0.1 Processing time

vii	18.5498 ± 0.6472 s
emboss	1.6530 ± 0.1549 s
blur	5.7246 ± 0.1986 s
wave	14.7431 ± 0.6649 s
muse	11.1059 ± 0.4983 s
night	22.6160 ± 0.2930 s
onnx	5.0682 ± 0.2718 s

Table 1: Processing time of jobs in the VM.

0.2 Least cost last intermediate results

k	schedule	g_j with no immediate successors
33	[34]	{34: 218.61}
32	[1, 34]	{1: 82.87, 3: 236.87, 6: 183.87}
31	[2, 1, 34]	{2: 167.8, 3: 231.8, 6: 178.8}
30	[5, 2, 1, 34]	{3: 220.69, 5: 145.69, 6: 167.69}
29	[11, 5, 2, 1, 34]	{3: 214.97, 6: 161.97, 11: 0, 12: 0, 24: 91.97}
28	[12, 11, 5, 2, 1, 34]	{3: 209.24, 6: 156.24, 12: 0, 15: 0, 24: 86.24}
27	[13, 12, 11, 5, 2, 1, 34]	{3: 207.59, 6: 154.59, 13: 0, 15: 0, 24: 84.59}
26	[15, 13, 12, 11, 5, 2, 1, 34]	{3: 202.52, 6: 149.52, 14: 147.52, 15: 0, 24: 79.52}
25	[24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 196.8, 6: 143.8, 14: 141.8, 16: 180.8, 24: 73.8}
24	[25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 191.07, 6: 138.07, 14: 136.07, 16: 175.07, 25: 0.07}
23	[26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 168.46, 6: 115.46, 14: 113.46, 16: 152.46, 26: 0}
22	[27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 157.35, 6: 104.35, 14: 102.35, 16: 141.35, 27: 0}
21	[28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 155.7, 6: 102.7, 14: 100.7, 16: 139.7, 28: 29.7}
20	[29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 150.63, 6: 97.63, 14: 95.63, 16: 134.63, 29: 0}
19	[30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 135.89, 6: 82.89, 14: 80.89, 16: 119.89, 30: 0, 31: 0}
18	[31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 134.23, 6: 81.23, 14: 79.23, 16: 118.23, 31: 0}
17	[32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 123.13, 6: 70.13, 14: 68.13, 16: 107.13, 32: 39.13}
16	[14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 118.06, 6: 65.06, 14: 63.06, 16: 102.06}
15	[6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 112.99, 6: 59.99, 16: 96.99}
14	[7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 111.34, 7: 0, 16: 95.34}
13	[8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 92.79, 8: 0, 16: 76.79}
12	[9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 87.06, 9: 0, 16: 71.06}
11	[10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 72.32, 10: 0, 16: 56.32}
10	[16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 66.6, 16: 50.6}
9	[17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 51.85, 17: 0}
8	[18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 37.11, 18: 0}
7	[19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 22.37, 19: 0, 21: 0}
6	[21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 20.71, 20: 0, 21: 0}
5	[20, 21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 19.06, 20: 0, 22: 0}
4	[22, 20, 21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 13.99, 22: 0}
3	[23, 22, 20, 21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 8.92, 23: 0}
2	[3, 23, 22, 20, 21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{3: 0}
1	[4, 3, 23, 22, 20, 21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{4: 0}
0	[33, 4, 3, 23, 22, 20, 21, 19, 18, 17, 16, 10, 9, 8, 7, 6, 14, 32, 31, 30, 29, 28, 27, 26, 25, 24, 15, 13, 12, 11, 5, 2, 1, 34]	{33: 0}

Table 2: Intermediate results obtained for k's (indices start at 1).

0.3 Tabu search vs LCL

Table 3 shows the tabu search algorithm is still capable of improving the total tardiness. But, it terminates at a local optima for problems with precedence. The tabu search with k=1000 and anther starting point shows the total tardiness becomes better than the LCL and new initial schedule.

Schedule	Complete time	Total tardiness
S_{init}	273.3685 ± 1.3804 s	1420.2161 ± 18.4862 s
LCL	270.4082 ± 2.3564 s	943.6579 ± 19.9618 s
Tabu K=10	269.6817 ± 1.3238 s	1415.6078 ± 13.3469 s
Tabu K=100	260.2111 ± 1.2124 s	1224.8819 ± 7.2954 s
Tabu K=1000	260.6390 ± 1.6231 s	964.3417 ± 16.8073 s
S'_{init}	265.3374 ± 2.0589 s	1072.8466 ± 18.1708 s
S'_{init} + Tabu K=1000	262.4886 ± 1.9523 s	878.3565 ± 12.4587 s

Table 3: Complete times and total tardiness of schdules in the VM.

k	tabu	g_best	candidates	g_y	tabu?
0	[]	1407.78	[33 32 23 31 30 22 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]	1407.78	x
1	[]	1407.78	[[33 23 32 31 30 22 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1407.78	[['x']]
2	[(23, 32)]	1407.78	[[33 23 32 30 31 22 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1407.78	[['x']]
3	[(23, 32), (30, 31)]	1407.78	[[33 23 30 32 31 22 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1407.78	[['x']]
4	[(23, 32), (30, 31), (30, 32)]	1407.78	[[33 23 30 32 22 31 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1407.78	[['x']]

Table 4: First 4 iterations of tabu with k=10 (indices start at 1).

k	tabu	g_best	candidates	g_y	tabu?
0	[]	1407.78	[33 32 23 31 30 22 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]	1407.78	x
16	[(20, 23), (29, 21), (21, 31), (21, 32), (21, 30)]	1407.78	[[33 20 23 22 21 30 32 31 19 29 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1407.78	[['x']]
23	[(19, 32), (19, 30), (19, 21), (19, 22), (19, 23)]	1407.78	[[33 20 19 23 22 21 30 32 31 29 18 28 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1402.71	[['x']]
24	[(19, 30), (19, 21), (19, 22), (19, 23), (18, 28)]	1402.71	[[33 20 19 23 22 21 30 32 31 18 29 28 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1395.34	[['x']]
34	[(17, 28), (17, 29), (17, 31), (17, 32), (17, 30)]	1395.34	[[33 20 19 23 22 21 18 17 30 32 31 29 28 27 14 26 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	1384.23	[['x']]

Table 5: First 4 new optimums of tabu with k=100 (indices start at 1).

k	tabu	g_best	candidates	g_y	tabu?
0	[]	1407.78	[33 32 23 31 30 22 20 29 21 19 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]	1407.78	x
16	[(20, 23), (29, 21), (21, 31), (21, 32), (21, 30)]	1407.78	[[33 20 23 22 21 30 32 31 19 29 28 18 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	[[1407.78]]	[['x']]
23	[(19, 32), (19, 30), (19, 21), (19, 22), (19, 23)]	1407.78	[[33 20 19 23 22 21 30 32 31 29 18 28 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	[[1402.71]]	[['x']]
24	[(19, 30), (19, 21), (19, 22), (19, 23), (18, 28)]	1402.71	[[33 20 19 23 22 21 30 32 31 18 29 28 27 17 26 14 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	[[1395.34]]	[['x']]
34	[(17, 28), (17, 29), (17, 31), (17, 32), (17, 30)]	1395.34	[[33 20 19 23 22 21 18 17 30 32 31 29 28 27 14 26 16 10 25 13 15 9 24 12 11 8 5 7 4 2 6 3 1 34]]	[[1384.23]]	[['x']]

Table 6: First 4 new optimums of tabu with k=1000 (indices start at 1).