CSci 435: Formal Languages and Automata

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**Home Assignment 5: 100 points + 15 points (optional)**

In any (N/D)PDA, assume that a start stack symbol z is already in the stack; so, you don’t have to insert z into the stack at the beginning of transition.

Q1. [20] For a given language L = { *w* | *na*(*w*) + *nb*(*w*) = *nc*(*w*) } where Σ = Γ = {*a*, *b, c*}

1. [10] Construct a PDA M that accepts L with Σ = Γ = {*a*, *b, c*}

*Ans.* The PDA M is defined by the transition function given by:

δ(*q0*, *a*, z) = {(*q0*, *a*)},

δ(*q0*, *a*, *a*) = {(*q0*, *a*)},

1. [10] Show the sequence of instantaneous descriptions for the acceptance of *acacbcbc* by M in 1).
2. [10, optional] Give a CFG G that generates L, L(G) = L.

Q2. [20] Construct an NPDA for the following languages.

1. [10] L1 = {*bba*\**bab*\* }
2. [10] L2 = {*bbb\*aba* }
3. [5, optional] L4 = L2 – L1.

Q3. [10] Give the language that is accepted by the NPDA M in a formal expression (including a regular expression) where M = ({*q0, q1, q2*}, {*a, b*}, {*a, b*, z}, δ, *q0*, z, { *q0* , *q1*, *q2*}), with transitions

♦ δ(*q0*, *a*, z) = {(*q1*, *a*), (*q2*, λ)},

♦ δ(*q1*, *b*, *a*) = {(*q1*, *b*)},

♦ δ(*q1*, *b*, *b*) = {(*q1*, *b*)},

♦ δ(*q1*, *a*, *b*) = {(*q2*, λ)},

Q4. [20] (A) Construct a NPDA that accepts the language defined by the given grammar and (B) give the language in a formal expression (including a regular expression).

1. S → *ab*S*b* | λ.
2. S → AA | *a*, A → SA | *ab*.

Hint: Convert the grammar into Greibach Normal Form, then apply Thm. 7.1.

Q5. [20] Find a (minimal) Context-Free Grammar that generates the language accepted by the NPDA M where M = ({*q0, q1*}, {*a, b*}, {*A*, z}, δ, *q0*, z, {*q1*}), with the transitions

♦ δ(*q0*, *a*, z) = {(*q0*, *Az*)},

♦ δ(*q0*, *b*, *A*) = {(*q0*, *AA*)},

♦ δ(*q0*, *a*, *A*) = (*q1*, λ).

Simplify the production rules by eliminating the useless variables and productions.

Q6. [10] Construct a Deterministic-PDA that accepts L= { *anbm* | 0 ≤ *m* < *n* } to show L is a Deterministic-CFL.