

Computational Results of L-PAD² Over Instance Sets A, B, and C

Table 1: Detailed computational results of L-PAD² over instance set A

Instance ID	①: O-CAM (60s)				①: O-CAM (3600s)				③: A-CAM+PO(60s)				④: L-PAD (60s)					L-PAD ² (60s)					
	LB	UB	Gap (%)	T (s)	LB	UB	Gap (%)	T (s)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Gap-③ (%)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Gap-③ (%)	Gap-④ (%)
A.4.2(1)	42.10	42.10	0.00	2.68	42.10	42.10	0.00	2.68	40.17	0.25	4.59	4.59	42.05	4.57	0.12	0.12	-4.69	42.05	0.01	0.12	0.12	-4.69	0.00
A.4.2(2)	39.12	39.12	0.00	2.77	39.12	39.12	0.00	2.77	38.59	0.34	1.35	1.35	38.59	3.55	1.35	1.35	0.00	38.59	<0.01	1.35	1.35	0.00	0.00
A.4.2(3)	38.15	38.15	0.00	2.67	38.15	38.15	0.00	2.67	37.58	0.21	1.49	1.49	37.86	3.86	0.76	0.76	-0.74	37.58	<0.01	1.49	1.49	0.00	0.73
A.4.2(4)	40.35	40.35	0.00	2.04	40.35	40.35	0.00	2.04	39.89	0.21	1.13	1.13	39.89	7.76	1.13	1.13	0.00	39.89	<0.01	1.13	1.13	0.00	0.00
A.4.2(5)	39.55	39.55	0.00	1.94	39.55	39.55	0.00	1.94	37.86	0.29	4.26	4.26	39.26	4.83	0.72	0.72	-3.70	39.38	0.01	0.44	0.44	-4.00	-0.29
Avg of A.4.2	39.85	39.85	0.00	2.42	39.85	39.85	0.00	2.42	38.82	0.26	2.57	2.57	39.53	4.91	0.82	0.82	-1.83	39.50	<0.01	0.90	0.90	-1.74	0.09
A.6.3(1)	57.12	57.12	0.00	31.28	57.12	57.12	0.00	31.28	57.02	0.84	0.17	0.17	57.02	33.23	0.17	0.17	0.00	57.02	0.03	0.17	0.17	0.00	0.00
A.6.3(2)	73.02	73.02	0.00	44.37	73.02	73.02	0.00	44.37	72.42	0.95	0.82	0.82	72.42	26.14	0.82	0.82	0.00	72.42	0.03	0.82	0.82	0.00	0.00
A.6.3(3)	51.70	51.70	0.00	49.36	51.70	51.70	0.00	49.36	51.53	0.91	0.33	0.33	51.53	31.36	0.33	0.33	0.00	51.53	0.03	0.33	0.33	0.00	0.00
A.6.3(4)	53.13	53.13	0.00	43.95	53.13	53.13	0.00	43.95	52.73	0.85	0.76	0.76	52.73	24.95	0.76	0.76	0.00	52.73	0.03	0.76	0.76	0.00	0.00
A.6.3(5)	54.75	54.75	0.00	33.39	54.75	54.75	0.00	33.39	54.47	0.79	0.51	0.51	54.47	26.33	0.51	0.51	0.00	54.47	0.02	0.51	0.51	0.00	0.00
Avg of A.6.3	57.94	57.94	0.00	40.47	57.94	57.94	0.00	40.47	57.63	0.87	0.52	0.52	57.63	28.40	0.52	0.52	0.00	57.63	0.03	0.52	0.52	0.00	0.00
A.8.4(1)	103.59	111.68	7.80	60.00	103.96	104.52	0.54	3600.00	99.84	5.65	3.62	3.96	99.40	60.00	4.04	4.38	0.44	102.41	0.11	1.14	1.49	-2.57	-3.02
A.8.4(2)	83.37	89.66	8.04	60.00	83.37	83.37	0.00	2758.00	79.62	6.17	4.50	4.50	83.13	60.00	0.29	0.29	-4.40	82.75	0.11	0.75	0.75	-3.93	0.45
A.8.4(3)	82.07	87.20	6.25	60.00	82.07	82.07	0.00	2540.00	81.60	2.50	0.57	0.57	81.60	60.00	0.57	0.57	0.00	81.60	0.11	0.57	0.57	0.00	0.00
A.8.4(4)	71.94	77.65	7.94	60.00	72.61	74.07	2.01	3600.00	70.75	6.91	1.66	2.57	72.47	54.61	-0.73	0.20	-2.43	72.47	0.11	-0.73	0.20	-2.43	0.00
A.8.4(5)	75.23	81.59	8.45	60.00	75.69	77.13	1.91	3600.00	74.34	2.62	1.18	1.78	73.61	56.22	2.15	2.74	0.98	74.34	0.11	1.18	1.78	0.00	-0.99
Avg of A.8.4	83.24	89.56	7.36	60.00	83.54	79.16	0.98	3600.00	81.23	4.77	2.30	2.67	82.04	59.30	1.26	1.64	-1.08	82.71	0.11	0.58	0.96	-1.78	-0.71
A.10.5(1)	93.74	101.88	8.69	60.00	94.36	98.54	4.43	3600.00	92.61	60.03	1.21	1.85	92.11	60.00	1.74	2.39	0.54	93.19	0.32	0.59	1.24	-0.63	-1.17
A.10.5(2)	94.06	105.86	12.50	60.00	97.58	101.79	4.31	3600.00	94.68	60.03	-0.66	2.97	93.02	60.00	1.10	4.67	1.75	96.75	0.51	-2.86	0.85	-2.18	-4.00
A.10.5(3)	99.75	108.39	8.65	60.00	101.08	104.57	3.45	3600.00	98.91	43.42	0.85	2.15	96.81	60.00	2.95	4.22	2.12	99.76	0.33	-0.01	1.31	-0.86	-3.05
A.10.5(4)	98.07	109.56	11.70	60.00	100.27	106.01	5.73	3600.00	98.17	60.05	-0.11	2.09	96.15	60.00	1.95	4.11	2.06	99.66	0.51	-1.62	0.61	-1.51	-3.65
A.10.5(5)	99.68	111.91	12.30	60.00	101.61	108.50	6.78	3600.00	100.30	60.04	-0.62	1.29	98.81	60.00	0.87	2.76	1.49	100.30	0.32	-0.62	1.29	0.00	-1.51
Avg of A.10.5	97.06	107.52	10.77	60.00	98.98	103.88	4.94	3600.00	96.93	56.71	0.13	2.07	95.38	60.00	1.72	3.63	1.59	97.93	0.40	-0.90	1.06	-1.04	-2.68
A.15.8(1)	151.48	165.86	9.50	60.00	153.01	164.22	7.33	3600.00	149.28	60.03	1.45	2.44	146.27	60.00	3.43	4.40	2.01	151.45	1.08	0.01	1.02	-1.46	-3.54
A.15.8(2)	140.35	157.46	12.20	60.00	144.33	155.84	7.97	3600.00	140.08	60.01	0.20	2.95	141.60	60.00	-0.89	1.90	-1.09	143.31	0.34	-2.11	0.71	-2.31	-1.21
A.15.8(3)	166.12	185.08	11.40	60.00	168.81	182.54	8.13	3600.00	162.73	60.01	2.04	3.60	152.22	60.00	8.37	9.83	6.46	166.70	0.64	-0.35	1.25	-2.44	-9.51
A.15.8(4)	146.59	169.36	15.50	60.00	151.93	167.31	10.10	3600.00	150.03	60.02	-2.34	1.26	143.79	60.00	1.91	5.36	4.16	149.03	0.45	-1.66	1.91	0.66	-3.64
A.15.8(5)	179.89	199.79	11.10	60.00	185.83	196.73	5.87	3600.00	181.32	60.04	-0.79	2.42	179.65	60.00	0.13	3.32	0.92	184.71	1.11	-2.68	0.60	-1.87	-2.82
Avg of A.15.8	156.89	175.51	11.94	60.00	160.78	173.33	7.88	3600.00	156.69	60.00	0.11	2.53	152.71	60.00	2.59	4.96	2.49	159.04	0.72	-1.36	1.10	-1.48	-4.14

Note. A.4.2(1): represents the first instance in instance group A.4.2; other instance IDs follow a similar naming pattern; **Gap**: $100\% \times (LB - UB) / LB$; **A Gap to B**: $100\% \times (Obj_B - Obj_A) / Obj_B$

Table 2: Detailed computational results of L-PAD² over instance set B

Instance ID	①: O-CAM (60s)				①: O-CAM (3600s)				③: A-CAM+PO(60s)				④: L-PAD (60s)					L-PAD ² (60s)					
	LB	UB	Gap (%)	T (s)	LB	UB	Gap (%)	T (s)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Gap-③ (%)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Gap-③ (%)	Gap-④ (%)
B.20_10(1)	0.00	265.65	-	60.00	246.58	264.98	7.46	3600.00	239.13	60.00	-	3.02	228.10	60.00	-	7.49	4.61	240.48	0.64	-	2.47	-0.56	-5.43
B.20_10(2)	0.00	236.49	-	60.00	217.48	235.93	8.48	3600.00	213.56	60.00	-	1.80	197.11	60.00	-	9.37	7.70	215.25	1.79	-	1.03	-0.79	-9.20
B.20_10(3)	0.00	224.22	-	60.00	208.25	223.65	7.39	3600.00	198.32	60.00	-	4.77	192.93	60.00	-	7.36	2.72	206.04	0.49	-	1.06	-3.89	-6.80
B.20_10(4)	0.00	227.40	-	60.00	209.30	226.78	8.35	3600.00	201.49	60.00	-	3.73	198.84	60.00	-	5.00	1.31	206.39	1.53	-	1.39	-2.43	-3.79
B.20_10(5)	0.00	220.64	-	60.00	202.41	220.05	8.71	3600.00	197.61	60.00	-	2.37	193.58	60.00	-	4.36	2.04	200.30	1.02	-	1.04	-1.36	-3.47
Avg of B.20_10	0.00	234.88	-	60.00	216.80	234.28	8.08	3600.00	210.02	60.00	-	3.14	202.11	60.00	-	6.72	3.68	213.69	1.10	-	1.40	-1.81	-5.74
B.25_10(1)	-	-	-	60.00	264.55	288.91	9.21	3600.00	259.35	60.00	-	1.96	255.20	60.00	-	3.53	1.60	262.32	1.19	-	0.84	-1.15	-2.79
B.25_10(2)	-	-	-	60.00	258.11	281.76	9.16	3600.00	258.15	60.00	-	-0.02	245.81	60.00	-	4.77	4.78	253.11	1.37	-	1.94	1.95	-2.97
B.25_10(3)	-	-	-	60.00	268.93	293.14	9.00	3600.00	264.59	60.00	-	1.61	254.55	60.00	-	5.35	3.79	264.29	0.81	-	1.73	0.11	-3.83
B.25_10(4)	-	-	-	60.00	260.51	289.55	11.10	3600.00	258.02	60.00	-	0.96	254.14	60.00	-	2.45	1.50	256.44	1.19	-	1.56	0.61	-0.90
B.25_10(5)	-	-	-	60.00	283.74	313.82	10.60	3600.00	277.75	60.00	-	2.11	272.30	60.00	-	4.03	1.96	278.45	0.85	-	1.86	-0.25	-2.26
Avg of B.25_10	-	-	-	60.00	267.17	293.43	9.81	3600.00	263.57	60.00	-	1.33	256.40	60.00	-	4.03	2.73	262.92	1.08	-	1.59	0.26	-2.55
B.30_10(1)	-	-	-	60.00	-	-	-	3600.00	294.22	60.00	-	-	298.92	60.00	-	-	-1.60	305.41	2.10	-	-	-3.80	-2.17
B.30_10(2)	-	-	-	60.00	-	-	-	3600.00	312.79	60.00	-	-	304.80	60.00	-	-	2.55	316.87	1.64	-	-	-1.30	-3.96
B.30_10(3)	-	-	-	60.00	-	-	-	3600.00	307.88	60.00	-	-	306.24	60.00	-	-	0.54	316.30	1.60	-	-	-2.73	-3.29
B.30_10(4)	-	-	-	60.00	-	-	-	3600.00	290.21	60.00	-	-	283.44	60.00	-	-	2.33	296.15	1.26	-	-	-2.05	-4.48
B.30_10(5)	-	-	-	60.00	-	-	-	3600.00	303.62	60.00	-	-	296.63	60.00	-	-	2.30	308.50	10.02	-	-	-1.61	-4.00
Avg of B.30_10	-	-	-	60.00	-	-	-	3600.00	301.74	60.00	-	-	298.01	60.00	-	-	1.22	308.64	3.32	-	-	-2.30	-3.58
B.40_15(1)	-	-	-	60.00	-	-	-	3600.00	407.40	60.00	-	-	420.36	60.00	-	-	-3.18	430.18	10.09	-	-	-5.59	-2.34
B.40_15(2)	-	-	-	60.00	-	-	-	3600.00	360.21	60.00	-	-	378.65	60.00	-	-	-5.12	385.46	5.19	-	-	-7.01	-1.80
B.40_15(3)	-	-	-	60.00	-	-	-	3600.00	351.86	60.00	-	-	376.05	60.00	-	-	-6.87	386.90	2.50	-	-	-9.96	-2.88
B.40_15(4)	-	-	-	60.00	-	-	-	3600.00	374.98	60.00	-	-	384.17	60.00	-	-	-2.45	397.09	1.75	-	-	-5.89	-3.36
B.40_15(5)	-	-	-	60.00	-	-	-	3600.00	376.68	60.00	-	-	391.01	60.00	-	-	-3.80	406.88	3.42	-	-	-8.02	-4.06
Avg of B.40_15	-	-	-	60.00	-	-	-	3600.00	374.23	60.00	-	-	390.05	60.00	-	-	-4.29	401.30	4.59	-	-	-7.29	-2.89
B.50_20(1)	-	-	-	60.00	-	-	-	3600.00	519.11	60.00	-	-	547.25	60	-	-	-5.42	557.63	3.44	-	-	-7.42	-1.90
B.50_20(2)	-	-	-	60.00	-	-	-	3600.00	464.40	60.00	-	-	488.48	60	-	-	-5.19	497.59	9.21	-	-	-7.15	-1.87
B.50_20(3)	-	-	-	60.00	-	-	-	3600.00	478.19	60.00	-	-	502.28	60	-	-	-5.04	515.51	7.17	-	-	-7.80	-2.63
B.50_20(4)	-	-	-	60.00	-	-	-	3600.00	455.34	60.00	-	-	470.14	60	-	-	-3.25	490.34	9.16	-	-	-7.69	-4.30
B.50_20(5)	-	-	-	60.00	-	-	-	3600.00	488.34	60.00	-	-	509.22	60	-	-	-4.28	524.33	5.40	-	-	-7.37	-2.97
Avg of B.50_20	-	-	-	60.00	-	-	-	3600.00	481.07	60.00	-	-	503.47	60.00	-	-	-4.63	517.08	6.88	-	-	-7.49	-2.73

Note. B.20_10(1): represents the first instance in instance group B.20_10; other instance IDs follow a similar naming pattern; **Gap:** $100\% \times (LB - UB) / LB$; **④ Gap to ③:** $100\% \times (Obj_{\textcircled{3}} - Obj_{\textcircled{4}}) / Obj_{\textcircled{3}}$

Table 3: Detailed computational results of L-PAD² over instance set C

Instance ID	①: O-CAM (60s)				①: O-CAM (3600s)				③: A-CAM+PO(60s)				④: L-PAD (60s)					L-PAD ² (60s)					
	LB	UB	Gap (%)	T (s)	LB	UB	Gap (%)	T (s)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Gap-③ (%)	Obj	T (s)	Gap-① (%)	Gap-② (%)	Gap-③ (%)	Gap-④ (%)
C_60_20(1)	-	-	-	60.00	-	-	-	3600.00	631.80	60.00	-	-	657.84	60.00	-	-	-4.12	672.40	5.02	-	-	-6.43	-2.21
C_60_20(2)	-	-	-	60.00	-	-	-	3600.00	563.24	60.00	-	-	589.69	60.00	-	-	-4.70	596.16	23.15	-	-	-5.84	-1.10
C_60_20(3)	-	-	-	60.00	-	-	-	3600.00	585.94	60.00	-	-	619.28	60.00	-	-	-5.69	627.41	12.01	-	-	-7.08	-1.31
C_60_20(4)	-	-	-	60.00	-	-	-	3600.00	585.92	60.00	-	-	607.52	60.00	-	-	-3.69	620.03	8.37	-	-	-5.82	-2.06
C_60_20(5)	-	-	-	60.00	-	-	-	3600.00	569.52	60.00	-	-	588.86	60.00	-	-	-3.40	612.35	6.27	-	-	-7.52	-3.99
Avg of C_60_20	-	-	-	60.00	-	-	-	3600.00	587.28	60.00	-	-	612.64	60.00	-	-	-4.32	625.67	10.96	-	-	-6.54	-2.13
C_70_20(1)	-	-	-	60.00	-	-	-	3600.00	696.24	60.00	-	-	731.48	60.00	-	-	-5.06	740.04	6.74	-	-	-6.29	-1.17
C_70_20(2)	-	-	-	60.00	-	-	-	3600.00	654.94	60.00	-	-	695.26	60.00	-	-	-6.16	697.80	29.05	-	-	-6.55	-0.37
C_70_20(3)	-	-	-	60.00	-	-	-	3600.00	709.57	60.00	-	-	735.26	60.00	-	-	-3.62	737.72	19.35	-	-	-3.97	-0.33
C_70_20(4)	-	-	-	60.00	-	-	-	3600.00	695.40	60.00	-	-	716.58	60.00	-	-	-3.05	723.56	11.08	-	-	-4.05	-0.97
C_70_20(5)	-	-	-	60.00	-	-	-	3600.00	687.54	60.00	-	-	704.92	60.00	-	-	-2.53	722.61	14.11	-	-	-5.10	-2.51
Avg of C_70_20	-	-	-	60.00	-	-	-	3600.00	688.74	60.00	-	-	716.70	60.00	-	-	-4.08	724.35	16.07	-	-	-5.19	-1.07
C_80_25(1)	-	-	-	60.00	-	-	-	3600.00	751.43	60.00	-	-	788.58	60.00	-	-	-4.95	804.92	15.89	-	-	-7.12	-2.07
C_80_25(2)	-	-	-	60.00	-	-	-	3600.00	746.30	60.00	-	-	775.03	60.00	-	-	-3.85	797.23	21.47	-	-	-6.82	-2.86
C_80_25(3)	-	-	-	60.00	-	-	-	3600.00	763.93	60.00	-	-	801.33	60.00	-	-	-4.90	810.50	14.12	-	-	-6.10	-1.14
C_80_25(4)	-	-	-	60.00	-	-	-	3600.00	750.99	60.00	-	-	792.27	60.00	-	-	-5.50	807.52	31.32	-	-	-7.53	-1.92
C_80_25(5)	-	-	-	60.00	-	-	-	3600.00	773.19	60.00	-	-	828.11	60.00	-	-	-7.10	846.36	23.60	-	-	-9.46	-2.20
Avg of C_80_25	-	-	-	60.00	-	-	-	3600.00	757.17	60.00	-	-	797.07	60.00	-	-	-5.26	813.31	21.28	-	-	-7.41	-2.04
C_90_25(1)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	899.92	60.00	-	-	-	915.02	15.93	-	-	-	-1.68
C_90_25(2)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	895.45	60.00	-	-	-	897.07	22.02	-	-	-	-0.18
C_90_25(3)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	845.52	60.00	-	-	-	864.84	51.65	-	-	-	-2.28
C_90_25(4)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	865.49	60.00	-	-	-	872.83	21.31	-	-	-	-0.85
C_90_25(5)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	895.42	60.00	-	-	-	897.66	51.90	-	-	-	-0.25
Avg of C_90_25	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	880.36	60.00	-	-	-	889.48	32.92	-	-	-	-1.05
C_100_25(1)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	1013.91	60.00	-	-	-	1020.95	45.09	-	-	-	-0.69
C_100_25(2)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	980.07	60.00	-	-	-	980.83	26.90	-	-	-	-0.08
C_100_25(3)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	1020.02	60.00	-	-	-	1022.94	43.73	-	-	-	-0.29
C_100_25(4)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	969.67	60.00	-	-	-	975.14	49.35	-	-	-	-0.56
C_100_25(5)	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	1013.77	60.00	-	-	-	1014.46	52.99	-	-	-	-0.07
Avg of C_100_25	-	-	-	60.00	-	-	-	3600.00	-	60.00	-	-	999.49	60.00	-	-	-	1002.86	43.61	-	-	-	-0.34

Note. C_60_20(1): represents the first instance in instance group C_60_20; other instance IDs follow a similar naming pattern; **Gap**: $100\% \times (|LB - UB|) / LB$; **Ⓐ Gap to Ⓑ**: $100\% \times (Obj_{\mathbb{B}} - Obj_{\mathbb{A}}) / Obj_{\mathbb{B}}$