Morse Code:
From MATLAB to Python

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Overview and Significance

- The goal of this project was to implement the Morse Code Tree Structure from an existing <u>MATLAB exercise</u> into Python and to replicate its ability to encode and decode.
  - Success was tested by the decoding exercise (19.1) included in the MATLAB pdf linked above, as well as with further original decoding and encoding tests (will be demonstrated later).

- The significance of this project has been the opportunity to work with various implementations of Tree Structures which will be directly related to computational and theoretical research in linguistic syntax.

*Tested only with English, but should work for any language using the same Alphabet.

Expertise Level and Skills Learned

- Solo Project
- Minimal programming experience at the start of this course:
  - Computational Linguistics 1 (introductory Python) : FA 2022
  - Computational Linguistics 2 (introductory Haskell) : SP 2023
- Skills Learned:
  - Tree Structures:
    - Nested lists, nested dictionaries, and dataframes
    - Constructing a class for leaves, then building a Tree Structure by defining relationships between leaves (this is the method used in the final version).
  - Regular expressions handling variability in user input

Morse Code Tree Structure
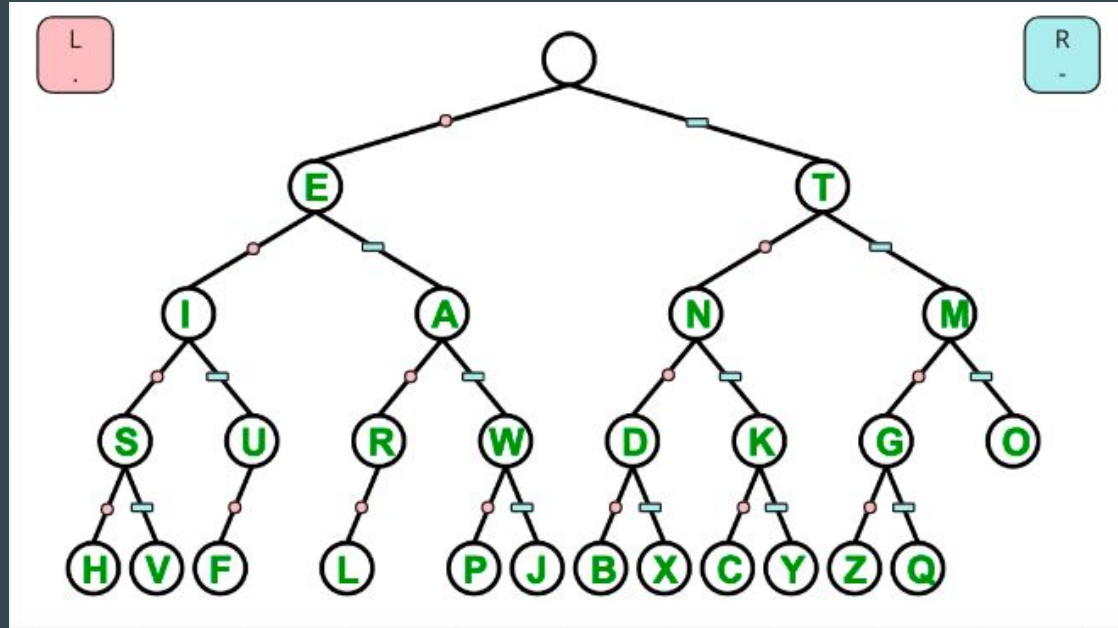
*Picture from MATLAB pdf with alterations for clarity

Techniques and Tools

- Tree structures

"And cell arrays, which are unique to Matlab,

are arrays whose elements are other arrays."

- MATLAB Morse Code Exercise

○ The MATLAB implementation used cell arrays to build the tree structure. Because these are unique to MATLAB, several alternatives were considered for building a tree structure that could be used to accomplish the same tasks.

Techniques and Tools

- Tree structures
  - Nested lists, nested dictionaries, and dataframes
    - These all represented the hierarchies well, but I wanted something that would let me access the relationships between any leaves regardless of distance as well as be easier to define new trees in the future.

Techniques and Tools

- Tree structures
  - Nested lists, nested dictionaries, and dataframes
  - Classes
    - In the end, I used defined a class for making leaves. Each leaf has a value (its letter) and can have attributes ('leftChild' and 'rightChild'). These attributes will each be leaves themselves, thereby allowing a tree to be built by defining the leaves relationships to each other.
    - This class can be reused in future projects to build binary trees for syntactic data.

Techniques and Tools

- Tree structures
  - Nested lists, nested dictionaries, and dataframes
  - Classes
    - Encoding was done by matching the letters in the input to the leaf who had this letter as its value and then determining its relations to the leaves above it (is this a left or right child? Is its mother a left or right child? And so on) till reaching the root. Decoding was done by following the dots and dashes (as they indicated right or left) until a space was reached and then collecting the value of the leaf it landed on.

Techniques and Tools

- Tree structures
  - Nested lists, nested dictionaries, and dataframes
  - Classes
  - Regular Expressions and handling variability in user input
    - Made sure input only contained characters that wouldn't cause errors, changed all input to uppercase, and informed user of acceptable types of input

Conclusion

- The most difficult aspect of the project was finding the right way to implement the tree structure.
- Fortunately, using leaves and their relationships not only worked for the Morse Code project, but will also allow for more accurate representations of syntactic hierarchies in linguistic data than the other attempted methods.

Hello! I can help you with Morse Code messages.
Would you like to encode (English to Morse Code)
or decode (Morse Code to English):

Type 'Encode' or 'Decode' or press 'Enter' to quit.
encode
What would you like to translate into Morse Code?
        (Press enter to go back)
Dwyer
 -.. .-- -.-- . .-.
What would you like to translate into Morse Code?
        (Press enter to go back)

Going back:

Hello! I can help you with Morse Code messages.
Would you like to encode (English to Morse Code)
or decode (Morse Code to English):

Type 'Encode' or 'Decode' or press 'Enter' to quit.
decode
What Morse Code would you like to translate into English?
        (Remember to put spaces between each letter)
        (Press enter to go back)
-... .-. .- -.. .-.. . -.--

References

Moler, C. B. (2011). *Experiments with MATLAB*. Society for Industrial and Applied Mathematics.