Analysis of Exploration vs. Exploitation in Adaptive Information Sampling

Appendix A - Results with Extended Data

TABLE I

PERFORMANCE METRICS FOR VARIANTS WITH INITIAL FIXED SWEEP SCENARIO WITH SIGNAL PROPAGATION EXPONENT N=3.

Approach	Source location	Samples	Rmse	Variance	Cumulative Distance
Alpha 0.75	**Src(0,0)**	**218 ± 3.46**	**4.3 ± 0.07**	**8.14 ± 2.5**	**87.2 ± 1.31**
	Src(0,14)	219 ± 4	4.08 ± 0.05	16.55 ± 16.73	97.03 ± 21.16
	Src(4,7)	222 ± 0	4.38 ± 0.21	9.25 ± 1.16	79.65 ± 1.55
	Src(9,0)	**220 ± 1**	**4.29 ± 0.1**	**7.1 ± 1.14**	**83.86 ± 2.27**
	Src(9,14)	216 ± 5.48	4.32 ± 0.09	15.09 ± 11.41	118.02 ± 43.35
Alpha 0.5	**Src(0,0)**	**212 ± 4.8**	**4.28 ± 0.06**	**9.62 ± 3.2**	**143.65 ± 35.3**
	Src(0,14)	204 ± 8.72	4.1 ± 0.08	21.44 ± 15.62	183.58 ± 67.3
	Src(4,7)	198 ± 6.08	4.22 ± 0.05	12.25 ± 5.16	227.79 ± 44.2
	Src(9,0)	**210 ± 6.71**	**4.17 ± 0.06**	**14.83 ± 14.58**	**139.26 ± 45.71**
	Src(9,14)	213 ± 6.56	4.2 ± 0.08	9.1 ± 2.81	147.36 ± 53.53
Alpha 0.25	**Src(0,0)**	**188 ± 5.66**	**4.17 ± 0.07**	**5.67 ± 0.46**	**320.34 ± 53.94**
	Src(0,14)	**184 ± 5.2**	**4.06 ± 0.08**	**5.67 ± 0.11**	**325.42 ± 35.96**
	Src(4,7)	174 ± 0	4.14 ± 0.07	4.73 ± 0.11	434.77 ± 10.35
	Src(9,0)	182 ± 6.56	4.16 ± 0.04	5.87 ± 0.32	362.33 ± 55.26
	Src(9,14)	182 ± 7.55	4.1 ± 0.08	5.87 ± 0.28	386.88 ± 61.49
Max Variance	Src(0,0)	153 ± 2.45	4.18 ± 0.03	2.57 ± 0.1	617.44 ± 18.47
	Src(0,14)	**153 ± 2**	**3.95 ± 0.08**	**2.44 ± 0.17**	**612.12 ± 14.42**
	Src(4,7)	155 ± 0	4.44 ± 0.13	3.0 ± 0.11	618.93 ± 15.65
	Src(9,0)	154 ± 1.73	4.2 ± 0.04	2.17 ± 0.18	625.74 ± 14.94
	Src(9,14)	**153 ± 2.65**	**4.16 ± 0.06**	**2.23 ± 0.14**	**617.44 ± 17.19**
Max Mean	Src(0,0)	221 ± 0	4.31 ± 0.11	11.39 ± 6.55	84.99 ± 0.14
	Src(0,14)	222 ± 0	4.48 ± 0.23	69.25 ± 73.97	78.95 ± 1.06
	Src(4,7)	**222 ± 1**	**4.77 ± 0.23**	**8.81 ± 0.63**	**77.74 ± 0.59**
	Src(9,0)	**222 ± 0**	**5.51 ± 0.43**	**4.74 ± 0.38**	**81.08 ± 1.44**
	Src(9,14)	223 ± 0	4.49 ± 0.15	66.27 ± 33.04	70.39 ± 1.04
MaxVarMaxMean	**Src(0,0)**	**178 ± 15.68**	**4.28 ± 0.03**	**5.07 ± 0.37**	**402.33 ± 98.39**
	Src(0,14)	178 ± 8.06	4.06 ± 0.13	5.19 ± 0.38	431.82 ± 59.98
	Src(4,7)	161 ± 13.08	4.46 ± 0.07	3.76 ± 0.84	563.6 ± 102.96
	Src(9,0)	**180 ± 12.21**	**4.16 ± 0.1**	**5.14 ± 0.59**	**405.4 ± 80.93**
	Src(9,14)	190 ± 9.9	4.23 ± 0.13	5.46 ± 1.26	324.07 ± 80.26
Fixed Sweep	**Src(0,0)**	**36 ± 1.41**	**4.37 ± 0.07**	**6.84 ± 0.3**	**68.48 ± 0.74**
	Src(0,14)	36 ± 1	4.25 ± 0.12	8.16 ± 0.34	68.08 ± 0.24
	Src(4,7)	36 ± 1.41	5.07 ± 0.13	9.43 ± 1.96	68.72 ± 1.03
	Src(9,0)	36 ± 0	5.99 ± 0.09	3.75 ± 0.32	68.25 ± 0.24
	Src(9,14)	**37 ± 0**	**4.39 ± 0.04**	**7.43 ± 0.79**	**68.07 ± 0.1**

TABLE II

PERFORMANCE METRICS FOR VARIANTS WITH INITIAL RANDOM WALK SCENARIO WITH SIGNAL PROPAGATION EXPONENT N=3.

Approach	Source location	Samples	Rmse	Variance	Cumulative Distance
Alpha 0.75	**Src(0,0)**	**206 ± 14.56**	**4.32 ± 0.04**	**23.98 ± 10.6**	**140.94 ± 75.37**
	Src(0,14)	191 ± 16.76	4.11 ± 0.12	18.94 ± 8.66	235.2 ± 63.26
	Src(4,7)	**207 ± 12.57**	**4.38 ± 0.2**	**25.1 ± 3.64**	**197.24 ± 92.54**
	Src(9,0)	209 ± 10.49	4.23 ± 0.05	27.19 ± 12.45	143.65 ± 29.05
	Src(9,14)	213 ± 6.56	4.59 ± 0.64	36.14 ± 22.46	158.95 ± 56.36
Alpha 0.5	**Src(0,0)**	**201 ± 6.32**	**4.24 ± 0.06**	**15.19 ± 1.78**	**234.19 ± 42.78**
	Src(0,14)	198 ± 7.62	4.11 ± 0.05	23.0 ± 20.5	265.11 ± 57.2
	Src(4,7)	181 ± 6.32	4.32 ± 0.07	13.37 ± 4.37	392.72 ± 51.95
	Src(9,0)	**196 ± 11.45**	**4.22 ± 0.09**	**14.82 ± 3.07**	**260.51 ± 92.4**
	Src(9,14)	194 ± 16.82	4.24 ± 0.07	14.24 ± 3.76	271.49 ± 101.21
Alpha 0.25	Src(0,0)	164 ± 7.62	4.15 ± 0.07	6.03 ± 0.6	530.88 ± 44.93
	Src(0,14)	**169 ± 4.47**	**4.03 ± 0.03**	**5.89 ± 0.35**	**466.23 ± 57.16**
	Src(4,7)	164 ± 2.24	4.1 ± 0.08	4.84 ± 0.1	535.12 ± 22.62
	Src(9,0)	172 ± 11.4	4.15 ± 0.06	5.94 ± 0.33	467.92 ± 109.09
	Src(9,14)	**169 ± 5.66**	**4.12 ± 0.04**	**5.94 ± 0.2**	**470.4 ± 46.25**
Max Variance	**Src(0,0)**	**146 ± 3.32**	**4.21 ± 0.06**	**2.43 ± 0.09**	**685.97 ± 22.06**
	Src(0,14)	**145 ± 3.61**	**4.07 ± 0.09**	**2.39 ± 0.16**	**686.95 ± 12.98**
	Src(4,7)	145 ± 3.87	4.25 ± 0.08	2.99 ± 0.13	703.79 ± 10.7
	Src(9,0)	146 ± 3.74	4.19 ± 0.07	2.26 ± 0.19	700.75 ± 8.85
	Src(9,14)	145 ± 3	4.16 ± 0.09	2.36 ± 0.08	703.92 ± 15.65
Max Mean	Src(0,0)	226 ± 0	4.88 ± 0.11	76.42 ± 50.15	57.99 ± 1.27
	Src(0,14)	225 ± 1.41	6.05 ± 1.42	62.87 ± 61.2	65.17 ± 8.5
	Src(4,7)	226 ± 1	6.23 ± 0.58	25.7 ± 3.18	58.29 ± 0.4
	Src(9,0)	**226 ± 0**	**7.05 ± 0.52**	**11.67 ± 7.62**	**62.5 ± 2.35**
	Src(9,14)	**226 ± 0**	**6.12 ± 0.99**	**12.53 ± 4.21**	**63.27 ± 1.45**
MaxVarMaxMean	Src(0,0)	170 ± 11.05	4.26 ± 0.06	4.84 ± 0.11	489.43 ± 58.39
	Src(0,14)	**173 ± 5.48**	**4.09 ± 0.07**	**5.1 ± 0.18**	**459.19 ± 62.19**
	Src(4,7)	160 ± 3.87	4.26 ± 0.08	5.23 ± 1.12	586.45 ± 38.89
	Src(9,0)	169 ± 9.54	4.27 ± 0.07	4.86 ± 0.17	506.21 ± 86.01
	Src(9,14)	**180 ± 10.3**	**4.12 ± 0.12**	**4.82 ± 0.15**	**406.98 ± 81.99**
Random Walk	**Src(0,0)**	**150 ± 1.41**	**4.52 ± 0.19**	**2.64 ± 0.3**	**520.5 ± 8.52**
	Src(0,14)	**150 ± 0**	**4.45 ± 0.1**	**2.52 ± 0.19**	**523.68 ± 2.16**
	Src(4,7)	149 ± 1.41	4.18 ± 0.04	4.91 ± 0.15	520.63 ± 6.13
	Src(9,0)	150 ± 1	4.6 ± 0.23	2.81 ± 0.33	522.13 ± 4.16
	Src(9,14)	150 ± 1.41	4.5 ± 0.21	2.62 ± 0.27	517.76 ± 7.03

TABLE III

PERFORMANCE METRICS FOR VARIANTS WITH INITIAL FIXED SWEEP SCENARIO WITH SIGNAL PROPAGATION EXPONENT N=2.

Approach	Source location	Samples	Rmse	Variance	Cumulative Distance
Alpha 0.75	Src(0,0)	218 ± 2	4.15 ± 0.13	7.04 ± 1.96	96.06 ± 10.12
	Src(0,14)	221 ± 1	4.05 ± 0.1	5.93 ± 1.93	81.12 ± 1.74
	Src(4,7)	221 ± 1	4.3 ± 0.11	6.61 ± 1.56	77.77 ± 0.44
	Src(9,0)	218 ± 3.16	4.24 ± 0.09	6.92 ± 2.88	108.05 ± 25.1
	Src(9,14)	222 ± 0	4.18 ± 0.05	4.48 ± 1.09	69.57 ± 0.7
Alpha 0.5	Src(0,0)	211 ± 2.65	4.21 ± 0.06	6.1 ± 0.43	128.74 ± 8.37
	Src(0,14)	214 ± 6.32	4.05 ± 0.14	5.53 ± 2.61	122.34 ± 51.18
	Src(4,7)	208 ± 6.71	4.17 ± 0.05	4.89 ± 0.43	166.94 ± 39.86
	Src(9,0)	216 ± 2.24	4.13 ± 0.04	4.9 ± 0.8	108.15 ± 6.37
	Src(9,14)	218 ± 4.58	4.24 ± 0.11	6.35 ± 2.15	109.94 ± 37.61
Alpha 0.25	Src(0,0)	197 ± 3.61	4.03 ± 0.05	3.8 ± 0.21	244.17 ± 34.61
	Src(0,14)	183 ± 5.83	3.94 ± 0.05	3.99 ± 0.15	325.84 ± 52.99
	Src(4,7)	180 ± 3.74	4.03 ± 0.04	3.15 ± 0.1	384.61 ± 36.33
	Src(9,0)	197 ± 9.49	4.1 ± 0.07	3.77 ± 0.16	238.37 ± 68.86
	Src(9,14)	184 ± 7.87	4.11 ± 0.05	3.91 ± 0.9	358.96 ± 69.58
Max Variance	Src(0,0)	154 ± 1.41	4.07 ± 0.08	1.6 ± 0.13	629.57 ± 8.02
	Src(0,14)	151 ± 1	3.96 ± 0.04	1.54 ± 0.13	617.18 ± 21.43
	Src(4,7)	150 ± 4.9	4.16 ± 0.05	1.95 ± 0.2	626.02 ± 26.1
	Src(9,0)	151 ± 2.24	4.15 ± 0.02	1.68 ± 0.04	632.61 ± 9.79
	Src(9,14)	151 ± 4.47	4.18 ± 0.07	1.43 ± 0.21	620.46 ± 23.43
Max Mean	Src(0,0)	219 ± 1	4.21 ± 0.19	42.41 ± 72.38	86.39 ± 2.04
	Src(0,14)	221 ± 0	4.03 ± 0.02	5.69 ± 1.35	79.9 ± 1.79
	Src(4,7)	221 ± 0	4.39 ± 0.16	5.4 ± 0.41	77.83 ± 0.84
	Src(9,0)	221 ± 0	5.18 ± 0.03	2.84 ± 0.22	79.99 ± 0.23
	Src(9,14)	223 ± 0	4.27 ± 0.12	6.67 ± 1.62	71.31 ± 3.48
MaxVarMaxMean	Src(0,0)	213 ± 4.12	4.14 ± 0.13	4.49 ± 0.24	143.54 ± 25.95
	Src(0,14)	207 ± 11.66	4.06 ± 0.09	4.24 ± 0.33	193.91 ± 92.48
	Src(4,7)	214 ± 1.41	4.34 ± 0.09	4.62 ± 0.26	141.27 ± 16.72
	Src(9,0)	198 ± 8.19	4.19 ± 0.05	4.71 ± 0.22	266.91 ± 74.04
	Src(9,14)	213 ± 7	4.15 ± 0.11	3.8 ± 0.59	144.14 ± 38.94
Fixed Sweep	Src(0,0)	36 ± 1	4.28 ± 0.06	5.36 ± 0.76	68.19 ± 0.16
	Src(0,14)	36 ± 0	4.17 ± 0.15	3.8 ± 0.44	68.03 ± 0.13
	Src(4,7)	36 ± 1	4.69 ± 0.28	4.87 ± 0.67	68.27 ± 0.14
	Src(9,0)	37 ± 0	5.35 ± 0.15	3.13 ± 0.66	68.09 ± 0.33
	Src(9,14)	37 ± 0	4.28 ± 0.13	4.6 ± 0.51	68.2 ± 0.18

TABLE IV

PERFORMANCE METRICS FOR VARIANTS WITH INITIAL RANDOM WALK SCENARIO WITH SIGNAL PROPAGATION EXPONENT N=2.

Approach	Source location	Samples	Rmse	Variance	Cumulative Distance
Alpha 0.75	Src(0,0)	199 ± 13.3	4.27 ± 0.19	68.25 ± 112.89	196.9 ± 50.99
	Src(0,14)	220 ± 7.94	3.98 ± 0.09	13.05 ± 4.11	100.6 ± 36.8
	Src(4,7)	218 ± 6.56	4.38 ± 0.2	14.56 ± 2.95	115.08 ± 47.51
	Src(9,0)	210 ± 10.54	4.21 ± 0.09	10.85 ± 2.14	169.41 ± 81.29
	Src(9,14)	223 ± 3.16	4.25 ± 0.1	9.01 ± 0.91	81.23 ± 20.35
Alpha 0.5	Src(0,0)	188 ± 17.69	4.11 ± 0.11	10.27 ± 0.44	337.03 ± 134.12
	Src(0,14)	194 ± 19.85	4.0 ± 0.11	8.15 ± 1.14	251.15 ± 117.29
	Src(4,7)	198 ± 4.24	4.23 ± 0.09	8.27 ± 3.82	248.43 ± 25
	Src(9,0)	205 ± 6.48	4.13 ± 0.12	8.56 ± 0.92	211.47 ± 53.82
	Src(9,14)	196 ± 15	4.1 ± 0.08	9.22 ± 2.33	279.89 ± 126.59
Alpha 0.25	Src(0,0)	170 ± 11.05	4.03 ± 0.03	4.22 ± 0.16	452.7 ± 58.65
	Src(0,14)	163 ± 10.25	3.99 ± 0.06	3.95 ± 0.39	499.61 ± 91.77
	Src(4,7)	166 ± 3.32	4.07 ± 0.06	3.21 ± 0.16	513.1 ± 30.55
	Src(9,0)	173 ± 9.22	4.11 ± 0.06	4.03 ± 0.06	432.53 ± 64.13
	Src(9,14)	179 ± 9.85	4.1 ± 0.06	3.84 ± 0.21	409.81 ± 81.41
Max Variance	Src(0,0)	145 ± 2.83	4.04 ± 0.07	1.71 ± 0.19	706.65 ± 20.44
	Src(0,14)	145 ± 1.41	4.0 ± 0.07	1.5 ± 0.14	714.51 ± 8.47
	Src(4,7)	142 ± 2	4.15 ± 0.07	1.88 ± 0.1	718.65 ± 25.38
	Src(9,0)	141 ± 5.83	4.17 ± 0.1	1.77 ± 0.17	709.49 ± 16.47
	Src(9,14)	141 ± 3.87	4.09 ± 0.09	1.64 ± 0.13	708.95 ± 12.11
Max Mean	Src(0,0)	218 ± 3.74	4.67 ± 0.41	310.41 ± 155.91	102.49 ± 23.41
	Src(0,14)	227 ± 0	4.43 ± 0.34	17.99 ± 4.97	60.72 ± 0.92
	Src(4,7)	223 ± 2.24	5.98 ± 1.47	126.23 ± 117.88	79.15 ± 17.39
	Src(9,0)	223 ± 3.46	5.46 ± 1.05	33.07 ± 55.04	84.8 ± 31.34
	Src(9,14)	226 ± 1	5.32 ± 0.91	6.37 ± 3.26	63.38 ± 2.25
MaxVarMaxMean	Src(0,0)	192 ± 4.58	4.03 ± 0.06	4.87 ± 0.11	322.8 ± 37
	Src(0,14)	171 ± 23.96	4.03 ± 0.05	5.04 ± 1.19	464.8 ± 167.34
	Src(4,7)	183 ± 13.34	4.2 ± 0.09	4.84 ± 0.18	404.13 ± 109.22
	Src(9,0)	191 ± 6.63	4.12 ± 0.03	4.84 ± 0.14	324.8 ± 32.79
	Src(9,14)	201 ± 7.55	4.24 ± 0.07	4.55 ± 0.29	246.06 ± 48.97
Random Walk	Src(0,0)	149 ± 0	4.23 ± 0.18	1.83 ± 0.29	526.27 ± 3.57
	Src(0,14)	149 ± 0	4.22 ± 0.1	1.69 ± 0.22	524.69 ± 4.04
	Src(4,7)	149 ± 2	4.12 ± 0.06	2.6 ± 0.25	518.56 ± 4.87
	Src(9,0)	149 ± 0	4.39 ± 0.28	1.77 ± 0.26	518.21 ± 6.42
	Src(9,14)	150 ± 1	4.36 ± 0.19	1.59 ± 0.21	517.81 ± 6.98

TABLE V

PERFORMANCE METRICS IN MULTI-ROBOT FIXED VORONOI PARTITION (FVP) SCENARIOS.

Approach	Source location	Samples	Rmse	Variance	Distance
Alpha0.75	**Src(0,0)**	**427 ± 26.32**	**4.15 ± 0.05**	**8.25 ± 1.06**	**147.61 ± 22.12**
	Src(0,14)	413 ± 42.11	3.96 ± 0.07	7.39 ± 0.82	207.91 ± 27.87
	Src(4,7)	443 ± 40.07	4.14 ± 0.16	14.36 ± 2.27	99.02 ± 8.41
	Src(9,0)	**423 ± 23.52**	**4.21 ± 0.07**	**8.71 ± 1.24**	**137.31 ± 15.42**
	Src(9,14)	426 ± 31.46	4.08 ± 0.04	10.19 ± 0.93	153.77 ± 13.46
Alpha0.5	**Src(0,0)**	**392 ± 11.49**	**4.17 ± 0.02**	**5.15 ± 0.37**	**226.44 ± 34.79**
	Src(0,14)	368 ± 14.66	3.96 ± 0.08	4.85 ± 0.67	316.08 ± 17.68
	Src(4,7)	419 ± 13.6	3.97 ± 0.06	9.11 ± 0.65	148.17 ± 16.5
	Src(9,0)	**426 ± 31.98**	**4.08 ± 0.1**	**6.0 ± 0.5**	**232.51 ± 15.78**
	Src(9,14)	410 ± 51.71	4.05 ± 0.04	7.49 ± 0.66	200.52 ± 12.75
Alpha0.25	**Src(0,0)**	**341 ± 7.55**	**4.14 ± 0.05**	**3.05 ± 0.23**	**396.0 ± 18.19**
	Src(0,14)	333 ± 5.74	3.87 ± 0.03	3.32 ± 0.3	404.58 ± 19.24
	Src(4,7)	400 ± 26.68	4.03 ± 0.09	4.47 ± 0.24	269.8 ± 21.18
	Src(9,0)	**359 ± 32.48**	**4.04 ± 0.04**	**3.88 ± 0.2**	**301.65 ± 30.46**
	Src(9,14)	373 ± 16.79	4.03 ± 0.04	4.64 ± 0.32	288.09 ± 10.16
MaxVar	**Src(0,0)**	**233 ± 4.36**	**4.07 ± 0.02**	**1.82 ± 0.12**	**591.97 ± 11.31**
	Src(0,14)	237 ± 4.47	3.9 ± 0.03	1.85 ± 0.1	589.39 ± 7.57
	Src(4,7)	241 ± 1.41	4.01 ± 0.05	2.04 ± 0.07	594.53 ± 4.32
	Src(9,0)	**235 ± 3.74**	**4.07 ± 0.04**	**1.81 ± 0.09**	**592.34 ± 10.7**
	Src(9,14)	233 ± 3.74	4.06 ± 0.03	1.84 ± 0.11	596.3 ± 5.61
MaxMean	**Src(0,0)**	**451 ± 28.58**	**5.47 ± 1.2**	**13.17 ± 4.77**	**62.97 ± 8.44**
	Src(0,14)	**495 ± 50.08**	**5.29 ± 1**	**10.44 ± 3.45**	**80.98 ± 10.35**
	Src(4,7)	438 ± 32.28	5.3 ± 0.72	24.68 ± 2.81	52.73 ± 2.59
	Src(9,0)	426 ± 26.65	4.48 ± 0.09	19.15 ± 1.68	58.08 ± 8.81
	Src(9,14)	418 ± 35.83	4.3 ± 0.06	17.92 ± 2.68	89.22 ± 14.13
MaxVarMaxMean	**Src(0,0)**	**385 ± 25.63**	**4.14 ± 0.05**	**4.12 ± 0.22**	**226.57 ± 17.21**
	Src(0,14)	367 ± 30.53	3.99 ± 0.05	4.15 ± 0.3	240.89 ± 19.71
	Src(4,7)	390 ± 33.78	4.05 ± 0.05	4.3 ± 0.17	265.15 ± 21.57
	Src(9,0)	**381 ± 30.4**	**4.1 ± 0.07**	**4.17 ± 0.24**	**244.34 ± 30.61**
	Src(9,14)	360 ± 10.34	4.01 ± 0.08	4.27 ± 0.16	274.0 ± 23.08
RW	**Src(0,0)**	**206 ± 7.68**	**4.73 ± 0.09**	**4.41 ± 0.49**	**513.45 ± 5.02**
	Src(0,14)	**208 ± 4.36**	**4.81 ± 0.21**	**4.36 ± 0.48**	**512.87 ± 7.79**
	Src(4,7)	201 ± 4.69	4.11 ± 0.08	6.94 ± 0.66	518.83 ± 2.46
	Src(9,0)	201 ± 4.12	4.89 ± 0.48	4.42 ± 0.88	515.89 ± 4.42
	Src(9,14)	205 ± 6.24	5.32 ± 0.14	3.58 ± 0.45	512.06 ± 6.01

TABLE VI

PERFORMANCE METRICS FOR MULTI-ROBOT DYNAMIC VORONOI PARTITION (DVP) SCENARIOS.

Approach	Source location	Samples	Rmse	Variance	Distance
Alpha0.75	**Src(0,0)**	**440 ± 22.52**	**4.12 ± 0.02**	**8.75 ± 0.99**	**93.36 ± 14.12**
	Src(0,14)	459 ± 37.76	4.14 ± 0.12	10.49 ± 2.04	90.44 ± 16.39
	Src(4,7)	533 ± 44.47	4.05 ± 0.07	11.49 ± 2.64	87.69 ± 13.62
	Src(9,0)	**442 ± 32.88**	**4.13 ± 0.06**	**9.74 ± 1.53**	**90.04 ± 15.02**
	Src(9,14)	443 ± 42.84	4.34 ± 0.21	10.0 ± 1.09	86.46 ± 20.69
Alpha0.5	Src(0,0)	406 ± 40.61	4.17 ± 0.05	8.01 ± 0.81	118.03 ± 11.78
	Src(0,14)	414 ± 31.24	4.07 ± 0.09	8.28 ± 0.38	121.39 ± 14.43
	Src(4,7)	395 ± 37.07	3.98 ± 0.06	8.38 ± 1.18	123.42 ± 9.97
	Src(9,0)	420 ± 46.97	4.08 ± 0.04	7.79 ± 1.19	120.66 ± 13.28
	Src(9,14)	405 ± 33.91	4.18 ± 0.06	7.83 ± 0.91	118.63 ± 7.72
Alpha0.25	**Src(0,0)**	**401 ± 21.75**	**4.14 ± 0.09**	**4.56 ± 0.35**	**201.79 ± 32.02**
	Src(0,14)	370 ± 42	4.02 ± 0.08	4.53 ± 0.37	216.35 ± 20.26
	Src(4,7)	361 ± 27.51	3.97 ± 0.04	3.98 ± 0.28	241.62 ± 21.72
	Src(9,0)	**385 ± 19.05**	**4.11 ± 0.02**	**4.64 ± 0.53**	**214.91 ± 39.74**
	Src(9,14)	393 ± 37.32	4.15 ± 0.06	4.78 ± 0.33	221.14 ± 13.03
MaxVar	Src(0,0)	249 ± 5.92	4.05 ± 0.03	1.72 ± 0.09	564.67 ± 7.72
	Src(0,14)	**242 ± 10.54**	**3.94 ± 0.1**	**1.82 ± 0.28**	**514.68 ± 78.59**
	Src(4,7)	240 ± 17.35	4.0 ± 0.05	2.22 ± 0.27	521.85 ± 54.78
	Src(9,0)	**241 ± 7**	**4.06 ± 0.04**	**1.83 ± 0.13**	**547.96 ± 15.25**
	Src(9,14)	246 ± 5.57	3.98 ± 0.03	1.73 ± 0.13	542.95 ± 18.25
MaxMean	Src(0,0)	457 ± 18.25	4.72 ± 0.41	16.03 ± 2.46	57.65 ± 5.13
	Src(0,14)	**450 ± 18.95**	**4.15 ± 0.1**	**15.3 ± 1.68**	**75.75 ± 6.78**
	Src(4,7)	457 ± 32.82	5.32 ± 0.63	57.51 ± 66.1	48.65 ± 3.88
	Src(9,0)	427 ± 33.2	4.25 ± 0.09	17.42 ± 4.07	63.51 ± 5.8
	Src(9,14)	**430 ± 26.76**	**4.33 ± 0.11**	**14.11 ± 1.05**	**69.14 ± 7.03**
MaxVarMaxMean	**Src(0,0)**	**410 ± 16.76**	**4.15 ± 0.03**	**4.23 ± 0.23**	**226.57 ± 40.15**
	Src(0,14)	400 ± 44.33	3.97 ± 0.07	4.49 ± 0.27	241.57 ± 36.57
	Src(4,7)	389 ± 22.45	4.03 ± 0.09	4.5 ± 0.25	244.56 ± 16.75
	Src(9,0)	**412 ± 37.13**	**4.09 ± 0.07**	**4.18 ± 0.27**	**231.55 ± 15.98**
	Src(9,14)	430 ± 46.38	4.12 ± 0.03	4.31 ± 0.09	225.17 ± 25.66
RW	**Src(0,0)**	**204 ± 9.43**	**4.68 ± 0.07**	**3.18 ± 0.39**	**495.62 ± 27.34**
	Src(0,14)	**204 ± 6.32**	**4.86 ± 0.2**	**2.86 ± 0.22**	**488.74 ± 23.65**
	Src(4,7)	207 ± 11.96	4.03 ± 0.04	5.28 ± 0.35	509.44 ± 21.2
	Src(9,0)	217 ± 18.19	5.0 ± 0.29	3.22 ± 0.57	499.83 ± 13.28
	Src(9,14)	221 ± 36.63	4.7 ± 0.26	4.0 ± 0.81	434.82 ± 144.25

TABLE VII

SUMMARY OF PERFORMANCE METRICS FOR INITIAL FIXED SWEEP SCENARIO WITH N=3.

FS Scenario n=3	Samples	RMSE	Variance	Cumulative Distance
Alpha75	219 ± 4	4.27 ± 0.15	11.23 ± 9.93	93.15 ± 25.59
Alpha50	**207 ± 8.66**	**4.19 ± 0.09**	**13.45 ± 10.97**	**168.33 ± 60.57**
Alpha25	**182 ± 7.42**	**4.13 ± 0.08**	**5.56 ± 0.51**	**365.95 ± 63.34**
MaxVar	153 ± 2	4.18 ± 0.17	2.48 ± 0.33	618.33 ± 16.78
MaxMean	222 ± 0	4.71 ± 0.49	32.09 ± 46.63	78.63 ± 4.9
MaxVarMaxMean	177 ± 15.39	4.24 ± 0.17	4.92 ± 0.97	425.45 ± 115.94
FS	36 ± 1	4.82 ± 0.66	7.12 ± 2.13	68.32 ± 0.64

TABLE VIII

SUMMARY OF PERFORMANCE METRICS FOR INITIAL RANDOM WALK SCENARIO WITH N=3.

RW Scenario n=3	Samples	RMSE	Variance	Cumulative Distance
Alpha75	205 ± 14.66	4.33 ± 0.35	26.27 ± 14.27	175.2 ± 75.87
Alpha50	**194 ± 12.61**	**4.23 ± 0.1**	**16.13 ± 10.27**	**284.8 ± 91.59**
Alpha25	**168 ± 7.68**	**4.11 ± 0.07**	**5.73 ± 0.57**	**494.11 ± 70.57**
MaxVar	145 ± 3.46	4.18 ± 0.1	2.49 ± 0.29	696.28 ± 16.86
MaxMean	226 ± 1	6.06 ± 1.1	37.84 ± 44.57	61.44 ± 4.94
MaxVarMaxMean	170 ± 10.63	4.2 ± 0.11	4.97 ± 0.54	489.65 ± 89.8
RW	150 ± 1	4.45 ± 0.22	3.1 ± 0.94	520.94 ± 6.34

TABLE IX

SUMMARY OF PERFORMANCE METRICS FOR INITIAL FIXED SWEEP SCENARIO WITH N=2.

FS Variants n=2	Samples	Rmse	Variance	Cumulative Distance
Alpha75	220 ± 2.45	4.18 ± 0.13	6.19 ± 2.19	86.51 ± 18.35
Alpha50	**213 ± 6**	**4.16 ± 0.11**	**5.55 ± 1.69**	**127.22 ± 40**
Alpha25	**188 ± 10.05**	**4.04 ± 0.08**	**3.72 ± 0.52**	**310.39 ± 80.73**
MaxVar	151 ± 3.46	4.1 ± 0.1	1.64 ± 0.24	625.17 ± 20.06
MaxMean	221 ± 1.41	4.42 ± 0.42	12.6 ± 35.67	79.09 ± 5.23
MaxVarMaxMean	209 ± 9.54	4.18 ± 0.14	4.37 ± 0.48	177.95 ± 75.3
FS	36 ± 1	4.55 ± 0.47	4.35 ± 1.01	68.16 ± 0.22

TABLE X

SUMMARY OF PERFORMANCE METRICS FOR INITIAL RANDOM WALK SCENARIO WITH N=2.

RW Variants n=2	Samples	Rmse	Variance	Cumulative Distance
Alpha75	214 ± 12.37	4.22 ± 0.2	23.15 ± 55.38	132.64 ± 67.37
Alpha50	**196 ± 15.13**	**4.12 ± 0.13**	**8.89 ± 2.25**	**265.59 ± 109.57**
Alpha25	**170 ± 10.68**	**4.06 ± 0.07**	**3.85 ± 0.41**	**461.55 ± 79.04**
MaxVar	143 ± 4	4.09 ± 0.1	1.7 ± 0.2	711.65 ± 18.14
MaxMean	223 ± 3.87	5.17 ± 1.09	98.82 ± 145.73	78.11 ± 24.49
MaxVarMaxMean	188 ± 16.61	4.12 ± 0.11	4.83 ± 0.58	352.52 ± 120.86
RW	149 ± 1	4.26 ± 0.2	1.9 ± 0.44	521.11 ± 6.45

TABLE XI

SUMMARY OF PERFORMANCE METRICS FOR MULTI-ROBOT FIXED VORONOI PARTITIONING CASES WITH N=3.

FVP Scenario	Samples	RMSE	Variance	Cumulative Distance
Alpha75	426 ± 34.81	4.11 ± 0.12	9.78 ± 2.82	149.12 ± 39.72
Alpha50	**403 ± 35.76**	**4.05 ± 0.1**	**6.52 ± 1.69**	**224.74 ± 58.42**
Alpha25	**361 ± 31.51**	**4.02 ± 0.1**	**3.87 ± 0.68**	**332.02 ± 60.44**
MaxVar	236 ± 5	4.02 ± 0.07	1.87 ± 0.13	592.91 ± 8.69
MaxMean	445 ± 44.78	4.97 ± 0.91	17.07 ± 5.91	68.8 ± 16.94
MaxVarMaxMean	377 ± 29.65	4.06 ± 0.08	4.2 ± 0.23	250.19 ± 28.6
RW	204 ± 6.24	4.77 ± 0.46	4.74 ± 1.3	514.62 ± 5.96

TABLE XII

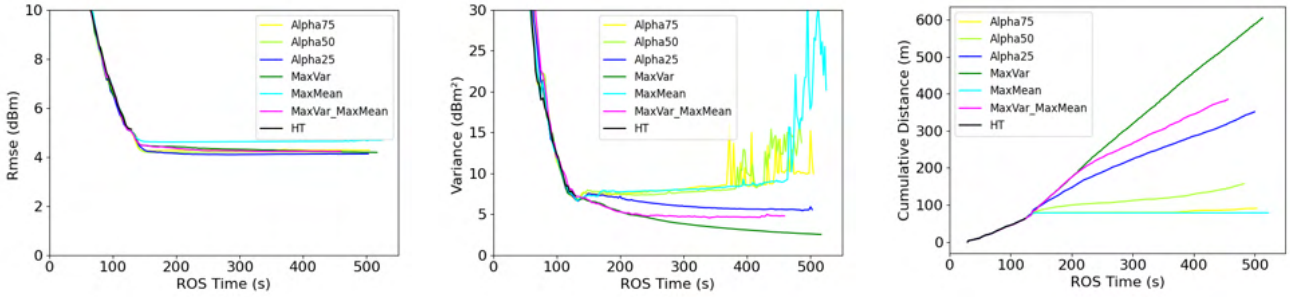
SUMMARY OF PERFORMANCE METRICS FOR MULTI-ROBOT DYNAMIC VORONOI PARTITIONING CASES WITH N=3.

DVP Scenario	Samples	RMSE	Variance	Cumulative Distance
Alpha75	463 ± 51.11	4.16 ± 0.15	10.1 ± 1.98	89.6 ± 16.35
Alpha50	**408 ± 39.29**	**4.1 ± 0.1**	**8.06 ± 0.97**	**120.42 ± 11.84**
Alpha25	**382 ± 34.22**	**4.08 ± 0.1**	**4.5 ± 0.47**	**219.16 ± 29.98**
MaxVar	244 ± 10.72	4.01 ± 0.07	1.86 ± 0.27	538.42 ± 47.83
MaxMean	444 ± 29.83	4.55 ± 0.55	24.08 ± 34.05	62.94 ± 11
MaxVarMaxMean	408 ± 37.96	4.07 ± 0.09	4.34 ± 0.27	233.89 ± 29.84
RW	211 ± 20.95	4.65 ± 0.39	3.71 ± 1.01	485.69 ± 72.39

TABLE XIII

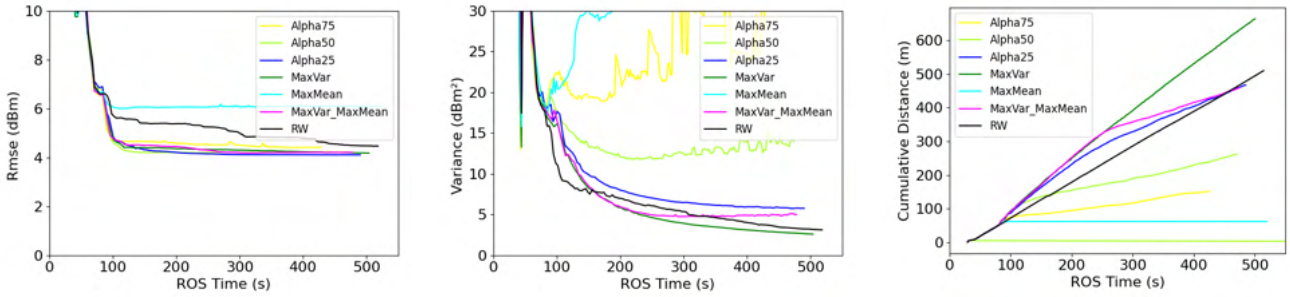
SOURCE LOCALIZATION MEAN ACCURACY (%) BY ALL APPROACHES.

		Samples	Alpha75	Alpha50	Alpha25	MaxVar	MaxMean	MaxVarMaxMean	RW/FS
Singe robot cases	**FS (n=2)**	10	28	24	24	20	20	24	20
		25	32	40	40	40	36	40	36
		35	**84**	72	72	68	68	64	
		45	**88**	**100**	**96**	**88**	**72**	**88**	
		50	88	100	96	100	72	92	
		After half samples	100	100	100	100	72	92	44
		After last sample	100	100	100	100	72	92	76
	FS (n=3)	10	24	32	28	28	32	28	24
		25	40	32	24	40	32	32	28
		35	**84**	68	68	72	68	76	
		45	**100**	**100**	**100**	**92**	**72**	**96**	
		50	100	100	100	92	72	92	
		After half samples	100	100	100	96	72	96	48
		After last sample	100	100	100	100	72	100	68
	RW (n=2)	10	40	32	44	44	32	44	32
		25	**96**	**100**	**100**	**100**	72	**100**	64
		35	**100**	**100**	**100**	**96**	72	**100**	68
		45	100	100	100	100	72	100	68
		50	100	100	96	100	72	100	72
		After half samples	100	100	100	100	72	100	76
		After last sample	100	100	100	100	72	100	100
	RW (n=3)	10	56	48	44	60	52	56	40
		25	**96**	**96**	**96**	**100**	56	**100**	64
		35	**100**	**96**	**96**	**100**	56	**100**	**80**
		45	100	96	100	100	56	100	80
		50	100	100	100	100	56	100	80
		After half samples	100	100	100	100	56	100	80
		After last sample	100	100	100	100	56	100	100
Multi-robot cases	**FVP** (n=3)	10	40	40	32	36	36	48	48
		25	**96**	**100**	**96**	**96**	44	**100**	64
		35	**100**	**100**	**100**	**100**	56	**100**	64
		45	100	100	100	100	64	96	60
		50	100	100	100	100	64	96	60
		After half sample	100	100	100	100	76	100	60
		After last sample	100	100	100	100	76	100	60
	DVP (n=3)	10	36	40	28	32	32	40	48
		25	**100**	**100**	**100**	**92**	56	**88**	56
		35	**100**	**100**	**100**	**96**	76	**100**	56
		45	100	100	100	96	88	100	60
		50	100	100	100	96	92	100	60
		After half samples	100	100	100	100	96	100	60
		After last sample	100	100	100	100	96	100	68



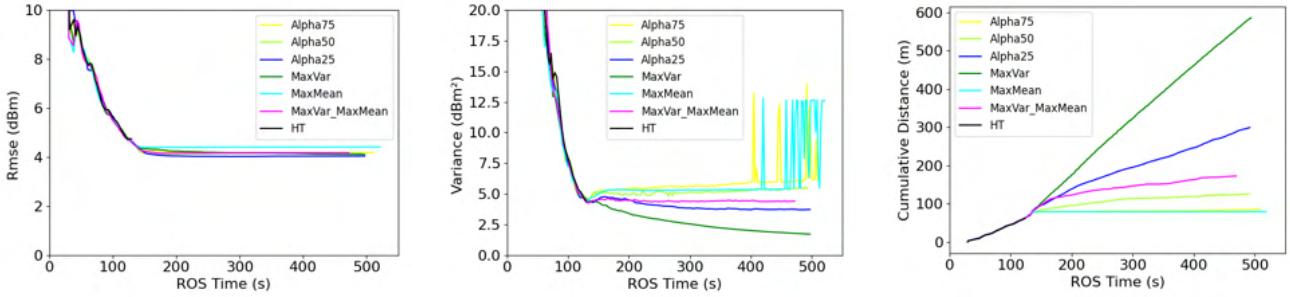
(a) RMSE (b) Variance (c) Cumulative Distance

Fig. 1. RMSE, Variance and Cumulative Distance for Fixed Sweep Variants for n=3.



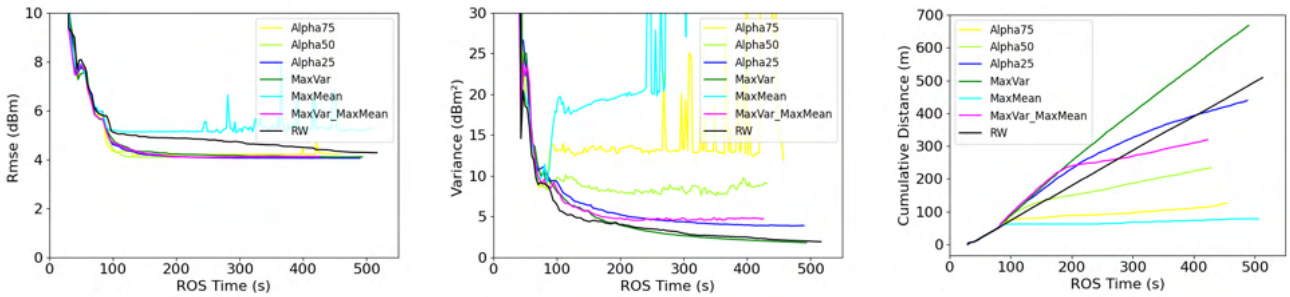
(a) RMSE (b) Variance (c) Cumulative Distance

Fig. 2. RMSE, Variance and Cumulative Distance for Random Walk Variants for n=3.



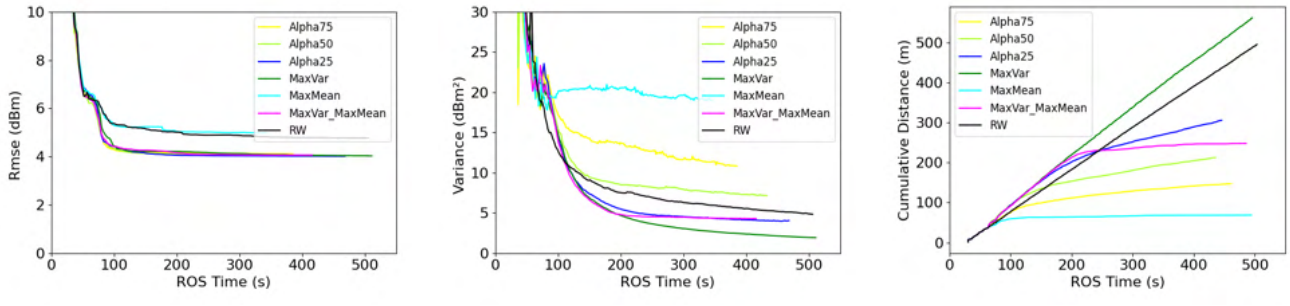
(a) RMSE (b) Variance (c) Cumulative Distance

Fig. 3. RMSE, Variance and Cumulative Distance for Hector Variants and n=2.



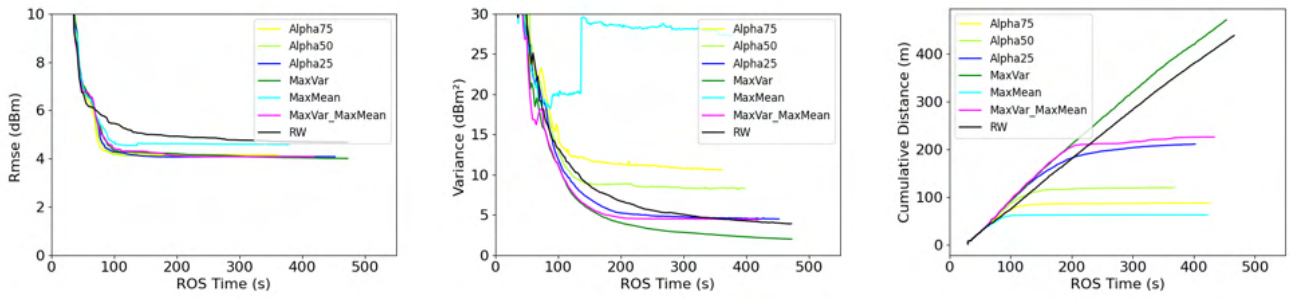
(a) RMSE (b) Variance (c) Cumulative Distance

Fig. 4. RMSE, Variance and Cumulative Distance for Random Walk Variants n=2.



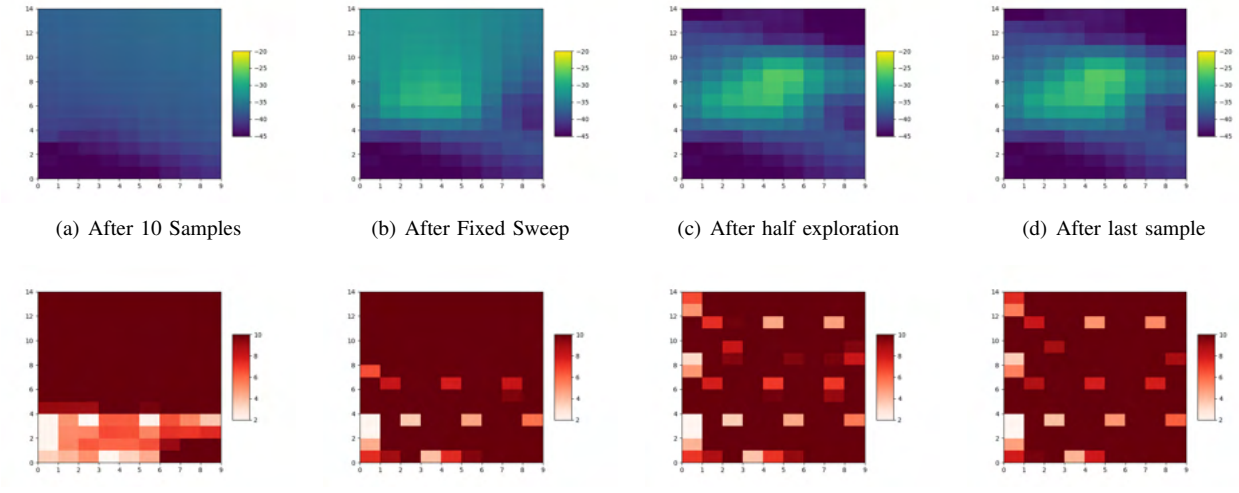
(a) RMSE (b) Variance (c) Cumulative Distance

Fig. 5. RMSE, Variance and Cumulative Distance for Multi-Robots in Fixed Voronoi Partitioning.



(a) RMSE (b) Variance (c) Cumulative Distance

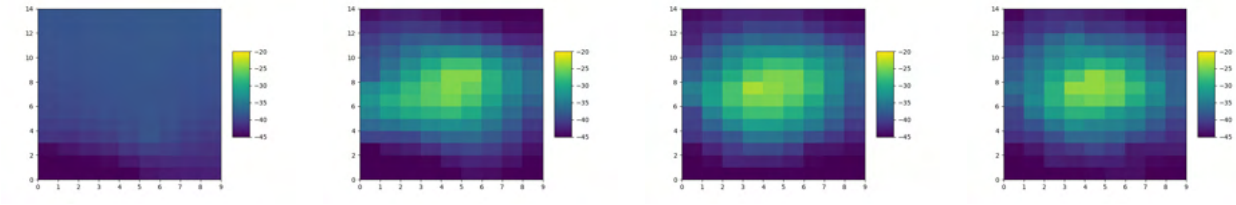
Fig. 6. RMSE, Var and Cumulative Distance for Multi-Robots in Dynamic Voronoi Partitioning.



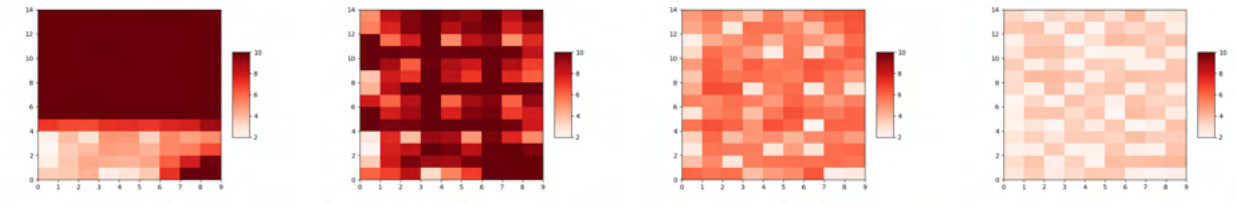
(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 7. Mean and Variance for Fixed Sweep Baseline and Source location (4,7).

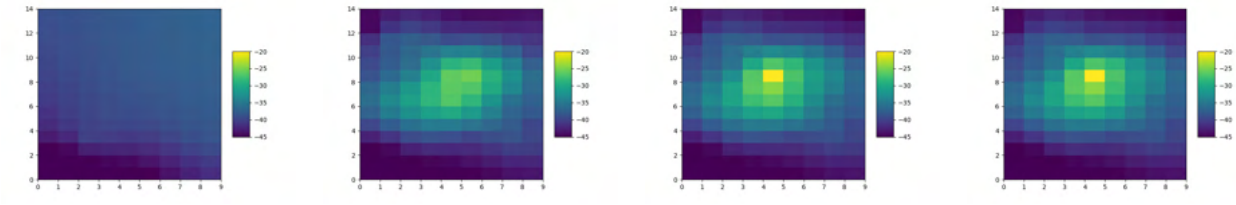


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

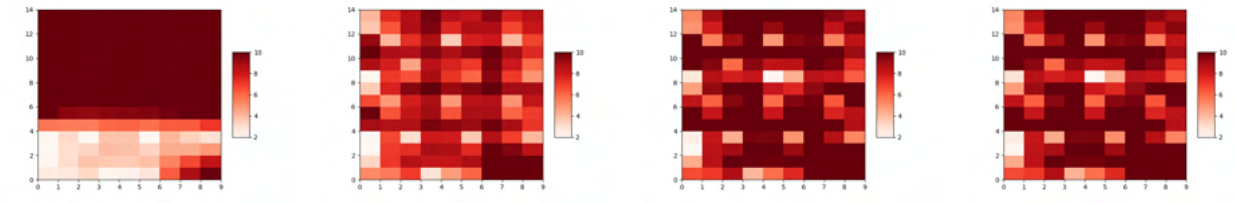


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 8. Fixed Sweep Scenario - Mean and Variance for MaxVar Approach and Source location (4,7)

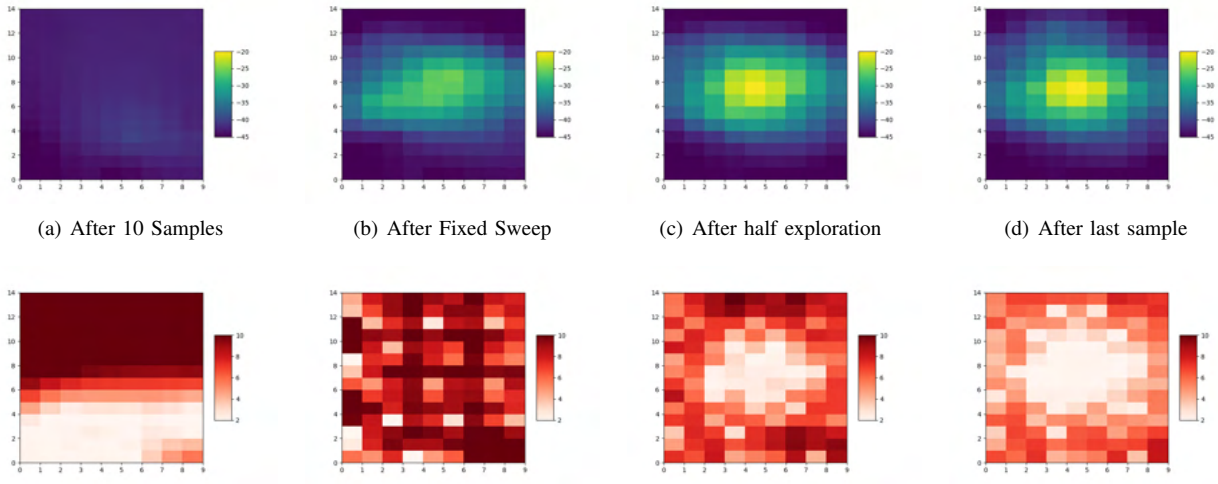


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample



(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

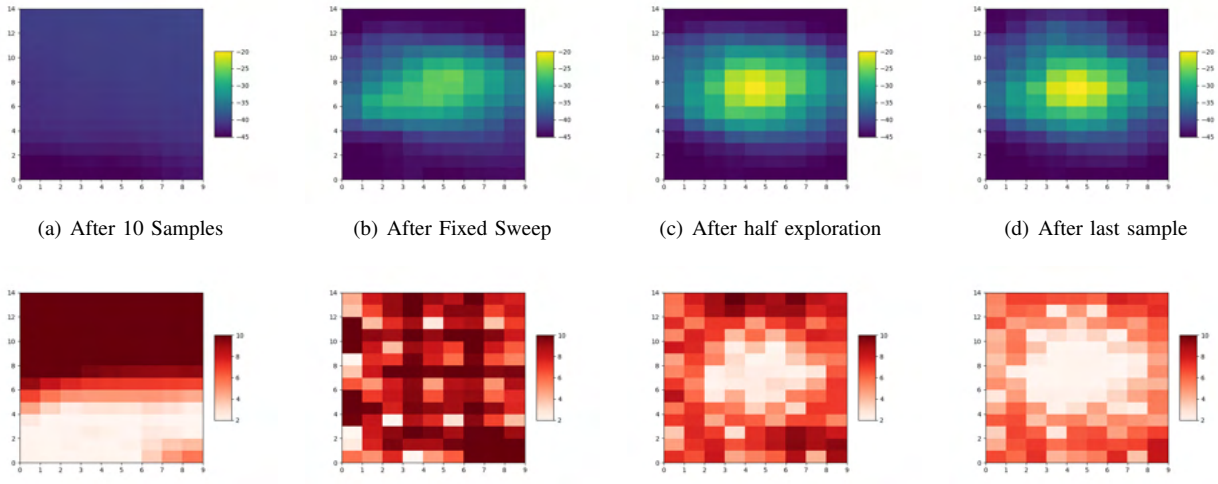
Fig. 9. Fixed Sweep Scenario - Mean and Variance for MaxMean Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

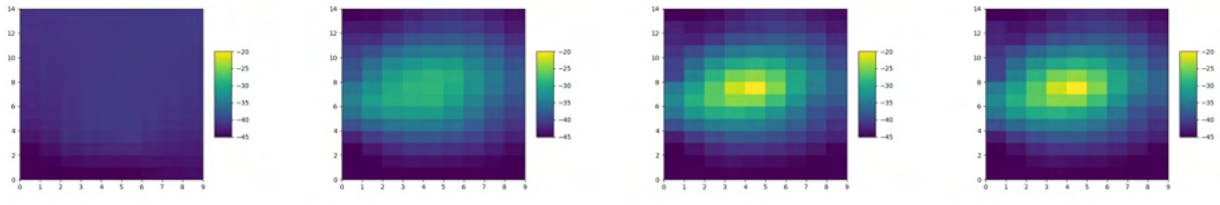
Fig. 10. Fixed Sweep Scenario - Mean and Variance for Alpha0.25 Approach and Source location (4,7)



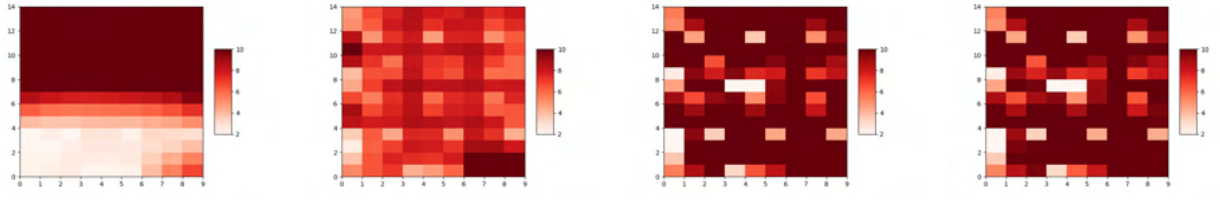
(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 11. Fixed Sweep Scenario - Mean and Variance for Alpha0.5 Approach and Source location (4,7)

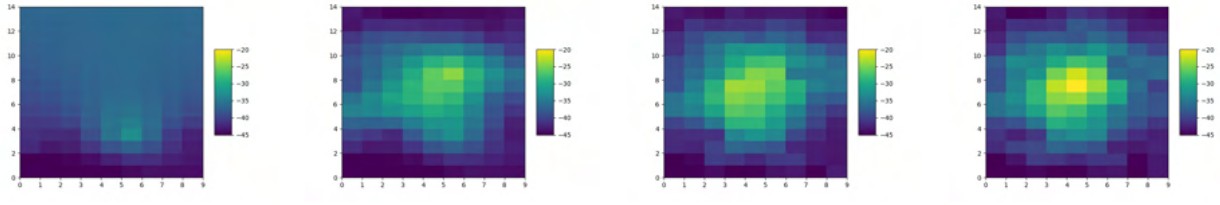


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

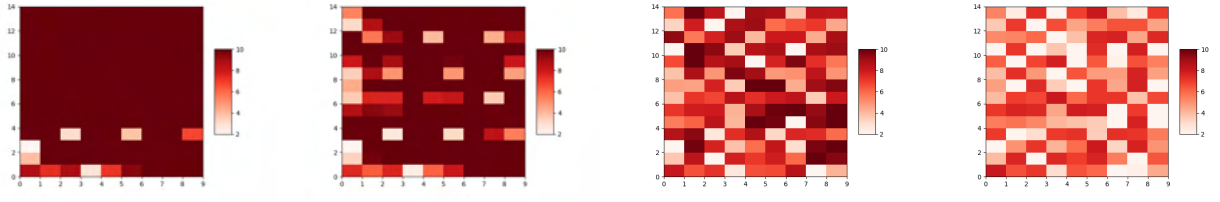


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 12. Fixed Sweep Scenario - Mean and Variance for Alpha0.75 Approach and Source location (4,7)

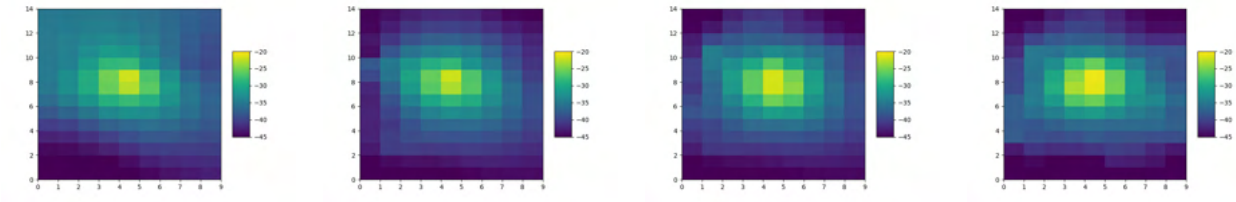


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

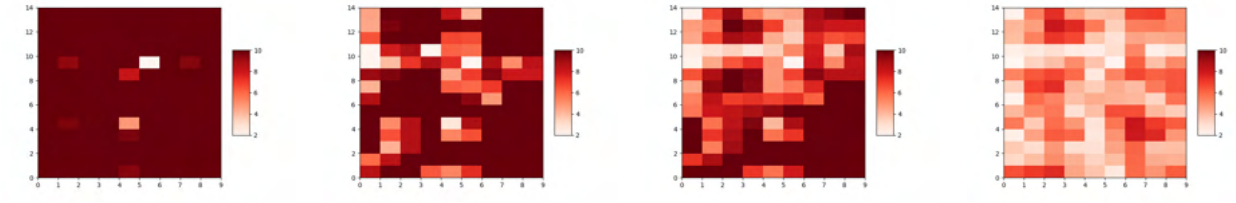


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 13. Fixed Sweep Scenario - Mean and Variance for MaxVarMaxMean Approach and Source location (4,7)

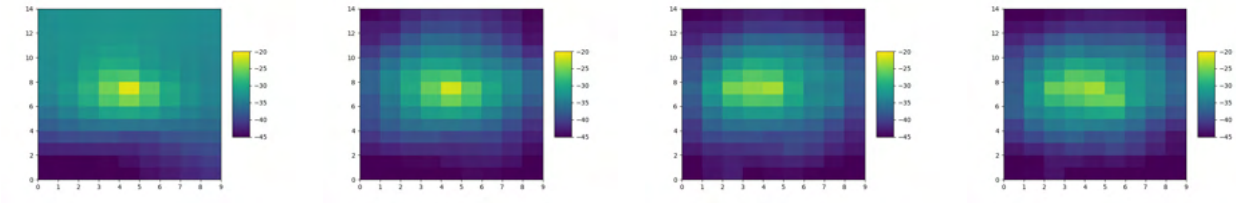


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

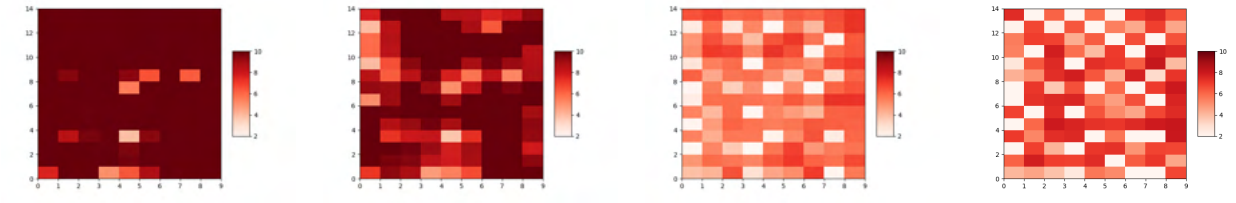


(e) After 10 Samples (f) After Fixed Sweep Equivalent (g) After half exploration (h) After last sample

Fig. 14. Mean and Variance for Random Walk Baseline and Source location (4,7).

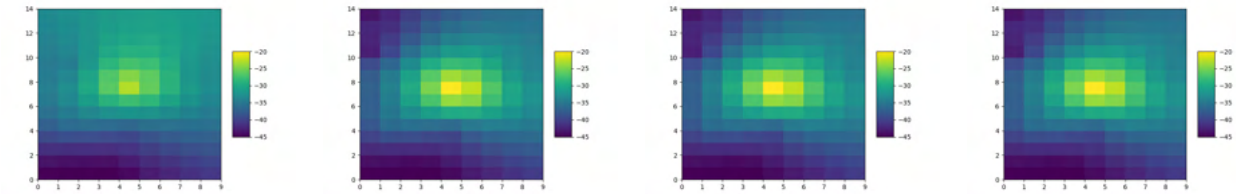


(a) After 10 Samples (b) After Fixed Sweep Equivalent Samples (c) After half exploration (d) After last sample

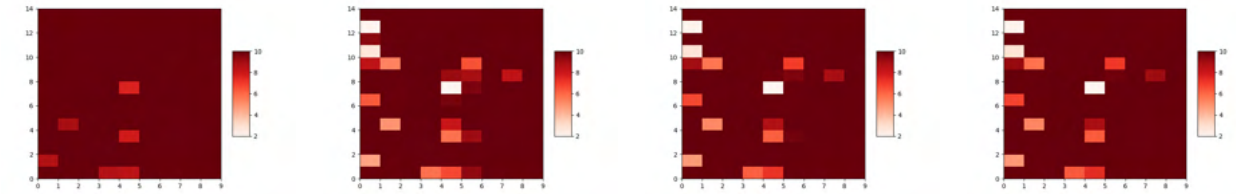


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 15. Random Walk Scenario - Mean and Variance for MaxVar Approach and Source location (4,7)

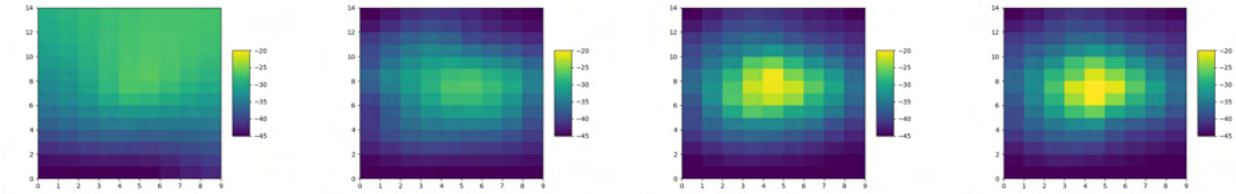


(a) After 10 Samples (b) After Fixed Sweep Equivalent Samples (c) After half exploration (d) After last sample

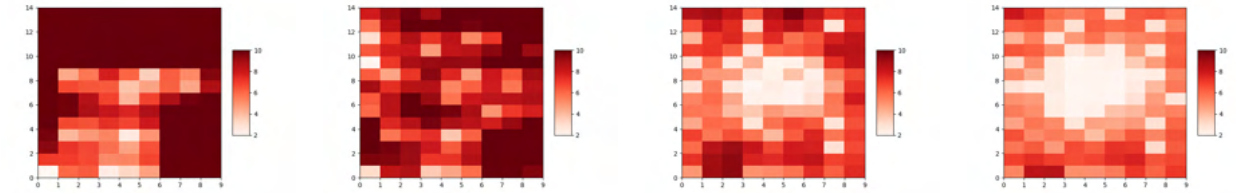


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 16. Random Walk Scenario - Mean and Variance for MaxMean Approach and Source location (4,7)

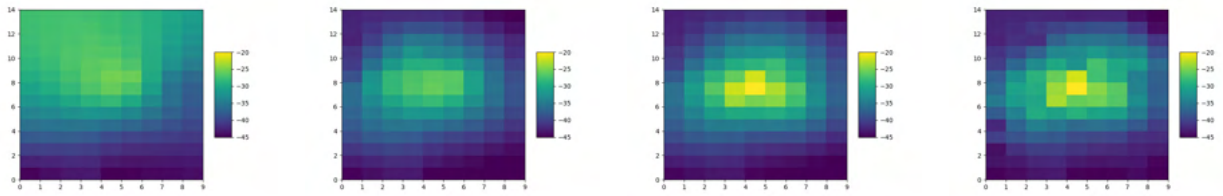


(a) After 10 Samples (b) After Fixed Sweep Equivalent Samples (c) After half exploration (d) After last sample

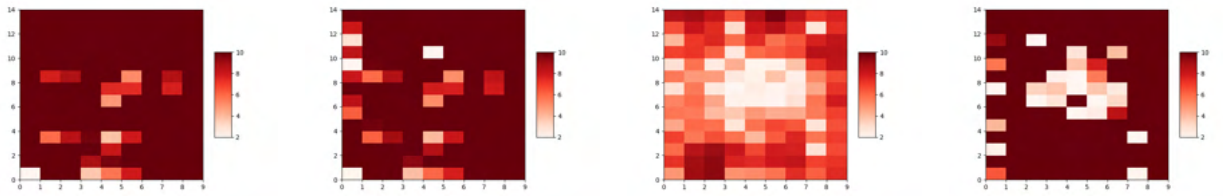


(e) After 10 Samples (f) After Fixed Sweep Equivalent Samples (g) After half exploration (h) After last sample

Fig. 17. Random Walk Scenario - Mean and Variance for Alpha0.25 Approach and Source location (4,7)

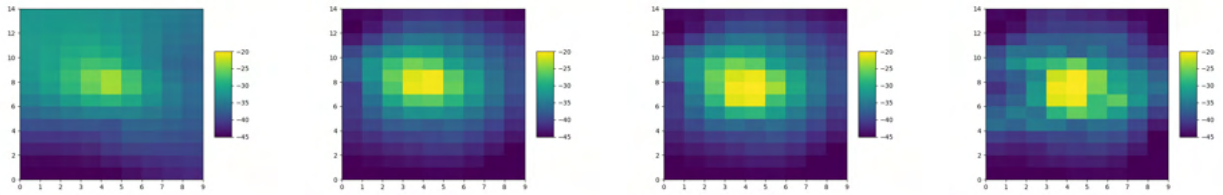


(a) After 10 Samples (b) After Fixed Sweep Equivalent Samples (c) After half exploration (d) After last sample

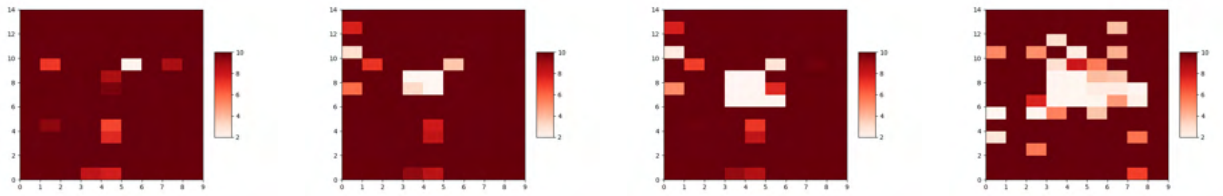


(e) After 10 Samples (f) After Fixed Sweep Equivalent Samples (g) After half exploration (h) After last sample

Fig. 18. Random Walk Scenario - Mean and Variance for Alpha 0.5 Approach and Source location (4,7)

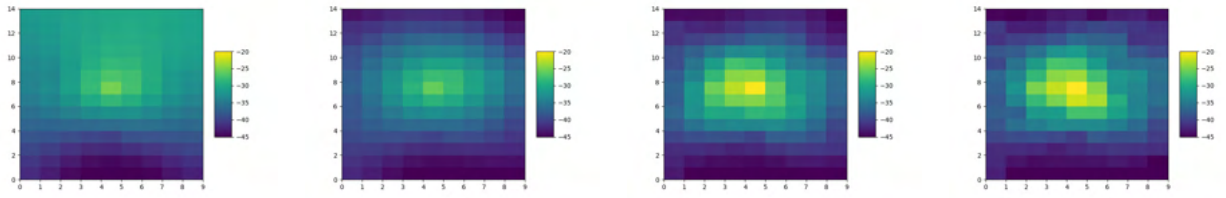


(a) After 10 Samples (b) After Fixed Sweep Equivalent Samples (c) After half exploration (d) After last sample

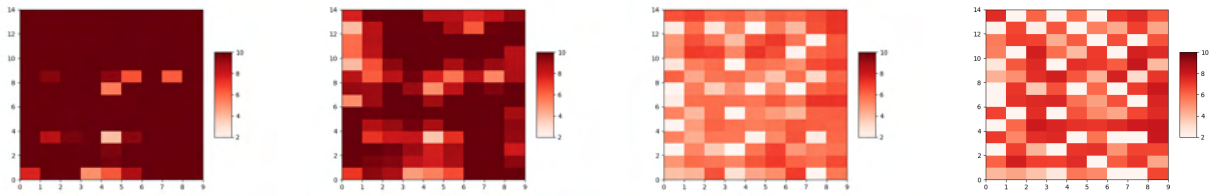


(e) After 10 Samples (f) After Fixed Sweep Equivalent Samples (g) After half exploration (h) After last sample

Fig. 19. Random Walk Scenario - Mean and Variance for Alpha0.75 Approach and Source location (4,7)

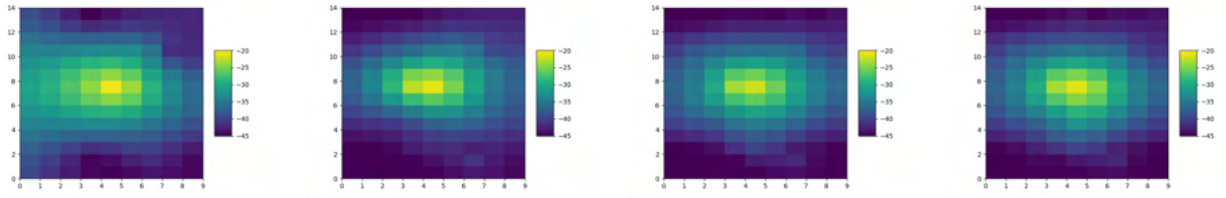


(a) After 10 Samples (b) After Fixed Sweep Equivalent Samples (c) After half exploration (d) After last sample

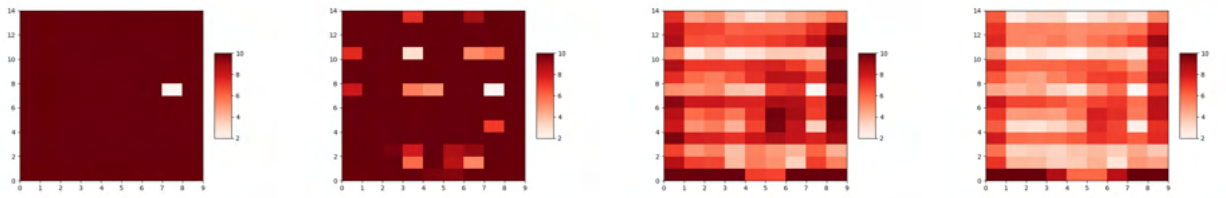


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 20. Random Walk Scenario - Mean and Variance for MaxVarMaxMean Approach and Source location (4,7)

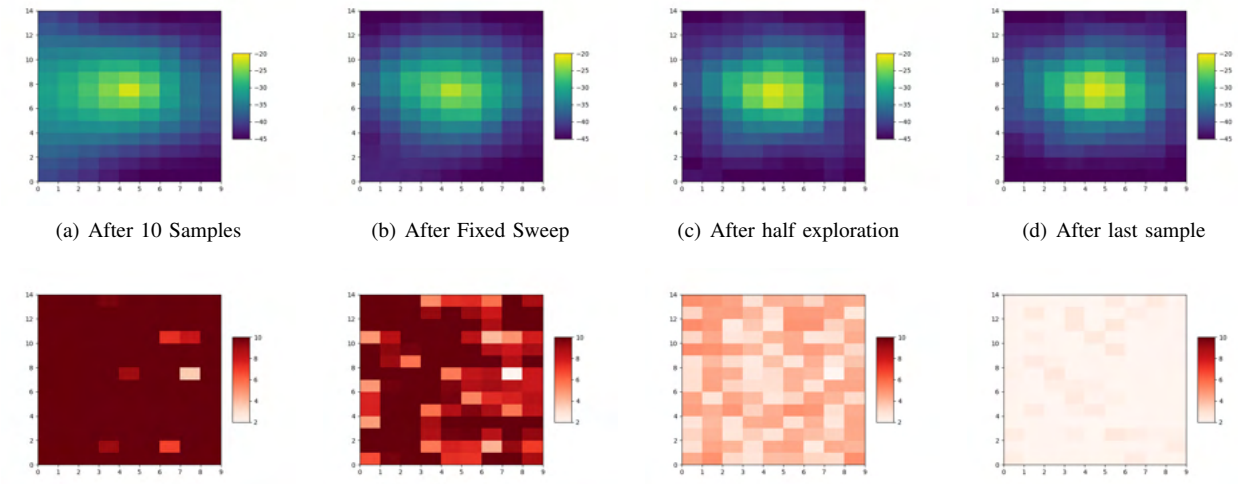


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample



(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

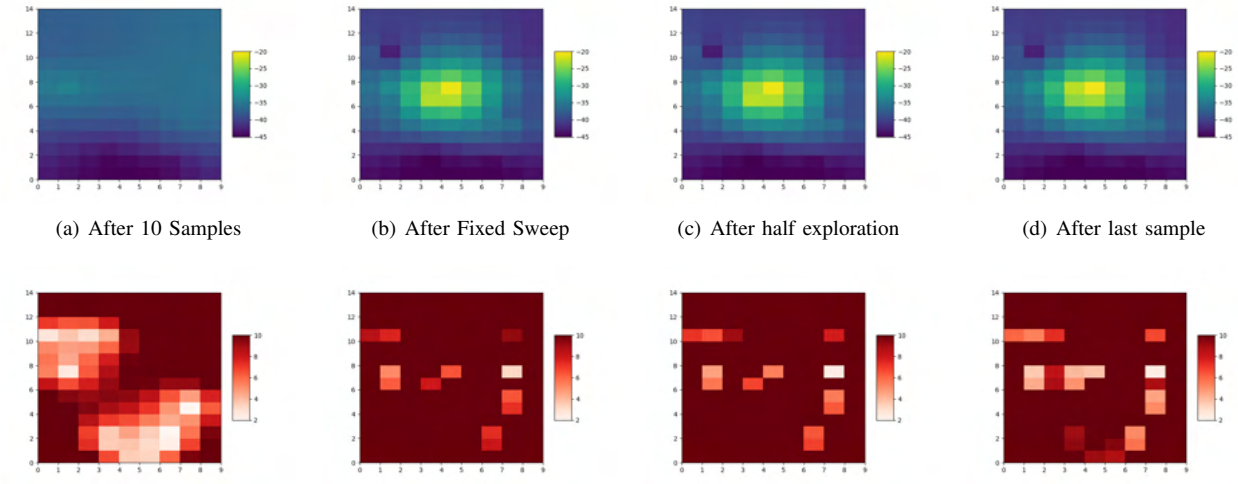
Fig. 21. Fixed Voronoi Partition - Mean and Variance for Random Walk Baseline and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

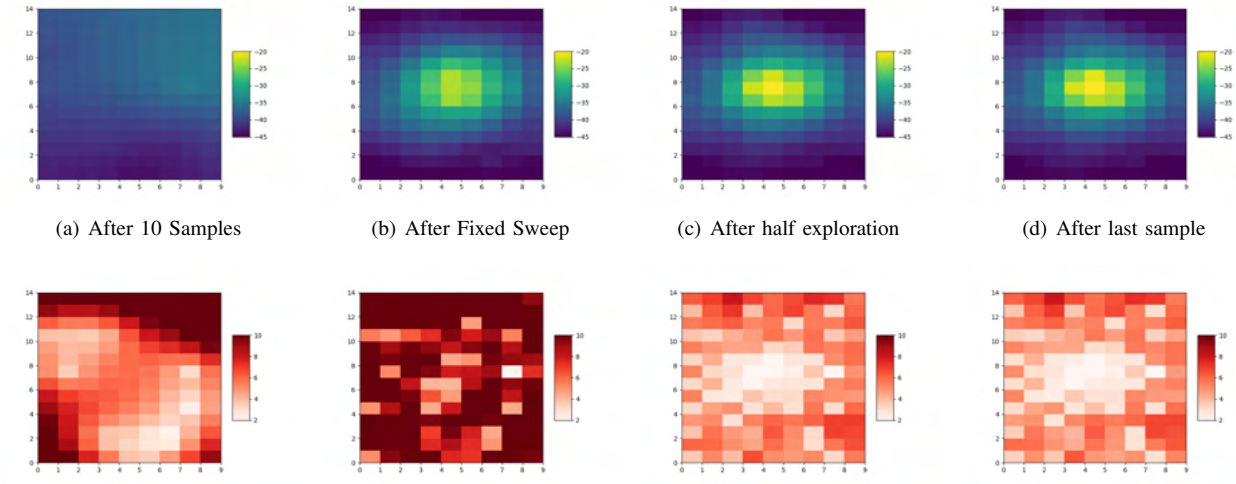
Fig. 22. Fixed Voronoi Partition - Mean and Variance for MaxVar Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

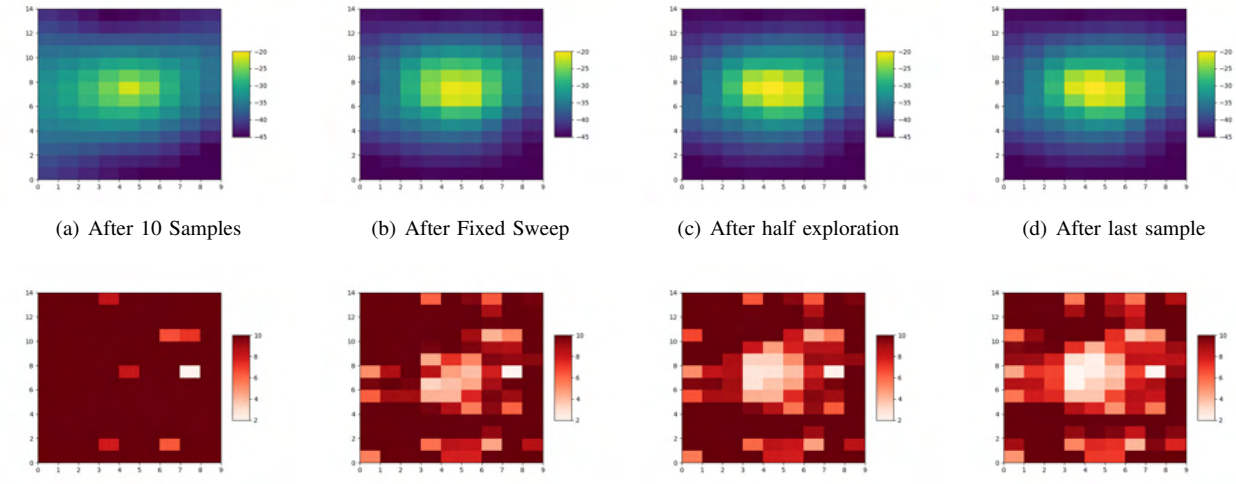
Fig. 23. Fixed Voronoi Partition - Mean and Variance for MaxMean Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

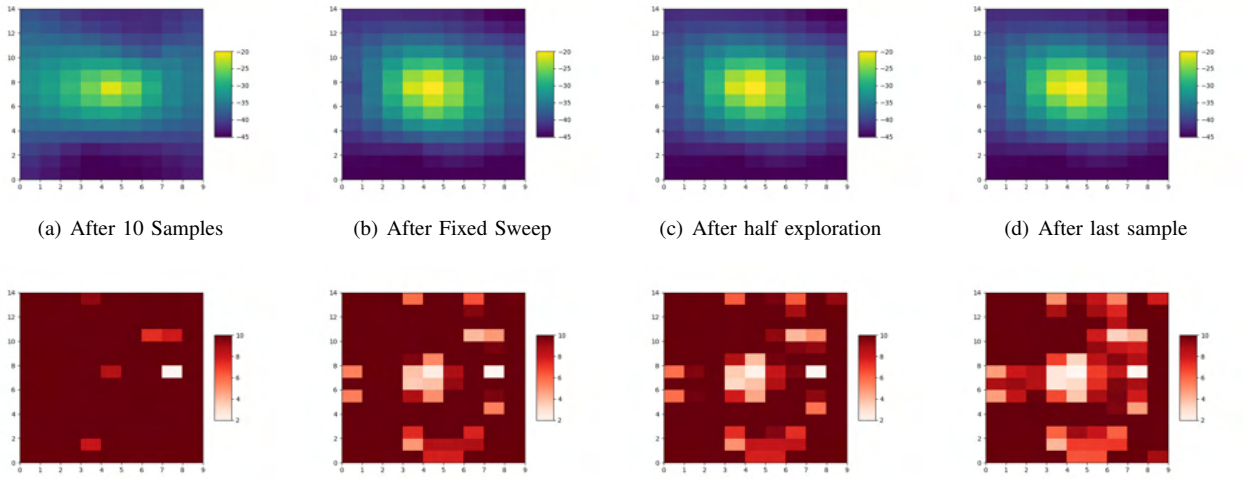
Fig. 24. Fixed Voronoi Partition - Mean and Variance for Alpha0.25 Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

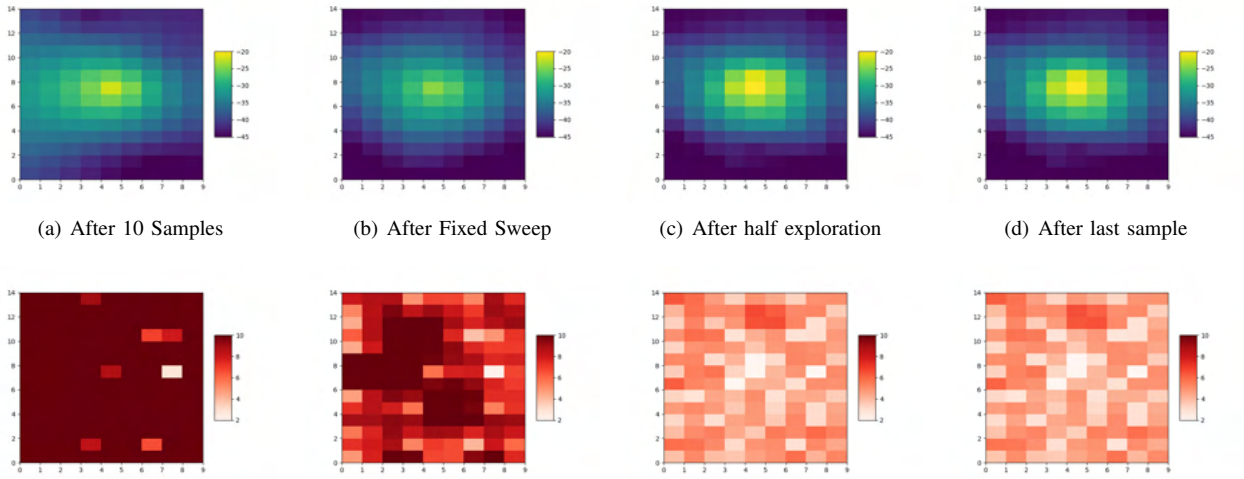
Fig. 25. Fixed Voronoi Partition - Mean and Variance for Alpha0.5 Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

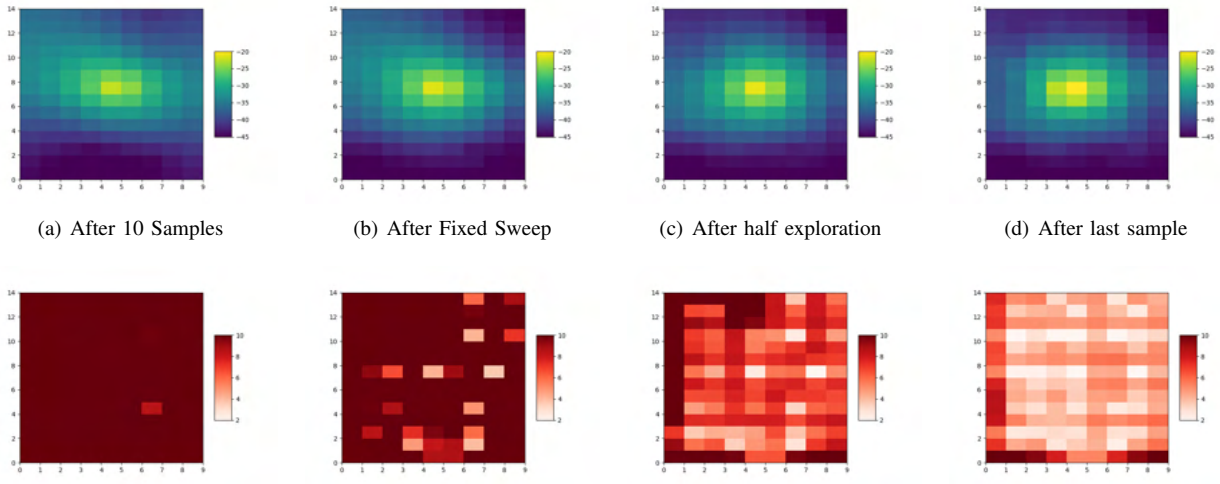
Fig. 26. Fixed Voronoi Partition - Mean and Variance for Alpha0.75 Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

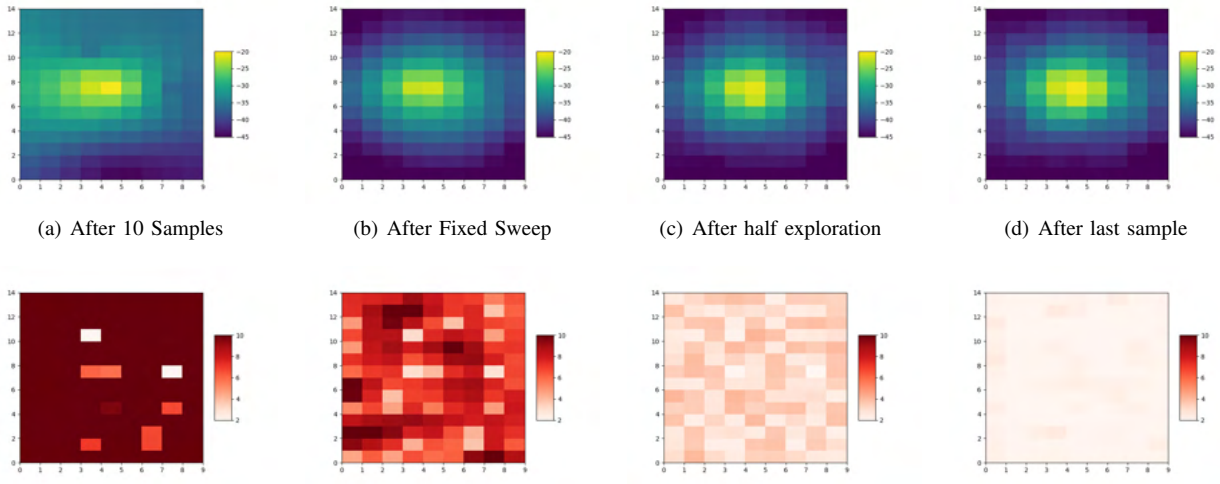
Fig. 27. Fixed Voronoi Partition - Mean and Variance for MaxVarMaxMean Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

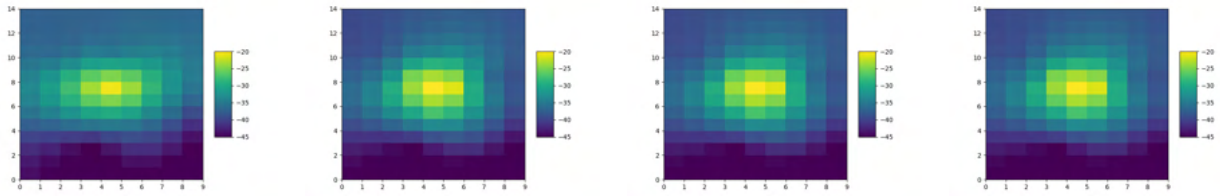
Fig. 28. Dynamic Voronoi Partition - Mean and Variance for Random Walk Baseline and Source location (4,7)



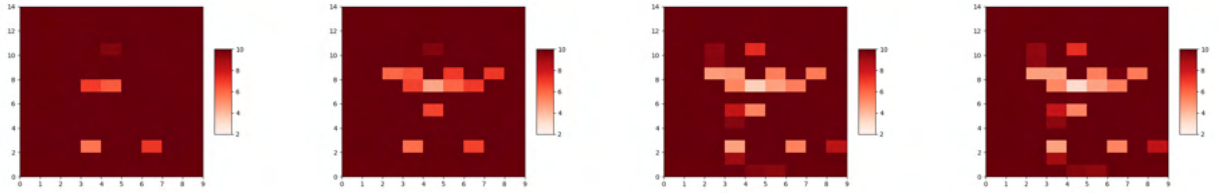
(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 29. Dynamic Voronoi Partition - Mean and Variance for MaxVar Approach and Source location (4,7)

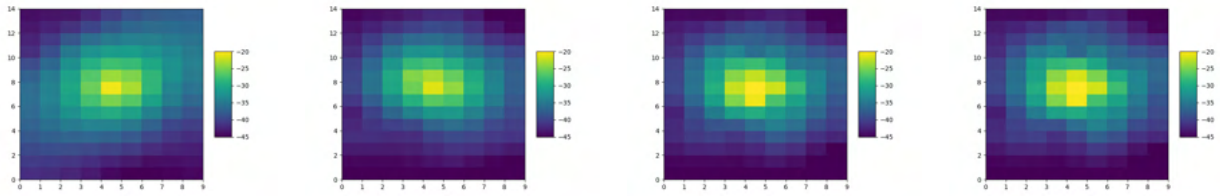


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

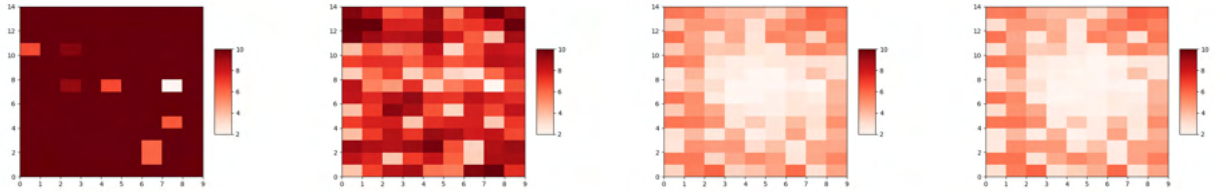


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 30. Dynamic Voronoi Partition - Mean and Variance for MaxMean Approach and Source location (4,7)

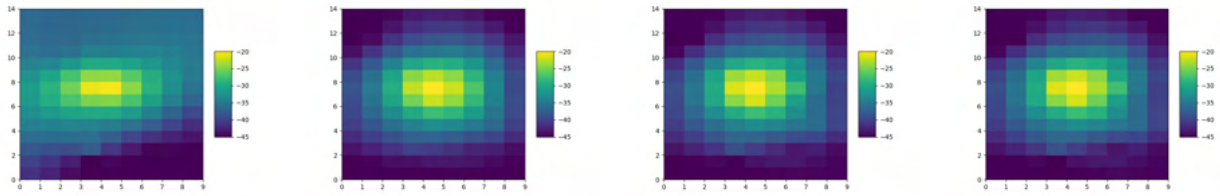


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

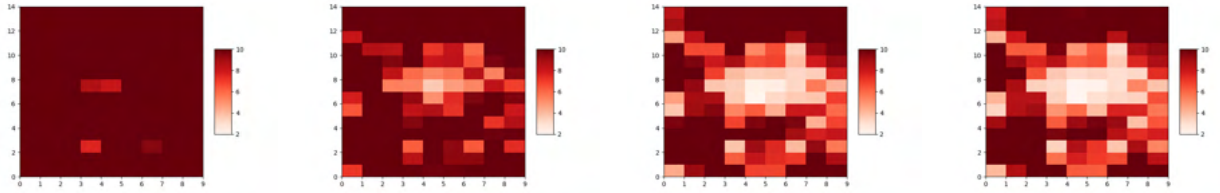


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 31. Dynamic Voronoi Partition - Mean and Variance for Alpha0.25 Approach and Source location (4,7)

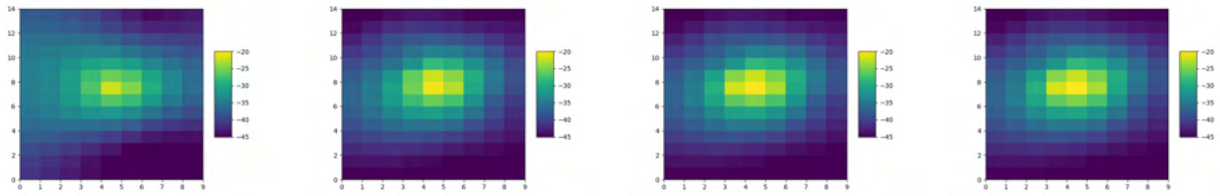


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

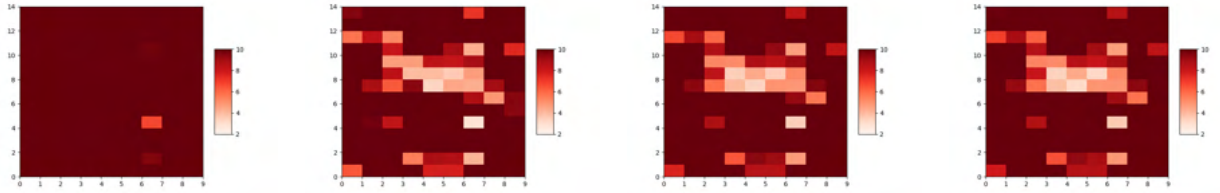


(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 32. Dynamic Voronoi Partition - Mean and Variance for Alpha0.5 Approach and Source location (4,7)

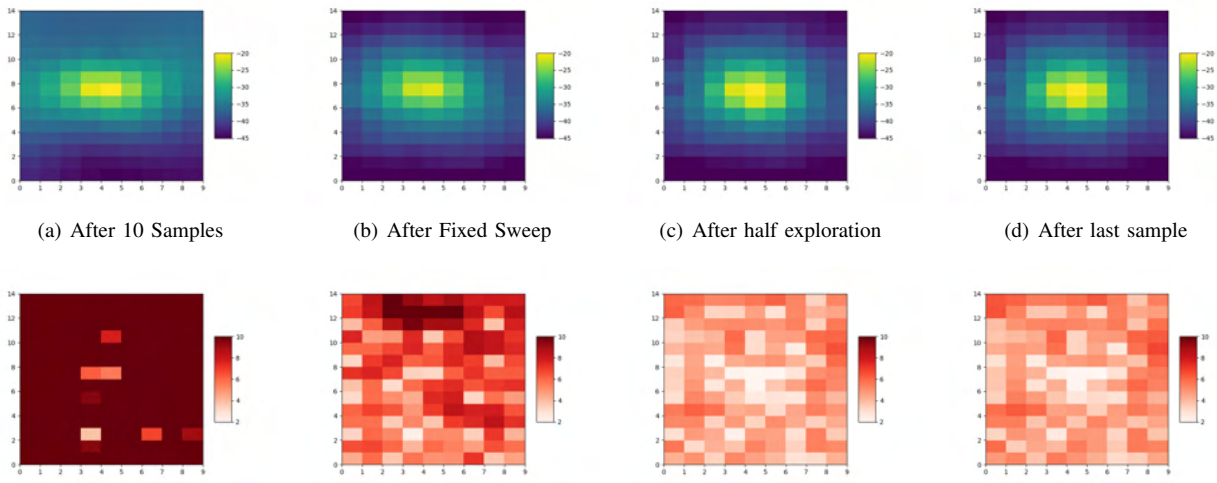


(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample



(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 33. Dynamic Voronoi Partition - Mean and Variance for Alpha0.75 Approach and Source location (4,7)



(a) After 10 Samples (b) After Fixed Sweep (c) After half exploration (d) After last sample

(e) After 10 Samples (f) After Fixed Sweep (g) After half exploration (h) After last sample

Fig. 34. Dynamic Voronoi Partition - Mean and Variance for MaxVarMaxMean Approach and Source location (4,7)