

$V_0(s)$

0	0	0	0
0	0	0	0
0	-1	0	-1
0	0	0	+10

$s_{1,1}$	$s_{1,2}$	$s_{1,3}$	$s_{1,4}$
$s_{2,1}$	$s_{2,2}$	$s_{2,3}$	$s_{2,4}$
$s_{3,1}$	$s_{3,2}$	$s_{3,3}$	$s_{3,4}$
$s_{4,1}$	$s_{4,2}$	$s_{4,3}$	$s_{4,4}$

Data:

$$\text{Living Reward} = -0.1$$

$$\gamma = 0.9$$

$$P \rightarrow \text{intended} = 0.7$$

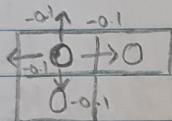
$$P \rightarrow \text{unintended} = 0.1$$

Action = {Right, Left, Up, Down}

$$V_0(s) = 0$$

$$\text{Reward into danger-state} = -1$$

$V_1(s_{1,1}) = ?$



$$R \rightarrow s_{1,2} \quad V_0(s_{1,1}) = 0$$

$$\text{intended: } R(s_{1,1}, R, s_{1,2}) = R(s_{1,1}, R, s_{1,1}) = -0.1$$

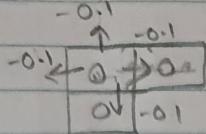
$$\Rightarrow P_R(s' = s_{1,2} | R, s_{1,1}) [R(s_{1,1}, R, s_{1,2}) + \gamma V_0(s_{1,2})] \\ + P_L(s' = s_{1,1} | R, s_{1,1}) [R(s_{1,1}, R, s_{1,1}) + \gamma V_0(s_{1,1})] \\ + P_U(s' = s_{1,1} | R, s_{1,1}) [R(s_{1,1}, R, s_{1,1}) + \gamma V_0(s_{1,1})] \\ + P_D(s' = s_{2,1} | R, s_{1,1}) [R(s_{1,1}, R, s_{2,1}) + \gamma V_0(s_{2,1})]$$

$$\Rightarrow (0.7 + 0.1 + 0.1 + 0.1) [-0.1 + (0.9)(0)]$$

$$\Rightarrow -0.1$$

$$| R(s_{1,2}) = -0.1 |$$

$L \rightarrow (S_B)$:



$$V_0(S_{1,1}) = 0$$

$$V_{k-1}$$

$$R P(S_{1,1} | L, S_{1,2}) = -0.1$$

$$L P(S_{1,1} | L, S_{1,1}) = -0.1$$

$$U P(S_{1,1} | L, S_{1,1}) = -0.1$$

$$D P(S_{1,1} | L, S_{2,1}) = -0.1$$

$$R P(S' = S_{1,2} | L, S_{1,1}) = 0.1$$

$$L P(S' = S_{1,1} | L, S_{1,1}) = 0.7$$

$$U P(S' = S_{1,1} | L, S_{1,1}) = 0.1$$

$$D P(S' = S_{2,1} | L, S_{1,1}) = 0.1$$

$$\begin{aligned}
 &= P(S' = S_{1,2} | L, S_{1,1}) [R(S_{1,1} | L, S_{1,2}) + \gamma V_0(S_{1,2})] \\
 &\quad + P(S' = S_{1,1} | L, S_{1,1}) [R(S_{1,1} | L, S_{1,1}) + \gamma V_0(S_{1,1})] \\
 &\quad + P(S' = S_{1,1} | L, S_{1,1}) [R(S_{1,1} | L, S_{1,1}) + \gamma V_0(S_{1,1})] \\
 &\quad + P(S' = S_{2,1} | L, S_{1,1}) [R(S_{1,1} | L, S_{2,1}) + \gamma V_0(S_{2,1})]
 \end{aligned}$$

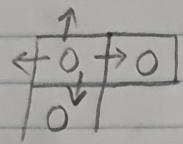
$$\begin{aligned}
 &= 0.1 [0.1 + (0.9)(0)] + 0.7 [-0.1 + (0.9)(0)] \\
 &\quad + 0.1 [-0.1 + (0.9)(0)] + 0.1 [-0.1 + (0.9)(0)]
 \end{aligned}$$

$$\Rightarrow -0.01 - 0.07 + -0.01 - 0.01$$

$$\Rightarrow -0.1$$

$$L \rightarrow (S_B) = -0.1$$

$U \rightarrow S_B$



$$V_0(S_{1,1}) = 0$$

$$R \quad R(S_{1,1} | U, S_{1,2}) = -0.1$$

$$V_0(S_{1,2}) = 0$$

$$L \quad R(S_{1,1} | U, S_{1,1}) = -0.1$$

$$V_0(S_{1,1}) = 0$$

$$U \quad R(S_{1,1} | U, S_{1,1}) = -0.1$$

$$V_0(S_{1,1}) = 0$$

$$D \quad R(S_{1,1} | U, S_{2,1}) = -0.1$$

$$V_0(S_{2,1}) = 0$$

$$R \quad P(S' = S_{1,2} | U, S_{1,1}) = 0.1$$

$$L \quad P(S' = S_{1,1} | U, S_{1,1}) = 0.1$$

$$U \quad P(S' = S_{1,1} | U, S_{1,1}) = 0.7$$

$$D \quad P(S' = S_{2,1} | U, S_{1,1}) = 0.1$$

$$\Rightarrow (0.1 + 0.1 + 0.7 + 0.1) [-0.1 + (0.9)(0)]$$

$$\Rightarrow -0.1$$

$$U \rightarrow S_B = -0.1$$

$D \rightarrow S_{2,1}$

$$V_0(S_{1,1}) = 0$$

$$R \quad R(S_{1,1} | D, S_{1,2}) = -0.1$$

$$V_0(S_{1,2}) = 0$$

$$L \quad R(S_{1,1} | D, S_{1,1}) = -0.1$$

$$V_0(S_{1,1}) = 0$$

$$U \quad R(S_{1,1} | D, S_{1,1}) = -0.1$$

$$V_0(S_{1,1}) = 0$$

$$D \quad R(S_{1,1} | D, S_{2,1}) = -0.1$$

$$V_0(S_{2,1}) = 0$$

$$R \quad P(S' = S_{1,2} | D, S_{1,1}) = 0.1$$

$$L \quad P(S' = S_{1,1} | D, S_{1,1}) = 0.1$$

$$U \quad P(S' = S_{1,1} | D, S_{1,1}) = 0.1$$

$$D \quad P(S' = S_{2,1} | D, S_{1,1}) = 0.7$$

$$\Rightarrow D \rightarrow S_{2,1} = -0.1$$

$$V_1(s_{1,1}) = \max(-0.1, -0.1, -0.1, -0.1)$$

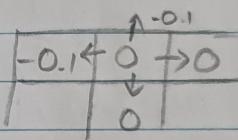
$$\boxed{V_1(s_{1,1}) = -0.1}$$

$$\underline{V_1(s_{1,2})} = ?$$

	-0.1	0	0	0
$V_1(s)$	0	0	0	0
	0	-1	0	-1
	0	0	0	+10

R $\rightarrow (s_{1,3})$

$$V_0(s_{1,2}) = 0$$



R $R(s_{1,2} | R, s_{1,3}) = -0.1$

$V_0(s_{1,3}) = 0$

L $R(s_{1,2} | L, s_{1,1}) = -0.1$

$V_0(s_{1,1}) = 0$

U $R(s_{1,2} | U, s_{1,2}) = -0.1$

$V_0(s_{1,2}) = 0$

D $R(s_{1,2} | D, s_{2,2}) = -0.1$

$V_0(s_{2,2}) = 0$

R $P(s' = s_{1,3} | R, s_{1,2}) = 0.7$

L $P(s' = s_{1,1} | R, s_{1,2}) = 0.1$

U $P(s' = s_{1,2} | R, s_{1,2}) = 0.1$

D $P(s' = s_{2,2} | R, s_{1,2}) = 0.1$

$$\Rightarrow \boxed{R \rightarrow (s_{1,3}) = -0.1}$$

$L \rightarrow (S_{1,1})$

$$V_0(S_{1,2}) = 0$$

$$R \quad R(S_{1,2} | L, S_{1,3}) = -0.1 \quad V_0(S_{1,3}) = 0$$

$$L \quad R(S_{1,2} | L, S_{1,1}) = -0.1 \quad V_0(S_{1,1}) = 0$$

$$U \quad R(S_{1,2} | L, S_{1,2}) = -0.1 \quad V_0(S_{1,2}) = 0$$

$$D \quad R(S_{1,2} | L, S_{2,2}) = -0.1 \quad V_0(S_{2,2}) = 0$$

$$R \quad P(S' = S_{1,3} | L, S_{1,2}) = 0.1$$

$$L \quad P(S' = S_{1,1} | L, S_{1,2}) = 0.7$$

$$U \quad P(S' = S_{1,2} | L, S_{1,2}) = 0.1$$

$$D \quad P(S' = S_{2,2} | L, S_{1,2}) = 0.1$$

$$\Rightarrow \boxed{L \rightarrow S_{(1,1)} = -0.1}$$

$U \rightarrow (S_{1,2})$

$$V_0(S_{1,2}) = 0$$

$$R \quad R(S_{1,2} | U, S_{1,3}) = -0.1 \quad V_0(S_{1,3}) = 0$$

$$L \quad R(S_{1,2} | U, S_{1,1}) = -0.1 \quad V_0(S_{1,1}) = 0$$

$$U \quad R(S_{1,2} | U, S_{1,2}) = -0.1 \quad V_0(S_{1,2}) = 0$$

$$D \quad R(S_{1,2} | U, S_{2,2}) = -0.1 \quad V_0(S_{2,2}) = 0$$

$$R \quad P(S' = S_{1,3} | U, S_{1,2}) = 0.1$$

$$L \quad P(S' = S_{1,1} | U, S_{1,2}) = 0.1$$

$$U \quad P(S' = S_{1,2} | U, S_{1,2}) = 0.7$$

$$D \quad P(S' = S_{2,2} | U, S_{1,2}) = 0.1$$

$$\Rightarrow \boxed{U \rightarrow S_{(1,1)} = -0.1}$$

$D \rightarrow (S_{2,2})$

$\boxed{0}$
★

$$V_0(S_{1,2}) = 0$$

$$R \quad R(S_{1,2} | D, S_{1,3}) = -0.1 \quad V_0(S_{1,2}) = 0$$

$$L \quad R(S_{1,2} | D, S_{1,1}) = -0.1 \quad V_0(S_{1,1}) = 0$$

$$U \quad R(S_{1,2} | D, S_{1,1}) = -0.1 \quad V_0(S_{1,1}) = 0$$

$$D \quad R(S_{1,2} | D, S_{2,2}) = -0.1 \quad V_0(S_{2,2}) = 0$$

$$R \quad P(S' = S_{1,3} | D, S_{1,2}) = 0.1$$

$$L \quad P(S' = S_{1,1} | D, S_{1,2}) = 0.1$$

$$U \quad P(S' = S_{1,1} | D, S_{1,2}) = 0.1$$

$$D \quad P(S' = S_{2,2} | D, S_{1,2}) = 0.7$$

$$\Rightarrow [D \rightarrow (S_{2,2}) \rightarrow -0.1]$$

$$V_1(S_{1,2}) = \max(R, L, U, D)$$

$$= \max(-0.1, -0.1, -0.1, -0.1)$$

$$\boxed{V_1(S_{1,2}) = -0.1}$$

$$\underline{V_1(S_{1,3})} =$$

-0.1	-0.1	?	?
?	?	?	?
?	-1	?	-1
?	?	?	10

0	0	0	0
0	0	0	0
0	-1	0	-1
0	0	0	10

Check if

$$V_0(S) = R = L = U = D = 0$$
$$R = R(R) = R(L) = R(U) = R(D) = -0.1$$

$$\boxed{V_1(S_{1,3}) = -0.1}$$

$$\underline{V_1(S_{1,4})} = ?$$

$$V_0(S) = R = L = U = D = 0$$
$$R = R(R) = R(L) = R(U) = R(D) = -0.1$$
$$P(R) + P(L) + P(U) + P(D) = 1$$

$$\boxed{V_1(S_{1,4}) = -0.1}$$

$$\cdot \underline{V_1(S_{2,1})} = ?$$

$$V_0(S) = R = L = U = D = 0$$
$$R = R(R) = R(L) = R(U) = R(D) = -0.1$$
$$P(R) + P(L) + P(U) + P(D) = 1$$

$$\boxed{V_1(S_{2,1}) = -0.1}$$

!

$$V_1(S_{2,2}) = ?$$

$$V_1(s_{2,2}) = ?$$

	$V_0(s_{1,2}) = 0$	$V_0(s_{2,3}) = 0$	$V_0(s_{2,2}) = 0$
$V_0(s_{2,2}) = 0$		$V_0(s_{3,2}) = -1$	

instead right now

$$\underline{R} \rightarrow (s_{2,3}) \rightarrow s_{(2,2)}$$

R	$R(s_{2,2} R, s_{2,3}) = -0.1$	$V_0(s_{2,3}) = 0$
L	$R(s_{2,2} R, s_{2,1}) = -0.1$	$V_0(s_{2,1}) = 0$
U	$R(s_{2,2} R, s_{1,2}) = -0.1$	$V_0(s_{1,2}) = 0$
D	$R(s_{2,2} R, s_{3,2}) = -1$	$V_0(s_{3,2}) = -1$

R	$P(s' = s_{2,3} R, s_{2,2}) = 0.7$
L	$P(s' = s_{2,1} R, s_{2,2}) = 0.1$
U	$P(s' = s_{1,2} R, s_{2,2}) = 0.1$
D	$P(s' = s_{3,2} R, s_{2,2}) = 0.1$

$$\begin{aligned}
 & P(s' = s_{2,3} | R, s_{2,2}) [R(s_{2,2} | R, s_{2,3}) + \gamma V_0(s_{2,2})] \\
 & + P(s' = s_{2,1} | R, s_{2,2}) [R(s_{2,2} | R, s_{2,1}) + \gamma V_0(s_{2,2})] \\
 & + P(s' = s_{1,2} | R, s_{2,2}) [R(s_{2,2} | R, s_{1,2}) + \gamma V_0(s_{2,2})] \\
 & + P(s' = s_{3,2} | R, s_{2,2}) [R(s_{2,2} | R, s_{3,2}) + \gamma V_0(s_{2,2})]
 \end{aligned}$$

$$\begin{aligned}
 \Rightarrow & 0.7 [-0.1 + (0.9)(0)] + 0.1 [-0.1 + (0.9)(0)] \\
 & + 0.1 [-0.1 + (0.9)(0)] + 0.1 [-1 + (0.9)(-1)]
 \end{aligned}$$

$$\Rightarrow -0.07 - 0.01 - 0.01 - 0.1$$

$$\Rightarrow \boxed{-0.19}$$

$L \rightarrow (S_{2,1}) \rightarrow (S_{2,2})$

$$R(S_{2,2} | L, S_{2,3}) = -0.1 \quad V_0(S_{2,3}) = 0$$

$$R(S_{2,2} | L, S_{2,1}) = -0.1 \quad V_0(S_{2,1}) = 0$$

$$R(S_{2,2} | L, S_{1,2}) = -0.1 \quad V_0(S_{1,2}) = 0$$

$$R(S_{2,2} | L, S_{3,2}) = -1 \quad V_0(S_{3,2}) = -1$$

$$P(S' = S_{2,3} | L, S_{2,2}) = 0.1$$

$$P(S' = S_{2,1} | L, S_{2,2}) = 0.7$$

$$P(S' = S_{1,2} | L, S_{2,2}) = 0.1$$

$$P(S' = S_{3,2} | L, S_{2,2}) = 0.1$$

$$\Rightarrow 0.1[-0.1 + (0.9)(0)] + 0.7[-0.1 + (0.9)(0)] \\ + 0.1[-0.1 + (0.9)(0)] + 0.1[-1 + (0.9)(-1)]$$

$$\Rightarrow [-0.28]$$

$U \rightarrow (S_{1,2}) \rightarrow (S_{2,2})$

$$R(S_{2,2} | U, S_{2,3}) = -0.1 \quad V_0(S_{2,3}) = 0$$

$$R(S_{2,2} | U, S_{2,1}) = -0.1 \quad V_0(S_{2,1}) = 0$$

$$R(S_{2,2} | U, S_{1,2}) = -0.1 \quad V_0(S_{1,2}) = 0$$

$$R(S_{2,2} | U, S_{3,2}) = -1 \quad V_0(S_{3,2}) = -1$$

$$P(S' = S_{2,3} | U, S_{2,2}) = 0.1$$

$$P(S' = S_{2,1} | U, S_{2,2}) = 0.1$$

$$P(S' = S_{1,2} | U, S_{2,2}) = 0.7$$

$$P(S' = S_{3,2} | U, S_{2,2}) = 0.1$$

$$\Rightarrow 0.1[-0.1 + (0.9)(0)] + 0.1[-0.1 + (0.9)(0)] \\ + 0.7[-0.1 + (0.9)(0)] + 0.1[-1 + (0.9)(-1)]$$

$$\Rightarrow [-0.28]$$

$$\begin{matrix} -0.2 & \text{or} & 0 \\ -1 & & 0 \end{matrix}$$

$D \rightarrow (S_{2,2}) \rightarrow (S_{2,2})$

R	$R(S_{2,2} D, S_{2,3}) = -0.1$	$V_0(S_{2,3}) = 0$
C	$R(S_{2,2} D, S_{2,1}) = -0.1$	$V_0(S_{2,1}) = 0$
U	$R(S_{2,2} D, S_{1,2}) = -0.1$	$V_0(S_{1,2}) = 0$
D	$R(S_{2,2} D, S_{3,2}) = -1$	$V_0(S_{3,2}) = -1$

R	$P(S' = S_{2,3} D, S_{2,2}) = 0.1$
C	$P(S' = S_{2,1} D, S_{2,2}) = 0.1$
U	$P(S' = S_{1,2} D, S_{2,2}) = 0.1$
D	$P(S' = S_{3,2} D, S_{2,2}) = 0.7$

$$\Rightarrow 0.1[-0.1 + 0.9(0)] + 0.1[-0.1 + 0.9(0)] + 0.1[-0.1 + 0.9(0)] \\ + 0.7[-1 + 0.9(-1)]$$

$$\Rightarrow [-1.36]$$

$$V_1(S_{2,2}) = \max(-0.28, -0.28, -0.28, -1.36)$$

$$[V_1(S_{2,2}) = -0.28]$$

-0.1	-0.1	-0.1	-0.1
-0.1	-0.28	?	?
?	-1?	?	-1
?	?	?	10

-0.1	-0.1	-0.1	-0.1
-0.1	-0.28	-0.1	?
?	-1?	?	-1?
-0.1	?	?	10

$$\underline{V_1(S_{2,4}) = ?}$$

0	0
0	(?)
?	-1

$$V_0(S_{2,4}) = 0$$

R \rightarrow L \rightarrow S_{2,4} Blocked right now

$$\begin{array}{ll}
 R & R(S_{2,4} | R, S_{2,4}) = -0.1 \quad V_0(S_{2,4}) = 0 \\
 L & R(S_{2,4} | R, S_{2,3}) = -0.1 \quad V_0(S_{2,3}) = 0 \\
 U & R(S_{2,4} | R, S_{1,4}) = -0.1 \quad V_0(S_{1,4}) = 0 \\
 D & R(S_{2,4} | R, S_{3,4}) = -1 \quad V_0(S_{3,4}) = -1
 \end{array}$$

$$\begin{array}{ll}
 R & P(S' = S_{2,4} | R, S_{2,4}) = 0.7 \\
 L & P(S' = S_{2,3} | R, S_{2,4}) = 0.1 \\
 U & P(S' = S_{1,4} | R, S_{2,4}) = 0.1 \\
 D & P(S' = S_{3,4} | R, S_{2,4}) = 0.1
 \end{array}$$

$$\Rightarrow 0.7[-0.1 + (0.9)(0)] + 0.1[-0.1 + (0.9)(0)] \\
 + 0.1[-0.1 + (0.9)(0)] + 0.1[-1 + (0.9)(-1)]$$

$$\Rightarrow -0.07 - 0.01 - 0.01 - 0.19$$

$$\Rightarrow \boxed{-0.29}$$

L \rightarrow S_{2,3} \rightarrow S_{2,4}

$$\begin{array}{ll}
 R & R(S_{2,4} | L, S_{2,4}) = -0.1 \quad V_0(S_{2,4}) = 0 \\
 L & R(S_{2,4} | L, S_{2,3}) = -0.1 \quad V_0(S_{2,3}) = 0 \\
 U & R(S_{2,4} | L, S_{1,4}) = -0.1 \quad V_0(S_{1,4}) = 0 \\
 D & R(S_{2,4} | L, S_{3,4}) = -1 \quad V_0(S_{3,4}) = -1
 \end{array}$$

$$R \quad P(S' = S_{2,4} | L, S_{2,4}) = 0.1$$

$$L \quad P(S' = S_{2,3} | L, S_{2,4}) = 0.7$$

$$U \quad P(S' = S_{1,4} | L, S_{2,4}) = 0.1$$

$$D \quad P(S' = S_{3,4} | L, S_{2,4}) = 0.1$$

$$\Rightarrow 0.1[-0.1 + (0.9)(0)] + 0.7[-0.1 + (0.9)(0)] \\ + 0.1[-0.1 + (0.9)(0)] + 0.1[-1 + (0.9)(-1)]$$

$$\Rightarrow -0.01 - 0.07 - 0.01 - 0.19$$

$$\Rightarrow [-0.28]$$

$$U \rightarrow (S_{1,4}) \rightarrow (S_{2,4})$$

$$R \quad R(S_{2,4} | U, S_{2,4}) = -0.1 \quad V_0(S_{2,4}) = 0$$

$$L \quad R(S_{2,4} | U, S_{2,3}) = -0.1 \quad V_0(S_{2,3}) = 0$$

$$U \quad R(S_{2,4} | U, S_{1,4}) = -0.1 \quad V_0(S_{1,4}) = 0$$

$$D \quad R(S_{2,4} | U, S_{3,4}) = -1 \quad V_0(S_{3,4}) = -1$$

$$R \quad P(S' = S_{2,4} | U, S_{2,4}) = 0.1$$

$$L \quad P(S' = S_{2,3} | U, S_{2,4}) = 0.1$$

$$U \quad P(S' = S_{1,4} | U, S_{2,4}) = 0.7$$

$$D \quad P(S' = S_{3,4} | U, S_{2,4}) = 0.1$$

$$\Rightarrow 0.1[-0.1] + 0.1[-0.1] + 0.7[-0.1]$$

$$+ 0.1[-1 + 0.9(-1)]$$

$$\Rightarrow [-0.28]$$

$$D \rightarrow (S_{3,4}) \rightarrow (S_{2,4})$$

$$R \quad R(S_{2,4} | D, S_{2,4}) = -0.1 \quad V_0 = 0$$

$$L \quad R(S_{2,4} | D, S_{2,3}) = -0.1 \quad V_0 = 0$$

$$U \quad R(S_{2,4} | D, S_{1,4}) = -0.1 \quad V_0 = 0$$

$$D \quad R(S_{2,4} | D, S_{3,4}) = -1 \quad V_0 = -1$$

$$R \quad P(S' = S_{2,4} | D, S_{2,4}) = 0.1$$

$$L \quad P(S' = S_{2,3} | D, S_{2,4}) = 0.1$$

$$U \quad P(S' = S_{1,4} | D, S_{2,4}) = 0.1$$

$$D \quad P(S' = S_{3,4} | D, S_{2,4}) = 0.7$$

$$\Rightarrow 0.1[-0.1] + 0.1[-0.1] + 0.1[-0.1] \\ + 0.7[-1 + 0.9(-1)]$$

$$\Rightarrow \boxed{-1.36}$$

$$\Rightarrow \boxed{V_1(S_{2,4}) = -0.28}$$

-0.1	-0.1	-0.1	-0.1
-0.1	-0.28	-0.1	-0.28
?	-1	?	-1
-0.1	?	?	-1.10

$$\underline{V_1(S_{3,1}) ?}$$

$$V_0(S_{3,1}) = 0$$

$$R \rightarrow (S_{3,2}) \rightarrow (S_{3,1})$$

$$R \quad R(S_{3,1} | R, S_{3,2}) = -1 \quad V_0 = -1$$

$$L \quad R(S_{3,1} | R, S_{3,1}) = -0.1 \quad V_0 = 0$$

$$U \quad R(S_{3,1} | R, S_{2,1}) = -0.1 \quad V_0 = 0$$

$$D \quad R(S_{3,1} | R, S_{1,1}) = -0.1 \quad V_0 = 0$$

$$R \quad P(S' = S_{3,2} | R, S_{3,1}) = 0.7$$

$$L \quad P(S' = S_{3,1} | R, S_{3,1}) = 0.1$$

$$U \quad P(S' = S_{2,1} | R, S_{3,1}) = 0.1$$

$$D \quad P(S' = S_{1,1} | R, S_{3,1}) = 0.1$$

$$\Rightarrow 0.7[-1 + 0.9(-1)] + 0.1[-0.1] + 0.1[-0.1] + 0.1[-0.1]$$

$$\Rightarrow \boxed{-1.36}$$

$L \rightarrow (S_{B,1}) \rightarrow (S_{3,1})$

R	R	$= -1$	$V_o = -1$
L	R	$= -0.1$	$V_o = 0$
U	R	$= -0.1$	$V_o = 0$
D	R	$= -0.1$	$V_o = 0$

R	P	$= 0.1$
L	P	$= 0.7$
U	P	$= 0.1$
D	P	$= 0.1$

$$\Rightarrow 0.1[-1 + 0.9(-1)] + 0.7[-0.1] + 0.1[-0.1] + 0.1[-0.1]$$

$$\Rightarrow \boxed{-0.28}$$

$U \rightarrow (S_{2,1}) \rightarrow (S_{3,1})$

R	R	$= -1$	$V_o = -1$
L	R	$= -0.1$	$V_o = 0$
U	R	$= -0.1$	$V_o = 0$
D	R	$= -0.1$	$V_o = 0$

R	P	$= 0.1$
L	P	$= 0.1$
U	P	$= 0.7$
D	P	$= 0.1$

$$\Rightarrow 0.1[-0.1 + 0.9(-1)] + 0.1[-0.1] + 0.7[-0.1] + 0.1[-0.1]$$

$$\Rightarrow \boxed{-0.28}$$

$$D \rightarrow S(4,1) \rightarrow S(3,1)$$

R	R
L	R
V	R
D	R

$$\begin{aligned} &= -1 \quad V_0 = -1 \\ &= -0.1 \quad V_0 = 0 \\ &= -0.1 \quad V_0 = 0 \\ &= -0.1 \quad V_0 = 0 \end{aligned}$$

R	P
L	P
V	P
D	P

$$\begin{aligned} &= 0.1 \\ &= 0.1 \\ &= 0.1 \\ &= 0.7 \end{aligned}$$

$$\Rightarrow 0.1[-1 + 0.9(-1)] + 0.1[-0.1] + 0.1[-0.1] + 0.7[-0.1]$$

$$\Rightarrow \boxed{-0.28}$$

$$\boxed{V_1(S_{3,1}) = -0.28}$$

-0.1	-0.1	-0.1	-0.1
-0.1	-0.28	-0.1	-0.28
-0.28	-1	?	-1
-0.1	?	?	10

0	0	0	0
0	0	0	0
0	-1	0	-1
0	0	0	10

$V_1(S_{3,2})$:

$R \rightarrow (3,3) \rightarrow (3,2)$

$$\begin{array}{ll}
 R \quad R(S_{3,2} | R, S_{3,3}) = -1 & V_0(S_{3,3}) = -1 \\
 L \quad R(S_{3,2} | R, S_{3,1}) = -1 & V_0(S_{3,1}) = -1 \\
 U \quad R(S_{3,2} | R, S_{2,2}) = -1 & V_0(S_{2,2}) = -1 \\
 D \quad R(S_{3,2} | R, S_{4,2}) = -1 & V_0(S_{4,2}) = -1
 \end{array}$$

$$\begin{array}{ll}
 R \quad P(S' = S_{3,3} | R, S_{3,2}) = 0.7 \\
 L \quad P(S' = S_{3,1} | R, S_{3,2}) = 0.1 \\
 U \quad P(S' = S_{2,2} | R, S_{3,2}) = 0.1 \\
 D \quad P(S' = S_{4,2} | R, S_{3,2}) = 0.1
 \end{array}$$

$$\begin{aligned}
 & \Rightarrow 0.7[-1 + (0.9)(-1)] + 0.1[-1 + (0.9)(-1)] + 0.1[-1 + (0.9)(-1)] \\
 & \quad + 0.1[-1 + (0.9)(-1)] \\
 & \Rightarrow [-1.9] = 0.4 \\
 & \quad = -1.9
 \end{aligned}$$

$L \rightarrow (3,1) \rightarrow (3,2)$

$$\begin{array}{ll}
 R \quad R(S_{3,2} | L, S_{3,3}) = -1 & V_0(S_{3,3}) = -1 \\
 L \quad R(S_{3,2} | L, S_{3,1}) = -1 & V_0(S_{3,1}) = -1 \\
 U \quad R(S_{3,2} | L, S_{2,2}) = -1 & V_0(S_{2,2}) = -1 \\
 D \quad R(S_{3,2} | L, S_{4,2}) = -1 & V_0(S_{4,2}) = -1
 \end{array}$$

$$\begin{array}{ll}
 R \quad P(S' = S_{3,3} | L, S_{3,1}) = 0.1 \\
 L \quad P(S' = S_{3,1} | L, S_{3,1}) = 0.7 \\
 U \quad P(S' = S_{2,2} | L, S_{3,1}) = 0.1 \\
 D \quad P(S' = S_{4,2} | L, S_{3,1}) = 0.1
 \end{array}$$

$(3,2)$, UP

$(4,4)$, UP

$\Rightarrow [-1.9]$

$U \rightarrow (2,2) \rightarrow (3,2)$

$$\begin{array}{ll}
 R & R \\
 L & R \\
 U & R \\
 D & R
 \end{array}
 \begin{array}{ll}
 = -1 & V_0(S_{3,3}) = -1 \\
 = -1 & V_0(S_{3,1}) = -1 \\
 = -1 & V_0(S_{2,2}) = -1 \\
 = -1 & V_0(S_{4,2}) = -1
 \end{array}$$

$$\begin{array}{ll}
 R & P \\
 L & P \\
 U & P \\
 D & P
 \end{array}
 \begin{array}{ll}
 = 0.1 \\
 = 0.1 \\
 = 0.7 \\
 = 0.1
 \end{array}$$

\Rightarrow

$\boxed{-1.9}$

$O \rightarrow (4,2) \rightarrow (3,2)$

$$\begin{array}{ll}
 R & R \\
 L & R \\
 U & R \\
 D & R
 \end{array}
 \begin{array}{ll}
 = -1 & V_0(S_{3,3}) = -1 \\
 = -1 & V_0(S_{3,1}) = -1 \\
 = -1 & V_0(S_{2,2}) = -1 \\
 = -1 & V_0(S_{4,2}) = -1
 \end{array}$$

$$\begin{array}{ll}
 R & P \\
 L & P \\
 U & P \\
 D & P
 \end{array}
 \begin{array}{ll}
 = 0.1 \\
 = 0.1 \\
 = 0.1 \\
 = 0.7
 \end{array}$$

$\Rightarrow \boxed{-1.9}$

$$\boxed{V_1(S_{3,2}) = -1.9}$$

$$\underline{V_1(S_{3,3})} =$$

$$R \rightarrow (3,4) \rightarrow (3,3)$$

$$\begin{array}{lll}
 R & R & = -1 \quad V_0 \quad = -1 \\
 L & R & = -1 \quad V_0 \quad = -1 \\
 U & R & = -0.1 \quad V_0 \quad = 0 \\
 D & R & = -0.1 \quad V_0 \quad = 0
 \end{array}$$

$$\begin{array}{lll}
 R & P & = 0.7 \\
 L & P & = 0.1 \\
 U & P & = 0.1 \\
 D & P & = 0.1
 \end{array}$$

$$\Rightarrow 0.7[-1 + 0.9(-1)] + 0.1[-1 + (0.9)(-1)] \\
 + 0.1[-0.1 + (0.9)(0)] + 0.1[-0.1 + 0.9(0)]$$

$$\Rightarrow \boxed{-1.54}$$

$$L \rightarrow (3,2) \rightarrow (3,3)$$

$$\begin{array}{lll}
 R & R & = -1 \quad V_0 \quad = -1 \\
 L & R & = -1 \quad V_0 \quad = -1 \\
 U & R & = -0.1 \quad V_0 \quad = 0 \\
 D & R & = -0.1 \quad V_0 \quad = 0
 \end{array}$$

$$\begin{array}{lll}
 R & P & = 0.1 \\
 L & P & = 0.7 \\
 U & P & = 0.1 \\
 D & P & = 0.1
 \end{array}$$

$$\Rightarrow 0.1[-1 + 0.9(-1)] + 0.7[-1 + 0.9(-1)] \\
 + 0.1[-0.1 + 0.9(0)] + 0.1[-0.1 + 0.9(0)]$$

$$\Rightarrow \boxed{-1.54}$$

$$U \rightarrow (2,3) \rightarrow (3,3)$$

$$\begin{array}{ll} n R & = -1 \\ l R & = -1 \\ u R & = -0.1 \\ d R & = -0.1 \end{array} \quad \begin{array}{ll} V_o & = -1 \\ V_o & = -1 \\ V_o & = 0 \\ V_o & = 0 \end{array}$$

$$\begin{array}{ll} n P & = 0.1 \\ l P & = 0.1 \\ u P & = 0.7 \\ d P & = 0.1 \end{array}$$

$$\begin{aligned} & \Rightarrow 0.1[-1 + 0.9(-1)] + 0.1[-1 + 0.9(-1)] \\ & \quad + 0.7[-0.1 + 0.9(0)] + 0.1[-0.1 + 0.9(0)] \\ & \Rightarrow \boxed{-0.46} \end{aligned}$$

$$D \rightarrow (4,3) \rightarrow (3,3)$$

$$\begin{array}{ll} n R = -1 & V_o = -1 \\ l R = -1 & V_o = -1 \\ u R = -0.1 & V_o = 0 \\ d R = -0.1 & V_o = 0 \end{array} \quad \begin{array}{l} P = 0.1 \\ P = 0.1 \\ P = 0.1 \\ P = 0.7 \end{array}$$

$$\begin{aligned} & 0.1[-1 + 0.9(0)] + 0.1[-1 + 0.9(-1)] + 0.1[0.1 + 0.9(0)] \\ & \quad + 0.7[-0.1 + 0.9(0)] \end{aligned}$$

$$\Rightarrow \boxed{-0.46}$$

$$\boxed{V_1(s_{3,3}) = -0.46}$$

$$\boxed{V_1(s_{3,4}) = -1.9}$$

$$V_1(S_{4,1}) =$$

$$\therefore V_1(S_{4,1}) = -0.1$$

$$V_1(S_{4,2}) =$$

$$V_2(S_{2,1}) = -0.28$$

$$V_1(S_{4,3}) =$$

$$R \rightarrow (4,4) \rightarrow (4,3)$$

$$R \quad R = 10 \quad V_o = 10 \quad P = 0.7$$

$$L \quad R = -0.1 \quad V_o = 0 \quad P = 0.1$$

$$O \quad R = -0.1 \quad V_o = 0 \quad P = 0.1$$

$$D \quad R = -0.1 \quad V_o = 0 \quad P = 0.1$$

$$\Rightarrow 0.7[10 + (0.9)(10)] + 0.1[-0.1 + 0.9(0)] \\ + 0.1[-0.1 + 0.9(0)] + 0.1[-0.1 + 0.9(0)]$$

$$\Rightarrow [13.27]$$

$$L \rightarrow (4,2) \rightarrow (4,3)$$

$$R \quad R = 10 \quad V_o = 10 \quad P = 0.1$$

$$L \quad R = -0.1 \quad V_o = 0 \quad P = 0.7$$

$$O \quad R = -0.1 \quad V_o = 0 \quad P = 0.1$$

$$D \quad R = -0.1 \quad V_o = 0 \quad P = 0.1$$

$$0.1[10 + 0.9(0)] + 0.7[-0.1 + 0.9(0)] + 0.1[-0.1 + 0.9(0)] \\ + 0.1[-0.1 + 0.9(0)]$$

$$\Rightarrow [10.81]$$

$$U \rightarrow (3,3) \rightarrow (4_B, 3)$$

$$\Rightarrow [1, 81]$$

$$O \rightarrow (3,3) \rightarrow (3,3)$$

$$\Rightarrow [1, 81]$$

$$\begin{array}{|c|c|} \hline & -1 \\ \hline 0 & 10 \\ \hline \end{array}$$

$$V_1(S_{4,3}) = 13.27$$

$$V_1(S_{4,4}):$$

$$R \rightarrow (4,4) \rightarrow (4,4)$$

R	$R = 10$	$V_o = 10$	$P = 0.7$
L	$R = 10$	$V_o = 10$	$P = 0.1$
U	$R = 10$	$V_o = 10$	$P = 0.1$
D	$R = 10$	$V_o = 10$	$P = 0.1$

$$0.7[10 + 0.9(10)] + 0.1[10 + 0.9(10)] + 0.1[10 + 0.9(10)] + 0.1[10 + 0.9(10)]$$

$$\Rightarrow [19]$$

$$L \rightarrow (4,3) \rightarrow (4,4)$$

R	$R = 10$	$V_o = 10$	$P = 0.9$
L	$R = 10$	$V_o = 10$	$P = 0.7$
U	$R = 10$	$V_o = 10$	$P = 0.1$
D	$R = 10$	$V_o = 10$	$P = 0.1$

$$\Rightarrow [319]$$

$U \rightarrow (3,4) \rightarrow (4,4)$

a $R = 10$ $V_0 = 10$ $P = 0.1$
c $R = 10$ $V_0 = 10$ $P = 0.1$
u $R = 10$ $V_0 = 10$ $P = 0.7$
d $R = 10$ $V_0 = 10$ $P = 0.1$

$\Rightarrow [19]$

$D \rightarrow (4,4) \rightarrow (4,4)$

$R = 10$ $V_0 = 10$ $P = 0.1$
 $R = 10$ $V_0 = 10$ $P = 0.1$
 $R = 10$ $V_0 = 10$ $P = 0.1$
 $R = 10$ $V_0 = 10$ $P = 0.7$

$\Rightarrow [19]$

$\boxed{V_1(s_{4,4}) = 15}$

$\therefore V_4(s) :$

-0.36	-0.38	2.76	-0.39
-0.42	2.39	7.23	2.36
2.46	-4.10	16.69	-4.10
8.85	18.27	33.32	10.95

(1,1), Up

Q5:

(S,,, UP)

$$\begin{array}{r} -0.35 \\ \hline -0.37 \end{array}$$

$$\text{intended} = 0.7$$

$$\text{unintended} = 0.1$$

$$\Rightarrow 0.1[-0.1 + 0.9(-0.38)] + 0.1[-0.1 + 0.9(0.36)] \\ + 0.1[-0.1 + 0.9(-0.36)] + 0.1[-0.1 + 0.9(-0.42)] \\ \Rightarrow \boxed{-0.4312}$$

(S,,, Down)

$$\Rightarrow 0.1[-0.1 + 0.9(-0.38)] + 0.1[-0.1 + 0.9(-0.36)] \\ + 0.1[-0.1 + 0.9(-0.36)] + 0.1[-0.1 + 0.9(-0.42)] \\ \Rightarrow \boxed{-0.4636}$$

(S,,, Right)

$$\Rightarrow 0.1[-0.1 + 0.9(-0.38)] + 0.1[-0.1 + 0.9(0.36)] \\ + 0.1[-0.1 + 0.9(-0.36)] + 0.1[-0.1 + 0.9(-0.42)] \\ \Rightarrow \boxed{-0.4421}$$

(S,,, Left)

$$\Rightarrow 0.1[-0.1 + 0.9(-0.38)] + 0.1[-0.1 + 0.9(-0.36)] \\ + 0.1[-0.1 + 0.9(-0.36)] + 0.1[-0.1 + 0.9(-0.42)] \\ \Rightarrow \boxed{-0.4321}$$

$$Q_5(S,,, \text{UP}) = -0.4312$$

$$Q_5(S,,, \text{Down}) = -0.4636$$

$$Q_5(S,,, \text{Right}) = -0.4421$$

$$Q_5(S,,, \text{Left}) = -0.4321$$

$Q_S : (S_{1,2})$

$(S_{1,2}, \text{Right})$

$$\Rightarrow 0.7[-0.1 + 0.9(2.76)] + 0.1[-0.1 + 0.9(-0.36)] \\ + 0.1[-0.1 + 0.9(-0.38)] + 0.1[-0.1 + 0.9(2.39)]$$

$$\Rightarrow [1.7873]$$

$$\Rightarrow \left\{ -0.1 + 0.9 \times [0.7(4.26) + 0.1(-0.35) + 0.1(-0.36) + 0.1(4.34)] \right.$$

$(S_{1,2}, \text{Left})$

$$\Rightarrow -0.1 + 0.9[0.1(2.76) + 0.7(-0.36) + 0.1(-0.38) + 0.1(2.39)]$$

$$\Rightarrow [0.1025]$$

$(S_{1,2}, \text{Up})$

$$\Rightarrow -0.1 + 0.9[0.1(2.76) + 0.1(-0.35) + 0.7(-0.38) + 0.1(2.39)]$$

$$\Rightarrow [0.0917]$$

$(S_{1,2}, \text{Down})$

$$\Rightarrow -0.1 + 0.9[0.1(2.76) + 0.1(-0.36) + 0.1(-0.38) + 0.7(2.39)]$$

$$\Rightarrow [1.5875]$$

$$Q_S(S_{1,2}, \text{Right}) = 1.7873$$

$$Q_S(S_{1,2}, \text{Left}) = 0.1025$$

$$Q_S(S_{1,2}, \text{Up}) = 0.0917$$

$$Q_S(S_{1,2}, \text{Down}) = 1.5875$$

$Q_5(s_{1,3})$

$(s_{1,3}, \text{Right})$

$$\Rightarrow -0.1 + 0.9 [0.7(-0.39) + 0.1(-0.38) \\ + 0.1(2.76) + 0.1(7.23)] \\ \Rightarrow [0.519]$$

$(s_{1,3}, \text{Left})$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.7(-0.38) + 0.1(2.76) \\ + 0.1(7.23)] \\ \Rightarrow [0.5246]$$

$(s_{1,3}, \text{Up})$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.1(-0.38) + 0.7(2.76) \\ + 0.1(7.23)] \\ \Rightarrow [2.2202]$$

$(s_{1,3}, \text{Down})$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.1(-0.38) + 0.1(2.76) \\ + 0.7(7.23)] \\ \Rightarrow [4.634]$$

$$Q_5(s_{1,3}, \text{Right}) = 0.519$$

$$Q_5(s_{1,3}, \text{Left}) = 0.5246$$

$$Q_5(s_{1,3}, \text{Up}) = 2.2202$$

$$Q_5(s_{1,3}, \text{Down}) = 4.634$$

$Q_5(S_{1,4})$

$(S_{1,4}, \text{Right})$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.1(2.76) + 0.1(-0.39) \\ + 0.1(2.36)]$$

$$\Rightarrow [0.08]$$

$(S_{1,4}, \text{Left})$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.1(2.76) + 0.1(-0.39) \\ + 0.1(2.36)]$$

$$\Rightarrow [1.78]$$

$(S_{1,4}, U_P)$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.1(2.76) + 0.1(-0.39) \\ + 0.1(2.36)]$$

$$\Rightarrow [0.08]$$

$(S_{1,4}, \text{Down})$

$$\Rightarrow -0.1 + 0.9 [0.1(-0.39) + 0.1(2.76) + 0.1(-0.39) \\ + 0.1(2.36)]$$

$$\Rightarrow [1.565]$$

$$Q_5(S_{1,4}, R) = 0.08$$

$$Q_5(S_{1,4}, L) = 1.781$$

$$Q_5(S_{1,4}, U) = 0.08$$

$$Q_5(S_{1,4}, D) = 1.565$$