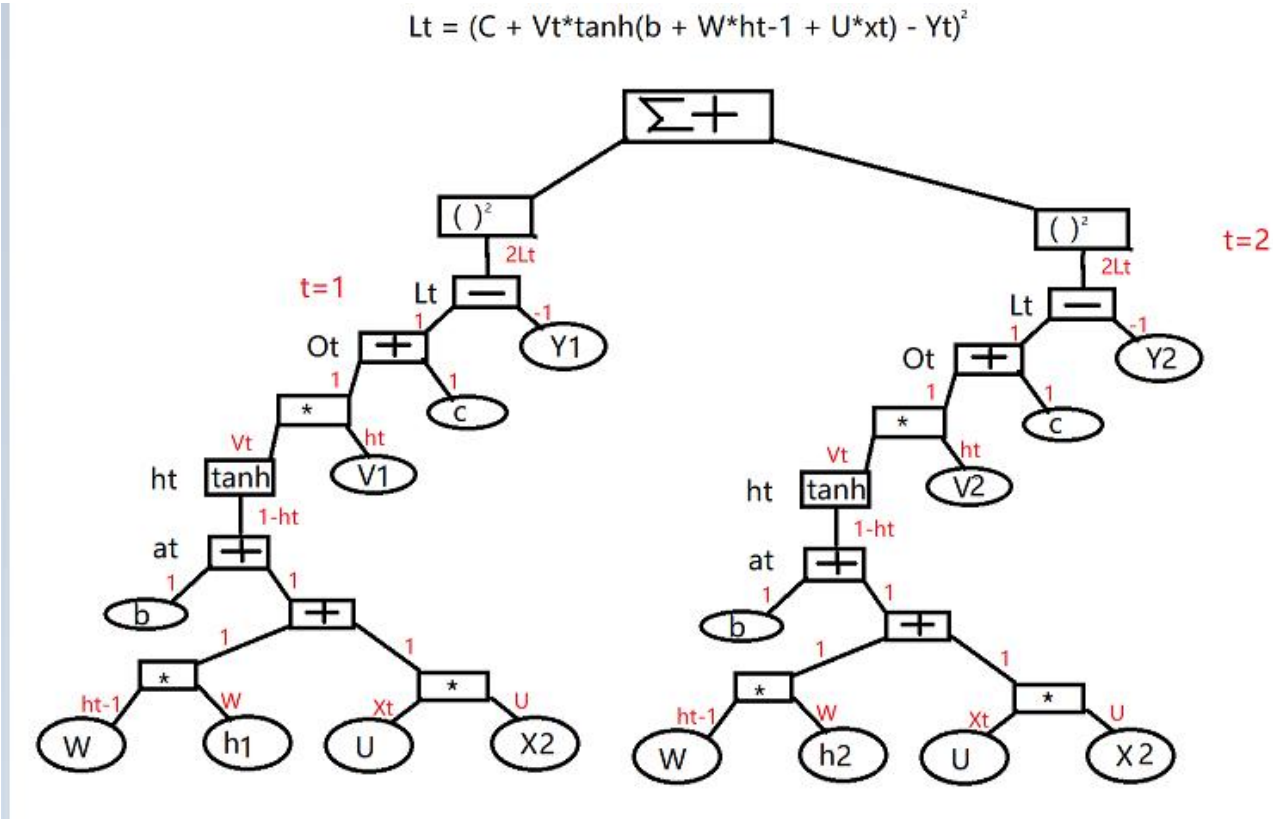
Problem 1: Computational Graphs and Backpropagation

Q1. Construct the computational graph.



Q2. What are the model parameters to be learned?

The parameters of b, W, U, c and V will be learned.

Q3.

See below

Q3												
Forward Pass	b=[0.1,1]T		w=	0.5	-0.4		U=	0.8	-0.3	0.5		
				-0.3	0.4			-1	0.1	0.9		
	c=0.7		V=[0.5,0.8]T									
	x1=[1,-1,1]T	y1=1.5										
	x2=[1,-1,-1]T	y2=0.8										
	a1=	b+Who+Ux0	=	[0.1,1]T	+	0.8	-0.3	0.5	*	[1,-1,1]T=		1.7
						-1	0.1	0.9				-0.2
	h1=	tanh(a1)	=	0.9345								
				-1974								
	O1=	c+Vth1	=	0.7	+	[0.5,0.8]	*	0.9345	=	1.0098		
								-1974				
	L1=	(O1 - y1)²	=	(1.0098-1.5	=	0.2403						
	as same as the above											
	a2=	b+Wh1+Ux2	=	1.2467								
				-2.4188								
	h2=	tanh(a2)	=	0.8475								
				-0.9843								
	O2=	c+Vth2	=	0.3363								
	L2=	(O2 - y2)²	=	0.21501769								
Backward Pass												
	∂TL/∂c	=	2(O1-y1)+2(O2-y2)		=	-1.9078						
	∂TL/∂v	=	2(O1-y1)h1+2(O2-y2)h2		=	-1.703						
						1.1064						
	∂TL/∂b	=	2(O1-y1)diag(1-h1²)		+	-0.1921						
			2(O2-y2)diag(1-h2²)		=	-0.7769						
	∂TL/∂U											
		=	2(O1-y1)diag(1-h1²)vX1		+	-0.1921	0.1921	0.0695				
			2(O1-y1)diag(1-h1²)vX2		=	-0.7769	0.7769	-0.7306				
	∂TL/∂W											
		=	2(O1-y1)diag(1-h1²)vh0		+	-0.1224	0.0258					
			2(O1-y1)diag(1-h1²)vh1		=	-0.0217	0.0046					

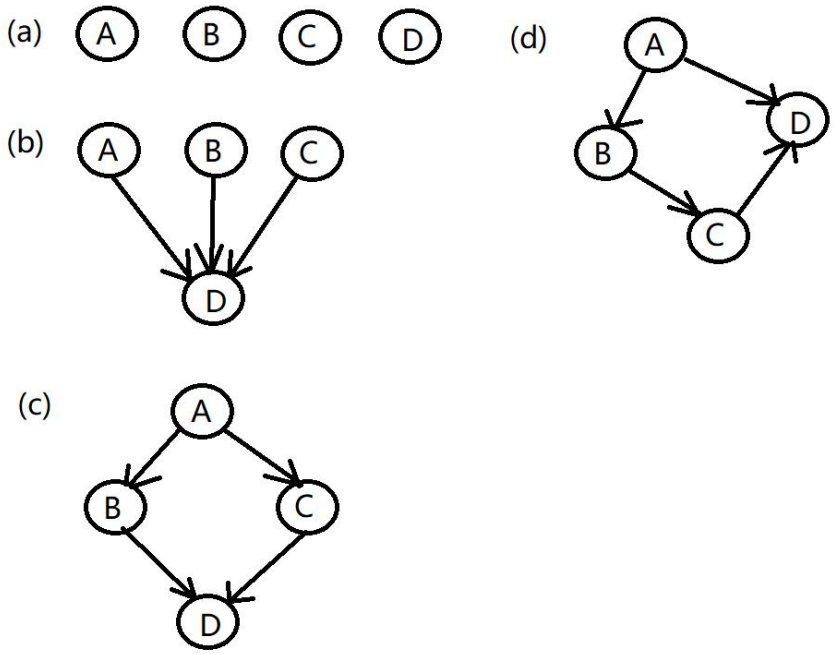
Problem 2: Naïve Bayes Classifier

P(ripe=yes) = 8 / 17	0.470588235				
P(ripe=no) = 9 / 17	0.529411765				
P(color=green | ripe=yes) = 3 / 8	0.375				
P(color=green | ripe=no) = 3 / 9	0.333333333				
P(root=slightly curly | ripe=yes) = 3 / 8	0.375				
P(root=slightly curly | ripe=no) = 4 / 9	0.444444444				
P(texture=clear | ripe=yes) = 7 / 8	0.875				
P(texture=clear | ripe=no) = 2 / 9	0.222222222				
P(texture=hard | ripe=yes) = 6 / 8	0.75				
P(texture=hard | ripe=no) = 6 / 9	0.666666667				
color=green, root=slightly curly, texture=clear, and surface=hard					
P(ripe=yes) = 8 / 17	P(color=green | ripe=yes) = 3 / 8	P(root=slightly curly | ripe=yes) = 3 / 8	P(texture=clear | ripe=yes) = 7 / 8	P(texture=hard | ripe=yes) = 6 / 8	0.043428309
P(ripe=no) = 9 / 17	P(color=green | ripe=no) = 3 / 9	P(root=slightly curly | ripe=no) = 4 / 9	P(texture=clear | ripe=no) = 2 / 9	P(texture=hard | ripe=no) = 6 / 9	0.011619463
					the result ripe label will be yes

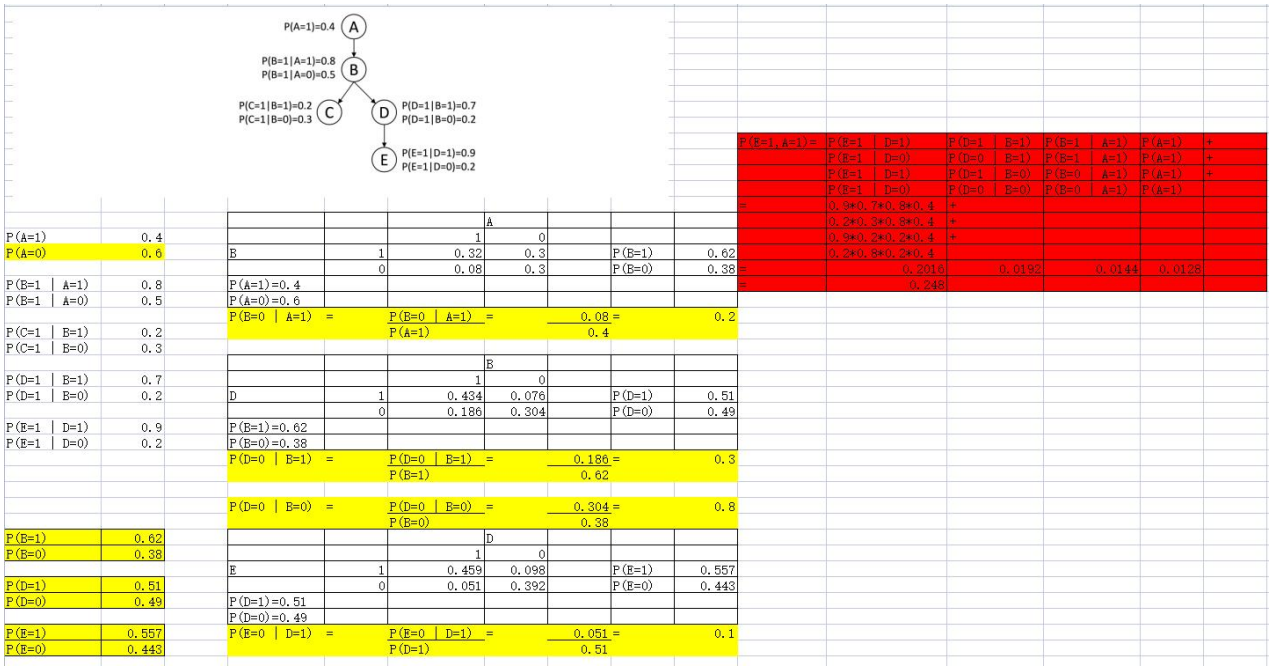
The prediction label will be Yes

Problem 3: Bayesian Networks

Q1.

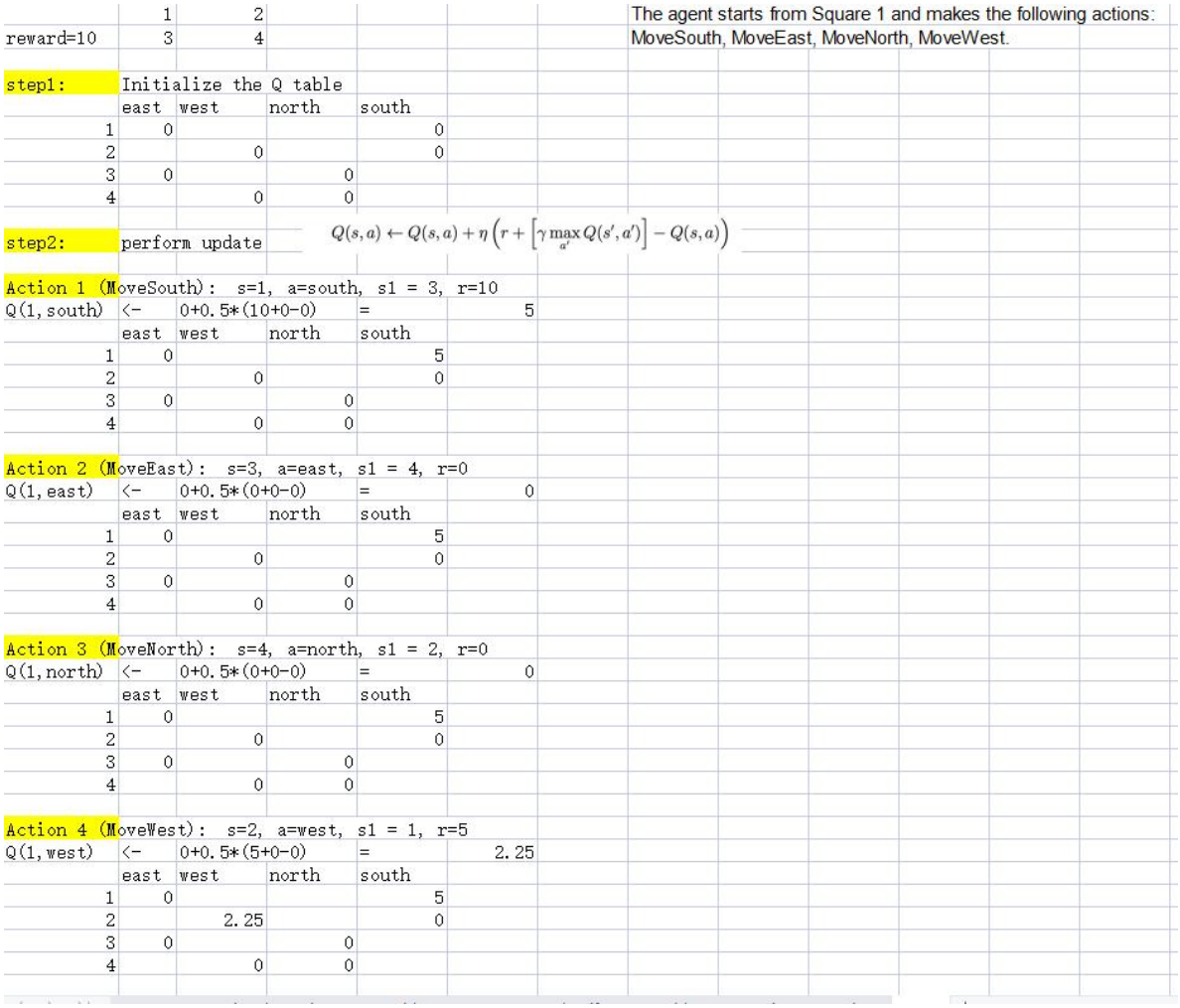


Q2.



P(E=1,A=1) = 0.248

Problem 4: Reinforcement Learning



	1	2				The agent starts from Square 1 and makes the following actions:
reward=10	3	4				MoveSouth, MoveEast, MoveNorth, MoveWest.
step1:	Initialize the Q table					
	east	west	north	south		
1	0			0		
2		0		0		
3	0		0			
4		0	0			
step2:	perform update	$Q(s,a) \leftarrow Q(s,a) + \eta\left(r + \left[\gamma \max_{a'} Q(s',a')\right] - Q(s,a)\right)$				
Action 1 (MoveSouth):	s=1,	a=south,	s1 = 3,	r=10		
Q(1, south)	<-	0+0.5*(10+0-0)	=		5	
	east	west	north	south		
1	0			5		
2		0		0		
3	0		0			
4		0	0			
Action 2 (MoveEast):	s=3,	a=east,	s1 = 4,	r=0		
Q(1, east)	<-	0+0.5*(0+0-0)	=		0	
	east	west	north	south		
1	0			5		
2		0		0		
3	0		0			
4		0	0			
Action 3 (MoveNorth):	s=4,	a=north,	s1 = 2,	r=0		
Q(1, north)	<-	0+0.5*(0+0-0)	=		0	
	east	west	north	south		
1	0			5		
2		0		0		
3	0		0			
4		0	0			
Action 4 (MoveWest):	s=2,	a=west,	s1 = 1,	r=5		
Q(1, west)	<-	0+0.5*(5+0-0)	=		2.25	
	east	west	north	south		
1	0			5		
2		2.25		0		
3	0		0			
4		0	0			

The final state will be

	East	west	north	south
1	0			5
2	0	2.25		0
3	0			0
4		0	0	