

Comparison of SMDP and Intra-Option Q-Learning in Taxi-v3 Domain

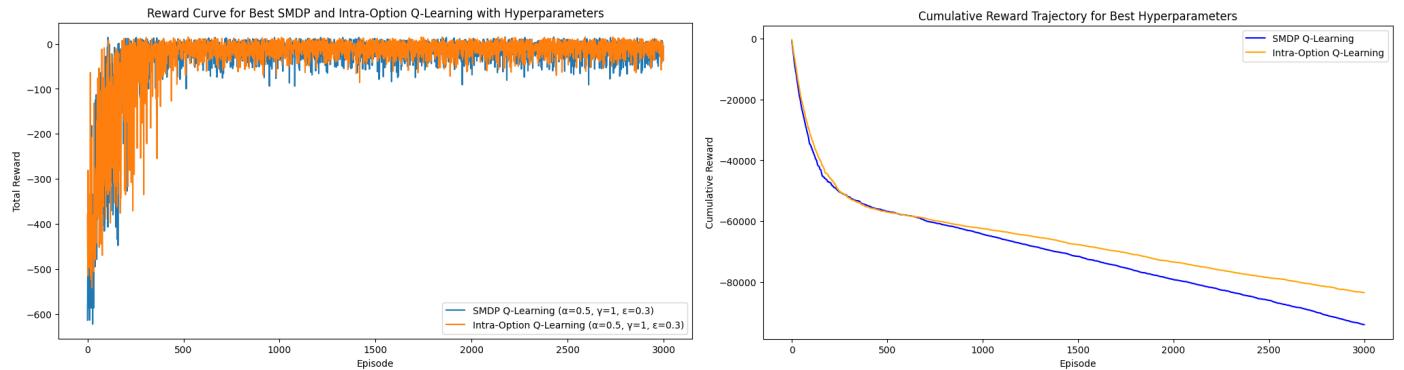
The task involved implementing 1-step Semi-Markov Decision Process (SMDP) Q-learning and Intra-option Q-learning in the Taxi-v3 environment. This environment simulates a grid where a taxi picks up and drops off passengers at designated locations. The goal is to maximize the total reward by efficiently navigating the environment and learning the best policy to achieve this.

Hyperparameter tuning

The performance of both algorithms was evaluated using different values for the hyperparameters:

- **Alpha (Learning Rate):** 0.1, 0.2, 0.5
- **Gamma (Discount Factor):** 0.9, 0.99, 1 (Used gamma values other than 0.9 for analysis)
- **Epsilon (Exploration Rate):** 0.1, 0.2, 0.3

Analysis of Reward Performance

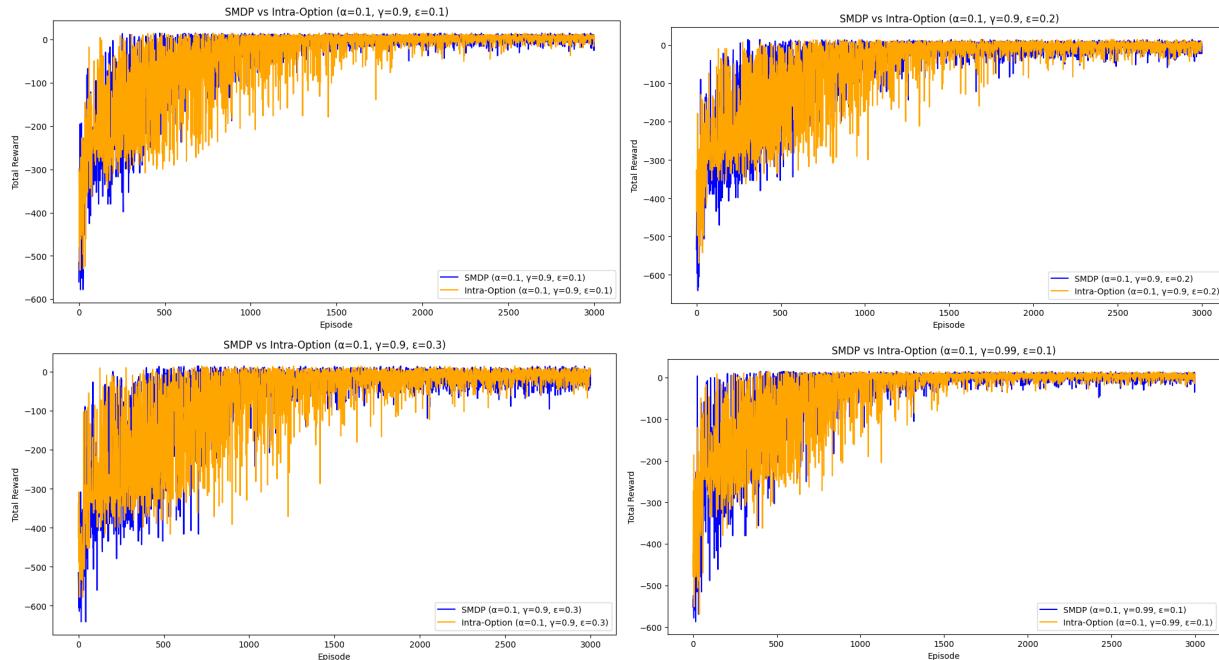


The reward curves plot the total reward as a function of episodes for both algorithms. The key findings from the data are summarized below:

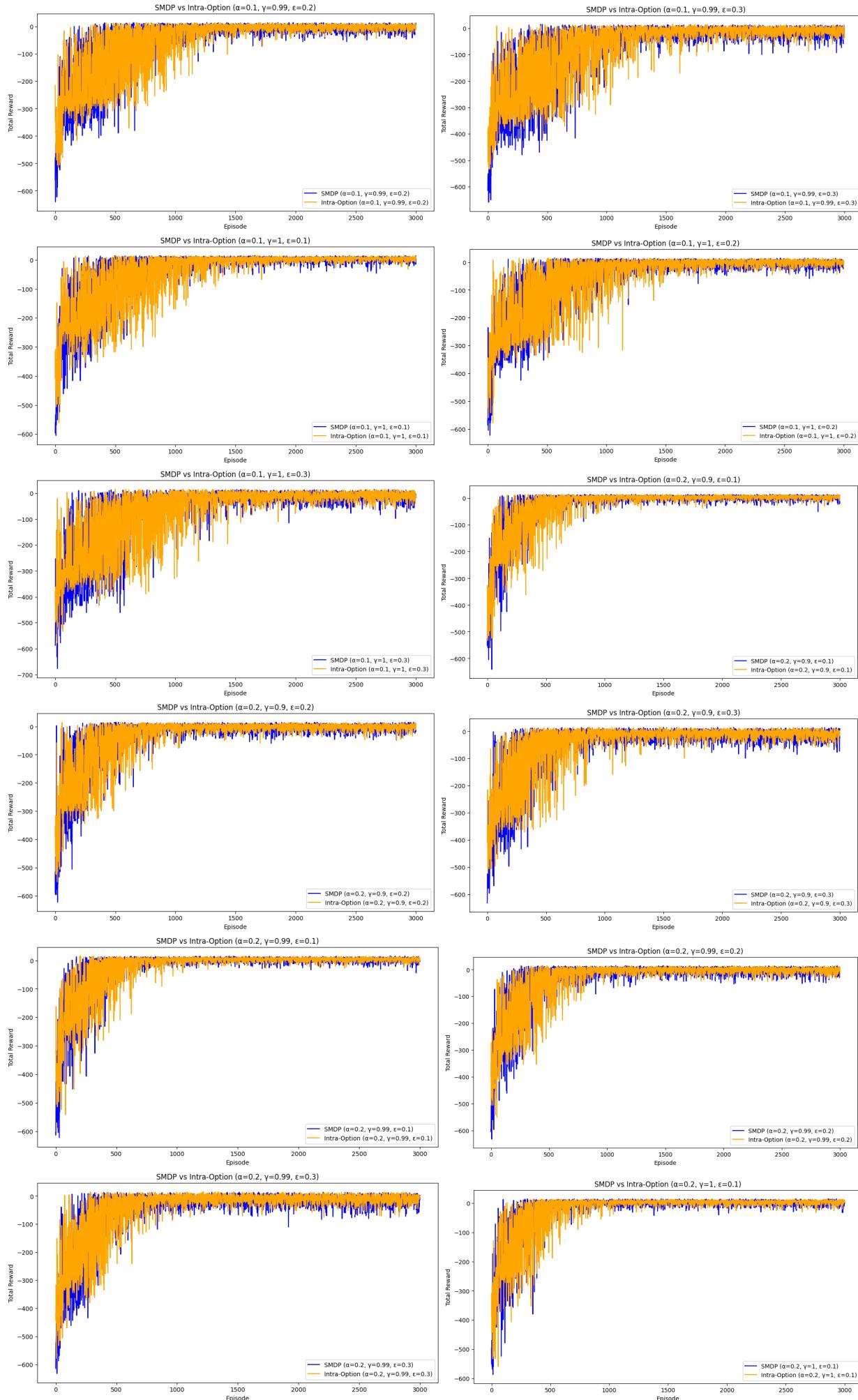
Initial Convergence: Both algorithms show rapid improvement in the first 500 episodes, with the Intra-option Q-learning slightly outperforming SMDP Q-learning in terms of initial convergence speed.

Stability: After around 1,500 episodes, both curves stabilize, oscillating around similar performance levels. Intra-option Q-learning has more consistent performance and fewer oscillations in the reward curves, showing that it handles exploration more effectively.

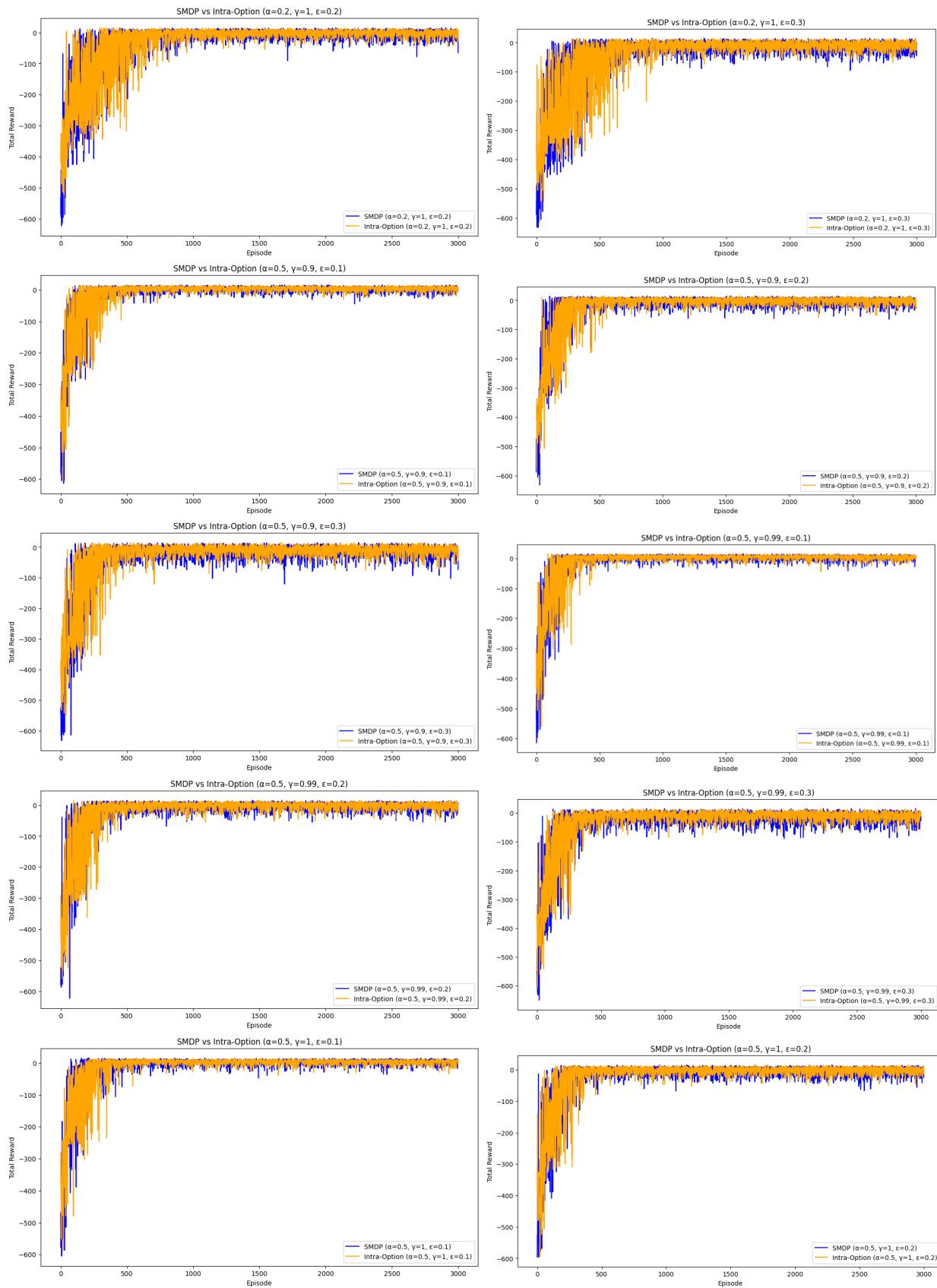
SMDP vs Intra-option Q-learning reward curve for same hyperparameter



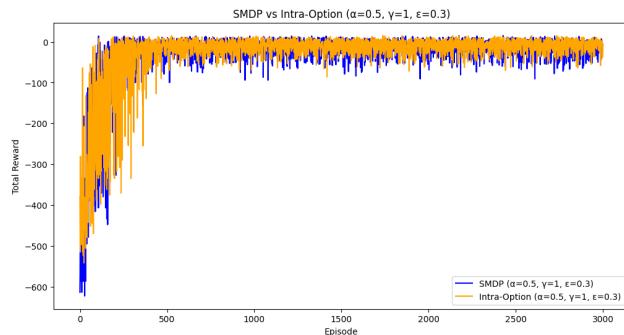
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The table below compares the performance of SMDP Q-learning and Intra-option Q-learning based on the hyperparameters:

- **Average Reward:** Mean rewards in last 100 episodes.
- **Best Reward:** Highest reward achieved in last 100 episodes during training.

Alpha	Gamma	Epsilon	SMDP		Intra-options	
			Avg Reward	Best Reward	Avg Reward	Best Reward
0.1	0.9	0.1	2.65	15	3.56	13
0.1	0.9	0.2	-2.2	15	-2.74	12
0.1	0.9	0.3	-10.78	15	-10.51	12
0.1	0.99	0.1	2.48	13	2.04	14
0.1	0.99	0.2	-4.81	13	-1.02	14
0.1	0.99	0.3	-17.47	13	-9.83	14
0.1	1	0.1	2.64	15	3.81	15
0.1	1	0.2	-6.16	14	-1.07	14
0.1	1	0.3	-15.78	12	-10.48	12
0.2	0.9	0.1	1.96	13	4.21	15
0.2	0.9	0.2	-2.44	15	-1.62	13
0.2	0.9	0.3	-12.92	14	-11.54	10
0.2	0.99	0.1	0.66	14	3.67	14
0.2	0.99	0.2	-4.04	15	-3.35	15
0.2	0.99	0.3	-13.83	12	-9.28	11
0.2	1	0.1	1.55	15	3.9	14
0.2	1	0.2	-6.88	15	-2.35	14
0.2	1	0.3	-17.02	13	-9.18	15
0.5	0.9	0.1	2.62	15	2.66	15
0.5	0.9	0.2	-5.04	14	-2.31	14
0.5	0.9	0.3	-16.02	12	-9.07	12
0.5	0.99	0.1	2.9	13	3.63	14
0.5	0.99	0.2	-6.97	14	-2.79	14
0.5	0.99	0.3	-19.52	15	-10.74	10
0.5	1	0.1	3.04	14	2.99	12
0.5	1	0.2	-6.9	14	-3.98	12
0.5	1	0.3	-15.38	11	-9.41	11

Key takeaways from the data and reward curves:

- **Higher Alpha:** As the learning rate increases both algorithms tend to achieve higher best rewards.
- **Intra-option Q-learning performs better** on average when compared to SMDP for similar hyperparameters. For instance, for $\alpha = 0.1$, $\gamma = 1$, $\epsilon = 0.1$, Intra-option Q-learning achieved an average reward of **3.81**, which is higher than SMDP value that is **2.64**.
- **Epsilon Variation:** Higher epsilon values lead to decreased performance for both algorithms, likely due to excessive exploration.

Policy Insights

The algorithms were tasked with learning how to:

- Efficiently move the taxi to the passenger's location.
- Pick up the passenger and navigate to the destination.
- Drop off the passenger.

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SMDP Q-learning: The learned policy tends to be more rigid, as it sticks to options until completion, which can slow down the discovery of better paths in some episodes.

Intra-option Q-learning: This algorithm leverages intra-options, which allow switching between options mid-execution based on better choices discovered during the episode. This flexibility enables it to find more optimal policies faster, as seen in the reward curves and the performance data.

Comparison Between SMDP and Intra-option Q-Learning

From the experiments, we can conclude:

Intra-option Q-learning shows faster convergence and better average performance across a variety of hyperparameters.

The flexibility of intra-options allows for more efficient policy exploration, which explains the observed improvement.

While both algorithms stabilize around similar reward levels, intra-option Q-learning achieves more consistent results with less fluctuation.

Conclusion

In summary, while both SMDP Q-learning and Intra-option Q-learning can solve the taxi problem, Intra-option Q-learning is superior in terms of learning speed and stability. Its ability to adapt during the execution of options provides a significant advantage, particularly when exploration plays a critical role in learning the optimal policy.

**Adding Best hyperparameters Q-values with heatmap of SMDP and Intra-option Q-learning here:
SMDP: (Please refer to python notebook for complete image)**

Q-Values for Best SMDP Q-Learning

0 -	0.00	0.00	0.00	0.00	0.00	0.00
1 -	9.00	10.00	9.00	10.00	11.00	1.00
2 -	13.00	14.00	12.71	14.00	15.00	5.00
3 -	10.00	11.00	10.00	11.00	12.00	2.00
4 -	3.00	-5.74	-7.97	-6.39	-17.90	-18.51
5 -	0.00	0.00	0.00	0.00	0.00	0.00
6 -	3.00	-9.82	-9.63	-0.89	-12.51	-12.71
7 -	-7.16	-1.18	6.00	-7.07	-15.89	-10.00
8 -	10.97	-5.95	1.09	5.55	-11.59	-11.02
9 -	6.99	-7.70	-7.63	-7.50	-11.35	-14.29
10 -	0.00	0.00	0.00	0.00	0.00	0.00
11 -	-8.15	-3.87	5.97	-8.26	-6.16	-13.22
12 -	5.00	-2.69	-3.52	2.02	-5.88	-6.41
13 -	6.96	-6.50	0.14	-1.04	-13.06	-10.79
14 -	5.00	0.37	1.25	-9.54	-15.19	-17.35
15 -	0.00	0.00	0.00	0.00	0.00	0.00
16 -	18.00	19.00	18.00	19.00	10.00	20.00
17 -	12.00	11.00	11.90	10.97	2.00	10.00
18 -	16.00	15.00	13.77	15.00	6.00	14.00
19 -	13.00	12.00	13.00	12.00	3.00	11.00
20 -	0.00	0.00	0.00	0.00	0.00	0.00
21 -	-6.54	1.44	5.17	10.00	-11.20	-11.88
22 -	3.88	10.81	10.61	14.00	2.15	-9.75
23 -	1.57	1.96	5.96	11.00	-1.00	0.09
24 -	-10.72	-5.11	-11.38	1.97	-16.45	-15.00
25 -	0.00	0.00	0.00	0.00	0.00	0.00
26 -	-9.65	-1.94	-9.78	1.90	-16.33	-12.25
27 -	7.00	2.59	-7.50	1.72	-4.62	-10.00
28 -	9.99	1.25	1.32	2.01	-10.00	-9.29
29 -	5.34	-2.77	-8.07	-7.44	-9.23	-15.27
30 -	0.00	0.00	0.00	0.00	0.00	0.00
31 -	7.00	-8.03	-1.13	-4.01	-3.44	-6.21
32 -	-9.16	-9.33	-9.33	3.67	-15.65	-15.19
33 -	8.00	3.64	6.75	-1.46	-3.18	-4.48
34 -	5.93	-4.42	-8.88	-2.57	-10.04	-16.69
35 -	0.00	0.00	0.00	0.00	0.00	0.00
36 -	16.99	17.41	17.85	19.00	8.56	8.96
37 -	12.99	-4.23	6.63	9.05	-2.20	-2.06
38 -	12.83	1.46	-2.77	14.97	-9.89	-7.75
39 -	14.00	11.86	8.63	7.71	-1.16	-5.00
40 -	0.00	0.00	0.00	0.00	0.00	0.00
41 -	5.00	1.28	0.80	-2.67	-10.99	-10.65
42 -	9.00	-7.45	-0.26	0.16	-13.16	-4.36
43 -	-9.04	-8.82	3.94	-9.00	-10.27	-7.31
44 -	-7.24	-1.23	9.00	4.31	-1.86	-1.23
45 -	0.00	0.00	0.00	0.00	0.00	0.00
46 -	7.00	7.94	9.00	8.00	-1.00	-1.00
47 -	-3.95	3.48	12.00	3.40	-12.29	-10.09
48 -	8.92	-7.25	-7.68	5.20	-6.16	-12.58
49 -	5.00	0.67	1.35	-9.13	-16.94	-16.79
50 -	0.00	0.00	0.00	0.00	0.00	0.00
51 -	6.00	-10.20	-10.25	-2.60	-11.03	-8.05
52 -	-0.84	-8.78	6.99	-8.66	-16.72	-9.01
53 -	8.98	5.38	-4.19	4.90	-3.75	-8.18
54 -	-7.08	-7.27	7.00	2.63	-13.15	-9.54
55 -	0.00	0.00	0.00	0.00	0.00	0.00
56 -	14.00	10.86	11.36	8.83	1.03	3.92
57 -	7.50	10.97	17.96	-1.38	0.91	-5.00
58 -	13.98	-3.50	1.35	4.73	-4.17	-1.04
59 -	10.86	-1.88	-2.59	1.75	-5.00	-5.00
60 -	0.00	0.00	0.00	0.00	0.00	0.00
61 -	2.92	-9.92	-1.35	4.00	-12.29	-7.93
62 -	8.00	5.11	3.11	2.01	-11.13	-5.42
63 -	5.00	-2.55	-0.16	-3.74	-17.79	-7.87
64 -	6.72	8.98	10.00	7.75	-0.32	-0.22
65 -	0.00	0.00	0.00	0.00	0.00	0.00
66 -	8.00	8.94	10.00	8.00	-0.00	-0.02
67 -	9.10	11.03	13.00	8.87	2.92	1.50
68 -	8.00	6.07	-1.35	-7.53	-15.55	-8.84
69 -	4.00	-9.35	-1.75	-2.70	-6.91	-13.02
70 -	0.00	0.00	0.00	0.00	0.00	0.00
71 -	4.99	-10.38	-4.54	-2.66	-11.77	-18.00
72 -	8.00	3.11	-3.67	-2.30	-11.91	-16.19
73 -	-5.05	0.62	7.96	-3.58	-12.80	-11.77
74 -	8.00	4.07	2.56	5.67	-5.66	-3.61
75 -	0.00	0.00	0.00	0.00	0.00	0.00
76 -	4.33	10.28	3.20	13.00	2.68	1.93
77 -	16.72	17.93	19.00	16.25	8.74	8.95
78 -	13.00	-4.25	-4.11	-4.04	-11.55	-8.43

77 -	16.72	17.93	19.00	16.25	8.74	8.95
78 -	13.00	-4.25	-4.11	-4.09	-11.55	-8.43
79 -	8.50	-2.50	14.00	-2.16	-8.09	-4.54
80 -	0.00	0.00	0.00	0.00	0.00	0.00
81 -	-4.55	-9.53	-9.76	2.98	-13.07	-16.54
82 -	-7.91	2.42	-1.10	6.95	-15.88	-13.29
83 -	0.39	-9.50	-9.29	4.00	-8.78	-14.35
84 -	9.00	10.00	9.97	8.96	11.00	1.00
85 -	0.00	0.00	0.00	0.00	0.00	0.00
86 -	9.00	10.00	10.00	9.00	11.00	1.00
87 -	12.00	13.00	13.00	12.00	14.00	4.00
88 -	-1.59	8.23	-1.24	6.84	-14.64	5.91
89 -	-10.06	-5.63	10.44	2.97	-12.11	-16.76
90 -	0.00	0.00	0.00	0.00	0.00	0.00
91 -	3.94	-10.77	10.88	-10.62	-15.75	-18.16
92 -	6.99	2.14	1.61	-8.59	-16.82	-7.08
93 -	9.00	1.52	1.50	0.61	-5.00	-3.73
94 -	1.14	-1.19	-6.98	6.98	-5.89	-13.02
95 -	0.00	0.00	0.00	0.00	0.00	0.00
96 -	12.00	11.00	11.00	11.97	2.00	10.00
97 -	18.00	19.00	19.00	18.00	10.00	20.00
98 -	12.00	10.99	11.00	12.00	2.00	10.00
99 -	15.00	14.00	14.00	12.93	4.99	12.99
100 -	0.00	0.00	0.00	0.00	0.00	0.00
101 -	8.00	10.00	7.99	9.00	-0.00	-0.01
102 -	10.95	14.00	12.00	13.00	4.00	4.00
103 -	8.99	11.00	9.00	10.00	1.00	1.00
104 -	4.00	-1.16	2.99	-9.32	-7.34	-12.54
105 -	0.00	0.00	0.00	0.00	0.00	0.00
106 -	4.00	-4.39	-9.62	-0.02	-8.41	-13.81
107 -	7.00	-6.71	-6.73	-1.90	-5.84	-14.62
108 -	12.00	1.05	9.05	9.95	0.15	-0.63
109 -	8.00	4.25	5.59	5.26	-3.00	-2.24
110 -	0.00	0.00	0.00	0.00	0.00	0.00
111 -	9.00	1.04	3.19	4.03	-8.27	-4.72
112 -	6.00	0.63	-9.16	-0.04	-13.45	-7.00
113 -	4.16	-2.23	8.00	3.54	-12.05	-7.51
114 -	6.00	1.14	-2.02	1.43	-10.36	-9.02
115 -	0.00	0.00	0.00	0.00	0.00	0.00
116 -	17.00	19.00	17.00	18.00	9.00	9.00
117 -	13.00	11.00	13.00	12.00	2.98	3.00
118 -	17.00	15.00	15.00	16.00	7.00	7.00
119 -	14.00	12.00	14.00	13.00	3.97	4.00
120 -	0.00	0.00	0.00	0.00	0.00	0.00
121 -	7.00	8.95	7.99	9.00	-1.06	-1.00
122 -	7.09	13.00	3.62	11.91	-0.14	-0.92
123 -	7.94	9.93	9.00	10.00	-0.00	-0.01
124 -	5.00	-4.89	10.37	10.05	-12.07	-11.66
125 -	0.00	0.00	0.00	0.00	0.00	0.00
126 -	5.00	-9.42	-2.63	-3.19	-7.90	-8.19
127 -	8.00	5.30	0.07	4.33	-4.77	-2.37
128 -	6.86	6.96	-5.84	11.00	-2.77	-8.69
129 -	-0.33	-0.11	4.34	7.00	-9.64	-4.94
130 -	0.00	0.00	0.00	0.00	0.00	0.00
131 -	8.00	-6.16	3.22	0.01	-3.56	-2.17
132 -	7.00	-9.00	3.84	0.04	-15.14	-13.74
133 -	9.00	5.83	4.54	6.56	-3.31	-7.46
134 -	7.00	-8.69	2.34	-1.96	-9.11	-9.17
135 -	0.00	0.00	0.00	0.00	0.00	0.00
136 -	14.91	18.00	16.96	16.80	3.72	8.00
137 -	14.00	7.46	8.32	11.50	-5.70	3.44
138 -	16.00	8.67	13.94	11.49	5.66	2.44
139 -	15.00	13.00	14.00	13.00	5.00	5.00
140 -	0.00	0.00	0.00	0.00	0.00	0.00
141 -	6.00	-9.12	-2.92	4.82	-5.11	-10.43
142 -	10.00	0.57	0.43	5.02	-3.53	-3.74
143 -	7.00	-2.78	0.65	-1.16	-14.01	-10.27
144 -	-8.30	8.00	4.07	2.40	-12.65	-13.12
145 -	0.00	0.00	0.00	0.00	0.00	0.00
146 -	6.00	8.00	7.95	7.00	-2.00	-2.01
147 -	2.09	11.00	3.24	2.82	-4.92	-0.30
148 -	10.00	0.08	-6.79	4.00	-10.58	-6.28
149 -	6.00	3.90	3.88	1.55	-4.05	-6.64
150 -	0.00	0.00	0.00	0.00	0.00	0.00
151 -	7.00	4.85	4.77	5.99	-9.80	-9.31
152 -	8					

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Sales	Actions	1	2	3	4	5	
165 - 0.00	0.00	0.00	0.00	0.00	0.00	0.00	
166 - 4.61	9.00	7.11	3.54	-2.65	-1.80		
167 - 2.77	12.00	8.50	5.99	-1.68	-1.07		
168 - 9.00	3.51	5.90	6.75	-1.12	-1.19		
169 - 3.10	1.96	-10.01	5.00	-6.47	-5.56		
170 - 0.00	0.00	0.00	0.00	0.00	0.00		
171 - 2.06	-0.72	-3.54	6.00	-4.44	-11.30		
172 - 9.00	-0.49	3.07	5.09	-1.61	-2.55		
173 - 11.00	2.17	8.14	1.93	-1.39	0.71		
174 - 9.00	6.63	6.83	5.82	-1.59	-1.77		
175 - 0.00	0.00	0.00	0.00	0.00	0.00		
176 - 14.00	11.99	11.75	14.00	3.97	4.00		
177 - 16.00	18.00	18.00	16.00	8.00	8.00		
178 - 3.33	4.11	11.51	14.00	3.49	3.09		
179 - 17.00	12.51	14.83	14.29	1.00	5.14		
180 - 0.00	0.00	0.00	0.00	0.00	0.00		
181 - 4.00	-4.15	-9.94	-2.86	-16.86	-10.44		
182 - 8.00	-7.39	-0.87	-7.55	-13.66	-7.29		
183 - 1.28	-9.53	-9.77	4.97	11.33	-8.22		
184 - 7.93	10.00	8.98	7.98	-0.10	-0.04		
185 - 0.00	0.00	0.00	0.00	0.00	0.00		
186 - 6.93	10.00	8.51	7.88	-1.06	-2.50		
187 - 11.00	13.00	11.99	11.00	3.00	3.00		
188 - 0.21	5.15	-2.57	8.00	-4.62	9.15		
189 - 9.88	9.86	-3.92	3.98	12.20	-16.74		
190 - 0.00	0.00	0.00	0.00	0.00	0.00		
191 - 2.61	-8.50	-1.65	5.00	-9.54	-16.02		
192 - 8.00	0.03	3.37	6.05	-5.46	-12.28		
193 - 4.73	6.42	8.78	10.00	-1.50	-4.68		
194 - 8.00	-7.57	-7.38	-7.48	-8.94	-12.10		
195 - 0.00	0.00	0.00	0.00	0.00	0.00		
196 - 12.98	10.94	12.00	13.00	3.00	3.00		
197 - 17.00	19.00	18.00	17.00	9.00	9.00		
198 - 13.00	10.88	11.99	13.00	3.00	3.00		
199 - 16.00	14.00	15.00	15.99	5.99	6.00		
200 - 0.00	0.00	0.00	0.00	0.00	0.00		
201 - 7.36	9.00	6.11	6.03	-1.86	-1.42		
202 - 10.98	13.00	11.00	11.97	3.00	2.98		
203 - 0.43	10.00	0.35	4.81	-1.77	6.53		
204 - 0.71	2.56	5.00	-9.29	-5.50	-5.82		
205 - 0.00	0.00	0.00	0.00	0.00	0.00		
206 - 8.90	2.90	5.00	3.59	-5.57	5.30		
207 - 1.04	2.77	8.00	3.41	-6.00	-13.82		
208 - 13.00	11.00	11.00	12.00	3.00	3.00		
209 - 9.00	7.00	7.00	7.99	-1.00	-1.01		
210 - 0.00	0.00	0.00	0.00	0.00	0.00		
211 - 10.00	8.00	8.00	9.00	-0.00	-0.00		
212 - 4.24	4.15	7.00	4.05	-3.74	-4.63		
213 - 1.74	-0.08	9.00	7.17	-2.90	-4.50		
214 - 4.10	-1.52	7.00	2.25	-3.03	5.66		
215 - 0.00	0.00	0.00	0.00	0.00	0.00		
216 - 16.00	18.00	16.00	17.00	8.00	8.00		
217 - 12.00	12.00	14.00	13.00	4.00	4.00		
218 - 18.00	16.00	16.00	17.00	8.00	8.00		
219 - 13.00	13.00	15.00	14.00	5.00	5.00		
220 - 0.00	0.00	0.00	0.00	0.00	0.00		
221 - 6.00	8.00	6.00	8.00	-2.00	-2.01		
222 - 9.99	11.93	10.00	12.00	2.00	2.00		
223 - 6.99	9.00	6.77	8.86	-1.01	-1.00		
224 - 3.99	3.99	6.00	3.56	-4.39	-5.39		
225 - 0.00	0.00	0.00	0.00	0.00	0.00		
226 - 3.75	3.84	6.00	4.00	-4.02	-4.01		
227 - 1.93	6.17	9.00	5.81	-7.24	-4.87		
228 - 9.96	9.99	10.00	12.00	2.00	2.00		
229 - 6.00	5.98	6.00	8.00	-2.00	-2.00		
230 - 0.00	0.00	0.00	0.00	0.00	0.00		
231 - 7.00	7.00	7.00	9.00	-1.00	-1.00		
232 - 1.57	5.57	8.00	5.28	-2.08	-2.13		
233 - 7.45	7.67	10.00	1.46	-0.02	-0.18		
234 - 4.82	5.54	8.00	5.77	-2.56	-2.11		
235 - 0.00	0.00	0.00	0.00	0.00	0.00		
236 - 15.00	17.00	15.00	17.00	7.00	7.00		
237 - 13.00	13.00	15.00	13.00	5.00	5.00		
238 - 15.00	15.00	15.00	17.00	7.00	7.00		
239 - 14.00	14.00	16.00	14.00	6.00	6.00		
240 - 0.00	0.00	0.00	0.00	0.00	0.00		
241 - 5.00	5.00	4.78	7.00	-3.03	-3.01		
242 - 8.99	9.00	8.99	11.00	1.00	0.65		
243 - 5.63	6.00	5.89	8.00	2.04	2.01		
244 - 4.64	2.65	7.00	4.96	-3.03	6.66		
245 - 0.00	0.00	0.00	0.00	0.00	0.00		
246 - 4.98	7.00	4.99	4.90	-3.10	-3.02		
247 - 7.79	9.93	10.00	7.39	-0.30	-0.02		
248 - 8.66	8.99	8.99	11.00	0.95	0.99		
249 - 4.61	4.64	4.49	7.00	-3.00	-3.01		
250 - 0.00	0.00	0.00	0.00	0.00	0.00		
251 - 5.93	5.97	5.97	8.00	-2.00	-2.00		
252 - 6.96	6.99	9.00	7.00	-1.40	-1.00		
253 - 8.97	8.85	11.00	8.77	0.96	0.97		
254 - 6.87	6.54	9.00	7.00	-1.12	-1.02		
255 - 0.00	0.00	0.00	0.00	0.00	0.00		
256 - 14.00	14.00	14.00	16.00	6.00	6.00		
257 - 14.00	16.00	16.00	14.00	6.00	6.00		
258 - 14.00	14.00	14.00	16.00	6.00	6.00		
259 - 15.00	15.00	17.00	15.00	7.00	7.00		
260 - 0.00	0.00	0.00	0.00	0.00	0.00		
261 - 2.47	3.96	3.39	6.00	-4.07	-4.02		
262 - 7.86	7.31	7.61	10.00	-0.19	-0.02		
263 - 4.93	4.96	4.93	7.00	-3.19	-3.34		
264 - 5.78	8.00	8.00	5.97	-2.01	-2.04		
265 - 0.00	0.00	0.00	0.00	0.00	0.00		
266 - 1.08	0.56	0.81	6.00	-8.12	-8.52		
267 - 8.68	10.92	11.00	8.99	0.97	0.91		
268 - 7.96	7.77	7.58	10.00	-0.02	-0.06		
269 - 3.50	2.38	-2.04	6.00	-4.87	-7.12		
270 - 0.00	0.00	0.00	0.00	0.00	0.00		
271 - 4.89	4.77	4.07	7.00	-3.11	-4.25		
272 - 10.00	7.99	7.94	8.00	-0.00	-0.00		
273 - 12.00	9.99	10.00	10.00	2.00	2.00		
274 - 10.00	8.00	8.00	8.00	-0.00	-0.01		
275 - 0.00	0.00	0.00	0.00	0.00	0.00		
276 - 13.00	13.00	13.00	15.00	5.00	5.00		
277 - 15.00	17.00	17.00	15.00	7.00	7.00		
278 - 13.00	13.00	13.00	15.00	5.00	5.00		
279 - 18.00	16.00	16.00	16.00	8.00	8.00		
280 - 0.00	0.00	0.00	0.00	0.00	0.00		
281 - 2.79	1.23	3.57	5.00	-7.72	-6.38		
282 - 5.46	3.29	5.49	9.00	-2.04	-8.30		
283 - 2.68	-2.78	-9.49	6.00	-7.43	-15.32		
284 - 6.73	9.00	7.52	6.94	-1.05	-1.21		
285 - 0.00	0.00	0.00	0.00	0.00	0.00		
286 - 0.39	9.00	4.26	-1.13	-7.26	-6.51		
287 - 9.99	12.00	10.98	9.99	1.97	2.00		
288 - 6.71	-0.68	-6.75	9.00	-8.42	-9.86		
289 - 0.37	-1.94	-3.57	4.94	-10.45	-15.92		
290 - 0.00	0.00	0.00	0.00	0.00	0.00		
291 - 0.05	-10.25	-10.36	6.00	-10.88	-9.87		
292 - 0.69	5.34	6.10	9.00	-2.37	-7.78		
293 - 4.33	8.15	9.10	11.00	0.85	-4.03		
294 - 0.84	5.24	0.52	9.00	-3.20	-2.76		
295 - 0.00	0.00	0.00	0.00	0.00	0.00		
296 - 11.29	3.74	6.79	14.00	1.75	2.44		
297 - 13.48	18.00	16.71	15.73	7.89	4.15		
298 - 12.00	12.00	13.00	14.00	4.00	4.00		
299 - 17.00	15.00	15.99	17.00	7.00	6.99		
300 - 0.00	0.00	0.00	0.00	0.00	0.00		
303 - 3.23	9.00	5.00	6.60	7.90	14.29	-11.03	
304 - 3.53	4.00	5.23	1.74	3.44	4.05	-10.13	-13.48
305 - 0.00	0.00	0.00	0.00	0.00	0.00		
306 - 10.11	4.00	3.44	-3.44	-4.02	-16.13	-15.97	
307 - 3.29	7.00	6.60	6.67	0.72	1.00		
308 - 15.00	17.00	16.00	16.00	7.00	7.00		
309 - 10.00	8.50	9.00	9.00	0.00	0.00		
310 - 0.00	0.00	0.00	0.00	0.00	0.00		
311 - 1.00	9.00	9.00	9.00	0.00	0.00		
312 - 1.19	1.00	1.00	1.00	0.00	0.00		
313 - 0.35	8.50	6.14	6.14	0.20	-3.90	-12.98	
314 - 1.82	6.50	4.05	4.05	0.00	0.00		
315 - 0.00	0.00	0.00	0.00	0.00	0.00		
316 - 15.00	17.00	16.00	16.00	7.00	7.00		
317 - 11.00	13.00	12.00	12.00	3.00	3.00		
318 - 19.00	17.00	18.00	18.00	9.00	9.00		
319 - 1.00	1.00	1.00	1.00	0.00	0.00		
320 - 0.00	0.00	0.00	0.00	0.00	0.00		
321 - 3.04	7.00	1.43	5.55	-7.92	-7.42	-4.22	
322 - 1.19	1.00	1.00	1.00	0.00	0.00		
323 - 0.00	0.00	0.00	0.00	0.00	0.00		
324 - 1.38	5.00	6.49	2.92	5.77	-18.50		
325 - 0.00</td							

Muskan Jindal

Intra-Options: (Please refer to python notebook for complete image)

