## Assignment D - Context-Free Languages 1

*Reminder of the recommended approach to best prepare you for success on the exams:*

1. Attempt each of the primary activities *without* reference to others' solutions or use of an automated computational tool (e.g., JFLAP).
2. Develop a solution and a set of data that helps validate the solution.
3. After you have deemed a solution satisfactory, implement that solution in JFLAP where appropriate and use JFLAP's features to analyze and test your work.
4. Clean up or annotate your solution as necessary for submission.

D1. Consider the language L1 over alphabet Σ = { a, b }, L1 = { w ∈ Σ\* | w is a palindrome of even length}. Recall that a palindrome is a string of characters that reads the same forwards and backwards. For example, abba, aa, λ, ababbaba ∈ L1, but a, aba, abbbab ∉ L1.

Demonstrate that L1 is context-free by constructing a PDA that recognizes L1.

Implement that PDA in JFLAP and upload the PDA as a file named d1evenpda.jff

D2. Consider the language L2 over alphabet Σ = { a, b }, L2 = { w ∈ Σ\* | w is a palindrome of odd length}. For example: abbba, a, abababa ∈ L2, but aa, abba, abbbab ∉ L2.

Demonstrate that L2 is context-free by constructing a PDA that recognizes L2.

Implement that PDA in JFLAP and upload the PDA as a file named d2oddpda.jff

D3. Consider the language L3 over alphabet Σ = { a, b }, L3 = { w ∈ Σ\* | w is a palindrome of any length}.

Construct a PDA that recognizes L3.

Implement that PDA in JFLAP, and upload the PDA as a file named d3allpda.jff

D123r. Use Online Text to report observations and insights about your learning associated with the design and construction of these PDA.

D4. Consider a language that models a subset of simple English sentences. In particular, the sentences are of the form <article> <noun> <verb>, where <article> is either of the words "a" or "the", <noun> is either of the words "dog" or "cat", and <verb> is either of the words "ran" or "walked". For example, "the dog ran" and "a dog walked" are both in the language but "a walked cat" is not.

Define the rules of a context-free grammar equivalent to this language with the set of variables V = { S, A, N, V }, the set of terminals T = { a, c, d, r, t, w }, and the start symbol S. Note the following interpretations of these symbols:  
A : <Article>  
N : <Noun>  
S : <Sentence>  
V : <Verb>  
a : "a"  
c : "cat"  
d : "dog"  
r : "ran"  
t : "the"  
w : "walked"

For example, the string "tdw" in this language would correspond to the English sentence "the dog walked".

Implement the grammar in JFLAP and upload the implementation as a file named d4cfg.jff

D4r. Use Online Text to report observations about the grammar and your learning experience associated with developing the grammar.