Performance Evaluation of a Parameter-Free Genetic Algorithm for Job-Shop Scheduling Problems

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1 Introduction

The job-shop scheduling problem (JSSP) is well known as one of the most difficult NP-hard combinatorial optimization problems. Genetic Algorithms (GAs) for solving the JSSP have been proposed, and they perform well compared with other approaches [1].

However, the tuning of genetic parameters has to be performed by trial and error, making optimization by GA *ad hoc*. To address this problem, Sawai et al. have proposed the Parameter-free Genetic Algorithm (PfGA), for which no control parameters for genetic operation need to be set in advance [3].

We have proposed an extended parameter-free GA for JSSP [2], and reported that the GA performed well without tedious parameter-tuning. This paper reports the result of empirical evaluation of the GA to a wider range of problem instances. The simulation results show that the GA performs well for many problem instances, and the performance can be improved greatly by increasing the number of subpopulations in the parallel distributed version.

2 Computational Results

The GA is tested by the benchmark problems from ORLib.We tested a wider range of instances, namely 10 tough problems, ORB01–ORB10, SWV01–SWV20, and TA01–TA30, but only the results for TA01–TA30 are shown in Table 1. The GA was run for each problem instance using 50 different random seeds. The maximum number of fitness evaluation was set to 1,000,000 for all cases.

- The GA can find the makespan that is equal to the optimal or the best upper bound in TA02, TA03, TA05, and TA07 when we increase the number of subpopulations.
- As we increase the number of subpopulations, the average makespan is reduced, but the best makespan does not always shorten.

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Table 1. Simulation results for TA problems

Prob.	$n \times m$	Best bounds[1]	$N=1$ Best	$N=1$ μ	$N=16$ Best	$N=16$ μ	$N=32$ Best	$N=32$ μ	$N=64$ Best	$N=64$ μ
TA01	15×15	1231	1265	1288.2	1249	1263.1	1248	1259.6	1241	1254.3
TA02	15×15	1244	1252	1280.9	**1244**	1264.3	**1244**	1261.0	**1244**	1255.8
TA03	15×15	1218(1206)	1228	1256.8	1219	1232.4	<u>1218</u>	1229.3	<u>1218</u>	1226.4
TA04	15×15	1175(1170)	1191	1222.6	1181	1195.0	1181	1191.3	1181	1188.4
TA05	15×15	1228(1210)	1253	1272.4	1236	1252.6	1236	1246.4	<u>1228</u>	1244.9
TA06	15×15	1240(1210)	1249	1286.8	1248	1263.7	1248	1258.6	1246	1255.4
TA07	15×15	1228(1223)	1250	1264.0	1236	1247.3	1233	1242.6	<u>1228</u>	1240.6
TA08	15×15	1217(1187)	1233	1266.8	1221	1242.0	1224	1238.2	1223	1233.1
TA09	15×15	1274(1247)	1314	1342.9	1296	1316.4	1292	1310.2	1284	1305.6
TA10	15×15	1241	1244	1299.0	1244	1265.1	1244	1256.3	1244	1246.5
TA11	20×15	1364(1321)	1416	1464.0	1395	1430.0	1408	1426.8	1398	1419.9
TA12	20×15	1367(1321)	1428	1471.6	1406	1435.4	1408	1430.8	1396	1421.8
TA13	20×15	1350(1271)	1407	1443.1	1378	1408.1	1361	1399.6	1371	1393.5
TA14	20×15	1345	1374	1405.5	1352	1378.0	1355	1373.6	1351	1365.8
TA15	20×15	1342(1293)	1412	1461.3	1388	1416.1	1379	1412.6	1384	1402.1
TA16	20×15	1368(1300)	1417	1462.8	1397	1426.9	1400	1420.2	1380	1413.8
TA17	20×15	1478(1458)	1498	1546.5	1496	1519.9	1494	1514.1	1490	1508.3
TA18	20×15	1396(1369)	1468	1519.1	1461	1489.1	1449	1477.6	1443	1468.9
TA19	20×15	1341(1276)	1419	1454.2	1398	1419.9	1390	1415.2	1382	1405.8
TA20	20×15	1353(1316)	1414	1453.3	1399	1420.0	1389	1414.1	1380	1406.8
TA21	20×20	1647(1539)	1729	1773.6	1687	1728.7	1688	1723.1	1685	1716.1
TA22	20×20	1603(1511)	1699	1736.2	1677	1697.3	1665	1689.7	1646	1683.3
TA23	20×20	1558(1472)	1635	1683.9	1595	1641.9	1598	1636.9	1589	1625.1
TA24	20×20	1651(1594)	1712	1767.8	1695	1730.3	1698	1722.0	1693	1716.2
TA25	20×20	1598(1496)	1665	1715.6	1651	1682.8	1644	1671.3	1650	1668.3
TA26	20×20	1655(1539)	1728	1766.3	1700	1728.7	1704	1724.7	1699	1719.7
TA27	20×20	1689(1616)	1787	1827.3	1737	1777.9	1725	1761.3	1741	1760.1
TA28	20×20	1615(1591)	1698	1739.4	1658	1691.5	1653	1685.9	1654	1676.4
TA29	20×20	1625(1514)	1689	1730.5	1655	1693.3	1656	1685.9	1653	1678.1
TA30	20×20	1596(1468)	1656	1717.8	1639	1679.0	1638	1667.7	1638	1661.5

– The relative error to the best upper bound is small enough in TA01–TA10, below 1%, when $N \geq 64$. But in TA11–TA30 it varies from 0.4% to 3.4% even in $N = 64$.

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