附表 1　多种群协同搜索策略与种群多样性维护策略有效性实验的详细数据

算例编号	C_{best}	$\bar{C}_{\max}$			
		SSA	SSA-1	SSA-2	ISSA
J15-S2-1	497	520.5	515.9	512.4	506.4
J15-S2-2	912	954.8	950.8	943.2	937.7
J15-S2-3	512	545.6	528.2	527.5	520.6
J15-S2-4	487	518.0	506.7	498.3	498.5
J15-S2-5	574	597.4	591.2	587.2	586.7
J15-S2-6	422	440.4	432.3	432.1	431.2
J15-S2-7	557	587.9	570.3	568.4	571.7
J15-S2-8	797	833.1	826.2	819.1	809.8
J15-S2-9	567	589.9	582.5	581.8	582.5
J15-S2-10	842	875.7	866.5	859.9	858.8
J15-S4-1	953	998.5	981.2	983.9	982.6
J15-S4-2	985	1034.8	1017.7	1011.0	1021.3
J15-S4-3	1053	1112.3	1085.3	1094.3	1081.9
J15-S4-4	737	786.1	764.3	763.3	756.7
J15-S4-5	835	876.0	860.7	862.2	862.4
J15-S4-6	956	999.0	974.8	992.2	981.3
J15-S4-7	1008	1077.5	1037.0	1038.4	1048.7
J15-S4-8	805	849.7	830.7	828.3	830.7
J15-S4-9	1065	1123.4	1100.9	1104.6	1102.9
J15-S4-10	607	644.3	629.2	623.1	621.3
J15-S6-1	887	937.7	911.4	917.7	917.2
J15-S6-2	808	843.1	840.1	841.6	831.4
J15-S6-3	966	1002.8	1002.0	989.8	990.3
J15-S6-4	1043	1103.7	1073.2	1076.6	1078.0
J15-S6-5	848	892.2	881.8	868.6	865.2
J15-S6-6	878	924.9	898.0	914.2	908.5
J15-S6-7	1075	1119.5	1099.7	1100.8	1107.0
J15-S6-8	998	1030.8	1028.5	1023.9	1019.6
J15-S6-9	980	1023.9	1013.3	1006.1	1006.6
J15-S6-10	975	1010.7	1015.5	1004.1	1008.0
J30-S2-1	948	1006.7	978.4	976.5	990.8
J30-S2-2	1632	1710.1	1698.6	1706.8	1681.9
J30-S2-3	998	1045.3	1040.5	1030.1	1043.0
J30-S2-4	1803	1931.3	1877.1	1881.3	1885.8
J30-S2-5	1674	1773.7	1738.8	1771.5	1729.3
J30-S2-6	1510	1590.4	1603.2	1557.0	1577.3
J30-S2-7	1747	1834.8	1854.8	1851.4	1796.2
J30-S2-8	1717	1831.8	1766.7	1810.3	1773.4

J30-S2-9	1012	1087.0	1044.2	1059.7	1058.9
J30-S2-10	1006	1052.9	1049.7	1045.1	1043.6
J30-S4-1	1503	1603.3	1563.5	1579.1	1544.0
J30-S4-2	1865	1981.5	1941.9	1946.4	1930.5
J30-S4-3	1885	1967.9	1980.8	1962.4	1952.1
J30-S4-4	1986	2066.0	2035.3	2089.6	2080.8
J30-S4-5	1034	1093.8	1074.6	1088.5	1084.1
J30-S4-6	1901	2022.4	1985.1	2008.3	1993.6
J30-S4-7	1882	2003.5	1935.9	1973.0	1926.1
J30-S4-8	1869	2006.7	1962.5	1967.2	1942.3
J30-S4-9	1206	1272.9	1267.7	1251.4	1242.7
J30-S4-10	1600	1713.9	1636.4	1658.8	1675.4
J30-S6-1	2129	2224.0	2191.4	2244.8	2211.6
J30-S6-2	1811	1909.2	1867.5	1887.3	1877.5
J30-S6-3	1742	1857.4	1789.9	1801.8	1787.7
J30-S6-4	1942	2079.1	2042.6	2064.6	1999.9
J30-S6-5	1653	1720.6	1740.4	1725.6	1702.8
J30-S6-6	1817	1917.9	1902.8	1934.0	1896.2
J30-S6-7	1936	2005.3	2006.7	2049.7	1996.6
J30-S6-8	2047	2181.3	2134.8	2153.7	2095.7
J30-S6-9	1760	1872.1	1852.6	1866.0	1808.2
J30-S6-10	1962	2053.7	2078.0	2077.2	2027.2
J45-S2-1	1160	1207.8	1188.7	1190.3	1179.1
J45-S2-2	2501	2609.4	2571.5	2566.3	2543.2
J45-S2-3	1458	1526.6	1490.2	1493.3	1489.5
J45-S2-4	2284	2379.1	2344.3	2342.7	2336.7
J45-S2-5	1505	1587.8	1536.0	1550.2	1540.8
J45-S2-6	1399	1459.9	1428.0	1440.7	1428.4
J45-S2-7	2788	2894.9	2855.5	2870.5	2854.0
J45-S2-8	2478	2594.3	2542.2	2544.7	2533.0
J45-S2-9	1393	1463.7	1428.7	1431.6	1420.3
J45-S2-10	1426	1483.2	1462.5	1467.2	1454.1
J45-S4-1	1601	1676.5	1643.9	1653.3	1636.5
J45-S4-2	2654	2779.7	2715.5	2754.2	2715.0
J45-S4-3	2701	2856.3	2784.4	2792.4	2756.0
J45-S4-4	2851	2982.1	2942.5	2937.0	2919.4
J45-S4-5	2712	2853.0	2796.3	2798.4	2783.8
J45-S4-6	2444	2546.8	2518.8	2531.1	2493.8
J45-S4-7	1664	1748.3	1705.7	1729.1	1703.7
J45-S4-8	2609	2717.2	2671.3	2678.5	2669.2
J45-S4-9	3068	3191.9	3156.0	3154.1	3146.5

J45-S4-10	1443	1520.0	1483.0	1498.2	1474.9
J45-S6-1	2897	3061.0	2978.9	3003.3	2967.6
J45-S6-2	2746	2889.6	2828.0	2841.5	2832.7
J45-S6-3	2628	2763.3	2696.5	2728.9	2684.4
J45-S6-4	1586	1673.7	1641.3	1637.7	1630.1
J45-S6-5	2783	2901.6	2849.7	2871.4	2862.3
J45-S6-6	1619	1713.7	1659.3	1680.0	1656.0
J45-S6-7	2527	2656.9	2593.6	2607.3	2593.4
J45-S6-8	3031	3186.8	3133.4	3145.5	3115.8
J45-S6-9	2606	2718.3	2691.1	2701.1	2666.9
J45-S6-10	2441	2554.0	2507.6	2519.3	2508.8

附表 2　MNEH 初始化方法有效性实验的详细数据

算例编号	C_{best}	启发式算法直接求解所得的 $C_{\max}$		ISSA 使用不同初始化方法求解所得的 $\bar{C}_{\max}$		
		NEH	MNEH	随机生成	NEH	MNEH
J15-S2-1	497	546	538	507.7	505.7	506.4
J15-S2-2	912	1036	998	939.4	939.6	936.0
J15-S2-3	512	553	544	519.5	520.5	518.2
J15-S2-4	487	531	528	497.2	499.0	496.3
J15-S2-5	574	627	621	586.9	590.1	585.6
J15-S2-6	422	458	455	432.3	431.4	430.9
J15-S2-7	557	588	589	572.5	571.8	570.6
J15-S2-8	797	996	942	811.8	809.2	806.4
J15-S2-9	567	609	603	583.4	581.3	581.6
J15-S2-10	842	948	998	857.0	857.7	855.7
J15-S4-1	953	1101	1027	986.1	980.2	980.8
J15-S4-2	985	1080	1052	1018.3	1019.8	1022.1
J15-S4-3	1053	1163	1134	1080.6	1078.3	1078.1
J15-S4-4	737	796	828	757.3	754.1	753.3
J15-S4-5	835	975	971	862.5	864.6	862.9
J15-S4-6	956	1101	1052	979.8	977.3	981.5
J15-S4-7	1008	1145	1144	1048.6	1052.9	1041.0
J15-S4-8	805	962	915	826.7	835.4	826.0
J15-S4-9	1065	1164	1136	1095.6	1108.5	1101.6
J15-S4-10	607	646	650	621.6	622.2	616.1
J15-S6-1	887	1042	990	923.3	913.6	909.2
J15-S6-2	808	876	866	829.6	827.3	827.5
J15-S6-3	966	1142	1080	988.5	986.8	990.0
J15-S6-4	1043	1176	1121	1085.3	1072.2	1078.2
J15-S6-5	848	929	972	868.2	862.8	862.6

J15-S6-6	878	983	939	914.3	902.7	903.6
J15-S6-7	1075	1162	1143	1105.8	1109.5	1102.4
J15-S6-8	998	1107	1079	1018.2	1017.7	1019.8
J15-S6-9	980	1092	1112	1007.8	1002.1	1002.0
J15-S6-10	975	1073	1018	1012.2	1002.0	1004.1
J30-S2-1	948	1028	1001	985.2	991.7	989.0
J30-S2-2	1632	1783	1767	1679.0	1669.3	1670.9
J30-S2-3	998	1060	1054	1038.4	1037.2	1022.7
J30-S2-4	1803	2013	2034	1870.6	1871.5	1879.9
J30-S2-5	1674	1798	1767	1714.8	1727.0	1710.4
J30-S2-6	1510	1701	1675	1586.9	1550.2	1556.0
J30-S2-7	1747	1861	1828	1794.1	1780.3	1781.0
J30-S2-8	1717	1930	1821	1753.8	1761.3	1738.9
J30-S2-9	1012	1065	1060	1052.4	1052.1	1055.5
J30-S2-10	1006	1096	1058	1036.5	1039.1	1038.4
J30-S4-1	1503	1599	1647	1527.3	1538.2	1538.8
J30-S4-2	1865	1994	1958	1916.2	1933.8	1908.8
J30-S4-3	1885	2031	1967	1947.1	1928.3	1952.2
J30-S4-4	1986	2146	2090	2090.2	2053.6	2057.7
J30-S4-5	1034	1148	1107	1085.4	1071.8	1067.4
J30-S4-6	1901	2023	2005	1982.6	1982.7	1957.2
J30-S4-7	1882	2049	1990	1906.9	1913.2	1911.0
J30-S4-8	1869	1988	1953	1943.5	1946.2	1920.5
J30-S4-9	1206	1309	1253	1228.9	1228.3	1233.1
J30-S4-10	1600	1723	1709	1677.1	1682.7	1666.7
J30-S6-1	2129	2256	2231	2224.3	2197.0	2190.9
J30-S6-2	1811	1889	1862	1881.6	1870.1	1861.3
J30-S6-3	1742	1901	1898	1785.5	1788.5	1781.6
J30-S6-4	1942	2097	2047	2014.1	1991.7	2004.7
J30-S6-5	1653	1856	1789	1695.6	1695.5	1706.3
J30-S6-6	1817	2006	1961	1880.6	1905.6	1910.0
J30-S6-7	1936	2102	2031	1997.7	1997.5	1981.8
J30-S6-8	2047	2218	2163	2103.0	2093.4	2092.6
J30-S6-9	1760	1891	1852	1819.8	1810.5	1812.2
J30-S6-10	1962	2134	2182	2037.0	2033.8	2027.1
J45-S2-1	1160	1247	1231	1183.0	1179.6	1172.9
J45-S2-2	2501	2672	2618	2542.6	2541.6	2527.3
J45-S2-3	1458	1539	1511	1496.0	1489.8	1484.9
J45-S2-4	2284	2488	2411	2338.6	2337.0	2323.5
J45-S2-5	1505	1571	1564	1543.8	1546.0	1534.5
J45-S2-6	1399	1513	1482	1426.7	1425.3	1424.8

J45-S2-7	2788	2959	2953	2857.9	2852.7	2846.5
J45-S2-8	2478	2697	2590	2543.4	2529.7	2528.9
J45-S2-9	1393	1502	1471	1421.7	1416.3	1416.2
J45-S2-10	1426	1478	1478	1455.9	1457.4	1449.4
J45-S4-1	1601	1653	1640	1634.2	1635.7	1631.9
J45-S4-2	2654	2793	2742	2712.8	2704.5	2698.5
J45-S4-3	2701	2894	2855	2764.7	2746.1	2738.7
J45-S4-4	2851	3010	2986	2918.6	2909.2	2906.9
J45-S4-5	2712	2835	2847	2786.0	2783.2	2776.6
J45-S4-6	2444	2509	2617	2502.4	2486.8	2489.8
J45-S4-7	1664	1711	1713	1707.5	1702.6	1696.5
J45-S4-8	2609	2771	2715	2666.7	2676.0	2656.1
J45-S4-9	3068	3147	3174	3138.6	3137.0	3141.0
J45-S4-10	1443	1515	1506	1476.6	1471.9	1466.7
J45-S6-1	2897	3014	3034	2972.6	2958.5	2963.9
J45-S6-2	2746	2836	2835	2836.5	2823.2	2825.7
J45-S6-3	2628	2708	2710	2688.7	2667.8	2666.6
J45-S6-4	1586	1682	1714	1627.2	1619.0	1626.7
J45-S6-5	2783	2883	2851	2866.4	2850.6	2848.9
J45-S6-6	1619	1800	1699	1655.1	1650.3	1650.0
J45-S6-7	2527	2611	2620	2585.5	2575.6	2574.3
J45-S6-8	3031	3172	3127	3124.5	3099.5	3108.4
J45-S6-9	2606	2721	2662	2667.8	2658.5	2646.4
J45-S6-10	2441	2559	2533	2514.0	2497.4	2489.6

附表 3　ISSA 对比实验的详细数据

算例编号	C_{best}	$\bar{C}_{\max}$				
		GA	IPSO	DABC	BSATS	ISSA
J15-S2-1	497	514.6	509.1	507.8	504.0	506.7
J15-S2-2	912	945.1	945.4	930.3	934.9	932.7
J15-S2-3	512	521.6	532.8	523.3	521.0	518.2
J15-S2-4	487	498.9	501.7	499.4	497.5	495.3
J15-S2-5	574	589.0	588.6	580.3	584.0	584.0
J15-S2-6	422	437.7	439.4	433.5	432.2	431.3
J15-S2-7	557	568.5	572.1	566.7	566.3	571.6
J15-S2-8	797	815.1	815.9	818.0	815.3	807.4
J15-S2-9	567	585.4	589.6	577.6	581.2	580.8
J15-S2-10	842	873.0	865.5	862.2	864.1	854.4
J15-S4-1	953	986.1	980.9	988.0	987.4	979.2
J15-S4-2	985	1020.6	1011.1	1013.4	1009.8	1016.0

J15-S4-3	1053	1077.5	1090.0	1092.5	1072.2	1076.5
J15-S4-4	737	753.7	754.1	765.5	765.1	752.4
J15-S4-5	835	862.1	868.0	858.1	851.6	858.4
J15-S4-6	956	992.1	974.8	981.1	973.0	983.8
J15-S4-7	1008	1034.4	1040.5	1026.4	1027.3	1040.9
J15-S4-8	805	824.6	824.4	826.6	825.8	827.7
J15-S4-9	1065	1093.8	1097.0	1094.7	1104.4	1095.0
J15-S4-10	607	629.1	620.0	617.7	627.4	614.1
J15-S6-1	887	920.8	909.9	908.7	913.5	910.4
J15-S6-2	808	836.0	830.6	822.9	823.6	828.9
J15-S6-3	966	1002.1	1000.4	982.2	980.6	991.1
J15-S6-4	1043	1079.4	1072.2	1061.2	1075.0	1075.0
J15-S6-5	848	861.6	876.1	875.0	874.3	859.3
J15-S6-6	878	901.9	905.5	906.6	902.5	901.9
J15-S6-7	1075	1108.2	1108.0	1094.6	1101.2	1097.1
J15-S6-8	998	1028.1	1025.1	1029.9	1028.4	1016.5
J15-S6-9	980	1001.4	1003.6	999.4	1011.4	1001.2
J15-S6-10	975	1003.1	994.7	995.8	994.7	1005.9
J30-S2-1	948	979.5	973.8	980.8	970.8	998.8
J30-S2-2	1632	1690.0	1680.5	1674.0	1676.3	1675.0
J30-S2-3	998	1029.7	1035.5	1031.7	1029.1	1028.6
J30-S2-4	1803	1853.4	1893.0	1873.3	1867.6	1887.7
J30-S2-5	1674	1714.6	1758.4	1731.9	1717.6	1708.2
J30-S2-6	1510	1550.8	1561.3	1547.5	1537.3	1566.6
J30-S2-7	1747	1826.4	1794.0	1807.1	1805.0	1781.4
J30-S2-8	1717	1798.2	1779.5	1769.2	1782.6	1748.5
J30-S2-9	1012	1039.9	1048.0	1046.7	1051.3	1054.3
J30-S2-10	1006	1044.2	1046.4	1048.6	1043.7	1045.0
J30-S4-1	1503	1575.4	1550.8	1580.2	1556.7	1535.9
J30-S4-2	1865	1946.7	1953.5	1949.6	1919.4	1914.6
J30-S4-3	1885	1929.7	1928.4	1929.3	1949.9	1945.2
J30-S4-4	1986	2065.5	2079.9	2061.8	2087.7	2049.3
J30-S4-5	1034	1064.8	1077.6	1083.6	1072.3	1078.1
J30-S4-6	1901	1996.6	1995.7	1994.3	1980.0	1968.1
J30-S4-7	1882	1984.5	1970.2	1964.5	1979.3	1915.9
J30-S4-8	1869	1952.3	1942.4	1936.7	1944.0	1925.9
J30-S4-9	1206	1241.7	1236.5	1240.8	1250.5	1235.0
J30-S4-10	1600	1684.0	1660.7	1674.6	1659.3	1655.0
J30-S6-1	2129	2197.5	2221.8	2202.8	2220.6	2189.5
J30-S6-2	1811	1856.6	1852.6	1859.0	1852.7	1847.7
J30-S6-3	1742	1826.6	1788.3	1803.4	1805.3	1771.5

J30-S6-4	1942	1990.1	2026.2	2027.4	2023.6	2011.0
J30-S6-5	1653	1723.3	1704.0	1723.8	1723.3	1705.8
J30-S6-6	1817	1919.3	1883.9	1906.3	1889.4	1912.7
J30-S6-7	1936	2029.2	2010.6	2026.0	1992.8	1982.7
J30-S6-8	2047	2160.8	2123.9	2099.3	2115.5	2087.8
J30-S6-9	1760	1836.8	1828.0	1851.4	1845.3	1797.6
J30-S6-10	1962	2072.0	1997.5	2043.8	2058.1	2028.4
J45-S2-1	1160	1205.0	1198.8	1194.0	1176.5	1173.7
J45-S2-2	2501	2606.3	2573.7	2564.2	2537.8	2523.1
J45-S2-3	1458	1494.2	1503.0	1484.3	1492.6	1483.6
J45-S2-4	2284	2338.6	2370.6	2349.1	2340.7	2324.8
J45-S2-5	1505	1556.1	1540.3	1523.7	1545.2	1538.0
J45-S2-6	1399	1437.6	1439.4	1421.0	1432.5	1425.8
J45-S2-7	2788	2849.7	2861.2	2853.6	2828.6	2836.5
J45-S2-8	2478	2530.9	2533.4	2551.9	2533.3	2534.6
J45-S2-9	1393	1451.4	1432.8	1427.9	1423.2	1416.2
J45-S2-10	1426	1479.3	1454.8	1455.0	1469.2	1448.7
J45-S4-1	1601	1638.6	1635.1	1635.1	1636.1	1635.2
J45-S4-2	2654	2734.6	2733.3	2713.4	2713.1	2702.8
J45-S4-3	2701	2787.9	2759.4	2807.3	2757.4	2733.6
J45-S4-4	2851	2966.1	2936.0	2955.7	2922.7	2898.0
J45-S4-5	2712	2805.9	2772.1	2800.7	2772.5	2781.8
J45-S4-6	2444	2516.0	2518.4	2507.2	2495.9	2483.7
J45-S4-7	1664	1703.7	1699.9	1708.1	1707.5	1697.8
J45-S4-8	2609	2701.6	2693.0	2663.3	2671.5	2652.7
J45-S4-9	3068	3144.2	3154.1	3145.5	3135.9	3148.2
J45-S4-10	1443	1493.9	1496.3	1486.5	1479.1	1466.9
J45-S6-1	2897	3000.6	2993.0	2974.0	2990.6	2966.3
J45-S6-2	2746	2806.2	2802.4	2814.9	2796.4	2820.1
J45-S6-3	2628	2708.7	2691.6	2696.0	2685.4	2673.0
J45-S6-4	1586	1651.3	1629.6	1621.4	1635.9	1628.9
J45-S6-5	2783	2842.8	2842.2	2844.7	2832.5	2848.1
J45-S6-6	1619	1670.1	1672.9	1642.4	1666.0	1651.0
J45-S6-7	2527	2615.4	2599.6	2594.1	2606.1	2583.0
J45-S6-8	3031	3101.3	3123.5	3122.2	3121.1	3122.3
J45-S6-9	2606	2656.7	2658.1	2657.9	2659.8	2650.6
J45-S6-10	2441	2538.2	2516.1	2516.6	2510.7	2493.2