Assignment 2

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Qusetion1：

(a)

Breadth first search, exclude repeated states:

Position	Start1	Start2	Start3	Start4	Start5
N	41	173	2409	9508	58419

(b)

Breadth first search, include repeated states:

Position	Start1(N=)	Start2
N	139	1857

(c)

A* with total Manhattan distance heuristic:

Position	Start1	Start2	Start3	Start4	Start5
N	6	11	19	61	213

(d)

A* with Misplace Tiles heuristic:

Changed parts:

```
misdist(X/Y, X1/Y1, D)  :-
    dif(X, X1, Dx),
    dif(Y, Y1, Dy),
    D is Dx + Dy,
    D > 0,
    D is 1,!.

misdist(X/Y, X1/Y1, D)  :-
    dif(X, X1, Dx),
    dif(Y, Y1, Dy),
    D = 0.
```

```
totdist([Tile|Tiles], [Position|Positions], D) :-
    misdist(Tile, Position, D1),
    totdist(Tiles, Positions, D2),
    D is D1 + D2.
```

Position	Start1	Start2	Start3	Start4	Start5
N	20	34	768	Run out of time	Run out of time

(e)

Base on this result, the order from slowest to fastest is **c>a>b>d.**

(f)

Position:

Requiring 20:

5	7	4
8	2	1
	6	3

Requiring 23:

5	7	4
8	2	
6	3	1

Requiring 26:

	5	7
8	2	4
6	3	1

With A* Manhattan Distance heuristic

Requiring steps	**20**	**23**	**26**
N	153	336	1305

Qusetion2：

(a)

$$h(x, y, x_G, y_G) = |x - x_G| + |y - y_G|$$

(b)

i. **No**, the Straight-Line-Distance heuristic can be used for any direction. But diagonally move can just move by 45°. and even the degree is 45, the distance is not same, Straight-Line-Distance heuristic is $\sqrt{2}$, the other is 1.

ii. **No**, because the agent can move diagonally. For example, if the agent moves from (0,0) to (1,1), for (a) heuristic, it cost 2 steps. While in (b) heuristic, it cost just one step.

iii.

$$h(x, y, x_G, y_G) = \max(|x - x_G|, |y - y_G|)$$

Qusetion3：

(a)

N	Time	sequence
1	2	[+ -]
2	3	[+ o -]
3	4	[+ o o -]
4	4	[+ + - -]
5	5	[+ + - o -]
6	5	[+ + o - -]
7	6	[+ + o – o -]
8	6	[+ + o o - -]
9	6	[+ + + - - -]
10	7	[+ + + - - o -]

n	time	sequence
11	7	[+ + + - o - -]
12	7	[+ + + o - - -]
13	8	[+ + + o - - o -]
14	8	[+ + + o - o - -]
15	8	[+ + + o o - - -]
16	8	[+ + + + - - - -]
17	9	[+ + + + - - - o -]
18	9	[+ + + + - - o - -]
19	9	[+ + + + - o - - -]
20	9	[+ + + + o - - - -]
21	10	[+ + + + o - - - o -]

(b)

The fastest way to get to the final is accelerate at the highest speed and slow down.

$s = \frac{1}{2}at^2$ s is distance, a is acceleration, t is time. For initial speed is 0.

Because in this question, final speed must be 0.

$s = \frac{1}{2}at_1{}^2 + \frac{1}{2}at_2{}^2$ t1 is accelerate time, t2 is slow down time

because speed from 0 to 0. t1 = t2. Let t = t1 +t2:

$s = a \cdot (\frac{1}{2}t)^2$

M(n,0) is the time t. n is the distant s, and in this question $|\mathrm{a}| = 1$. let them take place of s and t, the least time used is:

$$\mathrm{M(n,0)} = 2\sqrt{n}$$

In this question, all the things are discrete. So M(n,0) must be integer so:

$$\mathrm{M(n,0)} = \lceil 2\sqrt{n} \rceil$$

(c)

As same as (b), just change the first formula to:$s = \frac{1}{2}at^2 + vt$

$$\begin{cases} s = \dfrac{1}{2}at_1{}^2 + \dfrac{1}{2}at_2{}^2 + vt \\ \mathrm{a}t_1 + v = at_2 \end{cases}$$

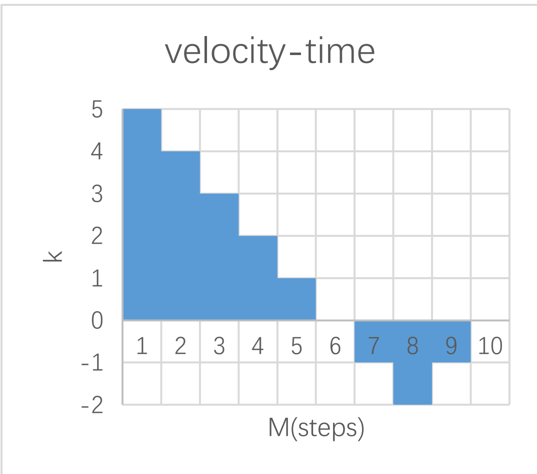
a = 1

$$t_1 + t_2 = 2\sqrt{\frac{1}{2}v^2 + s} - v$$

Because it is discrete, the speed change need one step:

$$\mathrm{M(n,k)} = \left\lceil 2\sqrt{n + \frac{1}{2}k(k+1)} \right\rceil - k$$

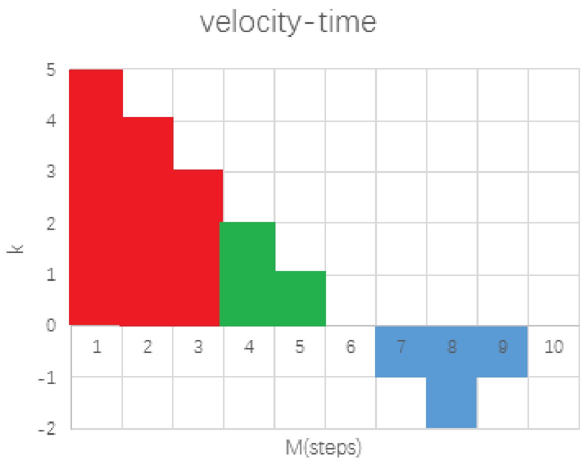
(d)



As the v-t diagram, the area of the blue part is the distance(n).

We can divide it into three parts. Red part is the n. Green part' s area equals blue part' s.

Let the red, green and blue M be t1, t2, t3 respectively.



$$\left(\frac{k(k+1)}{2}-n\right)=\frac{(t_2+1)t_2}{2}$$
$$(t_3+1)t_3=\frac{(t_2+1)t_2}{2}$$
$$\frac{(k+1)k}{2}=\frac{(t_1+t_2+1)(t_1+t_2)}{2}$$

Inferred:

$$\mathrm{M(n,k)}=\left\lceil k+\sqrt{\frac{1}{4}+\frac{(k+1)k}{2}-n}-\frac{1}{2}\right\rceil$$

(e)

Once a dimension gets the right position, let component of its velocity be 0, let another component get the goal. The result is the maximum of them.

$$\mathrm{M(n,k)}=\begin{cases}\left\lceil 2\sqrt{n+\frac{1}{2}k(k+1)}\right\rceil-k & n\geq\frac{1}{2}k(k-1)\\ \left\lceil k+\sqrt{\frac{1}{4}+\frac{(k+1)k}{2}-n}-\frac{1}{2}\right\rceil & n<\frac{1}{2}k(k-1)\end{cases}$$

$$\mathrm{h(r,c,u,v,}r_G,c_G)=\max(\mathrm{M}(r_G-r,u),M(c_G-c,v))$$