# ToC Spring 2022

Practice 1 – Solutions

1. Textbook, Page 83, Exercise 1.4. (a) i. {*w*| *w* has at least three a’s}

a,b

A

B

C

D

b

b

b

a

a

a

* 1. {*w*| *w* has at least two b’s}

a,b

1

2

3

a

a

b

b

* 1. {*w*| *w* has at least three a’s and at least two b’s}

A

1

B

1

C

1

D

1

2

A

2

B

2

C

2

D

A

3

3

B

C

3

D

3

a

a

a,b

b

b

b

a

a

a

a

a

a

a

a

a

b

b

b

b

b

b

b

b

(b) i. {*w*| *w* has exactly two a’s}

a,b

A

B

C

D

b

b

b

a

a

a

1. {*w*| *w* has at least two b’s}

a,b

1

2

3

a

a

b

b

1. {*w*| *w* has exactly two a’s and at least two b’s}

A

1

1

B

C

1

D

1

A

2

B

2

C

2

D

2

3

A

3

B

C

3

D

3

a

a

a,b

b

b

b

a

a

a

a

a

a

a

a

a

b

b

b

b

b

b

b

b

(c) i. {*w*| *w* has an even number of a’s}

1

2

b

b

a

a

ii. {*w*| *w* has one or two b’s}

a,b

A

B

C

D

a

a

a

b

b

# {*w*| *w* has an even number of a’s and one or two b’s}

1

A

B

1

1

C

D

1

A

2

B

2

C

2

D

2

b

b

a

a

a

a

a

a

a

a

b

b

b

b

b

b

1. i. {*w*| *w* has an even number of a’s}

1

2

b

b

a

a

* 1. {*w*| each a in *w* is followed by at least one b}

a,b

A

B

C

b

a

a

b

* 1. {*w*| *w* has an even number of a’s and each a is followed by at least one b}

A

1

B

1

C

1

A

2

2

B

2

C

b

b

b

b

a

a

a

a

a

a

b

b

1. i. {*w*| *w* starts with an a}

a,b

1

2

3

a,b

b

a

* 1. {*w*| *w* has at most one b}

a,b

A

B

C

a

a

b

b

* 1. {*w*| *w* starts with an a and has at most one b}

A

1

B

1

1

C

A

2

B

2

C

2

A

3

3

B

C

3

a

a

a,b

a

a

a,b

a

a

a

b

b

b

b

b

b

b

1. i. {*w*| *w* has an odd number of a’s}

1

2

b

b

a

a

* 1. {*w*| *w* ends with a b}

A

B

a

b

b

a

* 1. {*w*| *w* has an odd number of a’s and ends with a b}

A

1

B

1

A

2

2

B

b

b

a

a

a

a

b

b

1. i. {*w*| *w* has even length}

a,b

A

B

a,b

* + 1. {*w*| *w* has an odd number of a’s}

1

2

b

b

a

a

* + 1. {*w*| *w* has even length and an odd number of a’s}

A

1

B

1

A

2

2

B

a

a

a

a

b

b

b

b

2. Textbook, Page 84, Exercise 1.7.

# (a) The language {*w*| *w* ends with 00} with three states

1

2

3

0

,

1

0

0

1. The language {0} with two states

1

2

0

1. The language 0∗1∗0+ with three states

1

2

3

0

1

0

*λ*

0

1. The language 1∗(001+)∗ with three states

1

2

3

1

0

0

1

1. The language {*ε*} with one state

1

1. The language 0∗ with one state

1

0

1. Textbook, Page 86, Exercise 1.18. Give regular expressions generating the languages ofExercise 1.6.
   * 1. {*w*| *w* begins with a 1 and ends with a 0}

1Σ∗0

* + 1. {*w*| *w* contains at least three 1s}

Σ∗1Σ∗1Σ∗1Σ∗

* + 1. {*w*| *w* contains the substring 0101, i.e., *w* = *x*0101*y* for some *x* and *y*}

Σ∗0101Σ∗

* + 1. {*w*| *w* has length at least 3 and its third symbol is a 0}

ΣΣ0Σ∗

* + 1. {*w*| *w* starts with 0 and has odd length, or starts with 1 and has even length}

(0 ∪ 1Σ)(ΣΣ)∗

* + 1. {*w*| *w* doesn’t contain the substring 110}

0∗(10+)∗1∗