Computational Morphological Analysis of Yorùbá Language Words

S. I. Eludiora, O. R. Ayemonisan
Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria

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ABSTRACT

Nigeria official languages are English, Yorùbá, Igbo and Hausa. The focus of the study reported in this paper is to develop learning tool that can assist learners to learn the Yorùbá language using its alphabets. The study is critical to Yorùbá language, because of its endangerment. There is need to introduce different learning tools that can mitigate its extinction. A Yorùbá word perfect system was developed to assist people in learning the Yorùbá language. English and Yorùbá words formation are experimented using computational morphological approach (word formation). The theoretical framework considered Finite state automata (FSA) to realise different ways of combining the consonants and vowels to form word. Two to five letter words were considered. The system was designed and implemented using UML tools and python programming language. The system will teach the users on how the words are formed, and the number of syllables in each word. The user need not to know how to tone mark word before he/she can use the system. Any word typed will be analysed according to its number of syllables. This approach produces representatives of all parts of speech (POS) of the two languages. It produces corpora for the two languages.

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Corresponding Author:
S. I. Eludiora,
Department of Computer Science and Engineering,
Obafemi Awolowo University,
Ile-Ife, Nigeria.
Email: eludioraomolola@gmail.com

1. INTRODUCTION

Firstly, can other African languages be learnt using this approach? In a way can Igbo and Hausa (the other two Nigerian languages) be learnt using this approach? Yorùbá, Igbo and Hausa are tonal languages and possibly some other African languages. Secondly, can other world languages be learnt using this approach? Morphological analysis is the first step in many natural language processing tasks. Tasks such as parsing, machine translation, information retrieval and part of speech tagging, among others [1].

Morphology is the study of the internal structure of the word. Morphological analysis can be used to retrieve the grammatical features and properties of a morphologically inflected word [2]. It is the process of segmenting words into morphemes and analysing the word formation. It is a primary step for various types of text analysis of any language [2].

As noted in [3], morphology studies the internal structure of words. The building blocks are called morphemes. One distinguishes between free and bound morphemes. Free morphemes are those which can stand alone as word. Bound morphemes are those that always have to attach to other morphemes (Söhn, 2008). Morph or Morpheme is a minimal distinctive unit of grammar. E.g., a word like unselfish (àìníìfẹ́taraẹninikan) has three morphemes in the English language. They are: un-, self and -ish. In Yorùbá, it has nine morphemes: à + i + ní + ife + ńi + ara + ẹni + ní + kan which can be segmented [4].

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An allomorph is a possible way of realizing a morpheme. For example, the plural morpheme in English is realised by the allomorphs –es, -ies, -s. E.g., box (boxes), fly (flies) and book (books) [3]. The morpheme which expresses plurality in English, for instance, appears in several variants: cap/caps, log/logs, force/forces, mouse/mice, sheep/sheep, etc. Two of these variants form the voiceless [s] of caps, the voiced [z] of logs. The irregular shape of mice could be said to be an allomorph of the plural morpheme and the phenomenon is called allomorphs. The plural morphemes in Yorùbá are not expressed in this manner. For example, pupil and pupils; pupil means ọmọ ilé-èkò and pupils means àwọn ọmọ ilé-èkò.

Word formation in the two languages follows a simple process. In English, vowel can attach with a consonant to form a word, for example, in, on, of (mostly prepositions), etc. In Yorùbá, consonant can attach with a vowel to form a word or words (according to the variation of the tone marks usually verb), this word is usually a root word of a whole class of words, for example, dé cover, gé cut, àkà read etc. Pre-fixing a vowel to these words, a noun is formed from the same root word, for example, dé –> cover, a + dé –> crown, ọmọ ilé –> beat, i-lù –> drum [4].

In [5], extensive work on Yorùbá word syllabication had been done. The software developed can be used for tone marking and under-dotting of Yorùbá words. Our concern in this paper is to develop a tool that can simplify the word formation and how the syllable can be identified in a word. The tool can be used for other related languages within Africa and other parts of the world.

The remaining part of the paper is organized as follows: section 2 examines related works; section 3 gives the theoretical framework; section 3 section 4 discusses the results, while section 5 concludes the paper.

2. RELATED WORKS

In [5], is of opinion that if urgent steps are not taken by the stakeholders that Yorùbá Language will be endangered. He examined low-usage of the language in some states in South West of Nigeria. The findings show that the students find it difficult to communicate with the people using the Yorùbá language.

In [6], examined the factors or variables that are responsible for Yorùbá language endangerment. The results of the study show lack of commitment to indigenous language; habitat displacement, colonial legacy, and defective language planning are responsible to the gradual extinction. The study concluded that the Yorùbá language should be used at home, and it should be a criteria for post primary school admission.

In [7], laid down a basic way of learning the Yorùbá language. In the book the author explain different types of Yorùbá vowels and their features. The author discussed phonology and morphology of Yorùbá language. The author explained how words are formed. The book is informative and it will help learners.

In [8], examined the contributions of mother tongue in pre-Nursery or primary early childhood education. The study raised six issues: language background, situation in Nigeria, policy documentation on language in Nigeria, language theory and development, and problem statement and rationale. Success and failures of mother tongue usage in the country needs to be reviewed in order to address issues mentioned.

In [9], was of opinion that proper implementation of educational policies in Nigeria will increase the learning of indigenous languages in particular Yorùbá language.

In [10], presented that one of Nigerian educational policies stipulated it that "the first three years of primary education should be taught in learners’ mother tongue. The study conducted show that primary school teachers used were able to teach the subjects (like social studies), but with challenges.

In [11], examined which of the Yorùbá language (mother tongue learners) as a medium of instructions and English language as a medium of instructions to teach social studies in the nursery school would make the pupils perform excellently well. The experiment was carried out and the results show that the pupils taught with their mother tongue (Yorùbá language) perform better than those that were taught with English language.

In [12], learning is defined as a change in knowledge attributable to experience. Learning involves a change in the learner, learner’s knowledge and cause of the change is the learner’s experience. Learning is not measured through one operational definition. Rather, learning is a blend of comprehension, transfer of new material, and the retention of material. In fact, most transfer studies focus purely on the similarities and differences between the contexts of initial learning and subsequent transfer [13]. Given the current study, learning has been evaluated using a multimedia device.

In [13], proposed the use of E-learning approach to teach and learn the Yorùbá language. He opined that the Information and communication technology (ICT) is a good tool to increase the people’s interest in learning the language.

In [14], developed a windows mobile application for learning Yorùbá language. The learner can learn how to read alphabets, numbers and common words in Yorùbá language.
3. THEORETICAL FRAMEWORK

Finite state automata (FSA) technique was used to analyse different ways of forming words from the two languages’ alphabets. The FSA was used for two to five letter words, while some notable examples of single letter words were mentioned. In subsequent subsections, they will be discussed in details.

3.1. Single letter words

In English language, ‘I’ (pronoun) and ‘a’ (determiner) are the single letter words. In Yorùbá language it is mostly pronouns. Example:

‘Ô’ (3rd person singular, s/he, and it) and ‘A’ (we).

3.2. Two letter words

Two letter words (KF) in Yorùbá language are verbs and pronouns, and single syllable. In English language the two letter words can be CV (he, me, we, to, etc), and VC (an, on, in, it, of, etc). Figure 1 shows how two letters words are formed using the finite state automata. Table 1 shows all possible Yorùbá words that can be generated from Figure 1. The possible combinations of KF or CV are not sensible semantically in some cases, but syntactically they are sensible. The focus here is to address issue of syllable that will give meanings to all these possible combinations. Also in Figure 1, three different Yorùbá language tone marks are shown; high tone (H: ā), low tone (L: à) and mid-tone has no symbolic representation (a). The application of tone marks on vowels are used to resolve possible ambiguities in some words. If the tone marks cannot be used to distinguish the words, then such words can be distinguished contextually. A sensible two letter words can only form three different words maximally (bá, bà and ba), each word may have different meanings. For example, ‘bá’ is an ambiguous word. It means touch down or ferments.

Pure syllabic vowels (m and n) in Yorùbá language can be tone marked within a sentence or a phrase. In most cases they take high tone, and they are single letter words. For example: m bọ̀ and n lọ. Also, consonant Ṣṣ is the only one that has under dot. In most case it is used to stress word (e.g., telifísàn - television). The alphabet GB gb is a combination of two letters (also termed as digraph) is consonant not two consonants (gbè, gbá, gbọ̀ , etc).

Figure 1 explains possible ways of forming two letter words from both languages. The Yorùbá has one way of forming two letter words. That is, Konsonanti (K) + Faweli (F) => KF. The English language has two forms. That is, consonants (C) + vowels (V) => CV and VC. Examples are shown in Table 2.

### Table 1. Yorùbá language two letter words

| K + F | a | é | ì | ó | ò |
|-------|---|---|---|---|---|
| Bb    | B | B | B | B | B |
| B + a | bá | Bá | ba |
| B + e | Bé | Bé | Bé |
| B + i | Bí | Bí | Bí |
| B + o | Bò | Bò | Bò |
| B + u | Bù | Bù | Bù |

| K + F | a | é | ì | ó | ò |
|-------|---|---|---|---|---|
| Bb    | B | B | B | B | B |
| B + a | bá | Bá | ba |
| B + e | Bé | Bé | Bé |
| B + i | Bí | Bí | Bí |
| B + o | Bò | Bò | Bò |
| B + u | Bù | Bù | Bù |

### Table 2. English Language two letter words

| CV | POS | VC | POS |
|----|-----|----|-----|
| He | PRN | if | Conjunction |
| to | PRN | on | Preposition |
| be | Verb | an | Determiner |
| me | PRN | it | PRN |
| we | PRN | in | Preposition |
| go | Verb | of | Preposition |
| do | Verb | us | PRN |

3.3. Three letter words

In Figure 2, the state diagram of three letter words for English and Yorùbá languages is shown. For the Yorùbá language there are possible three combinations.

The first scenario (FKF) is shown in Table 3 (possible combinations of F, K, and F). It means that seven vowels can be combined with consonants prefix and postfix. The tone marks and under-dots produce different words. This is A + b + other vowels.
In scenario 2 (KFF), KFF produces one word as shown in Table 4. Scenario 3 (KFK) as shown in Table 5, gives the combination of KFK i.e. K + FK. The FK can represent the five nasal vowels mentioned in the previous section.

Table 4. Scenario 2: KF+F

| KF + F | Yorùbá word | Syllable | POS | English word | POS |
|--------|--------------|----------|-----|--------------|-----|
| na + a | Náà | 2 | AIỌO | The | Det |

Table 5. Scenario III: K+FK

| KFK | Yorùbá word | Syllable | POS | English word | POS |
|-----|--------------|----------|-----|--------------|-----|
| K + an | kán | 2 | V | brake | V |
| K + an | kàn | 2 | V | knock | V |
| Y + en | yên | 2 | article | that | article |
| G + un | gún | 2 | V | Stab | V |
| Y + an | yán | 2 | V | Yarn | V |

Table 6 shows different combination of consonants and vowels forming three letter words in English language. The combinations are: CCC, CVC, CCV, VVC, CVV and VCV. There are different words formed.

Table 6. Three letter words formation in English language

| Combinations | English word | POS |
|--------------|--------------|-----|
| CCC          | Fly          | noun |
| CVC          | Low          | Adjective |
| VCC          | Egg          | noun |
| CCV          | The          | Determiner |
| VVC          | Oil          | noun |
| CVV          | See          | verb |
| VCV          | Use          | verb |

3.4. Four letter words

Figure 3 depicts the English and Yorùbá language four letter words formation. KFKF and FKFK are two possible combinations for Yorùbá four letter words as shown in Table 7 and 8. These are sample words from possible words that can be generated.
There are eight (8) combinations of English four letter words as shown in Table 9. The combinations are: CVCV, CVVC, CVCC, VCVV, VCVC, CCVC, VCCV, and VVCC.

### Table 7. Scenario 1: KFKF

| Combinations | Yorùbá word | Syllable | POS | English word | POS |
|--------------|--------------|----------|-----|--------------|-----|
| da + ra      | dára         | 2        | Adj | Good         | Adj |
| pa + de      | pàdè         | 2        | Verb| to close     | Verb|
| pa + de      | pàdè         | 2        | Verb| to meet      | Verb|
| pa + da      | padà         | 2        | Verb| to return    | Verb|
| Ba + ba      | Baba         | 2        | Noun| Father       | Noun|

### Table 8. Scenario 2: F + KFK

| Combinations | Yorùbá word | Syllable | POS | English Equivalent | POS |
|--------------|--------------|----------|-----|--------------------|-----|
| E + gbọn     | Egbon        | 2        | Noun| brother            | noun|
| E + gbọn     | Egbon        | 2        | Noun| animal             | noun|
| E + ṣe        | Ẹ̀ gbọ́n     | 2        | Noun| Palan kernel oil   | noun|
| A + kọ        | Akọ          | 2        | Noun| time               | noun|
| E + gbọn     | Egbon        | 2        | Noun| Crab               | noun|
| E + gbọn     | Egbon        | 2        | Noun| joey               | noun|
| E + gbọn     | Egbon        | 2        | Noun| back               | noun|
| E + gbọn     | Egbon        | 2        | Noun| tongue             | noun|
| E + gbọn     | Egbon        | 2        | Noun| animal             | noun|
| i + dun       | Ọ̀dun        | 2        | Noun| Bed bug            | noun|

### Table 9. English four letter words

| Combinations | English word | POS |
|--------------|--------------|-----|
| CVCV         | Zone         | noun|
| CVVC         | Beak         | noun|
| CCVC         | Epic         | verb|
| VCCV         | Abba         | noun|
| VVCC         | Onk          | noun|

### 3.5. Five letter words

Five letter words pattern is shown in Figure 4 for the two languages. There are two possible ways of forming five letter words in Yorùbá language. It can be F + KF + KF as depicted in table 10 and F + F + KFK as depicted in Table 11.

### Table 10. Scenario 1: F + KF + KF

| Combinations | Yorùbá word | Syllable | POS | English Equivalent | POS |
|--------------|--------------|----------|-----|--------------------|-----|
| Ẹ + gbọn     | Egbon        | 2        | Noun| create             | verb|
| A + kọ        | Akọ          | 2        | Noun| flower             | noun|
| A + kọ        | Akọ          | 2        | Noun| time               | noun|

### Table 11. Scenario 2: F + F + KFK

| Combinations | Yorùbá word | Syllable | English Equivalent | POS |
|--------------|--------------|----------|--------------------|-----|
| O + ò + rùn  | Òrùn         | 3        | sun                | noun|
| O + ò + rùn  | Òrùn         | 3        | odour              | noun|

There are seven possible combinations for English language five letter word as shown in Table 12.
Table 12. English language five letter word combinations

| Combinations | English word | POS |
|--------------|--------------|-----|
| CCVCV        | Stone        | noun|
| CVVCV        | Widow        | noun|
| CVVCC        | Round        | noun|
| CCVVC        | Broom        | noun|
| CCVCC        | Chest        | noun|
| CVCCV        | Title        | noun|
| VCVVC        | Ocean        | noun|

4. CONCLUSION
4.1. System framework design

The system framework design covers the system database, and software design. Figure 5 depicts the system activity. In the theoretical framework section, two to five letter words were analysed for the two languages. The feature of each letter word was discussed in relation to the number of syllables. Morphemes differ from words as it was explained in the previous sections. According to Figure 5, the system determines whether a word is a Yoruba or not. If it is a Yoruba word, the system will check for the number of alphabets to know if it is two, three, four, or five letter words. The system will compare the word with the words in the database. If it matches, the system displays the possible number words that such a word can be represented. The user does not have to tone mark a word while typing the word. The system will analyse the word to determine how many possible words can be formed from that single word. It will provide different possible words that can be formed. For example, if *igba* is typed, after the analysis, the system will display five different words which are *igba* (200), *igbá* (season), *igbá* (garden egg), *igbá* (rope for climbing palm tree), *igbá* (calabash). The tone marks determine the syllables; in this case there are two syllables *igba*, it means the tone marks can be on the two vowels (i or a). These tone marks determine how words are pronounced (phonology). The Yoruba orthography (writing styles) depends on this tone marks to make meaning out of a word. It might not be critical in speech but critical in texts. It is problematic when reader is fixing meaning from the context. However, such a meaning may deviate from actual intended meaning. The system will display the total number of syllables, the parts of speech (POS) and the English language equivalent. The system activities diagram showing the various actions been performed by the system is shown in Figure 5.

Figure 5. The System Activities Diagram

4.2. Database design

The database design is based on the theoretical analysis done in the previous section. The structure of the database is different from the tables presented in the previous section. The database consists of words from two letter words to five letter words. The words were manually tone marked. Three things were considered in the database: the Yoruba word (tone marked), syllable, its equivalent in English language, and POS. Each letter word was separately designed for easy access. The system compares every word typed by the user with the word...
in the database. The database was designed to accept new words, but must be vetted by the system administrator.

4.3. Software design and implementation

Figure 6 shows how different modules relate with each other. There are four modules: startpage, selectview, analyse, and selectsearch. The startpage coordinates other modules. The selectview displays the word’s attributes. It displays the tone marked word, syllable, and POS. The selectsearch is the database that the startpage can access. SQLite was used to design the database. The code was implemented using python programming language. The system class diagram is shown in Figure 6.

5. RESULTS AND DISCUSSION

The system implementation considered all the modules and units to implement the whole system. Figure 7 depicts the Yorùbá word formation system. The system has user plane, where user can type a word. Below the user plane are: analyse, reset, and close buttons. The user can analyse the word by clicking the analyse button. The user can reset and type new word. Figures 8 show the system sample outputs.

The GUI displays the results of word analysed, it displays the number of syllables, Yorùbá language tone marked words, the equivalent words in English language, and the POS.
6. CONCLUSION

There were many things considered in this study and there are many ways of using them. The alphabets combination can provide reasonable size of corpora for the English and Yorùbá languages which can be used for machine translation. The FSA state diagram can be used for other language pair to see whether it is suitable. The final application can be used by Yorùbá Teachers at any level of education. This is similar to (but detailed than) Nursery/Primary English word perfect. In future, we will make it a multimedia system. Text, pictures, sounds will be included.

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