## CSE 512 Machine Learning HW5 Mihir Chakradeo 111462188

Q1.

[I]	HMM with tied mixtures
	$P(Ot Xt=j,0) = \sum_{k=1}^{K} wik N(Ot M_k, \Sigma_k) \forall j \in \{1,M_k\}$
-	Live all the interest of this word on the
Q. O	List all the parameters of this HMM model we have 3 distributions:
	(i) P(X1): (m-1) parameters
	Transition: 100 100 (100) (100)
7	(ii) P(X++   X+) : mx (m-1) parameters.
	Likelihood:
	(iii) P(Ot(Xt): * U*; K parameters (Mean)
	· Zy K parameters (covariance)
1 X	
13,117	(weights of GMM)
6,6	
(111)	11113 (x) 1+18-1+18)9 (x1+18)19 Z = (x)18
Q · (2)	Derive the Estep. What do we need
	to estimate in the E-step?
- Print	· modurati cuarrate crost (rin) mil
	For the E step, we need to estimate
	the Charles we held to animate
	the following distributions 100 000 000 000
	(i) P(X1/01/1) 14 (14 /14 /2 (740) 14)9
A STATE OF THE STA	(ii) P(X+101:7) ++ (1:01:X)4
	(II) PC XL, XLAN OIIT) +t.
	we calculate these using the forward
	backward pass as follows:
- 100	

	EORWARD PASS · dI(XI) = P(OI   XI) P(XI)
	Here, P(OIIXI) is given to us
(A (	PCXI) can be found out by counting.
-	· Now, we calc. 22(Xz)~2(XT):
	$Ai(Xi) = \sum_{i} P(0i Xi) P(Xi Xi-1=2i-1) Ai-1(2i-1)$
	21-11-11-12-10-12-
	here, plaibli) is given to us:
	P(xi xi-1=2i-1) can be found by counting.
	diri (211-1) from previous iteration.
	1.000.0001
$\overline{}$	BACKWARD PASS
(:11	Initialize: BTCX7)=1.
	. Generate backvards factors by eliminating Xi+1
	for i suith to imposit
	Bi(Xi) = E P(Oi+ Ni+ )P(Xi+1=21+1 Xi) Bi+1(21+1)
	Ni+1
	here, P(0i+1/2i+1) is given to us.
	P(Xi+1=xi+1 Xi) can be found by counting.
	Bit (ait) from previous iteration.
7.	For the F step, we need to allimete
	.: We can calculate involved production give
	P(XI OI:T) & di(Xi) \$1(Xi) \ \frac{1}{2}
	$P(x_i o_{i:T}) = \underline{A_i(x_i)_{B_i(x_i)}}$
	Zi di(Xi) Bi(Xi)
<b>(</b>	Acres and a second seco
	BYOW OF THE PROBLEM SERVENCE OF BY BYOND ON

	can be obtained as:
	P(Xi, Xi+1   O1:T) $d$ $di(Xi)$ $P(Xi+1)$ $Xi+1$ $P(Xi+1)$ $P(Xi+1)$ $P(Xi, Xi+1   O1:T) = di(Xi)$ $P(Xi+1 Xi)$ $P(Oi+1 Xi+1)$ $P(Xi+1 Xi+1)$
Q· (3)	Derive the M step. How do we update the parameters of the model.
(î)	$P(Xi=\hat{a}) = \sum_{m=1}^{n} P(X_i = \hat{a}_i   O_{i-\tau_i}^{i}) \qquad j \in \{1m\}$
(îi)	$T() = \sum_{i=1}^{M} \sum_{t=1}^{M} P(X_{t=i}, X_{t+1} = C \mid 0_{1:T}),$
(۱)	$P(j \rightarrow c) = T(j,c)$ $\sum_{c'} T(j,c')$
6	we update the parameters of the model with