment, collection of data, comparison of data to hypothesis and repetition of the experiment by another person. On the other hand, the double-blind method he said, involves the formation of a hypothesis about a treatment which can be generalised as the problem, selection of experimental and control group that are comparable except the treatment, data collection, statistical analysis of data and verification of statistical difference.

Furthermore, due to the interdisciplinary nature of computer science, the field accommodates adoption of diverse processes in research; hence evolution of research paradigms in the field which Demeyer indicated to include case studies. Demeyer (2011) outlined a spectrum of case studies which include feasibility study, pilot case, comparative study, observational study, literature review, formal model and simulation.

Feasibility studies aid the design of elaborate studies (Arnold et al., 2009). Such studies validate tools, estimate recruitment rate and parameters (Arain, Campbell, Cooper, & Lancaster, 2010). Chinsembu et al. (2015) describe feasibility studies in computer science as a means of verifying the possibility of an idea. It might involve the development of prototypes or extension of an existing model. While feasibility study validates ideas, a Pilot case known as demonstrator entails testing a proven idea in another context. For example, semantic representation of medical knowledge aided the performance of expert systems built on them (Shi et al., 2017); if because of this result, indigenous knowledge is represented with semantic technology, it amounts to a pilot case.

Furthermore, multiple techniques might exist to solve a problem; in such a case, a comparative study that seeks to decipher better technique is germane. Phenomena are understood through observational study, and the world can be understood or explained through a formal model. Lastly, simulation imitates a situation or a process.

Following Demeyer's spectrum, this research's case study would be a feasibility study, determining the possibility and viability of representing proverbs with semantic technologies. However, as stated earlier, that semantic representation has improved the use of medical knowledge; this case study can be considered as a pilot case. This study is considered a pilot case that investigates the possibility and viability of semantic representation of Nigerian Yoruba proverbs.

3.2. Performing the Pilot

Fallman (2003) said, "HCI researchers need to design research prototypes in order to be able to perform tests and evaluations". He called research based on such prototype "research through design". This pilot study was performed using this approach that is, the processes of achieving this study's aim were designed, and both process and resulting artefact were tested and evaluated. Table 1 shows the research objectives and corresponding methods to achieve the research aim; these methods constitute phases of the whole research process. Furthermore, research through design can be research-oriented design or design-oriented research; Zimmerman et al. (2007) clarified the difference between the two; the former yields an artefact or product while the latter yields knowledge. He further differentiated the two by the designer's intent. However, where the result of a process yields both artefact and knowledge; and intention is to solve a problem, complete stratification might impose an unnecessary problem in process nomenclature. This study is both knowledge and artefact oriented. The subsequent section describes the designed research process.

Table 1: Research objectives and corresponding methods for achieving them

S/N	Objective	Method
1	Identify minimum metadata about proverbs required to identify, explain, interpret and apply best fitting proverb(s) to a domain context from a pool of proverbs.	Review literature and elicit metadata using ethnography.
2	Design appropriate semantic representation of proverbs given the metadata identified in 1	Thematic analysis of elicited data
3	Develop an application to test the usability of the representation by linguistic applications.	Agile system development
4	Evaluate the suitability of proverbs applied to context by linguistic application based on this representation.	Test the developed system and evaluate its responses

3.3. Research Process

Following Fallman's (2003) definition of research through design, it is necessary to design a process; so in the context of this research, the methods of achieving identified research objectives serve as the basic phases of this research's process. Each method encapsulates specific actions, as shown in figure 1. The process started with a literature review on proverbs and how humans derive their meanings. This stage yielded partial attributes of proverbs needed to apply them to complaints. Following is an observational study which entails interview; this phase resulted in raw observations. The first objective was satisfied with these two processes. The raw observations were analysed using grounded theory. Grounded theory entails coding, concept classification and theme development. Themes which in this case are proverb attributes were the output of this phase. These attributes and the partial attributes identified through the literature review were subsequently used to design a proverb representation in JSON format. The next objective doubling as a process phase aimed to test the viability of this proverb representation by developing a linguistic application that manipulates proverb representation.

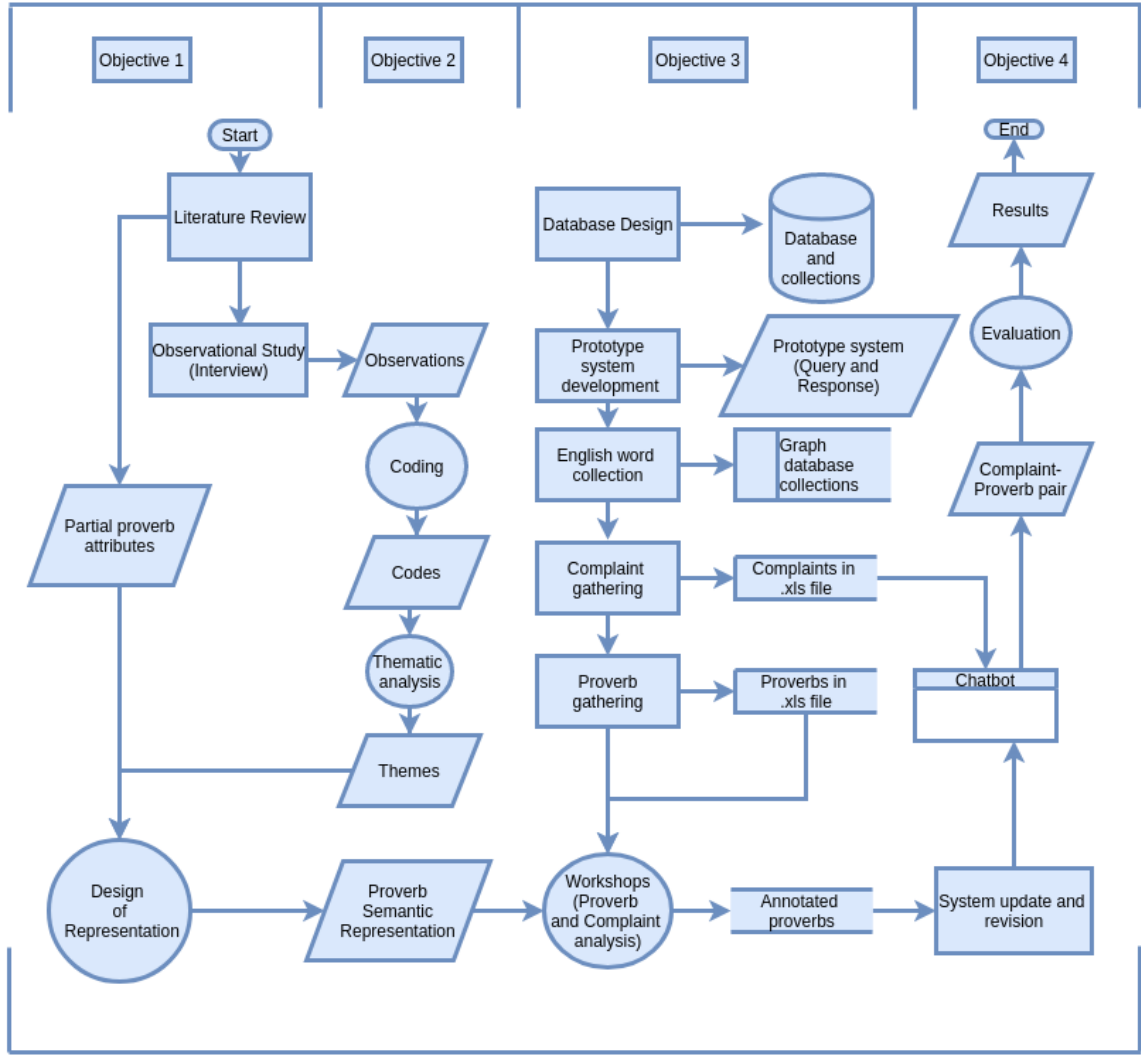


Figure 1: Data Flow Diagram of the Research Process

Thus, a query-response system was developed in a first agile iteration which finally evolved into a chatbot. Finally, the chatbot responses were evaluated, serving as the concluding process phase and research objective. The description of each research process phase follows.

3.4. Literature Review, Observational study and Design

Thirty-four published papers containing literature on proverbs or metadata, or ontology were reviewed. The papers reviewed include journal articles, conference proceedings and books. The following keywords were used to select reviewed papers **proverb**, **ontology**, **metadata**, **Indigenous knowledge** and **Yoruba**. Each paper has a minimum of two keywords in its title. The

papers emphasised different topics of the keywords, however, 8 of the papers focused on proverb while discussing IK and Yoruba society, eleven dwelt more on ontology and metadata, laying little emphasis on either IK or proverbs. This review and research, in general, was aided by Mendeley- a reference managing application. An excel table was created to take the summary of each article reviewed. The summary was analysed to identify cogent points. In the course of the review, literature about ontology gave much insight into designing semantic data structure for computer applications. Such literature identified possible alternatives to semantic representations, but JSON is apt because of its simplicity and portability.

Meanwhile, the review reveals that proverbs' metadata are information about proverbs often absent in the proverb but are needed to use a proverb. Similar to metadata in database management systems, they are not part of the original data but crucial to retrieval and manipulation of data. The review disclosed that words are essential metadata. Contrary to standard metadata which exists outside the data, contents of proverbs are meta in themselves. Thus, word indices would serve as metadata. The review also revealed that proverb usage is context-dependent. Most literature identified usefulness and characteristics of proverb but not the attribute needed to apply them. Greiner (1998) , Nakata (2002) , Otiso (2016), Granbom-Herranen (2011) stated that proverbs are full of wisdom, short, almost always accurate and metaphoric.

Hitherto, literature exposed generic characteristics of proverbs but yet to reveal specific attributes required to unravel the intuitive process of identifying proverb(s) that addresses a context. Hence a rapid ethnographic investigation was conducted. Ten skilful Yoruba proverb users (five males and five females) participated in the interview. Due to distance, the respondents were contacted online using WhatsApp messaging platform. Respondents' access to the internet, knowledge of English, adeptness in Yoruba proverb usage and readiness to participate in the research were criteria for participation. The interview took the form of a regular chat, and the main question the respondents answered was, "what informs the proverbs you apply to contexts?". The question is open-ended; hence, participants talked without coercion. 'The art of applying proverb(s) to a context is intuitive' quoting one of the respondents. Their responses were mostly examples and scenarios of applying proverbs. The words participants used to express themselves were documented. Those words further raised different questions until their points were clear enough. The data gathered were analysed qualitatively. Sequel to the analysis, the following attributes, namely, the lesson a proverb teaches, the role of listener, knowledge of the proverb user and need of the listener were identified as the metadata needed to apply a proverb to a context.

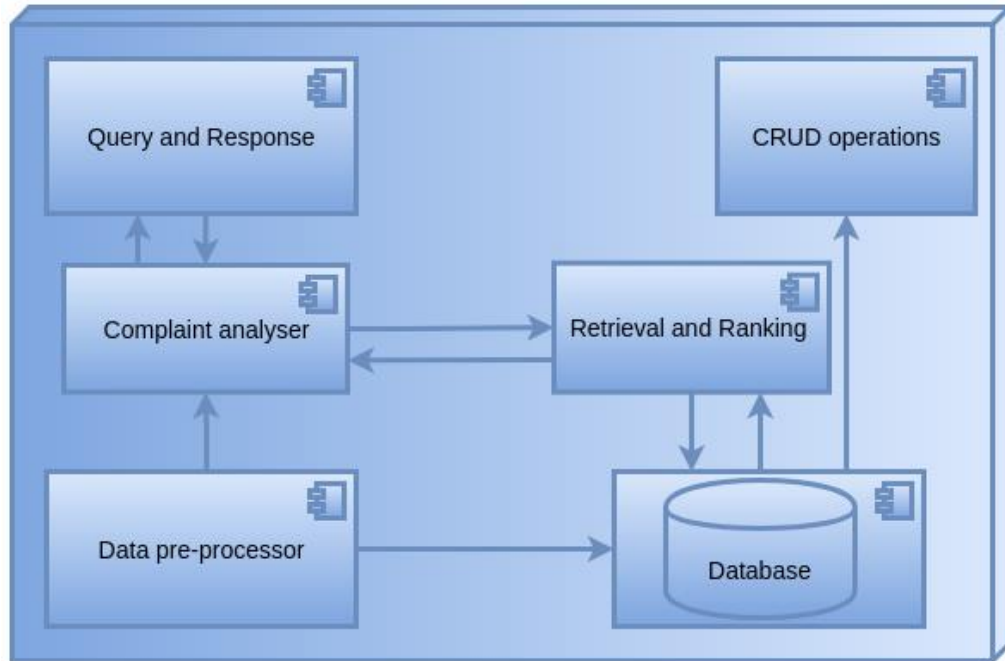


Figure 2: System organisation of the prototype application

3.5. First iteration of Prototype system development

Consequent to the identification of proverb metadata needed to apply it to a context; and the design of proverb semantic representation; the development of a prototype system commenced. The first iteration yielded a system with organisation shown in figure 2. The system was to verify the viability of this representation by developing a prototype linguistic application that imitates the use of proverbs. Meanwhile, the observational study conducted earlier reveals that given a person adept in using several proverbs, s/he selects proverb from memory and apply it when given a context or complaint. Based on the metadata gathered, the application was developed to emulate contextual proverb retrieval by proverb users. A graph database serves as human memory, while this application emulates the intuitive process involved in proverb retrieval based on available metadata. The development process of the prototype system is depicted in figure 3, and each subprocess discussed subsequently.

3.5.1. Technology selection

This application is data-driven, hence ease of retrieval and efficiency will depend on query complexity. Where relational databases' constraints and rules are compulsory, query complexity grows exponentially as the database expands. However, big data platforms like Facebook and Twitter have proven that graph technology-driven databases are quite more efficient. Also, since Craik & Jennings (1992) shows that human memory is in the form of linked nodes; graph databases are adapted to store data. There are several graph database applications, but consideration for use based on open source, ease of use, community support and graph formality reduced them to two. Table 2 shows the rationale for selecting Arangodb.

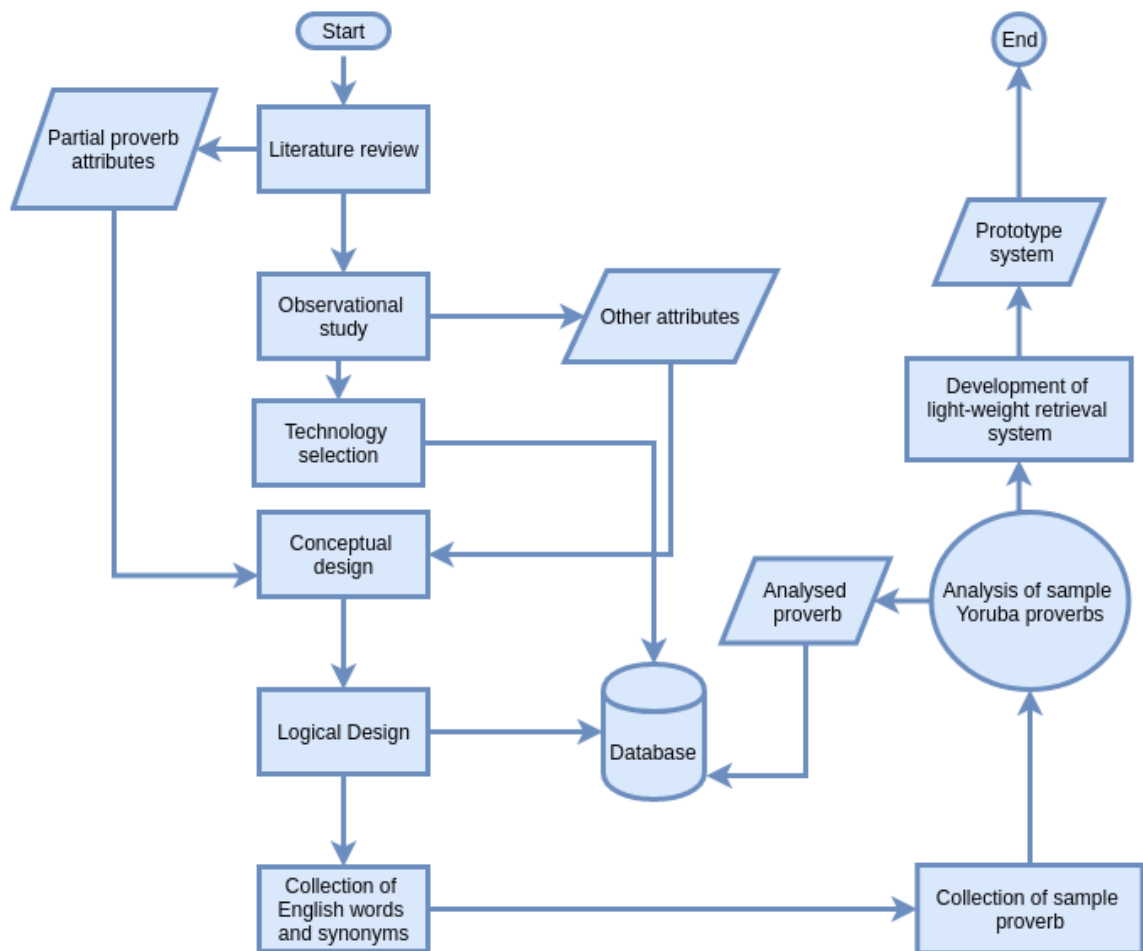
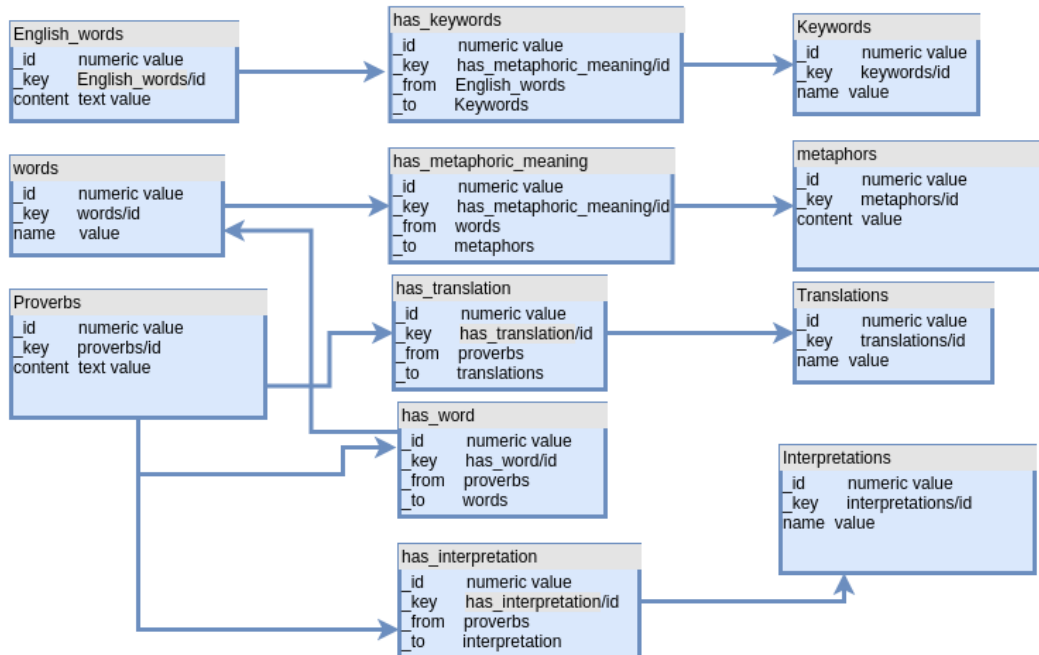


Figure 3: Development process of prototype system

Table 2: Rationale for database selection

Criteria	Neo4j	Arangodb
Open-source	Partially	Fully
Ease of use of query language	Partial	Partial
Graph formality	Directed	Not directed
Community support	Large	Large

Graph formality serves as a significant determinant because bi-directional transversal must be possible to imitate proverb retrieval. Observations during the analysis of data elicited through interview revealed that human move back and forth from proverb to the context in order to identify and apply a suitable proverb. This bidirectional operation is impossible with directed graph technologies. Such imposes a level of constraint on a graph, and transversal can only be in one direction either bottom-up or top-down. However, where direction is optional, transversal is more flexible and apposite to the intended imitation or emulation. In summary, Neo4j demands payment after trial and has directed links whereas, Arangodb is fully open source and non-directional. Thus Arangodb was selected.

**Figure 4: Graph database architecture**

3.5.2. Database design

Based on the attributes of proverbs identified earlier, the graph database has an architecture depicted in figure 4. The conceptual database design was based on the resulting proverb definition; it has document collections, namely Proverbs, Words, keywords, Metaphoric_meanings, Translations, interpretations and proverb_words. Furthermore, Logical design phase resulted in links (relationships) between documents. Based on the constraints imposed by the data collected, one of which is limiting metaphoric meaning to words. A proverb cannot directly have a metaphoric meaning. However, it does as its constituent words have metaphoric meanings. This constraint extends the applicability of proverbs to context. The links created are named thusly:

- has_metaphoric_meaning: an edge in this collection links a word to a metaphoric meaning document in the
- has_translation: this collection contains edges linking a proverb to its translation
- has_interpretation: contains edges linking a proverb to its interpretations
- has_keyword: contains edges linking English words to keywords
- has_word: contain edges linking proverbs to constituent indigenous words

The logical and conceptual entities implemented in Arangodb at this phase of iteration were maintained throughout the development process. The database was populated with Synonyms of common one thousand English words. Subsequently, a Yoruba proverb was analysed, and the necessary collections were populated. Subsequently, a light-weight retrieval system was built in PHP.

3.6. Second iteration

The database was left as it was but for few changes in document nomenclature. This phase increased the data, and little naming modification made to the database. The type of data needed determined the method to be used for collection. English word collection in the database, keyword and proverb collections were to be populated. These data were gathered from online repositories. Also, contexts or complaints were gathered using a questionnaire and at a workshop; after which they were analysed. The analysis of a context is such that it is represented in the form of a proverb. In summary, the following data were gathered:

- I. English words and synonyms
2. Proverbs
3. Contexts or complaints

4. Training database

1. English words and synonyms: commonly used English words were gathered from (“Word frequency data,” 2019) and a lightweight application to mine word synonyms using thesaurus API was created subsequently. This method gathered rich data but was time-consuming. An alternative is to iterate through NLTK wordnet and get the synsets. This was later applied to the full-blown application. The resulting document resides at <https://github.com/ovasoft/proverb>

2. Proverbs: there are six forms of data about proverbs that are needed: the meaningful words or phrases, the interpretation, the translation, lesson it teaches, role of listener and domain of application. Proverbs were gathered online from (Oyekan Owomoyela, 2004) and analysed by Yoruba proverb users. The analysis was an exercise at a two-day workshop in Osogbo, Osun state Nigeria from 17th June to 18th June 2019.

3.6.1. Proverb analysis workshop

The sole aim of organising the workshop was to analyse Yoruba proverbs in terms of the identified metadata. It is noteworthy that the words in proverbs are scarcely used contemporarily due to language dynamics; therefore, it is reasonable to consult people with age for this workshop. Nevertheless, since users of the resulting application would mostly be the younger generation, their opinion should be captured in the analysis.

Participants’ selection criteria and attendance: Experience in a field of expertise, proficient use of English as a second language, availability and diversity of occupation are criteria used to select participants. Whereas the use of English should not have been a criterion, but interpretation and translation would pose a challenge. The participants’ use of English helps resolve this challenge. There were twelve participants in all, five females and seven males - a retired and a serving Yoruba language Teacher, a retired Health practitioner, retired lawyer, and a politics-oriented person. Three of them are below 35 years of age, representing contemporary opinions. Two of the participants’ age is greater than 35 years and less than 50 years. Others are older than 55 years. Two of the participants were not in attendance the second day.

Modality: the workshop started at 10 am on both days. A presentation on work done so far on representing Yoruba proverbs with semantic technologies was made. Example analysis was done collectively with all the participants. The collective analysis took time; thus, the team was divided

into two syndicates. Each syndicate had four members with a floating member shuttling between the two.

3.6.2. Contexts and complaints

These words are used interchangeably. Since proverbs are applied to described contexts, sample contexts were gathered using questionnaire and workshop. The anonymous online questionnaire hosted at <https://forms.gle/3bzjyVUrMWB4q4LF6> featured introduction – the essence of the questionnaire and how to fill it up, followed by two questions, namely complaint summary and extensive description of the complaint. Seventy-five responses were received. The second set of complaints were gathered at a workshop held with undergraduate students of psychology and sociology at the Obafemi Awolowo University, Ile-ife, Nigeria on the 12th of June 2019. A presentation was made on the relationship between proverbs and complaints. Example complaint was analysed after which the participants raised roughly 50 other common daily complaints and analysed them.

Context should be analysed in the form of a proverb, that is, a context should have a domain of occurrence matching a proverb’s domain of application. Other context attributes should match proverb attributes shown in table 3.

Table 3: Proverb attributes and corresponding context attribute

Proverb attributes	Responding context attribute
Words	Words
Domain of application	Domain of occurrence
Role of listener	Role of the user in the described complaint
Lesson taught	Predicted lesson user needs

Automated context analysis depends on engineering the above features from the context. For example, if a user gives “my father is suffering from cancer, and I’m depressed” as a complaint; apart from the obvious words, domain of occurrence, role of the user and lesson the user needs must be predicted before appropriate proverb can be retrieved. Two options are available to engineer these features – traditional rule-based programming and machine learning. While the previous might not capture all possible scenarios, machine learning depends on large corpora of text which are not readily available. Though the context workshop was held to elicit this data,

unfortunately, it is rather a longitudinal time-oriented process. Alharthi, (2020a) spent more than three years gathering and analysing similar data, of which this study has a maximum of 2 years as its span. It was a dilemma; hence, available corpora were adapted.

3.6.3. Adapting data

Had it been that primary data was collected to train some machine or deep learning models context analysis, the training data should have each attribute in table 3. In addition, due to formalisation of lessons arrived at during analysis and discussed in section 4.3, the dataset should include Maslow need, self-determination theory need and good person classification. Table 4 shows an ideal dataset. Each of role of listener, domain of occurrence, sdt need, Maslow need and good person classification have formalised values. Thus, ML models need to be created for these attributes. Such models would predict which formalised value is most appropriate, given a complaint.

Table 4: Ideal dataset table

Complaint	Words	Role of listener	Domain of occurrence	Lesson-sdt need	Lesson-maslow need	Lesson-good person classification
I am struggling with my academics	"I", "am", "struggling", "with", "my", "academics"	Victim	Career	competence	self-actualization	Persistence

However, since a robust primary dataset is not available, those available online were adapted. From CNN news dataset set, sentences about formalised values of attributes needed to be retrieved and used as complaints. Though such sentences might not be accurately germane, they served the essential purpose to some extent. A semi-supervised learning approach was adopted to train four sequential deep learning models with two hidden layers. Semi-supervised training requires that few datasets are labelled and used to train a model, after which the model trains on the unlabelled dataset. Two approaches to adapt this dataset were ideated:

1. **Kmeans clustering:** kmeans group vectors into n specified clusters. It calculates the euclidean difference between cluster middle vector and vectors on the space, after that, assigns a vector to the nearest cluster middle. It takes the average of the vectors in a cluster to determine a new cluster middle vector. It repeats this process x specified times. Based on this, the files to be clustered are vectorised using word2vec (Mikolov et al., 2013) embedding. The model's keyed vector or vectorial representation of words are supplied to the Kmeans algorithm. Based on the keywords

collected, clusters are mapped to classes, that is family, career, finance, spiritual, mental, nutrition, safety and community in the case of domain. Finally, files that belong to these clusters are retrieved and labelled appropriately.

2. **Sudo file retrieval:** this method uses a dictionary for file labelling. Files in a corpus are word tokenized. Words with high frequency are stored as keys in a lookup dictionary. For every word as key, there is a list of files such word has a high frequency of occurrence. This dictionary is queried based on the keywords for classes, and a union of files returned.

Approach 2 was followed, and each attribute had more than 15,000 sentences. Noteworthy is the imbalance in the number of sentences. While some classes had above 1.5 million sentences, some had less than 20K sentences. All data are hosted at <https://github.com/ovasoft/proverb>

3.7. Prediction Model

Because proverbs are context-dependent, deep learning models that utilises context was trained. Using Keras with Tensorflow backend, an LSTM model was trained with the hyper-parameters shown in table 5

Table 5: LSTM model hyper-parameters

S/N	Hyper-parameters	Values
1	Maximum number of word to embed	50000
2	Maximum number of words in sentence	250
3	Embedding with dimension	300
4	Number of labels	(varies)
5	Optimizer	Adam
6	Activation	Softmax
7	Metric	Accuracy
8	Loss	Categorical_crossentropy

Accuracy was optimised while reducing loss. The model summary is shown in figure 5. Instances of this model were used for domain, sdt, good person classification and maslow predictions. Changes were made where required especially the number of labels or classes. The hyperparameters were tweaked, but this gave the best result.

Layer (type)	Output Shape	Param #
embedding_1 (Embedding)	(None, 250, 300)	15000000
spatial_dropout1d_1 (Spatial	(None, 250, 300)	0
lstm_1 (LSTM)	(None, 100)	160400
dense_1 (Dense)	(None, 22)	2222
Total params: 15,162,622		
Trainable params: 15,162,622		
Non-trainable params: 0		

Figure 5: Model summary

3.8. Retrieval and Ranking Algorithm

Retrieval of a proverb is based on the result of context analysis. Analysis of a context yields domain, SDT needs, Maslow need, good person class, and words. The proverbs are ranked and passed to the presentation layer. Ranking is based on metrics or signals. For instance, Google ranking algorithm depends on 200 signals (Dean, 2020) . Weight might be given to signals or not. State of the art ranking method uses machine learning model; however, it is dependent on data, which is scarce as far as this study is concerned. Thus, a retrieved proverb's rank depends on the probability of occurrence. A proverb that satisfies every metric is ranked first. Given two metrics a and b, proverbs are retrieved based on a and b. Set A being proverbs returned by the database when queried for proverbs with attribute a, Set B is similar to set A but query based on b.

Given that:

a and b are retrieval metrics

A is a set of proverbs retrieved based on a

B is a set of proverbs retrieved based on b

E is the universal set

$$A^0 = A - B$$

$$B^0 = B - A$$

Recall:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Let:

$$\mu = P(A \cup B)$$

There exist three subsets in μ namely

$$A^0, B^0 \text{ and } A \cap B$$

Where a and b are essential ranking factors, $A \cap B$ ranks higher than the other subsets. If weights are placed on the metrics, then A^0 and B^0 would be ranked based on weight. Otherwise, elements of both sets would rank equal

Similarly, given

$$A = \{p \mid p \text{ \textit{\textepsilon} } \text{proverbs retrieved based on words on the context}\}$$

$$B = \{p \mid p \text{ \textit{\textepsilon} } \text{proverbs retrieved based on domain of occurrence}\}$$

$$C = \{p \mid p \text{ \textit{\textepsilon} } \text{proverbs retrieved based on SDT need }\}$$

$$D = \{p \mid p \text{ \textit{\textepsilon} } \text{proverbs retrieved based on maslow needs }\}$$

$$E = \{p \mid p \text{ \textit{\textepsilon} } \text{proverbs retrieved based on good person classification }\}$$

Then:

$$\begin{aligned} P(A \cup B \cup C \cup D \cup E) &= P(A) + P(B) + P(C) + P(D) + P(E) \\ &- P(A \cap B) - P(A \cap C) - P(A \cap D) - P(A \cap E) - P(B \cap C) - P(B \cap D) \\ &- P(B \cap E) - P(C \cap D) - P(C \cap E) - P(D \cap E) + P(A \cap B \cap C) \\ &+ P(A \cap B \cap D) + P(A \cap B \cap E) + P(A \cap C \cap D) + P(A \cap C \cap E) \\ &+ P(A \cap D \cap E) + P(B \cap C \cap D) + P(B \cap C \cap E) + P(B \cap D \cap E) \\ &+ P(C \cap D \cap E) - P(A \cap B \cap C \cap D) - P(A \cap B \cap C \cap E) \\ &- P(A \cap C \cap D \cap E) - P(B \cap C \cap D \cap E) - P(A \cap B \cap D \cap E) \\ &+ P(A \cap B \cap C \cap D \cap E) \end{aligned}$$

Let

$$P_1 = \{p \mid p \in A \cap B \cap C \cap D \cap E\}$$

$$\begin{aligned} P_2 = &\{p \mid p \in (A \cap B \cap C \cap D) \cup (A \cap B \cap C \cap E) \cup (A \cap C \cap D \cap E) \\ &\cup (B \cap C \cap D \cap E) \cup (A \cap B \cap D \cap E)\} \end{aligned}$$

$$P_3 = \{p \mid p \in (A \cap B \cap C) \cup (A \cap B \cap D) \cup (A \cap B \cap E) \cup (A \cap C \cap D)\}$$

$$\cup (A \cap C \cap E) \cup (A \cap D \cap E) \cup (B \cap C \cap D) \cup (B \cap C \cap E) \cup (B \cap D \cap E) \cup (C \cap D \cap E)\}$$

$$P_4 = \{p \mid p \in (A \cap B) \cup (A \cap C) \cup (A \cap D) \cup (A \cap E) \cup (B \cap C) \cup (B \cap D) \cup (B \cap E) \cup (C \cap D) \cup (C \cap E) \cup (D \cap E)\}$$

$$A^0 = \{p \mid p \in A - (P_1 \cup P_2 \cup P_3 \cup P_4)\}$$

$$B^0 = \{p \mid p \in B - (P_1 \cup P_2 \cup P_3 \cup P_4)\}$$

$$C^0 = \{p \mid p \in C - (P_1 \cup P_2 \cup P_3 \cup P_4)\}$$

$$D^0 = \{p \mid p \in D - (P_1 \cup P_2 \cup P_3 \cup P_4)\}$$

$$E^0 = \{p \mid p \in E - (P_1 \cup P_2 \cup P_3 \cup P_4)\}$$

$$P_5 = \{p \mid p \in A^0 \cup B^0 \cup C^0 \cup D^0 \cup E^0\}$$

The algorithm ranks retrieved proverbs as follows:

$$R_1 = \{p \mid p \in P_1\}$$

$$R_2 = \{p \mid p \in P_2\}$$

$$R_3 = \{p \mid p \in P_3\}$$

$$R_4 = \{p \mid p \in P_4\}$$

$$R_5 = \{p \mid p \in P_5\}$$

3.8.1. Updated Retrieval Algorithm

Whereas the former algorithm gives equal weight to every metric, an updated version assigns different weights to each metric, the five metrics A, B, C, D, E listed above were assigned weights 0.25, 0.10, 0.20, 0.20 and 0.25 respectively. Proverbs retrieved based on words in context are weighted 0.25 because they contain words users used to express themselves. Because the “good person” classification found in the repository is a result of critical analysis by the author, the metric weighs 0.25. SDT and Maslow metrics are given 0.20 weight because of their interdependence. Finally, domain weighs 0.10 because complaint’s domain of occurrence overlap. For example, a complaint about finance will directly or indirectly affect the family and possibly career if the user is an entrepreneur. The resulting algorithm thus has 16 ranks as follows:

$$R_1 = \{p \mid p \in A \cap B \cap C \cap D \cap E\}$$

$$R_2 = \{p \mid p \in B \cap C \cap D \cap E\}$$

$$R_3 = \{p \mid p \in (A \cap B \cap C \cap E) \cup (A \cap C \cap D \cap E)\}$$

$$R_4 = \{p \mid p \in (A \cap B \cap C \cap D) \cup (A \cap B \cap D \cap E)\}$$

$$R_5 = \{p \mid p \in (B \cap C \cap E) \cup (C \cap D \cap E)\}$$

$$\begin{aligned}
R_6 &= \{p \mid p \in (B \cap C \cap D) \cup (B \cap D \cap E)\} \\
R_7 &= \{p \mid p \in (A \cap C \cap E)\} \\
R_8 &= \{p \mid p \in (A \cap B \cap C) \cup (A \cap B \cap E) \cup (A \cap C \cap D) \cup (A \cap D \cap E)\} \\
R_9 &= \{p \mid p \in (C \cap E) \cup (A \cap B \cap D)\} \\
R_{10} &= \{p \mid p \in (C \cap D) \cup (B \cap E) \cup (D \cap E) \cup (B \cap C)\} \\
R_{11} &= \{p \mid p \in (B \cap D)\} \\
R_{12} &= \{p \mid p \in (A \cap C) \cup (A \cap E)\} \\
R_{13} &= \{p \mid p \in (A \cap D) \cup (A \cap B)\} \\
R_{14} &= \{p \mid p \in (C^0) \cup (E^0)\} \\
R_{15} &= \{p \mid p \in (B^0) \cup (D^0)\} \\
R_{16} &= \{p \mid p \in (A^0)\}
\end{aligned}$$

3.9. Presentation Layer

This layer was actively coded in HTML, CSS and JavaScript for the following functionalities:

1. CRUD operations: this app avails authorized users to create proverb. Upon population of the database, a user can navigate to view all proverbs and click on a proverb for further operations. The proverb detail page runs on AJAX; thus, changes are synchronized with the database in real-time.
2. Query and Response: this page has a text input for users' query. Results are displayed and clickable for detailed information. When a proverb is clicked, detail containing narrative, translation, advice is shown on the right side of the screen.
3. Chat: while advances beyond rule-based chats exist, they require scarce dataset. Thus, a rule-based chatbot was developed in JavaScript and python. In order to fulfil the embodiment requirement for a chatbot, it was named Sunmonu after the famous Bible and History character known for proverbs, King Solomon which interpreted to Sunmonu in Yoruba language. Sunmonu starts a conversation when it is loaded so as to control the dialogue. A session with sunmonu is divided into introduction, body and conclusion. Sunmonu welcomes the user and waits for a response. It then describes its function to the user as a chatbot trying to learn how to apply indigenous proverbs to complaints accurately. It waits for human response and asks the user's name. Then, it proceeds to the body of conversation. Its task at this stage is to get user complaints and supporting information for analysis; ask questions to ascertain the correctness of its predictions;

allow the user to correct it predictions if need be; give indigenous proverbs along with best fitting advice; inquire user's evaluation.

Chapter Four

Data Analysis Result

Recall the first objective of the study is to identify minimum metadata about proverbs needed to apply them to given contexts appropriately. By implication, it is imperative to have a schema that would allow easy information retrieval where information is proverbs. This chapter discusses in detail, the analysis of Nigeria Yoruba proverbs, starting from the literature review of how proverbs generally derive their meaning unto the normalised form of attributes a proverb can have.

4.1. Proverb representations

Proverb metadata are information which might be present in the proverb or not but are useful to proverb retrieval. Identifying these metadata raises a question on how humans determine suitable proverbs to context. Since proverbs do not always have a direct meaning, answering the former question warrants that the means humans take to derive the meaning of proverbs be ascertained.

4.1.1. How Humans derive the meaning of proverbs

Granbom-Herranen (2011) identified four perspectives to deriving the meaning of proverbial expressions namely: ‘what is the proverb decoded to mean?’, ‘what do the words mean?’ ‘what does the speaker mean?’ and ‘how does the listener interpret the proverb?’. The first point of view assumes proverbs are codes and can only be decoded; it ignores context-based interpretation which violates general notion about proverbs as being context-dependent yet context transferable. This form of deriving proverb meanings reduces proverbs to historical artefacts with no relevance to contemporary societies; of which proverbs are still actively used. The second perspective uses the surface meaning of the words contained in a proverb. Interpretation is bound to the meaning of words in some space (time and place) (Granbom-Herranen, 2011). For example, a Yoruba proverb that says “*Şe b6o ti m6, 6l6w6a Ş6p6n*” translated directly to mean “Act proportionately to your ability, beautiful lady of Ş6p6n” would be limited to the time the proverb was coined and to Ş6p6n- the place the proverb was coined. Whereas, this proverb can be applied in any other geographical location because the points of emphasis are not the time and location; instead, the concept of moderation. This approach to deriving proverb meaning also reduces proverbs to

historical texts that expire over time. In the third case, the speaker gives meaning to the proverb. This is realistic but problematic to computers. Realistic because human understanding is dependent on knowledge which might be acquired by reading, listening or experience after which they apply knowledge to contexts. While it might be relatively easy to enable computers to read and listen, it might be difficult to store such experience for empirical use in other contexts. The fourth case deals with the listeners' perception, which might be different from the speaker's perception. This raises a need for shared knowledge and understanding.

Of the four approaches to deriving the meaning of proverbs, the meaning of words contained in a proverb, understanding of the speaker and understanding of the listener are identified to be metadata needed to apply a proverb to a context. While the understanding of a listener might be cryptic to the speaker and vice versa, common knowledge can resolve this discrepancy to some extent. Thus, a common explanation of words in a proverb are candidates of its metadata. In summary, words in a proverb and explanation of those words for common knowledge between speaker and listener are identified metadata of a proverb. However, proverbs are metaphoric, as such, explaining words in a proverb goes beyond specifying dictionary meaning. Therefore, it is imperative to study how metaphors are interpreted in order to explain words in a proverb correctly.

4.1.2. Deciphering the meaning of metaphoric

Proverbs are metaphoric, and this property obscures meaning but increases the range of application to contexts (Omolaoye & Winschiers-Theophilus, 2019). There exist several models of interpreting metaphors, but Comparison Theory, Interaction Theory, Intention Theory, Literal Interpretation and the Possible World Semantics Theory as explained by Granbom-Herranen (2011) were considered in this study. Comparison theory bases interpretation on comparing a proverb to a given context. When thinking about proverbs, it means either looking at the words (compositional principle) or the whole sentence (contextual principle) (Lakoff & Turner, 1989). At times, where a metaphoric word is a noun, its social, physical, intellectual, emotional attributes might be considered in the comparison process. This gives a vast possibility of interpretation which might sometime be spurious and irrelevant.

It should be noted that unlike the interaction theory, all proverbs cannot be compared to all contexts. Generally, according to the Interaction Theory, literal interpretation is not possible. The interaction theory makes all proverb fit into every context (Ortony, 1980). Interaction theory yields frivolous interpretations and as such, sparingly used.

Furthermore, Intention Theory hinges interpretation on the intention of the speaker. More often than never, this is the case but determining a person's intention is not a straight forward science or art. However, where intension is explicit, interpretation is direct. The Literal Interpretation also called one-world metaphor bases interpretation on the words in a proverb and their meaning (Hintikka, J., Sandu, 1994) . This theory reduces proverbs to mere statements (Omolaoye & Winschiers-Theophilus, 2019) . Finally, Possible World Semantic (PWS) Theory posits that in order to understand the meaning of a term, its extension should be understood both under the present circumstances and other kinds of circumstances (Lakoff & Turner, 1989) . This theory permits both figurative and lexical meanings of proverbs (Granbom-Herranen, 2011) .

Based on 'how interpretation is derived', 'possibility of figurative interpretation', 'possibility of lexical interpretation' and 'range of fitting context' as shown in table 6; interpreting proverb metaphoric words are based on comparison theory and possible world semantics. This implies that for every metaphoric word in a proverb, it must be accompanied by direct meaning and extensible meanings. Having identified possible metadata from literature which helps to answer how humans derive the meaning of a proverb. The question of what informs proverb selection for application to context remains unanswered. Therefore, an ethnographic study was conducted and observations made.

Table 6: Models of interpreting metaphors

S/N	Models of Interpreting metaphors	How interpretation is derived	Figurative Interpretation	Lexical /Literal Interpretation	Context Fit	Comment
1	Comparison theory	Comparing words or whole sentence with context	Possible	Possible	Related contexts	Excludes literal interpretation
2	Interaction theory	Relation between situation and utterance	Possible	Impossible	All Contexts	Can make proverbs irrelevant to contexts
3	Literal Interpretation	Direct meaning of words	Impossible	Possible	No context	Not applicable to contexts

4	Intention Theory	Intention of the speaker	Possible	Possible	Related contexts	human intentions which can be biased
5	Possible World Semantics	Understanding the meaning of words in present circumstance and other possible circumstances	Possible	Possible	Related contexts	Meaning changes as emphasis changes

4.1.3. Determining the criteria for selecting a proverb

An explorative ethnographic investigation was conducted to unravel the intuitive process of identifying proverb(s) that aptly addresses a context. Ten Yoruba proverb speakers were contacted for electronic interview. Due to distance barrier, the respondents were interviewed online using WhatsApp messaging platform. The interview took the form of a regular chat. Cultural ethics of salutation, inquiring about welfare were observed after which the project was introduced to the interviewee. They were asked, “what informs the proverbs you apply to contexts?”. The same question was coined in another way as “how do you select the proverb you apply to human complaints?”. Due to the open-ended nature of the questions, the participants talked without coercion. Since the interview was conducted on a popular chatting platform, they used emoji to express themselves. They did not feel under duress of any form because of the setting. ‘The art of applying proverb(s) to a context is intuitive’ quoting one of the respondents. Since it is difficult to construct the process of executing intuitive actions, they resorted to examples. Their responses were mostly examples and scenarios of applying proverbs. They explained how they would apply a proverb to a context, and observations were made.

One of the respondents said, “the judgement of a context is crucial to proverb selection”. Another said, “the victim might be in need of some form of lessons”. Others used words like theme, message and instruction to describe proverb and contexts. One participant was particular about how knowledgeable the listener is. He stressed that it really determines the kind of proverb he would use; that if need be, explanations must be given. He also noted that it is impossible to give what one does not have; hence the speaker’s knowledge of proverb is essential. His opinion confirms the literature previously reviewed. Another participant noted that he would consider his environment before applying a proverb. For example, he would not apply a proverb that underlines traditional

practices to a context raised by a person not disposed to traditional practices. Almost all of the participants were of the opinion that it is essential to accurately decipher the need of the listener. The following points were stated as crucial to applying proverbs: the theme of a proverb, judgment of proverb, instruction a proverb gives, message a proverb gives, a lesson a proverb teaches, the meaning of a proverb, explanation of a proverb, words in a proverb, domain of context, environment of context, words used to describe a context, personal experience and opinion of the speaker, personal judgement a speaker passes on a context, level of knowledge of the speaker and listener, the role of the listener and need of the listener. These points are considered as observations resulting from the interview.

4.2. Thematic analysis of Observations

Using grounded theory (Ellis, 1993) , the observations made were coded (similar observations were merged into code) and clustered (similar codes were classified) into the following themes as shown in figure 6: Audience attributes, personal attributes, context attributes and proverb attributes. The thematic analysis revealed that applying a proverb to a context is dependent on proverb attribute, context attributes, and human (speaker and listener) attributes. These attributes are intuitively used by Yoruba proverb users to “query” their memory for an appropriate proverb that suits a context.

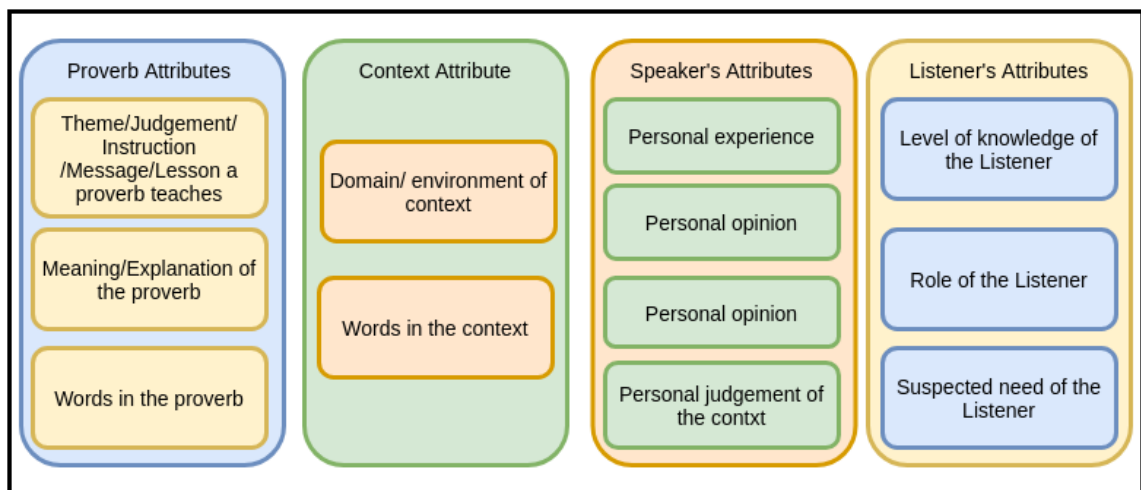


Figure 6: Themes of coded observation

Since the mind uses human language for processing, I constructed possible intuitive questions proverb users ask themselves to retrieve proverbs from memory in line with observations made.

Columns three and four of table 7 contain the intuitive questions and corresponding possible computer queries in natural language.

Table 7: Possible intuitive questions and corresponding possible computer queries.

Theme	Code	Possible Intuitive questions human ask	Corresponding possible natural language query
Proverb Attribute	Theme/judgment/ Instruction of proverb	What is the theme or instruction in the proverb?	What is the lesson the proverb teaches? (Q1)
	Words in a proverb	What are the words in the proverb? What is the meaning of the word(s)?	What words or group of words have meaning in the proverb? (Q2) What is the lexical meaning of those words? (Q3) What can a metaphoric word or group of words mean in a context? (Q4)
	Meaning/Explanation of the proverb	What is the meaning of the proverb?	What is the primary meaning of the proverb? (Q5)
Context Attribute	Domain/Environment of context	What is the domain/environment of the context the proverb is to be applied?	Which domain does a proverb primarily fit? (Q6) What other domains can the proverb fit? (Q7)
	Words in context	What are the words describing the context?	Which word or group of words are fundamental to the meaning of the context? (Q8)
Human	Listener's and speaker's knowledge	Does the listener understand the proverb?	Does the listener understand the proverb? (Q9)
	Role of listener	What is the role of the listener?	What is the role of the listener? (Q10)
	The suspected need of the listener	What is possibly the need of the listener?	What lesson can be passed across to the listener? (Q11)

A critical observation of the following pairs of questions (Q1, Q11), (Q2, Q8), (Q3, Q8), (Q4, Q8), (Q5, Q9), (Q6, Q10), (Q7, Q10) suggests that speakers intuitively question their repository of proverbs and the information available in context description with similar questions. They then compare the results and apply the proverb that has common responses to the context. Having answered the questions that arose in the course of designing a data structure for proverbs, I consider the following to be some of what informs the application of proverb(s) to context(s):

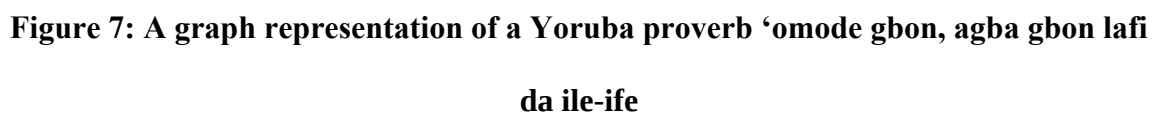
- Lesson the proverb teaches
- Lexical meaning of word or group of words that constitute the proverb
- Metaphoric meaning of words or group of words that constitute the proverb
- Primary meaning of the proverb (Translation and Interpretation)
- Primary domain the proverb can be used
- Other domains the proverb can be used
- The role of the listener in a domain
- Domain of context

4.2.1. Resulting Data Structure of Proverb

Having understood how humans derive the meaning of a proverb and how humans determine the suitable proverb(s) for a context; a proverb can be defined as an object with attributes namely- content, lexical meaning of word or group of words that constitute the proverb, metaphoric meaning of words in the proverb, translation, interpretation (relative proverb in destination language), the primary domain the proverb can be used (e.g. family, workplace, community, government), other domains the proverb can be used, the role of the Listener in a domain (victim or actor or observer) and lesson the proverb teaches. Thus, a proverb can be encoded in any suitable knowledge representation format like XML, JSON, Frame and RDF. For visualization purpose, a Yoruba proverb is represented as a graph and shown in figure 7.

4.3. Formalising attribute values

It is imperative to determine the possible values proverb attributes can take; otherwise, writing programs to service the interest of this study will be almost impossible. To this end, this section discusses the process taken to formalise (specify possible values) proverb attributes.



4.3.1. Lesson the proverb Teaches

Lesson a proverb teaches is somewhat ambiguous. How can lessons be categorised? Into what set of categories? These and many other questions make it impossible to toe the path of “the lesson a proverb teaches”. However, psychologists have worked on generalised human needs. So, instead of asking “what lesson does a proverb teach?”, rather ask what psychological need does a proverb meet? Maslow (1943) formalised and arranged human needs in order of priority attached to them. This classification includes physiological, safety, love, esteem and self-actualization needs. Physiological needs refer to human needs for nutrients necessary for body maintenance. This can be sourced from food, water, drinks, exercises, sex. These needs must be met for survival, while some may not directly affect existence, some do. Maslow claimed that physiological needs are the most pre-potent of all needs. By implication, if there exists an individual deprived of everything in life, it is most likely that his or her motivation will be physiological need. Thus, physiological needs are placed at the bottom of the triangular hierarchy shown in figure 8, occupying largest space, meaning, physiological needs are most prominent; such that when any of them arise, all effort is directed to meeting them.

Next to physiological needs is the safety need. Maslow opined that where physiological needs are well gratified, other sets of needs arise which he called safety needs. Provided physiological needs are gratified; these needs can dominate an individual to the point of undermining the first set of needs. Whereas safety might not be immediately apparent to adult as pressing in non-extreme case, they are to children. Maslow gave an example of children’s reaction to extreme sounds, sudden flashing of light, illness and adult’s preference for familiar things rather than unfamiliar alternatives. There are phenomena that make security need palpable such as war, crime wave, a societal disorder.

Provided physiological and safety needs are considerably gratified, there will arise the desire for love or belongingness. Like a person would thirst and hunger for water and food, in like manner, a person would crave for love and affection. Maslow claimed that as at the time of his write up, all theorists of psychopathology have stressed thwarting of the love need as the basis in the picture of maladjustment. It is, however, important to note that love and sex are different. Next to love need is the esteem need, either from self or from others in society.

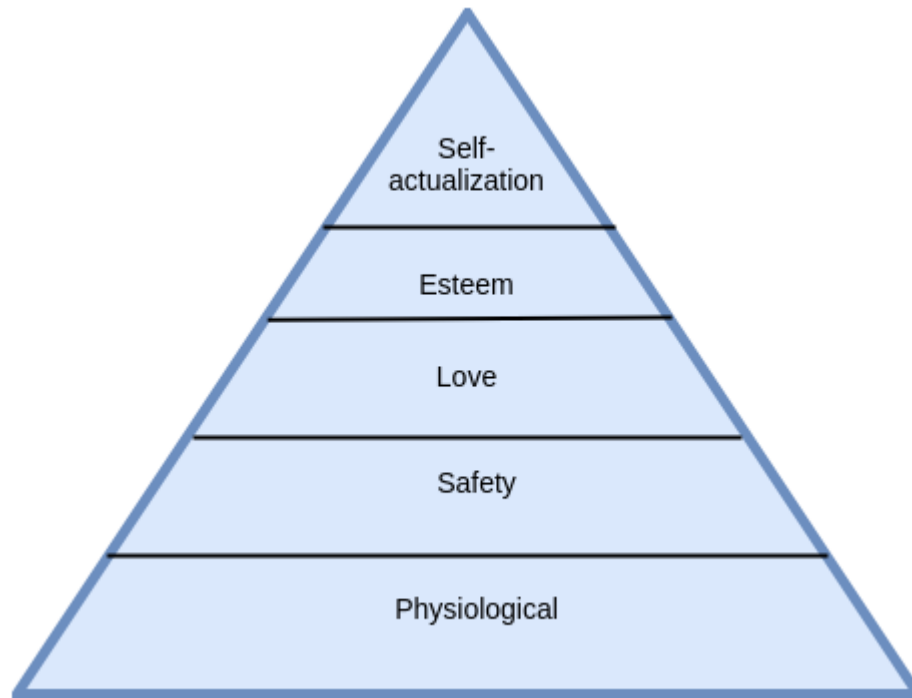


Figure 8: Maslow Hierarchy of needs modified from <https://shorturl.at/KOS48>

Esteem was typed into two forms; the first being desire for strength, achievement, independence and freedom; while the second is the desire for reputation, prestige, recognition, importance or appreciation. According to Maslow, the satisfaction of this need leads to a feeling of self-confidence, worth, capability and adequacy. The final category of human need, according to Maslow, is the self-actualization need. He said, though all previous needs might have been gratified satisfactorily, this form of need would yet arise. Furthermore, this form of needs is expressed as a desire to be what an individual wants to be.

Maslow's work has classified psychological needs. Lessons can, therefore, be formalised into these needs. Thus, a proverb can teach lessons relating to any of these needs. Likewise, a complaint can be classified to be a deficiency of information or insight about any of these needs. However, there are other theories that classify human psychological needs differently.

4.3.2. Self-determination theory

For over thirty years, Deci & Ryan (2012) worked on human motivation and personality in social contexts. They theorised on the premise that all human can make choices and manage themselves

provided that three fundamental psychological needs are met, namely, competence, autonomy and relatedness. Competence suggests the ability to perform with mastery. This is needed to create a feeling of confidence in individuals in order to act. Autonomy is a sense of independence, implying that people need to feel in control of their behaviours and goals. Lastly, relatedness, similar to love needs in Maslow hierarchy of needs. The theory implies that people need to experience affection from others in order to be their best. Deci and Ryan's classification of needs was adopted in order to be inclusive.

4.3.3. Good person classification.

The proverbs used for this study were selected from (Oyekan, 2004) . These proverbs are grouped into moral lessons or virtues and vices they teach or address. These classes overlap but are reduced to recklessness, daring, coolness, timidity, tenacity, cruelty, humility, patience, greed, candour, laziness, indiscipline, perseverance, honesty, acumen, consideration, genuineness, pride, kindness, moderation, and hypocrisy. Thus, these classifications also serve as possible values for lessons a proverb can teach.

In summary, Maslow grouped human needs into five categories; namely, physiological, safety, love, esteem and self-actualization while Deci & Ryan (2012) did into autonomy, competence and relatedness. Oyekan (2004) classified proverb lessons as listed above. Though Maslow and self-determination classification of needs are related, there exist some differences. SDT does not include physiological needs. On the other hand, good person classifications are common virtues and vices. To be inclusive, the three classifications were adopted. Thus, the lesson a proverb teaches is formalised to Maslow need a proverb addresses, SDT need a proverb addresses and Good person virtue a proverb addresses.

4.3.4. Domains of application, Role of Listener and Meaning

Ho, Hancock, & Miner (2018) in an attempt to mitigate stress on workers through research, opined that stress could emanate from several domains of life and thus, identified six domains of self-care namely physical, professional, relational, emotional, psychological and spiritual. They argued that these aspects of life could be stressed, and if stressed, can affect other aspects. For example, say an

individual is emotionally stressed (emotional domain), the stress most likely would affect professional domain if not well handled. As I conduct this study, I observe these domains intersect. To a degree, emotion is required at work. Moreover, no professional duty is exclusive of relationship with others.

Upon general search on the web to that corroborate Ho *et al.*(2018), the possible domain a proverb can be applied or context occur are spiritual, relationship, career, emotion, mental, health and finance.

Role of listener

The roles a listener can assume as identified by the interviewee are actor, victim or observer. An actor is a person that executes an action either good or bad. While lodging complaint, s/he can be called 'accused' in some cases. The victim is the recipient of the actor's action. Not necessarily adverse action. Thus, s/he can be called recipient at some point. Finally, an observer is not involved in the action but witnessed the incidence.

Meanings

There are no formalised values for meanings. However, definitions are expressed in terms of words in a database collection. A collection of unique wordnet synset was created. For each wordnet synset, a lemma named keyword was taken to represent the synset. The keyword in the database replaces words belonging to that synset in any of proverb words' or meaningful phrases' definitions. Likewise, when users give complaints, words are normalised to keyword representation before the retrieval process begin.

4.4. Proverb analysis

Proverbs were gathered and analysed according to the following attributes: content, words, translation, interpretation, metaphoric meaning, domain of application, maslow need addressed, SDT need addressed, good person classification, advice to the victim, advice to observer and advice to the actor. The analysis was done using Microsoft Excel spreadsheet.

4.4.1. Predicting values from user input

Recall the proposed system was to take user complaint as input and give a suitable proverb as output. Given a user input or complaint, the following attributes are to be determined: domain of occurrence, the role of the user in the complaint and possible lesson the user needs. To predict these values, machine learning models were trained with secondary data. Whereas secondary data may

serve the purpose of some projects, it does not, for this study. The data used were CNN news articles. These are not directly related to the project, but because there are no data suitable for this project, they had to be adapted. Secondary data that would suit this project should contain expressions of pride, honesty, timidity, autonomy and other criteria identified above. This affected the performance of these models, with each model gaining accuracy less than 60%. Primary data could have been gathered but getting data large enough to train learning models requires longitudinal research. In addition, it is expensive. Furthermore, since this study would serve as a proof of concept, the study was furthered given the available resources.

Chapter Five

System Design and Implementation

System design is the process of defining the components of a computer system in order to satisfy some requirement (Whitten, Bentley, & Dittman, 2000) . Given a set of user requirement from which system requirement evolves; the desired system can be implemented following any of system prototyping, joint application design or rapid application design methodologies (Ulrich, 2000) ; all which follow the orthodox system development life cycle in variant ways. This chapter briefly discusses the system development life cycle as applied to the development of the application used to test the viability of the designed proverb representation after which it discusses the approach taken to develop the resulting system of this study

5.1. System Development Life Cycle (SDLC)

Colloquially, SDLC is a process of ideating, analysing, implementing, testing and improving a system of software or hardware or both (Ruparelia, 2010) . While authors might vary the stages involved in the development of a system, requirement gathering and analysis, system design, system development, testing and deployment are inevitable; all of which are discussed in subsequent sections.

5.1.1. Requirement Specification and Analysis

Requirement Gathering and Analysis entails elicitation of functionalities expected of the system. This can be done through ethnographic processes like an interview, phone calls, questionnaire administration. The aim is to document what the system would do circumspectly (Nurmuliani, Zowghi, & Powell, 2004) . Analysis of the requirement would yield non-business requirements and some other forms of requirement. System analysis, more often than never, is qualitative. Ideally, this phase should yield documentation.

In the context of this research, requirements were specified in order to ascertain the viability of the designed proverb representation. The fundamental requirement is that the system applies sensible and apposite proverbs to human context. Given a human complaint, the resulting system should select proverb(s) from a database using some criteria, and return most suitable proverb(s) to the human complaint. This explanation of the specified requirement necessitates the need for a

database, retrieval, ranking, and presentation functionalities. The criteria for proverb retrieval must also be specified. Thus, a mechanism to determine criteria from context is germane to the system. From above, the system must be able to store proverbs, determine retrieval criteria from context, retrieve proverbs from the repository and present the proverbs.

5.1.2. System Architectural Design

Sequel to requirement elicitation and analysis, a suitable system architecture was chosen. There are many software architectures, and examples are client-server, component-based, microservice, layered architecture (Albin, 2003) . Also, the detail of system components was established at this stage. Where implemented, class definitions, relationships, functions and attributes are specified. Tools like Universal Markup Language (UML), Open Data Description Language (ODDL), Object Process Methodology (OPM), Entity Relationship Diagrams are used at this stage. Majorly, diagrams describing components and operations of the system are the results of this stage.

Following the specified requirements, the application has a data layer, application layer and a presentation layer. Each layer has microservices that perform different functions. Thus, the application has an architecture which is hybrid of layered and microservice. At the data layer, there is a graph database and data pre-processor. The application layer contains the complaint analyser, retrieval and ranking microservices. Lastly, at the presentation layer are chatbot, query-response interface and CRUD operation interface. Because the method of implementation was active coding, class diagrams were not drawn, but the architectural layout was designed, as shown in figure 9.

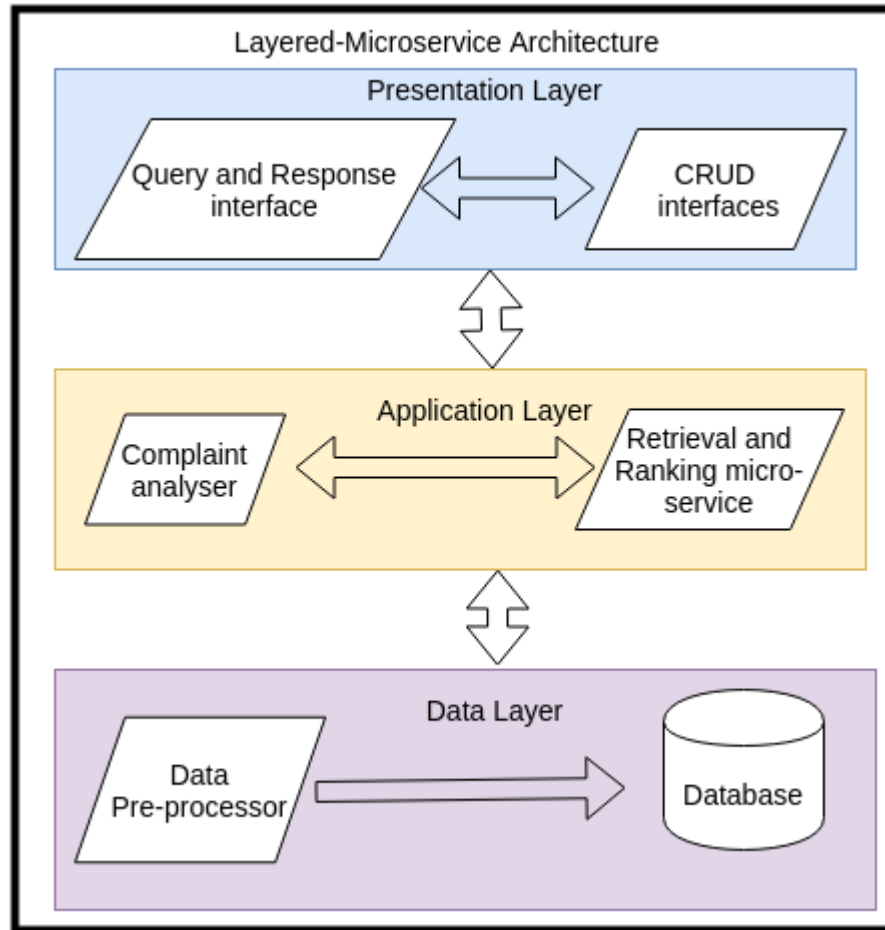


Figure 9: System architecture

5.1.3. Implementation, Testing and Deployment

Implementation involves coding, that is converting resulting diagrams from design to understandable computer artefacts in the form of programs. Programming languages like Java, python, C++ serve this purpose. Python and Javascript programming languages were used to develop this system. Figure 10 shows code snippet in python. Resulting application from implementation was tested before deployment. As Myers, Sandler, & Badgett (2011) suggested, the application passed unit testing, integration testing, system testing and acceptance testing. Finally, upon testing, a system should be deployed for the purpose for which it was developed.

However, instead of deployment, the application developed was evaluated as discussed in chapter six.

```
Thu 10:10 •
/var/www/devs/django/proverbs_net/proverbs/models.py (django) - Sublime Text (UNREGISTERED)
view Goto Tools Project Preferences Help
sample.html x models.py x
1 from django.db import models
2 from django.conf import settings
3 from arangoclient.models import Client
4 from django.urls import reverse
5 #from prophet.prophet import Prophet
6 #from data_processing.utils import cleaner
7 # Create your models here.
8
9 class Proverb(Client):
10
11     def __init__(self):
12         super().__init__()
13         self.collection = self.create_or_get_collection('proverbs')
14
15     def load_data(self, id):
16         if self.collection.has(id):
17             return self.collection.get(id)
18         else:
19             return -1
20
21     def create_proverb(self, data):
22         #validate the data
23         clean = []
24         if '***' in data:
```

Figure 10: Python code snippet

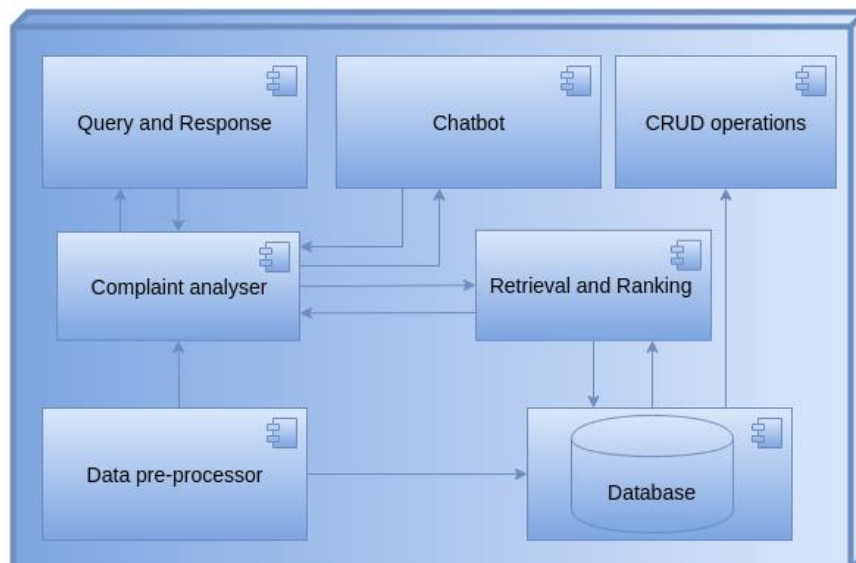


Figure 11: Final system organisation

5.2. System Organisation

This application has seven components, as shown in figure 11; accounting for its logical structure. Query and response component provides a text input where users give their complaints and proverbs are displayed as responses. Chatbot discusses with a user, thereby getting more information about the complaint. CRUD operations permit authorized users to create, retrieve, update and delete data in the system. The retrieval and ranking component ranks retrieved proverbs based on the result given by the complaint analyser. Data pre-processor prepares data used to train machine learning models used for prediction in the complaint analyser. It also populates the database with words and synonyms needed to formalise proverb attributes, meanings and user complaints. The database contains proverbs, words, domains and relationships existing among them. The subsequent sections describe how each logical component interact with other components in order to present users apposite proverbs.

5.3. System Operation

There are two types of users of the application, the general users that aim to get proverbs suitable to a complaint and the knowledge holders that populate the proverbs in the database. It is assumed knowledge holders are authenticated before accessing the platform. The user either adds a new proverb content or clicks on an existing proverb in order to modify it. If a new proverb content is added, this shows in the list of available proverbs. When a proverb is clicked, the user is taken to its detail page. The user identifies words or meaningful phrases in the proverb content and equally add their possible metaphoric meanings, maslow need addressed, SDT need addressed and good person classification of the proverb. Then s/he adds the translation, interpretations, advice to actor, observer and victim. The application subsequently links the proverb to English words and keywords; create links among the attribute and forms a graphical representation. The user can also update some of the existing information. Figure 12 is a flowchart showing the process of creating or modifying a proverb while figure 13 shows the “all proverb page”. A user intending to get proverbial advice to his or her complaint would rather chat with the bot. This discussion is divided into three phases, namely, introduction, body and conclusion.

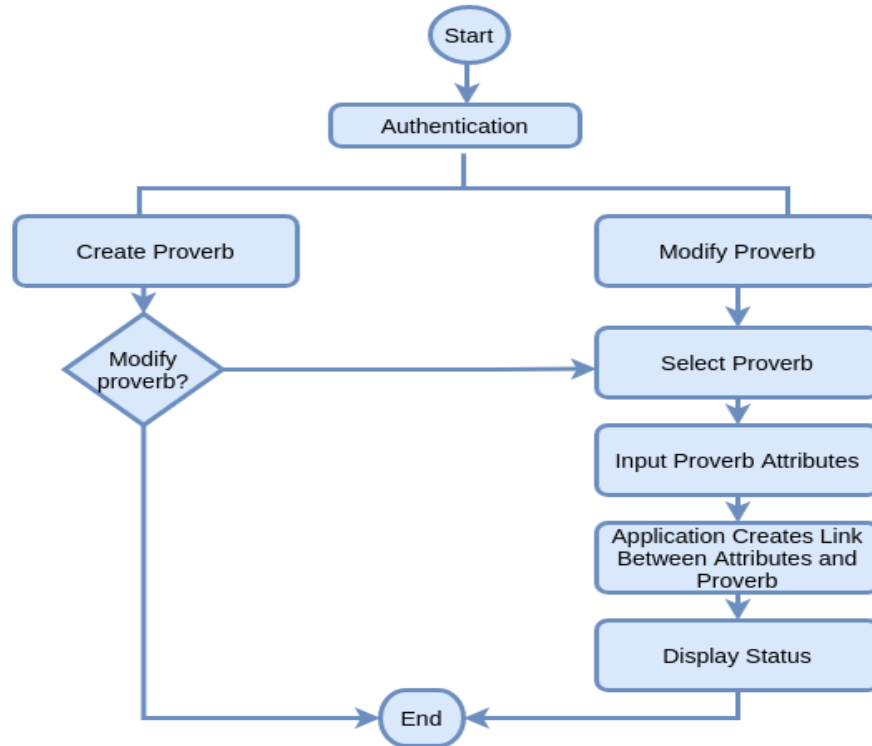


Figure 12: Flowchat of proverb creation and modification operations

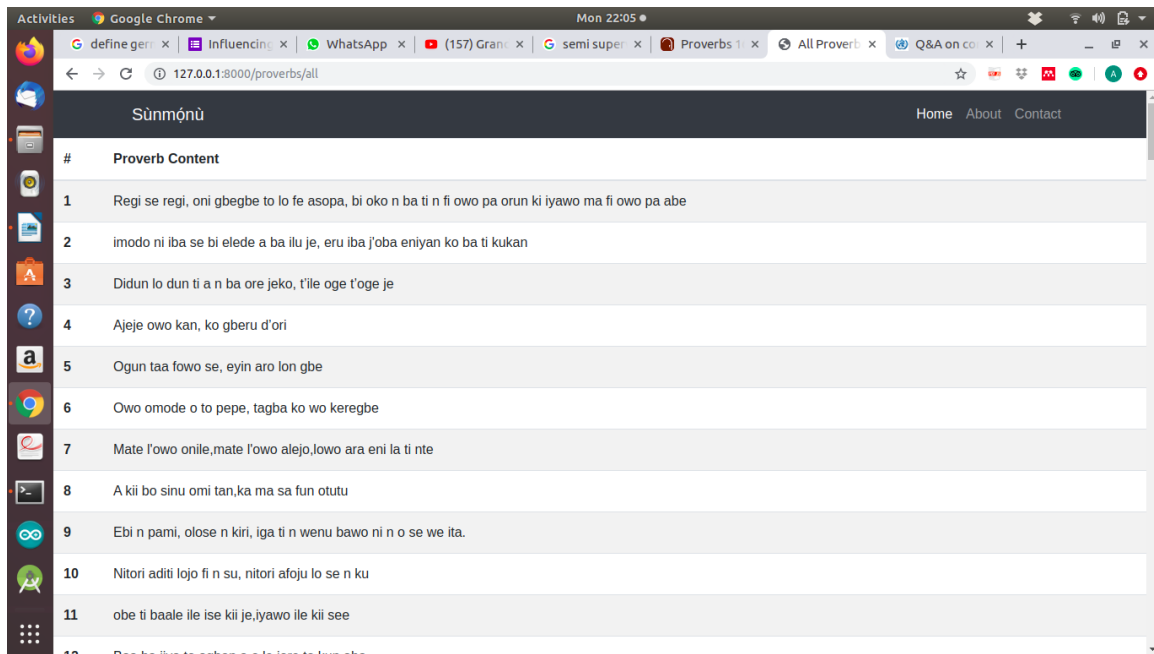


Figure 13: Interface of all proverbs

At the introduction stage, the bot welcomes and intimates the user of its function. It subsequently asks for the user's name and perceived role in the event intended to be described. It tells the user to input his complaints and subsequently probes further information about the context by asking if there are other relevant information that can help its understanding or asking if there is something else it should know?". The bot keeps asking such questions until the user signifies the absence of further relevant information. Then, the bot sends the information to the query module; this module performs basic cleaning operations and removal of stopwords from the text. The cleaned text is passed to machine learning models to predict self-determination theory need, maslow need and good person character need. These models return their predictions to the query module. While prediction is being made, word normalisation module normalises the words in the context to database keywords. The chatbot then probes the user to ascertain the models' prediction. This is because the models only attained less than 60% accuracy because of the training data used. When the user ascertains the predictions; either by eliminating or by adding to them, the bot sends the refined user prediction to the query module. This module sends these parameters to the retrieval module. The retrieved proverbs are passed onto the ranking module, and subsequently, the top three proverbs are sent to the user. The advice given is based on the role of the user in the described event. This process helps to gather primary data needed for training while still using the secondary adapted data.

5.4. Component operations

The system has seven components, as stated earlier. This section describes these components in detail and gives their abstracted flow of operation. Given this complaint "i am struggling with my academics". Each component plays a role in getting adequate proverb for the user. Subsequent sections describe the function(s) of each component in selecting and applying proverb to the complaint

5.4.1. Database

This is an implementation of arangodb3 graph database. The final database structure is depicted in figure 14, which comprises of five edges and 13 documents. The five edges contain 12 relationships shown in figure 14 and are distinguished by label attribute where necessary. The query language used is Arangodb query language. As shown in figure 14, there is a collection of proverbs from which proverb(s) are retrieved. Thus the role of the database is that it is a repository of proverbs, their attributes and normalised keywords.

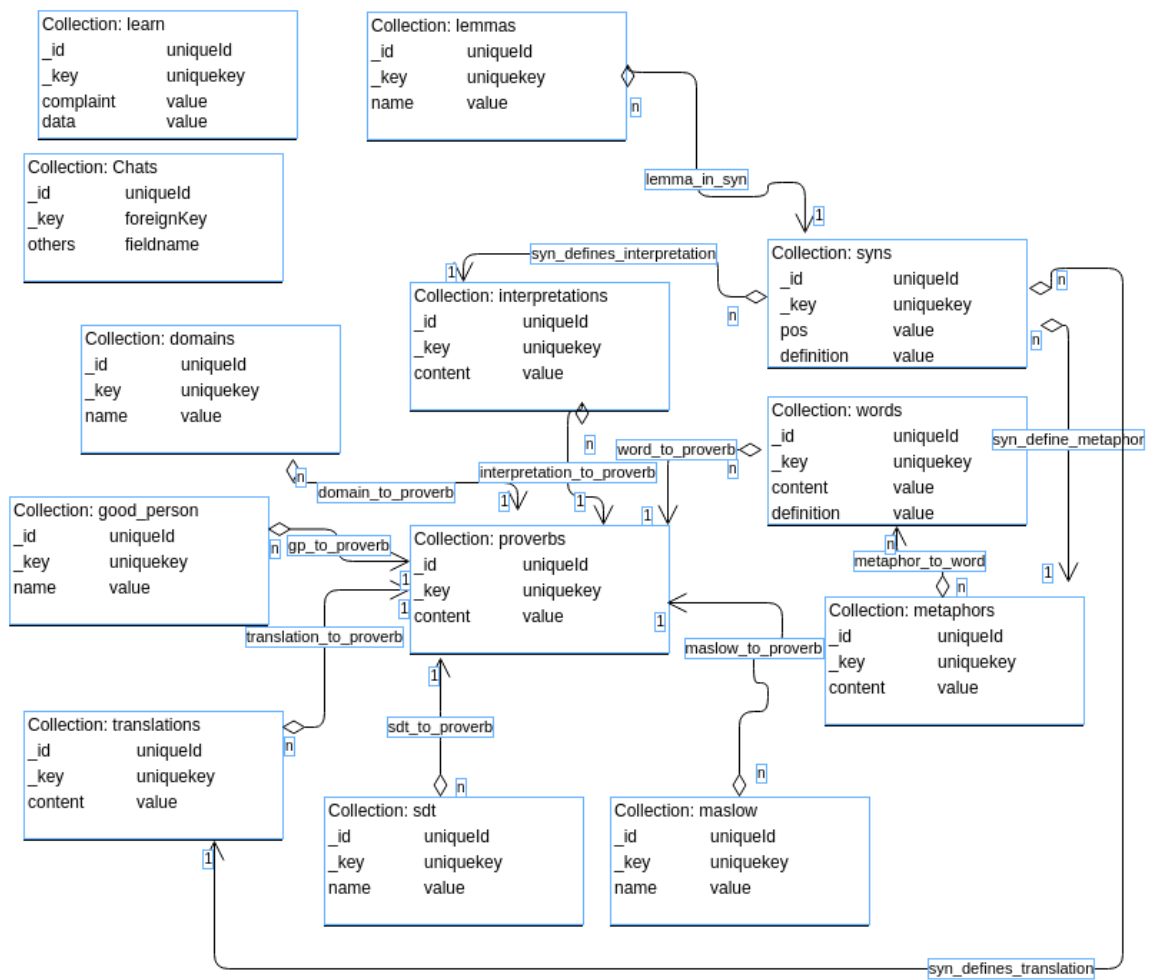


Figure 14: Final database architecture

5.4.2. Data Pre-processor

This component was used to prepare data used to train machine learning models. The data used are CNN news dataset(<https://github.com/abisee/cnn-dailymail>). As mentioned in the preceding section, keywords common to each classification were used to adapt these datasets. The component comprises of saved trained machine learning models and training dataset. The component does not contribute directly to proverb retrieval at run time; rather, it does at training time.

5.4.3. Complaint Analyser

This component takes string complaint as input and gives a dictionary as output. Figure 15 shows the process this component follows to output its result. It contains instances of the trained model in data pre-processor and a module for normalising words as described earlier. Figure 16 shows the block diagram of this component. The first model predicts the domain of occurrence of a complaint; the second predicts the needed self-determination theory need, the third predicts maslow need and the last model predicts good person attribute. A module in the component normalises the words used in the complaint. The resulting output, structured as a dictionary, contains these predictions. Therefore, this component would take the complaint “i am struggling with my academics” and predict the domain of occurrence which can be career, finance or any other trained value; predicts maslow need which can be physiological, esteem, love or any other maslow need; predicts sdt need which can be any of autonomy, belongingness or competence; and finally predicts good person classification which can be patience, tenacity or any other value. These predictions are stored in a dictionary and returned as output. This output serves as input to the retrieval and ranking component. Let the returned dictionary be predictions henceforth; where

```
predictions = {  
    “domains”:    [“career”, “emotion”],  
    “sdt”:        [“competence”],  
    “maslow”:     [“self-actualization”]  
    “good_person”: [“tenacity”, “perseverance”, “patience”]}
```

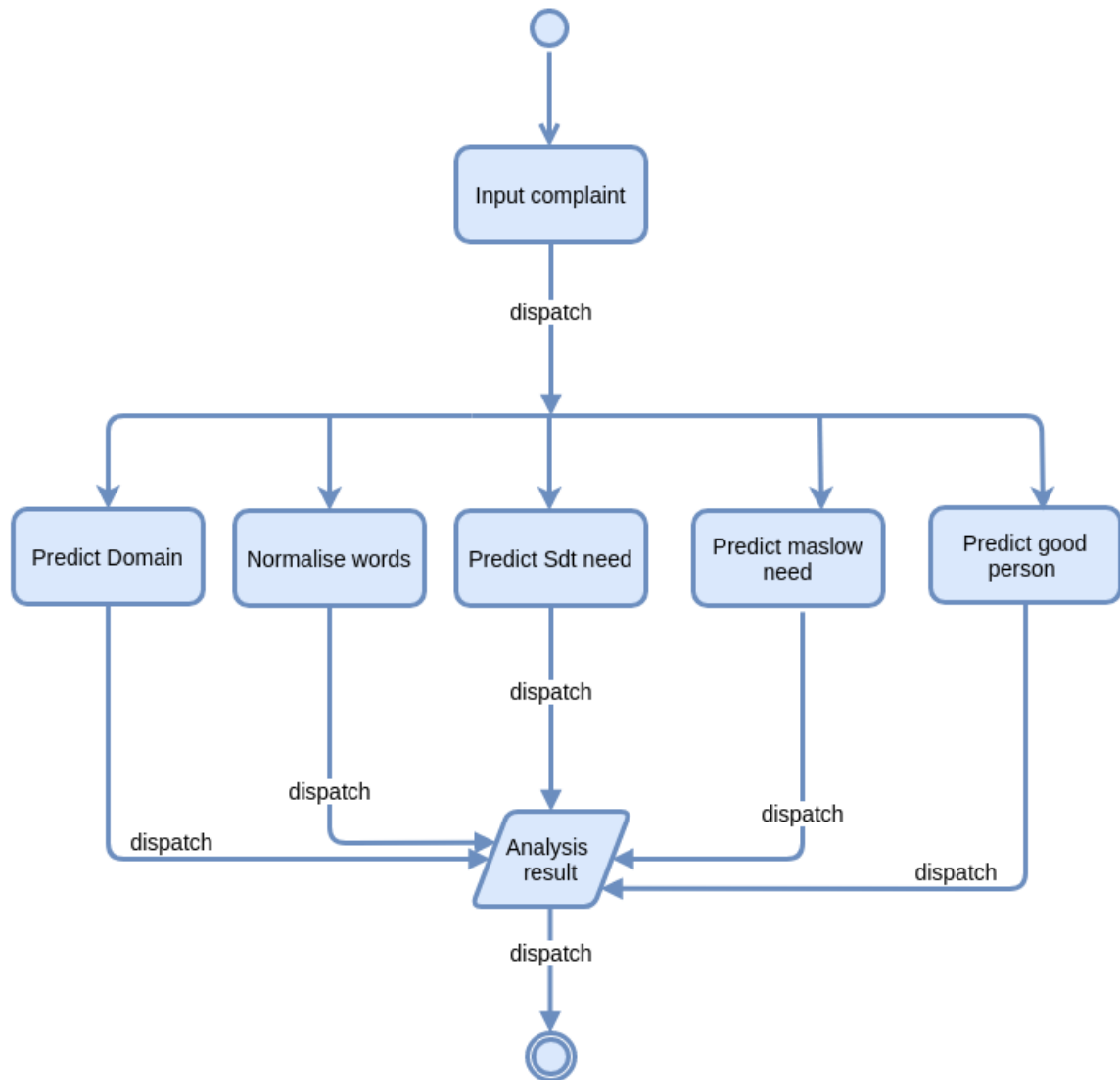


Figure 15: Complaint analyser activity diagrams

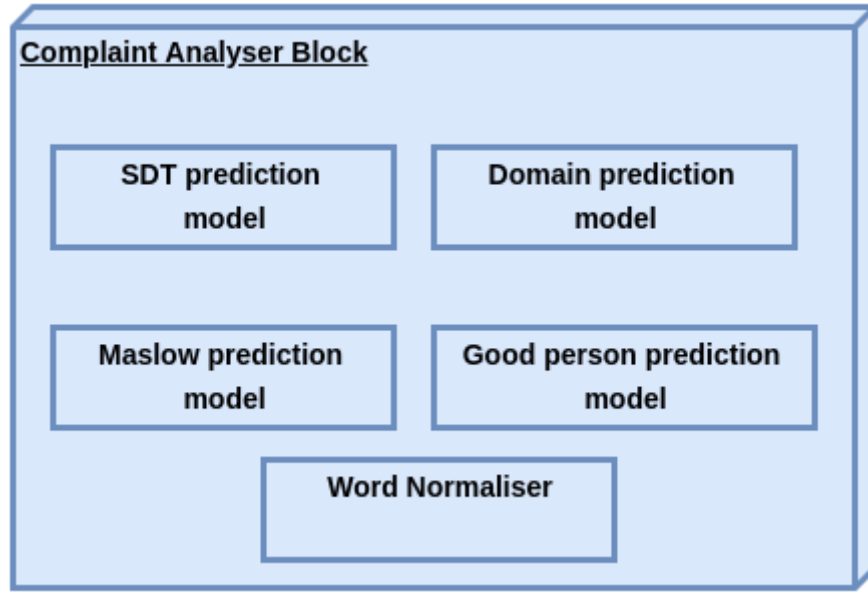


Figure 16: Complaint Analyser block diagram

5.4.4. Retrieval and Ranking Component

Retrieval is based on compiled AQL query with complaint analyser's output; meaning it takes complaint analyser's output as input and gives proverbs as output. It has proverbs retrieved according to words, sdt need, maslow need, good person attribute and domain. Figure 17 shows the flow of retrieving and ranking proverbs. Following the sample complaint being discussed. Dictionary "predictions" is the input to this component, AQL query is compiled with the values in predictions, retrieval made, then ranking. The result of the query is a dictionary of proverbs. Each key has a list of proverbs as its value. Following the scenario being discussed, a dictionary with five keys namely "words", "SDT", "domain", "good_person" and "maslow" all having list of proverbs as their values will be the output of this component. The proverbs in "words" are proverbs linked to the words in the user complaint. Proverbs in "SDT" are those that address the SDT needs predicted by the complaint analyser. Likewise proverbs in "domain", "good_person" and "maslow" address respective predictions.

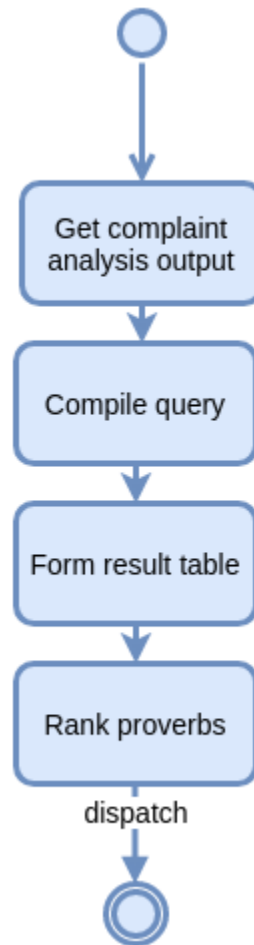


Figure 17: Flowchart of Retrieval and Ranking Algorithm

5.4.5. Query and Response

This interfaces with the complaint analyser. Sends raw text to the analyser, the latter sends its output to the retrieval and ranking component. The flow of the message moves to the Response interface. Figure 18 shows this sequence. The sample complaint being discussed would be given to the application through this component. However, the user may interact with the chatbot, which like the query and response interface, sends the complaint to the complaint analyser and follow the sequence in figure 18. Only that the response is returned to the bot whose interface is shown in figure 19

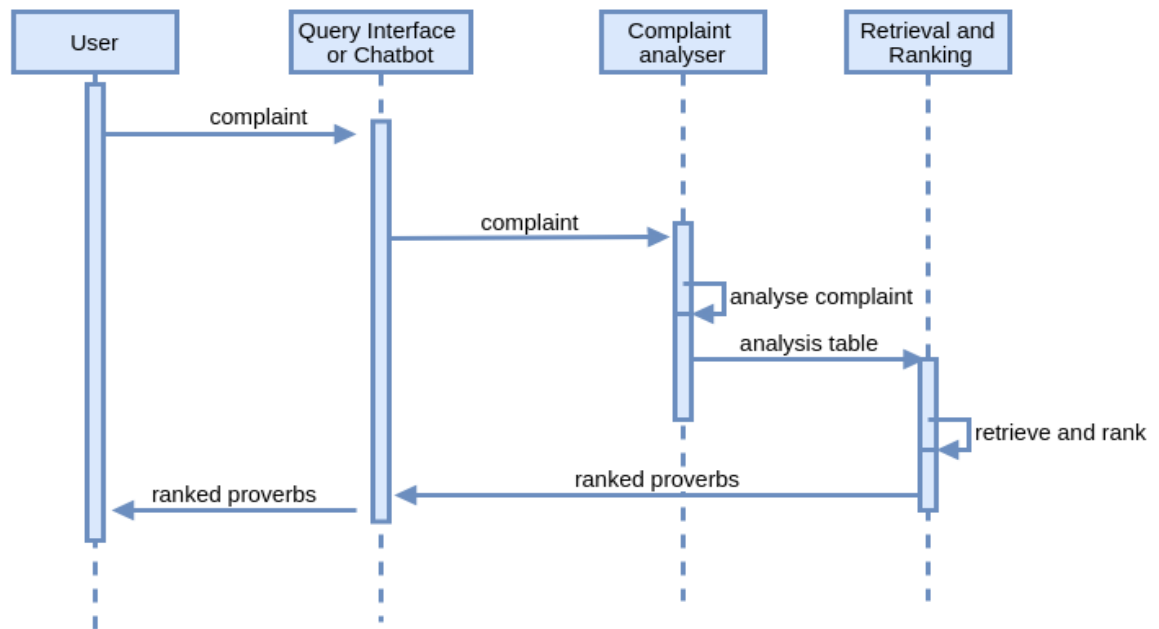


Figure 18: Sequence diagram of user interaction with system

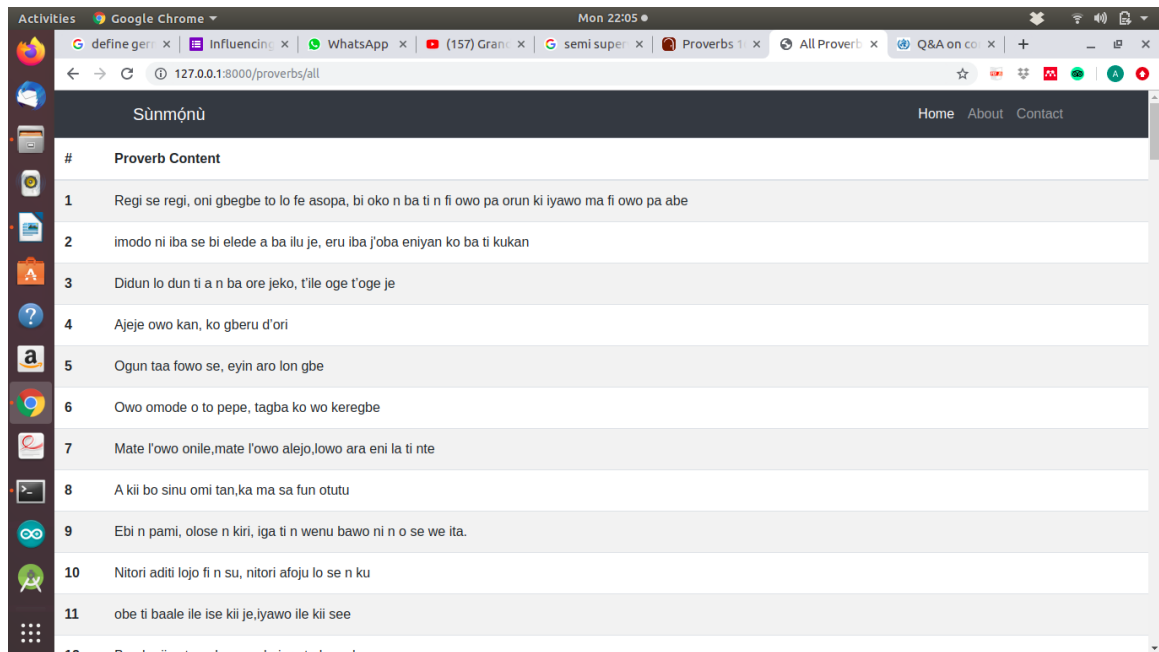


Figure 19: Chatbot interface

Chapter Six

Testing and Evaluation

Chapter one contains the problem which necessitated this research; being, Yoruba proverbs are yet to be represented with technologies that maximise their usefulness. Consequently, the research was aimed to create a semantic representation of proverbs that enable linguistic applications to apply proverbs to human complaints. This solution would transform indigenous proverbs from being passive knowledge to active wisdom applicable to contemporary challenges. Identification of metadata needed to define proverbs as understandable computer artefacts was the first objective which was achieved by literature review and interview with knowledge holders.

Furthermore, some proverbs were gathered from “thegood person” repository (Oyekan, 2004) and were analysed at a workshop. The supposed linguistic application to test the viability of the representation was designed and implemented as discussed in preceding chapters. This chapter, therefore, discusses the testing and evaluation of the system. How did the system perform when given complaints by users? What were the responses or evaluations of the users and how did they evaluate the system? Did the system address users’ complaint intelligently? How was the evaluation done? These questions are addressed in this chapter.

6.1. Testing

Software testing is a process to ascertain computer programs meet desired requirements and does nothing outside the requirement (Myers et al., 2011) . These processes are to assure quality. There are different types of software testing, but all do not apply to all software; hence, every software has some types of testing that suits them. This project employs unit testing, grey box, interface, functionality and system testing.

Unit testing implies ascertaining every unit of a program works right. This testing was carried out simultaneously with development. Every expression, assignment, function, class and module was tested. These were done manually as against automatically, which demands writing other pieces of code. Automated testing was not used because the system is a prototype. Furthermore, gray box testing was employed for machine learning models whose functionalities cannot be altered directly by changing code but by changing hyper-parameters; and interface testing was employed for the CRUD operation interface which knowledge holders would use extensively. Like the unit testing,

functionality test was conducted on all system components simultaneously with development. Upon the complete development of constituent components of the software, system testing was conducted.

6.2. System Testing

This was aimed to ascertain the system does what it was developed for, that is to respond to user's complaint with suitable proverbs. The system was given to seven users to test, and they were enjoined to evaluate the suitability of the proverb or advice the system gave them on a scale of 1 to 5. Suitability is based on reasonableness and helpfulness of the advice or proverb given to the user. The evaluators are co-researcher at the Faculty of computer science and Informatics at the Namibia University of Science and Technology. A visiting professor from Europe also joined in the testing. Table 8 shows their evaluations of the system. Evaluators suggested corrections which were subsequently incorporated into the application.

Table 8: First system testing and evaluation

S/N	User	Evaluation on a scale of 1 to 5
1	User 1	4
2	User 2	3
3	User 3	3
4	User 4	3
5	User 5	4
6	User 6	4
7	User 7	4
	Average	3.6

6.3. Evaluation

Evaluation is to assure the quality of the software. The development of this software partly followed the ISO/IEC 25010:2011 standard for software development. Considering that the application was aimed at applying suitable proverbs to human complaints, the quality here evaluated is the suitability of a proverb to a complaint. There are no parameters designed to measure suitability in the course of the study, which is one of the limitations of the system. However, the evaluation was based on the subjective judgment of evaluators which is the case in many human endeavours. Recall

that 70 complaints were gathered at the outset of the study, so the system responded to twenty of those complaints and its responses - proverbs and advice were given to evaluators. Table 9 shows some complaints lodged to the chatbot and the proverb given as response. Note that some complaints were given more than one advice.

Table 9: Sample complaints discussed with chatbot and proverb-advice duo it responded with.

Complaint	Proverb	Advice Given
People hate me	Şe b́oó tí mọ́, ẹ́lẹ́wàà Şàpón.	Moderate your boasting, (if) you are with distinct attribute(s)
A friend is struggling with his academics	Bí o ḿáa şe aya Olúgbón şe aya Olúgbón; bí o ḿáa şe aya Ařesà şe aya Ařesà, kí o yéé pákòkò légbèé ògiri; ẹnì tí yó şe aya Olúfẹ́ a kógbá wálé.	Be known for a course, and focus on it
	Bí ọwọ́ kò sin ilẹ́, tí kò sin ẹnu, ayo ní ńjẹ́.	If you are not distracted, you'll be glad in the end.
I am in love with my lecturer	Agba kii wa loja, ki ori omo tuntun wo	Seek Elderly advice
	Elede n pafo, o ro pe oun n sogbe	Try to observe when your conducts are unacceptable.

In order to get people to evaluate the system, a questionnaire was administered online, and 20 participants responded. Those contacted for evaluation are either research-oriented or indigenous knowledge-oriented or software development-oriented. They were to evaluate the suitability of advice the chatbot applied to complaints. Some evaluators are Namibian who do not understand Yoruba language; some are Igbo and some Yoruba. Figure 21 shows the evaluation of advice applied to “I am not happy because I don't know what I will do by the time I get home, securing a job is what my problem is all about”. The bot gave three advice. The first being “patience and wisdom is crucial to the success of many endeavours. So be patient and wise”, second being “It's

better to take care of problems before relaxing” and the third being “Diligence in one’s pursuit will certainly result in prosperity”. Eleven of the twenty evaluators rated the first advice 5 of 5. It connotes an excellent response. By implication, the advice was considered sensible and useful to the user. This suggests that individual differences, including background, world-view, personal orientation, and many other factors affect human response to advice; accentuating proverbs are perlocutionary; which means, their meanings can be different from individuals for several reasons; hence making people to either accept or reject the advice of a proverb. Notwithstanding, for most people, when proverbs are well analysed or explained, the wisdom therein is retained and used consciously or otherwise in future events.

Table 11 contains the evaluations of the proverbs-advice pair given to complaints. The average rating of each response was computed and rounded off or up. Value rounding was to ease the nomenclature of the rating shown in table 10. The content of table 11 is as copied from the respondents and the application.

Table 11: Rating and nomenclature

Rating	Nomenclature
1	Unsuitable
2	Fairly suitable
3	Suitable
4	Very suitable
5	Excellently suitable

Complaint: I am not happy because i don't know what i will do by the time i get home, securing a job is what my problem is all about

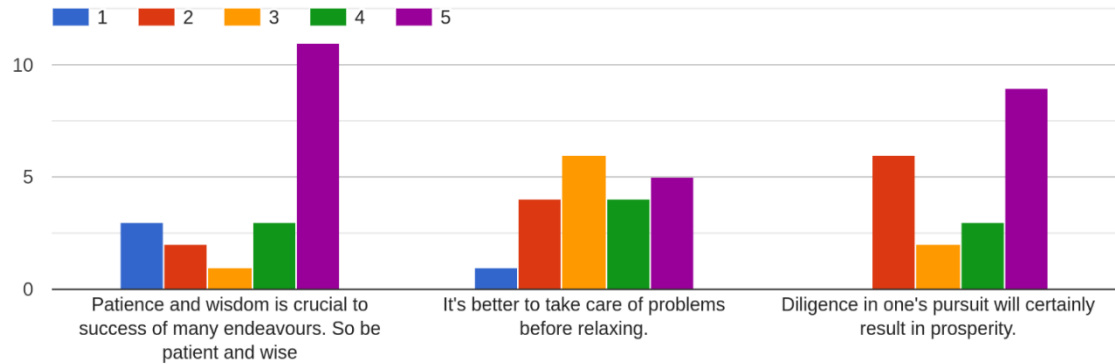


Figure 21: Evaluation of response to a sample complaint.

Table 10: Average rating of advice given to complaints.

S/N	Complaint	Advice	Average Rating	Rounded Rating
1.	People hate me	Moderate your boasting, if you have enviable distinct attribute	2.8	3.0
2.	A friend is struggling with his academics.	If he is not distracted, he'll be glad in the end.	3.6	4.0
3.	Complaint: I am in love with my lecturer.	Try to observe when your conducts are unacceptable.	2.4	2.0
4.	Complaint: I am in love with my lecturer.	Seek elderly (professional) advise	3	3.0
5.	Complaint: My young sister likes drinking and that's causing a big problem between her and my parents. what do i do to make her not to drink again?	Listen to the other party	2.9	3.0

6.	Complaint: My young sister likes drinking and that's causing a big problem between her and my parents. what do i do to make her not to drink again?	You may want to advise people not to overreach, and not to be too full of themselves.	3.1	3.0
7.	Complaint: I am not happy because i don't know what i will do by the time i get home, securing a job is what my problem is all about.	Patience and wisdom is crucial to success of many endeavours. So be patient and wise	3.85	4.0
8.	Complaint: I am not happy because i don't know what i will do by the time i get home, securing a job is what my problem is all about.	It's better to take care of problems before relaxing.	3.4	3.0
9.	Complaint: I am not happy because i don't know what i will do by the time i get home, securing a job is what my problem is all about	Diligence in one's pursuit will certainly result in prosperity.	3.75	4.0
10.	Complaint: My girlfriend cheats on me	When a person hurts you and afterwards seeks your wellness, he or she is most likely hypocritical and wants to take advantage of you. Be discreet with such people for they are good at exploiting vulnerabilities.	3.4	3.0
11.	Complaint: My girlfriend cheats on me	Never be too shy to speak out on your own behalf. Be bold and free yourself or others.	3.65	4.0
12.	Complaint: My employer told me he is not satisfied with my	Only an improved version of yourself can realise your dream.	3.3	3.0

	work yet i've dissipated so much energy into it.			
13.	Complaint: I failed an exam i took in second year university	On your path, you have not done the best, in that you did not discern what is best for you. You'll bear the consequences of what has happened. If the worst has happened, learn and re-strategise.	3.4	3.0
14.	Complaint: I failed an exam i took in second year university	Truthfulness to one's nature, and fulfillment of one's obligations are the determinants of one's worth.	3.1	3.0
15.	Complaint: I woke up this morning feeling very tired.	Certain tasks demand patience if they are to come out right. So be patient, however with wisdom.	2.7	3.0
16.	Complaint: I know I'm trying my best but I have a phobia for what the future holds. I know I can trust God but I really wish my future will really come out real fine.	One should attempt even the impossible.	3.5	4.0
17.	Complaint: The person I'm in love with is a cool person but I don't know if he loves me too or if it's a one sided affair.	With slow and steady application, even a difficult task will be done.	2.6	3.0
18.	Complaint: The person I'm in love with is a cool person but I don't know if he loves me too or if it's a one sided affair.	Seek elderly (professional) advise	3.25	3.0
19.	Complaint: The person I'm in love with is a cool person but I don't know if he loves me too or if it's a one sided affair.	One should not save others at the cost of one's own safety. You are important, save yourself first	3.05	3.0

20.	Complaint: I need money to pay my school fees. I'm almost approaching the deadline and it seems the money is not forthcoming.	Just be yourself.	2.6	3.0
21.	Complaint: I'm being over charged by the electricity agency and it's freaking me out.	One should not save others at the cost of one's own safety. You are important, save yourself first	2.1	2.0
22.	Complaint: I'm happy because I'm about to get married but the issue is that I don't have a good job that will meet up with my expectations, this has really brought me down.	Seek elderly (professional) advise	2.5	3.0
23.	Complaint: I'm happy because I'm about to get married but the issue is that I don't have a good job that will meet up with my expectations, this has really brought me down.	Only an improved version of yourself can realise your dream.	3.25	3.0
24.	Complaint: Disturbed about my work, did my project work and couldn't find the first three chapters, couldn't find it in my drive and couldn't find the hard copy.	Though, your mark of success might not be obvious, just be persistent	2.95	3.0
25.	Complaint: Disturbed about my work, did my project work and couldn't find the first three chapters, couldn't find it	If it's what you love to do and it's right, just persist.	3.15	3.0

	in my drive and couldn't find the hard copy.			
26.	Complaint:My husband got an information that I am in an affair with my boss. Though he trusts me that I couldn't do such, ever since he heard about it, though I didn't do it, it has made my mind go off from that organisation, I don't want to work in that organisation again because of that.	If the worst has happened, learn and re-strategise.	3.0	3.0
27.	Complaint:The hardest part of life is when someone tend to love you and you never wanted it .	It will amount to hypocrisy after having done evil or bad to a person, you subsequently seek his or her wellness. Desist from hurting others.	2.85	3.0
28.	Complaint:The hardest part of life is when someone tend to love you and you never wanted it .	Do not overreach, and do not be too full of yourself.	3.3	3.0
29.	Complaint:My team leader is a little bit bossy. This affects me such that it reduces my work input due to his bossy attitude.	Even if a person with abundance has taken the little you could claim. Be positive. However, deal with such people wisely.	3.55	4.0
30.	Complaint: My supervisor expects me to do everything, think on my own with very little supervision or guidance. He wants me to try and keep repeating stuffs till I get it right without telling me	One should attempt even the impossible.	3.05	3.0

	exactly what to do. It's really frustrating.			
31.	Complaint: I find it difficult to do routines, routines are boring and depressing and sometimes a goal set needs some regular set of routines to help achieve the goals. i find this difficult. there are days that i am very depressed because i can't help myself out of these challenges but however life must move on.	It is unwise to undertake a delicate matter like health recovery with impatience. Patience and wisdom is crucial to success of many endeavour. So be patient and be wise	3.55	4.0
	Average		3.12	

6.4. Observations

Advice with an average rating greater than 3.5 that is rounded up to 4; either address the possible cause of a problem and gives remedy as in instance 2 or gives insight to virtue required to solve a problem and subsequently instructs as in instances 7, 9 and 29. These pieces of advice are frank, constructive, address peculiarity of the domains of occurrence like instance 11. The advice given to cases 16 is motivational and addresses the problem directly while the advice given to instance 31 mentions the problem and gives direct instruction.

Furthermore, advice with average rating rounded up of off to 3.0 are instructional and directive as in instances 1 and 10. Those given to complaint instances 4, 13 and 26 proffer alternative sources of a solution while advice given to instances 4, 5, 6, 15, 19, 24, and 25 suggest solutions and instruct to act. Finally, in this category, advice given to instances 8, 12, 14, 19, 23 and 30 are objective, insightful, but not instructional.

Whereas, the advice with average rating rounded up or off to 2.0 are general and not specific as in the cases of instances 3, 20 and 21. Those applied to instances 7 and 21 requires further reasoning, while the pieces of advice applied to instances 17 and 20 do not suggest any form of action.

In summary, a piece of advice has one or more of the following attributes: addresses cause of the problem, suggests a solution, gives insight to solving the problem, instructs to act, motivates, proffers alternative source of solution, it is objective or explicit. These factors have varying

importance to evaluators. But it was observed that advice that has a combination of two or more of the following attributes: explicit, motivational, objective, address cause of the problem, suggests a solution, give insight to solving the problem, instructs to act, proffers alternative source of solution are ranked above 3.0. Let these factors be called “HF” henceforth. While pieces of advice that are not explicit, that need further explanation; do not suggest action or are too general are ranked low. Let these factors be called “LF” henceforth.

6.5. Interpretation

The scale of 5 is interpreted as follows, 5 – excellently suitable. Advice ranked 5.0 must have been appropriate to all evaluators. It also means the advice has a lot of HF attributes. Compared to human proverb users, this advice would have been given by a person who listened to understand the user’s plight. Possibly, he had witnessed or experienced a similar challenge and hence able to adequately relate with that situation. He thus gives an advice that suits the complaint, the complainer and himself. According to Dabaghi et al. (2010) , a proverb may have different meanings to the speaker and the hearer. But when a speaker uses a proverb in such a way that the intention and understanding of the speaker and listener intersect, the wisdom in the indigenous wisdom is transmitted. Rating 4.0 - very suitable implies that the proverb has considerable HF attributes but not as much as rating 5.0. When compared to human proverb user, the proverb could have been applied by a person with adequate experience and knowledge of proverb but due to some reason which can be the speaker’s use of language or the listener’s understanding of the proverb or the listener’s world view; the wisdom was faulted in a way by the listener. However, the advice met the need of the listener and probably affected opinion. Rating 3.0 implies the advice has considerable HF attributes but not as much as rating 4.0. However, as observed in the data, pieces of advice rated 3.0 are explicit or provide a solution to the challenge or suggest an alternative source of solution or are instructional or motivational or address the problem or its cause or are objective. These attributes suggest that a piece of advice rated 3.0 is sensible, explicit and helpful. However, evaluators might expect more practical instruction or suggestion. Individual value systems would have played a major role. Also, adjusting and substituting value systems might be difficult for some people, which is inevitable in proverb usage. Rating 2.0 implies the proverb or advice are not explicit, too general, does not suggest any practical solution; neither does it give insight to the cause of the problem. By extension, advice and proverbs with rating 2.0 have little or no HF attributes and some LF attributes as observed in the data. Rating 1 means the proverb or advice is out of context. Probably has no HF attributes and a lot of LF attributes.

Since the average rating of all advice given is 3.0, it suggests that the application is capable of applying sensible and helpful proverbs to complaints. Remember, the aim is to indirectly evaluate semantic proverb representation designed. Thus, if the linguistic application was able to identify, select and apply sensible, explicit and helpful proverbs to complaints despite the flaws in the prediction model accuracy, it can be concluded that the representation is apt and viable for the purpose for which it was designed namely to allow linguistic AI applications to apply indigenous proverbs to complaints.

Chapter Seven

Discussion

Having established the viability of representing indigenous proverbs semantically, a recap of the problem which led to this study, the objectives targeted, methods used in achieving the objectives, the solution derived, challenges faced and possible future works are discussed in this chapter.

7.1. Problem summary

Indigenous knowledge is rich information suitable for solving problems exclusive to geographic locations where such knowledge was developed; thus, campaign for applicability of indigenous knowledge to solving contemporary challenges in climate change, health care, agriculture, social wellbeing and other spheres of life gained momentum as a result of findings by researchers. Many of which defined IK to be pieces of knowledge about the environment and lifestyle of a people in a geographical location, stored intangibly in the form of folklores, festivals, songs, norms, value systems and proverbs. They are hardly documented in writing. However, with the introduction of western education, many imbibed documentation to archive this knowledge. The advent of computers led to the digitisation of indigenous knowledge. This has both positive and negative impact. Positively because contemporary generations have embraced foreign culture and education to the extent of neglecting the indigenous counterpart. Not because IK is not cogent or logical to problem-solving but because they are crude due to lack of refinement. Thus, documentations have helped to preserve the knowledge which would have gone into extinction with the aged knowledge holders. On the other hand, technologies used to document the knowledge obscure the potent wisdom inherent in IK. When a proverb used to resolve conflicts is reduced to strings of characters which the readers might not be able to interpret or the interpretation is out of context, such proverb has been made “a dog without teeth”. Proverbs were of interest because they are advisory. While carrying out a preliminary literature review, it was observed that the advisory potentials in proverbs had been scarcely harnessed.

However, there are enormous technological interventions to safeguarding IK; it was thus suggestive that these technologies can be pivotal to harnessing indigenous proverbs for instructional purposes. I view harness from two perspectives, the first being documentation for direct human access, the other being documentation for direct machine access and indirect human access through machines.

The second would avoid the tedious experience of browsing through archives of documents, improve human-computer interaction and give evidence to the possibility of machines learning culture. But the format with which proverbs are digitised are inadequate to achieve the second form of harness; thus, the fundamental problem is to solve the inadequate representation of indigenous proverbs. In congruence with this fundamental problem, the research was aimed at designing a semantic representation of indigenous proverbs. Semantic because such formality holds robust information which can be used by unplanned future technologies.

7.2. Research Evaluation

Zimmerman et al. (2007) proposed a set of criteria to evaluate research through design which are process, invention, relevance and extensibility. This section discusses the process of achieving the aim of the study, the invention of the study, the relevance of the invention and the extensibility of the invention. Some of the methods applied to achieve certain objectives do not result in inventions; however, each method can be evaluated by one or two of these criteria. Subsequent sections evaluate the methods through relevant criteria

7.2.1. Process.

Process entails the description of the rigour applied to methods, the rationale for the selection of specific methods and documentation (Zimmerman et al., 2007).

7.2.1.1. Identify Metadata and design semantic representation

Process entails articulation of the rationale for selecting a specific method. To achieve the first objective, which was to identify minimum metadata needed to apply proverbs, literature review and ethnography were methods employed. The combination of these methods was employed in order to capture existing perspectives of researchers and non-existing perspectives. Literature review captured proverbs' linguistic form, usage and importance but neglected salient attributes useful to their usage in context. Such attributes were captured using ethnography. I posit that while undertaking research through design, combination or hybridised methods should be employed where necessary in order to acquire robust information.

Also, when applying grounded theory, Maher, Hadfield, Hutchings, & de Eyto (2018) describe rigour as the depth of interaction a researcher has with data. Grounded theory was used to analyse transcripts of interviews. The data were collated from the chat platform and written in a paper which Maher *et al.* (2018) suggested to being a level of rigour because it brings the data closer to the researcher's mind and consciousness as against copying and pasting into application software. Further brainstorming and grouping of related concepts or words amount to another level of rigour. In order to code the observations made during the interviews, several brainstorming sessions were held with the participants. Upon the completion of the interviews, and observations collated, each participant was called to discuss the general observations made. Thus were the codes formulated. Subsequently, the codes were classified into themes, namely proverb attributes, context attributes and human attributes. A final call was made to ascertain the sufficiency of the themes, and the participants affirmed those to be minimal and sufficient to identify and apply proverbs to context. Whereas proverbs could have been analysed according to the attributes identified on some online platform in the form of questionnaires, workshop proves engaging. The participants dedicated two days to the workshop and as such, applied all knowledge possible to the analysis. Analysis of a proverb entails specifying the lesson it teaches, a narrative about it, metaphoric words and their possible meanings present in the proverb, interpretation, translation, domain of application and role of the listener. The participants analysed 50 proverbs. This process is also rigorous and time-consuming.

7.2.1.2. Develop an application to test representation viability

The method adopted to achieve this objective is software development which is the only means available; hence, the rationale of choosing this method. The rigour applied relates to the iterations and development standard upheld. As mentioned earlier, the development of the proverb retrieval application and chatbot was an iterative and incremental process. Each iteration improved functionality of the system units. Recall that several algorithms were implemented to achieve the same goal upon which most efficient algorithms were adopted. For example, while adapting data, kmeans clustering and pseudo-file retrieval were tested, and the latter ultimately selected. Multiple algorithm testing at each phase of iteration shows the rigour taken during development. The third arm of the evaluating process is documentation of which the codes are hosted online for public access.

Furthermore, agile development was adopted in order to manage time, permit active coding and test of alternative algorithms. It should be recalled that the whole process was guided by the

traditional software development life cycle, which is strict but assures standardised software development.

7.2.1.3. Evaluate the suitability of proverbs applied by the bot

The method of evaluating the suitability of proverbs applied to contexts by application is human judgment. No empirical tool was developed for the evaluation. However, bias was eliminated as much as possible by making sure 50% of evaluators have not been consulted at any point in the research prior to this point. Also, the evaluation was stringent and incremental. The first evaluation was aimed to improve system performance while the second to ascertain performance. Though human judgment is not objective, nonetheless, it is the best and only standard in evaluating applications built to imitate intuitive human actions. Moreover, they are the end-user.

7.2.2. Invention

Invention is of necessity to research through design. Zimmerman et al. (2007) described invention as novel integration of various subject matters to address a specific situation. This must include an extensive literature review. Also, invention entails providing engineers with guidance to technology development. In line with Zimmerman et al. (2007), literature was extensively reviewed and detailed in previous sections of this document.

7.2.2.1. Integration of various subject matters

Representing indigenous proverbs with semantic technology is interdisciplinary. The study of proverbs is paremiology while semantic technologies are tools in computer science. This research employed concepts from paremiology, linguistics, social science and computer science to derive this representation. Theories of how humans derive the meaning of proverbs were imperative to this design. These theories suggest some of the metadata pivotal to applying proverbs. Linguistic theories of how metaphors are interpreted aided further elicitation of metadata. Also, grounded theory which is a tool for social science researches was used to ascertain minimum metadata and finally, computer science was used to design the representation in JSON.

The integration of paremiology, linguistics, social science and computer science is interdisciplinary, which resulted in a novel representation of proverbs that computer applications can use to improve their interaction with humans. State of the art representation of proverbs is

ontological (Maayan Zhitomirsky-Geffet, Gila Prebor, 2017). Such representation is efficient for proverb retrieval but inefficient for learning human concepts that underlie the use of proverbs for problem-solving.

7.2.2.2. Integration of various technologies

The development of linguistic applications to evaluate the viability of the designed representation resulted in the integration of graph technology, deep learning models and Chatbots. Most Chatbots are built on deep learning or ontological databases. But this study incorporated rules, ontology and deep learning models for its chatbot. Integration of these three approaches is rare and to the best of literature reviewed, novel. Novel because it does not use conventional bot markup languages rather a scalable human dictionary for response generation. Also, it uses deep learning model not to learn response generation or intent detection rather predict user psychological need. The chatbot is novel in that its responses are rather proverbs and pieces of advice. In addition, adapting dataset required a combination of several algorithms to optimise the efficacy of the available dataset.

7.2.3. Relevance

Zimmerman et al. (2007) described relevance to be an articulation of **preferred state** a research design attempts to achieve. Relevance also include **support** for why the community should consider this preferred state and detail of the **current state**. Therefore, the relevance of this research design will be discussed under the points in bold.

7.2.3.1. Current state

Proverbs are represented as lists and at best RDF ontologies which only aid retrieval. Thus, proverbs are reduced to dormant knowledge and historical artefacts instead of active empirical wisdom that are applicable to common social challenges faced by humans.

7.2.3.2. Preferred state

Proverbs were used in indigenous societies to resolve challenges. It is preferred that they be used for similar purposes in contemporary societies by harnessing ubiquity and proliferation of computer applications especially conversational applications which interact with almost everyone. The preferred state of proverb is one such that applications like google search engine, google personal

assistant, apple Siri, amazon Alexa would use proverbs in their conversations, suggest solutions based on indigenous insight and respond to users in a culturally acceptable way.

7.2.3.3. Argument in support of preferred state.

Artificial intelligence has come to stay and will affect several aspects of human life. Also, interaction with machines will increase as AI improves. A factor of AI that will dictate its full blown deployment is ability to relate with humans culturally. Current AI have information and can respond only to problem with available data. They perform well in answering questions, making predictions, observing patterns and imitating some human conversational features. However, they lack the touch of indigenous human culture because data used to train AI models are contemporary. Moreover, indigenous data are scarce. Thus, this representation would avail AI engineers to introduce indigenous perspectives to AI models.

In addition, proverbs are advisory, they give insights tested by several generations to challenges. After all, “the things that hath been, it is that which shall be; and that which is done is that which shall be done: and there is no new thing under the sun” (Ecclesiastes 1:9 King James Version). So to every challenge, there exist an insightful proverb to solving it. This suggests that social issues that cause distress can be first aided by providing adequate proverbs to the concerned individuals. These advisory contents can be presented to concerned individuals through their phones or personal assistants.

7.2.4. Extensibility

Extensibility is the ability to build on the resulting outcomes of the research through design either by employing the process in a future design problem or understanding and leveraging the knowledge created by the resulting artefacts. The process designed during this research can be adapted to engineering cultural and indigenous technologies. There are other means of representing IK such as folklore and myths which suffer the limitations proverbs suffer. Novel technologies can be developed using the protocol designed during this research to improve the representation, usage and relevance of other forms of IK in contemporary societies.

Also, a fundamental attribute of proverbs is that they are persuasive. There are myriad of persuasive technologies aimed at influencing human behaviour. Such technologies depend on extrinsic and intrinsic motivations to affect humans. Sometimes, it might be difficult for an application to articulate its intention directly, most time inferences are left to users who might not infer. For

example, a persuasive Health application, which aims to help users reduce obesity. When a user gains weight, it might be impolite to confront the user with profound bitter truth considering the weight gained over time. The user can be presented a proverb and made to understand it. When properly comprehended, the gravity of his or her negligence would be exposed and hence would take proper action according to the instruction contained in the advice of the proverb.

Furthermore, the proverb representation designed can be integrated into e-learning platforms to teach IK indirectly and directly teach science. Aubusson, Harrison, & Ritchie (2006) accentuated the potentials in metaphors and analogies towards enhancing scientific knowledge acquisition, higher-level thinking and development of tools for interpreting science. Recall proverbs are metaphoric and as such are apt to improving scientific knowledge acquisition. Thus, western empirical knowledge would be learned through indigenous pragmatic knowledge.

Another way of extending the research is to adopt the representation for machine translation. In the course of the study, proverb translation is different from sentence translation. Whereas proverbs can be translated by using a close aphorism in destination language, some languages do not have corresponding equivalent proverbs (Lubris, 2019). In cases like this, semantic proverb representation can be adopted because the representation encodes the lessons a proverb teaches; which are universal hence lesson-based proverb translation. Such translation algorithms would identify the lesson a source proverb teaches and gets an epigram in the destination language that teaches the lesson.

Regarding extensibility, which demands that result of research through design be an employable process for future design or the resulting artefact be used to solve other problems; this research has both produced a reusable method for future design and applicable proverb representation for applications.

7.3. Reflections

In the course of attempting to solve the problem that indigenous proverbs are not represented with technologies that optimise their advisory prowess, some other issues were identified. These problems concern the field of artificial intelligence. Despite significant advances in the area since the start of this study, several issues remain unresolved and hence, discussed in subsequent sections.

7.3.1. Extending training Data scope

Epistemology is the theory of knowledge, especially concerning its methods, validity, scope and the distinction between justified belief and opinion. The issues identified concern the breadth of knowledge used by AI. Artificial intelligence depends heavily on data which is a body of knowledge about a subject. It identifies patterns in such data and makes predictions based on its observations. AI models have proven to be apposite at their tasks; they imitate human capabilities like object and voice recognition, language understanding and generation. At some point, these models outpace humans at data-driven decision making. However, AI cannot predict or observe beyond the data it learns. Meanwhile, data can be bias or skew, likewise AI (Srivastava & Rossi 2018). Bias is applicable to both narrow and general AI models. Narrow AI is an AI that makes use of algorithms to exploit large volumes of data to make predictions about a specific domain (LeCun, Bengio, & Hinton, 2015). On the other hand, Artificial General Intelligence refers to true intelligence indistinguishable from human intelligence and applicable to all problem solving (Trajtenberg, 2018). AGI is the utmost goal of all research in the field of AI (Naude & Dimitri, 2019).

Since AGI will be indistinguishable from human intelligence, it means agents with AGI would possess holistic knowledge that cut across almost all spheres of life, including fundamental indigenous knowledge, culture and ethics. As at the time of writing, AGI does not exist, but it seems stakeholders of AI have adopted the divide-and-conquer approach to achieve their goal. Some focus on robotics, some on vision, some on natural language processing and generation, some on cognitive science, others on domain knowledge engineering. But unfortunately, IK has little or no representation either in AI algorithm design or dataset engineering. It is, therefore, necessary that conscious effort be directed towards preserving IK in formats agents can learn. It is essential because IK contains cultural norms and practices which guide interaction within the society. Such knowledge should also constrain AGI agents while interacting in communities.

As I earlier implied, IK data are not readily available. Repositories such as Dataworld, Lionbridge, Kaggle, UCL machine learning repository, DAWEX and BDEX store datasets for research and model training but a search through them gave no useful dataset. A search for the words “indigenous”, “traditional”, “IK”, “proverb” and “folklores” on these repositories yielded no result. At best, those words were used to describe some demographic dataset or programming approach. Because language is the most basic and common form of IK, I was optimistic that indigenous language corpora would be abundant and readily available. Thus, a further search was conducted for languages. Lionbridge hosts a lot of language corpora. It contains Chinese, Turkish, Vietnamese, Japanese, Korean, Portuguese, Russian, Hindi, Dutch, French, Italian and many other

language datasets. However, a search for “Zulu”, “Swahili”, “Yoruba”, “Afrikaans” and “Igbo” yielded no result; thereby, intensifying the concern that IK might eventually be excluded in the future society powered by AGI.

In a race where data about almost every living and non-living thing are being documented and made available to prepare for the future anticipated AGI, data concerning the root of society are being neglected or hoarded. This unpleasant phenomenon compels an inquiry into factors mitigating IK dataset availability. In consonance with elements earlier mentioned in this documentation, IK is embedded in humans and community and thus might be difficult to elicit. Also, some forms of IK are copyright knowledge and some are sacred; making them publicly available might be dangerous. Finally, due to the format of IK, archiving them for machine learning might require some level of new processing and development as in the case of this study.

While these are valid, not all forms of IK are copyrightable, language, folklore and proverbs are not. I, therefore, posit that copyrightable IK should be clearly defined, and such be made available in machine-usable formats. I am also of the opinion that resources be invested in safeguarding intangible IK that are foundational to social norms and practices. Thus, significant advances would be made in training models some social intelligence.

7.3.2. AI algorithm cultural inefficiency

I liken AI algorithms to a straight mirror and data to a person standing in front of it. The mirror simply reflects the image of the person before it as is. What if we have mirrors capable of social intelligence just like sketch artists; mirrors that esteem human dignity above their perfection and accuracy? Extending this analogy to algorithms and data, what if we have AI algorithms capable of social intelligence, which will esteem human dignity above perfect and accurate presentation of data, be it symmetric, skewed or bias data?

Definition of artificial intelligence has been such that authors define to suit their philosophies or intentions. However, artificial intelligence requires that an agent be capable of making wise decisions when exposed to relatively or entirely new situations (Fazi, 2019). Per requisite ability to make a wise decision, AI agents have evolved from simple rule-based applications to sophisticated deep learning models capable of making smarter decisions in specific knowledge niche than humans. This level of intelligence is dependent on and proportional to data. Also, datasets are characteristically narrow and deep or broad and shallow; hence when current agents have narrow knowledge, they often have deep insight and accompanying intelligence. Similarly, broad dataset train agents with shallow ideas.

Because we desire useful agents, AI models are mostly narrow (Naudé & Dimitri, 2019) and consequently, best at their tasks. Due to agents' accuracy, speed and consistency, they have been deployed in business, health, public, education and other sectors to do routine tasks and take decisions at some point. Because of their deployment in various areas of society, agents interact with humans and make decisions that affect humans. As machine decisions affect humans, researchers like Srivastava & Rossi (2018) have concerns about decisions taken by machines. They opined that had choices left to social computers been made by humans; the society would expect the latter to be ethical. And if so be, machines should be ethical, which by implication, agents should have an integral component(s) adept in moral principles that govern a person's conducts and actions. Arguing from another perspective, since agents are becoming social that is, they interact with humans; they should also be conversant with societal norms and practices.

A deliberation on the correlation between "wise decision" and "social norm" is imperative. Whereas some societies are individualistic, it does not eliminate the fact that individuals belong to groups and groups belong to larger groups. We should not forget that groups have rules and codes which, according to Hofstede (2019) members comply to be conferred some desired status. Thus, individual decisions are constrained by fundamental ethos. Furthermore, when personal decisions affect other members of the society, the wittiness of a decision or action is subject to the judgment of the community according to cultural values. Consequently, we can say that a wise unit of a society, be it human or machine is one capable of making decisions that earn the accolade of his/her community.

Can we then confer wisdom or intelligence on social units that lack knowledge of fundamental cultural values? I am by no means demanding that machines do what they cannot do as described by Pitsch (2016) neither do I intend to undermine the advances made in the multidisciplinary field of artificial intelligence. Instead, I advocate that cultural agents be developed to mitigate data bias. Although categorical data of good or bad, temperate or aggressive, humble or proud, joyous or melancholic may be insufficient to train agents, researchers like (Hofstede, 2019; Piccolo & Pereira, 2019) have proposed models for designing cultural agents. Such models have an inherent knowledge of fundamental good or bad relative to cultures and so should be adopted to mitigate data bias.

For example, an agent built to inherently avoid discrimination would not give preference to male job seekers, neither would it tag a black man an animal when given an image of a crowd because of data bias. It would instead appeal to its sense of cultural and social intelligence, sacrifice accuracy for human-prestige, avoid criticism, learn and correct or reinforce its belief system. Contextualising this argument to this research, had the models predicting human needs been

equipped with fundamental knowledge of good and evil, the accuracy of the system would have been better. This study has accentuated one of the limitations of existing AI models which is inadequacy in algorithms in that they lack a touch of fundamental cultural values. Therefore, although, Naude & Dimitri (2019) ascribed AI bias to dataset bias, I posit that the inability of AI algorithms to inherently mitigate dataset bias is evidence to their limitations.

7.3.3. Can a bot simulate an indigenous elder?

Dreyfus argued throughout his life that a clear distinction between human and machine must be established (Van der Meulen & Bruinsma, 2019). His opinion is not farfetched from Turing's philosophy, which limited the ability of computers to simulations and abstractions (Fazi, 2019). The debate on the relationship between human and machine, when viewed from different perspectives, poses itself to be unending; therefore, I do not intend to dabble into this quagmire. Instead, to restate that this research aimed to represent proverbs with semantic technologies and consequently validate the viability of the representation. In the course of validating the representation, the chatbot developed proved the possibility of agents or bots imitating indigenous elders' skill of applying proverbs to context, but not without limitation. The elders possess wisdom that the formalism can not capture, such wisdom are beyond formalised knowledge.

In order to simulate a sage's use of proverb, a novel proverb formalism was designed. This supports Fazi's (2019) claim that for machines to think anything new, there must be a formalism. The word "think" is not in the context of the human mind. Instead, it is in a simulation context. Fazi (2019) likened the process of machine thought to the process machine learning algorithms take in processing and making decisions. We can generalise that new formalism yields new machine abilities and to improve AI we need more data formalisms.

7.3.4. Possibilities of Personality Formalism

Of interest is personality formalism because bots must have a personality which necessitates naming bots (Cahn, 2017). Google named their newly introduced chatbot Menna; Amazon named theirs, Alexa, Apple called theirs, Siri, and so on. But names do not define personality; rather, it is determined by experience, conduct, temperament, aesthetics, ethics, psychological traits all summed into personal culture inherited and modified by communal culture (Dreier, 2011). By implication, personality results from information about several spheres of life acquired overtime. Moreover, personality affects decision making, discussions, interactions and almost every action.

For example, two traders with the same amount of money might have machine learning model predict a sell, yes, they both sell, but the amount they trade differs because of their personalities; which is a function of their different experiences and personal culture.

Doubtlessly, beyond subject-specific data, human decision making is affected by other data summed up into personality, a function of culture and experience. Aiming at near-human intelligence for AI would require a touch of personality defined by culture. And as mentioned earlier, a new formalism abstracting personality might be necessary which, in turn will yield novel imitation of human abilities.

7.3.5. Improving human-computer interaction through Psychological data

Human-computer interaction has evolved to a point where humans and computers are integrated. Futurists now talk about transhumanism and cyborgs. These high-level AI systems would interact with humans with natural languages and are expected to have near-human intelligence. Human culture would still hold, and as such, machines would have to learn about human cultures. Nadarzynski, Bayley, Llewellyn, Kidsley, & Graham's (2020) study underlines the need for psychological interactivity by linguistic applications. They verified the acceptability of some technologies as media of rendering health services. Although video consultations and webchat services appear acceptable, there is currently little support for Sexual and Reproductive Health (SRH) Chatbots. The findings demonstrate a preference for human interaction in SRH services. They recommended that "Policymakers and intervention developers need to ensure that digital transformation is not only cost-effective but also acceptable to users". Whereas video-oriented means of interaction were acceptable to syndicates of Nadarzynski *et al.* (2020), chatbots were not. However, Hayes (2019) listed the veracity of Chatbots as it has been used for counselling and helped destigmatising mental health monitoring in homes and workplaces. It seems Hayes and Nadarzynski are contradictory. However, Ahmed & Amer (2012) suggested that the challenge of providing culturally appropriate psychological therapies needs to be addressed. Following Ahmed and Amer's advice, incorporating psychological and cultural principles into chatbots might ameliorate chatbot shortcomings identified by Nadarzynski.

7.3.6. Engineering cultural and psychological data

AI's dependence on data cannot be overemphasised, but data are scarce. Mackenzie, Pirker, & Reitsma (2020) worked on Models of Indigenous spatiality but bewailed by saying "the data for modelling Indigenous spatiotemporality remain scant, and the subject matter is rich". This, they explained to mean that general study of IK and specific study of indigenous spatiotemporality is a vibrant research niche, but data to model IK using technologies are scant. It is commonly said that data and knowledge multiply at an exponential rate, and it is ironic to say data is scarce. Notwithstanding, the data needed to study some subject are rare. The kind of data that increase exponentially are social media data, scientific data, customer comments and complaints, business-specific data, personal opinions on blogs, digitised novels, news either in text, audio or video. Data needed by Mackenzie and his team are scarce; likewise, data required to study psychological traits. At best, the available data which are secondary can be adapted like Alharthi (2020b) did. She published a psychological needs dataset emanating from social media content annotated by psychologists. She trained models with these datasets and achieved accuracy that is less than 90%. Other studies that needed and used social media data as primary dataset were able to train models to accuracies above 98%. Alharthi's model was able to attain such a degree of accuracy due to the amount of rigour in refining the data, which is expensive and time-consuming.

An alternative to adopting secondary data through refinement is gathering primary data by crowd-sourcing. A large number of internet users generate project-oriented data. The crowd might be paid or not. Projects with little or no funding would suffer if the data needed is extensive, which is always the case for most AI models. Thus, AI researches are tailored to the interest of sponsors. Sponsors might not invest in data that do not directly intersect with their interest but are crucial to the general advancement of AI. Such is psychological and cultural data. I envisage a significant improvement in general AI if there is sponsorship of cultural and psychological dataset engineering to train machine or deep learning models fundamental human concepts

7.4. Artificial Psychological and cultural intelligence (APCI).

Reed (2019) from his years of experience in the field of cognitive psychology and artificial intelligence wrote to "encourage greater integration of the fields of AI and cognitive psychology". Similarly, the field of sociology and anthropology can be integrated into AI. Such that there will exist artificial machines with psychological and cultural intelligence. This can be achieved by designing algorithms influenced by theories from psychology, anthropology and sociology. Another approach is to train ML models some concepts from such fields. Models with artificial

psychological and cultural intelligence should be able to sense and exhibit “exaggeration”, “pride”, “reckless”, “humility” and other traits where needed.

As at the time of writing, a search on Google Scholar and Google search engine for “artificial psychological and cultural intelligence” and “artificial cultural and psychological intelligence” returns no result. I, therefore, define Artificial psychological and cultural intelligence (APCI) as AI that imitates human psychological and cultural knowledge while leveraging computational intelligence. Advances in APCI is pivotal to improving the result of this research, thus an exciting area for further study.

Chapter Eight

Conclusion

On a final note, this chapter discusses the findings of this study, limitations and future works.

8.1. Major Findings

This study has extended existing knowledge under the subheadings in this section.

8.1.1. Proverb attributes needed to apply them to context

Whereas existing literature describes proverbs, they sparingly discuss the attributes required to apply them to complaints. This study reveals three categories of data needed to identify and use a proverb to address a complaint. These attributes include the words in a proverb and their metaphoric meanings, the lesson it teaches, the proverb's domain of application and role of the listener. Other identified attributes like interpretations and translations are to ensure a common knowledge between the speaker and the listener. Similarly, context inherent attributes are words used to describe a context, possible lesson a listener can be taught, the role of the listener and context domain of occurrence. Lastly, human-inherent attributes are proverb ken of speaker and general ken of listener.

Having identified the above factors, a proverb user can compare proverb and context attributes, select most correlating proverbs to context and apply them. This study has successfully formalised and simulated intuitive process of applying proverbs; which can be taught to learners and implemented by computers. An approach is that a person learns a set of proverbs and their attributes to satisfy the human-inherent condition. He further gets contexts and defines them in terms of the attributes specified above; finally, he selects and applies the best correlating proverbs. This process was codified into an application, and the app applied humanly acceptable proverbs to contexts 28 of 30 times. It should be noted that the software was limited by inadequate dataset, which implies performance can be improved.

8.1.2. A semantic representation of indigenous proverbs

To facilitate machine usage of indigenous knowledge, especially proverbs, a semantic representation of proverbs was designed. This representation is a JSON class with the proverb inherent attributes. Yoruba proverb objects were generated and stored online for public access. Proverb objects of other languages can be created and used by applications. Since the representation is in JSON, the data can be used by almost any computer application. Applications that are not JSON compatible require minimal scripting to convert JSON to their data format.

An advantage of this formalism is that humans can access time-tested advisory contents while interacting with computers. It also improves human-computer interaction. Proverbs are generally used in literary works for precise articulation of opinions. This formalism can avail computer applications this opportunity. Imagine Google assistant or Alexa or Siri using proverbs to convince her Boss.

8.1.3. Proven the possibility of machines using IK

Another contribution of this study to the body of knowledge is the proven possibility of machines using indigenous knowledge as against storing indigenous knowledge. Campaigns in support of Indigenous knowledge have advocated their safeguard. However, there exist some forms of IK that are empirical and should be taken as such. Scientific knowledge is used by humans, codified into algorithms and used for social engineering. IK can be used similarly, and this study has proven the feasibility and viability of the concept. This study's methodology can be adapted in studies aiming to use IK for social engineering through technology.

8.1.4. Importance of integrating psychology, sociology and anthropology with AI

Finally, the study corroborates other studies that advocate the integration of psychology, sociology, anthropology and AI. Intelligence is a complex concept that leverages knowledge from several domains of life. This fact should be incorporated into AI. That is, AI models, especially interaction models, should implement and learn wisdom from different spheres of life. Such intelligence would improve human-computer interaction and public acceptance of cyborgs.

8.2. Limitations

The major limitation of this study is regarding datasets. Deep learning models were to be trained to predict psychological traits such as pride, recklessness, humility, and so on. But training datasets for such predictions are not readily available. Whereas, the data could be engineered, but the process is time-consuming and fund demanding. Notwithstanding, this limitation reveals areas of future work

8.3. Further Work

Though this study was not aimed to be exploratory, it inadvertently suggests several directions of further work which can either be proverb oriented or not.

8.3.1. Proverb Oriented Future work

Future work regarding proverb representation and application by computer application can be:

1. Conduct longitudinal research which will gather data needed to train machine learning models. The best way to conduct such research is to collect primary data. This should involve the re-classification of lessons proverbs teach.
2. Develop a model that requires barest minimum data for training. A model that learns human concept and uses such a concept to reduce the magnitude of data needed for its training. Whereas there exist knowledge transfer models, they are task-specific as against more generalised concepts like pride and humility.

8.3.2. Future work in general AI

Future works under this category are general work relating to the integration of psychology, sociology, anthropology and artificial intelligence. Literature reveals the importance of this work. I propose human concepts be identified. Followed by specifying the means of converting those concepts to computer-understandable artefacts. The process of turning those concepts can be:

1. Training state of the art deep learning models Human concepts
2. Create human concept ontology
3. Hybridise methods 1 and 2

Deep learning models capable of forming object instances and updating object attributes as learning takes place should be adapted or designed. Subsequently, such models should be trained. Social

media data may be suitable, but they are not the best. Novels, movie manuscripts are best for such training. This process would require human labour; however, semi-supervised learning can be used. But, I strongly propose that humans annotate a considerable amount of the data.

The second approach is to create human concept ontology. This can be a graph formalism of relationships that exist among social, psychological and physical actions, events or entities. This approach will be time-consuming, labour intensive and error-prone. However, the process can be scoped. Finally, a combination of the two approaches may worth the while. Where fundamental axioms are designed for deep learning models. Resulting models should be subsequently trained as described for the first method.

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Appendix I



proverbs.xlsx



complaints.xlsx

Appendix II

4/20/2020

Influencing Decisions with proverbs: Sample Context/Complaint Collection

Influencing Decisions with proverbs: Sample Context/Complaint Collection

This research aims to design a system that influences human decisions through proverbs, thus data gathered will be solely used for research and proof of concept.

A context is basically a description of an occurrence in any area of life that might lead to taking a decision. Example "i am a student and my grades are bad", "My friend is depressed", "i saw my boyfriend with another lady", "I'm fed up of life" etc. You can fill the form as many times as possible.

Thanks

* Required

1. Context/Complaint Heading *

Not more than 50 characters

2. Context/Complaint Description *

Thanks

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Appendix III

4/20/2020

Sùnmònú's Response Evaluation

Sùnmònú's Response Evaluation

Sùnmònú is a chat bot that responds to complaints with indigenous Yoruba proverbs aiming to give indigenous point of view to given complaints. Some complaints (70 in all) were gathered at the outset of this project. Some of these complaints were used to develop the chat bot. Of these complaints, 20 were used to test the chat bot. This instrument is to evaluate the suitability of advice or comment Sùnmònú (the chat bot) passed on given complaints.

*** Required**

1. Your country of origin and tribe (Country-tribe) *

Grading

Following are users' complaints and corresponding comment(s) passed by the chat bot. On a scale of 1-5, 5 BEING HIGHEST, rate the suitability of the comment passed on respective complaints.

NOTE: 5 is the HIGHEST correlation and 1 is the LOWEST

Rate suitability or correlation of responses to complaints. 5 is the HIGHEST and 1 is the LOWEST

2. Complaint: People hate me *

Mark only one oval per row.

	1	2	3	4	5
Moderate your boasting, if you have enviable distinct attribute	☐	☐	☐	☐	☐

3. Complaint: A friend is struggling with his academics *

Mark only one oval per row.

	1	2	3	4	5
If he is not distracted, he'll be glad in the end.	☐	☐	☐	☐	☐

4. Complaint: I am in love with my lecturer *

Mark only one oval per row.

	1	2	3	4	5
Try to observe when your conducts are unacceptable.	☐	☐	☐	☐	☐
Seek elderly (professional) advise	☐	☐	☐	☐	☐

5. Complaint: My young sister likes drinking and that's causing a big problem between her and my parents. what do i do to make her not to drink again? *

Mark only one oval per row.

	1	2	3	4	5
Listen to the other party	☐	☐	☐	☐	☐
You may want to advise people not to overreach, and not to be too full of themselves.	☐	☐	☐	☐	☐

6. Complaint: I am not happy because i don't know what i will do by the time i get home, securing a job is what my problem is all about *

Mark only one oval per row.

	1	2	3	4	5
Patience and wisdom is crucial to success of many endeavours. So be patient and wise	☐	☐	☐	☐	☐
It's better to take care of problems before relaxing.	☐	☐	☐	☐	☐
Diligence in one's pursuit will certainly result in prosperity.	☐	☐	☐	☐	☐

7. Complaint: My girlfriend cheats on me *

Mark only one oval per row.

	1	2	3	4	5
When a person hurts you and afterwards seeks your wellness, he or she is most likely hypocritical and wants to take advantage of you. Be discreet with such people for they are good at exploiting vulnerabilities.	☐	☐	☐	☐	☐
Never be too shy to speak out on your own behalf. Be bold and free yourself or others.	☐	☐	☐	☐	☐

8. Complaint: My employer told me he is not satisfied with my work yet i've dissipated so much energy into it. *

Mark only one oval per row.

	1	2	3	4	5
Only an improved version of yourself can realise your dream.	☐	☐	☐	☐	☐

9. Complaint: I failed an exam i took in second year university *

Mark only one oval per row.

	1	2	3	4	5
On your path, you have not done the best, in that you did not discern what is best for you. You'll bear the consequences of what has happened. If the worst has happened, learn and re-strategise.	☐	☐	☐	☐	☐
Truthfulness to one's nature, and fulfillment of one's obligations are the determinants of one's worth.	☐	☐	☐	☐	☐

10. Complaint: I woke up this morning feeling very tired. *

Mark only one oval per row.

	1	2	3	4	5
Certain tasks demand patience if they are to come out right. So be patient, however with wisdom.	☐	☐	☐	☐	☐

11. Complaint: I know I'm trying my best but I have a phobia for what the future holds. I know I can trust God but I really wish my future will really come out real fine. *

Mark only one oval per row.

	1	2	3	4	5
One should attempt even the impossible.	☐	☐	☐	☐	☐

12. Complaint: The person I'm in love with is a cool person but I don't know if he loves me too or if it's a one sided affair. *

Mark only one oval per row.

	1	2	3	4	5
With slow and steady application, even a difficult task will be done.	☐	☐	☐	☐	☐
Seek elderly (professional) advise	☐	☐	☐	☐	☐
One should not save other's at the cost of one's own safety. You are important, save yourself first	☐	☐	☐	☐	☐

13. Complaint: I need money to pay my school fees. I'm almost approaching the deadline and it seems the money is not forthcoming. *

Mark only one oval per row.

	1	2	3	4	5
Just be yourself.	☐	☐	☐	☐	☐

14. Complaint: I'm being over charged by the electricity agency and it's freaking me out. *

Mark only one oval per row.

	1	2	3	4	5
One should not save other's at the cost of one's own safety. You are important, save yourself first	☐	☐	☐	☐	☐

15. Complaint: I'm happy because I'm about to get married but the issue is that I don't have a good job that will meet up with my expectations, this has really brought me down. *

Mark only one oval per row.

	1	2	3	4	5
Seek elderly (professional) advise	☐	☐	☐	☐	☐
Only an improved version of yourself can realise your dream.	☐	☐	☐	☐	☐

16. Complaint: Disturbed about my work, did my project work and couldn't find the first three chapters, couldn't find it in my drive and couldn't find the hard copy. *

Mark only one oval per row.

	1	2	3	4	5
Though, your mark of success might not be obvious, just be persistent	☐	☐	☐	☐	☐
If it's what you love to do and it's right, just persist.	☐	☐	☐	☐	☐

17. Complaint: My husband got an information that I am in an affair with my boss. Though he trusts me that I couldn't do such, ever since he heard about it, though I didn't do it, it has made my mind go off from that organisation, I don't want to work in that organisation again because of that. *

Mark only one oval per row.

	1	2	3	4	5
If the worst has happened, learn and re-strategise.	☐	☐	☐	☐	☐

18. Complaint: The hardest part of life is when someone tends to love you and you never wanted it. *

Mark only one oval per row.

	1	2	3	4	5
It will amount to hypocrisy after having done evil or bad to a person, you subsequently seek his or her wellness. Desist from hurting others.	☐	☐	☐	☐	☐
Do not overreach, and do not be too full of yourself.	☐	☐	☐	☐	☐

19. Complaint: My team leader is a little bit bossy. This affects me such that it reduces my work input due to his bossy attitude. *

Mark only one oval per row.

	1	2	3	4	5
Even if a person with abundance has taken the little you could claim. Be positive. However, deal with such people wisely.	☐	☐	☐	☐	☐

20. Complaint: My supervisor expects me to do everything, think on my own with very little supervision or guidance. He wants me to try and keep repeating stuffs till I get it right without telling me exactly what to do. It's really frustrating. *

Mark only one oval per row.

	1	2	3	4	5
One should attempt even the impossible.	☐	☐	☐	☐	☐

21. Complaint: I find it difficult to do routines, routines are boring and depressing and sometimes a goal set needs some regular set of routines to help achieve the goals. i find this difficult. there are days that i am very depressed because i can't help myself out of these challenges but however life must move on *

Mark only one oval per row.

	1	2	3	4	5
It is unwise to undertake a delicate matter like health recovery with impatience. Patience and wisdom is crucial to success of many endeavour. So be patient and be wise	☐	☐	☐	☐	☐

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Appendix IV

Sùnmònú's Response Evaluation

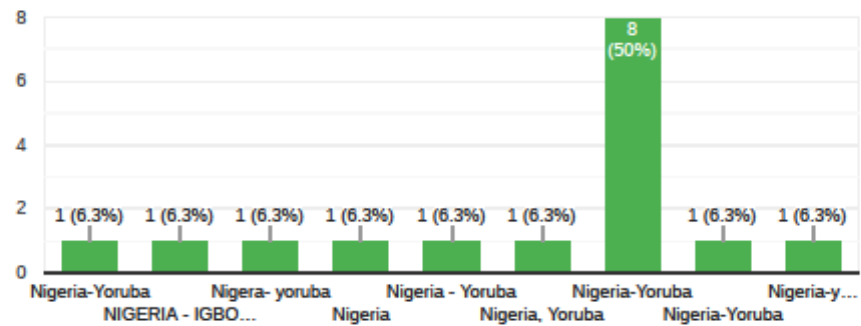
20 responses

[Publish analytics](#)

Your country of origin and tribe (Country-tribe)



16 responses

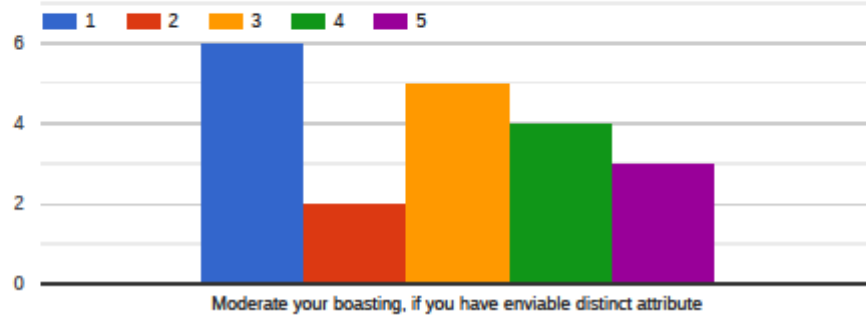


Grading

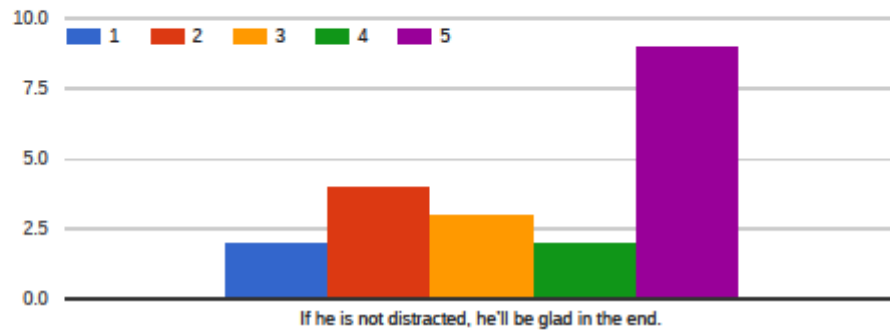
Rate suitability or correlation of responses to complaints. 5 is the HIGHEST and 1 is the LOWEST



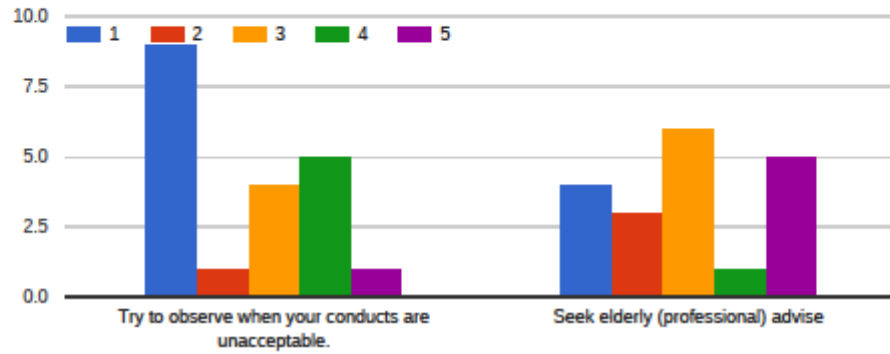
Complaint: People hate me



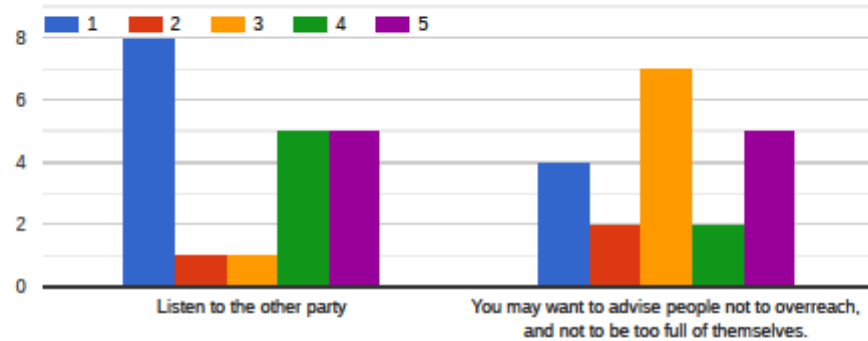
Complaint: A friend is struggling with his academics



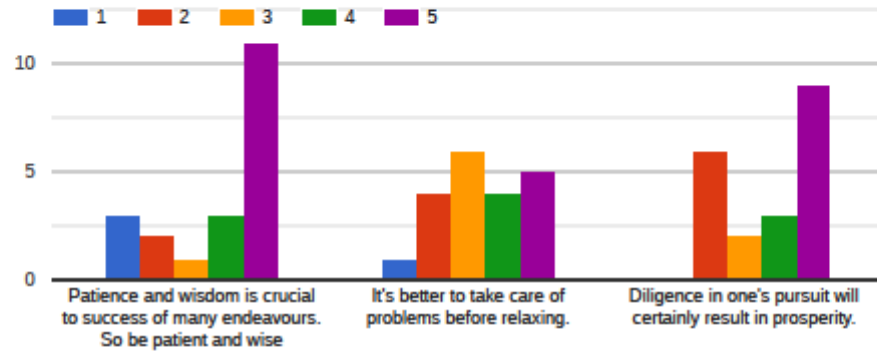
Complaint: I am in love with my lecturer



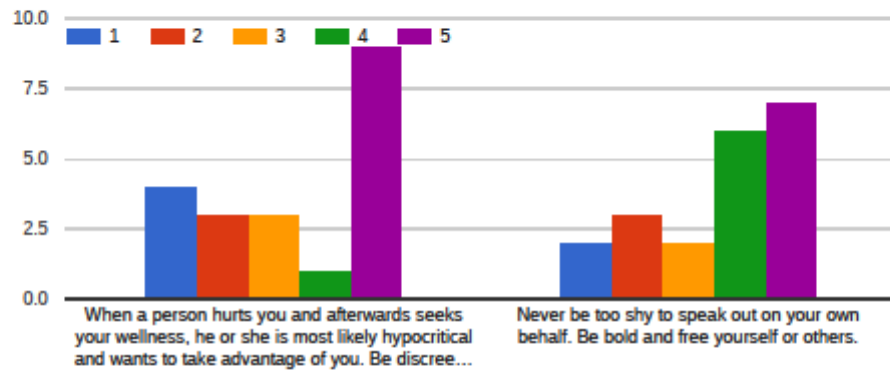
Complaint: My young sister likes drinking and that's causing a big problem between her and my parents. what do i do to make her not to drink again?



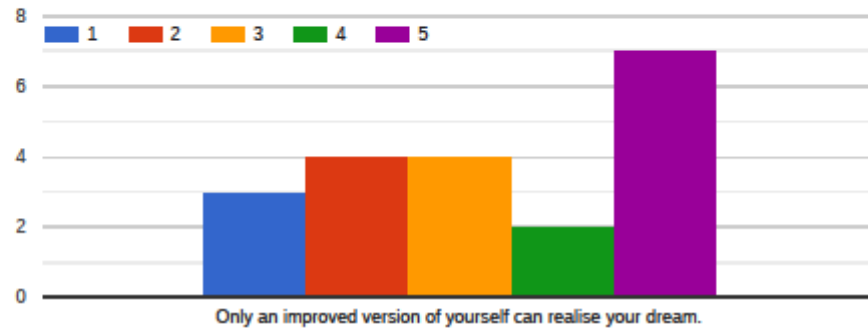
Complaint: I am not happy because i don't know what i will do by the time i get home, securing a job is what my problem is all about



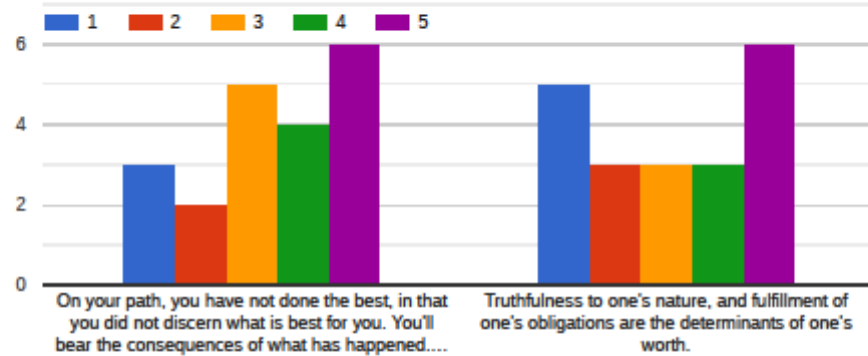
Complaint: My girlfriend cheats on me



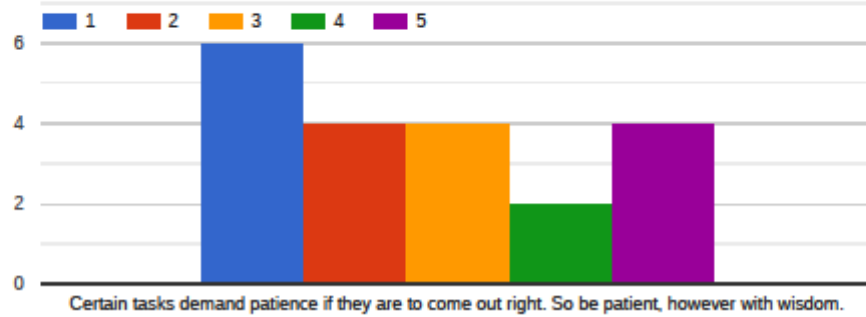
Complaint: My employer told me he is not satisfied with my work yet i've dissipated so much energy into it.



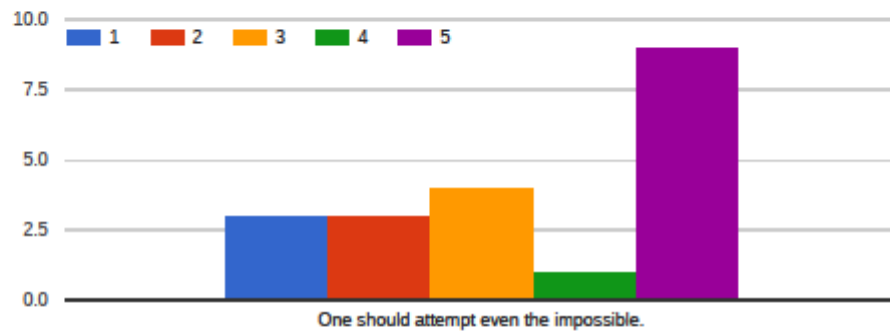
Complaint: I failed an exam i took in second year university



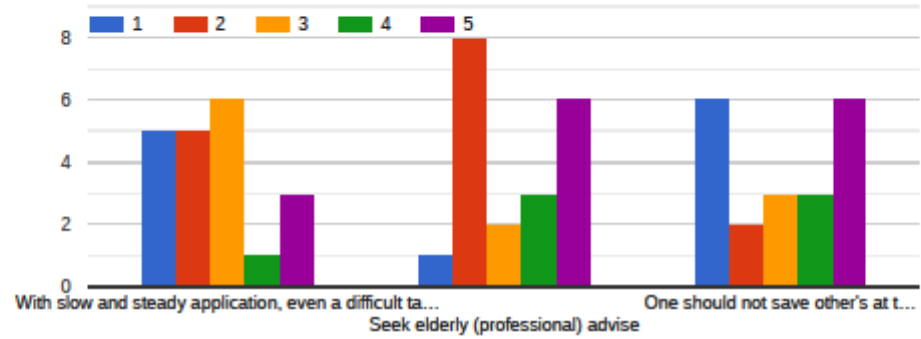
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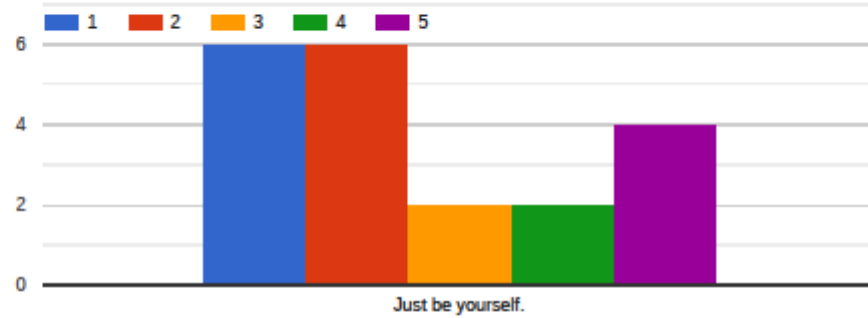
Complaint: I know I'm trying my best but I have a phobia for what the future holds. I know I can trust God but I really wish my future will really come out real fine.



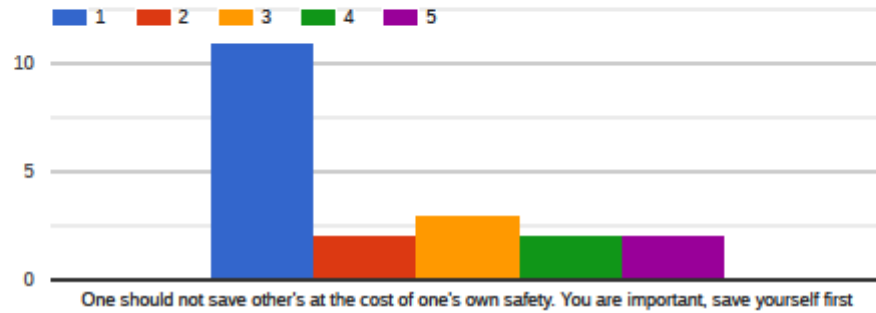
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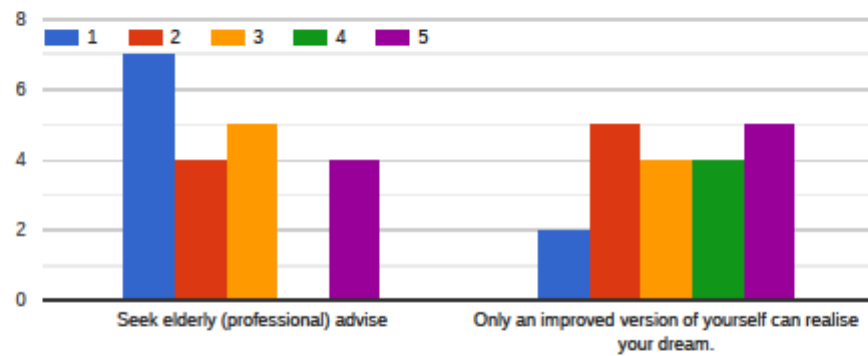
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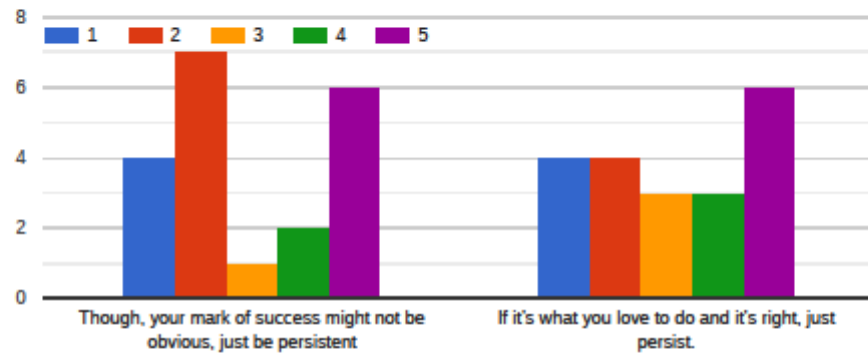
Complaint: I'm being over charged by the electricity agency and it's freaking me out.



Complaint: I'm happy because I'm about to get married but the issue is that I don't have a good job that will meet up with my expectations, this has really brought me down.



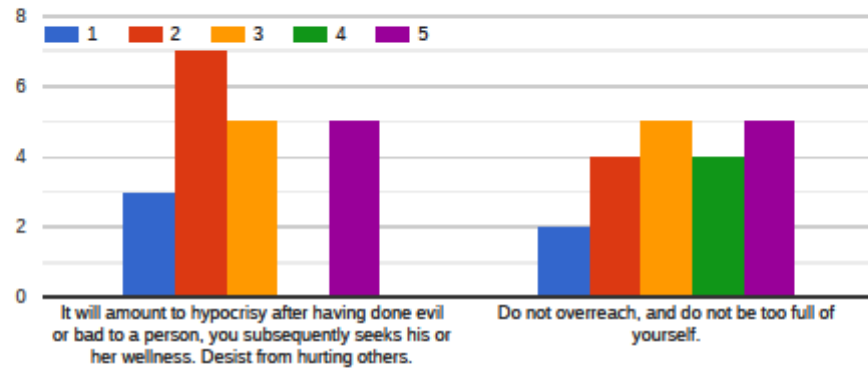
Complaint: Disturbed about my work, did my project work and couldn't find the first three chapters, couldn't find it in my drive and couldn't find the hard copy.



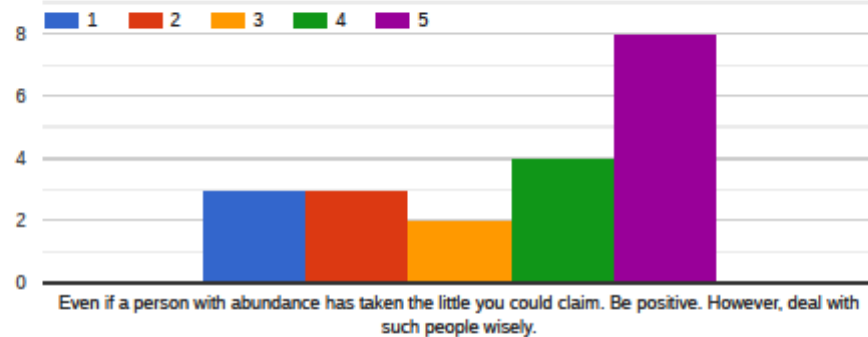
Complaint: My husband got an information that I am in an affair with my boss. Though he trusts me that I couldn't do such, ever since he heard about it, though I didn't do it, it has made my mind go off from that organisation, I don't want to work in that organisation again because of that.



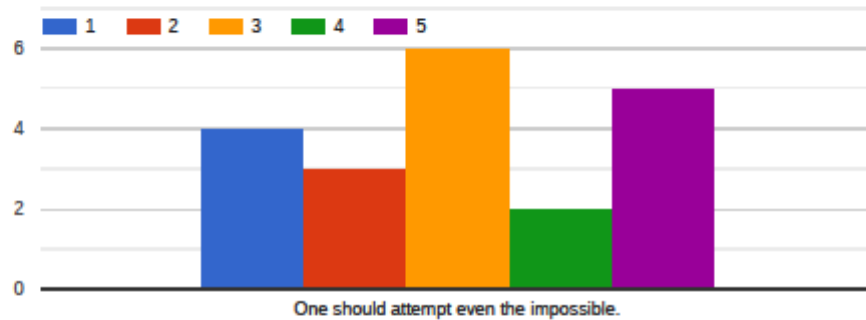
Complaint: The hardest part of life is when someone tends to love you and you never wanted it.



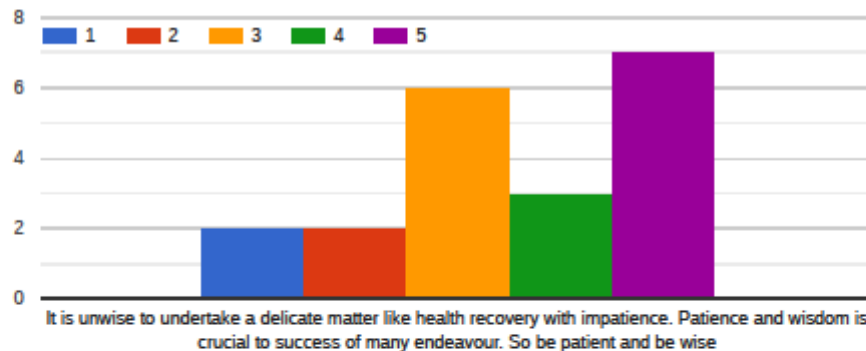
Complaint: My team leader is a little bit bossy. This affects me such that it reduces my work input due to his bossy attitude.



Complaint: My supervisor expects me to do everything, think on my own with very little supervision or guidance. He wants me to try and keep repeating stuffs till I get it right without telling me exactly what to do. It's really frustrating.



Complaint: I find it difficult to do routines, routines are boring and depressing and sometimes a goal set needs some regular set of routines to help achieve the goals. i find this difficult. there are days that i am very depressed because i can't help myself out of these challenges but however life must move on



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4/20/2020

Sünmönü's Response Evaluation

https://docs.google.com/forms/d/1mMgXkzu1tgXdNv8vm4krydg_gBA-ggLUO22b8-0RlN4/viewanalytics

12/12