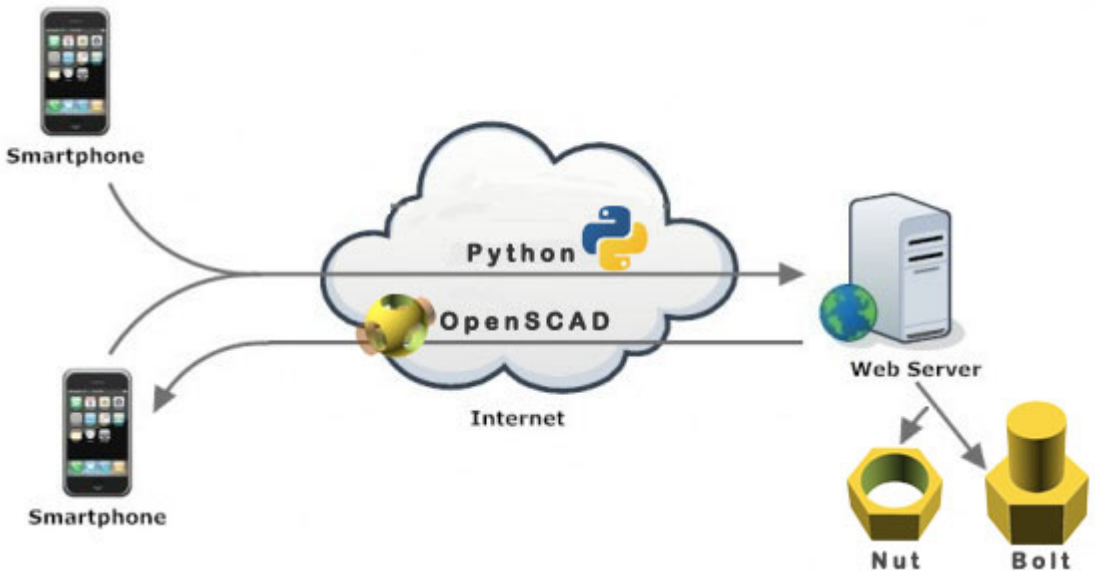
Coding Language

Bua

Version 1.0

A major leap from just problem-solving to project-based learning robotics environment



'Bua' is an open-source multilingual functional programming language closely linked to natural, native or indigenous languages syntax designed to handle symbolic computation.

(2023) Eric M. Mulovhedzi

Bua: A Pure Multilingual Coding Language

Eric M. Mulovhedzi (Spider Black)
South Africa (RSA)
info@spiderblackonline.co.za / info@budolearning.co.za
www.budolearning.co.za

Abstract. A purely multilingual and cross-platform coding or programming language would allow children, learners and coders to write computer programs in their own preferred native language; using any platform of their choice including mobile platforms without running into proficiency or and compatibility issues. Full cross-platform compatibility for application users provides for part of the solution; but the actual benefits are lost if children, learners and coders are still somehow hindered to express and communicate their ideas due to language barriers. We therefore propose a solution to the language-proficiency problem using a multilingual cross-platform coding or programming language. A child, learner or coder writes a computer program simply by making use of 'verbs' in conjuction with 'objects' in their native or indigenous language, and the utilization of syntax that is closely linked to human language grammar guarantees desired level of proficiency outcome in their expression of thoughts and ideas. A convergence between their native linguistic expressions and a multilingual computer coding language makes it possible to execute complex computer instructions with least amount of effort. As long as a child, learner or coder is able to speak and write atleast one language from as little as the age of four to five years old, they should be able to write successful computer programs such as those that can manufacture very complex 3D printable objects i.e. cylinder, cube, bolt, nut. The coding syntax itself requires very minimal understanging or no understanding at all of traditional programming languages such as Python, Java, C, C++, JavaScript, PHP, Visual Basics etc. Computer program instructions are written in very simple human-language-grammar friendly statements such as those used in English, isiZulu, Afrikaans, Tshivenda, isiXhosa, Xitsonga, isiNdebele, Sepedi, Sesotho, Setswana, siSwati etc.

1. Introduction

Growing in the Republic of South Africa, one of the most diverse countries in the world that has got about eleven (11) official languages spread across its nine beautiful provinces, witnessing furious arguments between individuals from different ethnic groups was very common in every school and educational institution I went to. Sometimes these arguments would even escalate into very intense debates by not only individuals but institutions of higher learning such as those involved in a matter which is before the constitutional court between "Gelyke Kanse and Others v Chairperson of the Senate, Chairperson of the Council and the University of Stellenbosch, CCT 311/17, 10 October 2019". The court case was about the application concerning the decisions of the Senate and Council of the University of Stellenbosch (University) to adopt a new language policy for the University (2016 Policy). The 2016 Policy was adopted under the Higher Education Act and the National Language Policy for Higher Education (LPHE).

> *[2] The 2016 Policy creates three language specifications: parallel medium, dual medium and single medium. Its effect is to adopt a preference for English in certain circumstances so as to advance the University's goals of equal access, multilingualism and integration while also maintaining and preserving Afrikaans, subject to demand and within the University's available resources. The University contended that the 2016 Policy, in contrast to the 2014 Policy that preceded it,*

While the Afrikaans language provision under the 2014 Policy could be preserved by fully parallel medium tuition, the cost would total about R640 million in infrastructure (including additional classrooms), plus about R78 million per year thereafter, in additional teaching and other personnel costs. This would entail a 20% increase in fees, an additional R8100 on top of the approximately R40 000 per year students on average pay now.

[3] Gelyke Kanse is a voluntary association originally formed to oppose the 2016 Policy but which now has broader goals in seeking to promote Afrikaans mother-tongue education and the acceptance of mother-tongue education as indispensable to community development. Along with individual applicants, including black, brown and white students affected by the 2016 Policy, Gelyke Kanse approached the High Court seeking an order reviewing and setting aside the 2016 Policy and reinstating the 2014 Policy.

Note that the Western Cape High Court had already dismissed the application holding the view that the University's obligations under section 29(2) of the Bill of Rights are limited to providing Afrikaans education where "reasonably practicable" and also through reasonable educational alternatives. But, assessing what is "reasonably practicable" would turn out to require consideration of both resource constraints (a factual criterion), and of equity, redress and non-racialism (the constitutional criterion).

Following arguments raised in this case, i think it is pretty clear and obvious for everyone to see that even if the courts had ruled otherwise, and though the constitutional criterion has already been somewhat met to a certain extent, it is going to be almost impossible for the South African government or any other government for that matter to raise a budget amounting to about R640 million of additional infrastructure fees for every university and college in South Africa as well as approximately R50 000 per year per student of tuition fees every year.

$\boldsymbol{B}_i$ = budget required for additional infrastructure = R640 million
$\boldsymbol{B}_p$ = budget required for additional teaching and other personnel costs = R78 million
$\boldsymbol{F}_s$ = additional student fees required = R8100

While an attempt could still be made for an intervention within the area of higher education, the national treasury of South Africa would still suffer a great deal in rasing this kind of budget for all the high schools and primary schools under the ministry of basic education's care and supervision. Also, the cost retraining teachers would be in magnitudes of billions, adding on to the national treasury's fiscal strain among others. As a result, introducing coding, robotics, AI and any other future technological changes inclussively into our classrooms as nations is always going to be a daunting task particularly in schools sitiauted in previously disadvantaged rural areas.

What is needed is a coding or programming language which is based on multilingual syntax and would allow children, learners and coders to write computer programs in their preferred native languages instead of traditional programming languages. Secondly, in order to allow a seamless and smooth transition into classrooms within the sector of basic education, the chosen coding language must have some resemblence of and similarities with an ordinary human language grammar within its linguistic expression.

2. Total National Treasury budget required to implement an inclusive curriculum

Statistics South Africa, the national statistical service of South Africa, recently published a report that shows that the number of schools in South Africa in 2021 to be roughly 26 000 coupled with 26 public universities.

26 = public universities
6 000 = high schools (grade 7 to grade 12)
20 000 = primary schools (grade 0 to grade 6)

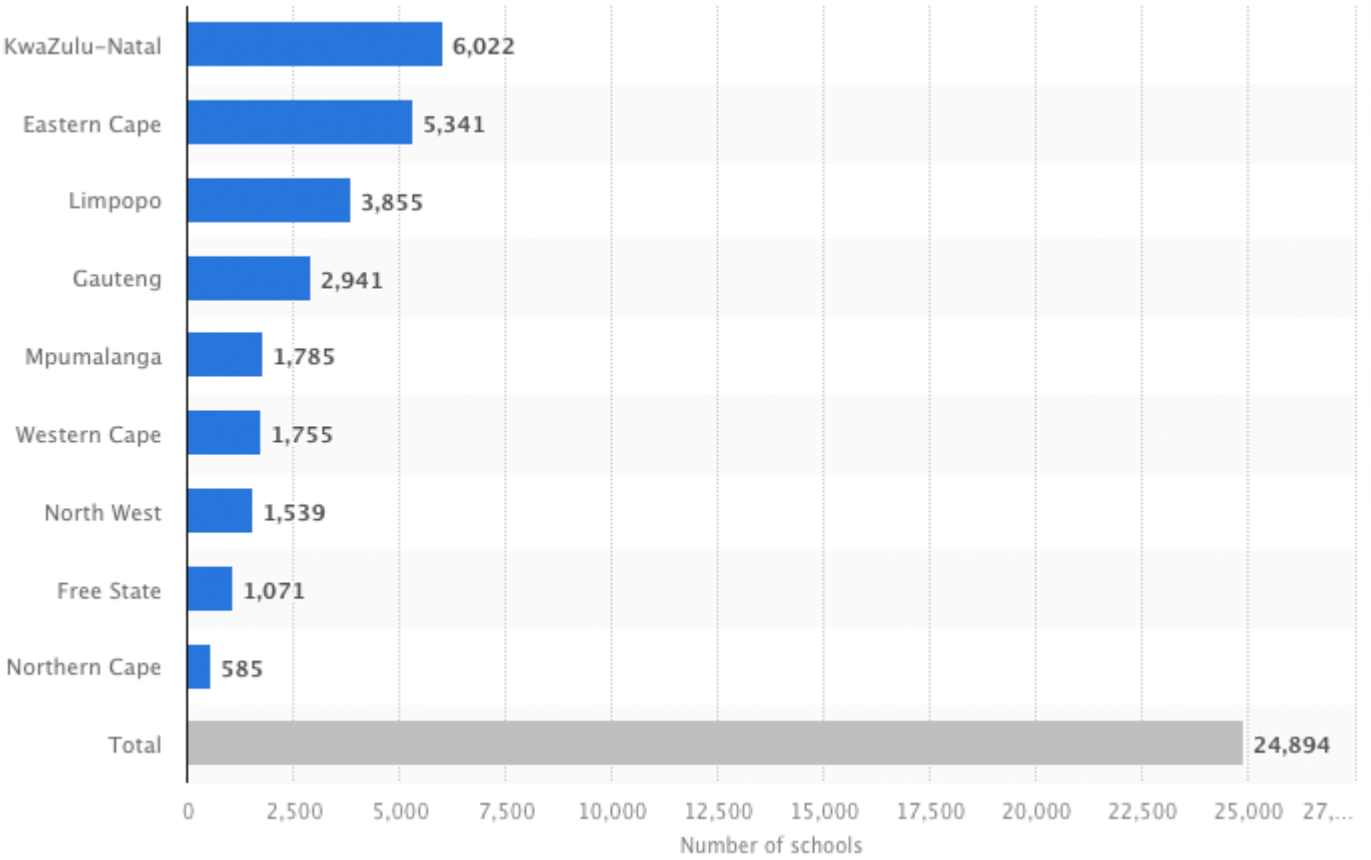


Figure 1: *This diagram, displays the "Number of schools in South Africa in 2021, by province". Published by Statista Research Department, Apr 26, 2023. Majority of the schools were located within the province of KwaZulu-Natal, reaching 6,022 schools. Then Eastern Cape and Limpopo followed with 5,341 and 3,855 schools, respectively.*

An estimate amount of money the National Treasury of South Africa would require to implement a multilingual, inclusive curriculum in all universities, high schools and primary schools combined in South Africa would be:

Total National Treasury Budget $= (B_i + B_p) \times (26 \times 6\,000 \times 20\,000)$

$= (\mathbf{640m + 78m}) \times (26 \times 6\,000 \times 20\,000)$

$=$ **R18.6 trillion**

3. Basic Structure of a Sentence

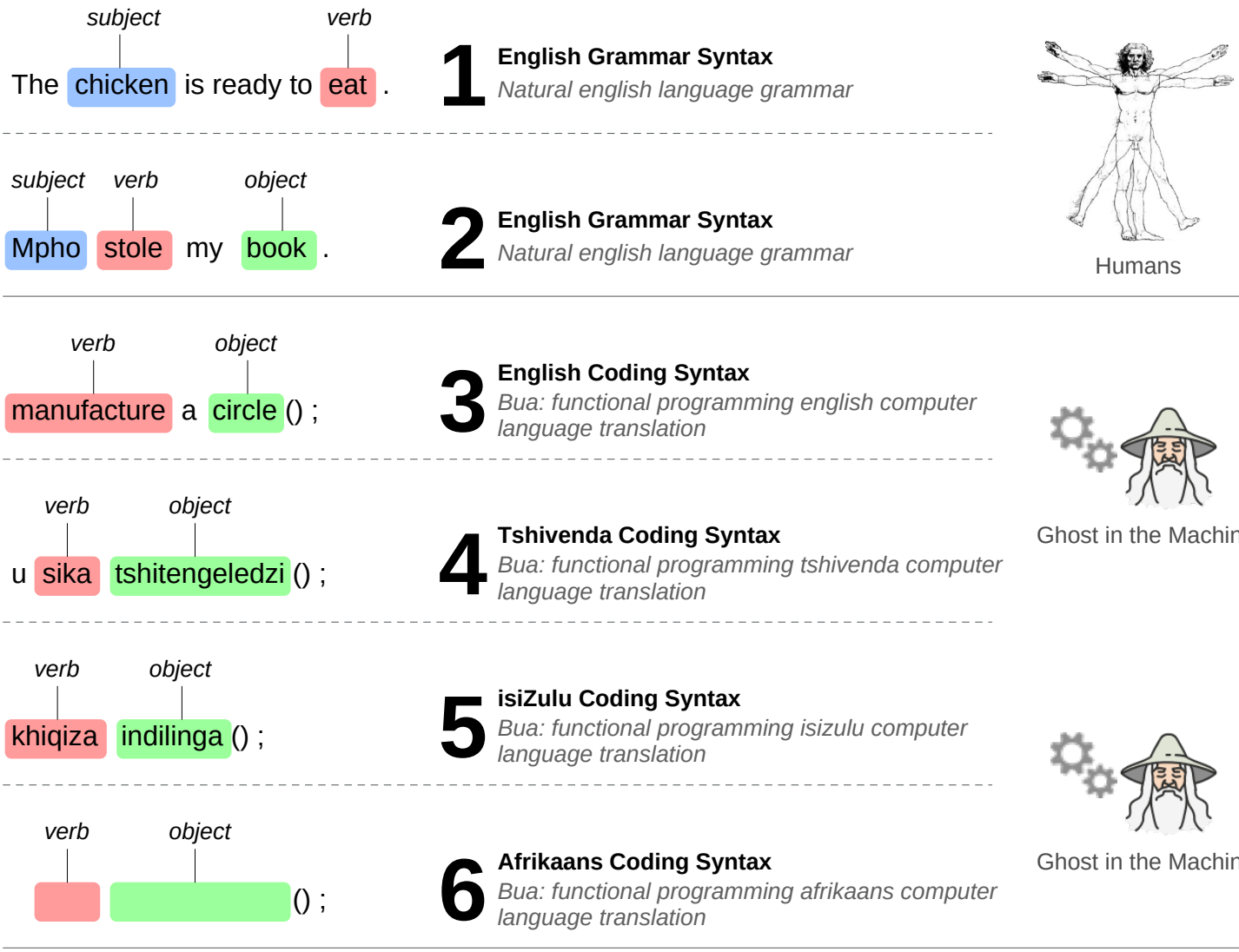


Figure 2: *This diagram, depicts how "Bua" as a functional programming language derives from natural, native or indigenous language grammar. Subsequently, it also reveals a fact on how the concept of coding or programing evolved from the underlying principles of philosophy of language or linguistics. Futhermore, it also grammatically demonstrates the fundamental distinction between human langunages and machine languages in as far as their syntax is concerned. It utilizes notions of basic structure of a human language sentence as input for translation into an internal machine language engine in order to produce desired process ouput.*

Sentences number 1 and 2 demonstrate the fact that in human language grammar words and group of words are identified in terms of the job they do in a sentence - their function; or in terms of their overall meaning in which they are used. Thus, a sentence is a group of words that contains a finte verb - in other words, a verb with a subject - and that makes complete sentence on its own. Now that we have seen that the subject does the action of the verb; the object is then the person or thing who suffers (or receives, or undergoes) that particular action.
Sentences number 3, 4, 5 and 6 already presuppose that the subject is the "Ghost in the Machine" so there is no need for coders or programmers to further specify it within the structure of sentences when communicating with the machine. Machine language translator only requires sentences with only 'verbs' and 'objects', for example: "'manufacture' a 'circle'();".

Notice the closing and opening brackets as well as the semicolon punctuation mark as part of the sentence syntactic structure. Unlike in the case of human language grammar, machine languages usually make use of a semicolon to denote the end of a sentence instead of a full stop as a punctuation mark. Secondly, the other major distinction between human language grammar and machine language syntax lies in the way they apply adjectives on their sentence structures. In machine language, adjectives are always enclosed within a set of brackets "()" and are usually positioned at the end of every sentence or statement right before a semicolon punctuation mark. These adjectives are usually referred to as 'parameters' or 'arguments' as shown in Figure 2 and Figure 3 below.

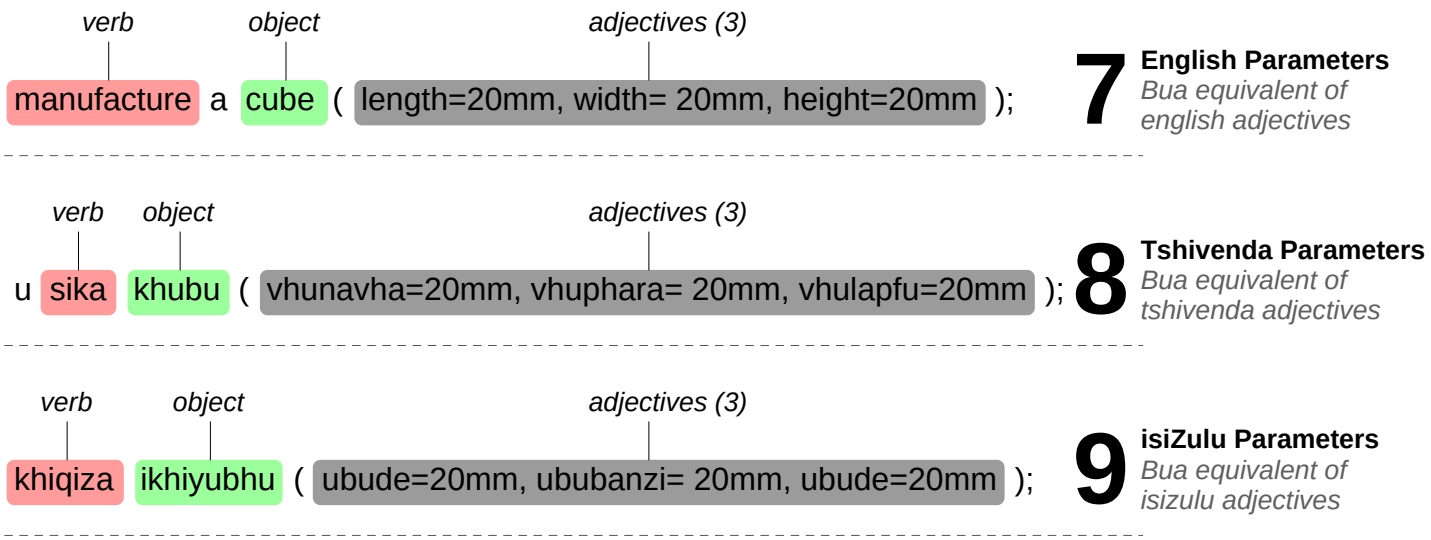


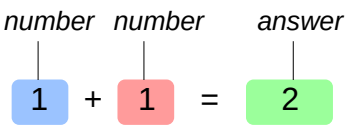
Figure 3: *This diagram, depicts "Bua" coding language's equivalent of adjectives which are commonly referred to as parameters in machine languages. Just as adjectives have the ability to qualify or modify objects in a sentence, parameters also modify or define the object or sets the condition of its operation. Mostly, parameters define actual measurements of an object from one end to the other such as length, width and height as in the case of a cubic object as depicted in this diagram. Note that "Bua" distance parameters are measured in metric system and this could either be in millimetre (mm), centimetre (cm), metre (m), or kilometre (km) units of which millimetre (mm) is the default that Bua machine language translator uses.*

Metric System is a decimal based system of measurement, referred to as the International System of Units (SI), and is used around the world (with the exception of USA and few other countries) eg. metre, kilogrram, litre. Sentences number 7, 8 and 9 demonstrate modification of an object called a 'cube'. Since a cube has got three dimentions, one would then need to specify three distance parameters namely: length, width height; vhunavha, vhuphara, vhulapfu; ubude, ububanzi; in english, tshivenda or isizulu respectively. Note that the default unit used by Bua machine language translator is millimetre (mm) and only "mm" needs to specified instead of the whole word or phrase.

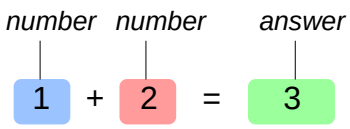
isiZulu Indigenous Language Exception: It turns out some indegenous languages do lack translation of certain mathematical or and scientific expressions while some simply use one word for different mathematical or scientific expressions. A typical example is found in isiZulu indigenous language predominantly spoken in the Republic of South Africa. The word "ubude" have double meaning depending on the context within which the mathematical or scientific expression is been utilized,

of which in this case it refers to either mathematical expression of measurement of 'length' or 'width' of a particular object depending on the contex. This is a phenomenon referred to as "Linguistic Ambiguity" which is simply a quality of language that makes speech or written text open to multiple interpretations. Bua machine language translator resolves this problem of linguistic ambiguity by assigning the first parameter "ubude" to a 'length' of that particular object and the latter to the parameter 'height' of the very same object. So, a Bua isiZulu syntactic set of object parameters "(ubude=20mm, ububanzi=20mm, ubude=20mm)" will be equivalent to "(length=20mm, width=20mm, height=20mm)" in Bua English syntax.

4. Computation of Mathematical Expressions



10 **The structure of an Addition function Syntax**
Natural english language grammar



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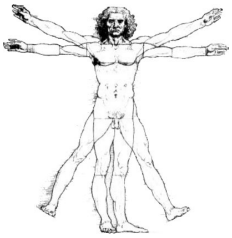
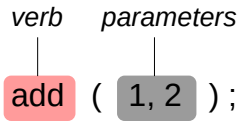
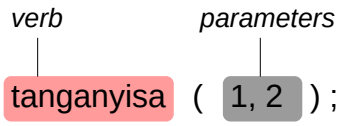


Humans

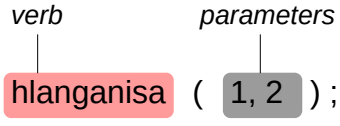


12 **English Addition Coding Syntax**
Bua: functional programming english computer language

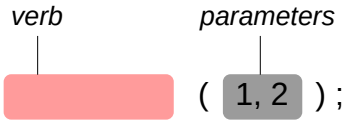


13 **Tshivenda Addition Coding Syntax**
Bua: functional programming tshivenda computer language

Ghost in the Machine



14 **isiZulu Addition Coding Syntax**
Bua: functional programming isizulu computer language



15 **Afrikaans Addition Coding Syntax**
Bua: functional programming afrikaans computer language

Ghost in the Machine

Figure 4: *The above diagram, depicts how "Bua" programming language interprets mathematical operators and functions in different native or indigenous languages. Sentences number 12, 13, 14 and 15 do not even require neither the subject nor object so there is no need for coders or programmers to specify them within the structure of a sentence when communicating with the machine. Machine language translator requires only sentences with just 'verbs' and 'parameters', for example: "add (1, 2);" or "tanganyisa (1, 2);" or "hlanganisa (1, 2);".*

Kripkenstein's Rule-following Paradox on Mathematical Expressions: This is a famous lingiustic paradox about whether is possible for humans to mean anything by the words of their language. Particulary, it aims to prove that it is impossible for us as humans to mean anything by words we use and assign to symbols and functions such as: the plus and the quus signs: $\mathbf{x+y = x \oplus y}$

But, for the purpose of this whitepaper, one can think of a function as a rule which takes one from arguments to values. For example: a mathematical addition function is a rule which, given a pair of numbers, gives you their sum as a value. Following this defination, thus, a function can be thought of as a kind of machine, into which you give some input and receive some output. So, functions are simply just machines which, for any given specific input, always give you the same output.

5. Applying Kripkenstein's definition on Mechatronics and Internet of Things (IoT)

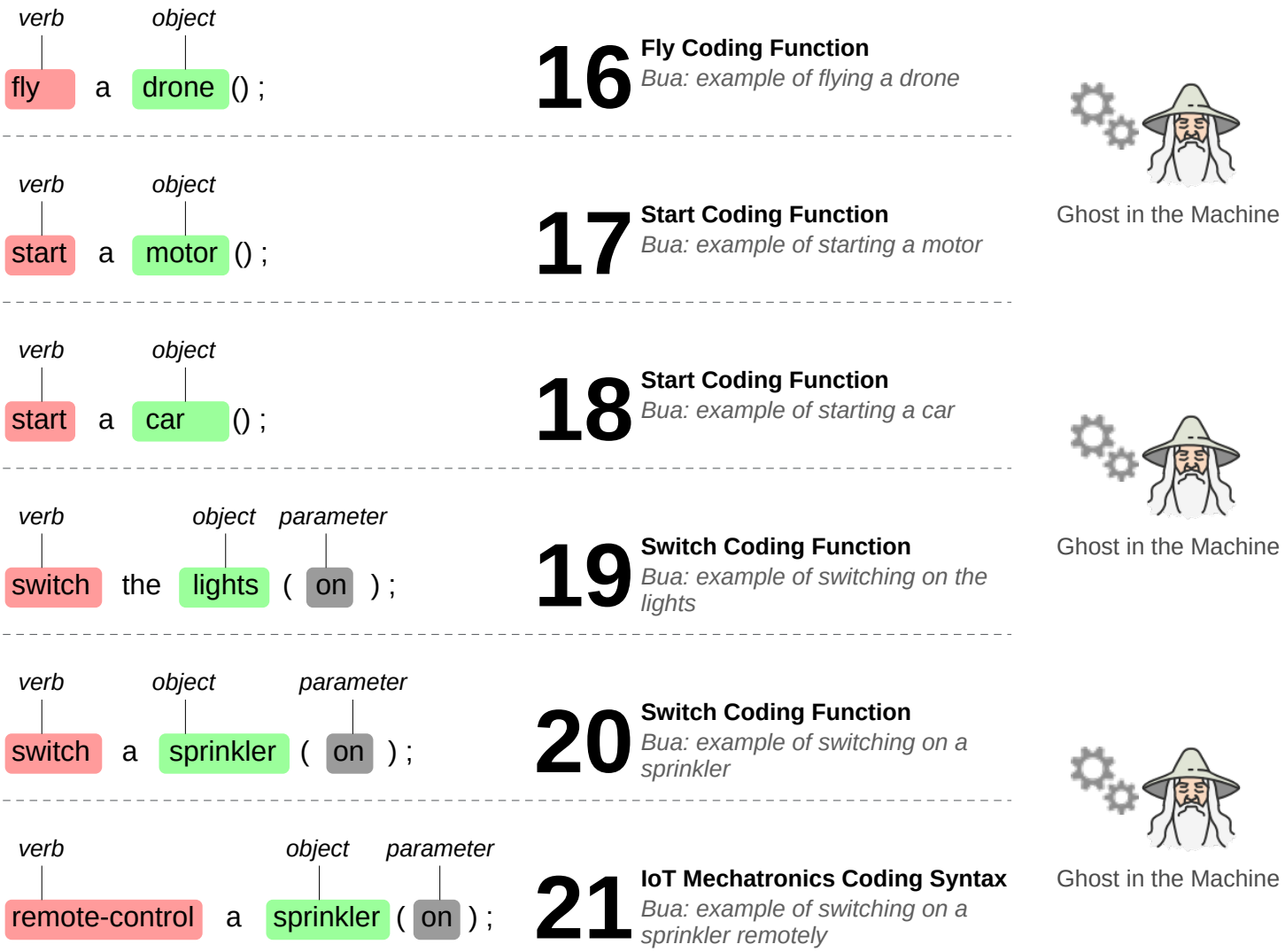


Figure 5:*The above diagram, depicts how "Bua" programming language interprets Mechatronics, Electronics, and Internet of Things (IoT) functions; also in different native or indigenous languages. Sentences number 16 - 20 are all mechatronics and electronics coding statements together with their native language counterparts, whereas sentence number 21, which begins with prefix 'remote-control', belongs to the IoT family.*

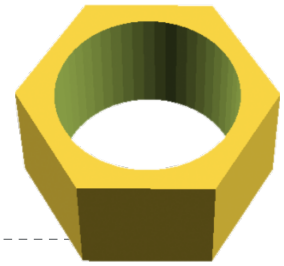
6. Examples of some 3D Printing applications written in Bua coding languae

verb object

manufacture a nut () ;

1) **This is a nut**

Bua: function to 3D model a nut as an output

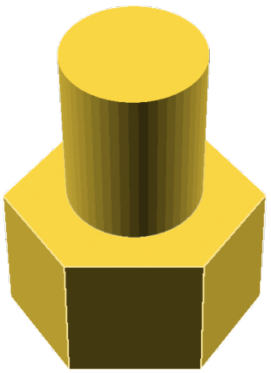


verb object

manufacture a bolt () ;

2) **This is a bolt**

Bua: function to 3D model a bolt as an output



verb object

manufacture a grandfather ();

3) **This is a grandfather**

Bua: function to 3D model a grandfather as an output

verb object

u sika mukalaha () ;

4) **Ha vha ndi mukalaha**

Bua: function to 3D model a grandfather as an output

verb object

khiqiza umkhulu () ;

5) **Umkhulu lo**

Bua: function to 3D model a grandfather as an output

7. Bua coding languae syntax in different native languages

English Coding Syntax	Tshivenda Coding Syntax	isiZulu Coding Syntax

manufacture a circle();
manufacture a square();
manufacture a cylinder();
manufacture a cube();
manufacture a bolt();
manufacture a nut();
	u sika tshitengeledzi();
	u sika tshikwea();
	u sika silinda();
	u sika khubu();
	u sika baudu();
	u sika baudu();
		khiqiza indilinga();
		khiqiza isikwele();
		khiqiza isilinda();
		khiqiza ikhiyubhu()
		khiqiza ibhawodi();
		khiqiza nati();

Afrikaans Coding Syntax	Xitsonga Coding Syntax	isiXhosa Coding Syntax

Sepedi Coding Syntax	Sesotho Coding Syntax	Setswana Coding Syntax

isiNdebele Coding Syntax	siSwati Coding Syntax	Khelobedu Coding Syntax

Sepulana Coding Syntax

Conclusion. We have proposed a solution to the language-proficiency problem using a multilingual cross-platform coding or programming language. We started with the notation whereby a child, learner or coder could write a computer program in their native or indigenous language simply by making use of 'verbs' in conjuction with 'objects', utilizing syntax that is closely linked to human language grammar. A convergence between their native linguistic expressions and a multilingual computer coding language will make it possible to execute complex computer instructions with the least possible amount of effort. For as long as a child, learner or coder is able to speak and write atleast one native language from as little as the age of four going to five years old, they would be able to write successful computer programs that can manufacture very complex 3D printable objects and automate repetitious industrial automation processes.

A multilingual, cross-platform computer coding language that is open-source (free use, modification and re-distribution) integrated with interactive learning platforms will significantly reduce the R18.6 trillion rands budget required to implement inclusive curriculum to almost zero. Existing language and literature teachers can easily teach this coding language without any need for some prior knowledge of computer science or pure mathematics making it very cost-effective to retrain teachers. Lingua francas, bridge languages, or trade languages such as Khelobedu and Sepulana, in the case of South Africa, could easily be made official coding languages without any legislative barriers witch are primarily due to national budget constraints.

Contributors. Dr Douwes Sorgdrager, Dr Mmboneni Muofhe, Livhuwani Masevhe, Azwihangwisi Netshikulwe, Maria S. Mulovhedzi, Thiathu Nemutanzhela, Tumi Tsele Mafela

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