CSci 435: Formal Languages and Automata

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**Home Assignment 6: 100 points + 20 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 a transition (and remove it at the end of the transitions).

Q1. [15] For a given language L = { *w* | *na*(*w*) + *nb*(*w*) = *nc*(*w*) } where Σ = Γ = {*a*, *b, c*}

1. [10] Construct a NPDA M that accepts L. Draw its transition diagram.

A diagram of a number of letters

Description automatically generated with medium confidence

1. [5] Show the sequence of instantaneous descriptions for the acceptance of *acacbcbc* by M in 1).

Acacbcbc, Stack: λ, q0

Cacbcbc, stack: a, q1

Acbcbc, stack: λ, q1

Cbcbc, stack: a, q1

Bcbc, stack: λ, q1

Cbc, stack: b, q1

Bc, stack: λ, q1

C, stack: b, q1

λ, stack: λ, q1 (accept)

1. [10, optional] Give a CFG G that generates L, L(G) = L.

S -> AC | BC | λ

A -> aA | a

B -> bB | b

C -> cC | c

Q2. [10] Construct an (N/D)PDA for the following languages.

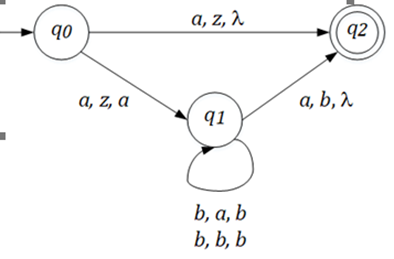
1. [10] L = {*anbm* | *n* ≥ *0, n* ≠ *m*}

A diagram of a flowchart

Description automatically generated

1. [10, optional] L = {*anbmcn+m* | *n, m* ≥ *0*}

Q3. [10] Give the language that is accepted by the NPDA M below 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



M = {Q, Σ, Γ, q0, z0, δ, F} | a + abna | n ≥ 0

M = a(1+abn)

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). Draw the transition diagrams.

1. S → *ab*S*b* | λ.

A diagram of a circle with arrows and a lock

Description automatically generated

1. S → AA | *a*, A → SA | *ab*.

A diagram of a diagram

Description automatically generated

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

Q5. [25] For 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).

1. [10] Find the Context-Free Grammar that generates the language accepted by M by Thm. 7.2.

CFG = ({q0, q1} {a, b} {A, z}) | δ(q0, a, z) = (q0, Az) and δ(q0, b, A) = (q0, ∀b)

S → aSz | bSb | λ

X → aAX | λ

S → X

1. [10] Simplify the production rules in (1) by eliminating useless variables and productions.

You must show the steps of the construction of CFG and simplification in (1) and (2).

S → aSz | bSb | λ

S → aA | bB | λ

A → a | λ

B → bBB | λ

We eliminate X as it does not have any useful productions.

1. [5] Give a language L = L(M) = L(G) in a formal description.

L = (anbn, λ | n ≥ 0)

Q6. [20] Show that L is a DCFL by constructing a deterministic PDA. Draw its transition diagram.

Use ∑= {a, b} and Γ = {A} with a special symbol z. λ may be used both for an input and a stack.

1. [10] L= { *anbm* | 0 ≤ *m* < *n* }

A diagram of a diagram of a diagram

Description automatically generated with medium confidence

1. [10] L = { *w* ∈ {*a, b*}\* | *na*(*w*) ≠ *nb*(*w*) }