SCSI1013: Discrete Structure
[2018/2019 - Semester 1]

TUTORIAL 4

Due Date: **12th December 2018 (Wednesday) - 10 A.M**

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1. Let $M = (S, I, q_0, f_s, F)$ be the Deterministic Finite Automata (DFA) such that $S = \{q_0, q_1, q_2, q_3\}$, $I = \{a, b\}$, $F=\{q_1, q_3\}$, and f_s is given by

$f_s(q_0,a)= q_1$, $f_s(q_2,a)= q_2$
$f_s(q_0,b)= q_2$, $f_s(q_2,b)= q_3$
$f_s(q_1,a)= q_2$, $f_s(q_3,a)= q_1$
$f_s(q_1,b)= q_1$, $f_s(q_3,b)= q_0$

a) Draw the state diagram of M.

b) Which of the strings are accepted by M?
   i. **aaaa**
   ii. **bbbbb**
   iii. **bbbaaa**
   iv. **ababa**

Show the sequence of configuration as part of your work.

2. Let M be a DFA as depicted on Figure 1.

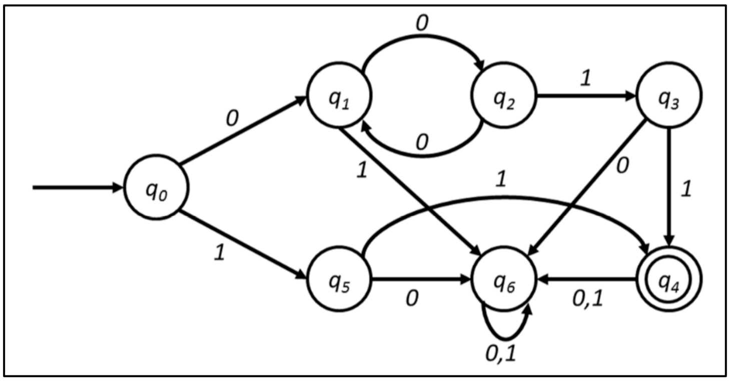

Figure 1: M

a) Find three strings that will be accepted by M.
b) Find three strings with length of four that will not be accepted by M.

3. Construct a state transition diagram of a DFA that accepts the given set of strings over {0, 1}

a) **00**

b) start with **100**

c) end with **010**

4. Let Z be a finite state machine such that the state transition diagram as shown in Figure 2.

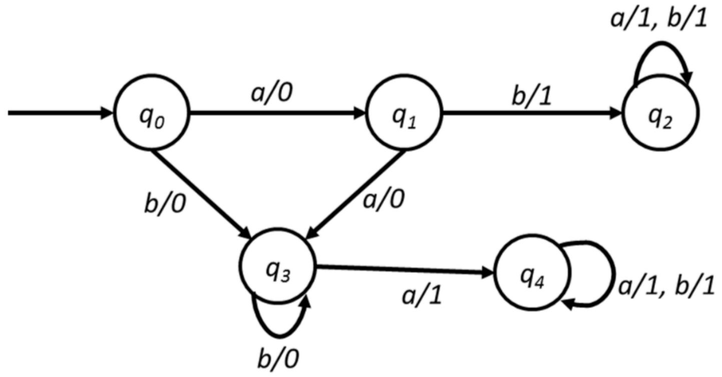

Figure 2

a) Write the transition table of Z.
b) Find the output string of the following input string. Then, check wheather the string is accepted by Z.
   i. **aabba**
   ii. **baba**

   You must show the sequence of configuration as part of your work.

c) Find two strings with length of four that will not be accepted by Z.

5. *Pac-Man* is an arcade game developed by a young Namco employee named Toru Iwatani and first released in Japan in 1980. It is considered one of the classics of the medium, virtually synonymous with video games, and an icon of 1980s. *Pac-Man* is one of the few games to have been consistently published for over three decades, having been remade on numerous platforms and spawned many sequels. Re-releases include ported and updated versions of the original arcade game.

   The typical version of Pac-Man is a one player game where he/she manoeuvres the Pac-Man around the maze, attempting to avoid four 'ghosts' characters while eating dots that distributed throughout the maze. Among the dots, there are four super dots that located at four corners of the maze. If the Pac-Man collides with the ghost, he loses one of his three lives and play resumes with the ghosts reassigned to their initial starting location. When Pac-Man eats a super dot, he is able to chase the ghosts for a few seconds of time before the super dot expires. The game ends when Pac-Man has lost all his three lives. Figure 3 shows a screenshot of the Pac-Man game.

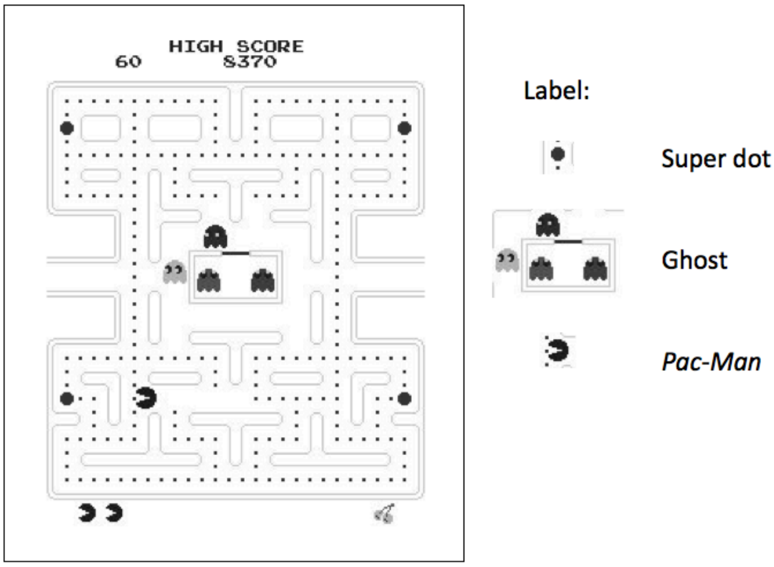

Figure 3

Noted that the ghosts in Pac-Man have four behaviours:

S_1 : randomly wander the maze
S_2 : chase Pac-Man when he is within the line of sight
S_3 : avoid Pac-Man when has consumed a super dot
S_4 : return to the initial position to restart the game

The inputs are:

A : spot Pac-Man (Pac-Man is within the line of sight)
B : lose Pac-Man (Pac-Man is not within the line of sight)
C : Pac-Man eats super dot
D : super dot expires
E : collides with Pac-Man
F : reach the initial position

The outputs are:

0 : nothing happened
1 : Pac-Man loses his life
2 : number of ghosts reduces by 1

Complete the transition table below.

State	Input, f_s						Output, f_o					
	A	B	C	D	E	F	A	B	C	D	E	F
S_1												
S_2												
S_3												
S_4												

6. Consider the (3,7) encoding function $f : B^3 \to B^7$ which is given by

$f(000) = 0000000$ $\quad f(100) = 1000101$
$f(001) = 0010110$ $\quad f(101) = 1010011$
$f(010) = 0101000$ $\quad f(110) = 1101101$
$f(011) = 0111110$ $\quad f(111) = 1111011$

a. Find the weight of the above encoding function
b. Find the minimum distance
c. How many errors can f detect?

7. If $H = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ is a parity check matrix

Find all group codes for $f_H : B^3 \to B^6$

8. Let $f : B^2 \to B^5$ are defined by,

$f(00) = 00000;$ $\quad f(01) = 01110;$ $\quad f(10) = 10101;$ $\quad f(11) = 11011$

a. Show that $f : B^3 \to B^5$ is a group code
b. Find its minimum distance

9. Consider the (3,) group encoding function $f : B^3 \to B^5$ define by

$f(000) = 00000$
$f(001) = 00101$
$f(010) = 01010$
$f(011) = 01101$
$f(100) = 10001$
$f(101) = 10100$
$f(110) = 11011$
$f(111) = 11111$

Decode the following words relative to a maximum likelihood function:

a) 10011 $\quad$ b) 11101 $\quad$ c) 01000