CECS 329, Homework Assignment 5, Spring 2025, Dr. Ebert

Directions: Please review the `Homework` section on page 6 of the syllabus including a list of all rules and guidelines for writing and submitting solutions.

Due Date: Thursday, April 17th as a PDF-file upload to the HW5 Canvas dropbox.

Problems

1. **Deriving Hawaiian words.** Recall that a **syllable** is a unit of pronunciation having one vowel sound, with optional surrounding consonants, and forming the whole or part of a word. Hawaiian has 13 letters: 5 vowels (a, e, i, o, u) and 8 consonants (m, n, p, k, ', h, w, l), including the glottal stop written with the okina ('). For Hawaiian words, a syllable consists of either i) a consonant followed by a vowel or ii) a single vowel. Sequences of two consecutive vowels are parsed as two syllables where the second syllable has no consonant. For example, the word "kou" can be (syllabically) parsed as ko/u. Hawaiian also has long vowels represented by a vowel with a diacritical mark above it (ā,ē,ī,ō, ū). These function identically to the regular short vowels.

   (a) Use the information above to define a context-free grammar that derives the language consisting of all possible words whose letters are drawn from the set of Hawaiian consonants and vowels, and for which the syllabic parsing for each word is consistent with the rules described above. For example, "kū'ai" (to buy / sell) is in the language since it uses Hawaiian letters and can be parsed as kū/'a/i. On the other hand "nail" is not in the language since, although it uses Hawaiian letters, there is no way to parse it according the above Hawaiian rules. For example, na/i/l does not follow the rules since "l" is not a valid syllable. Make sure to clearly define the variable set, terminal set, rules, and the start symbol of your grammar. (20 pts)

   (b) Use your grammar from part a) to derive the words i) pepeiao (ear), and ii) humuhumunukunukuapua'a (reef triggerfish). (10 pts)

2. A sequence of left and right parentheses is said to be **well-formed** iff i) there is an equal number of left and right parentheses and ii) moving from left to right in the sequence, the number of right parentheses witnessed never exceeds the number of left parentheses witnessed.

   (a) Provide the state diagram of a Turing machine that accepts the language of all well-formed sequences of parentheses. For example (())(()()) is in the language, but not ())(. You may assume that the empty word is well-formed. Provide a paragraph that explains how your machine works to decide if a sequence is well-formed. (20 pts)

   (b) Provide a text file (with a "txt" file extension) that consists of a program for your Turing machine from part a) and uses the required syntax for the simulator at

   `https://turingmachinesimulator.com/`

   (10 pts)