



# Path Planning Experiments

Comprehensive Report - All Runs

Generated: December 12, 2025 at 12:54:48



## Overall Summary

Total Experiment Groups

**5**

Total Runs

**25**

Total Algorithm Runs

**150**

Overall Success Rate

**96.7%**

Total Runtime

**65.7s**

Configuration

**experiments.json**



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## High Density Environment

Compare all 6 algorithms in a high-density random environment

## Run 1

**Start:** (37.616800209736454, 33.62538543067752) | **Goal:** (18.263083425280286, 60.51213366994582) | **Env:** RandomEnvironment ({"width": 100, "height": 100, "density": 5, "seed": 52, "robot\_radius": 1.0})

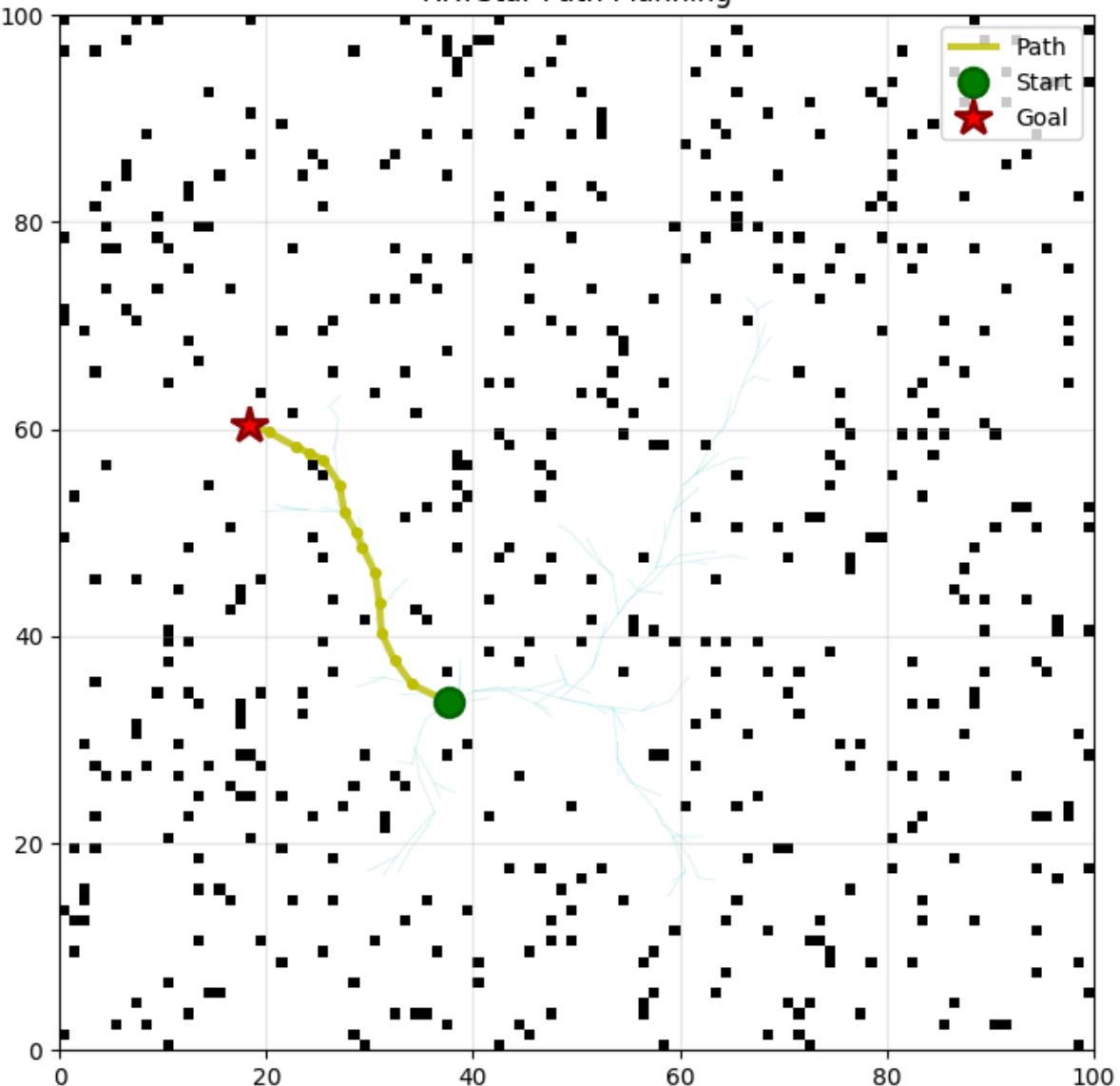
### Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.07	35.77	161	35.77
BiRRTStar ES	✓ Success	0.01	35.69	43	35.69
PRRTStar ES	✓ Success	0.20	42.12	113	42.30
RRTStarDubins ES	✓ Success	0.04	43.88	106	45.35
BiRRTStarDubins ES	✓ Success	0.01	69.17	73	71.83
PRRTStarDubins ES	✓ Success	0.19	41.13	93	48.10

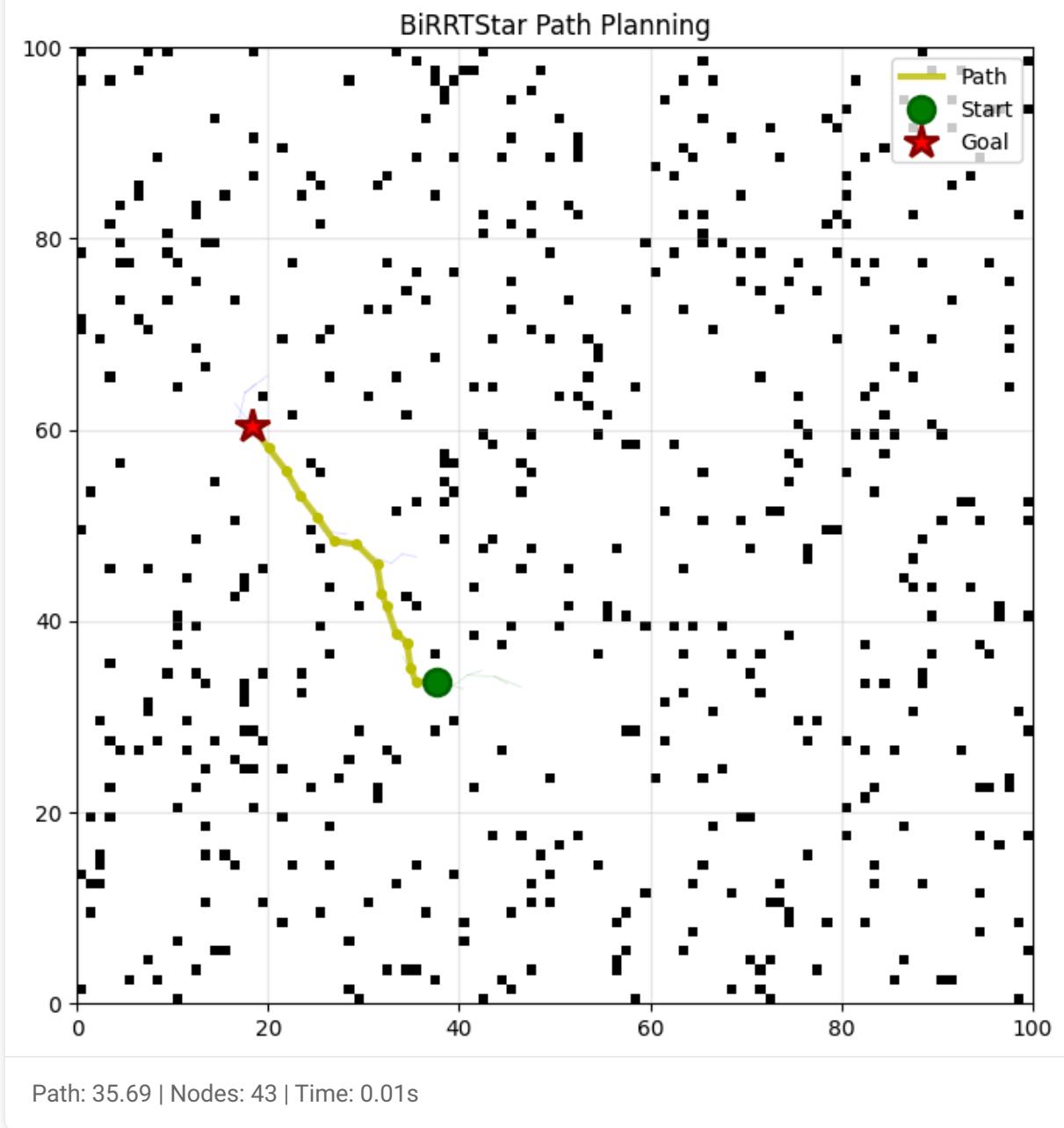
### Path Visualizations

RRTStar [Early Stop]

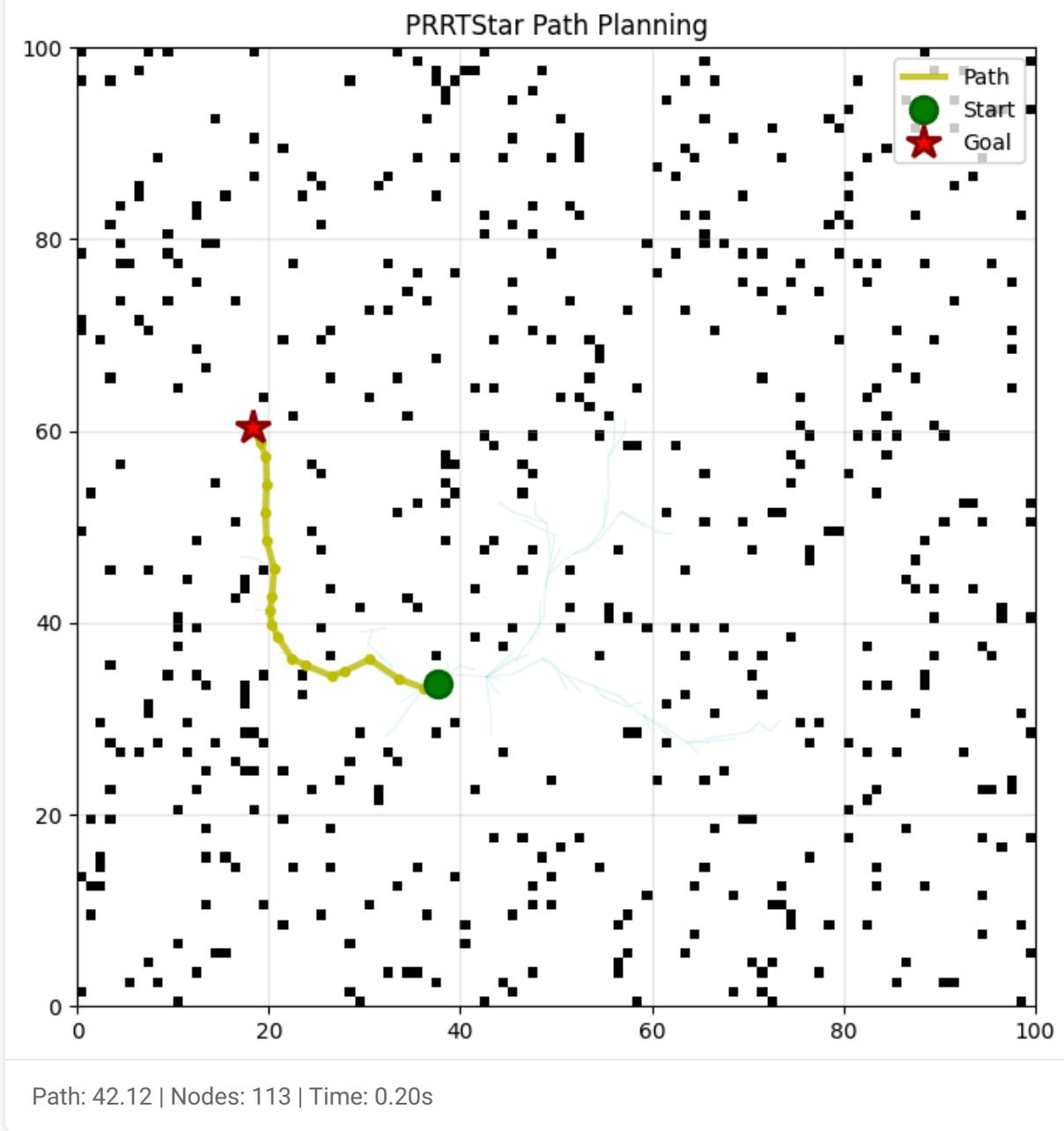
### RRTStar Path Planning



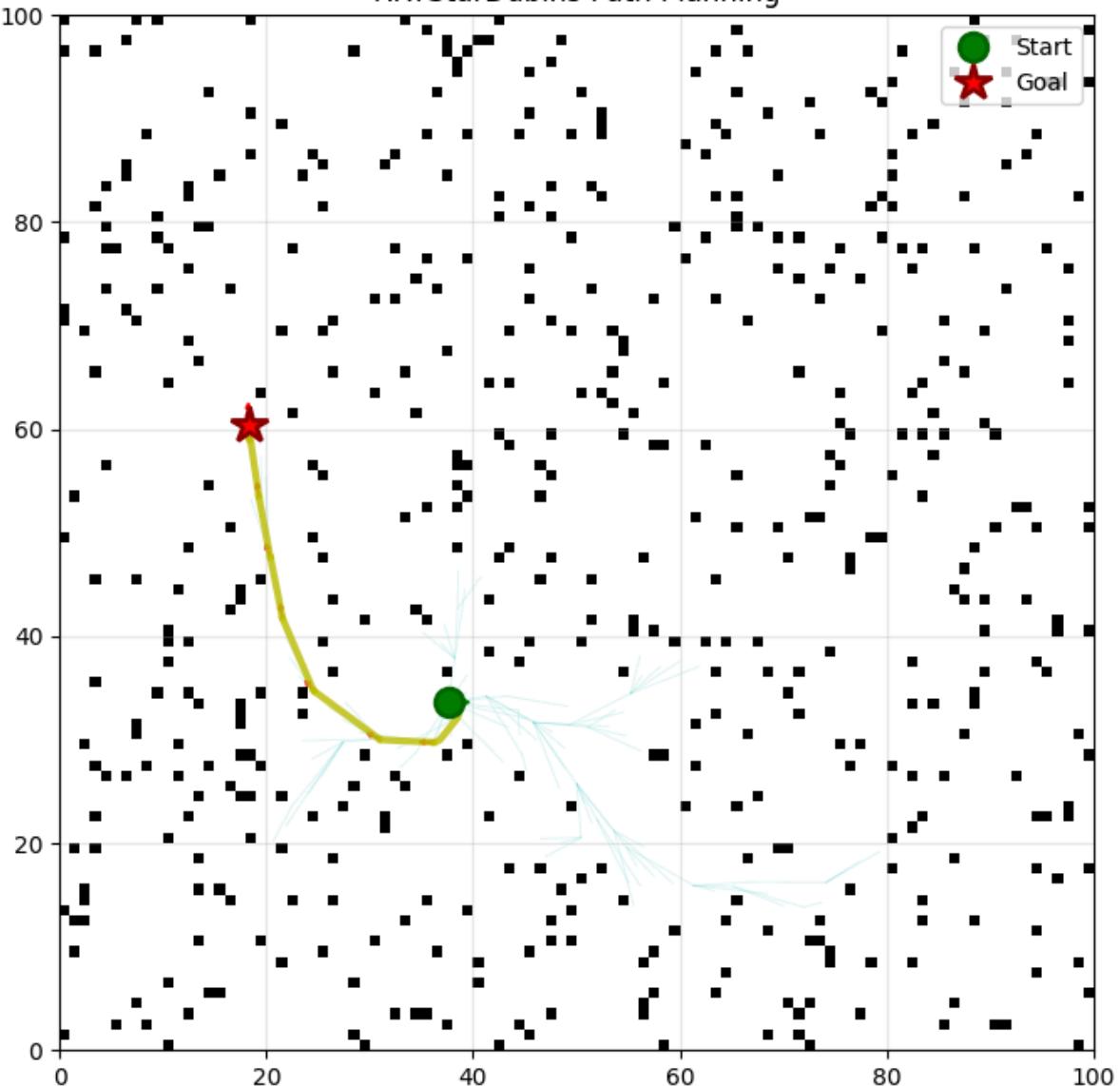
### BiRRTStar [Early Stop]



### PRRTStar [Early Stop]



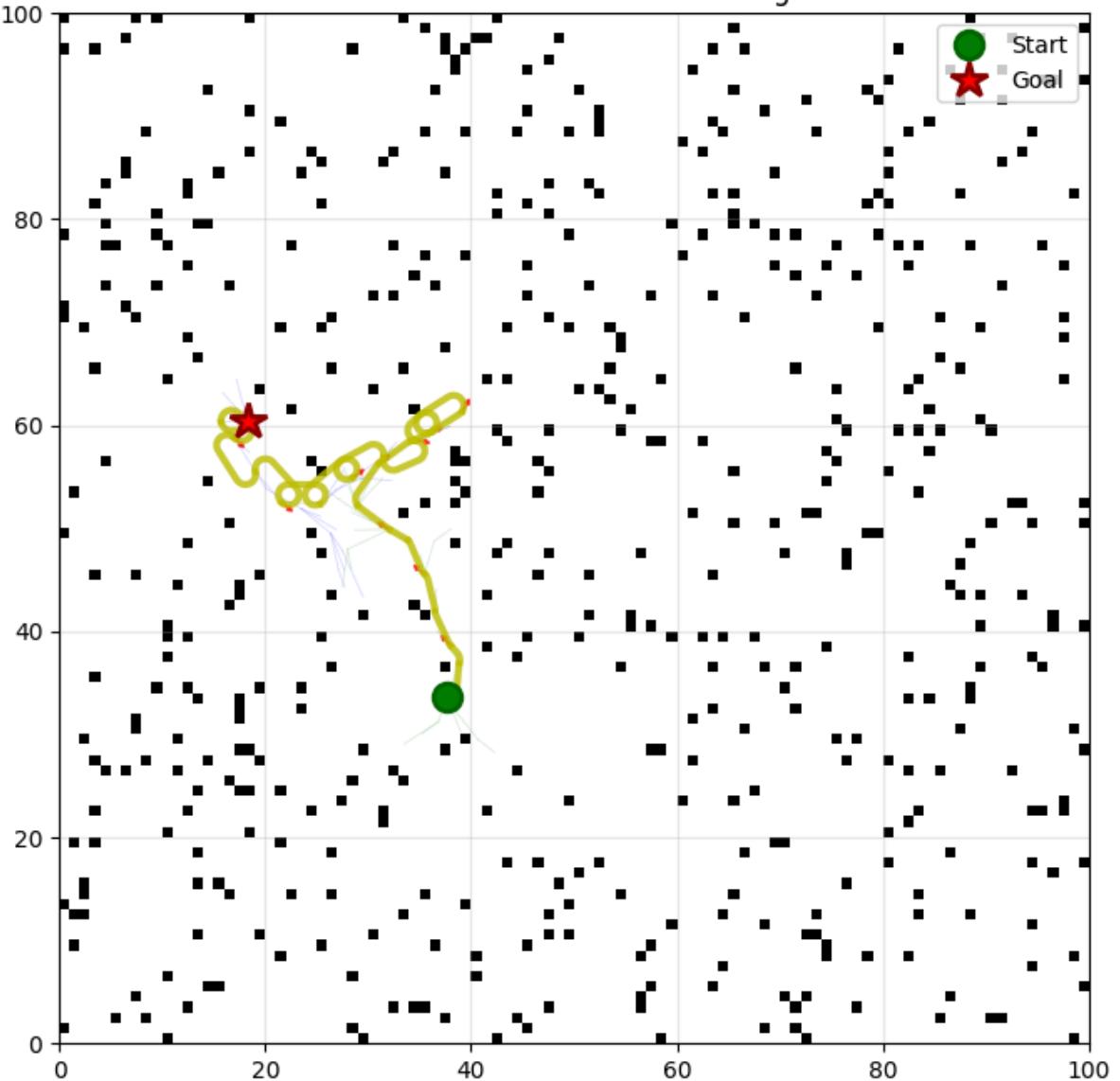
### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning**

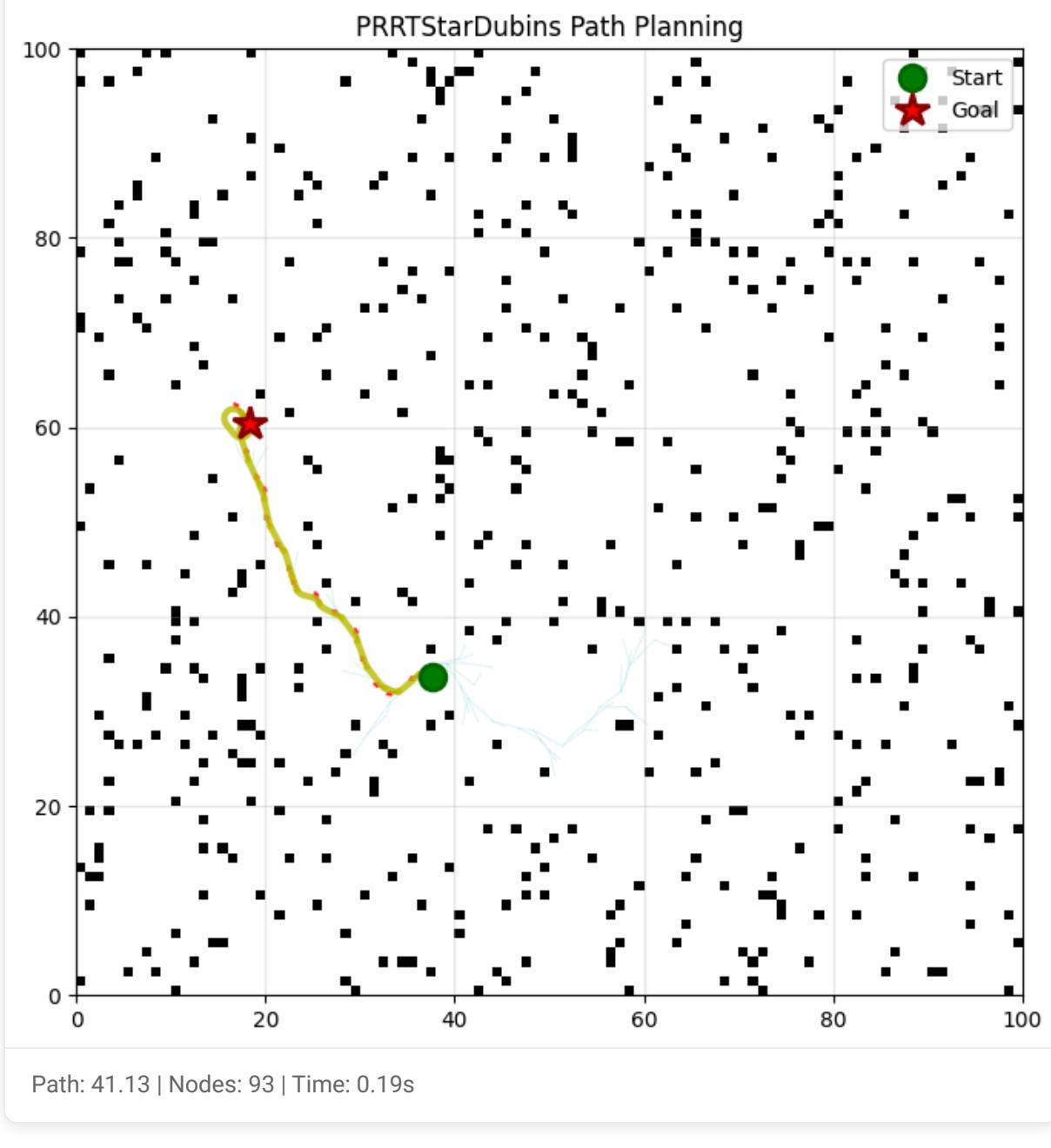
Path: 43.88 | Nodes: 106 | Time: 0.04s

**BiRRTStarDubins [Early Stop]**

## BiRRTStarDubins Path Planning



## PRRTStarDubins [Early Stop]



## Run 2

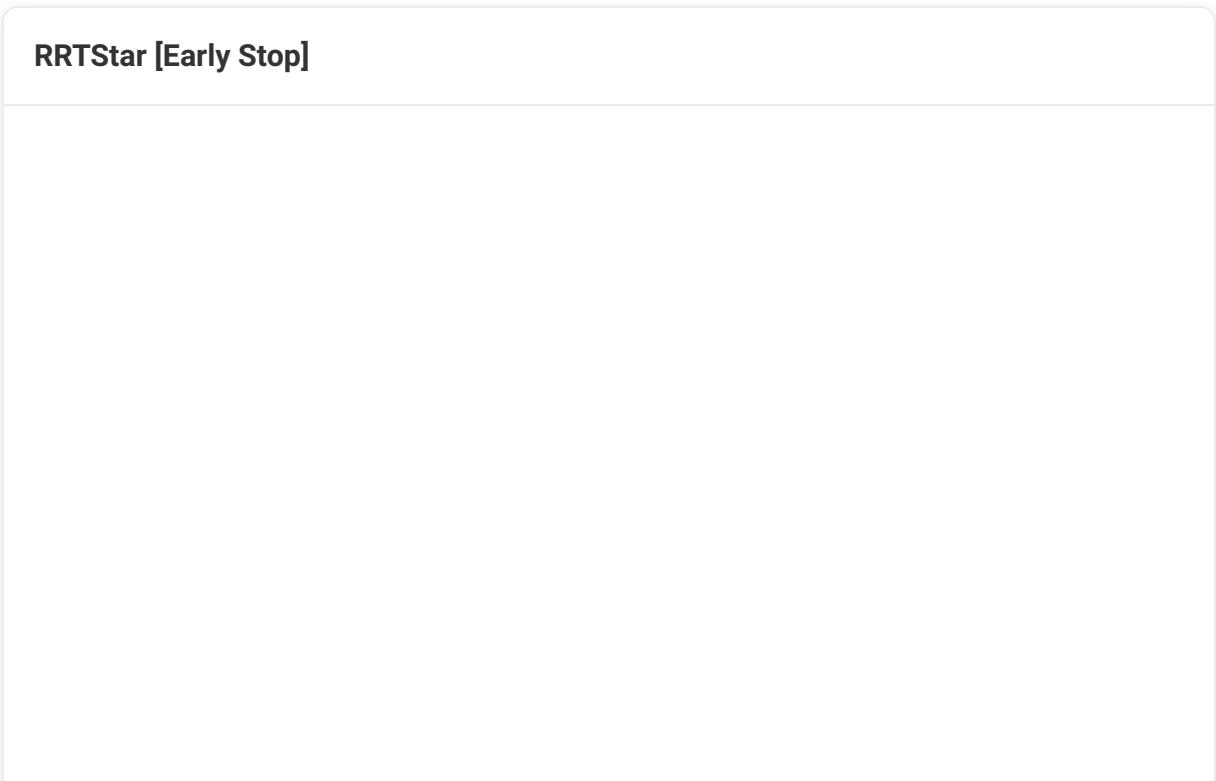
**Start:** (54.1295489005026, 3.72313986013933) | **Goal:** (24.302140423777278, 70.95564315842957) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 5, "seed": 52, "robot\_radius": 1.0})

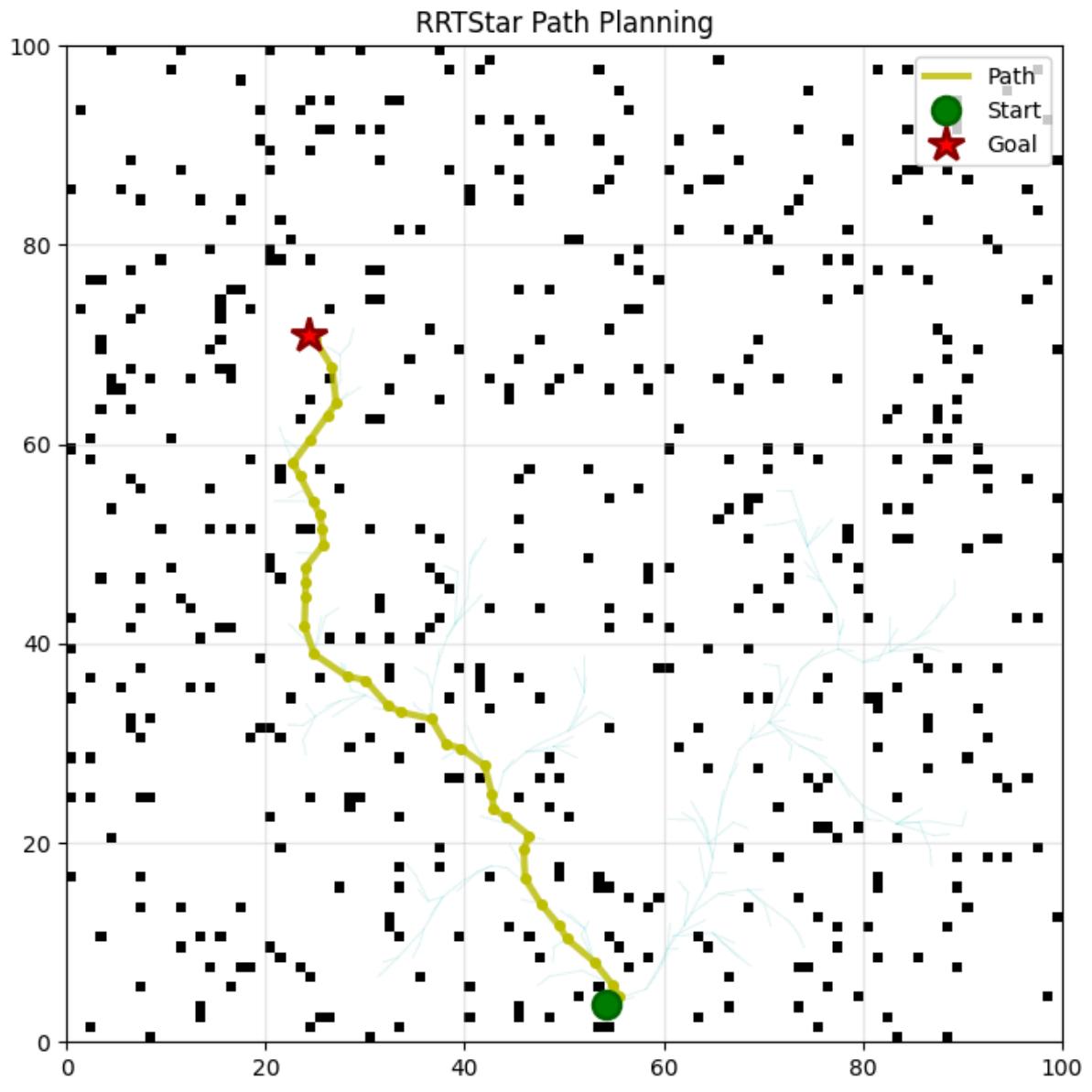
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.16	87.25	282	87.51
BiRRTStar ES	✓ Success	0.06	91.64	178	91.64
PRRTStar ES	✓ Success	0.13	80.06	104	80.06
RRTStarDubins ES	✓ Success	0.43	108.65	452	122.28
BiRRTStarDubins ES	✓ Success	0.03	81.12	90	82.53
PRRTStarDubins ES	✗ Failed	2.87	N/A	2	N/A

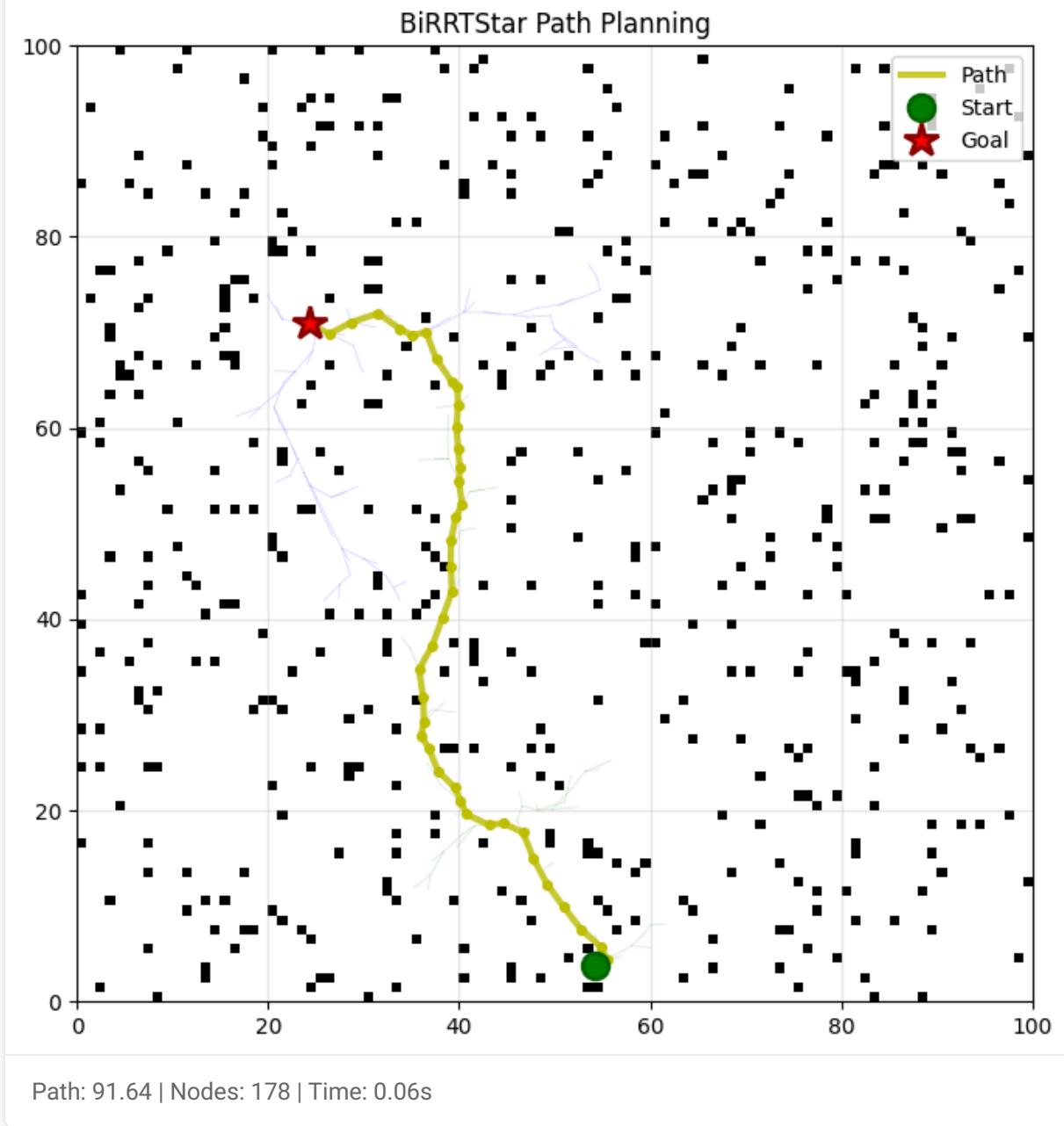
## Path Visualizations

RRTStar [Early Stop]

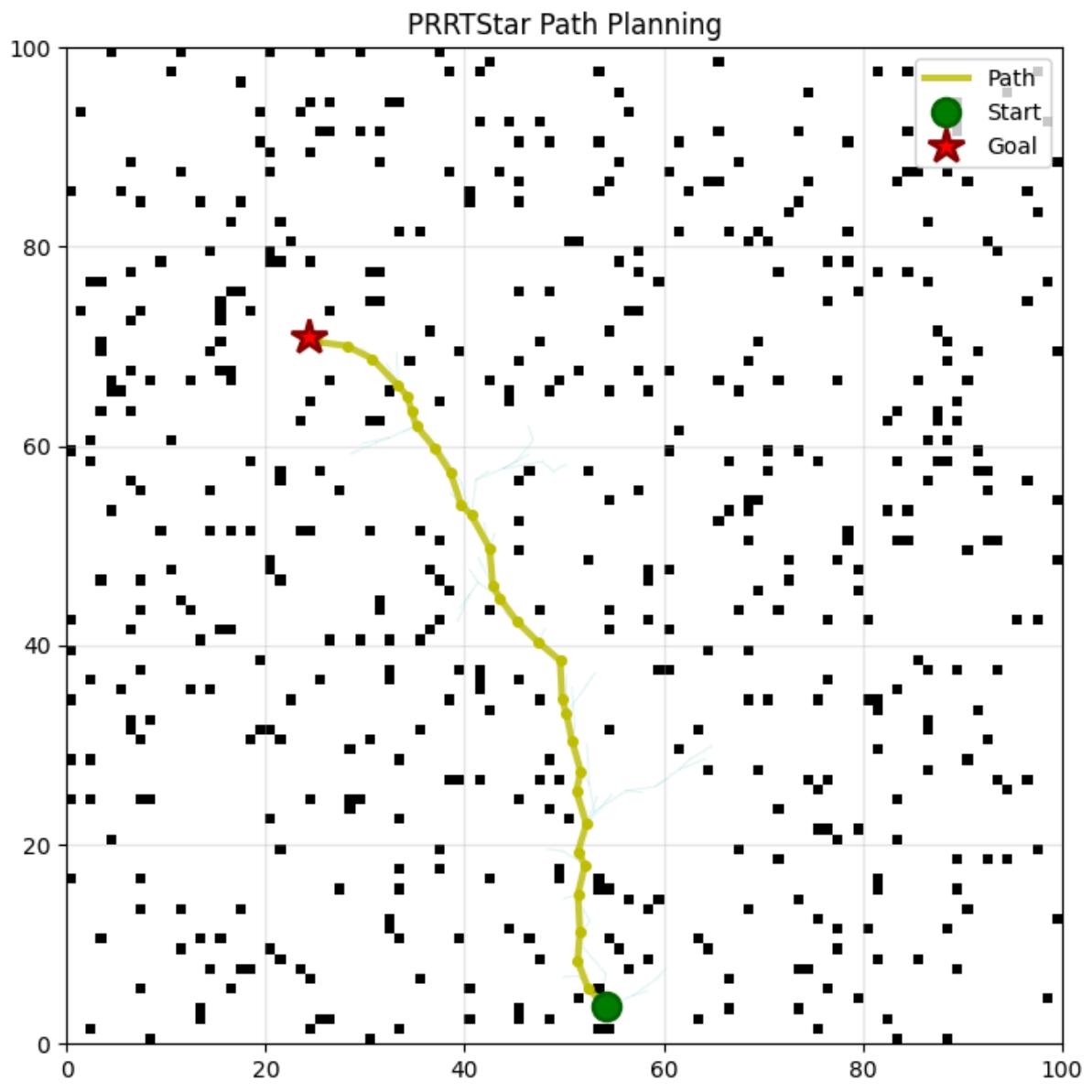




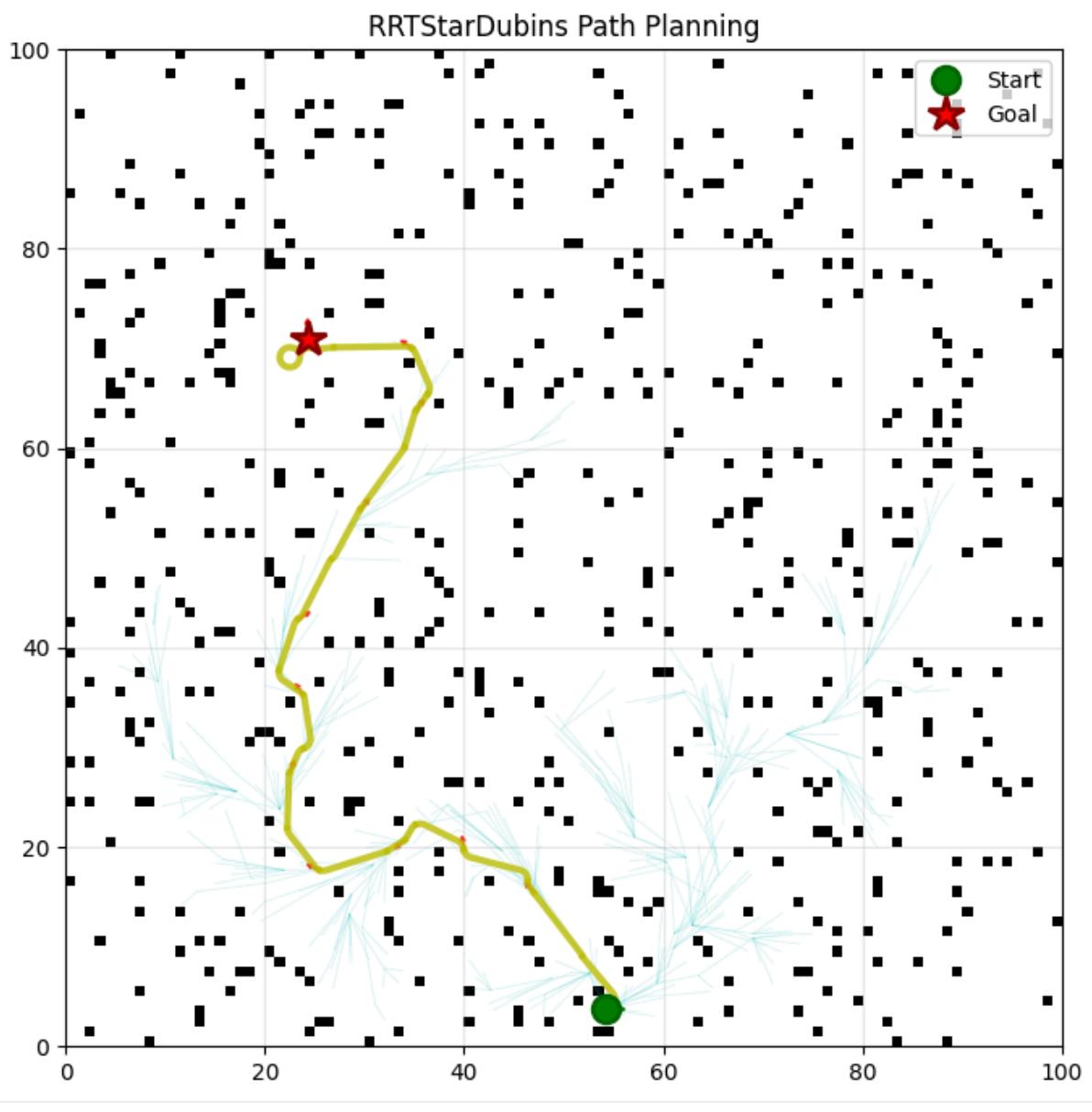
### BiRRTStar [Early Stop]



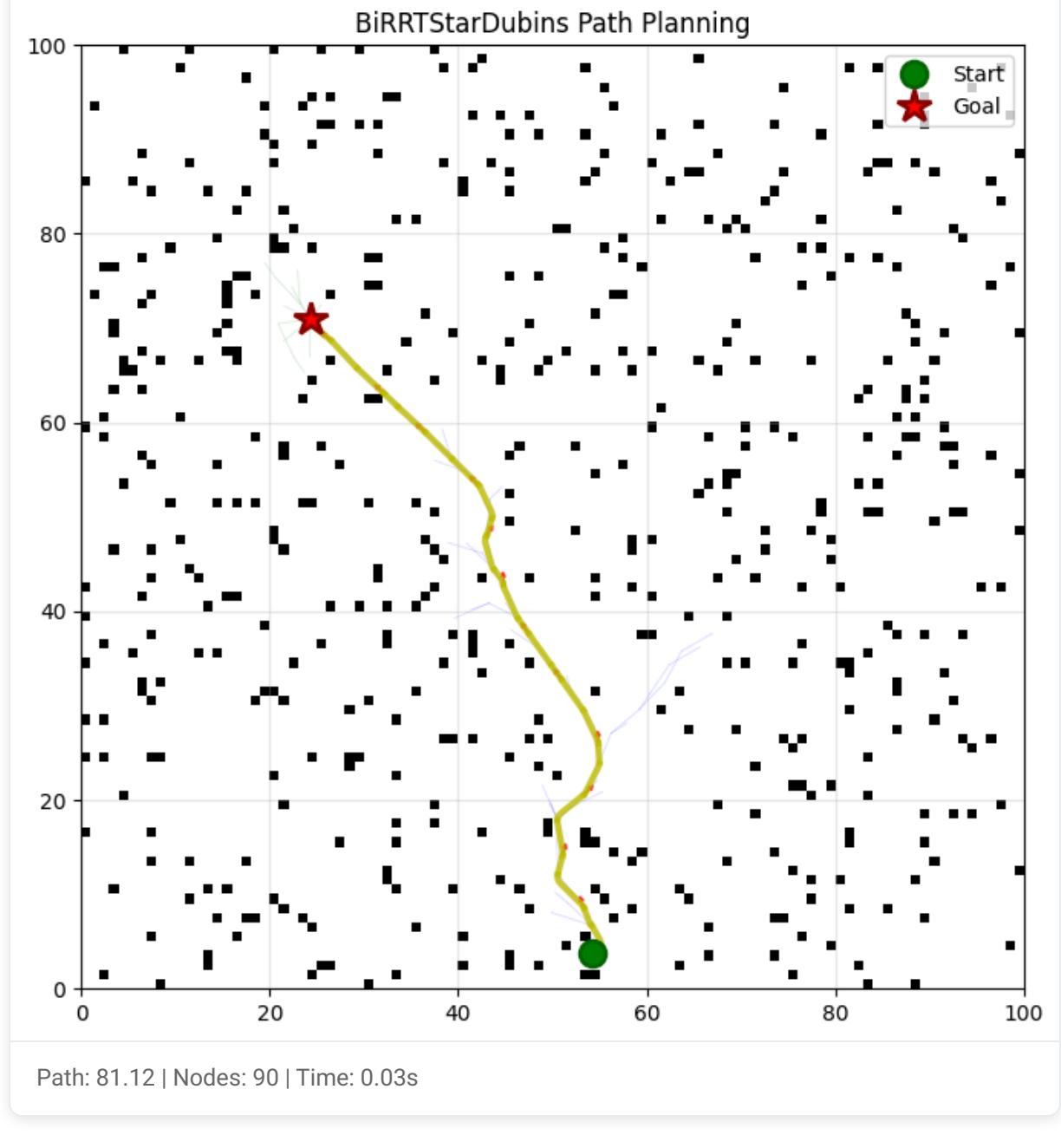
### PRRTStar [Early Stop]



### RRTStarDubins [Early Stop]



### BiRRTStarDubins [Early Stop]



## Run 3

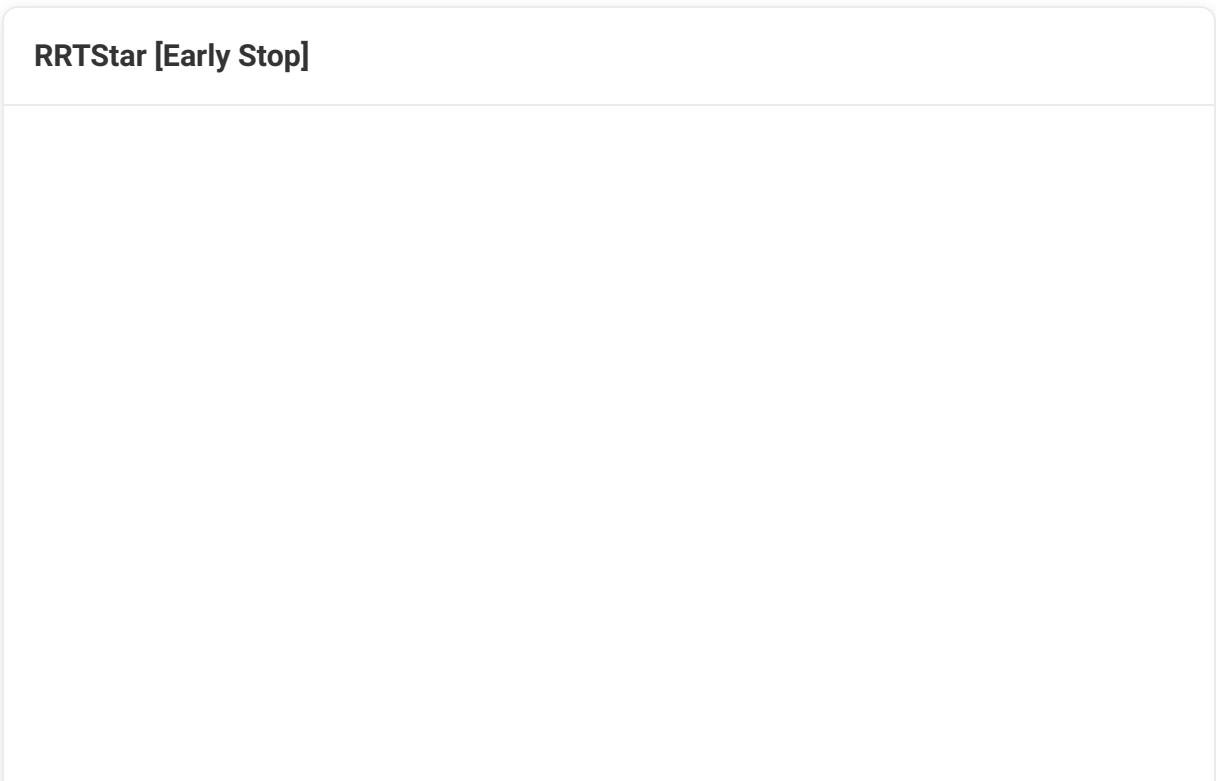
**Start:** (79.72514560777084, 1.2263789670627816) | **Goal:** (41.278212942339536, 33.56602555143304) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 5, "seed": 52, "robot\_radius": 1.0})

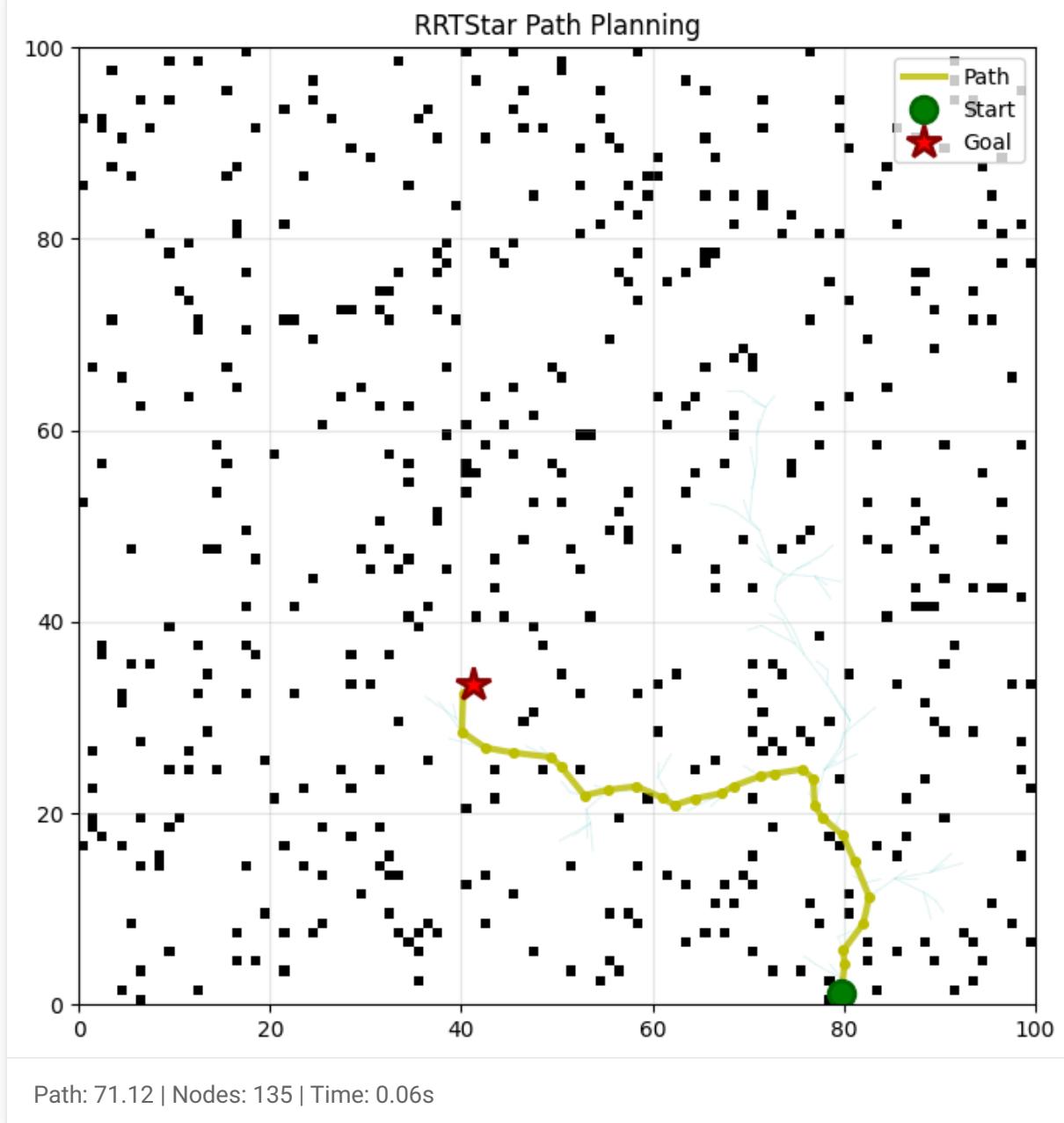
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.06	71.12	135	71.12
BiRRTStar ES	✓ Success	0.02	56.12	63	56.12
PRRTStar ES	✓ Success	0.08	54.90	60	54.90
RRTStarDubins ES	✓ Success	0.45	61.59	290	62.87
BiRRTStarDubins ES	✓ Success	0.20	63.94	215	68.09
PRRTStarDubins ES	✗ Failed	3.07	N/A	2	N/A

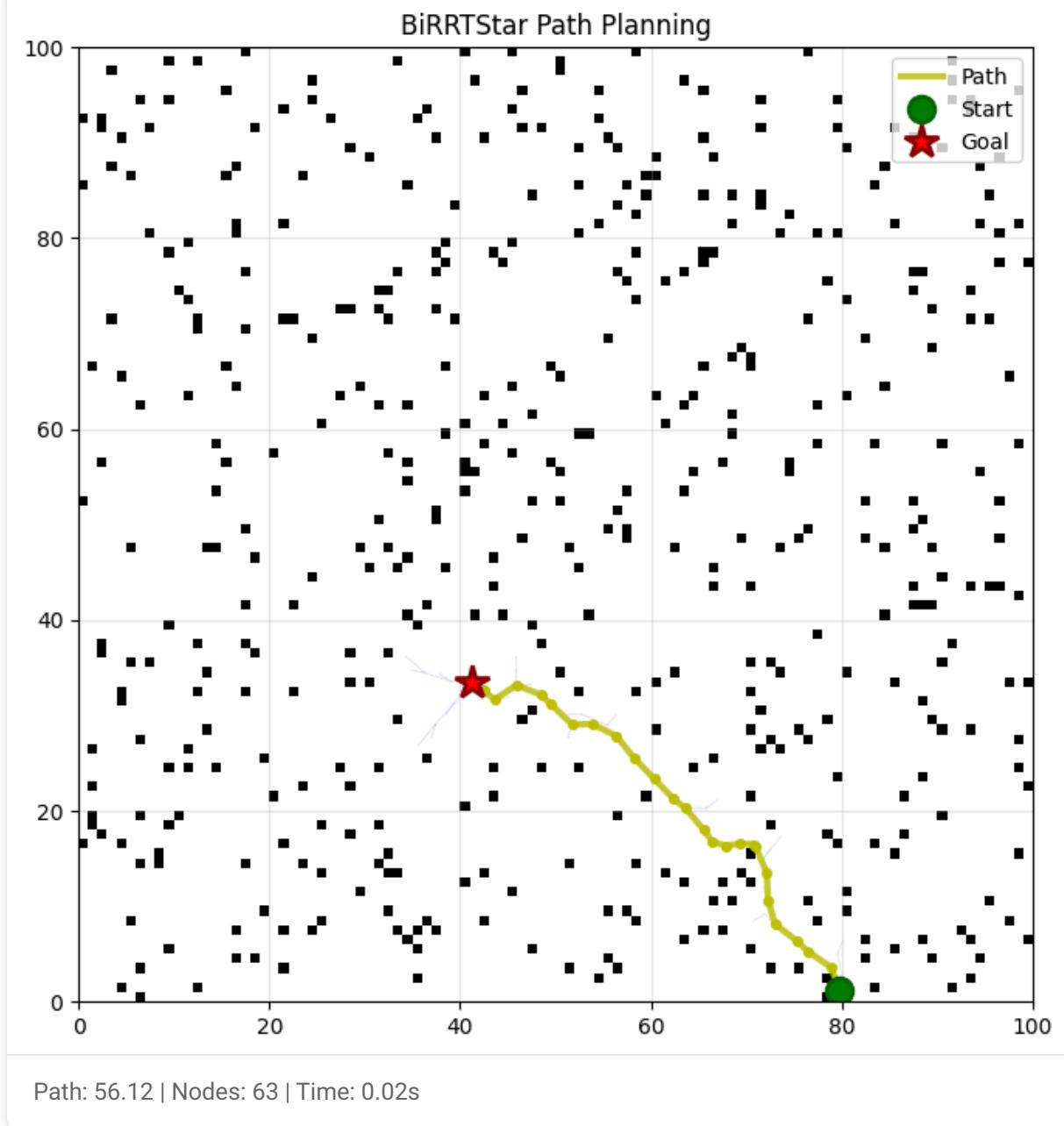
## Path Visualizations

RRTStar [Early Stop]

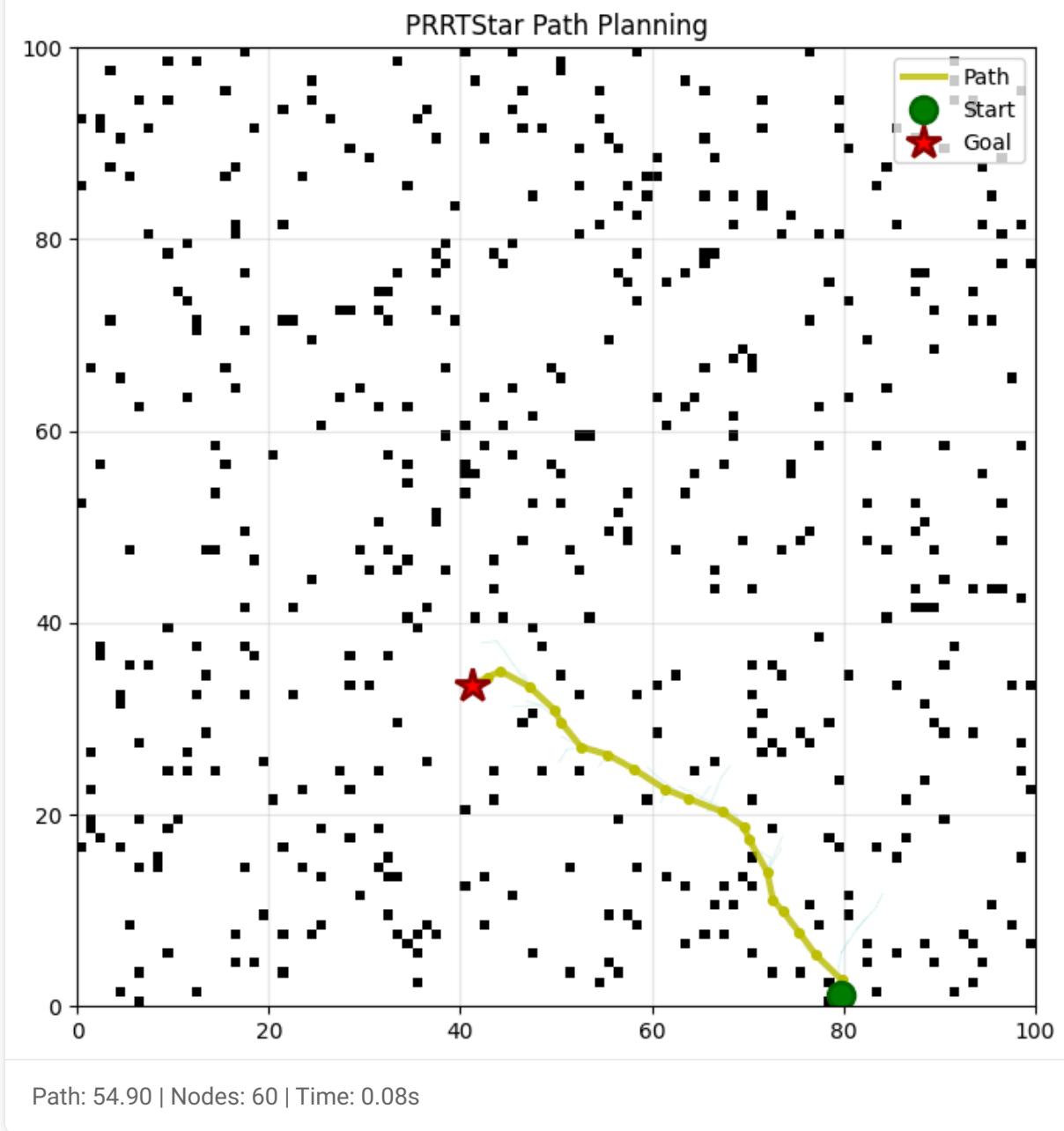




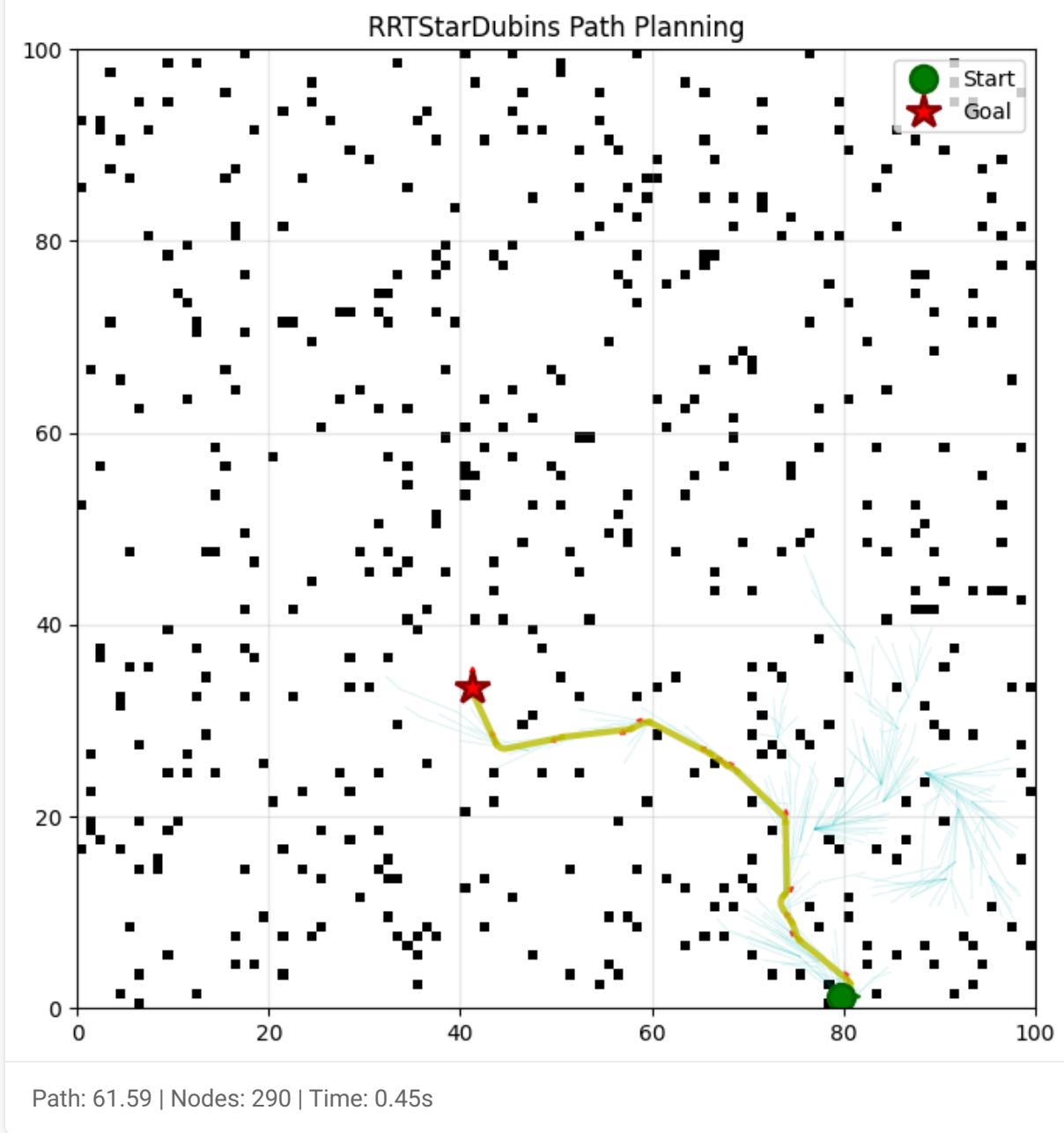
### BiRRTStar [Early Stop]



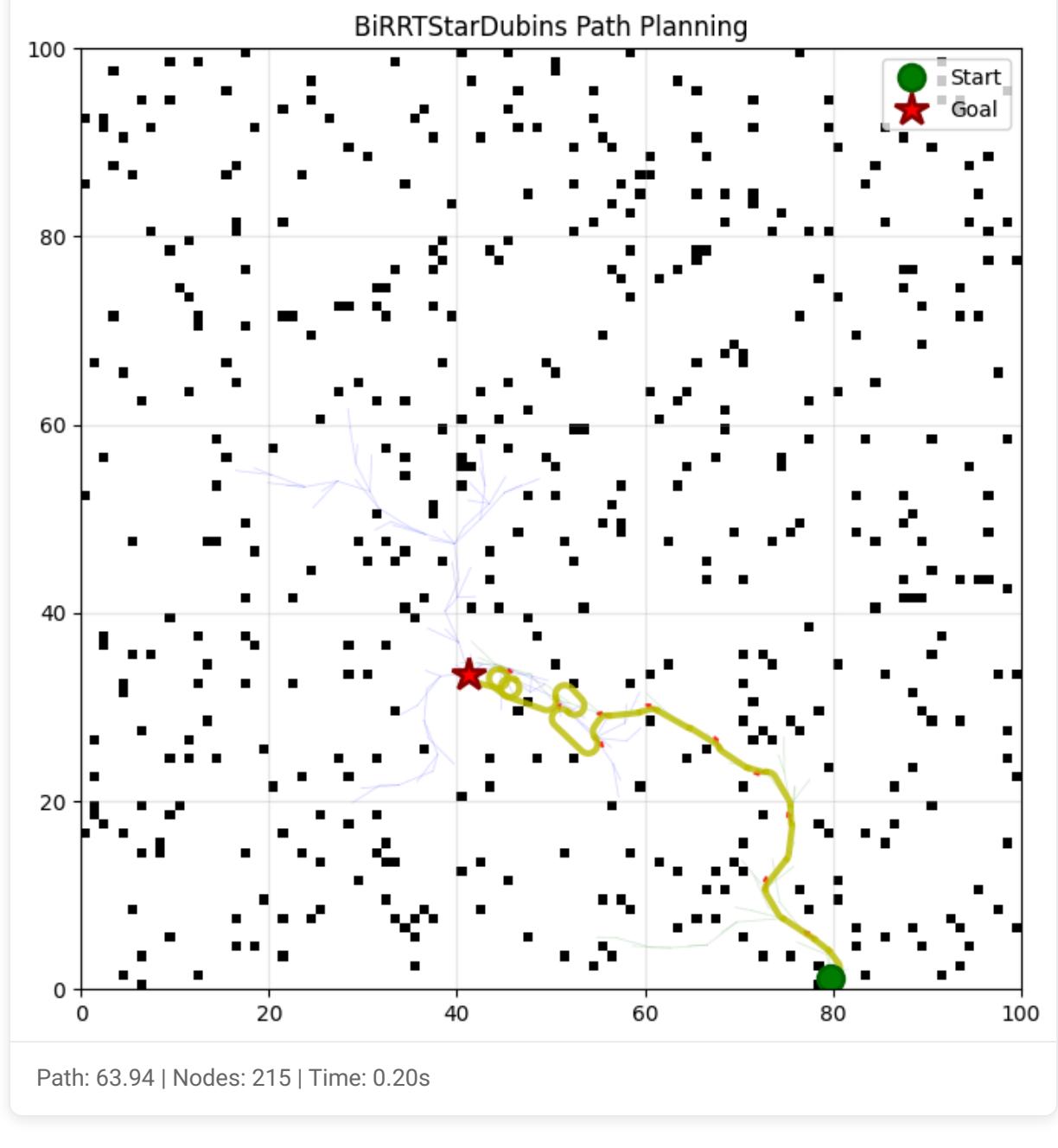
### PRRTStar [Early Stop]



### RRTStarDubins [Early Stop]



### BiRRTStarDubins [Early Stop]



## Run 4

**Start:** (60.310426979896555, 47.903899451210776) | **Goal:** (37.018730494623235, 63.83323379135554) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 5, "seed": 52, "robot\_radius": 1.0})

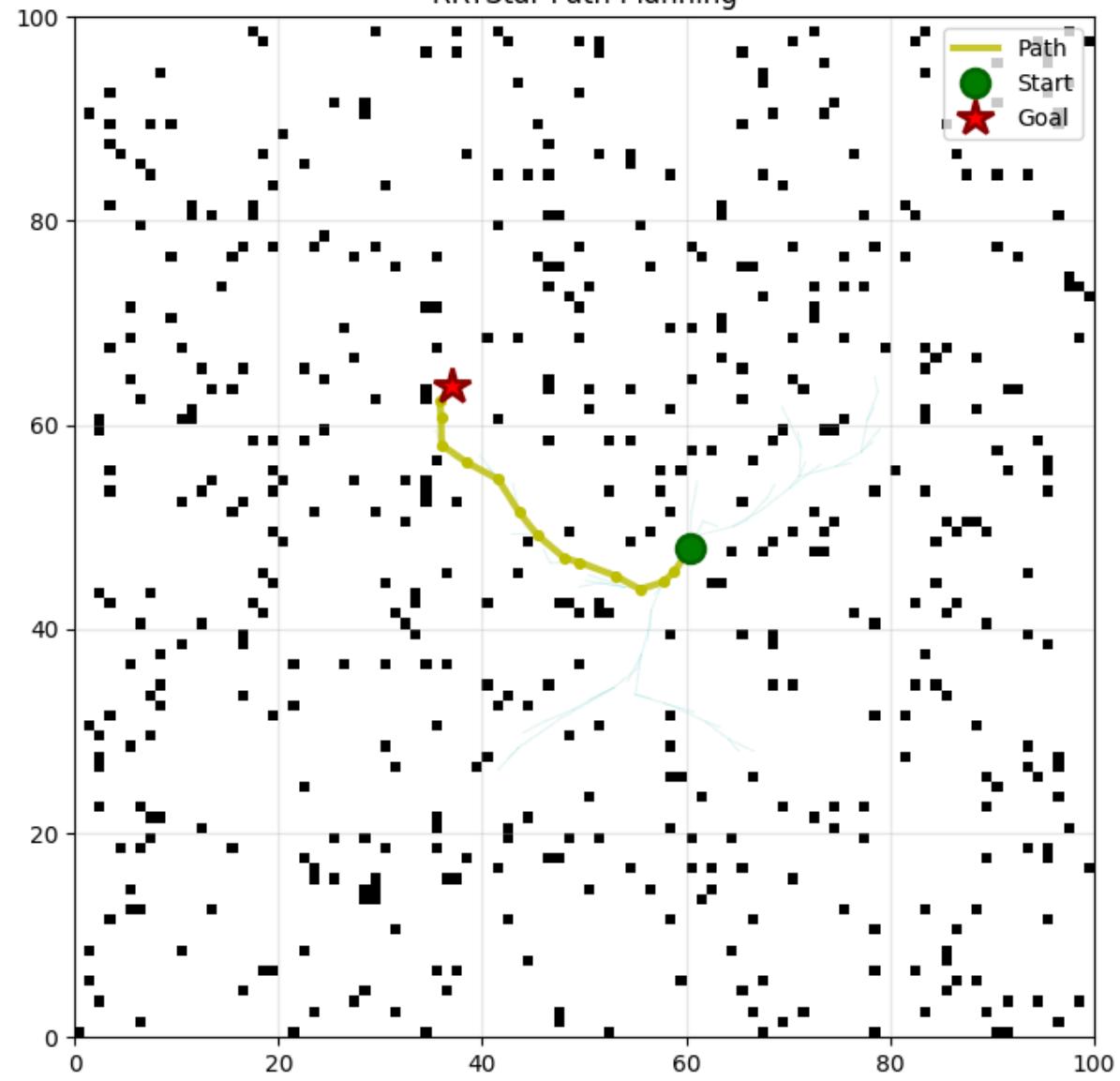
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.03	37.51	88	37.51
BiRRTStar ES	✓ Success	0.01	39.54	43	39.54
PRRTStar ES	✓ Success	0.29	42.40	180	42.40
RRTStarDubins ES	✓ Success	0.26	34.15	279	36.89
BiRRTStarDubins ES	✓ Success	0.05	61.07	140	63.63
PRRTStarDubins ES	✓ Success	0.51	33.35	268	39.95

## Path Visualizations

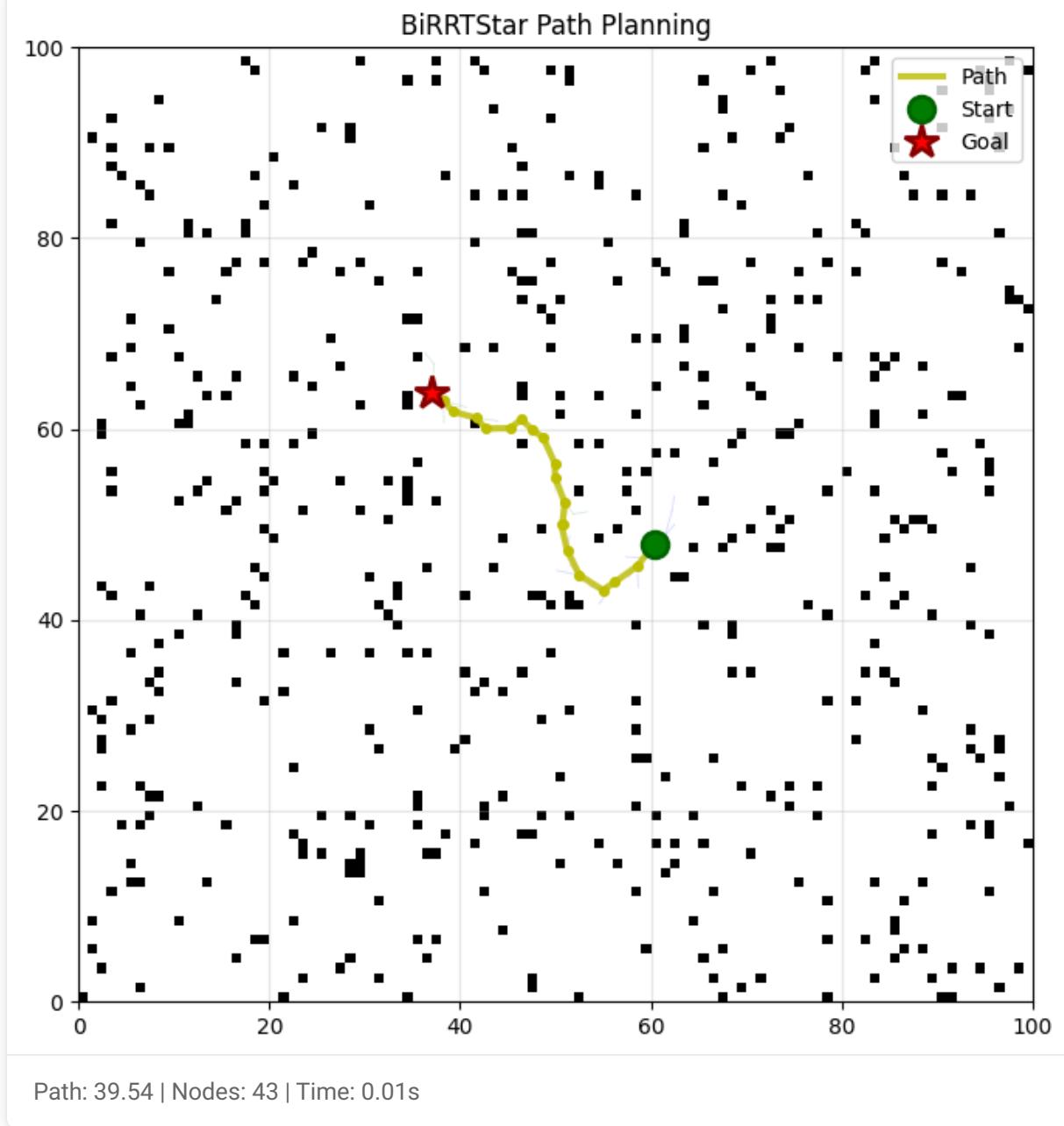
RRTStar [Early Stop]

### RRTStar Path Planning

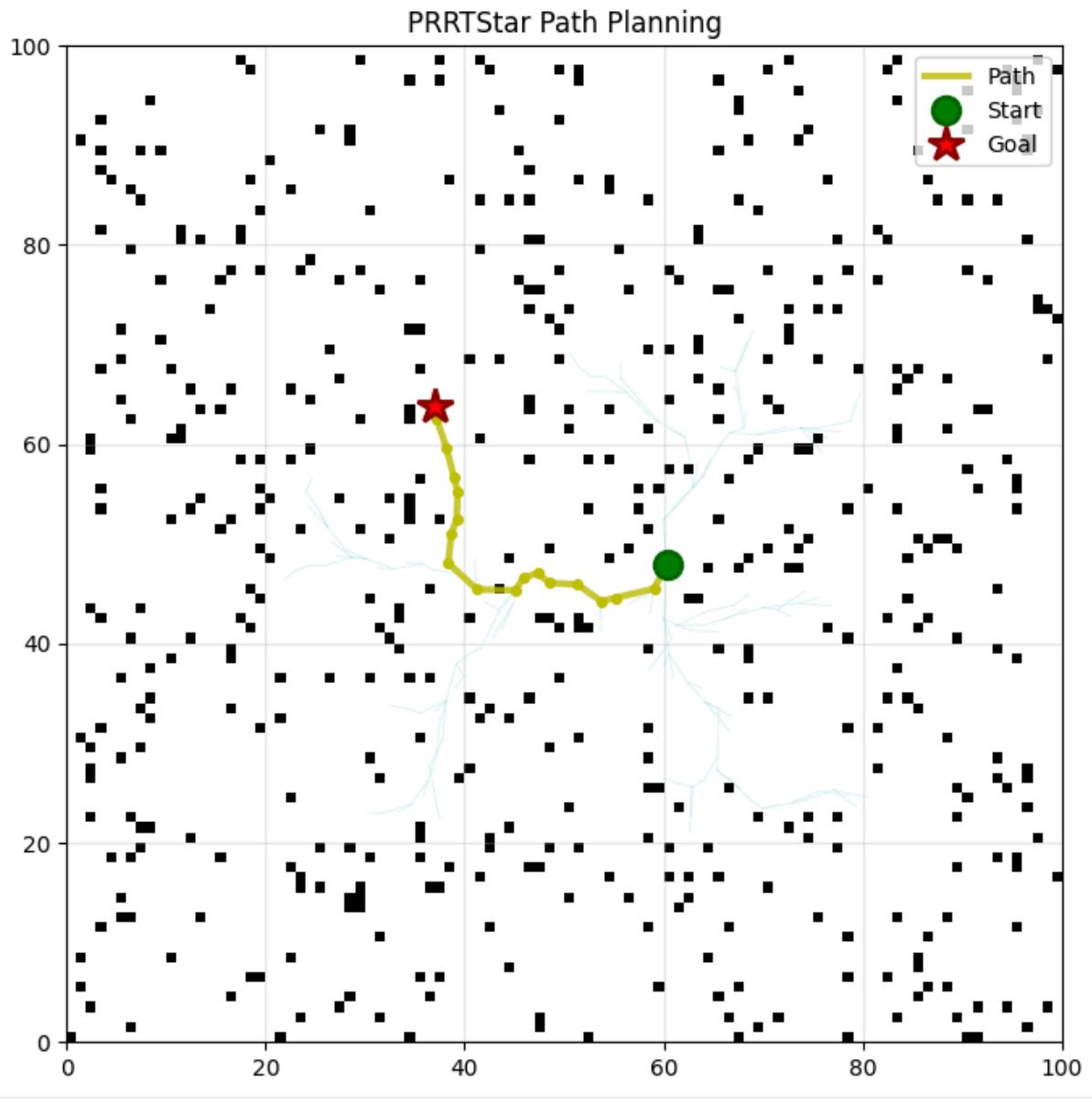


Path: 37.51 | Nodes: 88 | Time: 0.03s

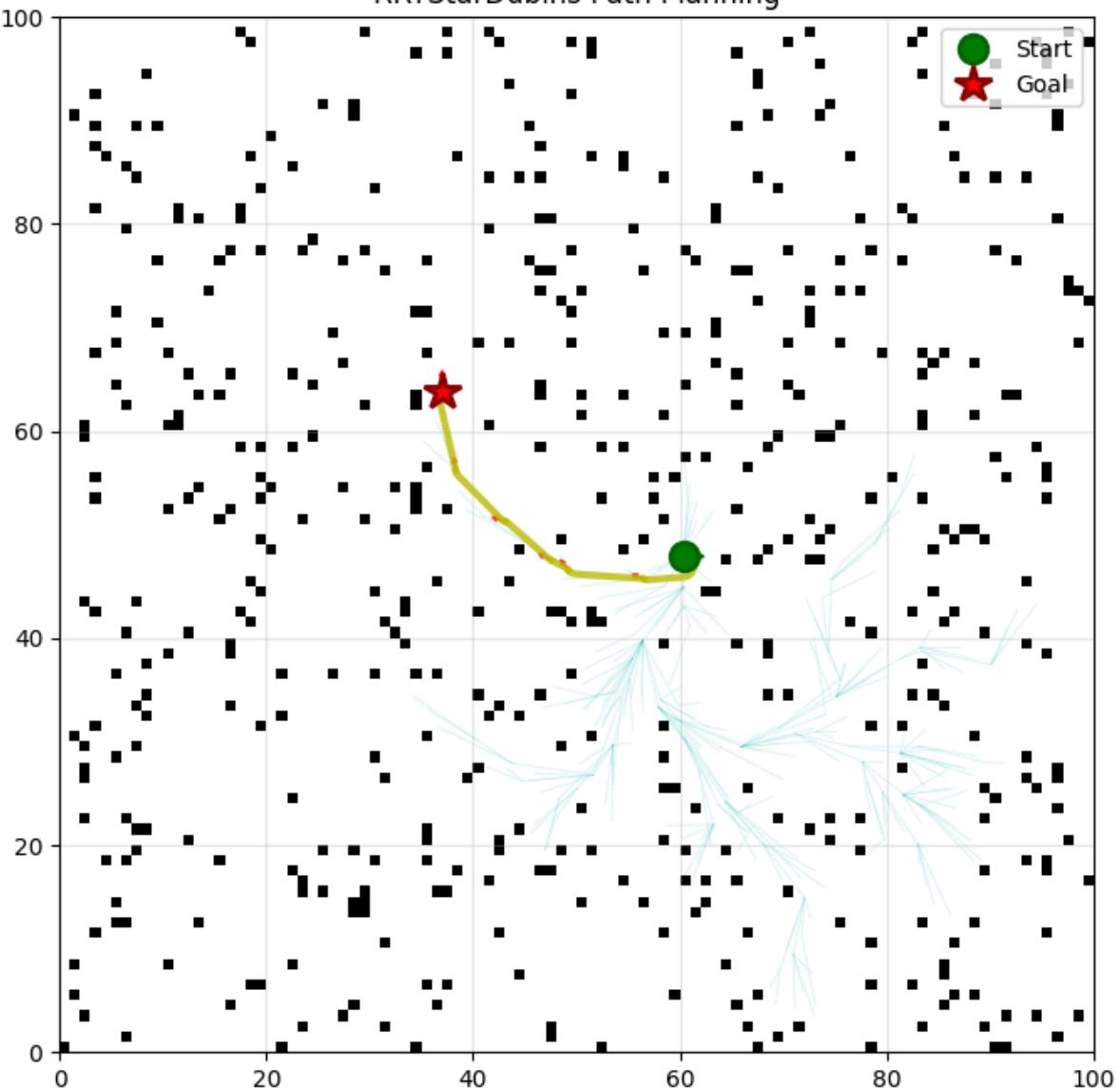
### BiRRTStar [Early Stop]



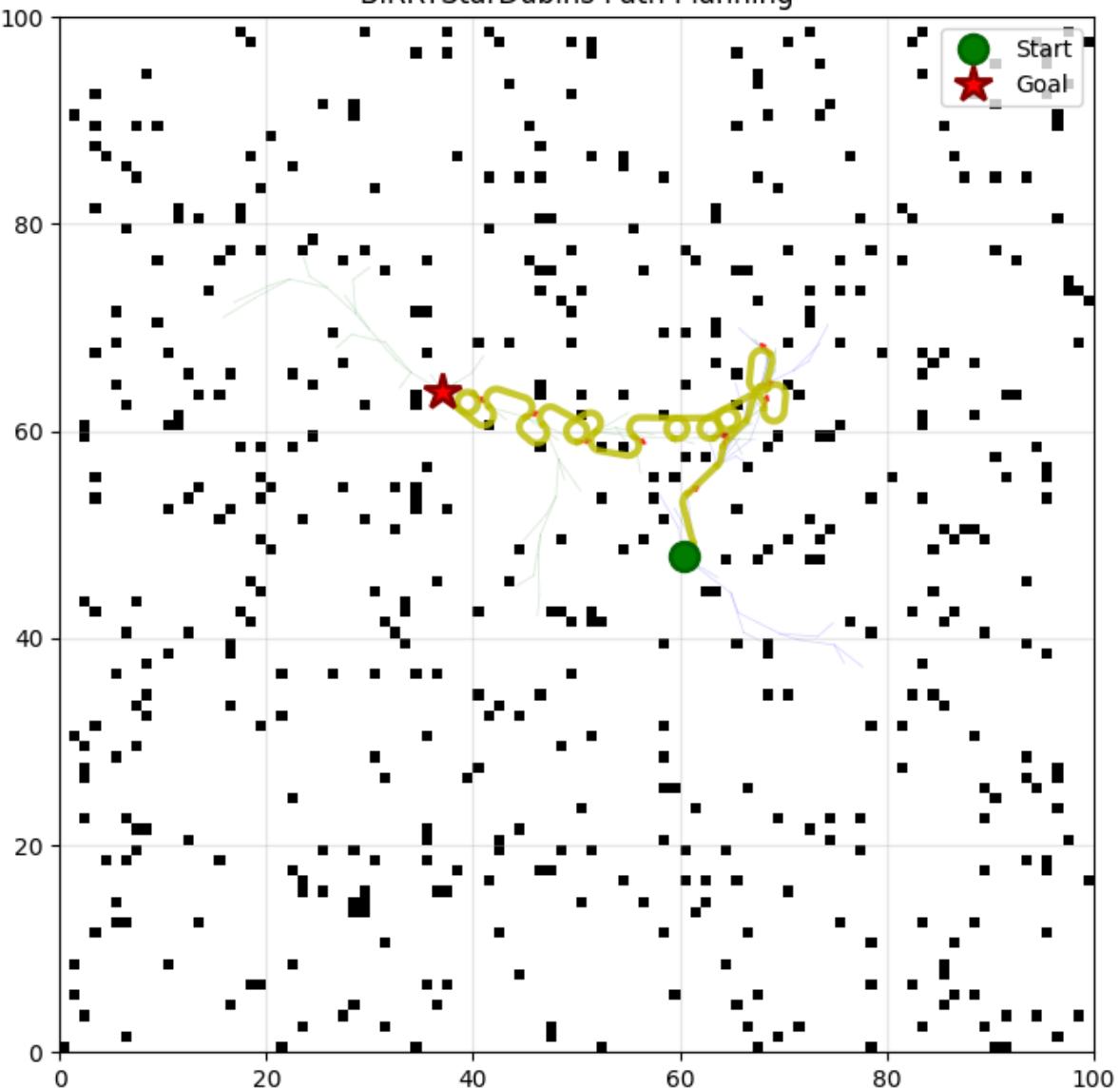
### PRRTStar [Early Stop]



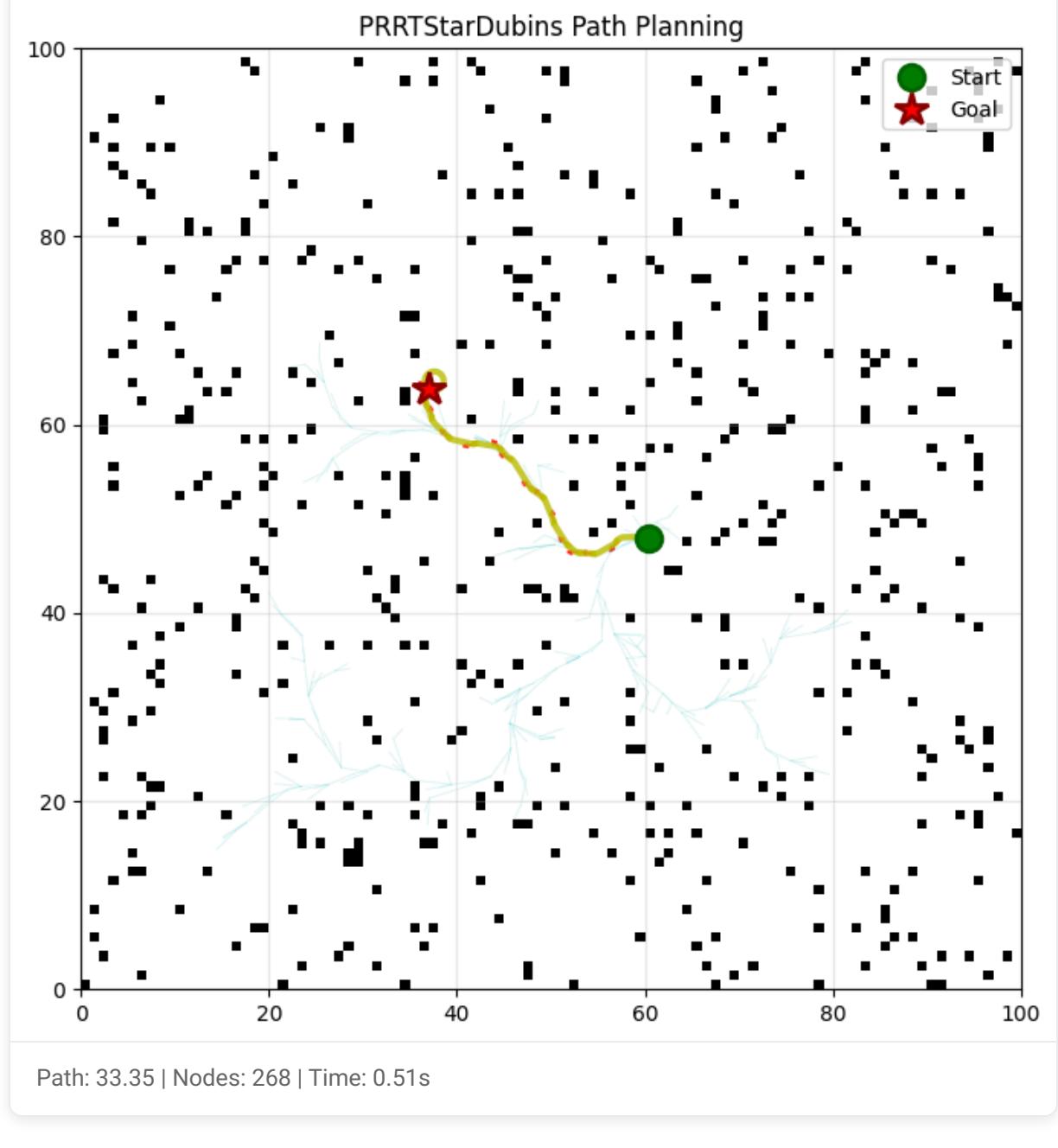
### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

### BiRRTStarDubins Path Planning



### PRRTStarDubins [Early Stop]



## Run 5

**Start:** (27.026425524481116, 4.604774942208475) | **Goal:** (67.68644359186024, 38.734596889155014) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 5, "seed": 52, "robot\_radius": 1.0})

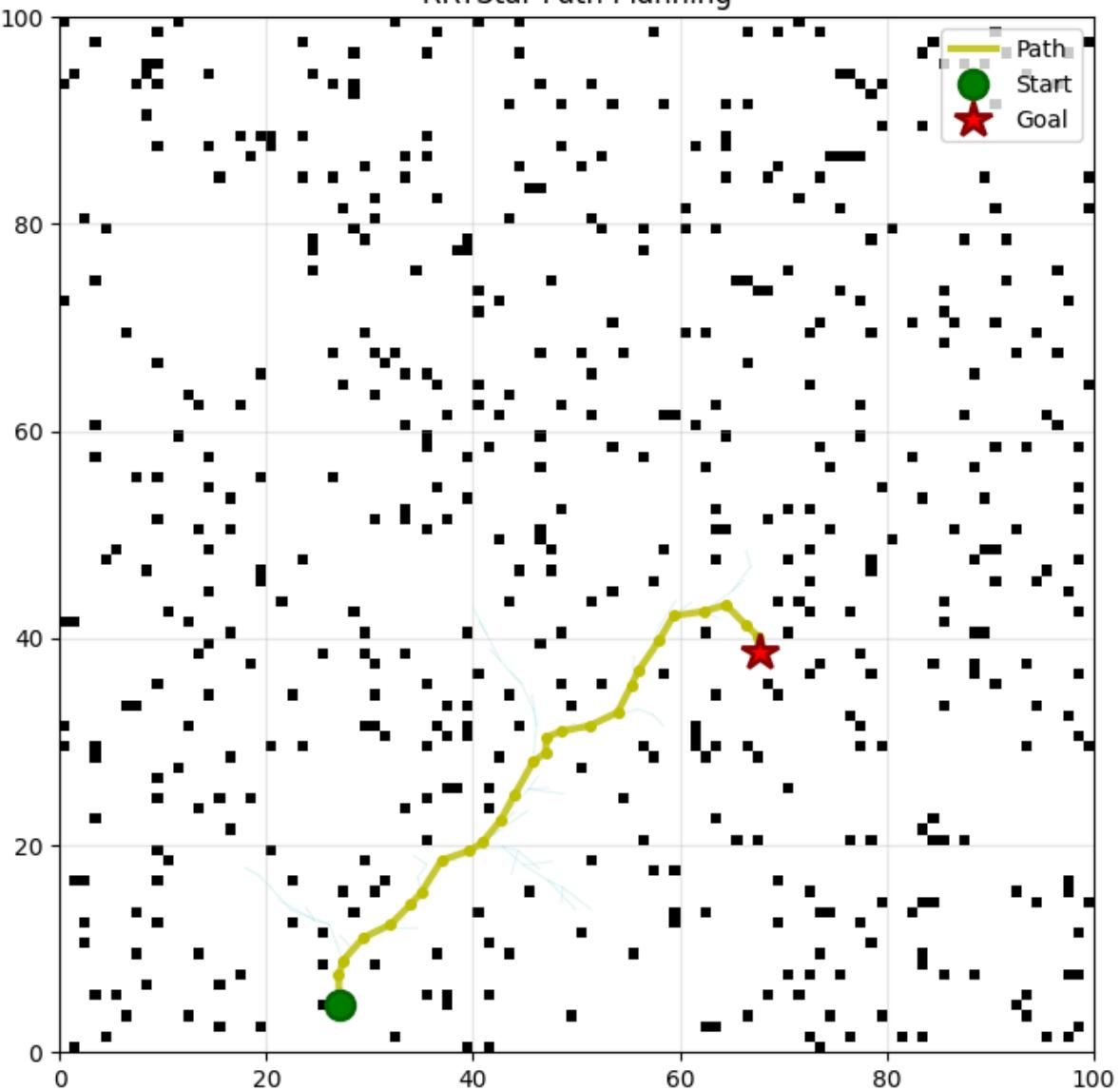
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.03	63.85	91	63.85
BiRRTStar ES	✓ Success	0.01	56.71	46	56.71
PRRTStar ES	✓ Success	0.16	66.97	114	66.97
RRTStarDubins ES	✓ Success	1.19	54.80	889	61.46
BiRRTStarDubins ES	✓ Success	0.02	60.64	136	64.42
PRRTStarDubins ES	✓ Success	4.96	58.20	1344	65.68

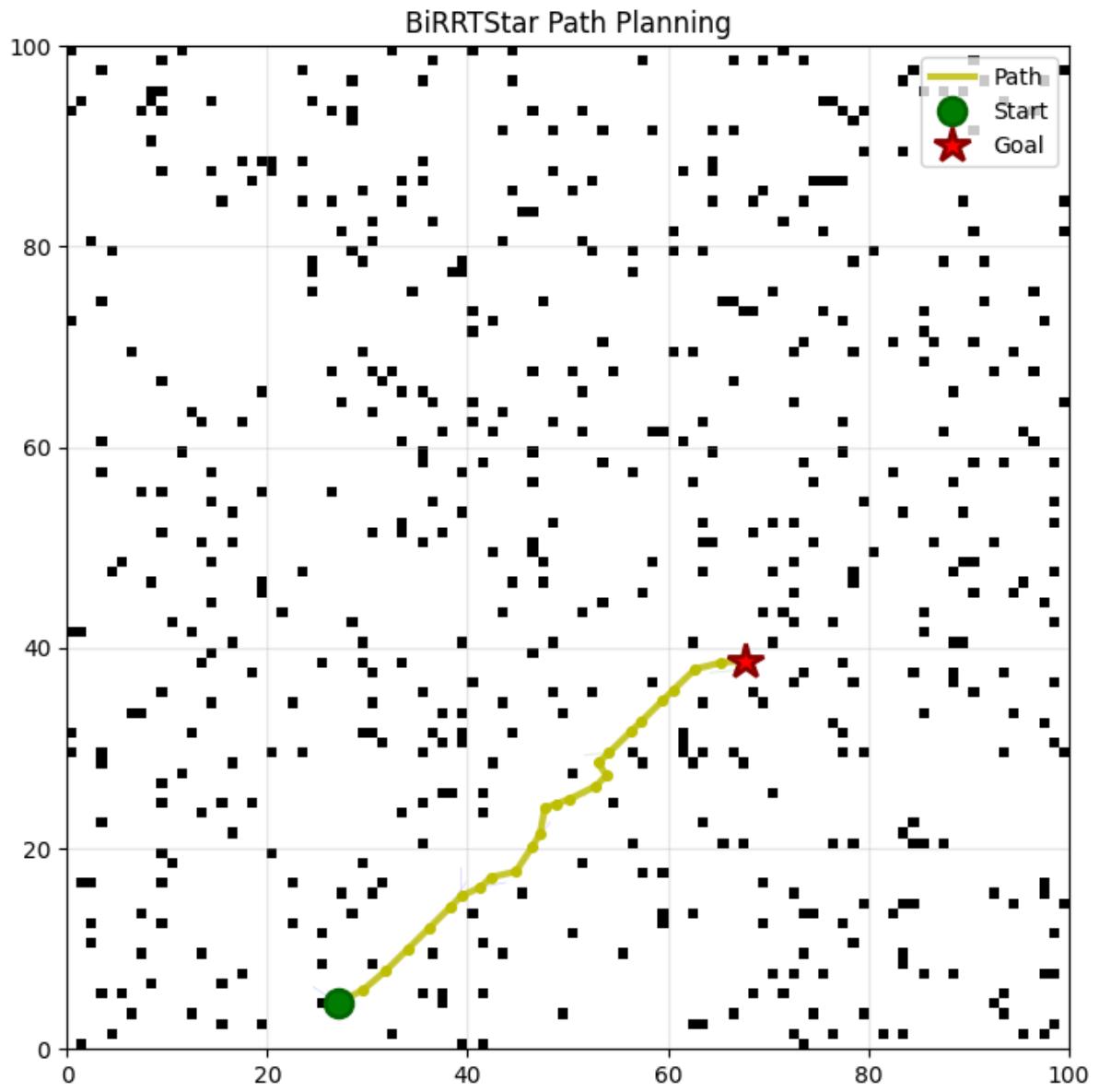
## Path Visualizations

RRTStar [Early Stop]

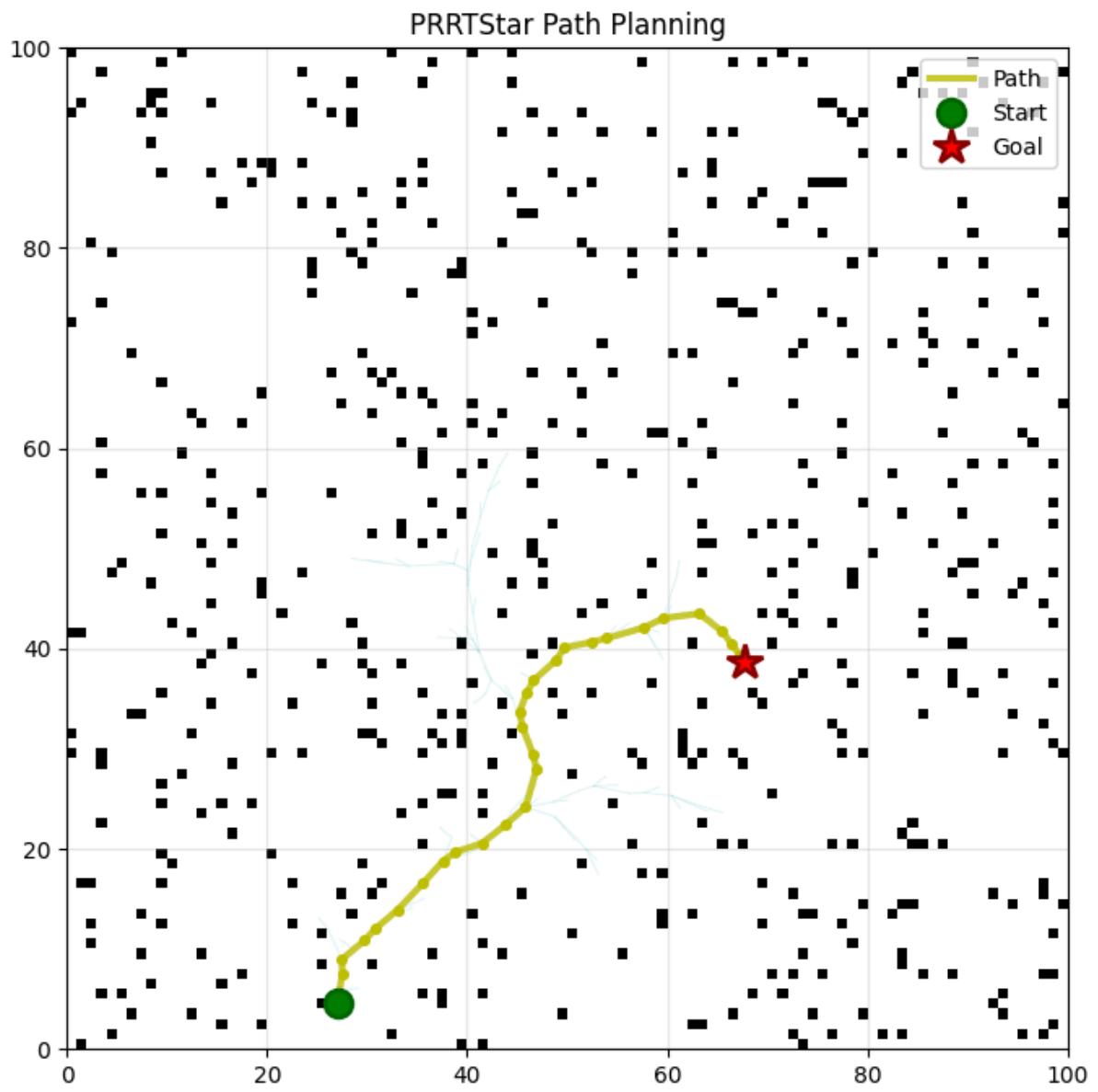
### RRTStar Path Planning



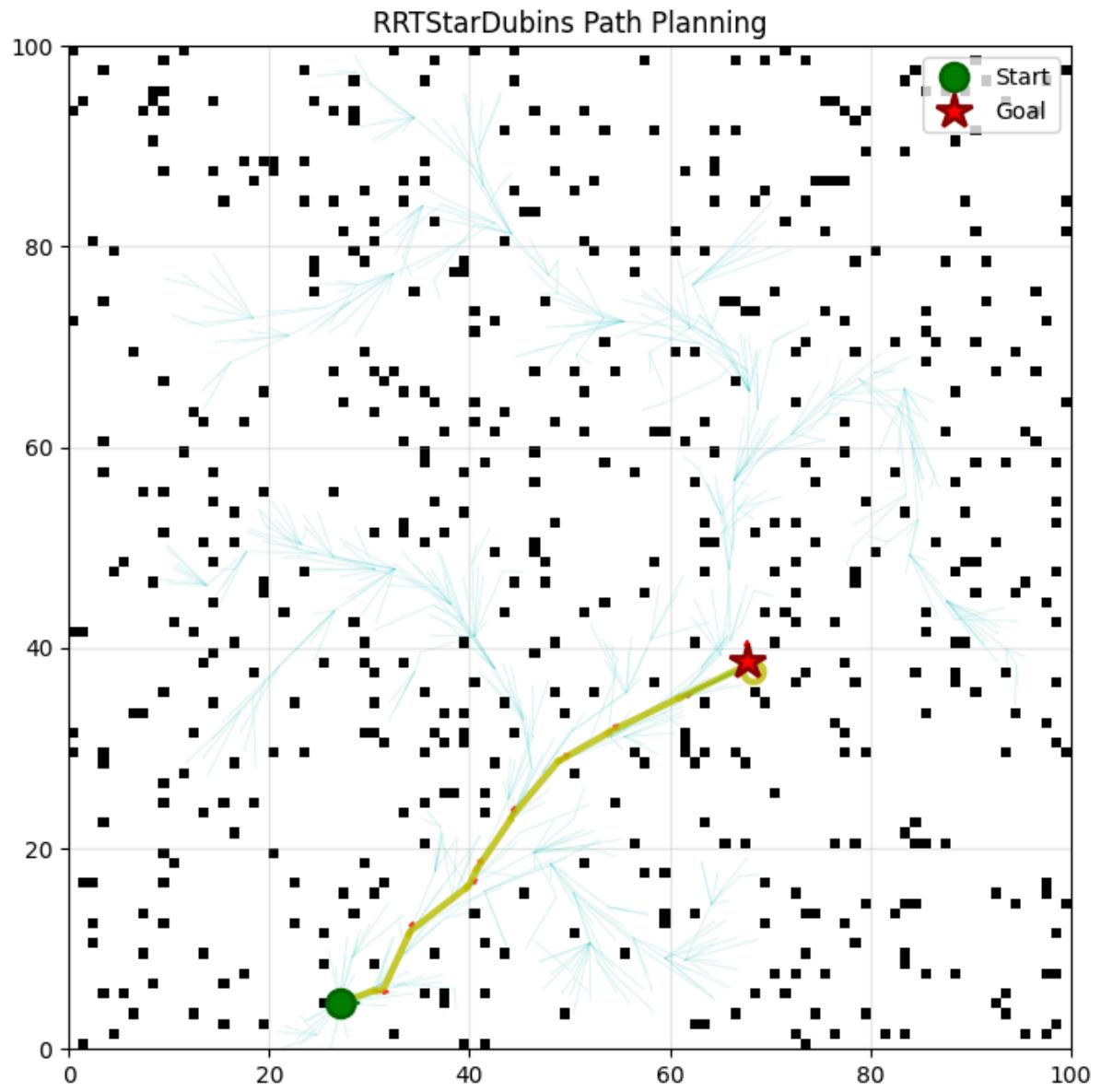
### BiRRTStar [Early Stop]



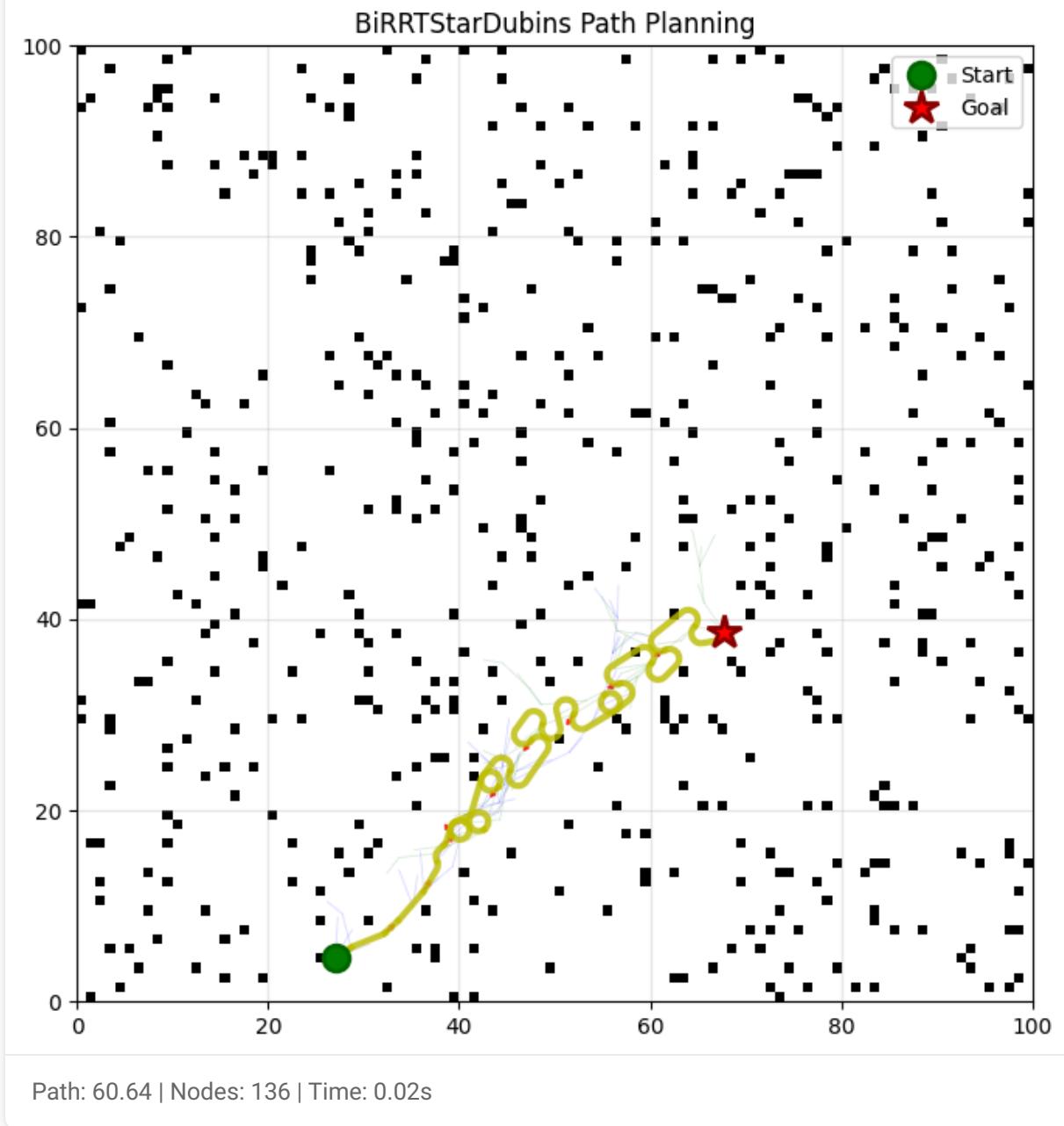
### PRRTStar [Early Stop]



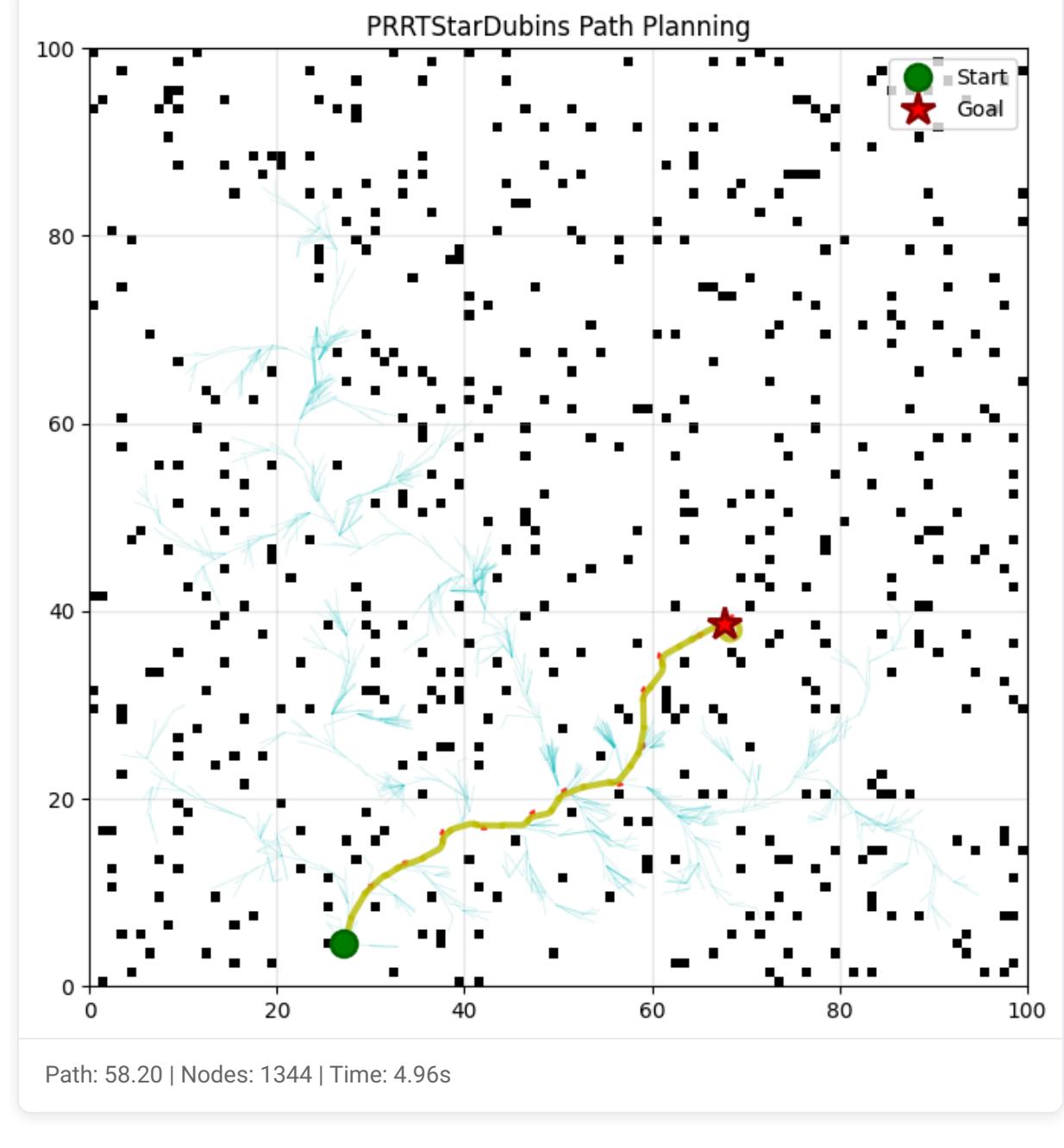
### RRTStarDubins [Early Stop]



### BiRRTStarDubins [Early Stop]



### PRRTStarDubins [Early Stop]



## Low Density Environment

Compare RRTStar, BiRRTStar, PRRTStar, and Dubins variants in a low-density random environment

## Run 1

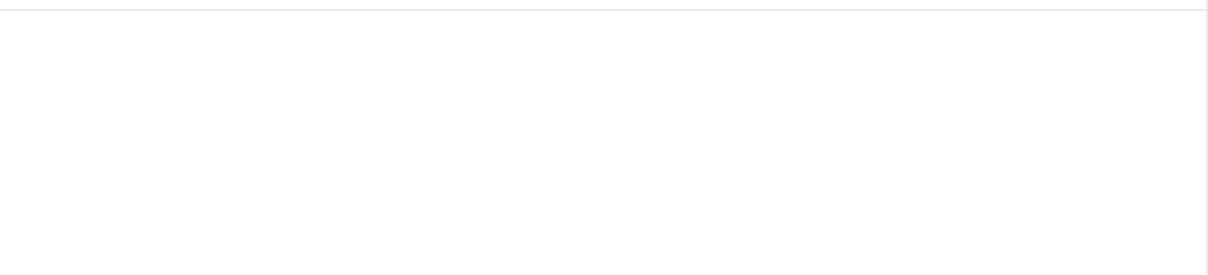
**Start:** (37.38935368297651, 33.32462720389405) | **Goal:** (17.680160467785438, 60.7052136761285) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 0.1, "seed": 52, "robot\_radius": 0.1 })

### Algorithm Results

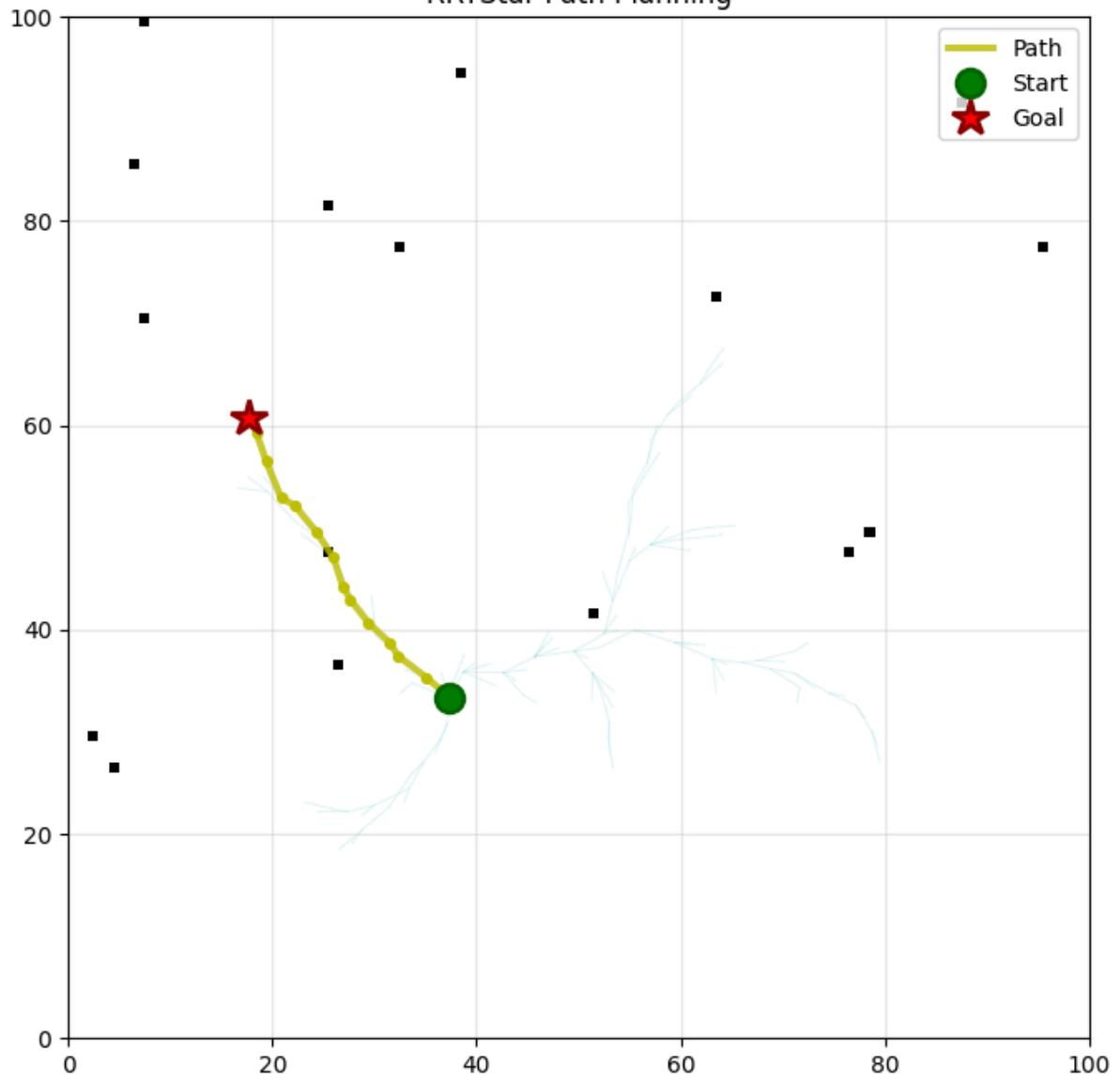
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.05	34.58	138	34.58
BiRRTStar ES	✓ Success	0.00	34.12	32	34.12
PRRTStar ES	✓ Success	0.12	34.48	39	34.48
RRTStarDubins ES	✓ Success	0.01	38.74	59	40.50
BiRRTStarDubins ES	✓ Success	0.00	45.19	46	47.79
PRRTStarDubins ES	✓ Success	0.16	34.87	58	41.56

### Path Visualizations

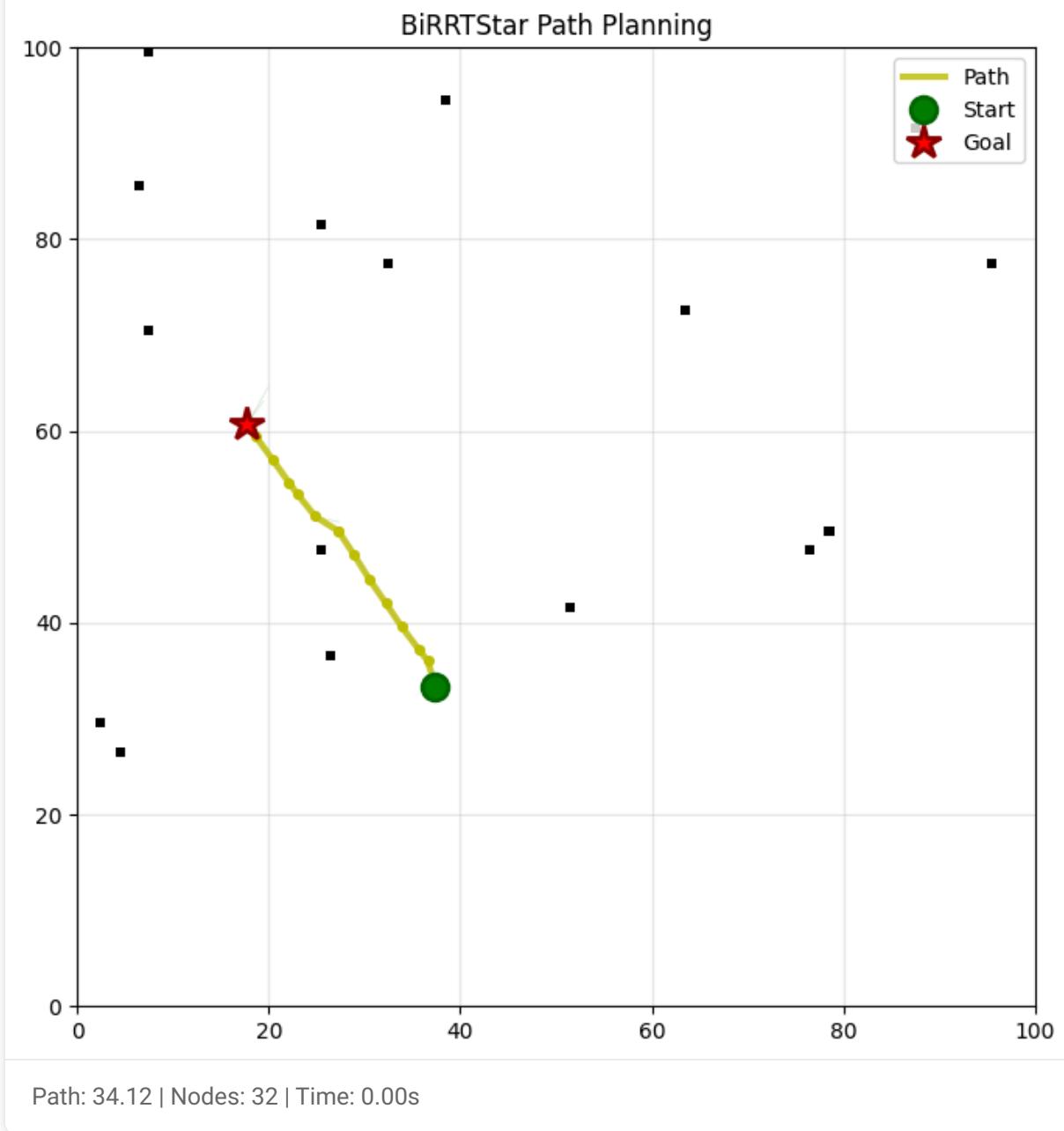
RRTStar [Early Stop]



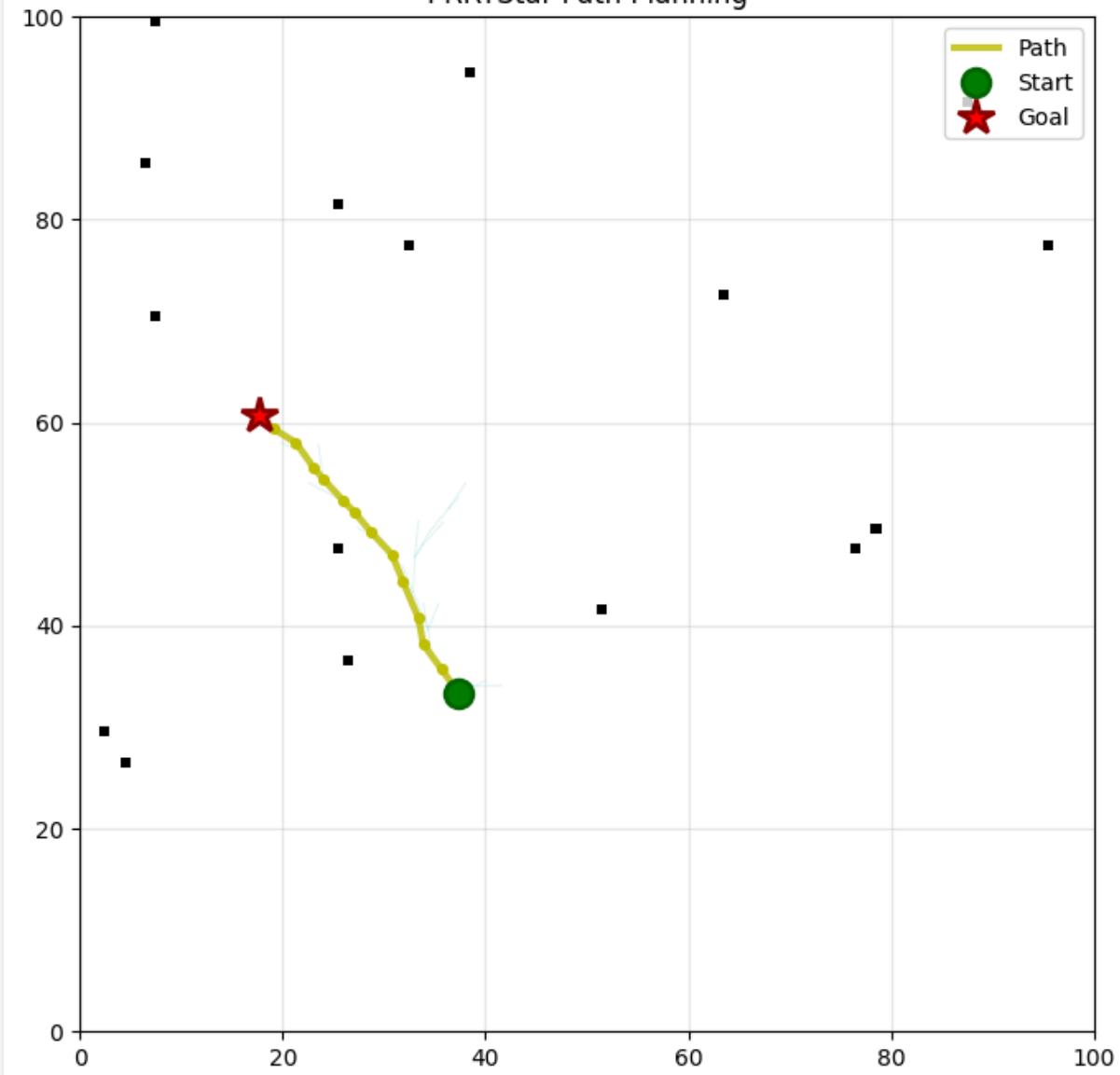
### RRTStar Path Planning

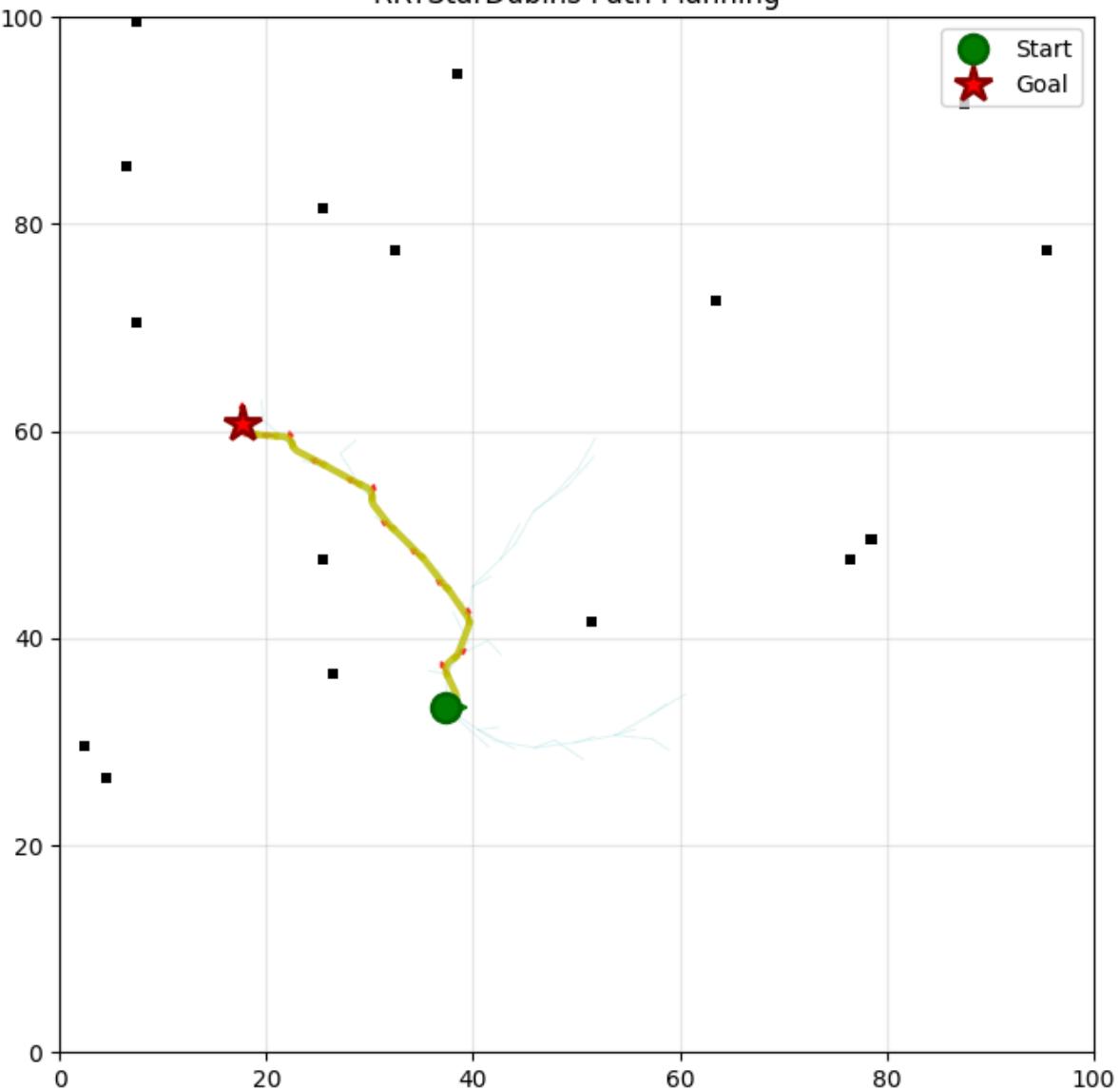


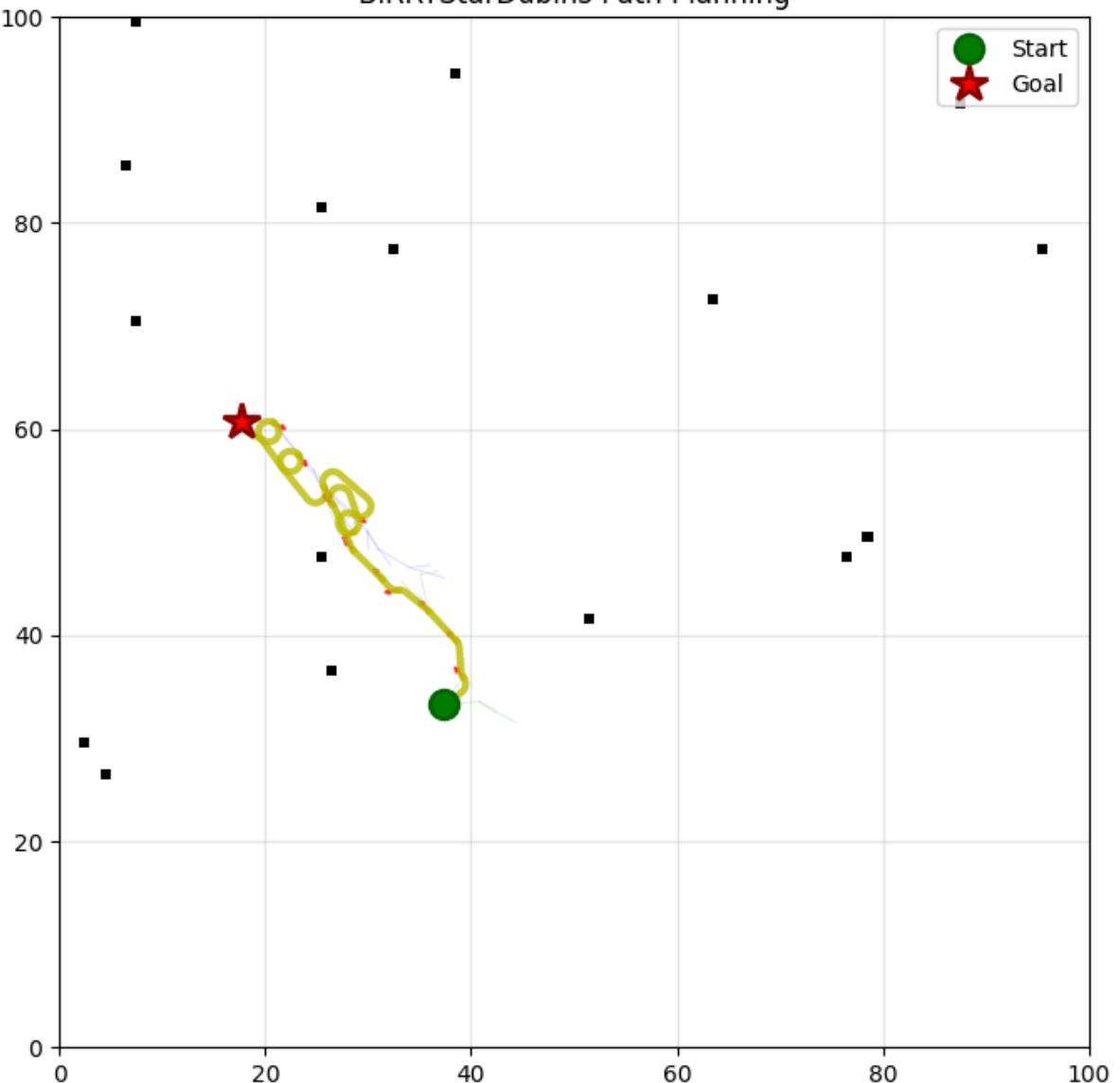
### BiRRTStar [Early Stop]



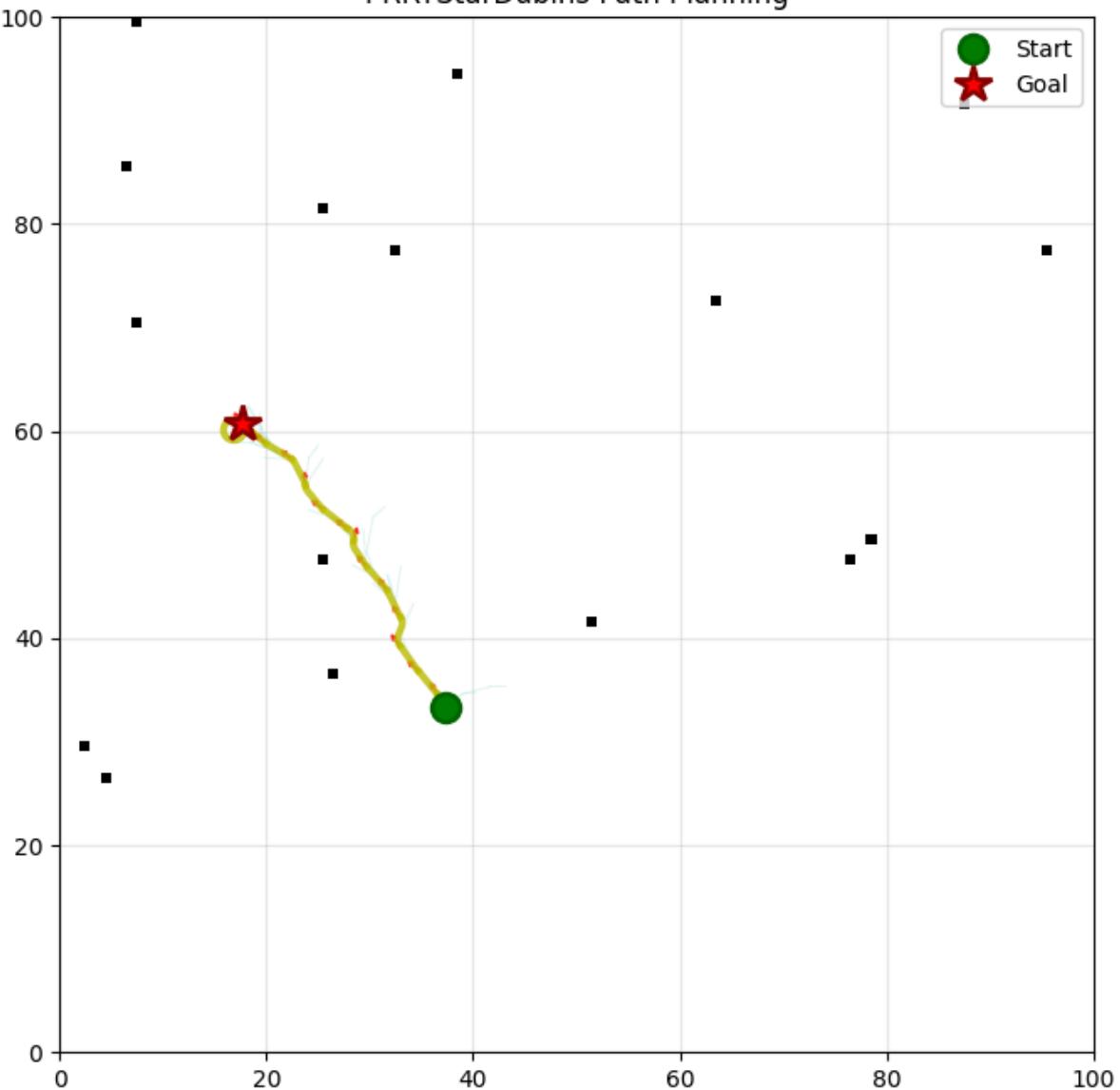
### PRRTStar [Early Stop]

**PRRTStar Path Planning****RRTStarDubins [Early Stop]**

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

**BiRRTStarDubins Path Planning****PRRTStarDubins [Early Stop]**

## PRRTStarDubins Path Planning



## Run 2

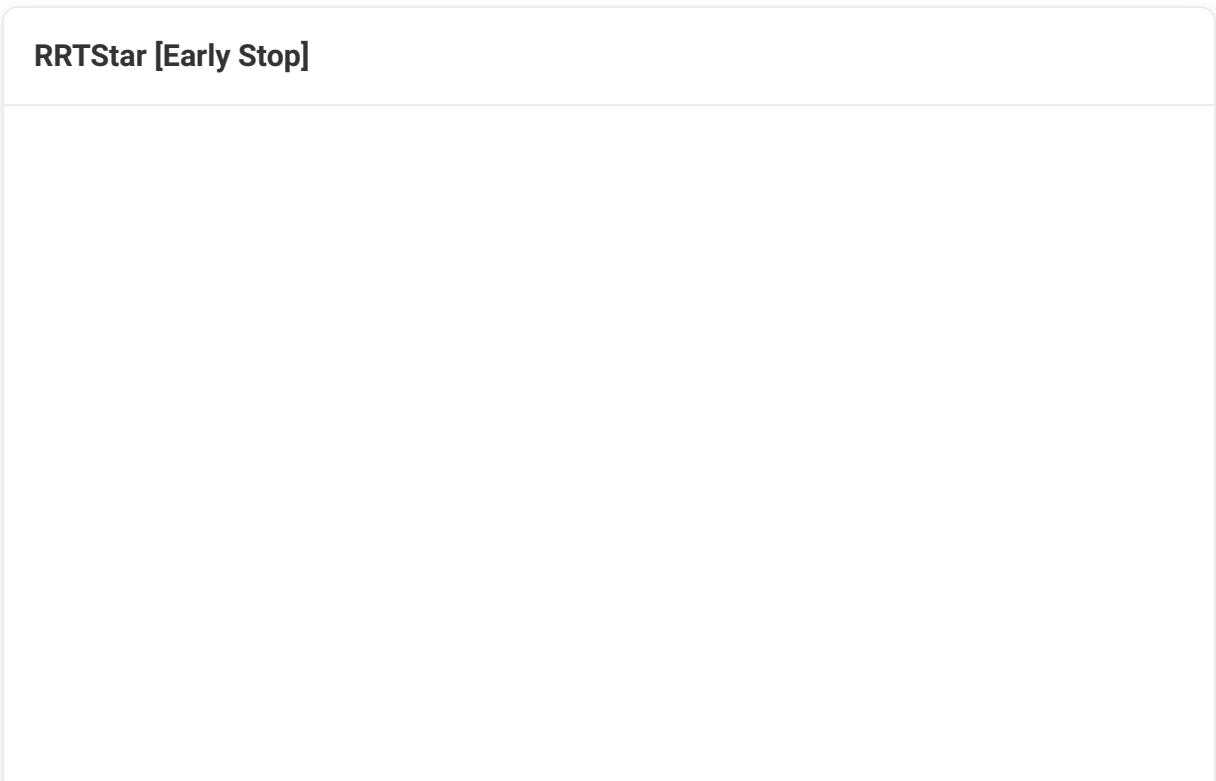
**Start:** (54.205397757858776, 2.8731567147133186) | **Goal:** (23.830138921356866, 71.34054272664562) | **Env:** RandomEnvironment ({"width": 100, "height": 100, "density": 0.1, "seed": 52, "robot\_radius": 0.1})

## Algorithm Results

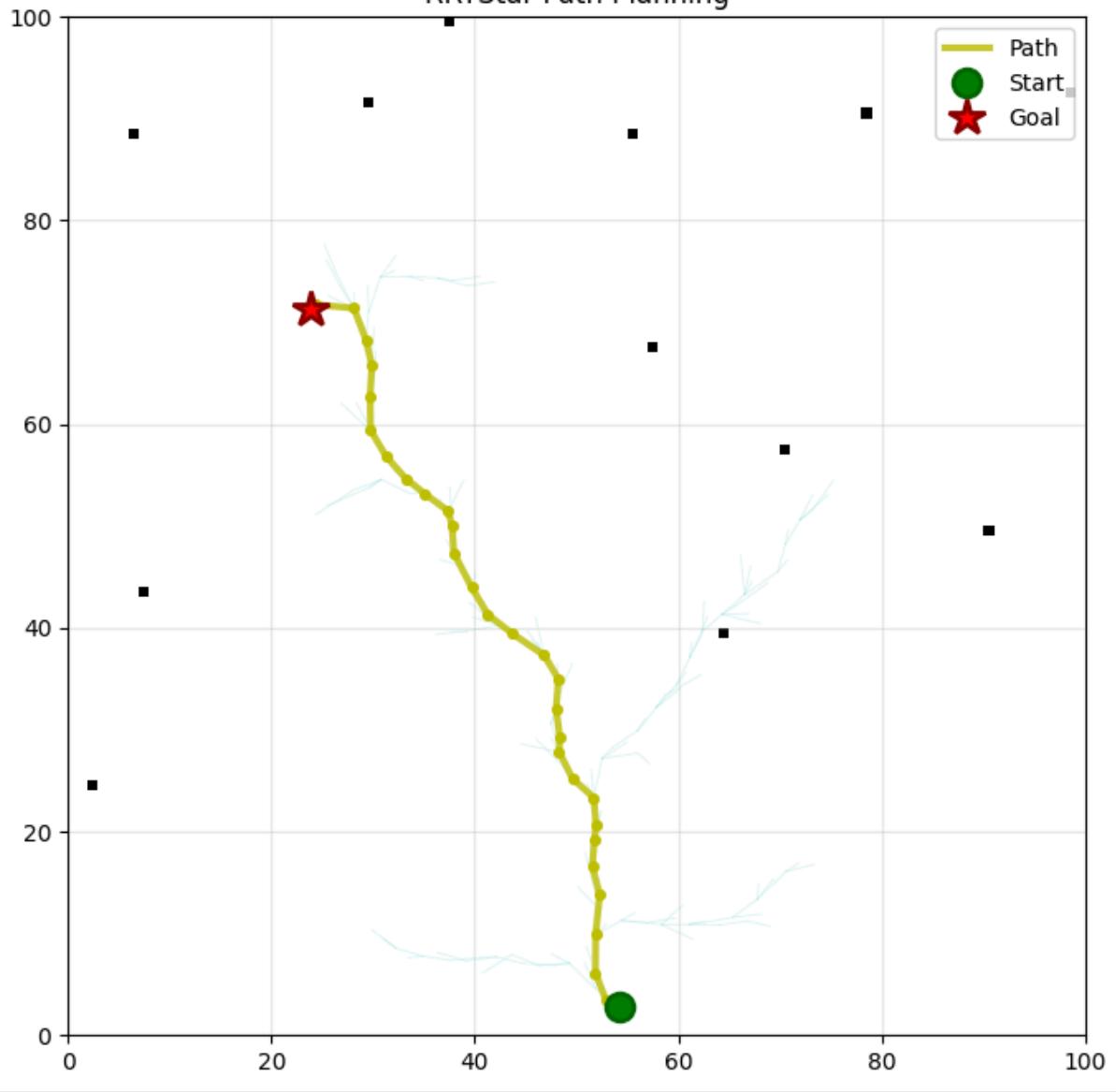
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.07	83.05	180	83.22
BiRRTStar ES	✓ Success	0.01	76.24	64	76.24
PRRTStar ES	✓ Success	0.21	76.36	73	76.36
RRTStarDubins ES	✓ Success	0.02	82.10	129	90.73
BiRRTStarDubins ES	✓ Success	0.00	84.39	64	88.52
PRRTStarDubins ES	✓ Success	0.16	78.23	66	85.61

## Path Visualizations

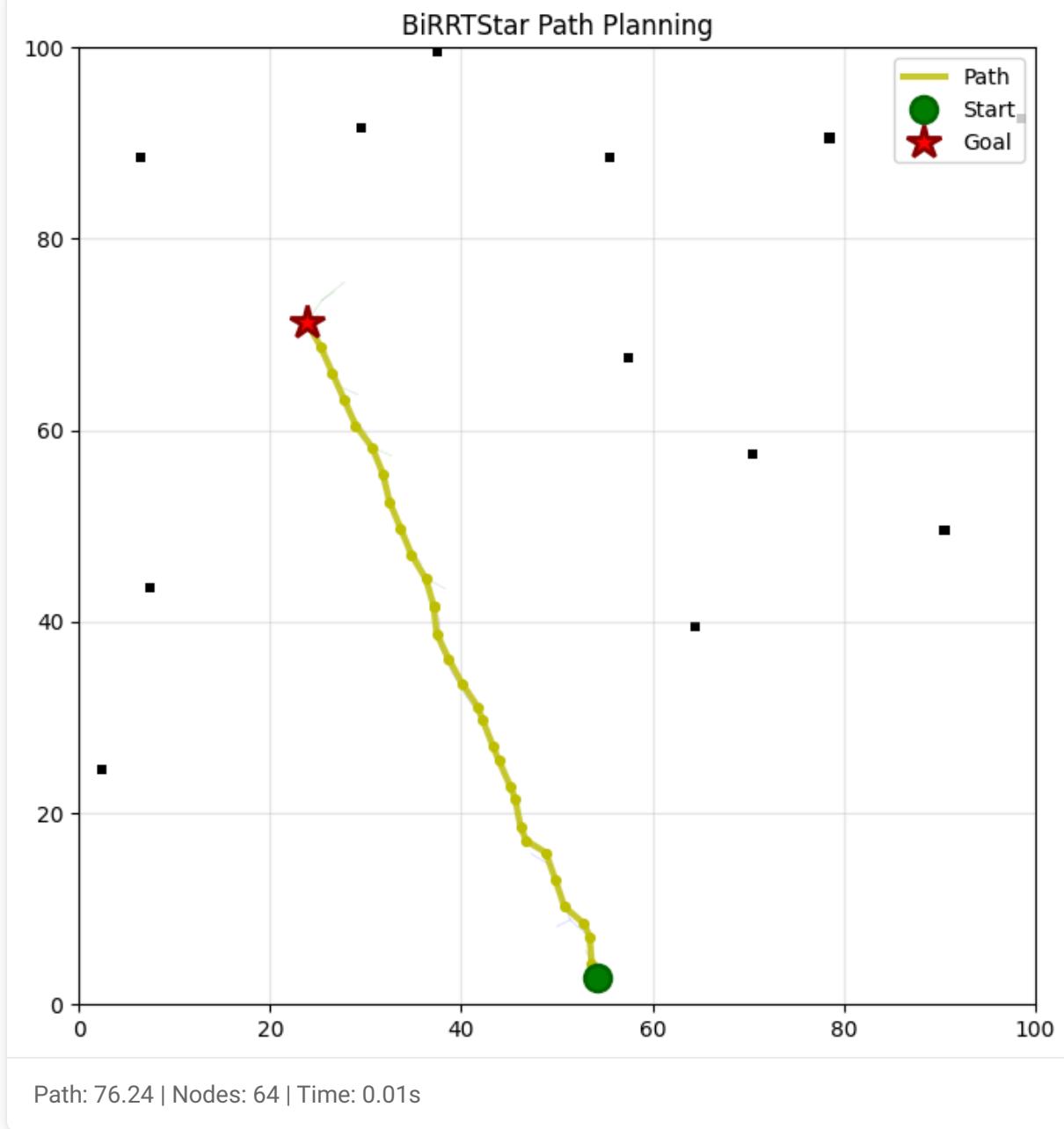
RRTStar [Early Stop]



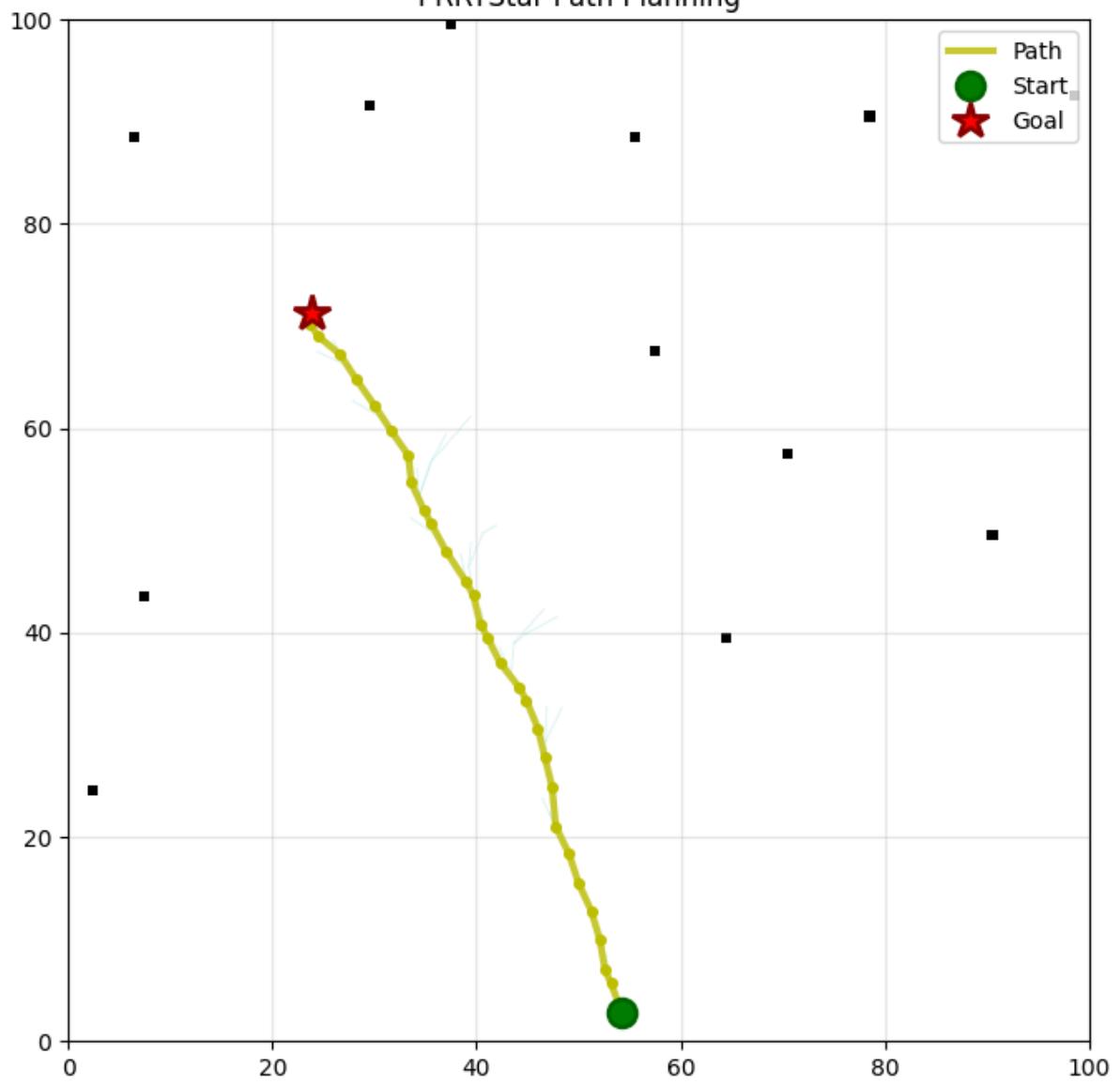
### RRTStar Path Planning

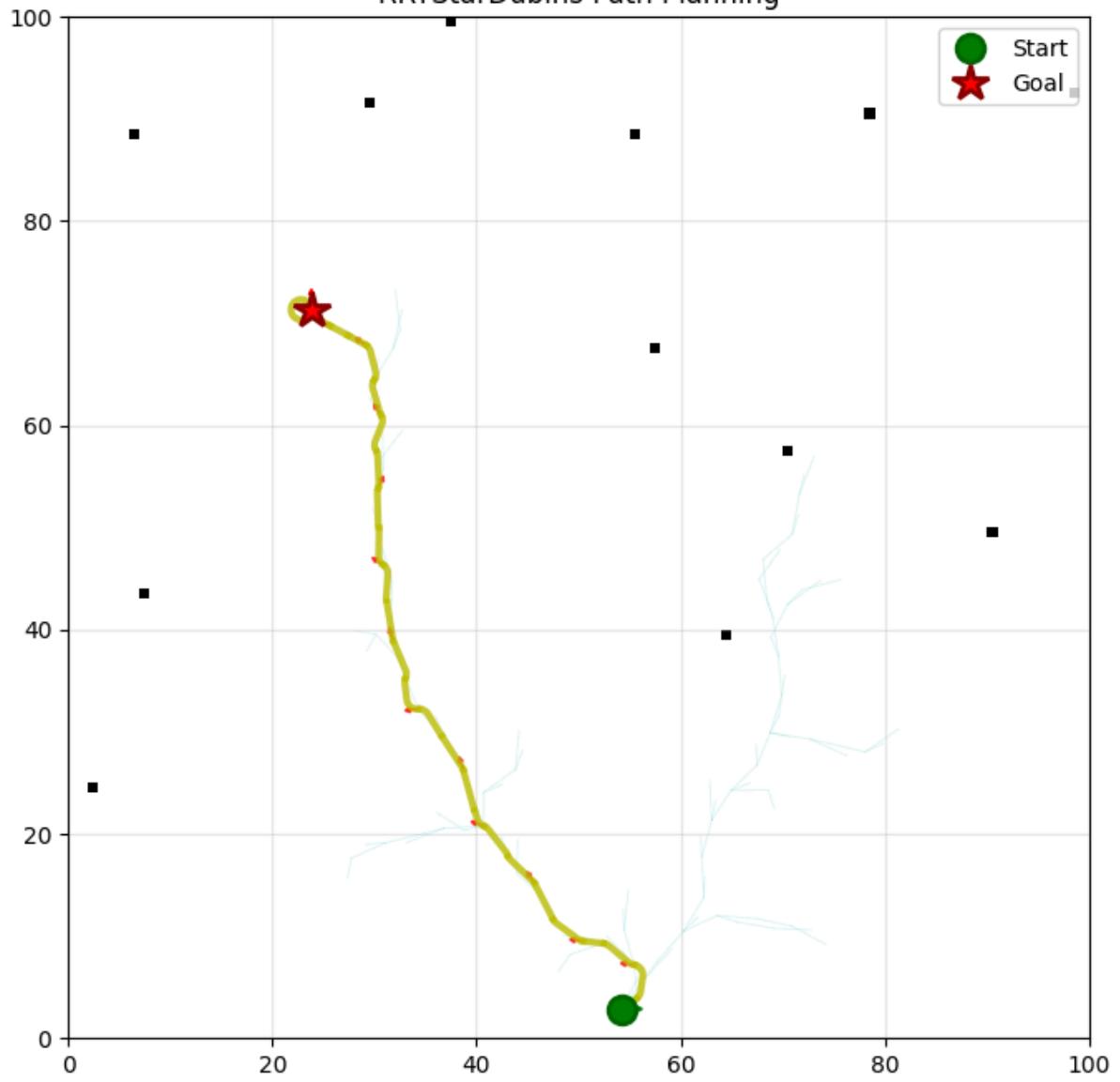


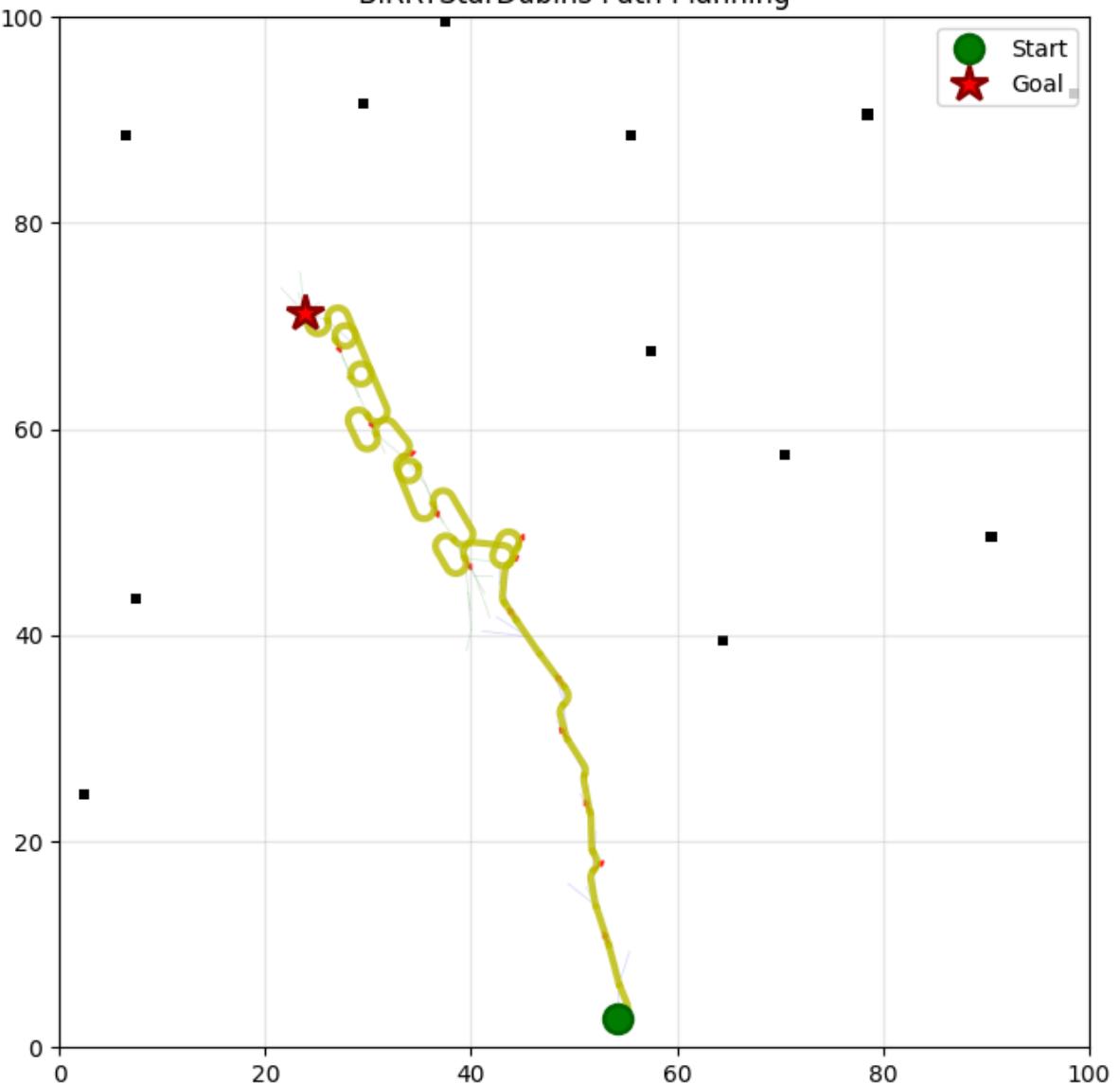
### BiRRTStar [Early Stop]

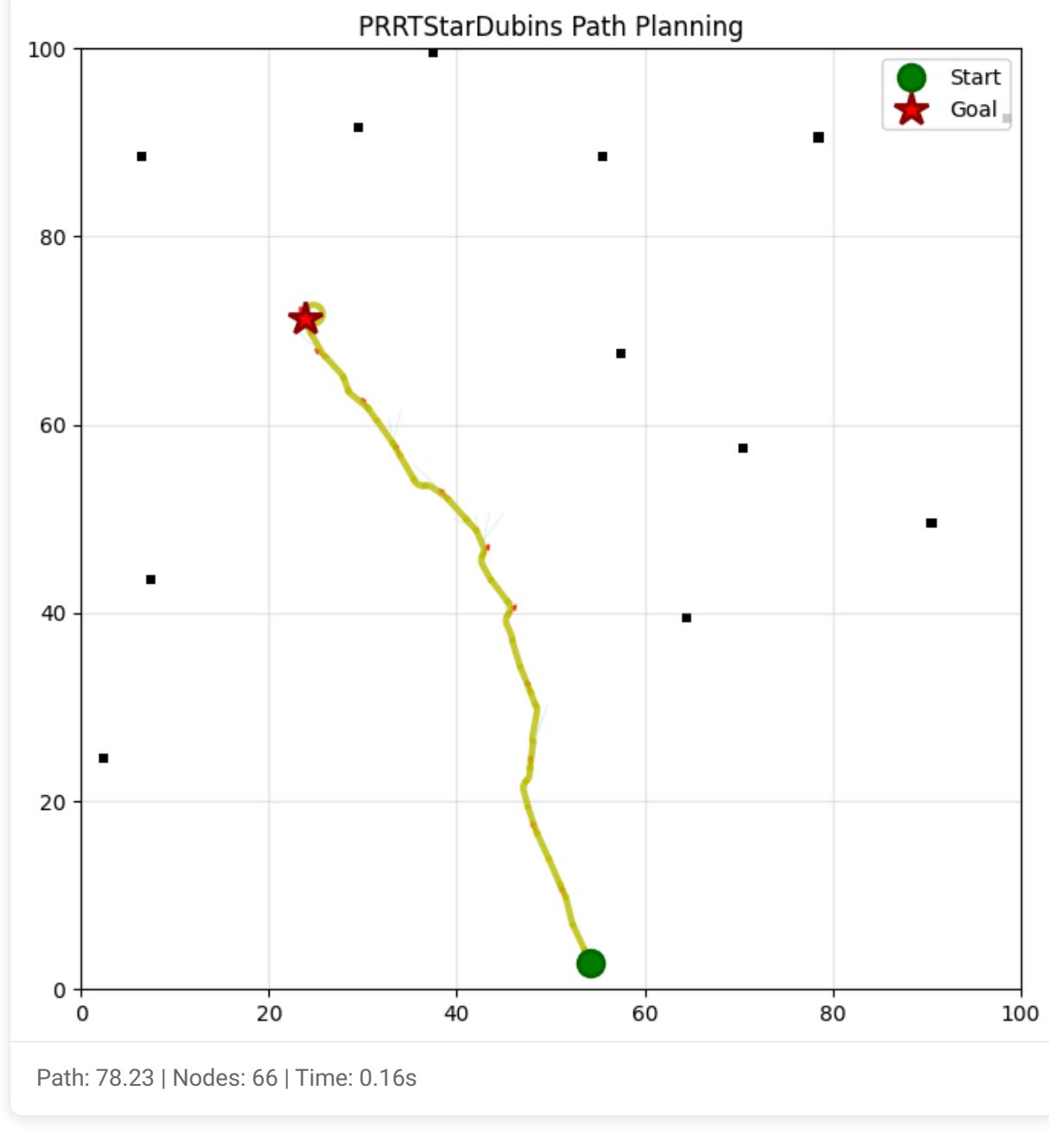


### PRRTStar [Early Stop]

**PRRTStar Path Planning****RRTStarDubins [Early Stop]**

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

**BiRRTStarDubins Path Planning****PRRTStarDubins [Early Stop]**



## Run 3

**Start:** (80.27111766995438, 0.3305369480904654) | **Goal:** (41.118016853525376, 33.264177041153246) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 0.1, "seed": 52, "robot\_radius": 0.1})

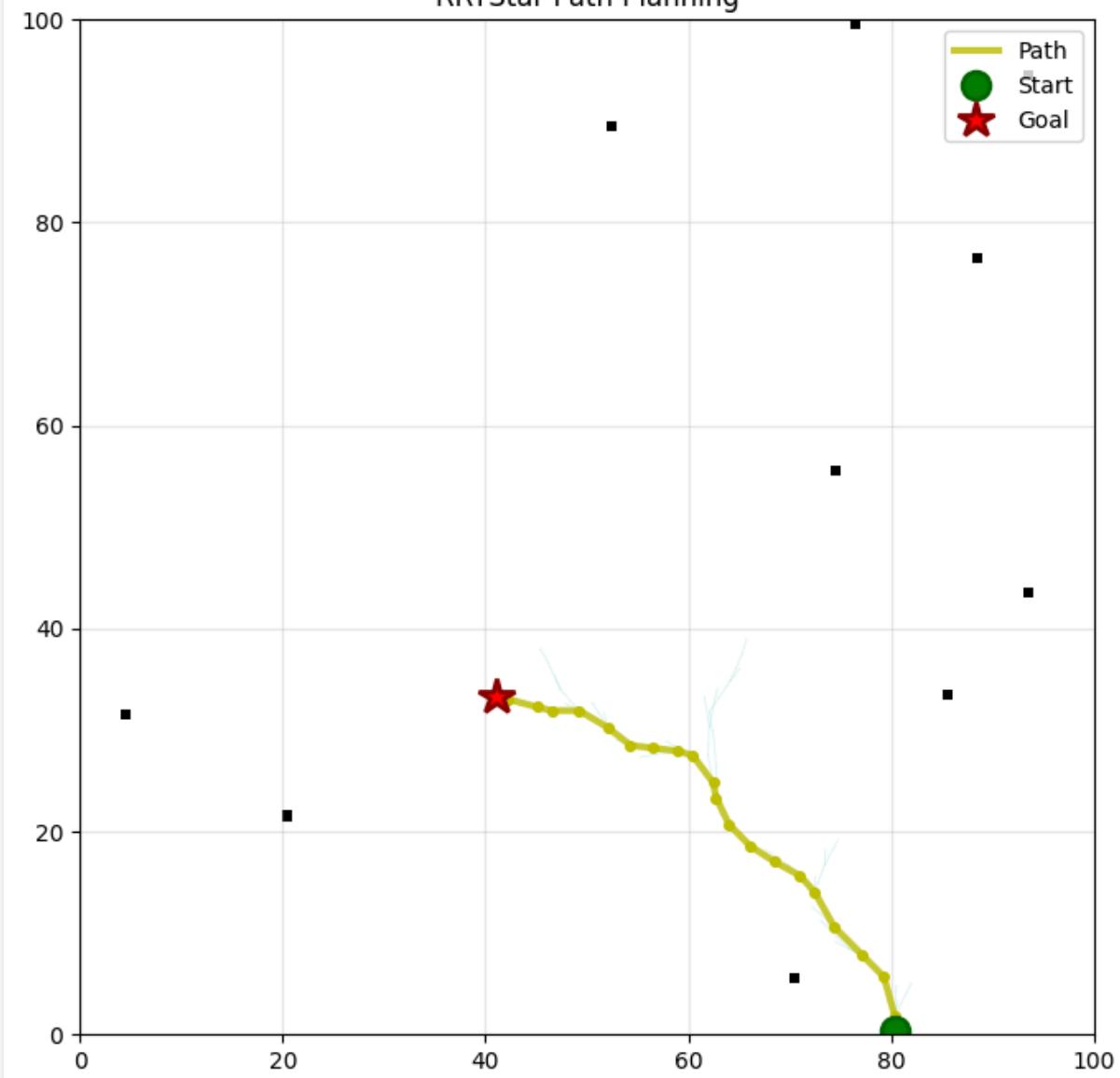
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.02	55.66	61	55.66
BiRRTStar ES	✓ Success	0.00	52.66	42	52.66
PRRTStar ES	✓ Success	0.11	52.73	37	52.73
RRTStarDubins ES	✓ Success	0.00	57.35	43	64.40
BiRRTStarDubins ES	✓ Success	0.01	60.62	100	63.86
PRRTStarDubins ES	✓ Success	0.13	51.98	51	58.39

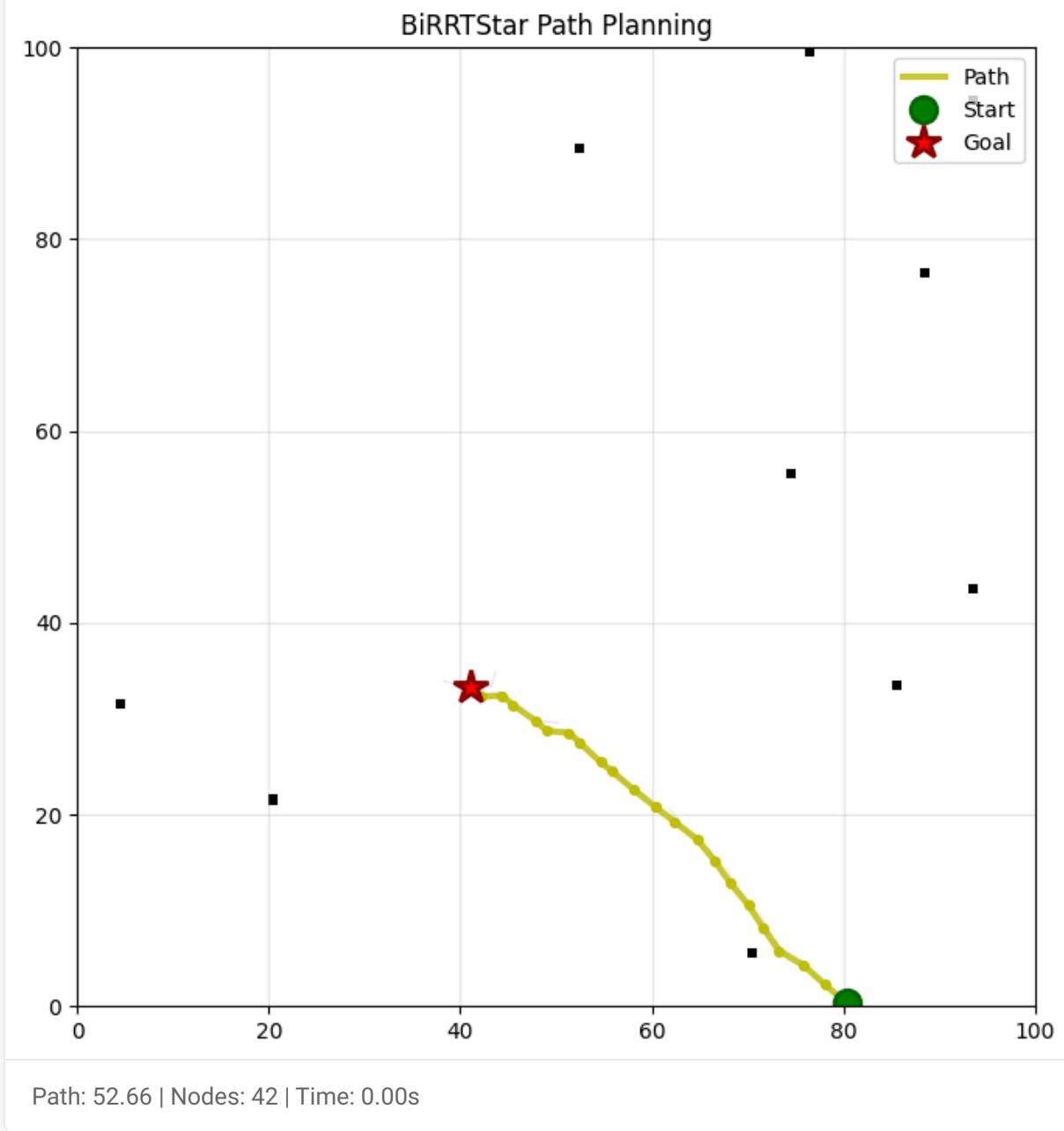
## Path Visualizations

RRTStar [Early Stop]

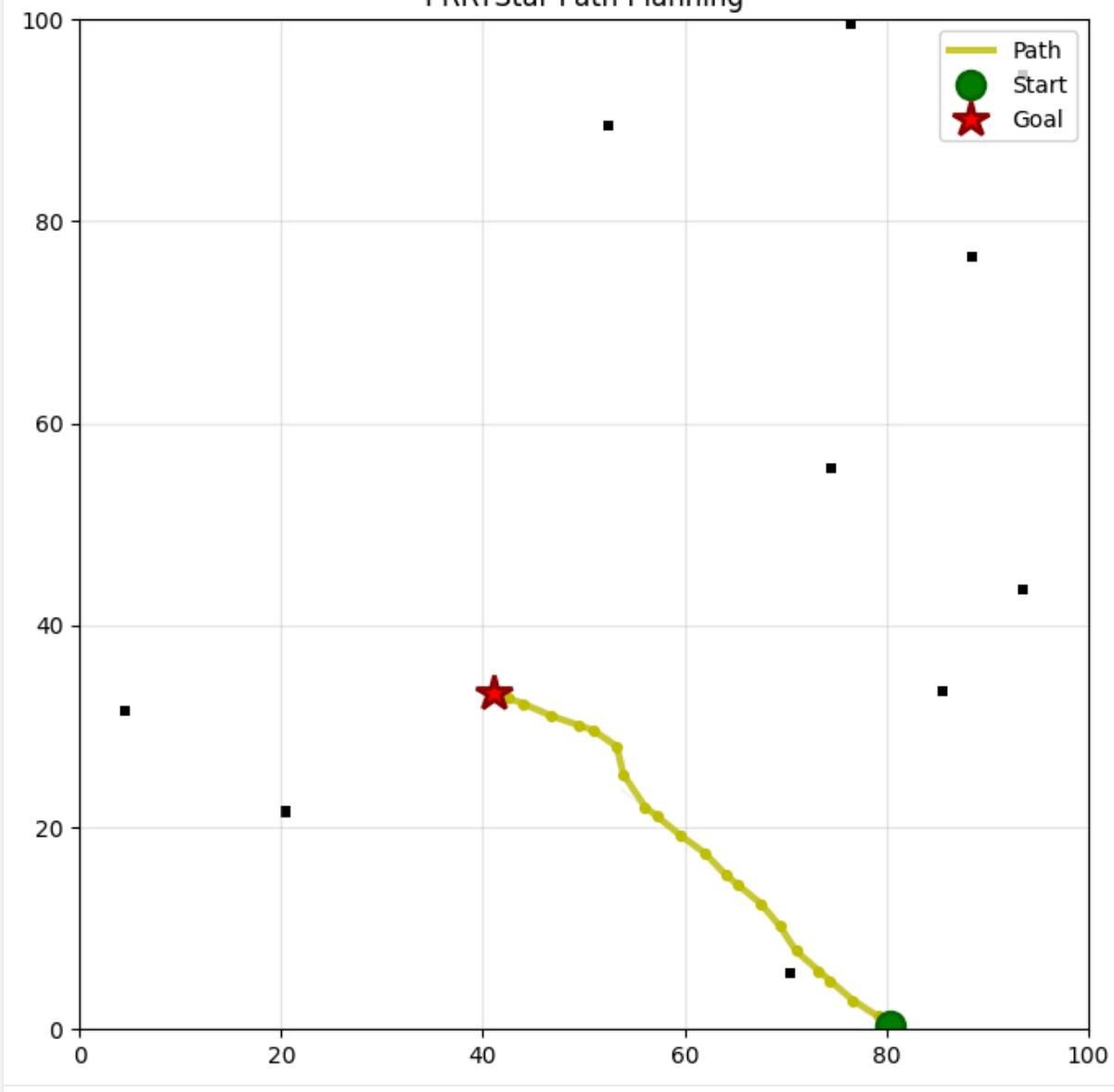
### RRTStar Path Planning

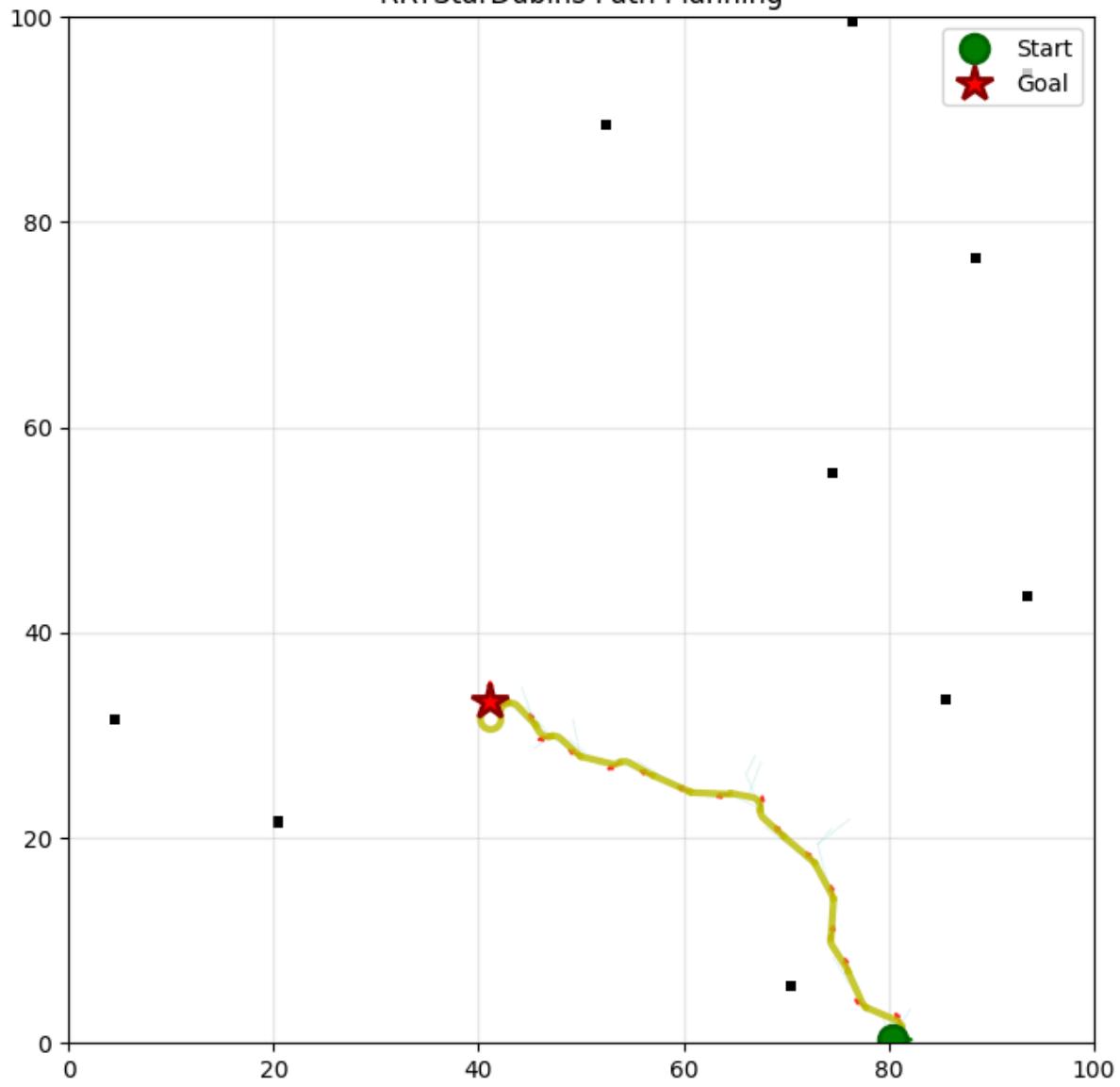


### BiRRTStar [Early Stop]

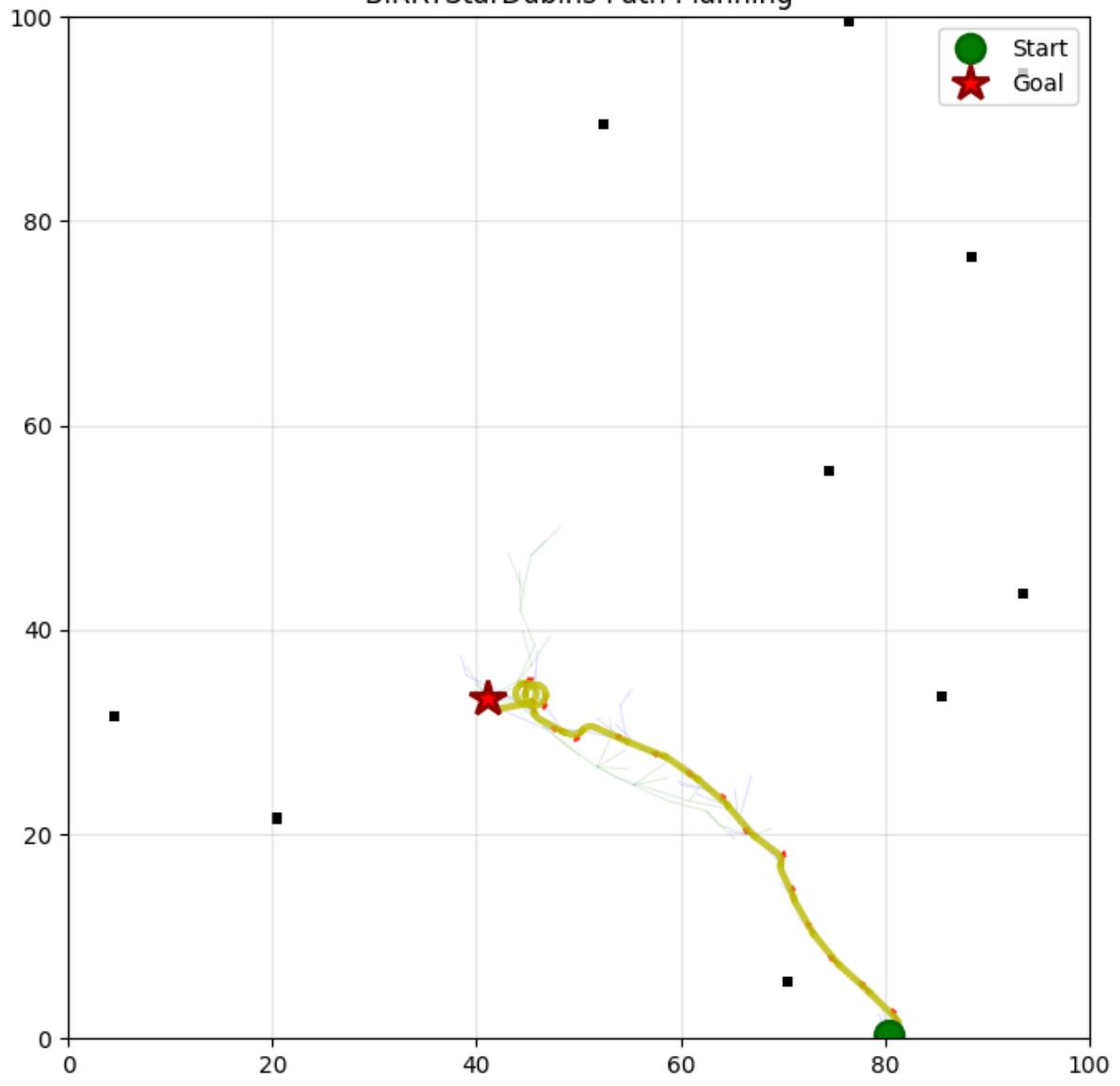


### PRRTStar [Early Stop]

**PRRTStar Path Planning****RRTStarDubins [Early Stop]**

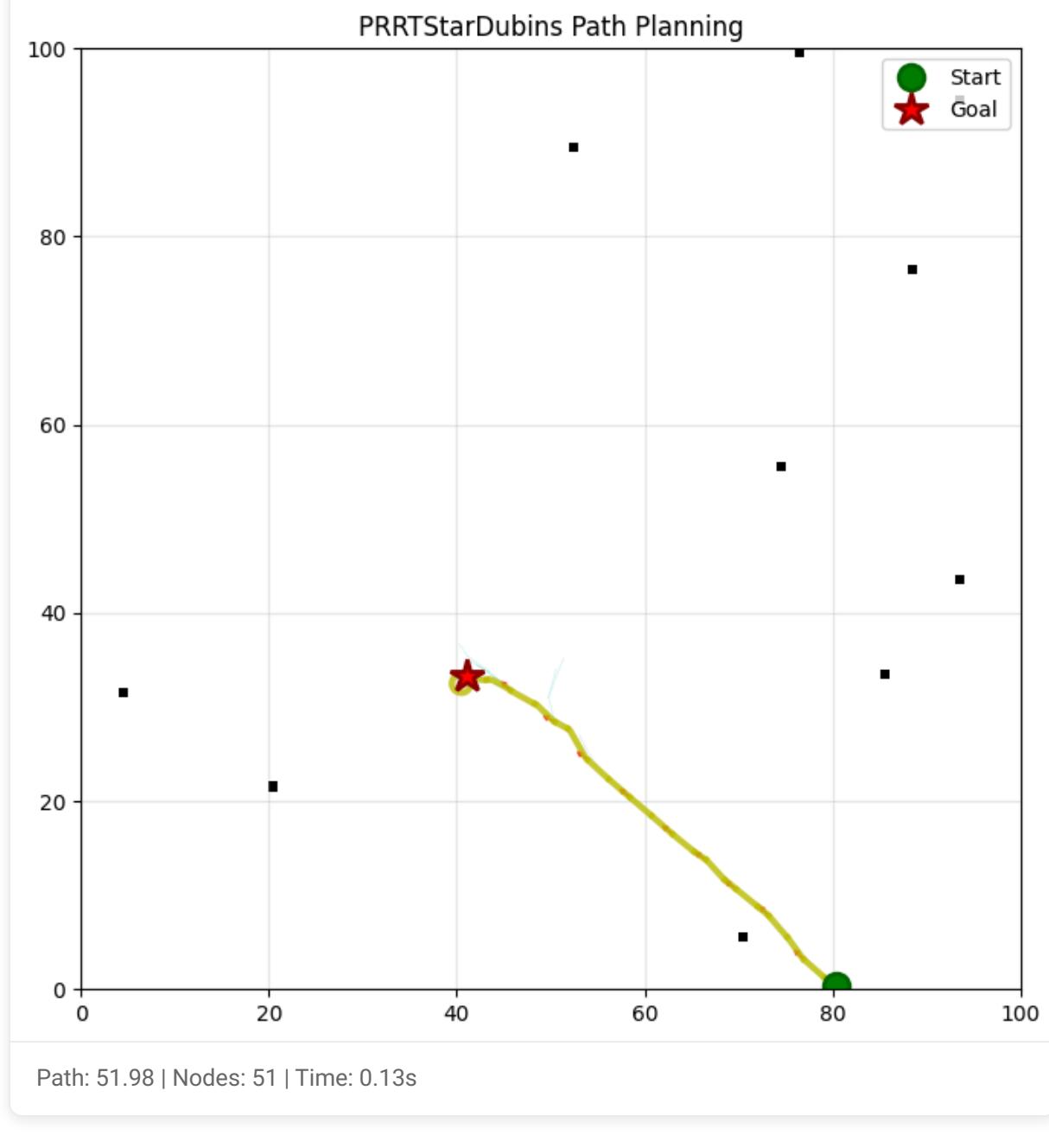
**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

### BiRRTStarDubins Path Planning



Path: 60.62 | Nodes: 100 | Time: 0.01s

### PRRTStarDubins [Early Stop]



## Run 4

**Start:** (60.49980216932323, 47.86539964521261) | **Goal:** (36.780299013912234, 64.08731359568657) | **Env:** RandomEnvironment ({ "width": 100, "height": 100, "density": 0.1, "seed": 52, "robot\_radius": 0.1 })

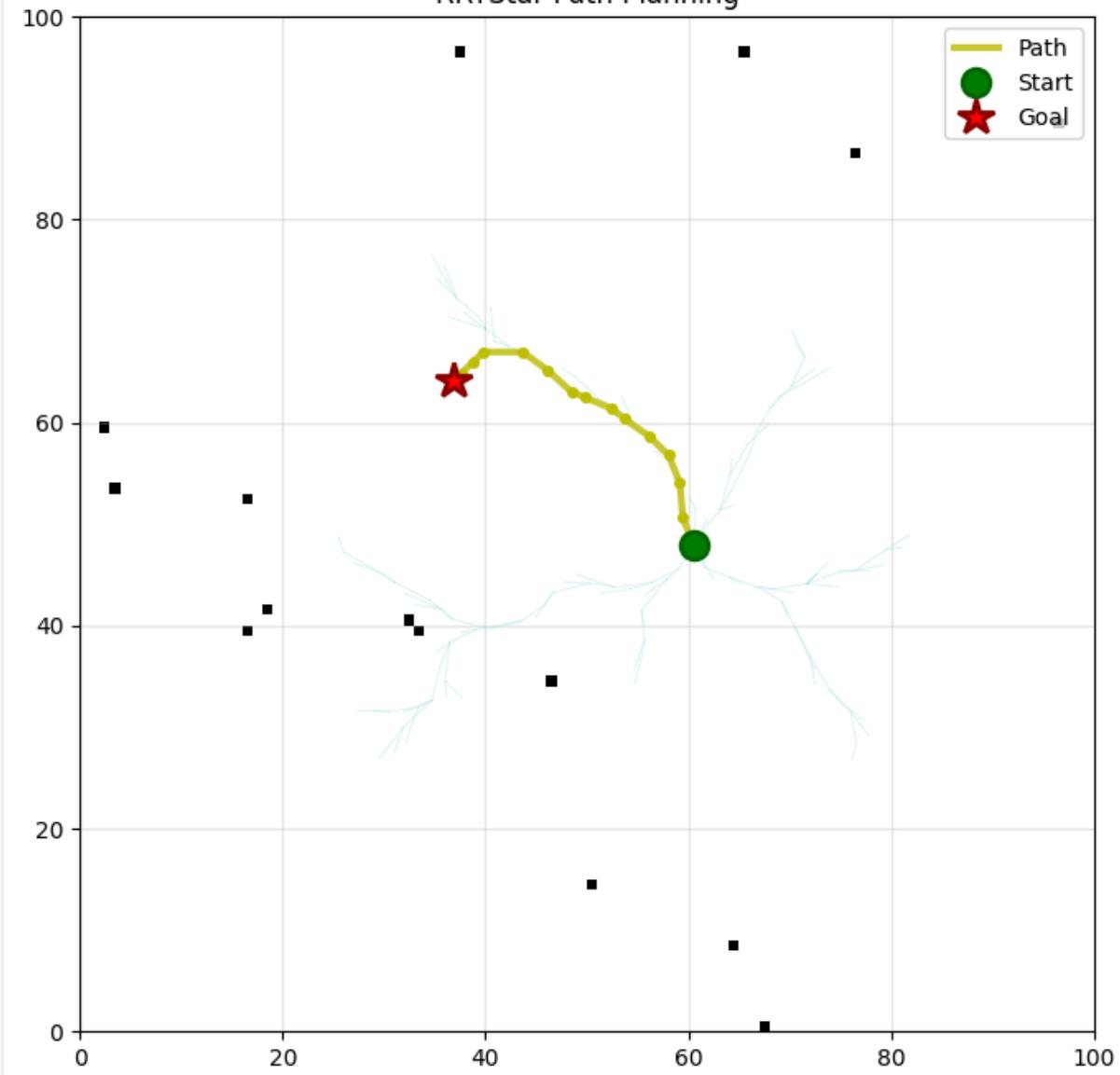
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.05	35.16	142	35.16
BiRRTStar ES	✓ Success	0.00	29.93	22	29.93
PRRTStar ES	✓ Success	0.06	29.04	24	29.04
RRTStarDubins ES	✓ Success	0.00	32.03	38	40.28
BiRRTStarDubins ES	✓ Success	0.01	37.03	104	39.91
PRRTStarDubins ES	✓ Success	0.12	28.94	45	35.50

## Path Visualizations

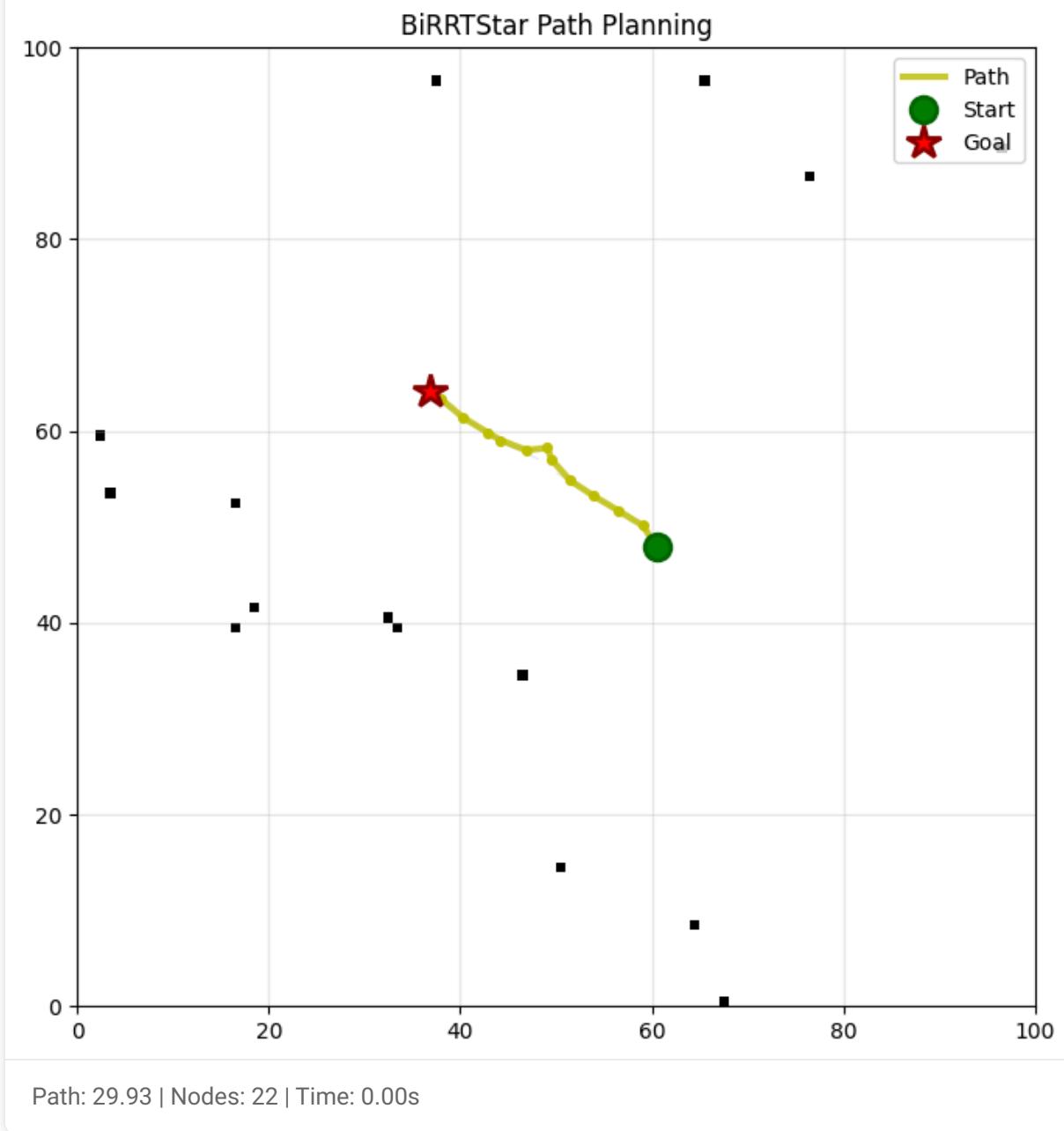
RRTStar [Early Stop]

### RRTStar Path Planning

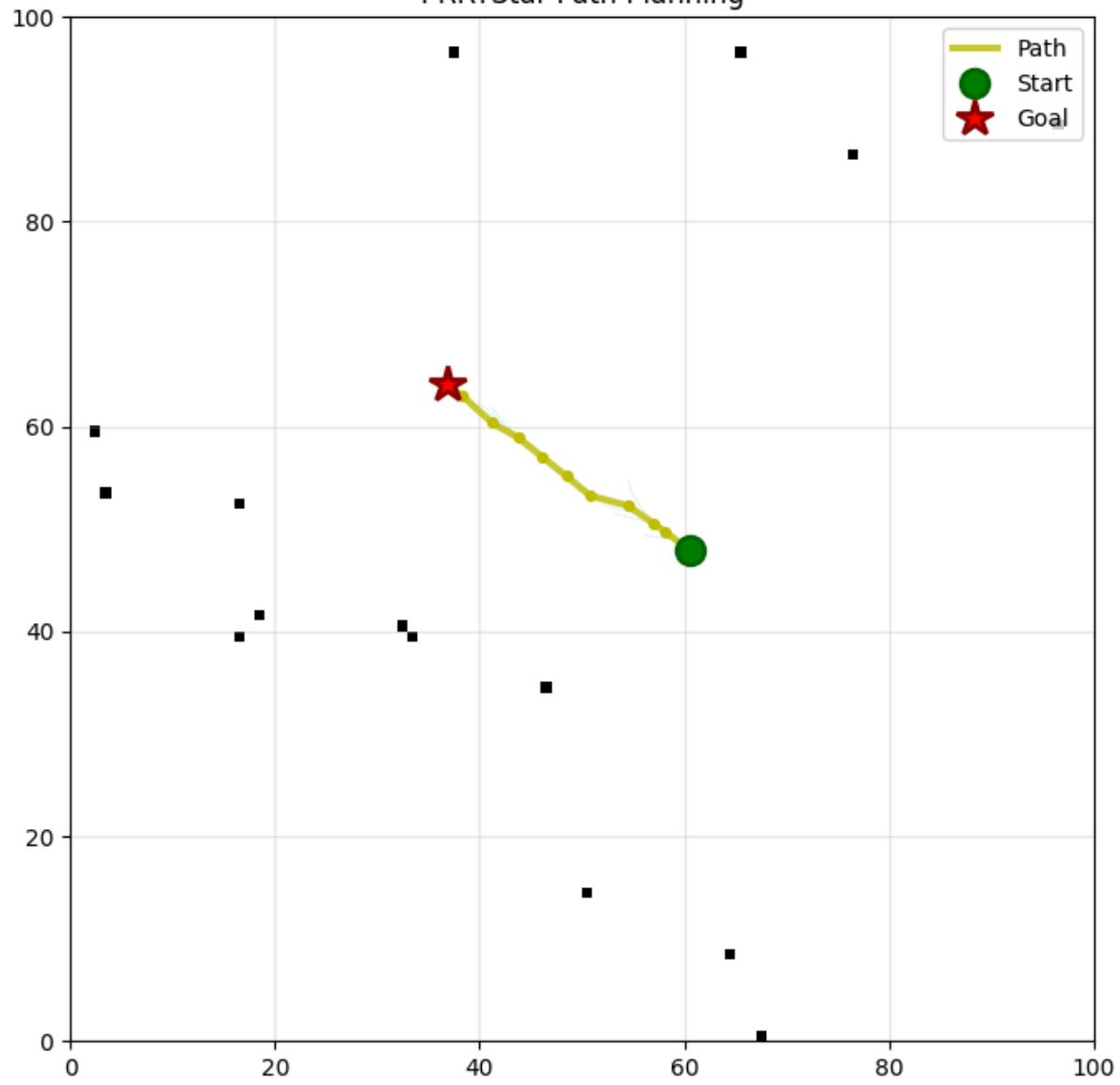


Path: 35.16 | Nodes: 142 | Time: 0.05s

### BiRRTStar [Early Stop]



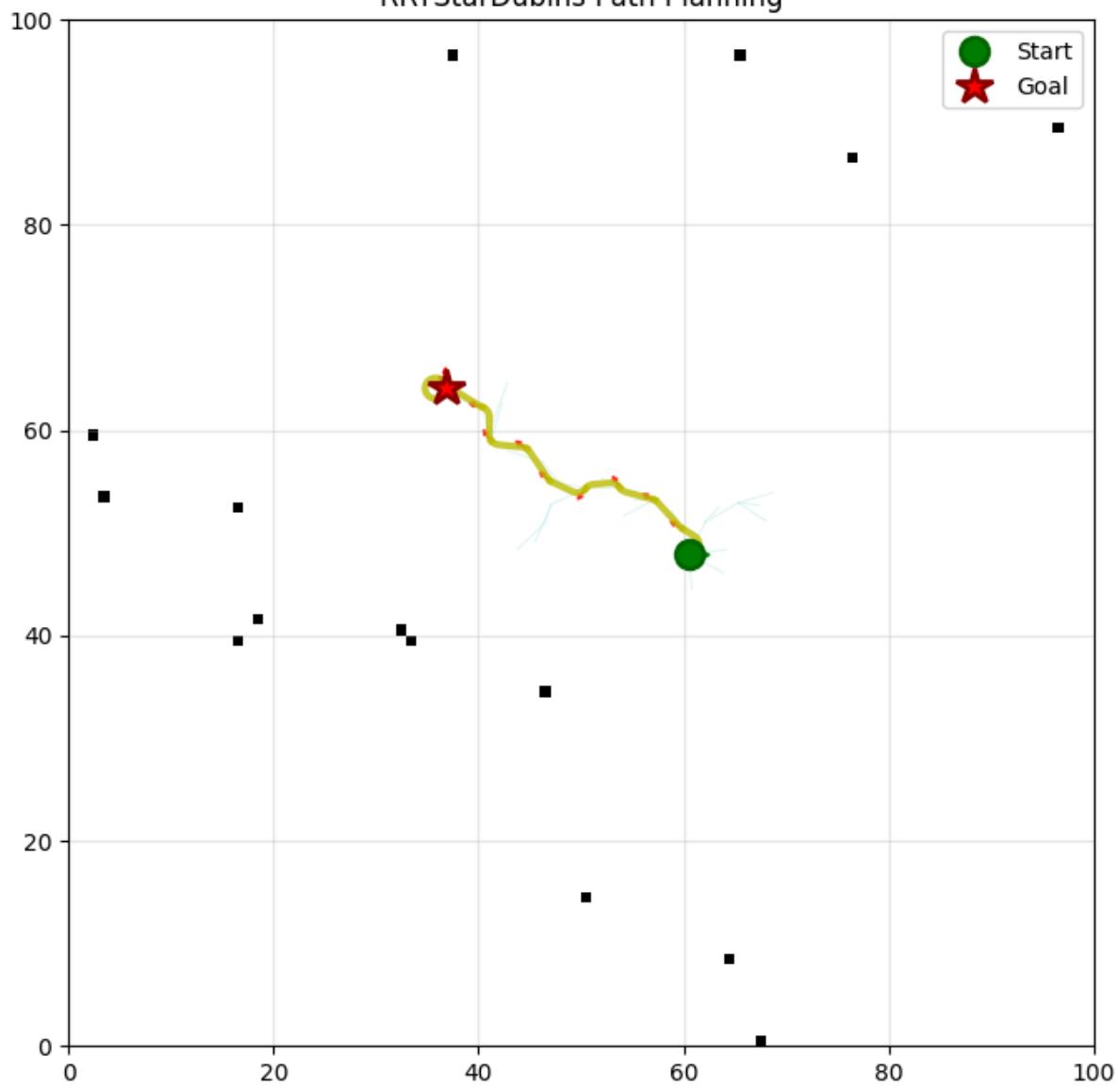
### PRRTStar [Early Stop]

**PRRTStar Path Planning**

Path: 29.04 | Nodes: 24 | Time: 0.06s

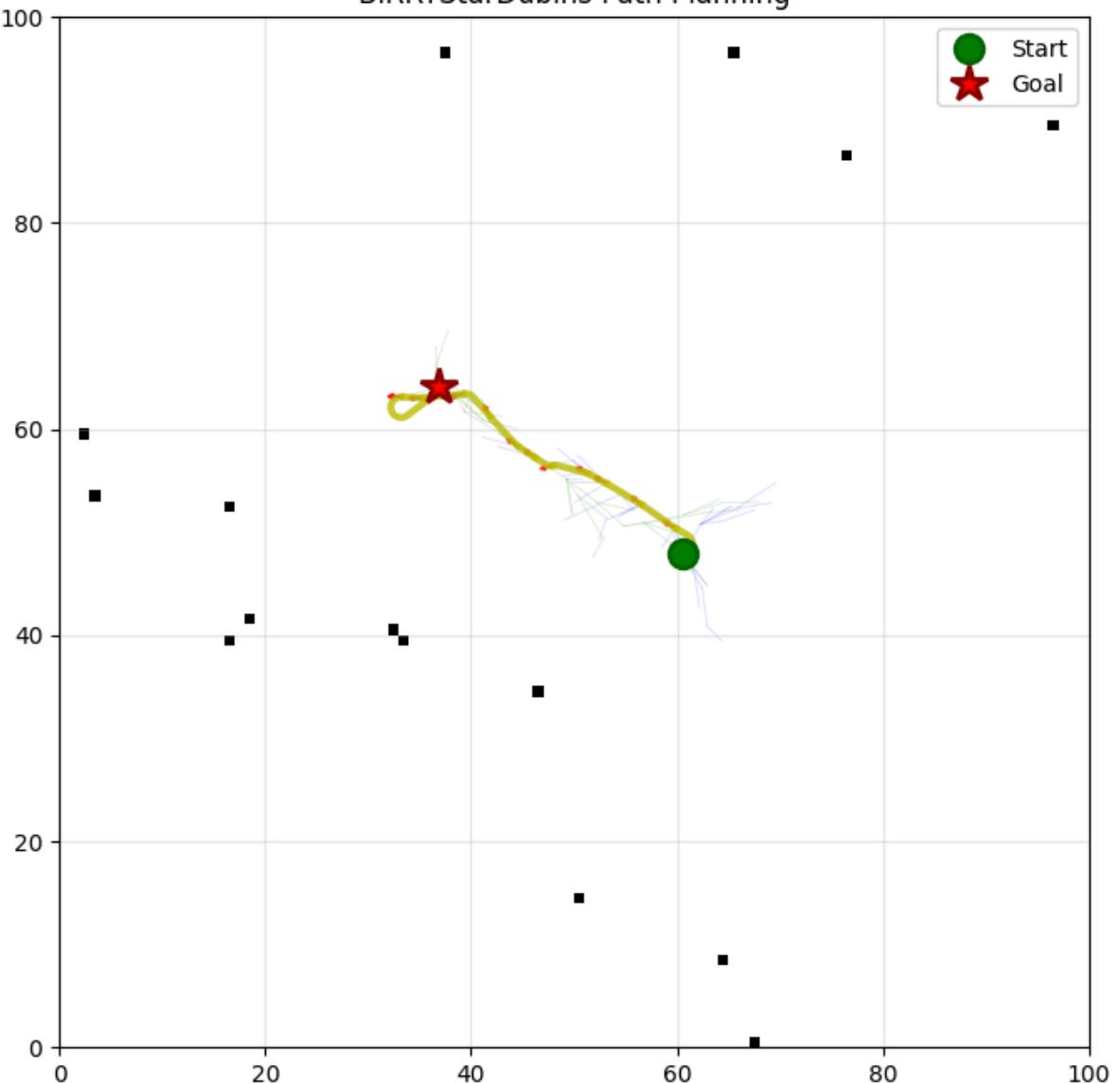
**RRTStarDubins [Early Stop]**

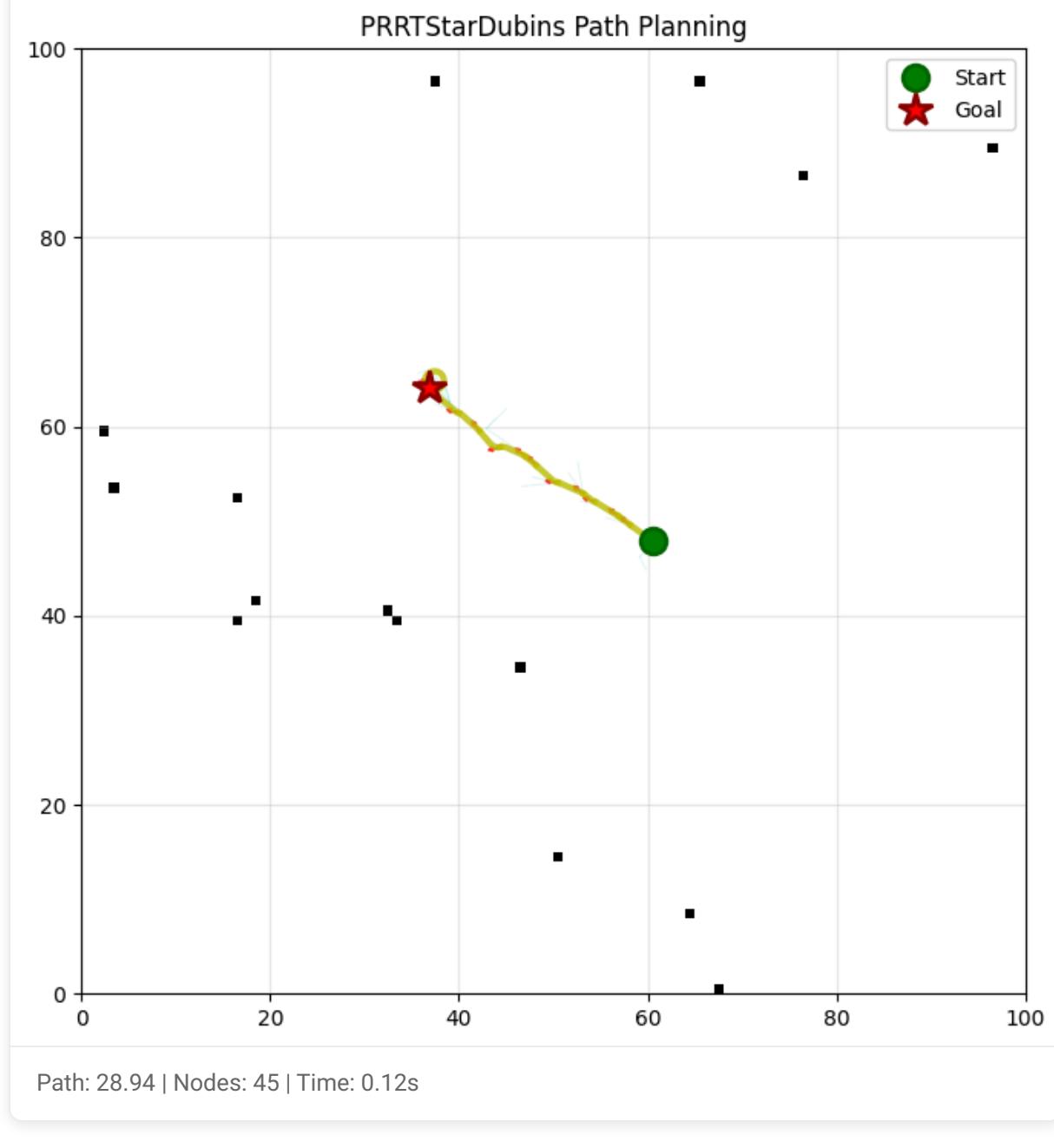
### RRTStarDubins Path Planning



Path: 32.03 | Nodes: 38 | Time: 0.00s

### BiRRTStarDubins [Early Stop]

**BiRRTStarDubins Path Planning****PRRTStarDubins [Early Stop]**



## Run 5

**Start:** (26.604461911665467, 3.7709850942082226) | **Goal:** (68.93587850217148, 12.395370882207182) | **Env:** RandomEnvironment ({"width": 100, "height": 100, "density": 0.1, "seed": 52, "robot\_radius": 0.1})

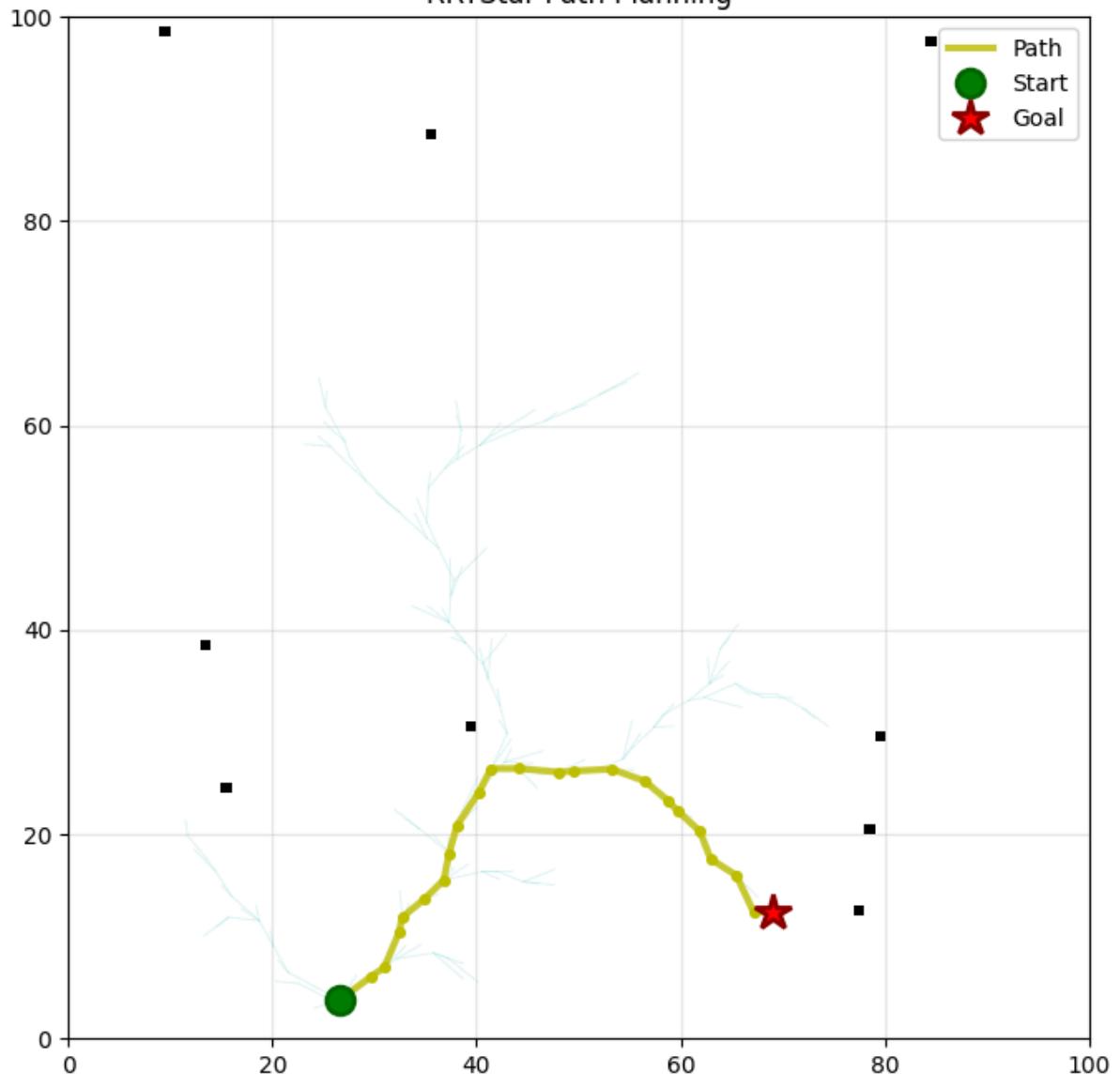
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.07	62.36	182	62.36
BiRRTStar ES	✓ Success	0.00	43.50	34	43.50
PRRTStar ES	✓ Success	0.14	48.72	46	48.77
RRTStarDubins ES	✓ Success	0.01	52.66	80	53.48
BiRRTStarDubins ES	✓ Success	0.00	47.50	32	50.08
PRRTStarDubins ES	✓ Success	0.19	50.08	68	57.11

## Path Visualizations

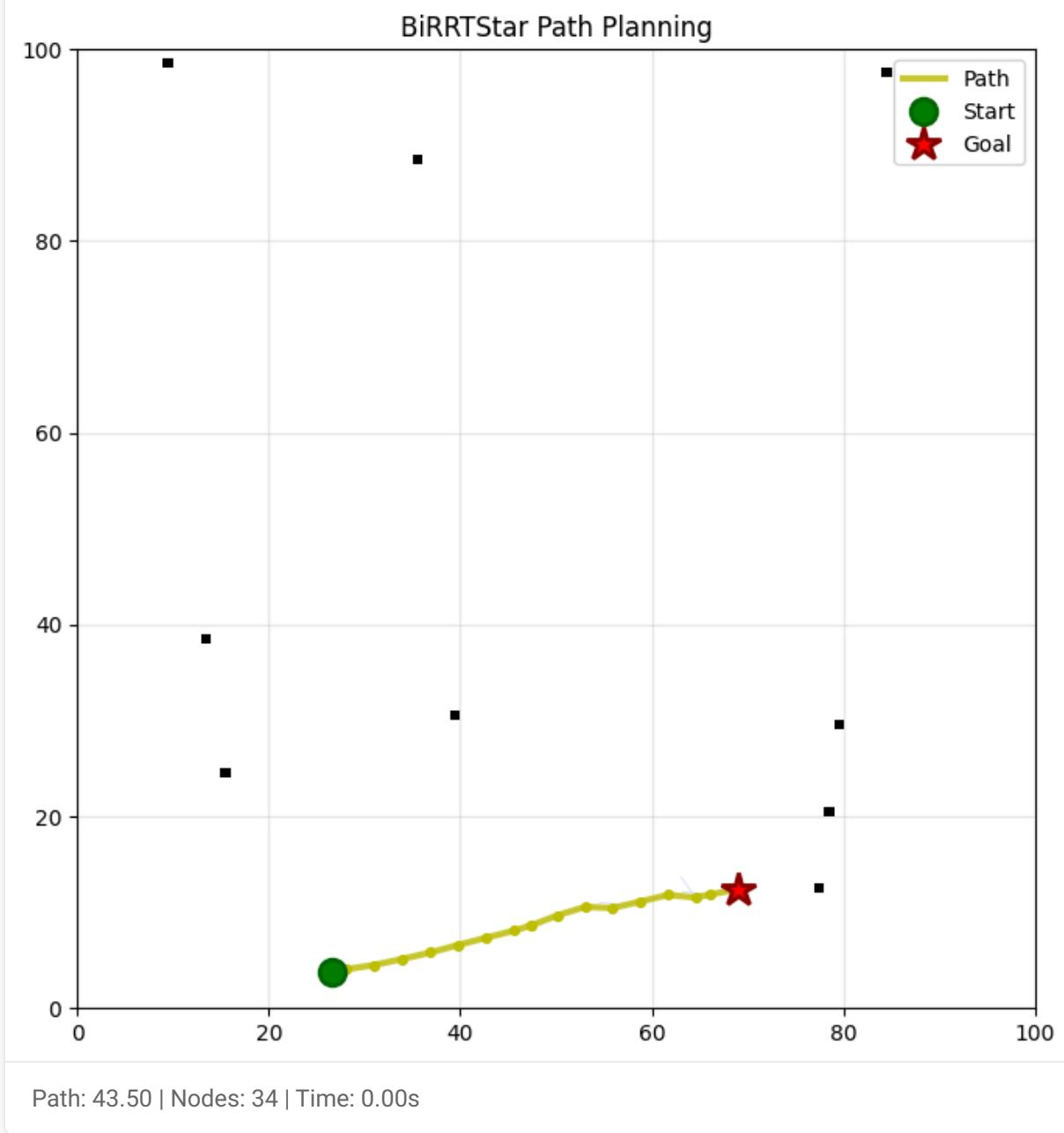
RRTStar [Early Stop]

### RRTStar Path Planning

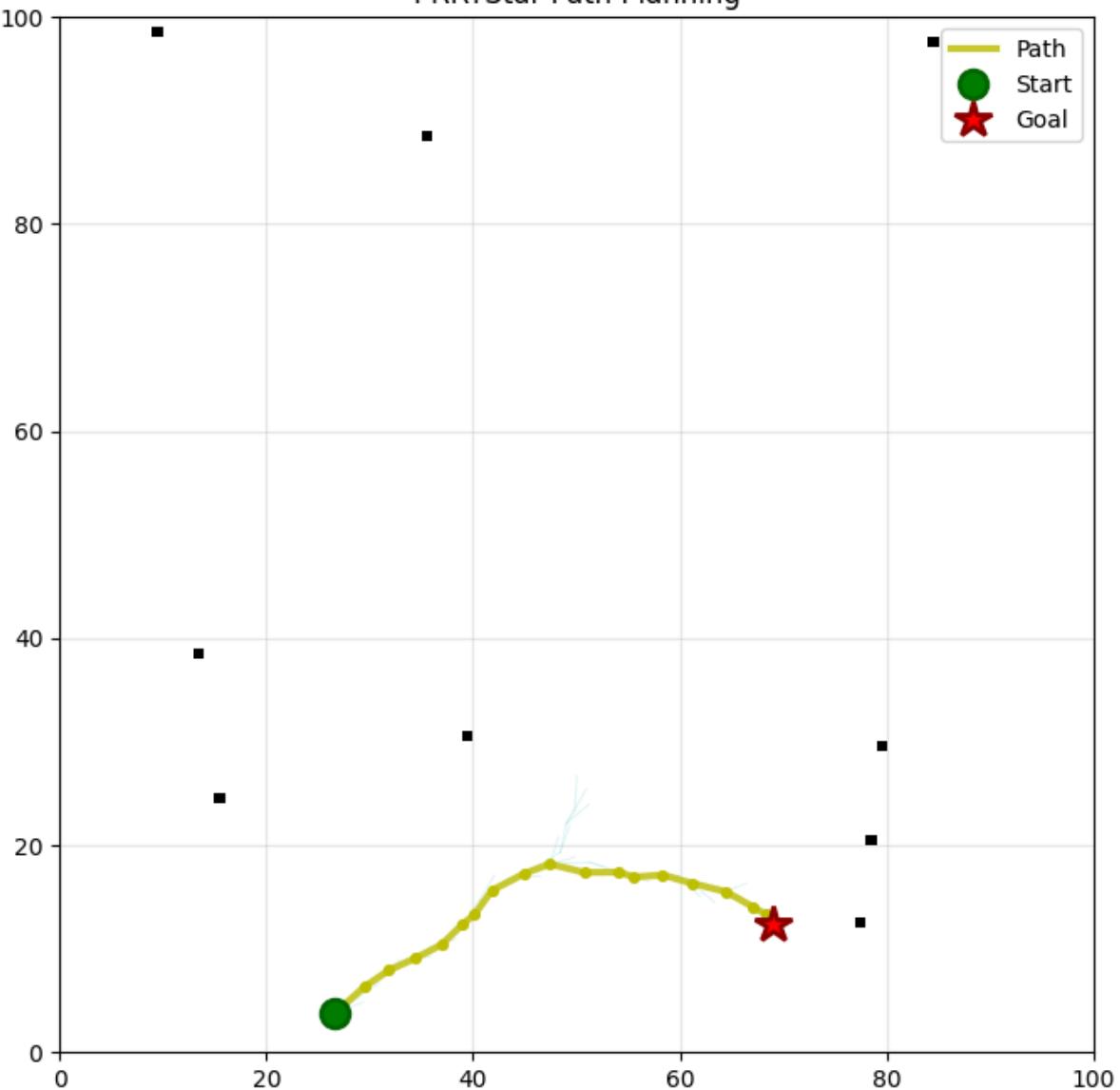


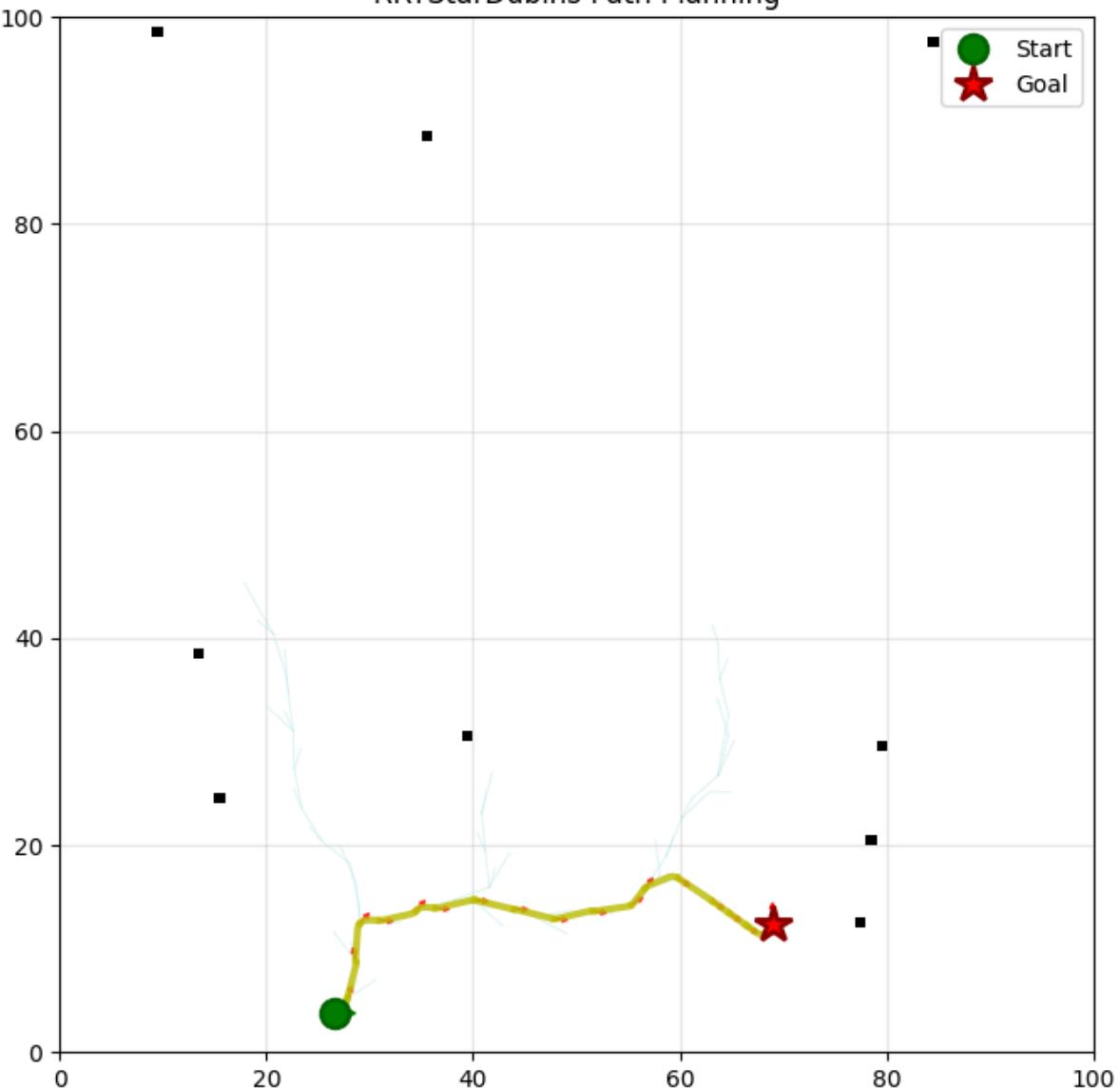
Path: 62.36 | Nodes: 182 | Time: 0.07s

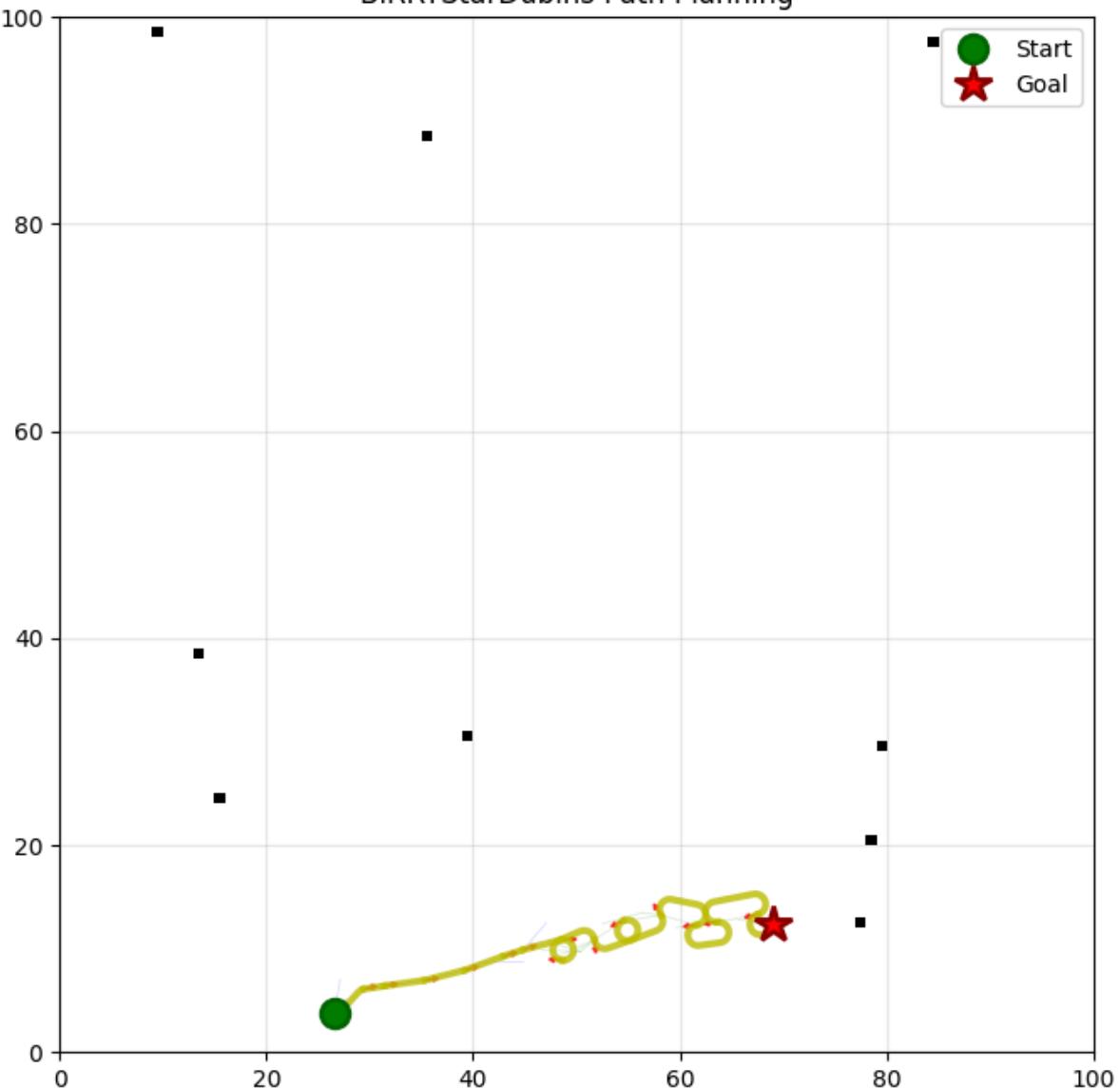
### BiRRTStar [Early Stop]



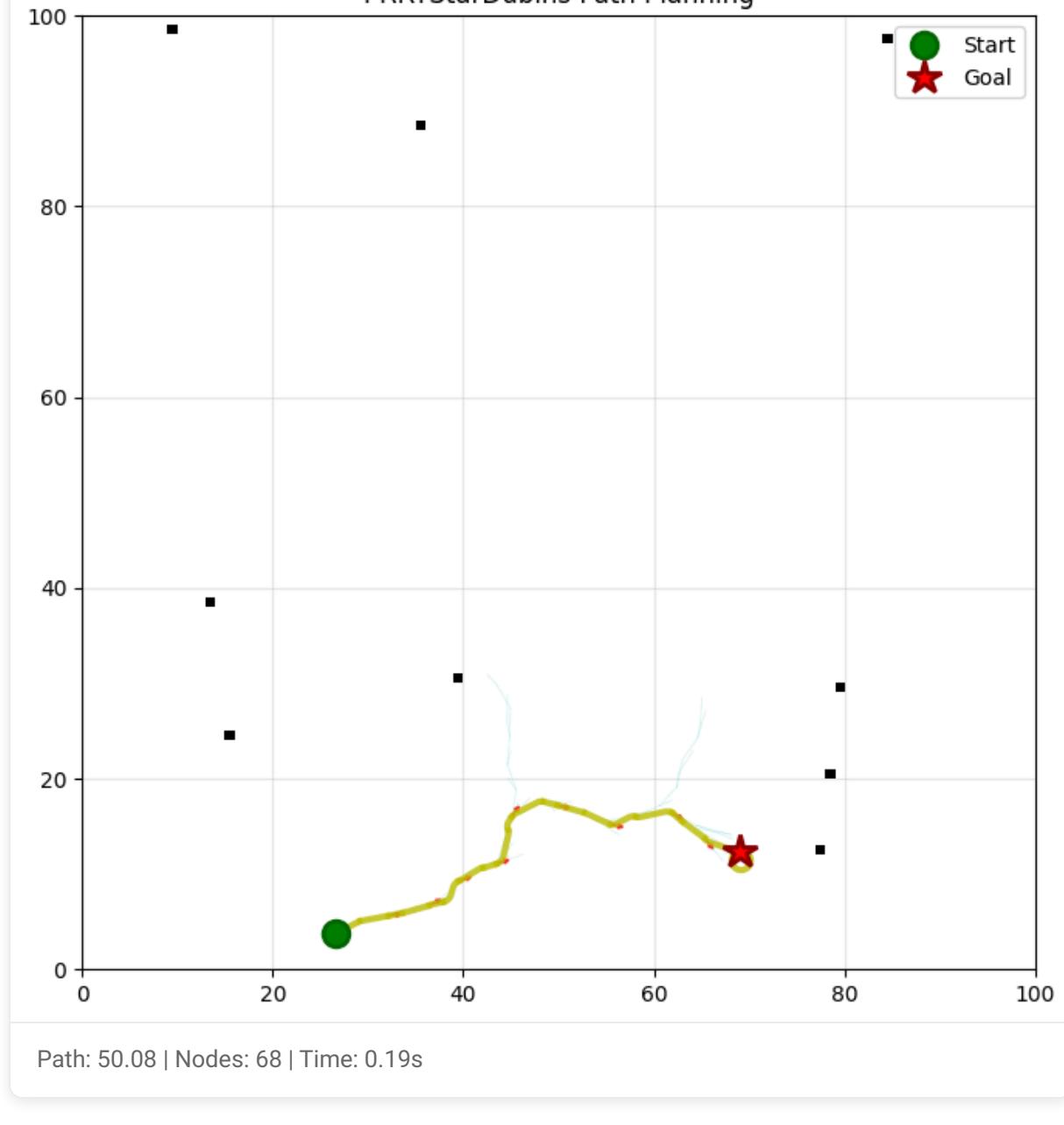
### PRRTStar [Early Stop]

**PRRTStar Path Planning****RRTStarDubins [Early Stop]**

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

**BiRRTStarDubins Path Planning****PRRTStarDubins [Early Stop]**

## PRRTStarDubins Path Planning



## Scaled Low Density Environment

Compare RRTStar, BiRRTStar, PRRTStar, and Dubins variants in a 200x200 low-density random environment

## Run 1

**Start:** (59.82262583264242, 19.044591477379196) | **Goal:** (25.34657314944875, 36.19809141054818) | **Env:** RandomEnvironment ({ "width": 200, "height": 200, "density": 0.1, "seed": 52, "robot\_radius": 0.1 })

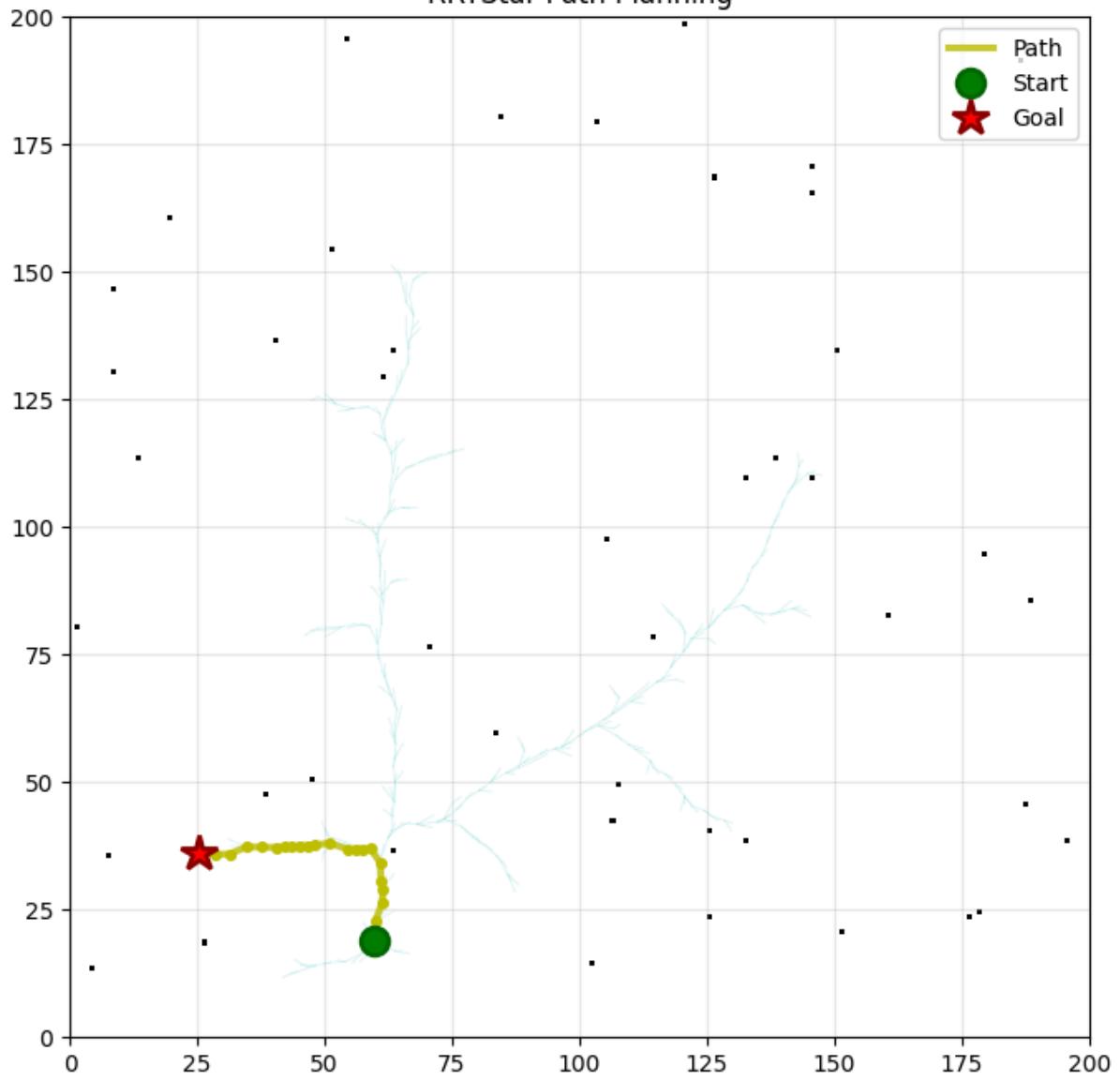
### Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.18	52.99	385	52.99
BiRRTStar ES	✓ Success	0.00	40.99	36	40.99
PRRTStar ES	✓ Success	0.22	40.98	70	40.98
RRTStarDubins ES	✓ Success	0.03	40.48	134	42.08
BiRRTStarDubins ES	✓ Success	0.00	50.13	66	55.05
PRRTStarDubins ES	✓ Success	0.39	49.74	120	57.15

### Path Visualizations

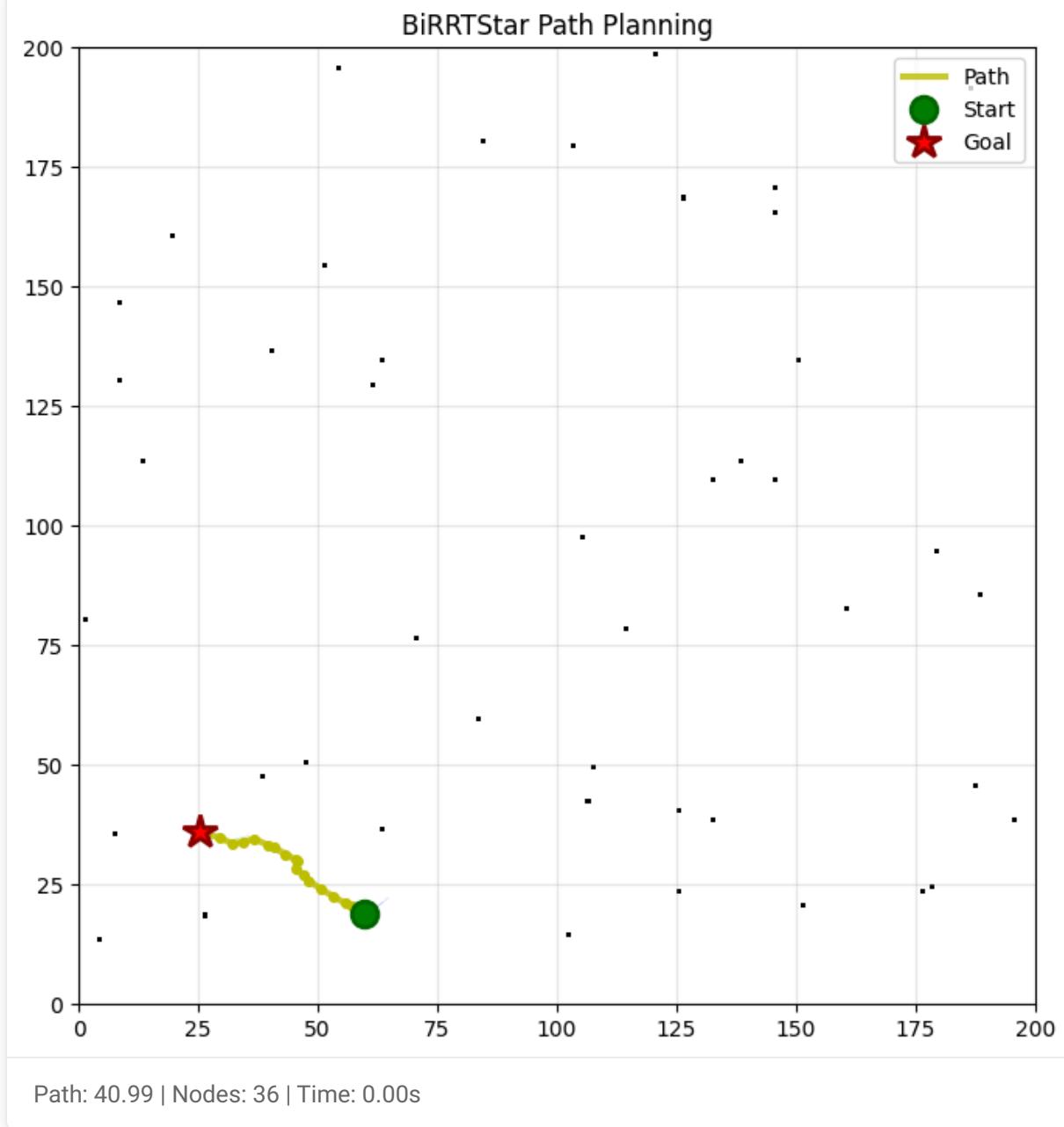
#### RRTStar [Early Stop]

### RRTStar Path Planning



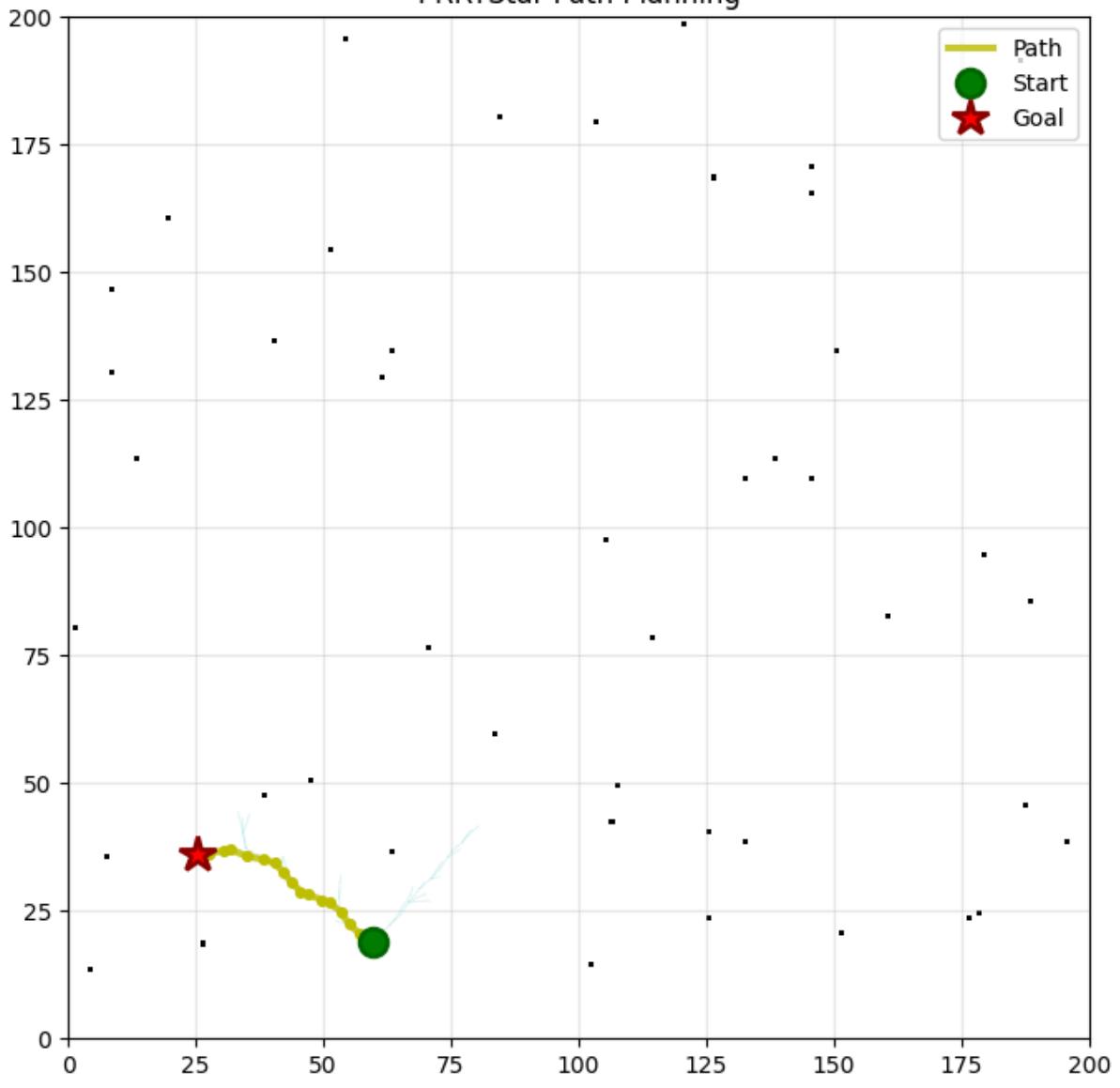
Path: 52.99 | Nodes: 385 | Time: 0.18s

### BiRRTStar [Early Stop]



### PRRTStar [Early Stop]

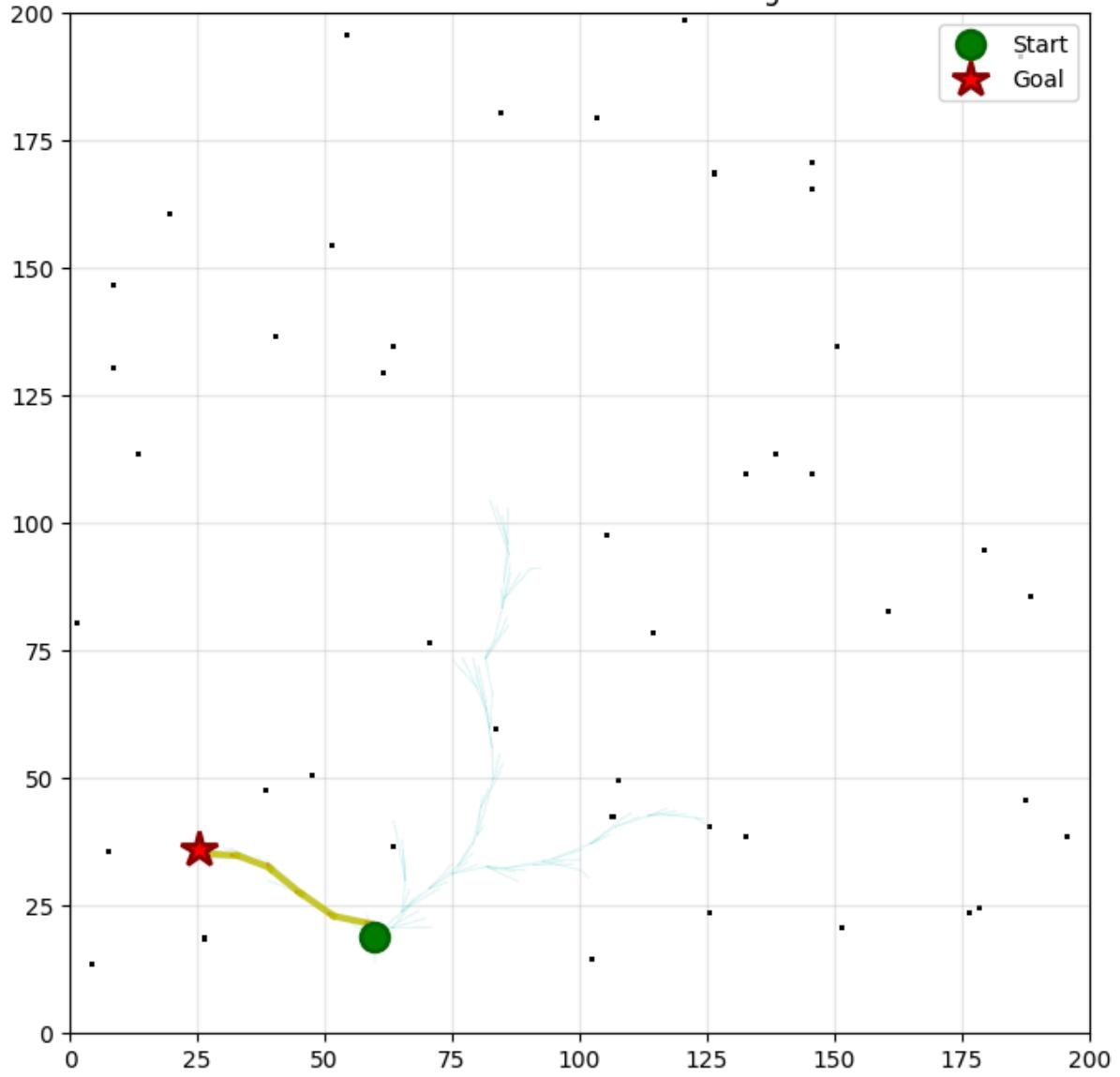
### PRRTStar Path Planning



Path: 40.98 | Nodes: 70 | Time: 0.22s

### RRTStarDubins [Early Stop]

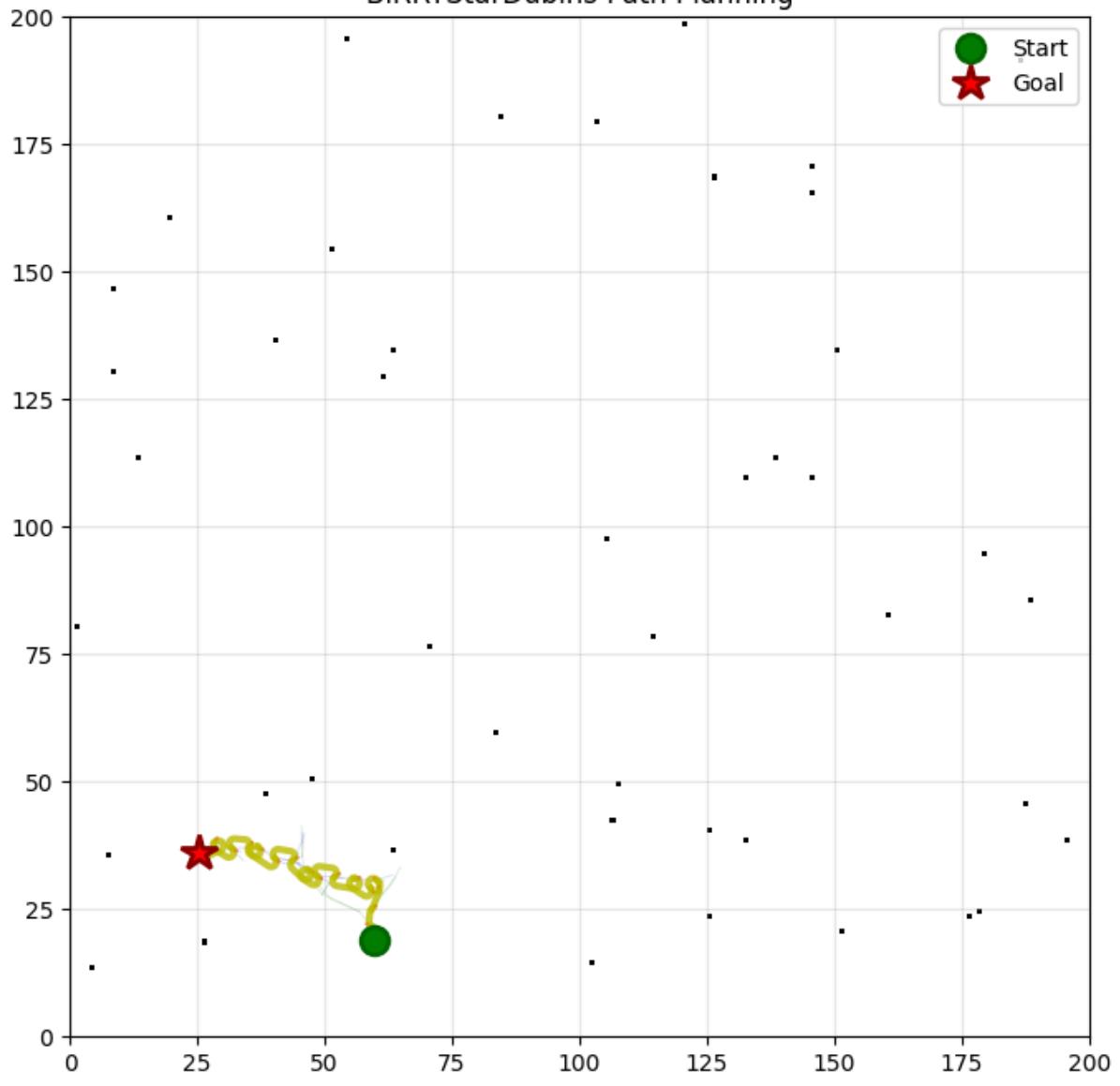
### RRTStarDubins Path Planning



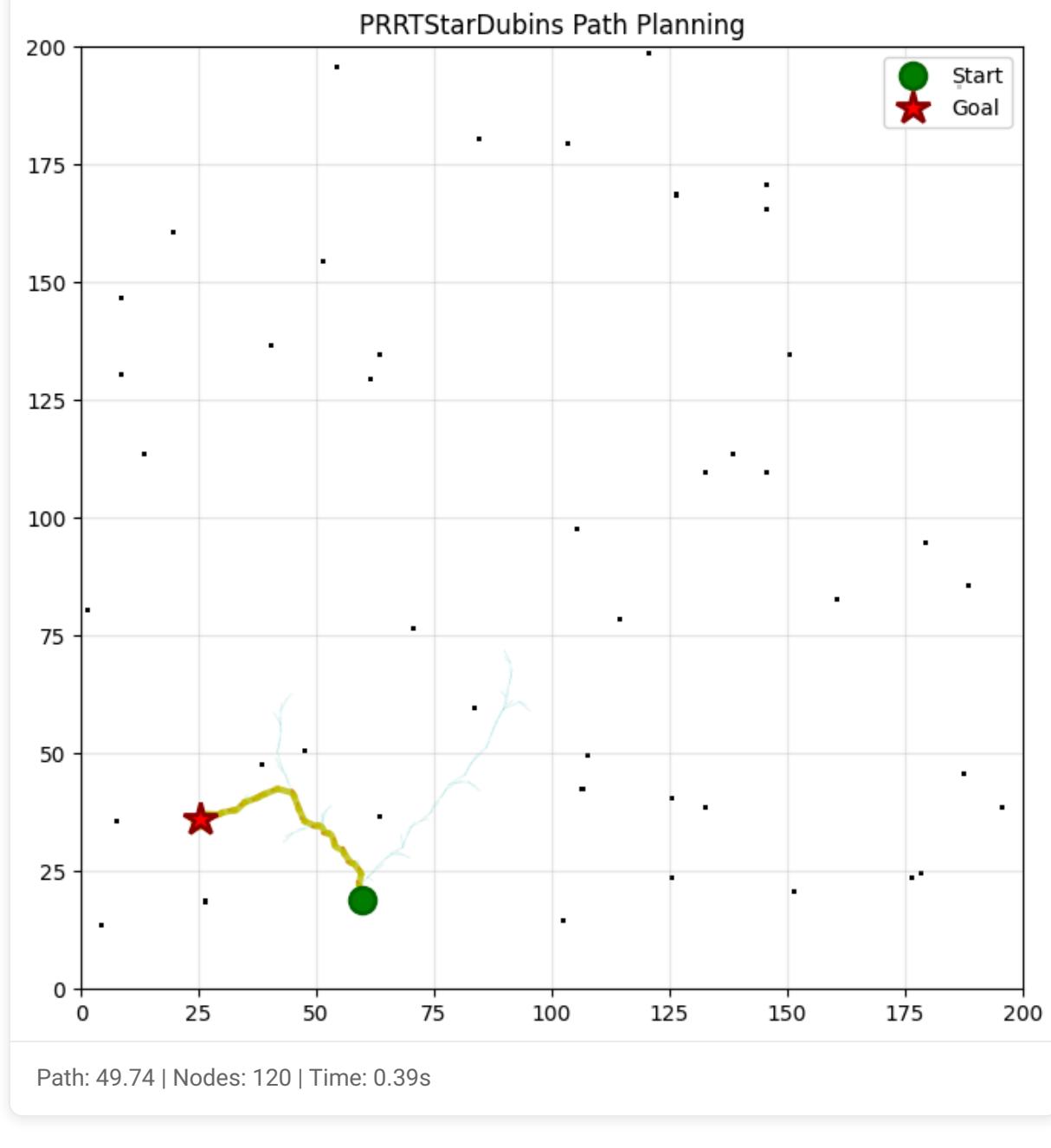
Path: 40.48 | Nodes: 134 | Time: 0.03s

### BiRRTStarDubins [Early Stop]

### BiRRTStarDubins Path Planning



### PRRTStarDubins [Early Stop]



## Run 2

**Start:** (171.75293632774836, 105.81813207722942) | **Goal:** (52.02168478106393, 192.03819703437668) | **Env:** RandomEnvironment ({"width": 200, "height": 200, "density": 0.1, "seed": 52, "robot\_radius": 0.1})

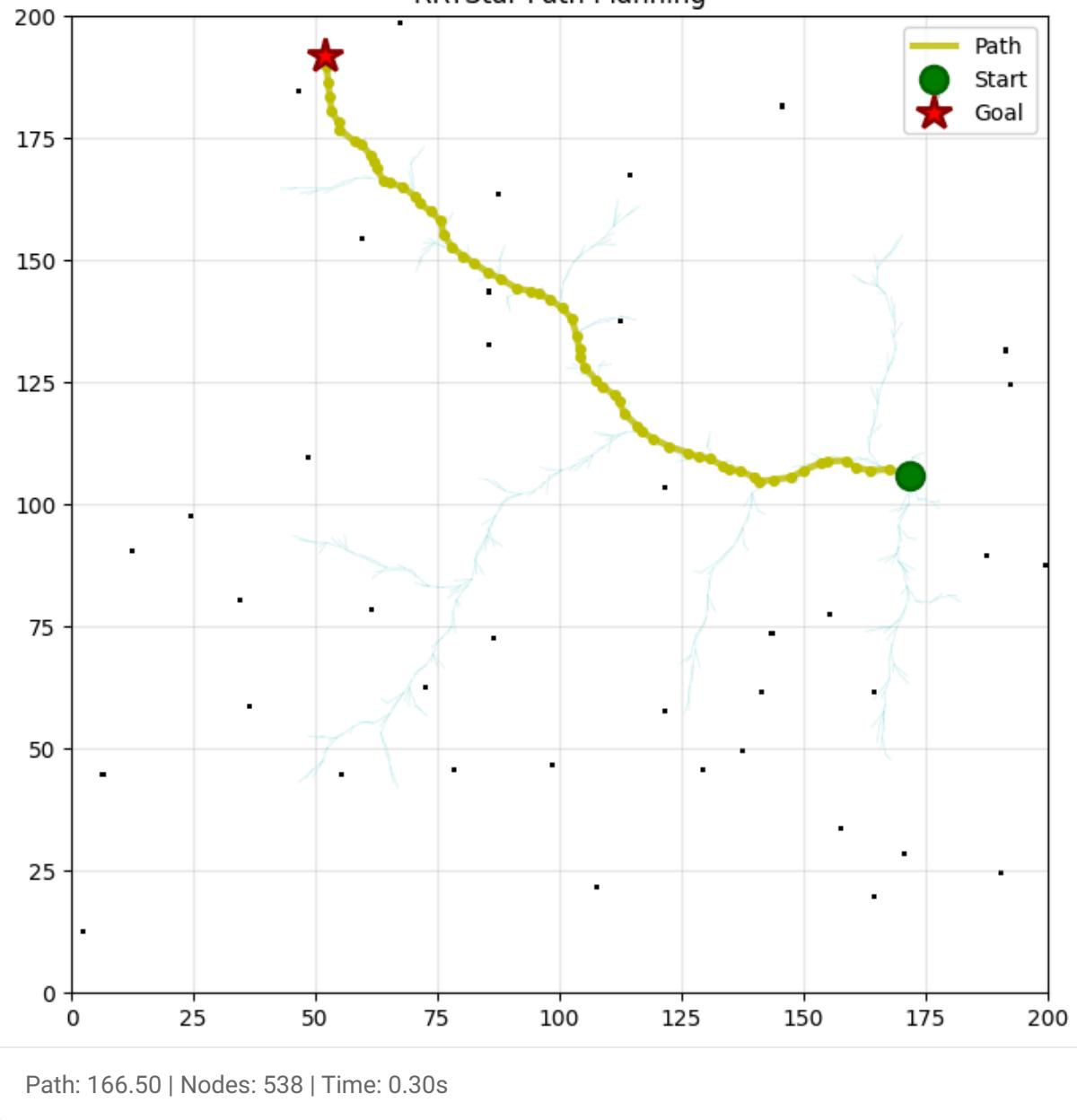
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.30	166.50	538	166.63
BiRRTStar ES	✓ Success	0.02	154.44	125	154.44
PRRTStar ES	✓ Success	1.16	159.35	316	159.35
RRTStarDubins ES	✓ Success	0.16	152.42	389	153.97
BiRRTStarDubins ES	✓ Success	0.01	157.99	128	162.31
PRRTStarDubins ES	✓ Success	1.04	158.50	300	166.81

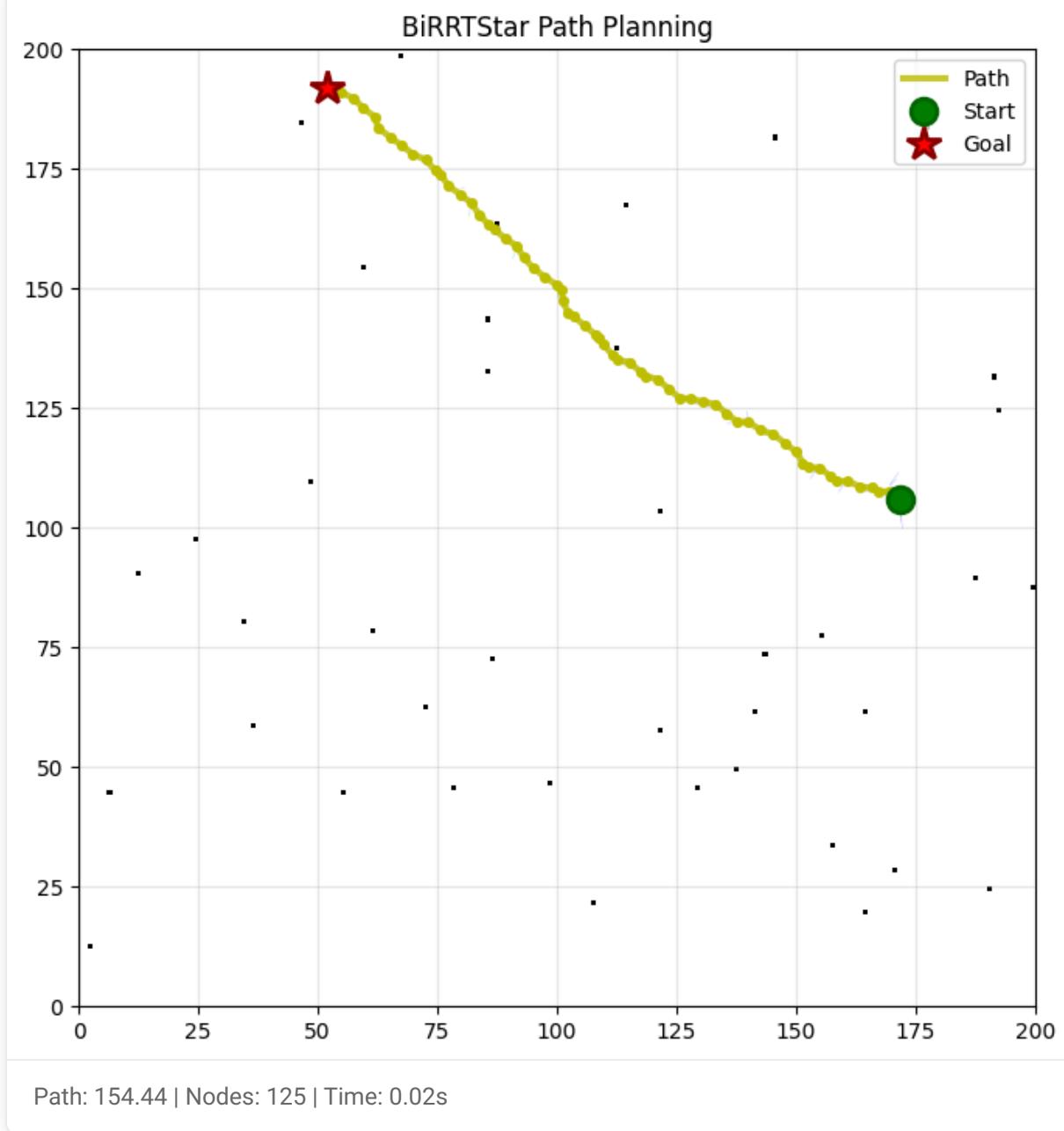
## Path Visualizations

RRTStar [Early Stop]

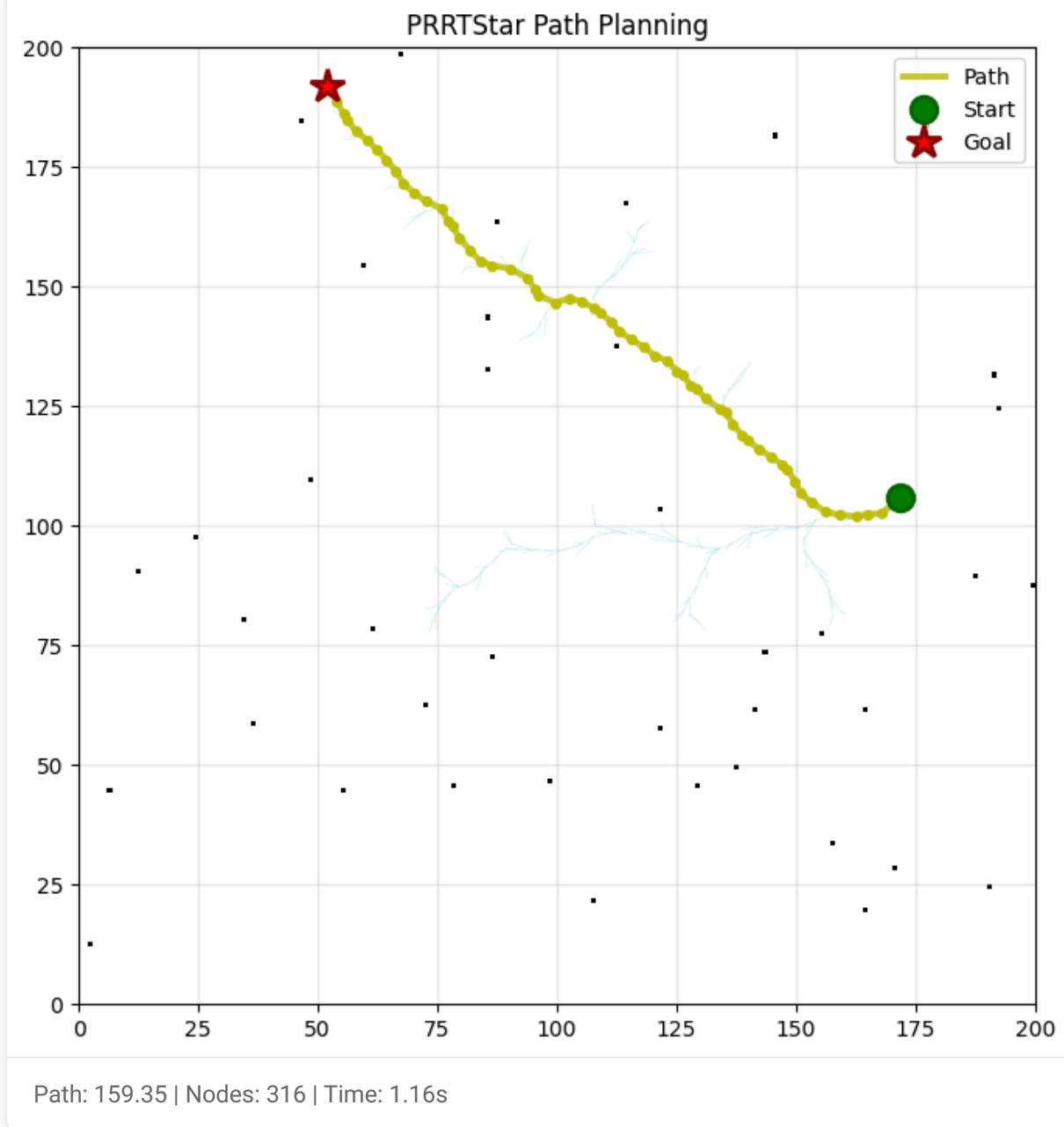
### RRTStar Path Planning



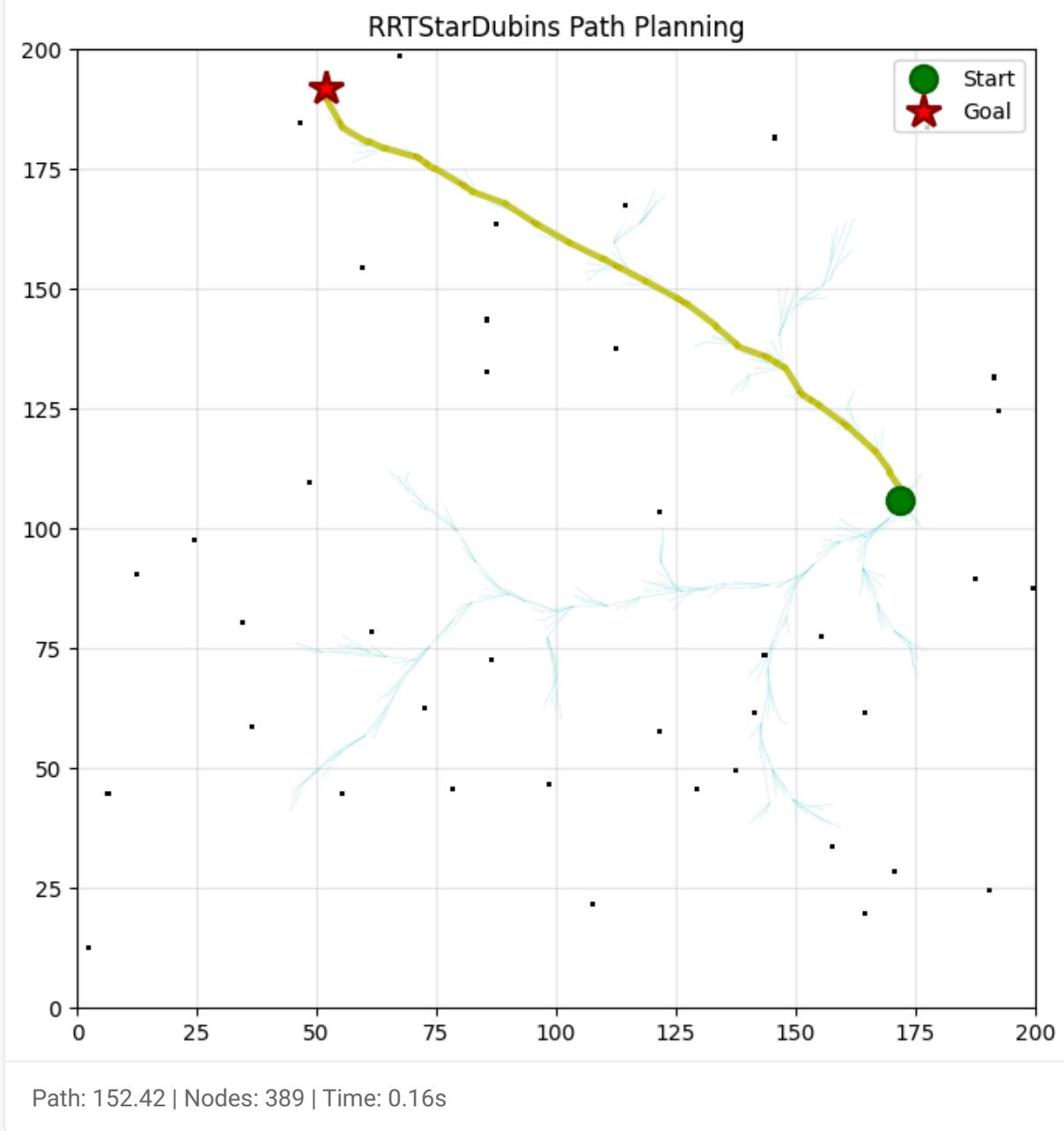
### BiRRTStar [Early Stop]



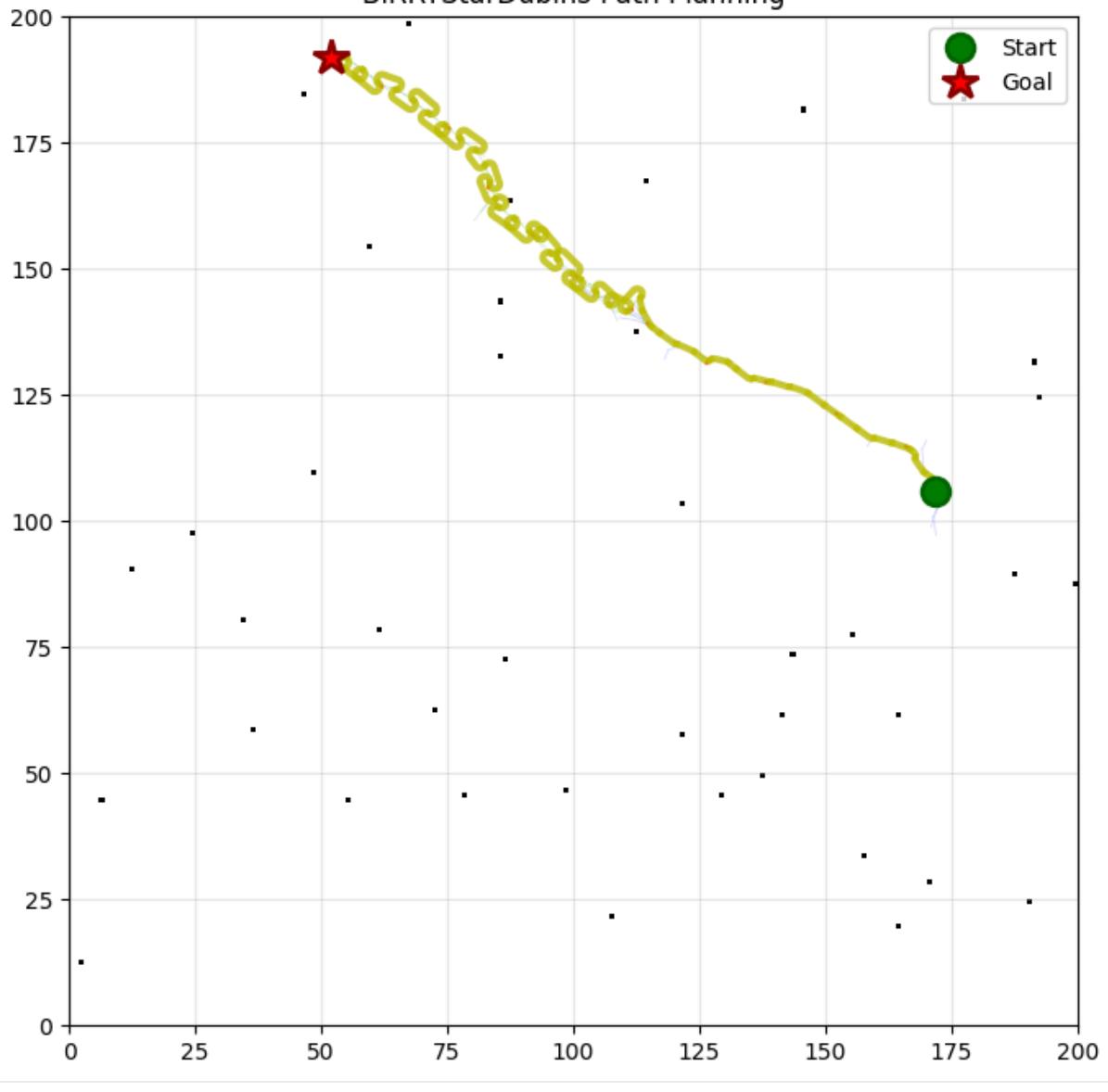
### PRRTStar [Early Stop]

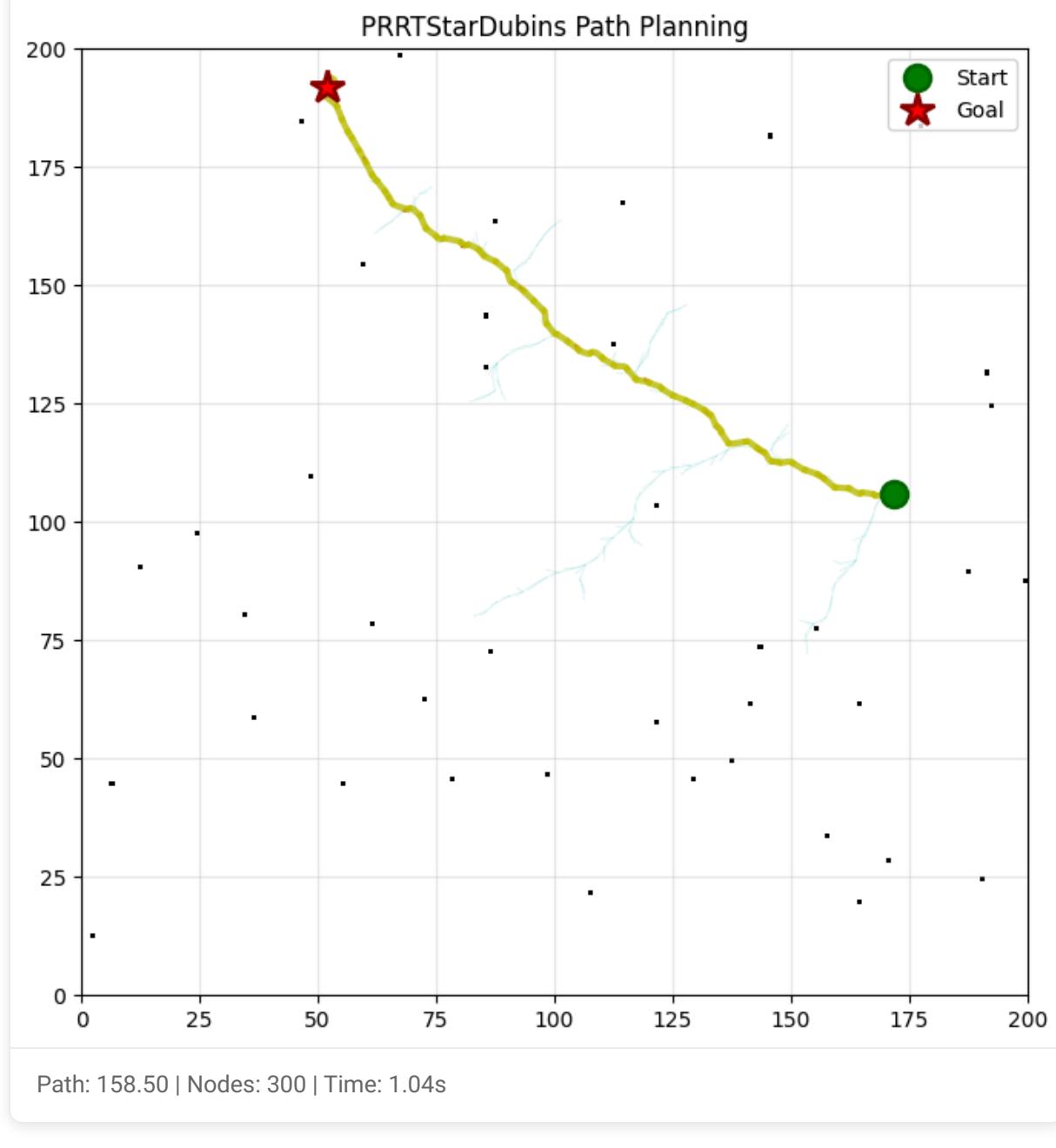


### RRTStarDubins [Early Stop]



### BiRRTStarDubins [Early Stop]

**BiRRTStarDubins Path Planning****PRRTStarDubins [Early Stop]**



## Run 3

**Start:** (69.55755602954434, 141.24517500861435) | **Goal:** (13.645461370841257, 27.116837842520237) | **Env:** RandomEnvironment ({"width": 200, "height": 200, "density": 0.1, "seed": 52, "robot\_radius": 0.1})

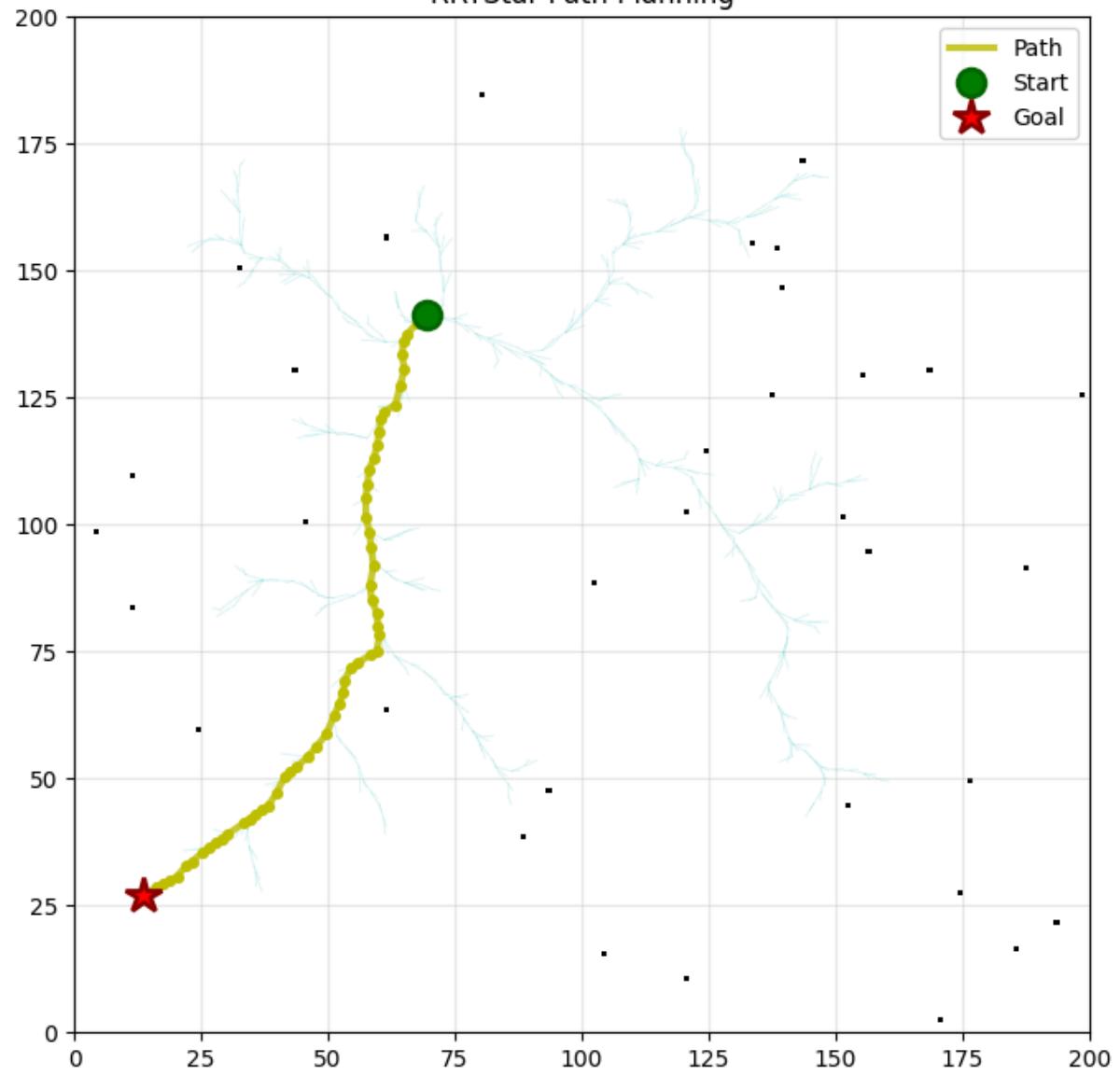
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.41	139.39	655	139.53
BiRRTStar ES	✓ Success	0.01	130.82	106	130.82
PRRTStar ES	✓ Success	0.99	132.62	282	132.62
RRTStarDubins ES	✓ Success	0.10	134.61	287	135.89
BiRRTStarDubins ES	✓ Success	0.01	131.03	104	133.50
PRRTStarDubins ES	✓ Success	1.20	138.69	348	146.59

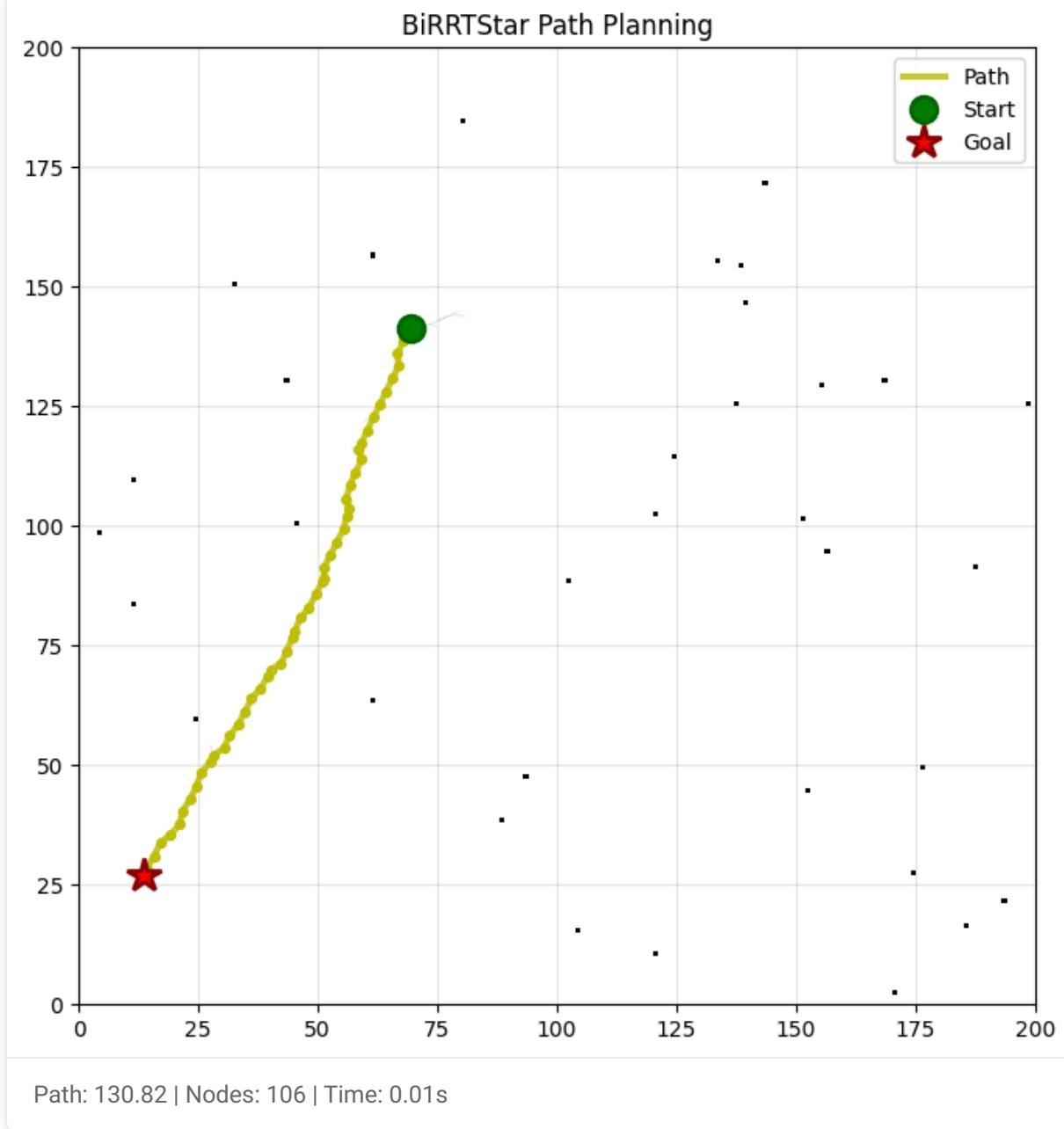
## Path Visualizations

RRTStar [Early Stop]

### RRTStar Path Planning

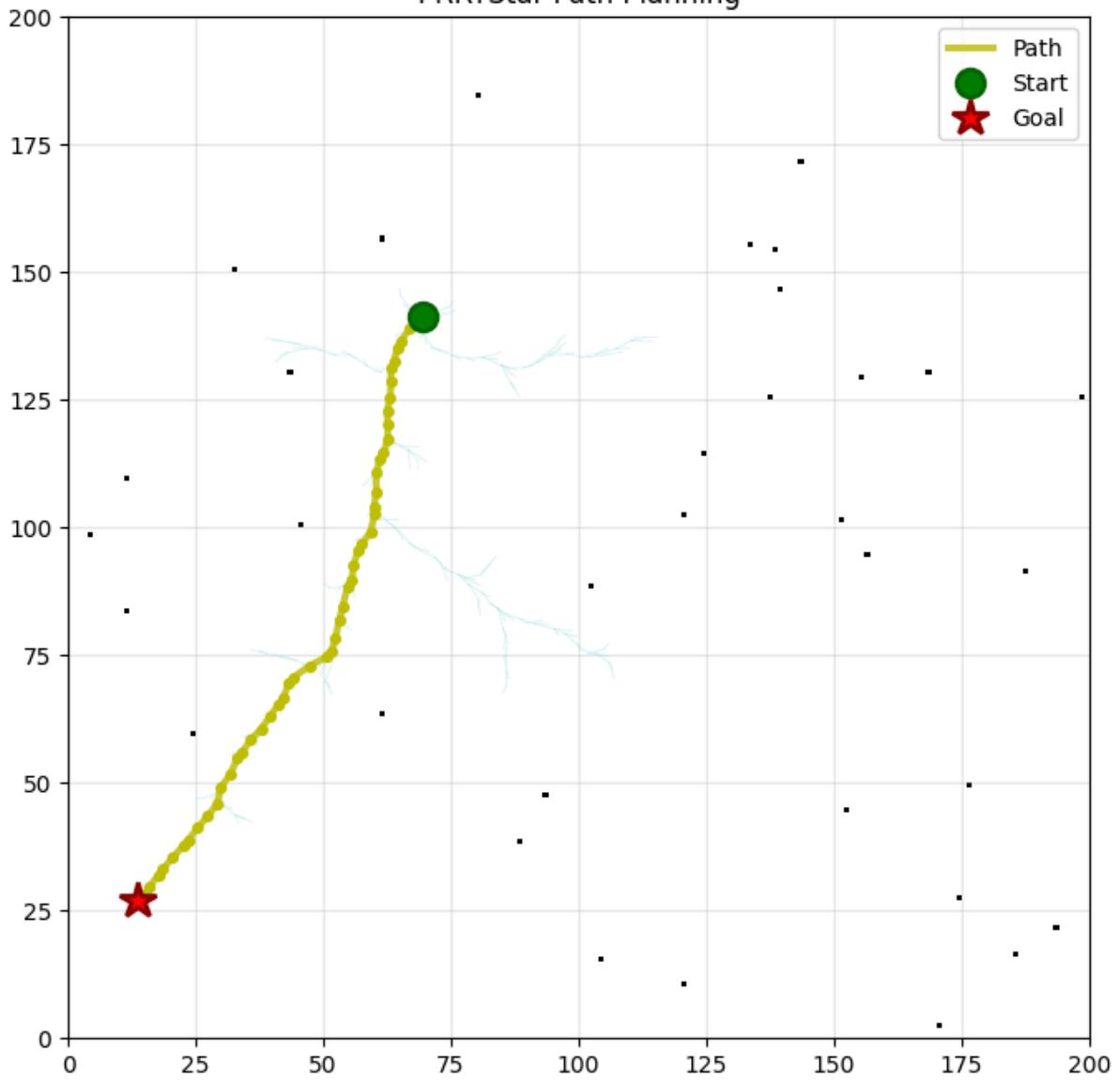


### BiRRTStar [Early Stop]



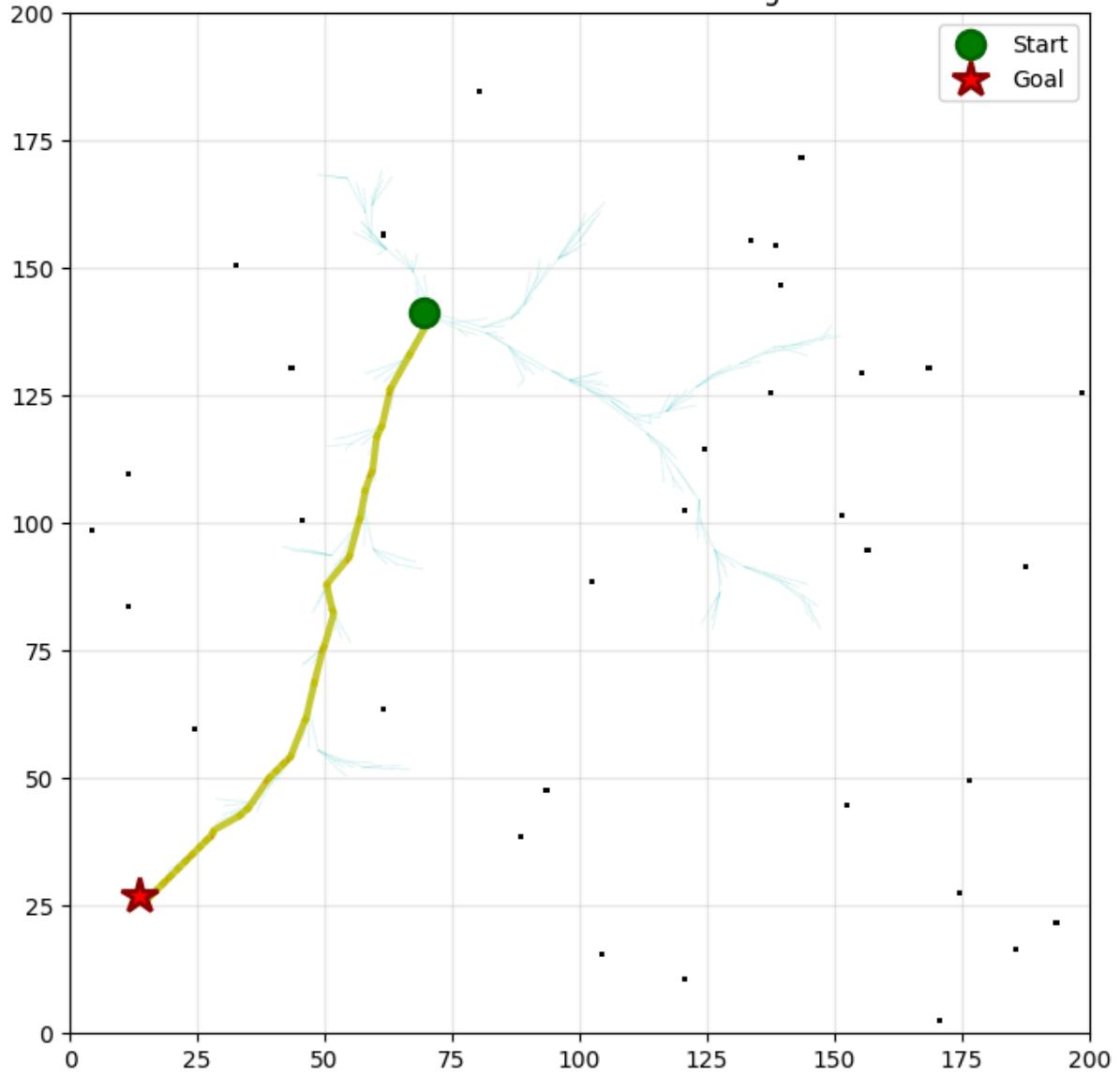
### PRRTStar [Early Stop]

### PRRTStar Path Planning



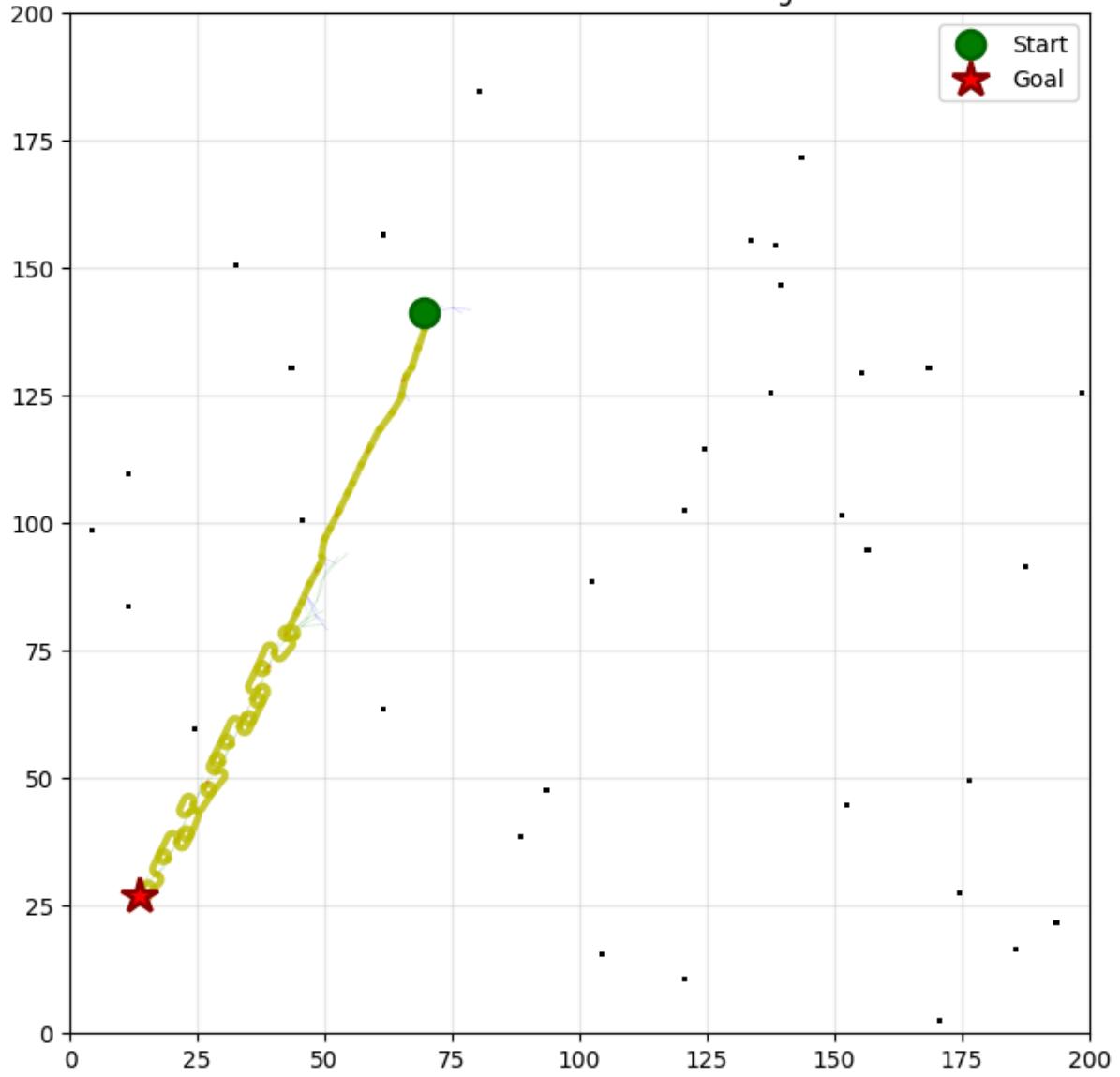
### RRTStarDubins [Early Stop]

### RRTStarDubins Path Planning



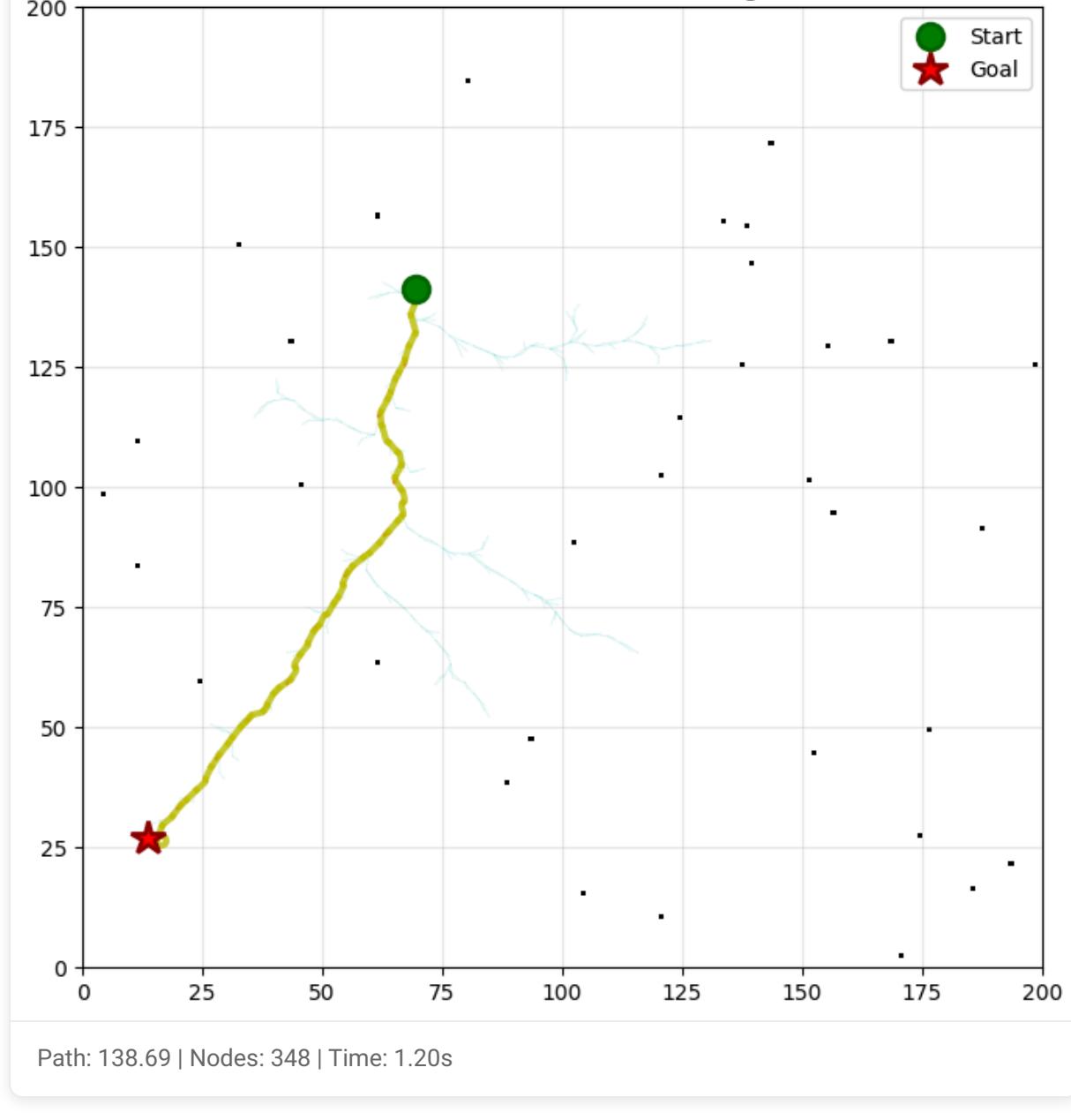
### BiRRTStarDubins [Early Stop]

### BiRRTStarDubins Path Planning



### PRRTStarDubins [Early Stop]

## PRRTStarDubins Path Planning



## Run 4

**Start:** (183.01964765116847, 94.37533772540178) | **Goal:** (91.39916501320715, 67.16777232980182) | **Env:** RandomEnvironment ({ "width": 200, "height": 200, "density": 0.1, "seed": 52, "robot\_radius": 0.1 })

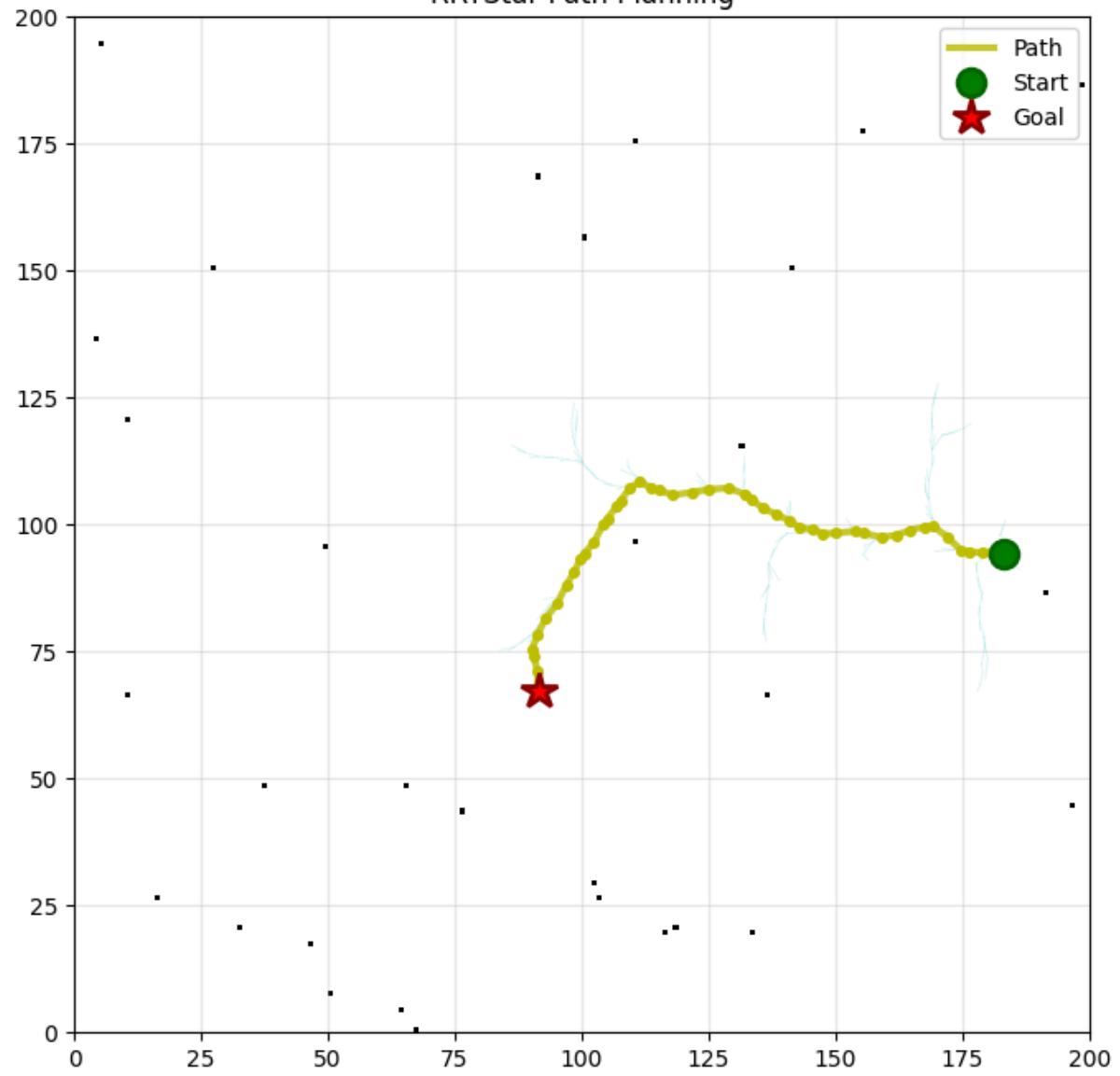
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.08	124.98	213	124.98
BiRRTStar ES	✓ Success	0.01	100.38	80	100.38
PRRTStar ES	✓ Success	0.38	101.19	115	101.19
RRTStarDubins ES	✓ Success	0.03	109.41	132	112.01
BiRRTStarDubins ES	✓ Success	0.01	109.56	150	112.57
PRRTStarDubins ES	✓ Success	0.34	102.85	107	110.24

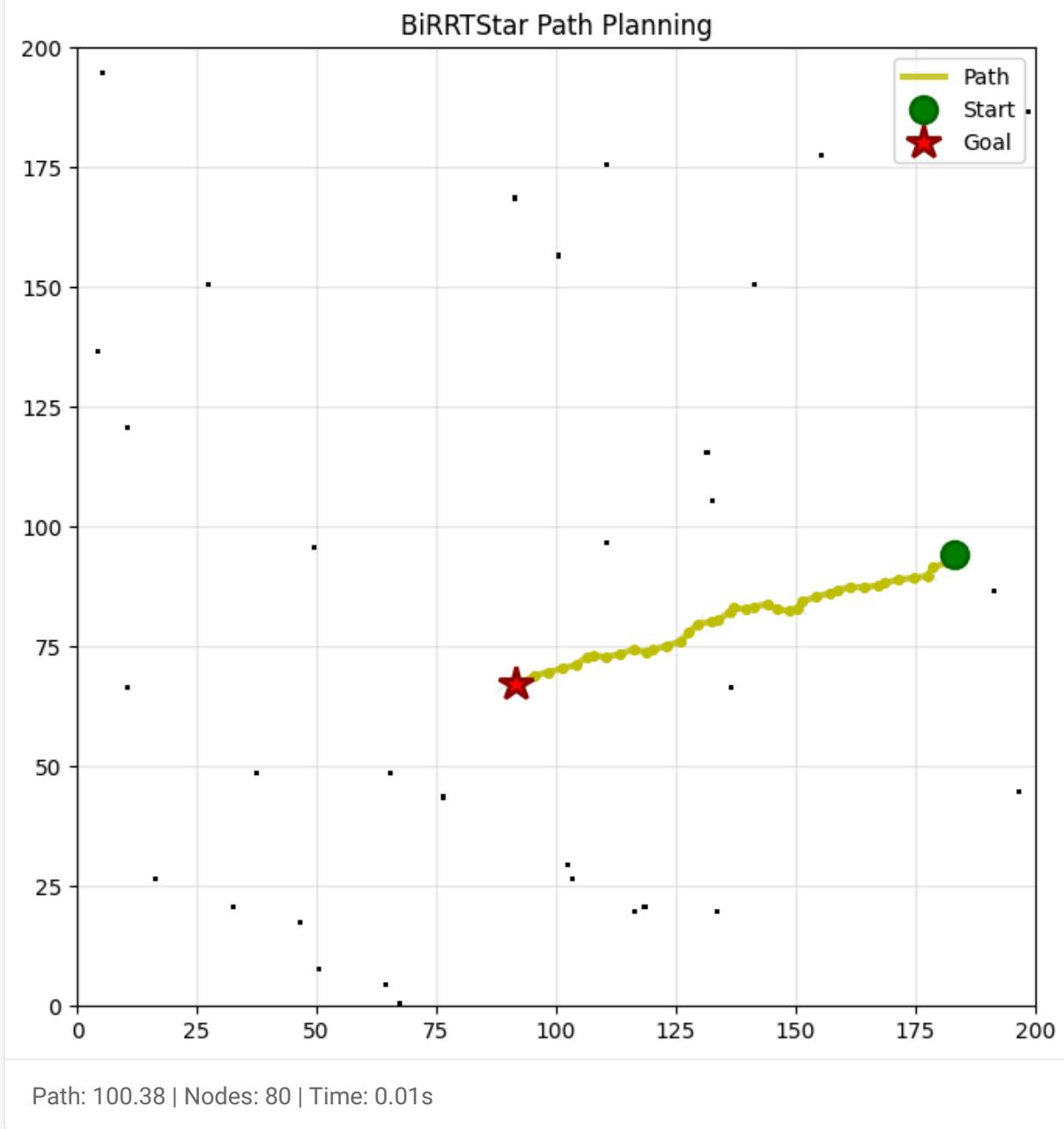
## Path Visualizations

### RRTStar [Early Stop]

### RRTStar Path Planning

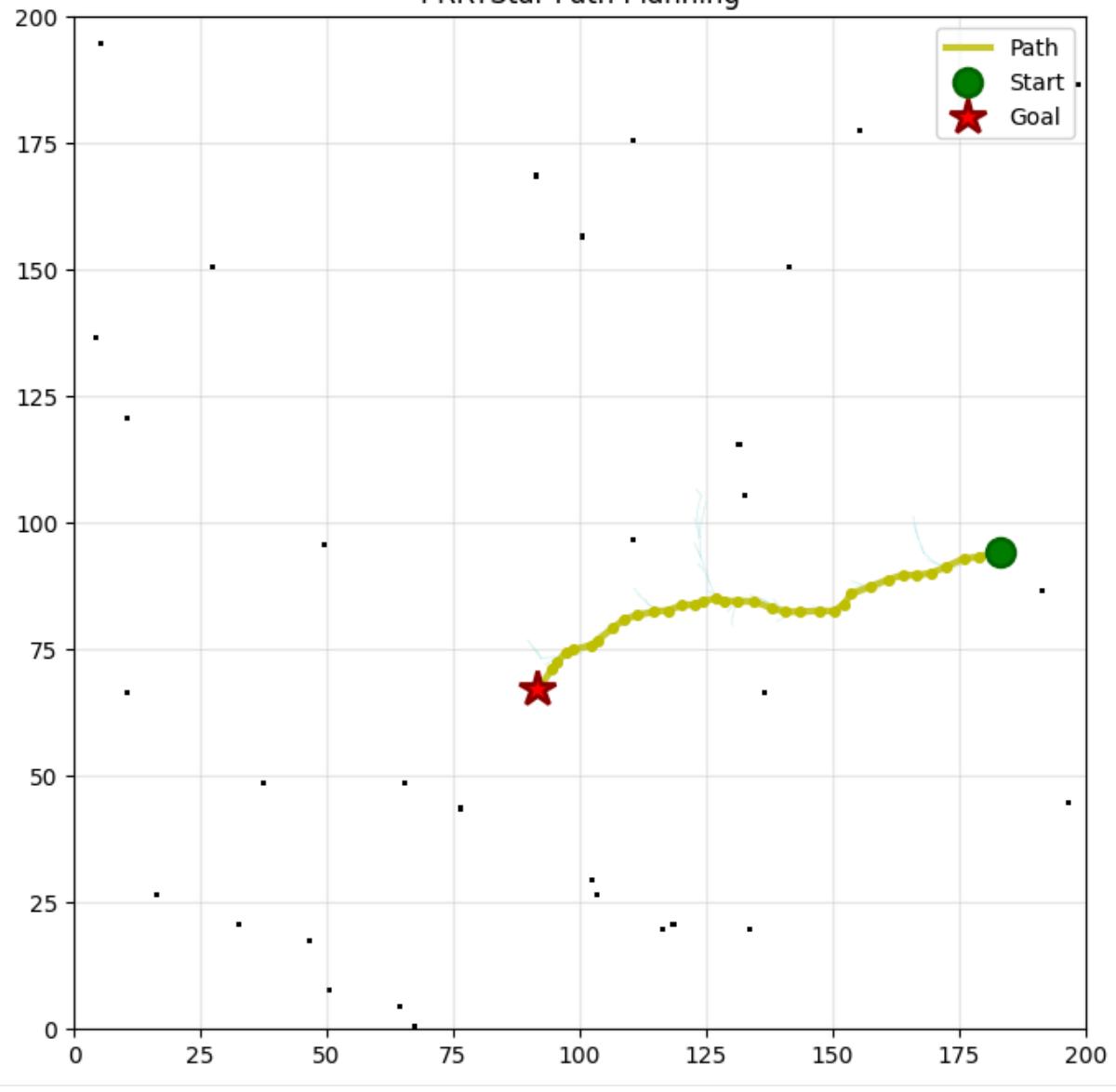


### BiRRTStar [Early Stop]



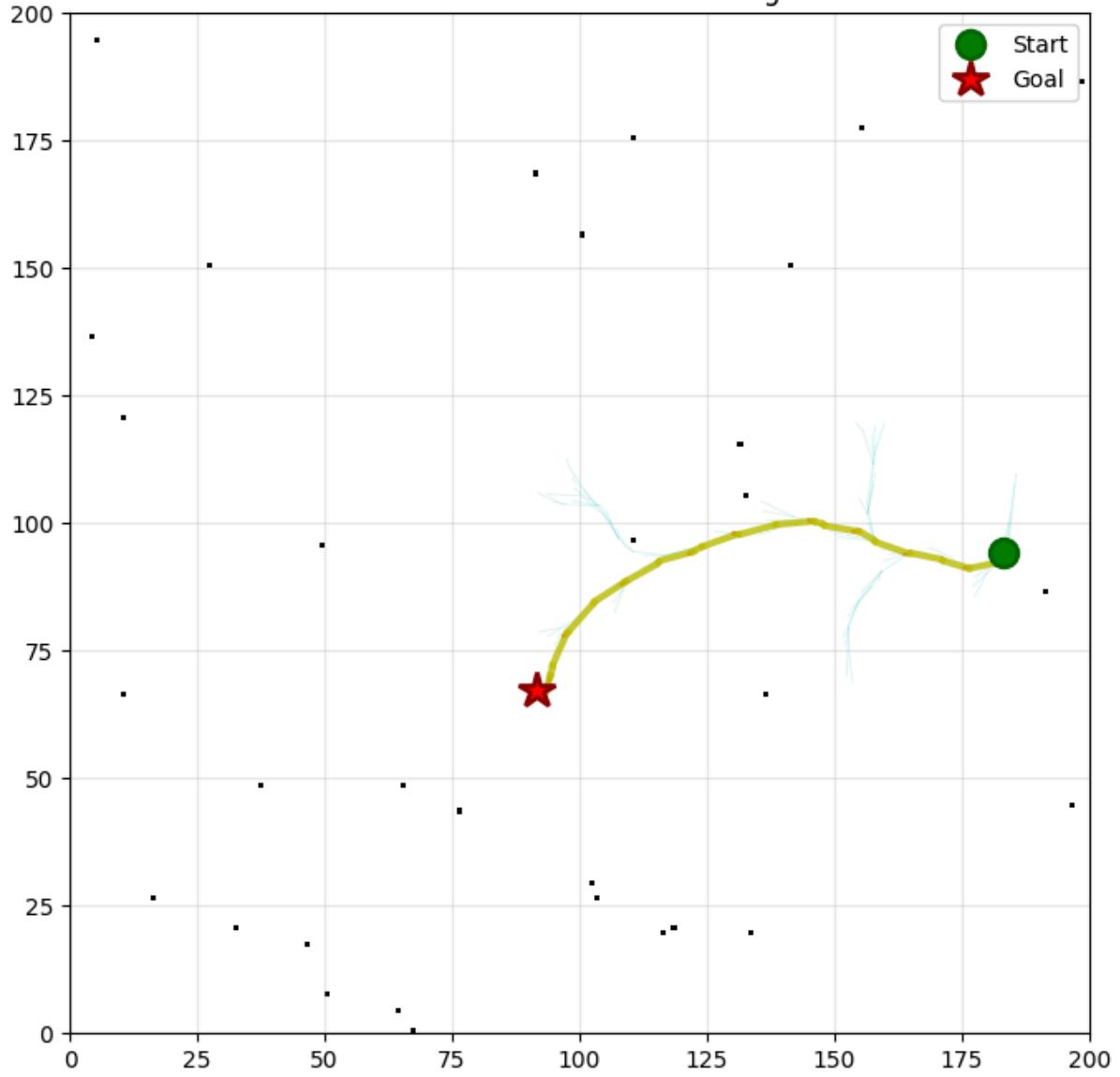
### PRRTStar [Early Stop]

### PRRTStar Path Planning



### RRTStarDubins [Early Stop]

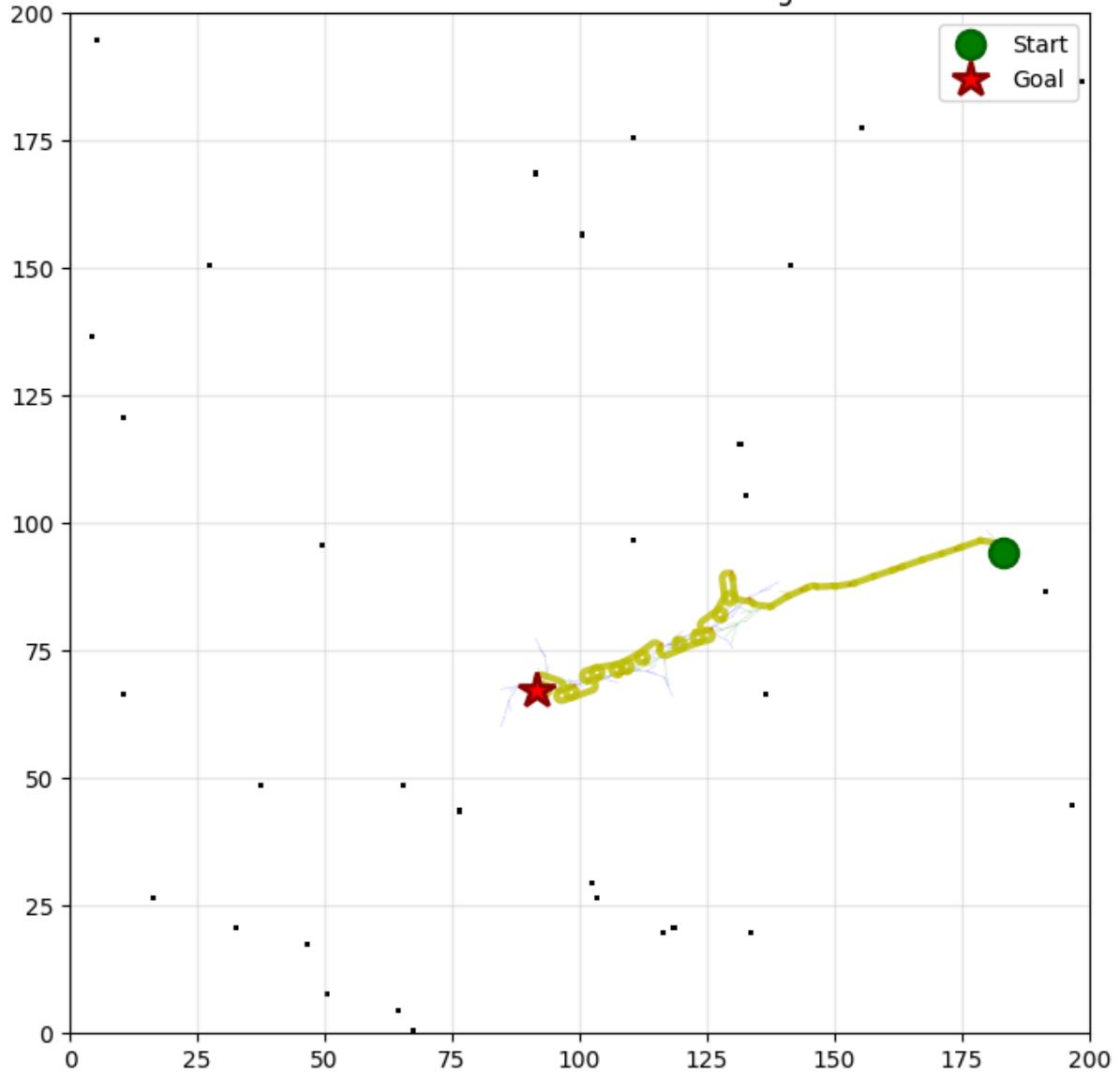
### RRTStarDubins Path Planning



Path: 109.41 | Nodes: 132 | Time: 0.03s

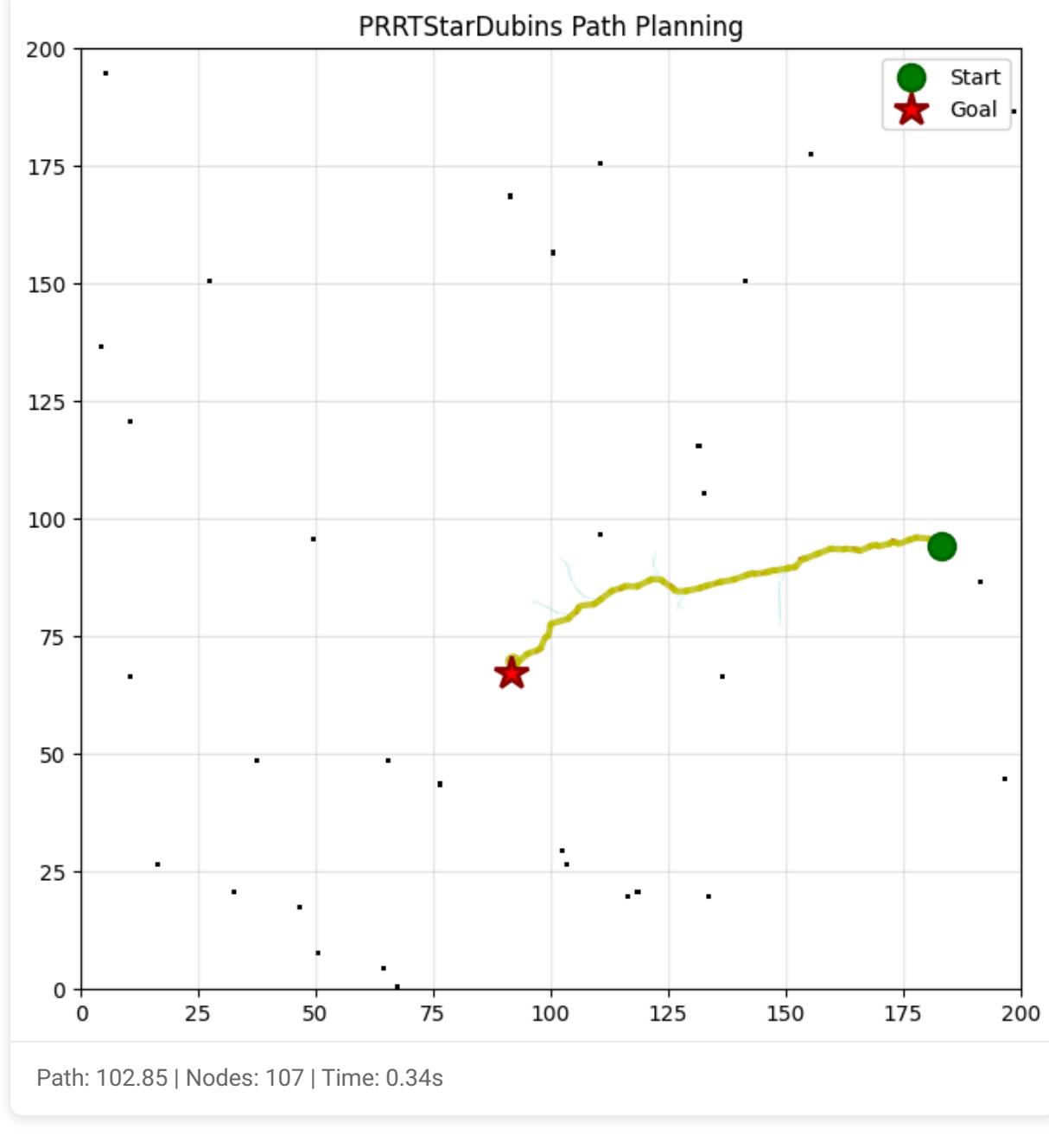
### BiRRTStarDubins [Early Stop]

### BiRRTStarDubins Path Planning



Path: 109.56 | Nodes: 150 | Time: 0.01s

### PRRTStarDubins [Early Stop]



## Run 5

**Start:** (125.78692118079351, 183.05992921088335) | **Goal:** (12.413030953899714, 196.04485598674862) | **Env:** RandomEnvironment ({"width": 200, "height": 200, "density": 0.1, "seed": 52, "robot\_radius": 0.1})

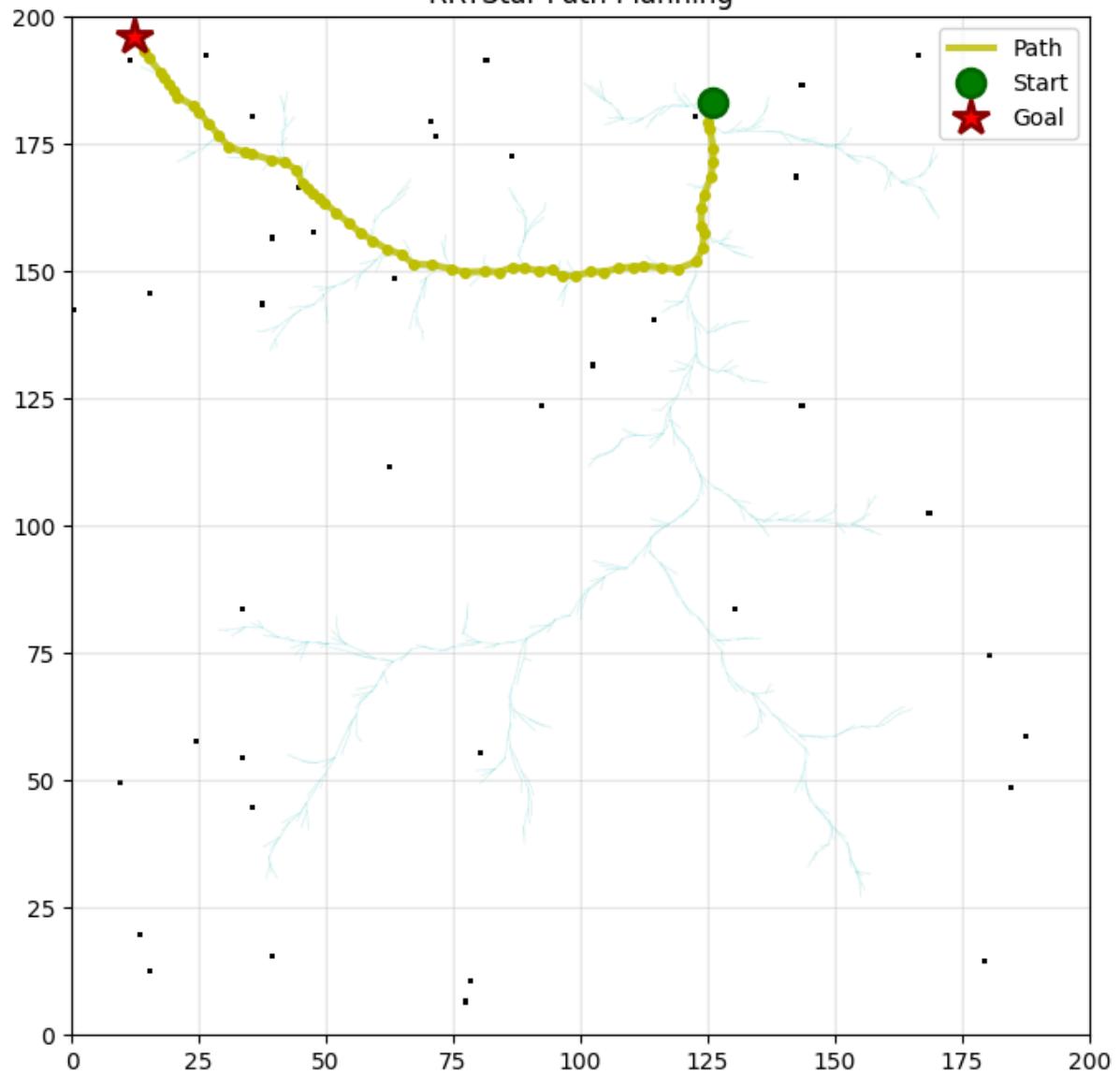
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.51	161.70	761	161.75
BiRRTStar ES	✓ Success	0.01	120.21	101	120.21
PRRTStar ES	✓ Success	1.21	123.20	341	123.20
RRTStarDubins ES	✓ Success	0.14	118.90	363	121.02
BiRRTStarDubins ES	✓ Success	0.01	128.70	140	133.38
PRRTStarDubins ES	✓ Success	0.99	130.29	289	139.16

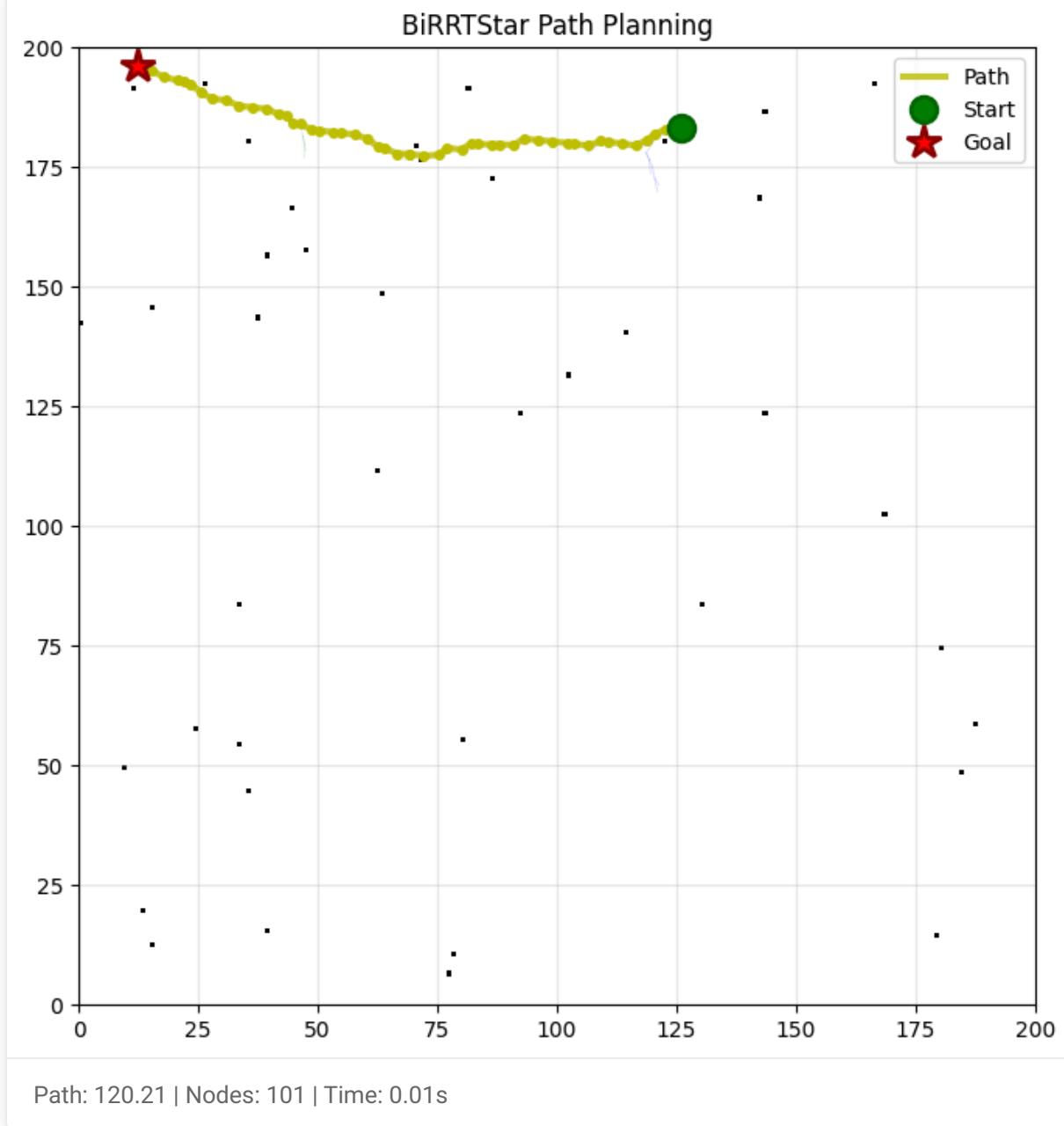
## Path Visualizations

RRTStar [Early Stop]

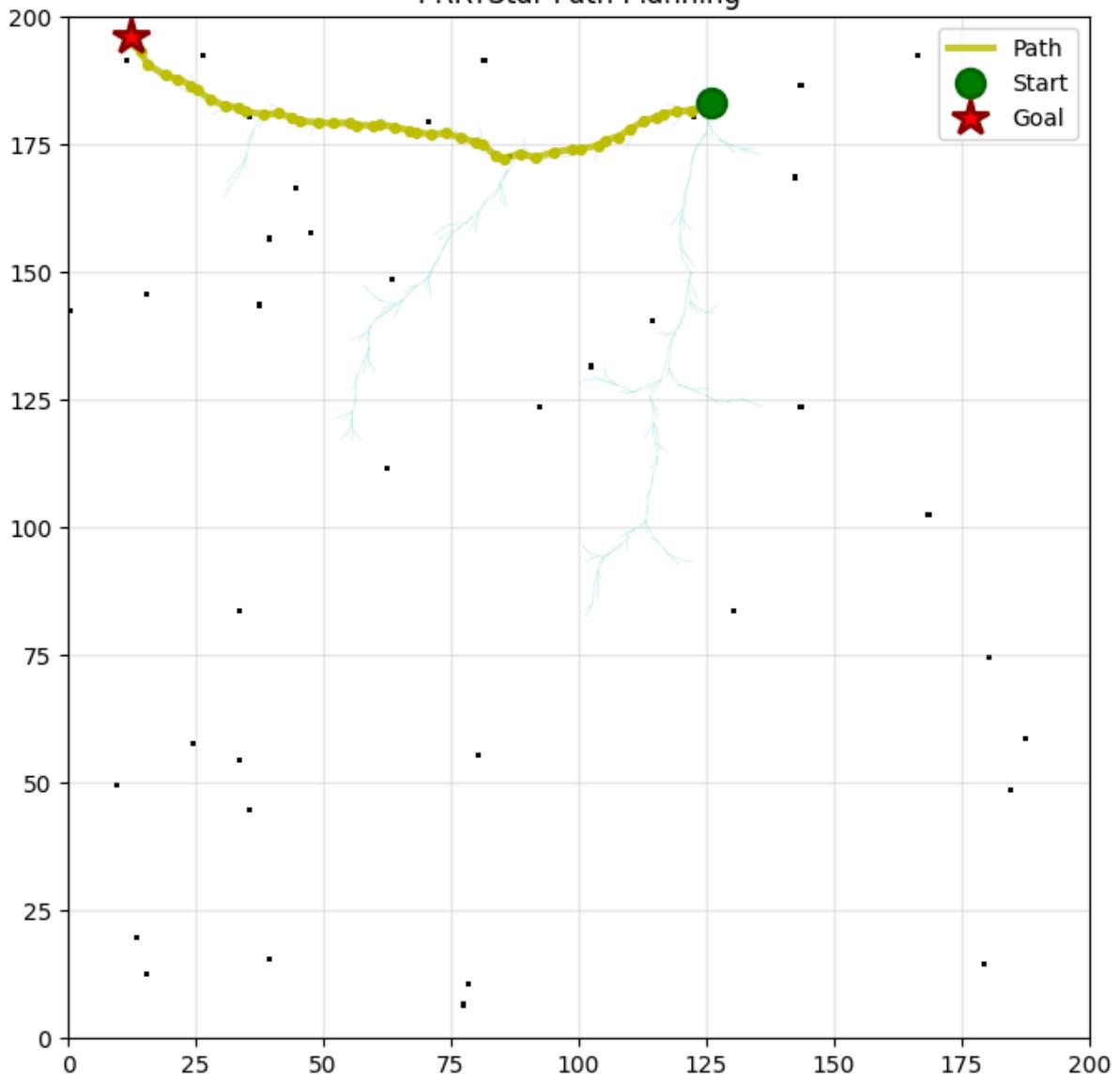
### RRTStar Path Planning

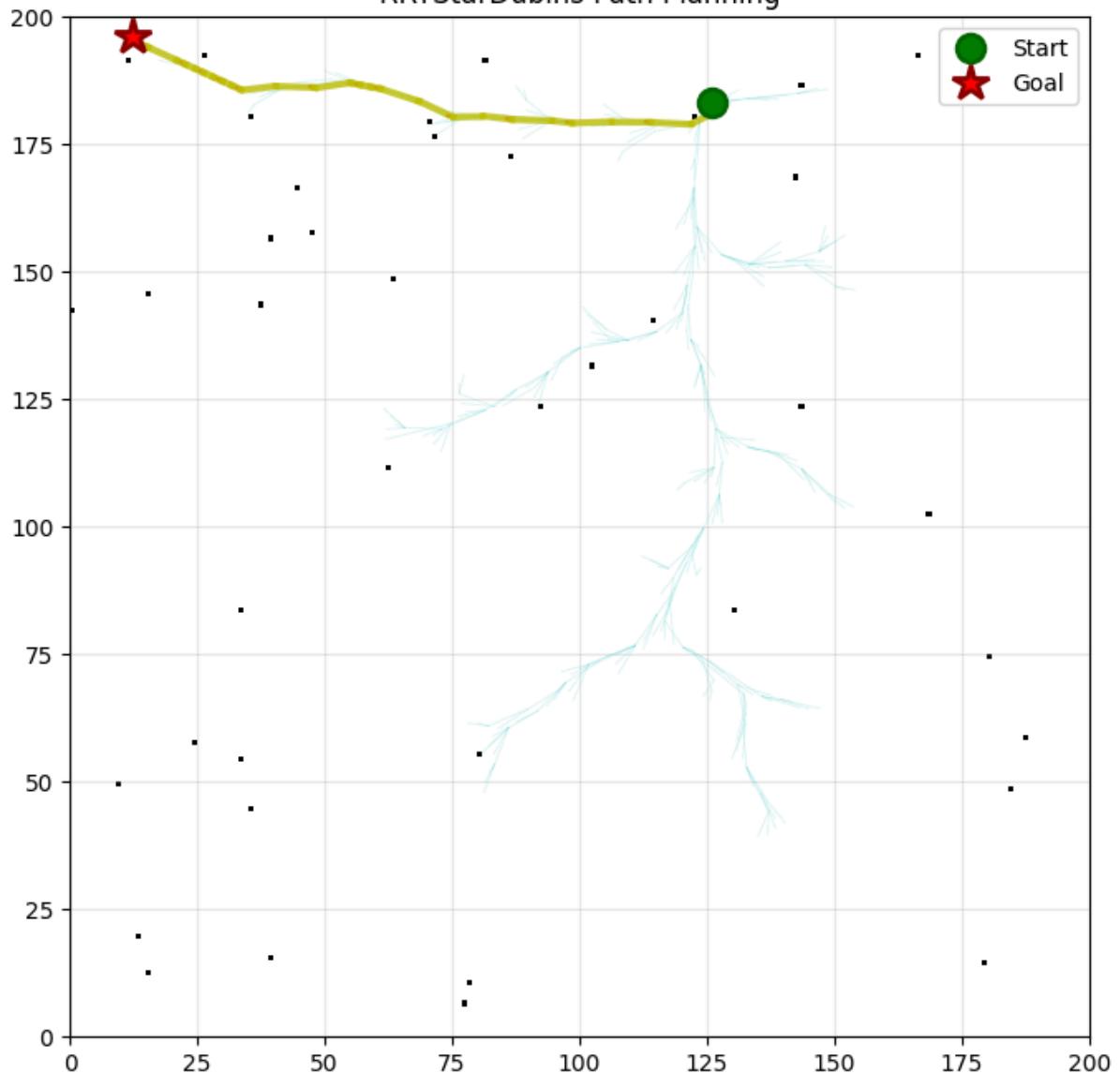


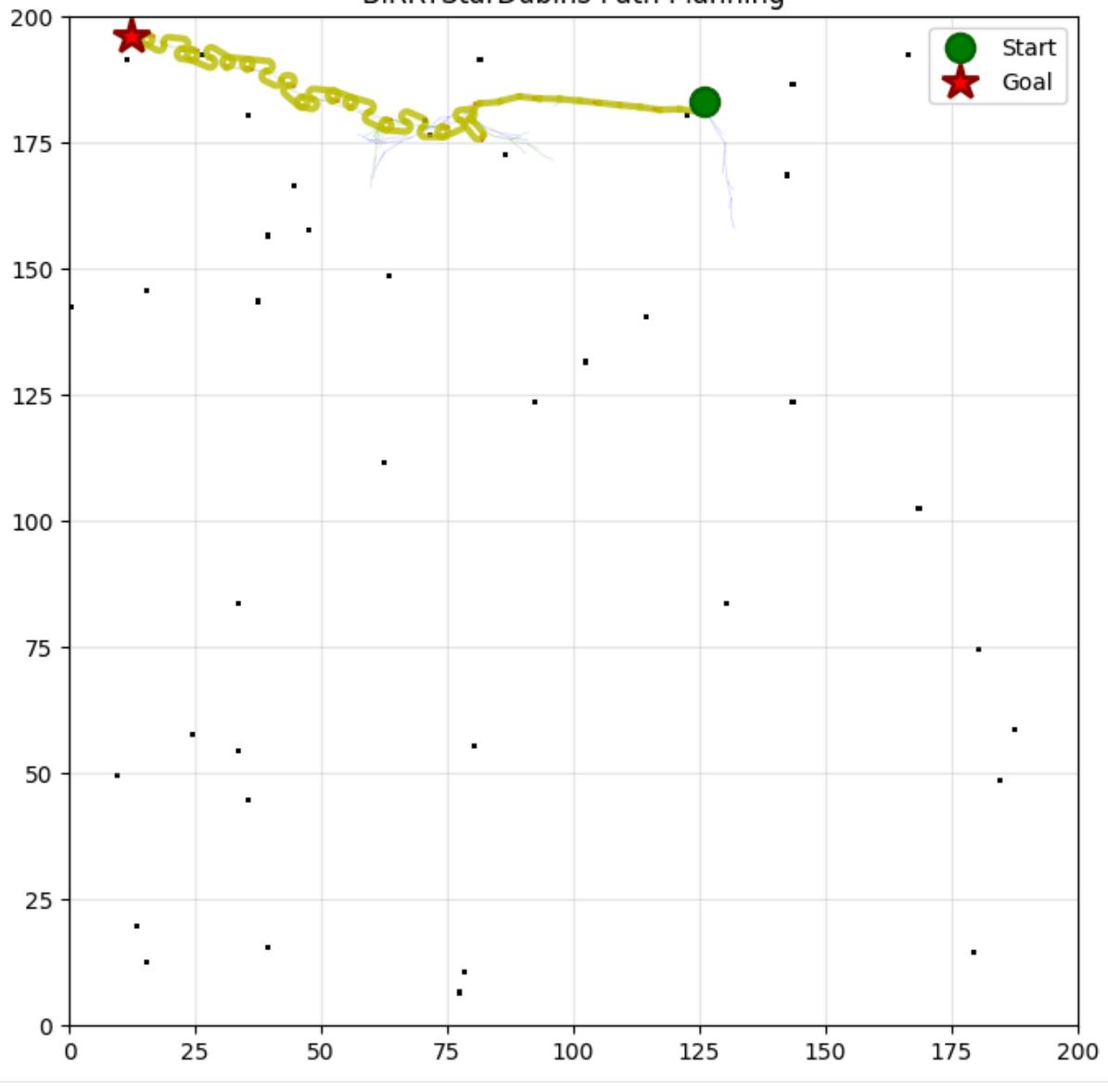
### BiRRTStar [Early Stop]

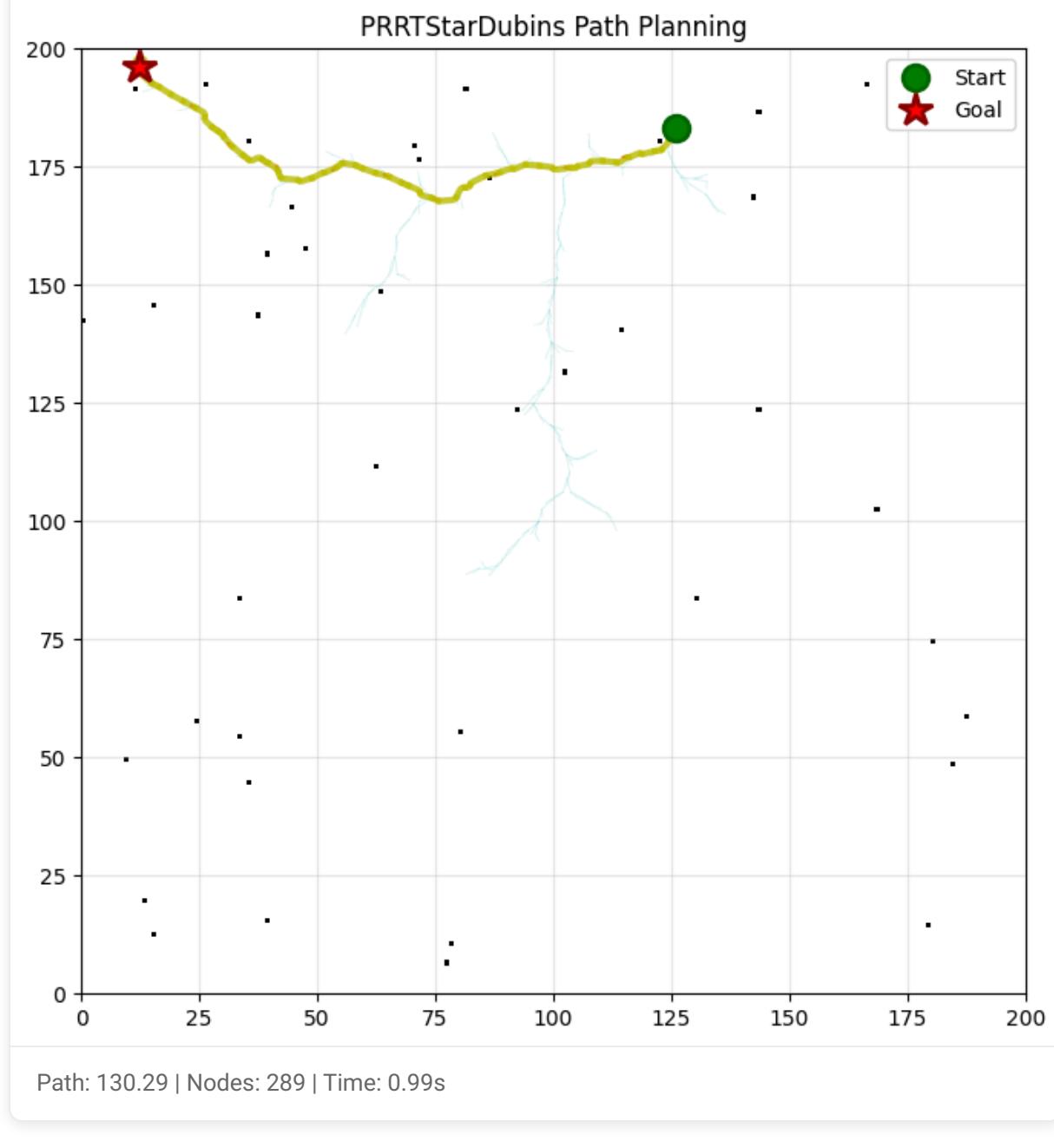


### PRRTStar [Early Stop]

**PRRTStar Path Planning****RRTStarDubins [Early Stop]**

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

**BiRRTStarDubins Path Planning****PRRTStarDubins [Early Stop]**



## Square Corridor - Tight

*Compare all algorithms in a tight square corridor environment*

**Run 1**

**Start:** (16.28982676335878, 16.28746299294786) | **Goal:** (82.57937879844133, 21.809232846471062) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 8, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

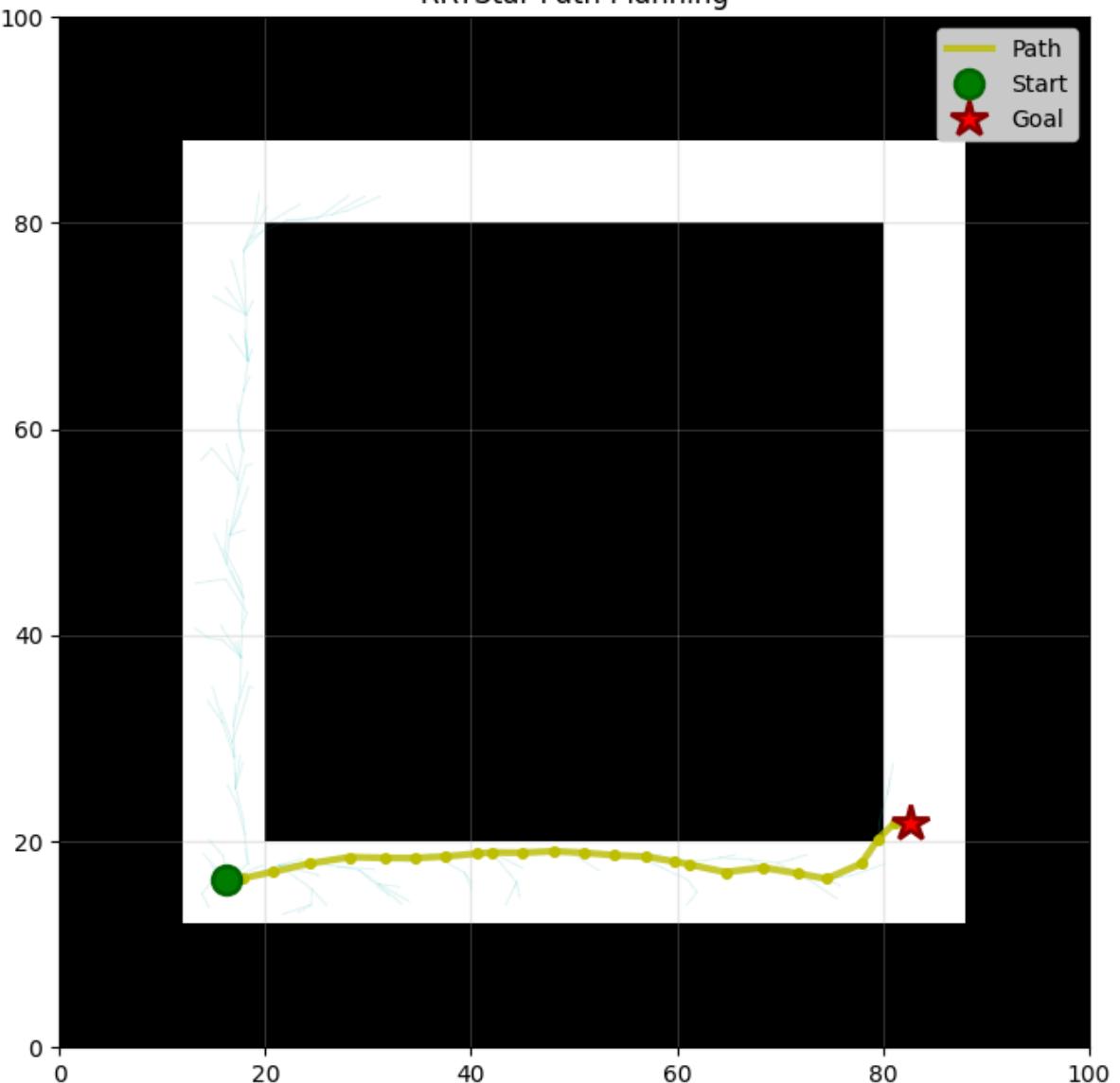
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.04	69.00	187	69.18
BiRRTStar ES	✓ Success	0.02	72.27	117	72.27
PRRTStar ES	✓ Success	0.18	68.40	143	68.40
RRTStarDubins ES	✓ Success	0.15	67.92	375	68.46
BiRRTStarDubins ES	✓ Success	0.03	73.92	202	75.93
PRRTStarDubins ES	✓ Success	0.40	67.14	210	67.72

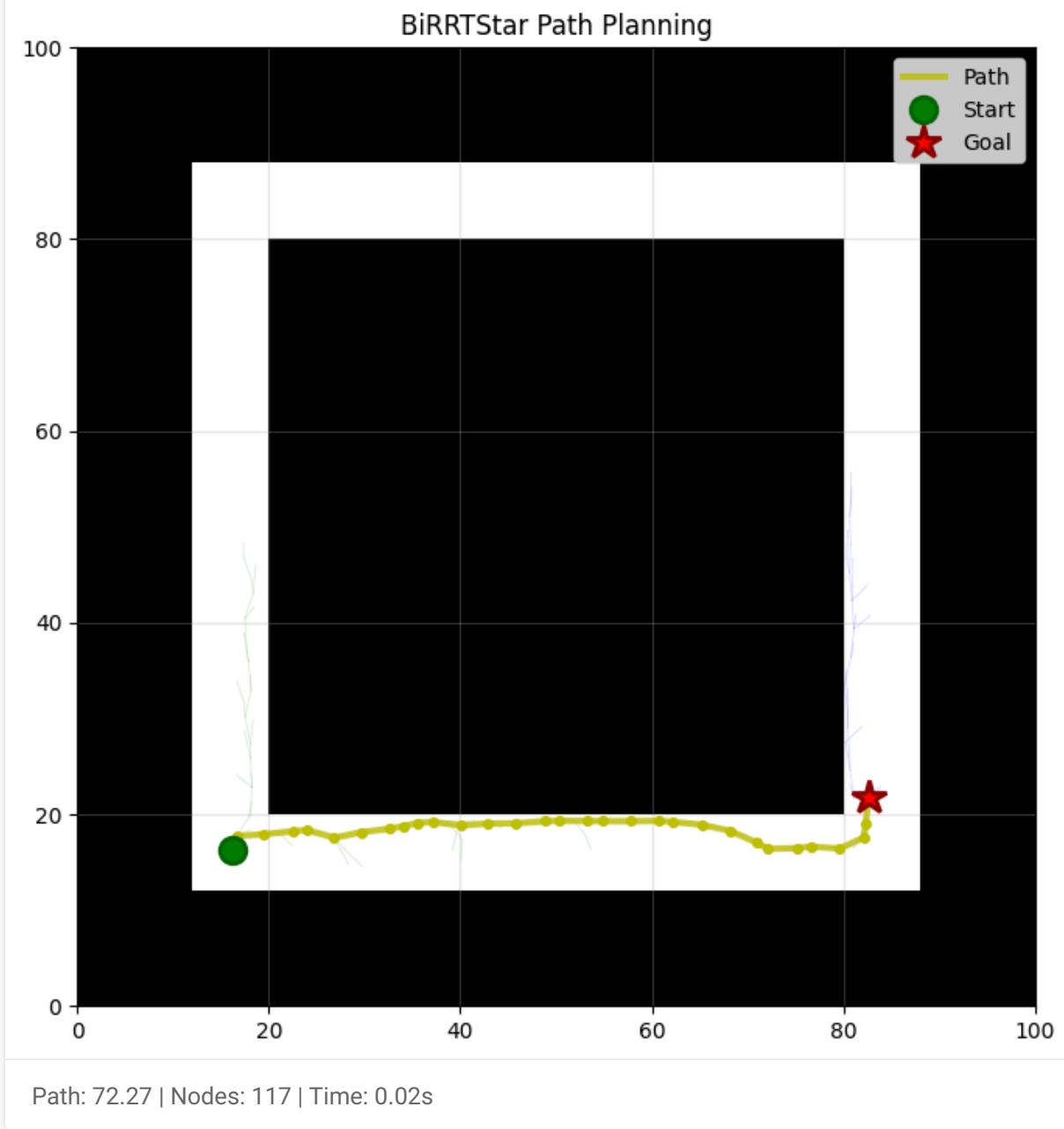
## Path Visualizations

### RRTStar [Early Stop]

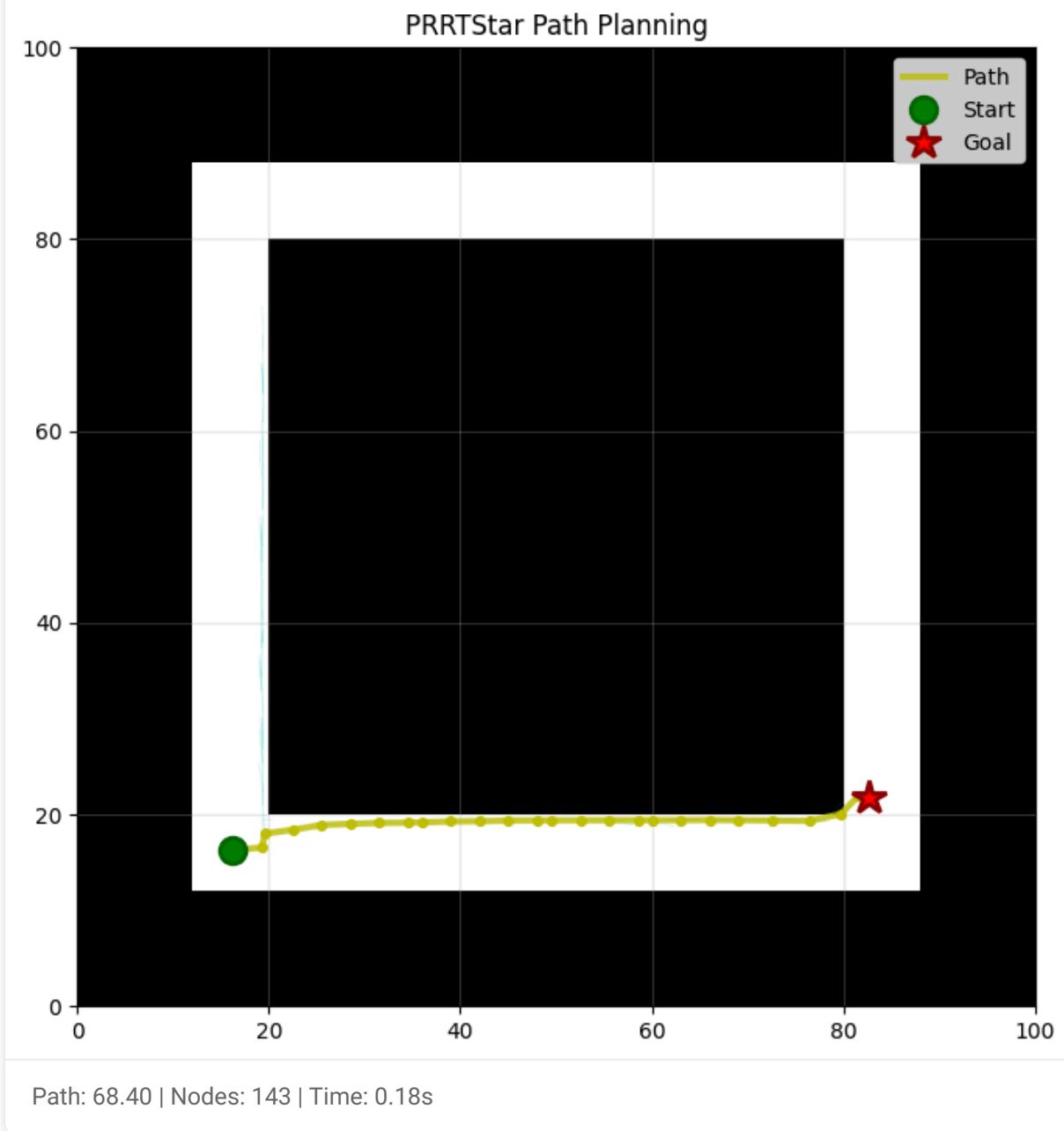
### RRTStar Path Planning



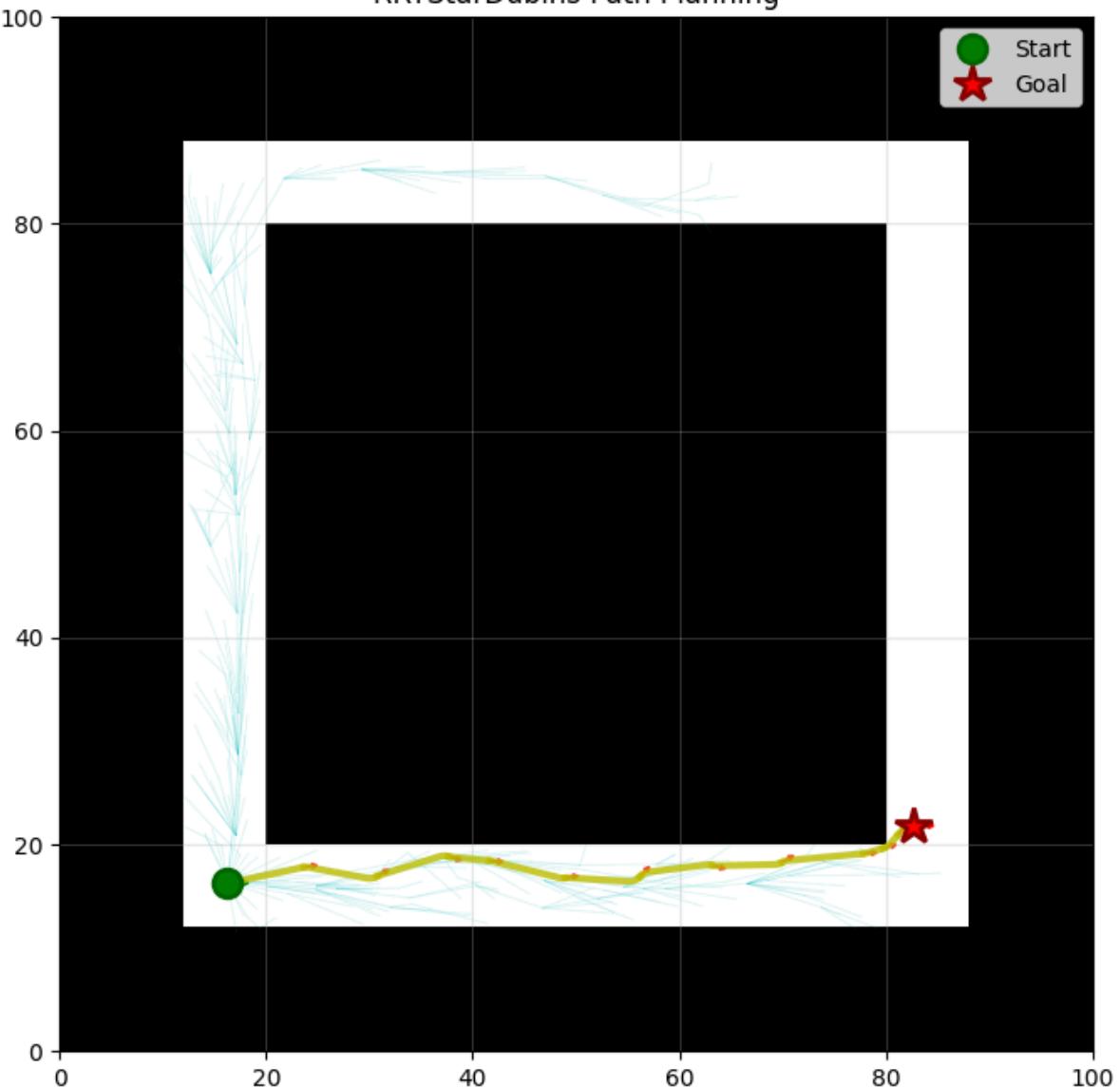
### BiRRTStar [Early Stop]



### PRRTStar [Early Stop]

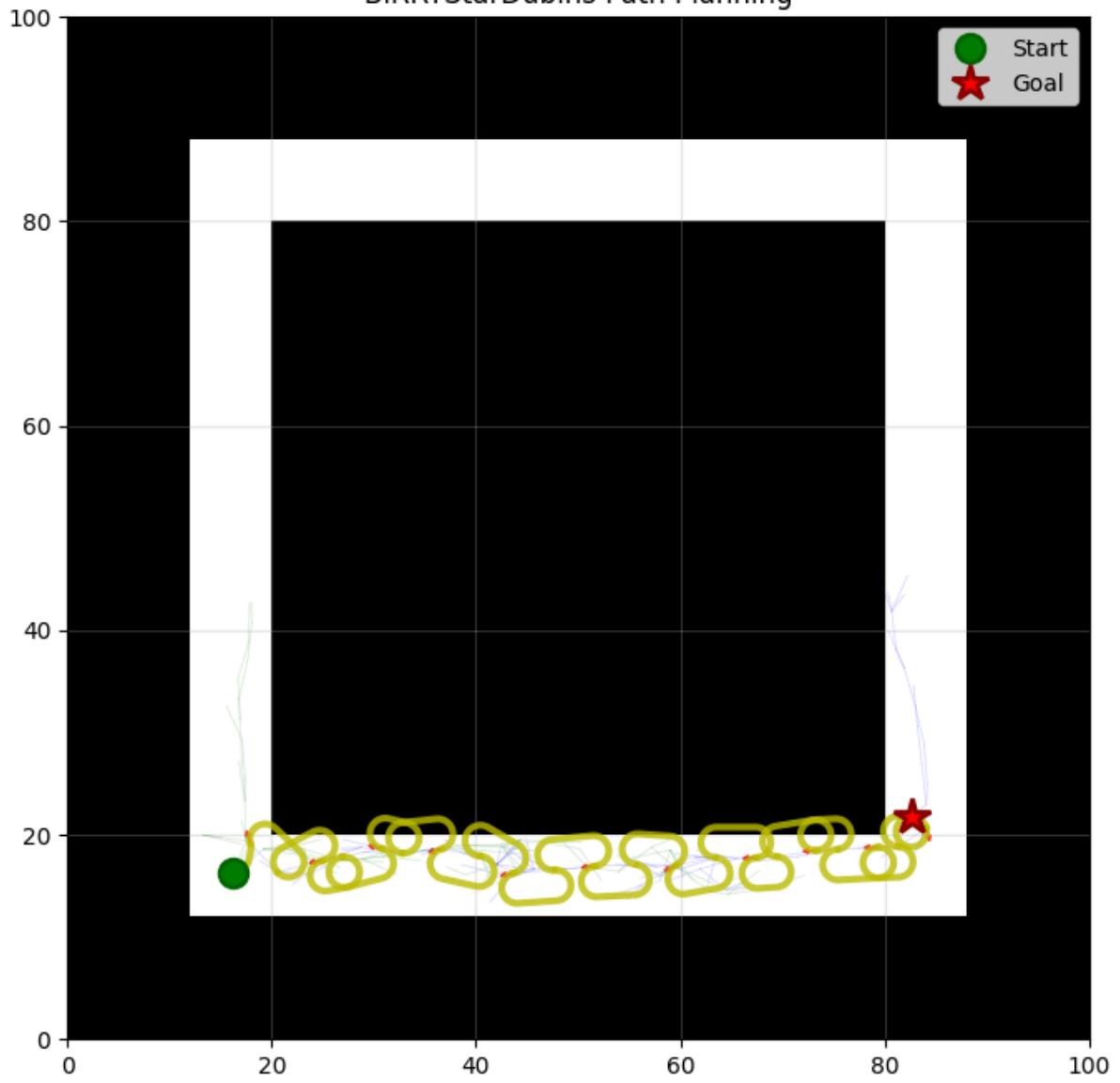


### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning**

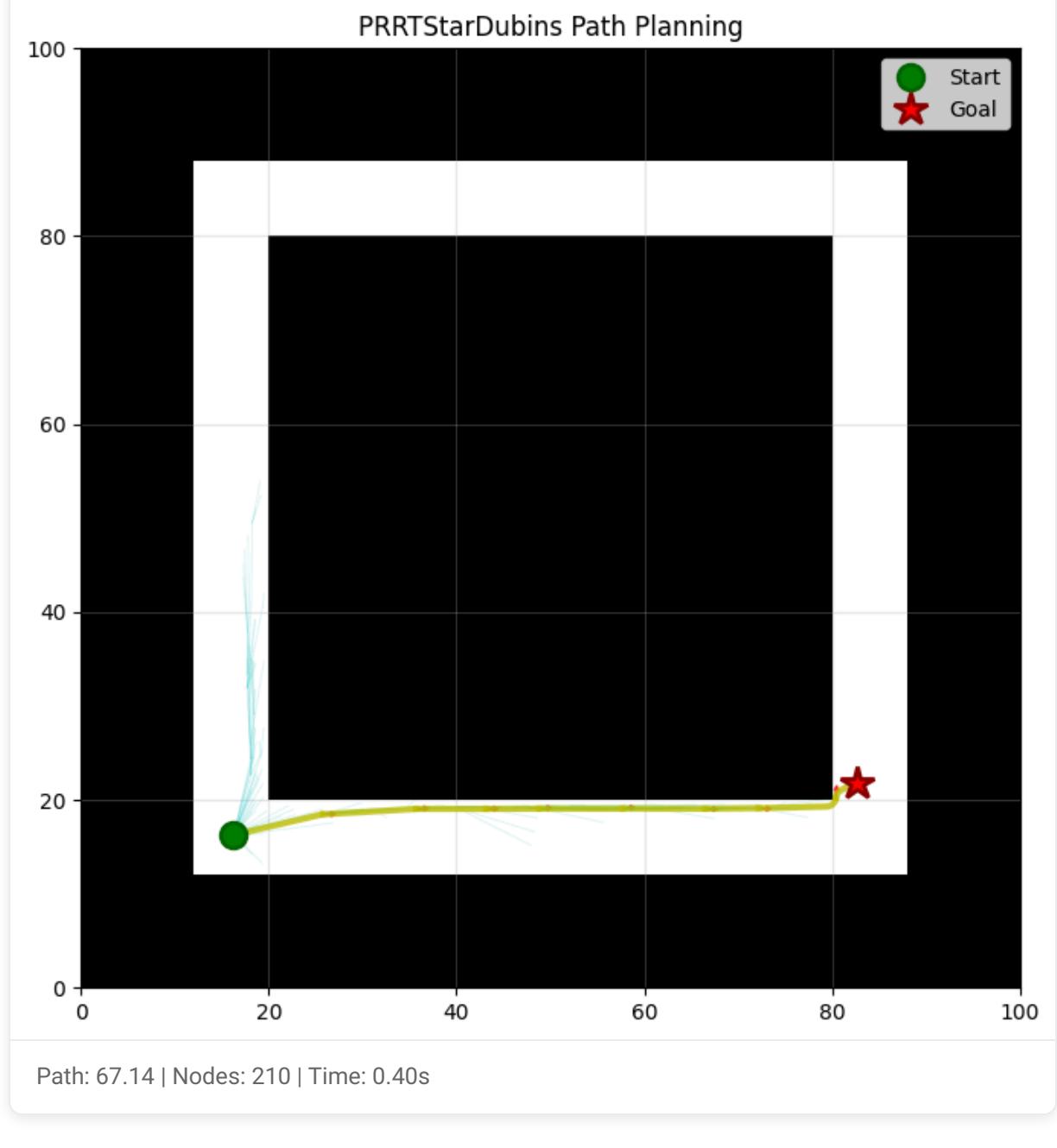
Path: 67.92 | Nodes: 375 | Time: 0.15s

**BiRRTStarDubins [Early Stop]**

**BiRRTStarDubins Path Planning**

Path: 73.92 | Nodes: 202 | Time: 0.03s

**PRRTStarDubins [Early Stop]**



## Run 2

**Start:** (16.28982676335878, 16.28746299294786) | **Goal:** (82.57937879844133, 21.809232846471062) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 8, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

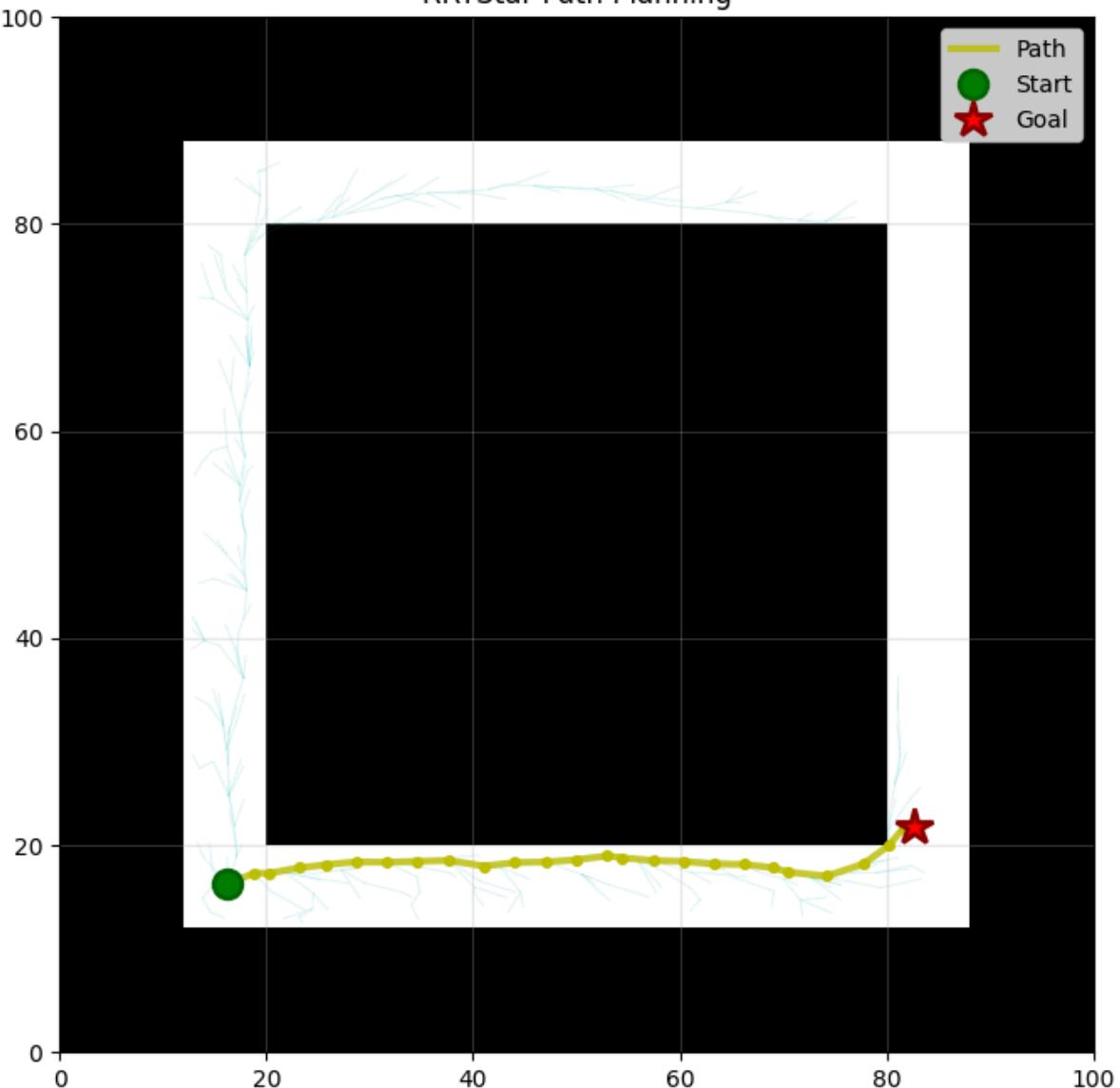
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.10	68.36	326	68.45
BiRRTStar ES	✓ Success	0.01	68.54	89	68.54
PRRTStar ES	✓ Success	0.15	67.57	132	67.57
RRTStarDubins ES	✓ Success	0.15	67.92	375	68.46
BiRRTStarDubins ES	✓ Success	0.03	73.92	202	75.93
PRRTStarDubins ES	✓ Success	0.41	68.47	195	74.56

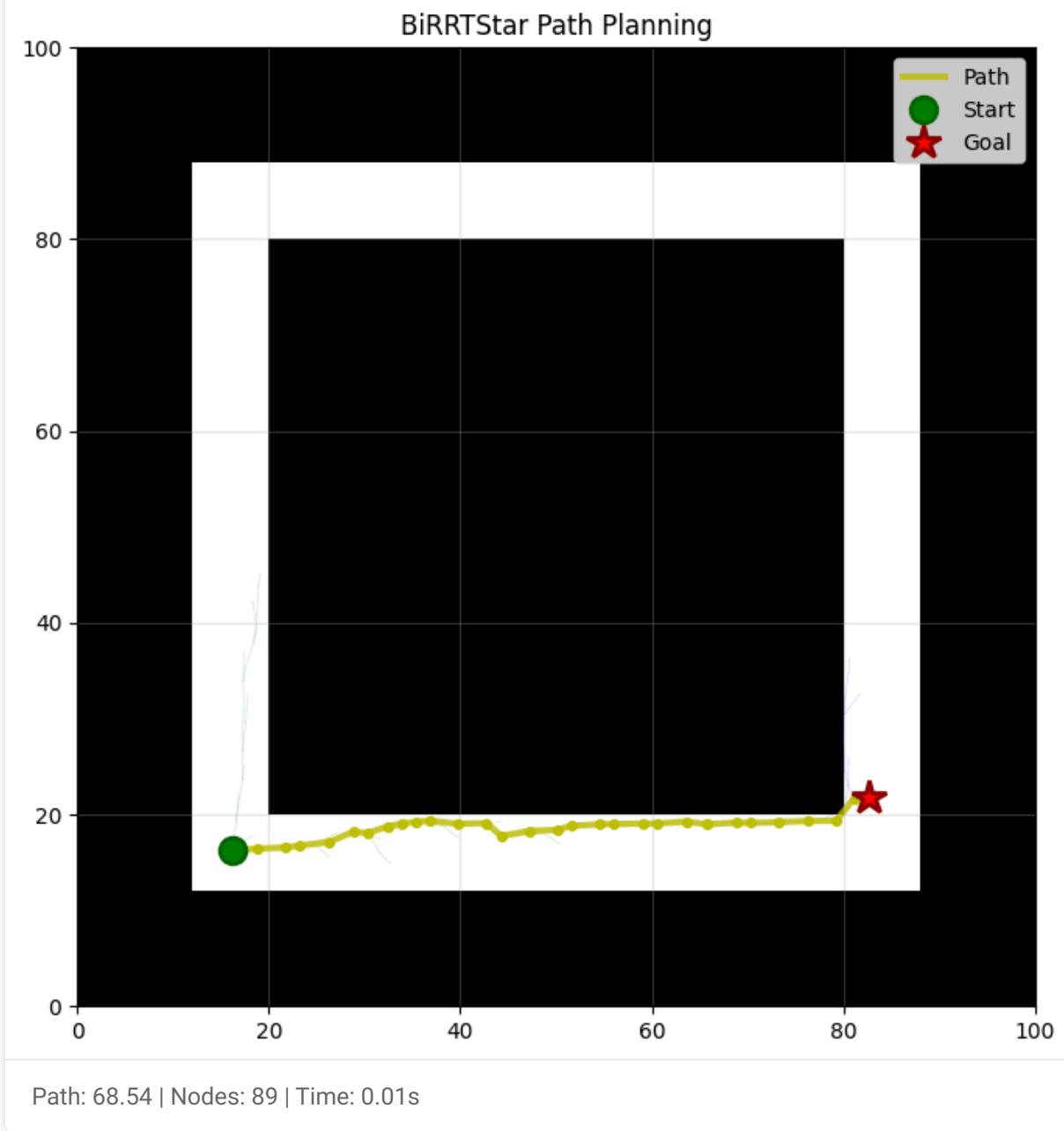
## Path Visualizations

RRTStar [Early Stop]

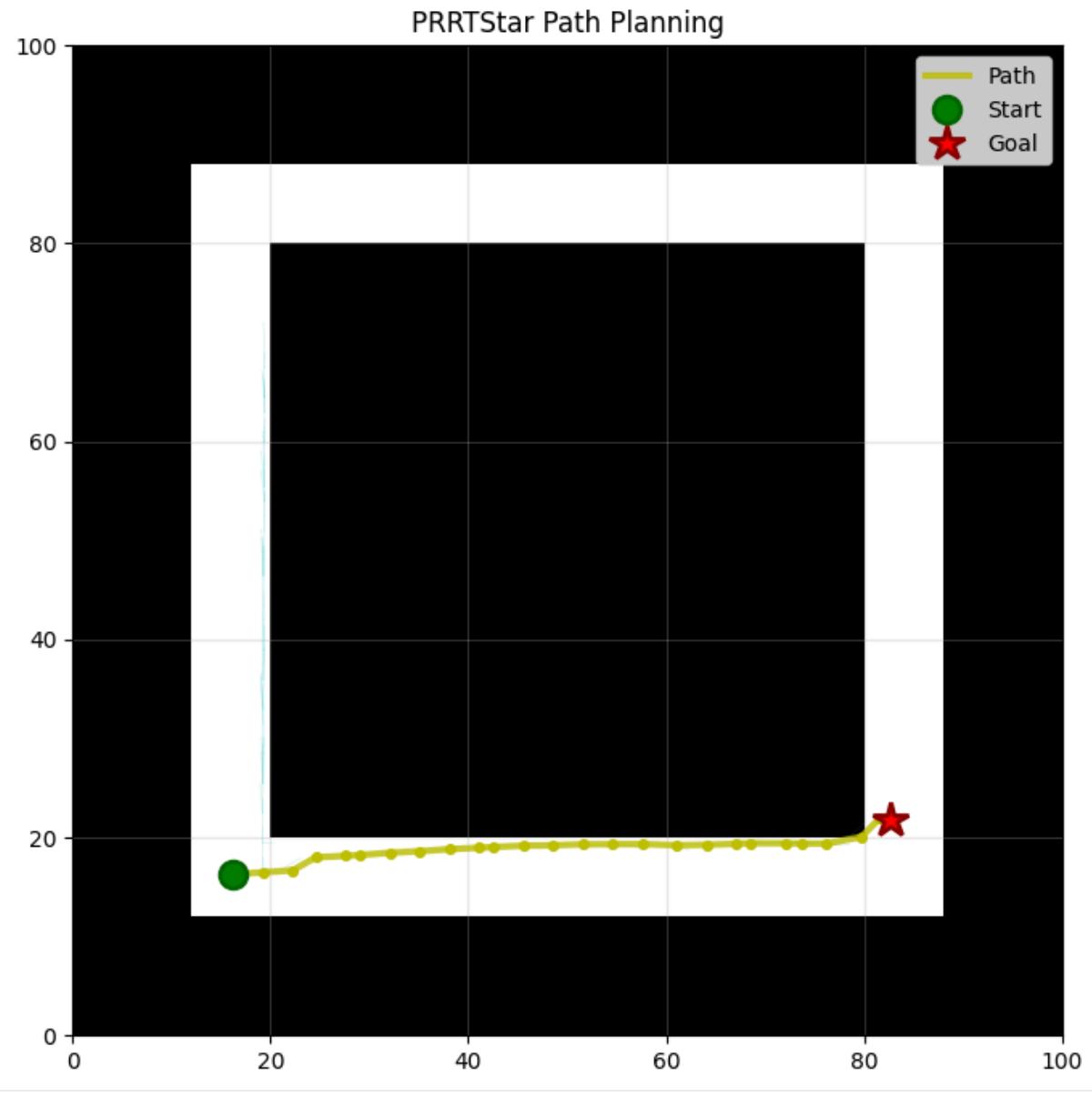
### RRTStar Path Planning



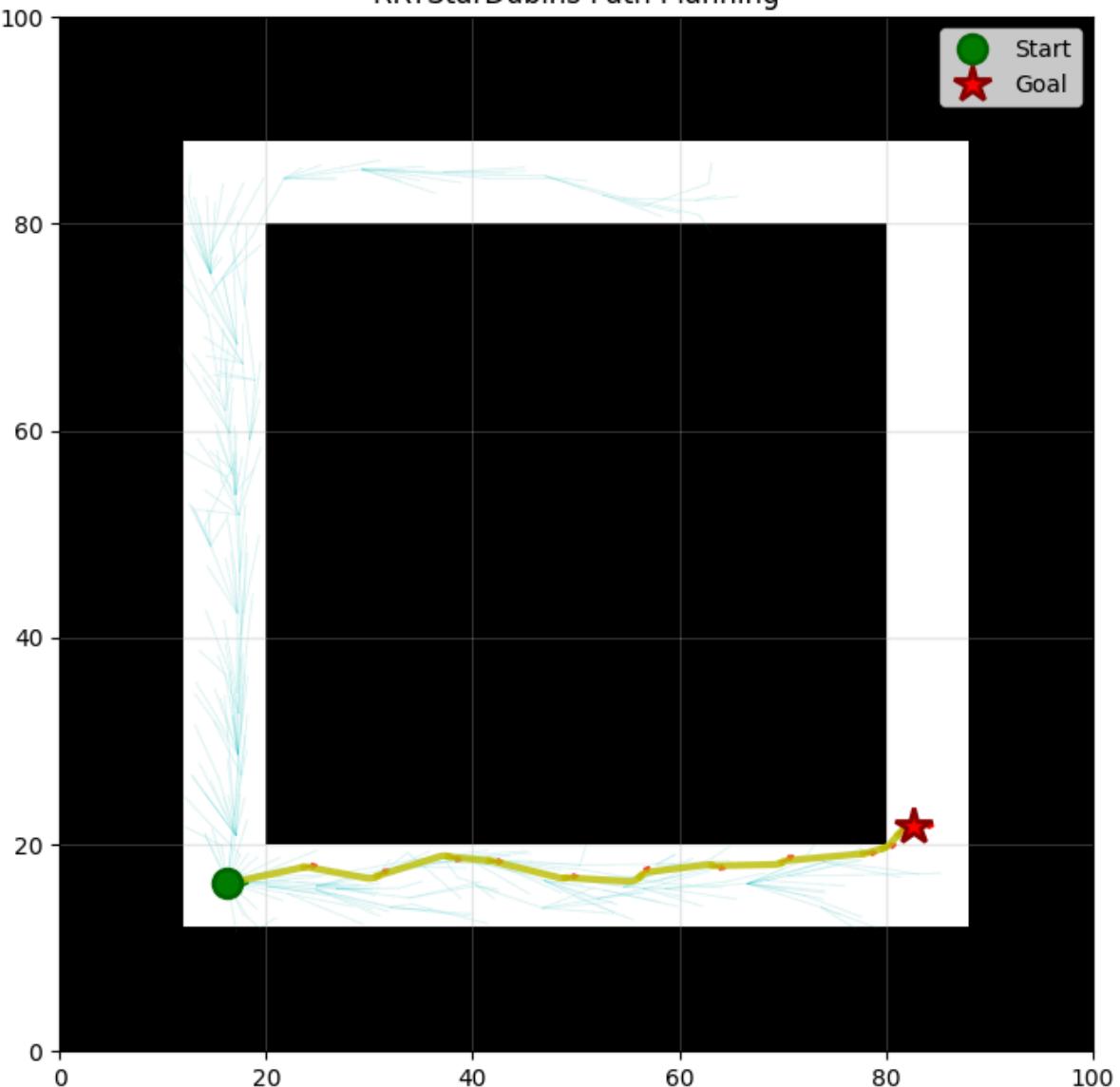
### BiRRTStar [Early Stop]



### PRRTStar [Early Stop]

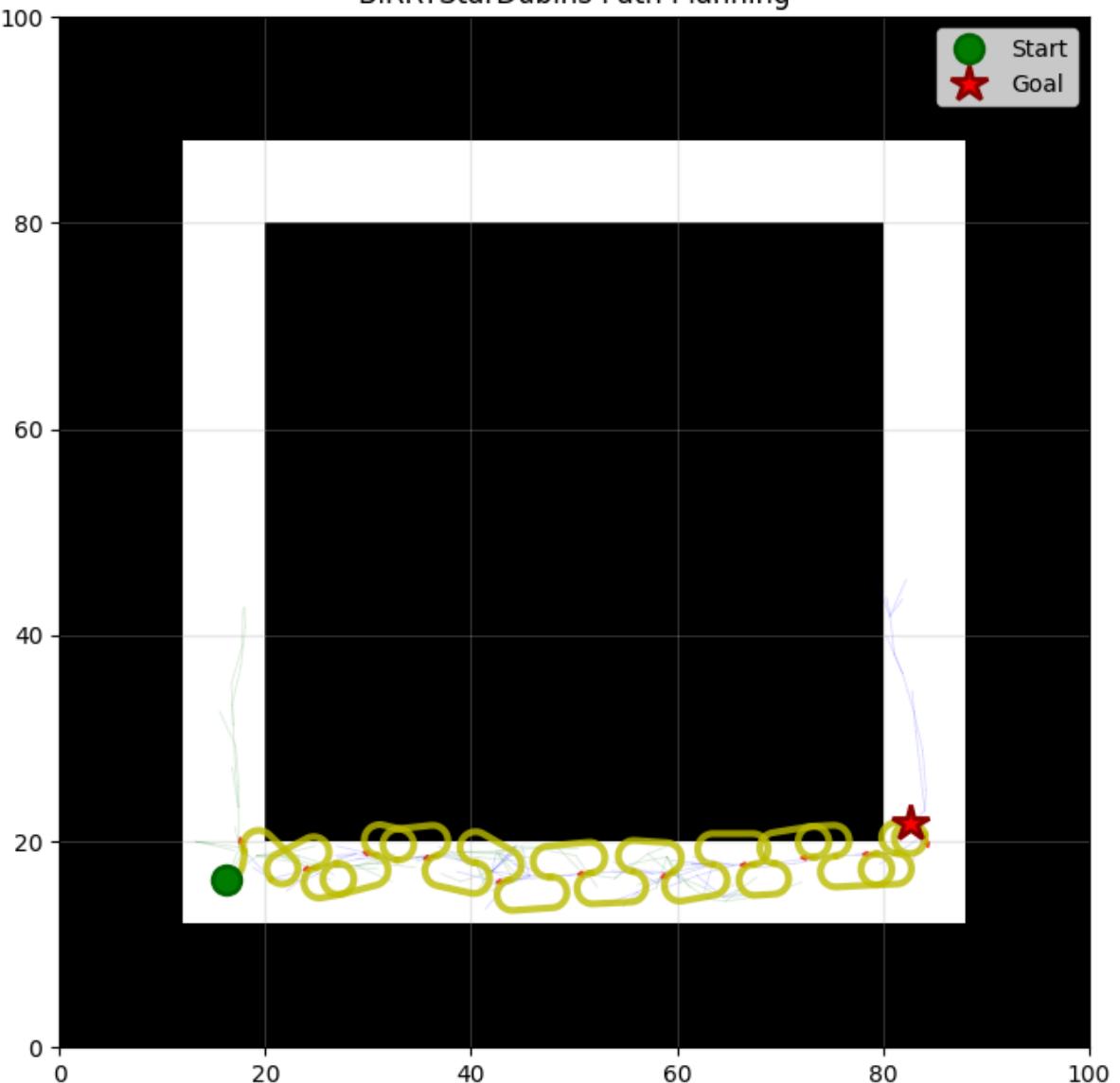


### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning**

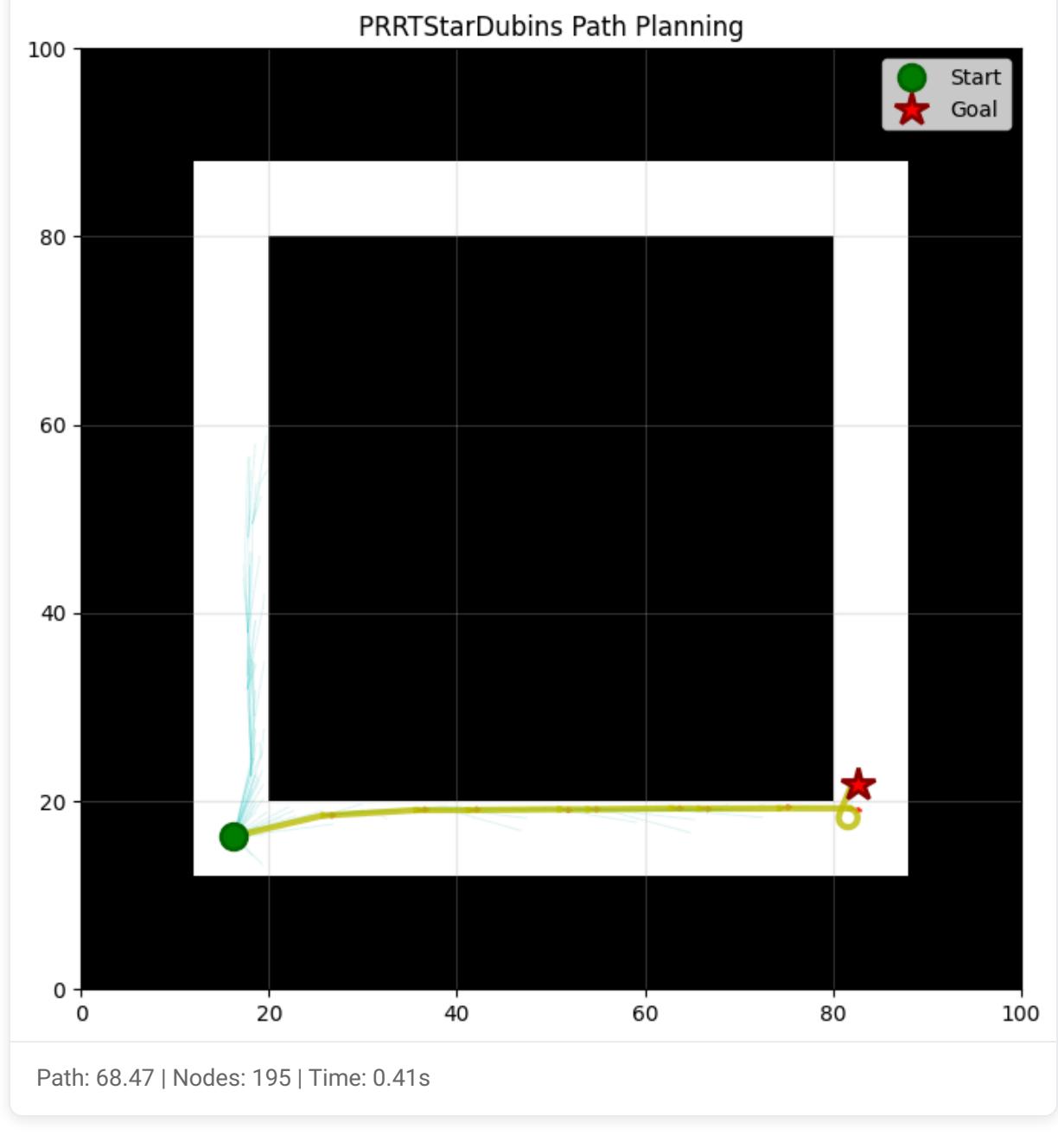
Path: 67.92 | Nodes: 375 | Time: 0.15s

**BiRRTStarDubins [Early Stop]**

**BiRRTStarDubins Path Planning**

Path: 73.92 | Nodes: 202 | Time: 0.03s

**PRRTStarDubins [Early Stop]**



## Run 3

**Start:** (16.28982676335878, 16.28746299294786) | **Goal:** (82.57937879844133, 21.809232846471062) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 8, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

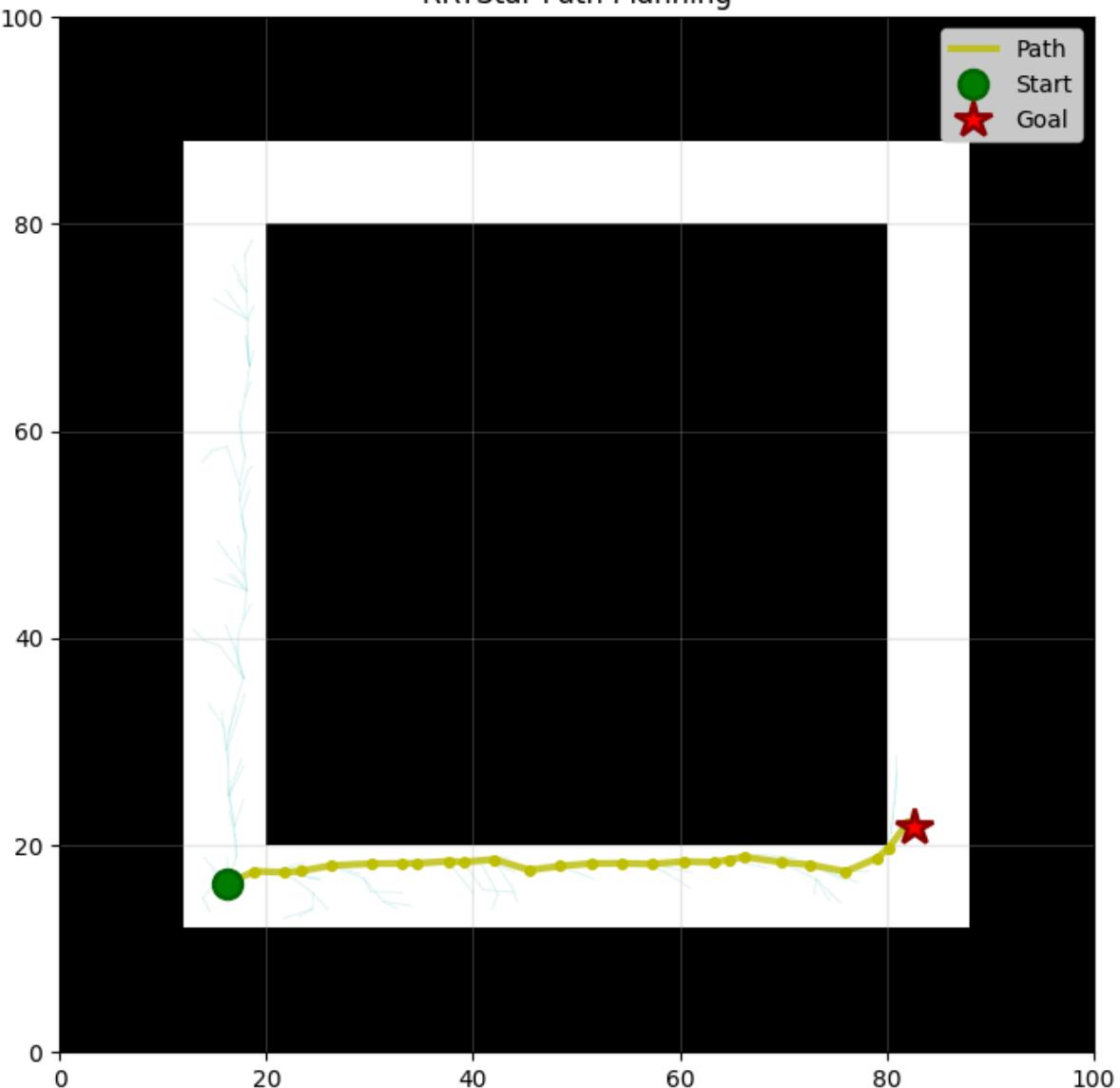
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.04	68.86	168	68.86
BiRRTStar ES	✓ Success	0.03	69.18	156	69.18
PRRTStar ES	✓ Success	0.17	67.54	148	67.54
RRTStarDubins ES	✓ Success	0.08	68.82	277	78.54
BiRRTStarDubins ES	✓ Success	0.02	84.40	167	86.98
PRRTStarDubins ES	✓ Success	0.16	67.53	91	73.75

## Path Visualizations

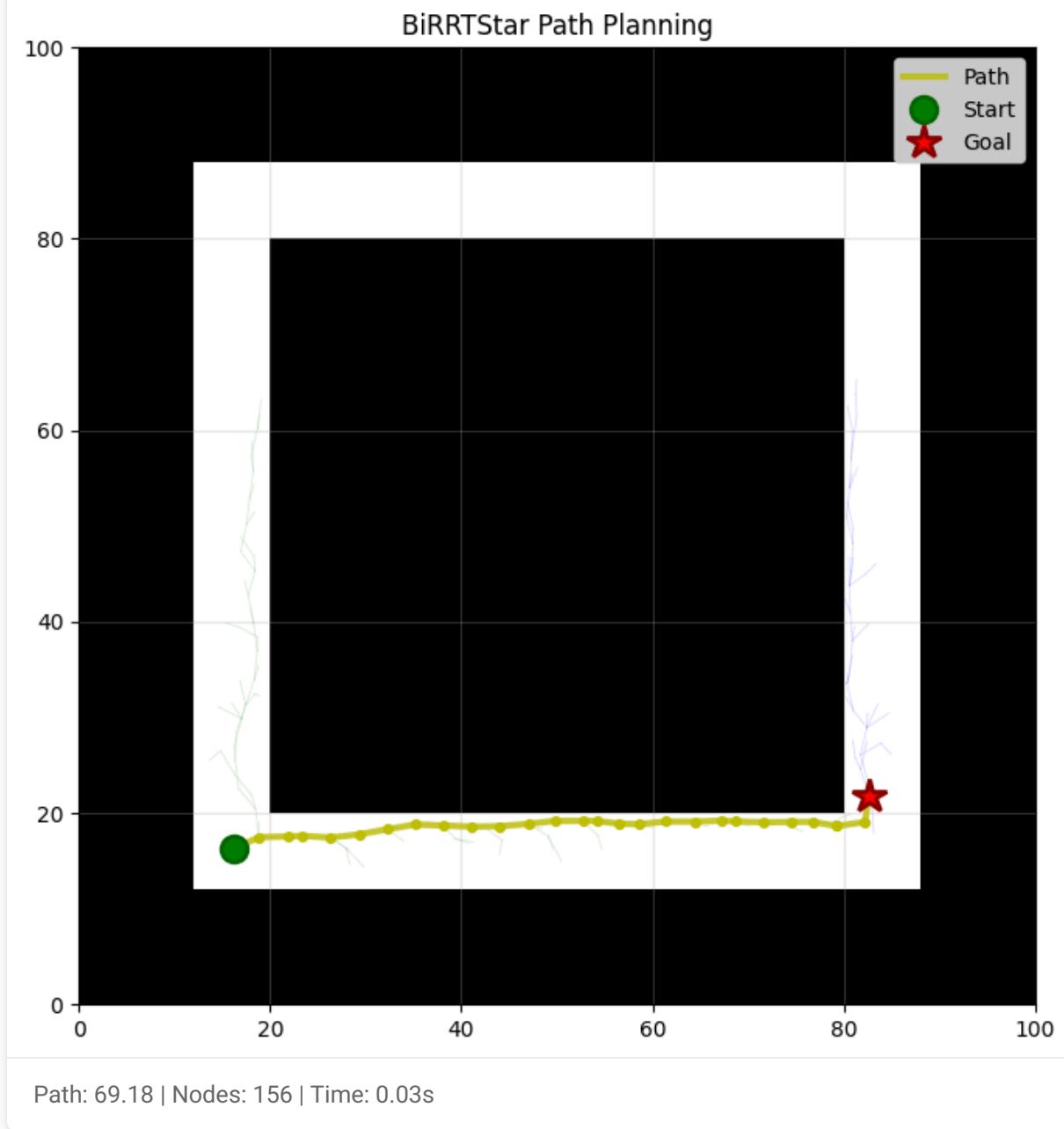
RRTStar [Early Stop]

### RRTStar Path Planning

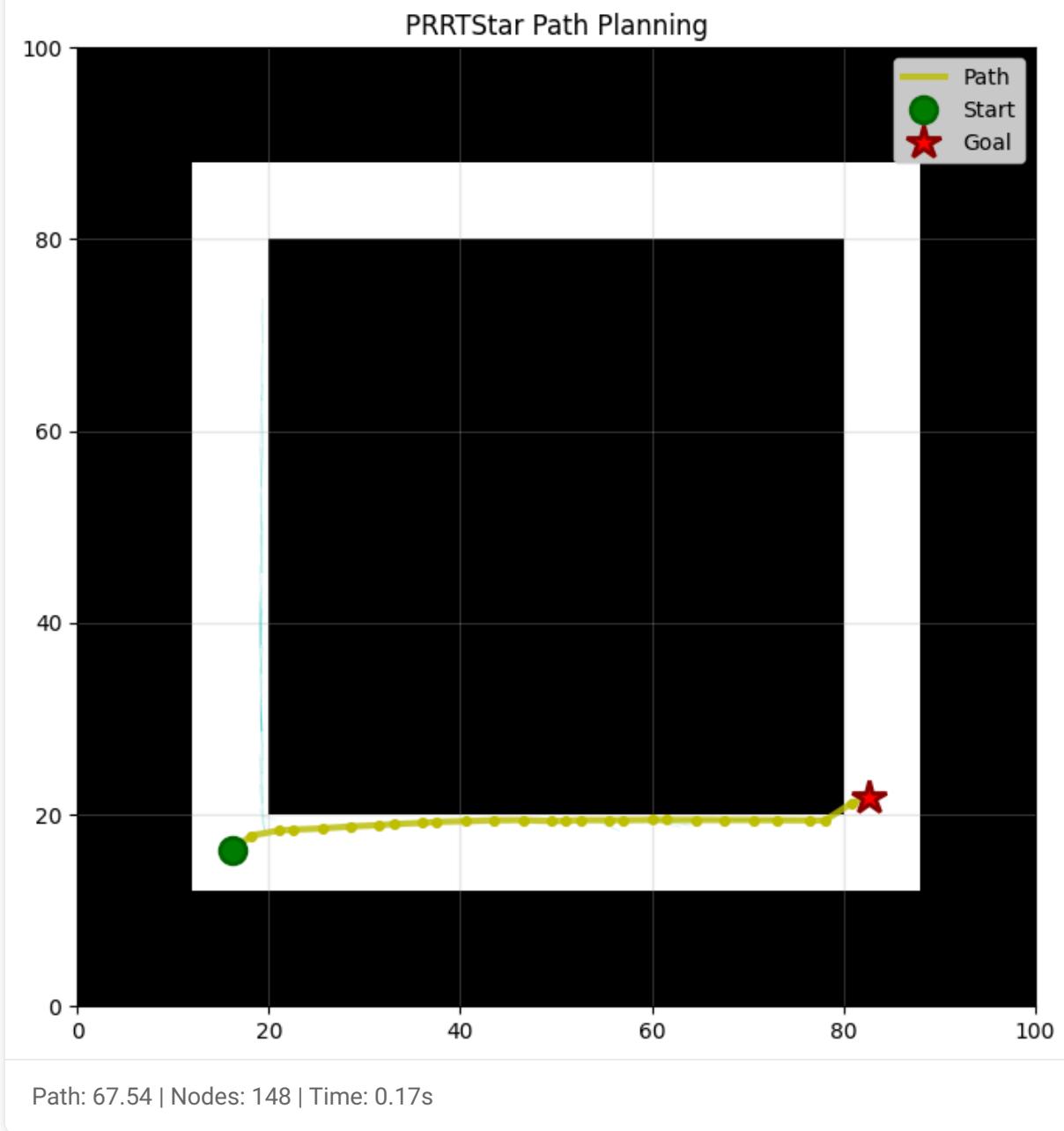


Path: 68.86 | Nodes: 168 | Time: 0.04s

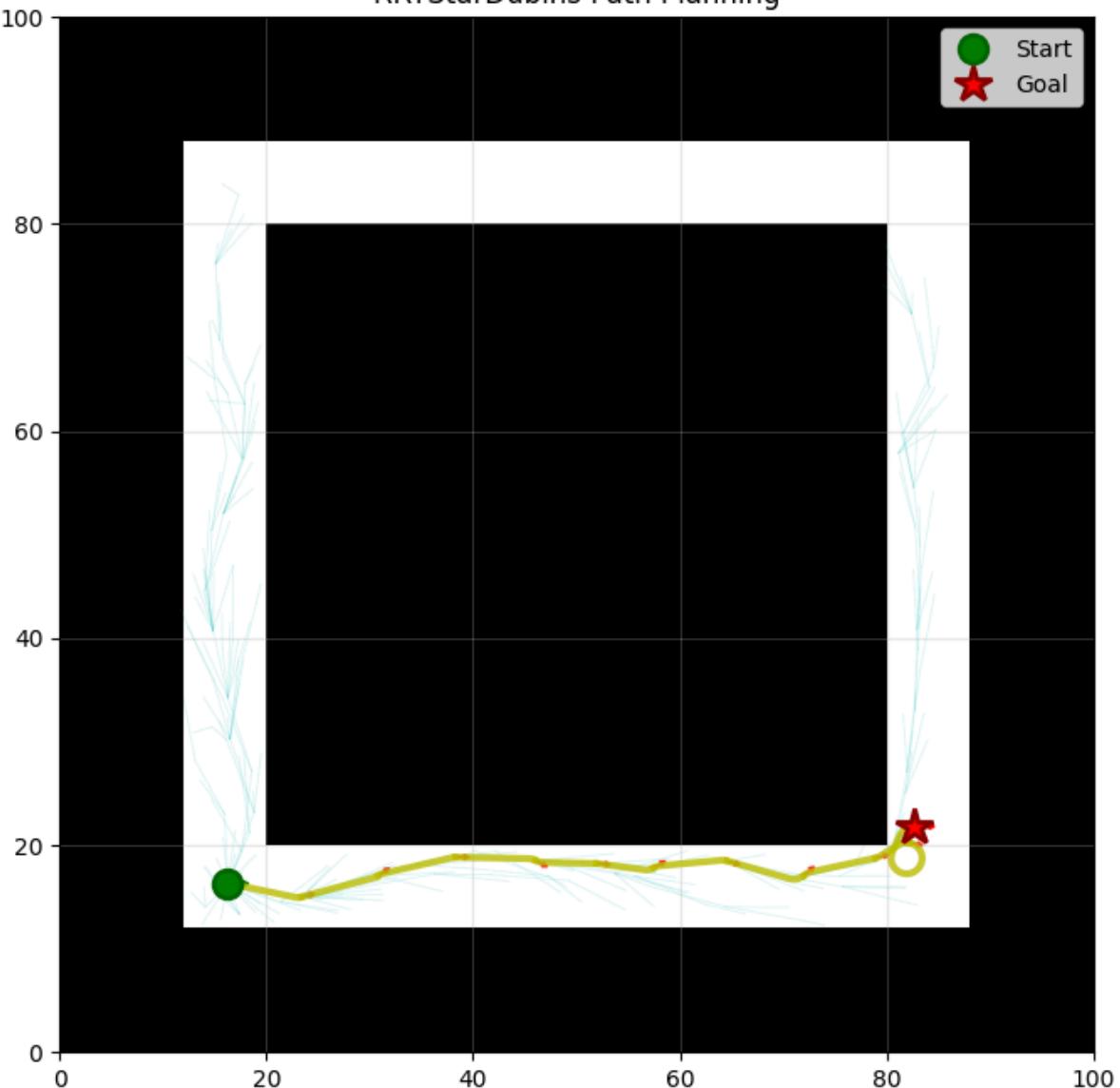
### BiRRTStar [Early Stop]



### PRRTStar [Early Stop]



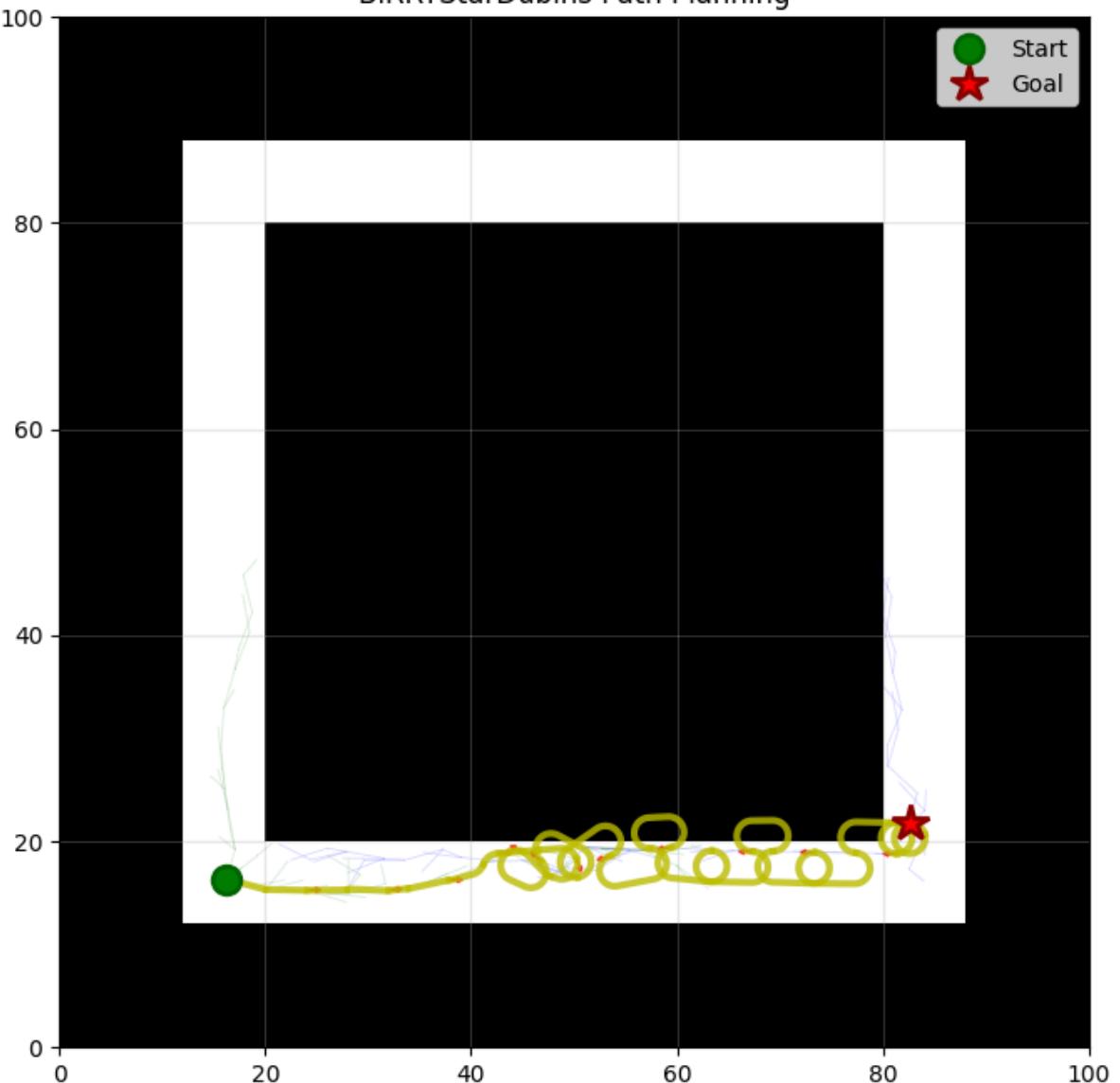
### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning**

Path: 68.82 | Nodes: 277 | Time: 0.08s

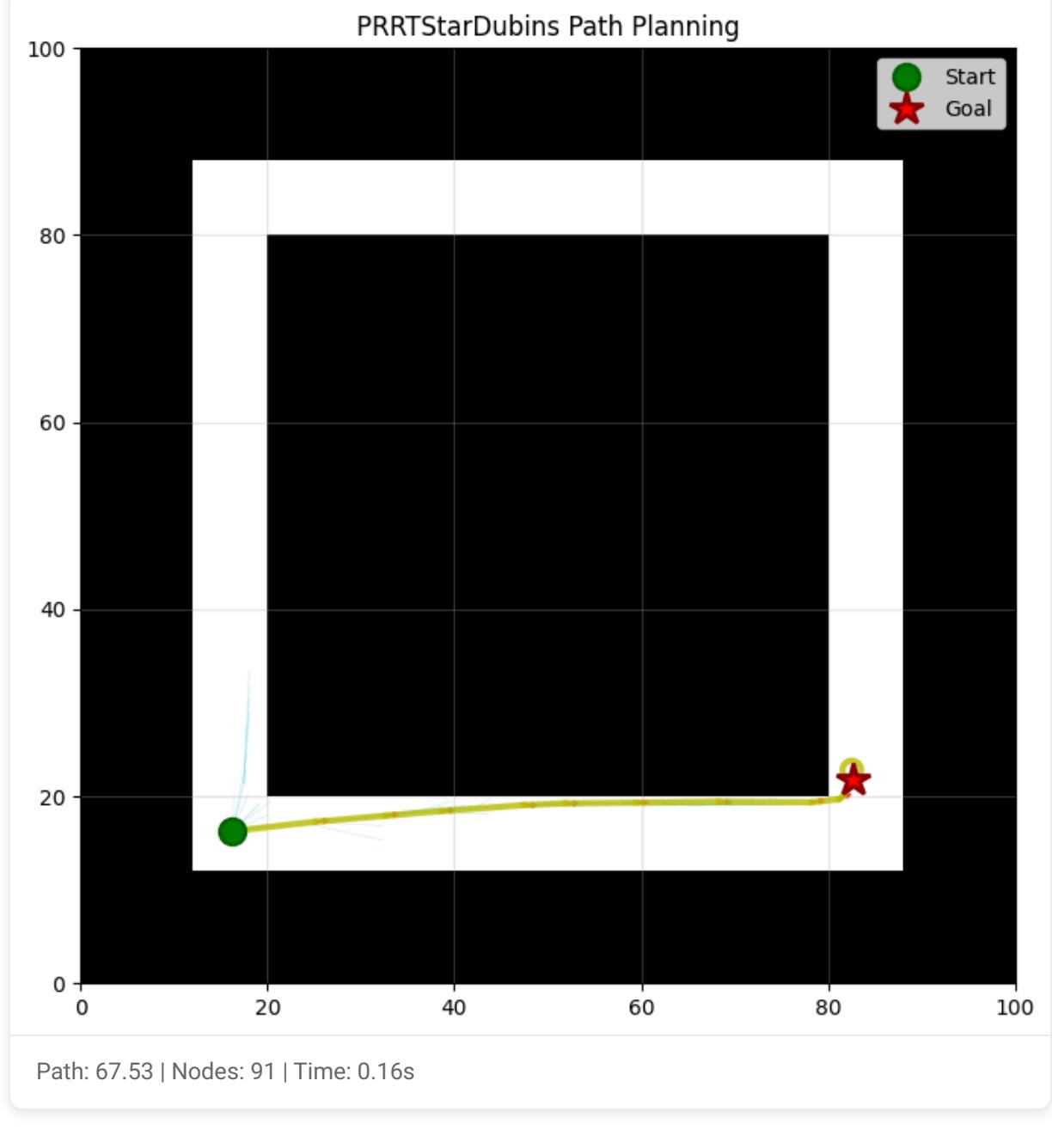
**BiRRTStarDubins [Early Stop]**

### BiRRTStarDubins Path Planning



Path: 84.40 | Nodes: 167 | Time: 0.02s

### PRRTStarDubins [Early Stop]



## Run 4

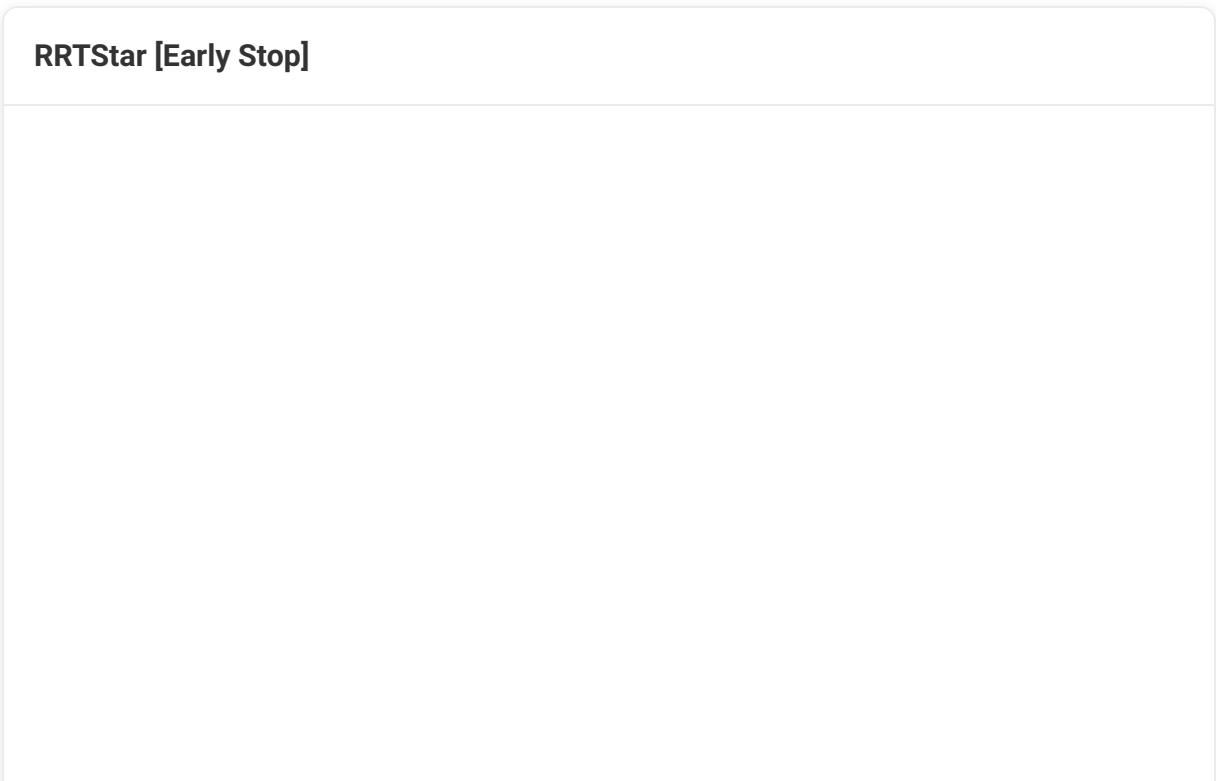
**Start:** (16.28982676335878, 16.28746299294786) | **Goal:** (82.57937879844133, 21.809232846471062) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 8, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

## Algorithm Results

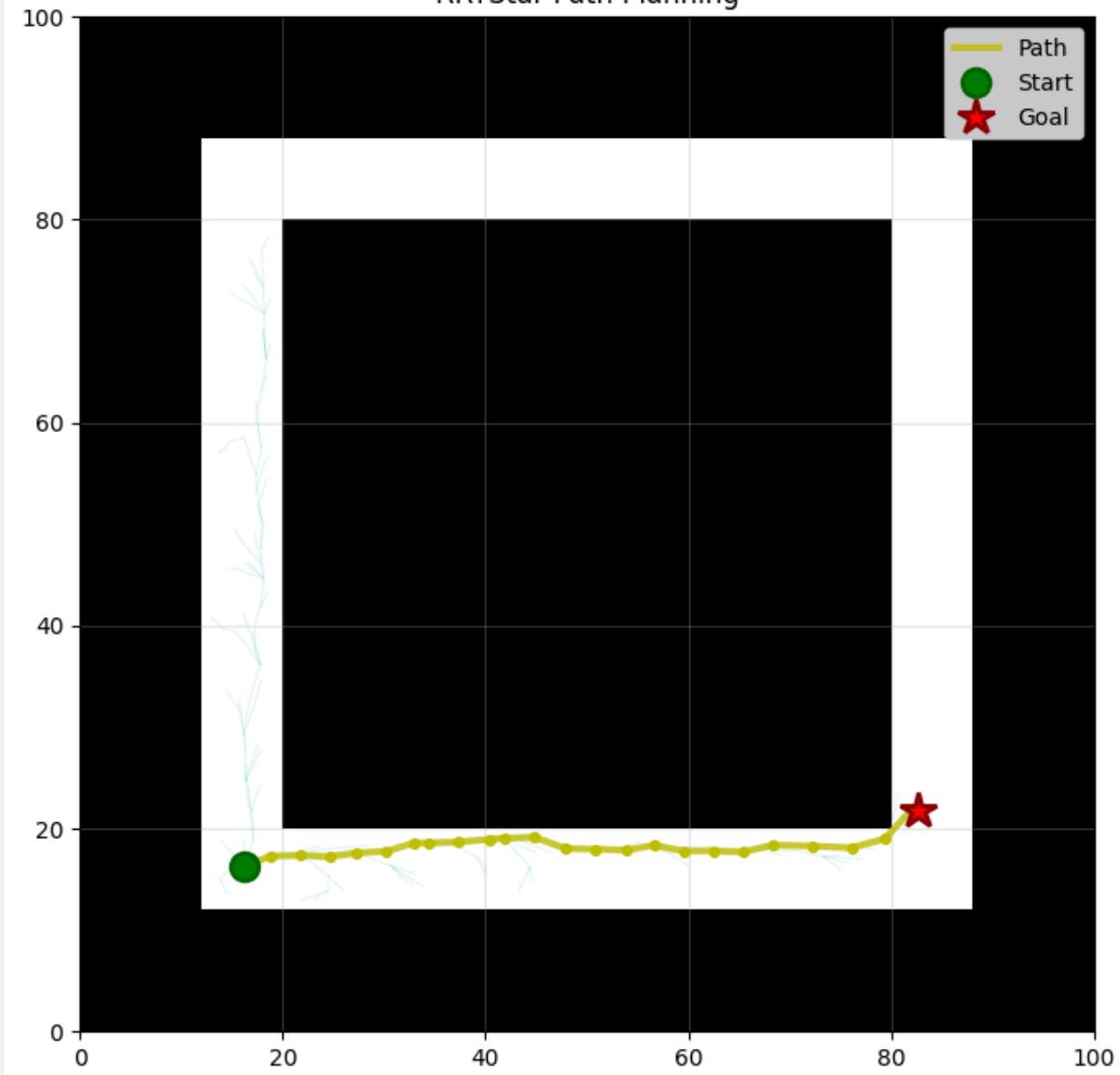
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.03	68.40	157	68.40
BiRRTStar ES	✓ Success	0.03	67.86	158	67.86
PRRTStar ES	✓ Success	0.17	67.50	148	67.50
RRTStarDubins ES	✓ Success	0.07	72.17	232	79.05
BiRRTStarDubins ES	✓ Success	0.02	80.48	137	82.80
PRRTStarDubins ES	✓ Success	0.52	66.90	267	67.56

## Path Visualizations

RRTStar [Early Stop]

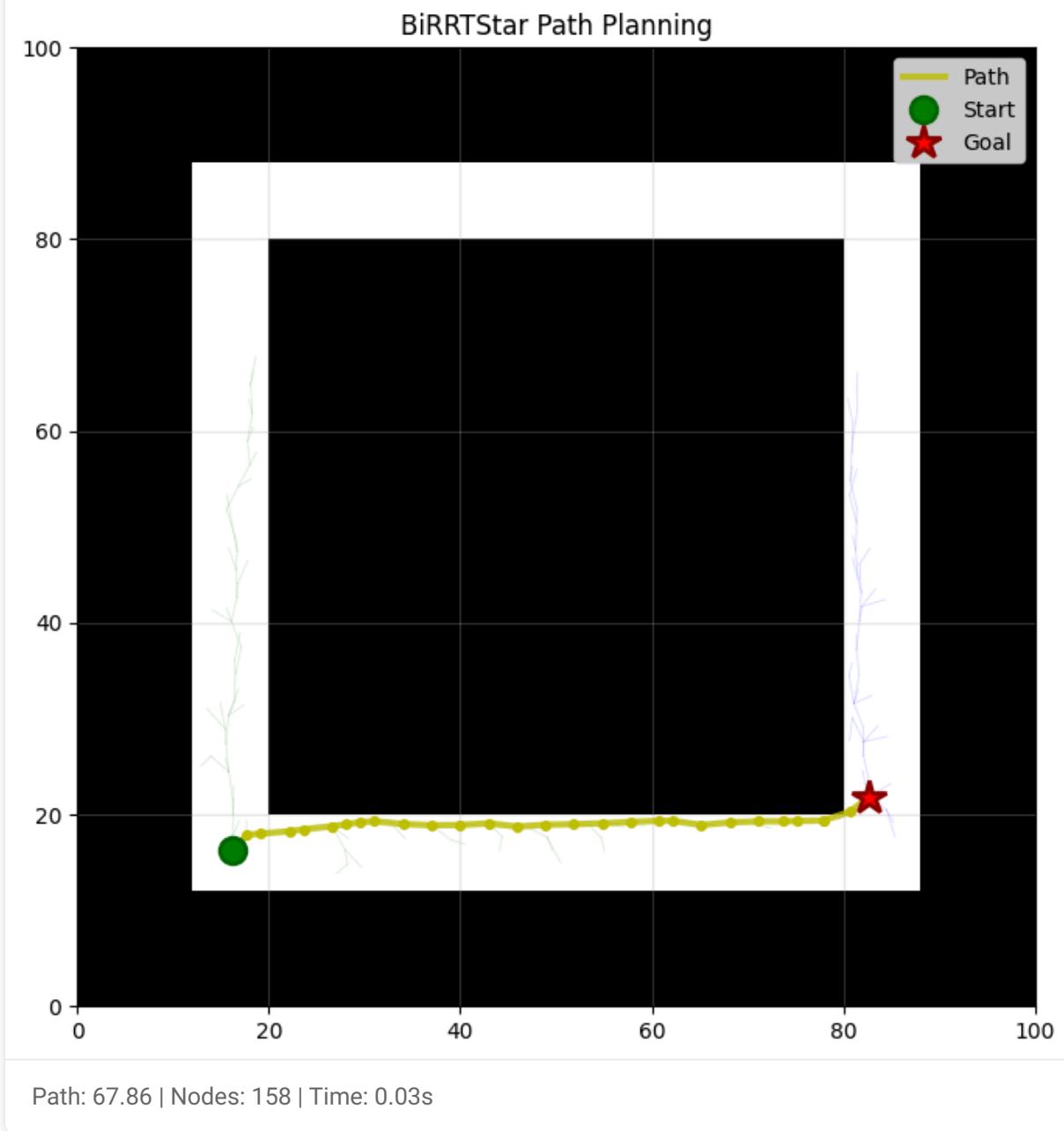


### RRTStar Path Planning

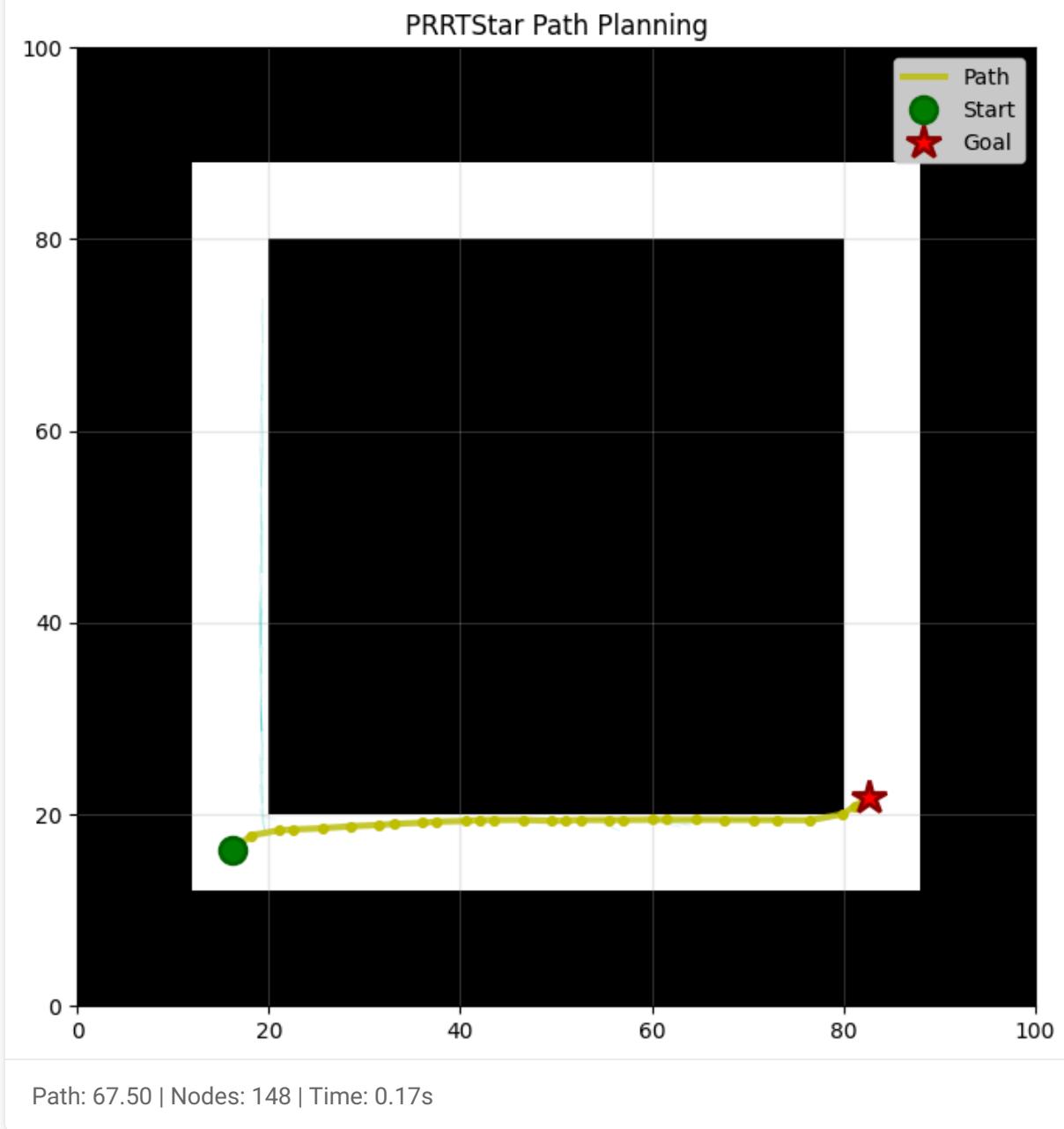


Path: 68.40 | Nodes: 157 | Time: 0.03s

### BiRRTStar [Early Stop]

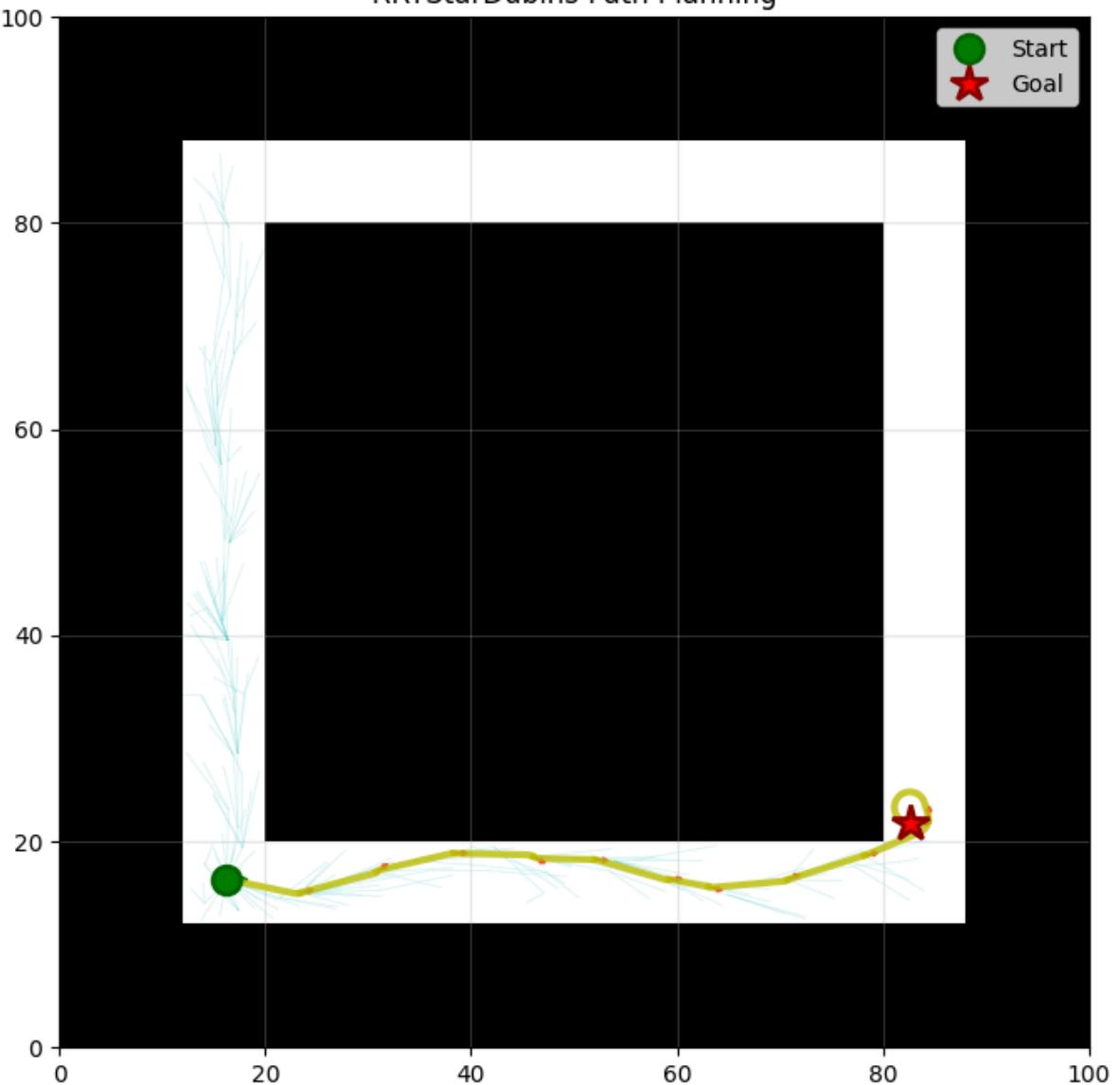


### PRRTStar [Early Stop]



### RRTStarDubins [Early Stop]

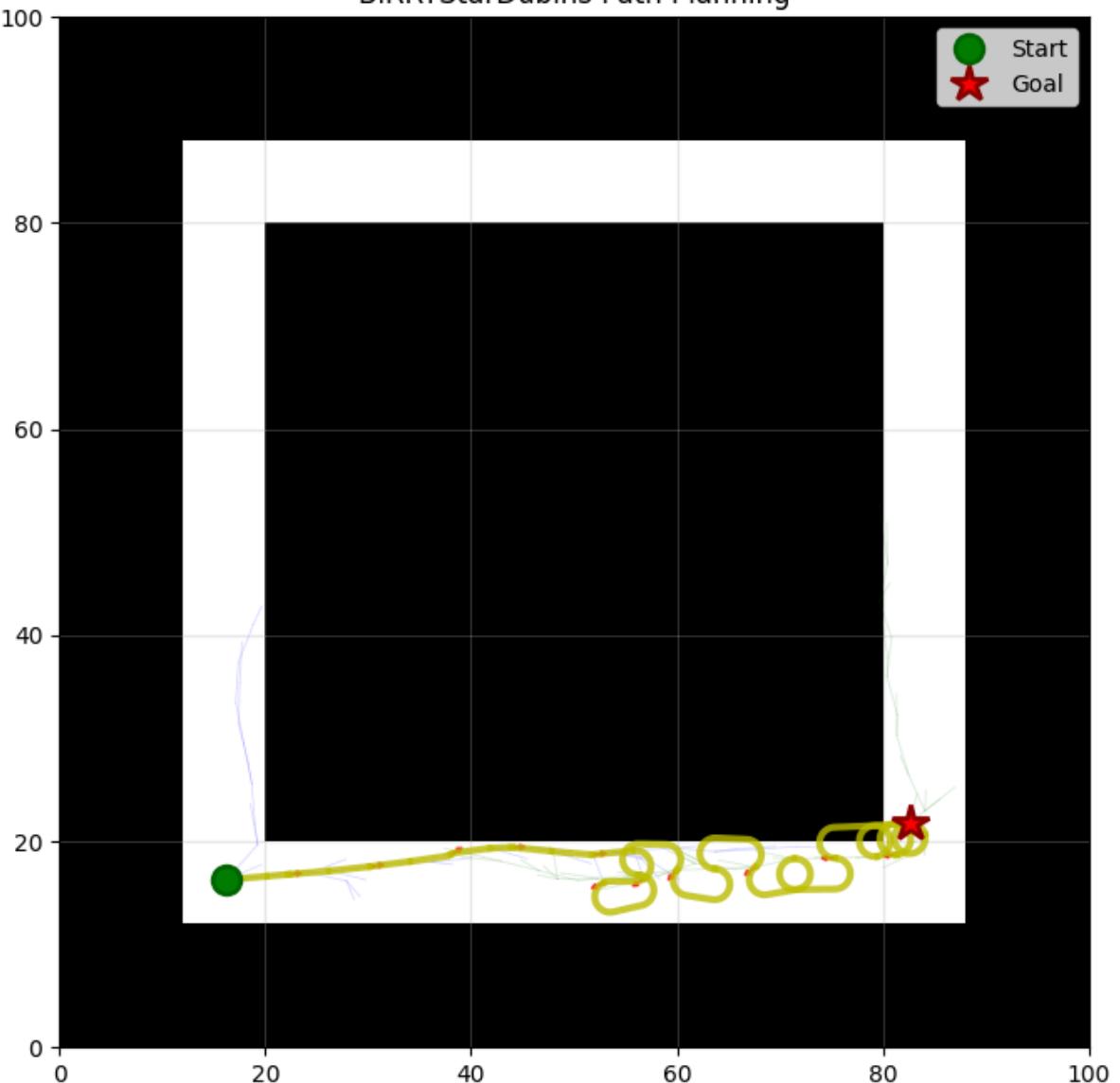
### RRTStarDubins Path Planning



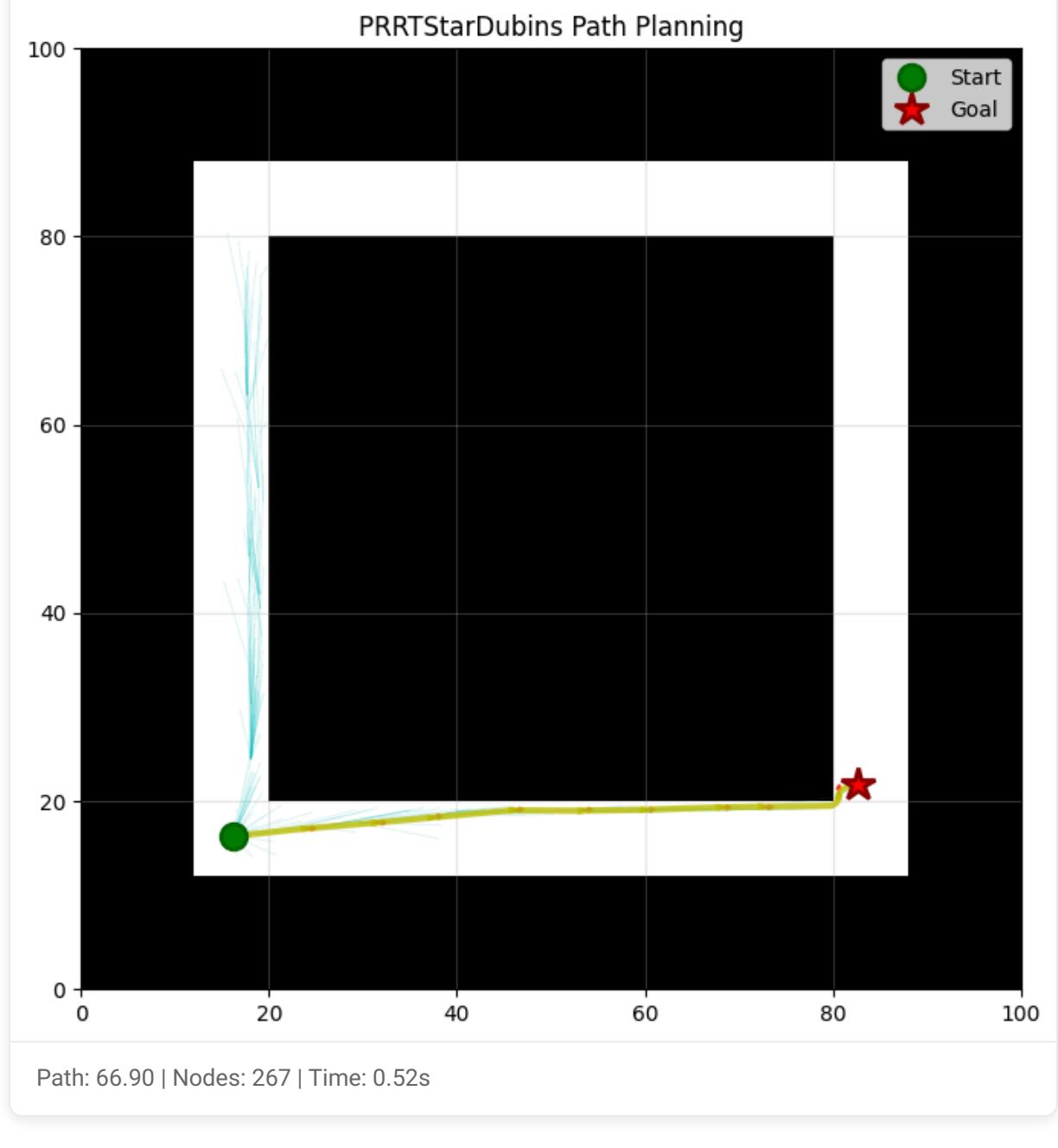
Path: 72.17 | Nodes: 232 | Time: 0.07s

### BiRRTStarDubins [Early Stop]

### BiRRTStarDubins Path Planning



### PRRTStarDubins [Early Stop]



## Run 5

**Start:** (16.28982676335878, 16.28746299294786) | **Goal:** (82.57937879844133, 21.809232846471062) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 8, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0})

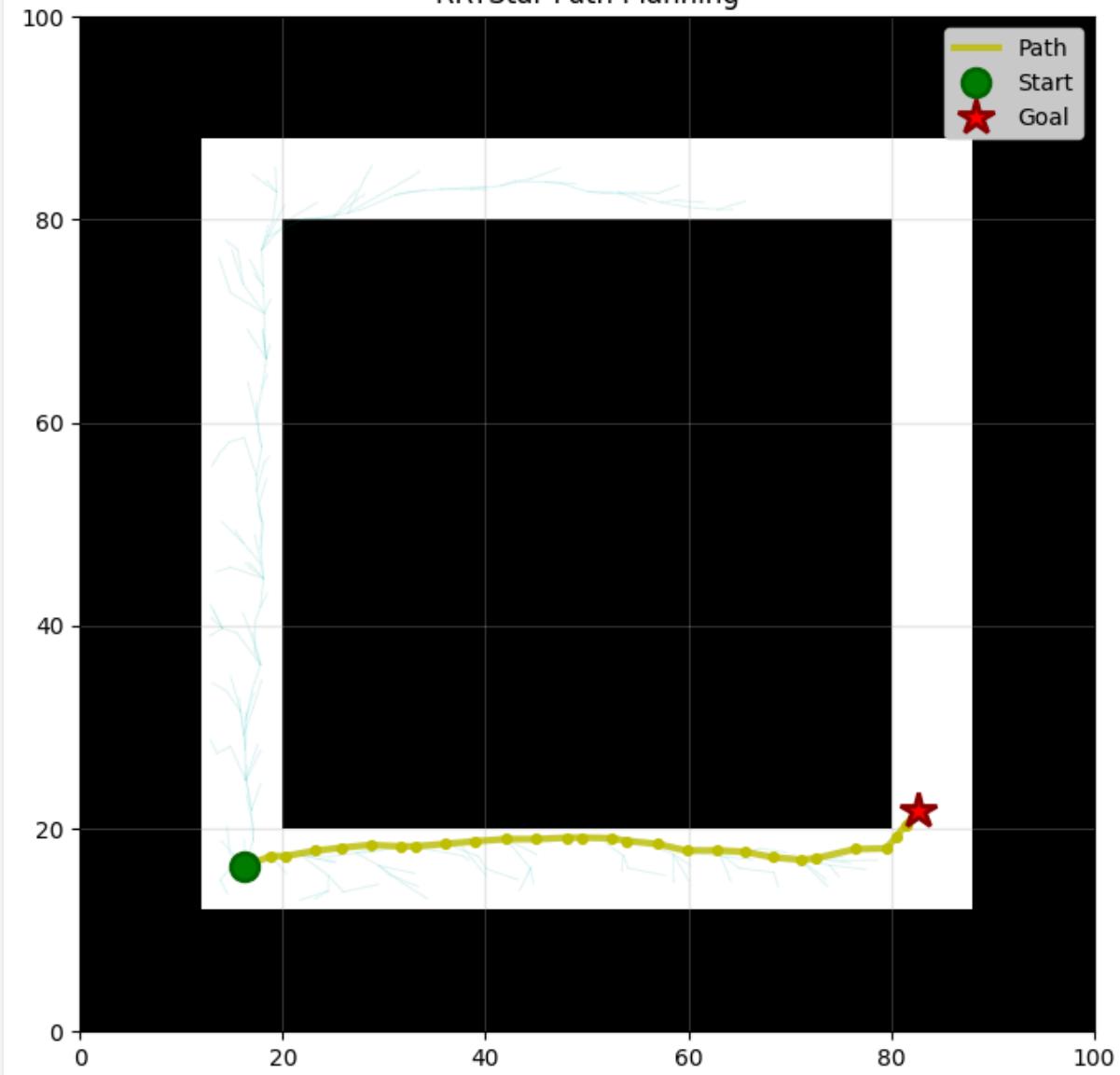
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.07	68.67	248	68.68
BiRRTStar ES	✓ Success	0.02	71.92	110	71.92
PRRTStar ES	✓ Success	0.13	68.82	113	68.82
RRTStarDubins ES	✓ Success	0.11	68.26	327	68.85
BiRRTStarDubins ES	✓ Success	0.03	67.86	186	68.55
PRRTStarDubins ES	✓ Success	0.53	67.10	267	72.90

## Path Visualizations

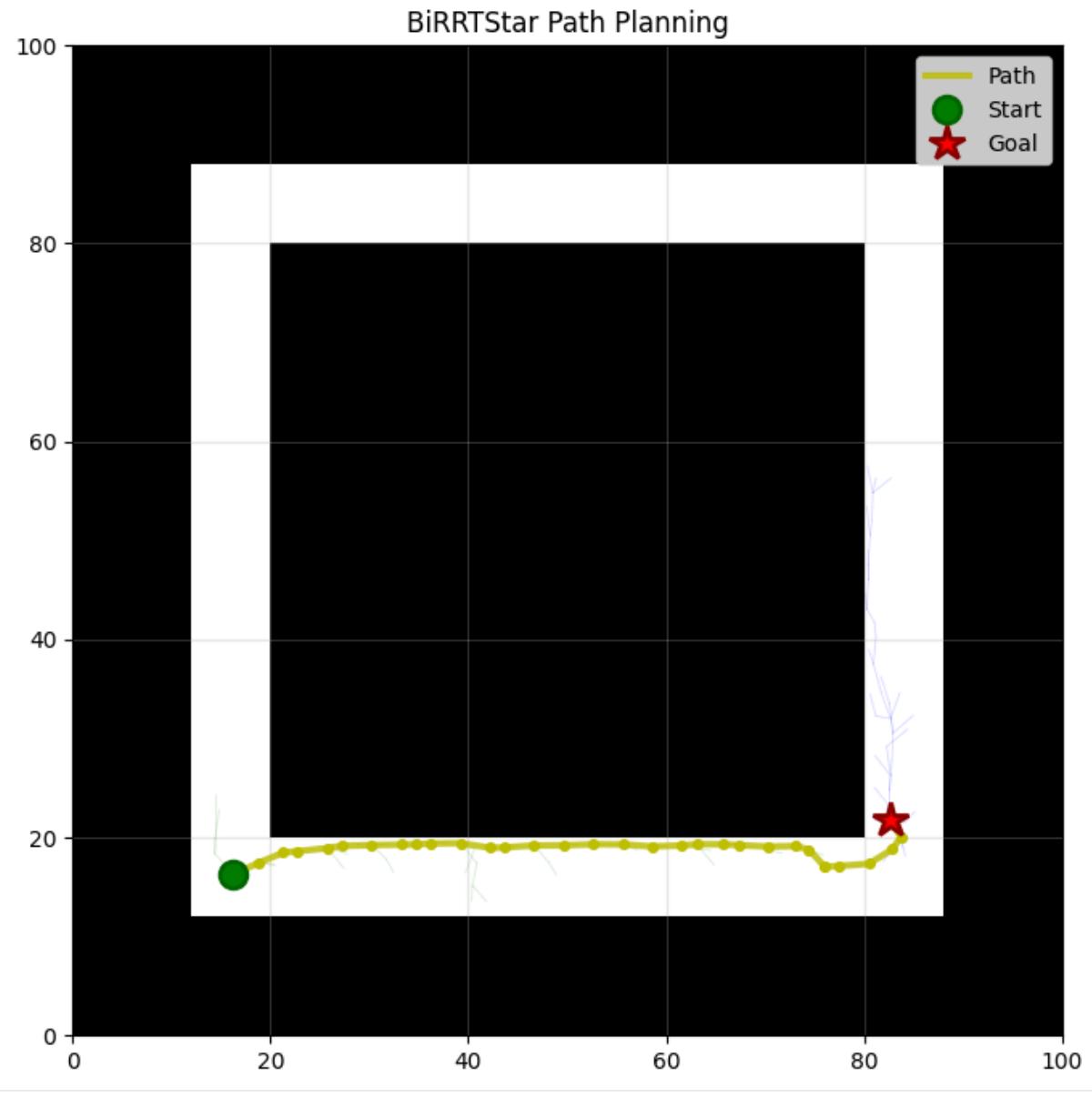
RRTStar [Early Stop]

### RRTStar Path Planning

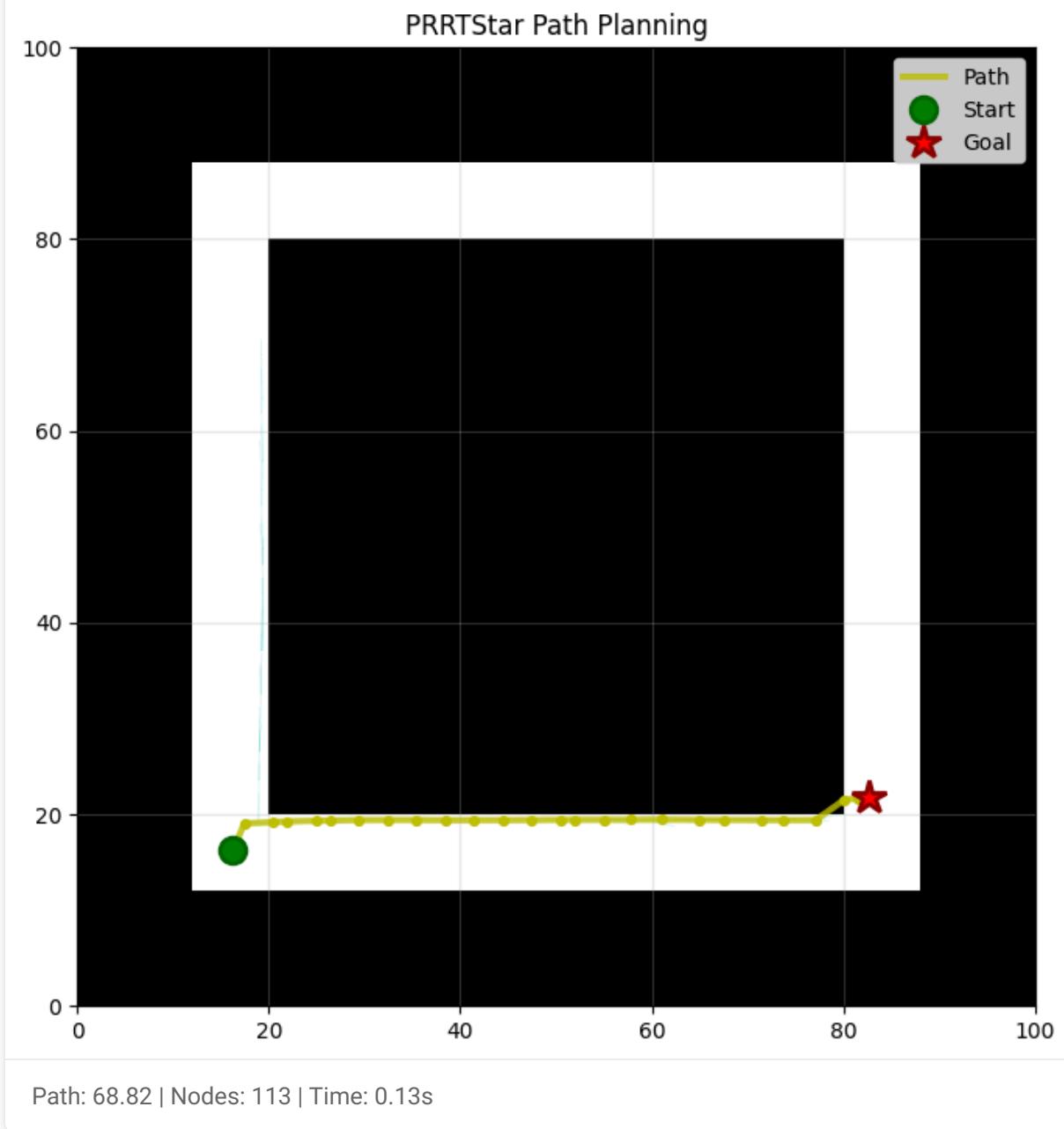


Path: 68.67 | Nodes: 248 | Time: 0.07s

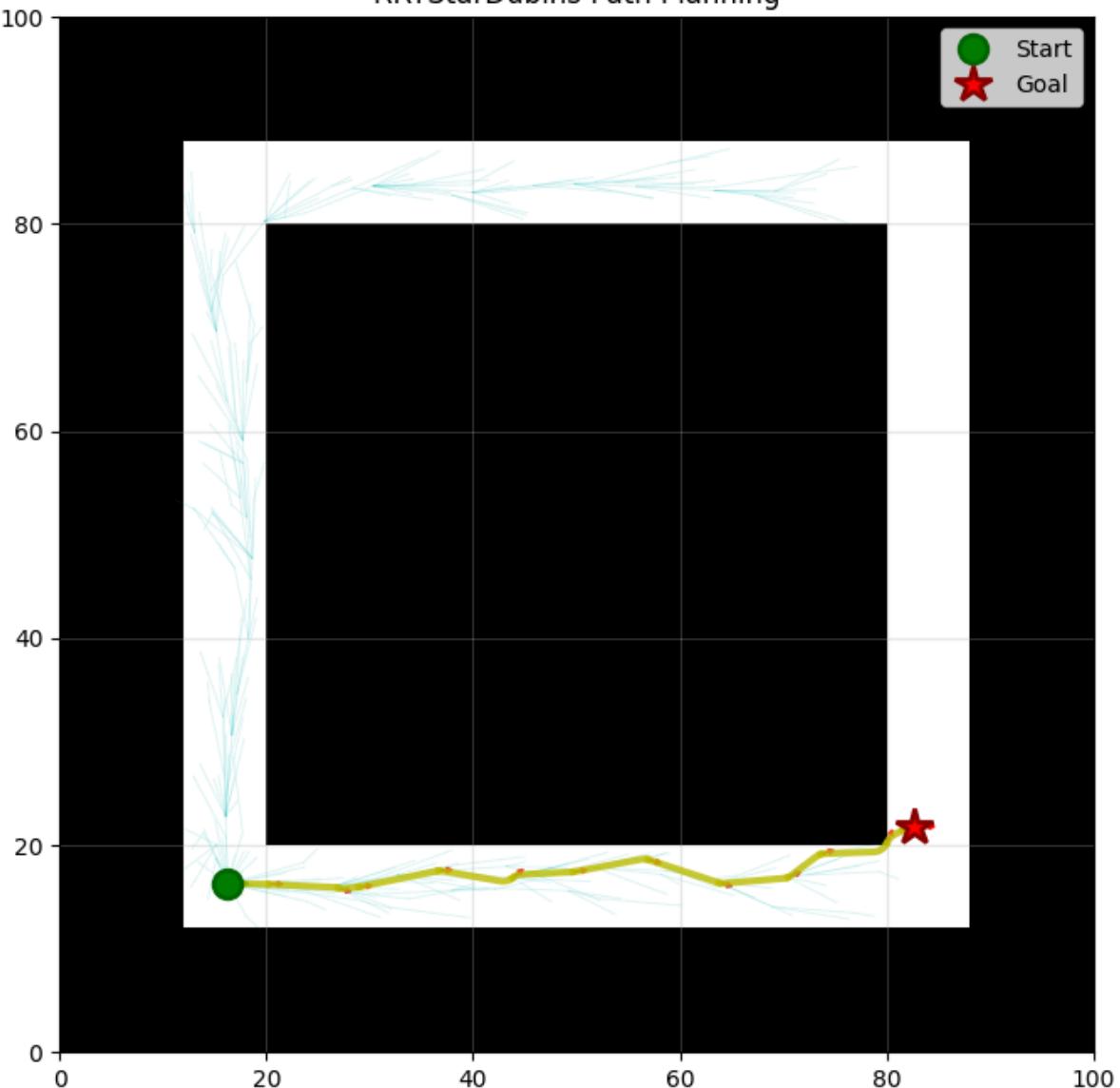
### BiRRTStar [Early Stop]



### PRRTStar [Early Stop]



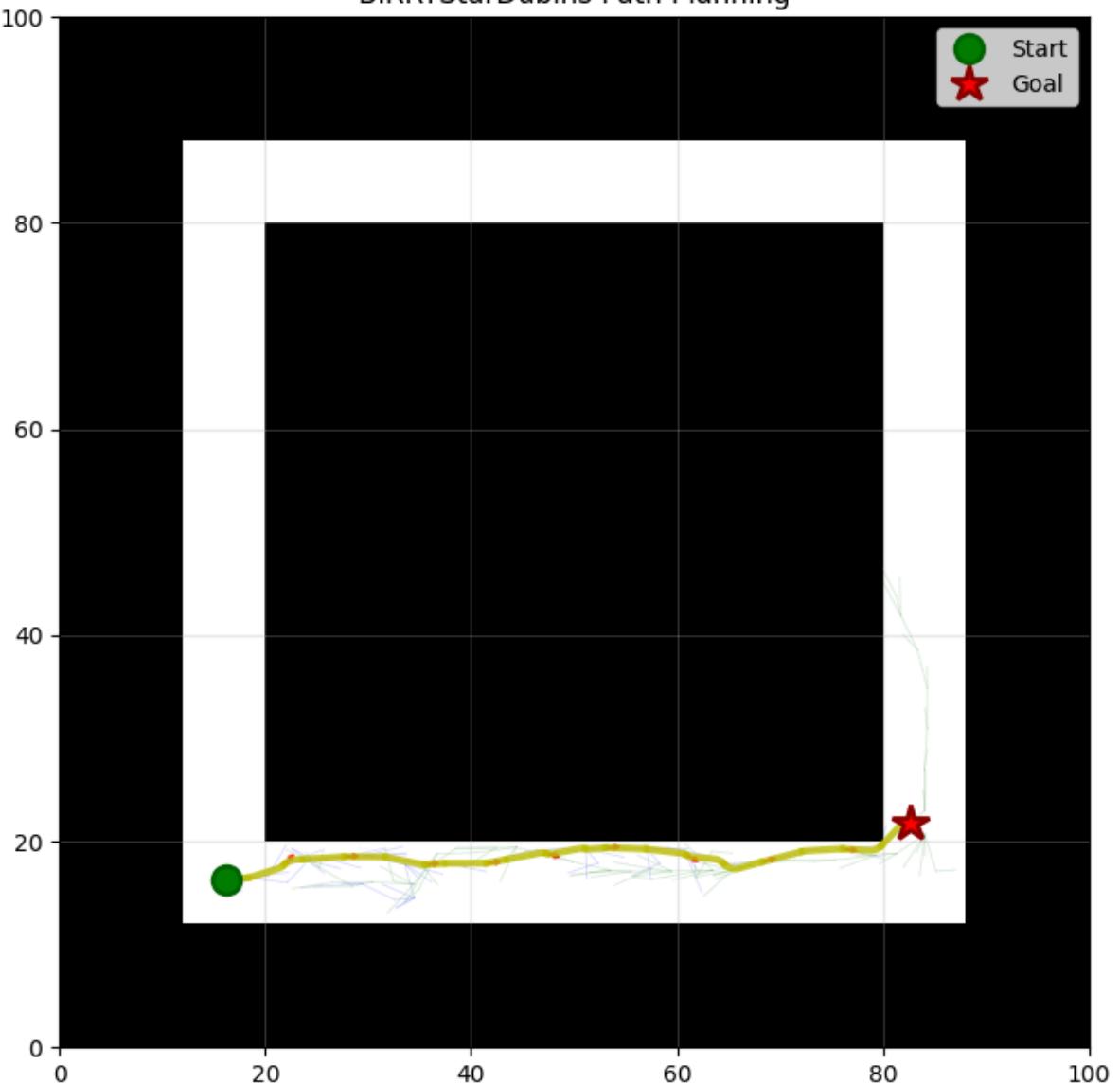
### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning**

Path: 68.26 | Nodes: 327 | Time: 0.11s

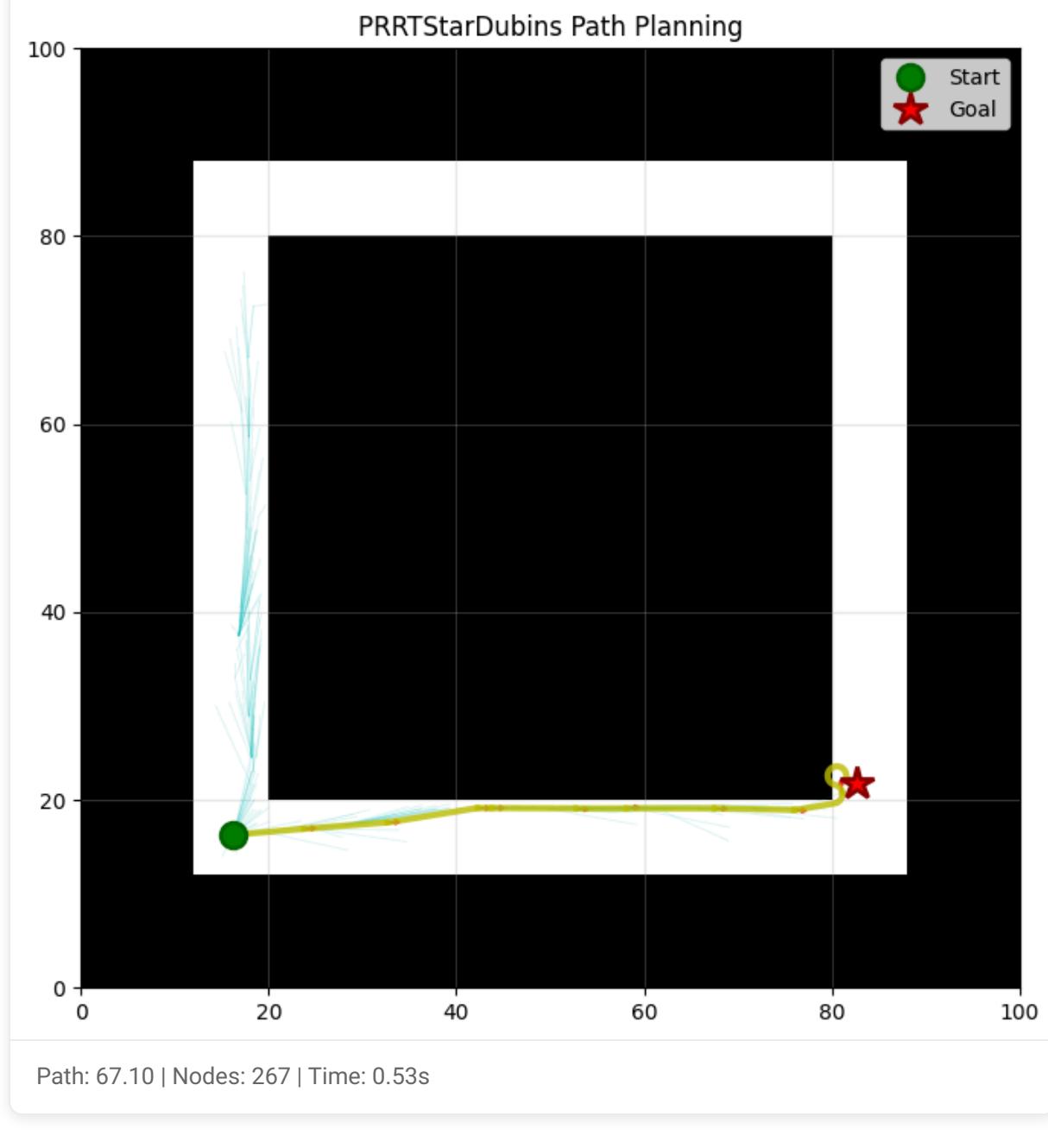
**BiRRTStarDubins [Early Stop]**

### BiRRTStarDubins Path Planning



Path: 67.86 | Nodes: 186 | Time: 0.03s

### PRRTStarDubins [Early Stop]



## Square Corridor - Wide

Compare all algorithms in a wide square corridor environment

### Run 1

**Start:** (37.704931647041526, 94.17000202817178) | **Goal:** (16.28982676335878, 16.28746299294786) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 20, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

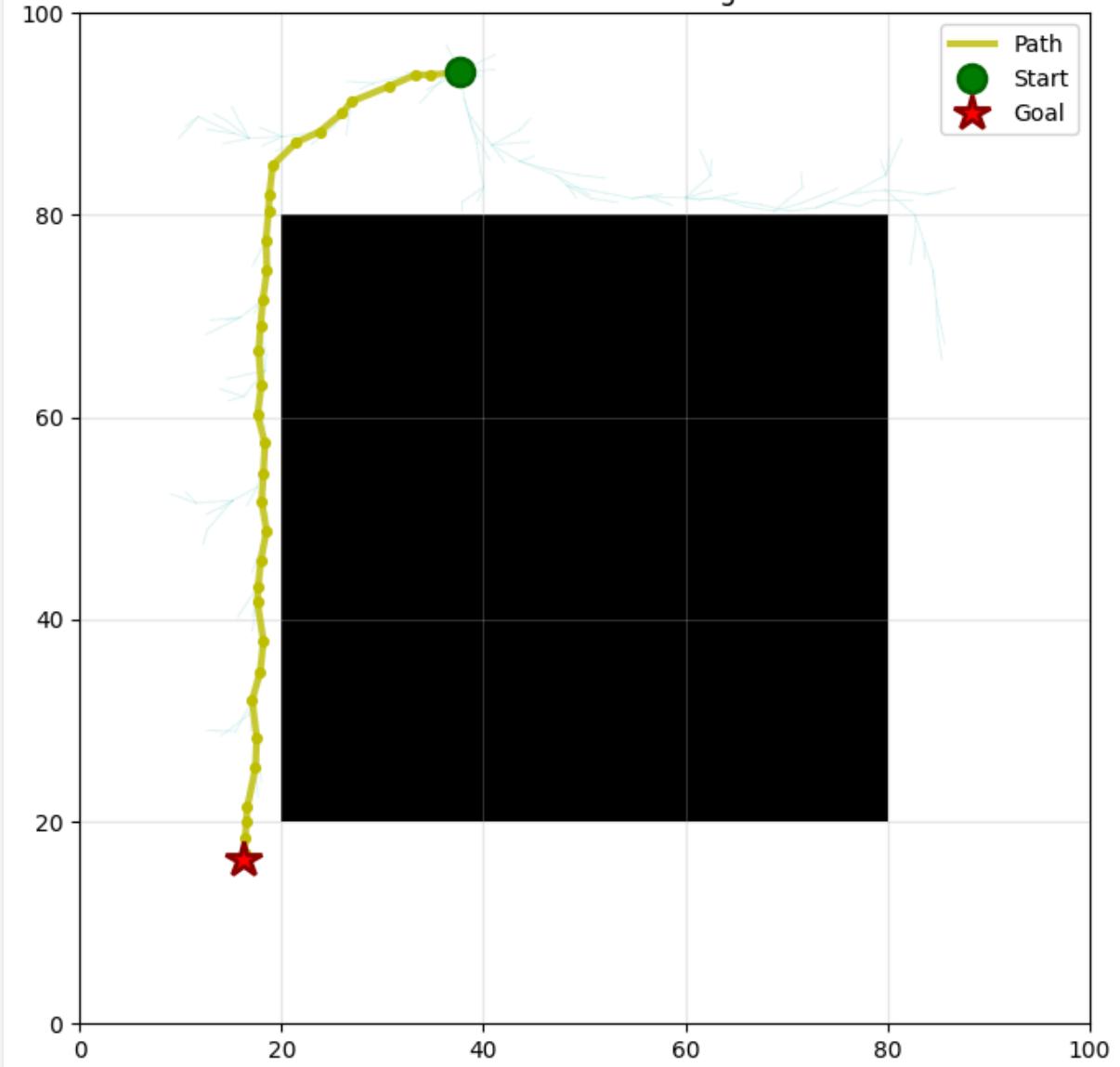
## Algorithm Results

Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.04	90.74	186	90.83
BiRRTStar ES	✓ Success	0.03	94.31	182	94.31
PRRTStar ES	✓ Success	0.89	170.39	369	170.85
RRTStarDubins ES	✓ Success	3.88	104.33	2451	131.71
BiRRTStarDubins ES	✓ Success	0.06	122.53	275	126.75
PRRTStarDubins ES	✗ Failed	5.40	N/A	1726	N/A

## Path Visualizations

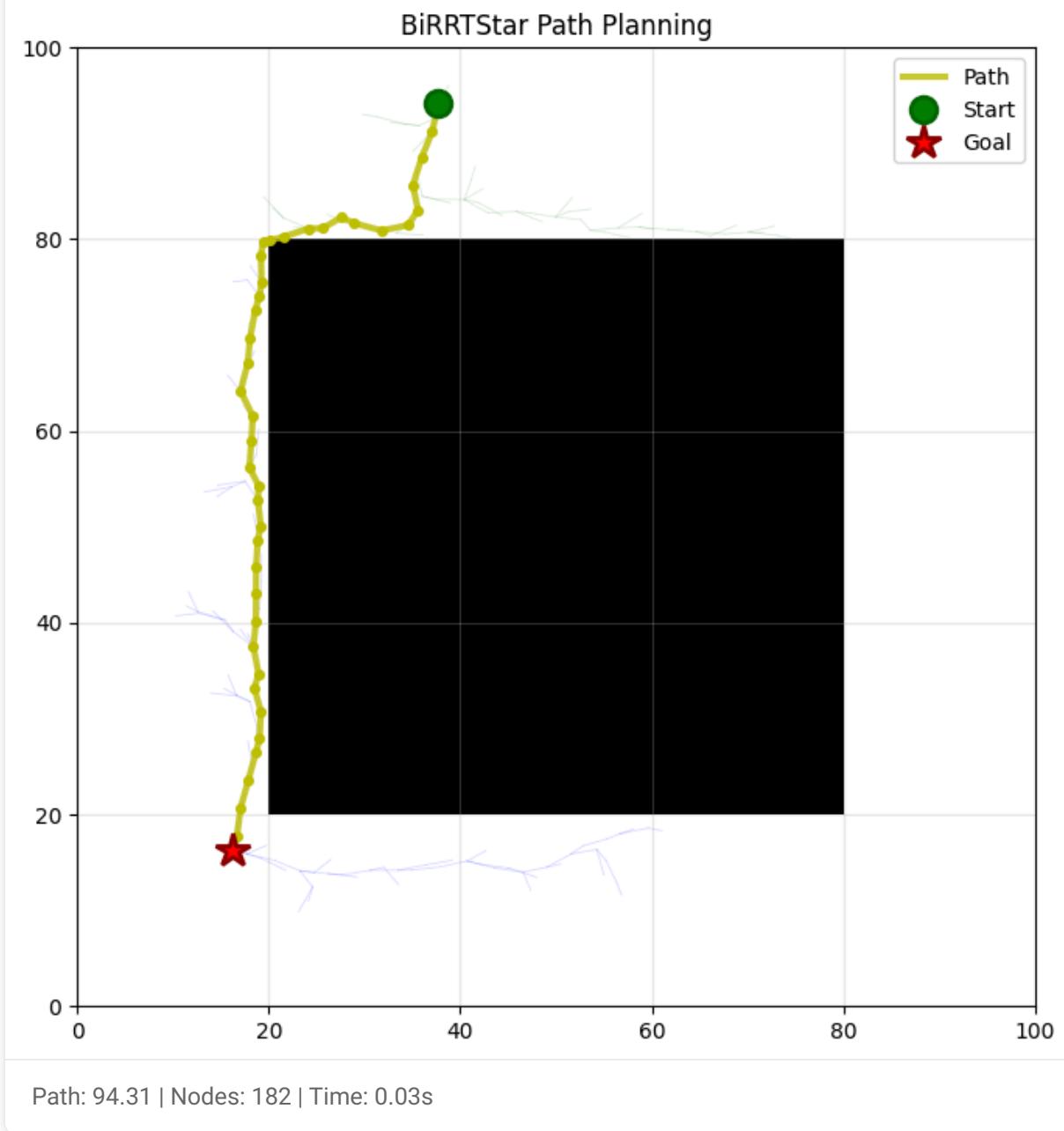
### RRTStar [Early Stop]

### RRTStar Path Planning



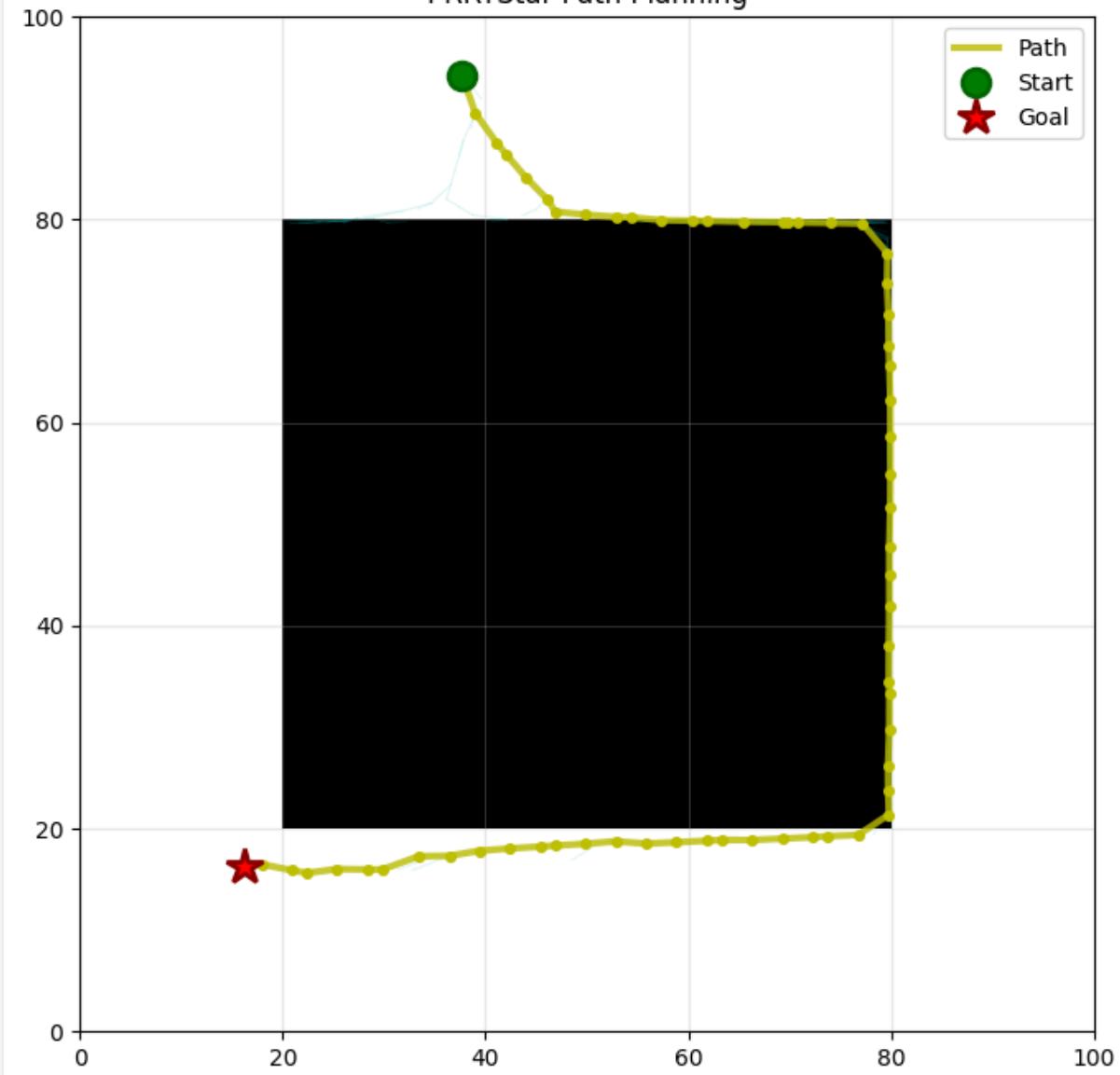
Path: 90.74 | Nodes: 186 | Time: 0.04s

### BiRRTStar [Early Stop]



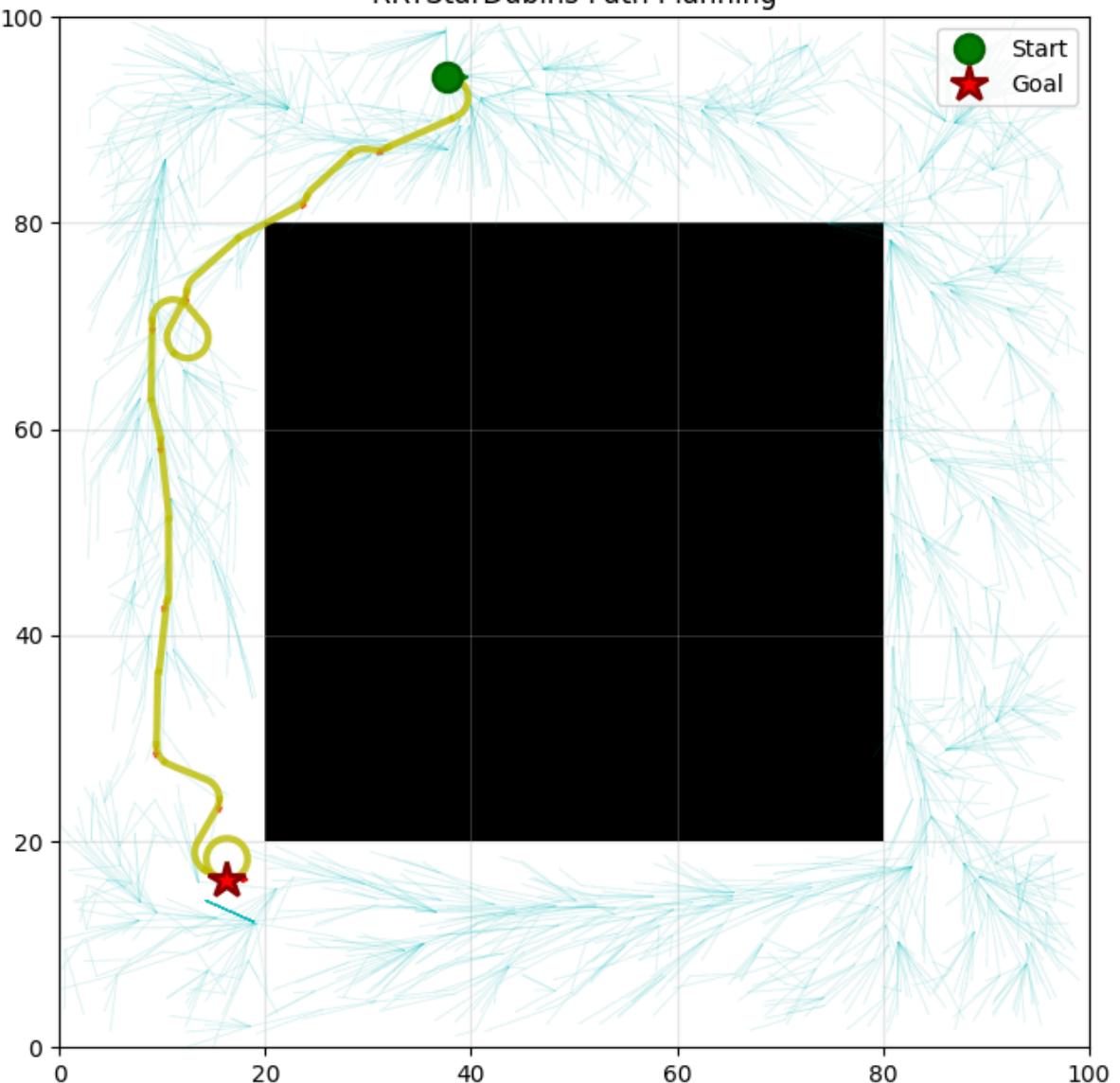
### PRRTStar [Early Stop]

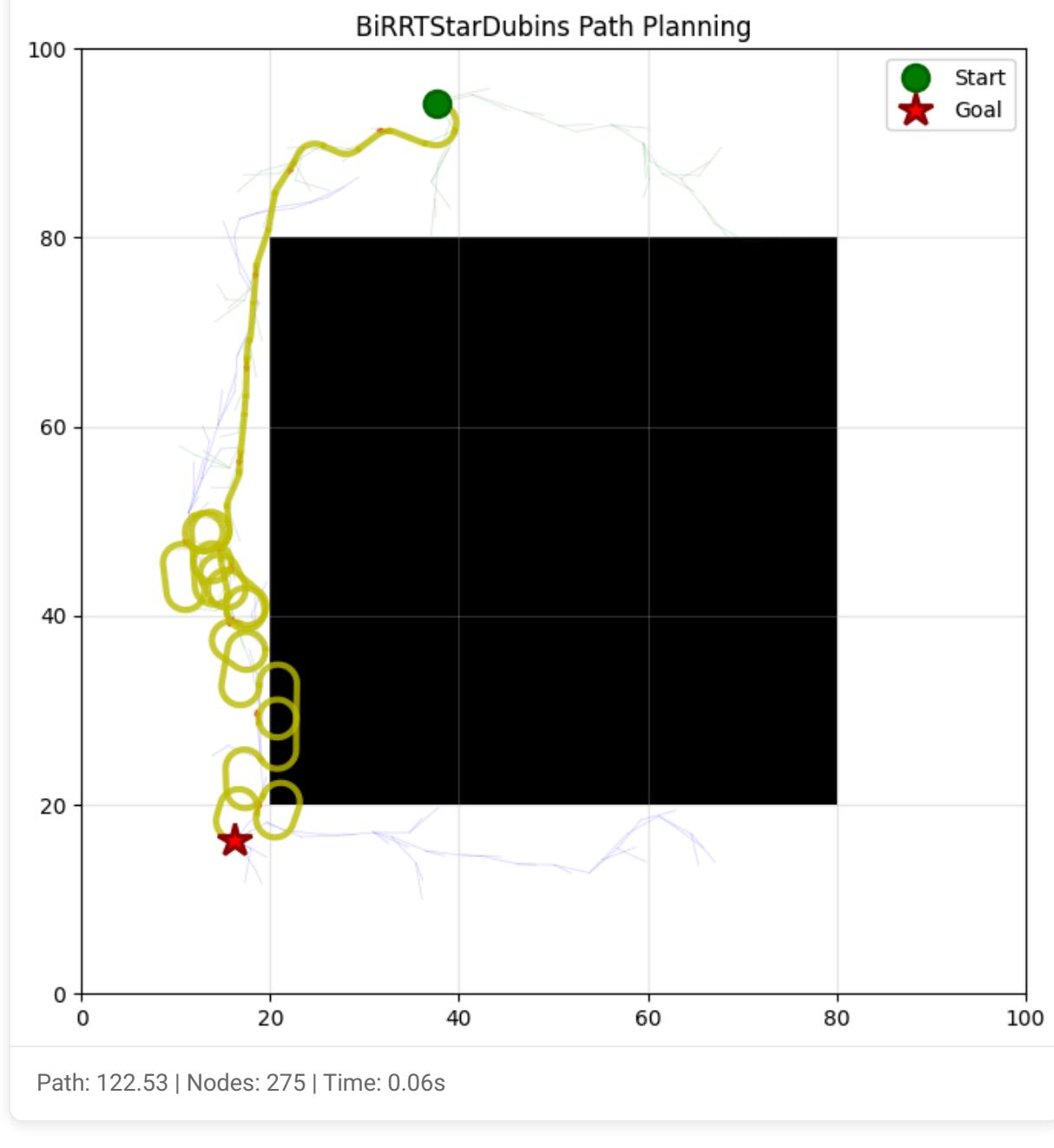
### PRRTStar Path Planning



Path: 170.39 | Nodes: 369 | Time: 0.89s

### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**



## Run 2

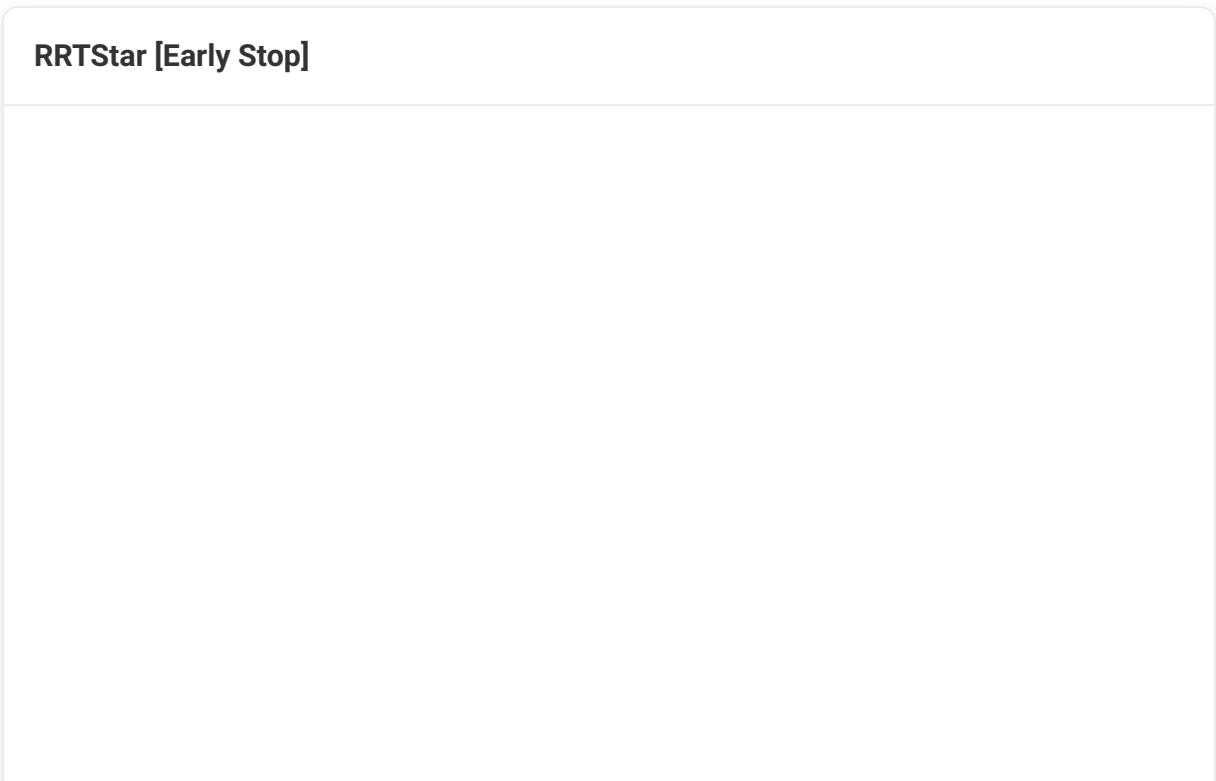
**Start:** (37.704931647041526, 94.17000202817178) | **Goal:** (16.28982676335878, 16.28746299294786) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 20, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

## Algorithm Results

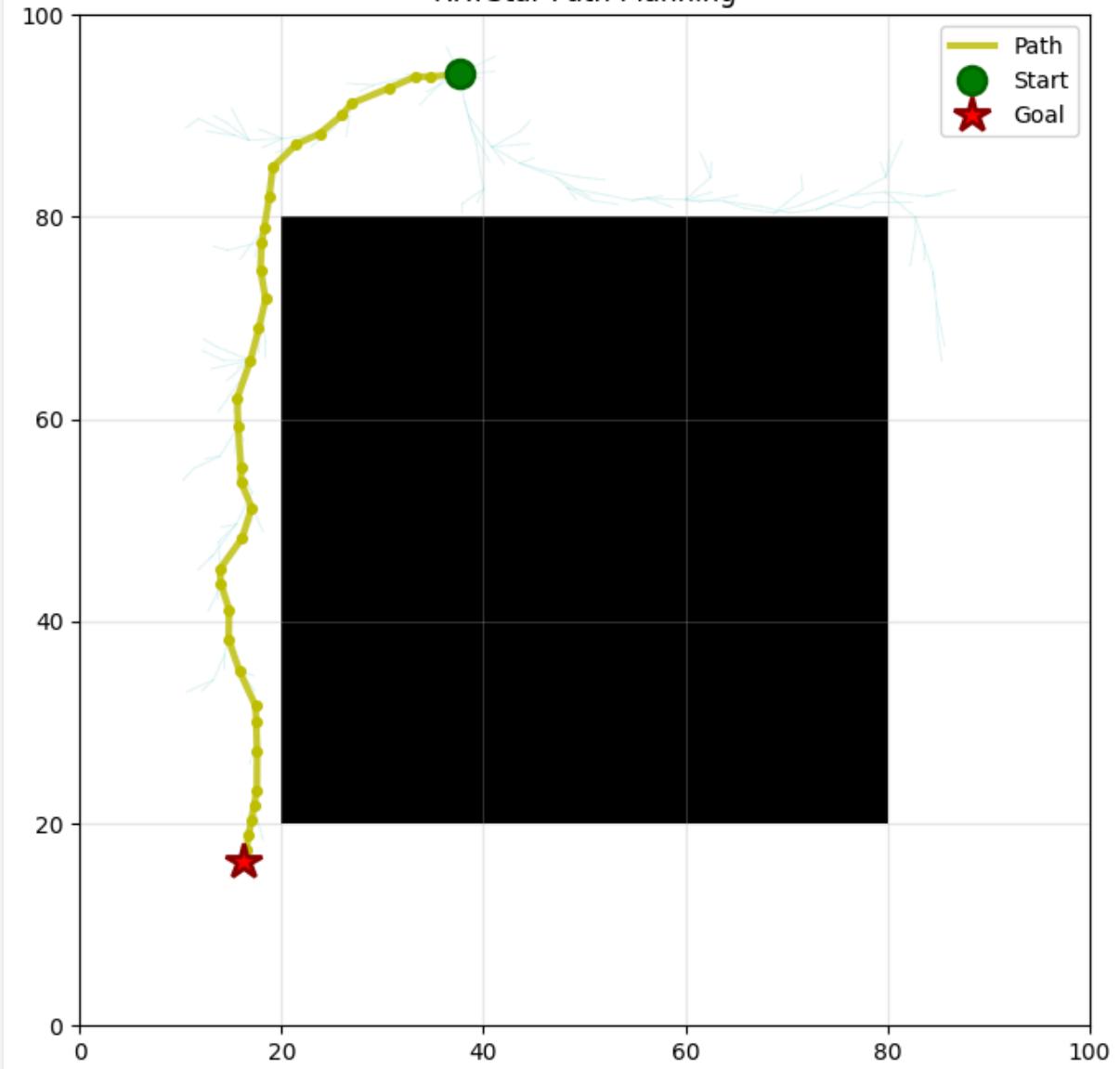
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.04	92.51	189	92.78
BiRRTStar ES	✓ Success	0.01	90.87	112	90.87
PRRTStar ES	✓ Success	0.88	95.77	363	95.77
RRTStarDubins ES	✓ Success	0.11	109.56	361	124.99
BiRRTStarDubins ES	✓ Success	0.11	100.61	338	103.35
PRRTStarDubins ES	✓ Success	3.09	177.19	1281	183.67

## Path Visualizations

RRTStar [Early Stop]

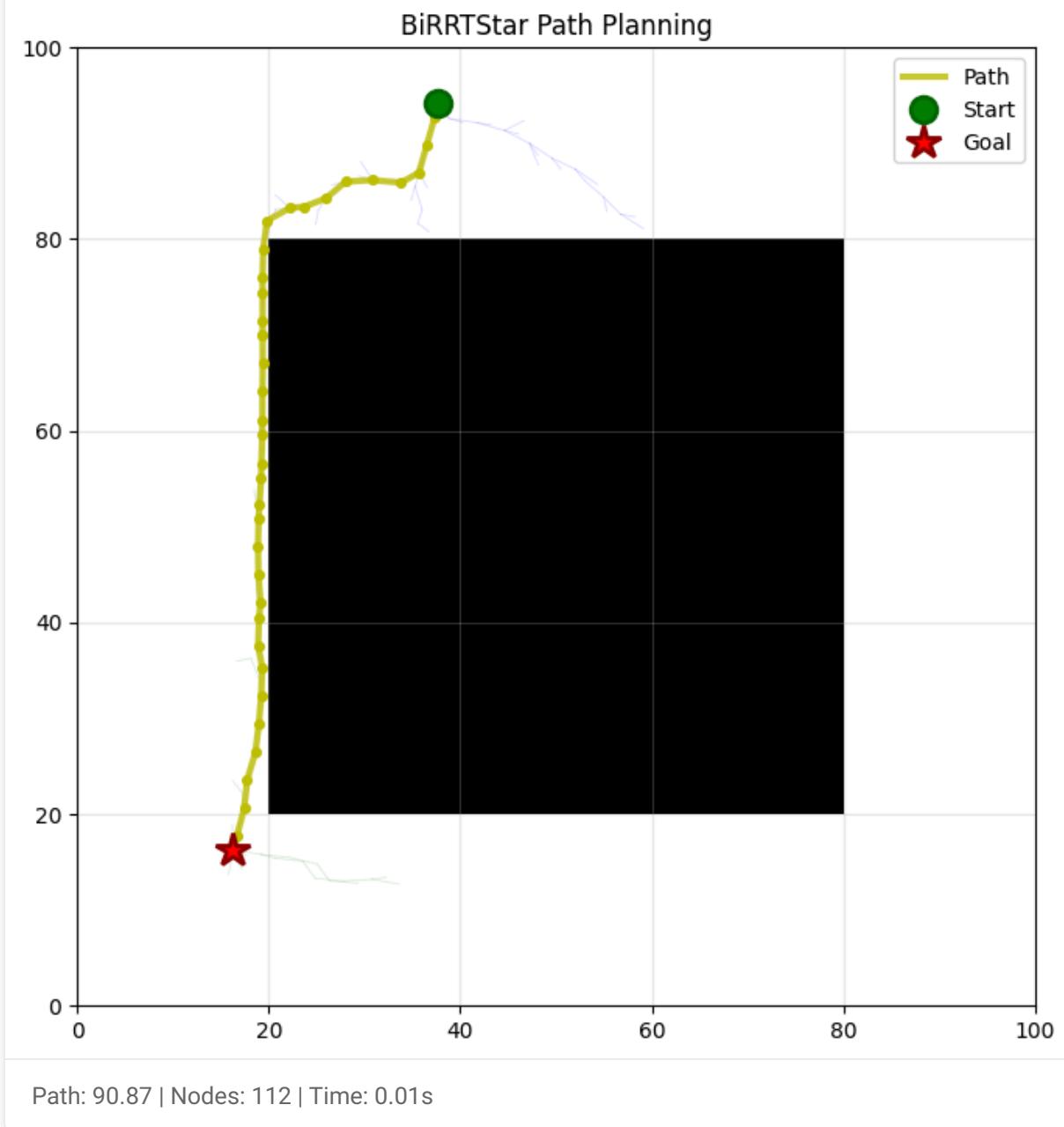


### RRTStar Path Planning



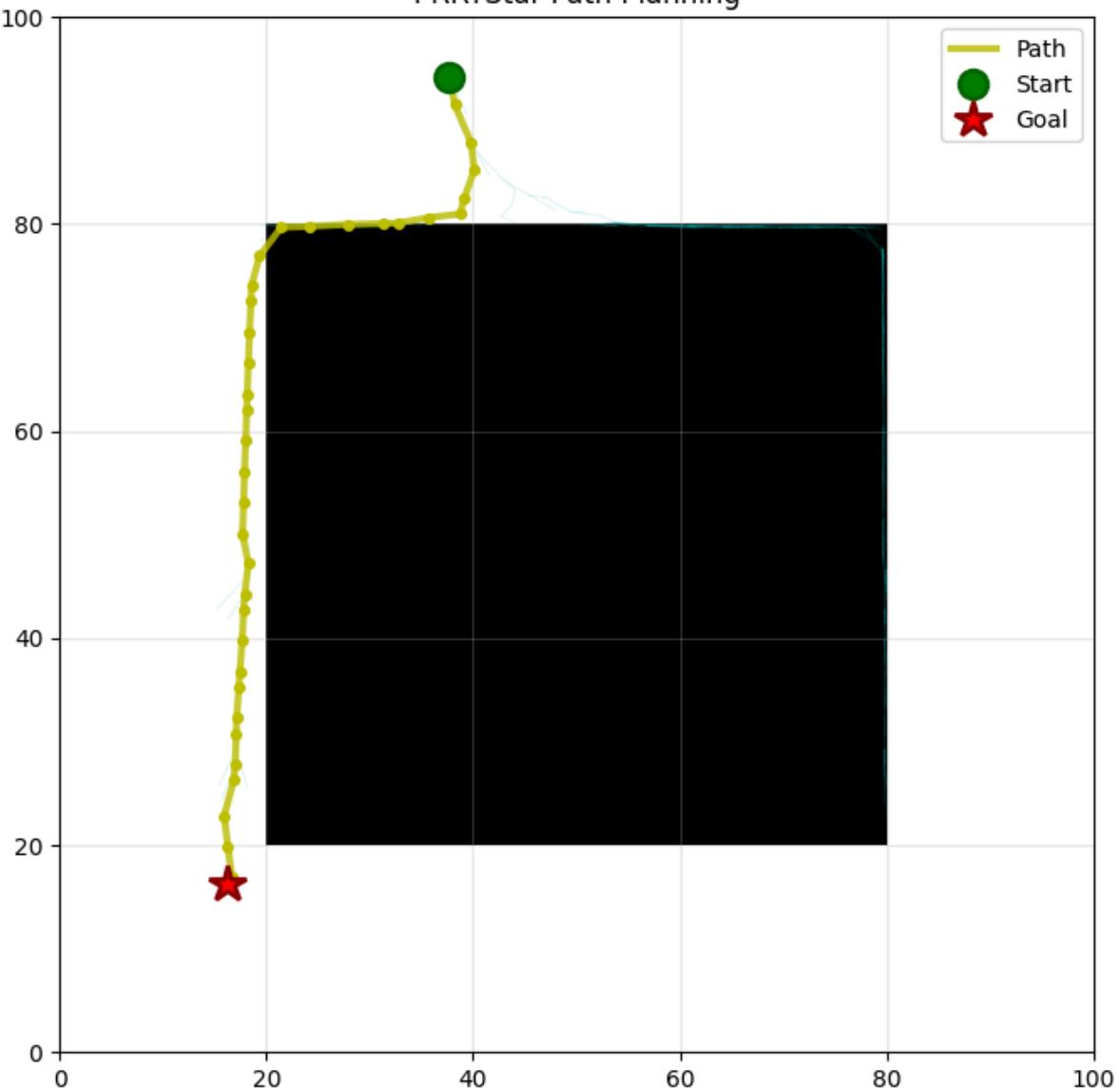
Path: 92.51 | Nodes: 189 | Time: 0.04s

### BiRRTStar [Early Stop]

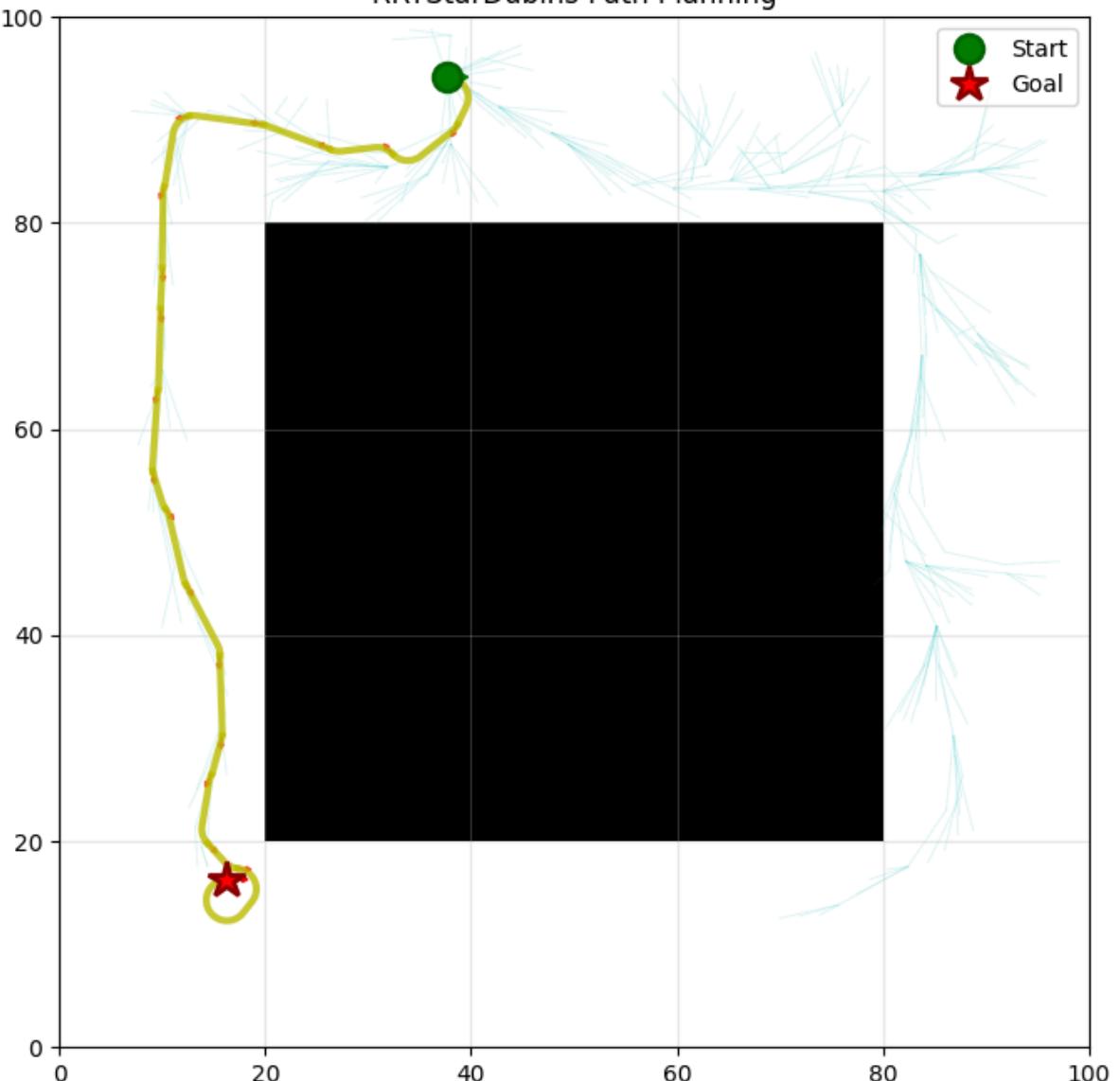


### PRRTStar [Early Stop]

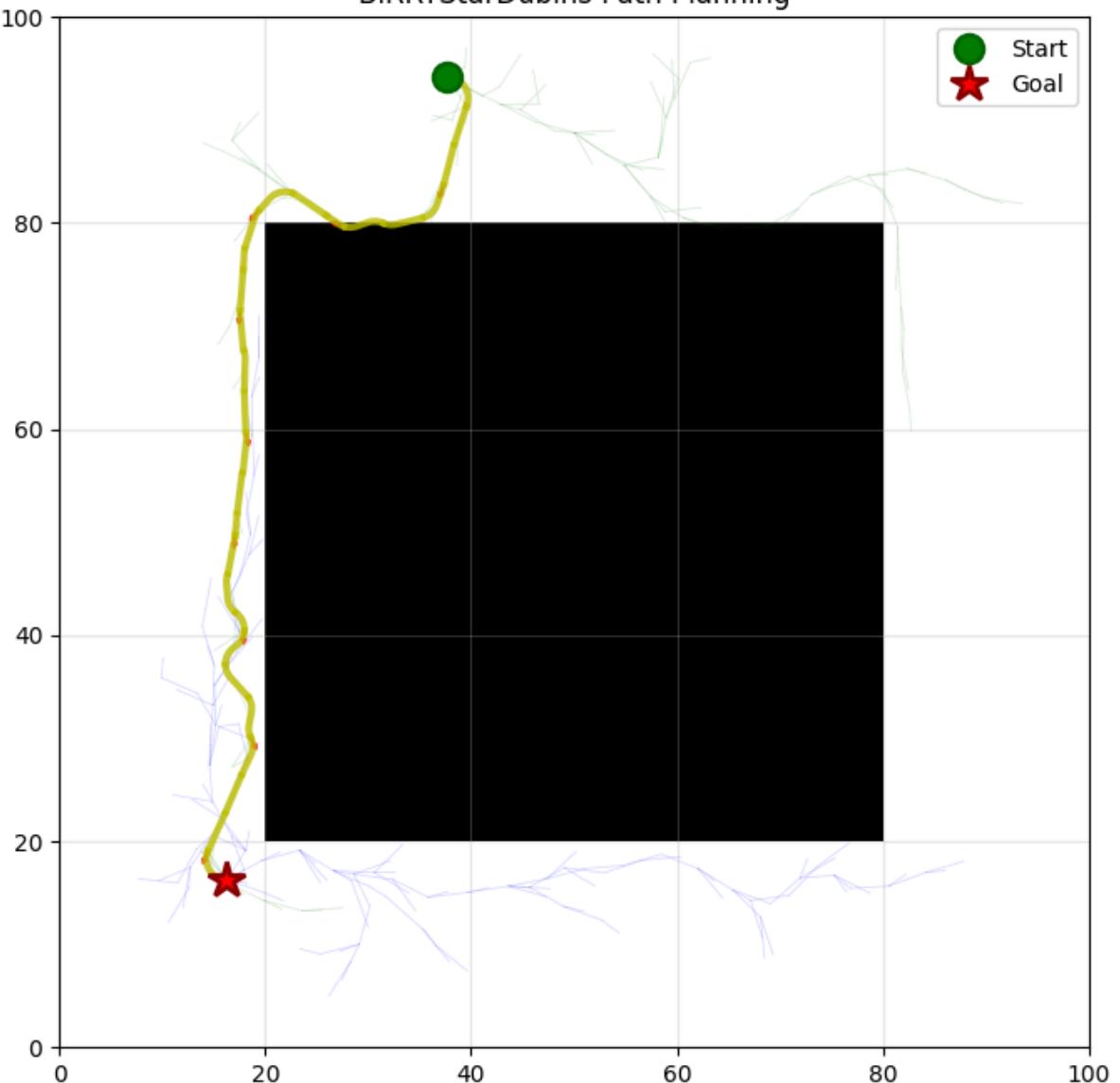
### PRRTStar Path Planning



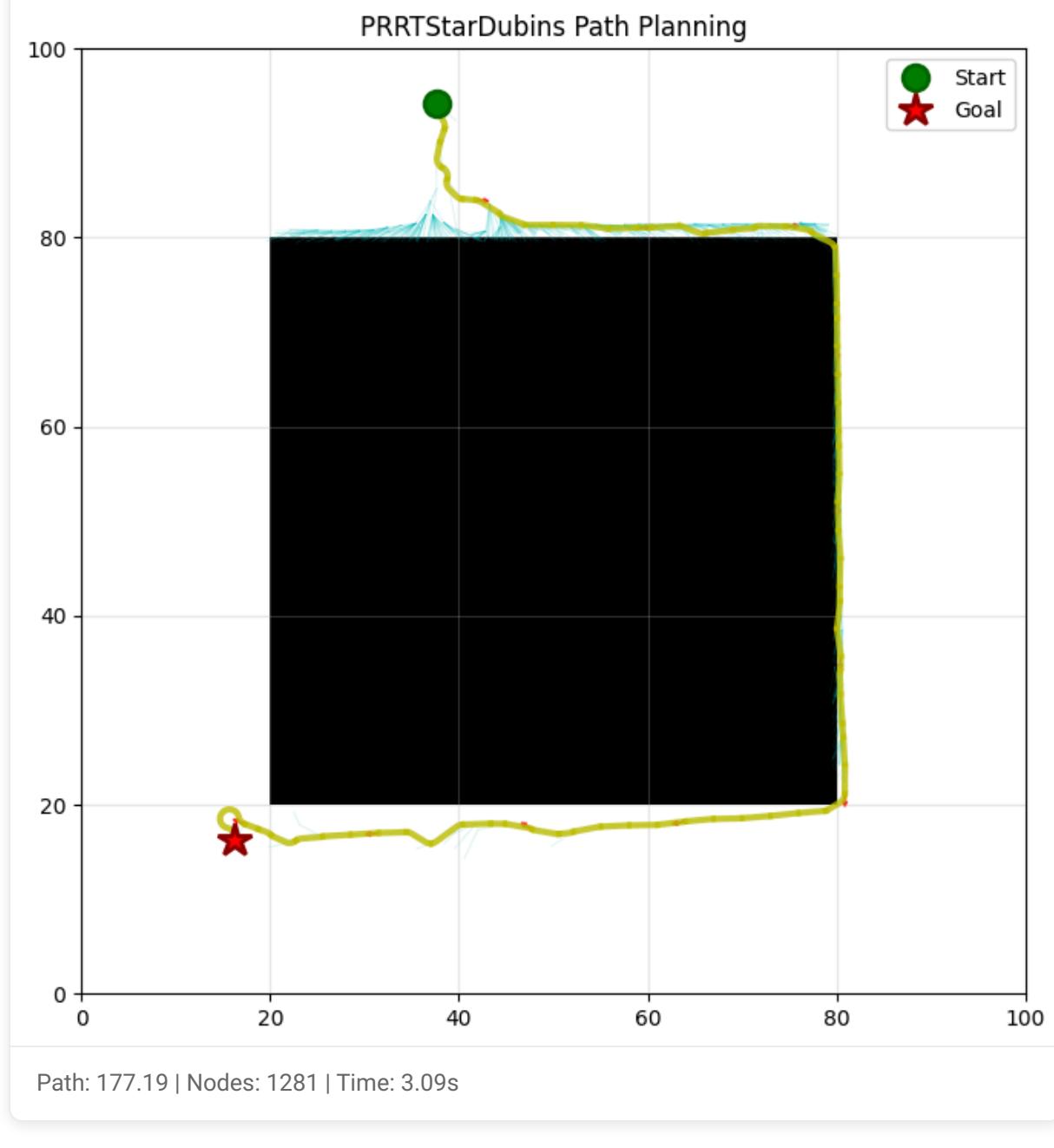
### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

### BiRRTStarDubins Path Planning



### PRRTStarDubins [Early Stop]



## Run 3

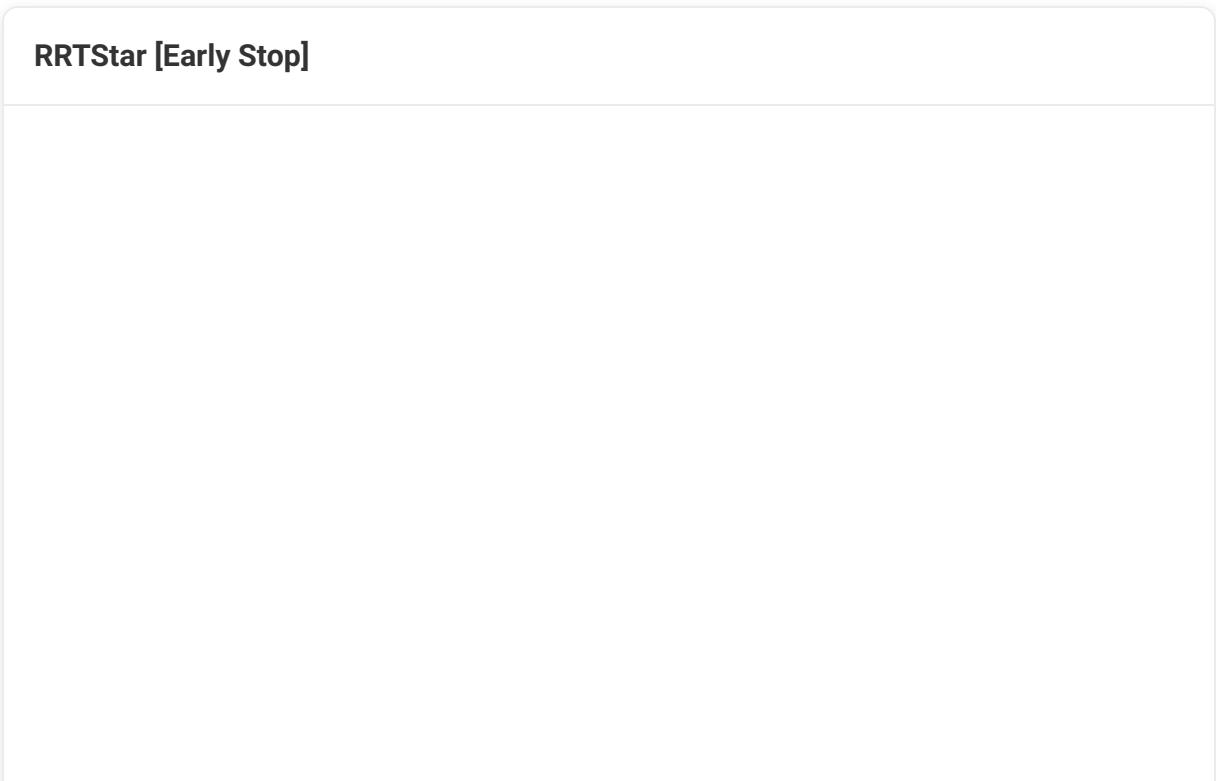
**Start:** (37.704931647041526, 94.17000202817178) | **Goal:** (16.28982676335878, 16.28746299294786) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 20, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

## Algorithm Results

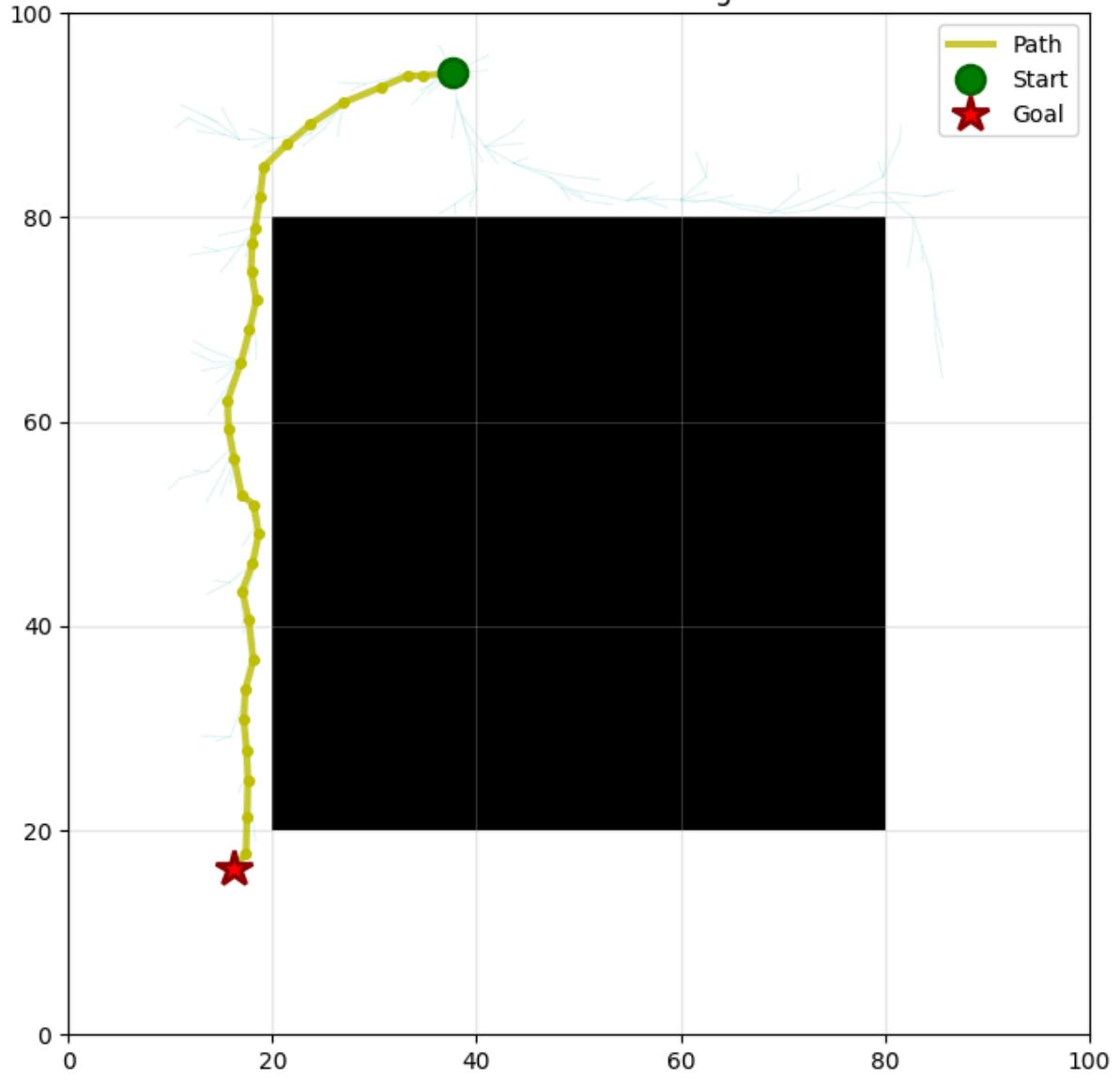
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.04	92.13	200	92.23
BiRRTStar ES	✓ Success	0.02	92.66	129	92.66
PRRTStar ES	✓ Success	0.33	92.08	141	92.08
RRTStarDubins ES	✓ Success	0.04	97.68	214	113.72
BiRRTStarDubins ES	✓ Success	0.14	142.00	462	144.42
PRRTStarDubins ES	✓ Success	1.89	102.37	772	109.23

## Path Visualizations

RRTStar [Early Stop]

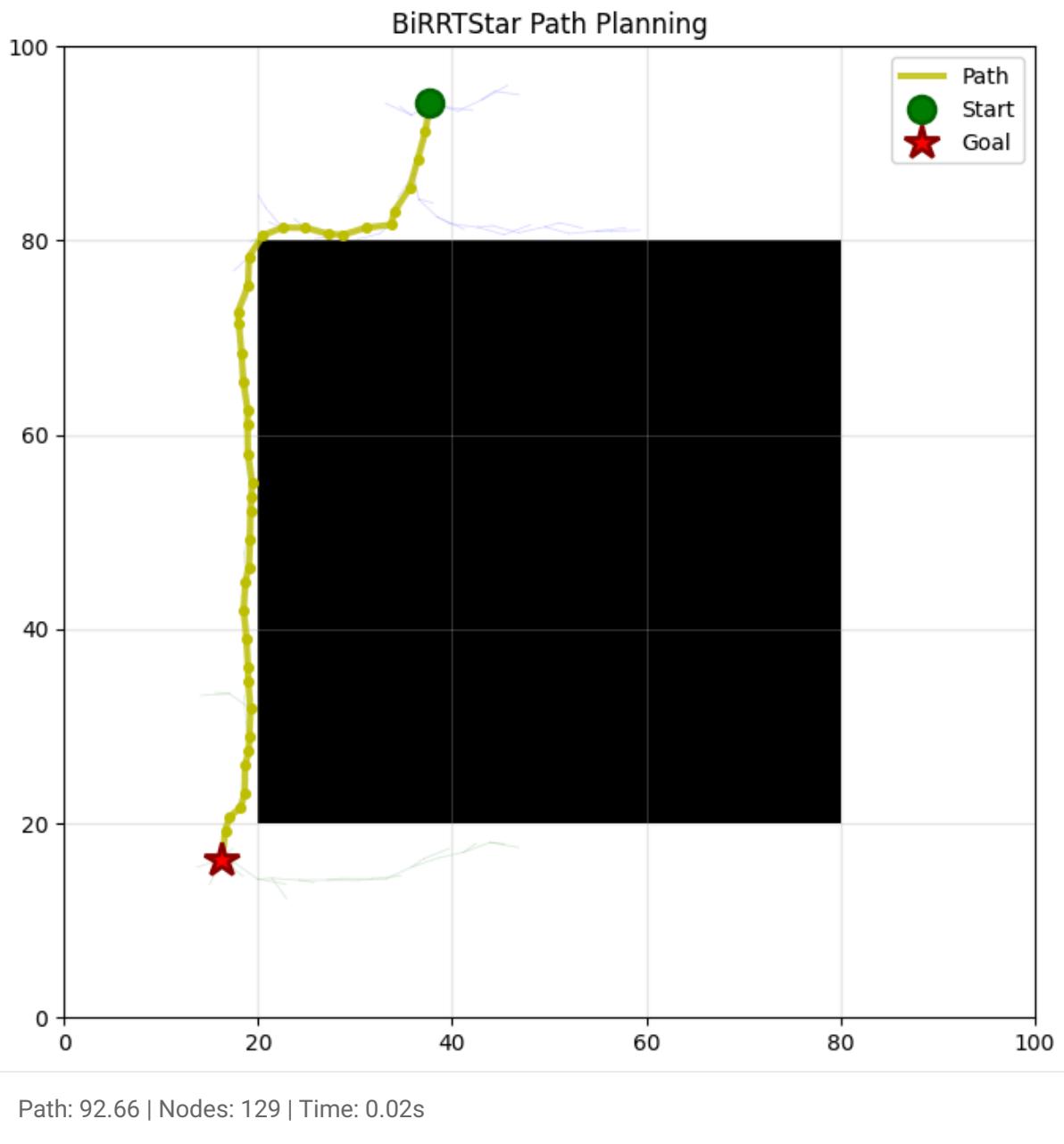


### RRTStar Path Planning

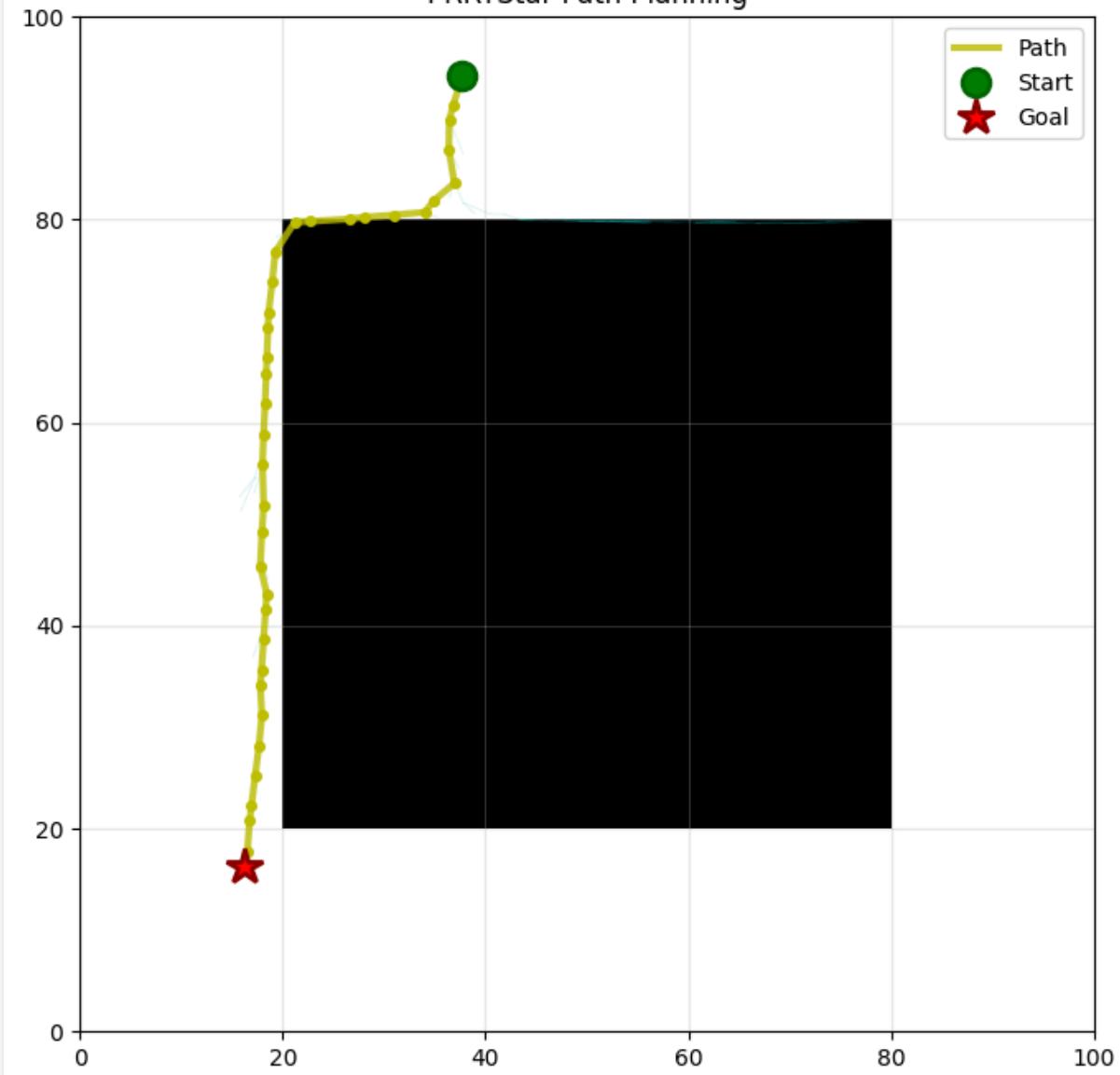


Path: 92.13 | Nodes: 200 | Time: 0.04s

### BiRRTStar [Early Stop]

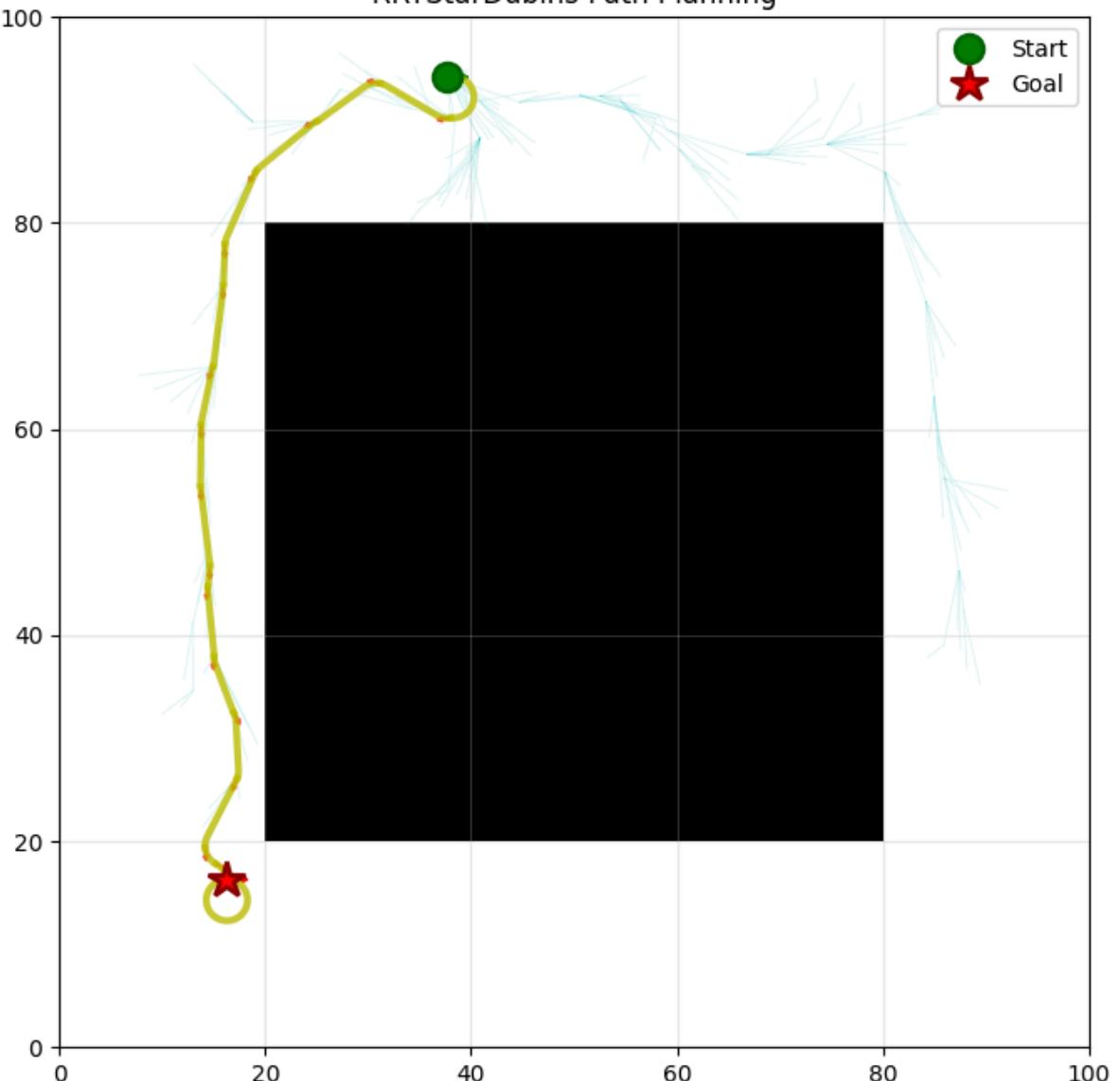


### PRRTStar [Early Stop]

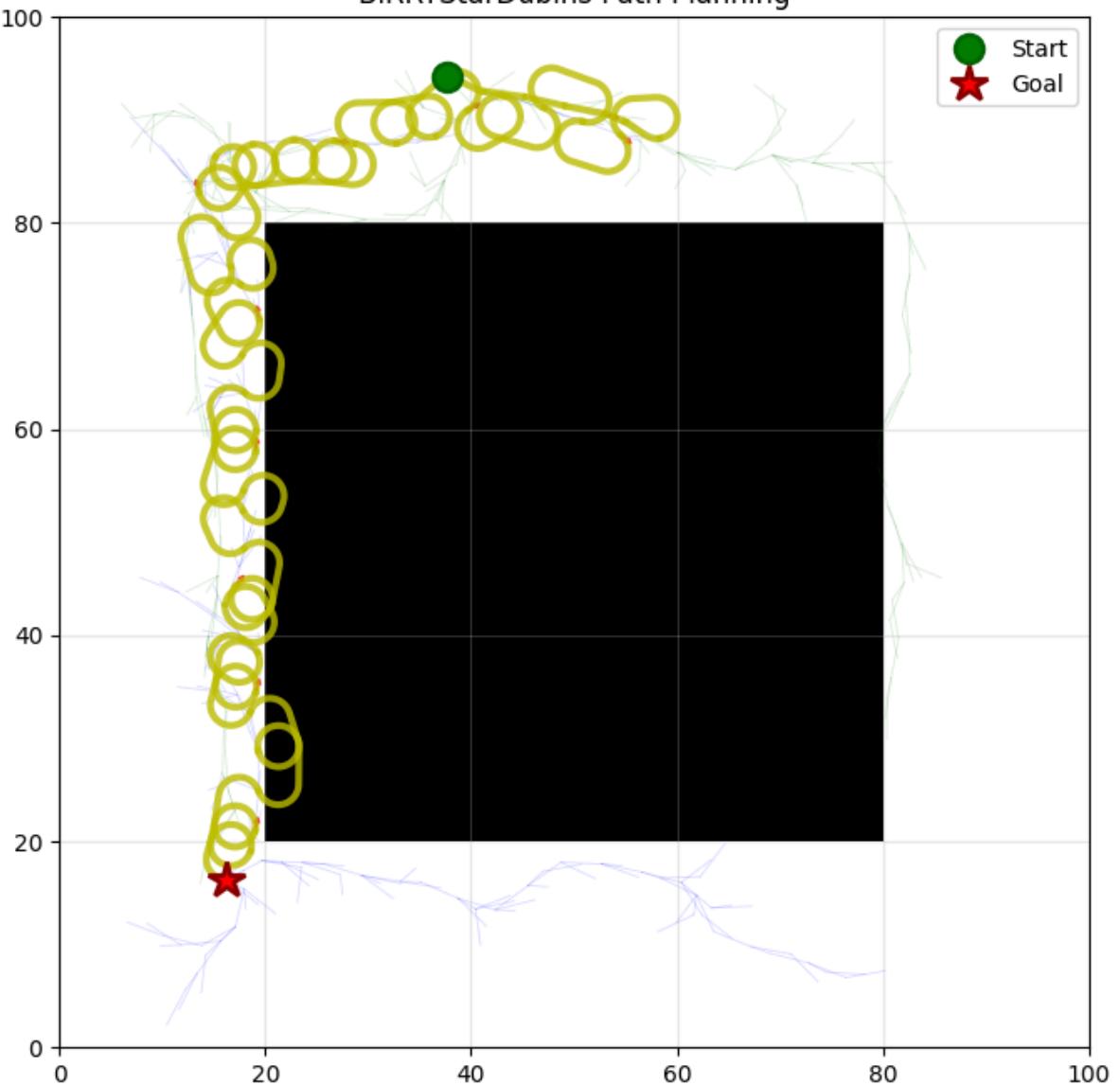
**PRRTStar Path Planning**

Path: 92.08 | Nodes: 141 | Time: 0.33s

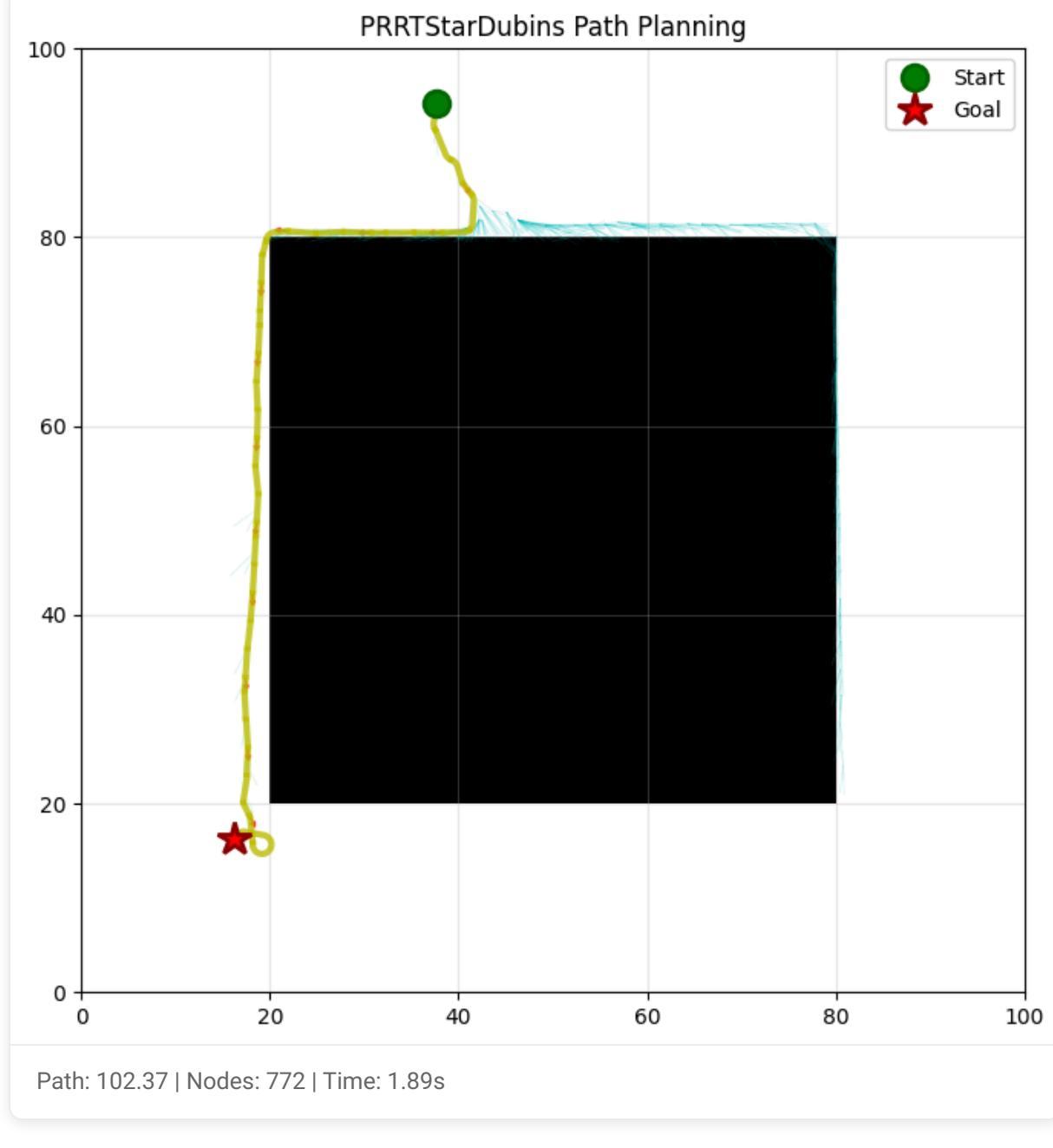
**RRTStarDubins [Early Stop]**

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

### BiRRTStarDubins Path Planning



### PRRTStarDubins [Early Stop]



## Run 4

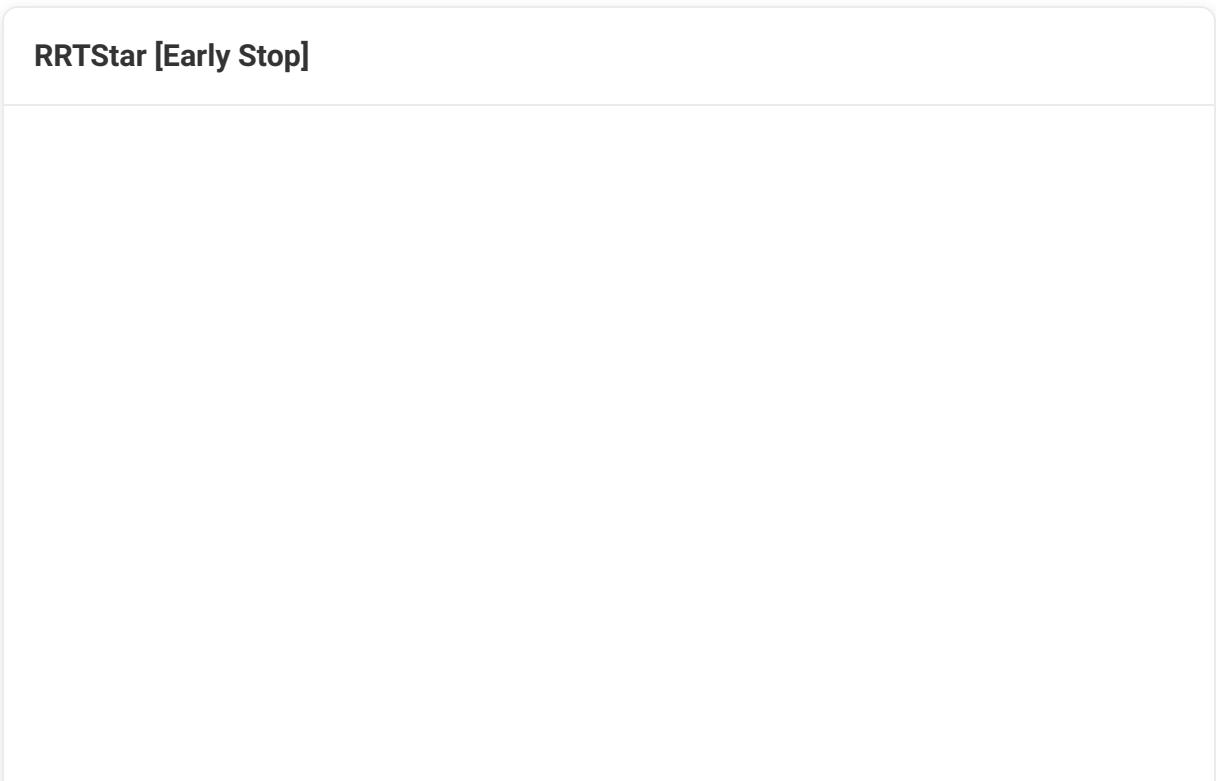
**Start:** (37.704931647041526, 94.17000202817178) | **Goal:** (16.28982676335878, 16.28746299294786) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 20, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

## Algorithm Results

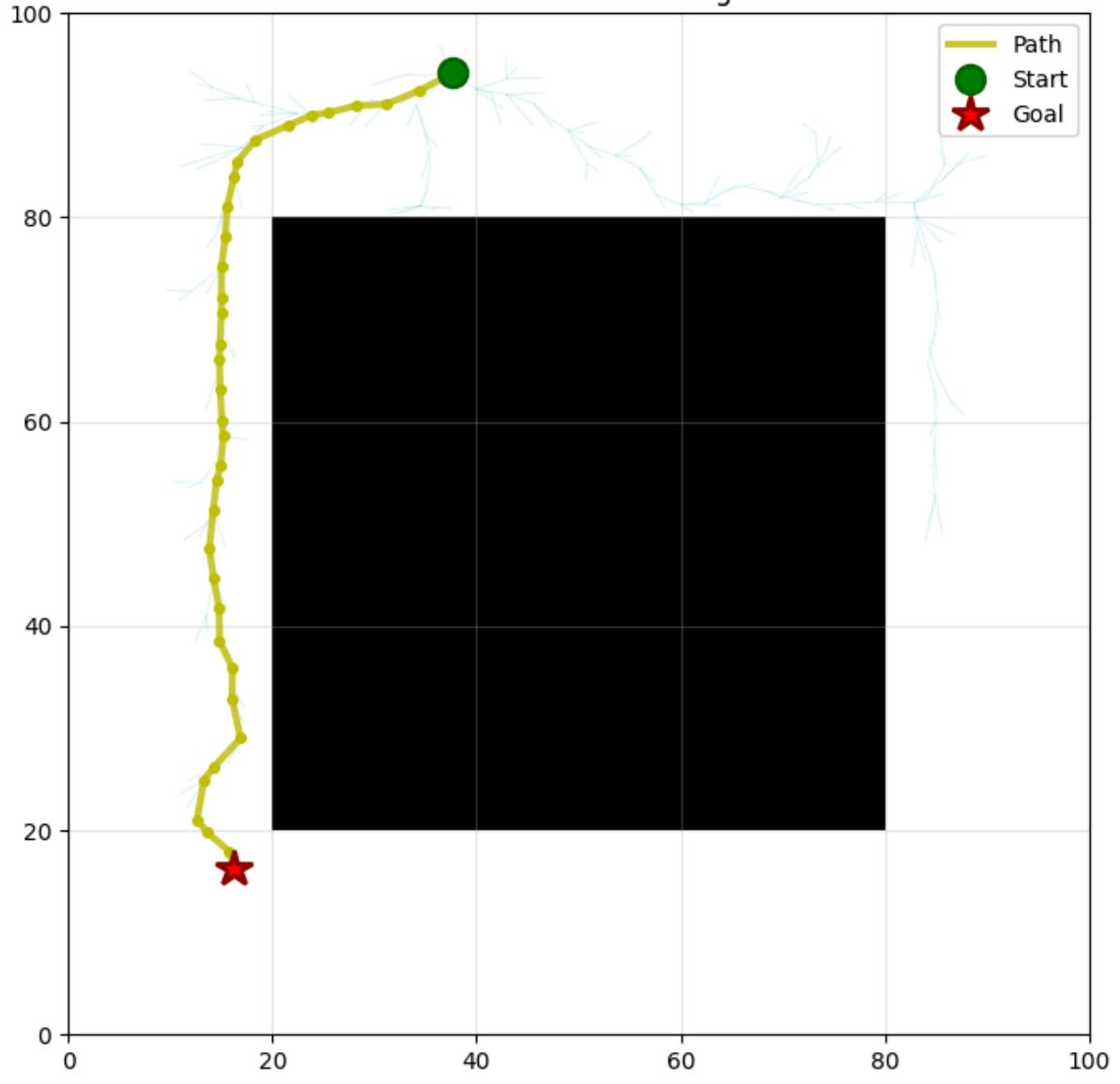
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.05	96.18	232	96.69
BiRRTStar ES	✓ Success	0.03	93.99	166	93.99
PRRTStar ES	✓ Success	1.06	91.18	378	91.18
RRTStarDubins ES	✓ Success	0.11	195.70	355	223.70
BiRRTStarDubins ES	✓ Success	0.12	111.59	363	114.00
PRRTStarDubins ES	✗ Failed	6.06	N/A	1927	N/A

## Path Visualizations

RRTStar [Early Stop]

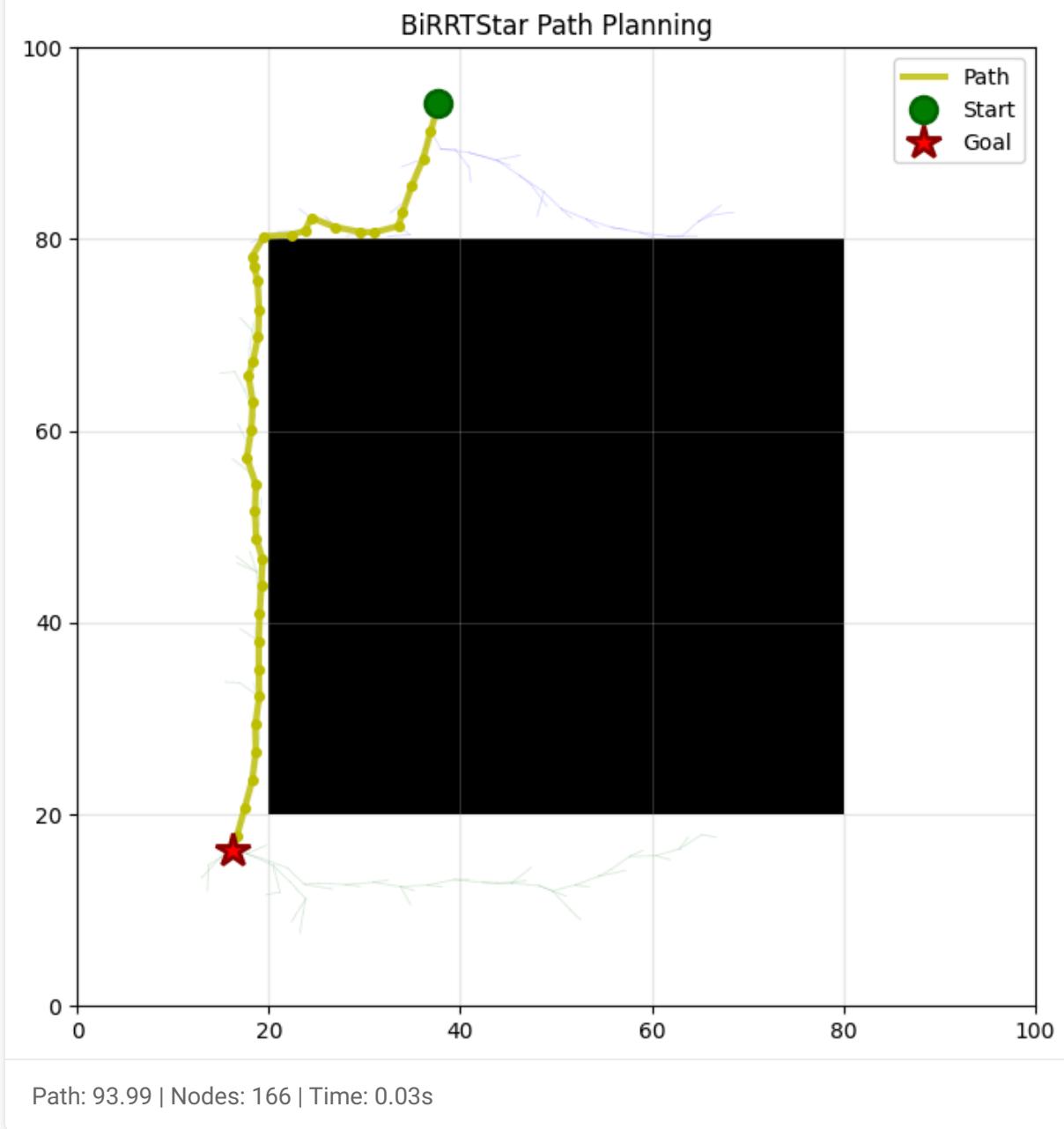


### RRTStar Path Planning

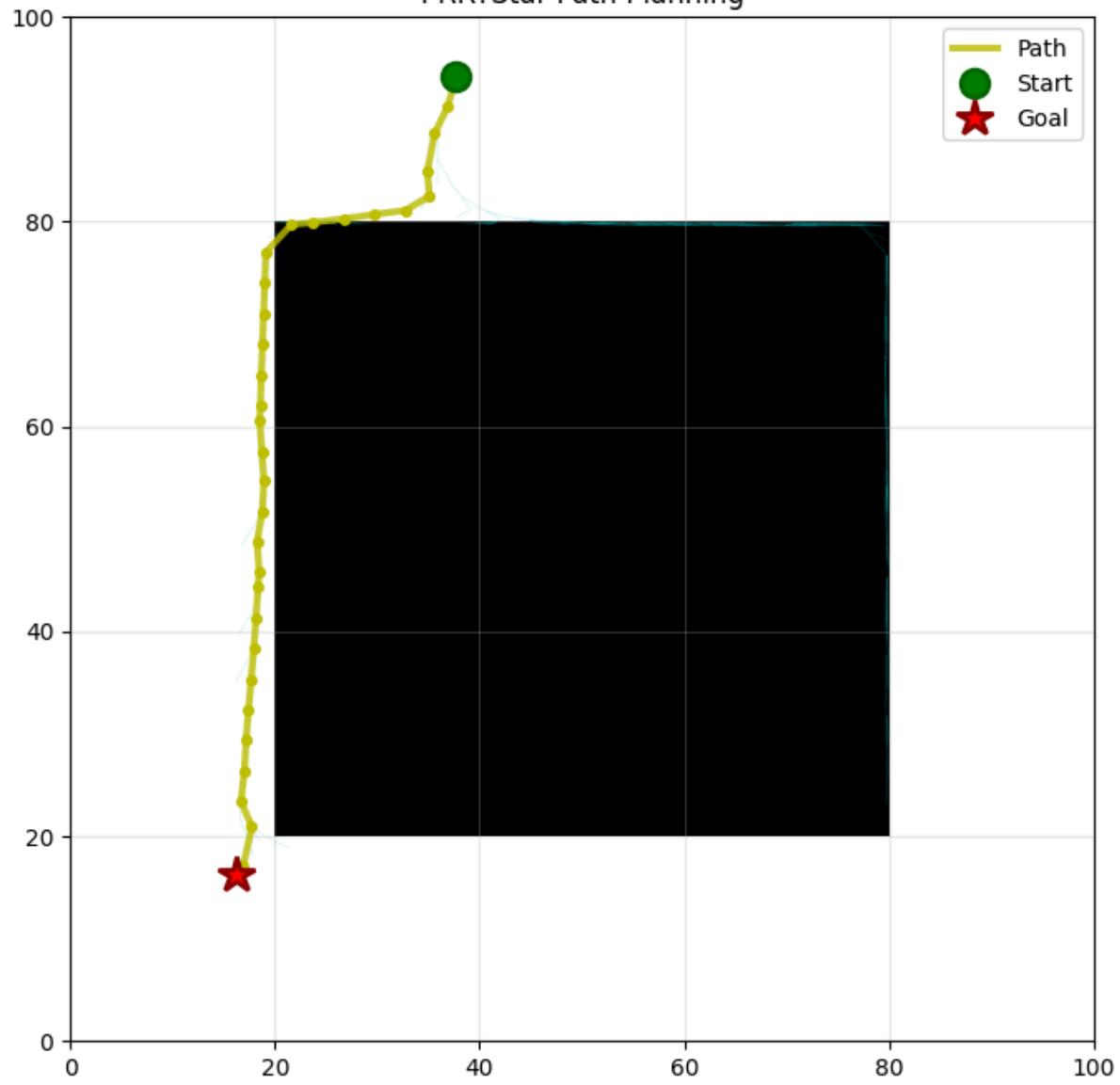


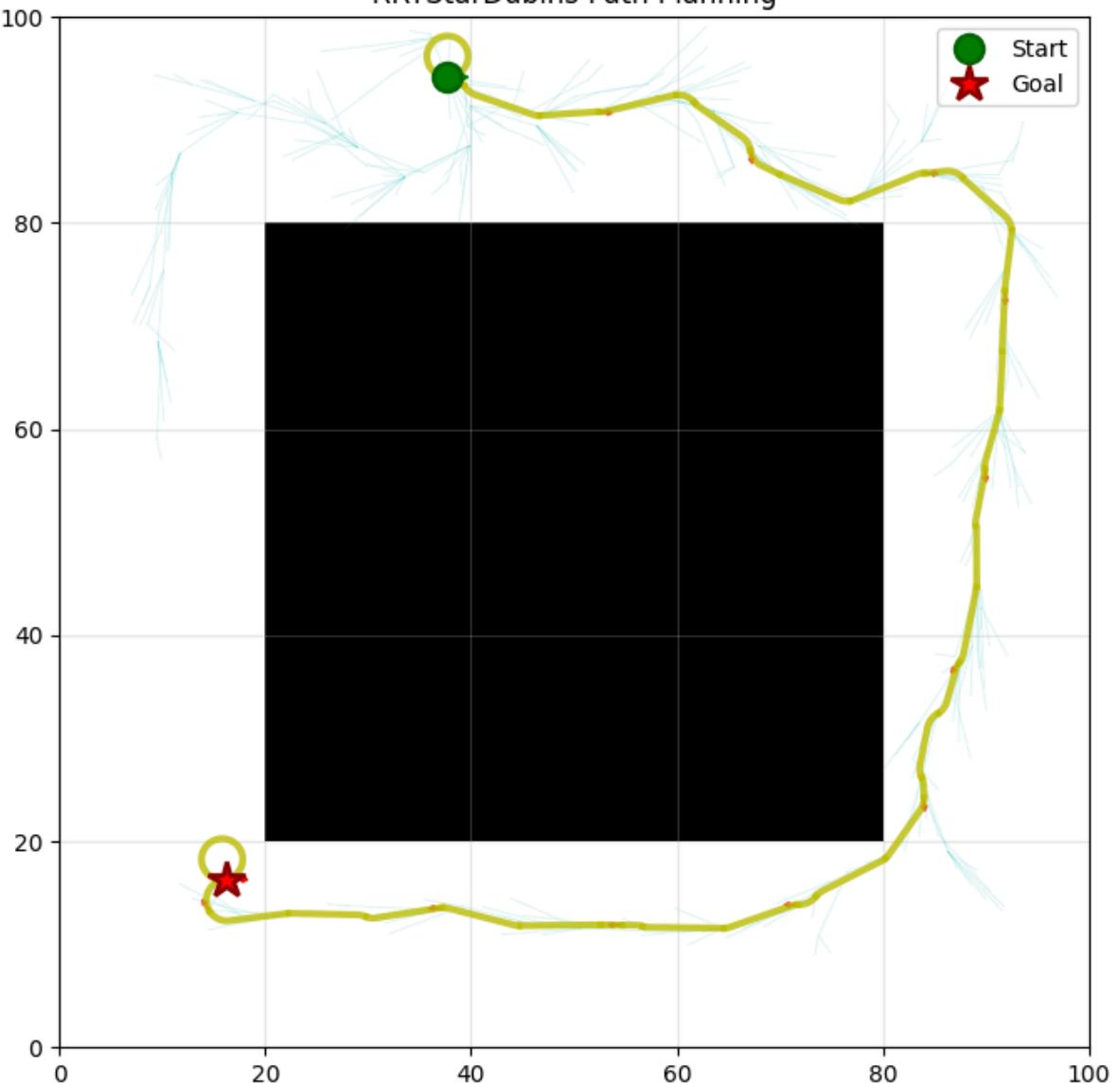
Path: 96.18 | Nodes: 232 | Time: 0.05s

### BiRRTStar [Early Stop]

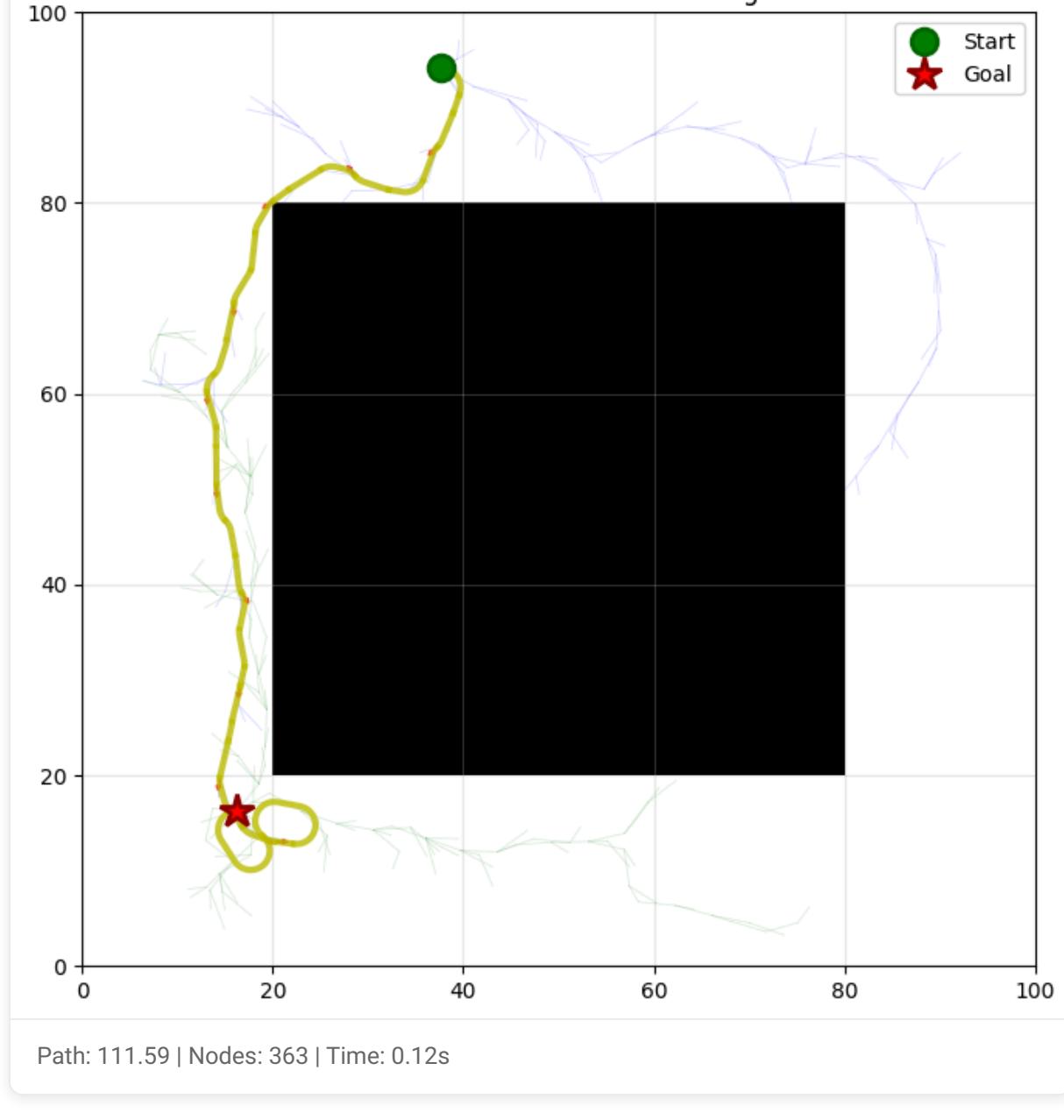


### PRRTStar [Early Stop]

**PRRTStar Path Planning****RRTStarDubins [Early Stop]**

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

## BiRRTStarDubins Path Planning



## Run 5

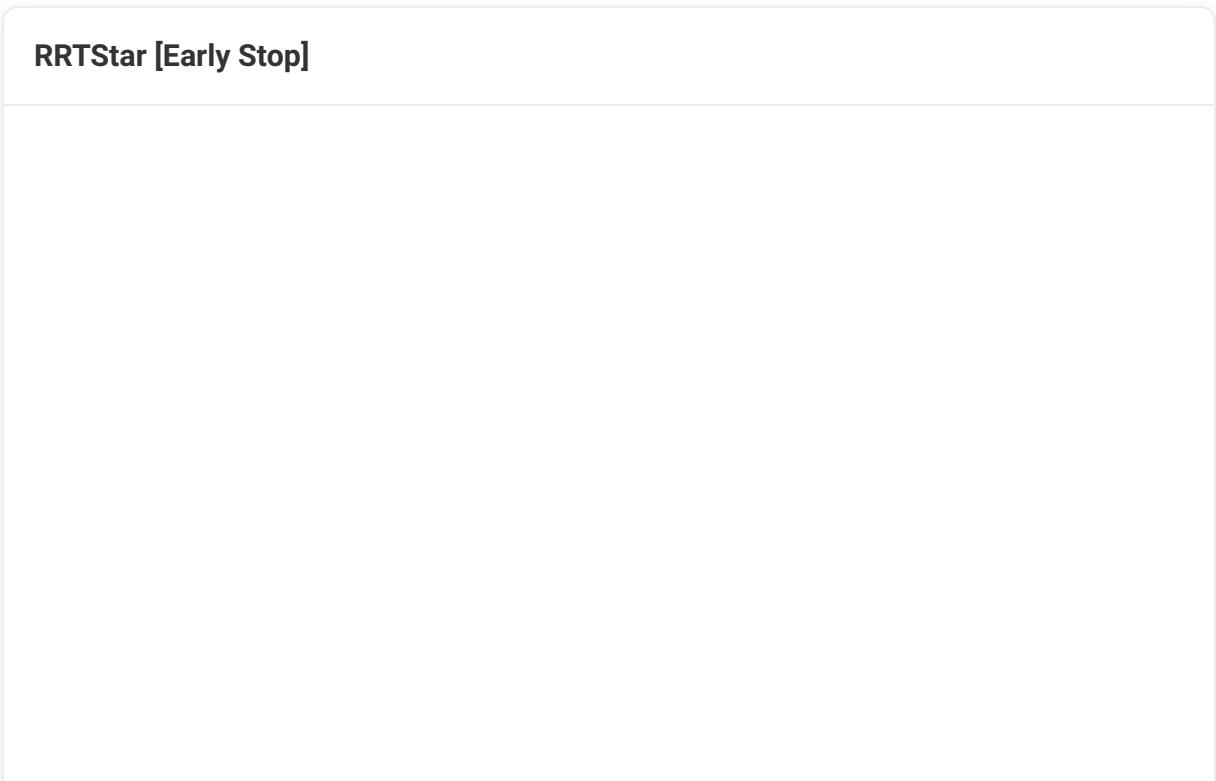
**Start:** (37.704931647041526, 94.17000202817178) | **Goal:** (16.28982676335878, 16.28746299294786) | **Env:** SquareCorridorEnvironment ({ "width": 100, "height": 100, "corridor\_width": 20, "center\_margin": 30, "seed": 42, "robot\_radius": 1.0 })

## Algorithm Results

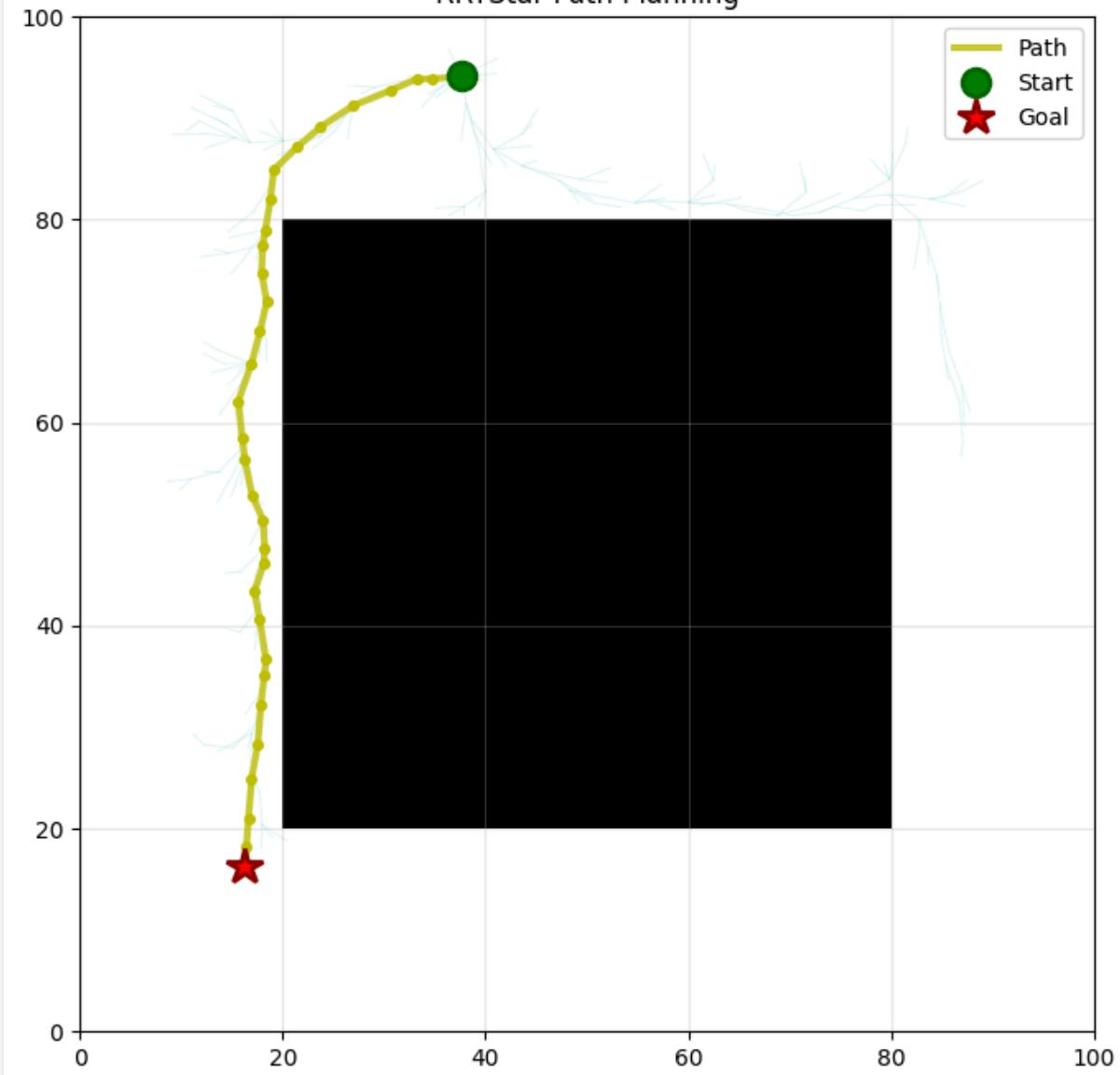
Algorithm	Status	Time (s)	Path Length	Nodes	Cost
RRTStar ES	✓ Success	0.05	91.27	229	91.38
BiRRTStar ES	✓ Success	0.03	94.93	158	94.93
PRRTStar ES	✓ Success	1.05	91.32	361	91.32
RRTStarDubins ES	✓ Success	2.50	98.25	1962	115.57
BiRRTStarDubins ES	✓ Success	0.14	129.97	413	132.78
PRRTStarDubins ES	✗ Failed	6.23	N/A	1969	N/A

## Path Visualizations

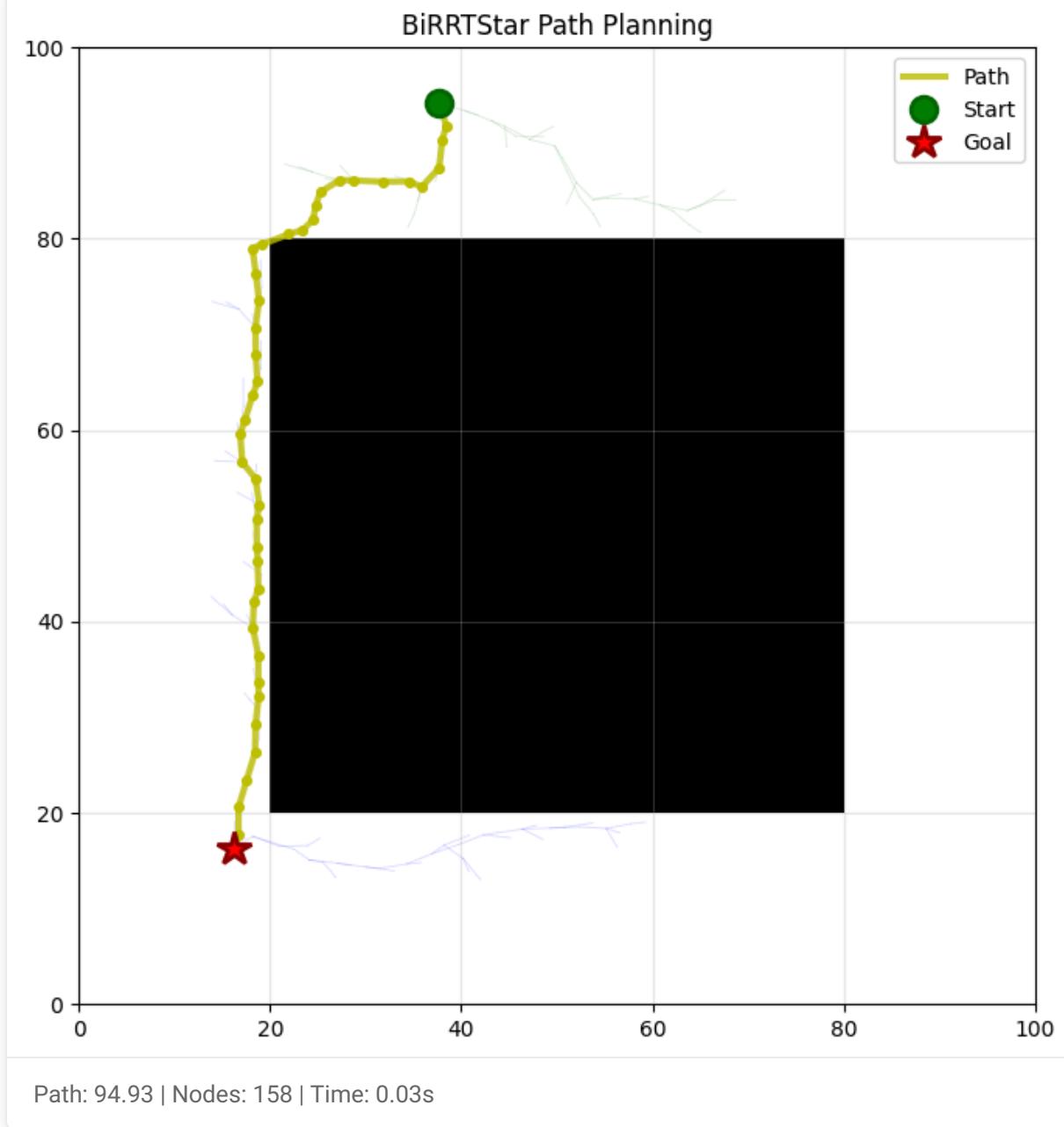
RRTStar [Early Stop]



### RRTStar Path Planning

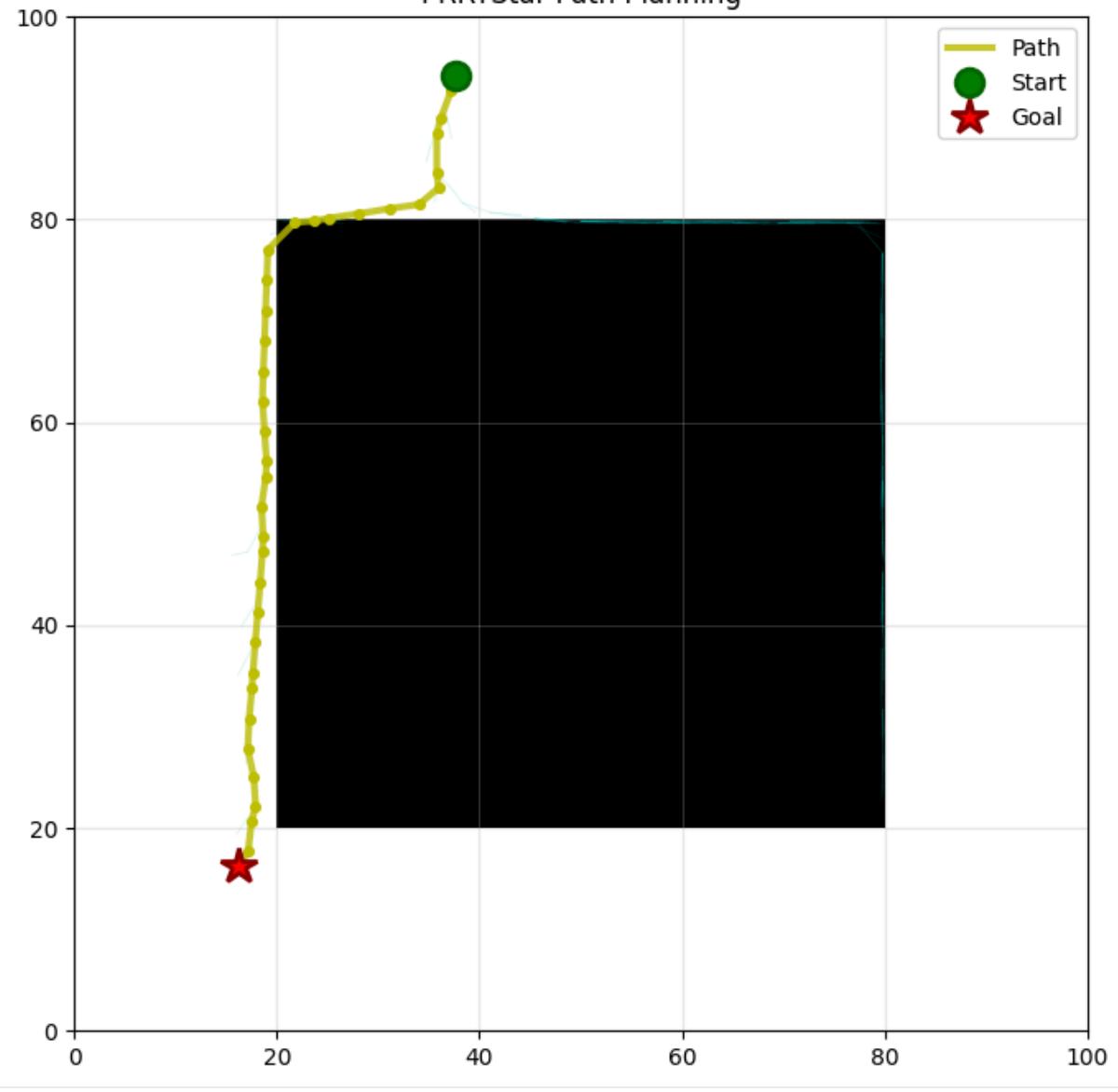


### BiRRTStar [Early Stop]

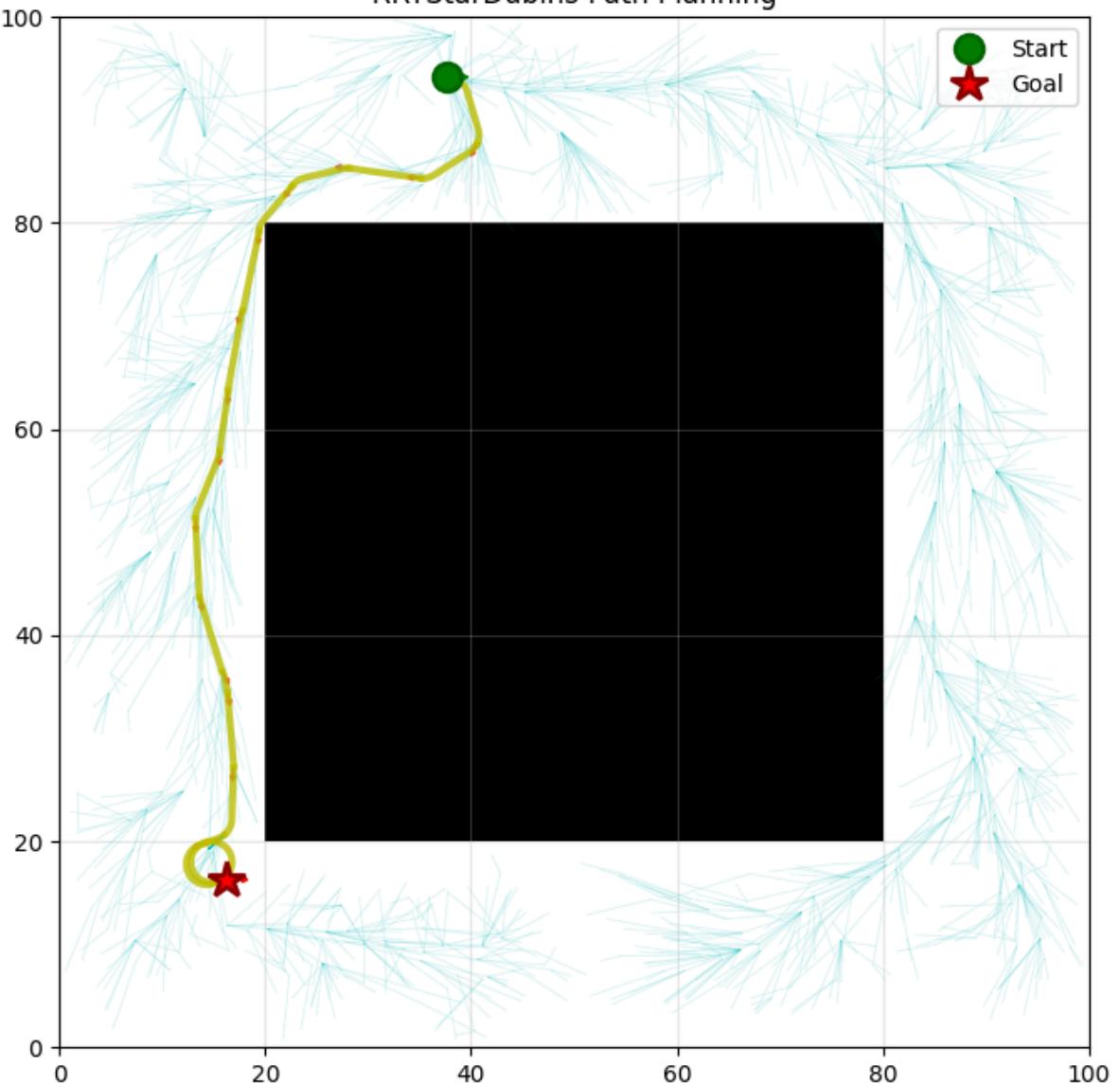


### PRRTStar [Early Stop]

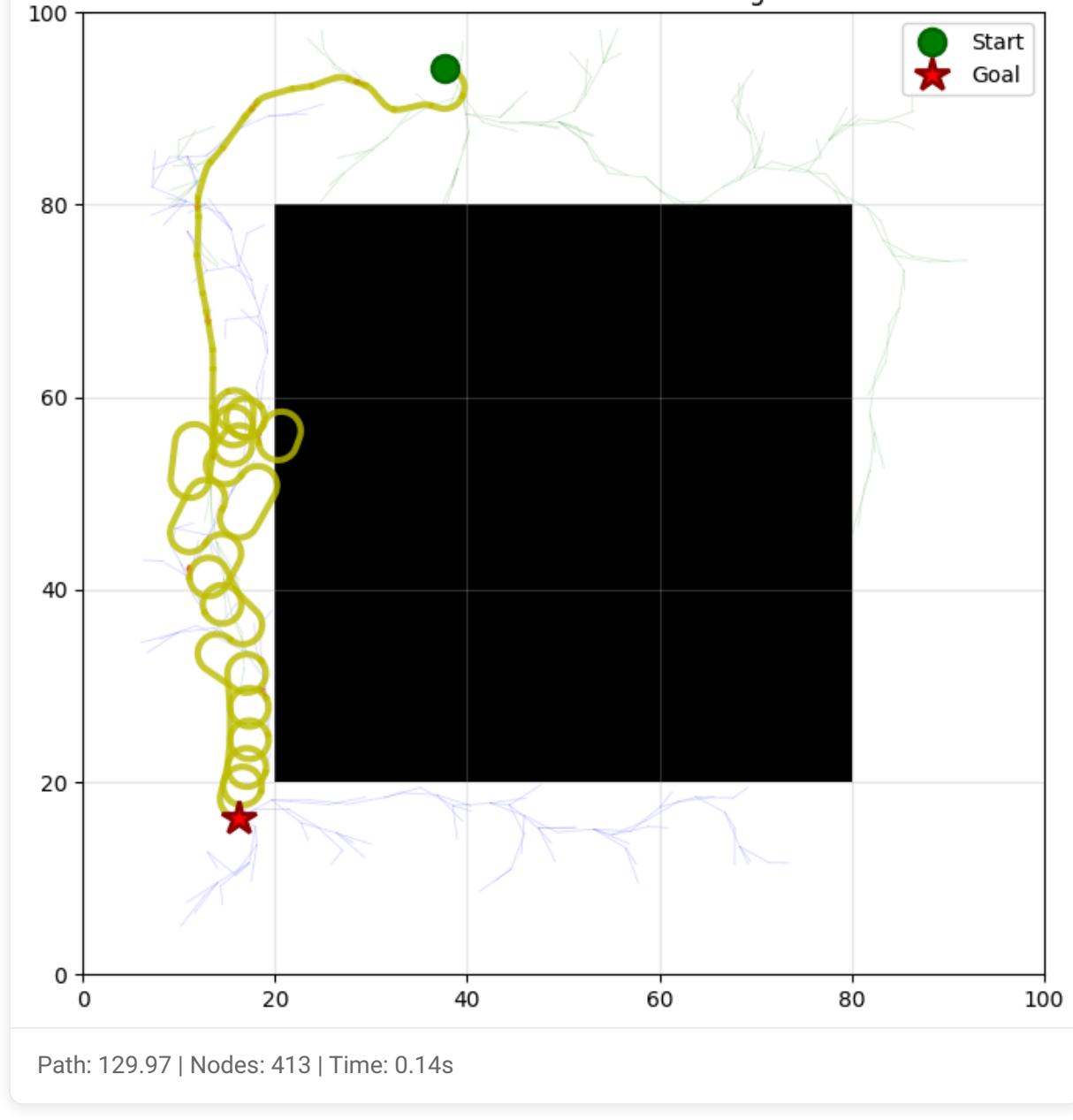
### PRRTStar Path Planning



### RRTStarDubins [Early Stop]

**RRTStarDubins Path Planning****BiRRTStarDubins [Early Stop]**

## BiRRTStarDubins Path Planning



## Algorithm Performance Summary (All Runs)

Algorithm	Success Rate	Avg Time (s)	Avg Path Length	Avg Nodes
BiRRTStar	25/25 (100.0%)	0.02	75.18	96

Algorithm	Success Rate	Avg Time (s)	Avg Path Length	Avg Nodes
<b>BiRRTStarDubins</b>	25/25 (100.0%)	0.04	87.02	173
<b>PRRTStar</b>	25/25 (100.0%)	0.42	78.63	168
<b>PRRTStarDubins</b>	20/25 (80.0%)	1.64	78.68	312
<b>RRTStar</b>	25/25 (100.0%)	0.10	80.72	245
<b>RRTStarDubins</b>	25/25 (100.0%)	0.40	82.89	424

Generated by Path Planning Experiment Framework  
 Configuration: experiments.json | Timestamp: 20251212\_125313