

## 7.3 Table of Contents

### Profiles

#### Breadth-First Search:

[\\*puzzle-2\\*](#)

[\\*puzzle-3\\*](#)

[\\*puzzle-4\\*](#)

[\\*puzzle-5\\*](#)

[\\*puzzle-6\\*](#)

#### A\* with Manhattan Distance:

[\\*puzzle-2\\*](#)

[\\*puzzle-3\\*](#)

[\\*puzzle-4\\*](#)

[\\*puzzle-5\\*](#)

[\\*puzzle-6\\*](#)

#### A\* with Manhattan Distance and Linear Conflict

[\\*puzzle-2\\*](#)

[\\*puzzle-3\\*](#)

[\\*puzzle-4\\*](#)

[\\*puzzle-5\\*](#)

[\\*puzzle-6\\*](#)

### Solutions

#### Breadth-First Search

[\\*puzzle-2\\*](#)

[\\*puzzle-3\\*](#)

[\\*puzzle-4\\*](#)

[\\*puzzle-5\\*](#)

#### A\* with Manhattan Distance

[\\*puzzle-2\\*](#)

[\\*puzzle-3\\*](#)

[\\*puzzle-4\\*](#)

[\\*puzzle-5\\*](#)

[\\*puzzle-6\\*](#)

#### A\* with Manhattan Distance and Linear Conflict

[\\*puzzle-2\\*](#)

[\\*puzzle-3\\*](#)

[\\*puzzle-4\\*](#)

[\\*puzzle-5\\*](#)

[\\*puzzle-6\\*](#)

# Profiles

## Breadth-First Search:

Expand Calls: 43.6k, 59.5k, 82.5k, 106k, 173k

Mean: 92.92k

Median: 82.5k

Memory: 432MiB, 586MiB, 856MiB, 1.01GiB, 1.65GiB

Mean: 906.8MiB

Median: 856MiB

*\*puzzle-2\**

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		Time			Allocations		
Tot / % measured:		75.0s / 3.00%			432MiB / 99.2%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
expand	43.6k	1.78s	78.8%	40.7µs	262MiB	61.2%	6.16KiB
possibleactions	43.6k	194ms	8.62%	4.45µs	158MiB	36.8%	3.71KiB
create node	58.8k	151ms	6.72%	2.57µs	6.29MiB	1.47%	112B
push	118k	107ms	4.74%	907ns	2.33MiB	0.54%	20.7B
pop	43.6k	24.5ms	1.09%	563ns	0.00B	0.00%	0.00B

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*\*puzzle-3\**

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		Time			Allocations		
Tot / % measured:		594s / 0.65%			1.01GiB / 100%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
expand	106k	2.34s	60.3%	22.1µs	638MiB	61.5%	6.19KiB
create node	128k	524ms	13.5%	4.09µs	13.7MiB	1.32%	112B
possibleactions	106k	512ms	13.2%	4.85µs	382MiB	36.9%	3.71KiB
push	257k	389ms	10.0%	1.52µs	3.00MiB	0.29%	12.3B
pop	106k	113ms	2.92%	1.07µs	0.00B	0.00%	0.00B

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*\*puzzle-4\**

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		Time			Allocations		
Tot / % measured:		243s / 1.31%			586MiB / 100%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
expand	59.5k	2.08s	65.3%	35.0µs	359MiB	61.3%	6.18KiB
create node	78.8k	404ms	12.6%	5.12µs	8.42MiB	1.44%	112B
possibleactions	59.5k	401ms	12.6%	6.75µs	215MiB	36.8%	3.71KiB
push	158k	244ms	7.66%	1.55µs	3.00MiB	0.51%	20.0B
pop	59.5k	57.8ms	1.81%	972ns	0.00B	0.00%	0.00B

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*\*puzzle-5\**

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		Time			Allocations		
Tot / % measured:		124s / 1.06%			856MiB / 95.8%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
expand	82.5k	717ms	54.9%	8.69µs	507MiB	61.8%	6.29KiB
possibleactions	82.5k	288ms	22.0%	3.48µs	299MiB	36.4%	3.71KiB
create node	104k	171ms	13.1%	1.65µs	11.5MiB	1.40%	116B
push	207k	101ms	7.76%	489ns	3.33MiB	0.41%	16.8B
pop	82.5k	29.0ms	2.22%	351ns	0.00B	0.00%	0.00B

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*\*puzzle-6\**

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Time	Allocations
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Tot / % measured:		1318s / 0.38%			1.65GiB / 100%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
expand	173k	2.74s	55.4%	15.9µs	1.01GiB	61.6%	6.17KiB
possibleactions	173k	808ms	16.3%	4.68µs	625MiB	37.0%	3.71KiB
create node	178k	731ms	14.8%	4.10µs	19.0MiB	1.13%	112B
push	356k	483ms	9.75%	1.35µs	4.00MiB	0.24%	11.8B
pop	173k	188ms	3.80%	1.09µs	0.00B	0.00%	0.00B

A\* with Manhattan Distance:

Expand Calls: 2.46k, 8.63k, 12.4k, 67.2k, 3.22M  
Mean: 662.1k  
Median: 12.4k  
Memory: 27MiB, 97.2MiB, 144MiB, 758MiB, 35.6GiB  
Mean: 7.32GiB  
Median: 144MiB

*\*puzzle-2\**

		Time			Allocations		
Tot / % measured:		488ms / 49.9%			144MiB / 97.6%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
dequeue	12.4k	107ms	43.8%	8.58µs	0.00B	0.00%	0.00B
heuristic score	33.7k	53.0ms	21.8%	1.57µs	16.4MiB	11.7%	510B
expand	12.4k	46.4ms	19.0%	3.73µs	75.4MiB	53.6%	6.21KiB
possibleactions	12.4k	29.9ms	12.3%	2.41µs	45.0MiB	32.0%	3.71KiB
create node	33.7k	6.96ms	2.86%	206ns	3.60MiB	2.56%	112B
push	12.4k	614µs	0.25%	49.4ns	257KiB	0.18%	21.1B

*\*puzzle-3\**

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		Time			Allocations		
Tot / % measured:		372ms / 44.6%			97.2MiB / 97.2%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
dequeue	8.63k	82.9ms	50.0%	9.61µs	0.00B	0.00%	0.00B
expand	8.63k	38.4ms	23.2%	4.45µs	52.1MiB	55.1%	6.18KiB
possibleactions	8.63k	25.2ms	15.2%	2.92µs	31.3MiB	33.1%	3.71KiB
heuristic score	23.1k	12.7ms	7.65%	548ns	8.46MiB	8.96%	384B
create node	23.1k	5.89ms	3.55%	255ns	2.47MiB	2.61%	112B
push	8.63k	652µs	0.39%	75.6ns	257KiB	0.27%	30.4B

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*\*puzzle-4\**

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		Time			Allocations		
Tot / % measured:		3.46s / 44.2%			758MiB / 98.1%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
dequeue	67.2k	882ms	57.8%	13.1µs	0.00B	0.00%	0.00B
expand	67.2k	304ms	19.9%	4.53µs	410MiB	55.2%	6.25KiB
possibleactions	67.2k	182ms	12.0%	2.72µs	244MiB	32.7%	3.71KiB
heuristic score	186k	92.1ms	6.03%	496ns	68.0MiB	9.14%	384B
create node	186k	61.6ms	4.03%	332ns	19.8MiB	2.67%	112B
push	67.2k	4.31ms	0.28%	64.1ns	2.00MiB	0.27%	31.2B

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*\*puzzle-5\**

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		Time			Allocations		
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Tot / % measured:		305s / 54.6%			35.6GiB / 98.2%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
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dequeue	3.22M	84.7s	50.8%	26.3µs	0.00B	0.00%	0.00B
expand	3.22M	37.3s	22.3%	11.6µs	19.3GiB	55.3%	6.29KiB
possibleactions	3.22M	34.9s	20.9%	10.8µs	11.4GiB	32.6%	3.71KiB
heuristic score	9.03M	6.32s	3.79%	700ns	3.23GiB	9.25%	384B
create node	9.03M	3.33s	2.00%	369ns	0.94GiB	2.70%	112B
push	3.22M	302ms	0.18%	93.7ns	33.0MiB	0.09%	10.7B
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*\*puzzle-6\**

		Time			Allocations		
		<hr/>			<hr/>		
Tot / % measured:		124ms / 49.5%			27.0MiB / 97.1%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
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dequeue	2.46k	24.8ms	40.5%	10.1µs	0.00B	0.00%	0.00B
expand	2.46k	15.8ms	25.8%	6.42µs	14.4MiB	54.9%	5.99KiB
possibleactions	2.46k	12.2ms	19.9%	4.94µs	8.91MiB	33.9%	3.70KiB
heuristic score	6.09k	5.09ms	8.31%	835ns	2.23MiB	8.49%	384B
create node	6.09k	2.99ms	4.89%	491ns	666KiB	2.48%	112B
push	2.46k	359µs	0.59%	146ns	64.4KiB	0.24%	26.8B
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A\* with Manhattan Distance and Linear Conflict

Expand Calls: 945, 1.13k, 2.05k, 34.2k, 59.3k

Mean: 19.5k

Median: 2.05k

Memory: 31.9MiB, 37.6MiB, 72MiB, 1.19GiB, 1.95GiB

Mean: 656k

Median: 72MiB

*\*puzzle-2\**

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		Time			Allocations		
Tot / % measured:		266ms / 82.9%			72.0MiB / 99.0%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
heuristic score	5.72k	187ms	84.7%	32.7µs	50.5MiB	71.0%	9.05KiB
dequeue	2.05k	17.1ms	7.75%	8.35µs	0.00B	0.00%	0.00B
expand	2.05k	8.68ms	3.93%	4.23µs	12.6MiB	17.6%	6.28KiB
possibleactions	2.05k	5.89ms	2.67%	2.87µs	7.43MiB	10.4%	3.71KiB
create node	5.72k	1.98ms	0.90%	347ns	626KiB	0.86%	112B
push	2.05k	179µs	0.08%	87.5ns	64.4KiB	0.09%	32.2B

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*\*puzzle-3\**

		Time			Allocations		
Tot / % measured:		80.0ms / 64.6%			37.6MiB / 99.1%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
heuristic score	3.01k	29.6ms	57.2%	9.84µs	26.0MiB	69.8%	8.86KiB
dequeue	1.13k	11.0ms	21.4%	9.77µs	0.00B	0.00%	0.00B
expand	1.13k	4.96ms	9.60%	4.39µs	6.80MiB	18.3%	6.16KiB
possibleactions	1.13k	3.84ms	7.42%	3.39µs	4.10MiB	11.0%	3.71KiB
create node	3.01k	1.98ms	3.82%	658ns	329KiB	0.86%	112B
push	1.13k	286µs	0.55%	253ns	32.4KiB	0.08%	29.3B

*\*puzzle-4\**

		Time			Allocations		
Tot / % measured:		3.03s / 57.8%			1.19GiB / 99.1%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
heuristic score	95.0k	835ms	47.7%	8.79µs	863MiB	71.5%	9.30KiB
dequeue	34.2k	574ms	32.8%	16.8µs	0.00B	0.00%	0.00B
expand	34.2k	162ms	9.28%	4.75µs	209MiB	17.3%	6.27KiB
possibleactions	34.2k	131ms	7.50%	3.84µs	124MiB	10.3%	3.71KiB
create node	95.0k	44.6ms	2.55%	470ns	10.1MiB	0.84%	112B
push	34.2k	4.08ms	0.23%	119ns	1.00MiB	0.08%	30.7B

*\*puzzle-5\**

		Time			Allocations		
Tot / % measured:		5.04s / 63.3%			1.95GiB / 99.3%		



Section	ncalls	time	%tot	avg	alloc	%tot	avg
heuristic score	155k	1.54s	48.3%	10.0µs	1.37GiB	70.5%	9.27KiB
dequeue	59.3k	1.09s	34.2%	18.4µs	0.00B	0.00%	0.00B
expand	59.3k	263ms	8.24%	4.43µs	354MiB	17.8%	6.11KiB
possibleactions	59.3k	216ms	6.76%	3.64µs	215MiB	10.8%	3.71KiB
create node	155k	71.7ms	2.25%	464ns	16.5MiB	0.83%	112B
push	59.3k	6.59ms	0.21%	111ns	1.00MiB	0.05%	17.7B

*\*puzzle-6\**

Time				Allocations			
Tot / % measured:		88.5ms / 55.6%		31.9MiB / 98.9%			
Section	ncalls	time	%tot	avg	alloc	%tot	avg
heuristic score	2.56k	24.6ms	50.0%	9.60µs	22.1MiB	70.0%	8.81KiB
dequeue	945	14.1ms	28.8%	15.0µs	0.00B	0.00%	0.00B
expand	945	4.51ms	9.16%	4.77µs	5.73MiB	18.2%	6.21KiB
possibleactions	945	3.82ms	7.76%	4.04µs	3.42MiB	10.9%	3.71KiB
create node	2.56k	1.92ms	3.90%	748ns	280KiB	0.87%	112B
push	945	183µs	0.37%	194ns	16.3KiB	0.05%	17.7B

# Solutions

## Breadth-First Search

*\*puzzle-2\**

Step 21:

[0, 1, 2]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 1), "DOWN")

Step 20:

[3, 1, 2]

[0, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(2, 1), "DOWN")

Step 19:

[3, 1, 2]

[6, 4, 5]

[0, 7, 8]

Action: (CartesianIndex(3, 1), "RIGHT")

Step 18:

[3, 1, 2]

[6, 4, 5]

[7, 0, 8]

Action: (CartesianIndex(3, 2), "UP")

Step 17:

[3, 1, 2]

[6, 0, 5]

[7, 4, 8]

Action: (CartesianIndex(2, 2), "UP")

Step 16:

[3, 0, 2]

[6, 1, 5]

[7, 4, 8]

Action: (CartesianIndex(1, 2), "LEFT")

Step 15:

[0, 3, 2]

[6, 1, 5]

[7, 4, 8]

Action: (CartesianIndex(1, 1), "DOWN")

Step 14:

[6, 3, 2]

[0, 1, 5]

[7, 4, 8]

Action: (CartesianIndex(2, 1), "RIGHT")

Step 13:

[6, 3, 2]

[1, 0, 5]

[7, 4, 8]

Action: (CartesianIndex(2, 2), "RIGHT")

Step 12:

[6, 3, 2]

[1, 5, 0]

[7, 4, 8]

Action: (CartesianIndex(2, 3), "UP")

Step 11:

[6, 3, 0]

```

[1, 5, 2]
[7, 4, 8]
Action: (CartesianIndex(1, 3), "LEFT")
Step 10:
[6, 0, 3]
[1, 5, 2]
[7, 4, 8]
Action: (CartesianIndex(1, 2), "LEFT")
Step 9:
[0, 6, 3]
[1, 5, 2]
[7, 4, 8]
Action: (CartesianIndex(1, 1), "DOWN")
Step 8:
[1, 6, 3]
[0, 5, 2]
[7, 4, 8]
Action: (CartesianIndex(2, 1), "DOWN")
Step 7:
[1, 6, 3]
[7, 5, 2]
[0, 4, 8]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 6:
[1, 6, 3]
[7, 5, 2]
[4, 0, 8]
Action: (CartesianIndex(3, 2), "UP")
Step 5:
[1, 6, 3]
[7, 0, 2]
[4, 5, 8]
Action: (CartesianIndex(2, 2), "LEFT")
Step 4:
[1, 6, 3]
[0, 7, 2]
[4, 5, 8]
Action: (CartesianIndex(2, 1), "UP")
Step 3:
[0, 6, 3]
[1, 7, 2]
[4, 5, 8]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 2:
[6, 0, 3]
[1, 7, 2]
[4, 5, 8]
Action: (CartesianIndex(1, 2), "DOWN")
Step 1:
[6, 7, 3]
[1, 0, 2]
[4, 5, 8]
Action: (CartesianIndex(2, 2), "DOWN")
Step 0:
[6, 7, 3]
[1, 5, 2]
[4, 0, 8]
Action: nothing

```

*\*puzzle-3\**

Step 24:

[0, 1, 2]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 1), "RIGHT")

Step 23:

[1, 0, 2]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 2), "DOWN")

Step 22:

[1, 4, 2]

[3, 0, 5]

[6, 7, 8]

Action: (CartesianIndex(2, 2), "LEFT")

Step 21:

[1, 4, 2]

[0, 3, 5]

[6, 7, 8]

Action: (CartesianIndex(2, 1), "DOWN")

Step 20:

[1, 4, 2]

[6, 3, 5]

[0, 7, 8]

Action: (CartesianIndex(3, 1), "RIGHT")

Step 19:

[1, 4, 2]

[6, 3, 5]

[7, 0, 8]

Action: (CartesianIndex(3, 2), "UP")

Step 18:

[1, 4, 2]

[6, 0, 5]

[7, 3, 8]

Action: (CartesianIndex(2, 2), "RIGHT")

Step 17:

[1, 4, 2]

[6, 5, 0]

[7, 3, 8]

Action: (CartesianIndex(2, 3), "DOWN")

Step 16:

[1, 4, 2]

[6, 5, 8]

[7, 3, 0]

Action: (CartesianIndex(3, 3), "LEFT")

Step 15:

[1, 4, 2]

[6, 5, 8]

[7, 0, 3]

Action: (CartesianIndex(3, 2), "UP")

Step 14:

[1, 4, 2]

[6, 0, 8]

[7, 5, 3]

Action: (CartesianIndex(2, 2), "LEFT")

Step 13:

[1, 4, 2]

[0, 6, 8]

```
[7, 5, 3]
Action: (CartesianIndex(2, 1), "UP")
Step 12:
[0, 4, 2]
[1, 6, 8]
[7, 5, 3]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 11:
[4, 0, 2]
[1, 6, 8]
[7, 5, 3]
Action: (CartesianIndex(1, 2), "RIGHT")
Step 10:
[4, 2, 0]
[1, 6, 8]
[7, 5, 3]
Action: (CartesianIndex(1, 3), "DOWN")
Step 9:
[4, 2, 8]
[1, 6, 0]
[7, 5, 3]
Action: (CartesianIndex(2, 3), "LEFT")
Step 8:
[4, 2, 8]
[1, 0, 6]
[7, 5, 3]
Action: (CartesianIndex(2, 2), "UP")
Step 7:
[4, 0, 8]
[1, 2, 6]
[7, 5, 3]
Action: (CartesianIndex(1, 2), "RIGHT")
Step 6:
[4, 8, 0]
[1, 2, 6]
[7, 5, 3]
Action: (CartesianIndex(1, 3), "DOWN")
Step 5:
[4, 8, 6]
[1, 2, 0]
[7, 5, 3]
Action: (CartesianIndex(2, 3), "DOWN")
Step 4:
[4, 8, 6]
[1, 2, 3]
[7, 5, 0]
Action: (CartesianIndex(3, 3), "LEFT")
Step 3:
[4, 8, 6]
[1, 2, 3]
[7, 0, 5]
Action: (CartesianIndex(3, 2), "UP")
Step 2:
[4, 8, 6]
[1, 0, 3]
[7, 2, 5]
Action: (CartesianIndex(2, 2), "LEFT")
Step 1:
[4, 8, 6]
```

[0, 1, 3]  
[7, 2, 5]  
Action: (CartesianIndex(2, 1), "UP")

Step 0:

[0, 8, 6]  
[4, 1, 3]  
[7, 2, 5]  
Action: nothing

*\*puzzle-4\**

Step 22:

[0, 1, 2]  
[3, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(1, 1), "DOWN")

Step 21:

[3, 1, 2]  
[0, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 1), "RIGHT")

Step 20:

[3, 1, 2]  
[4, 0, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 2), "UP")

Step 19:

[3, 0, 2]  
[4, 1, 5]  
[6, 7, 8]  
Action: (CartesianIndex(1, 2), "RIGHT")

Step 18:

[3, 2, 0]  
[4, 1, 5]  
[6, 7, 8]  
Action: (CartesianIndex(1, 3), "DOWN")

Step 17:

[3, 2, 5]  
[4, 1, 0]  
[6, 7, 8]  
Action: (CartesianIndex(2, 3), "LEFT")

Step 16:

[3, 2, 5]  
[4, 0, 1]  
[6, 7, 8]  
Action: (CartesianIndex(2, 2), "LEFT")

Step 15:

[3, 2, 5]  
[0, 4, 1]  
[6, 7, 8]  
Action: (CartesianIndex(2, 1), "UP")

Step 14:

[0, 2, 5]  
[3, 4, 1]  
[6, 7, 8]  
Action: (CartesianIndex(1, 1), "RIGHT")

Step 13:

[2, 0, 5]  
[3, 4, 1]  
[6, 7, 8]

```
        Action: (CartesianIndex(1, 2), "DOWN")
Step 12:
    [2, 4, 5]
    [3, 0, 1]
    [6, 7, 8]
    Action: (CartesianIndex(2, 2), "DOWN")
Step 11:
    [2, 4, 5]
    [3, 7, 1]
    [6, 0, 8]
    Action: (CartesianIndex(3, 2), "RIGHT")
Step 10:
    [2, 4, 5]
    [3, 7, 1]
    [6, 8, 0]
    Action: (CartesianIndex(3, 3), "UP")
Step 9:
    [2, 4, 5]
    [3, 7, 0]
    [6, 8, 1]
    Action: (CartesianIndex(2, 3), "UP")
Step 8:
    [2, 4, 0]
    [3, 7, 5]
    [6, 8, 1]
    Action: (CartesianIndex(1, 3), "LEFT")
Step 7:
    [2, 0, 4]
    [3, 7, 5]
    [6, 8, 1]
    Action: (CartesianIndex(1, 2), "DOWN")
Step 6:
    [2, 7, 4]
    [3, 0, 5]
    [6, 8, 1]
    Action: (CartesianIndex(2, 2), "LEFT")
Step 5:
    [2, 7, 4]
    [0, 3, 5]
    [6, 8, 1]
    Action: (CartesianIndex(2, 1), "UP")
Step 4:
    [0, 7, 4]
    [2, 3, 5]
    [6, 8, 1]
    Action: (CartesianIndex(1, 1), "RIGHT")
Step 3:
    [7, 0, 4]
    [2, 3, 5]
    [6, 8, 1]
    Action: (CartesianIndex(1, 2), "DOWN")
Step 2:
    [7, 3, 4]
    [2, 0, 5]
    [6, 8, 1]
    Action: (CartesianIndex(2, 2), "RIGHT")
Step 1:
    [7, 3, 4]
    [2, 5, 0]
```

[6, 8, 1]  
Action: (CartesianIndex(2, 3), "DOWN")  
Step 0:  
[7, 3, 4]  
[2, 5, 1]  
[6, 8, 0]  
Action: nothing

*\*puzzle-5\**

Step 23:  
[0, 1, 2]  
[3, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(1, 1), "DOWN")  
Step 22:  
[3, 1, 2]  
[0, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 1), "RIGHT")  
Step 21:  
[3, 1, 2]  
[4, 0, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 2), "RIGHT")  
Step 20:  
[3, 1, 2]  
[4, 5, 0]  
[6, 7, 8]  
Action: (CartesianIndex(2, 3), "DOWN")  
Step 19:  
[3, 1, 2]  
[4, 5, 8]  
[6, 7, 0]  
Action: (CartesianIndex(3, 3), "LEFT")  
Step 18:  
[3, 1, 2]  
[4, 5, 8]  
[6, 0, 7]  
Action: (CartesianIndex(3, 2), "LEFT")  
Step 17:  
[3, 1, 2]  
[4, 5, 8]  
[0, 6, 7]  
Action: (CartesianIndex(3, 1), "UP")  
Step 16:  
[3, 1, 2]  
[0, 5, 8]  
[4, 6, 7]  
Action: (CartesianIndex(2, 1), "UP")  
Step 15:  
[0, 1, 2]  
[3, 5, 8]  
[4, 6, 7]  
Action: (CartesianIndex(1, 1), "RIGHT")  
Step 14:  
[1, 0, 2]  
[3, 5, 8]  
[4, 6, 7]  
Action: (CartesianIndex(1, 2), "DOWN")



Step 13:  
[1, 5, 2]  
[3, 0, 8]  
[4, 6, 7]  
Action: (CartesianIndex(2, 2), "RIGHT")

Step 12:  
[1, 5, 2]  
[3, 8, 0]  
[4, 6, 7]  
Action: (CartesianIndex(2, 3), "UP")

Step 11:  
[1, 5, 0]  
[3, 8, 2]  
[4, 6, 7]  
Action: (CartesianIndex(1, 3), "LEFT")

Step 10:  
[1, 0, 5]  
[3, 8, 2]  
[4, 6, 7]  
Action: (CartesianIndex(1, 2), "DOWN")

Step 9:  
[1, 8, 5]  
[3, 0, 2]  
[4, 6, 7]  
Action: (CartesianIndex(2, 2), "LEFT")

Step 8:  
[1, 8, 5]  
[0, 3, 2]  
[4, 6, 7]  
Action: (CartesianIndex(2, 1), "DOWN")

Step 7:  
[1, 8, 5]  
[4, 3, 2]  
[0, 6, 7]  
Action: (CartesianIndex(3, 1), "RIGHT")

Step 6:  
[1, 8, 5]  
[4, 3, 2]  
[6, 0, 7]  
Action: (CartesianIndex(3, 2), "RIGHT")

Step 5:  
[1, 8, 5]  
[4, 3, 2]  
[6, 7, 0]  
Action: (CartesianIndex(3, 3), "UP")

Step 4:  
[1, 8, 5]  
[4, 3, 0]  
[6, 7, 2]  
Action: (CartesianIndex(2, 3), "UP")

Step 3:  
[1, 8, 0]  
[4, 3, 5]  
[6, 7, 2]  
Action: (CartesianIndex(1, 3), "LEFT")

Step 2:  
[1, 0, 8]  
[4, 3, 5]  
[6, 7, 2]

```
        Action: (CartesianIndex(1, 2), "DOWN")
Step 1:
    [1, 3, 8]
    [4, 0, 5]
    [6, 7, 2]
    Action: (CartesianIndex(2, 2), "DOWN")
Step 0:
    [1, 3, 8]
    [4, 7, 5]
    [6, 0, 2]
    Action: nothing
```

## A\* with Manhattan Distance

*\*puzzle-2\**

```
Step 21:
    [0, 1, 2]
    [3, 4, 5]
    [6, 7, 8]
    Action: (CartesianIndex(1, 1), "DOWN")
Step 20:
    [3, 1, 2]
    [0, 4, 5]
    [6, 7, 8]
    Action: (CartesianIndex(2, 1), "RIGHT")
Step 19:
    [3, 1, 2]
    [4, 0, 5]
    [6, 7, 8]
    Action: (CartesianIndex(2, 2), "DOWN")
Step 18:
    [3, 1, 2]
    [4, 7, 5]
    [6, 0, 8]
    Action: (CartesianIndex(3, 2), "LEFT")
Step 17:
    [3, 1, 2]
    [4, 7, 5]
    [0, 6, 8]
    Action: (CartesianIndex(3, 1), "UP")
Step 16:
    [3, 1, 2]
    [0, 7, 5]
    [4, 6, 8]
    Action: (CartesianIndex(2, 1), "RIGHT")
Step 15:
    [3, 1, 2]
    [7, 0, 5]
    [4, 6, 8]
    Action: (CartesianIndex(2, 2), "UP")
Step 14:
    [3, 0, 2]
    [7, 1, 5]
    [4, 6, 8]
    Action: (CartesianIndex(1, 2), "LEFT")
Step 13:
    [0, 3, 2]
    [7, 1, 5]
```

```
[4, 6, 8]
Action: (CartesianIndex(1, 1), "DOWN")
Step 12:
[7, 3, 2]
[0, 1, 5]
[4, 6, 8]
Action: (CartesianIndex(2, 1), "RIGHT")
Step 11:
[7, 3, 2]
[1, 0, 5]
[4, 6, 8]
Action: (CartesianIndex(2, 2), "DOWN")
Step 10:
[7, 3, 2]
[1, 6, 5]
[4, 0, 8]
Action: (CartesianIndex(3, 2), "LEFT")
Step 9:
[7, 3, 2]
[1, 6, 5]
[0, 4, 8]
Action: (CartesianIndex(3, 1), "UP")
Step 8:
[7, 3, 2]
[0, 6, 5]
[1, 4, 8]
Action: (CartesianIndex(2, 1), "RIGHT")
Step 7:
[7, 3, 2]
[6, 0, 5]
[1, 4, 8]
Action: (CartesianIndex(2, 2), "RIGHT")
Step 6:
[7, 3, 2]
[6, 5, 0]
[1, 4, 8]
Action: (CartesianIndex(2, 3), "UP")
Step 5:
[7, 3, 0]
[6, 5, 2]
[1, 4, 8]
Action: (CartesianIndex(1, 3), "LEFT")
Step 4:
[7, 0, 3]
[6, 5, 2]
[1, 4, 8]
Action: (CartesianIndex(1, 2), "LEFT")
Step 3:
[0, 7, 3]
[6, 5, 2]
[1, 4, 8]
Action: (CartesianIndex(1, 1), "DOWN")
Step 2:
[6, 7, 3]
[0, 5, 2]
[1, 4, 8]
Action: (CartesianIndex(2, 1), "DOWN")
Step 1:
[6, 7, 3]
```

[1, 5, 2]  
[0, 4, 8]  
Action: (CartesianIndex(3, 1), "RIGHT")

Step 0:  
[6, 7, 3]  
[1, 5, 2]  
[4, 0, 8]  
Action: nothing

*\*puzzle-3\**

Step 24:  
[0, 1, 2]  
[3, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(1, 1), "RIGHT")

Step 23:  
[1, 0, 2]  
[3, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(1, 2), "DOWN")

Step 22:  
[1, 4, 2]  
[3, 0, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 2), "LEFT")

Step 21:  
[1, 4, 2]  
[0, 3, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 1), "DOWN")

Step 20:  
[1, 4, 2]  
[6, 3, 5]  
[0, 7, 8]  
Action: (CartesianIndex(3, 1), "RIGHT")

Step 19:  
[1, 4, 2]  
[6, 3, 5]  
[7, 0, 8]  
Action: (CartesianIndex(3, 2), "UP")

Step 18:  
[1, 4, 2]  
[6, 0, 5]  
[7, 3, 8]  
Action: (CartesianIndex(2, 2), "RIGHT")

Step 17:  
[1, 4, 2]  
[6, 5, 0]  
[7, 3, 8]  
Action: (CartesianIndex(2, 3), "DOWN")

Step 16:  
[1, 4, 2]  
[6, 5, 8]  
[7, 3, 0]  
Action: (CartesianIndex(3, 3), "LEFT")

Step 15:  
[1, 4, 2]  
[6, 5, 8]  
[7, 0, 3]

```
        Action: (CartesianIndex(3, 2), "UP")
Step 14:
    [1, 4, 2]
    [6, 0, 8]
    [7, 5, 3]
    Action: (CartesianIndex(2, 2), "LEFT")
Step 13:
    [1, 4, 2]
    [0, 6, 8]
    [7, 5, 3]
    Action: (CartesianIndex(2, 1), "UP")
Step 12:
    [0, 4, 2]
    [1, 6, 8]
    [7, 5, 3]
    Action: (CartesianIndex(1, 1), "RIGHT")
Step 11:
    [4, 0, 2]
    [1, 6, 8]
    [7, 5, 3]
    Action: (CartesianIndex(1, 2), "RIGHT")
Step 10:
    [4, 2, 0]
    [1, 6, 8]
    [7, 5, 3]
    Action: (CartesianIndex(1, 3), "DOWN")
Step 9:
    [4, 2, 8]
    [1, 6, 0]
    [7, 5, 3]
    Action: (CartesianIndex(2, 3), "LEFT")
Step 8:
    [4, 2, 8]
    [1, 0, 6]
    [7, 5, 3]
    Action: (CartesianIndex(2, 2), "UP")
Step 7:
    [4, 0, 8]
    [1, 2, 6]
    [7, 5, 3]
    Action: (CartesianIndex(1, 2), "RIGHT")
Step 6:
    [4, 8, 0]
    [1, 2, 6]
    [7, 5, 3]
    Action: (CartesianIndex(1, 3), "DOWN")
Step 5:
    [4, 8, 6]
    [1, 2, 0]
    [7, 5, 3]
    Action: (CartesianIndex(2, 3), "DOWN")
Step 4:
    [4, 8, 6]
    [1, 2, 3]
    [7, 5, 0]
    Action: (CartesianIndex(3, 3), "LEFT")
Step 3:
    [4, 8, 6]
    [1, 2, 3]
```

```

[7, 0, 5]
Action: (CartesianIndex(3, 2), "UP")
Step 2:
[4, 8, 6]
[1, 0, 3]
[7, 2, 5]
Action: (CartesianIndex(2, 2), "LEFT")
Step 1:
[4, 8, 6]
[0, 1, 3]
[7, 2, 5]
Action: (CartesianIndex(2, 1), "UP")
Step 0:
[0, 8, 6]
[4, 1, 3]
[7, 2, 5]
Action: nothing

```

*\*puzzle-4\**

```

Step 22:
[0, 1, 2]
[3, 4, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 1), "DOWN")
Step 21:
[3, 1, 2]
[0, 4, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 1), "RIGHT")
Step 20:
[3, 1, 2]
[4, 0, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "UP")
Step 19:
[3, 0, 2]
[4, 1, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 2), "RIGHT")
Step 18:
[3, 2, 0]
[4, 1, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 3), "DOWN")
Step 17:
[3, 2, 5]
[4, 1, 0]
[6, 7, 8]
Action: (CartesianIndex(2, 3), "LEFT")
Step 16:
[3, 2, 5]
[4, 0, 1]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "LEFT")
Step 15:
[3, 2, 5]
[0, 4, 1]
[6, 7, 8]
Action: (CartesianIndex(2, 1), "UP")

```

Step 14:  
[0, 2, 5]  
[3, 4, 1]  
[6, 7, 8]  
Action: (CartesianIndex(1, 1), "RIGHT")

Step 13:  
[2, 0, 5]  
[3, 4, 1]  
[6, 7, 8]  
Action: (CartesianIndex(1, 2), "DOWN")

Step 12:  
[2, 4, 5]  
[3, 0, 1]  
[6, 7, 8]  
Action: (CartesianIndex(2, 2), "DOWN")

Step 11:  
[2, 4, 5]  
[3, 7, 1]  
[6, 0, 8]  
Action: (CartesianIndex(3, 2), "RIGHT")

Step 10:  
[2, 4, 5]  
[3, 7, 1]  
[6, 8, 0]  
Action: (CartesianIndex(3, 3), "UP")

Step 9:  
[2, 4, 5]  
[3, 7, 0]  
[6, 8, 1]  
Action: (CartesianIndex(2, 3), "UP")

Step 8:  
[2, 4, 0]  
[3, 7, 5]  
[6, 8, 1]  
Action: (CartesianIndex(1, 3), "LEFT")

Step 7:  
[2, 0, 4]  
[3, 7, 5]  
[6, 8, 1]  
Action: (CartesianIndex(1, 2), "DOWN")

Step 6:  
[2, 7, 4]  
[3, 0, 5]  
[6, 8, 1]  
Action: (CartesianIndex(2, 2), "LEFT")

Step 5:  
[2, 7, 4]  
[0, 3, 5]  
[6, 8, 1]  
Action: (CartesianIndex(2, 1), "UP")

Step 4:  
[0, 7, 4]  
[2, 3, 5]  
[6, 8, 1]  
Action: (CartesianIndex(1, 1), "RIGHT")

Step 3:  
[7, 0, 4]  
[2, 3, 5]  
[6, 8, 1]

```
        Action: (CartesianIndex(1, 2), "DOWN")
Step 2:
    [7, 3, 4]
    [2, 0, 5]
    [6, 8, 1]
    Action: (CartesianIndex(2, 2), "RIGHT")
Step 1:
    [7, 3, 4]
    [2, 5, 0]
    [6, 8, 1]
    Action: (CartesianIndex(2, 3), "DOWN")
Step 0:
    [7, 3, 4]
    [2, 5, 1]
    [6, 8, 0]
    Action: nothing
```

*\*puzzle-5\**

```
Step 23:
    [0, 1, 2]
    [3, 4, 5]
    [6, 7, 8]
    Action: (CartesianIndex(1, 1), "DOWN")
Step 22:
    [3, 1, 2]
    [0, 4, 5]
    [6, 7, 8]
    Action: (CartesianIndex(2, 1), "RIGHT")
Step 21:
    [3, 1, 2]
    [4, 0, 5]
    [6, 7, 8]
    Action: (CartesianIndex(2, 2), "RIGHT")
Step 20:
    [3, 1, 2]
    [4, 5, 0]
    [6, 7, 8]
    Action: (CartesianIndex(2, 3), "DOWN")
Step 19:
    [3, 1, 2]
    [4, 5, 8]
    [6, 7, 0]
    Action: (CartesianIndex(3, 3), "LEFT")
Step 18:
    [3, 1, 2]
    [4, 5, 8]
    [6, 0, 7]
    Action: (CartesianIndex(3, 2), "LEFT")
Step 17:
    [3, 1, 2]
    [4, 5, 8]
    [0, 6, 7]
    Action: (CartesianIndex(3, 1), "UP")
Step 16:
    [3, 1, 2]
    [0, 5, 8]
    [4, 6, 7]
    Action: (CartesianIndex(2, 1), "UP")
Step 15:
```



```
[0, 1, 2]
[3, 5, 8]
[4, 6, 7]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 14:
[1, 0, 2]
[3, 5, 8]
[4, 6, 7]
Action: (CartesianIndex(1, 2), "DOWN")
Step 13:
[1, 5, 2]
[3, 0, 8]
[4, 6, 7]
Action: (CartesianIndex(2, 2), "RIGHT")
Step 12:
[1, 5, 2]
[3, 8, 0]
[4, 6, 7]
Action: (CartesianIndex(2, 3), "UP")
Step 11:
[1, 5, 0]
[3, 8, 2]
[4, 6, 7]
Action: (CartesianIndex(1, 3), "LEFT")
Step 10:
[1, 0, 5]
[3, 8, 2]
[4, 6, 7]
Action: (CartesianIndex(1, 2), "DOWN")
Step 9:
[1, 8, 5]
[3, 0, 2]
[4, 6, 7]
Action: (CartesianIndex(2, 2), "LEFT")
Step 8:
[1, 8, 5]
[0, 3, 2]
[4, 6, 7]
Action: (CartesianIndex(2, 1), "DOWN")
Step 7:
[1, 8, 5]
[4, 3, 2]
[0, 6, 7]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 6:
[1, 8, 5]
[4, 3, 2]
[6, 0, 7]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 5:
[1, 8, 5]
[4, 3, 2]
[6, 7, 0]
Action: (CartesianIndex(3, 3), "UP")
Step 4:
[1, 8, 5]
[4, 3, 0]
[6, 7, 2]
Action: (CartesianIndex(2, 3), "UP")
```

Step 3:

[1, 8, 0]

[4, 3, 5]

[6, 7, 2]

Action: (CartesianIndex(1, 3), "LEFT")

Step 2:

[1, 0, 8]

[4, 3, 5]

[6, 7, 2]

Action: (CartesianIndex(1, 2), "DOWN")

Step 1:

[1, 3, 8]

[4, 0, 5]

[6, 7, 2]

Action: (CartesianIndex(2, 2), "DOWN")

Step 0:

[1, 3, 8]

[4, 7, 5]

[6, 0, 2]

Action: nothing

*\*puzzle-6\**

Step 28:

[0, 1, 2]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 1), "DOWN")

Step 27:

[3, 1, 2]

[0, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(2, 1), "DOWN")

Step 26:

[3, 1, 2]

[6, 4, 5]

[0, 7, 8]

Action: (CartesianIndex(3, 1), "RIGHT")

Step 25:

[3, 1, 2]

[6, 4, 5]

[7, 0, 8]

Action: (CartesianIndex(3, 2), "RIGHT")

Step 24:

[3, 1, 2]

[6, 4, 5]

[7, 8, 0]

Action: (CartesianIndex(3, 3), "UP")

Step 23:

[3, 1, 2]

[6, 4, 0]

[7, 8, 5]

Action: (CartesianIndex(2, 3), "UP")

Step 22:

[3, 1, 0]

[6, 4, 2]

[7, 8, 5]

Action: (CartesianIndex(1, 3), "LEFT")

Step 21:

[3, 0, 1]

```
[6, 4, 2]
[7, 8, 5]
Action: (CartesianIndex(1, 2), "LEFT")
Step 20:
[0, 3, 1]
[6, 4, 2]
[7, 8, 5]
Action: (CartesianIndex(1, 1), "DOWN")
Step 19:
[6, 3, 1]
[0, 4, 2]
[7, 8, 5]
Action: (CartesianIndex(2, 1), "DOWN")
Step 18:
[6, 3, 1]
[7, 4, 2]
[0, 8, 5]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 17:
[6, 3, 1]
[7, 4, 2]
[8, 0, 5]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 16:
[6, 3, 1]
[7, 4, 2]
[8, 5, 0]
Action: (CartesianIndex(3, 3), "UP")
Step 15:
[6, 3, 1]
[7, 4, 0]
[8, 5, 2]
Action: (CartesianIndex(2, 3), "UP")
Step 14:
[6, 3, 0]
[7, 4, 1]
[8, 5, 2]
Action: (CartesianIndex(1, 3), "LEFT")
Step 13:
[6, 0, 3]
[7, 4, 1]
[8, 5, 2]
Action: (CartesianIndex(1, 2), "LEFT")
Step 12:
[0, 6, 3]
[7, 4, 1]
[8, 5, 2]
Action: (CartesianIndex(1, 1), "DOWN")
Step 11:
[7, 6, 3]
[0, 4, 1]
[8, 5, 2]
Action: (CartesianIndex(2, 1), "DOWN")
Step 10:
[7, 6, 3]
[8, 4, 1]
[0, 5, 2]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 9:
```

```

[7, 6, 3]
[8, 4, 1]
[5, 0, 2]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 8:
[7, 6, 3]
[8, 4, 1]
[5, 2, 0]
Action: (CartesianIndex(3, 3), "UP")
Step 7:
[7, 6, 3]
[8, 4, 0]
[5, 2, 1]
Action: (CartesianIndex(2, 3), "UP")
Step 6:
[7, 6, 0]
[8, 4, 3]
[5, 2, 1]
Action: (CartesianIndex(1, 3), "LEFT")
Step 5:
[7, 0, 6]
[8, 4, 3]
[5, 2, 1]
Action: (CartesianIndex(1, 2), "LEFT")
Step 4:
[0, 7, 6]
[8, 4, 3]
[5, 2, 1]
Action: (CartesianIndex(1, 1), "DOWN")
Step 3:
[8, 7, 6]
[0, 4, 3]
[5, 2, 1]
Action: (CartesianIndex(2, 1), "DOWN")
Step 2:
[8, 7, 6]
[5, 4, 3]
[0, 2, 1]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 1:
[8, 7, 6]
[5, 4, 3]
[2, 0, 1]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 0:
[8, 7, 6]
[5, 4, 3]
[2, 1, 0]
Action: nothing

```

## A\* with Manhattan Distance and Linear Conflict

*\*puzzle-2\**

```

Step 21:
[0, 1, 2]
[3, 4, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 1), "DOWN")

```

Step 20:  
[3, 1, 2]  
[0, 4, 5]  
[6, 7, 8]  
Action: (CartesianIndex(2, 1), "DOWN")

Step 19:  
[3, 1, 2]  
[6, 4, 5]  
[0, 7, 8]  
Action: (CartesianIndex(3, 1), "RIGHT")

Step 18:  
[3, 1, 2]  
[6, 4, 5]  
[7, 0, 8]  
Action: (CartesianIndex(3, 2), "UP")

Step 17:  
[3, 1, 2]  
[6, 0, 5]  
[7, 4, 8]  
Action: (CartesianIndex(2, 2), "UP")

Step 16:  
[3, 0, 2]  
[6, 1, 5]  
[7, 4, 8]  
Action: (CartesianIndex(1, 2), "LEFT")

Step 15:  
[0, 3, 2]  
[6, 1, 5]  
[7, 4, 8]  
Action: (CartesianIndex(1, 1), "DOWN")

Step 14:  
[6, 3, 2]  
[0, 1, 5]  
[7, 4, 8]  
Action: (CartesianIndex(2, 1), "RIGHT")

Step 13:  
[6, 3, 2]  
[1, 0, 5]  
[7, 4, 8]  
Action: (CartesianIndex(2, 2), "RIGHT")

Step 12:  
[6, 3, 2]  
[1, 5, 0]  
[7, 4, 8]  
Action: (CartesianIndex(2, 3), "UP")

Step 11:  
[6, 3, 0]  
[1, 5, 2]  
[7, 4, 8]  
Action: (CartesianIndex(1, 3), "LEFT")

Step 10:  
[6, 0, 3]  
[1, 5, 2]  
[7, 4, 8]  
Action: (CartesianIndex(1, 2), "LEFT")

Step 9:  
[0, 6, 3]  
[1, 5, 2]  
[7, 4, 8]

```

        Action: (CartesianIndex(1, 1), "DOWN")
Step 8:
    [1, 6, 3]
    [0, 5, 2]
    [7, 4, 8]
    Action: (CartesianIndex(2, 1), "DOWN")
Step 7:
    [1, 6, 3]
    [7, 5, 2]
    [0, 4, 8]
    Action: (CartesianIndex(3, 1), "RIGHT")
Step 6:
    [1, 6, 3]
    [7, 5, 2]
    [4, 0, 8]
    Action: (CartesianIndex(3, 2), "UP")
Step 5:
    [1, 6, 3]
    [7, 0, 2]
    [4, 5, 8]
    Action: (CartesianIndex(2, 2), "LEFT")
Step 4:
    [1, 6, 3]
    [0, 7, 2]
    [4, 5, 8]
    Action: (CartesianIndex(2, 1), "UP")
Step 3:
    [0, 6, 3]
    [1, 7, 2]
    [4, 5, 8]
    Action: (CartesianIndex(1, 1), "RIGHT")
Step 2:
    [6, 0, 3]
    [1, 7, 2]
    [4, 5, 8]
    Action: (CartesianIndex(1, 2), "DOWN")
Step 1:
    [6, 7, 3]
    [1, 0, 2]
    [4, 5, 8]
    Action: (CartesianIndex(2, 2), "DOWN")
Step 0:
    [6, 7, 3]
    [1, 5, 2]
    [4, 0, 8]
    Action: nothing

```

*\*puzzle-3\**

```

Step 24:
    [0, 1, 2]
    [3, 4, 5]
    [6, 7, 8]
    Action: (CartesianIndex(1, 1), "RIGHT")
Step 23:
    [1, 0, 2]
    [3, 4, 5]
    [6, 7, 8]
    Action: (CartesianIndex(1, 2), "DOWN")
Step 22:

```

```
[1, 4, 2]
[3, 0, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "LEFT")
Step 21:
[1, 4, 2]
[0, 3, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 1), "DOWN")
Step 20:
[1, 4, 2]
[6, 3, 5]
[0, 7, 8]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 19:
[1, 4, 2]
[6, 3, 5]
[7, 0, 8]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 18:
[1, 4, 2]
[6, 3, 5]
[7, 8, 0]
Action: (CartesianIndex(3, 3), "UP")
Step 17:
[1, 4, 2]
[6, 3, 0]
[7, 8, 5]
Action: (CartesianIndex(2, 3), "LEFT")
Step 16:
[1, 4, 2]
[6, 0, 3]
[7, 8, 5]
Action: (CartesianIndex(2, 2), "LEFT")
Step 15:
[1, 4, 2]
[0, 6, 3]
[7, 8, 5]
Action: (CartesianIndex(2, 1), "UP")
Step 14:
[0, 4, 2]
[1, 6, 3]
[7, 8, 5]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 13:
[4, 0, 2]
[1, 6, 3]
[7, 8, 5]
Action: (CartesianIndex(1, 2), "DOWN")
Step 12:
[4, 6, 2]
[1, 0, 3]
[7, 8, 5]
Action: (CartesianIndex(2, 2), "DOWN")
Step 11:
[4, 6, 2]
[1, 8, 3]
[7, 0, 5]
Action: (CartesianIndex(3, 2), "RIGHT")
```

```

Step 10:
    [4, 6, 2]
    [1, 8, 3]
    [7, 5, 0]
    Action: (CartesianIndex(3, 3), "UP")
Step 9:
    [4, 6, 2]
    [1, 8, 0]
    [7, 5, 3]
    Action: (CartesianIndex(2, 3), "UP")
Step 8:
    [4, 6, 0]
    [1, 8, 2]
    [7, 5, 3]
    Action: (CartesianIndex(1, 3), "LEFT")
Step 7:
    [4, 0, 6]
    [1, 8, 2]
    [7, 5, 3]
    Action: (CartesianIndex(1, 2), "DOWN")
Step 6:
    [4, 8, 6]
    [1, 0, 2]
    [7, 5, 3]
    Action: (CartesianIndex(2, 2), "RIGHT")
Step 5:
    [4, 8, 6]
    [1, 2, 0]
    [7, 5, 3]
    Action: (CartesianIndex(2, 3), "DOWN")
Step 4:
    [4, 8, 6]
    [1, 2, 3]
    [7, 5, 0]
    Action: (CartesianIndex(3, 3), "LEFT")
Step 3:
    [4, 8, 6]
    [1, 2, 3]
    [7, 0, 5]
    Action: (CartesianIndex(3, 2), "UP")
Step 2:
    [4, 8, 6]
    [1, 0, 3]
    [7, 2, 5]
    Action: (CartesianIndex(2, 2), "LEFT")
Step 1:
    [4, 8, 6]
    [0, 1, 3]
    [7, 2, 5]
    Action: (CartesianIndex(2, 1), "UP")
Step 0:
    [0, 8, 6]
    [4, 1, 3]
    [7, 2, 5]
    Action: nothing

```

*\*puzzle-4\**

```

Step 22:
    [0, 1, 2]

```



```
[3, 4, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 1), "DOWN")
Step 21:
[3, 1, 2]
[0, 4, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 1), "RIGHT")
Step 20:
[3, 1, 2]
[4, 0, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "UP")
Step 19:
[3, 0, 2]
[4, 1, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 2), "RIGHT")
Step 18:
[3, 2, 0]
[4, 1, 5]
[6, 7, 8]
Action: (CartesianIndex(1, 3), "DOWN")
Step 17:
[3, 2, 5]
[4, 1, 0]
[6, 7, 8]
Action: (CartesianIndex(2, 3), "LEFT")
Step 16:
[3, 2, 5]
[4, 0, 1]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "LEFT")
Step 15:
[3, 2, 5]
[0, 4, 1]
[6, 7, 8]
Action: (CartesianIndex(2, 1), "UP")
Step 14:
[0, 2, 5]
[3, 4, 1]
[6, 7, 8]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 13:
[2, 0, 5]
[3, 4, 1]
[6, 7, 8]
Action: (CartesianIndex(1, 2), "DOWN")
Step 12:
[2, 4, 5]
[3, 0, 1]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "DOWN")
Step 11:
[2, 4, 5]
[3, 7, 1]
[6, 0, 8]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 10:
```

```

[2, 4, 5]
[3, 7, 1]
[6, 8, 0]
Action: (CartesianIndex(3, 3), "UP")
Step 9:
[2, 4, 5]
[3, 7, 0]
[6, 8, 1]
Action: (CartesianIndex(2, 3), "UP")
Step 8:
[2, 4, 0]
[3, 7, 5]
[6, 8, 1]
Action: (CartesianIndex(1, 3), "LEFT")
Step 7:
[2, 0, 4]
[3, 7, 5]
[6, 8, 1]
Action: (CartesianIndex(1, 2), "DOWN")
Step 6:
[2, 7, 4]
[3, 0, 5]
[6, 8, 1]
Action: (CartesianIndex(2, 2), "LEFT")
Step 5:
[2, 7, 4]
[0, 3, 5]
[6, 8, 1]
Action: (CartesianIndex(2, 1), "UP")
Step 4:
[0, 7, 4]
[2, 3, 5]
[6, 8, 1]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 3:
[7, 0, 4]
[2, 3, 5]
[6, 8, 1]
Action: (CartesianIndex(1, 2), "DOWN")
Step 2:
[7, 3, 4]
[2, 0, 5]
[6, 8, 1]
Action: (CartesianIndex(2, 2), "RIGHT")
Step 1:
[7, 3, 4]
[2, 5, 0]
[6, 8, 1]
Action: (CartesianIndex(2, 3), "DOWN")
Step 0:
[7, 3, 4]
[2, 5, 1]
[6, 8, 0]
Action: nothing

```

*\*puzzle-5\**

```

Step 23:
[0, 1, 2]
[3, 4, 5]

```

```
[6, 7, 8]
Action: (CartesianIndex(1, 1), "DOWN")
Step 22:
[3, 1, 2]
[0, 4, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 1), "RIGHT")
Step 21:
[3, 1, 2]
[4, 0, 5]
[6, 7, 8]
Action: (CartesianIndex(2, 2), "RIGHT")
Step 20:
[3, 1, 2]
[4, 5, 0]
[6, 7, 8]
Action: (CartesianIndex(2, 3), "DOWN")
Step 19:
[3, 1, 2]
[4, 5, 8]
[6, 7, 0]
Action: (CartesianIndex(3, 3), "LEFT")
Step 18:
[3, 1, 2]
[4, 5, 8]
[6, 0, 7]
Action: (CartesianIndex(3, 2), "LEFT")
Step 17:
[3, 1, 2]
[4, 5, 8]
[0, 6, 7]
Action: (CartesianIndex(3, 1), "UP")
Step 16:
[3, 1, 2]
[0, 5, 8]
[4, 6, 7]
Action: (CartesianIndex(2, 1), "UP")
Step 15:
[0, 1, 2]
[3, 5, 8]
[4, 6, 7]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 14:
[1, 0, 2]
[3, 5, 8]
[4, 6, 7]
Action: (CartesianIndex(1, 2), "DOWN")
Step 13:
[1, 5, 2]
[3, 0, 8]
[4, 6, 7]
Action: (CartesianIndex(2, 2), "RIGHT")
Step 12:
[1, 5, 2]
[3, 8, 0]
[4, 6, 7]
Action: (CartesianIndex(2, 3), "UP")
Step 11:
[1, 5, 0]
```

```
[3, 8, 2]
[4, 6, 7]
Action: (CartesianIndex(1, 3), "LEFT")
Step 10:
[1, 0, 5]
[3, 8, 2]
[4, 6, 7]
Action: (CartesianIndex(1, 2), "DOWN")
Step 9:
[1, 8, 5]
[3, 0, 2]
[4, 6, 7]
Action: (CartesianIndex(2, 2), "LEFT")
Step 8:
[1, 8, 5]
[0, 3, 2]
[4, 6, 7]
Action: (CartesianIndex(2, 1), "DOWN")
Step 7:
[1, 8, 5]
[4, 3, 2]
[0, 6, 7]
Action: (CartesianIndex(3, 1), "RIGHT")
Step 6:
[1, 8, 5]
[4, 3, 2]
[6, 0, 7]
Action: (CartesianIndex(3, 2), "RIGHT")
Step 5:
[1, 8, 5]
[4, 3, 2]
[6, 7, 0]
Action: (CartesianIndex(3, 3), "UP")
Step 4:
[1, 8, 5]
[4, 3, 0]
[6, 7, 2]
Action: (CartesianIndex(2, 3), "UP")
Step 3:
[1, 8, 0]
[4, 3, 5]
[6, 7, 2]
Action: (CartesianIndex(1, 3), "LEFT")
Step 2:
[1, 0, 8]
[4, 3, 5]
[6, 7, 2]
Action: (CartesianIndex(1, 2), "DOWN")
Step 1:
[1, 3, 8]
[4, 0, 5]
[6, 7, 2]
Action: (CartesianIndex(2, 2), "DOWN")
Step 0:
[1, 3, 8]
[4, 7, 5]
[6, 0, 2]
Action: nothing
```

*\*puzzle-6\**

Step 28:

[0, 1, 2]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 1), "RIGHT")

Step 27:

[1, 0, 2]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 2), "RIGHT")

Step 26:

[1, 2, 0]

[3, 4, 5]

[6, 7, 8]

Action: (CartesianIndex(1, 3), "DOWN")

Step 25:

[1, 2, 5]

[3, 4, 0]

[6, 7, 8]

Action: (CartesianIndex(2, 3), "DOWN")

Step 24:

[1, 2, 5]

[3, 4, 8]

[6, 7, 0]

Action: (CartesianIndex(3, 3), "LEFT")

Step 23:

[1, 2, 5]

[3, 4, 8]

[6, 0, 7]

Action: (CartesianIndex(3, 2), "LEFT")

Step 22:

[1, 2, 5]

[3, 4, 8]

[0, 6, 7]

Action: (CartesianIndex(3, 1), "UP")

Step 21:

[1, 2, 5]

[0, 4, 8]

[3, 6, 7]

Action: (CartesianIndex(2, 1), "UP")

Step 20:

[0, 2, 5]

[1, 4, 8]

[3, 6, 7]

Action: (CartesianIndex(1, 1), "RIGHT")

Step 19:

[2, 0, 5]

[1, 4, 8]

[3, 6, 7]

Action: (CartesianIndex(1, 2), "RIGHT")

Step 18:

[2, 5, 0]

[1, 4, 8]

[3, 6, 7]

Action: (CartesianIndex(1, 3), "DOWN")

Step 17:

[2, 5, 8]

[1, 4, 0]

```
[3, 6, 7]
Action: (CartesianIndex(2, 3), "DOWN")
Step 16:
[2, 5, 8]
[1, 4, 7]
[3, 6, 0]
Action: (CartesianIndex(3, 3), "LEFT")
Step 15:
[2, 5, 8]
[1, 4, 7]
[3, 0, 6]
Action: (CartesianIndex(3, 2), "LEFT")
Step 14:
[2, 5, 8]
[1, 4, 7]
[0, 3, 6]
Action: (CartesianIndex(3, 1), "UP")
Step 13:
[2, 5, 8]
[0, 4, 7]
[1, 3, 6]
Action: (CartesianIndex(2, 1), "UP")
Step 12:
[0, 5, 8]
[2, 4, 7]
[1, 3, 6]
Action: (CartesianIndex(1, 1), "RIGHT")
Step 11:
[5, 0, 8]
[2, 4, 7]
[1, 3, 6]
Action: (CartesianIndex(1, 2), "RIGHT")
Step 10:
[5, 8, 0]
[2, 4, 7]
[1, 3, 6]
Action: (CartesianIndex(1, 3), "DOWN")
Step 9:
[5, 8, 7]
[2, 4, 0]
[1, 3, 6]
Action: (CartesianIndex(2, 3), "DOWN")
Step 8:
[5, 8, 7]
[2, 4, 6]
[1, 3, 0]
Action: (CartesianIndex(3, 3), "LEFT")
Step 7:
[5, 8, 7]
[2, 4, 6]
[1, 0, 3]
Action: (CartesianIndex(3, 2), "LEFT")
Step 6:
[5, 8, 7]
[2, 4, 6]
[0, 1, 3]
Action: (CartesianIndex(3, 1), "UP")
Step 5:
[5, 8, 7]
```

```
[0, 4, 6]
[2, 1, 3]
Action: (CartesianIndex(2, 1), "UP")
```

Step 4:

```
[0, 8, 7]
[5, 4, 6]
[2, 1, 3]
Action: (CartesianIndex(1, 1), "RIGHT")
```

Step 3:

```
[8, 0, 7]
[5, 4, 6]
[2, 1, 3]
Action: (CartesianIndex(1, 2), "RIGHT")
```

Step 2:

```
[8, 7, 0]
[5, 4, 6]
[2, 1, 3]
Action: (CartesianIndex(1, 3), "DOWN")
```

Step 1:

```
[8, 7, 6]
[5, 4, 0]
[2, 1, 3]
Action: (CartesianIndex(2, 3), "DOWN")
```

Step 0:

```
[8, 7, 6]
[5, 4, 3]
[2, 1, 0]
Action: nothing
```