Details regarding the Job Shop Scheduling Problem experiments

Mohamed Siala[1,2,3], Christian Artigues[2,4], and Emmanuel Hebrard[2,4]

[1] Insight Center for Data Analytics. University College Cork. Ireland
[2] CNRS, LAAS, 7 avenue du colonel Roche, F-31400 Toulouse, France
[3] Univ de Toulouse, INSA, LAAS, F-31400 Toulouse, France
[4] Univ de Toulouse, LAAS, F-31400 Toulouse, France
{siala, artigues, hebrard}@laas.fr

Abstract. We first give the necessary steps to reproduce the Job Shop Scheduling Problem experiments. Then, we report the detailed results for each configuration.

1   Reproducing the Experiments

We detail in this section the reproduction steps for these experiments. The source code is available via github at **https://github.com/siala/Hybrid-Mistral**. After cloning the repository[1], the following command line is needed to use the exact version of the solver for all the tests:

```
$ git checkout cb72ba96d8bfad1b2d1a47a1f00cabfd2eeef06c
```

The command used to compile the source is the following:

```
$ make scheduler
```

The general command syntax for the tests is the following:

```
$ bin/scheduler BENCHNAME −type [ jla | jsp ] [−options ]
```

where BENCHNAME is the instance file location and '-type [jla | jsp]' indicates its type. The option '-seed v' is needed to precise the value of the randomization seed 'v'. The 10 seeds that we used in these tests range from 11041979 to 11041988.

The instances are available in:

- data/scheduling/jsp/taillard/ for Taillard instances. The option -type should have the value 'jsp' (default value)
- data/scheduling/jla/Lawrence/ for Lawrence instances. The option -type should have the value 'jla'

We show now the options used for each model.

- CP($task$): -taskweight 2

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[1] https://help.github.com/

- H($vsids, disj$): -fdlearning 2 -semantic 1 -keeplearning 1 -orderedexploration 1 -reduce 1 -fixedLearntSize 50000 -fixedlimitSize 75000 -vsids 1
- H($task, disj$): -fdlearning 2 -semantic 1 -keeplearning 1 -orderedexploration 1 -reduce 1 -fixedLearntSize 50000 -fixedlimitSize 75000 -taskweight 2
- H($vsids, lazy$): -fdlearning 2 -semantic 1 -keeplearning 1 -orderedexploration 1 -reduce 1 -fixedLearntSize 50000 -fixedlimitSize 75000 -lazygeneration 1 -vsids 1
- H($task, lazy$): -fdlearning 2 -semantic 1 -keeplearning 1 -orderedexploration 1 -reduce 1 -fixedLearntSize 50000 -fixedlimitSize 75000 -lazygeneration 1 -taskweight 2

The default restart strategy corresponds to a geometric restart. Luby restarts are also supported with the options "-restart luby -bandbrestart luby".

Last, in order to use the configuration for improving the lower bounds of Taillard open instances, the option "-lbcutoff 1400" should be added to precise the new time limit for each dichotomy step. The last configuration in the paper with 2500s per dichotomy step and 7200s cutoff is enabled via the options '-lbcutoff 2500 -optimise 30000'.

2 Detailed results

We give the detailed results for each set of experiments. In the following tables, we use one column for each model and one line for each instance.

Table1 presents Lawrence detailed results. In this table we report for each configuration the average CPU time 'T', the average optimality percentage '%O', and the minimum 'min' and average 'avg' upper bound across the 10 randomized runs.

Table 2 presents Taillard results with the same presentation protocol of Table 1. We add, however, a separate column, called **Best**, to report the best known upper bound in the literature.

Table 3 shows the lower bound experimental results. We report here the average 'avg' and the maximum 'max' lower bound found in the 10 randomized runs for each instance. The column **Best** shows the best known lower bound in the literature for each instance.

Finally, we present in Table 4 the second lower bound experimental results with 2500s as a time limit per dichotomy step and 7200s overall. The Luby restart configuration is indicated with '+L'.

	CP(task)				H($vsids,disj$)				H($vsids,lazy$)				H($task,disj$)				H($task,lazy$)			
	T	%O	Upper bound		T	%O	Upper bound		T	%O	Upper bound		T	%O	Upper bound		T	%O	Upper bound	
	avg	avg	min	avg	avg	avg	min	avg	avg	avg	min	avg	avg	avg	min	avg	avg	avg	min	avg
la01	0	100	666	666	0	100	666	666	0.01	100	666	666	0	100	666	666	0	100	666	666
la02	0.39	100	655	655	0.32	100	655	655	0.72	100	655	655	0.29	100	655	655	0.42	100	655	655
la03	0.10	100	597	597	0.12	100	597	597	0.24	100	597	597	0.13	100	597	597	0.17	100	597	597
la04	0.09	100	590	590	0.10	100	590	590	0.16	100	590	590	0.10	100	590	590	0.14	100	590	590
la05	0	100	593	593	0	100	593	593	0	100	593	593	0	100	593	593	0	100	593	593
la06	0.01	100	926	926	0.08	100	926	926	0.21	100	926	926	0.02	100	926	926	0.04	100	926	926
la07	3600	0	890	890	3600	0	890	890	3600	0	890	890	3600	0	890	890	3600	0	890	890
la08	0.05	100	863	863	0.12	100	863	863	0.14	100	863	863	0.04	100	863	863	0.06	100	863	863
la09	0	100	951	951	0.02	100	951	951	0.08	100	951	951	0.01	100	951	951	0.05	100	951	951
la10	0	100	958	958	0	100	958	958	0	100	958	958	0	100	958	958	0	100	958	958
la11	0.06	100	1222	1222	1.18	100	1222	1222	1.08	100	1222	1222	0.08	100	1222	1222	0.08	100	1222	1222
la12	0.17	100	1039	1039	0.36	100	1039	1039	0.59	100	1039	1039	0.10	100	1039	1039	0.14	100	1039	1039
la13	0.05	100	1150	1150	0.30	100	1150	1150	0.21	100	1150	1150	0.11	100	1150	1150	0.08	100	1150	1150
la14	0	100	1292	1292	0	100	1292	1292	0	100	1292	1292	0	100	1292	1292	0	100	1292	1292
la15	0.40	100	1207	1207	5.68	100	1207	1207	57.78	100	1207	1207	0.84	100	1207	1207	0.50	100	1207	1207
la16	0.50	100	945	945	0.46	100	945	945	0.84	100	945	945	0.42	100	945	945	0.74	100	945	945
la17	0.14	100	784	784	0.12	100	784	784	0.18	100	784	784	0.17	100	784	784	0.25	100	784	784
la18	0.06	100	848	848	0.06	100	848	848	0.10	100	848	848	0.08	100	848	848	0.09	100	848	848
la19	0.63	100	842	842	0.44	100	842	842	0.93	100	842	842	0.63	100	842	842	0.93	100	842	842
la20	0.17	100	902	902	0.11	100	902	902	0.20	100	902	902	0.16	100	902	902	0.23	100	902	902
la21	3600	0	1046	1046.90	1814.98	100	1046	1046	3600	0	1046	1047.30	3131.46	40	1046	1046.60	3600	0	1046	1048.50
la22	113.96	100	927	927	122.32	100	927	927	411.82	100	927	927	94.31	100	927	927	158.94	100	927	927
la23	0.47	100	1032	1032	0.72	100	1032	1032	1.76	100	1032	1032	0.42	100	1032	1032	0.61	100	1032	1032
la24	284.83	100	935	935	142.36	100	935	935	734.25	100	935	935	199.81	100	935	935	590.51	100	935	935
la25	261.62	100	977	977	140.87	100	977	977	592.85	100	977	977	164.27	100	977	977	517.63	100	977	977
la26	2608.44	30	1218	1221.60	355.52	100	1218	1218	1192.98	100	1218	1218	91.15	100	1218	1218	1053.38	80	1218	1218.20
la27	3600	0	1258	1265.40	3600	0	1246	1255.30	3600	0	1243	1270.70	3600	0	1244	1254.70	3600	0	1251	1262.20
la28	1864.95	50	1216	1217.70	1087.67	90	1216	1216.50	2757.92	40	1216	1218.60	1652.58	80	1216	1216.90	1298.31	70	1216	1216.70
la29	3600	0	1185	1200	3600	0	1169	1178.80	3600	0	1189	1201.60	3600	0	1171	1185.80	3600	0	1176	1194.80
la30	3.17	100	1355	1355	7.99	100	1355	1355	14.92	100	1355	1355	2.72	100	1355	1355	2.98	100	1355	1355
la31	9.04	100	1784	1784	75.66	100	1784	1784	428.89	90	1784	1786.90	4.48	100	1784	1784	5.19	100	1784	1784
la32	4.02	100	1850	1850	6.56	100	1850	1850	7.70	100	1850	1850	3.86	100	1850	1850	3.84	100	1850	1850
la33	6.13	100	1719	1719	85.34	100	1719	1719	15.97	100	1719	1719	7.01	100	1719	1719	9.50	100	1719	1719
la34	119.59	100	1721	1721	1544.30	70	1721	1721.80	587.08	90	1721	1721.80	19.31	100	1721	1721	12.15	100	1721	1721
la35	6.32	100	1888	1888	31.06	100	1888	1888	63.56	100	1888	1888	5.70	100	1888	1888	4.99	100	1888	1888
la36	109.69	100	1268	1268	74.69	100	1268	1268	163.54	100	1268	1268	64.81	100	1268	1268	115.33	100	1268	1268
la37	341.10	100	1397	1397	403.08	100	1397	1397	780.73	100	1397	1397	455.24	100	1397	1397	665.30	100	1397	1397
la38	362.23	100	1196	1196	328.16	100	1196	1196	1499.82	100	1196	1196	314.85	100	1196	1196	869.80	100	1196	1196
la39	44.89	100	1233	1233	37.93	100	1233	1233	61.68	100	1233	1233	23.68	100	1233	1233	33.47	100	1233	1233
la40	346.25	100	1222	1222	420.81	100	1222	1222	1514.04	100	1222	1222	355.45	100	1222	1222	626.58	100	1222	1222
average	522.24	87	1108.67	1109.39	437.24	91.50	1107.97	1108.48	632.32	88	1108.40	1109.58	434.86	90.50	1107.97	1108.65	509.31	88.75	1108.27	1109.11
PRD				0.0643				060				0.0427				062				0.0310

Table 2. Taillard detailed results

	CP(task				H(vsids,disj)				H(vsids,lazy)				H(task,disj)				H(task,lazy)				Best
	T	%O	Upper bound		T	%O	Upper bound		T	%O	Upper bound		T	%O	Upper bound		T	%O	Upper bound		
	avg	avg	min	avg	avg	avg	min	avg	avg	avg	min	avg	avg	avg	min	avg	avg	avg	min	avg	
tai01	29.34	100	1231	1231	13.28	100	1231	1231	43.30	100	1231	1231	12.56	100	1231	1231	17.30	100	1231	1231	1231
tai02	195.75	100	1244	1244	167.46	100	1244	1244	592.01	100	1244	1244	165.17	100	1244	1244	378.23	100	1244	1244	1244
tai03	178.39	100	1218	1218	84.04	100	1218	1218	354.68	100	1218	1218	157.97	100	1218	1218	542.80	100	1218	1218	1218
tai04	87.73	100	1175	1175	51.02	100	1175	1175	212.37	100	1175	1175	51.34	100	1175	1175	119.64	100	1175	1175	1175
tai05	1916.13	90	1224	1224.30	595.69	100	1224	1224	2577.84	80	1224	1224	1309.49	100	1224	1224	3353.32	40	1224	1226.20	1224
tai06	3600	0	1238	1243.70	3600	0	1238	1240.30	3600	0	1239	1245.40	3600	0	1238	1242.90	3600	0	1239	1246.80	1238
tai07	334.75	100	1227	1227	276.96	100	1227	1227	1279.98	100	1227	1227	310.29	100	1227	1227	1211.52	100	1227	1227	1227
tai08	214.81	100	1217	1217	151.69	100	1217	1217	783.87	100	1217	1217	182.57	100	1217	1217	782.11	100	1217	1217	1217
tai09	846.65	100	1274	1274	167.56	100	1274	1274	870.15	100	1274	1274	413.73	100	1274	1274	1702.72	100	1274	1274	1274
tai10	276.60	100	1241	1241	66.60	100	1241	1241	284.68	100	1241	1241	142.72	100	1241	1241	563.39	100	1241	1241	1241
tai11	3600	0	1397	1411.60	3600	0	1374	1384.90	3600	0	1375	1392.50	3600	0	1381	1397.80	3600	0	1386	1402.70	1357
tai12	3600	0	1395	1405.90	3600	0	1376	1387.40	3600	0	1384	1400.50	3600	0	1388	1396.80	3600	0	1382	1393.60	1367
tai13	3600	0	1353	1364.30	3600	0	1347	1353.80	3600	0	1358	1370.40	3600	0	1343	1353.50	3600	0	1354	1361.30	1342
tai14	3600	0	1345	1351.50	3600	0	1345	1352.40	3600	0	1349	1355.90	3600	0	1345	1349.60	3600	0	1345	1350.30	1345
tai15	3600	0	1375	1388.40	3600	0	1357	1372	3600	0	1363	1382.90	3600	0	1354	1374.20	3600	0	1360	1382	1339
tai16	3600	0	1388	1408.50	3600	0	1376	1385.70	3600	0	1376	1398.60	3600	0	1380	1388.40	3600	0	1381	1391.50	1360
tai17	3600	0	1473	1488.20	3600	0	1478	1486.70	3600	0	1476	1488.60	3600	0	1476	1488.90	3600	0	1473	1484.30	1462
tai18	3600	0	1439	1458.80	3600	0	1426	1438.60	3600	0	1425	1454.10	3600	0	1427	1443.20	3600	0	1428	1447.60	1396
tai19	3600	0	1367	1392.70	3600	0	1366	1377	3600	0	1362	1376.70	3600	0	1368	1379.20	3600	0	1351	1378.80	1332
tai20	3600	0	1367	1384.10	3600	0	1361	1368.50	3600	0	1367	1376.60	3600	0	1360	1373.40	3600	0	1363	1375.90	1348
tai21	3600	0	1668	1678.90	3600	0	1649	1662.90	3600	0	1650	1670.70	3600	0	1658	1671	3600	0	1643	1670	1642
tai22	3600	0	1639	1656.40	3600	0	1624	1646	3600	0	1630	1650.30	3600	0	1621	1636.70	3600	0	1623	1646.20	1600
tai23	3600	0	1579	1593.70	3600	0	1568	1578.40	3600	0	1576	1590.40	3600	0	1571	1588	3600	0	1567	1589.50	1557
tai24	3600	0	1645	1655.20	3600	0	1646	1655.70	3600	0	1652	1666.30	3600	0	1653	1659	3600	0	1646	1659.40	1644
tai25	3600	0	1625	1643.70	3600	0	1601	1617.90	3600	0	1614	1632.10	3600	0	1607	1629.20	3600	0	1615	1631.70	1595
tai26	3600	0	1684	1696.40	3600	0	1679	1685.80	3600	0	1676	1693	3600	0	1672	1684.50	3600	0	1674	1689.20	1645
tai27	3600	0	1701	1713.50	3600	0	1697	1704	3600	0	1701	1727	3600	0	1693	1705.10	3600	0	1694	1720.10	1680
tai28	3600	0	1623	1634.90	3600	0	1616	1621.90	3600	0	1603	1622.90	3600	0	1617	1621.60	3600	0	1617	1623	1603
tai29	3600	0	1642	1655.10	3600	0	1635	1639.20	3600	0	1635	1651	3600	0	1630	1640.50	3600	0	1630	1647.30	1625
tai30	3600	0	1629	1638.30	3600	0	1608	1617.40	3600	0	1613	1625	3600	0	1609	1622.40	3600	0	1607	1626.20	1584
tai31	3600	0	1866	1889.10	3600	0	1804	1852.30	3600	0	1808	1860.80	3600	0	1848	1863.30	3600	0	1825	1854.70	1764
tai32	3600	0	1901	1925.30	3600	0	1876	1895.40	3600	0	1891	1905.70	3600	0	1867	1907.60	3600	0	1873	1900	1784
tai33	3600	0	1914	1951.90	3600	0	1897	1921.10	3600	0	1876	1929.70	3600	0	1869	1916.10	3600	0	1897	1920.50	1791
tai34	3600	0	1946	1966.80	3600	0	1927	1941.60	3600	0	1914	1947.90	3600	0	1916	1930.90	3600	0	1923	1937.70	1829
tai35	3600	0	2007	2008.40	3600	0	2007	2016.30	3600	0	2007	2019.10	3600	0	2007	2007.80	3600	0	2007	2007	2007
tai36	3600	0	1904	1937.80	3600	0	1886	1905.60	3600	0	1878	1901	3600	0	1897	1910.90	3600	0	1888	1910.50	1819
tai37	3600	0	1871	1894.40	3600	0	1848	1870	3600	0	1844	1874.70	3600	0	1848	1871.80	3600	0	1844	1870.80	1771
tai38	3600	0	1783	1809	3600	0	1759	1777.10	3600	0	1752	1779.40	3600	0	1752	1779.40	3600	0	1756	1780.80	1673
tai39	3600	0	1854	1874.40	3600	0	1831	1852.80	3600	0	1832	1857.80	3600	0	1827	1848.40	3600	0	1807	1839.90	1795
tai40	3600	0	1814	1839.20	3600	0	1780	1801.60	3600	0	1763	1806.80	3600	0	1789	1805.50	3600	0	1771	1805.90	1674
tai41	3600	0	2148	2183.10	3600	0	2123	2142.70	3600	0	2114	2153.70	3600	0	2110	2134.40	3600	0	2115	2133.20	2006
tai42	3600	0	2055	2074.40	3600	0	2006	2038.40	3600	0	2012	2045.20	3600	0	2010	2033.80	3600	0	2024	2040	1945
tai43	3600	0	2003	2024.40	3600	0	1953	1976.30	3600	0	1936	1973.50	3600	0	1963	1982.70	3600	0	1961	1985	1846
tai44	3600	0	2128	2145.30	3600	0	2062	2099.70	3600	0	2075	2112.90	3600	0	2085	2107	3600	0	2086	2108.10	1982
tai45	3600	0	2094	2123.60	3600	0	2058	2081.60	3600	0	2075	2097.60	3600	0	2058	2088.90	3600	0	2063	2092.60	2000
tai46	3600	0	2138	2156.70	3600	0	2108	2126.30	3600	0	2095	2124.50	3600	0	2103	2123.20	3600	0	2104	2123.10	2006
tai47	3600	0	2037	2060.30	3600	0	1998	2015.90	3600	0	1991	2007.80	3600	0	1988	2017.40	3600	0	2016	2028	1889
tai48	3600	0	2086	2104.70	3600	0	2055	2074	3600	0	2028	2064.80	3600	0	2048	2072.40	3600	0	2043	2060.80	1941
tai49	3600	0	2099	2127.10	3600	0	2061	2082.30	3600	0	2073	2106.50	3600	0	2070	2096.40	3600	0	2063	2085.60	1963
tai50	3600	0	2083	2089.80	3600	0	2018	2045.20	3600	0	2014	2047.10	3600	0	2025	2047.60	3600	0	2001	2050.50	1923
tai51	3600	0	2834	2879.30	3600	0	2876	2889.40	3600	0	2868	2903.30	3600	0	2786	2815.10	3600	0	2775	2820.10	2760
tai52	3600	0	2843	2869.60	3600	0	2845	2873.70	3600	0	2855	2902.10	3600	0	2785	2811.70	3600	0	2769	2801.90	2756
tai53	3600	0	2777	2802.40	3600	0	2783	2801.50	3600	0	2768	2802.70	3600	0	2729	2756.10	3600	0	2740	2764.30	2717
tai54	3600	0	2848	2860.60	3600	0	2841	2878.70	3600	0	2871	2887	3600	0	2839	2840.60	3600	0	2839	2842.60	2839
tai55	3600	0	2802	2854	3600	0	2799	2844.90	3600	0	2813	2877.30	3600	0	2734	2788.10	3600	0	2763	2782.40	2679
tai56	3600	0	2870	2891.40	3600	0	2867	2894	3600	0	2885	2939.10	3600	0	2839	2854.40	3600	0	2829	2844.80	2781
tai57	3600	0	3002	3028.40	3600	0	3015	3047.30	3600	0	3044	3081.40	3336.38	10	2943	2973	3375.14	10	2943	2975.60	2943
tai58	3600	0	2966	2996.40	3600	0	2961	2987.80	3600	0	2969	3040.70	3600	0	2888	2923	3600	0	2901	2923.20	2885
tai59	3600	0	2788	2823	3600	0	2797	2837	3600	0	2835	2872.80	3600	0	2731	2758.10	3600	0	2723	2767.10	2655
tai60	3600	0	2842	2867.40	3600	0	2846	2874.10	3600	0	2871	2901.20	3600	0	2767	2805.80	3600	0	2773	2807	2723
tai61	3600	0	3086	3109	3600	0	3047	3077.90	3600	0	3044	3077.90	3600	0	2985	3021.50	3600	0	2988	3015.80	2868
tai62	3600	0	3157	3186.10	3600	0	3126	3156.50	3600	0	3115	3179.10	3600	0	3045	3111	3600	0	3057	3112	2869
tai63	3600	0	2896	2965.40	3600	0	2932	2953.20	3600	0	2849	2926.30	3600	0	2858	2891.70	3600	0	2861	2895.80	2755
tai64	3600	0	2864	2904.80	3600	0	2885	2898.80	3600	0	2831	2895	3600	0	2811	2837.80	3600	0	2794	2842.80	2702
tai65	3600	0	2946	2970.70	3600	0	2949	2961.60	3600	0	2878	2932	3600	0	2870	2895.70	3600	0	2853	2885.60	2725
tai66	3600	0	3044	3072.60	3600	0	3045	3076.80	3600	0	3018	3068.40	3600	0	2956	2991.10	3600	0	2927	2984	2845
tai67	3600	0	3041	3056.10	3600	0	3004	3019	3600	0	2950	2996.30	3600	0	2923	2986.10	3600	0	2895	2963.10	2825
tai68	3600	0	2962	2995.80	3600	0	2932	2976.10	3600	0	2919	2972.50	3600	0	2881	2913.80	3600	0	2869	2906.80	2784
tai69	3600	0	3172	3216.20	3600	0	3183	3222.80	3600	0	3176	3248.80	3600	0	3112	3154.70	3600	0	3101	3141.10	3071
tai70	3600	0	3217	3251.10	3600	0	3203	3256.60	3600	0	3204	3251.90	3600	0	3119	3160.20	3600	0	3131	3172.70	2995
PRD				3.6871				2.9661				2.8696				2.3291				2.2703	000

Table 3. Lower Bound Experiments

	CP(task) Lower bound		CP(task)+L Lower bound		H(vsids,disj) Lower bound		H(vsids,disj) +L Lower bound		H(vsids,lazy) Lower bound		H(vsids,lazy)+L Lower bound		H(task,disj) Lower bound		H(task,disj)+L Lower bound		H(task,lazy) Lower bound		H(task,lazy)+L Lower bound		**Best**
	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg	max	avg	
tai11	1273	1266.90	1282	1274.90	1294	1282.50	1298	1288.30	1273	1269.60	1272	1261.50	1280	1272.30	1282	1272.20	1273	1269.70	1273	1267.10	1357
tai12	1275	1262.60	1297	1273.80	1298	1292.20	1297	1287.70	1275	1271.60	1275	1267	1275	1267.10	1276	1264.90	1275	1266.90	1275	1260.10	1367
tai13	1270	1267.40	1293	1290	1302	1291.90	1305	1297	1290	1273	1291	1274	1290	1273.90	1300	1290	1270	1267.50	1270	1267.40	1342
tai15	1283	1264.80	1286	1260.50	1286	1278.70	1288	1278.80	1270	1263.20	1283	1266.30	1285	1267.20	1279	1260.80	1281	1268.70	1261	1248.20	1339
tai16	1271	1256.30	1292	1287.30	1293	1289.40	1293	1290	1280	1275	1292	1283.10	1276	1273.20	1276	1265.40	1272	1258.20	1272	1256.40	1360
tai18	1296	1274.40	1306	1296.20	1306	1301.90	1305	1290.70	1284	1278.40	1300	1277.90	1296	1271.80	1303	1276.70	1300	1282	1303	1268.80	1377
tai19	1202	1202	1223	1204.10	1202	1202	1202	1202	1202	1202	1202	1202	1223	1204.10	1202	1202	1202	1202	1202	1202	1332
tai20	1305	1300	1313	1299.60	1317	1311.20	1318	1311.70	1305	1300.30	1305	1298.10	1312	1302.20	1313	1294.30	1306	1298	1295	1284.80	1348
tai21	1593	1585.60	1599	1592.60	1611	1606.60	1613	1608.50	1601	1597.20	1608	1601.50	1597	1591.70	1599	1592.70	1592	1587.80	1599	1588.40	1642
tai22	1519	1503.77	1524	1505.66	1529	1509.22	1519	1500.66	1520	1504.11	1519	1500.55	1524	1505.11	1520	1503.77	1524	1505.33	1508	1495.66	1561
tai23	1502	1494.80	1502	1497.90	1507	1500.20	1514	1500.90	1502	1497.80	1501	1496.20	1503	1499.40	1502	1497.60	1502	1497.80	1502	1494	1518
tai24	1561	1557.60	1573	1568.10	1574	1571.70	1574	1569.60	1573	1568.10	1573	1565.60	1572	1564.50	1573	1564.40	1573	1568.80	1573	1567.20	1644
tai25	1515	1516.20	1530	1525.80	1544	1530.70	1537	1529.30	1525	1519.20	1530	1521.90	1530	1522.10	1529	1522	1529	1522	1530	1520.60	1558
tai26	1555	1545.10	1558	1551.50	1558	1551.90	1553	1549.80	1552	1544.30	1552	1544.80	1561	1553.60	1556	1547.60	1556	1548.40	1545	1540.60	1591
tai27	1592	1587.50	1601	1596.80	1601	1598	1602	1597.60	1593	1589.60	1593	1590.50	1601	1596.10	1599	1594.90	1604	1598.30	1596	1590.40	1652
tai28	1568	1562.70	1582	1568	1583	1578.20	1587	1576.50	1578	1569.10	1579	1568.60	1568	1565.60	1579	1565.50	1579	1567.70	1568	1564.20	1603
tai29	1559	1541.20	1569	1554	1573	1562.30	1576	1566.30	1563	1555.90	1567	1551.90	1560	1554.40	1560	1557.10	1557	1544.80	1560	1544.40	1573
tai30	1475	1469.70	1499	1482.30	1508	1502.10	1515	1503.80	1507	1498.90	1507	1485.70	1504	1476	1502	1488.70	1474	1469.50	1499	1475.90	1519
tai32	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774	1774
tai33	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1788
tai34	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828	1828
tai40	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1602	1651
tai41	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1906
tai42	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1761	1884
tai43	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1694	1809
tai44	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1948
tai45	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1731	1997
tai46	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1856	1957
tai47	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1690	1807
tai48	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1744	1912
tai49	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1758	1931
tai50	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1833

Table 4. Lower Bound Experiments with Longer Cutoff

Instance	H($vsids, disj$) Lower bound		H($vsids, disj$) +L Lower bound		**Best**
	max	avg	max	avg	
tai18	1306	1301.90	1308	1301.90	1377
tai22	1539	1524.20	1532	1509.10	1561
tai23	1515	1509.70	1518	1510.50	1518
tai25	1544	1540.10	1550	1542.20	1558
tai26	1565	1557	1562	1557.50	1591
tai27	1607	1600.20	1605	1599.80	1652
tai29	1575	1569.50	1583	1573.40	1573
tai30	1519	1510.10	1528	1516.50	1519
tai32	1774	1774	1774	1774	1774
tai33	1729	1729	1729	1729	1788
tai34	1828	1828	1828	1828	1828
tai40	1602	1602	1602	1602	1651
tai41	1830	1830	1830	1830	1906
tai42	1761	1761	1761	1761	1884
tai43	1694	1694	1694	1694	1809
tai44	1787	1787	1787	1787	1948
tai45	1731	1731	1731	1731	1997
tai46	1856	1856	1856	1856	1957
tai47	1690	1690	1690	1690	1807
tai48	1744	1744	1744	1744	1912
tai49	1758	1758	1758	1758	1931
tai50	1674	1674	1674	1674	1833