Ahadu: Amharic Based Programming Language

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English is the predominant language in Education

Students, whose native language is not English and are not proficient in English, face challenges when English is used in education.

Needing to mentally translate concepts into one's native language—especially in real-time while listening to a lecture—**increases extraneous cognitive load** and **decreases comprehension.**

Sweller, John. "Cognitive Load Theory, Learning Difficulty, and Instructional Design." (**1994**)

The difficulty of formulating verbal questions, along with anxiety about lack of English fluency, makes students **less likely to ask clarifying questions, participate in activities,** and **pursue studies predominantly taught in English**.

Probyn, Margaret. "Teachers Voices: Teachers Reflections on Learning and Teaching through the Medium of English as an Additional Language in South Africa." (**2001**)

“On educational grounds, [UNESCO] recommend that the use of the mother tongue be extended to as late a stage in education as possible. In particular, pupils should begin their schooling through the medium of the mother tongue because they understand it best …”

UNESCO (United Nations Educational, Scientific and Cultural Organization). “The use of vernacular languages in education.” (**1953**)

Computer Science is not exempt from these issues.

English in Computer science

Programming Languages

Keywords, Naming conventions, Identifiers (e.g., variable, function, and class names)

Documentations

Programming language libraries, tools, code comments, user manuals

Learning Resources

Textbooks, video tutorials, online guides, online communities, forums, ...

Understanding Learning Resources and source code

A survey done on a programming education website found that the most commonly reported barrier was **problems reading English instructional materials such as textbooks, online tutorials, discussion forums, and API docs.** (Guo, 2018)

They also reported trouble **understanding source code.**
A common root cause is that programming language keywords (such as “while”) are in English, and abbreviations, and idiomatic naming conventions for identifiers (e.g., function, class, and variable names) are commonly used.

For example, **the C function getch() stands for “get character”**.

Error Messages

A study comparing students from **Sebha University** in Libya and **CQUniversity** in Australia found differences in the challenges faced while learning programming. (Nnass, Colwing and Hadgraft, 2022)

The survey of Libyan students highlighted a specific issue—**error messages**—that significantly affected the learning of computer science students at the main Sebha University campus.

Native Language-Based Programming Languages

Are native language-based programming languages better?

While some studies show using resources, like textbooks, and lectures, based in native languages is beneficial for students, **limited studies are comparing the use of English-based programming languages and native-language-based programming languages for education,** especially for students being introduced to programming.

Scratch

Dasgupta and Hill, 2017 present models that estimate a **positive association between the growth rate of users' repertoires of programming blocks and the translation of their programming language and interface into their local languages.**

The most important effect of the use of native language-based programming language, not captured by the analysis, maybe that **being able to engage in one's primary language supports users who would otherwise not learn to code at all.**

Why aren’t native language-based programming languages widely used?

The main explanation is the limited availability of non-English-based programming languages. Translating programming languages and learning resources is complex and expensive (Alabau, 2015).

When programming language interfaces are not designed in English, it is often only in a small number of languages spoken like Spanish and French.

For speakers of other languages, especially for those belonging to small or marginalized linguistic groups, the only option is to use English.

Coding in Amharic

Amharic (አማርኛ) serves as the official working language of the Ethiopian federal government. As of 2018, it has over **32.4 million** mother-tongue speakers and more than **25.1 million** second-language speakers in 2019.

Amharic uses the **Ge'ez Fidel** for writing.

Ahadu

ኣሃዱ

Ahadu (አሃዱ)

Ahadu is an **Amharic-based programming language.**

Ahadu aims to serve as an **educational tool for Amharic speakers** interested in learning programming.

It also aims to introduce Amharic speakers previously not exposed to the concepts of programming or discouraged from learning programming due to language barriers to computer programming.

Objectives

To make learning to program for Amharic speakers easier!

To make learning to program for Amharic speakers more accessible and introduce more Amharic speakers to programming!

To design a programming language that exhibits close affinities with widely adopted programming languages, enabling individuals to seamlessly transfer their acquired knowledge and skills.

Ahadu is an Interpreted Language

LEXER

Convert the code text into a list of tokens

PARSER

Parse the list of tokens into an AST made of nodes

INTERPRETER

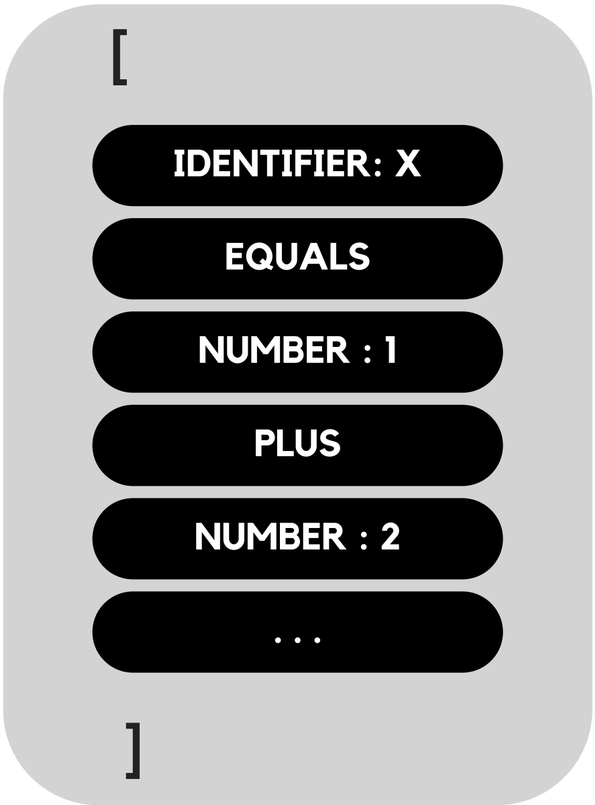
Execute the code associated with each node in the AST

PYTHON

The program is executed in Python

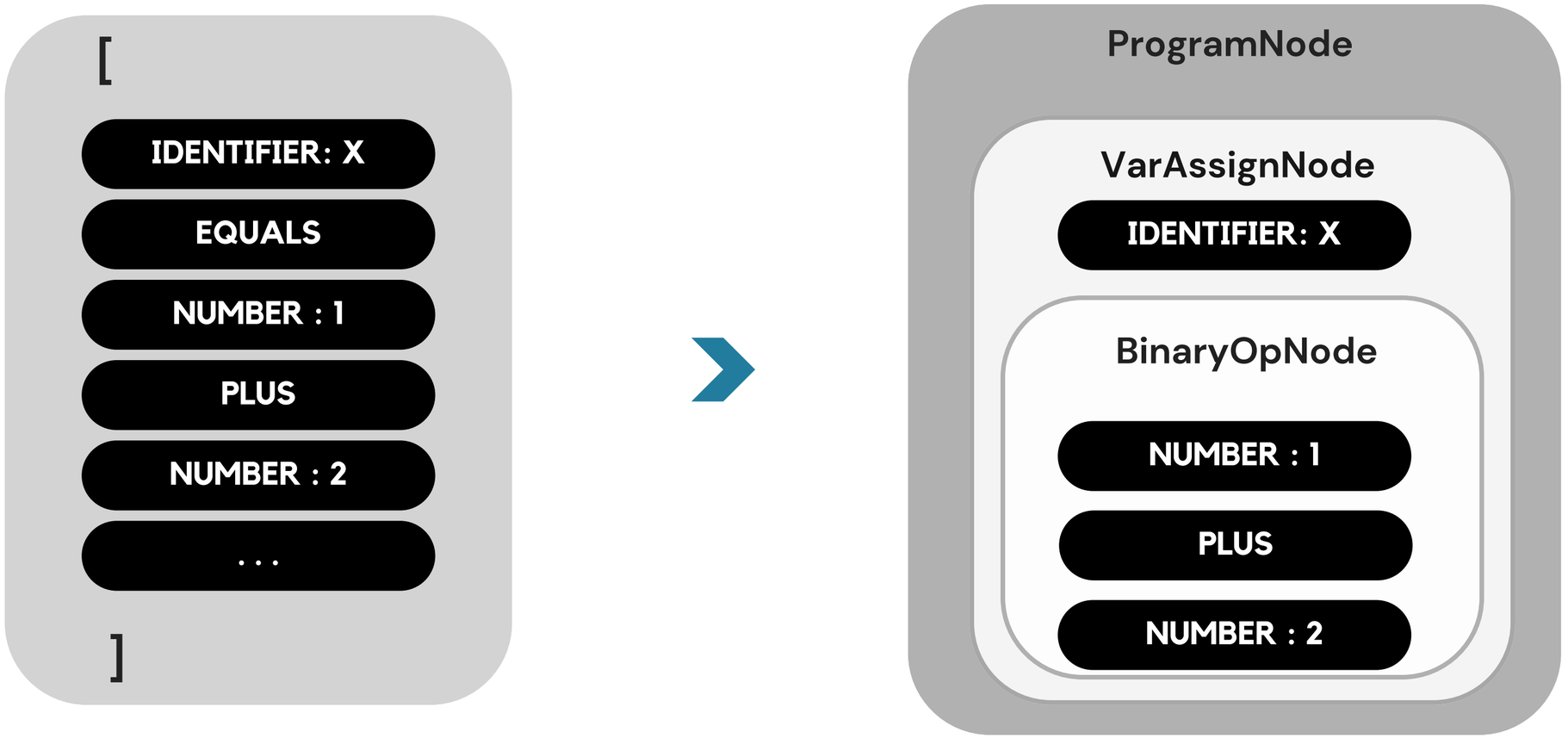
The Lexer

Eliminates unnecessary **spaces**, tabs, and line breaks, **comments.**
Recognizes keywords, identifiers, operators, and other language-specific constructs.
Generates a sequence of **tokens** that represent the structure of the source code.



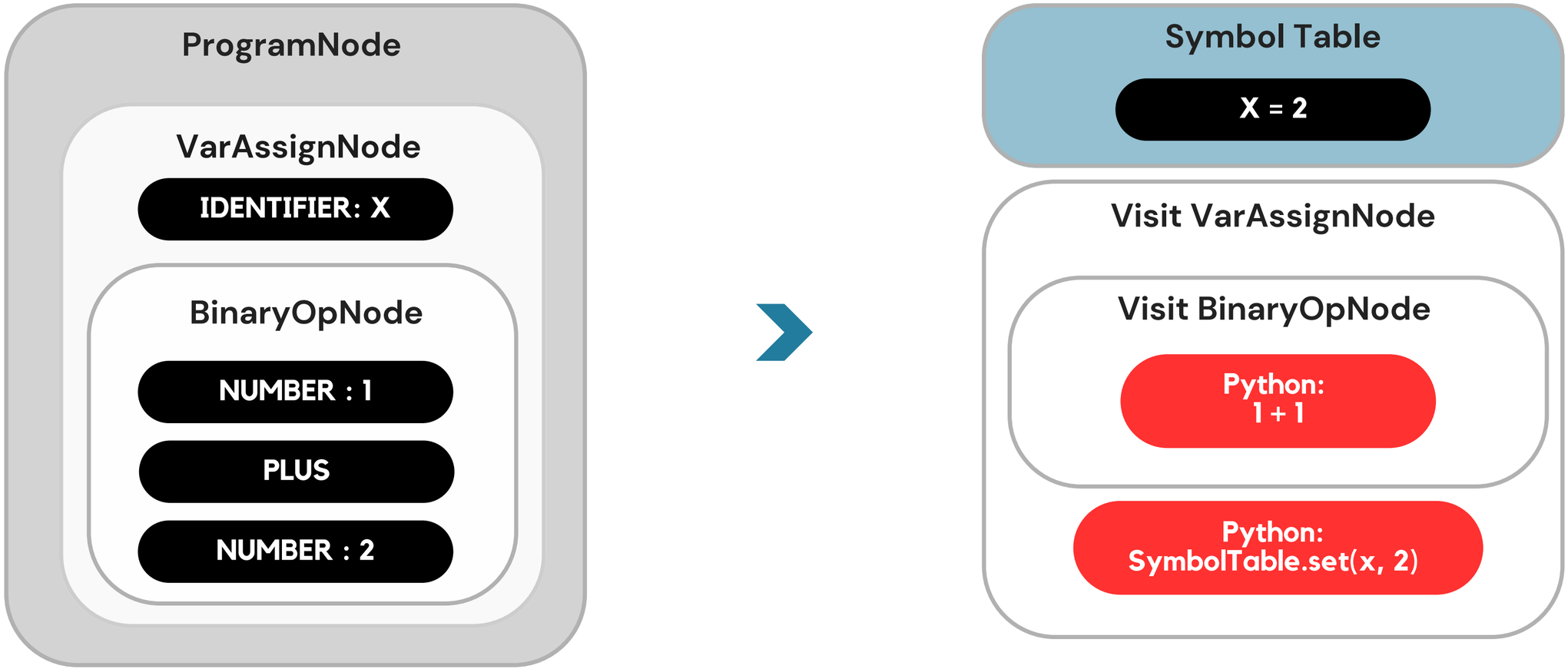
The Parser

Enforces the correct structure of the program by organizing tokens into **Nodes**.
Identifies and reports **syntax errors** in the source code.
Generates an **Abstract Syntax Tree** representing the statements and expressions in the source code.



The Interpreter

Keeps track of variables, functions, objects, and their values in a **Symbol Table**
Detects and handles **runtime errors**.
Traverses the Abstract Syntax Tree to visit each node and **executes** the corresponding operations.



Design

Keywords

Ge’ez Fidel Support

Syntax

Error Message

Keywords

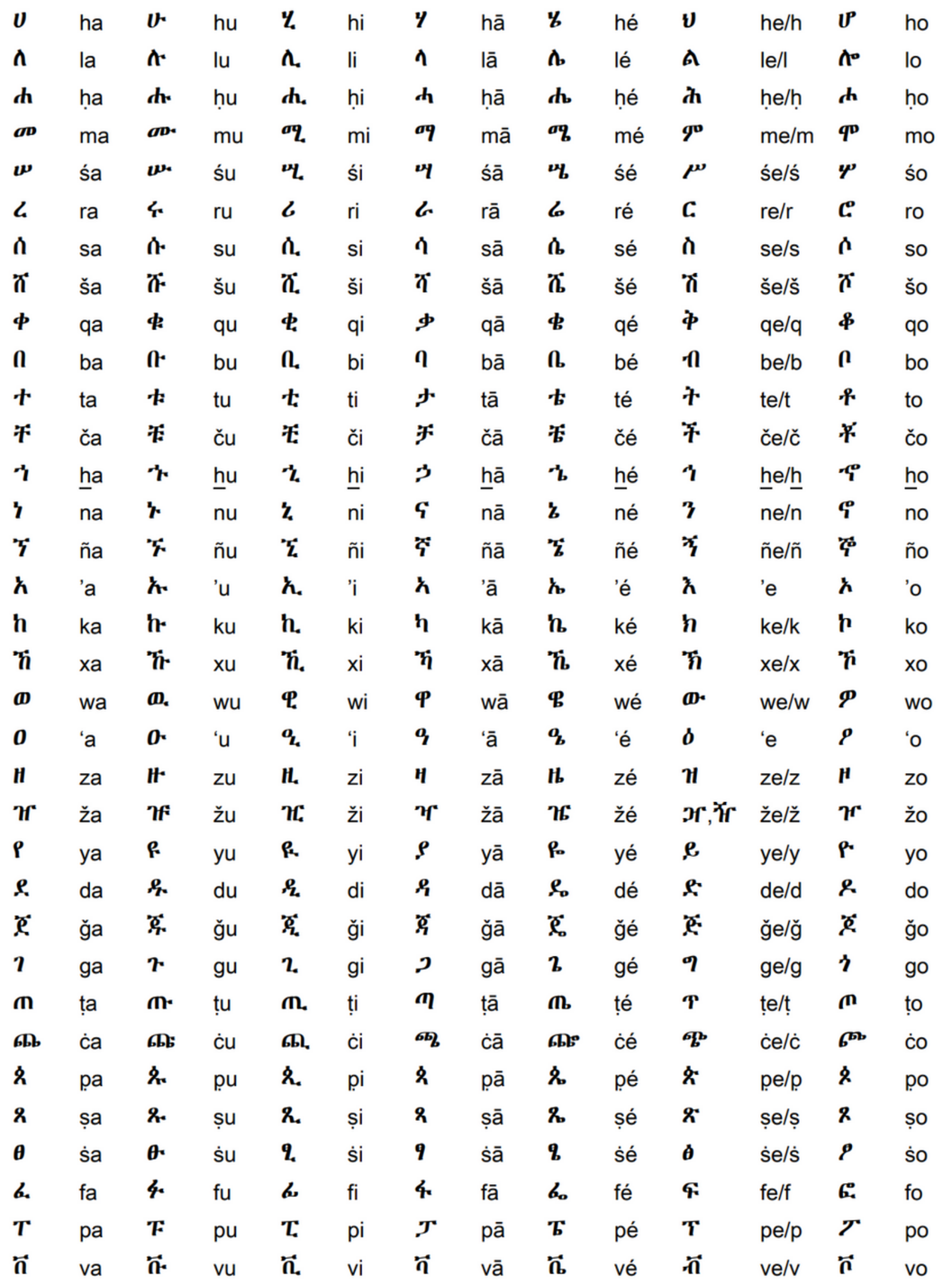
All keywords are in Amharic.

These are not mere translations of the English keywords but words that represent the concept of the keywords and are as easily **accessible and comprehensible** to Amharic speakers as possible.

ከሆነ	-	IF
አለበለዚያ	-	ELSE
እስከሆነ ድረስ	-	WHILE
እና	-	AND
ወይም	-	OR
ፃፍ	-	PRINT
. . .		. . .

Ge’ez Fidel in Identifiers

Variable, function, object names, strings, and comments will also support the Ge’ez Fidel letters in which Amharic is written, in addition to English letters.



ሀ	ha	ሁ	hu	ሂ	hi	ሃ	hā	ሄ	hé	ህ	he/h	ሆ	ho
ለ	la	ሉ	lu	ሊ	li	ላ	lā	ሌ	lé	ል	le/l	ሎ	lo
ሐ	ḥa	ሑ	ḥu	ሒ	ḥi	ሓ	ḥā	ሔ	ḥé	ሕ	ḥe/ḥ	ሖ	ḥo
መ	ma	ሙ	mu	ሚ	mi	ማ	mā	ሜ	mé	ም	me/m	ሞ	mo
ሠ	śa	ሡ	śu	ሢ	śi	ሣ	śā	ሤ	śé	ሥ	śe/ś	ሦ	śo
ረ	ra	ሩ	ru	ሪ	ri	ራ	rā	ሬ	ré	ር	re/r	ሮ	ro
ሰ	sa	ሱ	su	ሲ	si	ሳ	sā	ሴ	sé	ስ	se/s	ሶ	so
ሸ	ša	ሹ	šu	ሺ	ši	ሻ	šā	ሼ	šé	ሽ	še/š	ሾ	šo
ቀ	qa	ቁ	qu	ቂ	qi	ቃ	qā	ቄ	qé	ቅ	qe/q	ቆ	qo
በ	ba	ቡ	bu	ቢ	bi	ባ	bā	ቤ	bé	ብ	be/b	ቦ	bo
ተ	ta	ቱ	tu	ቲ	ti	ታ	tā	ቴ	té	ት	te/t	ቶ	to
ቸ	ča	ቹ	ču	ቺ	či	ቻ	čā	ቼ	čé	ች	če/č	ቾ	čo
ኀ	ha	ኁ	hu	ኂ	hi	ኃ	hā	ኄ	hé	ኅ	he/h	ኆ	ho
ነ	na	ኑ	nu	ኒ	ni	ና	nā	ኔ	né	ን	ne/n	ኖ	no
ኘ	ña	ኙ	ñu	ኚ	ñi	ኛ	ñā	ኜ	ñé	ኝ	ñe/ñ	ኞ	ño
አ	’a	ኡ	’u	ኢ	’i	ኣ	’ā	ኤ	’é	እ	’e	ኦ	’o
ከ	ka	ኩ	ku	ኪ	ki	ካ	kā	ኬ	ké	ክ	ke/k	ኮ	ko
ኸ	xa	ኹ	xu	ኺ	xi	ኻ	xā	ኼ	xé	ኽ	xe/x	ኾ	xo
ወ	wa	ዉ	wu	ዊ	wi	ዋ	wā	ዌ	wé	ው	we/w	ዎ	wo
ዐ	‘a	ዑ	‘u	ዒ	‘i	ዓ	‘ā	ዔ	‘é	ዕ	‘e	ዖ	‘o
ዘ	za	ዙ	zu	ዚ	zi	ዛ	zā	ዜ	zé	ዝ	ze/z	ዞ	zo
ዠ	ža	ዧ	žu	ዢ	ži	ዣ	žā	ዤ	žé	ጋ፞ዥ	že/ž	ዦ	žo
የ	ya	ዩ	yu	ዪ	yi	ያ	yā	ዬ	yé	ይ	ye/y	ዮ	yo
ደ	da	ዱ	du	ዲ	di	ዳ	dā	ዴ	dé	ድ	de/d	ዶ	do
ጀ	ǧa	ጁ	ǧu	ጂ	ǧi	ጃ	ǧā	ጄ	ǧé	ጅ	ǧe/ǧ	ጆ	ǧo
ገ	ga	ጉ	gu	ጊ	gi	ጋ	gā	ጌ	gé	ግ	ge/g	ጎ	go
ጠ	ṭa	ጡ	ṭu	ጢ	ṭi	ጣ	ṭā	ጤ	ṭé	ጥ	ṭe/ṭ	ጦ	ṭo
ጨ	ċa	ጩ	ċu	ጪ	ċi	ጫ	ċā	ጬ	ċé	ጭ	ċe/ċ	ጮ	ċo
ጰ	p̣a	ጱ	p̣u	ጲ	p̣i	ጳ	p̣ā	ጴ	p̣é	ጵ	p̣e/p̣	ጶ	p̣o
ጸ	ṣa	ጹ	ṣu	ጺ	ṣi	ጻ	ṣā	ጼ	ṣé	ጽ	ṣe/ṣ	ጾ	ṣo
ፀ	ṡa	ፁ	ṡu	ፂ	ṡi	ፃ	ṡā	ፄ	ṡé	ፅ	ṡe/ṡ	ፆ	ṡo
ፈ	fa	ፉ	fu	ፊ	fi	ፋ	fā	ፌ	fé	ፍ	fe/f	ፎ	fo
ፐ	pa	ፑ	pu	ፒ	pi	ፓ	pā	ፔ	pé	ፕ	pe/p	ፖ	po
ቨ	va	ቩ	vu	ቪ	vi	ቫ	vā	ቬ	vé	ቭ	ve/v	ቮ	vo

Syntax

Ahadu’s syntax is structured to be comprehensible for Amharic speakers by mimicking Amharic sentence structures.

At the same time, Ahadu’s syntax exhibits close affinities with Python, enabling individuals to seamlessly transfer their acquired knowledge and skills.

If Statement

Python

```
if (x == 1): y = 1
elif (x == 2): y = 2
else: y = 5
```

Ahadu

```
U == 1 ከሆነ ለ = 1
ግን U == 2 ከሆነ ለ = 2
አለበለዚያ ለ = 5
```

(expression) **IF** (expression)

(**BUT** (expression) **IF** (expression))*

(**ELSE** (expression))?

If Statement

Python

```
if (x == 1):
    y = 1
elif (x == 2):
    y = 2
else:
    y = 3
```

Ahadu

```
U == 1 ከሆነ :-
    ለ = 1
ግን U == 2 ከሆነ :-
    ለ = 2
አለበለዚያ :-
    ለ = 5
```

(expression) **IF THEN NEWLINE+** (**TAB** expression **NEWLINE+**)*
(**BUT** (expression) **IF THEN NEWLINE+** (**TAB** expression **NEWLINE+**)*)*
(**ELSE THEN NEWLINE+** (**TAB** expression **NEWLINE+**)*)?

Loop Statement

Python

```
while (x < 2):
    y = y + 1
    x = x + 1
```

Ahadu

```
U < 2 እስከሆነ ድረስ :-
    ለ = ለ + 1
    U = U + 1
```

(expression) **WHILE THEN NEWLINE**+ (**TAB** (expressions) **NEWLINE**+)*

Function Definition

Python

```
def add (x, y):
    sum = x + y
    return sum
```

Ahadu

```
ተግባር ደማሪ (ሀ፣ ለ)፦
    ድምር = ሀ + ለ
    ተመላሽ ድምር
```

FUNCTION IDENTIFIER LPARAM (**IDENTIFIER** (**COMMA IDENTIFIER**)*)* **PRARAM THEN NEWLINE+**
(**TAB** expression **NEWLINE+**)*

Class Definition

Python

```
class student (person):
    def init(self, x):
        self.name = x

haile = student(“Haile”)
print(haile.name)
```

Ahadu

```
ክላስ ተማሪ (ሰው) ፦
    ፈጣሪ (ሀ) ፦
        የተማሪ ስም = ሀ

ሃይሌ = ተማሪ(“ኃይለሚካኤል”)
ፃፍ(የሃይሌ ስም)
```

CLASS IDENTIFIER LPARAM (**IDENTIFIER**)? **PRARAM THEN NEWLINE**+

INIT LPARAM (**IDENTIFIER** (**COMMA IDENTIFIER**)*)* **PRARAM THEN NEWLINE**+
(**TAB** expression **NEWLINE**+)*

Error Messages

Understanding error messages is one of the main challenges studies identified non-native English speakers face.

Error messages outputted by the Ahadu interpreter are in Amharic.

Error messages are formatted to include helpful information to help the users understand the error and how to fix it.

Indentation Error

```
1  ክላስ ተማሪ (ሰው) ፦
2      ፈጣሪ (ሀ) ፦
3          የተማሪ ስም = ሀ
4
5  ሃይሌ = ተማሪ(“ኃይለሚካኤል”)
6      ፃፍ(የሃይሌ ስም)
7
```

የመስመር መጀመሪያ ክፍተት ስተት፤ መስመር 6 ላይ 1ኛው ምልክት

```
6:   ፃፍ(የእቃ ሀ)
     ↑
```

እዚህ መስመር ላይ ከሚያስፈልገው በላይ ክፍተት አለ። 0 ክፍተት ይጠነቃል።
ማስታወሻ፦ አንድ የመስመር መጀመሪያ ክፍተት አራት ስፔሶች ወይም አንድ ታብ መሆን አለበት።

Invalid Operation Error

```
1
2
3
4
```

```
ሀ = 1
ለ = “ቁጥር"
ሐ = ሀ + ለ
```

ሕጋዊ ያለሆነ ተግባር፤ መስመር 3 ላይ 7ኛው ምልክት

```
3: ሐ = ሀ + ለ
          ↑
```

እዚህ ላይ “ሀ” ቁጥር ሲሆን “ለ“ ደግሞ ፅሑፍ ነው።
ቁጥር እና ፅሑፍን መደመር አይቻልም።

Hello world!

Ahadu

```
1  ቀ(“Hello World!”)
2
3
```

Python

```
1  print(“Hello world!“)
2
3
```

Iterate through a list

Ahadu

```
ሃ = [1፣ 2፣ 3፣ 4፣ 5]
ቆጣሪ = 0
ቆጣሪ ‹ 5 እስከሆነ ድረስ:-
    ጻፍ(ሃ[ቆጣሪ])
    ቆጣሪ = ቆጣሪ + 1

```

Python

```
h = [1, 2, 3, 4]
counter = 0
while counter < 5:
    print(l[counter])
    counter = counter + 1

```

Future

ahaducode.com
Code Playground and guide and documentation for users

More Languages: Tigregna, Afan Oromo, ...

More integration with Python
Allowing Python code within Ahadu
Supporting importing Python Libraries

THANK YOU!

፨አመሰግናለሁ፨