Part 8.1: 2 points

Please select all the correct assertions on the Baum-Welch algorithm:

- ☐ It is a learning algorithm
  Correct, this is problem #3 in Lectures, Text and Rabiner tutorial
- ☐ It is guaranteed to converge to a global optimum
  Incorrect, Baum Welch/forward-backward is guaranteed to converge to a local optimum
- ☐ It is used in the learning scenario when the right answer is known vs. where the right answer is not known. E.g. observation of 1000 dice rolls and changing of dice vs. observation of 1000 dice rolls and changing of dice unknown
  Incorrect, e.g. in known dice changes Baum-Welch can optimize the model, unknown dice changes can be learned by Baum-Welch
- ☐ When the states are known, it is guaranteed to not overfit regardless of dataset size.
  Incorrect, small and sparse datasets can cause an overfit model to be learned
- ☐ It is a special case of the Expectation-Maximization algorithm using the forward-backward algorithm.
  Correct, from Rabiner page 264-265
- ☐ It is a method of computing the smoothed values all hidden state variables
  Correct, given a model's parameters and an observation sequence it is solving the distribution of a latent variable at some point in the sequence. In other words, what is the probability distribution at point in time t-x at time t

Part 8.2: 6 points, Your answers will be α values in given rectangles, rounded to 6 decimal places

Initial probabilities: S1:1., S2:0., S3:0., S4:0., S5:0.

Observation sequence: 720mm, 61mm, 420mm, 180mm

Initialization		A_1	b_j(O_t)				
	t0	t1			Alpha		
P(S0|T)	1	0	-		Formula		Result
P(S1|T)	0	1	0.491027		a_ij(S0->S1)*b_j(O_t)(S1)=		0.491027
P(S2|T)	0	0	0.0008		a_ij(S0->S2)*b_j(O_t)(S2)=		0.000000
P(S3|T)	0	0	0		a_ij(S0->S3)*b_j(O_t)(S3)=		0.000000
P(S4|T)	0	0	0		a_ij(S0->S4)*b_j(O_t)(S4)=		0.000000
P(S5|T)	0	0	0		a_ij(S0->S5)*b_j(O_t)(S5)=		0.000000

	A_t						
Induction	alpha_1	a_ij	b_j(O_t)				
	t1	t2					
P(S1|t2)					alpha_(S1,t2)=I+II+III+IV+V		0
S1->S1	0.491027	0.0000000	0.0000000	I	A_t-1(S1)*a_11*b_1(O_t)=		0
S2->S1	0.000000	0.0000000	0.0000000	II	A_t-1(S2)*a_21*b_1(O_t)=		0
S3->S1	0.000000	0.0000000	0.0000000	III	A_t-1(S3)*a_31*b_1(O_t)=		0
S4->S1	0.000000	0.0000000	0.0000000	IV	A_t-1(S4)*a_41*b_1(O_t)=		0
S5->S1	0.000000	0.0000000	0.0000000	V	A_t-1(S5)*a_51*b_1(O_t)=		0
P(S2|t2)					alpha_(S2,t2)=I+II+III+IV+V		0
S1->S2	0.491027	0.3000000	0.0000000	I	A_t-1(S1)*a_11*b_2(O_t)=		0
S2->S2	0.000000	0.4000000	0.0000000	II	A_t-1(S2)*a_22*b_2(O_t)=		0
S3->S2	0.000000	0.4000000	0.0000000	III	A_t-1(S3)*a_32*b_2(O_t)=		0
S4->S2	0.000000	0.3000000	0.0000000	IV	A_t-1(S4)*a_42*b_2(O_t)=		0
S5->S2	0.000000	0.4000000	0.0000000	V	A_t-1(S5)*a_52*b_2(O_t)=		0
P(S3|t2)					alpha_(S3,t2)=I+II+III+IV+V		0
S1->S3	0.491027	0.0000000	0.0000000	I	A_t-1(S1)*a_13*b_3(O_t)=		0
S2->S3	0.000000	0.2000000	0.0000000	II	A_t-1(S2)*a_23*b_3(O_t)=		0
S3->S3	0.000000	0.3000000	0.0000000	III	A_t-1(S3)*a_33*b_3(O_t)=		0
S4->S3	0.000000	0.0000000	0.0000000	IV	A_t-1(S4)*a_43*b_3(O_t)=		0
S5->S3	0.000000	0.0000000	0.0000000	V	A_t-1(S5)*a_53*b_3(O_t)=		0
P(S4|t2)					alpha_(S4,t2)=I+II+III+IV+V		0
S1->S4	0.491027	0.0000000	0.0001000	I	A_t-1(S1)*a_14*b_4(O_t)=		0
S2->S4	0.000000	0.2000000	0.0001000	II	A_t-1(S2)*a_24*b_4(O_t)=		0
S3->S4	0.000000	0.3000000	0.0001000	III	A_t-1(S3)*a_34*b_4(O_t)=		0
S4->S4	0.000000	0.6000000	0.0001000	IV	A_t-1(S4)*a_44*b_4(O_t)=		0
S5->S4	0.000000	0.4000000	0.0001000	V	A_t-1(S5)*a_54*b_4(O_t)=		0
P(S5|t2)					alpha_(S5,t2)=I+II+III+IV+V		0.24386581
S1->S5	0.491027	0.7000000	0.7094920	I	A_t-1(S1)*a_15*b_5(O_t)=		0.24386581
S2->S5	0.000000	0.2000000	0.7094920	II	A_t-1(S2)*a_25*b_5(O_t)=		0
S3->S5	0.000000	0.0000000	0.7094920	III	A_t-1(S3)*a_35*b_5(O_t)=		0
S4->S5	0.000000	0.1000000	0.7094920	IV	A_t-1(S4)*a_45*b_5(O_t)=		0
S5->S5	0.000000	0.2000000	0.7094920	V	A_t-1(S5)*a_55*b_5(O_t)=		0

	A_t											
Induction	alpha_2	a_ij		b_j(O_t)								
	t2	t3										
P(S1|T)							alpha_(S1,t3)=I+II+III+IV+V				0	
S1->S1	0.000000	0.0000000		0.0000330		I	A_t-1(S1)*a_11*b_1(O_t)=				0	
S2->S1	0.000000	0.0000000		0.0000330		II	A_t-1(S2)*a_21*b_1(O_t)=				0	
S3->S1	0.000000	0.0000000		0.0000330		III	A_t-1(S3)*a_31*b_1(O_t)=				0	
S4->S1	0.000000	0.0000000		0.0000330		IV	A_t-1(S4)*a_41*b_1(O_t)=				0	
S5->S1	0.243866	0.0000000		0.0000330		V	A_t-1(S5)*a_51*b_1(O_t)=				0	
P(S2|T)							alpha_(S2,t3)=I+II+III+IV+V				0.026664288	
S1->S2	0.000000	0.3000000		0.2733500		I	A_t-1(S1)*a_12*b_2(O_t)=				0	
S2->S2	0.000000	0.4000000		0.2733500		II	A_t-1(S2)*a_22*b_2(O_t)=				0	
S3->S2	0.000000	0.4000000		0.2733500		III	A_t-1(S3)*a_32*b_2(O_t)=				0	
S4->S2	0.000000	0.3000000		0.2733500		IV	A_t-1(S4)*a_42*b_2(O_t)=				0	
S5->S2	0.243866	0.4000000		0.2733500		V	A_t-1(S5)*a_52*b_2(O_t)=				0.026664288	
P(S3|T)							alpha_(S3,t3)=I+II+III+IV+V				0	
S1->S3	0.000000	0.0000000		0.0094450		I	A_t-1(S1)*a_13*b_3(O_t)=				0	
S2->S3	0.000000	0.2000000		0.0094450		II	A_t-1(S2)*a_23*b_3(O_t)=				0	
S3->S3	0.000000	0.3000000		0.0094450		III	A_t-1(S3)*a_33*b_3(O_t)=				0	
S4->S3	0.000000	0.0000000		0.0094450		IV	A_t-1(S4)*a_43*b_3(O_t)=				0	
S5->S3	0.243866	0.0000000		0.0094450		V	A_t-1(S5)*a_53*b_3(O_t)=				0	
P(S4|T)							alpha_(S4,t3)=I+II+III+IV+V				0	
S1->S4	0.000000	0.0000000		0.0000000		I	A_t-1(S1)*a_14*b_4(O_t)=				0	
S2->S4	0.000000	0.2000000		0.0000000		II	A_t-1(S2)*a_24*b_4(O_t)=				0	
S3->S4	0.000000	0.3000000		0.0000000		III	A_t-1(S3)*a_34*b_4(O_t)=				0	
S4->S4	0.000000	0.6000000		0.0000000		IV	A_t-1(S4)*a_44*b_4(O_t)=				0	
S5->S4	0.243866	0.4000000		0.0000000		V	A_t-1(S5)*a_54*b_4(O_t)=				0	
P(S5|T)							alpha_(S5,t3)=I+II+III+IV+V				0	
S1->S5	0.000000	0.7000000		0.0000000		I	A_t-1(S1)*a_15*b_5(O_t)=				0	
S2->S5	0.000000	0.2000000		0.0000000		II	A_t-1(S2)*a_25*b_5(O_t)=				0	
S3->S5	0.000000	0.0000000		0.0000000		III	A_t-1(S3)*a_35*b_5(O_t)=				0	
S4->S5	0.000000	0.1000000		0.0000000		IV	A_t-1(S4)*a_45*b_5(O_t)=				0	
S5->S5	0.243866	0.2000000		0.0000000		V	A_t-1(S5)*a_55*b_5(O_t)=				0	

	A_t										
Induction	alpha_1	a_ij		b_j(O_t)							
	t3	t4									
P(S1|T)							alpha_(S1,t4)=I+II+III+IV+V				0
S1->S1	0.000000	0.0000000		0.0000000		I	A_t-1(S1)*a_11*b_1(O_t)=				0
S2->S1	0.026664	0.0000000		0.0000000		II	A_t-1(S2)*a_21*b_1(O_t)=				0
S3->S1	0.000000	0.0000000		0.0000000		III	A_t-1(S3)*a_31*b_1(O_t)=				0
S4->S1	0.000000	0.0000000		0.0000000		IV	A_t-1(S4)*a_41*b_1(O_t)=				0
S5->S1	0.000000	0.0000000		0.0000000		V	A_t-1(S5)*a_51*b_1(O_t)=				0
P(S2|T)							alpha_(S2,t4)=I+II+III+IV+V				0
S1->S2	0.000000	0.3000000		0.0000000		I	A_t-1(S1)*a_12*b_2(O_t)=				0
S2->S2	0.026664	0.4000000		0.0000000		II	A_t-1(S2)*a_22*b_2(O_t)=				0
S3->S2	0.000000	0.4000000		0.0000000		III	A_t-1(S3)*a_32*b_2(O_t)=				0
S4->S2	0.000000	0.3000000		0.0000000		IV	A_t-1(S4)*a_42*b_2(O_t)=				0
S5->S2	0.000000	0.4000000		0.0000000		V	A_t-1(S5)*a_52*b_2(O_t)=				0
P(S3|T)							alpha_(S3,t4)=I+II+III+IV+V				4.63959E-07
S1->S3	0.000000	0.0000000		0.0000870		I	A_t-1(S1)*a_13*b_3(O_t)=				0
S2->S3	0.026664	0.2000000		0.0000870		II	A_t-1(S2)*a_23*b_3(O_t)=				4.63959E-07
S3->S3	0.000000	0.3000000		0.0000870		III	A_t-1(S3)*a_33*b_3(O_t)=				0
S4->S3	0.000000	0.0000000		0.0000870		IV	A_t-1(S4)*a_43*b_3(O_t)=				0
S5->S3	0.000000	0.0000000		0.0000870		V	A_t-1(S5)*a_53*b_3(O_t)=				0
P(S4|T)							alpha_(S4,t4)=I+II+III+IV+V				0.003453495
S1->S4	0.000000	0.0000000		0.6475880		I	A_t-1(S1)*a_14*b_4(O_t)=				0
S2->S4	0.026664	0.2000000		0.6475880		II	A_t-1(S2)*a_24*b_4(O_t)=				0.003453495
S3->S4	0.000000	0.3000000		0.6475880		III	A_t-1(S3)*a_34*b_4(O_t)=				0
S4->S4	0.000000	0.6000000		0.6475880		IV	A_t-1(S4)*a_44*b_4(O_t)=				0
S5->S4	0.000000	0.4000000		0.6475880		V	A_t-1(S5)*a_54*b_4(O_t)=				0
P(S5|T)							alpha_(S5,t4)=I+II+III+IV+V				0
S1->S5	0.000000	0.7000000		0.0000000		I	A_t-1(S1)*a_15*b_5(O_t)=				0
S2->S5	0.026664	0.2000000		0.0000000		II	A_t-1(S2)*a_25*b_5(O_t)=				0
S3->S5	0.000000	0.0000000		0.0000000		III	A_t-1(S3)*a_35*b_5(O_t)=				0
S4->S5	0.000000	0.1000000		0.0000000		IV	A_t-1(S4)*a_45*b_5(O_t)=				0
S5->S5	0.000000	0.2000000		0.0000000		V	A_t-1(S5)*a_55*b_5(O_t)=				0

8.3 6 points Your answers will be the β values in the given rectangles, rounded to 6 decimal places

Observation sequence: 350mm, 480mm, 400mm, 62mm

	B_t+1											
	beta_9	a_ij		b_j(O_t+1)								
	t9	t8		t9								
P(S1|T)							beta_(S1,t8)=I+II+III+IV+V				0.3135237	
S1->S1	1.000000	0.0000000		0.0000000		I	B_t+1(S1)*a_11*b_1(O_t+1)=				0	
S1->S2	1.000000	0.3000000		0.0000000		II	B_t+1(S2)*a_12*b_1(O_t+1)=				0	
S1->S3	1.000000	0.0000000		0.0000000		III	B_t+1(S3)*a_13*b_1(O_t+1)=				0	
S1->S4	1.000000	0.0000000		0.0001250		IV	B_t+1(S4)*a_14*b_1(O_t+1)=				0	
S1->S5	1.000000	0.7000000		0.4478910		V	B_t+1(S5)*a_15*b_1(O_t+1)=				0.3135237	
P(S2|T)							beta_(S2,t8)=I+II+III+IV+V				0.0896032	
S2->S1	1.000000	0.0000000		0.0000000		I	B_t+1(S1)*a_21*b_2(O_t+1)=				0	
S2->S2	1.000000	0.4000000		0.0000000		II	B_t+1(S2)*a_22*b_2(O_t+1)=				0	
S2->S3	1.000000	0.2000000		0.0000000		III	B_t+1(S3)*a_23*b_2(O_t+1)=				0	
S2->S4	1.000000	0.2000000		0.0001250		IV	B_t+1(S4)*a_24*b_2(O_t+1)=				0.000025	
S2->S5	1.000000	0.2000000		0.4478910		V	B_t+1(S5)*a_25*b_2(O_t+1)=				0.0895782	
P(S3|T)							beta_(S3,t8)=I+II+III+IV+V				0.0000375	
S3->S1	1.000000	0.0000000		0.0000000		I	B_t+1(S1)*a_31*b_3(O_t+1)=				0	
S3->S2	1.000000	0.4000000		0.0000000		II	B_t+1(S2)*a_32*b_3(O_t+1)=				0	
S3->S3	1.000000	0.3000000		0.0000000		III	B_t+1(S3)*a_33*b_3(O_t+1)=				0	
S3->S4	1.000000	0.3000000		0.0001250		IV	B_t+1(S4)*a_34*b_3(O_t+1)=				0.0000375	
S3->S5	1.000000	0.0000000		0.4478910		V	B_t+1(S5)*a_35*b_3(O_t+1)=				0	
P(S4|T)							beta_(S4,t8)=I+II+III+IV+V				0.0448641	
S4->S1	1.000000	0.0000000		0.0000000		I	B_t+1(S1)*a_41*b_4(O_t+1)=				0	
S4->S2	1.000000	0.3000000		0.0000000		II	B_t+1(S2)*a_42*b_4(O_t+1)=				0	
S4->S3	1.000000	0.0000000		0.0000000		III	B_t+1(S3)*a_43*b_4(O_t+1)=				0	
S4->S4	1.000000	0.6000000		0.0001250		IV	B_t+1(S4)*a_44*b_4(O_t+1)=				0.000075	
S4->S5	1.000000	0.1000000		0.4478910		V	B_t+1(S5)*a_45*b_4(O_t+1)=				0.0447891	
P(S5|T)							betB_1(S5,t8)=I+II+III+IV+V				0.0896282	
S5->S1	1.000000	0.0000000		0.0000000		I	B_t+1(S1)*a_51*b_5(O_t+1)=				0	
S5->S2	1.000000	0.4000000		0.0000000		II	B_t+1(S2)*a_52*b_5(O_t+1)=				0	
S5->S3	1.000000	0.0000000		0.0000000		III	B_t+1(S3)*a_53*b_5(O_t+1)=				0	
S5->S4	1.000000	0.4000000		0.0001250		IV	B_t+1(S4)*a_54*b_5(O_t+1)=				0.00005	
S5->S5	1.000000	0.2000000		0.4478910		V	B_t+1(S5)*a_55*b_5(O_t+1)=				0.0895782	

	B_t+1										
	beta_8	a_ij		b_j(O_t+1)							
	t8	t7		t8							
P(S1|T)							beta_(S1,t7)=I+II+III+IV+V				0.004456729
S1->S1	0.313524	0.0000000		0.0000100		I	B_t+1(S1)*a_11*b_1(O_t+1)=				0
S1->S2	0.089603	0.3000000		0.1657950		II	B_t+1(S2)*a_12*b_1(O_t+1)=				0.004456729
S1->S3	0.000038	0.0000000		0.0054776		III	B_t+1(S3)*a_13*b_1(O_t+1)=				0
S1->S4	0.044864	0.0000000		0.0000000		IV	B_t+1(S4)*a_14*b_1(O_t+1)=				0
S1->S5	0.089628	0.7000000		0.0000000		V	B_t+1(S5)*a_15*b_1(O_t+1)=				0
P(S2|T)							beta_(S2,t7)=I+II+III+IV+V				0.005942346
S2->S1	0.313524	0.0000000		0.0000100		I	B_t+1(S1)*a_21*b_2(O_t+1)=				0
S2->S2	0.089603	0.4000000		0.1657950		II	B_t+1(S2)*a_22*b_2(O_t+1)=				0.005942305
S2->S3	0.000038	0.2000000		0.0054776		III	B_t+1(S3)*a_23*b_2(O_t+1)=				4.1082E-08
S2->S4	0.044864	0.2000000		0.0000000		IV	B_t+1(S4)*a_24*b_2(O_t+1)=				0
S2->S5	0.089628	0.2000000		0.0000000		V	B_t+1(S5)*a_25*b_2(O_t+1)=				0
P(S3|T)							beta_(S3,t7)=I+II+III+IV+V				0.005942367
S3->S1	0.313524	0.0000000		0.0000100		I	B_t+1(S1)*a_31*b_3(O_t+1)=				0
S3->S2	0.089603	0.4000000		0.1657950		II	B_t+1(S2)*a_32*b_3(O_t+1)=				0.005942305
S3->S3	0.000038	0.3000000		0.0054776		III	B_t+1(S3)*a_33*b_3(O_t+1)=				6.1623E-08
S3->S4	0.044864	0.3000000		0.0000000		IV	B_t+1(S4)*a_34*b_3(O_t+1)=				0
S3->S5	0.089628	0.0000000		0.0000000		V	B_t+1(S5)*a_35*b_3(O_t+1)=				0
P(S4|T)							beta_(S4,t7)=I+II+III+IV+V				0.004456729
S4->S1	0.313524	0.0000000		0.0000100		I	B_t+1(S1)*a_41*b_4(O_t+1)=				0
S4->S2	0.089603	0.3000000		0.1657950		II	B_t+1(S2)*a_42*b_4(O_t+1)=				0.004456729
S4->S3	0.000038	0.0000000		0.0054776		III	B_t+1(S3)*a_43*b_4(O_t+1)=				0
S4->S4	0.044864	0.6000000		0.0000000		IV	B_t+1(S4)*a_44*b_4(O_t+1)=				0
S4->S5	0.089628	0.1000000		0.0000000		V	B_t+1(S5)*a_45*b_4(O_t+1)=				0
P(S5|T)							betB_1(S5,t7)=I+II+III+IV+V				0.005942305
S5->S1	0.313524	0.0000000		0.0000100		I	B_t+1(S1)*a_51*b_5(O_t+1)=				0
S5->S2	0.089603	0.4000000		0.1657950		II	B_t+1(S2)*a_52*b_5(O_t+1)=				0.005942305
S5->S3	0.000038	0.0000000		0.0054776		III	B_t+1(S3)*a_53*b_5(O_t+1)=				0
S5->S4	0.044864	0.4000000		0.0000000		IV	B_t+1(S4)*a_54*b_5(O_t+1)=				0
S5->S5	0.089628	0.2000000		0.0000000		V	B_t+1(S5)*a_55*b_5(O_t+1)=				0

	B_t+1									
	beta_7	a_ij		b_j(O_t+1)						
	t7	t6		t7						
P(S1|T)						beta_(S1,t6)=I+II+III+IV+V			0.001121271	
S1->S1	0.004457	0.0000000		0.0008160	I	B_t+1(S1)*a_11*b_1(O_t+1)=			0	
S1->S2	0.005942	0.3000000		0.6289720	II	B_t+1(S2)*a_12*b_1(O_t+1)=			0.001121271	
S1->S3	0.005942	0.0000000		0.0000050	III	B_t+1(S3)*a_13*b_1(O_t+1)=			0	
S1->S4	0.004457	0.0000000		0.0000000	IV	B_t+1(S4)*a_14*b_1(O_t+1)=			0	
S1->S5	0.005942	0.7000000		0.0000000	V	B_t+1(S5)*a_15*b_1(O_t+1)=			0	
P(S2|T)						beta_(S2,t6)=I+II+III+IV+V			0.001495034	
S2->S1	0.004457	0.0000000		0.0008160	I	B_t+1(S1)*a_21*b_2(O_t+1)=			0	
S2->S2	0.005942	0.4000000		0.6289720	II	B_t+1(S2)*a_22*b_2(O_t+1)=			0.001495028	
S2->S3	0.005942	0.2000000		0.0000050	III	B_t+1(S3)*a_23*b_2(O_t+1)=			5.94237E-09	
S2->S4	0.004457	0.2000000		0.0000000	IV	B_t+1(S4)*a_24*b_2(O_t+1)=			0	
S2->S5	0.005942	0.2000000		0.0000000	V	B_t+1(S5)*a_25*b_2(O_t+1)=			0	
P(S3|T)						beta_(S3,t6)=I+II+III+IV+V			0.001495037	
S3->S1	0.004457	0.0000000		0.0008160	I	B_t+1(S1)*a_31*b_3(O_t+1)=			0	
S3->S2	0.005942	0.4000000		0.6289720	II	B_t+1(S2)*a_32*b_3(O_t+1)=			0.001495028	
S3->S3	0.005942	0.3000000		0.0000050	III	B_t+1(S3)*a_33*b_3(O_t+1)=			8.91355E-09	
S3->S4	0.004457	0.3000000		0.0000000	IV	B_t+1(S4)*a_34*b_3(O_t+1)=			0	
S3->S5	0.005942	0.0000000		0.0000000	V	B_t+1(S5)*a_35*b_3(O_t+1)=			0	
P(S4|T)						beta_(S4,t6)=I+II+III+IV+V			0.001121271	
S4->S1	0.004457	0.0000000		0.0008160	I	B_t+1(S1)*a_41*b_4(O_t+1)=			0	
S4->S2	0.005942	0.3000000		0.6289720	II	B_t+1(S2)*a_42*b_4(O_t+1)=			0.001121271	
S4->S3	0.005942	0.0000000		0.0000050	III	B_t+1(S3)*a_43*b_4(O_t+1)=			0	
S4->S4	0.004457	0.6000000		0.0000000	IV	B_t+1(S4)*a_44*b_4(O_t+1)=			0	
S4->S5	0.005942	0.1000000		0.0000000	V	B_t+1(S5)*a_45*b_4(O_t+1)=			0	
P(S5|T)						betB_1(S5,t6)=I+II+III+IV+V			0.001495028	
S5->S1	0.004457	0.0000000		0.0008160	I	B_t+1(S1)*a_51*b_5(O_t+1)=			0	
S5->S2	0.005942	0.4000000		0.6289720	II	B_t+1(S2)*a_52*b_5(O_t+1)=			0.001495028	
S5->S3	0.005942	0.0000000		0.0000050	III	B_t+1(S3)*a_53*b_5(O_t+1)=			0	
S5->S4	0.004457	0.4000000		0.0000000	IV	B_t+1(S4)*a_54*b_5(O_t+1)=			0	
S5->S5	0.005942	0.2000000		0.0000000	V	B_t+1(S5)*a_55*b_5(O_t+1)=			0	

8.4 Select all that apply, What are valid re-estimation formulas for HMM parameters **(2 points)**:

- ☐ Expected frequency in state S_i at time (t=1)

Correct, Rabiner page 265 (40a)

- ☐ Expected number of transitions from state S_i to state S_j / expected number of transitions from state S_i

Correct, Rabiner page 265 (40b)

- ☐ Expected number of times in state j and observing symbol v_k / expected number of times in state j

Correct, Rabiner page 265 (40c)

- ☐ $\overline{C}jk = \sum_{t=1}^{T} \gamma_t(j,k) / \sum_{t=1}^{T} \sum_{k=1}^{M} \gamma_t(j,k)$

Correct, Rabiner page 267 (52)

- ☐ $\overline{\mu}_{jk} = \sum_{t=1}^{T} \gamma_t(j,k) \cdot O_t \; / \sum_{t=1}^{T} \gamma_t(j,k)$

Correct, Rabiner page 267 (53)

- ☐ $\overline{U}_{jk} = \sum_{t=1}^{T} \gamma_t(j,k) \cdot (O_t - \mu_{jk})(O_t - \mu_{jk})' \; / \sum_{t=1}^{T} \gamma_t(j,k)$

Correct, Rabiner page 267 (54)