Exercise 5.1

Of which Chomsky type are the following productions?

(1) B → cA = Type: 0, 2, 3

(2) cA → B = Type: 0

(3) cA → BaB = Type: 0

(4) C → aBc = Type: 0,2

0: (NT or terminal)* NT(NT or terminal)* → (NT or terminal)*

1: σNTσ → σ(NT or terminal)+σ

σ = (NT or terminal)*

2: (NT) → (NT or terminal)*

3: (NT) →(terminal to NT)

(NT) →(terminal)

(NT) →(ε)

Exercise 5.2 - obligatory (4 points)

The following DTD (document type definition) for XML documents is given:

```
<!DOCTYPE a [
<!ELEMENT a (b | c)>
<!ELEMENT b (c, d?)*>
<!ELEMENT c (#PCDATA)>
<!ELEMENT d (#PCDATA)>
]>
```

(b or c)

(c, d is optional) c is optional with ε

Which of the following XML documents are valid with respect to this DTD? Indicate all errors which are contained in the documents.

(1) Valid

```
<a>
    <c>
        xyz
    </c>
</a>
```

<c> should contain only elementary text

(2) Invalid

```
<a>
    <b>
        <c> 12 </c>
        <d> 34 </d>
        <d> 56 </d>
    </b>
</a>
```

- the second element <d> is not possible. A <c> must follow.

(3) Invalid

```
<a>
    <b>
        <d> 555 </d>
        <c> 444 </c>
        <d> 333 </d>
    </b>
```

(4) Valid

```
<a>
    <b>
        <c> rrr </c>
```

<c> 666 </c>

- element b should be 2nd to element c.
- a should only contain elements a or b.

<c> sss </c>
<d> ttt </d>
<c> uuu </c>

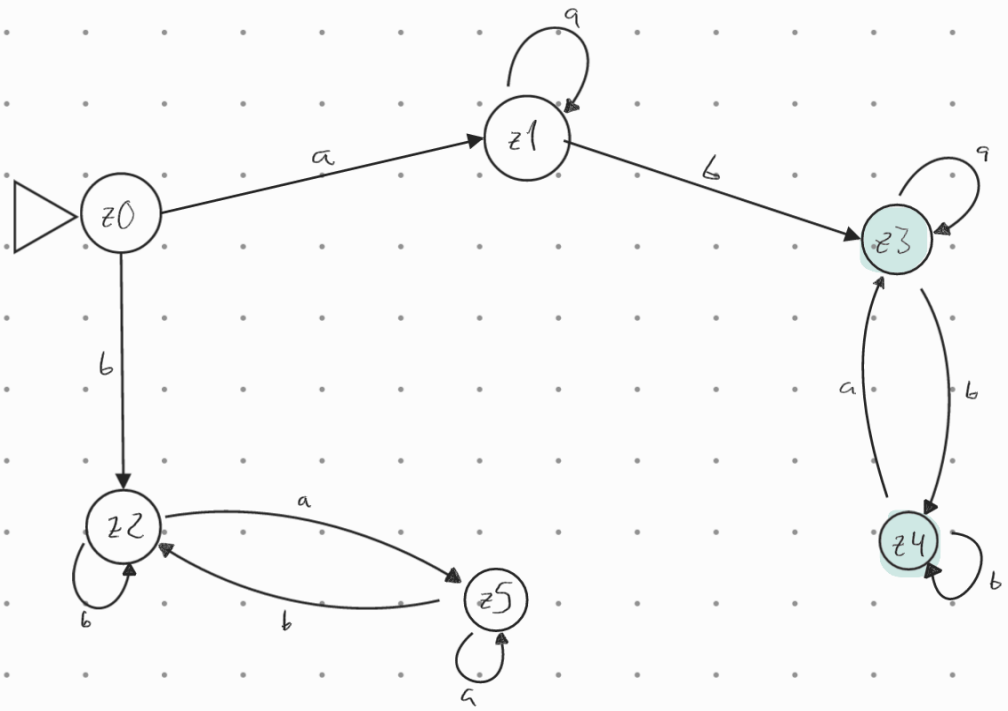
- the child elementd of <d> are in the correct position.

Exercise 5.3 - obligatory (6 points)

Let A = (Q, Σ, δ, z0, E) be a deterministic finite automaton (DFA), where

Z = {z0, z1, z2, z3, z4, z5}
S = {a, b}
δ (z0,a) = z1 δ(z0, b) = z2
δ (z1,a) = z1 δ(z1, b) = z3
δ (z2,a) = z5 δ(z2, b) = z2
δ (z3,a) = z3 δ(z3, b) = z4
δ (z4,a) = z3 δ(z4, b) = z4
δ (z5,a) = z5 δ(z5, b) = z2
E = {z3, z4}

a) Draw A as a transition diagram.



b) Which of the following strings are accepted by A.
(1) ba = not accepted
(2) bbb = not accepted
(3) baabab = not accepted

(4) abababbaaababbba = accepted, stops at z3

c) Which language L(A) is accepted by A?

L(A) = (a+, b, a*, b+, a+)

S → AB

A → aA | ε

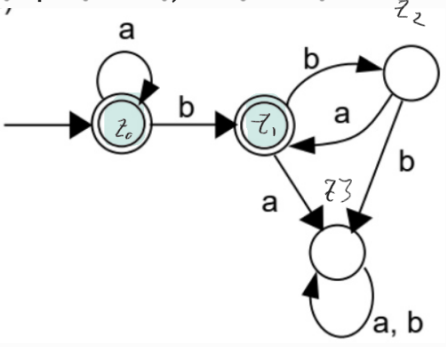
B → bC

C → aC | bD | ε

D → bD | aC | ε

Exercise 5.4

What language does the following DEA accept? (can be specified as a regular expression)



Z = {z0, z1, z2, z3}

S = {a, b}

δ (z0,a) = z0 δ(z0, b) = z1

δ (z1,a) = z3 δ(z1, b) = z2

δ (z2,a) = z1 δ(z2, b) = z3

δ (z3,a) = z3 δ(z3, b) = z3

E = {z0, z1}

S → AB

A → aA | ε

B → b(ba)* | ε

Exercise 5.5

a) Let S = {0,1}. Define a deterministic finite automaton (DFA) that accepts the language

L1 = {w ε S* | |w| is odd

Z = {z0, z1, z2, z3}

S = {0, 1}

δ (z0,1) = z1 δ(z0, 0) = z2

δ (z1,0) = z3 δ(z1, 1) = z0δ (z2,0) = z0 δ(z2, 1) = z3

δ (z3,0) = z1 δ(z3, 1) = z2

E = {z3}

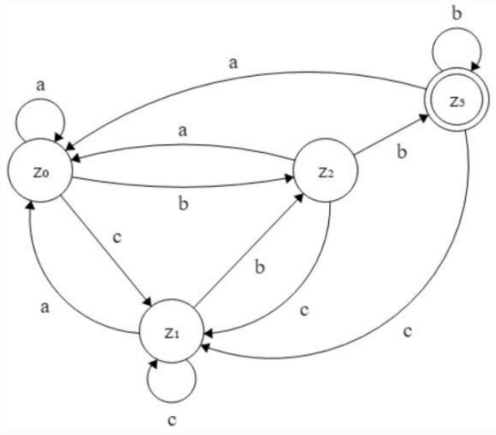
b) Let S = {0,1}. Define a DFA that accepts the language
L2 = { 11w00 | w ε S*} U { 00w11 | w ε S*}.

c) Let S = {a, b}. Define a DFA accepting all strings w ε S* that start with character b and contain an odd number of a characters.

Exercise 5.6 - obligatory (6 points)

Let S = {a, b, c}.

a) Define a DFA that accepts all strings ending with bb.

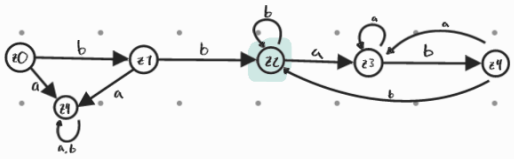


A = (Z, S, δ, z0, E)
Z = {z0, z1, z2, z3}
S = {a, b, c}

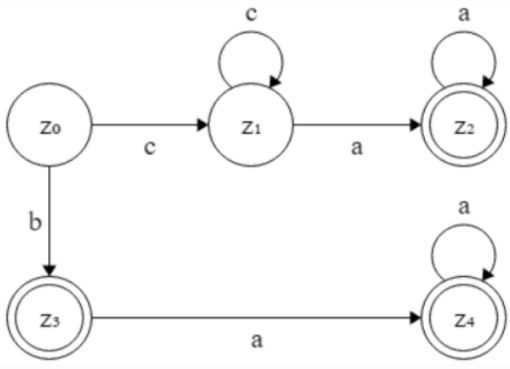
δ : Z × Σ → Z
δ (z0, a) = z0
δ (z0, b) = z2
δ (z0, c) = z1
δ (z1, a) = z0

δ (z1, b) = z2
δ (z1, c) = z1
δ (z2, a) = z0
δ (z2, b) = z3
δ (z2, c) = z1
δ (z3, a) = z0
δ (z3, b) = z3
δ (z3, c) = z1
z0 is initial state
E = { z3 }

Ending with bb with {a,b}



b) Define a DFA that accepts the language of the regular expression (c+a|b)a*.



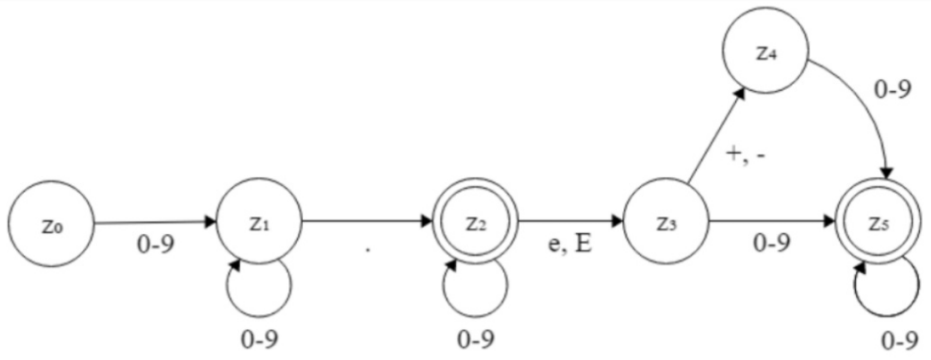
B = (Z, S, δ, z0, E)
Z = {z0, z1, z2, z3, z4}
S = {a, b, c}

δ : Z × Σ → Z
δ (z0, c) = z1
δ (z1, c) = z1
δ (z1, a) = z2
δ (z2, a) = z2
δ (z0, b) = z3
δ (z3, a) = z4
δ (z4, a) = z4
z0 is initial state
E = {z2, z3, z4}

Exercise 5.7

Define a DFA that accepts all floating-point numbers that are build as following:
• The integer part preceding the decimal point and the fractional part after the

decimal point can consist of an arbitrary number of digits (one or more).
• If there is an exponent, it begins with 'e' or 'E', has an optional sign '+' or '-' and an arbitrary number of digits (one or more).
Here are some examples:
123.4500
12.345e6
0.20E+678
1004.5e-6789
You can omit error states.



A = (Z, S, δ, z0, E)
Z = {z0, z1, z2, z3, z4, z5}
S = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., +, -, e, E}

δ : Z × Σ → Z
δ (z0, 0-9) = z1
δ (z1, 0-9) = z1
δ (z1, .) = z2
δ (z2, 0-9) = z2
δ (z2, {e, E}) = z3
δ (z3, {+, -}) = z4
δ (z3, 0-9) = z5
δ (z5, 0-9) = z5
z0 is initial state
E = {z2, z5}