Sequential Data

Hidden Markov Models

a) $P(x|M)$ using forward Algorithm. $x = \cdot CGTCAG$

Initializing the forward algorithm for the starting point of t: Hidden states = S_1 and S_2

- For all states

$$\forall s_k \in \{s_1, s_2\}, \quad \alpha_1^k = P(x_1 | \Pi_1 = s_k) P(\Pi_1 = s_k)$$

Iterating the forward algorithm for getting the next value of t:

$$\forall s_k \in \{s_1, s_2\}, \quad t \in \{2, 3, 4, 5, 6\}$$

$$\alpha_t^k = P(x_t | \pi_t = s_k) \sum_{i \in \{1,2\}} \alpha_{t-1}^i a_{ik}$$

Getting the results for $P(x|M)$ by providing the two states of s_k as s_1 and s_2.

α	α_1^k	α_2^k	α_3^k	α_4^k	α_5^k	α_6^k
$s_k = s_1$	0.05	0.032	0.0029	3.92×10^{-4}	3.488×10^{-4}	1.3011×10^{-4}
$s_k = s_2$	0.2	0.017	0.008	0.0028	2.31×10^{-4}	2.547×10^{-5}

Sequential Data

Hidden Markov Models

b) Most likely path of hidden states using the Viterbi algorithm.

Viterbi looks for the most probable path.

Using Viterbi algorithm to calculate the value of V_t^k for two different states S_1 and S_2 for t different observations.

$t = 1,2,3,4,5,6$ for $s_k = S_1, S_k = S_2$

V_t^k	V_1^k	V_2^k	V_3^k	V_4^k	V_5^k	V_6^k
S_1	0.05	0.0160	0.0013	1.024×10^{-4}	1.3107×10^{-4}	4.194×10^{-5}
S_2	0.20	0.0160	0.0013	0.0016	1.3107×10^{-4}	1.048×10^{-5}

Multiple paths are leading us to the sequence x.

Hence, we are using viterbi algorithm.

Here to find the shortest path by maximising $Ptr(K,t)$ for states S_1 and S_2.

Ptr (K,t)	S_1	S_2
Ptr (K,1)	S_1	S_1
Ptr (K,2)	S_1	S_2
Ptr (K,3)	S_1	S_2
Ptr (K,4)	S_1	S_2
Ptr (K,5)	S_2	S_2
ptr (K,6)	S_1	S_2

The most likely path is.

$S_2, S_2, S_2, S_2, S_1, S_1$

Gated Recurrent Unit

a) What values of r_{ij} and z_{ij} would cause the new state for h_{ij} to be similar to its old state?

Ans. When z_{ij} is near 1, then any value for r_{ij} would cause the new state for h_{ij} to be similar to its old state, according to the linked paper.

b). If r_{ij} and z_{ij} are both close to 0, how would the state for h_{ij} be updated?

Ans. According to eq (7) and (8) from the linked paper, the new state of h_{ij} will have to be initialized from scratch. based on the input variable if r_{ij} and z_{ij} are both close to 0. But this is also partially dependent on the set of r_{ij} values. For all i and the weight matrix W, which demonstrates the links between all these values of r_{ij}. Hence, where r_{ij} and z_{ij} are both close to zero, then the state of h_{ij} will be updated by being reinitialized for scratch.