7.2 Table of Contents

Profiles

A* Search with Misplaced Tiles:

		Time			Allocations		
Tot / % measured:		177s / 54.3%			21.1GiB / 97.6%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
dequeue	2.08M	63.6s	66.3%	30.6μs	0.00B	0.00%	0.00B
expand	2.08M	17.9s	18.7%	8.64μs	12.6GiB	61.1%	6.35KiB
possibleactions	2.08M	11.9s	12.4%	5.74μs	7.36GiB	35.8%	3.71KiB
create node	5.95M	1.70s	1.78%	286ns	636MiB	3.02%	112B
heuristic score	5.95M	624ms	0.65%	105ns	0.00B	0.00%	0.00B
push	2.08M	170ms	0.18%	82.0ns	17.0MiB	0.08%	8.58B

A* Search with Manhattan Score:

		Time			Allocations		
Tot / % measured:		759ms / 50.8%			151MiB / 97.6%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg

dequeue	13.4k	156ms	40.4%	11.6µs	0.00B	0.00%	0.00B
expand	13.4k	96.5ms	25.0%	7.18µs	81.5MiB	55.2%	6.21KiB
create node	36.5k	69.2ms	17.9%	1.90µs	3.90MiB	2.64%	112B
possibleactions	13.4k	43.1ms	11.2%	3.21µs	48.7MiB	33.0%	3.71KiB
heuristic score	36.5k	19.6ms	5.08%	538ns	13.4MiB	9.05%	384B
push	13.4k	1.45ms	0.38%	108ns	257KiB	0.17%	19.6B

A* Search with Manhattan Score and Linear Conflict

	Time				Allocations		
Tot / % measured:		391ms / 62.6%			200MiB / 99.3%		
Section	ncalls	time	%tot	avg	alloc	%tot	avg
heuristic score	16.0k	122ms	49.9%	7.67µs	141MiB	71.0%	9.07KiB
dequeue	5.73k	64.9ms	26.5%	11.3µs	0.00B	0.00%	0.00B
expand	5.73k	37.5ms	15.3%	6.54µs	35.1MiB	17.6%	6.27KiB
possibleactions	5.73k	13.5ms	5.50%	2.35µs	20.8MiB	10.4%	3.71KiB
create node	16.0k	6.30ms	2.57%	395ns	1.70MiB	0.86%	112B
push	5.73k	560µs	0.23%	97.7ns	129KiB	0.06%	22.9B

Solutions

A* Search with Misplaced Tiles:

```
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
```

A* Search with Manhattan Score:

```
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
```

A* Search with Manhattan Score and Linear Conflict

```
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]
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        [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
```