Navaho Linguistics for Quantum Hardware Education

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This document is written by Onri Jay Benally, an Indigenous American born and raised on the Navaho tribe (Diné Bikeyah). Its purpose is to develop and collect Navaho terms associated with quantum information science and technology (QIST), highlighting on quantum hardware engineering. As you may find, this development is motivated by the drive not only to exploit linguistics as a way of better understanding emerging technology, but to also serve as a tool to contribute to the quantum community at large. With that, it may be possible to form a model around this effort in order to break down barriers to entry when it comes to approaching or incorporating oneself into the field of QIST.

If you are interested in learning Navaho, the first section of this document will cover some basic ideas about the language. This will be followed by some examples of how one might think about names and labels from the Indigenous American perspective. It may be worth noting that although Navaho is considered to be a Tier 5 or Category 5 language in terms of difficulty for native English speakers, practicality is our main concern.

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Towards Using Linguistics for Quantum Hardware Comprehension

The Navaho language is highly descriptive, has a heavy presence of verb usage, and is rich in consonant clusters and tonality. It is important to note that the many biomes and topographical differences found on the tribal lands are contributing factors to the various Navaho dialects. This is especially true for the mountainous regions, where pronunciation and modern spelling can vary in a slight manner.

As you may or may not know, the Navaho language was only practiced through oral expression for thousands of years in what is now called North America. Not until relatively recent history did Navaho linguists and language experts decide to pick a written form that could adopt Navaho phonetics. So far, the Latin script (commonly used to write English alphabets) has been the default for writing since then. There are other scripts or writing systems such as Cyrillic (commonly used to write Slavic alphabets, including Russian) that can express Navaho phonetics as well, however it is not actively taught or practiced in the tribe. Either way, the spelling of words are expected to be pronounced phonetically.

For example, it is generally known that Diné has two English spellings: Navaho and Navajo (both pronounced the same). The letter (j), used in the word Navajo, is exclusive to the spelling of the word. If one observes (j) in any other Diné word, then it should be pronounced the same as the English letter (j) or its linearized form (dzh). Keep this in mind.

Virtually all English words can be translated into Navaho based on the depth of understanding and functionality of the word. Thus, when a new English term is coined or invented, a Navaho description can be given and verified by sharing it with another Navaho speaker who should understand what one is saying with context.

In the era of rapidly advancing science, technology, and art, one can express new Navaho terms by simply spending some time to consider the semantics, followed by documenting or producing a shareable form of the new term. Such is the case for topics like quantum mechanics and quantum engineering, provided as examples in this repository. Over time, this documentation is expected to retain a fair amount of content for driving explanations of advanced and technical topics of today (especially quantum), in Navaho.

Towards a Model for Learning & Using Navaho for Quantum Education

- Find the root word.
- How does it behave?
- What is the historical relation?
- What is the suffix?
- What is the prefix?
- What are the particles, if any?
- Acknowledge that order doesn't matter that much inside the suffixes & prefixes.

For the original documentation:

- The quick brown fox jumped over the lazy dog, example in Navaho.
- Cyrillic example for "blue" in Navaho.
- Chart formation blueprint.
- Generate a table of Navaho characters in Unicode.
- Explore a draw-to-text for Navaho characters referencing Unicode.
- Label dilution refrigerator in Navaho.
- Label tunnel junctions & physical qubit components in Navaho, may include original micrographs & renderings in Blender.
- Potential contributions to Qiskit/ Qiskit Metal documentation in Navaho (from paper to GitHub pull requests).

Note: Unicode is mentioned here due to its convenience of character generation when one desires to correctly spell Navaho words. This form of character generation may provide a robust sequence of protocols for practical language usage in digital form, further strengthening any future initiatives to automate Navaho translation.

Language Ideas for Quantum Hardware Comprehension

From idea to practice...

	English Term	Navaho Term
Initial Idea	Computer	Béésh = Metal Łichíí' = Red Nitsékees = Think
Final Version	Computer	Béésh Łichíí' Nitsékeesí = [A piece of copper that thinks]

Figure 1: *Computer* in Navaho.

Other examples:

The quick brown fox = Ma'ii dibéłchíí tsįįłgo or Ma'ii yishtłizh tsįįłgo
Lazy dog = léechąą'í iłhóyéé
Jumped = nahacha or dah nahacha or dahnáníjįįh
To jump = dahnáníshjįįh
Jumping = dah nahácha'go
Laziness = iłhóyéé
Slow or in vain = chéédh
The quick brown fox jumped over the lazy dog = Ma'ii dibéłchíí tsįįłgo léechąą'í iłhóyéé dahnáníjįįh

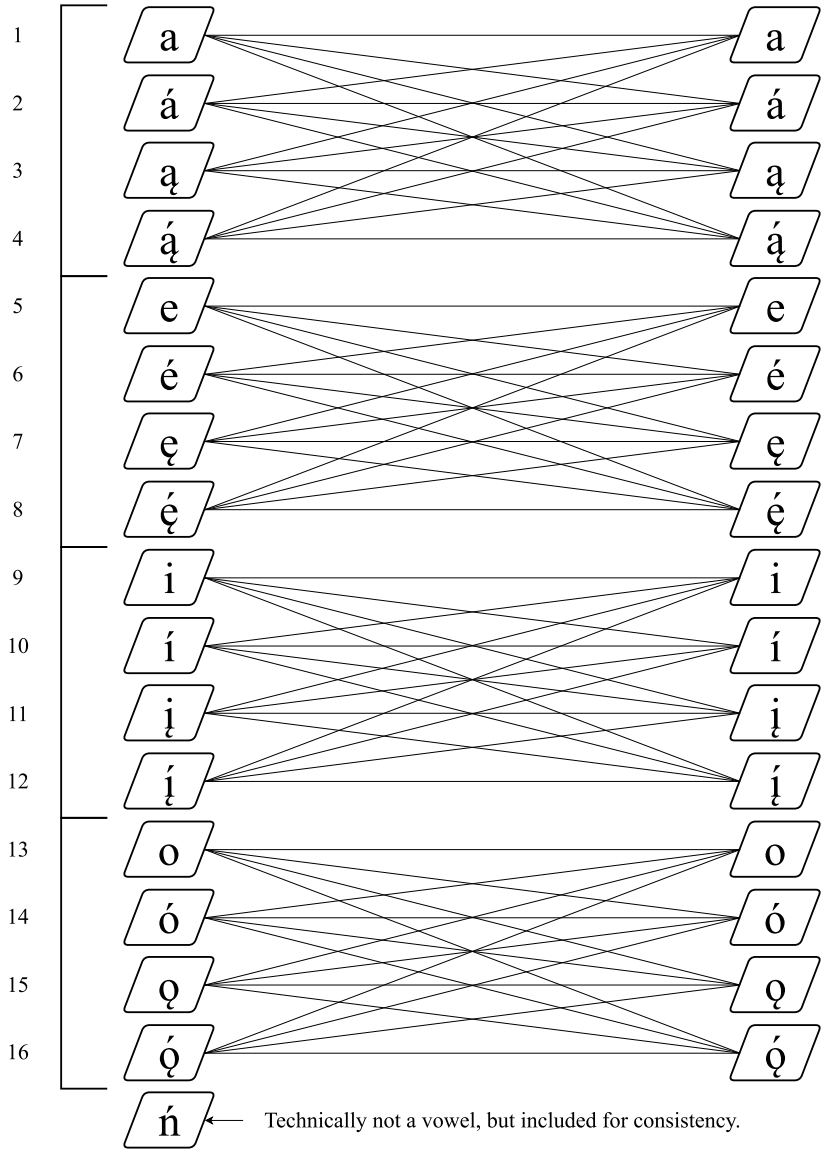

Figure 2: Navaho long vowel network by Onri Jay Benally

Navaho Character	UTF-8 "U+" Notation	UTF-8 "\u" Notation
A	U+0041	\u0041
B	U+0042	\u0042
Ch	U+0043 U+0068	\u0043\u0068
Ch’	U+0043 U+0068 U+0027	\u0043\u0068\u0027
D	U+0044	\u0044
Dl	U+0044 U+006C	\u0044\u006C
Dz	U+0044 U+007A	\u0044\u007A
E	U+0045	\u0045
G	U+0047	\u0047
Gh	U+0047 U+0068	\u0047\u0068
H	U+0048	\u0048
Hw	U+0048 U+0077	\u0048\u0077
I	U+0049	\u0049
J	U+004A	\u004A
K	U+004B	\u004B
K’	U+004B U+0027	\u004B\u0027
Kw	U+004B U+0077	\u004B\u0077
L	U+004C	\u004C
Ł	U+0141	\u0141
M	U+004D	\u004D
N	U+004E	\u004E
O	U+004F	\u004F
S	U+0053	\u0053
Sh	U+0053 U+0068	\u0053\u0068
T	U+0054	\u0054
T’	U+0054 U+0027	\u0054\u0027
Tł	U+0054 U+0142	\u0054\u0142
Tł’	U+0054 U+0142 U+0027	\u0054\u0142\u0027
Ts	U+0054 U+0073	\u0054\u0073
Ts’	U+0054 U+0073 U+0027	\u0054\u0073\u0027
W	U+0057	\u0057
X	U+0058	\u0058
Y	U+0059	\u0059
Z	U+005A	\u005A
aa	U+0061 U+0061	\u0061\u0061
á	U+00E1	\u00E1
áá	U+00E1 U+00E1	\u00E1\u00E1
ą	U+0105	\u0105
ąą	U+0105 U+0105	\u0105\u0105
ą	U+0105 U+0301	\u0105\u0301
ąą	U+0105 U+0301 U+0105 U+0301	\u0105\u0301\u0105\u0301
aá	U+0061 U+00E1	\u0061\u00E1
aą	U+0061 U+0105	\u0061\u0105

aą	U+0061 U+0105 U+0301	\u0061\u0105\u0301
áa	U+00E1 U+0061	\u00E1\u0061
áą	U+00E1 U+0105	\u00E1\u0105
áą	U+00E1 U+0105 U+0301	\u00E1\u0105\u0301
ąa	U+0105 U+0061	\u0105\u0061
ąá	U+0105 U+00E1	\u0105\u00E1
ąą	U+0105 U+0105 U+0301	\u0105\u0105\u0301
ąa	U+0105 U+0301 U+0061	\u0105\u0301\u0061
ąá	U+0105 U+0301 U+00E1	\u0105\u0301\u00E1
ąą	U+0105 U+0301 U+0105	\u0105\u0301\u0105
ee	U+0065 U+0065	\u0065\u0065
é	U+00E9	\u00E9
éé	U+00E9 U+00E9	\u00E9\u00E9
ę	U+0119	\u0119
ęę	U+0119 U+0119	\u0119\u0119
ę	U+0119 U+0301	\u0119\u0301
ęę	U+0119 U+0301 U+0119 U+0301	\u0119\u0301\u0119\u0301
eé	U+0065 U+00E9	\u0065\u00E9
eę	U+0065 U+0119	\u0065\u0119
eę	U+0065 U+0119 U+0301	\u0065\u0119\u0301
ée	U+00E9 U+0065	\u00E9\u0065
éę	U+00E9 U+0119	\u00E9\u0119
éę	U+00E9 U+0119 U+0301	\u00E9\u0119\u0301
ęe	U+0119 U+0065	\u0119\u0065
ęé	U+0119 U+00E9	\u0119\u00E9
ęę	U+0119 U+0119 U+0301	\u0119\u0119\u0301
ęe	U+0119 U+0301 U+0065	\u0119\u0301\u0065
ęę	U+0119 U+0301 U+0119	\u0119\u0301\u0119
ęé	U+0119 U+0301 U+00E9	\u0119\u0301\u00E9
ii	U+0069 U+0069	\u0069\u0069
í	U+00ED	\u00ED
íí	U+00ED U+00ED	\u00ED\u00ED
į	U+012F	\u012F
įį	U+012F U+012F	\u012F\u012F
į	U+012F U+0301	\u012F\u0301
įį	U+012F U+0301 U+012F U+0301	\u012F\u0301\u012F\u0301
ií	U+0069 U+00ED	\u0069\u00ED
iį	U+0069 U+012F	\u0069\u012F
iį	U+0069 U+012F U+0301	\u0069\u012F\u0301
íi	U+00ED U+0069	\u00ED\u0069
íį	U+00ED U+012F	\u00ED\u012F
íį	U+00ED U+012F U+0301	\u00ED\u012F\u0301
įi	U+012F U+0069	\u012F\u0069
įí	U+012F U+00ED	\u012F\u00ED

į́į́	U+012F U+012F U+0301	\u012F\u012F\u0301
į́i	U+012F U+0301 U+0069	\u012F\u0301\u0069
į́í	U+012F U+0301 U+00ED	\u012F\u0301\u00ED
į́į́	U+012F U+0301 U+012F	\u012F\u0301\u012F
oo	U+006F U+006F	\u006F\u006F
ó	U+00F3	\u00F3
óó	U+00F3 U+00F3	\u00F3\u00F3
ǫ	U+01EB	\u01EB
ǫǫ	U+01EB U+01EB	\u01EB\u01EB
ǫ	U+01EB U+0301	\u01EB\u0301
ǫǫ	U+01EB U+0301 U+01EB U+0301	\u01EB\u0301\u01EB\u0301
oó	U+006F U+00F3	\u006F\u00F3
oǫ	U+006F U+01EB	\u006F\u00EB
oǫ	U+006F U+01EB U+0301	\u006F\u01EB\u0301
óo	U+00F3 U+006F	\u00F3\u006F
óǫ	U+00F3 U+01EB	\u00F3\u01EB
óǫ	U+00F3 U+01EB U+0301	\u00F3\u01EB\u0301
ǫo	U+01EB U+006F	\u01EB\u006F
ǫó	U+01EB U+00F3	\u01EB\u00F3
ǫǫ	U+01EB U+01EB U+0301	\u01EB\u01EB\u0301
ǫo	U+01EB U+0301 U+006F	\u01EB\u0301\u006F
ǫǫ	U+01EB U+0301 U+01EB	\u01EB\u0301\u01EB
ǫó	U+01EB U+0301 U+00F3	\u01EB\u0301\u00F3
ń	U+0144	\u0144