

# House\_Experiment\_3\_\_

## Comparsion of controllers

### -Global planner: NavFn

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	100.0	76.11	19.91	30.8	8.17	8.3	0.47	16.36	0.16	0.99
DWB	waypoints_1	86.67	95.30	20.33	28.7	8.27	8.3	3.53	20.54	0.12	3.12
DWB	circle_2	100.0	45.64	18.81	25.3	8.26	8.3	0.40	8.80	0.44	0.68
DWB	square_3	100.0	47.78	19.30	25.4	8.30	8.4	0.00	10.13	0.25	1.04
RPP	single_goal_0	93.33	70.35	18.72	27.5	8.32	8.4	2.13	15.61	0.12	1.27
RPP	waypoints_1	86.67	91.04	19.27	27.7	8.36	8.4	2.87	20.77	0.12	1.99
RPP	circle_2	100.0	44.05	17.40	22.9	8.31	8.4	0.27	8.90	0.45	0.79
RPP	square_3	100.0	50.30	18.01	26.1	8.31	8.4	0.73	10.35	0.28	1.43
DWB_RSC	single_goal_0	100.0	75.16	20.64	29.5	8.38	8.5	0.40	16.38	0.31	0.94
DWB_RSC	waypoints_1	80.0	96.87	21.18	28.7	8.40	8.4	5.27	20.34	0.12	3.08
DWB_RSC	circle_2	100.0	49.61	19.84	25.4	8.40	8.5	0.67	8.89	0.44	0.75
DWB_RSC	square_3	100.0	48.31	20.31	27.2	8.40	8.4	0.00	10.13	0.25	0.96
RPP_RSC	single_goal_0	93.33	69.72	19.48	48.0	8.40	8.5	2.13	15.52	0.18	0.95
RPP_RSC	waypoints_1	100.0	94.51	19.31	27.2	8.43	8.5	0.47	21.97	0.26	1.82
RPP_RSC	circle_2	100.0	40.82	18.70	25.7	8.40	8.5	0.00	8.82	0.45	0.69
RPP_RSC	square_3	100.0	48.44	18.90	24.6	8.40	8.5	0.00	10.27	0.29	1.35
MPPI	single_goal_0	100.0	87.70	22.57	31.1	8.51	8.6	0.93	16.28	0.28	1.13
MPPI	waypoints_1	93.33	87.44	22.22	31.1	8.55	8.6	1.40	21.27	0.12	2.11
MPPI	circle_2	100.0	36.18	20.44	27.3	8.50	8.5	0.00	8.56	0.45	0.59
MPPI	square_3	100.0	44.16	21.19	26.9	8.50	8.5	0.00	10.21	0.3	0.9
Graceful	single_goal_0	93.33	73.03	20.23	27.8	8.55	8.7	1.47	15.78	0.12	1.76
Graceful	waypoints_1	100.0	110.05	20.62	34.6	8.60	9.1	0.00	22.50	0.27	1.61
Graceful	circle_2	100.0	47.21	18.96	24.7	8.59	8.6	0.07	8.94	0.47	0.93
Graceful	square_3	100.0	56.82	19.54	26.3	8.60	8.6	0.07	10.39	0.36	1.29

### -Global planner: smac\_planner

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	100.0	76.63	20.82	29.2	8.60	8.6	0.73	16.24	0.18	1.01
DWB	waypoints_1	100.0	98.50	20.76	28.1	8.60	8.7	0.53	21.41	0.29	2.24
DWB	circle_2	100.0	48.84	20.60	27.4	8.60	8.6	0.60	8.86	0.44	0.73
DWB	square_3	80.0	78.42	20.87	28.2	8.61	8.7	3.27	15.10	0.26	2.91
RPP	single_goal_0	100.0	74.35	19.77	26.6	8.60	8.7	1.87	16.35	0.31	0.99
RPP	waypoints_1	100.0	92.22	19.62	27.5	8.61	8.7	0.60	21.61	0.32	1.87
RPP	circle_2	100.0	41.78	17.50	22.8	8.60	8.6	0.07	8.84	0.45	0.73
RPP	square_3	100.0	56.82	19.05	26.8	8.61	8.7	5.00	10.45	0.21	1.57
DWB_RSC	single_goal_0	80.0	70.51	21.69	31.8	8.68	8.7	5.20	13.82	0.12	1.63
DWB_RSC	waypoints_1	93.33	96.36	28.00	100.0	8.87	11.6	2.20	20.97	0.12	2.41
DWB_RSC	circle_2	100.0	54.66	22.21	40.9	8.85	9.4	1.20	9.01	0.46	0.88
DWB_RSC	square_3	86.67	67.96	21.32	45.9	8.81	8.9	3.07	11.70	0.28	1.82
RPP_RSC	single_goal_0	100.0	73.03	20.36	29.9	8.84	8.9	1.40	16.29	0.22	1.01
RPP_RSC	waypoints_1	100.0	92.35	20.23	26.4	8.87	8.9	0.47	21.59	0.34	1.89
RPP_RSC	circle_2	100.0	41.37	19.11	25.1	8.83	8.9	0.07	8.83	0.42	0.69
RPP_RSC	square_3	100.0	52.57	19.89	26.0	8.83	8.9	2.87	10.37	0.24	1.35
MPPI	single_goal_0	100.0	70.76	23.27	30.0	8.89	8.9	0.47	16.00	0.2	1.0
MPPI	waypoints_1	100.0	87.16	22.74	29.9	8.90	9.0	0.40	21.37	0.21	1.69
MPPI	circle_2	100.0	43.37	22.28	28.3	8.90	9.0	0.60	8.59	0.46	0.7
MPPI	square_3	100.0	52.27	22.59	29.6	8.90	9.0	3.00	10.48	0.31	0.92
Graceful	single_goal_0	100.0	80.10	21.74	28.9	8.93	9.0	0.33	16.49	0.19	0.98
Graceful	waypoints_1	100.0	110.06	21.17	28.8	8.93	9.0	0.27	22.14	0.3	1.76
Graceful	circle_2	100.0	49.64	20.64	26.6	8.90	9.0	0.13	9.02	0.45	1.11
Graceful	square_3	100.0	56.42	20.93	27.5	8.92	9.0	2.07	10.36	0.3	1.1

### -Global planner: ThetaStar

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	100.0	84.75	22.79	31.5	8.96	9.1	3.40	16.04	0.21	1.08
DWB	waypoints_1	86.67	101.69	23.00	30.9	8.99	9.1	2.87	20.42	0.12	2.69
DWB	circle_2	100.0	49.37	22.46	28.3	8.99	9.0	0.87	8.85	0.45	0.75
DWB	square_3	86.67	58.81	22.39	29.7	8.99	9.1	2.47	11.37	0.2	1.64
RPP	single_goal_0	100.0	73.31	21.75	28.4	9.00	9.1	2.20	16.07	0.17	0.93
RPP	waypoints_1	100.0	92.77	21.64	28.3	9.00	9.1	1.27	20.90	0.17	1.79

RPP	circle_2	100.0	42.97	21.07	26.3	9.00	9.1	0.13	8.86	0.44	0.77
RPP	square_3	93.33	51.10	21.57	28.0	9.00	9.1	3.07	9.92	0.21	1.41
DWB_RSC	single_goal_0	60.0	106.99	23.82	31.9	9.05	9.1	9.00	13.97	0.12	2.11
DWB_RSC	waypoints_1	73.33	123.13	23.35	31.6	9.08	9.2	4.60	18.91	0.2	2.57
DWB_RSC	circle_2	100.0	47.03	22.88	32.0	9.06	9.1	0.40	8.82	0.41	0.71
DWB_RSC	square_3	100.0	49.10	23.10	29.4	9.09	9.1	0.60	10.18	0.26	0.91
RPP_RSC	single_goal_0	100.0	71.57	22.41	29.1	9.10	9.2	1.07	15.99	0.21	0.87
RPP_RSC	waypoints_1	100.0	92.08	22.55	28.5	9.10	9.2	1.20	20.90	0.32	1.79
RPP_RSC	circle_2	100.0	43.12	21.78	28.1	9.10	9.1	0.27	8.86	0.43	0.72
RPP_RSC	square_3	100.0	54.80	22.21	43.0	9.10	9.2	3.47	10.46	0.23	1.42
MPPI	single_goal_0	100.0	67.06	25.12	33.3	9.15	9.2	1.07	15.76	0.18	0.93
MPPI	waypoints_1	100.0	84.88	24.59	31.6	9.20	9.3	0.13	20.86	0.19	1.61
MPPI	circle_2	100.0	45.38	24.18	31.7	9.20	9.2	0.93	8.57	0.48	0.69
MPPI	square_3	100.0	54.31	24.48	30.5	9.20	9.3	0.80	11.23	0.33	1.07
Graceful	single_goal_0	100.0	74.50	23.50	30.1	9.21	9.3	0.00	16.09	0.31	0.83
Graceful	waypoints_1	93.33	104.11	23.33	31.0	9.25	9.3	1.53	20.80	0.15	1.93
Graceful	circle_2	100.0	47.78	23.04	28.9	9.22	9.3	0.07	9.00	0.51	1.09
Graceful	square_3	100.0	57.10	22.88	28.7	9.24	9.3	2.80	10.44	0.28	0.99

**-Global planner: Lattice**

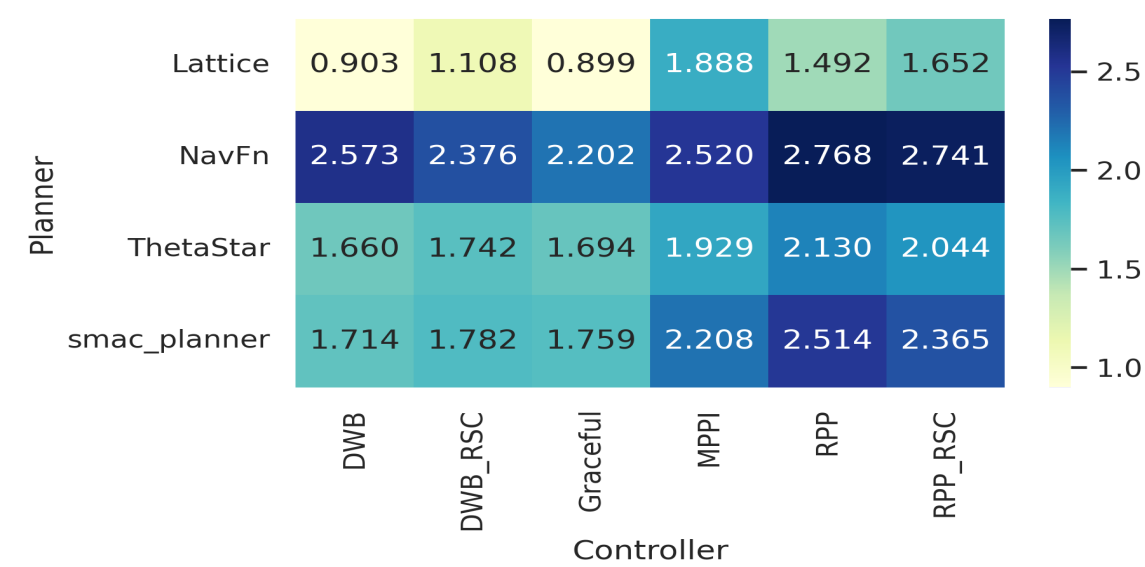
Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	100.0	74.78	25.30	33.3	9.30	9.4	0.40	16.21	0.22	1.17
DWB	waypoints_1	53.33	139.37	24.98	32.4	9.34	9.5	8.87	20.76	0.19	4.08
DWB	circle_2	100.0	45.51	24.49	31.3	9.31	9.4	0.47	8.73	0.45	0.8
DWB	square_3	73.33	81.58	24.67	31.4	9.34	9.4	5.27	14.98	0.27	2.88
RPP	single_goal_0	100.0	71.04	23.83	30.6	9.38	9.5	1.00	16.25	0.15	1.07
RPP	waypoints_1	100.0	94.88	23.74	32.4	9.39	9.5	2.73	21.20	0.25	1.95
RPP	circle_2	100.0	44.31	23.31	29.6	9.40	9.4	0.27	9.21	0.4	0.77
RPP	square_3	93.33	59.34	23.09	29.4	9.40	9.4	6.73	10.29	0.2	1.49
DWB_RSC	single_goal_0	100.0	73.56	25.48	33.9	9.40	9.4	0.47	16.18	0.32	1.01
DWB_RSC	waypoints_1	73.33	122.31	24.54	31.9	9.45	9.5	5.20	20.34	0.21	3.0
DWB_RSC	circle_2	100.0	45.75	25.07	31.2	9.43	9.5	0.47	8.78	0.45	0.85
DWB_RSC	square_3	80.0	84.39	24.05	32.0	9.47	9.5	3.60	13.17	0.29	2.24
RPP_RSC	single_goal_0	100.0	70.23	23.84	32.1	9.50	9.5	0.47	16.25	0.25	1.11
RPP_RSC	waypoints_1	80.0	90.89	23.66	32.6	9.50	9.6	5.93	18.60	0.16	1.89
RPP_RSC	circle_2	100.0	44.43	23.29	29.3	9.50	9.6	0.40	9.24	0.42	0.81

RPP_RSC	square_3	100.0	58.39	22.94	31.0	9.49	9.5	4.47	10.81	0.2	1.68
MPPI	single_goal_0	100.0	69.68	26.49	35.0	9.50	9.6	0.47	15.97	0.22	1.04
MPPI	waypoints_1	100.0	85.59	25.89	33.9	9.52	9.6	0.00	21.04	0.22	1.67
MPPI	circle_2	100.0	36.99	25.95	31.4	9.51	9.6	0.40	8.55	0.48	0.83
MPPI	square_3	93.33	50.02	24.77	30.9	9.51	9.6	3.20	10.21	0.32	1.11
Graceful	single_goal_0	100.0	79.97	24.62	34.0	9.57	9.7	0.33	16.36	0.14	1.15
Graceful	waypoints_1	100.0	110.22	24.02	32.4	9.59	9.6	0.07	21.58	0.18	1.99
Graceful	circle_2	100.0	54.94	23.64	31.1	9.59	9.6	0.00	9.28	0.5	1.27
Graceful	square_3	100.0	72.37	23.00	29.0	9.59	9.6	2.80	10.79	0.28	1.64

## Performace analysis

Based on the criteria:Time, path\_length, CPU, Memory, Safety

The score of each controller and planner combinations are:



## Success rate

Planners' success rate are:

- Planner: Lattice, Success Rate: 93.61%
- Planner: ThetaStar, Success Rate: 95.56%
- Planner: smac\_planner, Success Rate: 97.50%
- Planner: NavFn, Success Rate: 96.94%

**Controllers' success rate are:**

Controller: Graceful, Success Rate: 99.17%

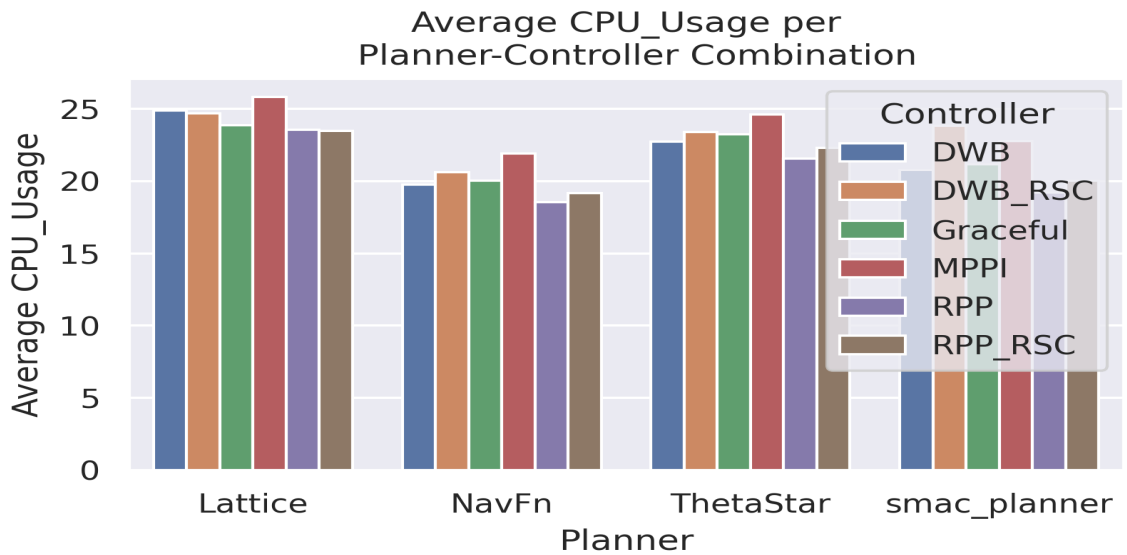
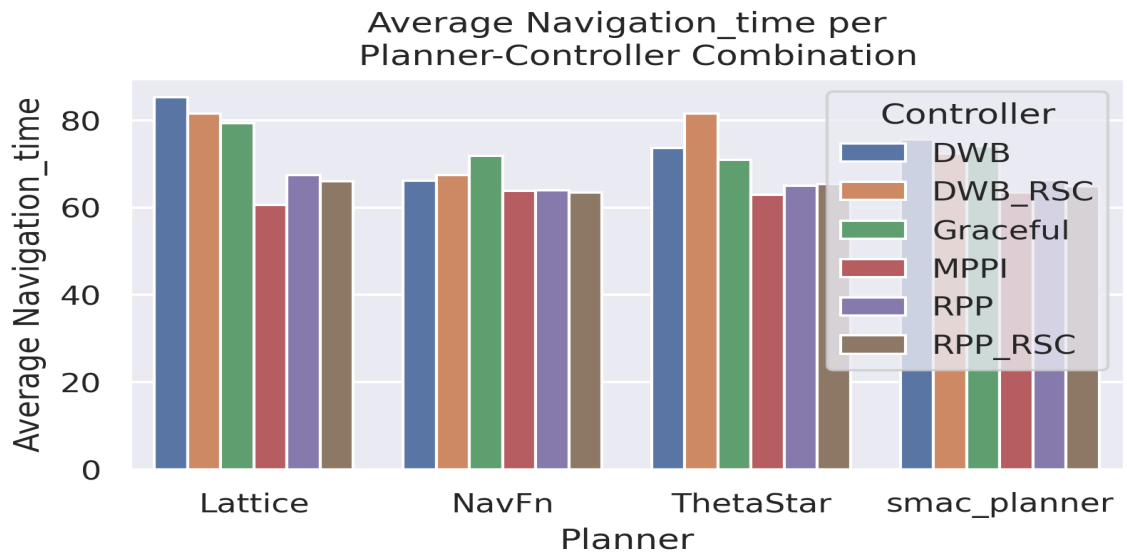
Controller: MPPI, Success Rate: 99.17%

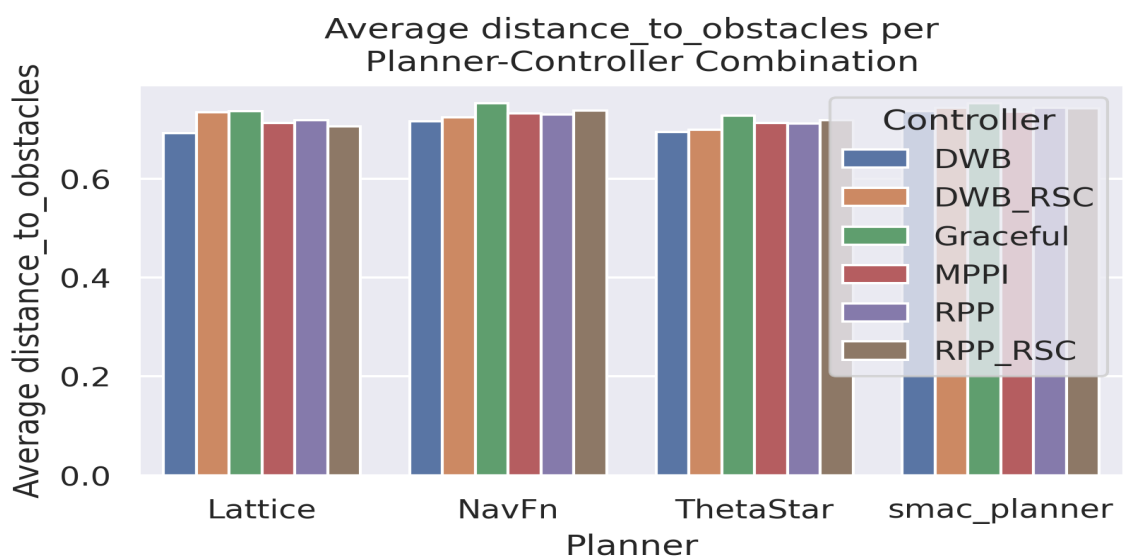
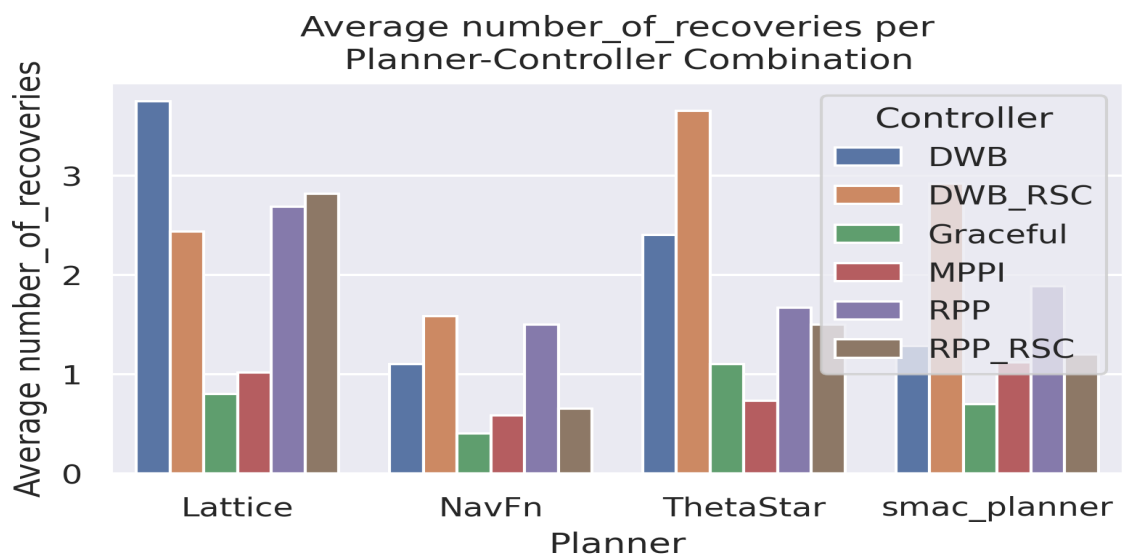
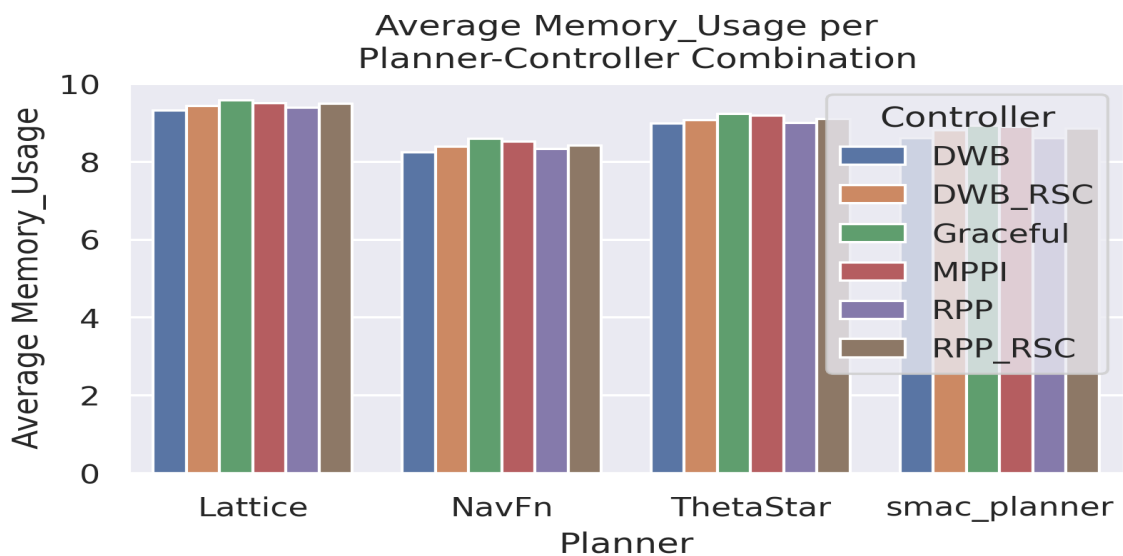
Controller: RPP\_RSC, Success Rate: 98.33%

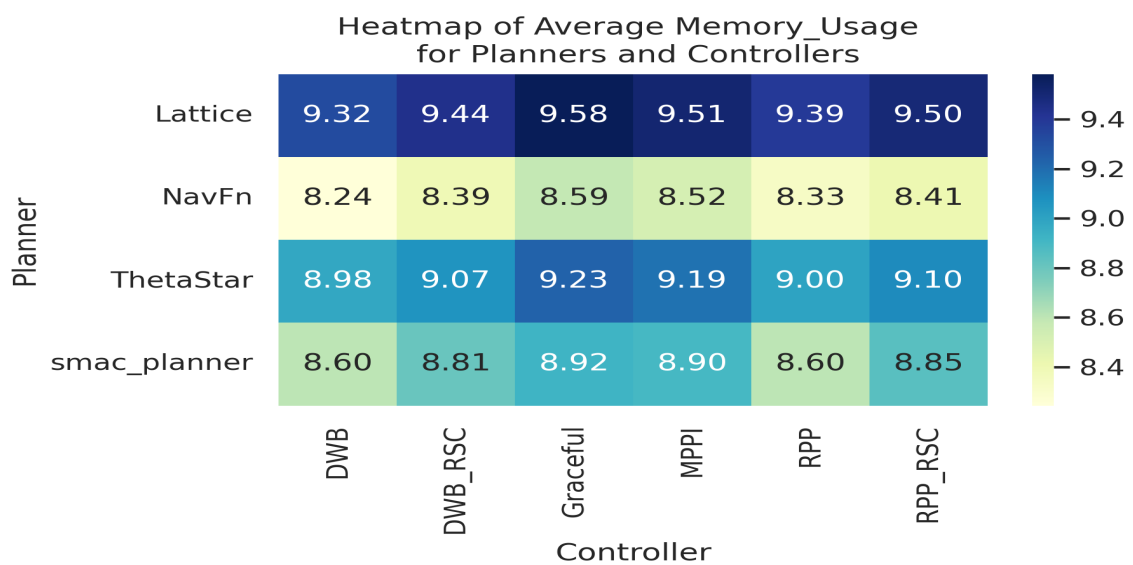
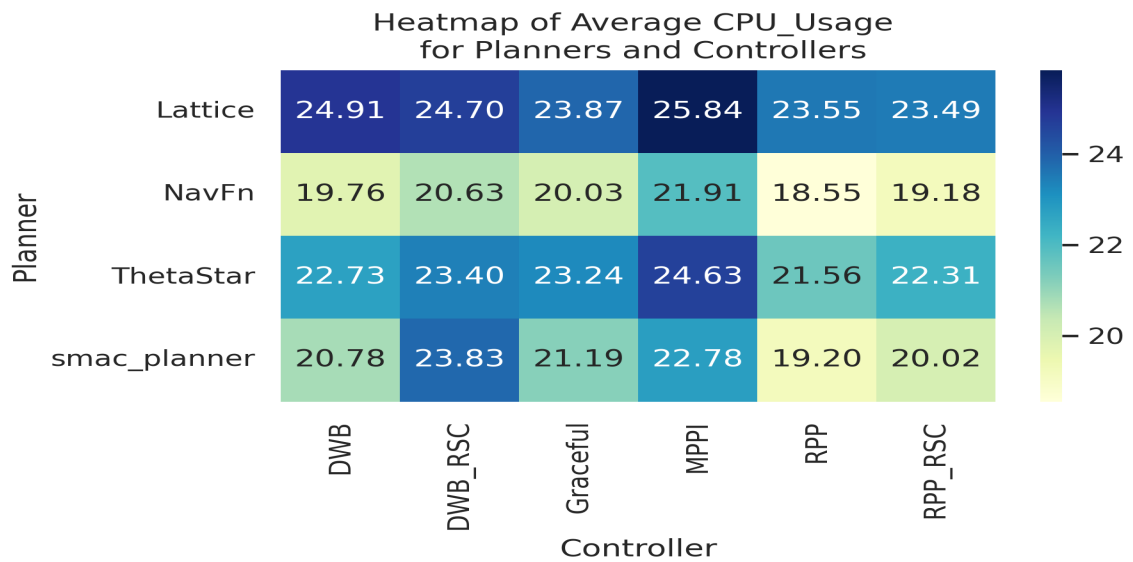
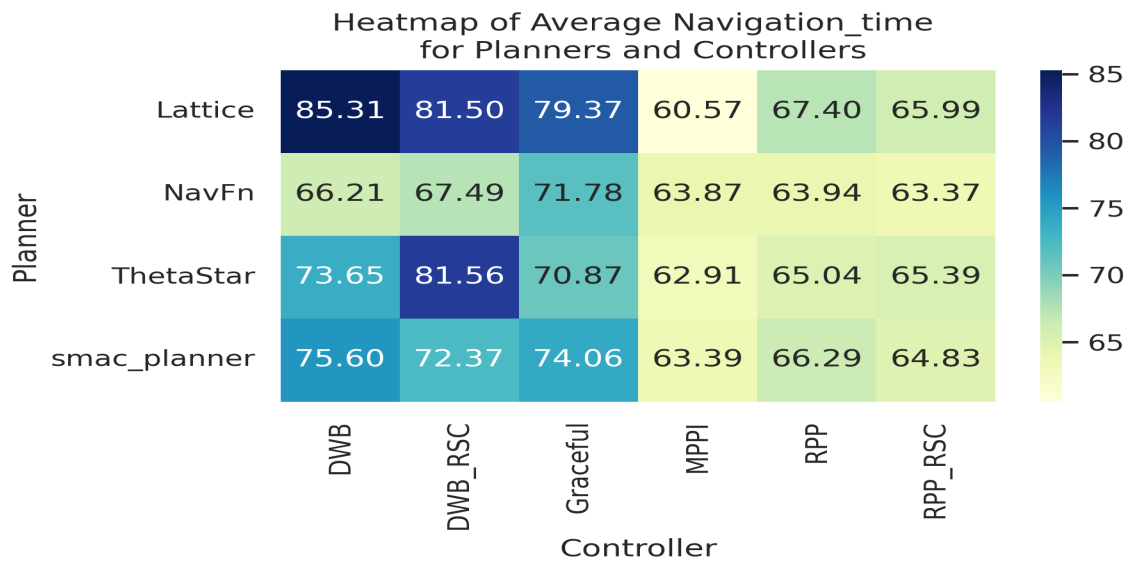
Controller: DWB\_RSC, Success Rate: 89.17%

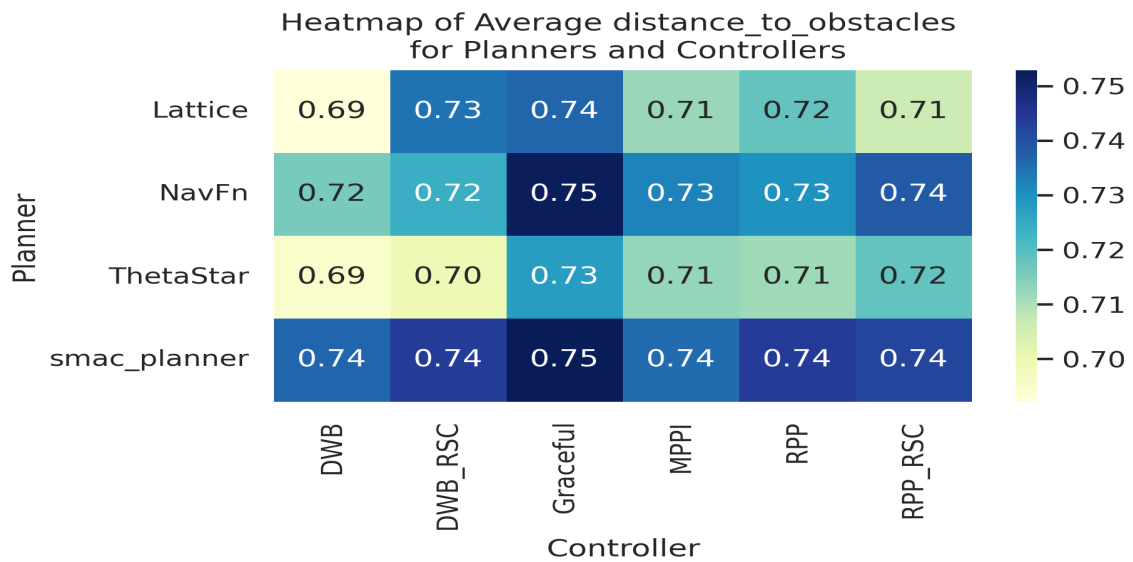
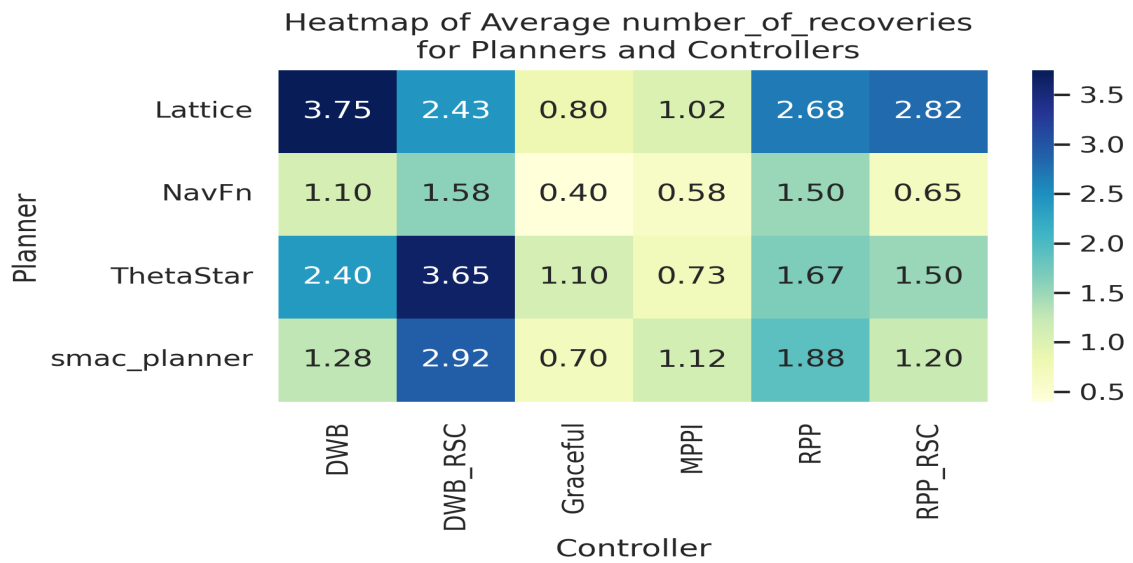
Controller: RPP, Success Rate: 97.92%

Controller: DWB, Success Rate: 91.67%



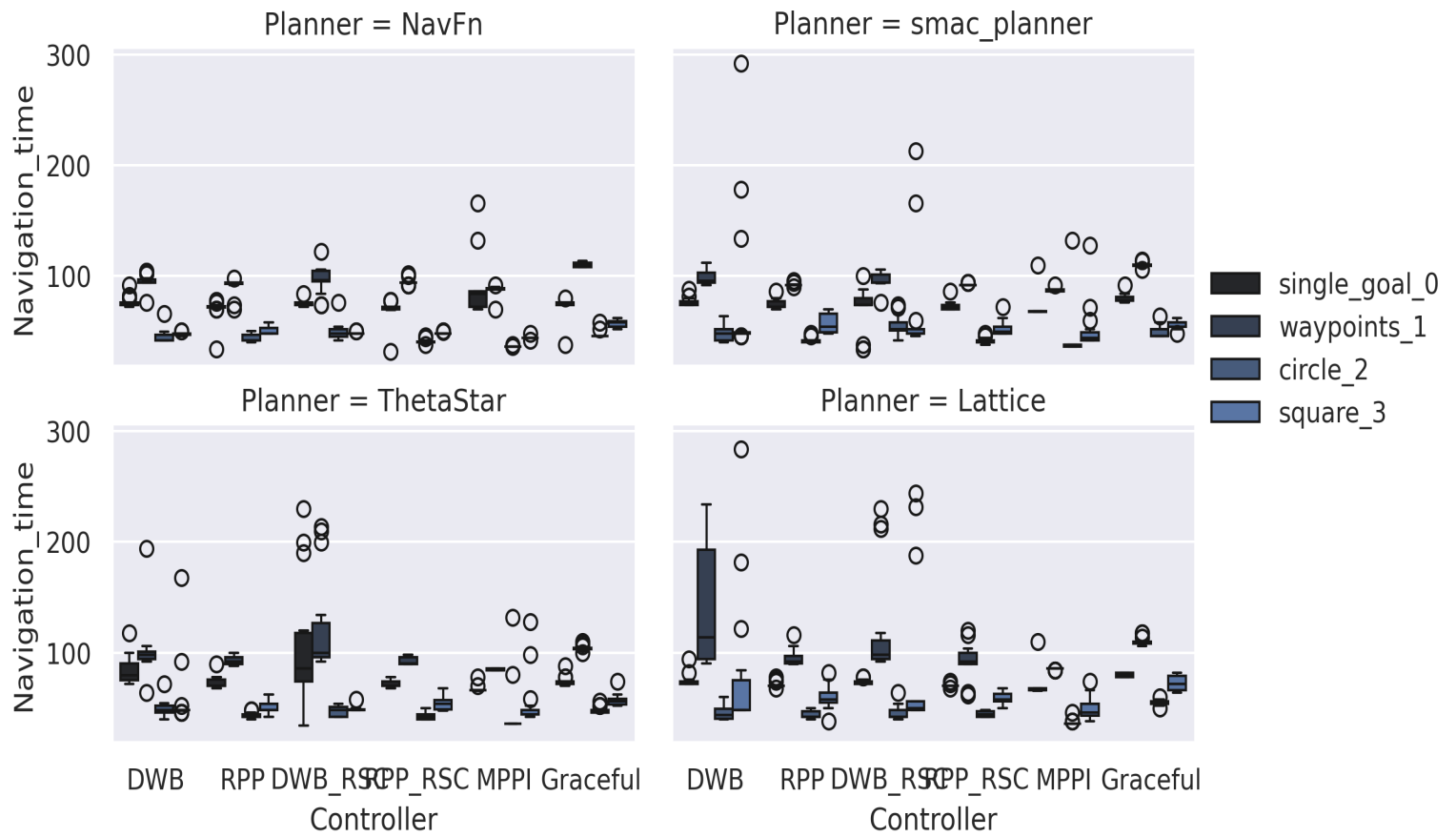






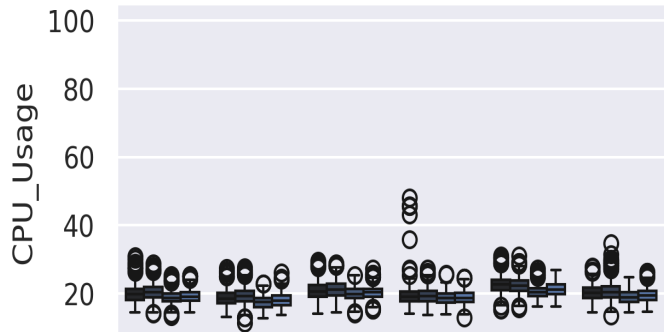


# Complex Distribution of Navigation\_time by Planner, Controller, and Trajectory Type

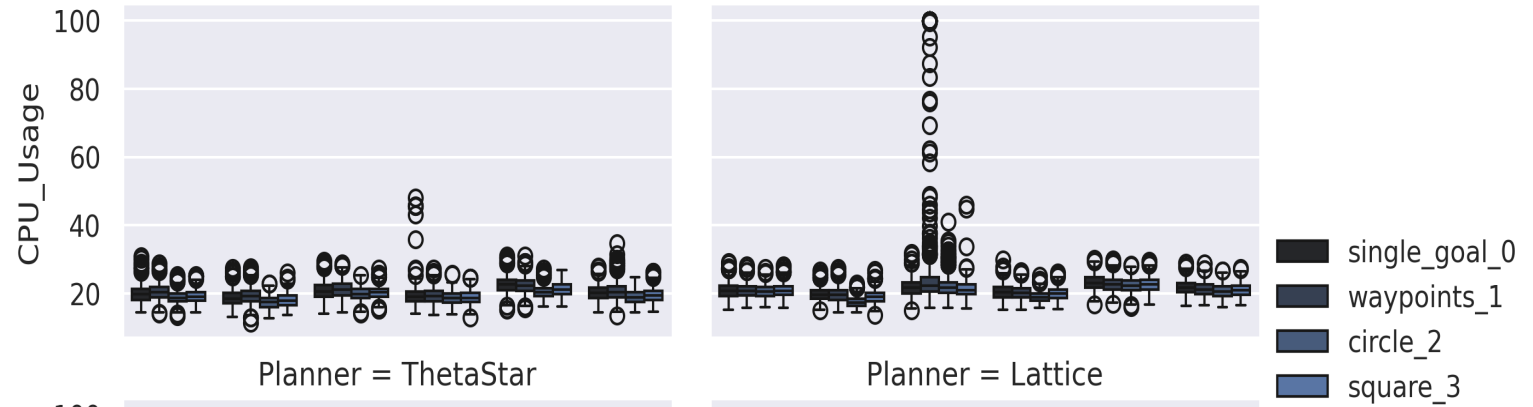


# Complex Distribution of CPU\_Usage by Planner, Controller, and Trajectory Type

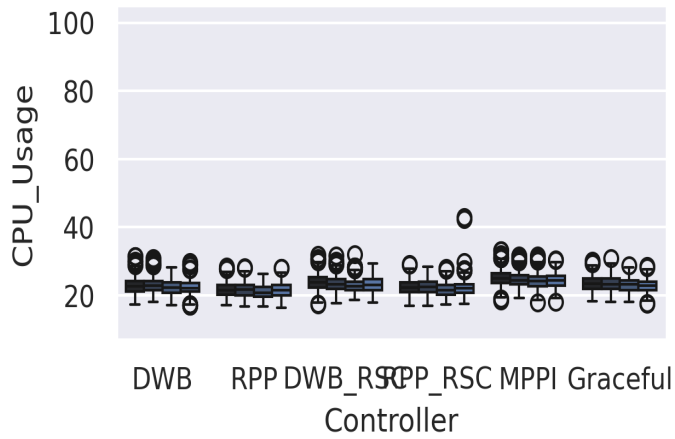
Planner = NavFn



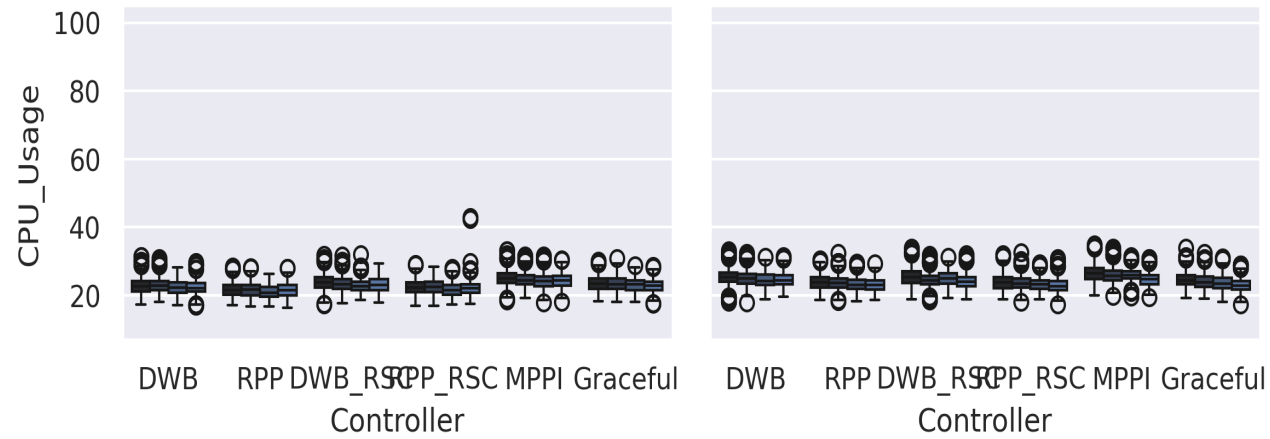
Planner = smac\_planner



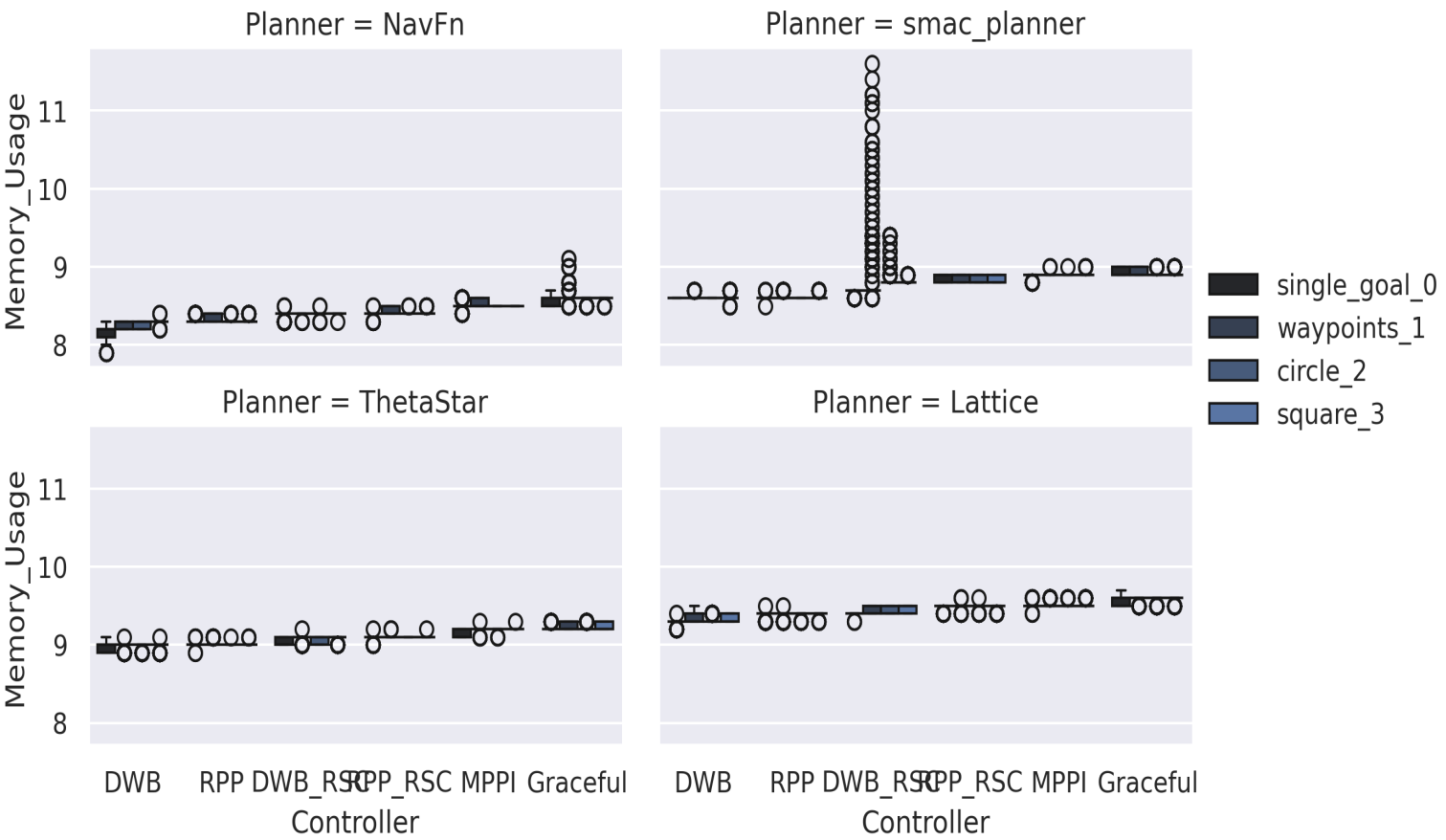
Planner = ThetaStar



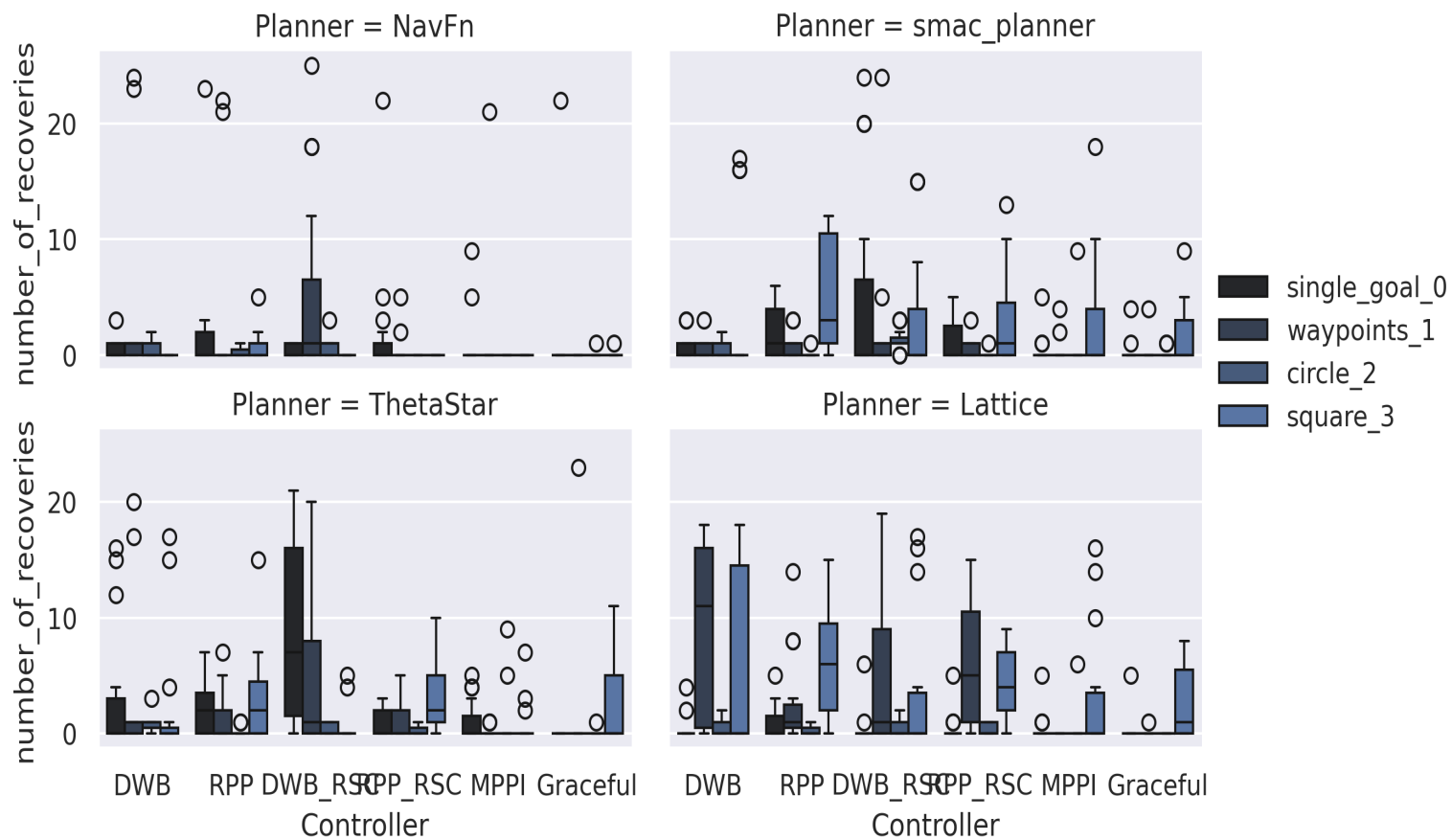
Planner = Lattice



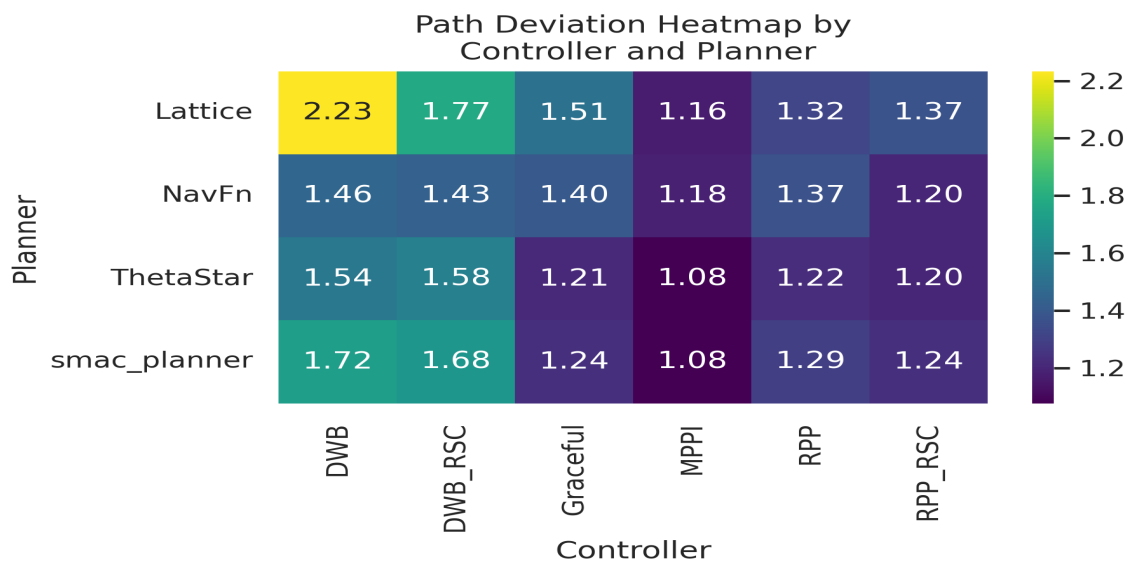
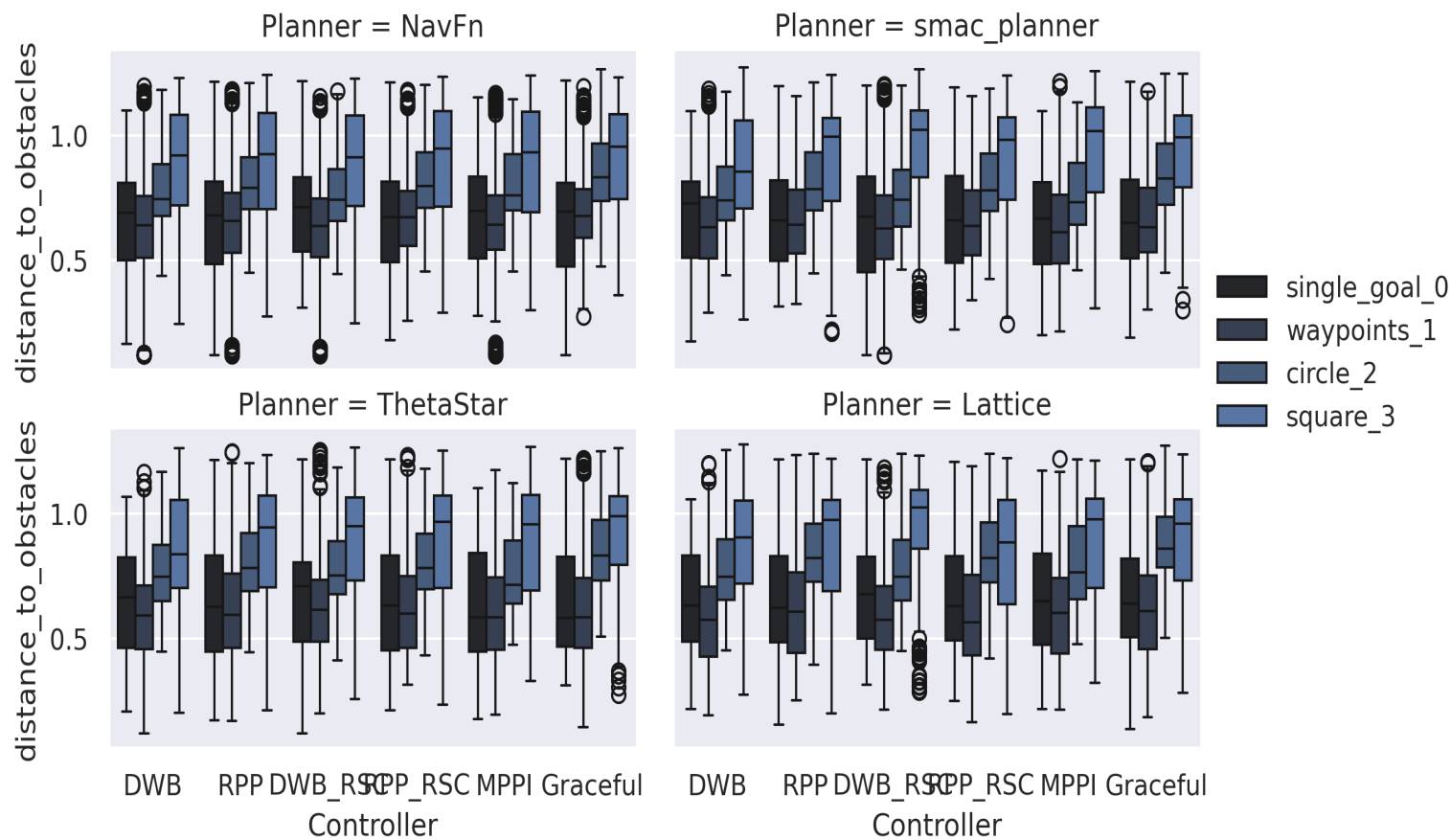
Complex Distribution of Memory\_Usage  
by Planner, Controller, and Trajectory Type

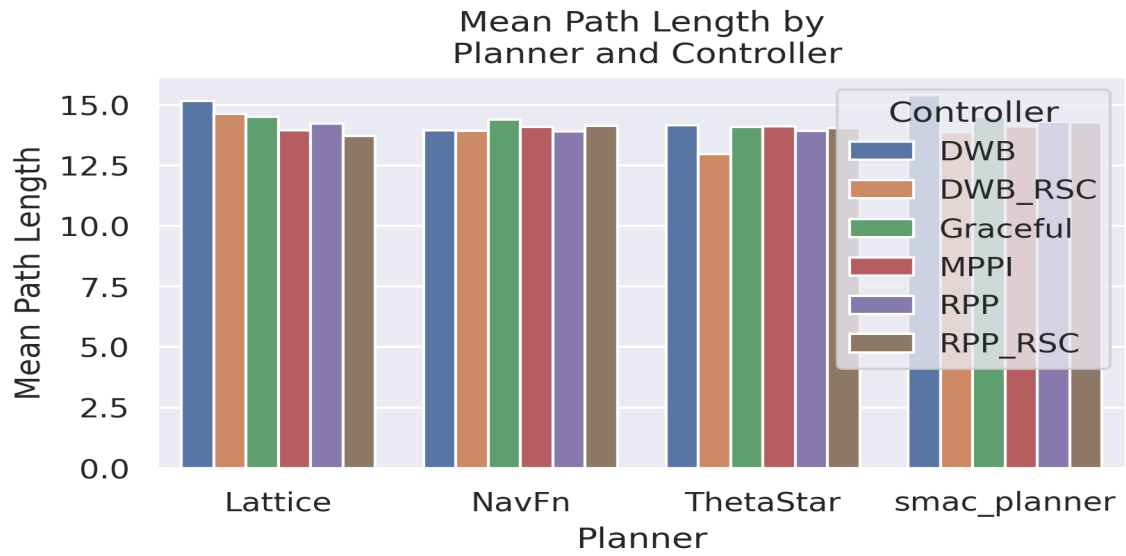


# Complex Distribution of number\_of\_recoveries by Planner, Controller, and Trajectory Type



Complex Distribution of distance\_to\_obstacles  
by Planner, Controller, and Trajectory Type



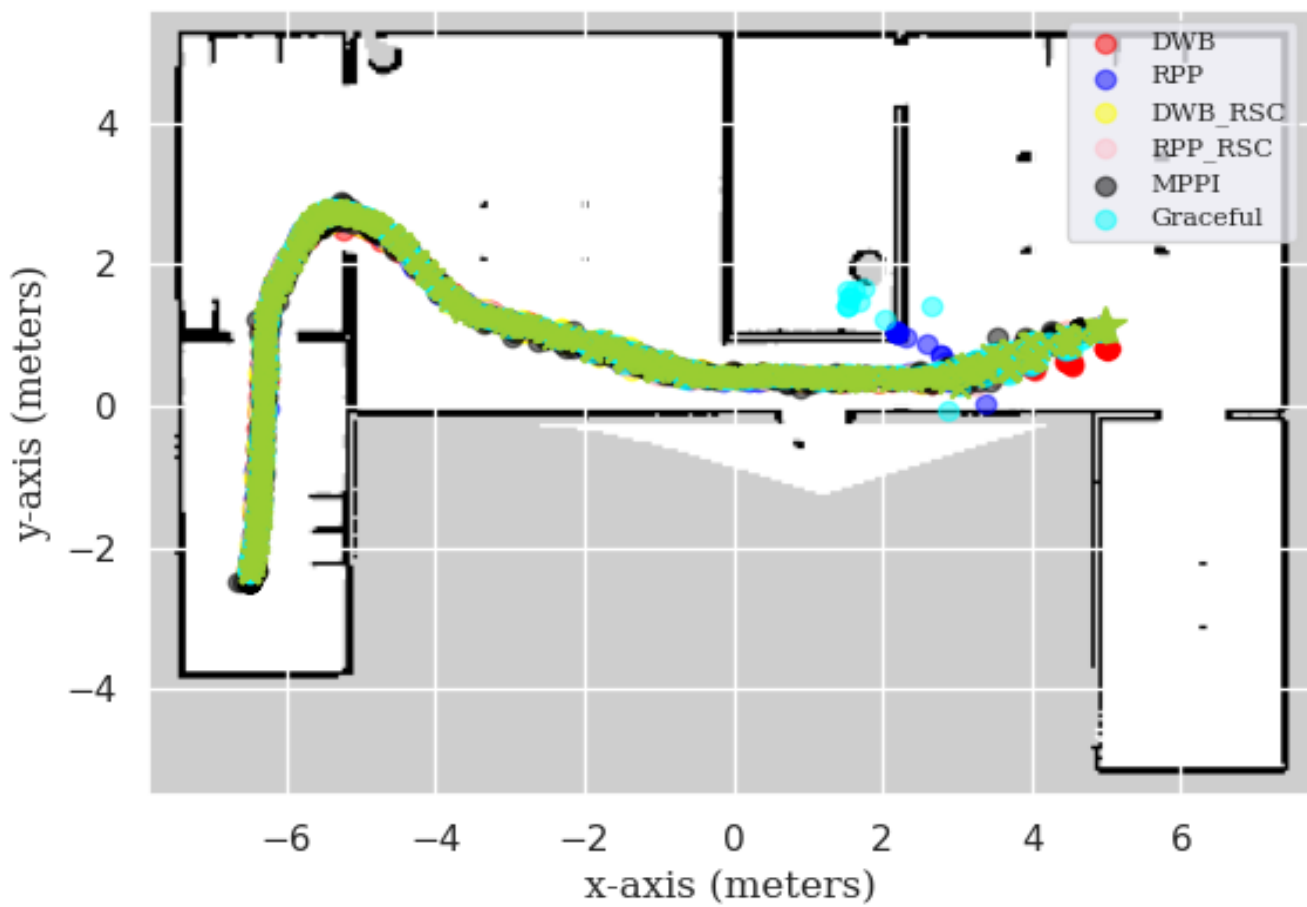


-Global planner: NavFn

Traveled path

-Trajectory type: single\_goal\_0

x Global planner path \* Waypoints ★ Initial pose

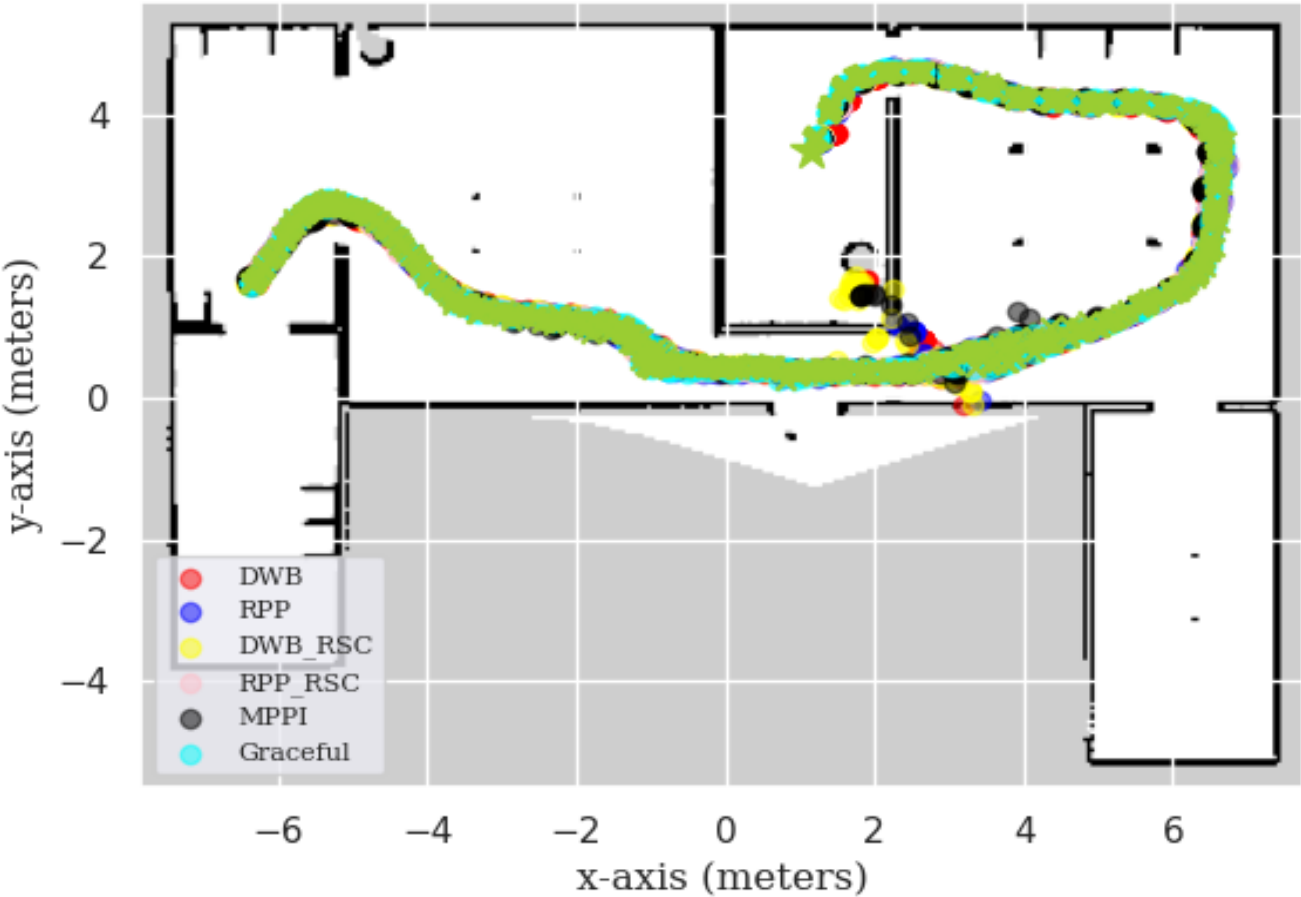


-Global planner: NavFn

Traveled path

-Trajectory type: waypoints\_1

x Global planner path \* Waypoints ★ Initial pose

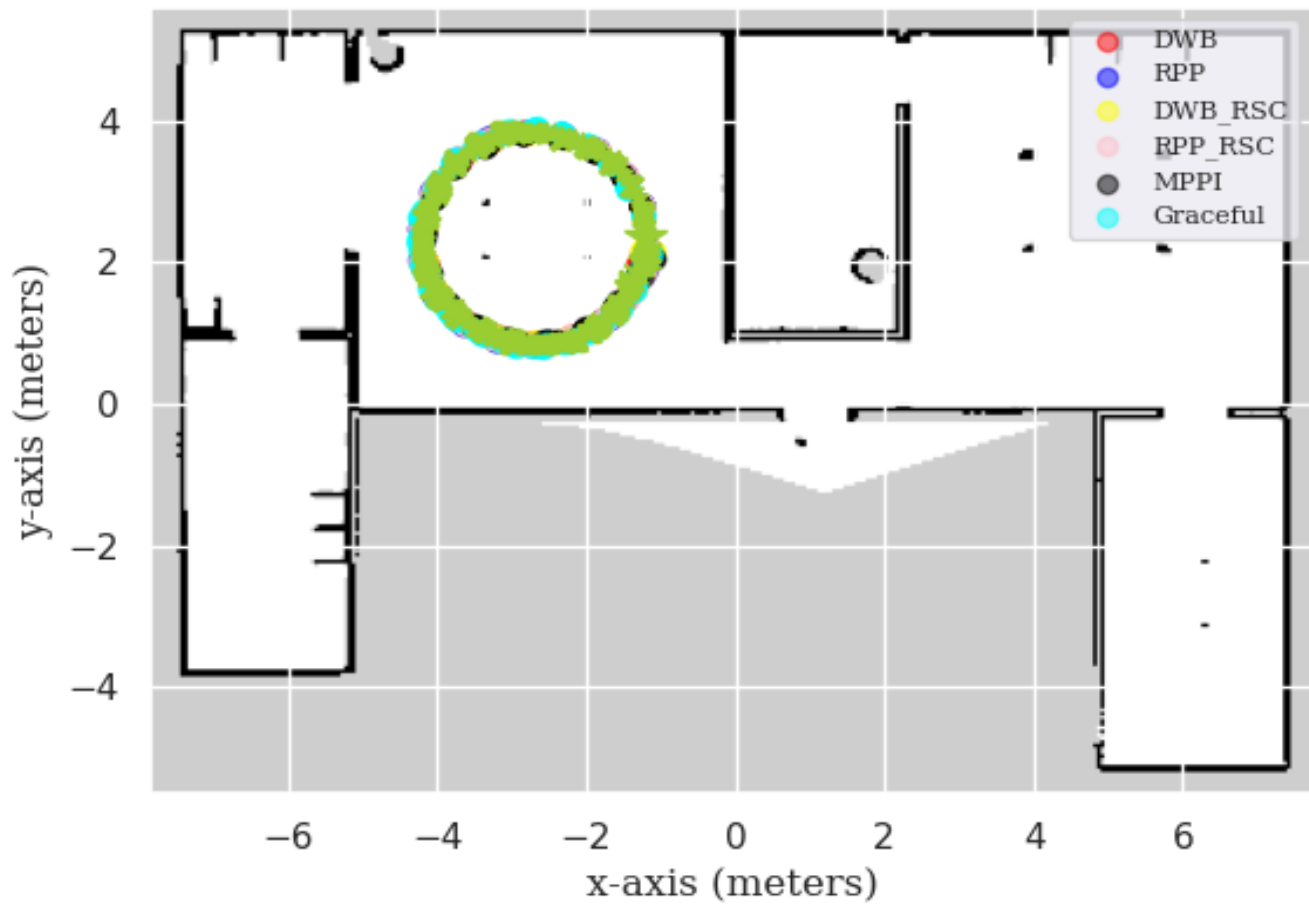


-Global planner: NavFn

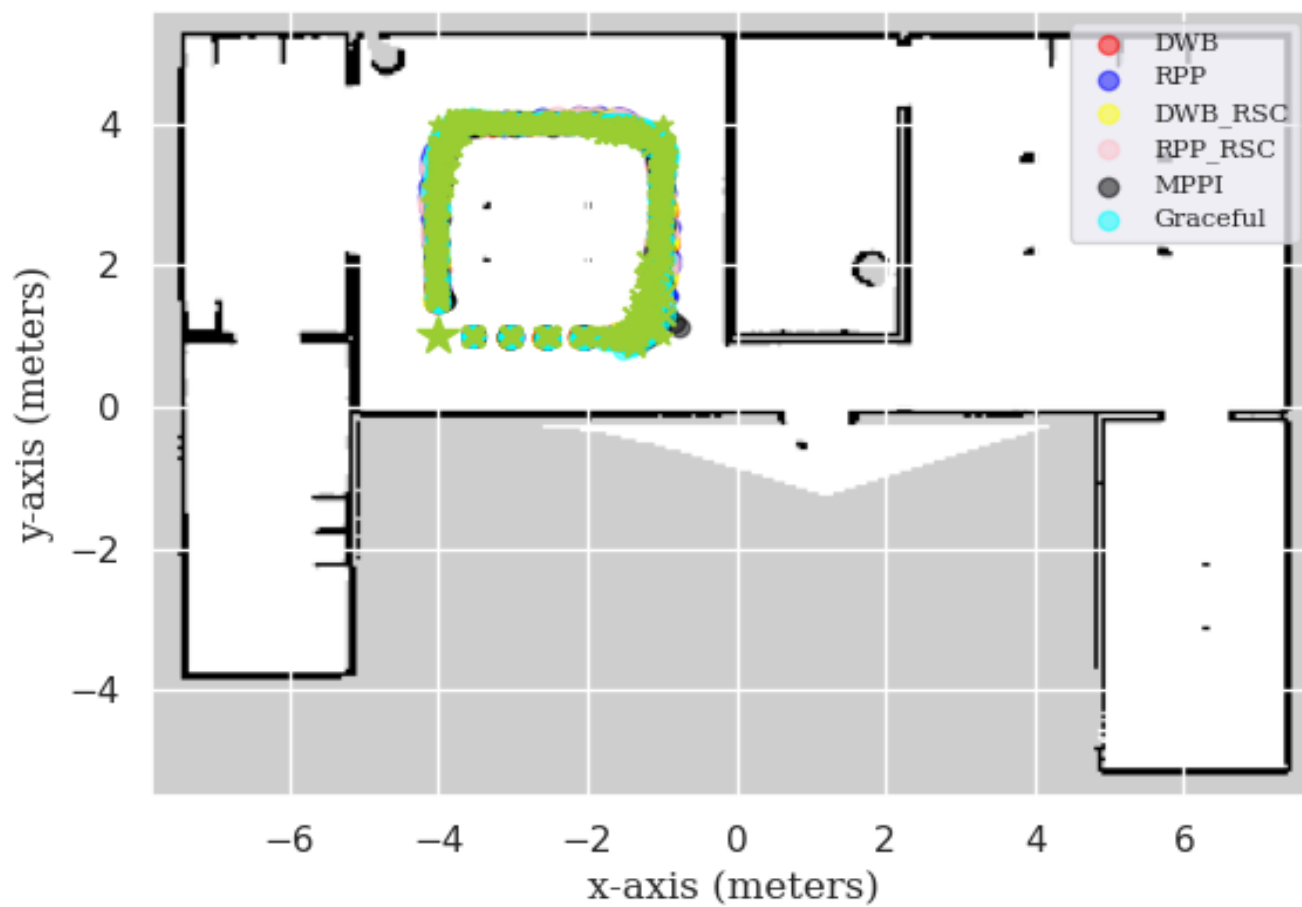
Traveled path

-Trajectory type: circle\_2

x Global planner path \* Waypoints ★ Initial pose





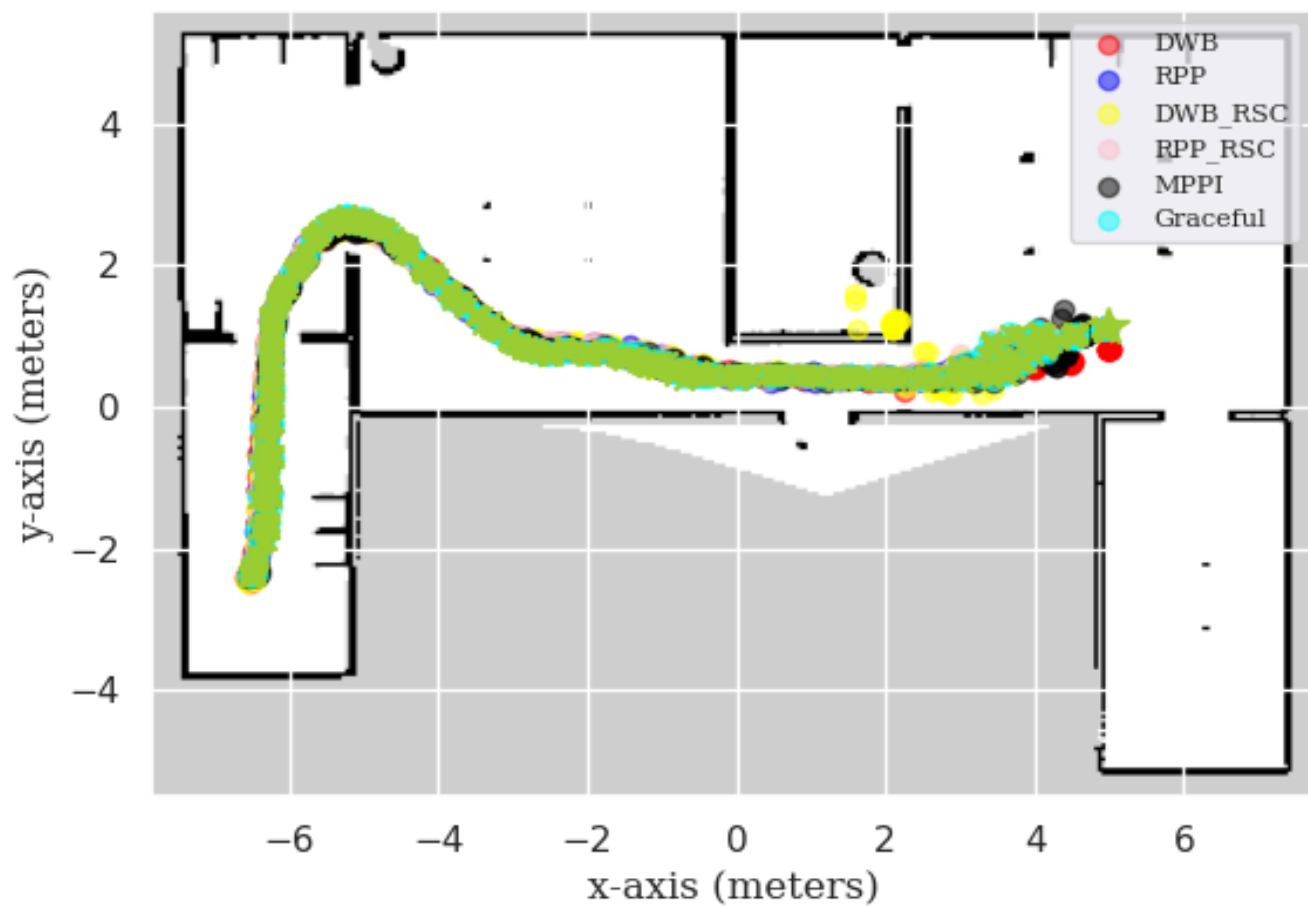


-Global planner: smac\_planner

Traveled path

-Trajectory type: single\_goal\_0

x Global planner path \* Waypoints ★ Initial pose

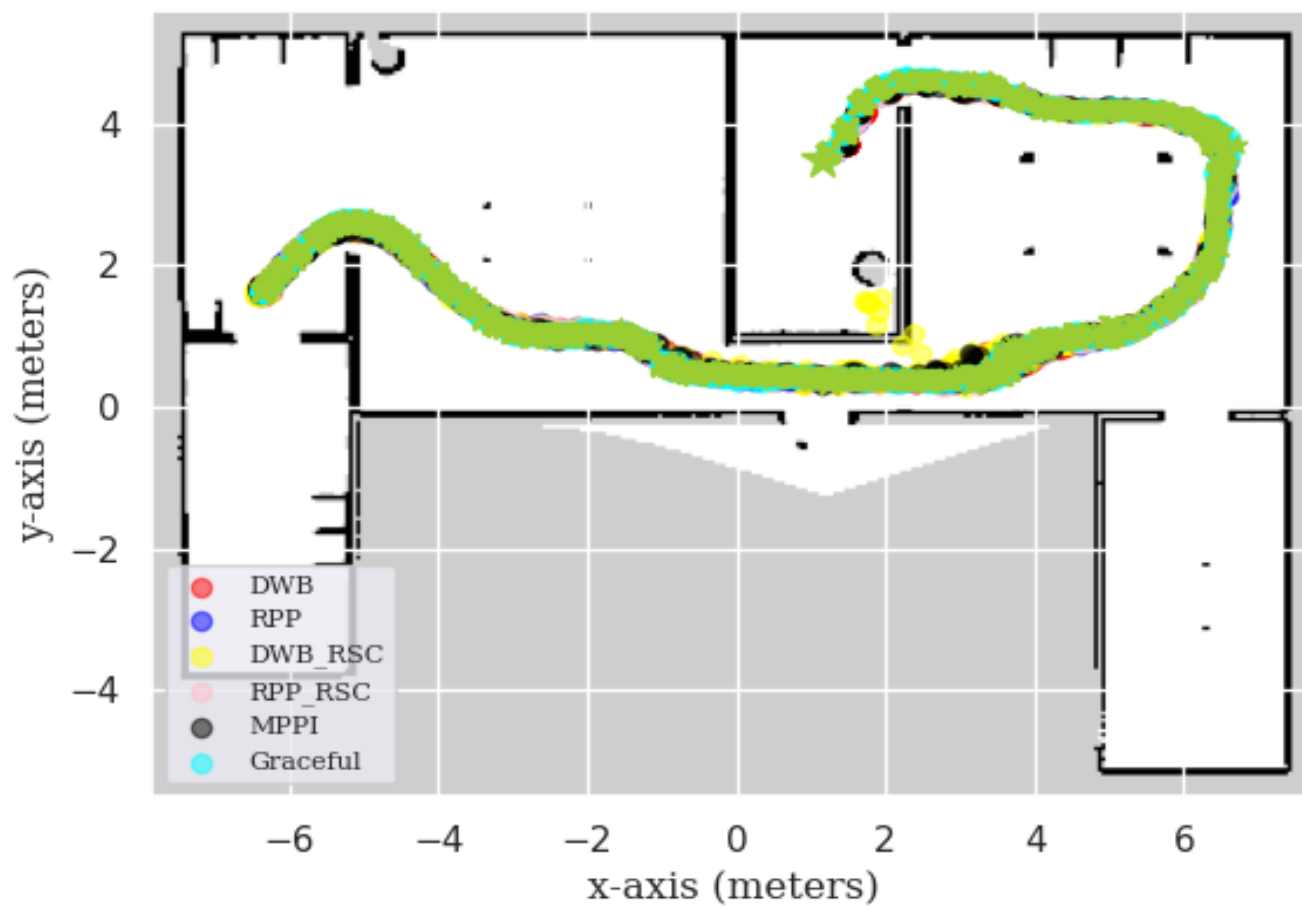


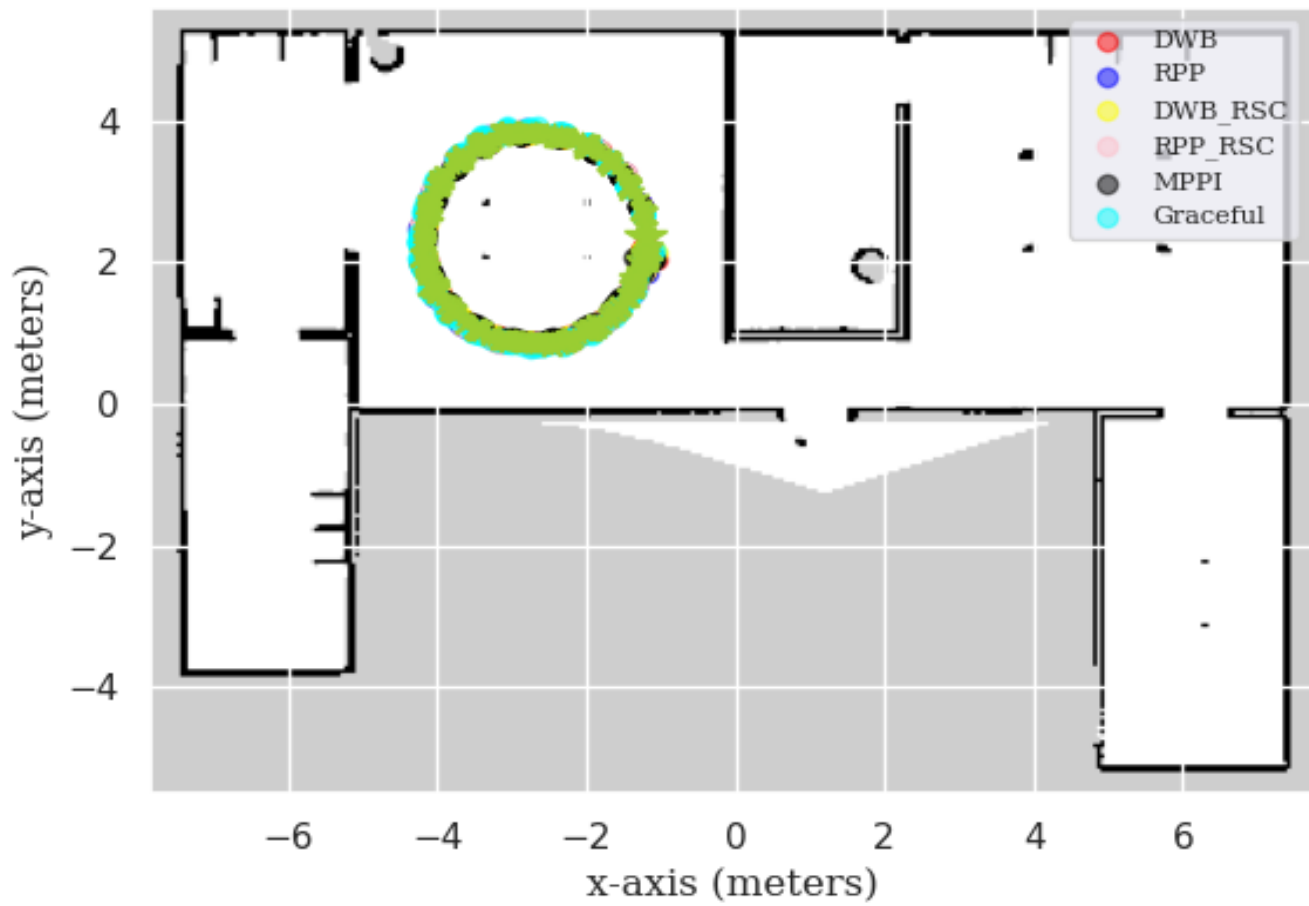
-Global planner: smac\_planner

Traveled path

-Trajectory type: waypoints\_1

x Global planner path \* Waypoints ★ Initial pose



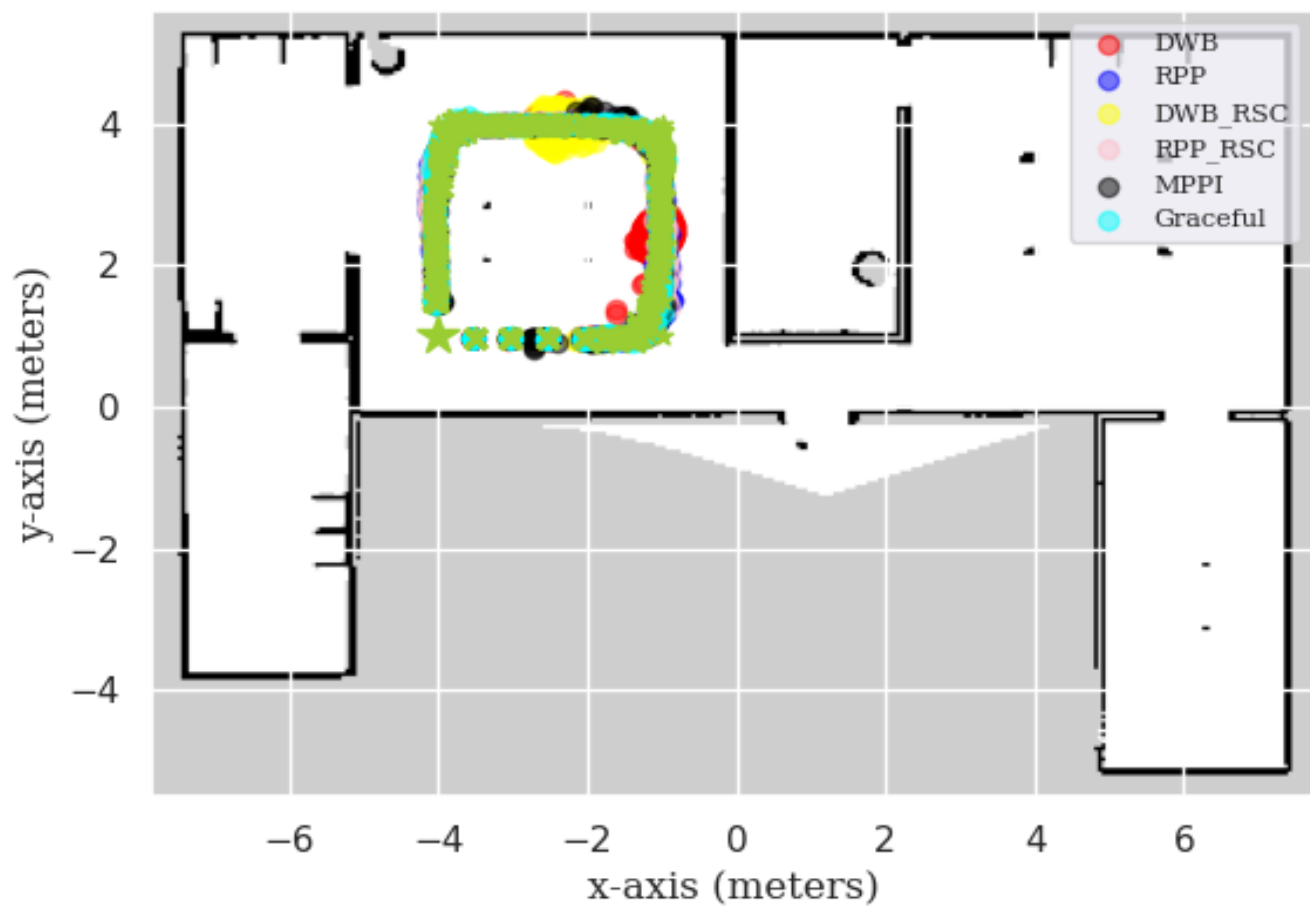


-Global planner: smac\_planner

Traveled path

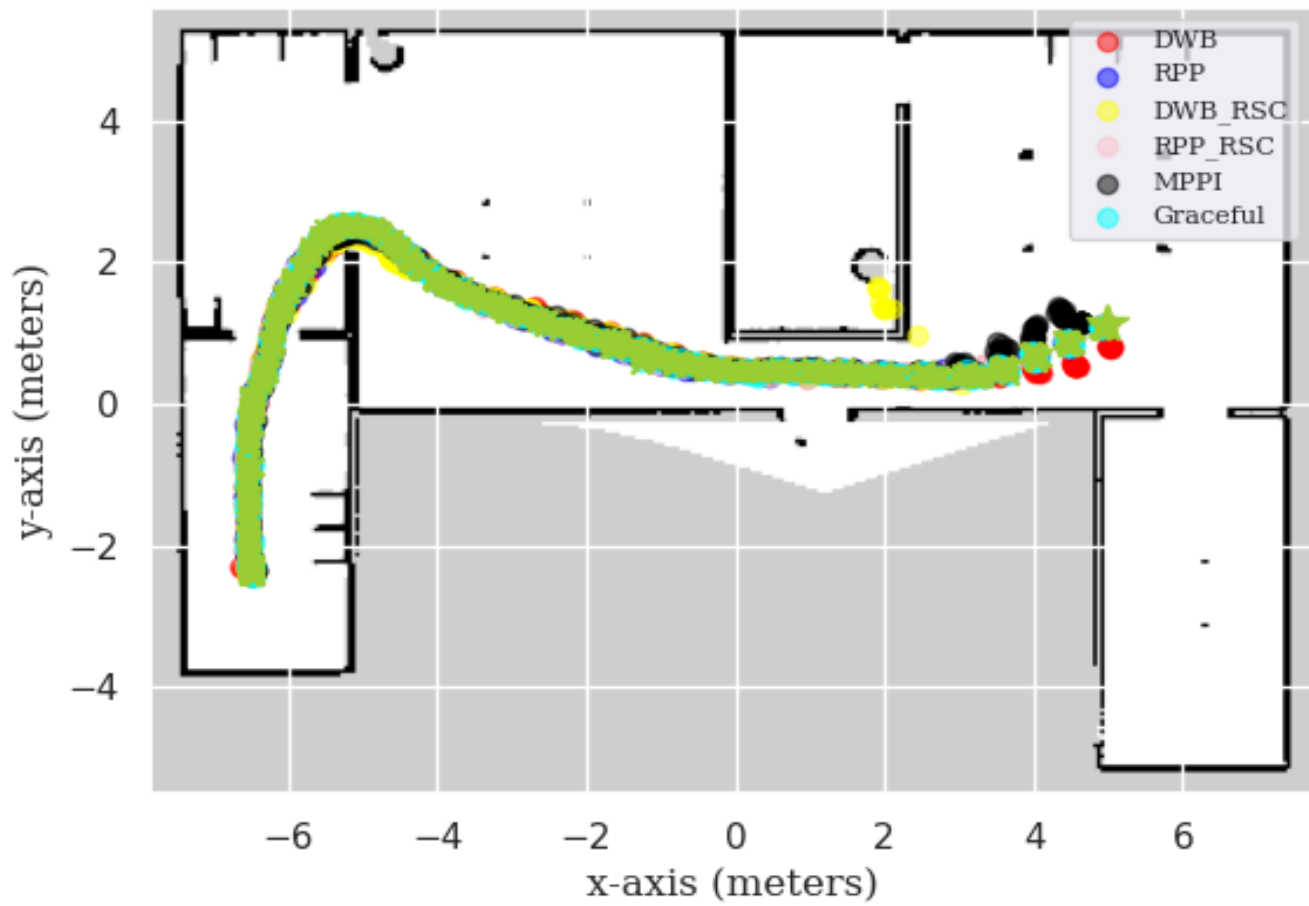
-Trajectory type: square\_3

x Global planner path \* Waypoints ★ Initial pose



-Global planner: ThetaStar

-Trajectory type: single\_goal\_0

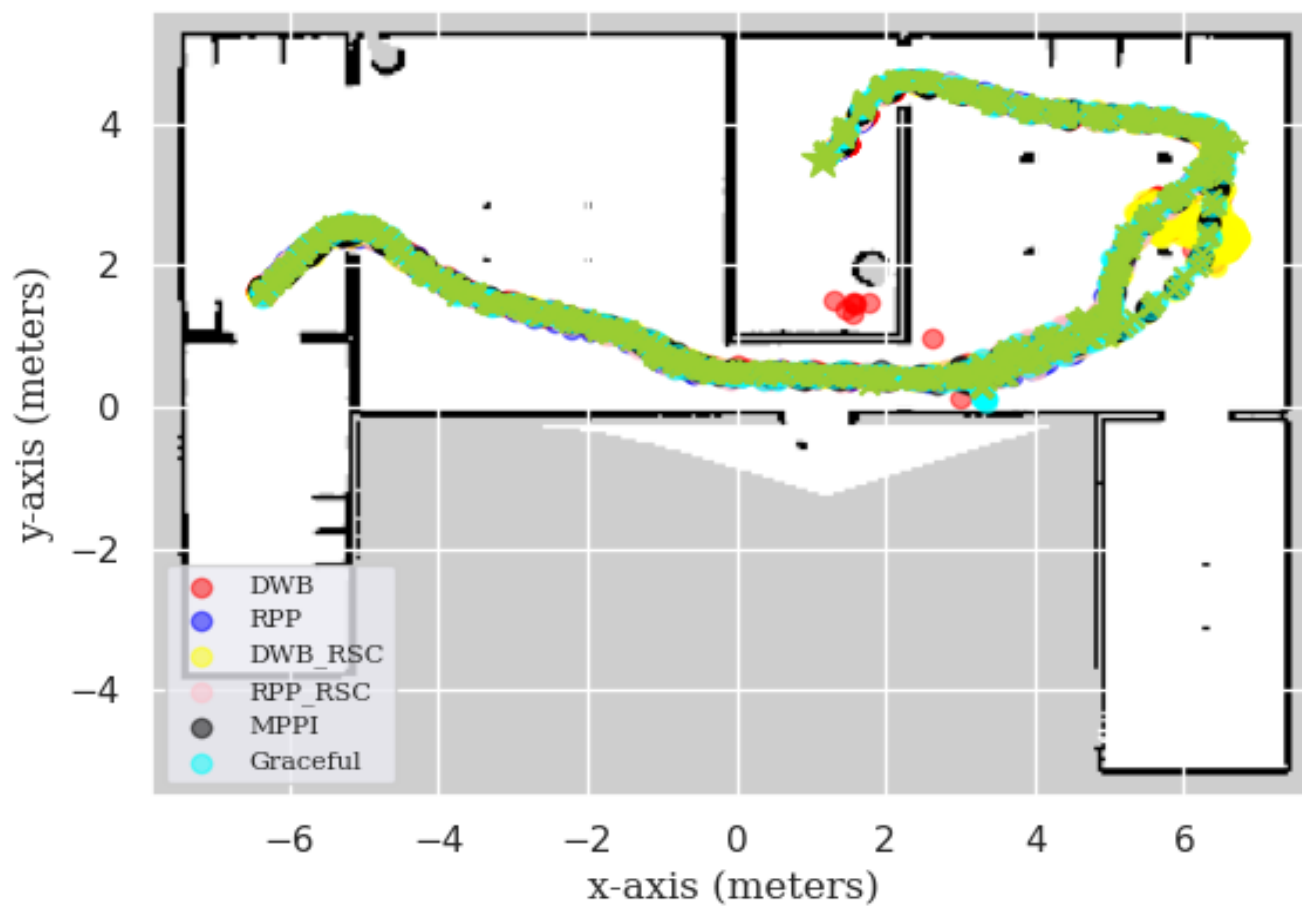


-Global planner: ThetaStar

Traveled path

-Trajectory type: waypoints\_1

x Global planner path \* Waypoints ★ Initial pose

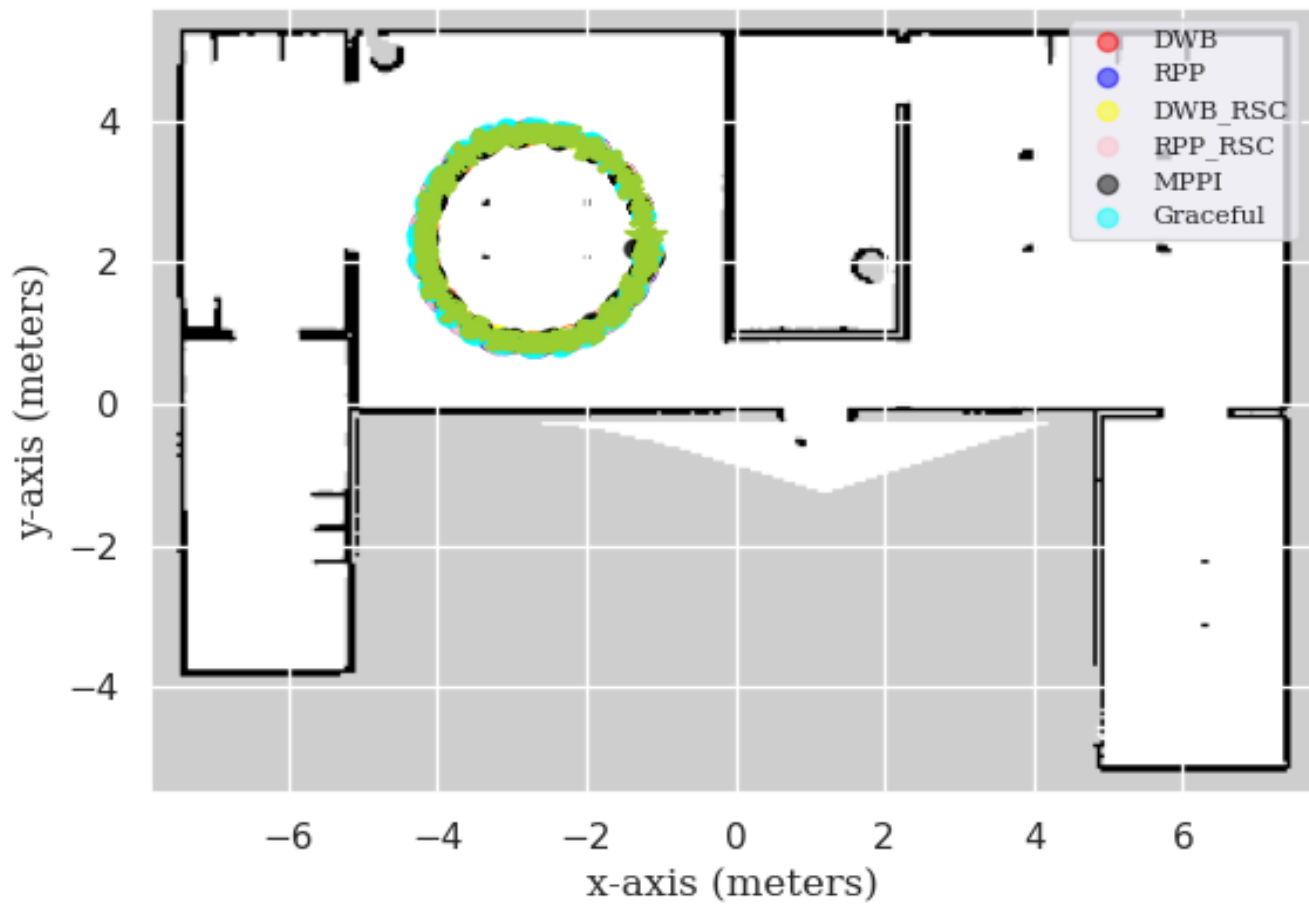


-Global planner: ThetaStar

Traveled path

-Trajectory type: circle\_2

x Global planner path \* Waypoints ★ Initial pose



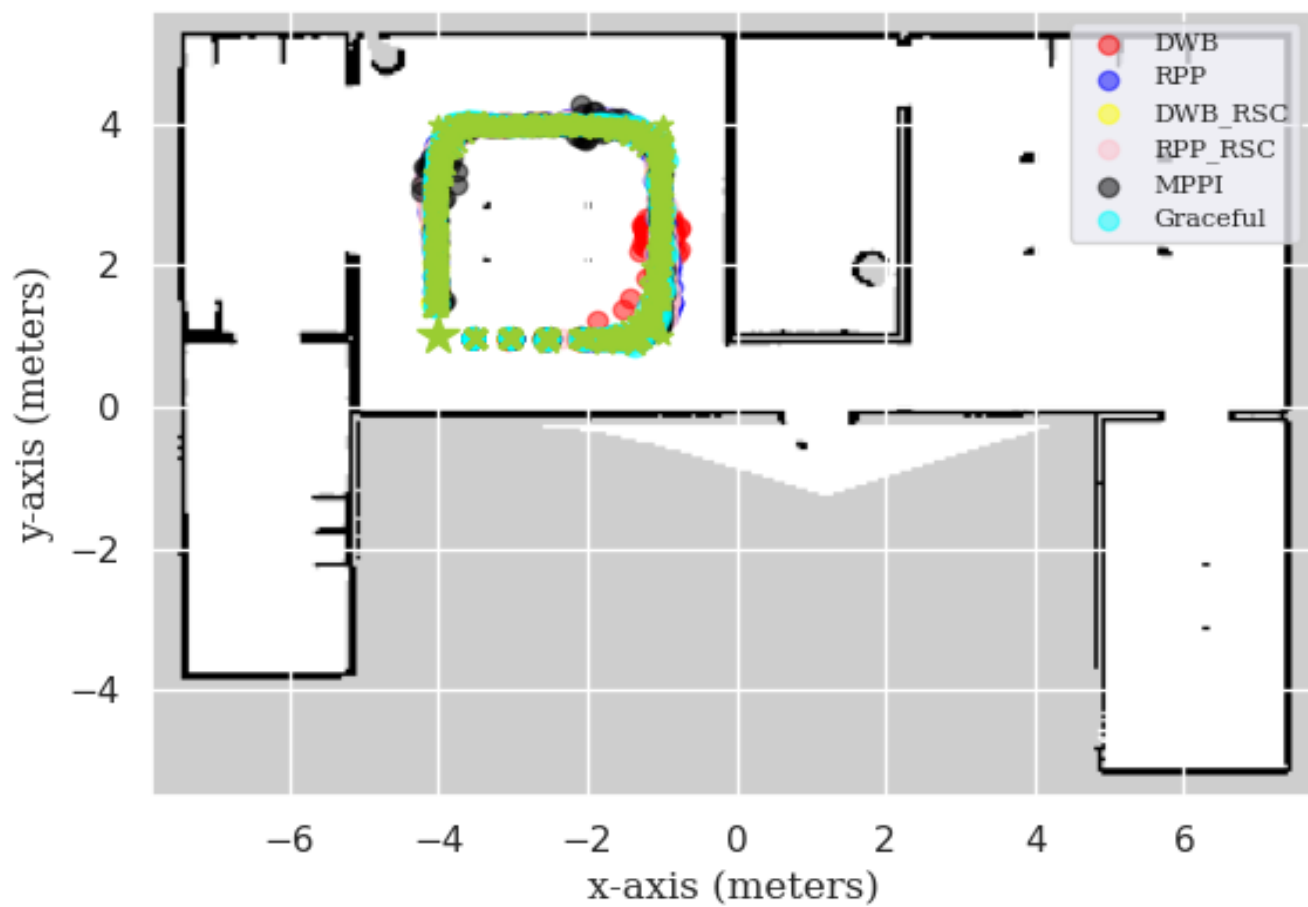
-Global planner: ThetaStar

Traveled path

-Trajectory type: square\_3

x Global planner path \* Waypoints ★ Initial pose



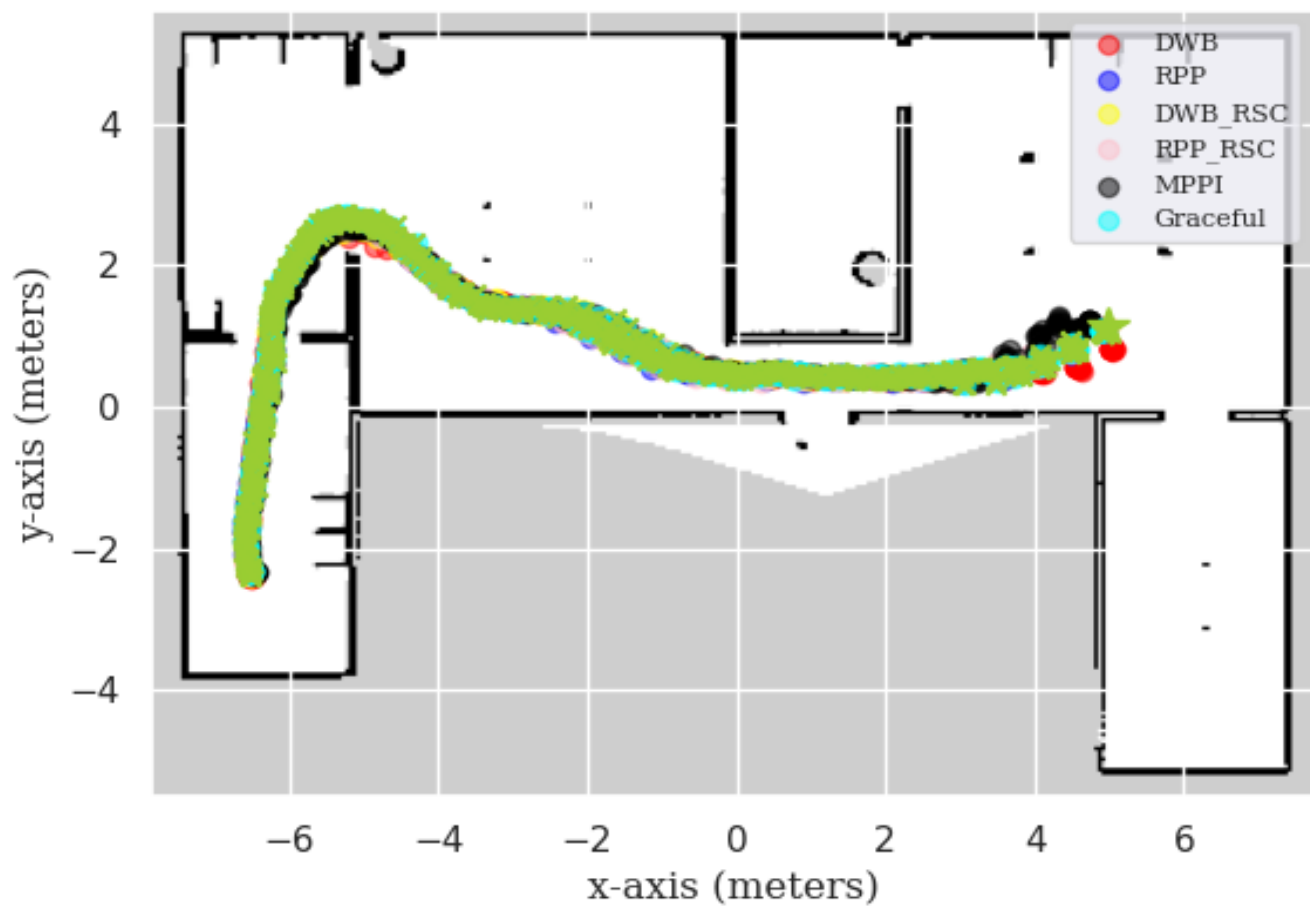


-Global planner: Lattice

Traveled path

-Trajectory type: single\_goal\_0

x Global planner path \* Waypoints ★ Initial pose

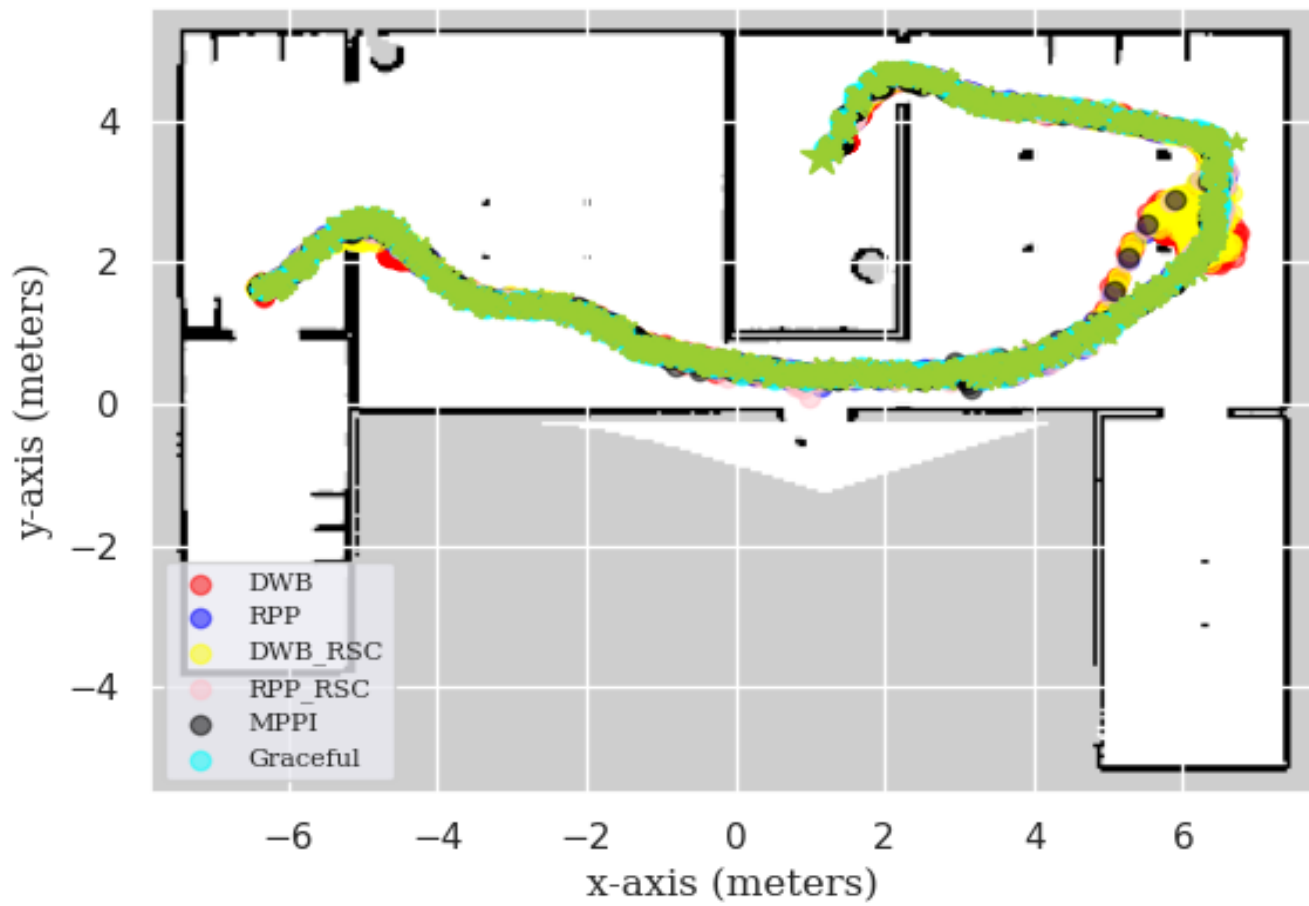


-Global planner: Lattice

Traveled path

-Trajectory type: waypoints\_1

x Global planner path \* Waypoints ★ Initial pose

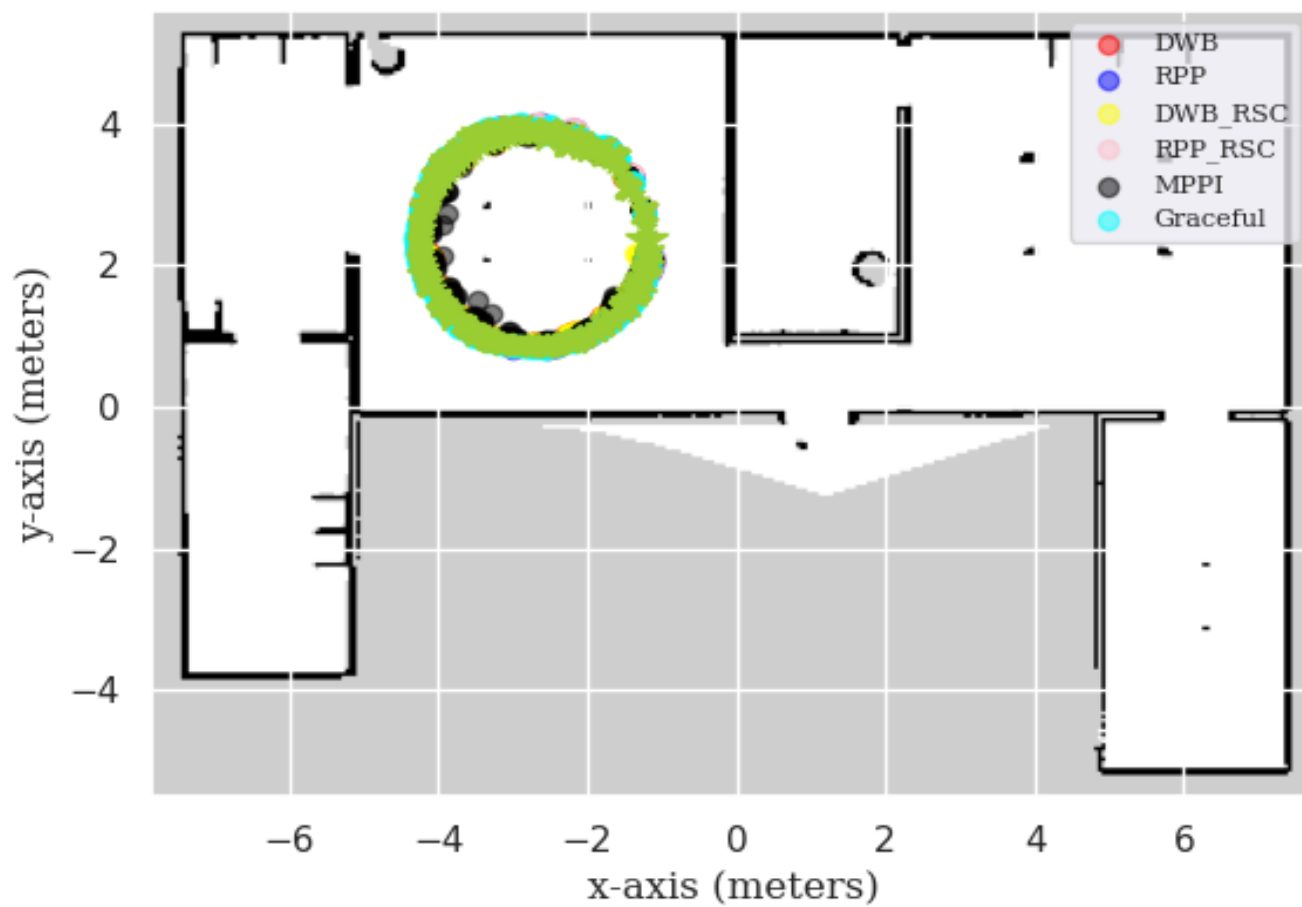


-Global planner: Lattice

Traveled path

-Trajectory type: circle\_2

x Global planner path \* Waypoints ★ Initial pose

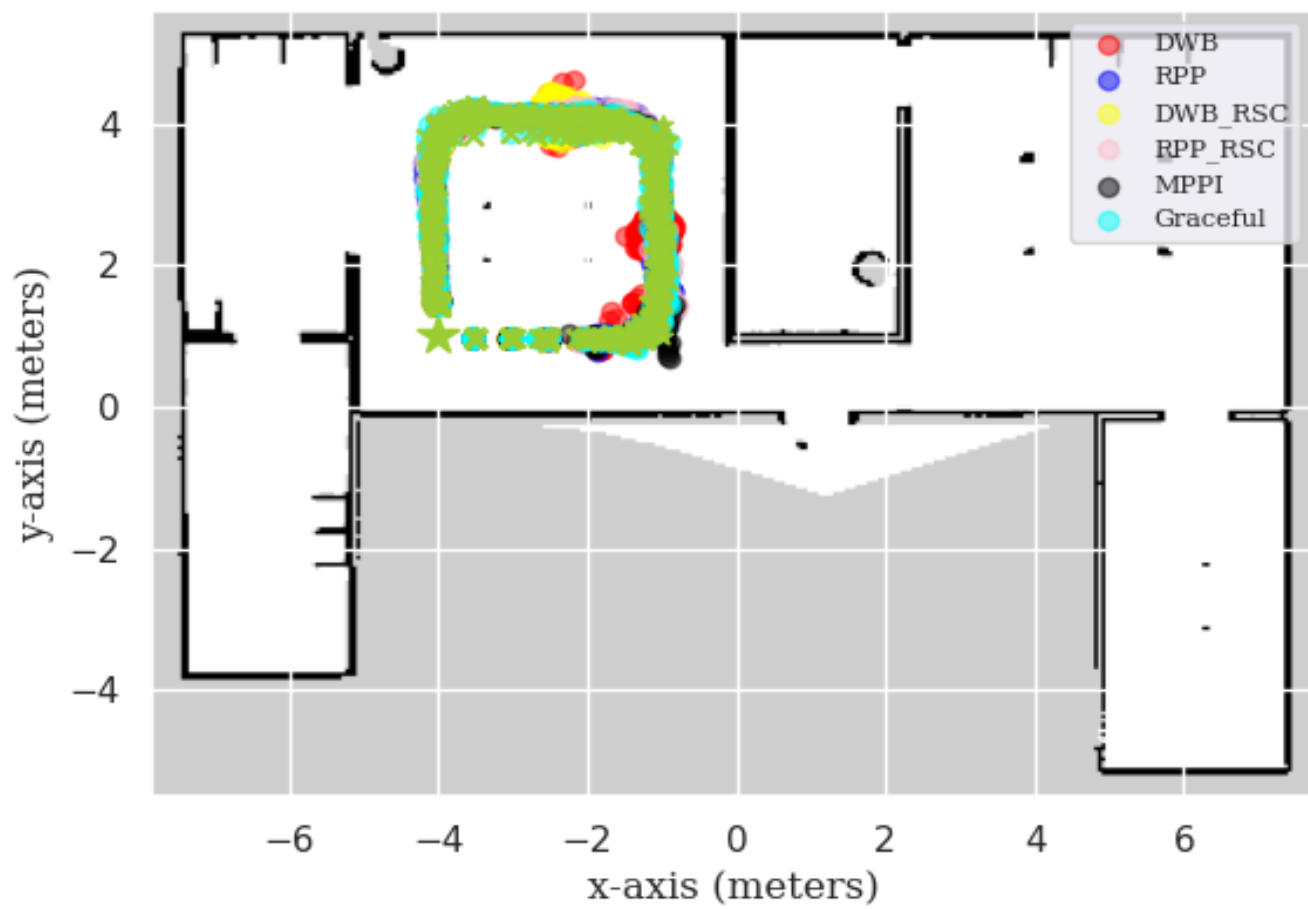


-Global planner: Lattice

Traveled path

-Trajectory type: square\_3

x Global planner path \* Waypoints ★ Initial pose



## Failure report

Recorded log messages of navigation nodes, if any message is recorded