A Sequential landmark planning

Let $P = (\Sigma, s_0, g)$ be a probabilistic planning problem, let $\langle \varphi_1, \dots, \varphi_k \rangle$ be a sequence of landmarks where $\varphi_k = g$. For $i \in \{1, \dots, k\}$, suppose policy π_i achieves φ_i. A solution to P can be obtained by running policies $\pi_1, \dots, \pi_k$ in sequence.

Algorithm 4 SequentialPlan

1: **procedure** SEQUENTIAL-PLAN($\Sigma, s_0, \langle \varphi_1, \dots, \varphi_k \rangle$)
2: $\quad s \leftarrow s_0$
3: $\quad$ **for** $i = 1 \dots k$ **do**
4: $\quad\quad \pi_i \leftarrow$ policy for (Σ, s, φ_i)
5: $\quad\quad$ **while** $s \not\models \varphi_i$ **do**
6: $\quad\quad\quad s \leftarrow \mathsf{apply}(s, \pi_i(s))$

In the best case, for a well-chosen sequence of landmarks, this can yield an exponential reduction in planning time.

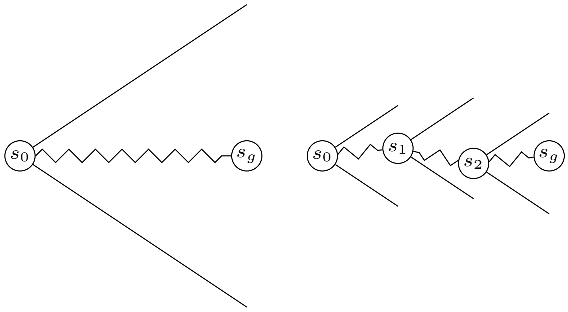

Figure A1. Suppose φ_1 and φ_2 are landmarks such that $s_1 \models \varphi_1$ and $s_2 \models \varphi_2$. In the best case, sequential planning can yield an exponential speed-up.

However, in general, for a problem $P = (\Sigma, s_0, g)$ and an unordered collection of landmarks Φ, there is no unique "optimal" sequencing of Φ that minimizes expected cost. As illustrated in Figure A2, in the classical setting, the best order to achieve a set of landmarks in may depend on the subplans used for each landmark. Moreover, in the probabilistic setting, the optimal sequence for attaining landmarks can even depend on the probabilistic outcomes of actions.

(a) classical problem **(b)** probabilistic problem

Figure A2. In both problems, suppose φ_1 and φ_2 are landmarks such that $s_2, s_3 \models \varphi_1$ and $s_1, s_4 \models \varphi_2$. Without first fixing policies π_1 and π_2 which achieve φ_1 and φ_2, respectively, it is unclear whether SEQUENTIALPLAN($\Sigma, s_0, \langle \varphi_1, \varphi_2 \rangle$) or SEQUENTIALPLAN($\Sigma, s_0, \langle \varphi_2, \varphi_1 \rangle$) would be better.

Moreover, the SEQUENTIAL-PLAN procedure is incomplete. Failures can occur in two situations: (1) the chosen landmark is unreachable, or (2) a deadlock state is encountered from which the final goal is unreachable. Consider the execution of SEQUENTIALPLAN($\Sigma, s_0, \langle \varphi_1, \varphi_2 \rangle$). In

(a) softlocking problem **(b)** deadlocking problem

Figure A3. In both problems, consider the execution of SEQUENTIALPLAN($\Sigma, s_0, \langle \varphi_1, \varphi_2 \rangle$). In **(a)**, if φ_1 is achieved by reaching state s_2, it is impossible to achieve φ_2. In **(b)**, if φ_1 is achieved by reaching state s_1, it is impossible to reach the final goal.

Figure A3(a), suppose policy π_1 achieves φ_1 by reaching state s_2. Upon completion of φ_1, the next landmark φ_2 is impossible to achieve, and thus the SEQUENTIALPLAN procedure fails on Line 4. In Figure A3(b), if SEQUENTIALPLAN achieves landmarks φ_1 by reaching state s_1, a deadlock state is reached where the final goal is no longer achievable.

B Additional early benchmarks

Average cost (number of rollouts; less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	190.1	32.3	**162.4**	62.7	**167.5**	58.9	180.8	45.8	173.8	52.9
10	184.0	41.5	**145.5**	65.7	**142.1**	70.5	**152.2**	67.7	167.3	59.4
20	175.0	51.2	**120.8**	68.6	**114.8**	75.6	**118.3**	70.4	**127.6**	70.9
50	157.8	58.9	**69.1**	57.0	**70.1**	58.2	**86.5**	70.6	**87.8**	65.6
100	145.4	59.9	**41.0**	33.4	**51.1**	38.2	**53.1**	47.6	**61.8**	55.5
200	110.9	58.4	**32.3**	15.1	**40.3**	40.6	**33.4**	21.6	**36.9**	27.2
500	65.9	40.7	**28.4**	18.0	**27.5**	9.1	**32.1**	23.6	**28.3**	10.8
1000	44.3	19.5	**28.8**	19.0	**25.7**	7.8	**27.5**	10.3	**26.1**	5.2
2000	39.6	14.5	**24.3**	6.1	**25.3**	5.0	**26.7**	7.1	**26.2**	5.2
5000	32.6	10.0	**23.2**	4.0	**24.1**	4.3	**23.6**	4.4	**25.1**	4.4

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**8.36e-04**	**4.02e-03**	1.52e-01	2.34e-02
10	N/A	**3.23e-05**	**1.79e-05**	**6.92e-04**	4.80e-02
20	N/A	**1.72e-07**	**5.93e-08**	**8.43e-08**	**6.05e-06**
50	N/A	**1.08e-16**	**3.68e-16**	**3.82e-10**	**1.58e-10**
100	N/A	**9.23e-27**	**2.78e-22**	**1.67e-19**	**2.17e-15**
200	N/A	**1.03e-21**	**1.08e-14**	**2.38e-20**	**3.63e-18**
500	N/A	**1.61e-11**	**3.90e-13**	**4.61e-09**	**1.38e-12**
1000	N/A	**2.33e-06**	**1.86e-12**	**5.90e-10**	**9.85e-13**
2000	N/A	**3.57e-14**	**2.44e-13**	**1.75e-10**	**4.86e-12**
5000	N/A	**4.65e-12**	**2.95e-10**	**3.50e-11**	**1.77e-08**

(a) `prob_blocksworld` problem `p1`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

Average cost (number of rollouts; less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	193.3	23.3	**124.9**	77.7	**161.0**	64.3	**145.5**	70.4	**138.9**	73.1
10	188.3	34.5	**99.1**	76.6	**111.7**	79.1	**138.5**	72.8	**118.6**	78.8
20	170.1	55.4	**85.9**	68.4	**107.6**	77.4	**107.7**	76.2	**118.8**	77.5
50	133.4	68.7	**52.3**	45.5	**68.9**	62.9	**71.1**	63.3	**72.6**	66.3
100	112.9	65.6	**34.3**	25.2	**37.6**	28.0	**46.2**	43.2	**47.8**	42.4
200	74.0	51.8	**30.5**	23.9	**29.1**	14.8	**33.3**	21.6	**31.5**	24.1
500	41.2	20.0	**24.0**	10.0	**24.9**	7.9	**26.2**	11.5	**29.8**	17.5
1000	28.0	10.0	**20.4**	4.2	**23.8**	4.5	25.0	6.1	26.9	10.3
2000	23.5	7.9	**19.8**	5.2	21.5	4.3	22.2	4.1	24.4	4.8
5000	22.4	7.9	**18.1**	5.5	21.4	4.4	23.0	5.1	24.6	5.7

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**1.60e-11**	**7.01e-05**	**1.06e-07**	**7.34e-09**
10	N/A	**3.38e-16**	**2.01e-12**	**3.35e-07**	**7.74e-11**
20	N/A	**6.30e-14**	**6.57e-08**	**5.16e-08**	**6.87e-06**
50	N/A	**1.58e-14**	**1.47e-08**	**4.40e-08**	**1.52e-07**
100	N/A	**1.62e-17**	**4.12e-16**	**1.17e-11**	**2.44e-11**
200	N/A	**6.81e-10**	**2.55e-11**	**3.45e-09**	**1.60e-09**
500	N/A	**4.75e-10**	**7.28e-10**	**9.18e-08**	**2.84e-04**
1000	N/A	**1.00e-08**	**1.25e-03**	2.69e-02	5.07e-01
2000	N/A	**8.69e-04**	5.47e-02	2.04e-01	3.95e-01
5000	N/A	**1.37e-04**	3.49e-01	6.09e-01	5.58e-02

(b) `prob_blocksworld` problem `p2`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

Average cost (number of rollouts; less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	190.0	32.6	**160.5**	64.6	**158.9**	68.6	**159.7**	64.2	**159.5**	68.5
10	182.9	41.7	**121.8**	77.1	**111.7**	79.0	**138.7**	74.1	**144.9**	71.6
20	166.0	60.8	**103.5**	73.2	**108.5**	78.9	**130.5**	77.4	**118.8**	77.9
50	129.9	72.0	**65.7**	60.3	**64.2**	53.3	**92.4**	73.4	**96.1**	70.8
100	92.7	62.7	**37.0**	32.6	**50.3**	48.8	**67.5**	55.6	**63.8**	58.3
200	63.2	46.8	**26.9**	22.2	**32.5**	27.9	**40.3**	39.8	**42.3**	30.8
500	34.6	18.0	**21.3**	12.2	**20.0**	7.6	**22.1**	8.8	**23.7**	11.4
1000	24.3	9.0	**17.2**	6.2	**18.4**	4.5	**19.2**	8.7	**20.0**	9.0
2000	21.5	7.4	**17.0**	4.3	19.1	4.7	**16.8**	4.2	19.5	7.2
5000	19.1	7.2	**16.2**	3.4	16.9	4.2	17.4	4.2	17.7	4.9

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**5.64e-04**	**5.24e-04**	**3.73e-04**	**6.57e-04**
10	N/A	**1.24e-08**	**1.36e-10**	**1.39e-05**	**1.08e-04**
20	N/A	**6.75e-08**	**1.63e-06**	**2.16e-03**	**6.00e-05**
50	N/A	**2.21e-08**	**2.46e-09**	**1.93e-03**	**4.30e-03**
100	N/A	**2.11e-10**	**8.36e-06**	**1.02e-02**	**4.00e-03**
200	N/A	**1.07e-08**	**2.81e-06**	**1.55e-03**	**1.57e-03**
500	N/A	**3.99e-07**	**1.16e-09**	**2.47e-07**	**1.64e-05**
1000	N/A	**8.43e-08**	**1.24e-06**	**5.54e-04**	**3.93e-03**
2000	N/A	**1.21e-05**	1.99e-02	**5.14e-06**	9.53e-02
5000	N/A	**1.34e-03**	2.12e-02	7.67e-02	1.50e-01

(c) `prob_blocksworld` problem `p3`. The landmark extraction algorithm LM^{RHW} generated 12 nontrivial landmarks for this problem.

Figure A4. The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `prob_blocksworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	191.8	28.0	**161.2**	63.5	**152.0**	67.4	**160.9**	63.5	**166.4**	58.1
10	189.4	34.4	**136.6**	71.6	**139.2**	69.2	**150.2**	63.6	**151.7**	68.3
20	170.5	55.2	**130.9**	71.6	**129.5**	72.5	**142.8**	65.7	145.4	67.8
50	158.4	58.6	**96.5**	67.8	**96.1**	64.6	**96.3**	66.4	**115.1**	71.9
100	134.4	70.9	**54.7**	46.2	**63.9**	47.4	**55.0**	34.9	**89.4**	65.5
200	101.9	59.5	**34.3**	19.2	**38.2**	14.4	**42.2**	28.6	**57.7**	44.7
500	52.0	30.3	**25.3**	6.3	**27.2**	9.9	**26.9**	9.2	**30.4**	14.5
1000	43.3	27.1	**22.7**	5.2	**24.4**	7.6	**23.3**	6.7	**26.0**	9.9
2000	31.9	12.9	**20.4**	5.2	**22.2**	6.6	**20.9**	6.1	**23.5**	7.5
5000	26.0	6.9	**20.1**	4.5	**20.9**	4.3	**21.0**	5.6	**21.5**	7.1

less greedy ⟵ α ⟶ more greedy

Average cost

0/UCT	0.2	0.5	0.8	1
N/A	**2.02e-04**	**5.45e-06**	**1.78e-04**	**8.32e-04**
N/A	**4.76e-08**	**8.59e-08**	**5.80e-06**	**3.46e-05**
N/A	**2.11e-04**	**1.46e-04**	**5.82e-03**	1.40e-02
N/A	**1.61e-08**	**5.55e-09**	**1.02e-08**	**8.57e-05**
N/A	**1.38e-13**	**3.51e-11**	**6.16e-15**	**8.57e-05**
N/A	**1.18e-16**	**1.01e-15**	**8.80e-13**	**8.57e-07**
N/A	**5.96e-12**	**3.33e-10**	**1.70e-10**	**1.13e-07**
N/A	**1.36e-09**	**3.64e-08**	**4.65e-09**	**6.28e-07**
N/A	**4.09e-11**	**3.78e-08**	**4.41e-10**	**2.70e-06**
N/A	**4.09e-09**	**2.44e-07**	**2.33e-06**	**1.03e-04**

less greedy ⟵ α ⟶ more greedy

p-values

(d) `prob_blocksworld` problem `p4`. The landmark extraction algorithm $\mathrm{LM}^{\mathrm{RHW}}$ generated 12 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	190.7	34.8	**154.8**	69.6	**144.1**	72.4	**150.7**	68.9	**163.0**	63.9
10	179.3	46.6	**113.7**	75.9	**123.1**	75.2	**135.7**	72.8	**122.1**	79.9
20	168.9	55.2	**106.3**	73.1	**108.3**	70.5	**109.6**	77.4	**133.3**	74.2
50	149.0	62.3	**62.8**	54.0	**75.4**	63.1	**72.5**	62.9	**89.1**	67.6
100	113.4	67.5	**42.1**	34.4	**47.5**	41.2	**48.7**	39.6	**72.0**	64.9
200	69.5	49.7	**28.7**	22.6	**27.9**	11.7	**36.3**	26.6	**40.9**	32.3
500	37.4	23.9	**20.7**	5.4	**22.5**	9.9	**23.2**	14.3	**24.5**	14.8
1000	27.5	16.0	**18.4**	5.5	**19.6**	5.7	**21.2**	6.1	**22.2**	7.1
2000	20.8	6.5	**17.8**	4.5	**18.5**	4.6	**18.1**	5.4	19.4	6.8
5000	19.8	7.0	**16.1**	4.2	**16.5**	3.7	17.6	4.4	18.4	6.1

less greedy ⟵ α ⟶ more greedy

Average cost

0/UCT	0.2	0.5	0.8	1
N/A	**1.02e-04**	**1.44e-06**	**1.47e-05**	**1.23e-03**
N/A	**2.06e-09**	**1.56e-07**	**2.37e-05**	**3.11e-07**
N/A	**2.27e-08**	**2.99e-08**	**2.61e-07**	**1.08e-03**
N/A	**7.31e-16**	**2.99e-11**	**5.86e-12**	**8.57e-08**
N/A	**1.35e-13**	**2.56e-11**	**3.40e-11**	**1.90e-04**
N/A	**1.37e-09**	**6.15e-11**	**1.01e-06**	**5.00e-05**
N/A	**2.12e-08**	**1.46e-06**	**1.79e-05**	**9.97e-05**
N/A	**5.73e-06**	**7.46e-05**	**1.50e-03**	**8.43e-03**
N/A	**1.13e-03**	**1.12e-02**	**5.75e-03**	2.01e-01
N/A	**1.27e-04**	**2.94e-04**	2.16e-02	1.86e-01

less greedy ⟵ α ⟶ more greedy

p-values

(e) `prob_blocksworld` problem `p5`. The landmark extraction algorithm $\mathrm{LM}^{\mathrm{RHW}}$ generated 10 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	200.0	0.0	200.0	0.0	197.8	13.8	200.0	0.0
10	200.0	0.0	200.0	0.0	198.2	15.9	200.0	0.0	200.0	0.0
20	200.0	0.0	200.0	0.0	198.3	14.3	199.3	5.8	200.0	0.0
50	200.0	0.0	191.8	31.1	197.0	19.1	190.3	33.7	196.0	19.8
100	200.0	0.0	198.1	13.8	192.8	30.6	198.3	15.0	198.5	12.9
200	200.0	0.0	196.7	20.4	200.0	0.0	200.0	0.0	200.0	0.0
500	200.0	0.0	192.9	30.3	200.0	0.0	200.0	0.0	200.0	0.0
1000	200.0	0.0	196.1	23.7	195.3	24.6	200.0	0.0	196.9	19.3
2000	200.0	0.0	200.0	0.0	196.4	21.9	194.6	27.3	196.4	22.1
5000	200.0	0.0	196.1	23.8	195.8	25.6	200.0	0.0	196.0	24.5

less greedy ⟵ α ⟶ more greedy

Average cost

0/UCT	0.2	0.5	0.8	1
N/A	NaN	NaN	1.74e-01	NaN
N/A	NaN	3.19e-01	NaN	NaN
N/A	NaN	3.19e-01	3.19e-01	NaN
N/A	2.37e-02	1.76e-01	1.41e-02	8.20e-02
N/A	2.44e-01	4.38e-02	3.19e-01	3.19e-01
N/A	1.58e-01	NaN	NaN	NaN
N/A	4.38e-02	NaN	NaN	NaN
N/A	1.57e-01	1.02e-01	NaN	1.66e-01
N/A	NaN	1.57e-01	8.68e-02	1.57e-01
N/A	3.21e-01	3.21e-01	NaN	3.21e-01

less greedy ⟵ α ⟶ more greedy

p-values

(f) `prob_blocksworld` problem `p6`. The landmark extraction algorithm $\mathrm{LM}^{\mathrm{RHW}}$ generated 20 nontrivial landmarks for this problem.

Figure A4 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `prob_blocksworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT $\bar{x}$	0/UCT σ	0.2 $\bar{x}$	0.2 σ	0.5 $\bar{x}$	0.5 σ	0.8 $\bar{x}$	0.8 σ	1 $\bar{x}$	1 σ
	less greedy ⟵ α ⟶ more greedy									
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
10	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
50	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
100	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
200	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
500	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
1000	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
2000	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
5000	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy ⟵ α ⟶ more greedy				
5	N/A	NaN	NaN	NaN	NaN
10	N/A	NaN	NaN	NaN	NaN
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	NaN	NaN	NaN
100	N/A	NaN	NaN	NaN	NaN
200	N/A	NaN	NaN	NaN	NaN
500	N/A	NaN	NaN	NaN	NaN
1000	N/A	NaN	NaN	NaN	NaN
2000	N/A	NaN	NaN	NaN	NaN
5000	N/A	NaN	NaN	NaN	NaN

p-values

(g) `prob_blocksworld` problem `p7`. The landmark extraction algorithm LM^{RHW} generated 26 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\bar{x}$	0/UCT σ	0.2 $\bar{x}$	0.2 σ	0.5 $\bar{x}$	0.5 σ	0.8 $\bar{x}$	0.8 σ	1 $\bar{x}$	1 σ
	less greedy ⟵ α ⟶ more greedy									
5	200.0	0.0	200.0	0.0	199.4	4.8	200.0	0.0	200.0	0.0
10	200.0	0.0	199.7	2.9	200.0	0.0	200.0	0.0	200.0	0.0
20	200.0	0.0	193.3	26.1	**191.3**	28.8	194.9	22.0	196.7	16.8
50	200.0	0.0	**184.4**	38.9	**184.4**	38.7	**191.7**	28.3	**189.1**	32.9
100	200.0	0.0	193.9	26.3	**188.0**	37.9	193.0	29.6	192.8	31.0
200	200.0	0.0	193.4	28.1	197.9	17.8	193.1	29.4	195.1	23.0
500	200.0	0.0	193.2	29.0	197.9	17.9	196.8	19.7	192.6	31.3
1000	200.0	0.0	194.3	25.4	193.4	28.4	196.8	20.2	190.7	35.2
2000	200.0	0.0	**184.5**	45.1	**181.9**	46.9	**187.5**	39.5	**169.1**	57.7
5000	198.6	12.0	**140.0**	70.0	**153.8**	68.1	**175.4**	54.4	**153.8**	68.1

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy ⟵ α ⟶ more greedy				
5	N/A	NaN	3.19e-01	NaN	NaN
10	N/A	3.19e-01	NaN	NaN	NaN
20	N/A	2.64e-02	**9.41e-03**	4.69e-02	8.70e-02
50	N/A	**6.59e-04**	**6.42e-04**	**1.24e-02**	**4.79e-03**
100	N/A	4.71e-02	**7.05e-03**	4.36e-02	4.46e-02
200	N/A	4.40e-02	3.19e-01	4.51e-02	6.62e-02
500	N/A	4.48e-02	3.19e-01	1.57e-01	4.26e-02
1000	N/A	5.29e-02	4.71e-02	1.69e-01	2.32e-02
2000	N/A	**3.52e-03**	**1.04e-03**	**6.66e-03**	**7.84e-06**
5000	N/A	**3.69e-11**	**9.47e-08**	**4.13e-04**	**9.49e-08**

p-values

(h) `prob_blocksworld` problem `p8`. The landmark extraction algorithm LM^{RHW} generated 24 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\bar{x}$	0/UCT σ	0.2 $\bar{x}$	0.2 σ	0.5 $\bar{x}$	0.5 σ	0.8 $\bar{x}$	0.8 σ	1 $\bar{x}$	1 σ
	less greedy ⟵ α ⟶ more greedy									
5	200.0	0.0	199.3	6.0	200.0	0.0	196.9	16.0	200.0	0.0
10	200.0	0.0	196.9	18.9	193.1	26.6	197.0	18.3	200.0	0.0
20	200.0	0.0	198.0	16.4	198.5	12.7	195.3	23.7	197.0	18.5
50	200.0	0.0	**181.8**	45.1	**185.8**	42.0	**184.7**	42.1	**188.4**	36.9
100	200.0	0.0	195.5	23.2	191.6	33.3	191.5	32.9	194.8	25.7
200	200.0	0.0	193.7	29.4	195.6	25.0	195.8	22.6	197.5	15.9
500	200.0	0.0	194.8	26.2	194.5	27.3	196.4	22.3	192.6	31.8
1000	200.0	0.0	188.8	38.6	192.7	31.2	193.9	27.0	189.6	37.2
2000	200.0	0.0	**179.1**	49.4	**177.7**	54.3	**178.1**	53.3	**187.7**	41.9
5000	199.6	3.2	**138.6**	73.1	**147.0**	73.6	**147.0**	74.0	**153.5**	70.7

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy ⟵ α ⟶ more greedy				
5	N/A	3.19e-01	NaN	1.01e-01	NaN
10	N/A	1.57e-01	2.66e-02	1.57e-01	NaN
20	N/A	2.99e-01	3.19e-01	8.52e-02	1.58e-01
50	N/A	**6.21e-04**	**3.90e-03**	**2.02e-03**	**7.12e-03**
100	N/A	9.51e-02	3.04e-02	2.71e-02	8.28e-02
200	N/A	6.74e-02	1.26e-01	1.10e-01	1.82e-01
500	N/A	8.51e-02	8.17e-02	1.60e-01	4.58e-02
1000	N/A	1.29e-02	4.34e-02	5.34e-02	1.64e-02
2000	N/A	**3.38e-04**	**5.12e-04**	**4.97e-04**	**1.23e-02**
5000	N/A	**2.47e-11**	**5.76e-09**	**6.73e-09**	**8.39e-08**

p-values

(i) `prob_blocksworld` problem `p9`. The landmark extraction algorithm LM^{RHW} generated 22 nontrivial landmarks for this problem.

Figure A4 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `prob_blocksworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

	less greedy ⟵ α ⟶ more greedy									
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	184.7	40.7	**85.1**	60.1	**72.9**	58.8	**87.1**	65.8	**80.2**	67.3
10	187.9	36.1	**58.8**	52.7	**52.6**	44.2	**43.1**	32.3	**64.7**	53.4
20	187.7	40.6	**32.9**	15.5	**33.8**	26.2	**32.3**	24.8	**32.4**	22.6
50	164.8	53.7	**26.1**	14.0	**29.1**	22.2	**27.4**	22.0	**31.2**	25.3
100	144.2	59.9	**26.7**	21.8	**25.3**	11.6	**26.7**	28.0	**25.9**	27.5
200	92.5	52.2	**22.7**	8.0	**20.8**	9.3	**19.6**	5.1	**21.8**	15.8
500	49.1	24.7	**19.9**	6.0	**18.1**	3.1	**18.6**	5.2	**17.9**	4.3
1000	31.1	11.1	**17.7**	2.7	**17.2**	3.8	**16.1**	2.7	**18.1**	4.5
2000	24.0	6.4	**17.2**	2.8	**16.1**	2.1	**15.4**	1.8	**17.6**	4.2
5000	19.6	3.4	**16.6**	2.4	**15.6**	2.7	**14.8**	1.4	**16.3**	3.5

Average cost

	less greedy ⟵ α ⟶ more greedy				
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**2.78e-23**	**1.11e-27**	**1.00e-20**	**2.78e-22**
10	N/A	**7.79e-38**	**3.70e-45**	**9.02e-57**	**1.82e-35**
20	N/A	**2.43e-66**	**3.27e-60**	**1.46e-61**	**8.82e-63**
50	N/A	**1.06e-47**	**2.06e-44**	**4.14e-45**	**1.09e-42**
100	N/A	**5.55e-34**	**2.78e-36**	**1.58e-32**	**6.24e-33**
200	N/A	**3.99e-22**	**7.97e-23**	**1.00e-23**	**1.52e-21**
500	N/A	**4.15e-18**	**2.50e-20**	**1.92e-19**	**2.66e-20**
1000	N/A	**7.41e-19**	**4.76e-19**	**4.60e-22**	**8.49e-17**
2000	N/A	**2.64e-14**	**1.42e-18**	**2.39e-21**	**2.62e-11**
5000	N/A	**3.66e-09**	**1.11e-13**	**1.84e-22**	**1.40e-08**

p-values

(a) `elevators` problem `p1`. The landmark extraction algorithm LM^{RHW} generated 10 nontrivial landmarks for this problem.

	less greedy ⟵ α ⟶ more greedy									
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	76.5	56.7	**37.3**	46.0	**40.3**	47.5	**27.1**	25.6	**36.2**	41.2
10	40.2	31.8	**19.1**	19.3	**14.3**	8.6	**13.8**	9.3	**14.7**	14.5
20	23.2	16.2	**10.3**	2.4	**10.7**	4.2	**10.6**	5.5	**11.3**	10.5
50	12.9	4.4	**9.2**	2.7	**9.1**	1.6	**9.2**	1.3	**9.4**	1.6
100	11.5	3.2	**9.1**	2.0	**9.4**	1.8	**9.6**	2.3	**9.9**	2.2
200	10.4	2.1	**8.8**	1.1	9.7	1.6	**9.1**	1.3	9.6	3.1
500	9.9	1.5	**8.8**	1.0	**9.2**	1.6	**9.3**	1.3	**9.1**	1.0
1000	9.6	1.1	**8.8**	1.2	9.1	1.3	**8.9**	0.9	**8.6**	1.0
2000	9.8	1.4	**8.8**	1.3	**8.9**	1.1	**8.8**	1.1	**8.7**	1.0
5000	9.9	3.6	**8.6**	1.0	9.1	1.1	**8.7**	0.9	**8.5**	0.9

Average cost

	less greedy ⟵ α ⟶ more greedy				
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**7.36e-06**	**3.98e-05**	**1.59e-10**	**1.81e-06**
10	N/A	**2.23e-06**	**2.31e-10**	**1.34e-10**	**2.97e-09**
20	N/A	**2.98e-10**	**1.45e-09**	**2.42e-09**	**4.01e-07**
50	N/A	**3.85e-09**	**6.54e-11**	**8.42e-11**	**1.29e-09**
100	N/A	**3.01e-07**	**1.68e-06**	**7.35e-05**	**7.67e-04**
200	N/A	**1.48e-08**	2.80e-02	**1.67e-05**	6.87e-02
500	N/A	**5.18e-07**	**2.93e-03**	**6.21e-03**	**8.70e-05**
1000	N/A	**1.42e-04**	3.03e-02	**6.70e-05**	**4.29e-07**
2000	N/A	**3.86e-05**	**2.77e-05**	**4.98e-06**	**4.04e-08**
5000	N/A	**3.13e-03**	6.57e-02	**4.70e-03**	**1.65e-03**

p-values

(b) `elevators` problem `p2`. The landmark extraction algorithm LM^{RHW} generated 6 nontrivial landmarks for this problem.

	less greedy ⟵ α ⟶ more greedy									
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	195.3	21.5	**78.8**	65.1	**68.6**	51.5	**68.1**	54.0	**73.9**	60.2
10	197.1	18.2	**80.9**	67.6	**83.2**	69.7	**98.3**	73.8	**73.5**	70.2
20	195.6	26.5	**63.1**	65.5	**56.7**	56.0	**65.4**	67.4	**64.4**	66.8
50	195.1	24.5	**70.3**	76.5	**63.5**	71.0	**57.4**	69.4	**88.4**	83.3
100	192.8	29.0	**56.1**	65.6	**42.7**	54.5	**46.0**	60.5	**48.6**	60.9
200	184.6	39.0	**43.1**	58.6	**43.2**	54.2	**35.9**	47.6	**38.6**	51.3
500	148.2	59.8	**25.2**	29.7	**33.0**	45.3	**33.2**	45.3	**30.9**	35.3
1000	91.5	55.5	**31.3**	42.6	**21.0**	12.5	**25.2**	24.3	**22.8**	20.9
2000	48.8	32.2	**21.5**	16.1	**19.8**	7.8	**18.9**	9.8	**21.8**	12.9
5000	31.6	10.4	**18.3**	4.8	**18.7**	6.0	**17.2**	5.0	**18.6**	5.1

Average cost

	less greedy ⟵ α ⟶ more greedy				
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**9.70e-31**	**4.67e-43**	**2.06e-41**	**3.26e-35**
10	N/A	**7.08e-30**	**4.40e-28**	**1.29e-21**	**6.97e-31**
20	N/A	**1.14e-34**	**1.61e-42**	**5.66e-33**	**1.37e-33**
50	N/A	**1.93e-27**	**5.84e-32**	**1.31e-34**	**5.47e-20**
100	N/A	**2.26e-35**	**2.42e-46**	**2.06e-41**	**2.36e-40**
200	N/A	**1.26e-37**	**6.31e-40**	**4.42e-46**	**5.37e-43**
500	N/A	**5.50e-34**	**4.90e-27**	**5.25e-27**	**1.48e-30**
1000	N/A	**7.06e-12**	**2.97e-20**	**5.98e-17**	**2.06e-18**
2000	N/A	**8.01e-10**	**3.00e-12**	**1.84e-12**	**3.03e-10**
5000	N/A	**1.51e-18**	**1.50e-16**	**2.11e-20**	**9.87e-18**

p-values

(c) `elevators` problem `p3`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

Figure A5. The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `elevators` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

	less greedy		⟵ α ⟶				more greedy			
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	129.3	70.8	**<u>66.6</u>**	62.1	**72.1**	66.3	**78.8**	69.0	**73.7**	71.9
10	113.9	68.7	**45.2**	51.8	**46.3**	57.4	**<u>44.0</u>**	56.1	**52.7**	64.1
20	105.6	58.3	**61.1**	66.0	**43.5**	46.9	**<u>41.9</u>**	51.2	**49.7**	55.3
50	63.5	37.7	**30.9**	34.1	**<u>26.8</u>**	24.9	**34.5**	31.7	**35.1**	39.2
100	40.9	20.4	**20.0**	13.6	**18.7**	10.5	**<u>18.2</u>**	12.4	**21.6**	17.1
200	24.8	8.8	**16.4**	3.9	**15.9**	4.5	**<u>15.0</u>**	2.9	**16.3**	5.1
500	18.1	3.7	**15.4**	2.1	**15.1**	2.0	**<u>14.5</u>**	2.9	**15.5**	3.4
1000	16.3	2.3	**15.4**	1.9	**<u>14.4</u>**	1.6	**14.6**	1.9	**15.2**	2.5
2000	16.1	1.9	**14.9**	1.8	**14.5**	1.9	**<u>14.2</u>**	2.0	**14.7**	2.4
5000	15.0	1.6	14.5	1.4	**<u>13.8</u>**	1.1	**14.2**	1.5	14.3	1.9

Average cost

less greedy		⟵ α ⟶	more greedy	
0/UCT	0.2	0.5	0.8	1
N/A	**4.64e-08**	**1.01e-06**	**1.87e-05**	**4.36e-06**
N/A	**1.25e-10**	**9.02e-10**	**2.00e-10**	**8.14e-08**
N/A	**2.33e-05**	**2.98e-11**	**4.61e-11**	**1.32e-08**
N/A	**1.27e-07**	**6.90e-11**	**1.05e-06**	**1.25e-05**
N/A	**9.66e-12**	**3.11e-14**	**7.90e-14**	**3.52e-09**
N/A	**4.19e-12**	**9.96e-13**	**4.17e-16**	**2.02e-11**
N/A	**2.08e-07**	**3.66e-09**	**5.63e-10**	**1.44e-05**
N/A	**5.91e-03**	**3.01e-08**	**1.64e-06**	**5.13e-03**
N/A	**5.98e-05**	**1.88e-07**	**5.81e-09**	**1.04e-04**
N/A	6.76e-02	**5.15e-07**	**1.18e-03**	2.36e-02

p-values

(d) `elevators` problem `p4`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

	less greedy		⟵ α ⟶				more greedy			
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	179.6	46.4	**<u>60.7</u>**	67.6	**90.2**	81.8	**77.1**	79.5	**77.2**	73.8
10	175.7	47.8	**<u>23.0</u>**	30.1	**32.2**	47.0	**29.6**	38.8	**25.7**	32.0
20	159.3	57.0	**27.2**	33.5	**27.8**	40.8	**<u>23.6</u>**	33.3	**<u>23.6</u>**	31.5
50	105.0	59.0	**22.2**	26.0	**22.7**	30.4	**<u>16.4</u>**	8.6	**27.3**	37.2
100	74.0	48.4	**18.6**	21.4	**21.9**	20.6	**<u>16.9</u>**	10.5	**17.7**	12.5
200	42.1	27.9	**17.5**	6.8	**17.5**	6.9	**<u>15.5</u>**	3.9	**16.3**	8.4
500	24.8	10.9	**16.7**	4.0	**16.3**	3.9	**<u>14.4</u>**	2.0	**14.9**	3.8
1000	18.2	6.3	17.7	4.1	17.6	5.8	<u>16.9</u>	5.9	16.9	5.0
2000	16.2	3.3	15.3	2.1	14.7	2.0	**<u>14.3</u>**	1.8	14.7	2.8
5000	15.2	2.5	15.2	2.0	**13.8**	1.1	**<u>13.7</u>**	1.1	**14.2**	1.9

Average cost

less greedy		⟵ α ⟶	more greedy	
0/UCT	0.2	0.5	0.8	1
N/A	**4.50e-25**	**8.84e-14**	**2.17e-17**	**8.77e-19**
N/A	**1.39e-51**	**2.13e-40**	**3.55e-45**	**9.23e-50**
N/A	**2.14e-37**	**9.98e-35**	**1.27e-38**	**3.21e-39**
N/A	**2.88e-21**	**2.93e-20**	**6.24e-26**	**2.15e-17**
N/A	**6.83e-16**	**1.22e-14**	**2.69e-18**	**1.09e-17**
N/A	**7.55e-12**	**8.85e-12**	**1.26e-13**	**2.04e-12**
N/A	**7.94e-09**	**1.96e-09**	**1.23e-13**	**6.93e-12**
N/A	5.63e-01	5.54e-01	1.85e-01	1.69e-01
N/A	4.05e-02	**5.60e-04**	**1.34e-05**	**2.17e-03**
N/A	9.43e-01	**2.67e-05**	**8.96e-06**	**6.89e-03**

p-values

(e) `elevators` problem `p5`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

	less greedy		⟵ α ⟶				more greedy			
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	200.0	0.0	**189.6**	30.6	**187.9**	32.7	**<u>182.3</u>**	42.2	**188.7**	32.9
10	200.0	0.0	192.0	29.9	**<u>182.8</u>**	38.3	192.0	28.3	**193.3**	22.2
20	200.0	0.0	**176.2**	44.3	**184.4**	37.4	**172.2**	46.8	**<u>166.1</u>**	51.8
50	200.0	0.0	**138.3**	55.9	**132.9**	60.0	**124.9**	56.9	**<u>115.3</u>**	52.4
100	200.0	0.0	**100.5**	46.8	**95.9**	44.7	**100.5**	56.0	**<u>94.4</u>**	47.6
200	200.0	0.0	**84.3**	52.8	**75.6**	49.6	**<u>69.0</u>**	41.2	**84.6**	58.2
500	200.0	0.0	**69.9**	45.5	**63.2**	46.3	**65.6**	45.9	**<u>62.9</u>**	46.2
1000	200.0	0.0	**76.9**	62.9	**<u>55.7</u>**	40.8	**70.6**	63.7	**61.5**	50.1
2000	200.0	0.0	**51.2**	41.4	**49.3**	45.3	**<u>40.1</u>**	20.7	**55.1**	48.5
5000	200.0	0.0	**38.4**	20.0	**39.6**	33.6	**38.4**	27.8	**<u>35.4</u>**	8.3

Average cost

less greedy		⟵ α ⟶	more greedy	
0/UCT	0.2	0.5	0.8	1
N/A	**3.84e-03**	**1.61e-03**	**3.69e-04**	**3.43e-03**
N/A	2.13e-02	**1.52e-04**	1.52e-02	**9.41e-03**
N/A	**7.32e-06**	**4.02e-04**	**7.95e-07**	**7.29e-08**
N/A	**3.75e-17**	**1.69e-17**	**4.44e-22**	**6.92e-29**
N/A	**4.61e-40**	**2.48e-44**	**1.54e-32**	**4.39e-42**
N/A	**1.90e-41**	**6.95e-48**	**3.91e-60**	**5.13e-37**
N/A	**1.91e-54**	**2.91e-56**	**1.09e-55**	**1.88e-56**
N/A	**1.84e-36**	**7.42e-66**	**4.67e-38**	**9.21e-53**
N/A	**7.67e-67**	**1.33e-62**	**1.5e-112**	**9.99e-57**
N/A	**2.4e-115**	**3.64e-83**	**5.67e-95**	**2.7e-172**

p-values

(f) `elevators` problem `p6`. The landmark extraction algorithm LM^{RHW} generated 15 nontrivial landmarks for this problem.

Figure A5 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `elevators` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	191.9	28.0	**190.8**	31.1	192.1	28.1	196.0	21.8
10	200.0	0.0	194.7	22.3	193.6	25.0	194.3	25.9	193.0	30.7
20	200.0	0.0	194.2	23.3	194.0	25.4	**192.0**	26.5	192.8	27.8
50	200.0	0.0	**179.9**	43.9	**183.5**	41.4	**177.3**	42.7	**179.5**	45.0
100	200.0	0.0	**142.9**	64.3	**157.6**	56.4	**160.8**	56.4	**155.9**	59.1
200	200.0	0.0	**130.6**	64.9	**139.4**	63.2	**122.3**	65.6	**130.5**	64.5
500	200.0	0.0	**100.7**	57.4	**110.7**	57.6	**98.5**	58.7	**104.0**	64.7
1000	200.0	0.0	**83.8**	47.3	**77.9**	44.5	**77.9**	47.4	**84.0**	52.4
2000	200.0	0.0	**56.6**	23.9	**58.9**	26.3	**56.6**	34.3	**61.0**	34.6
5000	200.0	0.0	**46.7**	14.4	**51.1**	28.8	**47.4**	28.1	**53.2**	37.9

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1.31e-02	**1.12e-02**	1.54e-02	1.12e-01
10	N/A	4.18e-02	2.80e-02	6.11e-02	5.11e-02
20	N/A	3.16e-02	4.19e-02	**9.43e-03**	2.59e-02
50	N/A	**1.10e-04**	**7.47e-04**	**9.09e-06**	**1.28e-04**
100	N/A	**2.00e-12**	**1.11e-09**	**1.27e-08**	**1.42e-09**
200	N/A	**2.03e-16**	**6.09e-14**	**5.83e-19**	**1.43e-16**
500	N/A	**1.76e-31**	**2.37e-27**	**1.98e-31**	**7.54e-26**
1000	N/A	**7.80e-47**	**2.04e-52**	**3.16e-49**	**5.86e-42**
2000	N/A	**8.29e-97**	**4.86e-90**	**2.02e-75**	**4.10e-73**
5000	N/A	**1.2e-132**	**5.62e-88**	**6.78e-91**	**4.33e-71**

less greedy ⟵ α ⟶ more greedy

p-values

(g) elevators problem p7. The landmark extraction algorithm LM^{RHW} generated 16 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	200.0	0.0	200.0	0.0	199.7	2.5	198.6	8.4
10	200.0	0.0	199.3	5.8	199.9	1.0	199.1	5.2	199.2	7.3
20	200.0	0.0	199.4	4.6	198.3	10.7	195.1	17.6	199.4	3.9
50	200.0	0.0	**176.4**	38.3	**191.3**	20.1	**179.7**	34.8	**186.5**	26.1
100	200.0	0.0	**160.4**	40.3	**156.2**	42.5	**164.0**	44.5	**177.0**	35.6
200	200.0	0.0	**142.6**	43.8	**134.2**	45.7	**142.8**	42.6	**139.2**	47.3
500	200.0	0.0	**120.1**	49.6	**120.3**	46.1	**117.1**	45.8	**122.3**	44.4
1000	200.0	0.0	**106.4**	46.4	**108.9**	45.2	**112.0**	38.8	**107.7**	38.5
2000	200.0	0.0	**98.3**	28.8	**98.8**	37.3	**94.4**	34.0	**98.2**	26.8
5000	200.0	0.0	**93.2**	31.6	**102.6**	34.9	**95.5**	31.2	**96.7**	30.2

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	3.19e-01	1.61e-01
10	N/A	3.19e-01	3.19e-01	1.57e-01	3.19e-01
20	N/A	2.85e-01	1.77e-01	1.64e-02	2.04e-01
50	N/A	**3.46e-07**	**2.54e-04**	**1.24e-06**	**1.44e-05**
100	N/A	**1.88e-14**	**1.57e-15**	**7.54e-11**	**1.02e-07**
200	N/A	**7.92e-22**	**7.88e-25**	**1.24e-22**	**2.94e-21**
500	N/A	**9.23e-29**	**1.98e-31**	**3.38e-33**	**7.15e-32**
1000	N/A	**9.00e-38**	**1.05e-37**	**3.94e-43**	**9.64e-46**
2000	N/A	**8.71e-66**	**7.82e-52**	**6.46e-59**	**6.27e-70**
5000	N/A	**2.06e-63**	**2.69e-53**	**4.93e-63**	**4.30e-64**

less greedy ⟵ α ⟶ more greedy

p-values

(h) elevators problem p8. The landmark extraction algorithm LM^{RHW} generated 16 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	198.7	11.3
10	200.0	0.0	200.0	0.0	196.2	19.4	199.1	5.4	199.6	3.1
20	200.0	0.0	199.3	5.5	199.1	5.7	198.6	11.9	200.0	0.0
50	200.0	0.0	**187.4**	28.1	**193.0**	21.7	**190.4**	22.2	**192.9**	21.6
100	200.0	0.0	**177.0**	37.0	**175.6**	40.6	**171.2**	43.4	**177.2**	39.7
200	200.0	0.0	**148.9**	46.9	**140.7**	48.4	**133.7**	45.2	**148.9**	44.7
500	200.0	0.0	**113.9**	45.8	**117.7**	50.5	**126.3**	48.7	**107.3**	48.1
1000	200.0	0.0	**100.3**	35.7	**96.1**	37.5	**91.4**	37.4	**101.6**	44.4
2000	200.0	0.0	**88.3**	33.2	**86.4**	36.8	**97.1**	37.9	**96.3**	34.1
5000	200.0	0.0	**81.8**	32.6	**82.9**	33.7	**74.2**	28.0	**77.0**	24.2

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	3.19e-01
10	N/A	NaN	9.16e-02	1.70e-01	3.19e-01
20	N/A	2.57e-01	1.71e-01	3.19e-01	NaN
50	N/A	**1.54e-04**	**5.93e-03**	**2.47e-04**	**5.08e-03**
100	N/A	**2.81e-07**	**6.16e-07**	**5.02e-08**	**1.78e-06**
200	N/A	**7.42e-17**	**6.88e-20**	**1.92e-25**	**5.03e-18**
500	N/A	**8.53e-35**	**3.39e-29**	**1.48e-26**	**7.58e-36**
1000	N/A	**2.50e-53**	**6.29e-53**	**2.38e-55**	**4.63e-42**
2000	N/A	**3.24e-63**	**1.37e-58**	**6.99e-52**	**1.18e-57**
5000	N/A	**2.33e-67**	**6.68e-65**	**1.12e-79**	**7.37e-87**

less greedy ⟵ α ⟶ more greedy

p-values

(i) elevators problem p9. The landmark extraction algorithm LM^{RHW} generated 14 nontrivial landmarks for this problem.

Figure A5 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the elevators domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	199.7	2.4	199.2	6.6	198.9	9.6	200.0	0.0
10	200.0	0.0	197.5	14.2	199.9	1.2	198.1	10.1	199.4	3.3
20	200.0	0.0	197.1	16.5	198.7	11.5	200.0	0.0	198.6	12.4
50	200.0	0.0	**193.5**	22.0	195.6	18.0	**190.1**	25.2	**189.5**	26.1
100	200.0	0.0	**177.7**	33.4	**179.5**	30.4	**167.0**	40.4	**174.5**	36.2
200	200.0	0.0	**164.1**	41.1	**164.9**	39.0	**162.8**	38.9	**158.4**	36.2
500	200.0	0.0	**152.2**	41.3	**153.0**	40.9	**145.5**	38.0	**147.9**	38.7
1000	200.0	0.0	**141.8**	37.7	**139.9**	36.4	**138.3**	38.7	**150.1**	38.1
2000	200.0	0.0	**134.7**	36.5	**142.2**	39.4	**137.6**	41.0	**141.7**	36.8
5000	200.0	0.0	**136.4**	34.2	**137.9**	41.1	**130.9**	37.7	**131.7**	39.4

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	3.19e-01	3.19e-01	3.19e-01	NaN
10	N/A	1.23e-01	3.19e-01	9.66e-02	9.71e-02
20	N/A	1.34e-01	3.19e-01	NaN	3.19e-01
50	N/A	**1.08e-02**	3.60e-02	**8.36e-04**	**6.24e-04**
100	N/A	**4.30e-08**	**2.87e-08**	**5.76e-11**	**8.61e-09**
200	N/A	**3.83e-12**	**9.77e-13**	**6.94e-14**	**3.78e-18**
500	N/A	**2.25e-18**	**3.37e-18**	**1.07e-24**	**1.17e-22**
1000	N/A	**2.80e-27**	**1.07e-29**	**2.38e-28**	**8.28e-22**
2000	N/A	**8.39e-33**	**1.60e-25**	**9.95e-27**	**3.57e-28**
5000	N/A	**2.31e-34**	**1.76e-26**	**1.02e-33**	**1.53e-31**

p-values

(j) `elevators` problem `p10`. The landmark extraction algorithm LM^{RHW} generated 16 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
10	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
50	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
100	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
200	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
500	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
1000	200.0	0.0	199.0	9.0	198.5	8.2	200.0	0.0	199.9	0.7
2000	200.0	0.0	196.8	14.9	198.5	8.8	198.6	7.2	198.5	10.5
5000	200.0	0.0	**193.4**	21.1	197.9	11.5	198.4	6.6	195.2	17.3

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	NaN
10	N/A	NaN	NaN	NaN	NaN
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	NaN	NaN	NaN
100	N/A	NaN	NaN	NaN	NaN
200	N/A	NaN	NaN	NaN	NaN
500	N/A	NaN	NaN	NaN	NaN
1000	N/A	3.19e-01	1.23e-01	NaN	3.19e-01
2000	N/A	6.30e-02	1.40e-01	8.69e-02	2.07e-01
5000	N/A	**7.43e-03**	1.23e-01	4.11e-02	1.82e-02

p-values

(k) `elevators` problem `p11`. The landmark extraction algorithm LM^{RHW} generated 26 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	199.9	0.8	200.0	0.0	199.9	1.2	200.0	0.0
10	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	197.9	18.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
50	200.0	0.0	200.0	0.0	198.6	11.8	200.0	0.0	200.0	0.0
100	200.0	0.0	199.6	3.6	200.0	0.0	200.0	0.0	199.2	7.3
200	200.0	0.0	198.4	13.5	198.6	7.8	198.7	11.5	196.6	18.0
500	200.0	0.0	**189.9**	30.5	**189.7**	25.1	**191.7**	25.1	**191.2**	29.9
1000	200.0	0.0	**171.6**	44.7	**182.2**	37.6	**177.5**	37.9	**176.6**	42.2
2000	200.0	0.0	**160.5**	52.2	**156.1**	52.9	**149.9**	54.7	**162.2**	44.7
5000	200.0	0.0	**133.6**	52.0	**138.7**	52.9	**142.4**	54.6	**137.0**	49.9

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	3.19e-01	NaN	3.19e-01	NaN
10	N/A	NaN	NaN	NaN	3.19e-01
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	3.19e-01	NaN	NaN
100	N/A	3.19e-01	NaN	NaN	3.19e-01
200	N/A	3.19e-01	1.23e-01	3.14e-01	1.02e-01
500	N/A	**4.60e-03**	**4.82e-04**	**5.04e-03**	**1.15e-02**
1000	N/A	**1.53e-07**	**6.51e-05**	**8.56e-07**	**3.87e-06**
2000	N/A	**9.21e-10**	**3.13e-11**	**5.08e-13**	**1.35e-11**
5000	N/A	**4.10e-21**	**2.10e-18**	**4.50e-16**	**8.58e-21**

p-values

(l) `elevators` problem `p12`. The landmark extraction algorithm LM^{RHW} generated 18 nontrivial landmarks for this problem.

Figure A5 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `elevators` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

Average cost (less greedy ⟵ α ⟶ more greedy); rows: number of rollouts

	0/UCT		0.2		0.5		0.8		1	
	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
10	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
50	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
100	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
200	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
500	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
1000	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
2000	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
5000	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0

p-values (less greedy ⟵ α ⟶ more greedy)

	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	NaN
10	N/A	NaN	NaN	NaN	NaN
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	NaN	NaN	NaN
100	N/A	NaN	NaN	NaN	NaN
200	N/A	NaN	NaN	NaN	NaN
500	N/A	NaN	NaN	NaN	NaN
1000	N/A	NaN	NaN	NaN	NaN
2000	N/A	NaN	NaN	NaN	NaN
5000	N/A	NaN	NaN	NaN	NaN

(m) `elevators` problem `p13`. The landmark extraction algorithm LM^{RHW} generated 30 nontrivial landmarks for this problem.

Average cost (less greedy ⟵ α ⟶ more greedy); rows: number of rollouts

	0/UCT		0.2		0.5		0.8		1	
	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
10	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
50	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
100	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
200	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
500	200.0	0.0	198.2	11.3	198.6	8.6	199.3	3.5	199.5	2.5
1000	200.0	0.0	196.8	12.8	**193.5**	14.6	**192.0**	17.9	**191.6**	19.8
2000	200.0	0.0	**188.3**	21.4	**185.3**	24.7	**186.2**	23.9	**178.9**	29.4
5000	200.0	0.0	**162.3**	30.5	**156.9**	32.7	**162.5**	31.5	**166.3**	32.0

p-values (less greedy ⟵ α ⟶ more greedy)

	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	NaN
10	N/A	NaN	NaN	NaN	NaN
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	NaN	NaN	NaN
100	N/A	NaN	NaN	NaN	NaN
200	N/A	NaN	NaN	NaN	NaN
500	N/A	1.69e-01	1.63e-01	1.03e-01	1.13e-01
1000	N/A	3.40e-02	**1.67e-04**	**1.51e-04**	**3.39e-04**
2000	N/A	**4.67e-06**	**7.67e-07**	**1.52e-06**	**5.09e-09**
5000	N/A	**3.99e-20**	**4.42e-22**	**3.96e-19**	**4.88e-16**

(n) `elevators` problem `p14`. The landmark extraction algorithm LM^{RHW} generated 24 nontrivial landmarks for this problem.

Average cost (less greedy ⟵ α ⟶ more greedy); rows: number of rollouts

	0/UCT		0.2		0.5		0.8		1	
	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ	$\overline{x}$	σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
10	200.0	0.0	200.0	0.0	200.0	0.0	199.0	8.8	200.0	0.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
50	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
100	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
200	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
500	200.0	0.0	200.0	0.0	200.0	0.0	199.7	1.9	200.0	0.0
1000	200.0	0.0	199.4	5.3	199.9	1.0	200.0	0.0	199.3	4.0
2000	200.0	0.0	198.3	8.3	199.0	5.6	199.4	4.4	199.0	7.5
5000	200.0	0.0	195.1	18.0	197.1	10.8	**196.6**	10.1	**196.7**	11.2

p-values (less greedy ⟵ α ⟶ more greedy)

	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	NaN
10	N/A	NaN	NaN	3.19e-01	NaN
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	NaN	NaN	NaN
100	N/A	NaN	NaN	NaN	NaN
200	N/A	NaN	NaN	NaN	NaN
500	N/A	NaN	NaN	1.57e-01	NaN
1000	N/A	3.19e-01	3.19e-01	NaN	1.57e-01
2000	N/A	8.10e-02	1.32e-01	2.20e-01	2.29e-01
5000	N/A	1.95e-02	2.26e-02	**3.77e-03**	**1.16e-02**

(o) `elevators` problem `p15`. The landmark extraction algorithm LM^{RHW} generated 24 nontrivial landmarks for this problem.

Figure A5 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `elevators` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

	less greedy		⟵	α ⟶	more greedy					
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Average cost

	less greedy	⟵ α ⟶		more greedy	
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	NaN
10	N/A	NaN	NaN	NaN	NaN
20	N/A	NaN	NaN	NaN	NaN
50	N/A	NaN	NaN	NaN	NaN
100	N/A	NaN	NaN	NaN	NaN
200	N/A	NaN	NaN	NaN	NaN
500	N/A	NaN	NaN	NaN	NaN
1000	N/A	NaN	NaN	NaN	NaN
2000	N/A	NaN	NaN	NaN	NaN
5000	N/A	NaN	NaN	NaN	NaN

p-values

(a) `zenotravel` problem `p1`. The landmark extraction algorithm LM^{RHW} generated 0 nontrivial landmarks for this problem. This problem instance is trivial—the initial state satisfies the goal condition.

	less greedy		⟵	α ⟶	more greedy					
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
5	200.0	0.0	200.0	0.0	200.0	0.0	199.9	0.9	197.9	9.5
10	200.0	0.0	199.2	4.5	199.3	4.5	199.5	4.0	196.3	18.2
20	200.0	0.0	197.8	15.6	199.9	1.3	198.2	12.7	199.9	0.8
50	200.0	0.0	198.4	7.7	196.5	17.8	195.7	15.8	197.4	10.5
100	198.8	10.6	196.8	17.6	197.7	12.1	195.4	19.9	196.4	15.3
200	196.8	14.2	190.7	25.2	198.7	6.3	192.4	21.0	194.0	17.4
500	198.0	9.8	191.2	21.3	**188.5**	23.9	**189.2**	25.2	**189.9**	22.9
1000	196.3	22.3	190.1	21.6	**183.2**	30.6	192.5	22.5	**185.3**	27.6
2000	194.3	21.8	**175.4**	32.5	**178.1**	30.3	185.6	26.4	185.3	27.1
5000	194.9	22.5	**172.0**	35.2	**169.4**	35.7	**173.3**	36.3	**175.3**	33.1

Average cost

	less greedy	⟵ α ⟶		more greedy	
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	3.19e-01	5.50e-02
10	N/A	1.10e-01	1.60e-01	3.19e-01	8.17e-02
20	N/A	2.30e-01	3.19e-01	2.30e-01	2.59e-01
50	N/A	8.33e-02	8.81e-02	1.92e-02	3.18e-02
100	N/A	4.09e-01	5.67e-01	2.00e-01	2.77e-01
200	N/A	6.65e-02	2.93e-01	1.36e-01	2.75e-01
500	N/A	1.28e-02	**1.69e-03**	**5.66e-03**	**5.61e-03**
1000	N/A	8.58e-02	**3.38e-03**	3.06e-01	**8.43e-03**
2000	N/A	**4.96e-05**	**2.50e-04**	3.05e-02	2.64e-02
5000	N/A	**4.45e-06**	**5.46e-07**	**2.17e-05**	**3.96e-05**

p-values

(b) `zenotravel` problem `p2`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

	less greedy		⟵	α ⟶	more greedy					
	0/UCT		0.2		0.5		0.8		1	
number of rollouts	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	199.7	2.5
10	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0
20	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	199.3	6.4
50	200.0	0.0	199.6	3.3	199.7	2.1	198.9	9.1	198.7	11.1
100	200.0	0.0	199.3	4.0	198.5	9.8	199.3	5.9	197.9	9.9
200	200.0	0.0	197.7	13.9	**194.8**	16.4	197.8	12.4	196.4	15.6
500	200.0	0.0	197.1	16.0	197.1	15.2	199.1	4.7	198.5	9.2
1000	200.0	0.0	197.4	10.5	197.3	16.4	197.6	16.2	197.4	15.9
2000	200.0	0.0	**195.6**	14.5	194.8	20.6	196.3	16.4	197.2	11.4
5000	200.0	0.0	196.9	10.8	**194.3**	16.5	198.1	9.9	196.1	14.2

Average cost

	less greedy	⟵ α ⟶		more greedy	
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	3.19e-01
10	N/A	NaN	NaN	NaN	NaN
20	N/A	NaN	NaN	NaN	3.19e-01
50	N/A	3.19e-01	1.92e-01	3.19e-01	3.19e-01
100	N/A	1.31e-01	1.84e-01	2.92e-01	7.01e-02
200	N/A	1.57e-01	**7.02e-03**	1.23e-01	5.07e-02
500	N/A	1.16e-01	1.01e-01	9.01e-02	1.60e-01
1000	N/A	3.53e-02	1.56e-01	2.02e-01	1.64e-01
2000	N/A	**9.94e-03**	3.02e-02	4.94e-02	3.57e-02
5000	N/A	1.53e-02	**3.53e-03**	9.08e-02	1.94e-02

p-values

(c) `zenotravel` problem `p3`. The landmark extraction algorithm LM^{RHW} generated 13 nontrivial landmarks for this problem.

Figure A6. The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `zenotravel` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	200.0	0.0	200.0	0.0	199.8	1.4	200.0	0.0
10	200.0	0.0	200.0	0.3	200.0	0.0	195.8	19.7	199.3	4.3
20	200.0	0.0	198.6	12.0	197.9	14.4	199.6	3.1	200.0	0.0
50	199.3	5.9	191.9	26.4	199.0	8.4	194.0	23.5	195.4	20.7
100	200.0	0.0	194.2	22.5	193.4	25.4	199.2	4.4	193.7	22.8
200	199.6	3.2	195.1	19.8	**189.7**	29.0	194.6	22.5	192.6	24.1
500	200.0	0.0	**187.2**	31.8	**185.8**	32.8	**191.9**	24.8	194.0	21.5
1000	200.0	0.0	**184.3**	34.8	**191.3**	25.6	**190.2**	25.3	**192.9**	21.3
2000	199.8	1.7	**180.2**	39.3	**185.3**	31.4	**184.8**	32.3	**190.1**	22.4
5000	200.0	0.0	**179.5**	33.1	**173.1**	40.3	**177.1**	41.1	**179.8**	31.0

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	3.19e-01	NaN
10	N/A	3.19e-01	NaN	6.42e-02	1.83e-01
20	N/A	3.19e-01	2.05e-01	3.19e-01	NaN
50	N/A	1.94e-02	8.05e-01	5.97e-02	1.15e-01
100	N/A	2.63e-02	2.56e-02	1.38e-01	1.86e-02
200	N/A	5.09e-02	**3.86e-03**	5.89e-02	1.31e-02
500	N/A	**6.19e-04**	**2.62e-04**	**5.58e-03**	1.78e-02
1000	N/A	**1.43e-04**	**3.72e-03**	**1.01e-03**	**4.46e-03**
2000	N/A	**2.92e-05**	**1.05e-04**	**9.07e-05**	**2.48e-04**
5000	N/A	**3.04e-07**	**4.13e-08**	**3.56e-06**	**8.72e-08**

less greedy ⟵ α ⟶ more greedy

p-values

(d) `zenotravel` problem `p4`. The landmark extraction algorithm LM^{RHW} generated 11 nontrivial landmarks for this problem.

number of rollouts	0/UCT $\overline{x}$	0/UCT σ	0.2 $\overline{x}$	0.2 σ	0.5 $\overline{x}$	0.5 σ	0.8 $\overline{x}$	0.8 σ	1 $\overline{x}$	1 σ
5	200.0	0.0	200.0	0.0	200.0	0.0	200.0	0.0	199.8	1.7
10	200.0	0.0	200.0	0.0	199.9	0.6	200.0	0.0	199.7	2.9
20	200.0	0.0	195.2	19.0	199.2	7.3	200.0	0.0	198.4	14.0
50	200.0	0.0	199.3	5.2	197.2	15.2	200.0	0.0	199.0	8.5
100	200.0	0.0	197.0	14.1	198.3	10.3	198.6	8.4	199.5	3.3
200	200.0	0.0	198.4	10.4	197.6	11.5	198.2	8.0	198.0	10.4
500	200.0	0.0	196.7	14.4	**195.1**	16.3	197.3	16.6	198.5	8.9
1000	200.0	0.0	197.5	11.6	**195.3**	14.9	196.8	11.5	197.1	10.7
2000	200.0	0.0	**193.0**	16.3	**192.3**	20.7	**190.6**	26.0	**190.3**	24.4
5000	200.0	0.0	**189.3**	22.8	**187.6**	22.4	**188.5**	19.7	**189.3**	22.6

less greedy ⟵ α ⟶ more greedy

Average cost

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	NaN	NaN	NaN	3.19e-01
10	N/A	NaN	3.19e-01	NaN	3.19e-01
20	N/A	3.08e-02	3.19e-01	NaN	3.19e-01
50	N/A	2.26e-01	1.11e-01	NaN	3.19e-01
100	N/A	6.42e-02	1.53e-01	1.57e-01	1.79e-01
200	N/A	1.73e-01	7.22e-02	4.89e-02	1.03e-01
500	N/A	4.93e-02	**9.92e-03**	1.64e-01	1.53e-01
1000	N/A	6.53e-02	**6.68e-03**	1.88e-02	1.88e-02
2000	N/A	**2.80e-04**	**1.59e-03**	**2.19e-03**	**7.22e-04**
5000	N/A	**7.91e-05**	**3.67e-06**	**1.15e-06**	**6.91e-05**

less greedy ⟵ α ⟶ more greedy

p-values

(e) `zenotravel` problem `p5`. The landmark extraction algorithm LM^{RHW} generated 12 nontrivial landmarks for this problem.

Figure A6 (cont'd). The left tables report the average cost (lower is better) of the solutions generated by LAMP in the `zenotravel` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values comparing the average cost of solutions generated by LAMP with the average cost of solutions generated by standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

C Additional probabilistically interesting benchmarks

Success rate (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.31	**0.56**	0.43	0.47	**0.56**
10	0.76	0.73	0.65	0.71	0.68
20	0.75	0.91	0.73	0.76	0.76
50	0.93	0.93	0.87	0.77	0.75
100	0.97	0.92	0.97	0.85	0.64
200	0.99	1.00	0.97	0.96	0.67
500	1.00	0.99	1.00	0.97	0.75
1000	1.00	0.96	0.96	1.00	0.68
2000	0.99	0.99	1.00	0.99	0.80
5000	1.00	0.95	1.00	0.97	0.64

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**4.35e-03**	1.79e-01	6.72e-02	**4.35e-03**
10	N/A	8.25e-01	2.79e-01	6.09e-01	4.25e-01
20	N/A	8.43e-02	9.44e-01	9.44e-01	9.44e-01
50	N/A	1	4.74e-01	8.02e-02	4.18e-02
100	N/A	5.60e-01	1	1.79e-01	2.93e-04
200	N/A	9.44e-01	9.44e-01	7.94e-01	5.00e-04
500	N/A	9.44e-01	1	7.91e-01	5.69e-03
1000	N/A	6.64e-01	6.64e-01	1	5.00e-04
2000	N/A	1	9.44e-01	1	4.00e-02
5000	N/A	5.50e-01	1	7.91e-01	9.14e-05

(a) `exploding_blocksworld` problem `p1`. The landmark extraction algorithm LM^{RHW} generated 7 nontrivial landmarks for this problem.

Success rate (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.83	0.95	0.92	0.85	0.93
10	0.99	1.00	0.95	0.96	0.97
20	1.00	1.00	1.00	1.00	0.99
50	1.00	1.00	1.00	1.00	0.96
100	1.00	1.00	1.00	1.00	0.95
200	1.00	1.00	1.00	1.00	0.99
500	1.00	1.00	1.00	1.00	0.97
1000	1.00	1.00	1.00	1.00	0.97
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1.85e-01	3.12e-01	8.16e-01	2.43e-01
10	N/A	9.44e-01	6.69e-01	7.94e-01	9.44e-01
20	N/A	1	1	1	9.44e-01
50	N/A	1	1	1	6.64e-01
100	N/A	1	1	1	5.50e-01
200	N/A	1	1	1	9.44e-01
500	N/A	1	1	1	7.91e-01
1000	N/A	1	1	1	7.91e-01
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

(b) `exploding_blocksworld` problem `p2`. The landmark extraction algorithm LM^{RHW} generated 4 nontrivial landmarks for this problem.

Success rate (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.27	**0.51**	**0.55**	**0.55**	**0.49**
10	0.32	**0.77**	**0.68**	**0.69**	**0.57**
20	0.56	0.80	0.77	**0.87**	0.80
50	0.81	0.77	0.92	0.88	0.88
100	0.95	0.96	0.79	0.83	0.76
200	0.93	0.93	0.99	0.84	0.88
500	0.99	0.97	0.95	0.91	0.73
1000	0.99	0.91	0.96	0.89	0.73
2000	0.97	0.92	0.89	0.89	0.76
5000	0.99	1.00	0.92	0.95	0.88

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	**5.69e-03**	**1.40e-03**	**1.40e-03**	**8.72e-03**
10	N/A	**8.45e-07**	**9.13e-05**	**4.98e-05**	**4.79e-03**
20	N/A	1.26e-02	2.81e-02	**1.19e-03**	1.26e-02
50	N/A	7.07e-01	2.47e-01	4.89e-01	4.89e-01
100	N/A	9.44e-01	7.80e-02	1.85e-01	4.05e-02
200	N/A	1	5.55e-01	3.08e-01	5.74e-01
500	N/A	9.44e-01	6.69e-01	3.65e-01	5.69e-03
1000	N/A	3.65e-01	7.94e-01	2.89e-01	5.69e-03
2000	N/A	5.60e-01	3.70e-01	3.70e-01	1.94e-02
5000	N/A	9.44e-01	4.53e-01	6.69e-01	2.29e-01

(c) `exploding_blocksworld` problem `p3`. The landmark extraction algorithm LM^{RHW} generated 7 nontrivial landmarks for this problem.

Figure A7. The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `exploding_blocksworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

	less greedy	⟵	α	⟶	more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.00	0.03	**0.17**	**0.12**	0.04
10	0.00	**0.12**	**0.09**	**0.15**	0.08
20	0.01	**0.20**	**0.20**	**0.17**	0.09
50	0.05	**0.24**	**0.27**	0.16	0.15
100	0.07	**0.29**	**0.25**	**0.28**	0.07
200	0.08	**0.40**	**0.40**	**0.24**	0.07
500	0.12	**0.41**	**0.41**	**0.44**	0.11
1000	0.41	0.39	0.47	0.52	0.12
2000	0.39	0.60	0.48	0.45	0.16
5000	0.55	0.48	0.59	0.59	0.08

Success rate

	less greedy	⟵	α	⟶	more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	4.37e-01	**9.15e-05**	**2.28e-03**	2.02e-01
10	N/A	**2.28e-03**	**9.73e-03**	**5.00e-04**	2.05e-02
20	N/A	**1.83e-04**	**1.83e-04**	**8.45e-04**	5.13e-02
50	N/A	**1.66e-03**	**5.00e-04**	5.13e-02	7.83e-02
100	N/A	**4.99e-04**	**2.56e-03**	**8.45e-04**	1
200	N/A	**7.11e-06**	**7.11e-06**	**1.10e-02**	9.44e-01
500	N/A	**9.15e-05**	**9.15e-05**	**2.66e-05**	9.44e-01
1000	N/A	8.02e-01	5.77e-01	2.47e-01	9.15e-05
2000	N/A	1.97e-02	3.04e-01	4.69e-01	3.63e-03
5000	N/A	4.96e-01	7.11e-01	7.11e-01	1.59e-09

p-values

(d) `exploding_blocksworld` problem `p4`. The landmark extraction algorithm LM$^{\text{RHW}}$ generated 9 nontrivial landmarks for this problem.

	less greedy	⟵	α	⟶	more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

	less greedy	⟵	α	⟶	more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1	1	1	1
10	N/A	1	1	1	1
20	N/A	1	1	1	1
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(e) `exploding_blocksworld` problem `p5`. The landmark extraction algorithm LM$^{\text{RHW}}$ generated 0 nontrivial landmarks for this problem. This problem instance is trivial—the initial state satisfies the goal condition.

	less greedy	⟵	α	⟶	more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.00	0.04	0.03	0.03	0.03
10	0.00	0.01	0.04	0.03	0.00
20	0.00	0.05	0.03	**0.16**	0.05
50	0.00	0.08	**0.13**	0.07	**0.11**
100	0.00	0.08	0.07	0.05	**0.09**
200	0.01	0.07	0.07	0.09	0.09
500	0.00	**0.09**	**0.12**	**0.12**	**0.19**
1000	0.00	**0.20**	**0.11**	**0.19**	**0.13**
2000	0.07	**0.31**	0.13	0.20	**0.23**
5000	0.09	**0.27**	**0.28**	**0.37**	**0.28**

Success rate

	less greedy	⟵	α	⟶	more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	2.02e-01	4.37e-01	4.37e-01	4.37e-01
10	N/A	9.44e-01	2.02e-01	4.37e-01	1
20	N/A	1.04e-01	4.37e-01	**2.14e-04**	1.04e-01
50	N/A	2.05e-02	**9.83e-04**	4.43e-02	**4.63e-03**
100	N/A	2.05e-02	4.43e-02	1.04e-01	**9.73e-03**
200	N/A	1.79e-01	1.79e-01	5.13e-02	5.13e-02
500	N/A	**9.73e-03**	**2.28e-03**	**2.28e-03**	**4.98e-05**
1000	N/A	**2.05e-05**	**4.63e-03**	**4.98e-05**	**9.83e-04**
2000	N/A	**2.34e-04**	2.29e-01	2.32e-02	**8.72e-03**
5000	N/A	**8.72e-03**	**5.69e-03**	**9.13e-05**	**5.69e-03**

p-values

(f) `exploding_blocksworld` problem `p6`. The landmark extraction algorithm LM$^{\text{RHW}}$ generated 16 nontrivial landmarks for this problem.

Figure A7 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `exploding_blocksworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

less greedy ⟵ α ⟶ more greedy

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.00	0.01	0.00	0.01	0.00
10	0.00	0.01	0.03	0.00	0.03
20	0.00	0.04	0.05	0.01	0.03
50	0.00	0.04	0.03	0.03	0.04
100	0.00	0.03	0.03	0.01	0.00
200	0.00	0.00	0.01	0.01	0.01
500	0.00	0.01	0.00	0.00	0.00
1000	0.00	0.00	0.01	0.04	0.01
2000	0.00	0.01	0.00	0.00	0.03
5000	0.00	0.01	0.01	0.01	0.03

Success rate

less greedy ⟵ α ⟶ more greedy

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	9.44e-01	1	9.44e-01	1
10	N/A	9.44e-01	4.37e-01	1	4.37e-01
20	N/A	2.02e-01	1.04e-01	9.44e-01	4.37e-01
50	N/A	2.02e-01	4.37e-01	4.37e-01	2.02e-01
100	N/A	4.37e-01	4.37e-01	9.44e-01	1
200	N/A	1	9.44e-01	9.44e-01	9.44e-01
500	N/A	9.44e-01	1	1	1
1000	N/A	1	9.44e-01	2.02e-01	9.44e-01
2000	N/A	9.44e-01	1	1	4.37e-01
5000	N/A	9.44e-01	9.44e-01	9.44e-01	4.37e-01

p-values

(g) `exploding_blocksworld` problem `p7`. The landmark extraction algorithm LM^{RHW} generated 17 nontrivial landmarks for this problem.

less greedy ⟵ α ⟶ more greedy

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.00	0.05	0.07	0.07	0.00
10	0.00	**0.09**	**0.17**	0.08	0.07
20	0.00	**0.16**	**0.20**	**0.20**	**0.13**
50	0.01	**0.29**	**0.27**	**0.28**	**0.29**
100	0.00	**0.32**	**0.20**	**0.33**	**0.37**
200	0.00	**0.40**	**0.44**	**0.32**	**0.37**
500	0.05	**0.47**	**0.45**	**0.56**	**0.56**
1000	0.07	**0.56**	**0.52**	**0.52**	**0.67**
2000	0.09	**0.52**	**0.67**	**0.53**	**0.49**
5000	0.15	**0.77**	**0.73**	**0.77**	**0.60**

Success rate

less greedy ⟵ α ⟶ more greedy

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1.04e-01	4.43e-02	4.43e-02	1
10	N/A	**9.73e-03**	**9.15e-05**	2.05e-02	4.43e-02
20	N/A	**2.14e-04**	**2.05e-05**	**2.05e-05**	**9.83e-04**
50	N/A	**8.93e-07**	**4.39e-06**	**1.94e-06**	**8.93e-07**
100	N/A	**1.51e-08**	**2.05e-05**	**6.34e-09**	**4.04e-10**
200	N/A	**6.07e-11**	**4.27e-12**	**1.51e-08**	**4.04e-10**
500	N/A	**8.67e-09**	**1.95e-08**	**2.13e-11**	**2.13e-11**
1000	N/A	**1.55e-10**	**1.72e-09**	**1.72e-09**	**8.90e-14**
2000	N/A	**3.56e-08**	**2.91e-12**	**1.61e-08**	**1.80e-07**
5000	N/A	**8.45e-13**	**1.18e-11**	**8.45e-13**	**5.02e-08**

p-values

(h) `exploding_blocksworld` problem `p8`. The landmark extraction algorithm LM^{RHW} generated 13 nontrivial landmarks for this problem.

less greedy ⟵ α ⟶ more greedy

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.00	0.01	0.01	0.03	0.03
10	0.00	0.07	0.07	0.05	**0.16**
20	0.00	**0.19**	**0.16**	**0.11**	**0.12**
50	0.00	**0.21**	**0.20**	**0.31**	0.07
100	0.00	**0.24**	**0.15**	**0.21**	**0.27**
200	0.00	**0.27**	**0.31**	**0.23**	**0.24**
500	0.00	**0.33**	**0.24**	**0.29**	**0.20**
1000	0.00	**0.25**	**0.35**	**0.32**	**0.32**
2000	0.00	**0.39**	**0.35**	**0.36**	**0.25**
5000	0.00	**0.33**	**0.35**	**0.40**	**0.32**

Success rate

less greedy ⟵ α ⟶ more greedy

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	9.44e-01	9.44e-01	4.37e-01	4.37e-01
10	N/A	4.43e-02	4.43e-02	1.04e-01	**2.14e-04**
20	N/A	**4.98e-05**	**2.14e-04**	**4.63e-03**	**2.28e-03**
50	N/A	**8.80e-06**	**2.05e-05**	**3.52e-08**	4.43e-02
100	N/A	**1.78e-06**	**5.00e-04**	**8.80e-06**	**3.92e-07**
200	N/A	**3.92e-07**	**3.52e-08**	**3.79e-06**	**1.78e-06**
500	N/A	**6.34e-09**	**1.78e-06**	**8.05e-08**	**2.05e-05**
1000	N/A	**8.37e-07**	**2.59e-09**	**1.51e-08**	**1.51e-08**
2000	N/A	**1.55e-10**	**2.59e-09**	**1.03e-09**	**8.37e-07**
5000	N/A	**6.34e-09**	**2.59e-09**	**6.07e-11**	**1.51e-08**

p-values

(i) `exploding_blocksworld` problem `p9`. The landmark extraction algorithm LM^{RHW} generated 17 nontrivial landmarks for this problem.

Figure A7 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `exploding_blocksworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

	less greedy		⟵ α ⟶		more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.23	0.36	0.25	0.32	0.32
10	0.25	**0.49**	0.45	**0.57**	**0.51**
20	0.52	0.64	0.51	0.60	0.53
50	0.52	0.65	0.71	0.64	0.55
100	0.55	0.56	0.65	0.71	0.72
200	0.64	0.68	0.59	0.67	0.72
500	0.53	0.61	0.61	0.68	0.59
1000	0.60	0.59	0.68	0.68	0.61
2000	0.60	0.68	0.75	0.77	0.68
5000	0.59	0.57	0.65	0.61	0.51

Success rate

	less greedy		⟵ α ⟶		more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1.04e-01	7.55e-01	2.39e-01	2.39e-01
10	N/A	**5.69e-03**	1.94e-02	**2.89e-04**	**3.63e-03**
20	N/A	2.14e-01	9.44e-01	4.16e-01	9.44e-01
50	N/A	1.66e-01	5.13e-02	2.14e-01	8.20e-01
100	N/A	9.44e-01	2.76e-01	9.77e-02	7.24e-02
200	N/A	7.24e-01	6.11e-01	8.29e-01	4.31e-01
500	N/A	4.19e-01	4.19e-01	1.28e-01	6.03e-01
1000	N/A	9.44e-01	4.29e-01	4.29e-01	9.44e-01
2000	N/A	4.29e-01	1.37e-01	7.36e-02	4.29e-01
5000	N/A	9.44e-01	5.14e-01	8.26e-01	4.14e-01

p-values

(a) `tireworld` problem `p1`. The landmark extraction algorithm LM^{RHW} generated 5 nontrivial landmarks for this problem.

	less greedy		⟵ α ⟶		more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.89	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

	less greedy		⟵ α ⟶		more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	2.29e-01	2.29e-01	2.29e-01	2.29e-01
10	N/A	1	1	1	1
20	N/A	1	1	1	1
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(b) `tireworld` problem `p2`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

	less greedy		⟵ α ⟶		more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.83	0.96	0.99	0.99	1.00
10	0.93	0.93	0.97	1.00	0.99
20	0.96	0.99	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

	less greedy		⟵ α ⟶		more greedy
number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1.38e-01	7.68e-02	7.68e-02	5.60e-02
10	N/A	1	6.73e-01	4.48e-01	5.55e-01
20	N/A	7.94e-01	6.64e-01	6.64e-01	6.64e-01
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(c) `tireworld` problem `p3`. The landmark extraction algorithm LM^{RHW} generated 2 nontrivial landmarks for this problem.

Figure A8. The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	less greedy	$\longleftarrow$	α	$\longrightarrow$	more greedy
	0/UCT	0.2	0.5	0.8	1
5	0.84	0.92	0.92	0.91	0.93
10	0.97	0.97	0.96	0.97	0.95
20	0.99	1.00	1.00	1.00	0.99
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

number of rollouts	less greedy	$\longleftarrow$	α	$\longrightarrow$	more greedy
	0/UCT	0.2	0.5	0.8	1
5	N/A	3.89e-01	3.89e-01	4.82e-01	3.08e-01
10	N/A	1	9.44e-01	1	7.97e-01
20	N/A	9.44e-01	9.44e-01	9.44e-01	1
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(d) `tireworld` problem `p4`. The landmark extraction algorithm LM^{RHW} generated 2 nontrivial landmarks for this problem.

number of rollouts	less greedy	$\longleftarrow$	α	$\longrightarrow$	more greedy
	0/UCT	0.2	0.5	0.8	1
5	0.92	0.99	0.93	1.00	0.97
10	0.96	1.00	0.97	0.97	1.00
20	1.00	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

number of rollouts	less greedy	$\longleftarrow$	α	$\longrightarrow$	more greedy
	0/UCT	0.2	0.5	0.8	1
5	N/A	4.53e-01	9.44e-01	3.59e-01	5.60e-01
10	N/A	6.64e-01	9.44e-01	9.44e-01	6.64e-01
20	N/A	1	1	1	1
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(e) `tireworld` problem `p5`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

number of rollouts	less greedy	$\longleftarrow$	α	$\longrightarrow$	more greedy
	0/UCT	0.2	0.5	0.8	1
5	0.95	1.00	0.99	1.00	0.99
10	0.99	1.00	1.00	1.00	1.00
20	0.99	1.00	0.99	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

number of rollouts	less greedy	$\longleftarrow$	α	$\longrightarrow$	more greedy
	0/UCT	0.2	0.5	0.8	1
5	N/A	5.50e-01	6.69e-01	5.50e-01	6.69e-01
10	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01
20	N/A	9.44e-01	1	9.44e-01	9.44e-01
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(f) `tireworld` problem `p6`. The landmark extraction algorithm LM^{RHW} generated 2 nontrivial landmarks for this problem.

Figure A8 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

Success rate (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.64	0.77	0.87	0.85	0.84
10	0.89	0.93	0.92	0.95	0.99
20	0.95	0.99	1.00	0.97	1.00
50	1.00	0.99	1.00	1.00	1.00
100	0.97	0.99	1.00	1.00	0.99
200	0.96	1.00	1.00	1.00	1.00
500	0.97	1.00	1.00	1.00	0.97
1000	0.99	1.00	1.00	1.00	1.00
2000	1.00	1.00	0.99	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	1.71e-01	1.63e-02	2.43e-02	3.54e-02
10	N/A	6.84e-01	8.07e-01	5.69e-01	2.89e-01
20	N/A	6.69e-01	5.50e-01	7.97e-01	5.50e-01
50	N/A	9.44e-01	1	1	1
100	N/A	9.44e-01	7.91e-01	7.91e-01	9.44e-01
200	N/A	6.64e-01	6.64e-01	6.64e-01	6.64e-01
500	N/A	7.91e-01	7.91e-01	7.91e-01	1
1000	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01
2000	N/A	1	9.44e-01	1	1
5000	N/A	1	1	1	1

(g) `tireworld` problem `p7`. The landmark extraction algorithm LM^{RHW} generated 2 nontrivial landmarks for this problem.

Success rate (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.73	0.93	0.88	0.88	0.91
10	0.95	0.96	0.96	0.92	0.93
20	0.93	0.96	0.95	1.00	0.99
50	0.99	1.00	1.00	1.00	1.00
100	0.99	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	2.95e-02	1.18e-01	1.18e-01	6.16e-02
10	N/A	9.44e-01	9.44e-01	8.02e-01	9.44e-01
20	N/A	8.00e-01	9.44e-01	4.48e-01	5.55e-01
50	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01
100	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

(h) `tireworld` problem `p8`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

Success rate (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	0.51	0.55	**0.75**	0.71	0.64
10	0.79	0.77	0.77	0.76	0.88
20	0.80	0.89	0.88	0.81	0.92
50	0.91	0.95	0.95	0.95	0.89
100	0.92	1.00	1.00	0.96	1.00
200	1.00	0.99	0.95	1.00	0.99
500	0.97	0.99	1.00	1.00	1.00
1000	1.00	0.99	1.00	1.00	1.00
2000	0.99	1.00	1.00	1.00	1.00
5000	0.99	1.00	1.00	1.00	1.00

p-values (less greedy ⟵ α ⟶ more greedy)

number of rollouts	0/UCT	0.2	0.5	0.8	1
5	N/A	7.05e-01	**1.18e-02**	3.60e-02	1.64e-01
10	N/A	9.44e-01	9.44e-01	8.23e-01	3.24e-01
20	N/A	3.20e-01	4.01e-01	9.44e-01	1.92e-01
50	N/A	6.81e-01	6.81e-01	6.81e-01	9.44e-01
100	N/A	3.59e-01	3.59e-01	6.77e-01	3.59e-01
200	N/A	9.44e-01	5.50e-01	1	9.44e-01
500	N/A	9.44e-01	7.91e-01	7.91e-01	7.91e-01
1000	N/A	9.44e-01	1	1	1
2000	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01
5000	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01

(i) `tireworld` problem `p9`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

Figure A8 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy		⟵ α ⟶		more greedy
5	0.81	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy		⟵ α ⟶		more greedy
5	N/A	4.00e-02	4.00e-02	4.00e-02	4.00e-02
10	N/A	1	1	1	1
20	N/A	1	1	1	1
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(j) `tireworld` problem `p10`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy		⟵ α ⟶		more greedy
5	0.97	0.97	0.93	0.96	0.99
10	0.99	0.99	0.97	1.00	0.99
20	1.00	1.00	0.99	1.00	0.99
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy		⟵ α ⟶		more greedy
5	N/A	1	6.73e-01	9.44e-01	9.44e-01
10	N/A	1	9.44e-01	9.44e-01	1
20	N/A	1	9.44e-01	1	9.44e-01
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(k) `tireworld` problem `p11`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy		⟵ α ⟶		more greedy
5	0.88	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00
500	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00
2000	1.00	1.00	1.00	1.00	1.00
5000	1.00	1.00	1.00	1.00	1.00

Success rate

number of rollouts	0/UCT	0.2	0.5	0.8	1
	less greedy		⟵ α ⟶		more greedy
5	N/A	1.79e-01	1.79e-01	1.79e-01	1.79e-01
10	N/A	1	1	1	1
20	N/A	1	1	1	1
50	N/A	1	1	1	1
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(l) `tireworld` problem `p12`. The landmark extraction algorithm LM^{RHW} generated 1 nontrivial landmark for this problem.

Figure A8 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	0/UCT (less greedy)	0.2	0.5 ($\longleftarrow \alpha \longrightarrow$)	0.8	1 (more greedy)
5	0.47	**0.73**	**0.73**	**<u>0.75</u>**	0.69
10	0.83	0.88	0.91	0.95	<u>0.96</u>
20	0.89	<u>0.99</u>	0.91	0.95	0.93
50	0.97	0.99	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
100	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
200	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
500	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
1000	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
2000	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
5000	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>

Success rate

number of rollouts	0/UCT (less greedy)	0.2	0.5 ($\longleftarrow \alpha \longrightarrow$)	0.8	1 (more greedy)
5	N/A	**4.77e-03**	**4.77e-03**	**3.06e-03**	1.63e-02
10	N/A	5.88e-01	3.94e-01	1.85e-01	1.38e-01
20	N/A	2.89e-01	9.44e-01	5.69e-01	6.84e-01
50	N/A	9.44e-01	7.91e-01	7.91e-01	7.91e-01
100	N/A	1	1	1	1
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(m) `tireworld` problem `p13`. The landmark extraction algorithm LM[RHW] generated 1 nontrivial landmark for this problem.

number of rollouts	0/UCT (less greedy)	0.2	0.5 ($\longleftarrow \alpha \longrightarrow$)	0.8	1 (more greedy)
5	0.28	**0.57**	**0.71**	**0.65**	**<u>0.77</u>**
10	0.71	0.84	0.84	<u>0.85</u>	0.75
20	0.87	0.91	0.88	<u>0.93</u>	0.92
50	0.88	0.99	0.97	0.99	<u>1.00</u>
100	0.99	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
200	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
500	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
1000	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
2000	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
5000	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>

Success rate

number of rollouts	0/UCT (less greedy)	0.2	0.5 ($\longleftarrow \alpha \longrightarrow$)	0.8	1 (more greedy)
5	N/A	**8.53e-04**	**2.47e-06**	**3.09e-05**	**8.05e-08**
10	N/A	1.62e-01	1.62e-01	1.22e-01	7.15e-01
20	N/A	6.91e-01	9.44e-01	4.74e-01	5.77e-01
50	N/A	2.29e-01	2.94e-01	2.29e-01	1.79e-01
100	N/A	9.44e-01	9.44e-01	9.44e-01	9.44e-01
200	N/A	1	1	1	1
500	N/A	1	1	1	1
1000	N/A	1	1	1	1
2000	N/A	1	1	1	1
5000	N/A	1	1	1	1

p-values

(n) `tireworld` problem `p14`. The landmark extraction algorithm LM[RHW] generated 1 nontrivial landmark for this problem.

number of rollouts	0/UCT (less greedy)	0.2	0.5 ($\longleftarrow \alpha \longrightarrow$)	0.8	1 (more greedy)
5	0.37	**<u>0.71</u>**	**0.64**	**0.67**	0.60
10	0.49	**<u>0.81</u>**	**0.75**	**<u>0.81</u>**	0.68
20	0.77	<u>0.81</u>	0.80	<u>0.81</u>	<u>0.81</u>
50	0.77	0.81	<u>0.85</u>	0.84	0.76
100	0.85	0.84	<u>0.87</u>	0.77	0.76
200	0.84	0.77	0.83	0.80	<u>0.87</u>
500	0.81	0.84	<u>0.85</u>	<u>0.85</u>	0.84
1000	0.87	0.93	<u>0.95</u>	0.84	0.79
2000	0.96	<u>0.97</u>	<u>0.97</u>	0.80	0.83
5000	0.92	<u>0.97</u>	<u>0.97</u>	0.93	0.87

Success rate

number of rollouts	0/UCT (less greedy)	0.2	0.5 ($\longleftarrow \alpha \longrightarrow$)	0.8	1 (more greedy)
5	N/A	**3.15e-04**	**3.67e-03**	**1.45e-03**	1.31e-02
10	N/A	**8.05e-04**	**7.70e-03**	**8.05e-04**	4.96e-02
20	N/A	7.07e-01	8.21e-01	7.07e-01	7.07e-01
50	N/A	7.07e-01	4.08e-01	4.99e-01	9.44e-01
100	N/A	9.44e-01	9.44e-01	4.08e-01	3.30e-01
200	N/A	4.99e-01	9.44e-01	7.03e-01	8.14e-01
500	N/A	8.17e-01	7.01e-01	7.01e-01	8.17e-01
1000	N/A	4.74e-01	3.80e-01	8.14e-01	4.05e-01
2000	N/A	9.44e-01	9.44e-01	7.68e-02	1.38e-01
5000	N/A	5.60e-01	5.60e-01	9.44e-01	5.77e-01

p-values

(o) `tireworld` problem `p15`. The landmark extraction algorithm LM[RHW] generated 3 nontrivial landmarks for this problem.

Figure A8 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts. In all tables, boldfaced values indicate where LAMP significantly dominated standard UCT at the same number of rollouts, with $p < 0.0125$, the adjusted level using a Bonferroni adjustment of $\alpha_{stat} = 0.05/4$.

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	0.88	0.60	0.59	0.64	0.51
10	0.89	0.65	0.67	0.72	0.63
20	0.92	0.51	0.55	0.48	0.69
50	1.00	0.60	0.55	0.48	0.52
100	1.00	0.73	0.60	0.53	0.61
200	1.00	0.99	0.56	0.63	0.77
500	1.00	1.00	0.89	0.61	0.63
1000	1.00	1.00	1.00	0.59	0.59
2000	1.00	1.00	1.00	0.55	0.65
5000	1.00	1.00	1.00	0.64	0.53

Success rate

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	N/A	2.97e-03	1.86e-03	1.07e-02	7.92e-05
10	N/A	1.04e-02	1.54e-02	6.31e-02	4.49e-03
20	N/A	1.09e-05	6.88e-05	2.87e-06	1.45e-02
50	N/A	1.39e-05	9.46e-07	2.10e-08	2.23e-07
100	N/A	3.63e-03	1.39e-05	4.63e-07	2.66e-05
200	N/A	9.44e-01	1.89e-06	4.98e-05	1.31e-02
500	N/A	1	2.29e-01	2.66e-05	4.98e-05
1000	N/A	1	1	7.18e-06	7.18e-06
2000	N/A	1	1	9.46e-07	1.64e-04
5000	N/A	1	1	9.14e-05	4.63e-07

p-values

(a) `triangle_tireworld` problem `p1`. The landmark extraction algorithm LM$^{\text{RHW}}$ generated 2 nontrivial landmarks for this problem.

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	0.71	0.21	0.27	0.29	0.35
10	0.71	0.21	0.28	0.27	0.25
20	0.89	0.27	0.13	0.16	0.27
50	0.97	0.25	0.20	0.11	0.29
100	0.99	0.33	0.20	0.13	0.15
200	1.00	0.47	0.12	0.15	0.31
500	1.00	0.35	0.23	0.15	0.08
1000	1.00	0.41	0.33	0.11	0.12
2000	1.00	0.43	0.29	0.09	0.23
5000	1.00	0.47	0.33	0.17	0.19

Success rate

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	N/A	2.50e-08	1.07e-06	5.67e-06	9.15e-05
10	N/A	2.50e-08	2.47e-06	1.07e-06	4.38e-07
20	N/A	9.03e-12	8.94e-18	2.18e-16	9.03e-12
50	N/A	4.79e-15	1.74e-17	9.96e-23	1.89e-13
100	N/A	2.51e-12	5.13e-18	1.19e-21	9.45e-21
200	N/A	9.28e-09	4.28e-23	2.35e-21	8.00e-14
500	N/A	2.51e-12	2.56e-17	2.35e-21	8.52e-26
1000	N/A	2.88e-10	8.45e-13	6.05e-24	4.28e-23
2000	N/A	7.06e-10	2.24e-14	6.81e-25	2.56e-17
5000	N/A	9.28e-09	8.45e-13	5.38e-20	2.78e-19

p-values

(b) `triangle_tireworld` problem `p2`. The landmark extraction algorithm LM$^{\text{RHW}}$ generated 4 nontrivial landmarks for this problem.

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	0.17	0.12	0.21	0.17	0.11
10	0.36	0.07	0.08	0.16	0.08
20	0.45	0.12	0.11	0.07	0.08
50	0.53	0.07	0.08	0.08	0.07
100	0.60	0.11	0.07	0.04	0.11
200	0.68	0.27	0.13	0.09	0.08
500	0.59	0.19	0.28	0.07	0.23
1000	0.61	0.35	0.17	0.15	0.08
2000	0.75	0.25	0.20	0.08	0.16
5000	0.60	0.27	0.24	0.15	0.09

Success rate

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	0.08	0.04	0.05	0.01	0.01
10	0.13	0.04	0.01	0.07	0.05
20	0.07	0.04	0.07	0.03	0.05
50	0.09	0.05	0.05	0.04	0.04
100	0.13	0.03	0.01	0.04	0.03
200	0.15	0.05	0.07	0.00	0.04
500	0.12	0.08	0.07	0.04	0.04
1000	0.07	0.09	0.09	0.04	0.04
2000	0.08	0.15	0.11	0.08	0.07
5000	0.08	0.03	0.08	0.03	0.04

p-values

(c) `triangle_tireworld` problem `p3`. The landmark extraction algorithm LM$^{\text{RHW}}$ generated 4 nontrivial landmarks for this problem.

Figure A9. The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `triangle_tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts.

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	0.05	0.04	0.04	0.01	<u>0.08</u>
10	<u>0.05</u>	0.04	0.01	0.04	0.03
20	0.09	<u>0.11</u>	0.04	0.04	0.04
50	<u>0.11</u>	0.03	0.03	0.05	0.07
100	<u>0.15</u>	0.07	0.04	0.05	0.01
200	<u>0.12</u>	0.01	0.04	<u>0.12</u>	0.01
500	0.11	<u>0.13</u>	0.08	0.04	0.05
1000	<u>0.15</u>	0.08	0.07	0.11	0.07
2000	0.08	<u>0.13</u>	0.09	0.09	0.05
5000	0.12	<u>0.13</u>	<u>0.13</u>	0.04	0.07

Success rate

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	N/A	9.44e-01	9.44e-01	3.04e-01	6.60e-01
10	N/A	9.44e-01	3.04e-01	9.44e-01	6.21e-01
20	N/A	9.44e-01	2.89e-01	2.89e-01	2.89e-01
50	N/A	7.68e-02	7.68e-02	3.12e-01	5.06e-01
100	N/A	1.53e-01	4.00e-02	7.83e-02	3.64e-03
200	N/A	1.31e-02	1.04e-01	1	1.31e-02
500	N/A	7.24e-01	7.24e-01	1.79e-01	3.12e-01
1000	N/A	2.61e-01	1.53e-01	5.44e-01	1.53e-01
2000	N/A	3.59e-01	9.44e-01	9.44e-01	6.60e-01
5000	N/A	9.44e-01	9.44e-01	1.04e-01	3.58e-01

p-values

(d) `triangle_tireworld` problem `p4`. The landmark extraction algorithm $\mathrm{LM}^{\mathrm{RHW}}$ generated 4 nontrivial landmarks for this problem.

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	0.01	0.00	0.00	<u>0.03</u>	0.01
10	<u>0.04</u>	0.00	0.00	0.01	0.00
20	0.01	<u>0.03</u>	0.00	0.01	<u>0.03</u>
50	<u>0.03</u>	0.00	0.00	0.01	0.01
100	<u>0.04</u>	0.00	0.01	0.00	0.01
200	<u>0.03</u>	0.01	0.01	0.00	0.00
500	0.00	0.01	<u>0.04</u>	0.01	0.01
1000	<u>0.03</u>	0.01	0.00	0.01	0.01
2000	0.01	<u>0.03</u>	<u>0.03</u>	0.01	0.00
5000	0.01	<u>0.03</u>	<u>0.03</u>	0.01	0.01

Success rate

number of rollouts	less greedy 0/UCT	0.2	⟵ α ⟶ 0.5	0.8	more greedy 1
5	N/A	9.44e-01	9.44e-01	9.44e-01	1
10	N/A	2.02e-01	1.04e-01	3.04e-01	1.04e-01
20	N/A	9.44e-01	9.44e-01	1	9.44e-01
50	N/A	4.37e-01	4.37e-01	9.44e-01	9.44e-01
100	N/A	2.02e-01	5.31e-01	2.02e-01	5.31e-01
200	N/A	9.44e-01	9.44e-01	4.37e-01	4.37e-01
500	N/A	9.44e-01	2.02e-01	9.44e-01	9.44e-01
1000	N/A	9.44e-01	4.37e-01	9.44e-01	9.44e-01
2000	N/A	9.44e-01	9.44e-01	1	9.44e-01
5000	N/A	9.44e-01	9.44e-01	1	1

p-values

(e) `triangle_tireworld` problem `p5`. The landmark extraction algorithm $\mathrm{LM}^{\mathrm{RHW}}$ generated 4 nontrivial landmarks for this problem.

Figure A9 (cont'd). The left tables report the success rate (higher is better) of the solutions generated by LAMP in the `triangle_tireworld` domain over 75 runs. Underlined values indicate the best performing α-value in the row. The right tables report p-values computed using a two-tailed Boschloo exact test comparing the success rate of LAMP with the success rate of standard UCT ($\alpha = 0$) at the same number of rollouts.