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Mixed Problem Set #1

Selected Definitions:

1. What is a context free grammar and what is the language generated by a context free grammar?
    a. A CFG is a set of rewriting rules used to generate a pattern of strings. A CFG requires 4 different elements:
        i. A set of terminal rules.
        ii. A set of nonterminal rules.
        iii. A set of production rules or rewriting rules
        iv. A start symbol.
    b. The language generated by a context free grammar is the set of all strings of terminal symbols that are derivable from the start symbol.
2. What is an L-System?
    a. An L-system is a parallel rewriting system and formal grammar involving 3 components:
        i. An alphabet.
        ii. A start symbol.
        iii. A production for each symbol of the alphabet that maps the symbol to a list of symbols.
3. What is a Post Production System?
    a. A Post Production System consists of a set of production rules. For each rule there is a pattern of strings to match on the left side and a replacement on the right. Form the initial string rules that match are applied to produce new strings.
4. What is a Markov Process?
    a. A process that is a random/probabilistic model that that has the "Markov Property". The Markov property is satisfied by a process if one can predict for the future of the process based solely on the present state, as well as if you know something about past states.

Context Free Grammars and Language Description Alternatives:

1. What can you say that is positive about the first approach, the natural language approach?
    a. Something that I think is positive about the first approach is that the approach explained the grammar production by production leaving nothing undefined.
2. What can you say that is negative about the first approach, the natural language approach?
    a. Something that I believe is negative about the first approach is that if you have not worked with CFG's in the past, I believe it would be hard for someone to list their production rules. Leaving someone to potentially confused about what symbol is the start symbols and which symbols are terminal or non-terminal.
3. What can you say that is positive about the second approach, the CFG approach?

    a. Something positive about the second approach is that all the productions are listed, and you can clearly distinguish what the production rules are, and which symbols are terminal or non-terminal.
4. What can you say that is negative about the second approach, the CFG approach?
    a. Something negative about the second approach is that if you have never worked with a CFG the list of production rules may not make sense. The list of productions may just look like a bunch of string with symbols to them.
5. What sentence in this language will you get by applying the rules of the CFG in the following order: 1 4?

    sst → set (1)

    → {} (4)

6. What sentence in this language will you get by applying the rules of the CFG in the following order: 2 7 10 12?

    sst → sequence (2)

    → <thingstring> (7)

    → <thing> (10)

    → <*> (12)

7. What sentence in this language will you get by applying the rules of the CFG in the following order: 3 9 11 13 1 5 11 12 10 12 11 12 10 12?

    sst → tuple (3)

    → (thingstring) (9)

    → (thing thingstring) (11)
    → (sst thingstring) (13)

    → (set thingstring) (1)

    → ({thingstring} thingstring) (5)

    → ({thingstring}thing thingstring) (11)

    → ({thingstring} * thingstring) (12)

    → ({thingstring} * thing) (10)

    → ({thingstring}* *) (12)

    → ({ thing thingstring} * *) (11)

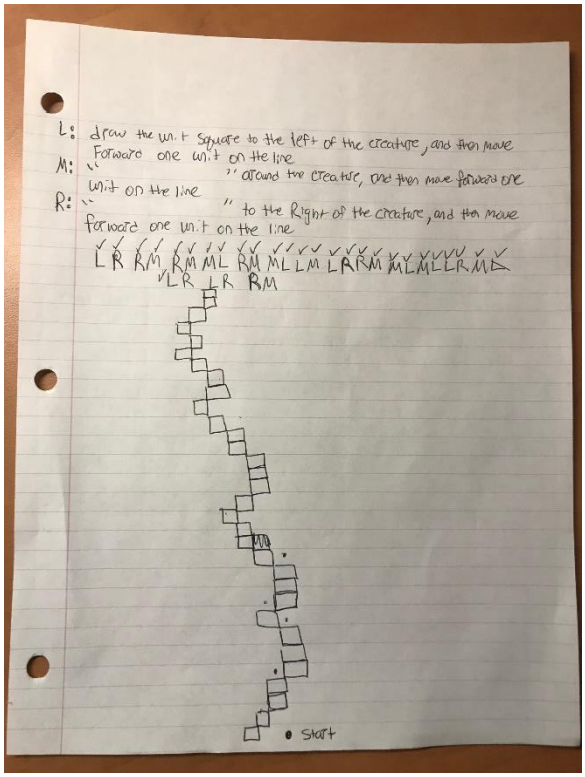
    → ({ * thingstring} * *) (12)

    → ({ * thing} * *) (10)

→ ({* *}* *) (12)

L-System Simulation of a Barnett Newman Line:

1. Write down the fifth generation of this L-system.
    a. G0: M
    b. G1: RM
    c. G2: LRRM
    d. G3: MLLRLRRM
    e. G4: RMMLMLLRMLLRLRRM
    f. G5: LRRMRMMLRMMLLMLRRMMLMLLRMLLRLRRM
2. Draw the fifth generation L-system image corresponding to a screen creature with a pen that executes three instructions, R and M and L.
    a. L: Draw the unit square to the left of the creature, and then move forward one unit on the line.
    b. M: Draw the unit square around the creature, and then move forward one unit on the line.
    c. R: Draw the unit square to the right of the creature, and then move forward one unit on the line.



PPS1: A post Production System:

Axiom and theorem:

- P- is the sole axiom
- Suppose that x is a hyphen-string. If Px is a theorem, so is Pxx

Questions:

1. Show that P-------- Is theorem of PPS1 by working within the system.
    a. P- (axiom)
    b. P-- (from a)
    c. P---- (from b)
    d. P-------- (from c)
2. Write down the five shortest theorems of PPS1.
    a. P-
    b. P--
    c. P----
    d. P--------
    e. P----------
3. Specify a decision procedure for determining theorem hood in PPS1.
    a. The group of hyphens following the P must be one of the numbers in the doubling sequence. (2^ n, where n is the number of generations your on)
4. Provide an I argument that the string P------ is not a theorem of PPS1.
    a. P------ is not a theorem in this system because the number of hyphens cannot be generated by doubling the number of hyphens starting with the axiom.
5. In one English sentence, say what subset of the natural numbers you think it was my intent to capture with PPS1.
    a. The subset of natural numbers that I thought you were trying to capture is the doubling sequence.

CFG1: A Context Free Grammar:

CFG:

1. S → P D
2. D → -
3. D → D -

Questions:

1. What is the terminal set for this CFG?
    a. {P, -}
2. What is the nonterminal set for this CFG?
    a. {S, D}
3. What is the start symbol for this CFG?
    a. S

4. Show that P------ is a sentence in the language defined by thus CFG by deriving it from the start symbol.
    a. S → P D
    b. → P D -
    c. → P D - -
    d. → P D - - -
    e. → P D - - - -
    f. → P D - - - - -
    g. → P - - - - - -
5. Write down the five shortest sentences of the P- system.
    a. S
    b. P D
    c. P -
    d. P D -
    e. P - -
6. In one English sentence, describe the language generated by CFG1.
    a. The language generated by CFG1 is supposed to resemble the set of symbols that the subset of PPS1 stems from.

<u>CFG1 vs PPS1:</u>

1. True or False: The set of strings of symbols defined by PPS1 is a subset of the set of strings of symbols defined by CFG1.
    a. True
2. True or False: The set of strings of symbols defined by CFG1 is a subset of the set of strings of symbols defined by PPS1.
    a. False
3. Do one of the following tasks:
    a. Define a Post Production System whose theorems correspond to the sentences in CFG1.
        i. P- is the sole axiom
        ii. Suppose that x is a hyphen-stringq
    b. Define a Context Free Grammar whose sentences correspond to the theorems of PPS1.

<u>CFGs vs PPSs:</u>

Answer the following questions with CFG or PPS, depending on which is the best answer:

1. It inherently involves an alphabet, a finite set of initial “words”, each consisting of a string of symbols, and a set of string rewriting rules.
    a. PPS
2. It inherently involves terminal symbols, nonterminal symbols, production mapping nonterminal symbols to strings of symbols, and a start symbol.
    a. CFG

3. Which was invented first, CFG or PPS?
    a. PPS
4. Which one can be defined by placing restrictions on the other one?
    a. CFG
5. It is more closely associated with theoretical computer science.
    a. PPS
6. It is more closely associated with theoretical linguistics.
    a. CFG
7. The strings produced are generally referred to as sentences.
    a. CFG
8. The strings produced are generally referred to as theorems.
    a. PPS
9. Hofstadter uses this formalism in his presentation of Godel's incompleteness theorem (which we never quite got to look at this semester).
    a. PPS
10. Is more closely associated with Noam Chomsky.
    a. CFG