

Step 1:

	$v_k(s)$	$v_{k+1}(s)$	v_{k+2}	A	B	C
A	0	-1		D	E	F
B	0	-1		G	H	I
D	0	-1				
E	0	-1		D	D	0
F	0	-1		D	D	D
H	0	-1		D	D	D

$$\begin{aligned} 1.) v_{k+1}(A) &= \frac{1}{4} [(-1 + v(A)) + (-1 + v(B)) + (-1 + v(D)) + (-1 + v(A))] \\ &= \frac{1}{4} [(-1 + 0) + (-1 + 0) + (-1 + 0) + (-1 + 0)] \\ &= \frac{1}{4} [-1 + (-1) + (-1) + (-1)] \end{aligned}$$

$$v_{k+1} = -1$$

$$\begin{aligned} 2.) v_{k+1}(B) &= \frac{1}{4} [(-1 \xleftarrow{v(A)} + (-1 \xrightarrow{v(C)}) + (-1 \xdownarrow{v(E)}) + (-1 \xuparrow{v(B)})] \\ &= \frac{1}{4} [(-1 + 0) + (-1 + 0) + (-1 + 0) + (-1 + 0)] \\ &= -1 \end{aligned}$$

$$3.) v_{k+1}(D) = -1$$

$$4.) v_{k+1}(E) = -1$$

$$5.) v_{k+1}(F) = -1$$

$$6.) v_{k+1}(H) = -1$$

$$7.) \begin{matrix} -1 & -1 & 0 \\ -1 & -1 & -1 \end{matrix}$$

$$\begin{matrix} D & -1 & 0 \end{matrix}$$

Step 2:

$$8.) q_{k+1}(A, \text{LEFT}) = -1 + v(A) \\ = -1 + (-1) \\ = -2$$

$$11.) q_{k+1}(A, \text{DOWN}) = -1 + v(D) \\ = -1 + (-1) \\ = -2$$

$$9.) q_{k+1}(A, \text{RIGHT}) = -1 + v(B) \\ = -1 + (-1) \\ = -2$$

$$12.) \pi_{k+1}(A) = \begin{array}{c} \uparrow \\ \leftarrow \rightarrow \\ \downarrow \end{array}$$

$\uparrow \downarrow \rightarrow$?	
?	?	?
	?	

$$10.) q_{k+1}(A, \text{UP}) = -1 + v(A) \\ = -1 + (-1) \\ = -2$$

$$13.) q_{k+1}(B, \text{LEFT}) = -1 + v(A) \\ = -1 + (-1) \\ = -2$$

$$16.) q_{k+1}(B, \text{DOWN}) = -1 + v(E) \\ = -1 + (-1) \\ = -2$$

$$14.) q_{k+1}(B, \text{RIGHT}) = -1 + v(C) \\ = -1 + 0$$

$$\boxed{= -1}$$

$\uparrow \downarrow \rightarrow$	\rightarrow	
?	?	?
	?	

$$15.) q_{k+1}(B, \text{UP}) = -1 + v(B) \\ = -1 + (-1) \\ = -2$$

$$18) q_{k+1}(D, \text{LEFT}) = -1 + v(D)$$

$$= -1 + (-1)$$

$$= -2$$

$$21) q_{k+1}(D, \text{DOWN}) = -1 + 0$$

$$= -1$$

$$19) q_{k+1}(D, \text{RIGHT}) = -1 + v(E)$$

$$= -1 + (-1)$$

$$= -2$$

$$22) \pi_{k+1}(D) = \{ \text{DOWN} \}$$

$\uparrow\downarrow$	\rightarrow	
\downarrow	?	?
	!	

$$20) q_{k+1}(D, \text{UP}) = -1 + v(A)$$

$$= -1 + (-1)$$

$$= -2$$

$$23) q_{k+1}(E, \text{LEFT}) = -1 + v(D)$$

$$= -1 + (-1)$$

$$= -2$$

$$26) q_{k+1}(E, \text{DOWN}) = -1 + v(H)$$

$$= -1 + (-1)$$

$$= -2$$

$$24) q_{k+1}(E, \text{RIGHT}) = -1 + v(F)$$

$$= -1 + (-1)$$

$$= -2$$

$$27) \pi_{k+1}(E) = \uparrow\downarrow\rightarrow$$

$\uparrow\downarrow$	\rightarrow	
\downarrow	$\uparrow\downarrow$?
	!	

$$25) q_{k+1}(E, \text{UP}) = -1 + v(B)$$

$$= -1 + (-1)$$

$$= -2$$

$$28.) q_{k+1}(F, \text{LEFT}) = -1 + v(E)$$

$$= -1 + (-1)$$

$$= \boxed{-2}$$

$$31.) q_{k+1}(F, \text{DOWN}) = -1 + v(I)$$

$$= -1 + 0$$

$$= \boxed{-1}$$

$$29.) q_{k+1}(F, \text{RIBHT}) = -1 + v(F)$$

$$= -1 + (-1)$$

$$= \boxed{-2}$$

$$32.) \Pi_{k+1}(F) = \{ \text{UP}, \text{DOWN} \}$$

$\uparrow \downarrow \rightarrow$	\rightarrow	
\downarrow	$\uparrow \downarrow \rightarrow$	\uparrow \downarrow
	?	

$$30.) q_{k+1}(F, \text{UP}) = -1 + v(c)$$

$$= -1 + D$$

$$= \boxed{-1}$$

$$33.) q_{k+1}(H, \text{LEFT}) = -1 + v(b)$$

$$= -1 + D$$

$$= \boxed{-1}$$

$$36.) q_{k+1}(H, \text{DOWN}) = -1 + v(H)$$

$$= -1 + (-1)$$

$$= \boxed{-2}$$

$$34.) q_{k+1}(H, \text{RIBHT}) = -1 + v(I)$$

$$= -1 + D$$

$$= \boxed{-1}$$

$$37.) \Pi_{k+1}(H) = \{ \text{LEFT}, \text{RIBHT} \}$$

$\uparrow \downarrow \rightarrow$	\rightarrow	
\downarrow	$\uparrow \downarrow \rightarrow$	\uparrow \downarrow
	$\leftarrow \rightarrow$	

$$35.) q_{k+1}(H, \text{UP}) = -1 + v(E)$$

$$= -1 + (-1)$$

$$= \boxed{-2}$$

38.)

$\leftrightarrow\uparrow$	\rightarrow	
\downarrow	$\leftrightarrow\uparrow$	\uparrow
$\leftarrow\rightarrow$		

— going back to step 1 —

Step 1:

	$V_K(S)$	$V_{K+1}(S)$	V_{K+2}	A	B	C
A	0	-1	-2	D	E	F
B	0	-1	-1.75	G	H	I
D	0	-1	-1.75			
E	0	-1	-2		-1	0
F	0	-1	-1.5		-1	-1
H	0	-1	-1.5	0	-1	0

$$\begin{aligned}
 39.) V_{K+2}(A) &= \frac{1}{4} \left[(-1 + V(A)) + (-1 + V(B)) + (-1 + V(C)) + (-1 + V(D)) \right] \\
 &= \frac{1}{4} [(-1 + (-1)) + (-1 + (-1)) + (-1 + (-1)) + (-1 + (-1))] \\
 &= \frac{1}{4} [(-2) + (-2) + (-2) + (-2)] \\
 &= \boxed{-2}
 \end{aligned}$$

$$\begin{aligned}
 40.) V_{K+2}(B) &= \frac{1}{4} \left[(-1 + V(A)) + (-1 + V(C)) + (-1 + V(B)) + (-1 + V(E)) \right] \\
 &= \frac{1}{4} [(-1 + (-1)) + (-1 + 0) + (-1 + (-1)) + (-1 + (-1))] \\
 &= \frac{1}{4} [(-2) + (-1) + (-2) + (-2)] \\
 &= \frac{1}{4} \boxed{-7} \\
 &= \boxed{-1.75}
 \end{aligned}$$

$$\begin{aligned}
 41) V_{K+2}(D) &= \frac{1}{4} [(-1 + v(D)) + (-1 + v(F)) + (-1 + v(A)) + (-1 + v(B))] \\
 &= \frac{1}{4} [(-1 + (-1)) + (-1 + (-1)) + (-1 + (-1)) + (-1 + 0)] \\
 &= \frac{1}{4} (-2 - 2 - 2 - 1) \\
 &= \frac{1}{4} (-7) \\
 &= \boxed{-1.75}
 \end{aligned}$$

$$\begin{aligned}
 42) V_{K+2}(E) &= \frac{1}{4} [(-1 + v(D)) + (-1 + v(F)) + (-1 + v(B)) + (-1 + v(H))] \\
 &= \frac{1}{4} [(-1 + (-1)) + (-1 + (-1)) + (-1 + (-1)) + (-1 + (-1))] \\
 &= \frac{1}{4} (-2 - 2 - 2 - 2) \\
 &= \boxed{-2}
 \end{aligned}$$

$$\begin{aligned}
 43) V_{K+2}(F) &= \frac{1}{4} [(-1 + v(E)) + (-1 + v(F)) + (-1 + v(C)) + (-1 + v(I))] \\
 &= \frac{1}{4} [(-1 + (-1)) + (-1 + (-1)) + (-1 + 0) + (-1 + 0)] \\
 &= \frac{1}{4} (-2 - 2 - 1 - 1) \\
 &= \frac{1}{4} (-5) \\
 &= \boxed{-1.5}
 \end{aligned}$$

$$\begin{aligned}
 44) V_{K+2}(H) &= \frac{1}{4} [(-1 + v(B)) + (-1 + v(I)) + (-1 + v(E)) + (-1 + v(B))] \\
 &= \frac{1}{4} [(-1 + 0) + (-1 + 0) + (-1 + (-1)) + (-1 + (-1))] \\
 &= \frac{1}{4} (-1 - 1 - 2 - 2) \\
 &= \frac{1}{4} (-6) \\
 &= \boxed{-1.5}
 \end{aligned}$$

$$\begin{matrix}
 -2 & -1.75 & 0 \\
 -1.75 & -2 & -1.5 \\
 0 & -1.5 & 0
 \end{matrix}$$

Step 2:

$$45.) q_{k+2}(A, \text{LEFT}) = -1 + v(A) \\ = -1 + (-2) \\ = -3$$

$$q_{k+2}(A, \text{DOWN}) = -1 + v(D) \\ = -1 + (-1.75) \\ = -2.75$$

$$q_{k+2}(A, \text{RIGHT}) = -1 + v(B) \\ = -1 + (-1.75) \\ = -2.75$$

$$\pi_{k+2}(A) = \{\text{DOWN, RIGHT}\}$$

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\uparrow \downarrow \rightarrow$	\uparrow
	$\leftarrow \rightarrow$	

$$q_{k+2}(A, \text{UP}) = -1 + v(A) \\ = -1 + (-2) \\ = -3$$

$$46.) q_{k+2}(B, \text{LEFT}) = -1 + v(A) \\ = -1 + (-2) \\ = -3$$

$$q_{k+2}(B, \text{DOWN}) = -1 + v(E) \\ = -1 + (-2) \\ = -3$$

$$q_{k+2}(B, \text{RIGHT}) = -1 + v(C) \\ = -1 + 0 \\ = -1$$

$$\pi_{k+2}(B) = \{\text{RIGHT}\}$$

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\uparrow \downarrow \rightarrow$	\uparrow
	$\leftarrow \rightarrow$	

$$q_{k+2}(B, \text{UP}) = -1 + v(B) \\ = -1 + (-1.75) \\ = -2.75$$

$$47.) q_{K+Z}(D, \text{LEFT}) = -1 + v(D) \\ = -1 + (-1.75) \\ = -2.75$$

$$q_{K+Z}(D, \text{DOWN}) = -1 + v(B) \\ = -1 + D \\ = -1$$

$$q_{K+Z}(D, \text{RIGHT}) = -1 + v(E) \\ = -1 + (-2) \\ = -3$$

$$\Pi_{K+Z}(D) = \{ \text{DOWN} \}$$

$$q_{K+Z}(D, \text{UP}) = -1 + v(A) \\ = -1 + (-2) \\ = -3$$

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\uparrow \rightarrow$	\uparrow
	$\leftarrow \rightarrow$	

$$48.) q_{K+Z}(E, \text{LEFT}) = -1 + v(D) \\ = -1 + (-1.75) \\ = -2.75$$

$$q_{K+Z}(E, \text{DOWN}) = -1 + v(H) \\ = -1 + (-1.5) \\ = -2.5$$

$$q_{K+Z}(E, \text{RIGHT}) = -1 + v(F) \\ = -1 + (-1.5) \\ = -2.5$$

$$\Pi_{K+Z}(F) = \{ \text{RIGHT, DOWN} \}$$

$$q_{K+Z}(E, \text{UP}) = -1 + v(B) \\ = -1 + (-1.75) \\ = -2.75$$

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\uparrow \rightarrow$	\uparrow
	$\leftarrow \rightarrow$	

$$49.) q_{K+Z}(F, \text{LEFT}) = -1 + v(F) \\ = -1 + (-2) \\ = -3$$

$$q_{K+Z}(F, \text{DOWN}) = -1 + v(1) \\ = -1 + 0 \\ = \boxed{-1}$$

$$q_{K+Z}(F, \text{RIGHT}) = -1 + v(F) \\ = -1 + (-1.5) \\ = -2.5$$

$$\pi_{K+Z}(F) = \{\text{UP}, \text{DOWN}\}$$

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\downarrow \rightarrow$	\uparrow
	$\leftarrow \rightarrow$	

$$q_{K+Z}(F, \text{UP}) = -1 + v(c) \\ = -1 + 0 \\ = \boxed{-1}$$

$$50.) q_{K+Z}(H, \text{LEFT}) = -1 + v(b) \\ = -1 + 0 \\ = \boxed{-1}$$

$$q_{K+Z}(H, \text{DOWN}) = -1 + (-1.5) \\ = -2.5$$

$$q_{K+Z}(H, \text{RIGHT}) = -1 + 0 \\ = \boxed{-1}$$

$$\pi_{K+Z}(H) = \{\text{LEFT}, \text{RIGHT}\}$$

$$q_{K+Z}(H, \text{UP}) = -1 + (-2) \\ = -3$$

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\downarrow \rightarrow$	\uparrow
	$\leftarrow \rightarrow$	

/ /

51.) { DOWN, RIGHT }

52.) { RIGHT }

53.) { DOWN }

54.) { RIGHT, DOWN }

55.) { UP, DOWN }

56.) { LEFT, RIGHT }

$$\begin{array}{c|c|c} 57.) \begin{array}{c|c|c} -2 & -1.75 & D \\ \hline -1.75 & -2 & -1.5 \\ \hline & -1.5 & \end{array} \end{array}$$

58.)

$\downarrow \rightarrow$	\rightarrow	
\downarrow	$\curvearrowleft \rightarrow$	$\uparrow \downarrow$
	$\leftarrow \rightarrow$	