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STEP 1

$$1) V_{K+1}(A) = \frac{1}{4} = [(-1+V(A)) + (-1+V(B)) + (-1+V(D)) + (-1+V(A))] \\ V_{K+1}(A) = \frac{1}{4} = [(-1+0) + (-1+0) + (-1+0) + (-1+0)] \\ V_{K+1}(A) = -1$$

$$2) V_{K+1}(B) = \frac{1}{4} [(-1+V(A)) + (-1+V(C)) + (-1+V(E)) + (-1+V(B))] \\ V_{K+1}(B) = \frac{1}{4} [(-1+0) + (-1+0) + (-1+0) + (-1+0)] \\ V_{K+1}(B) = -1$$

$$3) V_{K+1}(D) = \frac{1}{4} [(-1+V(D)) + (-1+V(E)) + (-1+V(G)) + (-1+V(A))] \\ V_{K+1}(D) = \frac{1}{4} [(-1+0) + (-1+0) + (-1+0) + (-1+0)] \\ V_{K+1}(D) = -1$$

$$4) V_{K+1}(E) = \frac{1}{4} [(-1+V(D)) + (-1+V(F)) + (-1+V(H)) + (-1+V(B))] \\ V_{K+1}(E) = \frac{1}{4} [(-1+0) + (-1+0) + (-1+0) + (-1+0)] \\ V_{K+1}(E) = -1$$

$$5) V_{K+1}(F) = \frac{1}{4} [(-1+V(E)) + (-1+V(F)) + (-1+V(I)) + (-1+V(C))] \\ V_{K+1}(F) = \frac{1}{4} [(-1+0) + (-1+0) + (-1+0) + (-1+0)] \\ V_{K+1}(F) = -1$$

$$6) V_{K+1}(H) = \frac{1}{4} [(-1+V(G)) + (-1+V(I)) + (-1+V(H)) + (-1+V(E))] \\ V_{K+1}(H) = \frac{1}{4} [(-1+0) + (-1+0) + (-1+0) + (-1+0)] \\ V_{K+1}(H) = -1$$

7) PUT THE NEW VALUE

-1	-1	0
-1	-1	-1
0	-1	0

$$8) q_{K+1}(A, \text{LEFT}) = -1 + V(A) \\ q_{K+1}(A, \text{LEFT}) = -1 + (-1) \\ w_{K+1}(A, \text{LEFT}) = -2$$

$$9) q_{K+1}(A, \text{RIGHT}) = -1 + V(B) \\ q_{K+1}(A, \text{RIGHT}) = -1 + (-1) \\ q_{K+1}(A, \text{RIGHT}) = -2$$

$$10) q_{K+1}(UP) = -1 + V(A) \\ q_{K+1}(A, UP) = -1 + (-1) \\ v_{K+1}(A, UP) = -2$$



$$11) q_{k+1}(A, \text{DOWN}) = -1 + 0$$

$$q_{k+1}(A, \text{DOWN}) = -1 + (-1)$$

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

$$12) \pi_{k+1}(A) = \text{LEFT, RIGHT, UP, DOWN}$$

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

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

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

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

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

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

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

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

$$17) \pi_{k+1}(B) = \text{RIGHT}$$

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

$$q_{k+1}(D, \text{LEFT}) = -2$$

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

$$q_{k+1}(D, \text{RIGHT}) = -2$$

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

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

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

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

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

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

$$q_{k+1}(E, \text{LEFT}) = -2$$

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

$$q_{k+1}(E, \text{RIGHT}) = -2$$

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

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

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

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

$$27) \pi_{k+1}(E) = \text{LEFT, RIGHT, UP, DOWN}$$

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

$$q_{k+1}(F, \text{LEFT}) = -2$$

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

$$q_{k+1}(F, \text{RIGHT}) = -2$$

$$30) q_{k+1}(F, \text{UP}) = -1 + (0)$$

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

$$31) q_{k+1}(F, \text{DOWN}) = -1 + (0)$$

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

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

$$33) q_{k+1}(H, \text{LEFT}) = -1 + (0)$$

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



$$34) q_{k+1}(H, \text{RIGHT}) = -1 + (0) \\ q_{k+1}(H, \text{RIGHT}) = -1$$

$$35) q_{k+1}(H, \text{UP}) = -1 + (-1) \\ q_{k+1}(H, \text{UP}) = -2$$

$$36) q_{k+1}(H, \text{DOWN}) = -1 + (-1) \\ q_{k+1}(H, \text{DOWN}) = -2$$

$$37) \pi_{k+1} = \text{LEFT}, \text{RIGHT}$$

$$38) \begin{array}{c} \updownarrow \\ \downarrow \end{array} \rightarrow 0 \\ \begin{array}{c} \updownarrow \\ \updownarrow \end{array} \\ 0 \leftrightarrow 0$$

$$45) q_*(A, \text{LEFT}) = -1 + (-2) = -3 \\ \text{RIGHT} = -1 + (-1.75) = -2.75 \\ \text{UP} = -1 + (-2) = -3 \\ \text{DOWN} = -1 + (-1.75) = -2.75$$

$$46) q_*(B, \text{LEFT}) = -1 + (-2) = -3 \\ \text{RIGHT} = -1 + (0) = -1 \\ \text{UP} = -1 + (-1.75) = -2.75 \\ \text{DOWN} = -1 + (-2) = -3$$

$$47) q_*(C, \text{LEFT}) = -1 + (-1.75) = -2.75 \\ \text{RIGHT} = -1 + (-2) = -3 \\ \text{UP} = -1 + (-2) = -3 \\ \text{DOWN} = -1 + (0) = -1$$

$$39) V_*(A) = \frac{1}{4} [(-2) + (-2) + (-2) + (-2)] \\ V_*(A) = -2$$

$$40) V_*(B) = \frac{1}{4} [(-2) + (-1) + (-2) + (-2)] \\ V_*(B) = -1.75$$

$$41) V_*(D) = \frac{1}{4} [(-2) + (-2) + (-2) + (-1)] \\ V_*(D) = -1.75$$

$$42) V_*(E) = \frac{1}{4} [(-2) + (-2) + (-2) + (-2)] \\ V_*(E) = -2$$

$$43) V_*(F) = \frac{1}{4} [(-2) + (-2) + (-1) + (-1)] \\ V_*(F) = -1.5$$

$$44) V_*(H) = \frac{1}{4} [(-1) + (-1) + (-2) + (-2)] \\ V_*(H) = -1.5$$

$$48) q_*(E, \text{LEFT}) = -1 + (-1.75) = -2.75 \\ \text{RIGHT} = -1 + (-1.5) = -2.5 \\ \text{UP} = -1 + (-1.75) = -2.75 \\ \text{DOWN} = -1 + (-1.5) = -2.5$$

$$49) q_*(F, \text{LEFT}) = -1 + (-2) = -3 \\ \text{RIGHT} = -1 + (1.5) = 0.5 \\ \text{UP} = -1 + (0) = -1 \\ \text{DOWN} = -1 + (0) = -1$$

$$50) q_*(H, \text{LEFT}) = -1 + (0) = -1 \\ \text{RIGHT} = -1 + (0) = -1 \\ \text{UP} = -1 + (-2) = -3 \\ \text{DOWN} = -1 + (-1.5) = -2.5$$

51)  $\pi^*(A) = \text{RIGHT, DOWN}$

52)  $\pi^*(B) = \text{RIGHT}$

53)  $\pi^*(D) = \text{DOWN}$

54)  $\pi^*(E) = \text{RIGHT, DOWN}$

55)  $\pi^*(F) = \text{UP, DOWN}$

56)  $\pi^*(H) = \text{LEFT, RIGHT}$

57) PUT THE OPTIMAL VALUE FUNCTIONS IN THE 3X3 GRID:

-2	-1.75	0
-1.75	-2	-1.5
0	-1.5	0

58) PUT THE OPTIMAL POLICY IN THE 3X3 GRID:

