# 2023 NCKU CSIE Compiler Quiz 1

1. (45 %) Write regular expressions for the following character sets, or give reasons why no regular expression can be written:

   (a) (5 %) All strings of lowercase letters that begin and end in a.

   (b) (5 %) All strings of lowercase letters that either begin or end in a (or both).

   (c) (5 %) All strings of digits that contain no leading zeros.

   (d) (5 %) All strings of digits that represent even numbers.

   (e) (5 %) All strings of digits such that all the 2's occur before all the 9's.

   (f) (5 %) All strings of a's and b's that contain no three consecutive b's.

   (g) (5 %) All strings of a's and b's that contain an odd number of a's or an odd number of b's (or both).

   (h) (5 %) All strings of a's and b's that contain an even number of a's and an even number of b's.

   (i) (5 %) All strings of a's and b's that contain exactly as many a's and b's.

2. (25 %) Use Thompson's construction to convert the regular expression $(aa|b)^*(a|bb)^*$ into an NFA.

3. (30 %) Convert the NFA of part 2 into a DFA using the subset construction.

1.
a. letter = (a|b|…|y|z)
    RE = (a(letter)*a)|a
b. letter = (a|b|…|y|z)
    RE = (a(letter)*)|((letter)*a)
c. RE = (1|2|-|8|9)(0|1|2|-|8|9)*
d. even_number=(0|2|4|6|8)
    RE =(0|1|-|8|9)*(even_number)
e. RE =(0|1|…|7|8)*(0|1|3|…|9)*
f. RE =(ε|b|bb)(a|ab|abb)*
g. RE = odd number of a's | odd number of b's
        = (b*a(b|ab*a)*)|(a*b(a|ba*b)*)
h. RE = ((ab|ba)(aa|bb)*(ab|ba)|aa|bb)*
i. This cannot be described by a regular expression because regular expression can't count.

2.
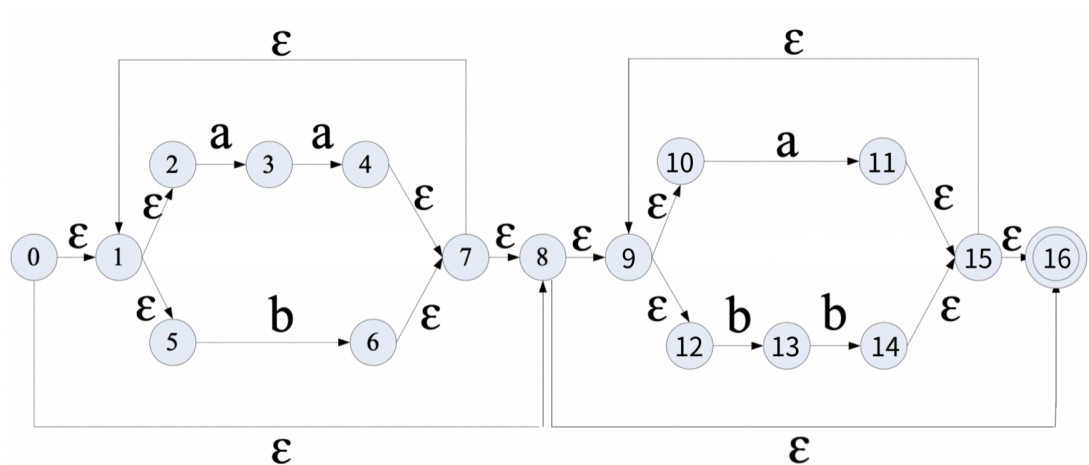
3.
s = [0]
A=ε-closure(s)=[0,1,2,5,8,9,10,12,16]
B=ε-closure([3,11])=[3,9,10,11,12,15,16] # move to a from A
C=ε-closure([6,13])=[1,2,5,6,7,8,9,10,12,13,16] # move to b from A
D=ε-closure([4,11])=[1,2,4,5,7,8,9,10,11,12,15,16] # move to a from B
E=ε-closure([13])=[13] # move to b from B
B2=B=ε-closure([3,11]) # move to a from C
F=ε-closure([6,13,14])=[1,2,5,6,7,8,9,10,12,13,14,15,16] # move to b from C
B3=B=ε-closure([3,11]) # move to a from D
C2=C=ε-closure([6,13]) # move to b from D
G=ε-closure([14])=[9,10,12,14,15,16] # move to b from E
B4=B=ε-closure([3,11]) # move to a from F
F2=F=ε-closure([6,13,14]) # move to b from F

H=ε-closure([11])=[9,10,11,12,15,16] # move to a from G
E2=E=ε-closure([13]) # move to b from G
H2=H=ε-closure([11]) # move to a from H
E3=E=H=ε-closure([13]) # move to b from H