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Paper Title: ________Artificial Intelligence_______________________________________

Course:___________B.Sc.(Hons.) Computer Science__________________________________

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Assignment File Name ____2017CSC1059_AI_Practical_________________________________

List of Files in the submitted Archive in format ZIP .

1. Adder, Decoder, Encoder, Mux, DeMux, Multiplier.pl(This file contains the additional code)
2. Flip-Flips.pl
3. Gates.pl

Archive Size in KB : 2.5 kB (2,470 bytes)

Special Assignment in lieu of Semester End Practical Examination May-June 2020
B.Sc. (Hons.) Computer Science Semester-VI
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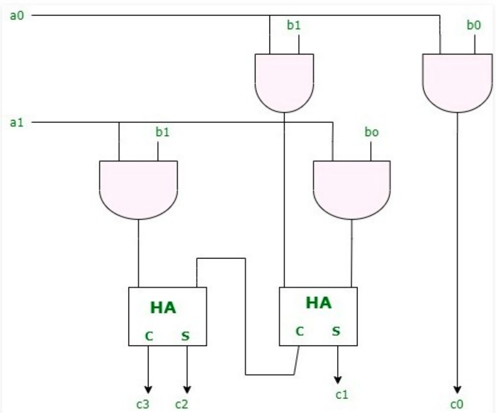
Functional Extension of the work done earlier

Ans : The additional functional capability that I have added is “2-bit by 2-bit binary multiplier”. For implementation of multiplier with a combinational circuit, consider the multiplication of the two-bit number 11 and 10. Here, the multiplicand bits are b1 = 1, b0 = 1 and the multplier bits are a1 = 1, a0 = 0. And the product is c3 = 0, c2 = 1, c1 = 1 and c0 = 0.

		b1(1)	b0(1)
	x	a1(1)	a0(0)
		0	0
	1	1	
c3(0)	c2(1)	c1(1)	c0(0)



The code added is:

```
%% 2-bit by 2-bit binary multiplier
multiply(a0, a1, b0, b1, c3, c2, c1, c0):-
        and(a0, b0, c0),
        and(a0, b1, X1),
        and(a1, b0, Y1),
        and(a1, b1, X2),
        half_adder(X1, Y1, c1, Y2),
        half_adder(X2, Y2, c2, c3).
```

Epidemic Modelling

Ans (a): I have tried to model the epidemic from human perspective. I have chosen to model this from human perspective beacause until vaccine for the infection is available, prevention is the only option we have. So in a way this can guide us how to tackle the epidemic.
This model mainly includes how people got infected, what is the daily infection rate and by what factor it is spreading.
Here, Exponential model is used for calculation of rate/growth of spread of infection.

(b): Let this rectangle represent the city. It is divided into 9 regions based on their living condition.

DZ	SPZ	ISZ
SSZ	MSZ	MICZ
MOCZ	HCZ	ECZ

From the given data, we know the percentage of population living in:

15% in extreme congestion zone (ECZ)
30% in high congestion zone (HCZ)

35% in moderate congestion zone (MOCZ)
10% in mild congestion zone (MICZ)
7% in moderately spaced zone (MSZ)
2% in safe space zone (SSZ)
0.8% in ideal space zone (ISZ)
0.1% in sparse zone (SPZ)
0.1% in dispersed zone (DZ)

Now assuming the total population of the city is (N) = 2,00,00,000.
Distributing this according to the percentage given. So, the total number of people living in each region is:

$2x10^4$	$2x10^4$	$16x10^4$
$4x10^5$	$14x10^5$	$2x10^6$
$7x10^6$	$6x10^6$	$3x10^6$

Assuming a random distribution of initial carriers (i.e. carrier exists in a set of people with a very small probability, but uniformly – say there is one carrier per r persons (e.g. r = 1 million).
Therefore, the number of infected people in each region given by (population of that region / 10,00,000) is:

$0.02 \approx 0$	$0.02 \approx 0$	$0.16 \approx 0$
$0.4 \approx 0$	$1.4 \approx 1$	2
7	6	3

Now, the exponential model can be applied to find the rate of spread of infection. Therefore,

$$N_i = I_i \cdot (DIR)^{d-1}$$

where, I_i is number of people initially infected / total infected at start of the day,
DIR is Daily Infection Rate
d is Number of Days
N_i is New cases

Now, assuming the daily Mobility of Population (MOP) at two levels:
Static (S) – eveyone stays at home
Dynamic (D) – normal movement for work etc.

Case 1: Static Mobility of Population (Best Case Scenario)
In this case, the infected people are quarantined at home and no one is outside. The virus mutates and actually dies out.
Since the probability of transmission of virus depends on two conditions:
1) if carrier is within 2 meter radius of another person
2) for the duration is more than 5 sec

These four regions namely DZ, SPZ, ISZ and SSZ won't be affected by the virus since the Average inter-person space (radial) for these four regions is more than 2.5 m and the city is already on complete lockdown which prevents people from meeting with each other.
As for the rest of regions, lets assume that transmission of virus is very slow and is moving from one single person to another single person at time.
Therefore, DIR = 1.

Thus, the total number of cases on day 1 will be:

MSZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 1(1)^{1-1}$ => $N_i = 1$.

MICZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 2(1)^{1-1}$ => $N_i = 2$.

ECZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 3(1)^{1-1}$ => $N_i = 3$.

HCZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 6(1)^{1-1}$ => $N_i = 6$.

MOCZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 7(1)^{1-1}$ => $N_i = 7$.
Total : 19 cases on Day 1.

For Day 2,

MSZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 1(1)^{2-1}$ => $N_i = 1$.

MICZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 2(1)^{2-1}$ => $N_i = 2$.

ECZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 3(1)^{2-1}$ => $N_i = 3$.

HCZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 6(1)^{2-1}$ => $N_i = 6$.

MOCZ : $N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 7(1)^{2-1}$ => $N_i = 7$.
Total : 19 cases on Day 2.
Overall: Day 1 + Day 2 = 19 + 19 = 38.

From the above calculation, it can be said that cases are doubling each day only in these four regions even after complete lockdown.

So, this forms a geometric series,
19, 38, 76, 152, . . ., 1,84,00,000(total population of five region where infection has spread).
This can be written using nth term of GP(a = 19, r = 2)
Day 1 => $19(2)^{1-1} = 19$,
Day 2 => $19(2)^{2-1} = 38$,
Similarly, at Day n

Day n => $19(2)^{n-1}$
Therefore, the time needed for X% population to be infected can be calculated as:
=> (X / 100) x 1,84,00,000 (population effected)
=> Since the sequence is in GP with a = 19 and r = 2, n = days, can be calculated using the nth term of GP.
=> $a(r)^{n-1}$ = (X / 100) x 1,84,00,000
=> $(r)^{n-1}$ = (X / 100) x 9,68,421
=> $(r)^{n-1}$ = (X) x 9,684.21
=> $\log_2 r^{n-1} = \log_2((X) \times 9{,}684.21)$
=> n -1 = $\log_2((X) \times 9{,}684.21)$
=> n = $\log_2((X) \times 9{,}684.21) + 1$

For example:- To find out how much time it will take to affect 5% of population, just put X = 5 and then number of days will be:
=> n = $\log_2((5) \times 9{,}684.21) + 1$
=> n = $\log_2(48421.05) + 1$
=> n = 15.56 + 1
=> n = 16.56 ≈ 17

Therefore, in approximately 17 days 5% of population living in infected regions will get infected.

Case 2: Dynamic Mobility of Population (Worst Case Scenario)

In this case , the infected person is not in Quarantine. He/She is roaming freely and spreading the virus.
Also, breaking the city into regions does not work here since there is no restriction on movement of people.

Therefore, number of people initialy infected can be calculated as:
=> Total population / 10,00,000
=> 2,00,00,000 / 10,00,000
=> 20 people.

Now, lets say each person is spreading th virus to atleast 50 people in a day since there is no restriction on movement.
Therefore, DIR = 50.

Thus, the total number of cases on day 1 will be:

$N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 20(50)^{1-1}$ => $N_i = 20$.

For Day 2,

$N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 20(50)^{2-1}$ => $N_i = 1{,}000$.

For Day 3,

$N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 20(50)^{3-1}$ => $N_i = 50{,}000$.

This again forms a geometric series,
20, 1000, 50000, . . . , 2,00,00,000(total population)
Again this can be written using nth term of GP(a = 20, r = 50)
Day 1 => $20(50)^{1-1} = 20$,
Day 2 => $20(50)^{2-1} = 1{,}000$,
Similarly, at Day n
Day n => $20(50)^{n-1}$
Therefore, the time needed for X% population to be infected can be calculated as:
=> (X / 100) x 2,00,00,000 (population effected)
=> Since the sequence is in GP with a = 20 and r = 50, n = days, can be calculated using the nth term of GP.
=> $a(r)^{n-1} = (X / 100) \times 2{,}00{,}00{,}000$
=> $(r)^{n-1} = (X / 100) \times 10{,}00{,}000$
=> $(r)^{n-1} = (X) \times 10{,}000$
=> $\log_{50} r^{n-1} = \log_{50}((X) \times 10{,}000)$
=> $n - 1 = \log_{50}((X) \times 10{,}000)$
=> $n = \log_{50}((X) \times 10{,}000) + 1$

For example:- To find out how much time it will take to affect 5% of population, just put X = 5 and then number of days will be:
=> $n = \log_{50}((5) \times 10{,}000) + 1$
=> $n = \log_{50}(50{,}000) + 1$
=> $n = 2.76 + 1$
=> $n = 3.76 \approx 4$
Therefore, in approximately 4 days 5% of total population will get infected.

This situation can be made better by containment of infection, isolating the infected individuals as soon as they are identified. Special medical wards can be set up in remote places where infected people can stay during infection so that the infection does not spread from one person to another either direcly or indirectly.

So, in this case DIR becomes 0.
Now, using the exponential model, we get:

$N_i = I_i \cdot (DIR)^{d-1}$ => $N_i = 20(0)^{1-1}$ => $N_i = 0$.

$N_i = 0$ means no new cases will occur.
And as for infected people, they will stay under isolation until they are completely healed.