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 CS 156 SPRING 2021
 Professor Sanjoy Paul
 Homework 5

SJSU.txt

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	52	434	551	0.0079
Simple heuristic	52	434	512	0.0077
Better heuristic (optional)	52	434	250	0.0048
Gen heuristic (optional)	52	434	88	0.0014

QUEST A

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	17	178	93	0.0012
Simple heuristic	17	178	88	0.0013
Better heuristic (optional)	17	178	38	0.0006
Gen heuristic (optional)	17	178	38	0.0007

QUEST B

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	116	886	408628	14.5184
Simple heuristic	116	886	397356	15.3593
Better heuristic (optional)	116	886	291058	10.4744
Gen heuristic (optional)	113	893	2552	0.0724

QUEST C

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	48	554	308	0.0032
Simple heuristic	48	554	296	0.0034
Better heuristic (optional)	48	554	117	0.0017
Gen heuristic (optional)	48	554	99	0.0016

QUEST D

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	31	452	1275	0.0213
Simple heuristic	31	452	1248	0.021
Better heuristic (optional)	31	452	363	0.0082
Gen heuristic (optional)	48	480	76	0.0017

QUEST E

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME

Null heuristic	12	144	383	0.0061
Simple heuristic	12	144	353	0.0059
Better heuristic (optional)	12	144	22	0.0004
Gen heuristic (optional)	12	144	22	0.0004

QUEST F

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	75	453	73100	1.7691
Simple heuristic	75	453	68037	1.6826
Better heuristic (optional)	75	453	32250	0.7755
Gen heuristic (optional)	83	517	7244	0.2299

QUEST G

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	96	579	2412853	192.8528
Simple heuristic	96	579	2246779	187.6238
Better heuristic (optional)	96	579	1140453	83.3046
Gen heuristic (optional)	112	707	65854	4.0757

QUEST H

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	40	296	1045	0.0144
Simple heuristic	40	296	1003	0.0144
Better heuristic (optional)	40	296	648	0.012
Gen heuristic (optional)	52	378	320	0.0072

QUEST L

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	47	299	2915	0.0549
Simple heuristic	47	299	2634	0.0497
Better heuristic (optional)	47	299	363	0.0107
Gen heuristic (optional)	49	315	49	0.0014

NOWAY

	PATH LENGTH	COST	NUMBER OF EXPANED	PROCESSING TIME
Null heuristic	fail	fail	38	0.0013
Simple heuristic	fail	fail	78	0.0013
Better heuristic (optional)	fail	fail	78	0.0013
Gen heuristic (optional)	fail	fail	78	0.0015

Are there cases where some of the heuristics (B), (C) or (D) performed better than (A) and why do you think it happened?

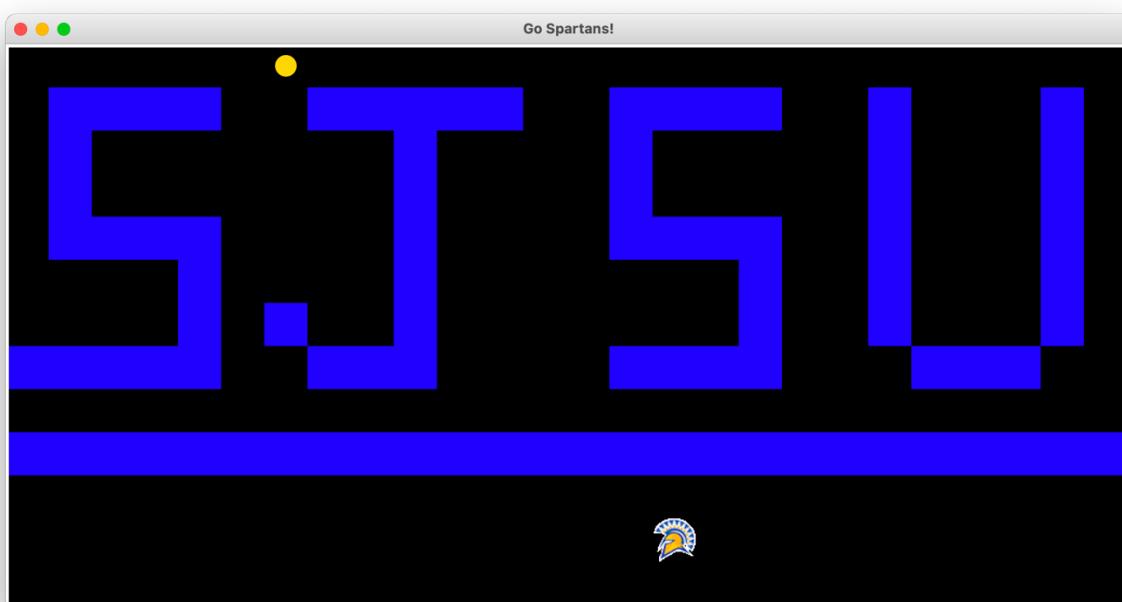
- Single heuristic is heuristic used with A* to find manhattan distance from single medal. Running A* with this single heuristic, give us better performance than uniform cost search.

- Heuristic used with A* to find Manhattan distance * action cost from single medal Running A* with this better heuristic, gives us better performance than A* with single_heuristic.
- General heuristic takes the better heuristic of every medal and adds it to a list, where it is compared to other heuristics.
- For most of case we can see there are significant reduce of number of expanded and processing time compare between Null heuristic, Simple heuristic, Better heuristic and General heuristic.

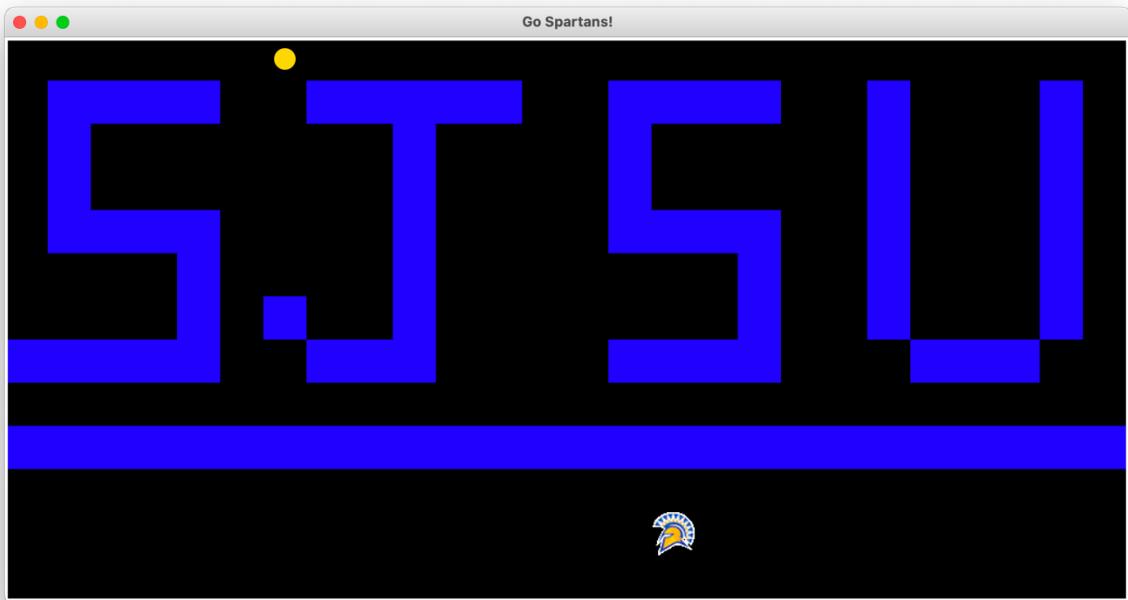
Noway.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py noway.txt astar null_heuristic
The quest failed!
Number of nodes expanded: 78
Processing time: 0.0013 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py noway.txt astar single_heuristic
The quest failed!
Number of nodes expanded: 78
Processing time: 0.0013 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py noway.txt astar better_heuristic
The quest failed!
Number of nodes expanded: 78
Processing time: 0.0013 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py noway.txt astar gen_heuristic
The quest failed!
Number of nodes expanded: 78
Processing time: 0.0015 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

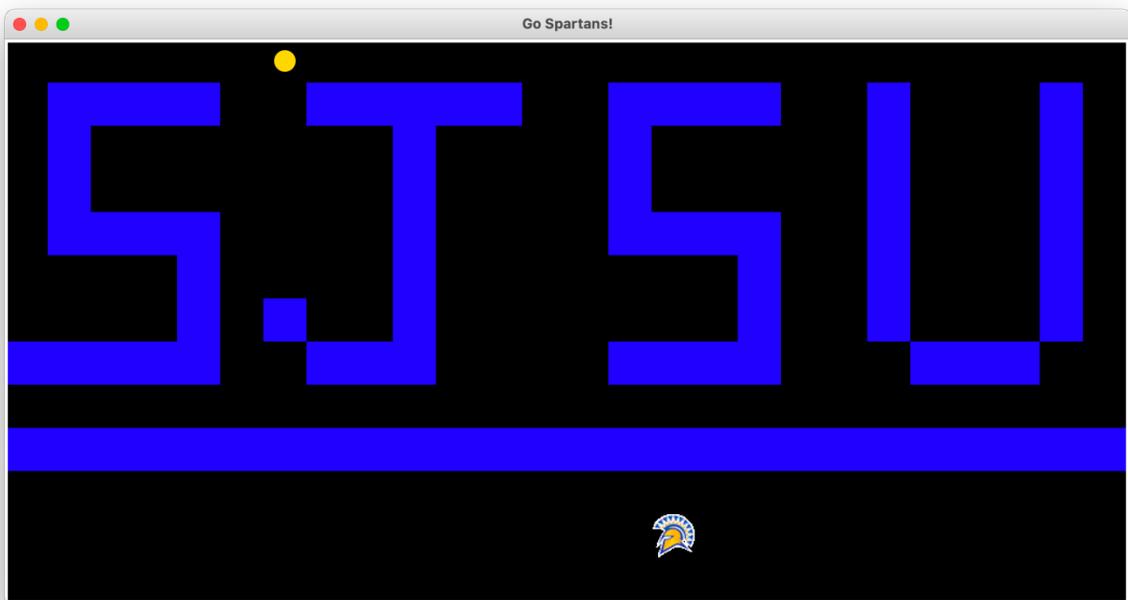
Null heuristic



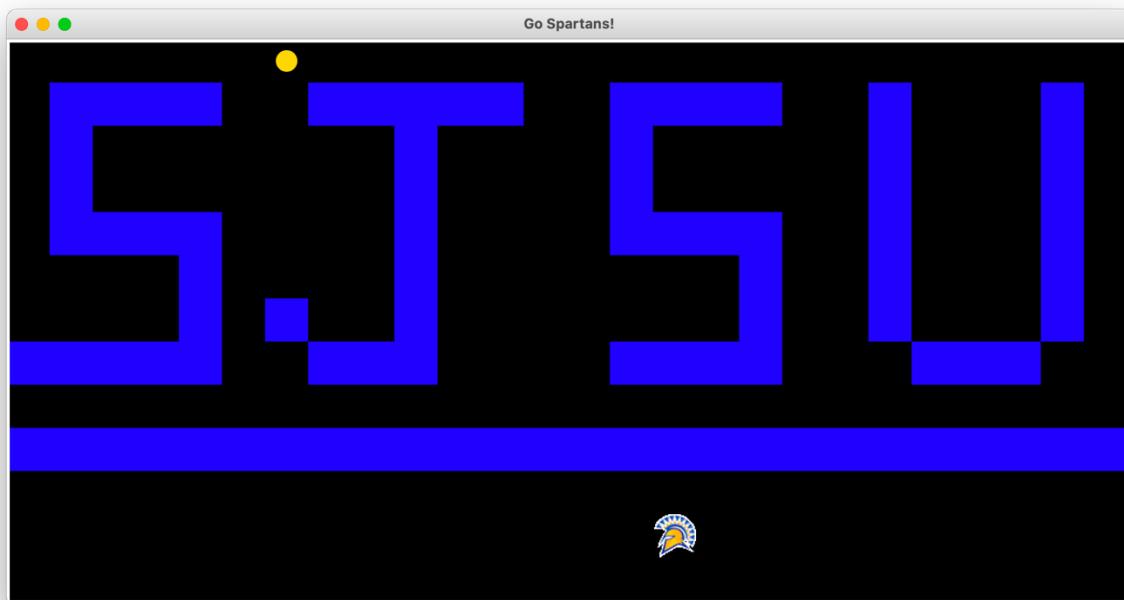
Simple heuristic



Better heuristi(optional)



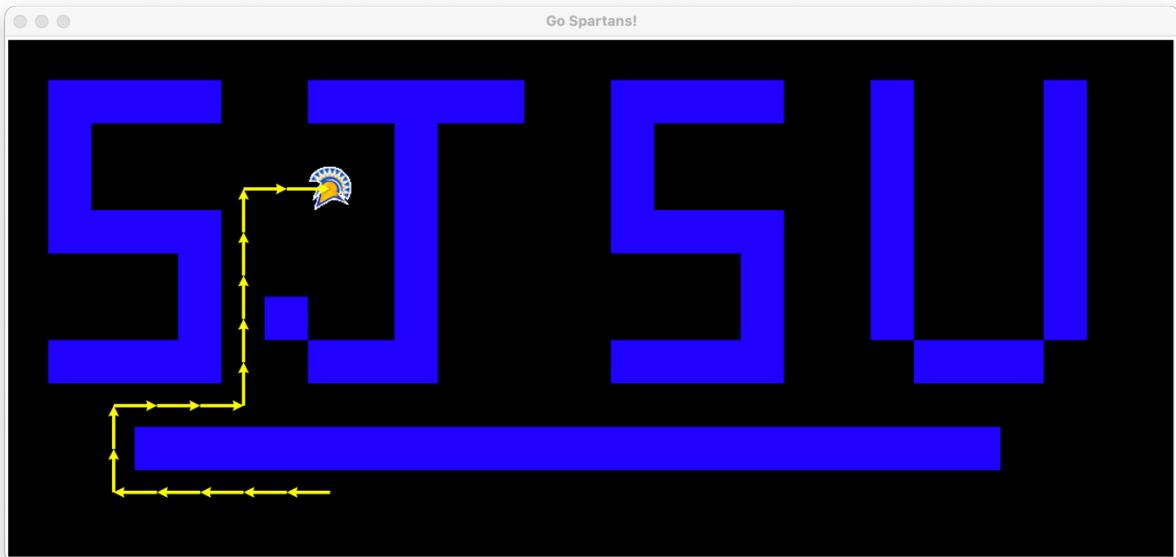
Gen heuristic (optional)



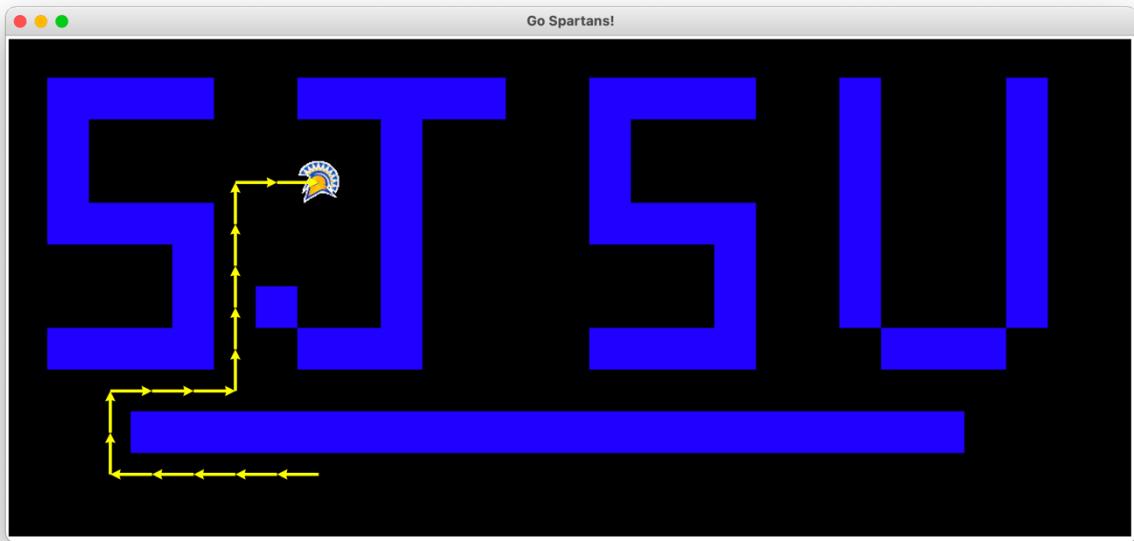
QUEST A.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questA.txt astar null_heuristic
Path length: 17
Carrots consumed: 178
Number of nodes expanded: 93
Processing time: 0.0012 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questA.txt astar single_heuristic
Path length: 17
Carrots consumed: 178
Number of nodes expanded: 88
Processing time: 0.0013 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questA.txt astar better_heuristic
Path length: 17
Carrots consumed: 178
Number of nodes expanded: 38
Processing time: 0.0006 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questA.txt astar gen_heuristic
Path length: 17
Carrots consumed: 178
Number of nodes expanded: 38
Processing time: 0.0007 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

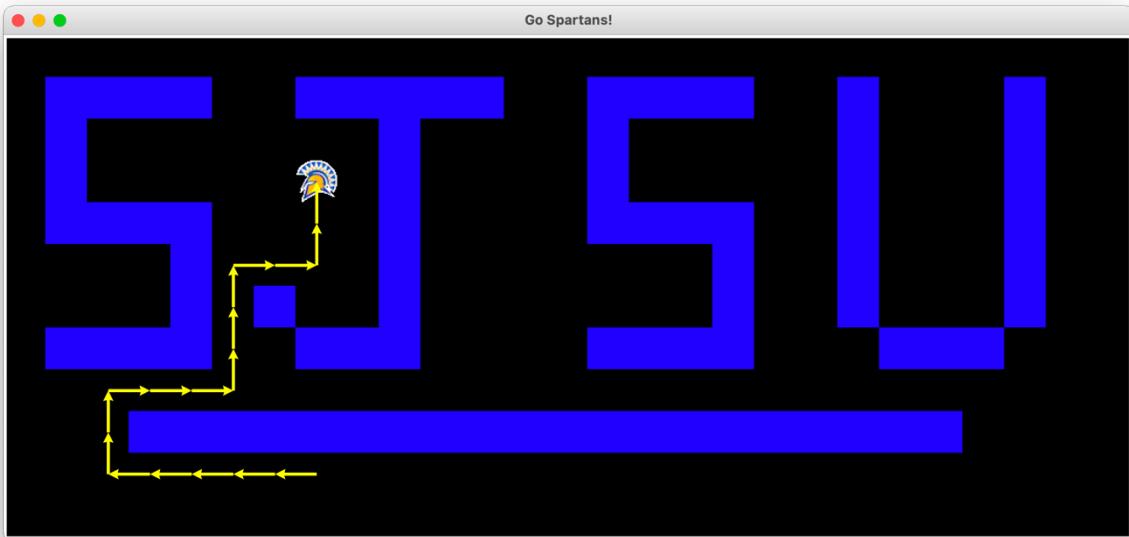
Null heuristic



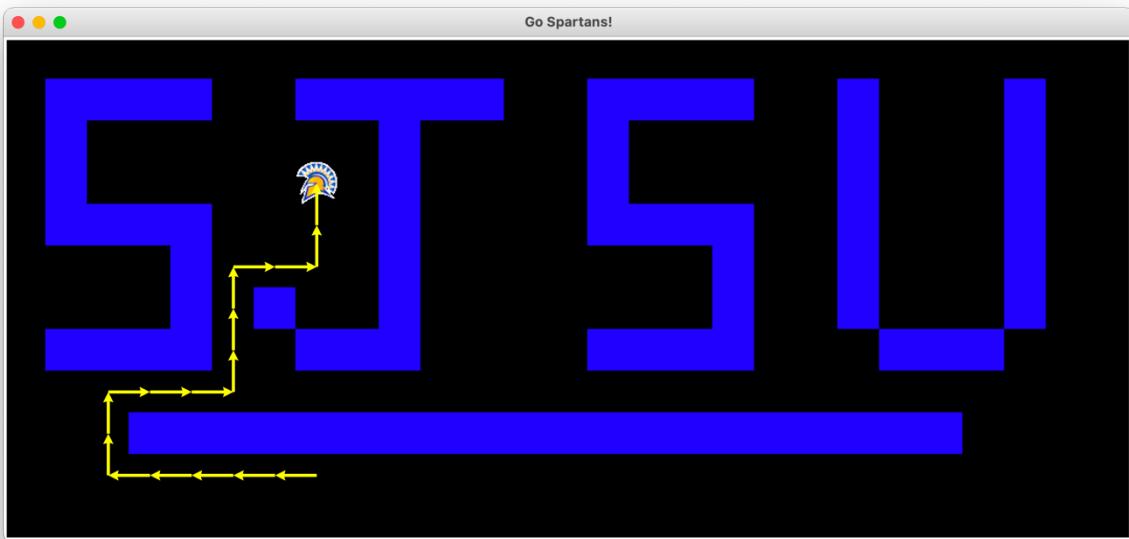
Simple heuristic



Better heuristic(optional)



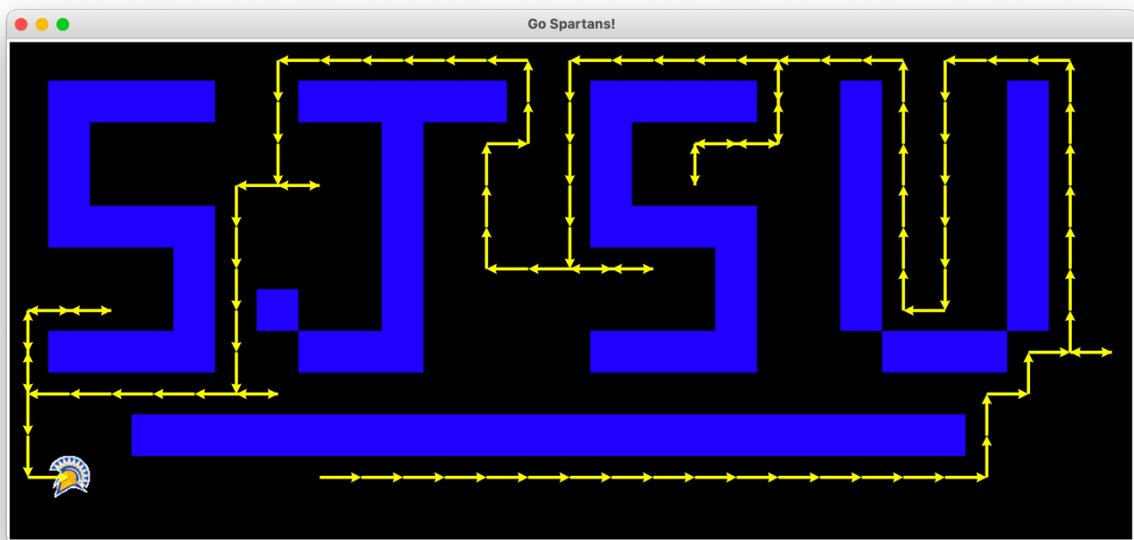
Gen heuristic (optional)



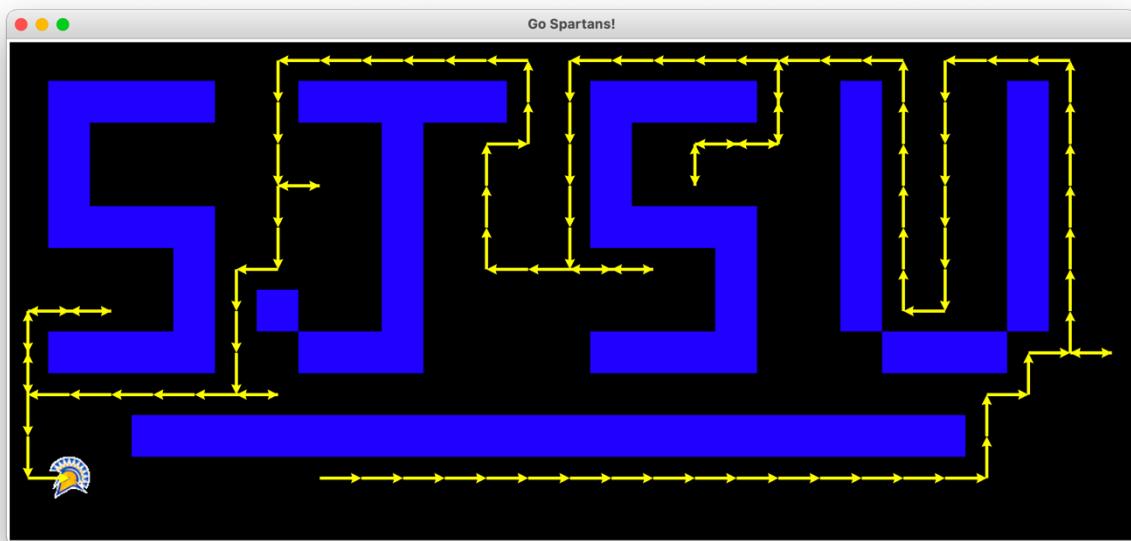
QUEST B.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questB.txt astar null_heuristic
Path length: 116
Carrots consumed: 886
Number of nodes expanded: 408628
Processing time: 14.5184 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questB.txt astar single_heuristic
Path length: 116
Carrots consumed: 886
Number of nodes expanded: 397356
Processing time: 15.3593 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questB.txt astar better_heuristic
Path length: 116
Carrots consumed: 886
Number of nodes expanded: 291058
Processing time: 10.4744 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questB.txt astar gen_heuristic
Path length: 113
Carrots consumed: 893
Number of nodes expanded: 2552
Processing time: 0.0724 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

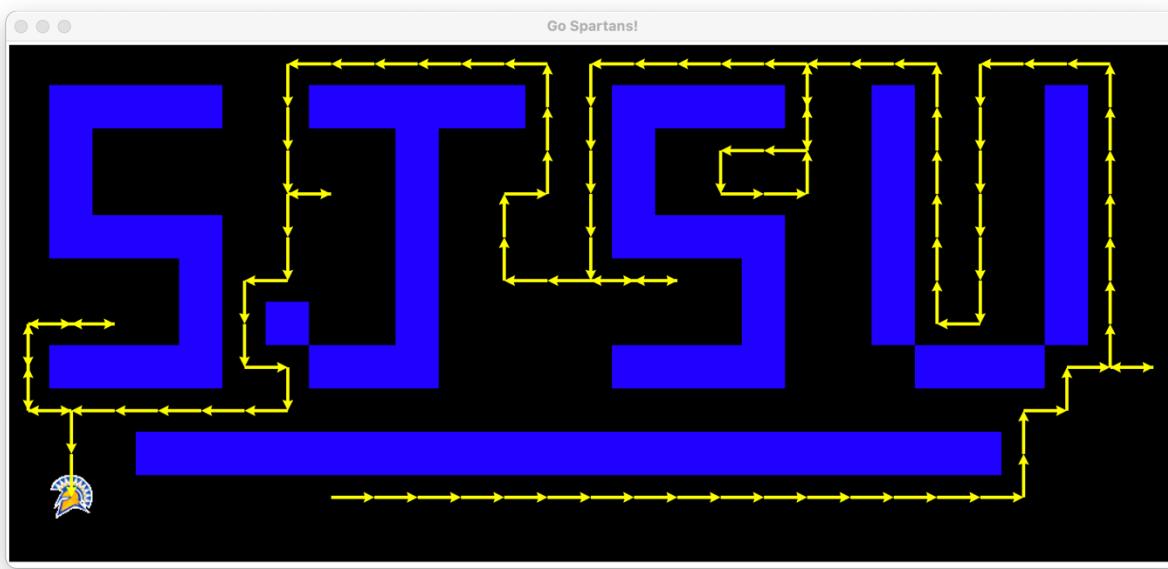
Null heuristic



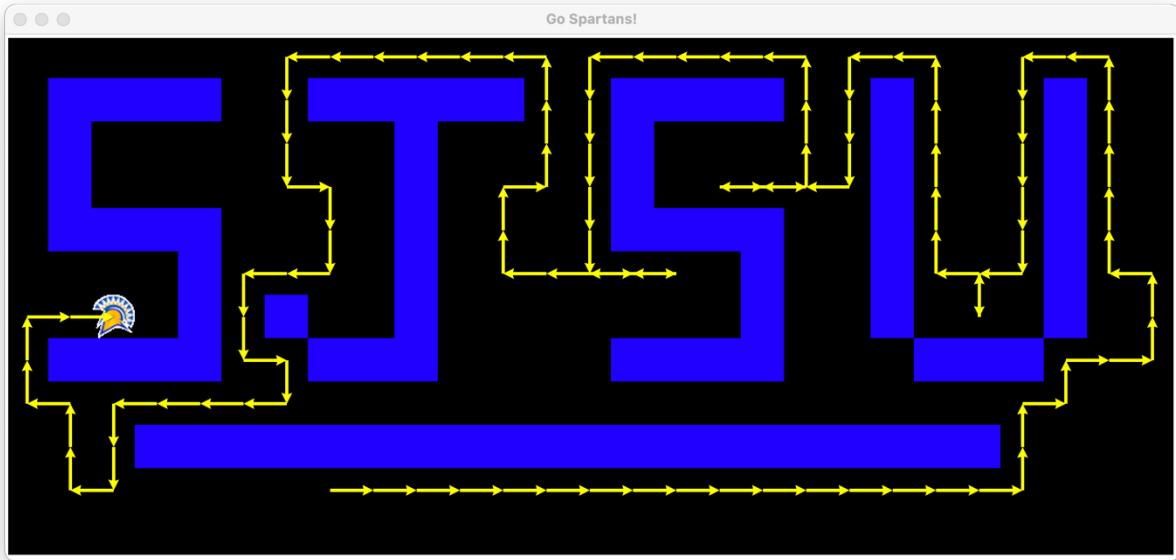
Simple heuristic



Better heuristi(optional)



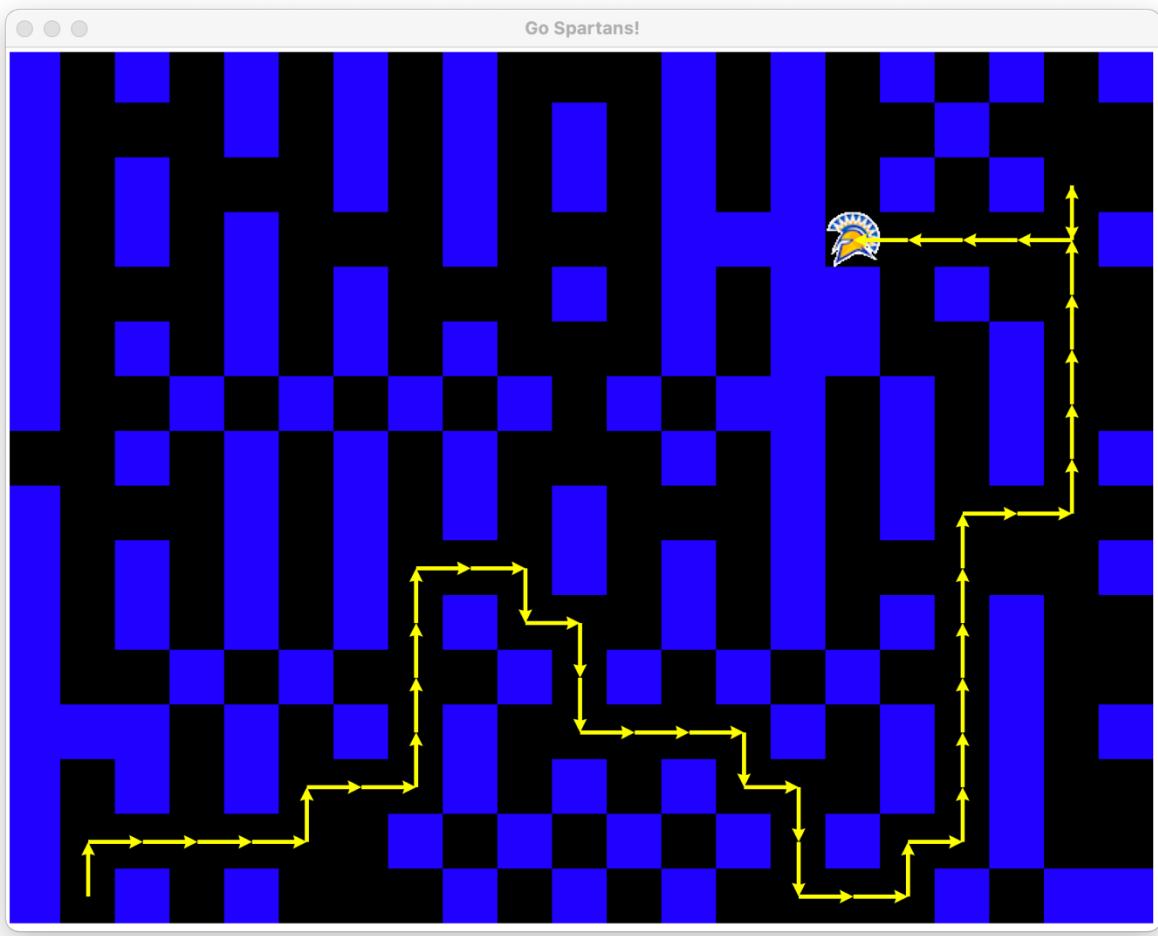
Gen heuristic (optional)



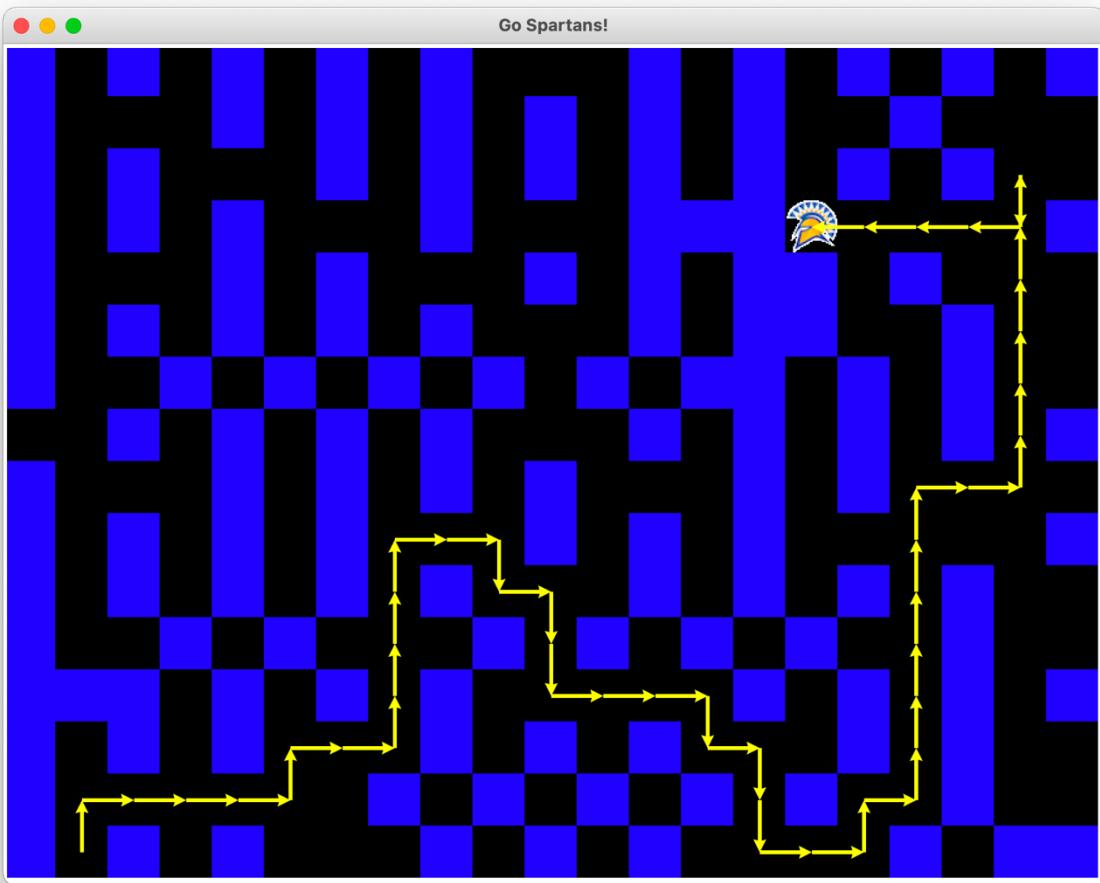
QUEST C.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questC.txt astar null_heuristic
Path length: 48
Carrots consumed: 554
Number of nodes expanded: 308
Processing time: 0.0032 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questC.txt astar single_heuristic
Path length: 48
Carrots consumed: 554
Number of nodes expanded: 296
Processing time: 0.0034 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questC.txt astar better_heuristic
Path length: 48
Carrots consumed: 554
Number of nodes expanded: 117
Processing time: 0.0017 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questC.txt astar gen_heuristic
Path length: 48
Carrots consumed: 554
Number of nodes expanded: 99
Processing time: 0.0016 (sec)
```

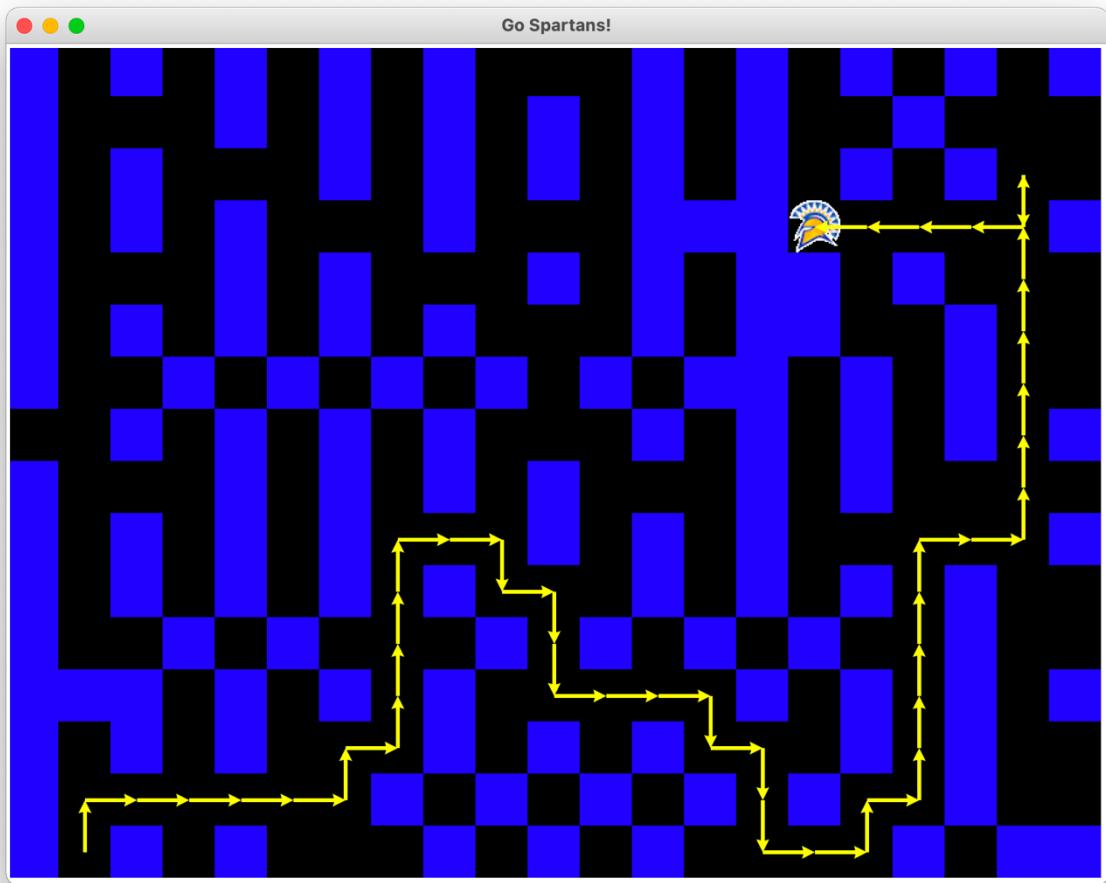
Null heuristic



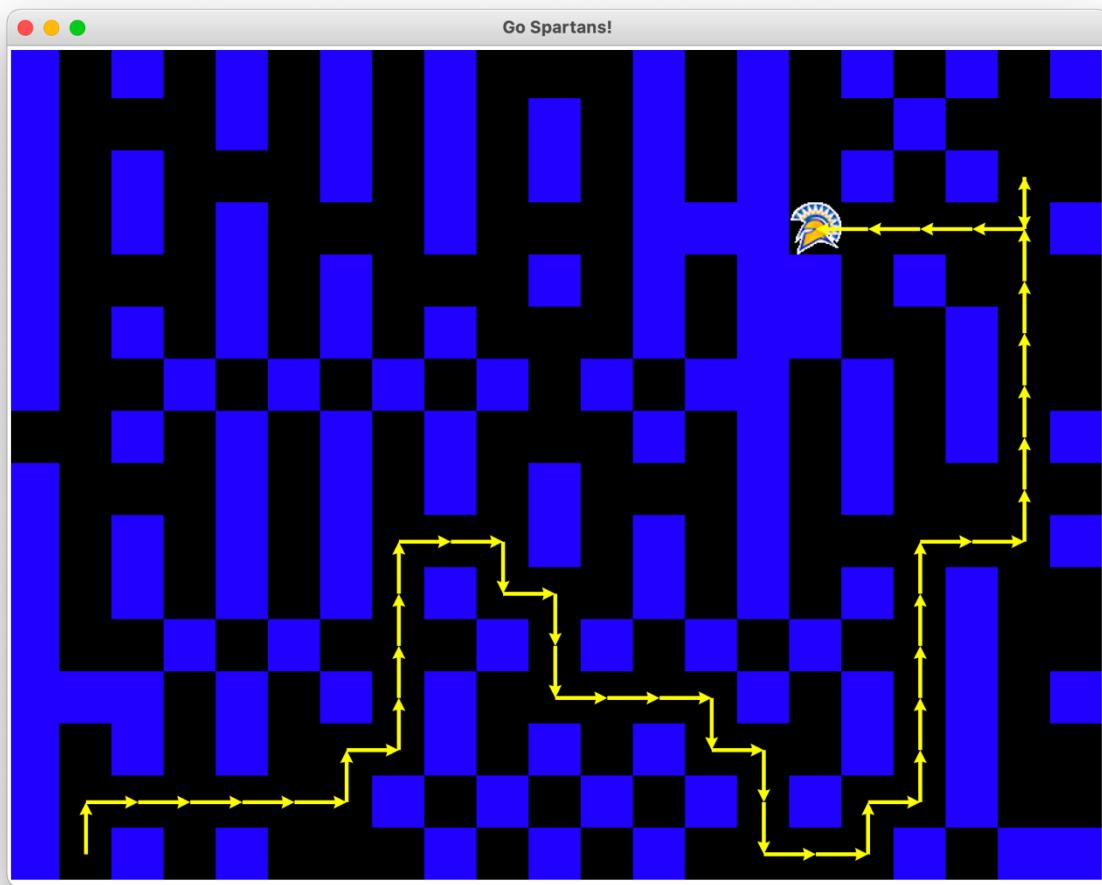
Simple heuristic



Better heuristi(optional)



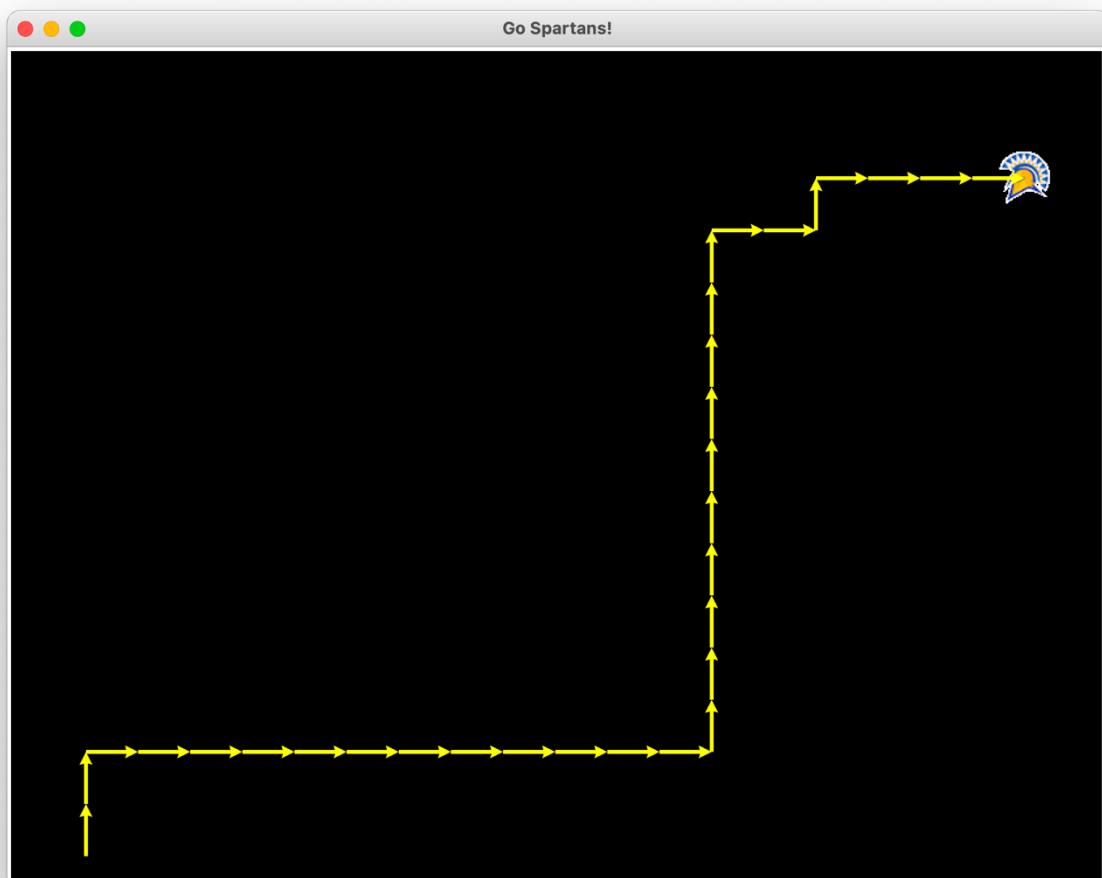
Gen heuristic (optional)



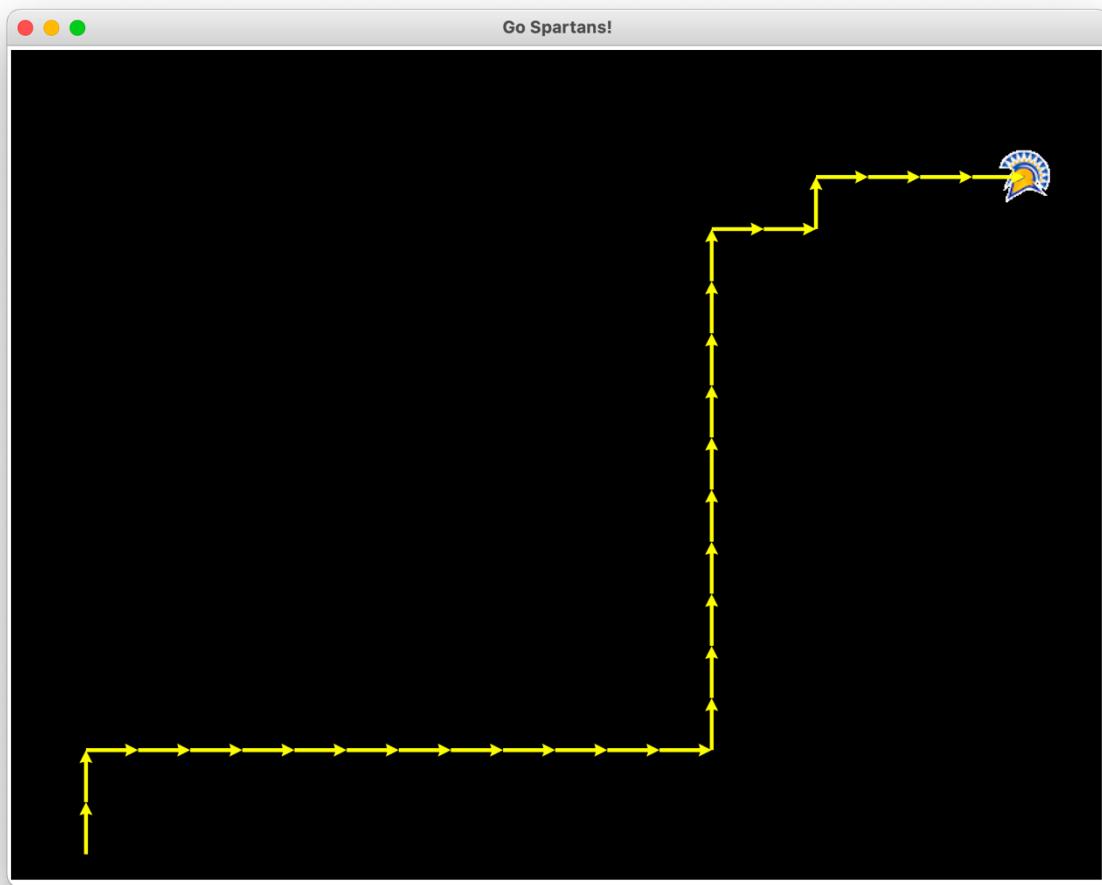
QUEST D.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questD.txt astar null_heuristic
Path length: 31
Carrots consumed: 452
Number of nodes expanded: 1275
Processing time: 0.0213 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questD.txt astar single_heuristic
Path length: 31
Carrots consumed: 452
Number of nodes expanded: 1248
Processing time: 0.0210 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questD.txt astar better_heuristic
Path length: 31
Carrots consumed: 452
Number of nodes expanded: 363
Processing time: 0.0082 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questD.txt astar gen_heuristic
Path length: 48
Carrots consumed: 480
Number of nodes expanded: 76
Processing time: 0.0017 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

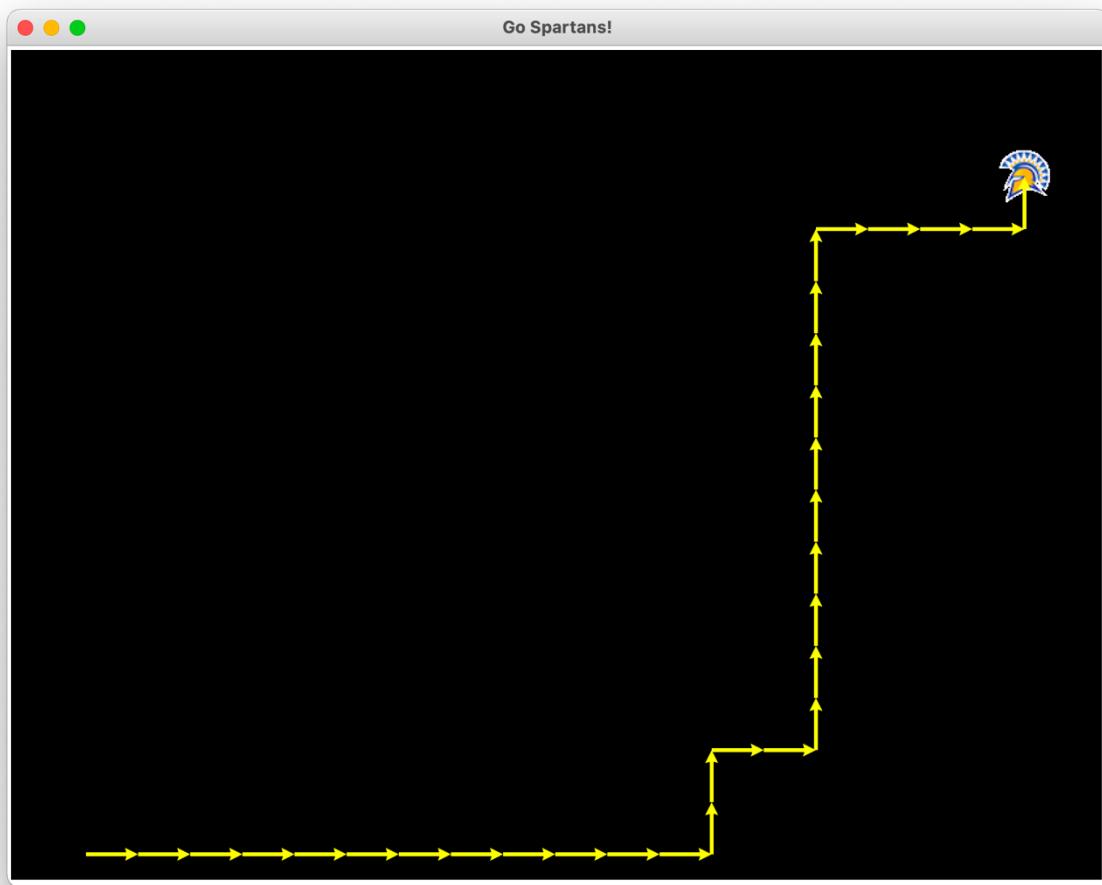
Null heuristic



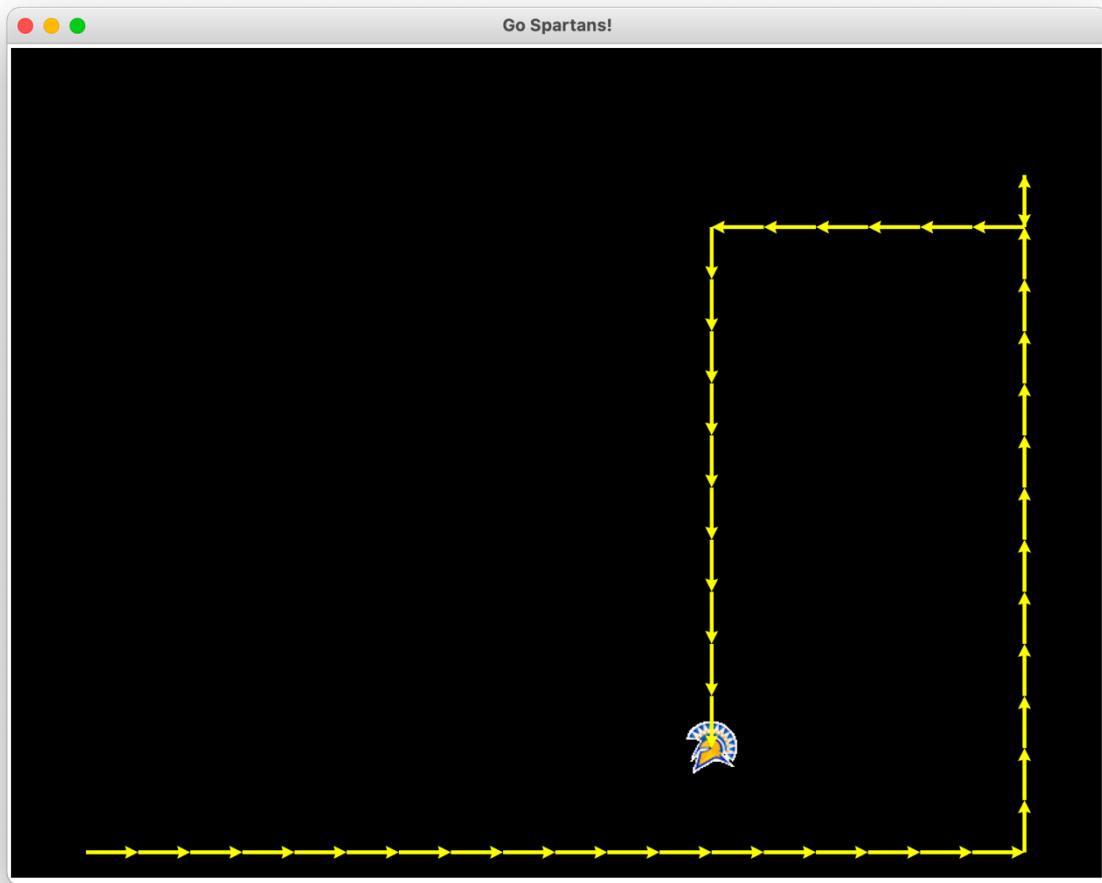
Simple heuristic



Better heuristi(optional)



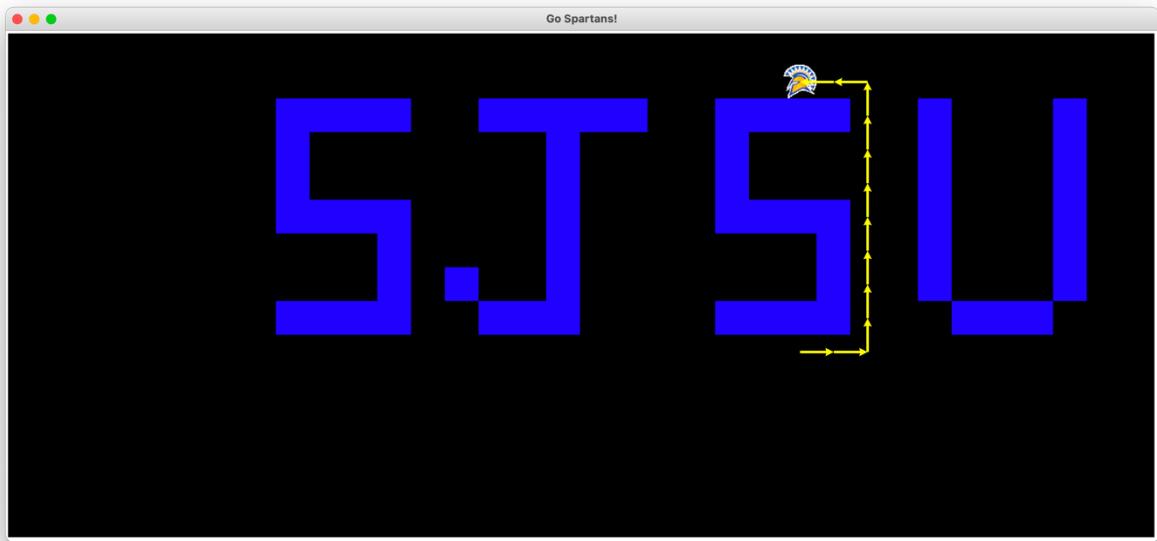
Gen heuristic (optional)



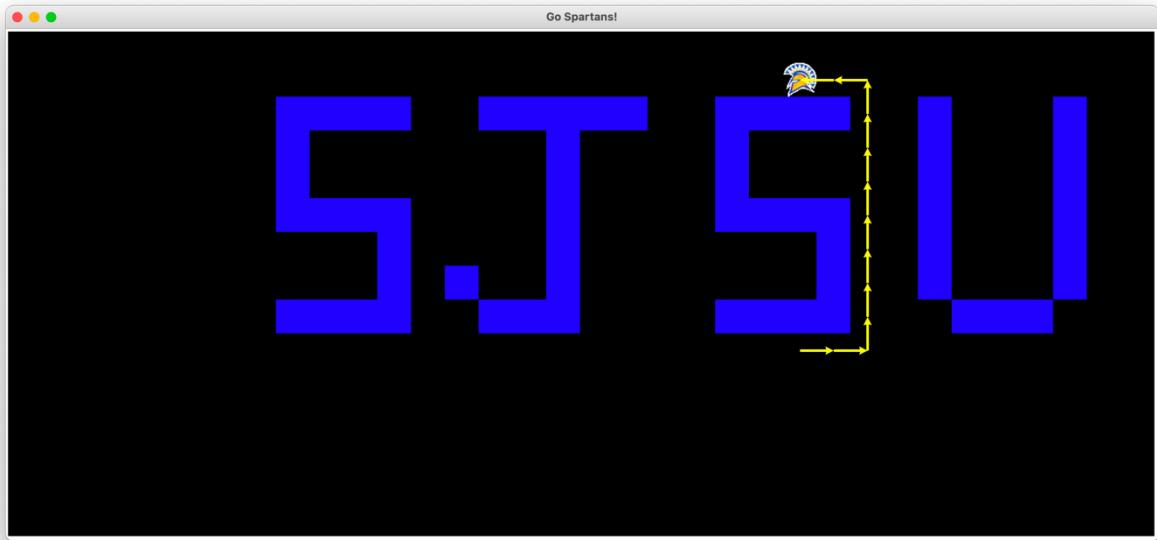
QUEST E.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questE.txt astar null_heuristic
Path length: 12
Carrots consumed: 144
Number of nodes expanded: 383
Processing time: 0.0061 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questE.txt astar single_heuristic
Path length: 12
Carrots consumed: 144
Number of nodes expanded: 353
Processing time: 0.0059 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questE.txt astar better_heuristic
Path length: 12
Carrots consumed: 144
Number of nodes expanded: 22
Processing time: 0.0004 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questE.txt astar gen_heuristic
Path length: 12
Carrots consumed: 144
Number of nodes expanded: 22
Processing time: 0.0004 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

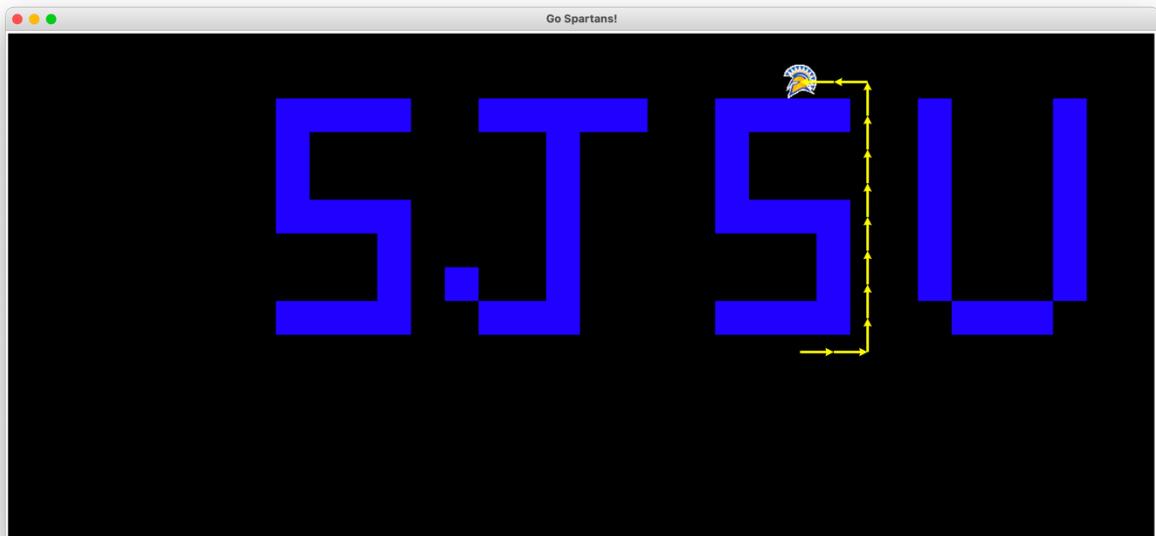
Null heuristic



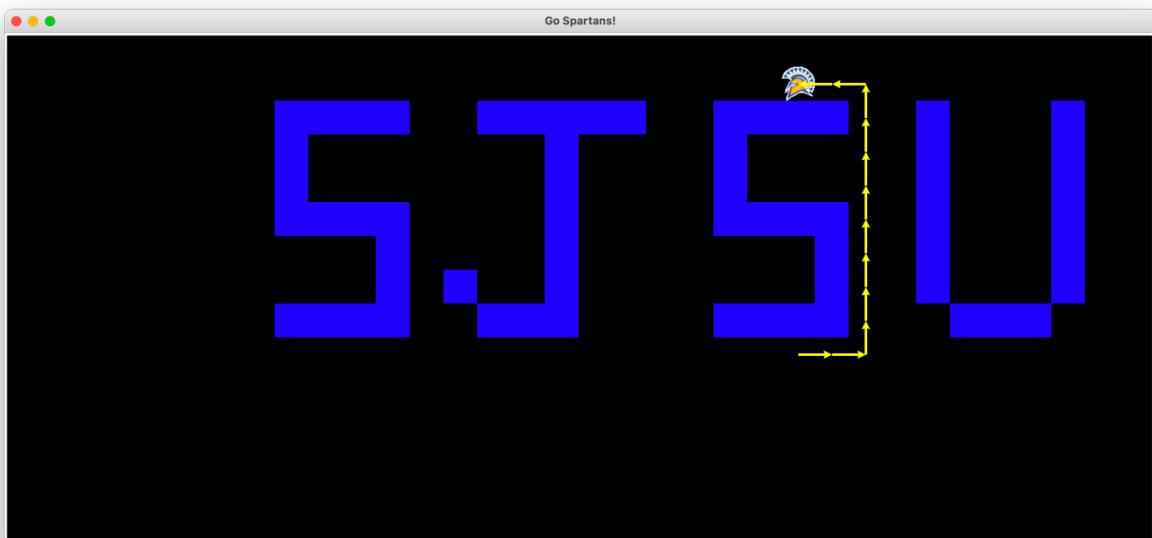
Simple heuristic



Better heuristic(optional)



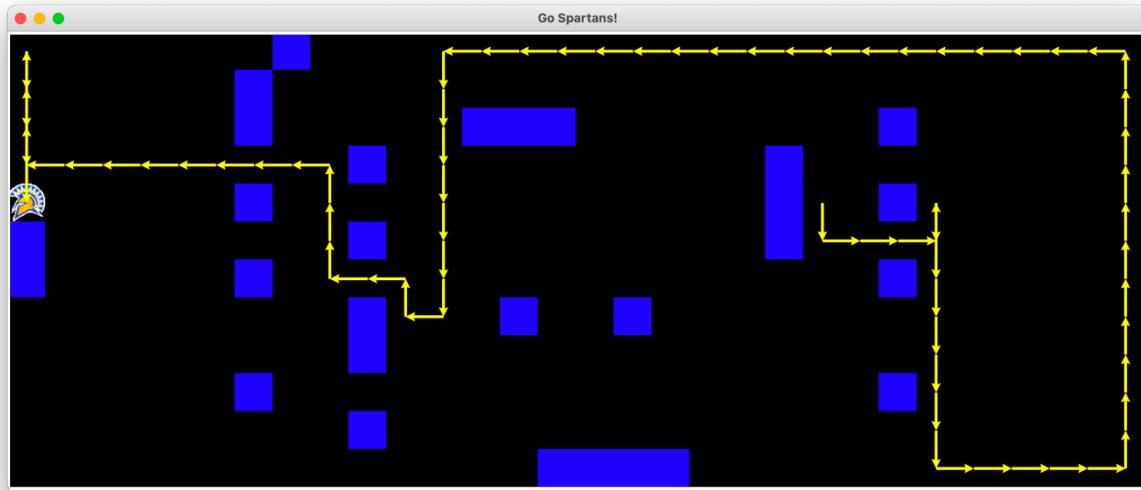
Gen heuristic (optional)



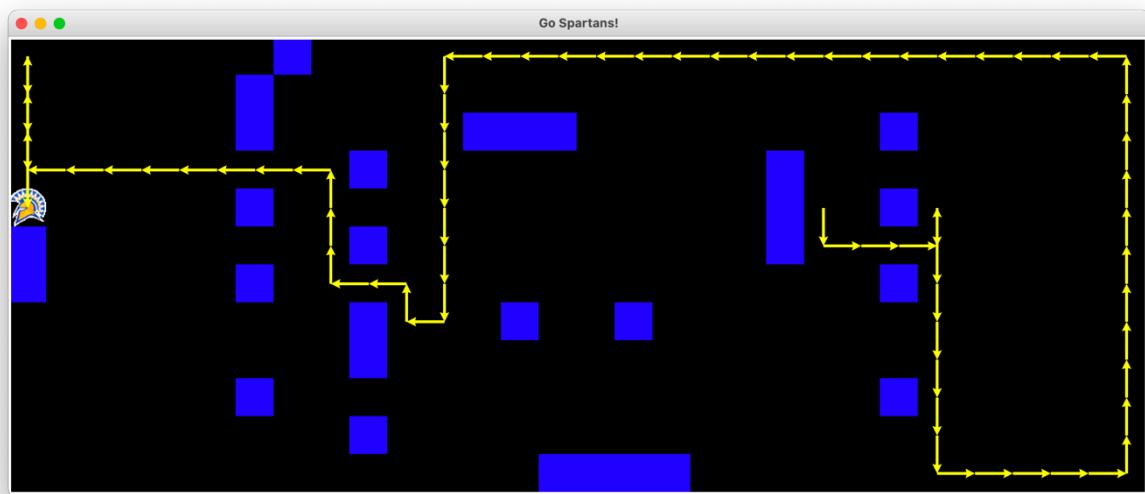
QUEST F.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questF.txt astar null_heuristic
Path length: 75
Carrots consumed: 453
Number of nodes expanded: 73100
Processing time: 1.7691 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questF.txt astar single_heuristic
Path length: 75
Carrots consumed: 453
Number of nodes expanded: 68037
Processing time: 1.6826 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questF.txt astar better_heuristic
Path length: 75
Carrots consumed: 453
Number of nodes expanded: 32250
Processing time: 0.7755 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questF.txt astar gen_heuristic
Path length: 83
Carrots consumed: 517
Number of nodes expanded: 7244
Processing time: 0.2299 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

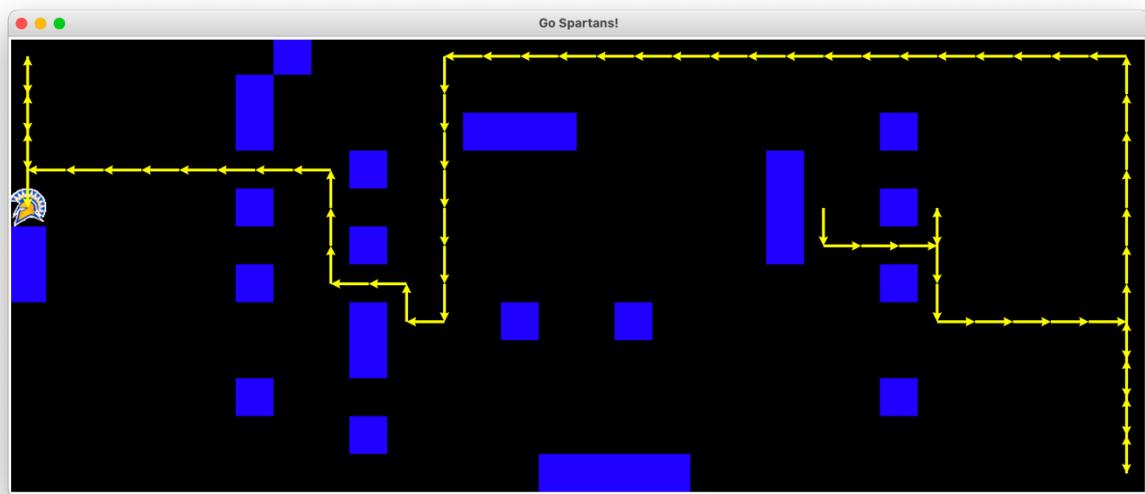
Null heuristic



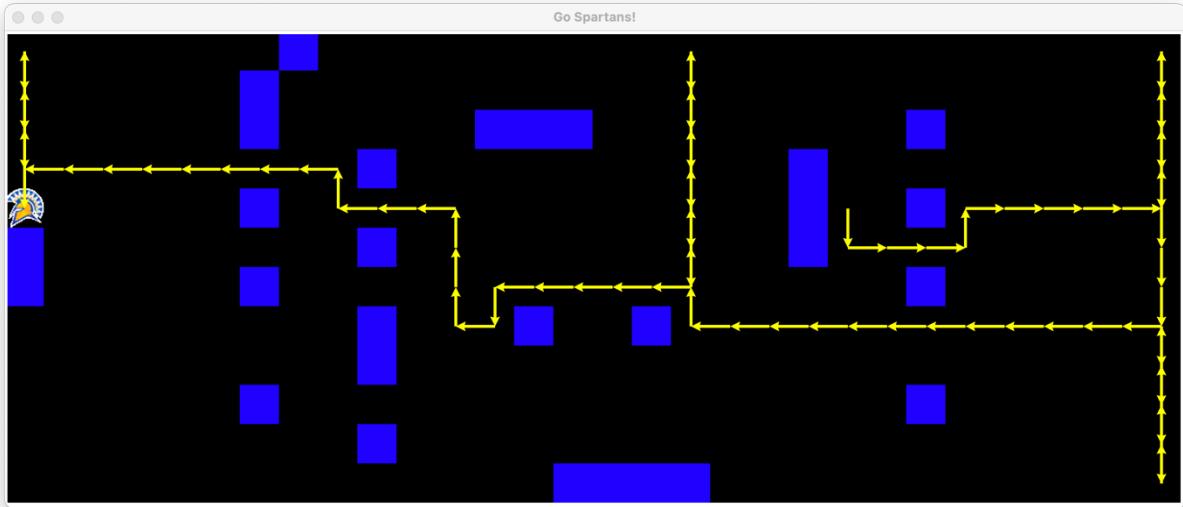
Simple heuristic



Better heuristic(optional)



Gen heuristic (optional)



QUEST G.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questG.txt astar gen_heuristic
Path length: 112
Carrots consumed: 707
Number of nodes expanded: 65854
Processing time: 4.0757 (sec)

(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questG.txt astar null_heuristic
Path length: 96
Carrots consumed: 579
Number of nodes expanded: 2412853
Processing time: 192.8528 (sec)

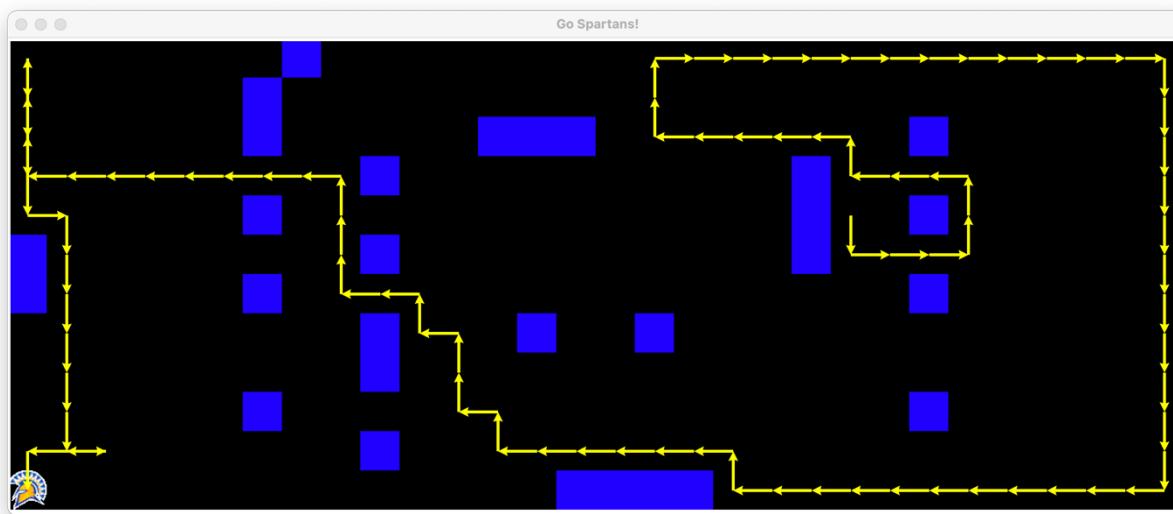
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ █

(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questG.txt astar single_heuristic
Path length: 96
Carrots consumed: 579
Number of nodes expanded: 2246779
Processing time: 187.6238 (sec)

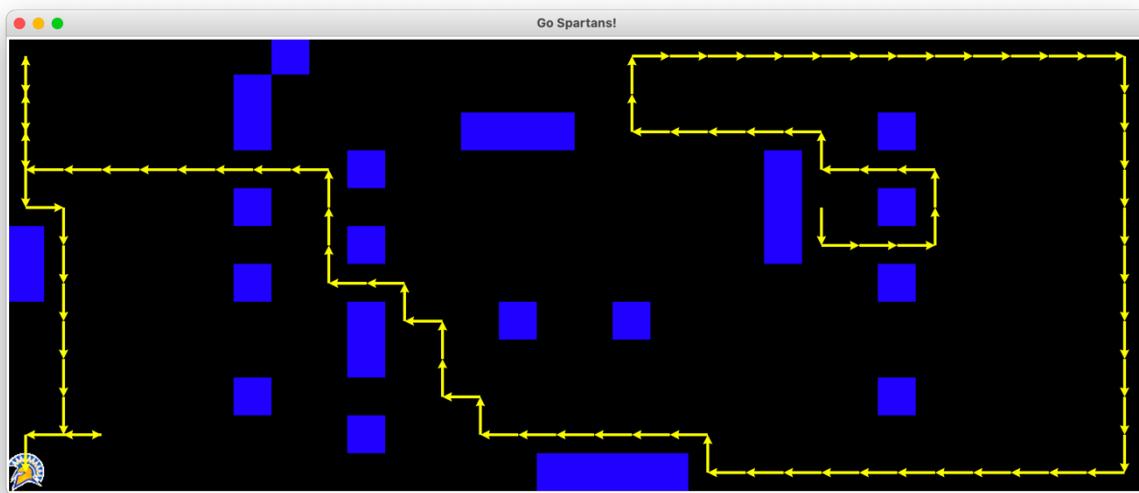
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ █

(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questG.txt astar better_heuristic
Path length: 96
Carrots consumed: 579
Number of nodes expanded: 1140453
Processing time: 83.3046 (sec)

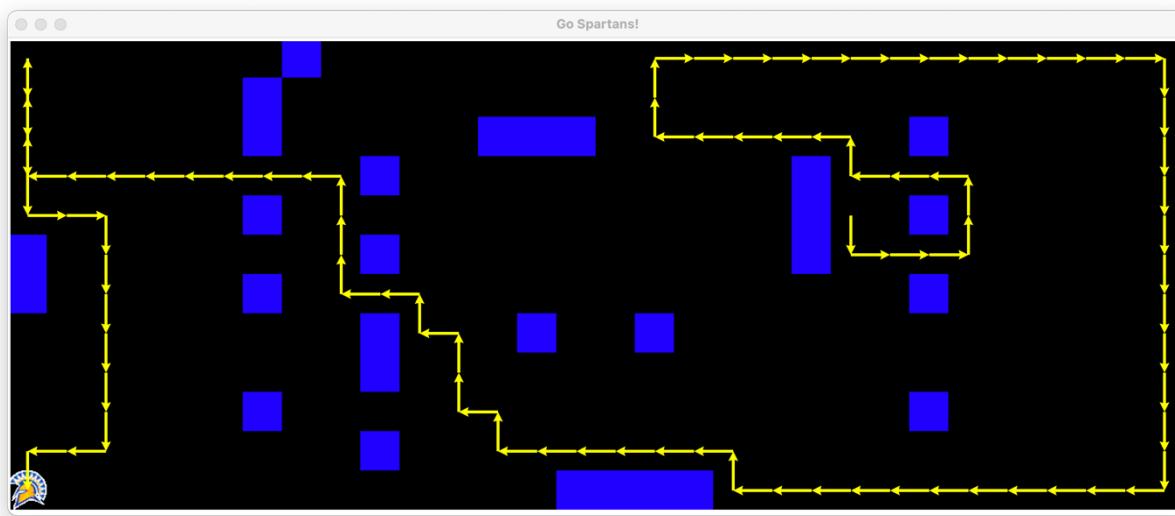
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```



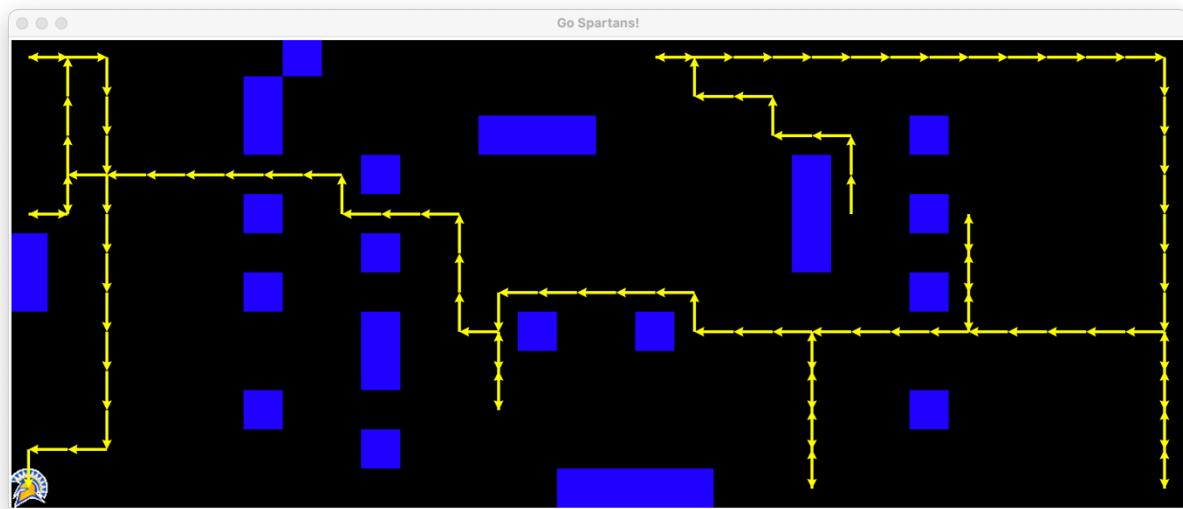
Simple heuristic



Better heuristic(optional)



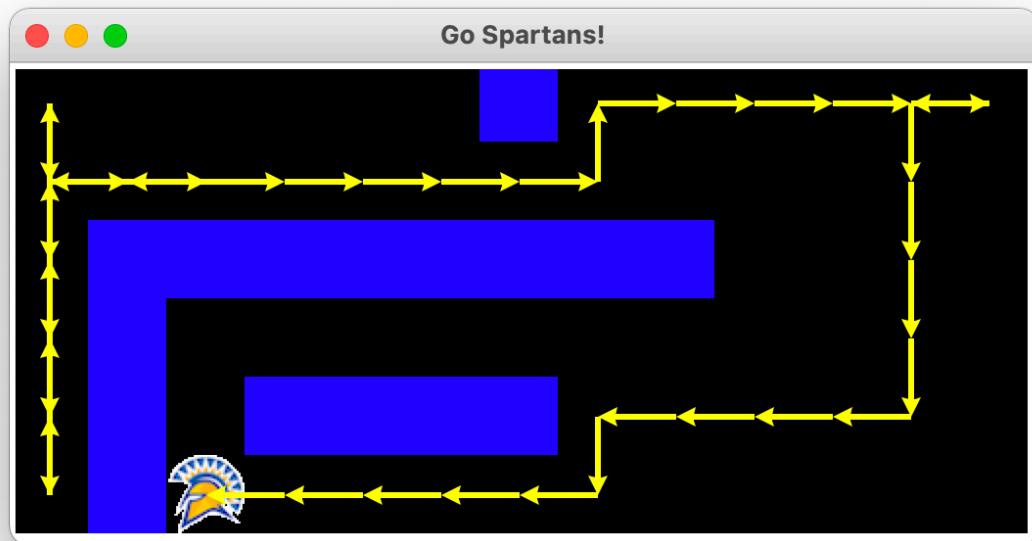
Gen heuristic (optional)



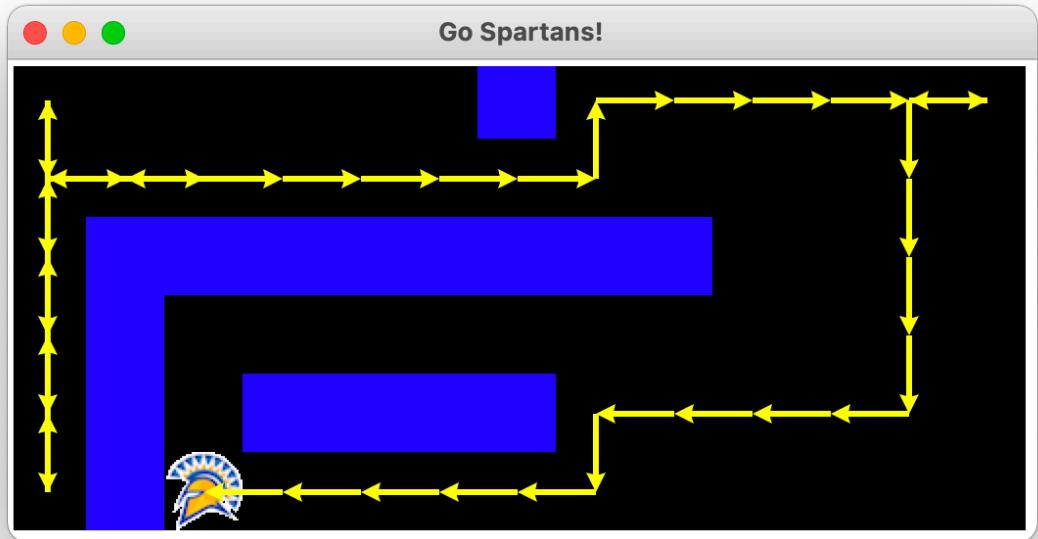
QUEST H .txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questH.txt astar gen_heuristic
Path length: 52
Carrots consumed: 378
Number of nodes expanded: 320
Processing time: 0.0072 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questH.txt astar better_heuristic
Path length: 40
Carrots consumed: 296
Number of nodes expanded: 648
Processing time: 0.0107 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questH.txt astar simple_heuristic
Traceback (most recent call last):
  File "spartanquest.py", line 291, in <module>
    main()
  File "spartanquest.py", line 270, in main
    heuristic_function = getattr(informed_search, heuristic)
AttributeError: module 'informed_search' has no attribute 'simple_heuristic'
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questH.txt astar single_heuristic
Path length: 40
Carrots consumed: 296
Number of nodes expanded: 1003
Processing time: 0.0144 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questH.txt astar null_heuristic
Path length: 40
Carrots consumed: 296
Number of nodes expanded: 1045
Processing time: 0.0144 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$
```

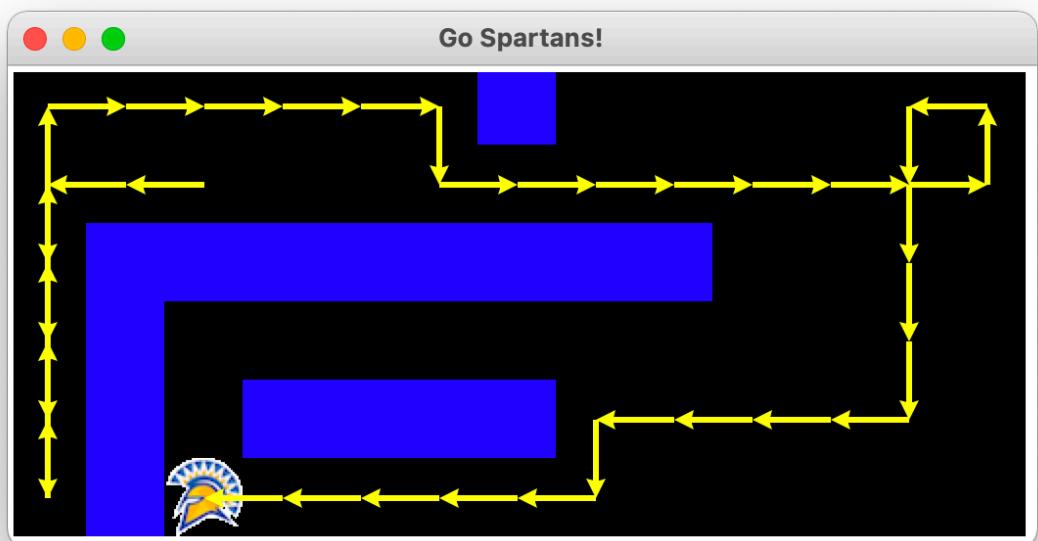
Null heuristic



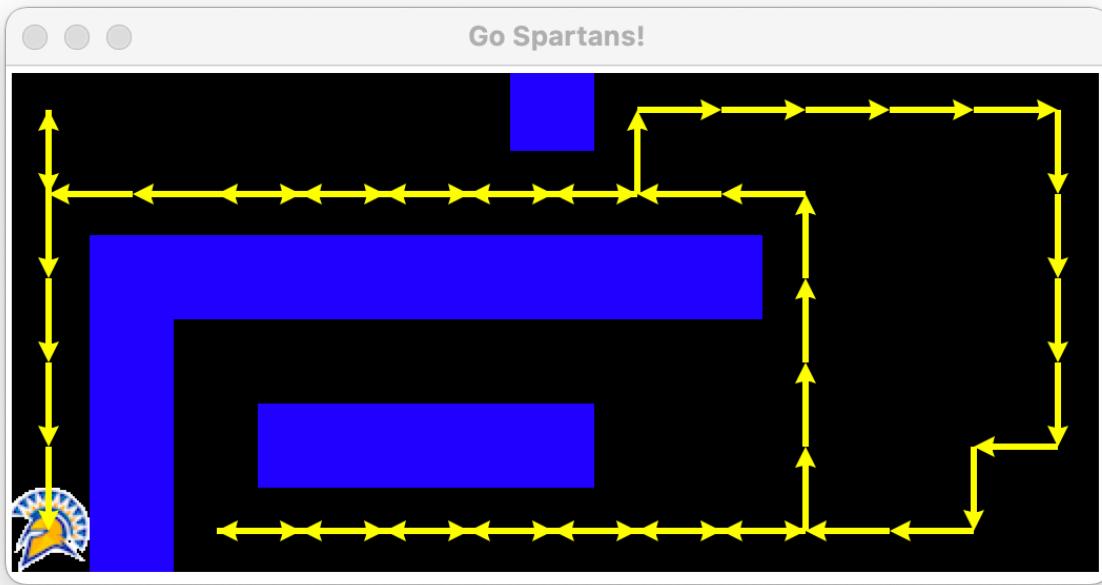
Simple heuristic



Better heuristic(optional)



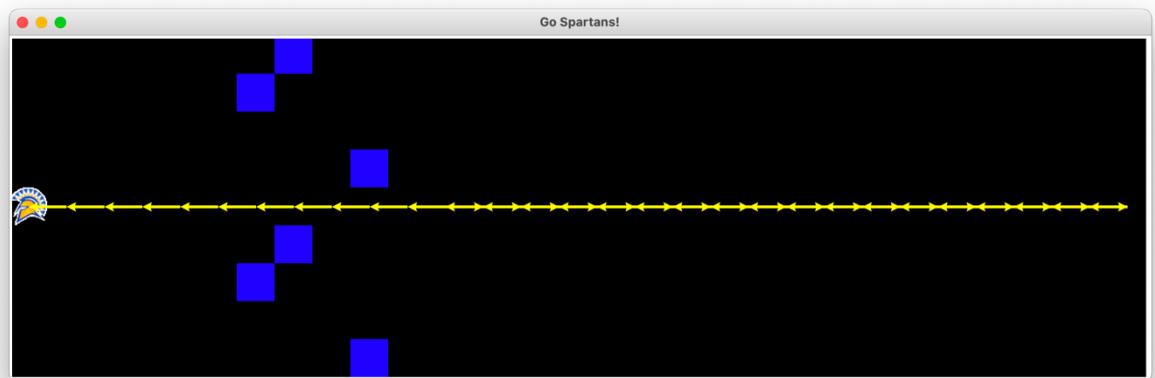
Gen heuristic (optional)



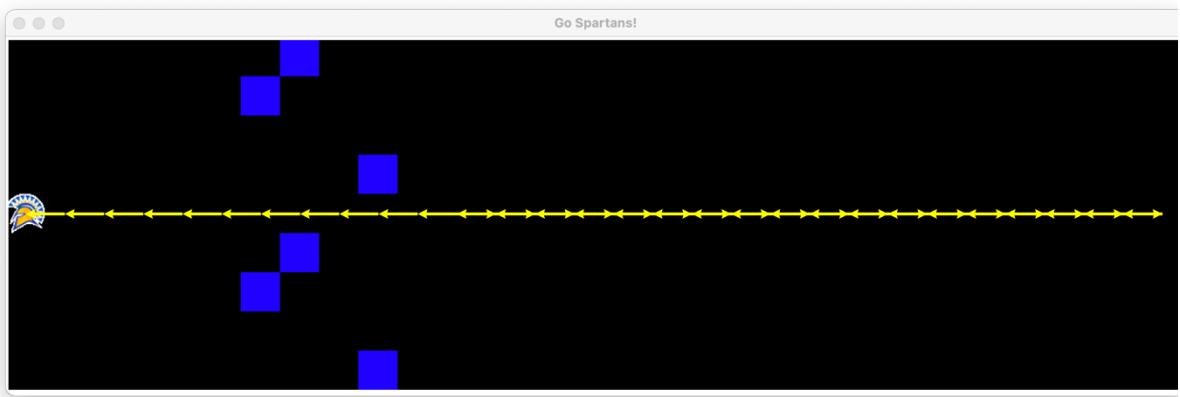
QUEST L .txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questL.txt astar null_heuristic
Path length: 47
Carrots consumed: 299
Number of nodes expanded: 2915
Processing time: 0.0549 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questL.txt astar single_heuristic
Path length: 47
Carrots consumed: 299
Number of nodes expanded: 2634
Processing time: 0.0497 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questL.txt astar better_heuristic
Path length: 47
Carrots consumed: 299
Number of nodes expanded: 363
Processing time: 0.0077 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py questL.txt astar gen_heuristic
Path length: 49
Carrots consumed: 315
Number of nodes expanded: 49
Processing time: 0.0014 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ 
```

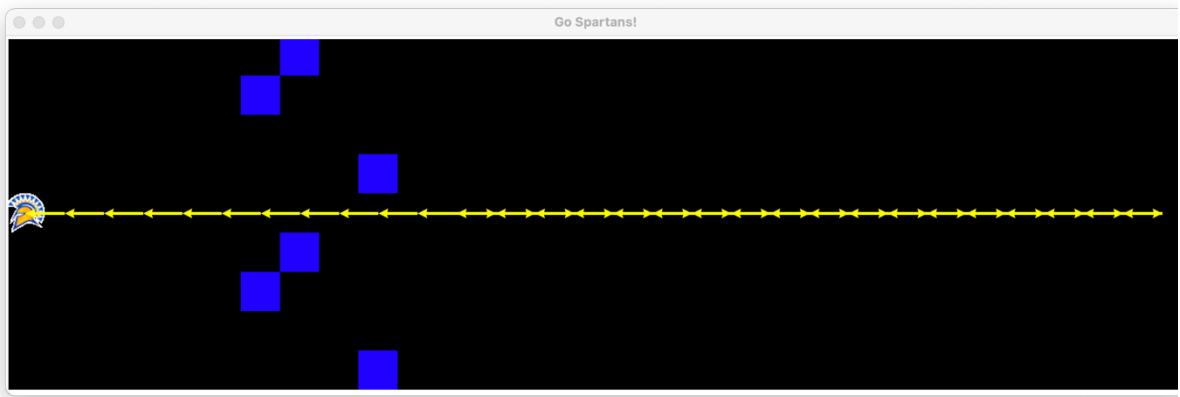
Null heuristic



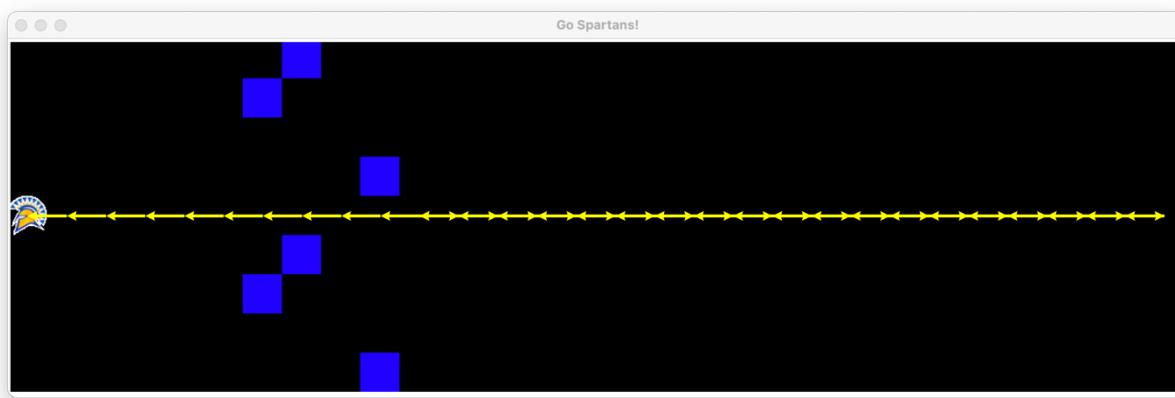
Simple heuristic



Better heuristic(optional)



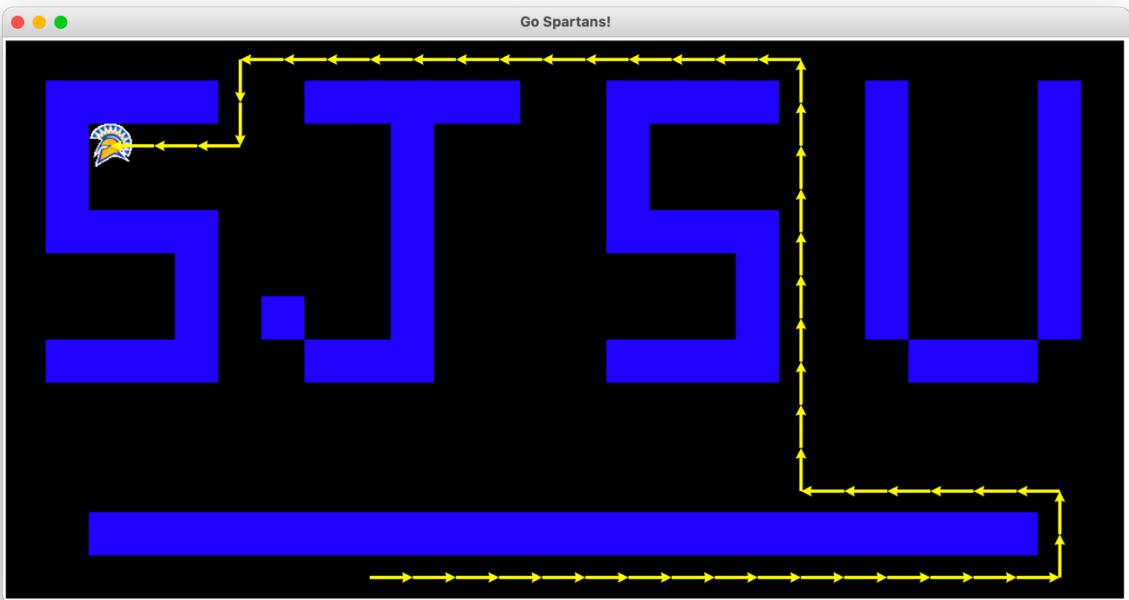
Gen heuristic (optional)



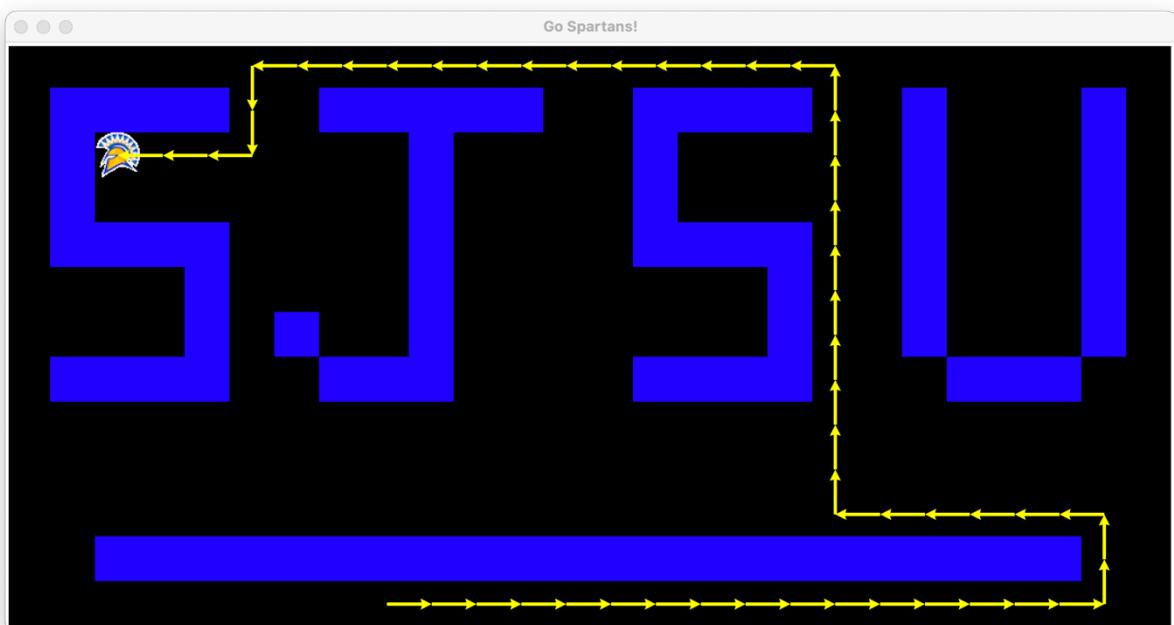
SJSU.txt

```
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py SJSU.txt astar
Path length: 52
Carrots consumed: 434
Number of nodes expanded: 551
Processing time: 0.0075 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py SJSU.txt astar single_heuristic
Path length: 52
Carrots consumed: 434
Number of nodes expanded: 512
Processing time: 0.0077 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py SJSU.txt astar better_heuristic
Path length: 52
Carrots consumed: 434
Number of nodes expanded: 250
Processing time: 0.0048 (sec)
(venv) (base) TGs-MacBook-Pro:hw4 GiangDuong$ python spartanquest.py SJSU.txt astar gen_heuristic
Path length: 52
Carrots consumed: 434
Number of nodes expanded: 88
Processing time: 0.0014 (sec)
```

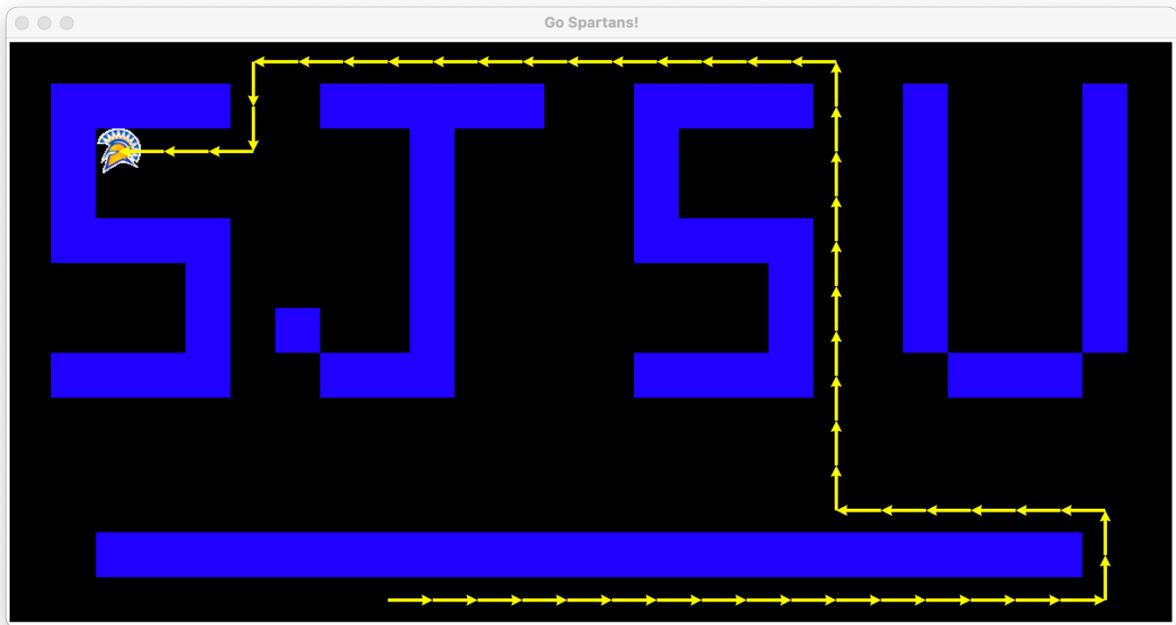
Null heuristic



Simple heuristic



Better heuristic(optional)



Gen heuristic (optional)

