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1 a) Let's suppose

$S_e$  = Exit floor

$S_c$  = Call floor

$S_l$  = Lift floor

for each reward = -7

$$F(U_{e,c,e}) = -7 \times (|S_e - S_c| + |S_c - S_l| + 1)$$

Getting in/out of elevator

b) Action Set,  $A = \{1, 2, 3, 4, 5, 6\}$  Epsilon Greedy Method  
i.e. 6 floors

$$Q(0) = \sum P(S_c) \sum P(S_e|S_c) F(U_{e,c,e})$$

(c) ~~P(S<sub>c</sub>) = 1~~ when call floor  $S_c = 1$   
(i)  $P(S_{e=2,3,4,5,6}|S_c=1) = \frac{1}{5} = 0.2$  when exit floor can be 2, 3, 4, 5, 6

$$\begin{aligned} Q(1) &= \{1 \times 0.2 \times -7 \times (11-11+12-11+2)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (11-11+13-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (11-11+14-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (11-11+15-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (11-11+16-11+1)\} \\ &= \dots -28 \end{aligned}$$

$$\begin{aligned} Q(2) &= \{1 \times 0.2 \times -7 \times (12-11+12-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (12-11+13-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (12-11+14-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times (12-11+15-11+1)\} + \\ &\quad \{1 \times 0.2 \times -7 \times ((2-1)+16-11+1)\} \\ &= \dots -35 \end{aligned}$$

$$\begin{aligned} Q(3) &= \{ 1 \times 0.2 \times -7 \times (|3-1| + |2-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|3-1| + |3-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|3-1| + |4-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|3-1| + |5-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|3-1| + |6-1| + 1) \} + \\ &= -42 \end{aligned}$$

$$\begin{aligned} Q(4) &= \{ 1 \times 0.2 \times -7 \times (|4-1| + |2-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|4-1| + |3-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|4-1| + |4-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|4-1| + |5-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|4-1| + |6-1| + 1) \} + \\ &= -49 \end{aligned}$$

$$\begin{aligned} Q(5) &= \{ 1 \times 0.2 \times -7 \times (|5-1| + |2-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|5-1| + |3-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|5-1| + |4-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|5-1| + |5-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|5-1| + |6-1| + 1) \} + \\ &= -56 \end{aligned}$$

$$\begin{aligned} Q(6) &= \{ 1 \times 0.2 \times -7 \times (|6-1| + |2-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|6-1| + |3-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|6-1| + |4-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|6-1| + |5-1| + 1) \} + \\ &\quad \{ 1 \times 0.2 \times -7 \times (|6-1| + |6-1| + 1) \} + \\ &= -63 \end{aligned}$$

iii Exit = 1st floor

call = 2-6 floor

$$P(S_{C=2,4,5,3,6}) = \frac{1}{5} = 0.2$$

$$P(S_{e=1} | S_{C=2,4,5,3,6}) = 1$$

$$\begin{aligned} Q(1) &= \{0.2 \times -7 \times (12-1) + 12-1\} + \\ &\quad \{0.2 \times -7 \times (13-1) + 13-1\} + \\ &\quad \{0.2 \times -7 \times (14-1) + 14-1\} + \\ &\quad \{0.2 \times -7 \times (15-1) + 15-1\} + \\ &\quad \{0.2 \times -7 \times (16-1) + 16-1\} \\ &= -49 \end{aligned}$$

$$\begin{aligned} Q(2) &= \{0.2 \times -7 \times (12-2) + 12-1\} + \\ &\quad \{0.2 \times -7 \times (12-3) + 13-1\} + \\ &\quad \{0.2 \times -7 \times (12-4) + 14-1\} + \\ &\quad \{0.2 \times -7 \times (12-5) + 15-1\} + \\ &\quad \{0.2 \times -7 \times (12-6) + 16-1\} \\ &= -42 \end{aligned}$$

$$\begin{aligned} Q(3) &= \{0.2 \times -7 \times (13-2) + 12-1\} + \\ &\quad \{0.2 \times -7 \times (13-3) + 13-1\} + \\ &\quad \{0.2 \times -7 \times (13-4) + 14-1\} + \\ &\quad \{0.2 \times -7 \times (13-5) + 15-1\} + \\ &\quad \{0.2 \times -7 \times (13-6) + 16-1\} \\ &= -37.8 \end{aligned}$$

$$\begin{aligned} Q(4) &= \{0.2 \times -7 \times (14-2) + 12-1\} + \\ &\quad \{0.2 \times -7 \times (14-3) + 13-1\} + \\ &\quad \{0.2 \times -7 \times (14-4) + 14-1\} + \\ &\quad \{0.2 \times -7 \times (14-5) + 15-1\} + \\ &\quad \{0.2 \times -7 \times (14-6) + 16-1\} \\ &= -36.4 \end{aligned}$$

$$\begin{aligned}
 Q(5) &= \{ 0.2x - 7x(15-21+|2-11+1|) + \\
 &\quad \{ 0.2x - 7x(15-31+|3-11+1|) + \\
 &\quad \{ 0.2x - 7x(15-41+|4-11+1|) + \\
 &\quad \{ 0.2x - 7x(15-51+|5-11+1|) + \\
 &\quad \{ 0.2x - 7x(15-61+|6-11+1|) \\
 = & -37.8
 \end{aligned}$$

$$\begin{aligned}
 Q(6) &= \{ 0.2x - 7x(16-21+|2-11+1|) + \\
 &\quad \{ 0.2x - 7x(16-31+|3-11+1|) + \\
 &\quad \{ 0.2x - 7x(16-41+|4-11+1|) + \\
 &\quad \{ 0.2x - 7x(16-51+|5-11+1|) + \\
 &\quad \{ 0.2x - 7x(16-61+|6-11+1|) \\
 = & -42
 \end{aligned}$$

$$\begin{aligned}
 \text{c) } \text{iii} \quad 50\% \rightarrow \text{Call floor} = 2 & \quad P(S_C=2) = \frac{1}{2} \\
 \text{Exit floor} = 1, 3, 5, 6, 4 & \quad P(S_E=1, 3, 5, 6 | S_C=2) = \frac{1}{10} \\
 50\% \rightarrow \text{Call floor} = 2, 3, 4, 5, 6 & \quad P(S_C=2, 3, 4, 5, 6) = \frac{1}{10} \\
 \text{Exit floor} = 1 & \quad P(S_E=1 | S_C=2, 3, 4, 5, 6) = \frac{1}{2}
 \end{aligned}$$

$$\begin{aligned}
 Q(1) &= \frac{1}{2} \times \frac{1}{10} \times -7 \times \{ |1-2| + |2-11+1| + \\
 &\quad |1-2| + |2-3| + |1-2| + |2-4| + |1-2| + |2-5| + \\
 &\quad |1-2| + |2-6| + |1-3| + |1-3| + |1-4| + |1-4| + |1-5| + |1-5| + \\
 &\quad |1-6| + |1-6| \} \\
 &= -19.6
 \end{aligned}$$

$$Q(2) = \frac{1}{2} \times \frac{1}{10} \times -7 \times \{ |2-2| + |2-1| + 1 + \\ |2-2| + |2-3| + 1 + \\ |2-2| + |2-4| + 1 + \\ |2-2| + |2-5| + 1 + \\ |2-2| + |2-(1+2)| + 3 + \}$$

$$\frac{1}{10} \times \frac{1}{2} \times -7 \times \{ |2-2| + |2-1| + 1 + \\ |2-3| + |2-1| + 1 + \\ |2-4| + |2-1| + 1 + \\ |2-5| + |2-1| + 1 + \\ |2-6| + |2-1| + 1 + 3 \}$$

$$= \dots -16.1$$

$$Q(3) = \frac{1}{2} \times \frac{1}{10} \times -7 \times \{ |3-2| + |2-1| + 1 + \\ |3-2| + |2-3| + 1 + \\ |3-2| + |2-4| + 1 + \\ |3-2| + |2-5| + 1 + \\ |3-2| + |2-6| + 1 + 3 + \}$$

$$\frac{1}{10} \times \frac{1}{2} \times -7 \times \{ |3-2| + |2-1| + 1 + \\ |3-3| + |3-1| + 1 + \\ |3-4| + |4-1| + 1 + \\ |3-5| + |5-1| + 1 + \\ |3-6| + |6-1| + 1 \}$$

$$= -16.8$$

$$Q(4) = \frac{1}{2} \times \frac{1}{10} \times -7 \times \{ |4-2| + |2-1| + 1 + \\ |4-2| + |2-3| + 1 + \\ |4-2| + |2-4| + 1 + \\ |4-2| + |2-5| + 1 + \\ |4-2| + |2-6| + 1 + 3 + \}$$

$$\frac{1}{10} \times \frac{1}{2} \times -7 \times \{ |4-2| + |2-1| + 1 + \\ |4-3| + |3-1| + 1 + \\ |4-4| + |4-1| + 1 + \\ |4-5| + |5-1| + 1 + \\ |4-6| + |6-1| + 1 \}$$

$$= -18.2$$

(6)

$$Q(5) = \frac{1}{2} \times \frac{1}{10} \times -7 \times \{ |5-2| + |2-1| + 1 + \\ |5-2| + |2-3| + 1 + \\ |5-2| + |2-4| + 1 + \\ |5-2| + |2-5| + 1 + \\ |5-2| + |2-6| + 1 \}$$

$$\frac{1}{10} \times \frac{1}{2} \times -7 \times \{ |5-2| + |2-1| + 1 + \\ |5-3| + |3-1| + 1 + \\ |5-4| + |4-1| + 1 + \\ |5-5| + |5-1| + 1 + \\ |5-6| + |6-1| + 1 \}$$

$$= -20.3$$

$$Q(6) = \frac{1}{2} \times \frac{1}{10} \times -7 \times \{ |6-2| + |2-1| + 1 + \\ |6-2| + |2-3| + 1 + \\ |6-2| + |2-4| + 1 + \\ |6-2| + |2-5| + 1 + \\ |6-2| + |2-6| + 1 \}$$

$$\frac{1}{10} \times \frac{1}{2} \times -7 \times \{ |6-2| + |2-1| + 1 + \\ |6-3| + |3-1| + 1 + \\ |6-4| + |4-1| + 1 + \\ |6-5| + |5-1| + 1 + \\ |6-6| + |6-1| + 1 \}$$

$$= -23.1$$

2 (a) Action Set,  $A = \{1, 2, 3, 4, 5, 6\}$  i.e. 6 floors

$s_e$  = Exit floor,  $s_c$  = Call floor,  $s_e$  = lift floor

for each reward = -7

$$F(U_{e,c,c}) = -7 \times (|s_e - s_c| + |s_c - s_e|) + 1$$

New Utility function for quadratic is:-

$$Q(e) = \sum P(s_c) \sum P(s_e | s_c) * (F(U_{e,c,c}))^2$$

$$= \sum P(s_c) \sum P(s_e | s_c) * 49 * (|s_e - s_c| + |s_c - s_e|) + 1)^2$$