**Supplementary File for Paper: A Q-Learning-Assisted Co-Evolutionary Algorithm for Distributed Assembly Flexible Job Shop Scheduling Problems**

This supplementary file contains seven sections. Section 1 provides an illustration of evolutionary strategies regarding three populations. Section 2 reports the pseudo code of the Q-learning-assisted iterative local search method. Section 3 gives the information of 30 constructed instances. Section 4 shows the results and analysis regarding parameter setting of QA-CEA. Section 5 offers the results of parameter experiments regarding the rival approaches. Section 6 gives the comparison results of QA-CEA and CEA. Section 7 shows the comparison results of QA-CEA and HGA, HTLBO, IGWO.

**1 Illustration of evolutionary strategies**

This section illustrates the evolutionary strategies in terms of three populations. Fig. S1(a) gives the evolutionary strategies for individuals in , i.e., factory allocation of jobs. It uses two factories and four jobs. and indicate two parent individuals, and respectively represent offspring individuals obtained by crossover and mutation methods. Fig. S1(b) shows the evolutionary strategies for individuals in , i.e., machine arrangement of operations. It employs three machines per factory, four jobs, and two operations per job. and signify two parent individuals, and severally indicate offspring individuals acquired by crossover and mutation methods. Fig. S1(c) provides an illustration of the evolutionary strategies for individuals in , i.e., operation processing sequence. and denote two parent individuals. It adopts four jobs and two operations per job. and mean offspring individuals obtained by crossover and mutation methods, respectively.



**(a)** Illustration of evolutionary strategies for individuals in .

**(b)** Illustration of evolutionary strategies for individuals in .

**(c)** Illustration of evolutionary strategies for individuals in .

**Figure S1:** Evolutionary strategies of individuals in populations.

**2 Pseudo code of ILS approach**

This section gives the pseudo code of the Q-learning-assisted iterative local search (ILS) method as shown in Algorithm S1, where is the best solution identified during the historical search procedure, is a new solution obtained by using a selected neighborhood structure for , and is a given parameter.

|  |
| --- |
| **Algorithm S1: ILS.** |
| **Input:** , , and .  **Output:** an improved .  **Begin**  .  **while** () **do**  Select a neighborhood structure based on the Q-learning method.  Produce a new individual .  **if** ( is better than ) **then**  .  **end if**  .  **end while**  **End.** |

**3 Information of constructed instances**

The employed instances are constructed based on the Hurink, Jurisch and Thole benchmark for the flexible job shop scheduling problems. The details of the constructed instances are given in Table S1.

**Table S1:** Information of 30 constructed instances.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Instance |  |  |  | Production |  | Instance |  |  |  | Production |
| DPSA01 | 2 | 5 | 20 | {la01, la02} |  | DPSA16 | 3 | 10 | 60 | {la31, la32} |
| DPSA02 | 2 | 10 | 20 | {la16, la17} |  | DPSA17 | 4 | 5 | 60 | {la06, la07, la08, la09} |
| DPSA03 | 3 | 5 | 20 | {la01, la02} |  | DPSA18 | 4 | 10 | 60 | {la31, la32} |
| DPSA04 | 3 | 10 | 20 | {la16, la17} |  | DPSA19 | 2 | 5 | 80 | {la11, la12, la13, la14} |
| DPSA05 | 4 | 5 | 20 | {la01, la02} |  | DPSA20 | 2 | 10 | 80 | {la26, la27, la28, la29} |
| DPSA06 | 4 | 10 | 20 | {la16, la17} |  | DPSA21 | 3 | 5 | 80 | {la11, la12, la13, la14} |
| DPSA07 | 2 | 5 | 40 | {la11, la12} |  | DPSA22 | 3 | 10 | 80 | {la26, la27, la28, la29} |
| DPSA08 | 2 | 10 | 40 | {la26, la27} |  | DPSA23 | 4 | 5 | 80 | {la11, la12, la13, la14} |
| DPSA09 | 3 | 5 | 40 | {la11, la12} |  | DPSA24 | 4 | 10 | 80 | {la26, la27, la28, la29} |
| DPSA10 | 3 | 10 | 40 | {la26, la27} |  | DPSA25 | 2 | 5 | 100 | {la11, la12, la13, la14, la15} |
| DPSA11 | 4 | 5 | 40 | {la11, la12} |  | DPSA26 | 2 | 10 | 100 | {la20, la33, la34, la35} |
| DPSA12 | 4 | 10 | 40 | {la26, la27} |  | DPSA27 | 3 | 5 | 100 | {la11, la12, la13, la14, la15} |
| DPSA13 | 2 | 5 | 60 | {la06, la07, la08, la09} |  | DPSA28 | 3 | 10 | 100 | {la20, la33, la34, la35} |
| DPSA14 | 2 | 10 | 60 | {la31, la32} |  | DPSA29 | 4 | 5 | 100 | {la11, la12, la13, la14, la15} |
| DPSA15 | 3 | 5 | 60 | {la06, la07, la08, la09} |  | DPSA30 | 4 | 10 | 100 | {la20, la33, la34, la35} |

**4 Parameter setting of the proposed approach**

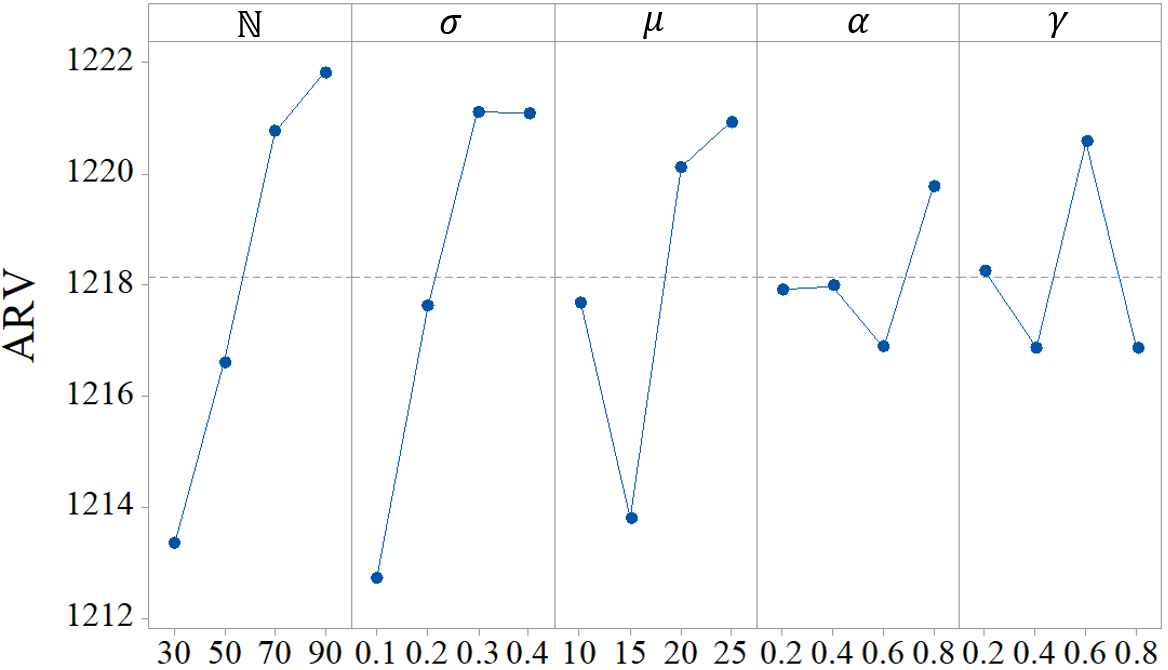
In this section, we provide the experimental results of parameter setting regarding QA-CEA. Table S2 provides the four levels of parameters and all the parameter combinations. QA-CEA with each combination solves an instance DPSA15 with three factories, five machines per factory and 60 jobs for 20 times, and the objective values across 20 times are calculated as average response variable (ARV) values. The experimental results are shown in Table S2, and the response and rank of parameters are reported in Table S3. Fig. S2 gives the influence trend of parameters. It can be found that a promising parameter combination is , , , and . It will be used in the verfication experiments.

**Table S2:** Orthogonal array and ARV.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Levels | | | | | ARV |
|  |  |  |  |  |
| 1 | 30 | 0.1 | 10 | 0.2 | 0.2 | 1207.35 |
| 2 | 30 | 0.2 | 15 | 0.4 | 0.4 | 1207.05 |
| 3 | 30 | 0.3 | 20 | 0.6 | 0.6 | 1219.50 |
| 4 | 30 | 0.4 | 25 | 0.8 | 0.8 | 1219.45 |
| 5 | 50 | 0.1 | 15 | 0.6 | 0.8 | 1204.30 |
| 6 | 50 | 0.2 | 10 | 0.8 | 0.6 | 1219.70 |
| 7 | 50 | 0.3 | 25 | 0.2 | 0.4 | 1220.90 |
| 8 | 50 | 0.4 | 20 | 0.4 | 0.2 | 1221.50 |
| 9 | 70 | 0.1 | 20 | 0.8 | 0.4 | 1217.70 |
| 10 | 70 | 0.2 | 25 | 0.6 | 0.2 | 1221.90 |
| 11 | 70 | 0.3 | 10 | 0.4 | 0.8 | 1221.85 |
| 12 | 70 | 0.4 | 15 | 0.2 | 0.6 | 1221.60 |
| 13 | 90 | 0.1 | 25 | 0.4 | 0.6 | 1221.50 |
| 14 | 90 | 0.2 | 20 | 0.2 | 0.8 | 1221.80 |
| 15 | 90 | 0.3 | 15 | 0.8 | 0.2 | 1222.20 |
| 16 | 90 | 0.4 | 10 | 0.6 | 0.4 | 1221.80 |

**Table S3:** Response and rank of parameters for QA-CEA.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Level |  |  |  |  |  |
| 1 | 1213 | 1213 | 1218 | 1218 | 1218 |
| 2 | 1217 | 1218 | 1214 | 1218 | 1217 |
| 3 | 1221 | 1221 | 1220 | 1217 | 1221 |
| 4 | 1222 | 1221 | 1221 | 1220 | 1217 |
| Delta | 8 | 8 | 7 | 3 | 4 |
| Rank | 1 | 2 | 3 | 5 | 4 |



**Figure S2:** Influence trend of parameters in QA-CEA.

**5 Parameter setting of the rival approaches**

In this section, the Taguchi experiments are carried out to tune the parameter values of comparison algorithms. The experiment conditions are the same with QA-CEA. The results and analysis are reported in Tables S4-S9.

1) HGA has two parameters: population size and mutation rate . The parameter levels are given as: and . The experimental results and parameter ranks are provided in Tables S4 and S5, respectively. It is found that a better parameter combination is: and . It is used in the validation experiments.

**Table S4:** Orthogonal array and ARV regarding HGA.

|  |  |  |  |
| --- | --- | --- | --- |
| No. | Levels | | ARV |
|  |  |
| 1 | 30 | 0.05 | 1489.75 |
| 2 | 30 | 0.10 | 1519.40 |
| 3 | 30 | 0.15 | 1535.20 |
| 4 | 30 | 0.20 | 1580.00 |
| 5 | 50 | 0.05 | 1466.35 |
| 6 | 50 | 0.10 | 1528.95 |
| 7 | 50 | 0.15 | 1550.75 |
| 8 | 50 | 0.20 | 1562.70 |
| 9 | 70 | 0.05 | 1440.38 |
| 10 | 70 | 0.10 | 1493.00 |
| 11 | 70 | 0.15 | 1525.15 |
| 12 | 70 | 0.20 | 1528.31 |
| 13 | 90 | 0.05 | 1459.90 |
| 14 | 90 | 0.10 | 1519.25 |
| 15 | 90 | 0.15 | 1548.35 |
| 16 | 90 | 0.20 | 1573.65 |

**Table S5:** Response and rank of parameters for HGA.

|  |  |  |
| --- | --- | --- |
| Level |  |  |
| 1 | 1531 | 1464 |
| 2 | 1527 | 1515 |
| 3 | 1497 | 1540 |
| 4 | 1525 | 1561 |
| Delta | 34 | 97 |
| Rank | 2 | 1 |

2) HTLBO has three parameters: population size , local search times , and population initialization ratio . Each parameter has four levels: , , and . Tables S6 and S7 offer the experimental results and parameter ranks. It is seen that a promising parameter setting is: , , and . It is adopted in the comparison experiments.

**Table S6:** Orthogonal array and ARV regarding HTLBO.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Levels | | | ARV |
|  |  |  |
| 1 | 30 | 10 | 0.5 | 1372.15 |
| 2 | 30 | 15 | 0.6 | 1468.95 |
| 3 | 30 | 20 | 0.7 | 1463.95 |
| 4 | 30 | 25 | 0.8 | 1357.75 |
| 5 | 50 | 10 | 0.6 | 1361.65 |
| 6 | 50 | 15 | 0.5 | 1369.80 |
| 7 | 50 | 20 | 0.8 | 1364.50 |
| 8 | 50 | 25 | 0.7 | 1373.35 |
| 9 | 70 | 10 | 0.7 | 1357.15 |
| 10 | 70 | 15 | 0.8 | 1344.00 |
| 11 | 70 | 20 | 0.5 | 1361.10 |
| 12 | 70 | 25 | 0.6 | 1361.90 |
| 13 | 90 | 10 | 0.8 | 1357.10 |
| 14 | 90 | 15 | 0.7 | 1342.35 |
| 15 | 90 | 20 | 0.6 | 1361.90 |
| 16 | 90 | 25 | 0.5 | 1365.40 |

**Table S7:** Response and rank of parameters for HTLBO.

|  |  |  |  |
| --- | --- | --- | --- |
| Level |  |  |  |
| 1 | 1416 | 1362 | 1367 |
| 2 | 1367 | 1381 | 1389 |
| 3 | 1356 | 1388 | 1384 |
| 4 | 1357 | 1365 | 1356 |
| Delta | 60 | 26 | 33 |
| Rank | 1 | 3 | 2 |

3) IGWO possesses three parameters: population size , local search times and leader ratio . The parameter levels are provided as: , , and . The results are shown in Tables S8 and S9. We can find that IGWO with , and can realize better results. This combination is used in the comparison experiments.

**Table S8:** Orthogonal array and ARV regarding IGWO.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Levels | | | ARV |
|  |  |  |
| 1 | 30 | 8 | 0.05 | 1244.10 |
| 2 | 30 | 12 | 0.10 | 1250.30 |
| 3 | 30 | 16 | 0.20 | 1243.00 |
| 4 | 30 | 20 | 0.40 | 1260.00 |
| 5 | 50 | 8 | 0.10 | 1247.50 |
| 6 | 50 | 12 | 0.05 | 1242.95 |
| 7 | 50 | 16 | 0.40 | 1256.55 |
| 8 | 50 | 20 | 0.20 | 1256.47 |
| 9 | 70 | 8 | 0.20 | 1253.05 |
| 10 | 70 | 12 | 0.40 | 1257.40 |
| 11 | 70 | 16 | 0.05 | 1251.20 |
| 12 | 70 | 20 | 0.10 | 1252.05 |
| 13 | 90 | 8 | 0.40 | 1251.85 |
| 14 | 90 | 12 | 0.20 | 1249.50 |
| 15 | 90 | 16 | 0.10 | 1247.10 |
| 16 | 90 | 20 | 0.05 | 1247.25 |

**Table S9:** Response and rank of parameters for IGWO.

|  |  |  |  |
| --- | --- | --- | --- |
| Level |  |  |  |
| 1 | 1249 | 1249 | 1246 |
| 2 | 1251 | 1250 | 1249 |
| 3 | 1253 | 1249 | 1251 |
| 4 | 1249 | 1254 | 1256 |
| Delta | 5 | 5 | 10 |
| Rank | 3 | 2 | 1 |

**6 Comparison results of QA-CEA and CEA**

In this section, a variant of QA-CEA (named as CEA), which randomly selects a neighborhood structure for the best solution in the local search phase, is compared with QA-CEA to verify the effectiveness of Q-Learning approaches. The comparison results of QA-CEA and CEA are reported in Table S10. It is found that QA-CEA beats CEA on 12 out of 15 instances as regards and 13 out of 15 instances in terms of , which indicates that QA-CEA can achieve better results in most cases. Based on , it is observed that QA-CEA surpasses CEA on 8 instances, signifying that QA-CEA has similar stability to CEA. Meanwhile, the -test method at a significance level of 0.05 with a freedom degree of 38 [58] is used to analyze comparison results. The symbols “+”, “~”, and “-” indicate that QA-CEA is significantly better than, statistically equal to, and significantly worse than CEA. It is discovered that QA-CEA is significantly better than CEA on 9 instances, and statistically equal to CEA on the rest instances. Hence, we infer that the Q-learning approaches play positive roles in improving the performance of QA-CEA.

**Table S10:** Comparison results of QA-CEA and CEA.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Instance | QA-CEA | | |  | CEA | | | -test |
|  |  |  |  |  |  |  |
| DPSA02 | **0.0030** | **0.0000** | **0.0021** |  | 0.0044 | 0.0011 | 0.0023 | + |
| DPSA04 | **0.0032** | **0.0000** | **0.0017** |  | 0.0040 | 0.0013 | 0.0020 | ~ |
| DPSA06 | **0.0002** | **0.0000** | **0.0002** |  | 0.0006 | 0.0000 | 0.0009 | + |
| DPSA08 | **0.0021** | **0.0000** | 0.0013 |  | 0.0030 | 0.0010 | **0.0009** | + |
| DPSA10 | **0.0037** | **0.0000** | 0.0021 |  | 0.0039 | 0.0013 | **0.0018** | ~ |
| DPSA12 | **0.0033** | **0.0000** | 0.0016 |  | 0.0047 | 0.0031 | **0.0011** | + |
| DPSA14 | **0.0018** | **0.0000** | 0.0009 |  | 0.0023 | 0.0011 | **0.0007** | + |
| DPSA16 | **0.0029** | **0.0000** | 0.0011 |  | 0.0037 | 0.0025 | **0.0009** | + |
| DPSA18 | **0.0012** | **0.0000** | **0.0008** |  | 0.0022 | 0.0006 | **0.0008** | + |
| DPSA20 | **0.0010** | **0.0000** | 0.0007 |  | 0.0013 | 0.0003 | **0.0005** | + |
| DPSA22 | **0.0012** | **0.0000** | **0.0006** |  | 0.0022 | 0.0010 | 0.0007 | + |
| DPSA24 | **0.0026** | **0.0000** | **0.0012** |  | 0.0031 | 0.0004 | **0.0012** | ~ |
| DPSA26 | 0.0009 | **0.0000** | 0.0006 |  | **0.0007** | 0.0003 | **0.0005** | ~ |
| DPSA28 | 0.0009 | 0.0002 | **0.0005** |  | **0.0007** | **0.0000** | **0.0005** | ~ |
| DPSA30 | 0.0015 | 0.0005 | **0.0007** |  | **0.0012** | **0.0000** | 0.0010 | ~ |
| Average | 0.0020 | 0.0000 | 0.0011 |  | 0.0025 | 0.0009 | 0.0011 |  |

**7 Comparison results of QA-CEA and HGA, HTLBO, IGWO**

This section provides the comparison results of QA-CEA and HGA, HTLBO, IGWO as shown in Table S11. We find that QA-CEA is superior to HGA, HTLBO, and IGWO on 30, 30, and 28 instances in terms of, respectively. According to , it is seen that QA-CEA wins HGA, HTLBO, and IGWO on all the instances. Via metric , we discover that QA-CEA achieves better results than HGA and HTLBO in most of the instances. By analyzing the average of , , and values regarding all the instances, it is found that QA-CEA achieves smaller values than its rivals. Thus, we conclude that QA-CEA has stronger competitiveness in addressing the concerned problem.

**Table S11:** Comparison results acquired by four methods.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Instance | QA-CEA | | |  | HGA | | |  |  | HTLBO | | |  |  | IGWO | | |  |  |
|  |  |  | Rank |  |  |  |  | Rank |  |  |  |  | Rank |  |  |  |  | Rank |
| DPSA01 | **0.0027** | **0.0000** | 0.0017 | 1 | 0.0141 | 0.0084 | 0.0039 | + | 3 | 0.0183 | 0.0118 | 0.0030 | + | 4 | 0.0056 | 0.0029 | **0.0013** | + | 2 |
| DPSA02 | **0.0030** | **0.0000** | 0.0021 | 1 | 0.0276 | 0.0205 | 0.0056 | + | 4 | 0.0199 | 0.0135 | 0.0036 | + | 3 | 0.0055 | 0.0022 | **0.0015** | + | 2 |
| DPSA03 | **0.0035** | **0.0000** | 0.0017 | 1 | 0.0146 | 0.0060 | 0.0040 | + | 3 | 0.0165 | 0.0111 | 0.0031 | + | 4 | 0.0041 | 0.0009 | **0.0014** | ~ | 2 |
| DPSA04 | **0.0032** | **0.0000** | 0.0017 | 1 | 0.0244 | 0.0181 | 0.0048 | + | 4 | 0.0159 | 0.0113 | 0.0029 | + | 3 | 0.0040 | 0.0010 | **0.0016** | ~ | 2 |
| DPSA05 | **0.0035** | 0.0004 | **0.0019** | 1 | 0.0143 | 0.0091 | 0.0031 | + | 3 | 0.0149 | 0.0089 | 0.0034 | + | 4 | 0.0062 | **0.0000** | **0.0019** | + | 2 |
| DPSA06 | 0.0002 | **0.0000** | **0.0002** | 2 | 0.0126 | 0.0069 | 0.0028 | + | 4 | 0.0090 | 0.0023 | 0.0026 | + | 3 | **0.0001** | **0.0000** | **0.0002** | ~ | 1 |
| DPSA07 | **0.0014** | **0.0000** | **0.0008** | 1 | 0.0190 | 0.0116 | 0.0038 | + | 4 | 0.0133 | 0.0098 | 0.0021 | + | 3 | 0.0041 | 0.0021 | **0.0008** | + | 2 |
| DPSA08 | **0.0021** | **0.0000** | 0.0013 | 1 | 0.0419 | 0.0365 | 0.0035 | + | 4 | 0.0225 | 0.0182 | 0.0022 | + | 3 | 0.0068 | 0.0047 | **0.0010** | + | 2 |
| DPSA09 | **0.0024** | **0.0000** | **0.0013** | 1 | 0.0226 | 0.0153 | 0.0041 | + | 4 | 0.0157 | 0.0104 | 0.0036 | + | 3 | 0.0050 | 0.0023 | 0.0014 | + | 2 |
| DPSA10 | **0.0037** | **0.0000** | 0.0021 | 1 | 0.0377 | 0.0288 | 0.0041 | + | 4 | 0.0192 | 0.0159 | 0.0020 | + | 3 | 0.0039 | 0.0015 | **0.0012** | ~ | 2 |
| DPSA11 | **0.0029** | **0.0000** | **0.0014** | 1 | 0.0241 | 0.0176 | 0.0040 | + | 4 | 0.0183 | 0.0147 | 0.0025 | + | 3 | 0.0046 | 0.0023 | 0.0015 | + | 2 |
| DPSA12 | **0.0033** | **0.0000** | 0.0016 | 1 | 0.0368 | 0.0307 | 0.0042 | + | 4 | 0.0211 | 0.0171 | 0.0028 | + | 3 | 0.0034 | 0.0003 | **0.0010** | ~ | 2 |
| DPSA13 | **0.0011** | **0.0000** | 0.0006 | 1 | 0.0185 | 0.0149 | 0.0024 | + | 4 | 0.0111 | 0.0085 | 0.0017 | + | 3 | 0.0027 | 0.0021 | **0.0003** | + | 2 |
| DPSA14 | **0.0018** | **0.0000** | 0.0009 | 1 | 0.0447 | 0.0386 | 0.0041 | + | 4 | 0.0200 | 0.0154 | 0.0024 | + | 3 | 0.0072 | 0.0065 | **0.0005** | + | 2 |
| DPSA15 | **0.0016** | **0.0000** | **0.0009** | 1 | 0.0240 | 0.0188 | 0.0036 | + | 4 | 0.0148 | 0.0115 | 0.0022 | + | 3 | 0.0049 | 0.0037 | **0.0009** | + | 2 |
| DPSA16 | **0.0029** | **0.0000** | 0.0011 | 1 | 0.0493 | 0.0408 | 0.0052 | + | 4 | 0.0218 | 0.0168 | 0.0023 | + | 3 | 0.0082 | 0.0060 | **0.0010** | + | 2 |
| DPSA17 | **0.0014** | **0.0000** | 0.0007 | 1 | 0.0295 | 0.0219 | 0.0037 | + | 4 | 0.0218 | 0.0168 | 0.0027 | + | 3 | 0.0049 | 0.0021 | **0.0008** | + | 2 |
| DPSA18 | **0.0012** | **0.0000** | 0.0008 | 1 | 0.0456 | 0.0396 | 0.0029 | + | 4 | 0.0205 | 0.0179 | 0.0020 | + | 3 | 0.0038 | 0.0026 | **0.0006** | + | 2 |
| DPSA19 | **0.0013** | **0.0000** | **0.0006** | 1 | 0.0196 | 0.0164 | 0.0025 | + | 4 | 0.0115 | 0.0090 | 0.0013 | + | 3 | 0.0025 | 0.0005 | **0.0006** | + | 2 |
| DPSA20 | **0.0010** | **0.0000** | 0.0007 | 1 | 0.0476 | 0.0414 | 0.0041 | + | 4 | 0.0206 | 0.0148 | 0.0021 | + | 3 | 0.0051 | 0.0044 | **0.0004** | + | 2 |
| DPSA21 | **0.0010** | **0.0000** | **0.0005** | 1 | 0.0272 | 0.0196 | 0.0030 | + | 4 | 0.0139 | 0.0101 | 0.0022 | + | 3 | 0.0044 | 0.0030 | 0.0007 | + | 2 |
| DPSA22 | **0.0012** | **0.0000** | 0.0006 | 1 | 0.0538 | 0.0435 | 0.0042 | + | 4 | 0.0220 | 0.0180 | 0.0024 | + | 3 | 0.0058 | 0.0046 | **0.0005** | + | 2 |
| DPSA23 | **0.0014** | **0.0000** | 0.0010 | 1 | 0.0314 | 0.0250 | 0.0038 | + | 4 | 0.0172 | 0.0118 | 0.0027 | + | 3 | 0.0026 | 0.0014 | **0.0007** | + | 2 |
| DPSA24 | **0.0026** | **0.0000** | 0.0012 | 1 | 0.0546 | 0.0457 | 0.0056 | + | 4 | 0.0252 | 0.0185 | 0.0029 | + | 3 | 0.0052 | 0.0044 | **0.0005** | + | 2 |
| DPSA25 | 0.0023 | **0.0000** | 0.0015 | 2 | 0.0201 | 0.0149 | 0.0023 | + | 4 | 0.0094 | 0.0062 | 0.0015 | + | 3 | **0.0017** | 0.0008 | **0.0004** | ~ | 1 |
| DPSA26 | **0.0009** | **0.0000** | 0.0006 | 1 | 0.0448 | 0.0376 | 0.0025 | + | 4 | 0.0165 | 0.0144 | 0.0017 | + | 3 | 0.0048 | 0.0041 | **0.0004** | + | 2 |
| DPSA27 | **0.0012** | **0.0000** | 0.0007 | 1 | 0.0274 | 0.0239 | 0.0025 | + | 4 | 0.0122 | 0.0090 | 0.0016 | + | 3 | 0.0033 | 0.0021 | **0.0005** | + | 2 |
| DPSA28 | **0.0006** | **0.0000** | **0.0005** | 1 | 0.0547 | 0.0467 | 0.0042 | + | 4 | 0.0223 | 0.0170 | 0.0022 | + | 3 | 0.0067 | 0.0056 | 0.0006 | + | 2 |
| DPSA29 | **0.0017** | **0.0000** | 0.0009 | 1 | 0.0308 | 0.0248 | 0.0039 | + | 4 | 0.0155 | 0.0094 | 0.0030 | + | 3 | 0.0018 | 0.0003 | **0.0005** | ~ | 2 |
| DPSA30 | **0.0010** | **0.0000** | **0.0007** | 1 | 0.0566 | 0.0498 | 0.0039 | + | 4 | 0.0223 | 0.0188 | 0.0021 | + | 3 | 0.0056 | 0.0034 | 0.0014 | + | 2 |
| Average | 0.0019 | 0.0000 | 0.0011 | 1.0667 | 0.0323 | 0.0258 | 0.0037 |  | 3.9000 | 0.0174 | 0.0130 | 0.0024 |  | 3.1000 | 0.0045 | 0.0026 | 0.0009 |  | 1.9333 |