African Wordnet: facilitating language learning in African languages

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Abstract

The development of the African Wordnet (AWN) has reached a stage of maturity where the first steps towards an application can be attempted. The AWN is based on the expand method, and to compensate for the general resource scarceness of the African languages, various development strategies were used. The aim of this paper is to investigate the usefulness of the current isiZulu Wordnet in an application such as language learning. The advantage of incorporating the wordnet of a language into a language learning system is that it provides learners with an integrated application to enhance their learning experience by means of the unique sense identification features of wordnets. In this paper it will be demonstrated by means of a variety of examples within the context of a basic free online course how the isiZulu Wordnet can offer the language learner improved decision support.

1 Introduction

The development of the African Wordnet (AWN) containing wordnets for five African languages, namely Setswana (TSN), isiXhosa (XHO), isiZulu (ZUL), Sesotho sa Leboa (NSO) and Tshivenda (VEN), has reached a stage of maturity where the first steps towards an application can be attempted.

The aim of this paper is to investigate the usefulness of the current isiZulu Wordnet[1] in an application such as language learning. Against the background of a multi-lingual scenario of eleven official languages of South Africa, the National Development Plan 2030 (NDP) enjoins all South Africans to learn at least one indigenous language as part of nation-building and social cohesion (South African Government, 2017). Such an imperative calls for prioritizing the development of language learning courses. Currently, very limited material exists to support language learners who wish to focus on improving their skills in their own time, without much cost involved and with actual real-world examples.

Most of the material developed to engage learners of an African language, are either taught in time-consuming (university) classes or after purchasing expensive software with generic course content and teaching style. An exception is a set of basic free online courses **LE**arn **T**o **S**peak an **A**frican **L**anguage (*LetsAL*) (University of South Africa, 2010) that were developed for first time language learners of some of the indigenous South African languages, namely Setswana, isiXhosa, isiZulu, Sesotho and Sesotho sa Leboa.

Although the African languages can still be regarded as under-resourced (cf. the resource audit performed by Grover, Van Huyssteen and Pretorius, 2011) the African Wordnet (AWN) project reported in Bosch and Griesel (2017), has played a significant role in filling the gap as available source of data for further human language technology and linguistic research. The individual African languages wordnets, with less than 20,000 synsets per language, are still relatively small in comparison to some of the large wordnets such as the Princeton WordNet[2] (117 659 synsets for English) and the FinnWordNet[3] (120 449 synsets for Finnish). Nevertheless, we investigate the possibility of using the AWN effectively as support for language learners in a computer assisted language learning (CALL) environment. Our focus is on isiZulu.

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[1] Available for download from https://rma.nwu.ac.za/index.php/resource-catalogue/african-wordnet-isizulu.html. Please note that this catalogue will soon be transitioned to the newly constituted South African Centre for Digital Language Resources (SADiLaR) https://rma.nwu.ac.za/index.php/about-sadilar/

[2] http://wordnet.princeton.edu/wordnet/man/wnstats.7WN.html

[3] http://www.ling.helsinki.fi/en/lt/research/finnwordnet/news.shtml

In this paper, the interaction between the AWN and *LetsAL* will be explored as a first step towards moving to a more integrated CALL system, with a focus on improving user interaction. A brief background to both the AWN and *LetsAL* will be provided, before the contents of the two resources is assessed. We also discuss ways to integrate the AWN into the current *LetsAL* system, with a view on moving towards an intelligent CALL (iCALL) application as proposed in Bosch and Griesel (2013). Fast-tracking the expansion of the AWN with *LetsAL* data is also shown to be effective, even with minimal additional resources.

2 Background

In this section, we discuss the status quo of the African Wordnet as potential language learning support resource and provide background on the *LetsAL* courses.

2.1 The African Wordnet Project

The African Wordnet Project (AWN) deals with the development of aligned wordnets for African languages spoken in South Africa (i.e. languages belonging to the Bantu language family) as multilingual knowledge resources with the long-term purpose of including a wide variety of related languages also from other parts of Africa. Bosch and Griesel (2017) discuss the development strategies implemented for building a first version of the AWN for five languages in parallel.

The expand model was followed from the onset since, as stated by Ordan and Wintner (2007), this model provides a tested structure for building a new resource and is therefore typically the choice for less resourced languages. During the first development phases, the AWN used the extended Common Base Concepts list from the EuroNet Project[4] as well as the Core Concepts list designed for the BalkaNet Project[5] to extract English synsets for linguists to include and translate into the African languages concerned. However, it soon became clear that a more localised approach was needed. The seed lists mentioned above contain many concepts that are not lexicalised in the African context.

As the development team became more experienced, and appropriate lexical resources became available, more localised support could be given in the form of frequency-based seed terms

and semi-automatic linking of lemmas from bilingual wordlists and the PWN (Princeton University, 2017). Opportunities to harvest usage examples from online corpora also contributed to promising results.

Throughout the development, the AWN used the DEBVisDic editor tools (DEBVisDic: WordNet editor and browser, n.d.) which are distributed as freeware and were recently relaunched as a web application (Rambousek and Horak, 2016).

2.2 The current *LetsAL* environment

In an initiative to actively promote African languages in anticipation of the Soccer World Cup that took place in South Africa in 2010, a modest beginning was made with the development of free online courses that focus on basic language skills (Mischke, n.d.).

Figure. 1. Learn To Speak an African Language (*LetsAL*)

The so-called *LetsAL* (**LE**arn **T**o **S**peak an **A**frican **L**anguage) courses are aimed at first time language learners, who are offered basic lessons covering 10 general themes, including greetings and courtesies; asking for help; numbers, days, months, seasons; question words, quantities, weather; banks, taxis and restaurants; transportation and finding your way; touring and socializing; at the filling station; the human body and ailments; as well as shopping and sport. Each theme is explored via a list of appropriate vocabulary and phrases accompanied by translations, a short dialogue as well as a video to contextualize the content. Noteworthy cultural customs are also shared, such as who greets first or the role of a traditional doctor. This Open Educational Resource (OER) created by the University of South

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[4] See http://www.illc.uva.nl/EuroWordNet/
[5] See http://www.dblab.upatras.gr/balkanet/

Africa (2010) is actively used by banks and private schools for language learning purposes.

When compared to similar products involving international languages, several areas begging for further development become apparent, e.g. inclusion of real-time interaction between learners; games and fun content included for assessment purposes; etc. (see Bosch and Griesel, 2013). Currently the courses also do not offer links to other external resources. It is in this area where the AWN, already freely available for the five languages, could play a central role in future improvements to these courses.

3 Incorporating AWN in *LetsAL* as additional reference material

The advantages of incorporating all available natural language processing (NLP) resources for a language into a CALL system, is that learners are offered an integrated application to enhance their understanding of the subject matter. In a related study, Winiwarter (2011) describes COLLIE – a collaborative language learning and instruction environment for Japanese foreign language learners. This system combines advanced NLP tools such as machine translation and complex analysers with the English PWN and the Japanese Wordnet to provide learners with translations of Japanese webpages, as well as detailed information on the word level. "All this information is very useful as decision support for selecting the word sense, reading, and English translation of a Japanese word" (Winiwater, 2011:3761).

While NLP support is still limited for isiZulu, it is important that we integrate the resources that are freely available and use them to the best advantage of language learners. The learner improved decision support that can be offered by the isiZulu AWN, which typically covers a variety of semantic relations including synonymy and antonymy, along with usage example sentences and definitions, will be demonstrated by means of a selection of examples within the context of *LetsAL*. Each of the example words already occur in the *LetsAL* course material, but only with the English translation and no further information on meaning nuances or associated misconceptions in isiZulu. To illustrate the need for more disambiguating context and the type of information that a language learner might also find useful, we combined information from the isiZulu AWN and the relevant information from the English PWN (Princeton University, 2017) in tables

1 – 10. The significance of these examples is discussed, before a suggestion for improving the current *LetsAL* environment with similar information is made at the end of this section.

IsiZulu and most of the languages belonging to the Bantu language family are known as tone languages in which pitch variation plays a role in conveying lexical as well as grammatical distinctions[6] (cf. Poulos and Msimang, 1998:543, and Heine and Nurse, 2000:152). The two basic tone levels that can be distinguished in isiZulu, namely high (H) and low (L), may be marked by means of placing acute and grave accents above the syllables of a word, or by placing the symbols H and L after the word, e.g.

índòdà (man) OR *indoda* HLL (man)

In the following pairs of nouns and verb stems it is illustrated how tone distinguishes meaning:

íthàngá (thigh) HLH
íthàngà (pumpkin) HLL

ínyàngá (moon; month) HLH
ínyàngà (herbalist) HLL

-dúmà (be tasteless) HL
-dùmá (roar, be famous) LH

Since tone is not, however, marked in the standard orthography of isiZulu, language learners are often confronted with a difficult choice between two meanings of (seemingly) the same word. It should also be noted that tones are not absolute. Tones documented in dictionaries usually refer to tones of the word as it occurs in isolation or in sentence final position. In other sentence positions, tones may undergo various changes.

3.1 Example 1: *ithanga*

A case of homonymy which is an example of potential confusion for language learners is the noun *ithanga* which occurs in the human body theme of *LetsAL*, with the English translation of "thigh". In a different context such as vegetables, the meaning of *ithanga* is completely different and unrelated, namely "pumpkin". The differentiated meanings of the orthographic form of *ithanga* (thigh/pumpkin) are illustrated in Tables 1 and 2.

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[6] We only concentrate on lexical distinctions in this paper.

POS: n; ID PWN 2.0: ENG20-05243922-n;
ID PWN 3.1: 05569882
Synonyms: *ithanga* :1
Definition: *isitho somuntu esiphakathi kwedolo ne-nqulu*
Usage: *umdlalikazi watheleka emcimbini wama-Grammy esho ngelokwe eliveza lonke ithanga*
Domain: anatomy
Synonyms: thigh :1
Definition: the part of the leg between the hip and the knee
Domain: anatomy

Table 1. *ithanga* (anatomy domain)

POS: n; ID PWN 2.0: ENG20-07263505-n;
ID PWN 3.1: 07751486
Synonyms: *ithanga* :2
Definition: *isitshalo esimila phansi esinombala ophuzi*
Usage: *kanti-ke abangani abathathu bapheka ithanga elikhulu kakhulu*
Domain: gastronomy
Synonyms: pumpkin :2
Definition: usually large pulpy deep-yellow round fruit of the squash family maturing in late summer or early autumn
Domain: gastronomy

Table 2. *ithanga* (gastronomy domain)

3.2 Example 2: *inyanga*

The *LetsAL* example *inyanga* is a noun with two related meanings "moon" and "month" though in different domains, namely time_period and astonomy respectively, as shown in Tables 3 and 4. It is significant that the same orthographic noun has a third meaning "herbalist" (in the medicine domain) which however is unrelated to the former two meanings, therefore representing a homonymous relationship (cf. Table 5).

POS: n; ID PWN 2.0: ENG20-14348156-n;
ID PWN 3.1: 15234209
Synonyms: *inyanga* :1
Definition: *isikhathi sezinsuku ezingamashumi amathathu*
Usage: *inyanga yesibili manje*
Usage: *ngiphumule inyanga eyodwa ngemuva kwama-Olympics*
Domain: time_period
Synonyms: calendar month :1, month :1
Definition: one of the twelve divisions of the calendar year
Usage: he paid the bill last month
Domain: time_period

Table 3. *inyanga* (time_period domain)

POS: n; ID PWN 2.0: ENG20-08772174-n;
ID PWN 3.1: 09381255
Synonyms: *inyanga* :1
Definition: *isathalayithi yoMhlaba ekhanyisa esibhakabhakeni*
Usage: *inyanga iphuma ebusuku*
Usage: *wabona inyanga eyisiliva iqala ukuphakama phezulu esibhakabhakeni*
Domain: astronomy
Synonyms: moon :1
Definition: the natural satellite of the Earth
Usage: the average distance to the moon is 384,400 kilometers
Usage: men first stepped on the moon in 1969
Domain: astronomy

Table 4. *inyanga* (astronomy domain)

POS: n; ID PWN 2.0: ENG20-09516232-n;
ID PWN 3.1: 10191128
Synonyms: *inyanga* :1
Definition: *umuntu onolwazi lokwelapha izifo ngemithi*
Usage: *uGcabashe umbikele ukuthi akaphilile udinga ukubona inyanga*
Usage: *inyanga ithi ifuna ukuthenga umuthi omhlophe*
Domain: medicine
Synonyms: herbalist :1, herb doctor :1
Definition: a therapist who heals by the use of herbs
Domain: medicine

Table 5. *inyanga* (medicine domain)

3.3 Example 3: *siza/lekelela*

Synonymy, the central relation encoded in word-nets, is represented in Table 6 by means of the the *LetsAL* examples *siza, lekelela* (help, assist), two isiZulu verbs that are exchangeable in most contexts.

POS: v; ID PWN 2.0: ENG20-02472355-v;
ID PWN 3.1: 02553283
Synonyms: *lekelela* :1, *siza* :1
Definition: *ukwelekelela noma ukusiza ekwenzeni okuthile*
Usage: *le nhlangano ilekelela ekufundiseni izingane eziqhamuka emakhaya*
Usage: *iholo lakhe lisiza ukuthi akwazi ukuphilisa umndeni*
Synonyms: help :1, assist :1, aid :1
Definition: give help or assistance; be of service
Usage: Everyone helped out during the earthquake
Usage: Can you help me carry this table?
Usage: She never helps around the house

Table 6. *siza – lekelela* (synonymous verbs)

3.4 Example 4: *luhlaza/vuthiwe*

Adjectives in wordnets are typically organized in terms of antonymy (Princeton University, 2017). The *LetsAL* examples *luhlaza* (raw) in Table 7 and *vuthiwe* (cooked) in Table 8 reflect the semantic contrasts involved between the two adjectives. For the purposes of wordnet construction we adhere to the English part-of-speech term "adjective", although this category includes so-called adjective as well as relative and verb stems as noun qualifiers in isiZulu (also see Le Roux et al., 2008:276).

POS: a; ID PWN 2.0: ENG20-00589776-a; ID PWN 3.1: 00622052
Synonyms: *luhlaza* :4
Definition: *ukudla okungavuthiwe*
Usage: *Babengawusebenzisi umlilo, babemane bayifukuthe bayidle luhlaza inyama*
Domain: gastronomy
-->> [near_antonym] vuthiwe:1
Synonyms: raw :3
Definition: not treated with heat to prepare it for eating
Domain: gastronomy
-->> [near_antonym] cooked:1

Table 7. *luhlaza* (raw)

POS: a; ID PWN 2.0: ENG20-00586933-a; ID PWN 3.1: 00618376
Synonyms: *vuthiwe* :1
Definition: *kuphekiwe kulungele ukudliwa*
Usage: *ukudla okuvuthiwe kudayiswa emgwaqweni*
Domain: gastronomy
-->> [near_antonym] raw:3
Synonyms: cooked :1
Definition: having been prepared for eating by the application of heat
Domain: gastronomy
-->> [near_antonym] raw:3

Table 8. *vuthiwe* (cooked)

For language learners, it would also be useful to take note of the additional antonymous relations of *luhlaza* (green, unripe) and *vuthiwe* (ripe, mature) to avoid confusion, as illustrated in Tables 9 and 10.

3.5 Implementation

We propose that the current *LetsAL* environment be enriched with the data from the AWN in much the same way as suggested above and in the COLLIE project. Synonyms, usage examples, definitions and other semantic relations, as described in Tables 1 to 10, can all assist

POS: a; ID PWN 2.0: ENG20-01442460-a; ID PWN 3.1: 01497045
Synonyms: *luhlaza* :5
Definition: *okungavuthiwe kwezithelo*
Usage: *abanye badla izithelo eziluhlaza*
-->> [near_antonym] vuthiwe:2
Synonyms: green :3, unripe :1, unripened :1, immature :4
Definition: not fully developed or mature; not ripe
Usage: unripe fruit
Usage: fried green tomatoes
Usage: green wood
-->> [near_antonym] ripe:1, mature:4

Table 9. *luhlaza* (green, unripe)

POS: a; ID PWN 2.0: ENG20-01441835-a; ID PWN 3.1: 01496321
Synonyms: *vuthiwe* :2
Definition: *okulungele ukudliwa noma ukuphuzwa*
Usage: *izitshalo zikabhekilanga zivuthiwe lapho umbala ngemuva kwesihloko ushintsha*
-->> [near_antonym] luhlaza:5
Synonyms: ripe :1, mature :4
Definition: fully developed or matured and ready to be eaten or used
Usage: ripe peaches
Usage: full-bodies mature wines
-->> [near_antonym] green:3, unripe:1, unripened:1, immature:4

Table 10. *vuthiwe* (ripe, mature)

learners to understand not only the broad meaning of words in context, but can also point out subtle differences and potential language specific pitfalls such as those involving orthography.

Figure 2 shows a mockup of the value-added website, including a pop-up window with information for the isiZulu word *ithanga* (thigh) in the anatomy domain. A link to the PWN (Princeton University, 2017) or the isiZulu AWN entry (at the top of the pop-up window) gives learners access to the full synset without cluttering the *LetsAL* environment. The domain, usage example(s) and definition(s) are also shown. If any other disambiguating or relevant relations such as polysemy or antonymy are identified for a particular synset, the information will also be presented in the pop-up circle. In the example (Figure 2), a hypernym for *ithanga* is *isitho* (limb). We deliberately avoid the use of the terms "synset" and "hypernym" since users of *LetsAL* are assumed to be general language learners who might not be familiar with these terms.
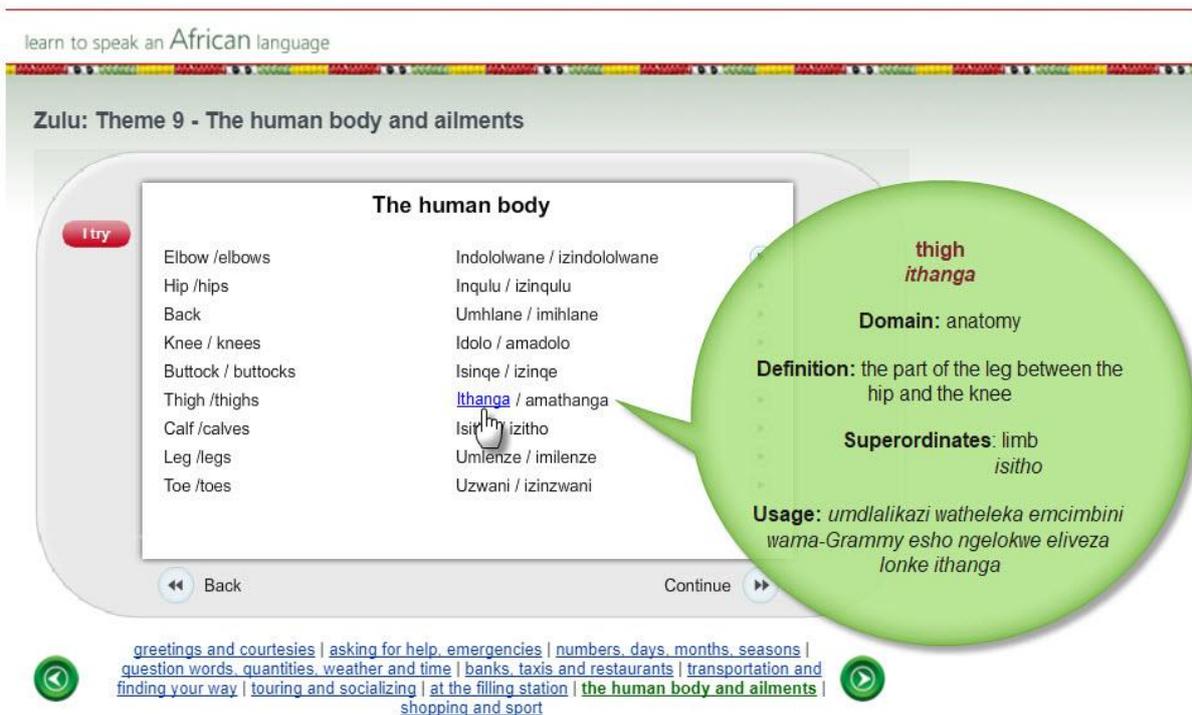
Figure 2. AWN data enriching the *LetsAL* learner experience

4 Expanding the AWN with *LetsAL*

Marrying the AWN and *LetsAL* to some extent, offers valuable advantages for users of both resources. Language learners will benefit greatly from having the additional information included in the AWN readily available in the *LetsAL* interface (see Section 3). In turn, the AWN will also become a more balanced resource by including fundamental meanings, such as those presented in a beginner course for L2 or foreign language learners.

To measure the amount of overlap between the two resources, a list of unique words was first extracted, and function words removed. This resulted in a list of 486 shared words. Of this list, 94 were already included in the isiZulu AWN and therefore also removed from our experiment, resulting in a list of 392 words from the *LetsAL* content that are not covered in the AWN yet. This clearly shows that there is still some work to be done on the isiZulu AWN to achieve a balanced coverage of the most basic vocabulary, as taught to language learners. To this end, methods previously employed in the AWN to speed up development of new synsets, namely semi-automatic linking of information from bilingual wordlists to information from the PWN. In short, this method uses the minimum amount of additional resources to extract potential synsets from the English for each word in the African language. A human expert then assesses the validity of each link before it is included in the AWN. The results when applying this method to the isiZulu *LetsAL* data can be seen in Table 11.

POS category	Lemmas in *LetsAL*	Possible links identified	Correct matches added to AWN
Nouns	259	130	119
Verbs	126	51	46
Adjectives	9	7	7
TOTAL	**392**	**188**	**172**

Table 11. Results of the linking experiment

A human expert provided a bilingual list (English – isiZulu) of meaningful stems, derived from all the vocabulary and dialogues included in the *LetsAL* course for isiZulu. The English stems with their associated synsets were extracted from PWN (Princeton University, 2017) and limited to those with attributes "sense:1". We also split the data on POS categories assigned by a linguist to limit the choices necessary in the validation step. The lemmas that were already included in the AWN were not presented for validation again as the goal of this experiment was rather to improve the coverage of the AWN, than the depth of already included synsets. That important aspect will be covered in a next pass on the data. Following this method grew the isiZulu AWN with 172 additional synsets in a matter of a few hours – now totaling 10 954 synsets.

5   Conclusion and future work

The *LetsAL* infrastructure lends itself perfectly to inclusion of data from the AWN as additional on-line reference source. Incorporating this feature for isiZulu into the live system will be our primary focus, where after the same improvement will be made to the other three languages for which a wordnet already exists (namely isiXhosa, Setswana and Sesotho sa Leboa). The AWN project is about to enter a new development stage and it is therefore planned to add Sesotho as a sixth language. As soon as a wordnet is available, it can be incorporated into the *LetsAL* course.

Growing the AWN is also a priority and the project team is looking at the best method by which to select new synsets for inclusion. The comparison with *LetsAL* presented here will serve as valuable input for the next phase of development, especially the low initial coverage of basic terminology, as shown in Section 4. The team is also performing comparisons with what is currently included in the AWN and a base list of terms for the African languages compiled by Snider and Roberts (2004). The so-called SIL-CAWL contains 1700 words in various categories such as *Man's Physical Being* and *Environment*. A further aim in the next phase of development of the AWN will be to fast-track inclusion of usage examples. For this experiment, an open-source corpus management system named NoSketch Engine (Rychlý, 2007) was used to manually look up usage examples in three small, but freely available online corpora for isiZulu, created in the Wortschatz project at the University of Leipzig[7].

Future work will include optimising a semi-automatic process by which developers of the AWN are presented with the best candidate sentences from the corpora, to be edited and included as usage examples. Roughly 4 000 isiZulu synsets in the AWN do not have any usage examples added yet, so speeding up development in this category is essential.

Another promising resource that needs to be explored for possible inclusion in an iCALL system such as this, is ImageNet (2016)). This extension of PWN 3.0 includes a large image database organised according to the WordNet hierarchy to further disambiguate the meaning of each node. The example in Table 2 (*pumpkin*) could for instance be further enhanced by adding a link to its ImageNet counterpart (see http://image-net.org/synset?wnid=n12158443). Images could also be used in an assessment component to *LetsAL* or to base interactive games on – two important aspects that are envisaged for future work as well.

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[7] See https://nlp.fi.muni.cz/trac/noske for more details on NoSketch Engine and http://wortschatz.uni-leipzig.de/en for information on the Wortschatz project. Access to the isiZulu corpora in NoSktech Engine is via http://cql.corpora.uni-leipzig.de/?corpusId=zul_mixed_2014.

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