Tutorial session 4

Exercise 1

a) We have 3 dices; F, 1, and 2.

The croupier changes the dices accross time.
We can represent the probabilities ~~to~~ ~~chan~~ of changind from one dice to another with the Transition matrix A.

We assume a first order markov model → ~~was~~ memory The only state that has impact on the current state is the previous state.

~~one row per state plus an extra row for initial state~~

$$A = \begin{bmatrix} a_{0F} & a_{01} & a_{02} & - \\ a_{FF} & a_{F1} & a_{F2} & a_{FE} \\ a_{1F} & a_{11} & a_{12} & a_{1E} \\ a_{2F} & a_{21} & a_{22} & a_{2E} \end{bmatrix}$$

✓ Transition matrix

~~This doesn't not~~ exist because the coupier cannot finish the game as soon as the game starts.

~~ca~~ ~~the sum~~ of the probabilities of each row is one.

There is no row for the final state

Probability of the coupier of using the dice 2 to finish the game

→ $a_{ij} = P(X_T = s_j \mid X_{T-1} = s_i)$

→ $\forall i \sum_{j=0}^{n+1} a_{ij} = 1$ → ~~[illegible]~~ ~~[illegible]~~ for all the states, the sum of the probabilities of going from that state the the other states is one.... check next example

now we have the observation matrix.
The observation matrix represents the probability of seeing an observation in a specific state.

In this case the observation matrix represents the probability of obtaining a specific number in each of the dices

for a fair dice a row would be: (1/6, 1/6, 1/6, 1/6, 1/6, 1/6)

$$B = \begin{bmatrix} b_F(1) & b_F(2) & b_F(3) & b_F(4) & b_F(5) & b_F(6) \\ b_1(1) & b_1(2) & b_1(3) & b_1(4) & b_1(5) & b_1(6) \\ b_2(1) & b_2(2) & b_2(3) & b_2(4) & b_2(5) & b_2(6) \end{bmatrix}$$

The sum of the probabilities in a row is one

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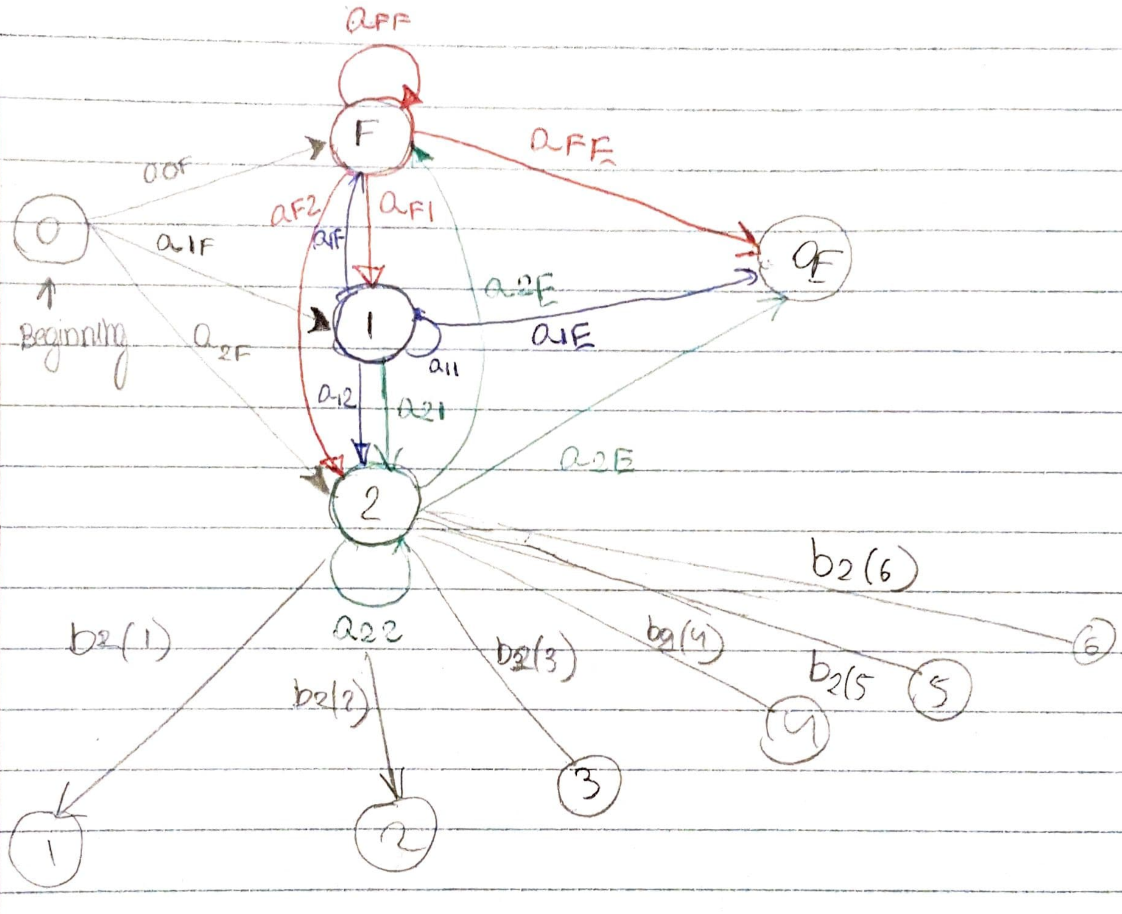
Question 1, part b)

b) drawing Time !!!



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Question 1 part 3

I) The crupier never switches directly from F to L2.

$a_{F2} = 0$

II) The crupier know in advance how many dice throws the sequene will contain and makes seure that the dice is always F on the last roll.

$a_{1F} = 0$

$a_{2F} = 0$

- $a_{FE} \Rightarrow$ we do not know with the given information. We ~~[illegible]~~ need all the other transition probabilities of F. a_{FF}, a_{F1}, a_{F2}, a_{F}

~~III)~~

III) The crupier never rolls 2 more than twice in a row.

~~[illegible]~~ second order markov

$$\underbrace{P(X_T = 2 \mid X_{T-1} = 2, X_{T-2} = 2)}$$

- We know for sure that a_{22} is lower or equal than 0.5. because we cannot get ~~the~~ more than 2 sequences in a row)

iv) The croupier always switches dice after rolling a 6

→ We do not know the extent that this will affect the transition probabilities. What we know is that there is a dice ~~with~~ that always return 6. Then

$a_{Dice6\ Dice6} = 0$

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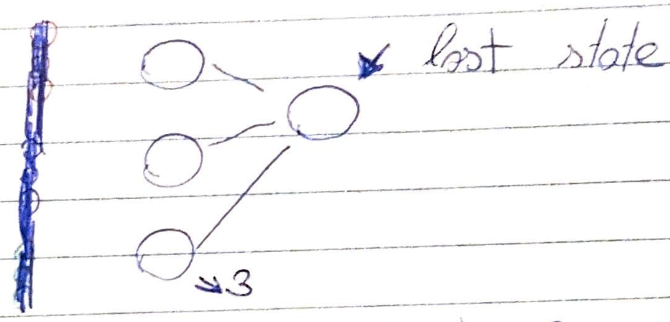
Question 2) Part 1)

We keep N^q states.

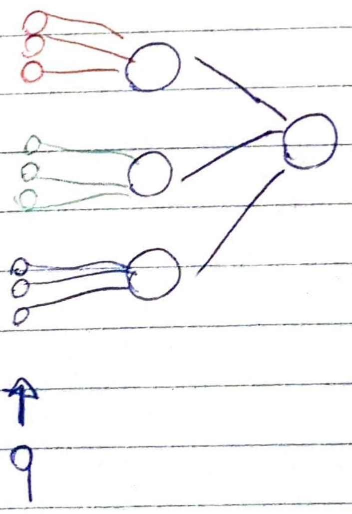
number of states

order of the HMM

example; the states=3 HMM order = 1



example; the states = 3, HMM order = 2



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Question 2 Part 2

b) $O(N^{2O+1} T)$

O is the order an T is the time