

Supplementary Document of “Knee Point Identification Based on Trade-Off Utility”

Ke Li¹, Haifeng Nie², Huiru Gao² and Xin Yao^{3,4}

¹Department of Computer Science, University of Exeter, EX4 4QF, Exeter, UK

²College of Computer Science & Engineering, University of Electronic Science and Technology of China, Chengdu 611731, China

³Department of Computer Science and Engineering, Southern University of Science and Technology, Shenzhen, China

⁴CERCIA, School of Computer Science, University of Birmingham, B15 2TT, Birmingham, UK

*Email: k.li@exeter.ac.uk

Table 1: Number of generations used for different test problem instances

Test instance	$m=2$	$m=3$	$m=5$	$m=8$	$m=10$
CKP	200	✓	✓	✓	✓
DODK	200	✓	✓	✓	✓
DEBDK	200	500	✓	✓	✓
PMOP1	200	500	3,000	5,000	8,000
PMOP2	200	500	3,000	5,000	8,000
PMOP3	200	500	3,000	5,000	8,000
PMOP4	500	1,000	5,000	8,000	12,000
PMOP5	500	1,000	5,000	8,000	12,000
PMOP6	300	800	3,000	5,000	8,000
PMOP7	300	800	3,000	5,000	8,000
PMOP8	300	800	3,000	5,000	8,000
PMOP9	300	800	3,000	5,000	8,000
PMOP10	400	1,000	5,000	8,000	12,000
PMOP11	400	1,000	5,000	8,000	12,000
PMOP12	400	1,000	5,000	8,000	12,000
PMOP13	300	800	3,000	5,000	8,000
PMOP14	300	800	3,000	5,000	8,000

Algorithm 1: The t -th generation of NSGA-II-KPITU

Input: parent population P_t
Output: P_{t+1}

- 1 $S_t \leftarrow \emptyset, i \leftarrow 1;$
- 2 Use crossover and mutation to generate Q_t ;
- 3 $R_t \leftarrow P_t \cup Q_t$;
- 4 Use non-dominated sorting to divide R_t into several non-domination levels F_1, F_2, \dots ;
- 5 **repeat**
- 6 | $S_t \leftarrow S_t \cup F_i, i \leftarrow i + 1$;
- 7 **until** $|S_t| \geq N$;
- 8 $l \leftarrow i - 1$;
- 9 **if** $|S_t| == N$ **then**
- 10 | $P_{t+1} \leftarrow S_t$;
- 11 **else**
- 12 | $P_{t+1} \leftarrow \bigcup_{i=1}^{l-1} F_i$;
- 13 | $K \leftarrow \text{KPITU}(F_l)$;
- 14 | **if** $|K| == N - |P_{t+1}|$ **then**
- 15 | $P_{t+1} \leftarrow P_{t+1} \cup K$;
- 16 | **else if** $|K| > N - |P_{t+1}|$ **then**
- 17 | $F_l \leftarrow$ the first $N - |P_{t+1}|$ solutions in K ;
- 18 | $P_{t+1} \leftarrow P_{t+1} \cup F_l$;
- 19 | **else**
- 20 | **repeat**
- 21 | $P_{t+1} \leftarrow P_{t+1} \cup K, F_l \leftarrow F_l \setminus K$;
- 22 | $K \leftarrow \text{KPITU}(F_l)$;
- 23 | **until** $|K| \geq N - |P_{t+1}|$;
- 24 | **if** $|K| == N - |P_{t+1}|$ **then**
- 25 | $P_{t+1} \leftarrow P_{t+1} \cup K$;
- 26 | **else**
- 27 | $F_l \leftarrow$ the first $N - |P_{t+1}|$ solutions in K ;
- 28 | $P_{t+1} \leftarrow P_{t+1} \cup F_l$;

29 **return** P_{t+1}

Algorithm 1 gives the pseudo-code of using KPITU to guide NSGA-II to search for knee point(s), dubbed NSGA-II-KPITU. Specifically, let us consider the t -th generation of NSGA-II-KPITU where the parent population is denoted as P_t and the offspring population is denoted as Q_t (both of them have the same size N). The environmental selection first uses the non-dominated sorting to divide the hybrid population of the parents and offspring into several non-domination levels (F_1, F_2 and so on). Thereafter, solutions in the first several levels have a higher priority to be chosen to construct the next parent population until its size is equal to N or for the first time exceeds N (lines 5 to 7). Let us denote the last acceptable non-domination level as F_l . Instead of calculating the crowding distance as in the original NSGA-II, here we use $\text{KPITU}(F_l)$ shown in Algorithm ?? to identify the *potential* knee point(s) (denoted as K) from F_l . If the solutions in K have already filled the next parent population, the environmental selection at the t -th generation terminates (lines 14 and 15). On the other hand, if the size of K is smaller than the size of the remaining slot, we will use KPITU to identify the knee point(s) from $F_l \setminus K$ (lines 19 to 28); otherwise, we use $\text{Sort}(K)$ to sort the solutions in K according to their accumulative trade-off utility and the first several ones will be used to fill the remaining slot (lines 16 to 18).

1 Plots of population distribution on problems with one global knee point

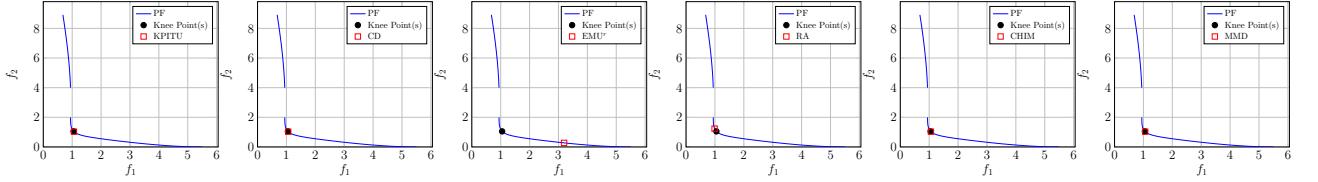


Figure 1: Knee points obtained by different KPI methods on DO2DK with one global knee point.

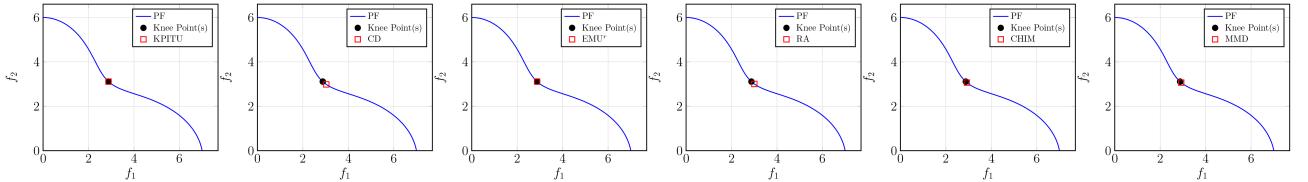


Figure 2: Knee points obtained by different KPI methods on CKP with one global knee point.

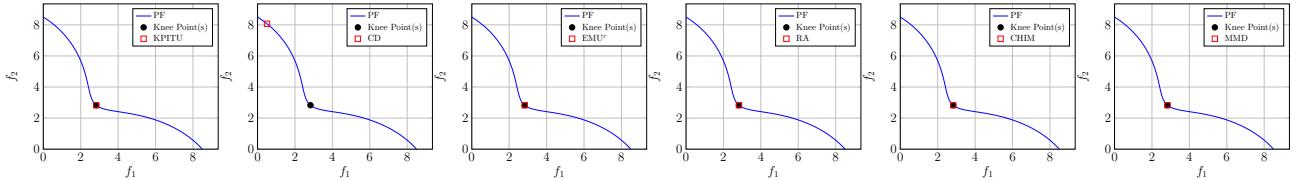


Figure 3: Knee points obtained by different KPI methods on DEB2DK with one global knee point.

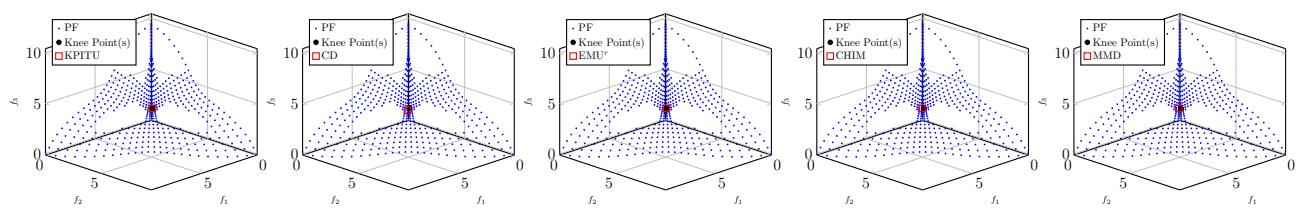


Figure 4: Knee points obtained by different KPI methods on DEB3DK with one global knee point.

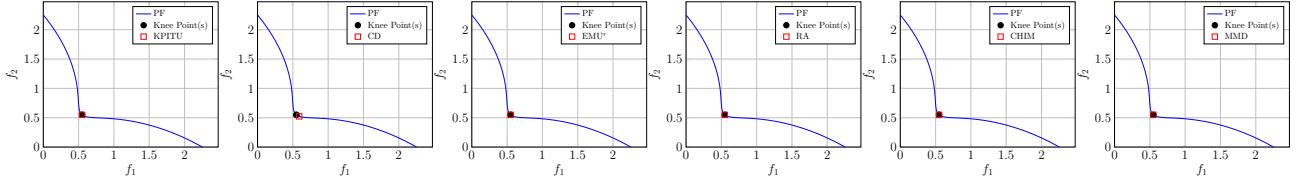


Figure 5: Knee points obtained by different KPI methods on 2-objective PMOP1 with one global knee point.

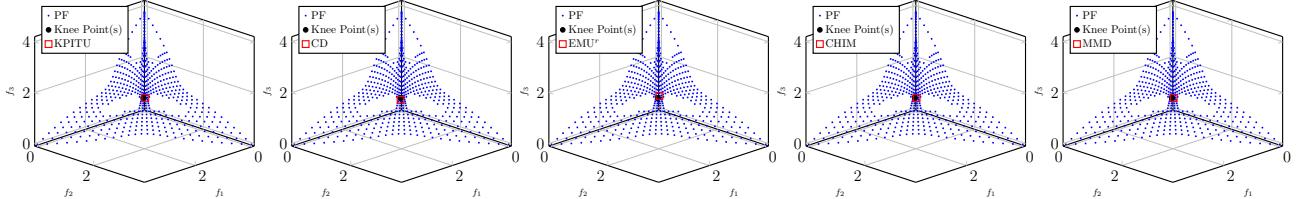


Figure 6: Knee points obtained by different KPI methods on 3-objective PMOP1 with one global knee point.

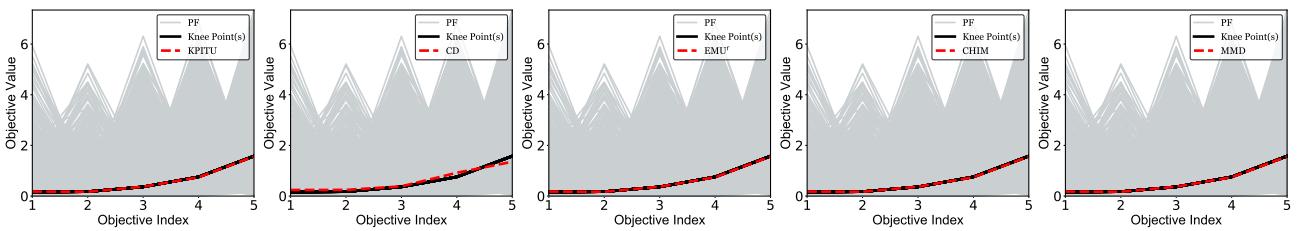


Figure 7: Knee points obtained by different KPI methods on 5-objective PMOP1 with one global knee point.

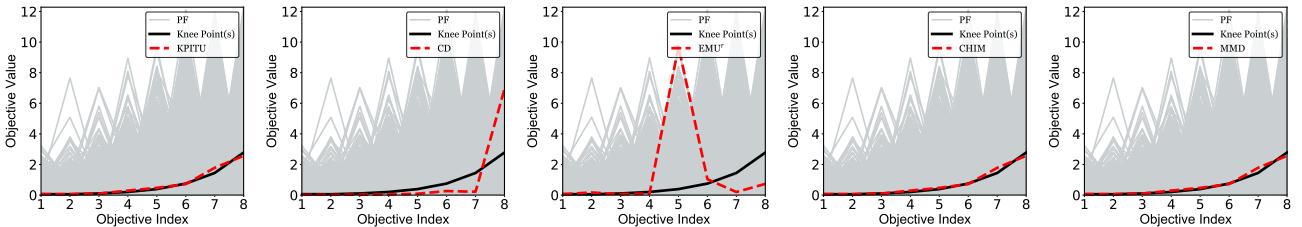


Figure 8: Knee points obtained by different KPI methods on 8-objective PMOP1 with one global knee point.

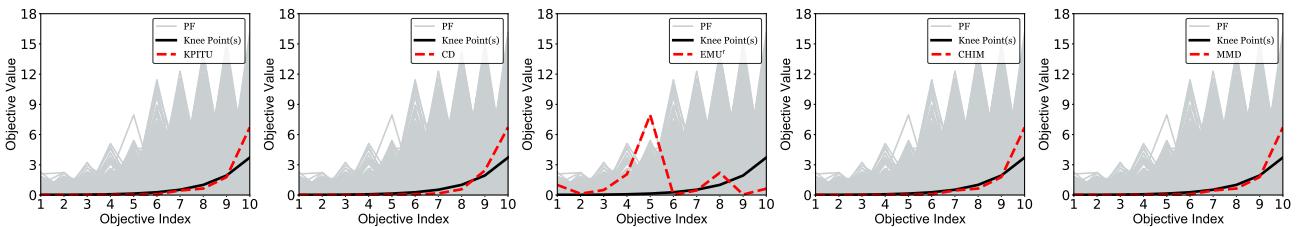


Figure 9: Knee points obtained by different KPI methods on 10-objective PMOP1 with one global knee point.

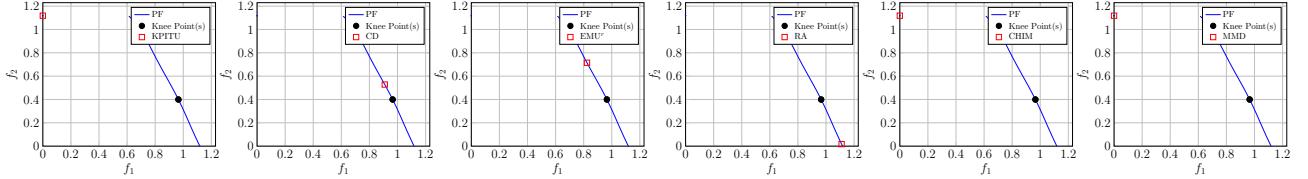


Figure 10: Knee points obtained by different KPI methods on 2-objective PMOP2 with one global knee point.

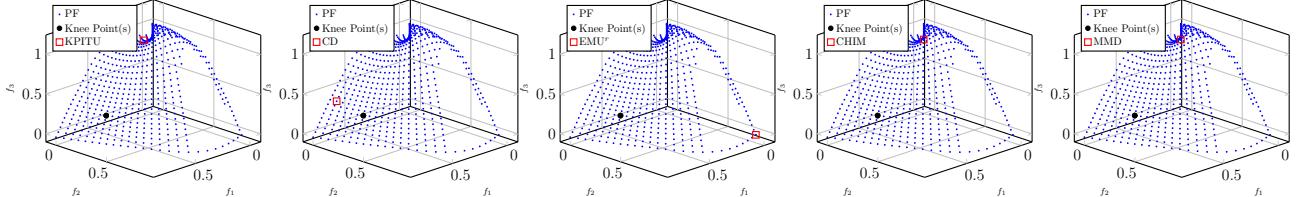


Figure 11: Knee points obtained by different KPI methods on 3-objective PMOP2 with one global knee point.

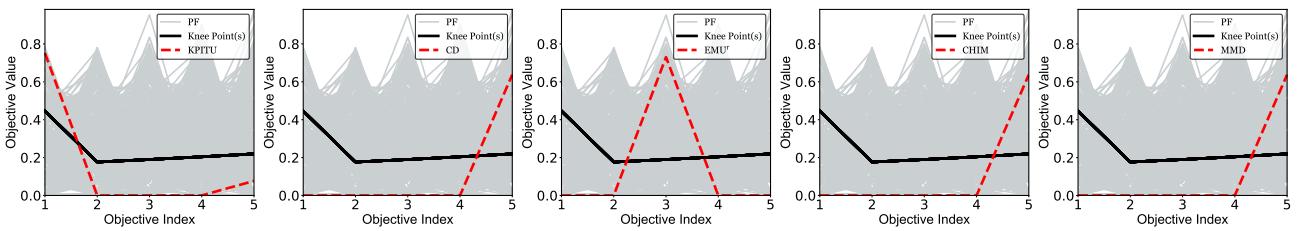


Figure 12: Knee points obtained by different KPI methods on 5-objective PMOP2 with one global knee point.

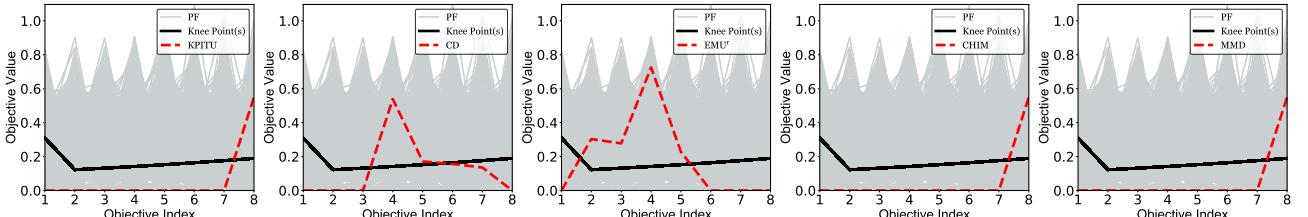


Figure 13: Knee points obtained by different KPI methods on 8-objective PMOP2 with one global knee point.

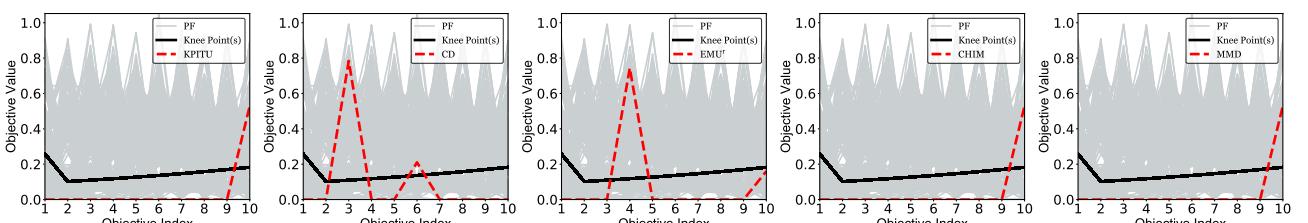


Figure 14: Knee points obtained by different KPI methods on 10-objective PMOP2 with one global knee point.

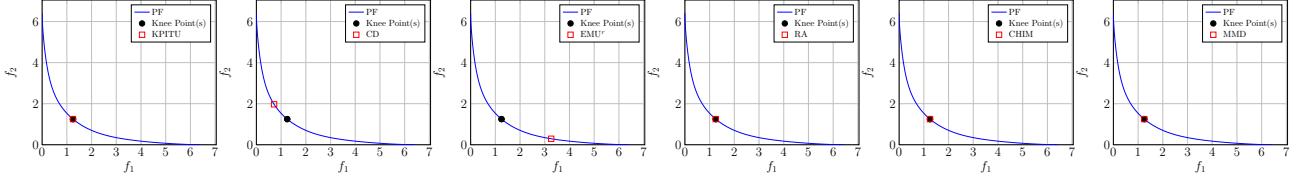


Figure 15: Knee points obtained by different KPI methods on 2-objective PMOP3 with one global knee point.

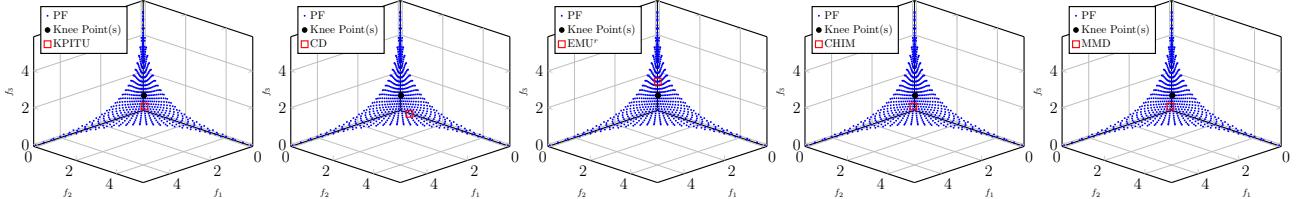


Figure 16: Knee points obtained by different KPI methods on 3-objective PMOP3 with one global knee point.

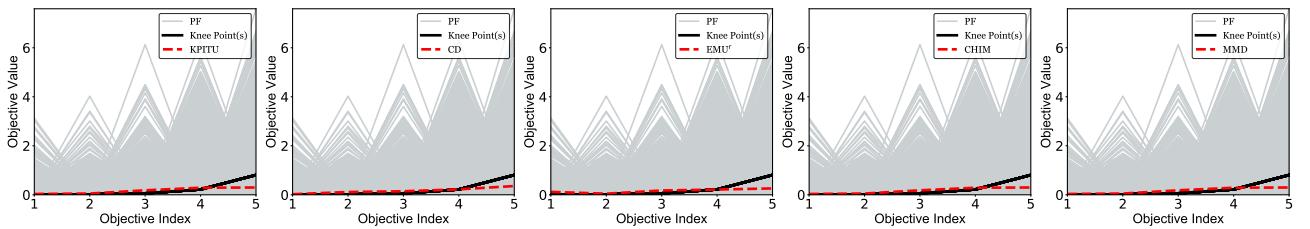


Figure 17: Knee points obtained by different KPI methods on 5-objective PMOP3 with one global knee point.

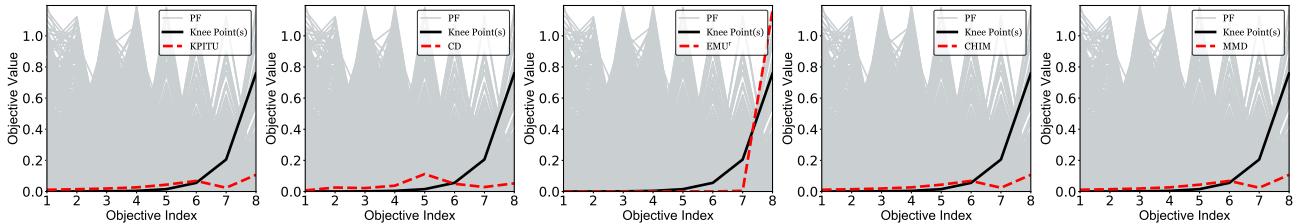


Figure 18: Knee points obtained by different KPI methods on 8-objective PMOP3 with one global knee point.

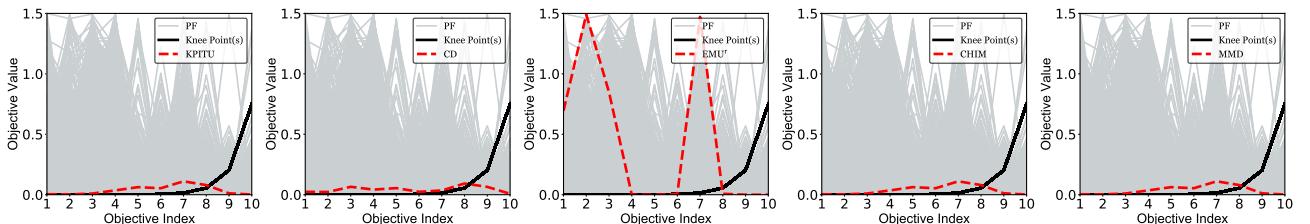


Figure 19: Knee points obtained by different KPI methods on 10-objective PMOP3 with one global knee point.

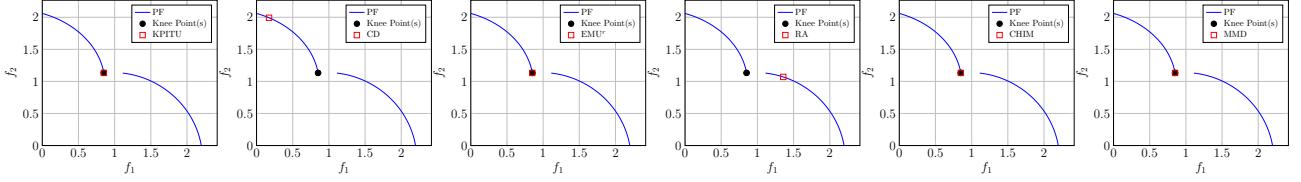


Figure 20: Knee points obtained by different KPI methods on 2-objective PMOP4 with one global knee point.

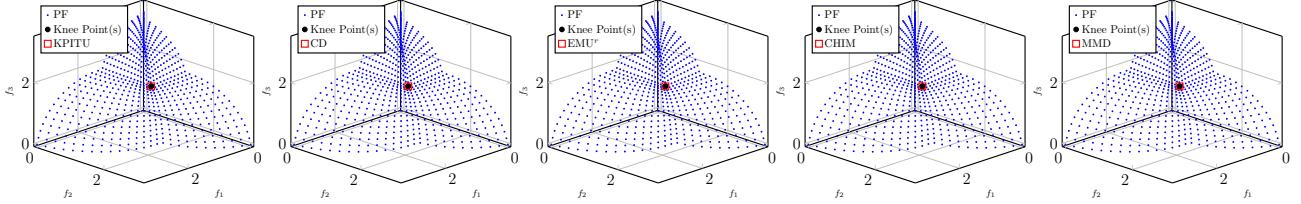


Figure 21: Knee points obtained by different KPI methods on 3-objective PMOP4 with one global knee point.

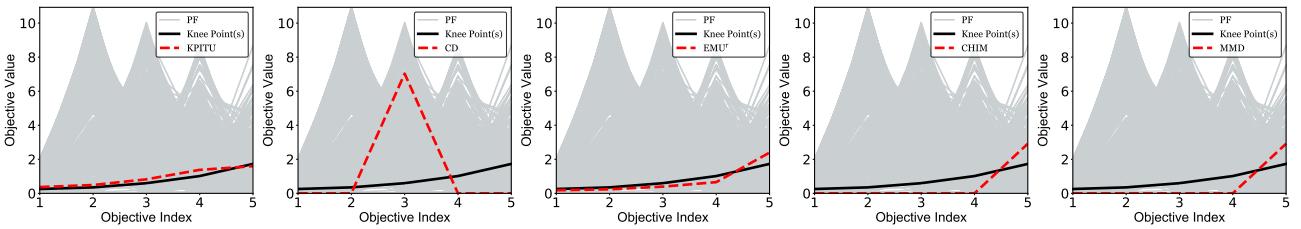


Figure 22: Knee points obtained by different KPI methods on 5-objective PMOP4 with one global knee point.

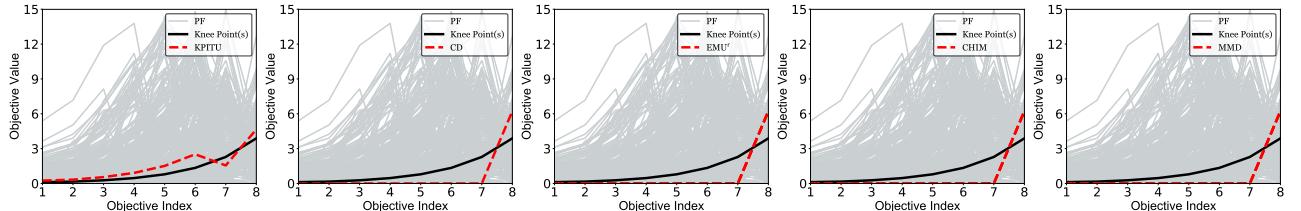


Figure 23: Knee points obtained by different KPI methods on 8-objective PMOP4 with one global knee point.

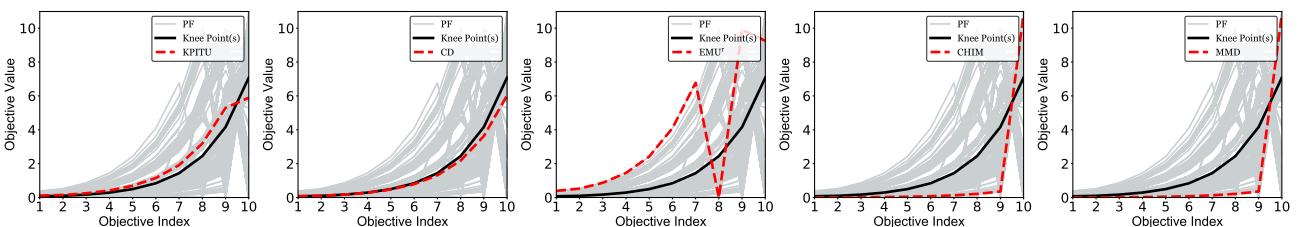


Figure 24: Knee points obtained by different KPI methods on 10-objective PMOP4 with one global knee point.

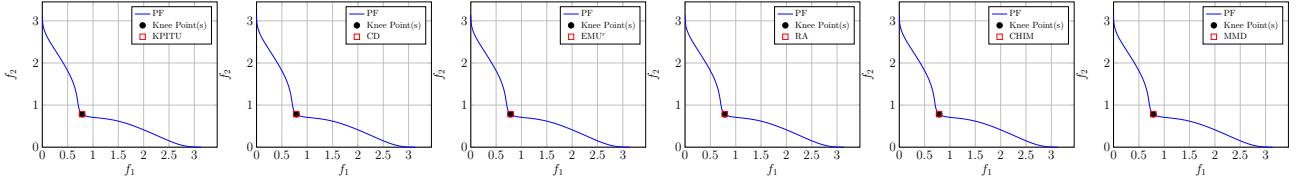


Figure 25: Knee points obtained by different KPI methods on 2-objective PMOP6 with one global knee point.

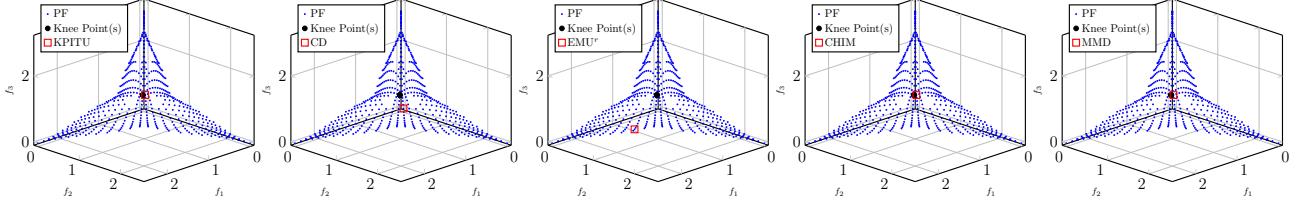


Figure 26: Knee points obtained by different KPI methods on 3-objective PMOP6 with one global knee point.

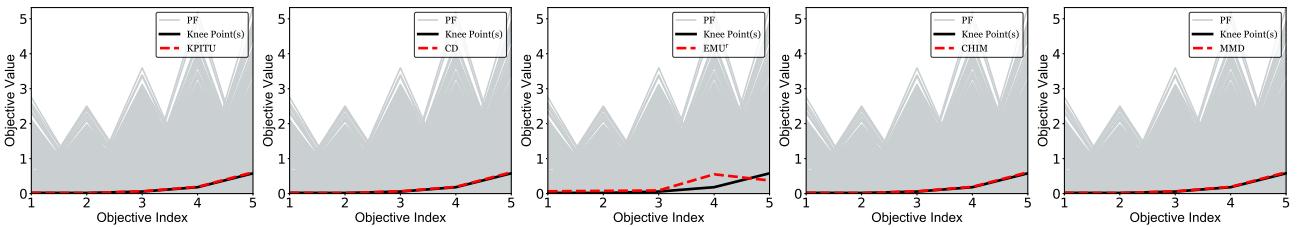


Figure 27: Knee points obtained by different KPI methods on 5-objective PMOP6 with one global knee point.

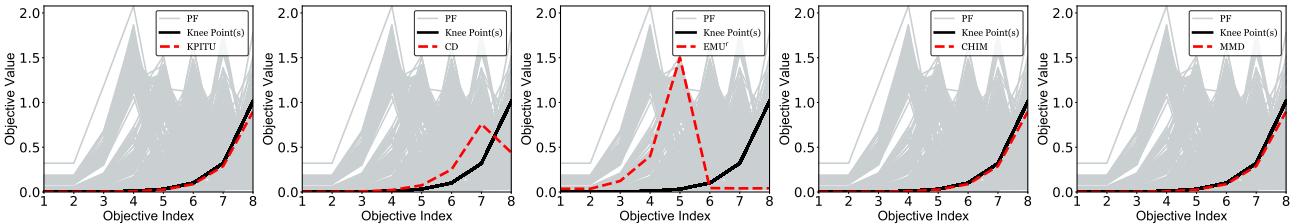


Figure 28: Knee points obtained by different KPI methods on 8-objective PMOP6 with one global knee point.

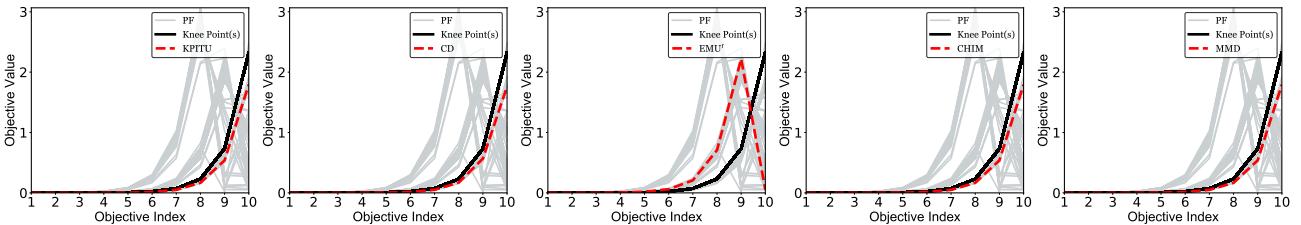


Figure 29: Knee points obtained by different KPI methods on 10-objective PMOP6 with one global knee point.

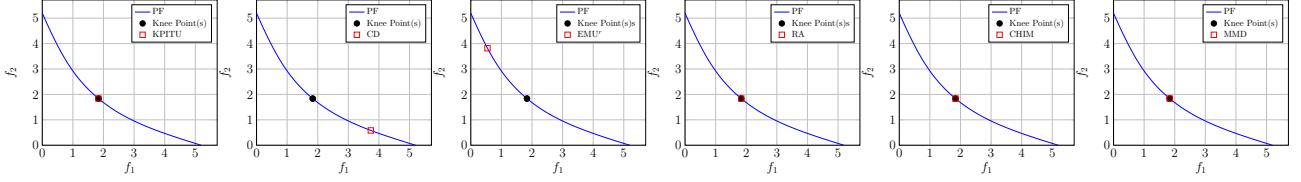


Figure 30: Knee points obtained by different KPI methods on 2-objective PMOP7 with one global knee point.

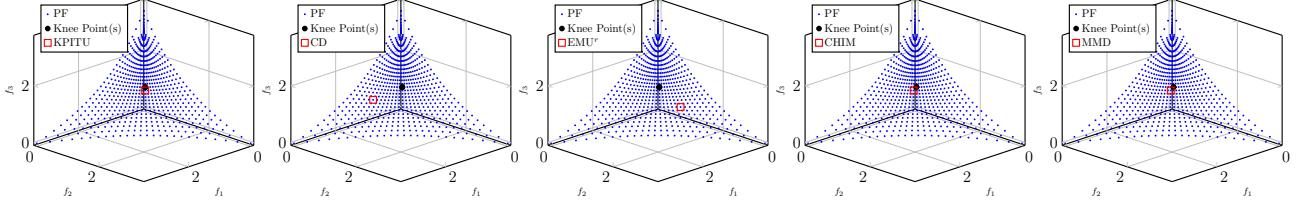


Figure 31: Knee points obtained by different KPI methods on 3-objective PMOP7 with one global knee point.

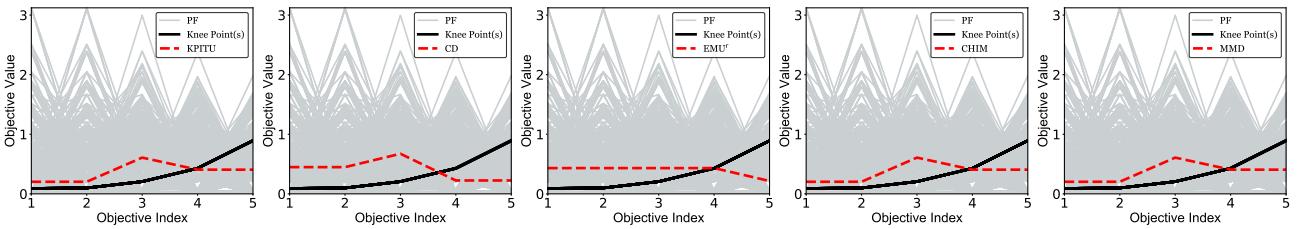


Figure 32: Knee points obtained by different KPI methods on 5-objective PMOP7 with one global knee point.

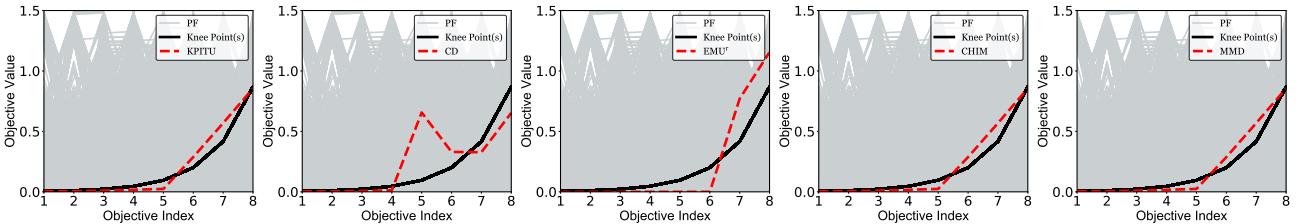


Figure 33: Knee points obtained by different KPI methods on 8-objective PMOP7 with one global knee point.

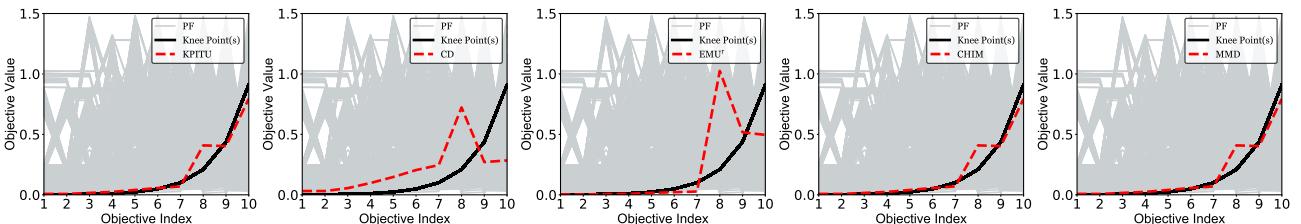


Figure 34: Knee points obtained by different KPI methods on 10-objective PMOP7 with one global knee point.

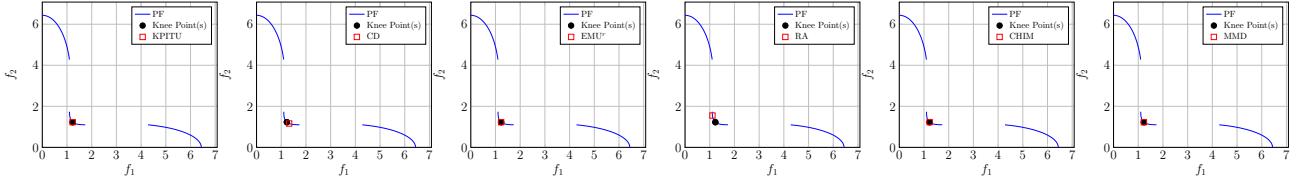


Figure 35: Knee points obtained by different KPI methods on 2-objective PMOP8 with one global knee point.

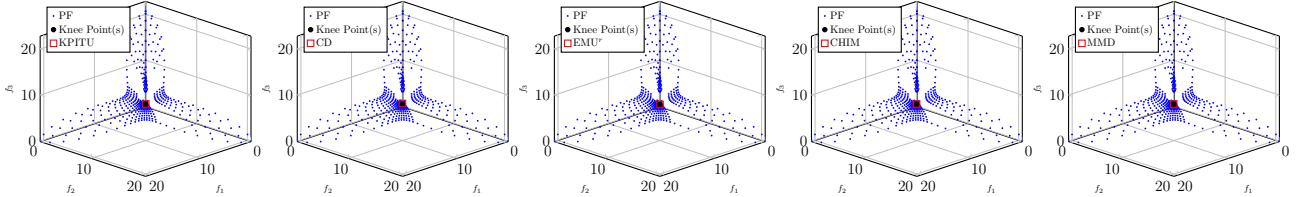


Figure 36: Knee points obtained by different KPI methods on 3-objective PMOP8 with one global knee point.

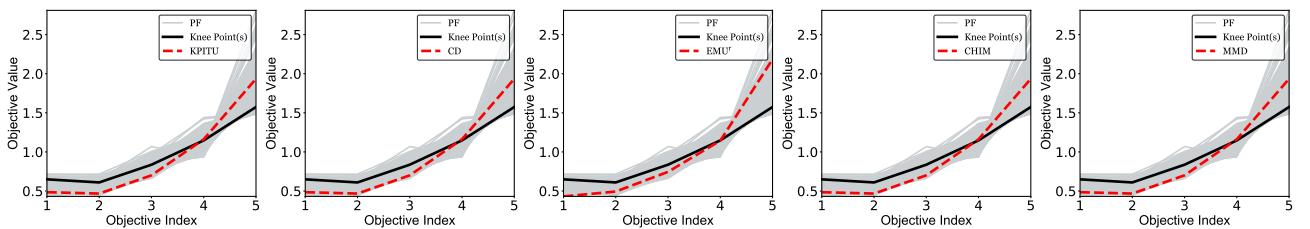


Figure 37: Knee points obtained by different KPI methods on 5-objective PMOP8 with one global knee point.

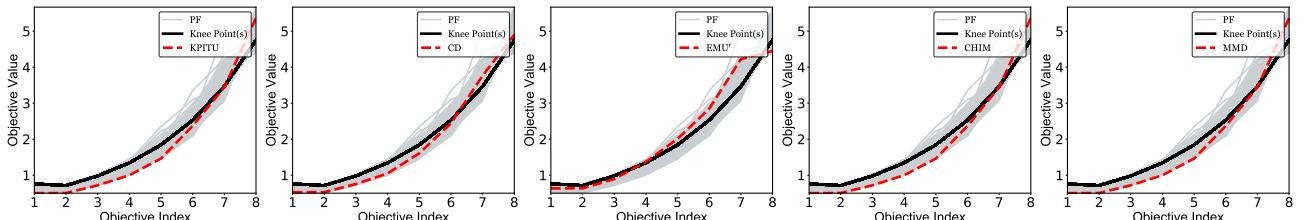


Figure 38: Knee points obtained by different KPI methods on 8-objective PMOP8 with one global knee point.

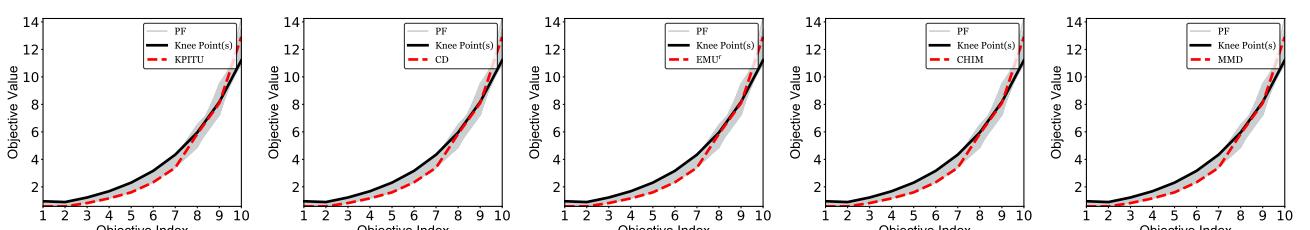


Figure 39: Knee points obtained by different KPI methods on 10-objective PMOP8 with one global knee point.

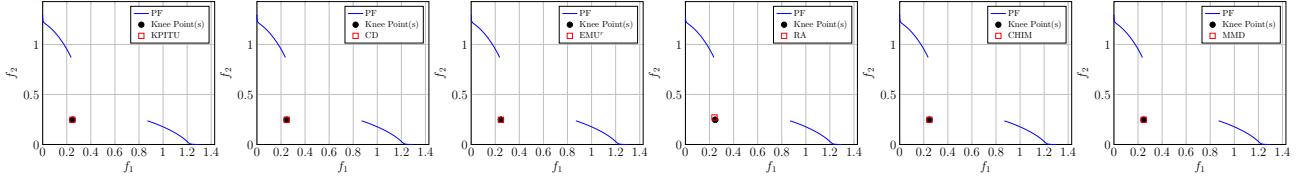


Figure 40: Knee points obtained by different KPI methods on 2-objective PMOP9 with one global knee point.

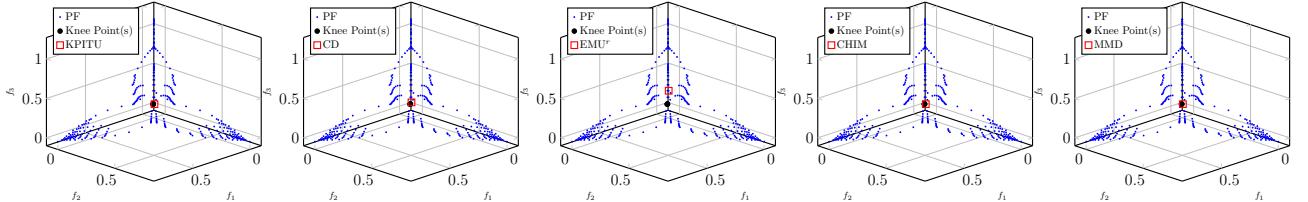


Figure 41: Knee points obtained by different KPI methods on 3-objective PMOP9 with one global knee point.

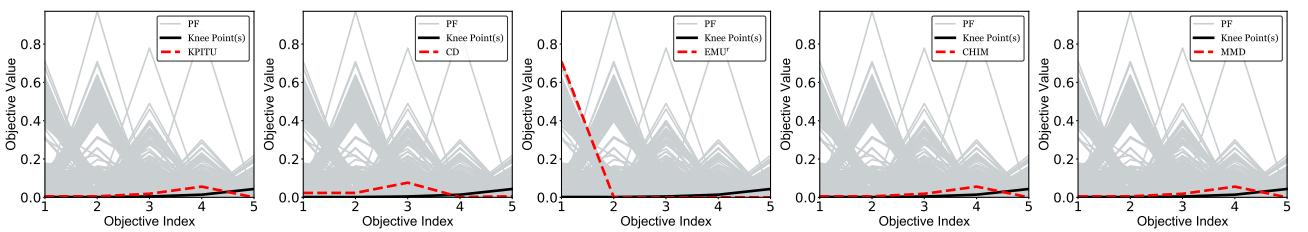


Figure 42: Knee points obtained by different KPI methods on 5-objective PMOP9 with one global knee point.

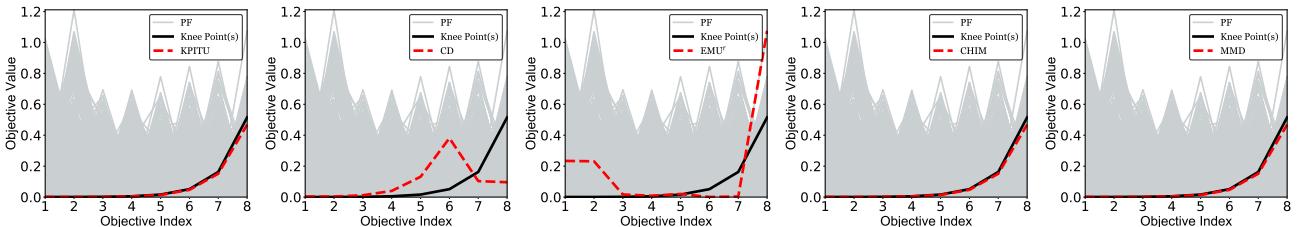


Figure 43: Knee points obtained by different KPI methods on 8-objective PMOP9 with one global knee point.

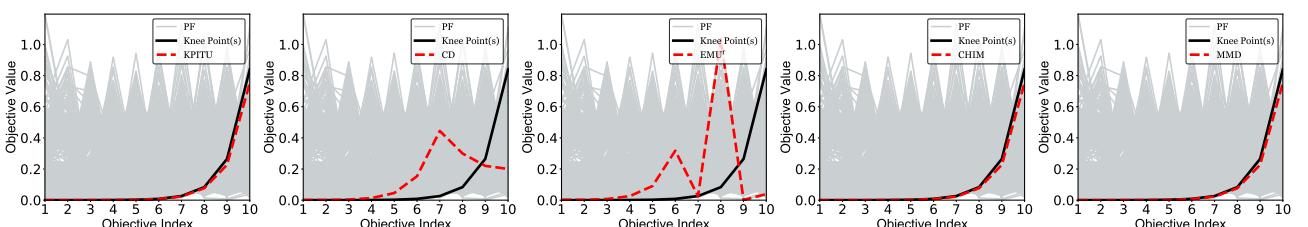


Figure 44: Knee points obtained by different KPI methods on 10-objective PMOP9 with one global knee point.

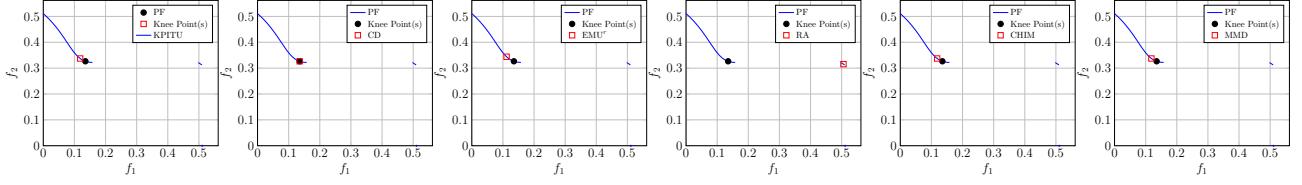


Figure 45: Knee points obtained by different KPI methods on 2-objective PMOP11 with one global knee point.

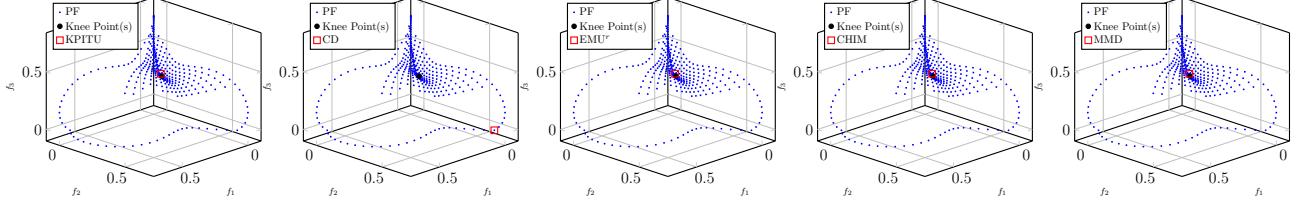


Figure 46: Knee points obtained by different KPI methods on 3-objective PMOP11 with one global knee point.

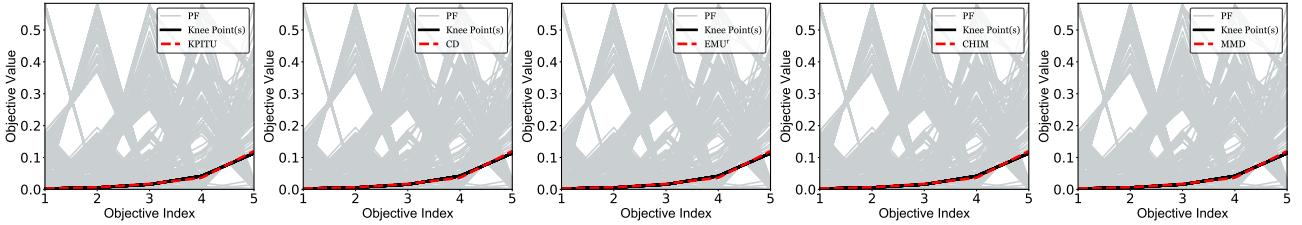


Figure 47: Knee points obtained by different KPI methods on 5-objective PMOP11 with one global knee point.

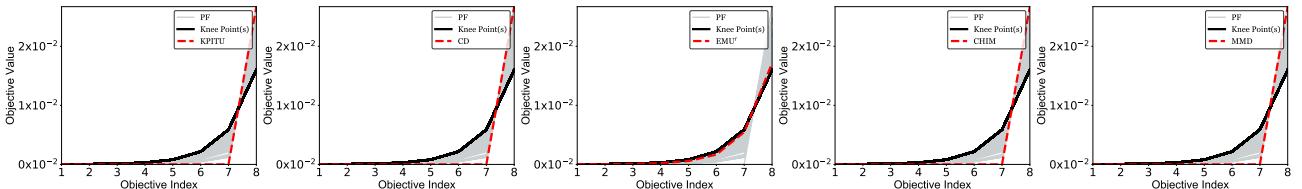


Figure 48: Knee points obtained by different KPI methods on 8-objective PMOP11 with one global knee point.

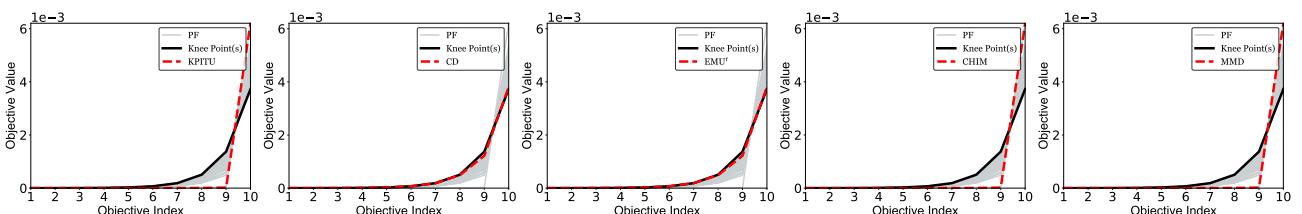


Figure 49: Knee points obtained by different KPI methods on 10-objective PMOP11 with one global knee point.

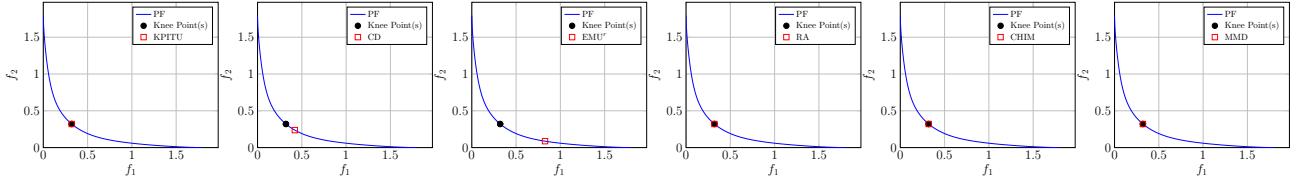


Figure 50: Knee points obtained by different KPI methods on 2-objective PMOP12 with one global knee point.

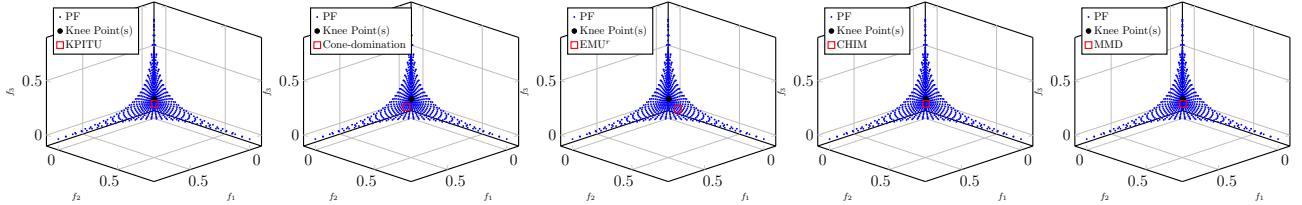


Figure 51: Knee points obtained by different KPI methods on 3-objective PMOP12 with one global knee point.

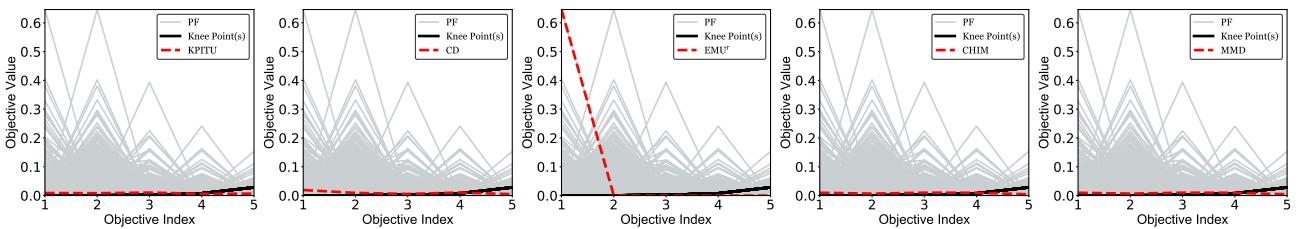


Figure 52: Knee points obtained by different KPI methods on 5-objective PMOP12 with one global knee point.

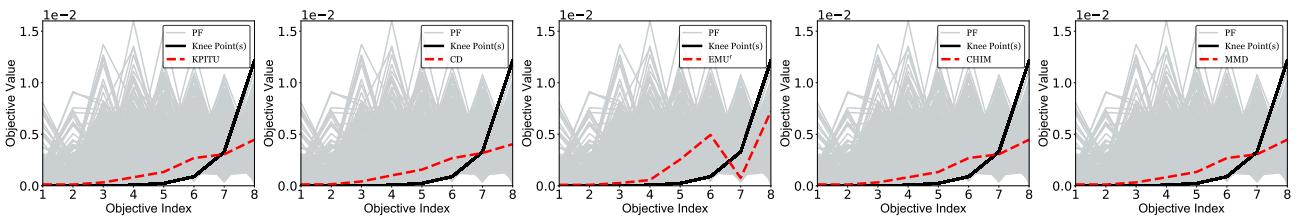


Figure 53: Knee points obtained by different KPI methods on 8-objective PMOP12 with one global knee point.

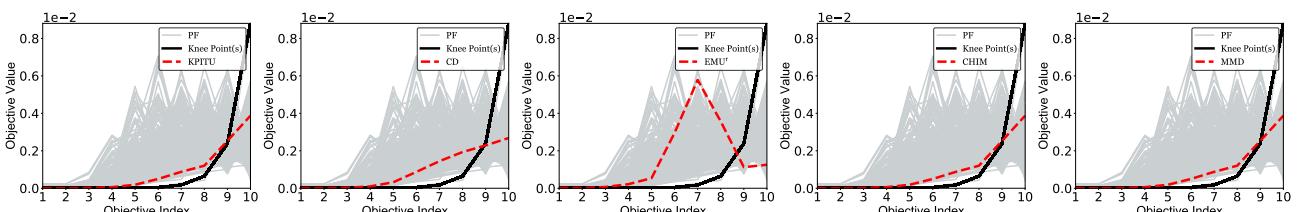


Figure 54: Knee points obtained by different KPI methods on 10-objective PMOP12 with one global knee point.

2 Plots of population distribution on problems with local knee points

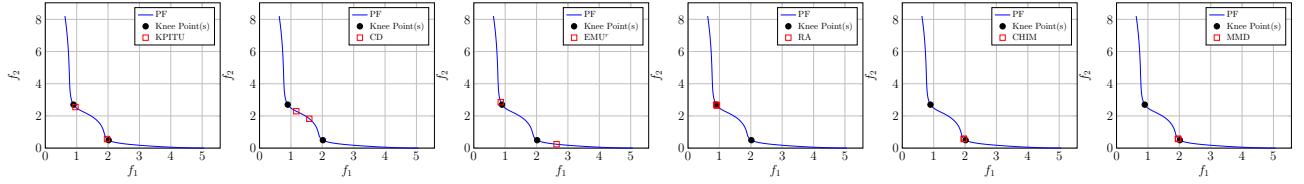


Figure 55: Knee points obtained by different KPI methods on DO2DK with local knee points.

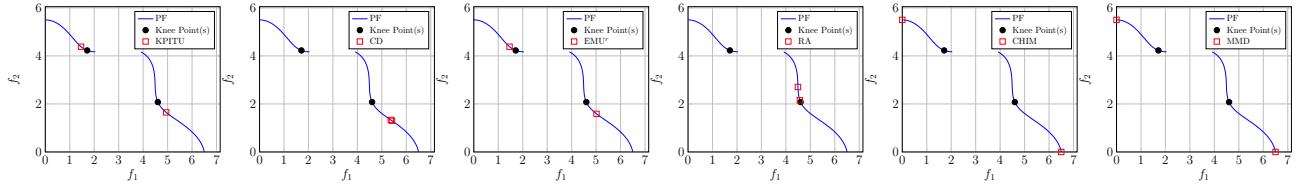


Figure 56: Knee points obtained by different KPI methods on CKP with local knee points.

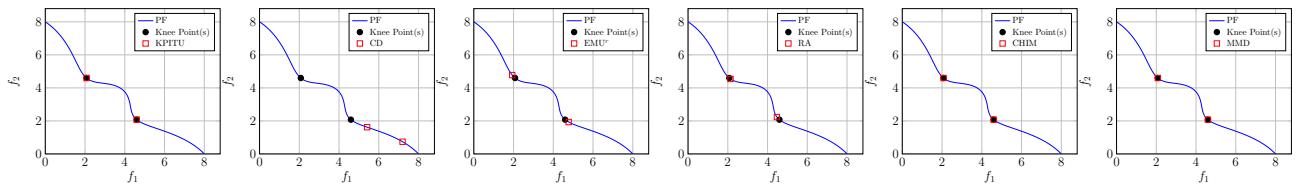


Figure 57: Knee points obtained by different KPI methods on DEB2DK with local knee points.

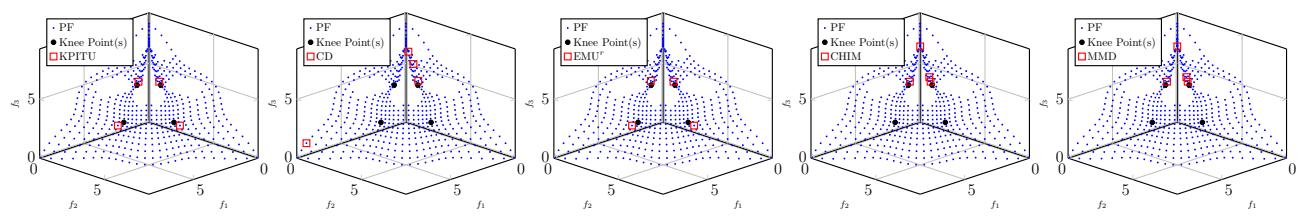


Figure 58: Knee points obtained by different KPI methods on DEB3DK with local knee points.

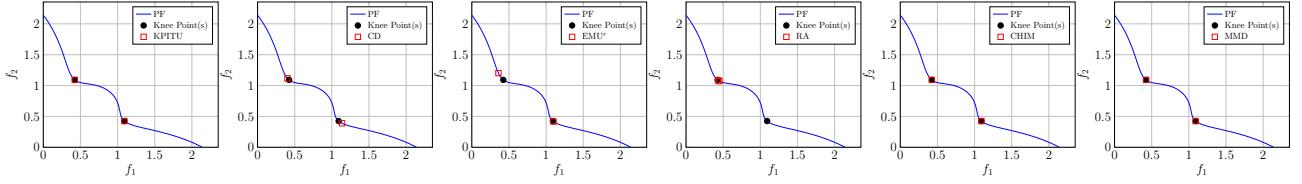


Figure 59: Knee points obtained by different KPI methods on 2-objective PMOP1 with local knee points.

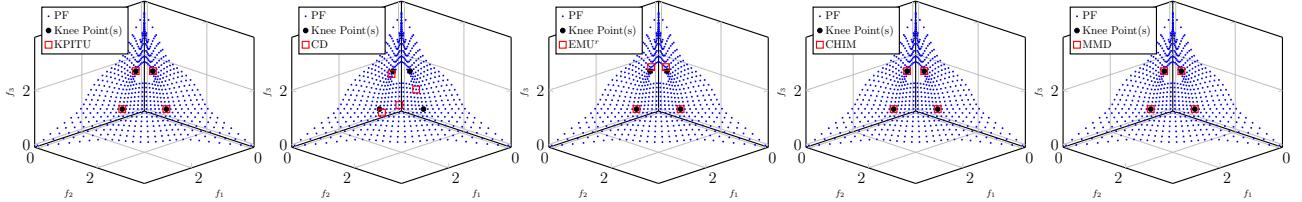


Figure 60: Knee points obtained by different KPI methods on 3-objective PMOP1 with local knee points.

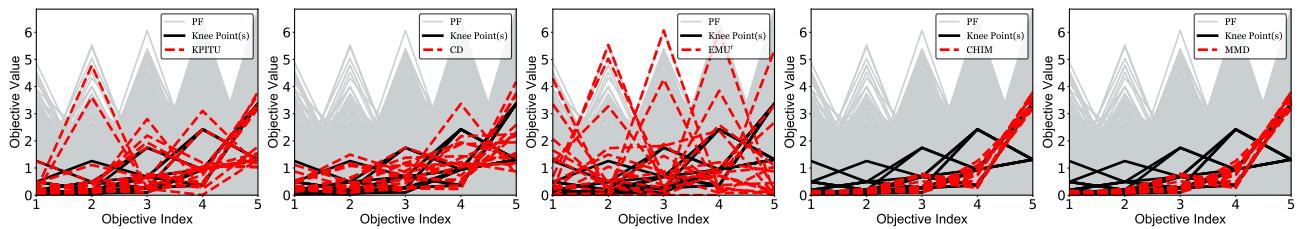


Figure 61: Knee points obtained by different KPI methods on 5-objective PMOP1 with local knee points.

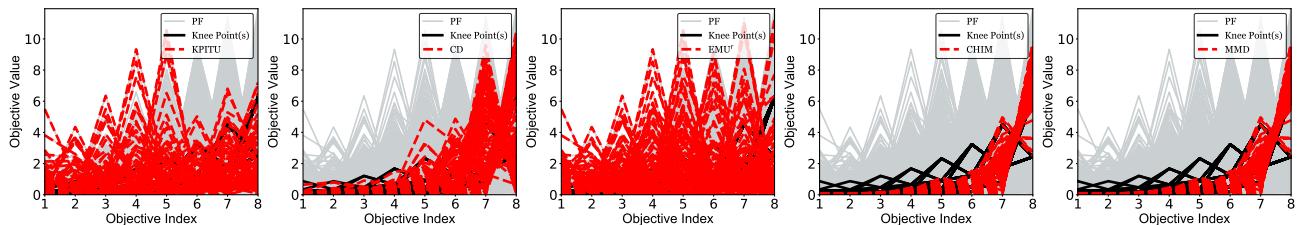


Figure 62: Knee points obtained by different KPI methods on 8-objective PMOP1 with local knee points.

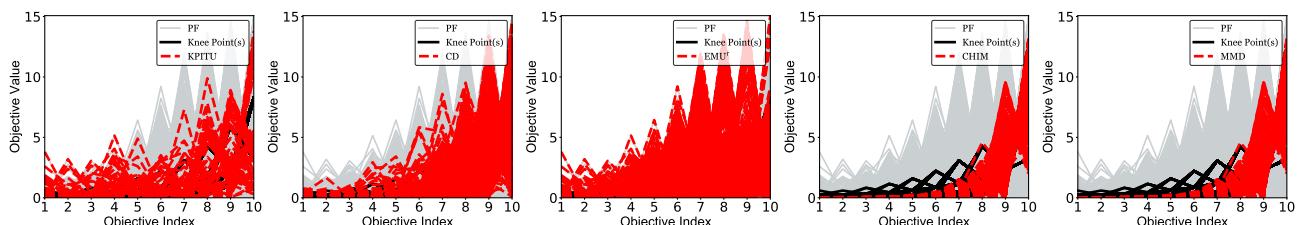


Figure 63: Knee points obtained by different KPI methods on 10-objective PMOP1 with local knee points.

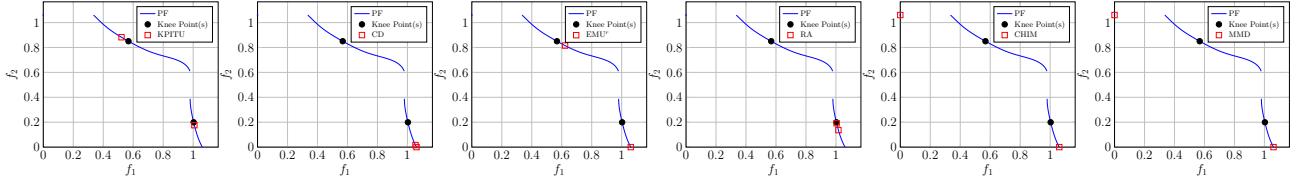


Figure 64: Knee points obtained by different KPI methods on 2-objective PMOP2 with local knee points.

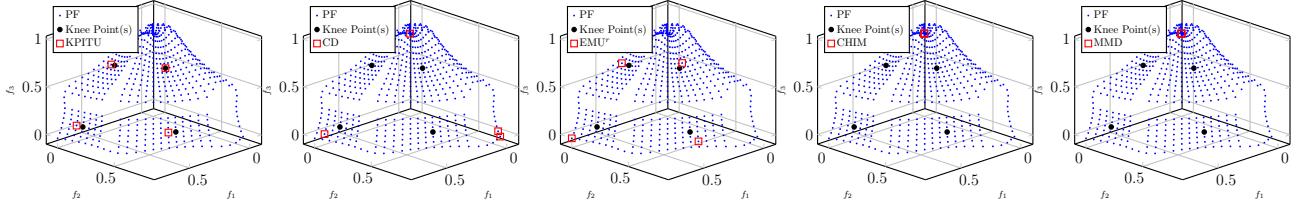


Figure 65: Knee points obtained by different KPI methods on 3-objective PMOP2 with local knee points.

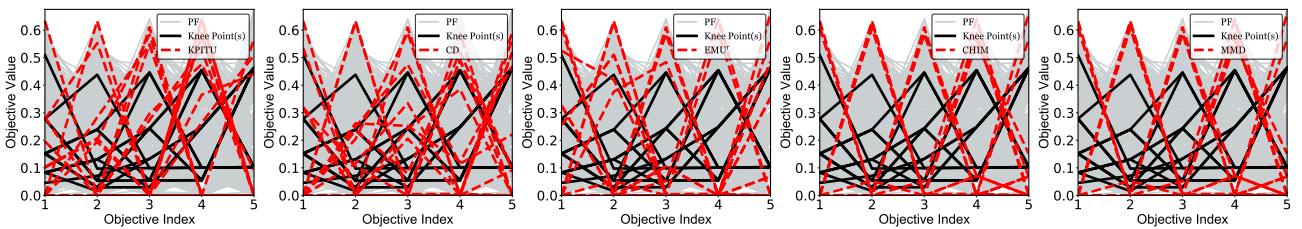


Figure 66: Knee points obtained by different KPI methods on 5-objective PMOP2 with local knee points.

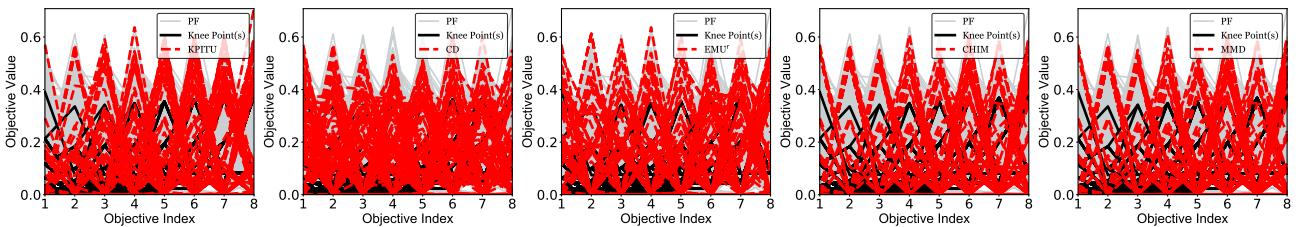


Figure 67: Knee points obtained by different KPI methods on 8-objective PMOP2 with local knee points.

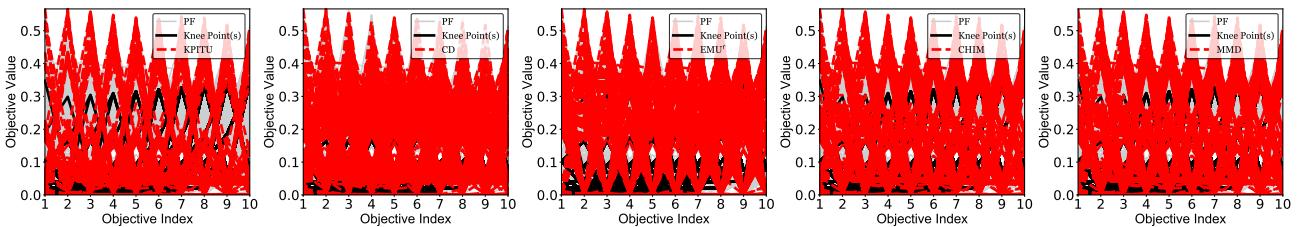


Figure 68: Knee points obtained by different KPI methods on 10-objective PMOP2 with local knee points.

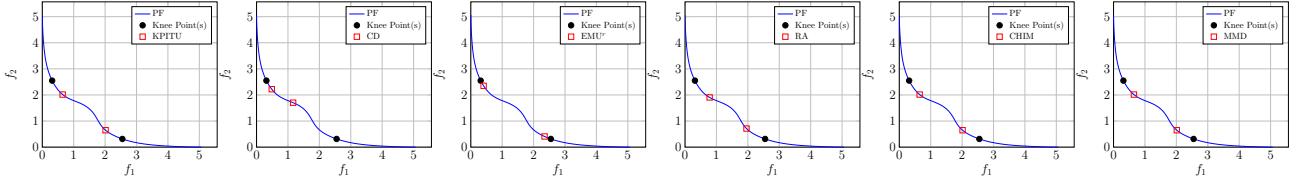


Figure 69: Knee points obtained by different KPI methods on 2-objective PMOP3 with local knee points.

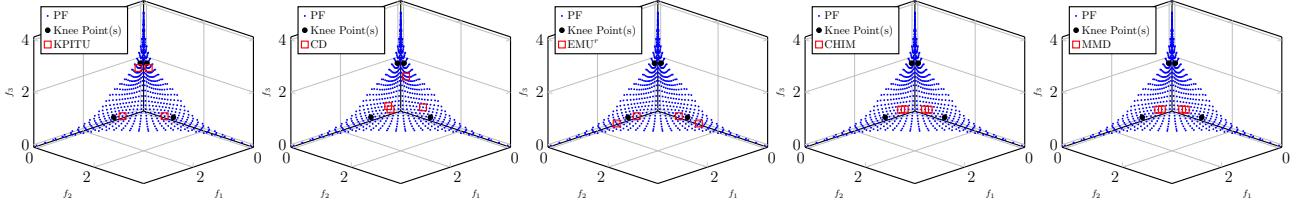


Figure 70: Knee points obtained by different KPI methods on 3-objective PMOP3 with local knee points.

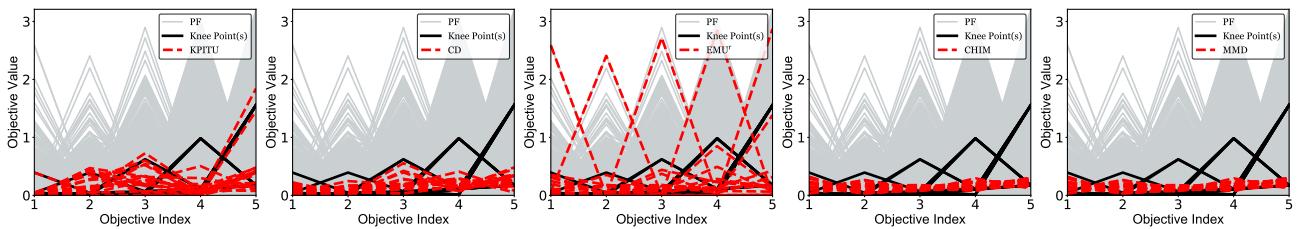


Figure 71: Knee points obtained by different KPI methods on 5-objective PMOP3 with local knee points.

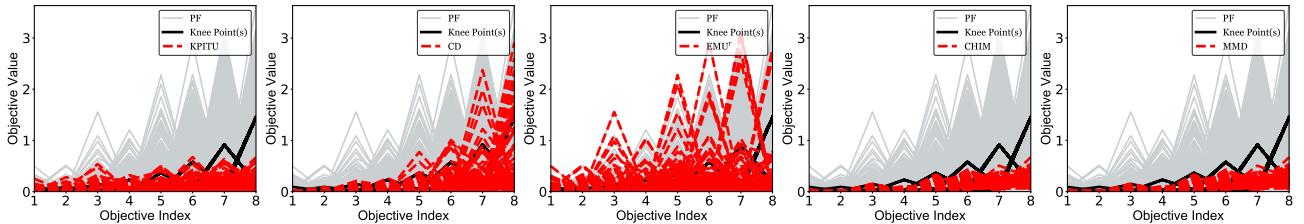


Figure 72: Knee points obtained by different KPI methods on 8-objective PMOP3 with local knee points.

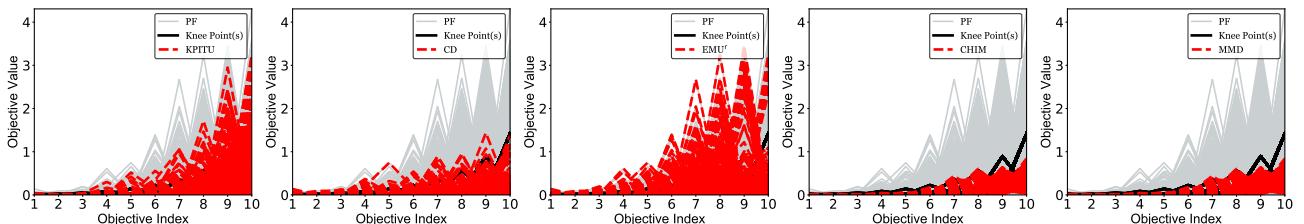


Figure 73: Knee points obtained by different KPI methods on 10-objective PMOP3 with local knee points.

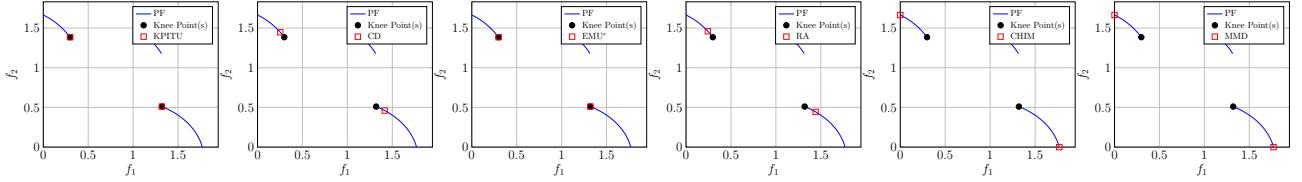


Figure 74: Knee points obtained by different KPI methods on 2-objective PMOP4 with local knee points.

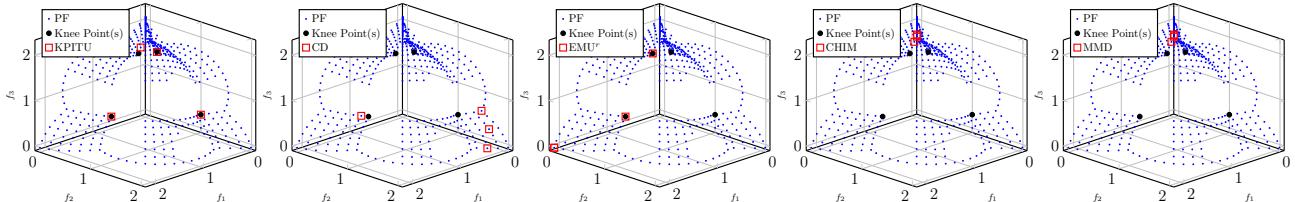


Figure 75: Knee points obtained by different KPI methods on 3-objective PMOP4 with local knee points.

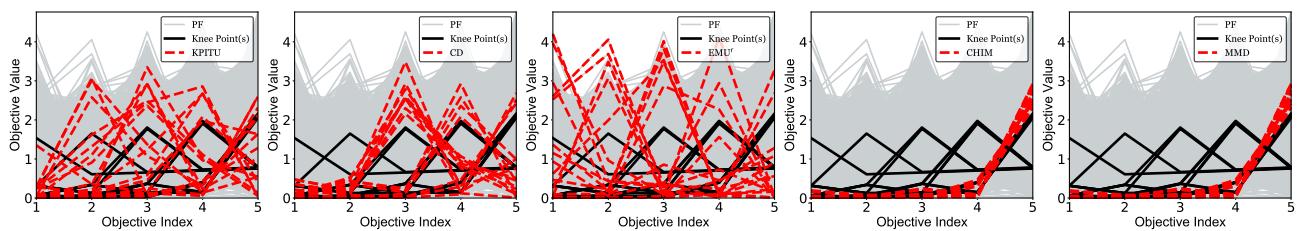


Figure 76: Knee points obtained by different KPI methods on 5-objective PMOP4 with local knee points.

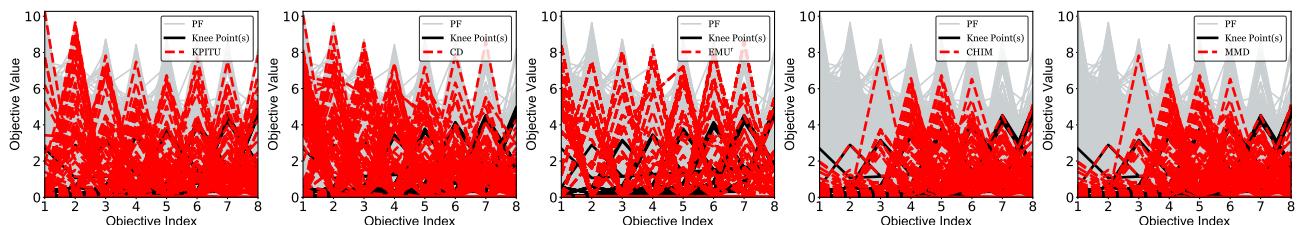


Figure 77: Knee points obtained by different KPI methods on 8-objective PMOP4 with local knee points.

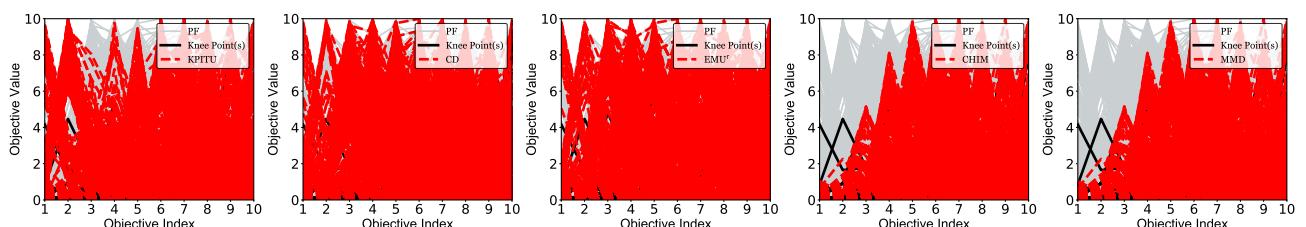


Figure 78: Knee points obtained by different KPI methods on 10-objective PMOP4 with local knee points.

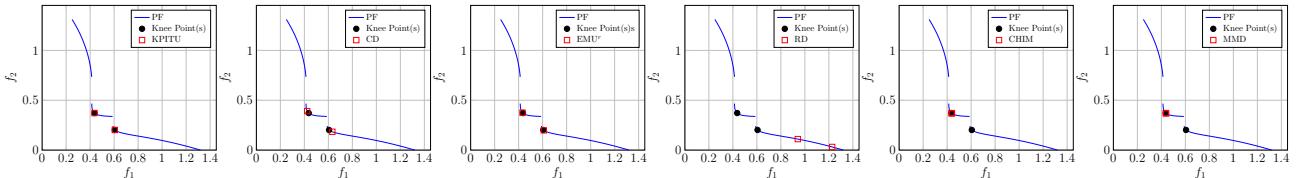


Figure 79: Knee points obtained by different KPI methods on 2-objective PMOP5 with local knee points.

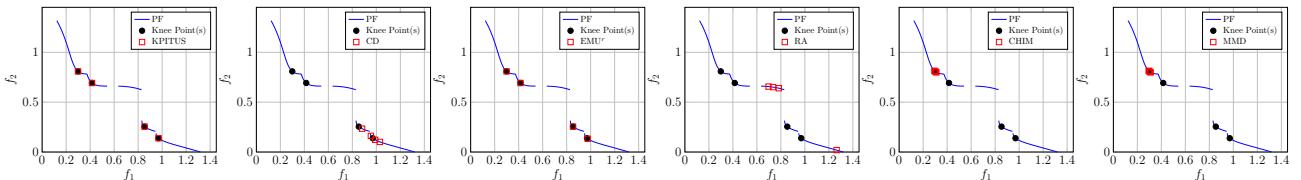


Figure 80: Knee points obtained by different KPI methods on 2-objective PMOP5 with local knee points.

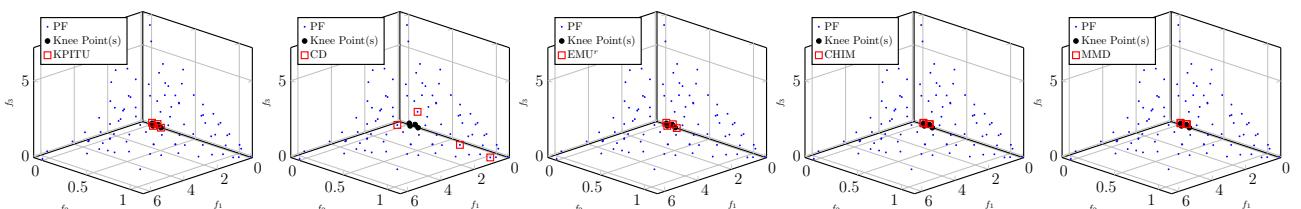


Figure 81: Knee points obtained by different KPI methods on 3-objective PMOP5 with local knee points.

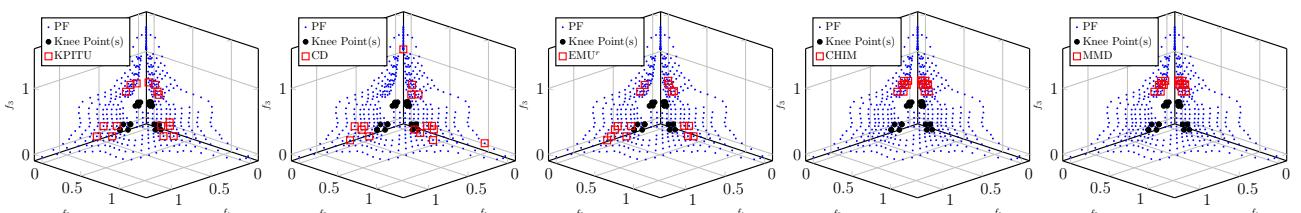


Figure 82: Knee points obtained by different KPI methods on 3-objective PMOP5 with local knee points.

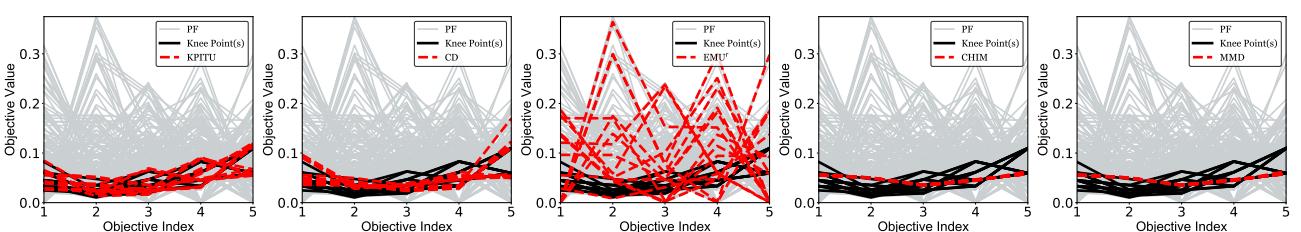


Figure 83: Knee points obtained by different KPI methods on 5-objective PMOP5 with local knee points.

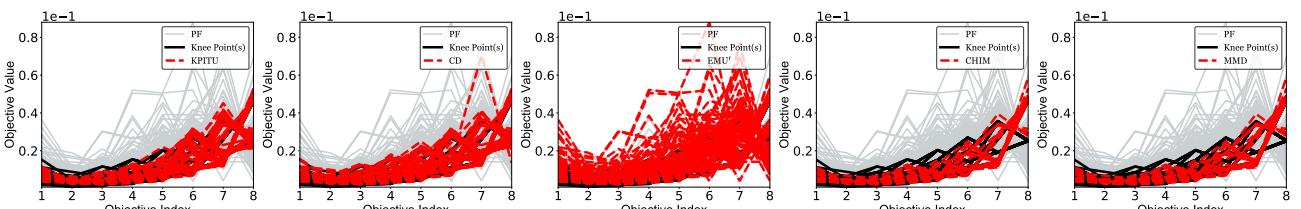


Figure 84: Knee points obtained by different KPI methods on 8-objective PMOP5 with local knee points.

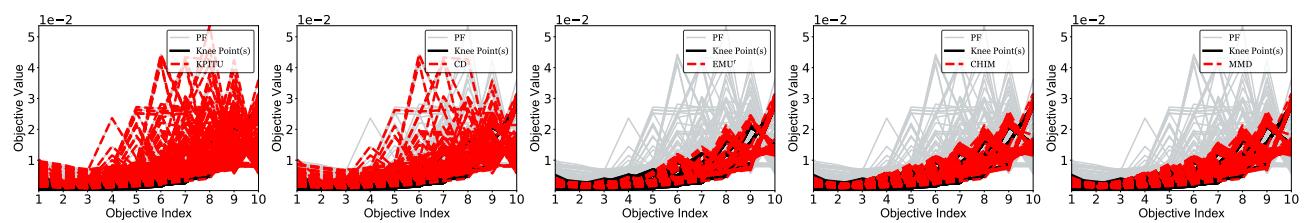


Figure 85: Knee points obtained by different KPI methods on 10-objective PMOP5 with local knee points.

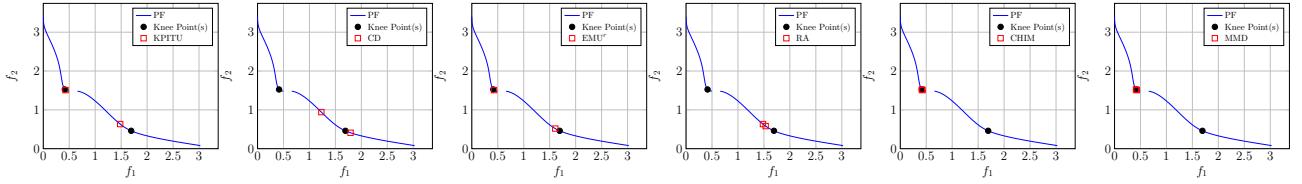


Figure 86: Knee points obtained by different KPI methods on 2-objective PMOP6 with local knee points.

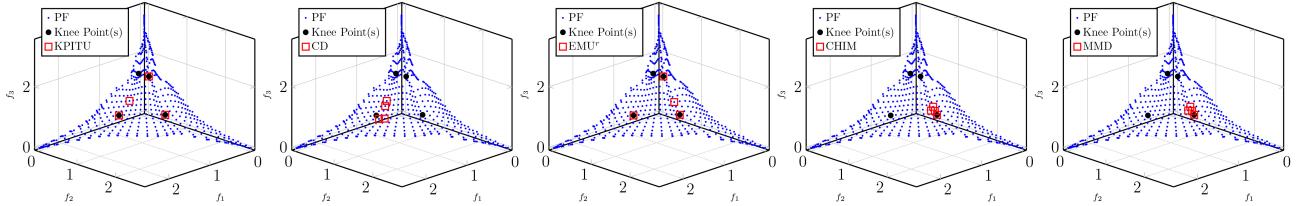


Figure 87: Knee points obtained by different KPI methods on 3-objective PMOP6 with local knee points.

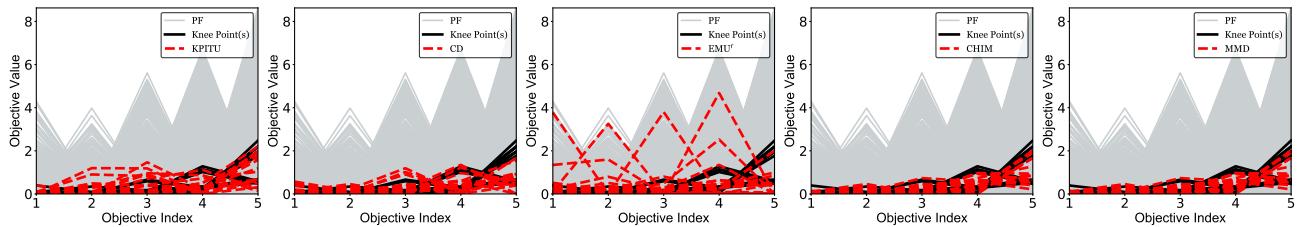


Figure 88: Knee points obtained by different KPI methods on 5-objective PMOP6 with local knee points.

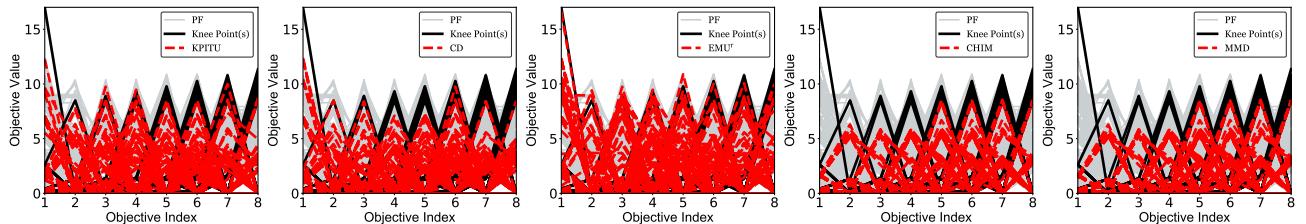


Figure 89: Knee points obtained by different KPI methods on 8-objective PMOP6 with local knee points.

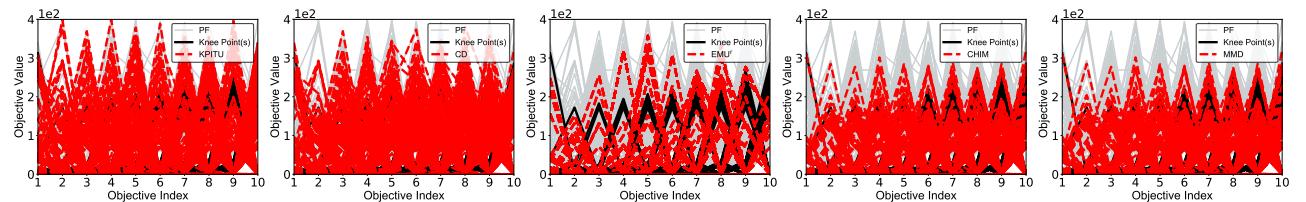


Figure 90: Knee points obtained by different KPI methods on 10-objective PMOP6 with local knee points.

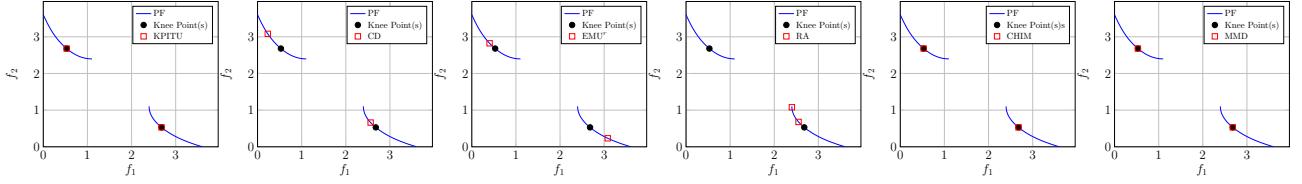


Figure 91: Knee points obtained by different KPI methods on 2-objective PMOP7 with local knee points.

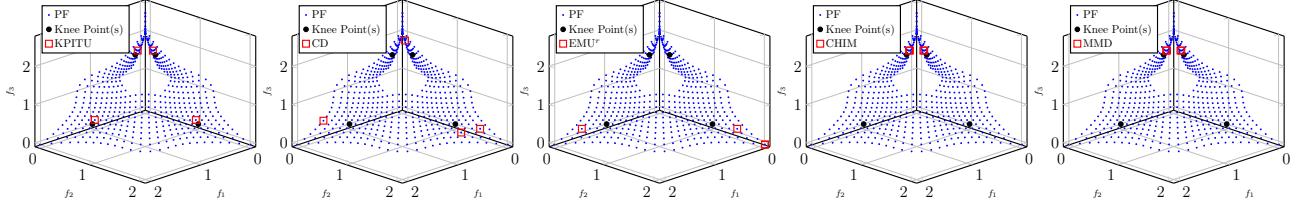


Figure 92: Knee points obtained by different KPI methods on 3-objective PMOP7 with local knee points.

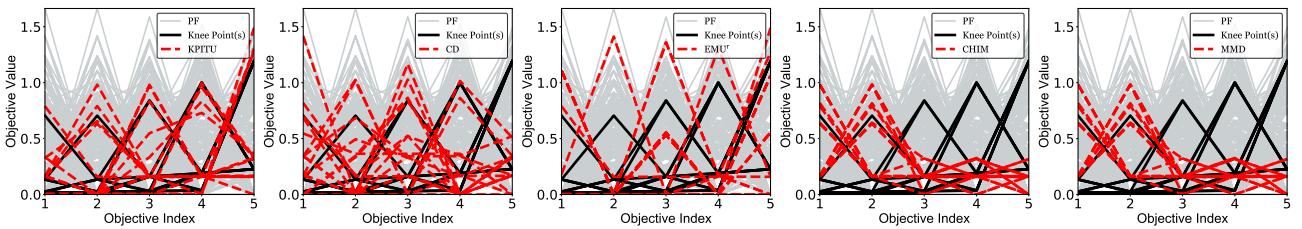


Figure 93: Knee points obtained by different KPI methods on 5-objective PMOP7 with local knee points.

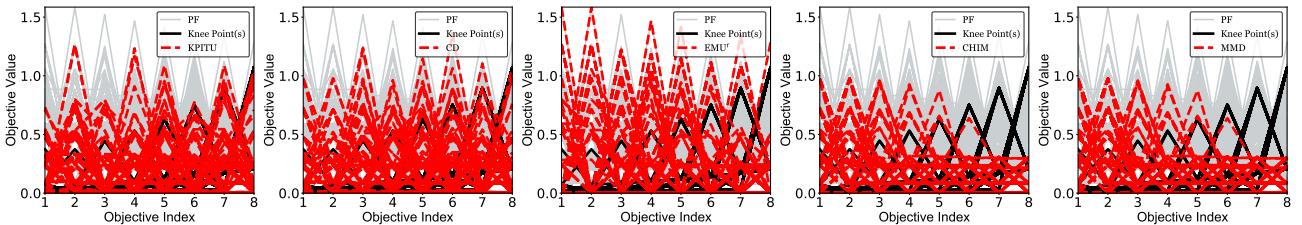


Figure 94: Knee points obtained by different KPI methods on 8-objective PMOP7 with local knee points.

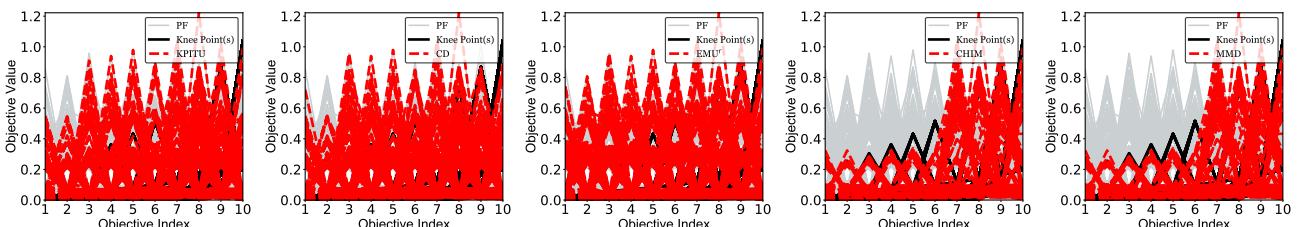


Figure 95: Knee points obtained by different KPI methods on 10-objective PMOP7 with local knee points.

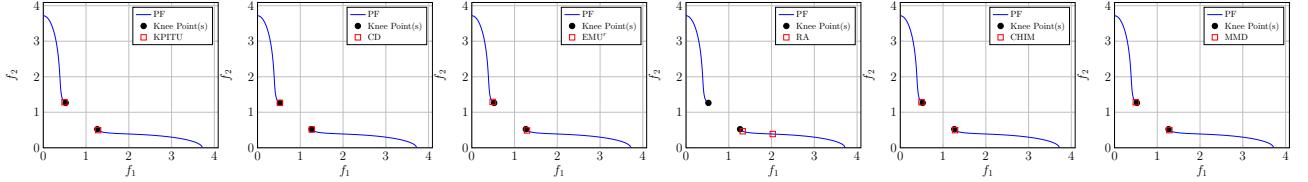


Figure 96: Knee points obtained by different KPI methods on 2-objective PMOP8 with local knee points.

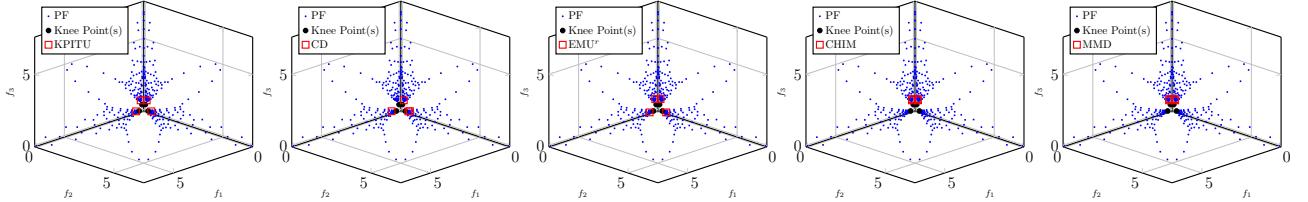


Figure 97: Knee points obtained by different KPI methods on 3-objective PMOP8 with local knee points.

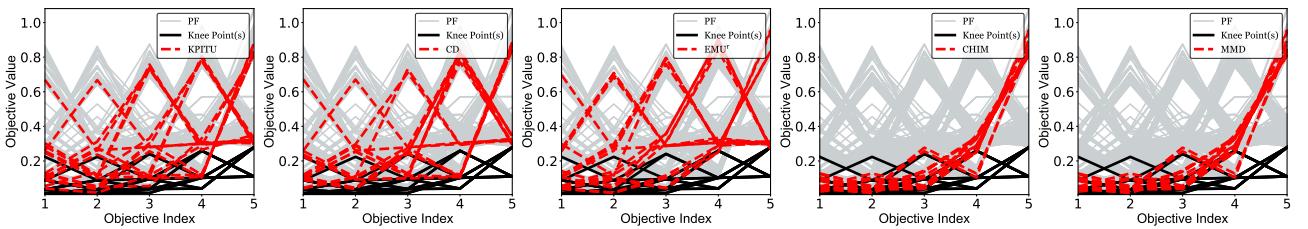


Figure 98: Knee points obtained by different KPI methods on 5-objective PMOP8 with local knee points.

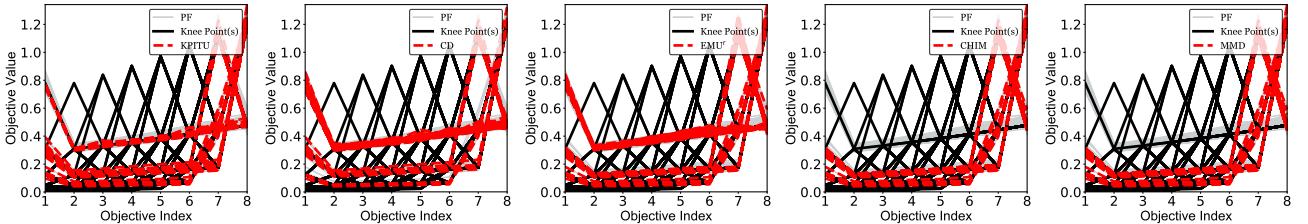


Figure 99: Knee points obtained by different KPI methods on 8-objective PMOP8 with local knee points.

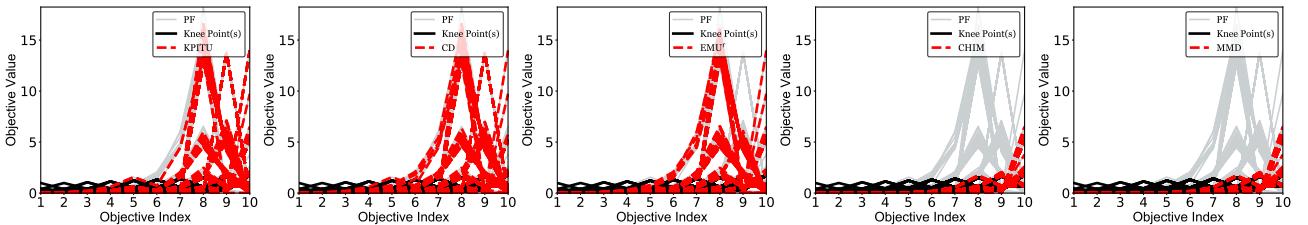


Figure 100: Knee points obtained by different KPI methods on 10-objective PMOP8 with local knee points.

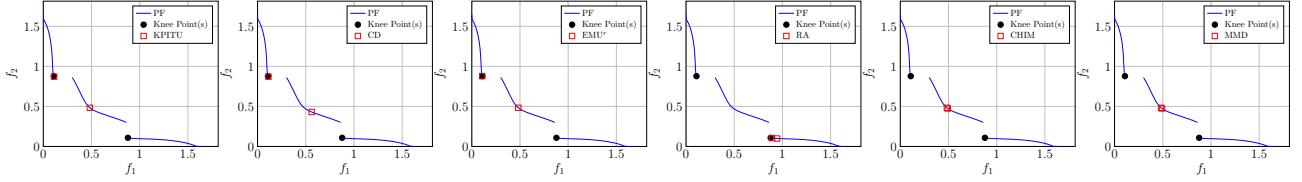


Figure 101: Knee points obtained by different KPI methods on 2-objective PMOP9 with local knee points.

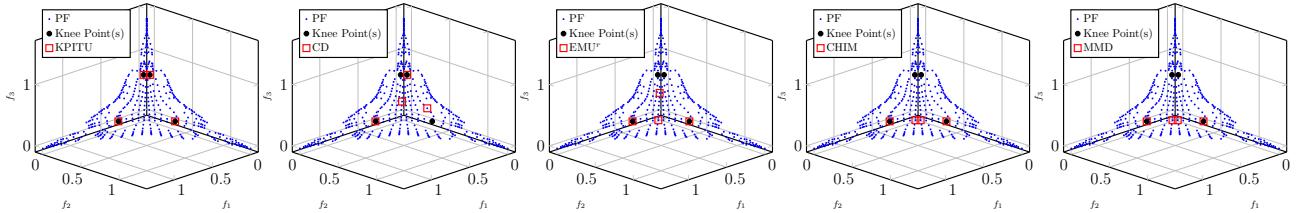


Figure 102: Knee points obtained by different KPI methods on 3-objective PMOP9 with local knee points.

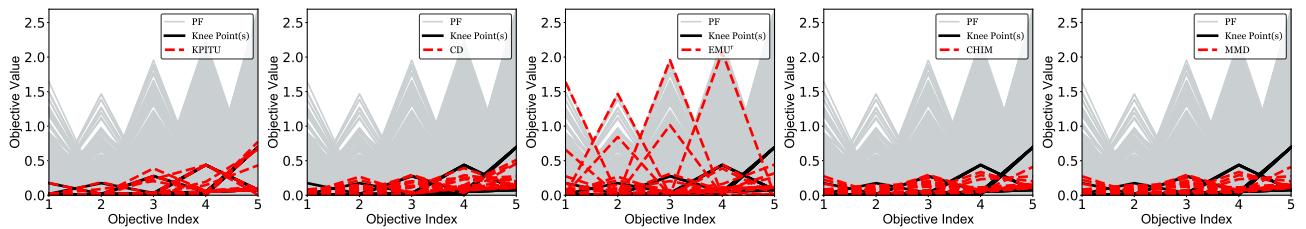


Figure 103: Knee points obtained by different KPI methods on 5-objective PMOP9 with local knee points.

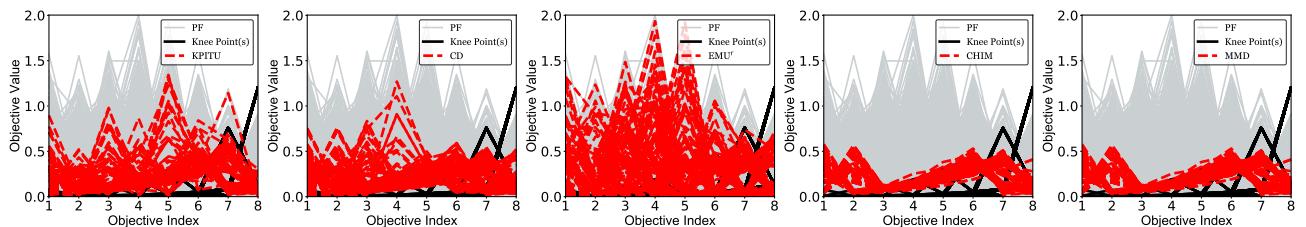


Figure 104: Knee points obtained by different KPI methods on 8-objective PMOP9 with local knee points.

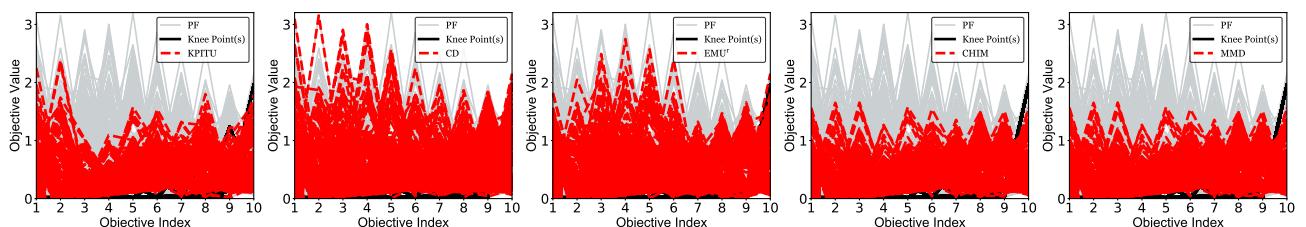


Figure 105: Knee points obtained by different KPI methods on 10-objective PMOP9 with local knee points.

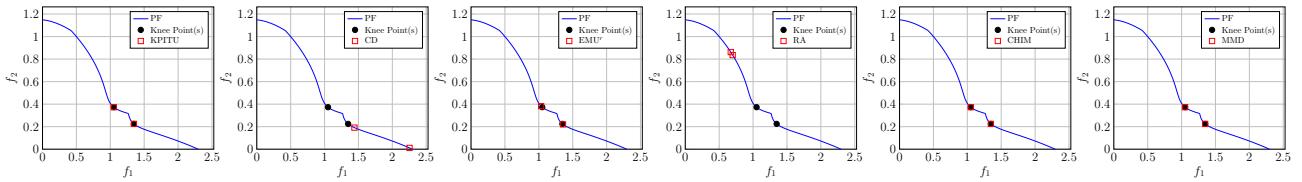


Figure 106: Knee points obtained by different KPI methods on 2-objective PMOP10 with local knee points.

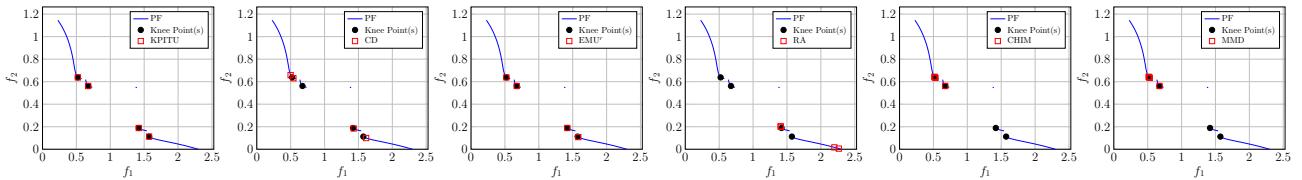


Figure 107: Knee points obtained by different KPI methods on 2-objective PMOP10 with local knee points.

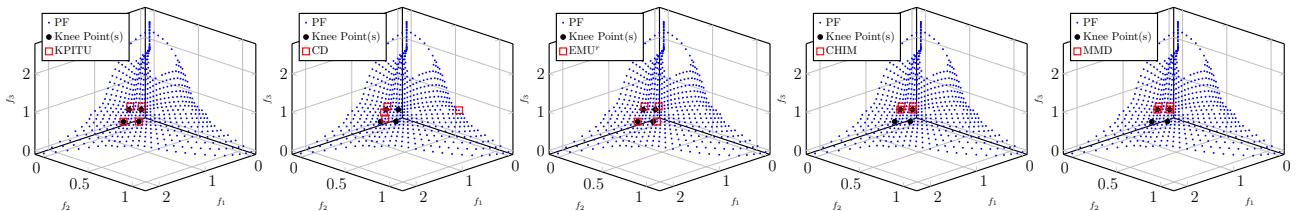


Figure 108: Knee points obtained by different KPI methods on 3-objective PMOP10 with local knee points.

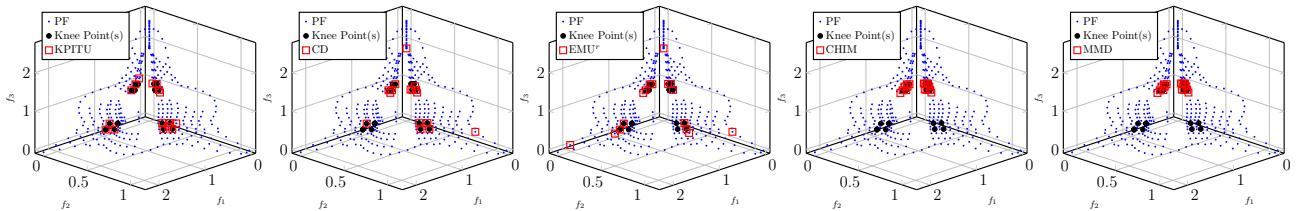


Figure 109: Knee points obtained by different KPI methods on 3-objective PMOP10 with local knee points.

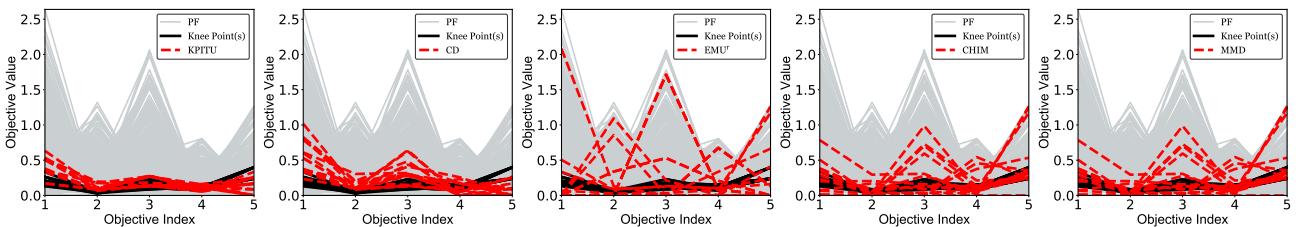


Figure 110: Knee points obtained by different KPI methods on 5-objective PMOP10 with local knee points.

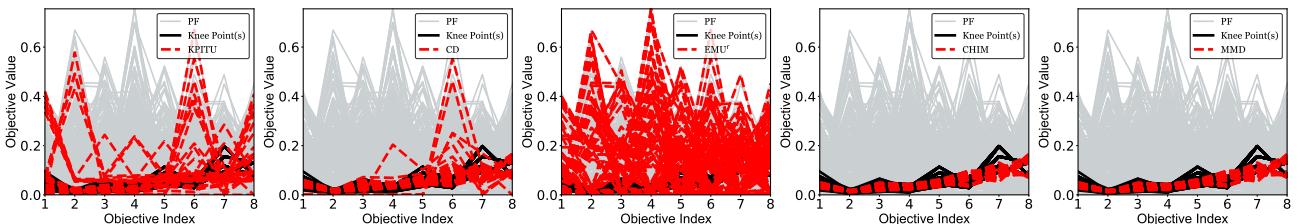


Figure 111: Knee points obtained by different KPI methods on 8-objective PMOP10 with local knee points.

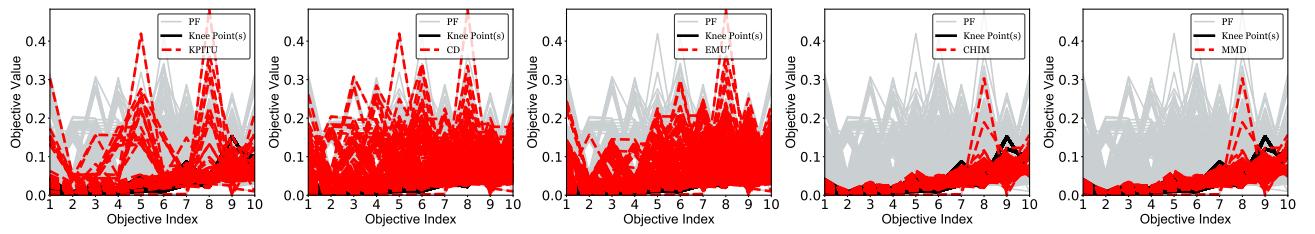


Figure 112: Knee points obtained by different KPI methods on 10-objective PMOP10 with local knee points.

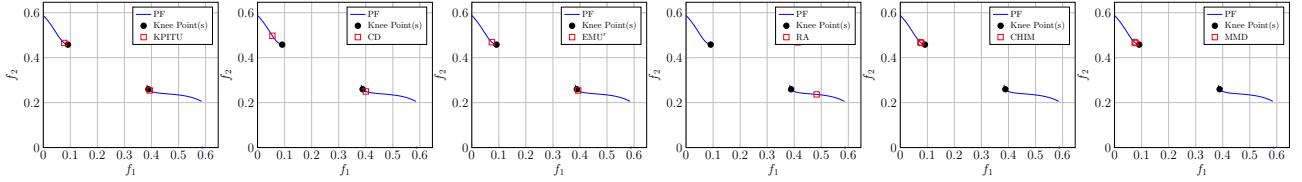


Figure 113: Knee points obtained by different KPI methods on 2-objective PMOP11 with local knee points.

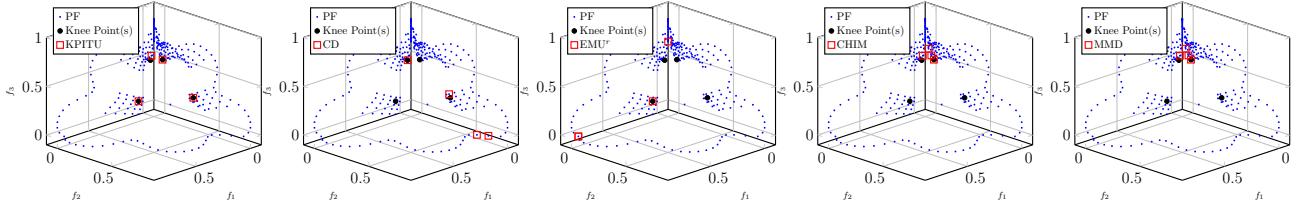


Figure 114: Knee points obtained by different KPI methods on 3-objective PMOP11 with local knee points.

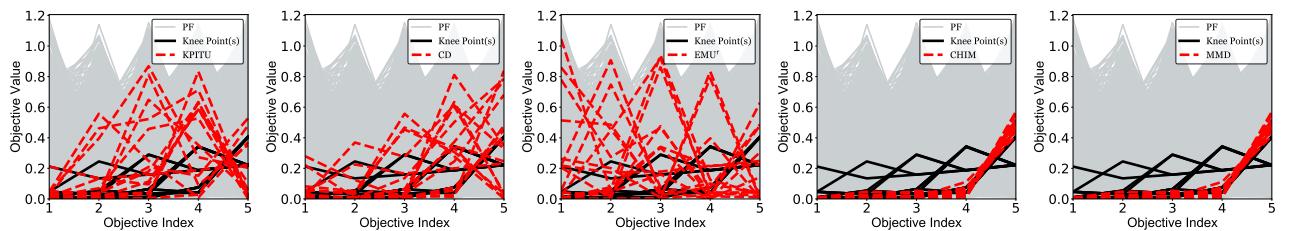


Figure 115: Knee points obtained by different KPI methods on 5-objective PMOP11 with local knee points.

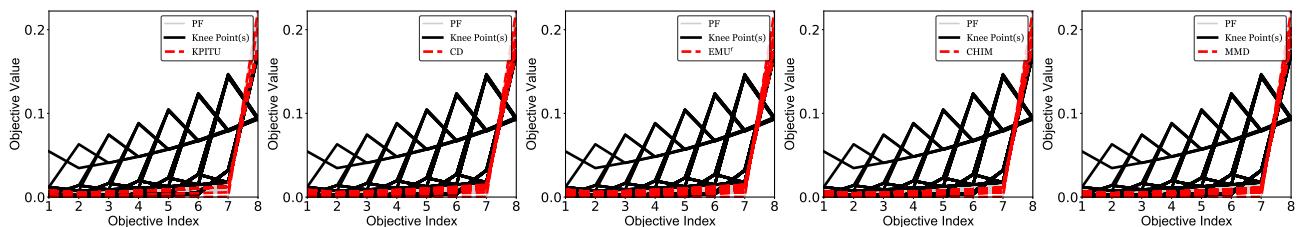


Figure 116: Knee points obtained by different KPI methods on 8-objective PMOP11 with local knee points.

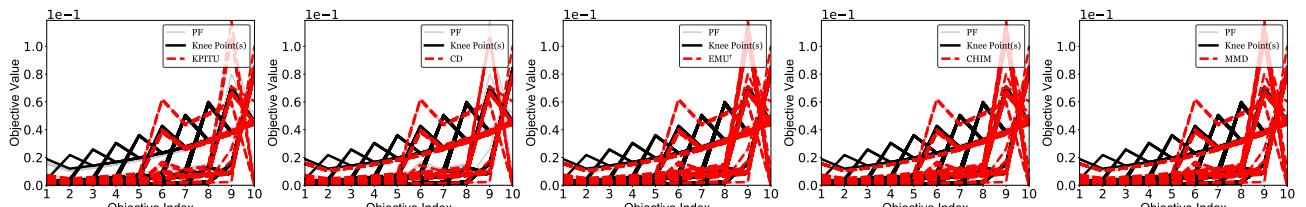


Figure 117: Knee points obtained by different KPI methods on 10-objective PMOP11 with local knee points.

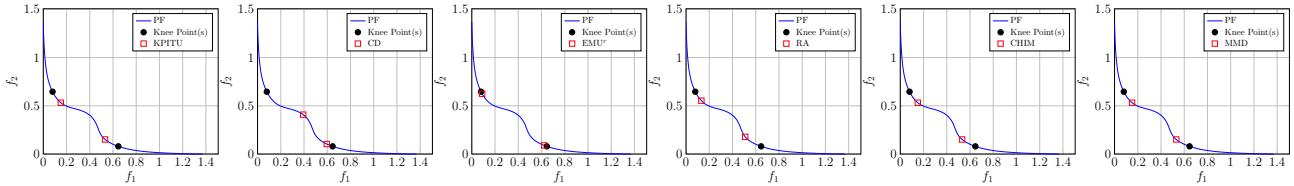


Figure 118: Knee points obtained by different KPI methods on 2-objective PMOP12 with local knee points.

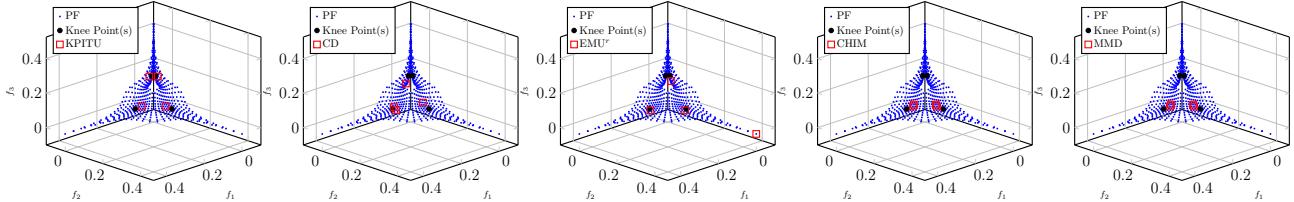


Figure 119: Knee points obtained by different KPI methods on 3-objective PMOP12 with local knee points.

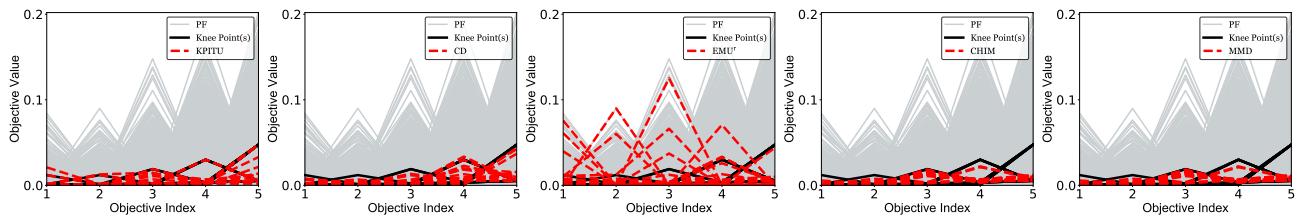


Figure 120: Knee points obtained by different KPI methods on 5-objective PMOP12 with local knee points.

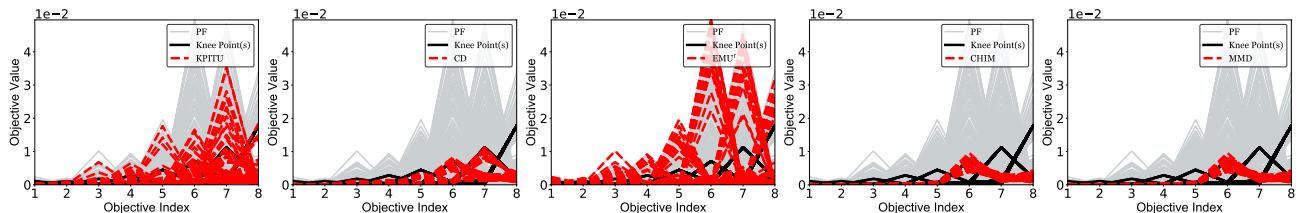


Figure 121: Knee points obtained by different KPI methods on 8-objective PMOP12 with local knee points.

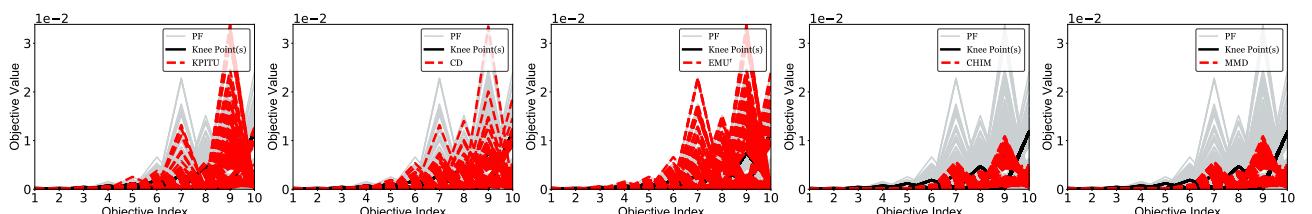


Figure 122: Knee points obtained by different KPI methods on 10-objective PMOP12 with local knee points.

3 Plots of population distribution on problems with infinitely many knee points

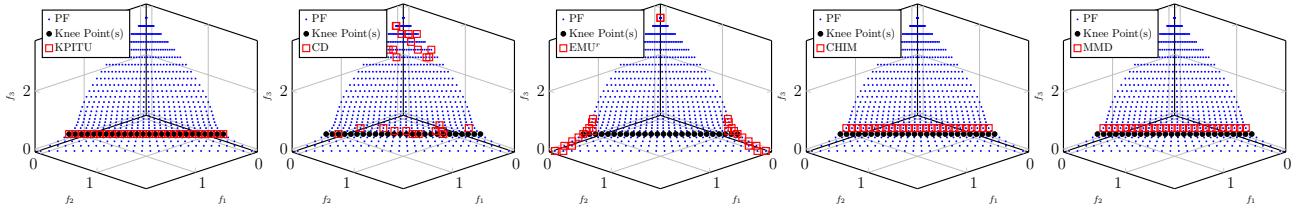


Figure 123: Knee points obtained by different KPI methods on 3-objective PMOP13 with one knee region.

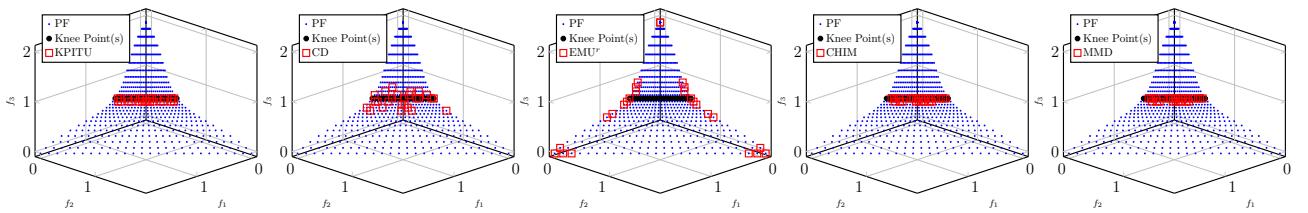


Figure 124: Knee points obtained by different KPI methods on 3-objective PMOP14 with one knee region.

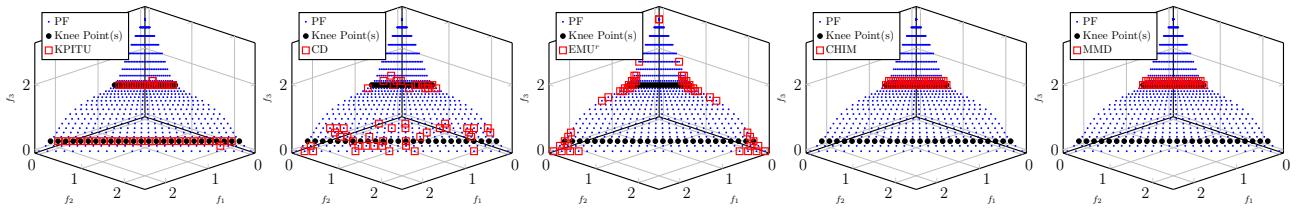


Figure 125: Knee points obtained by different KPI methods on 3-objective PMOP13 with two knee regions.

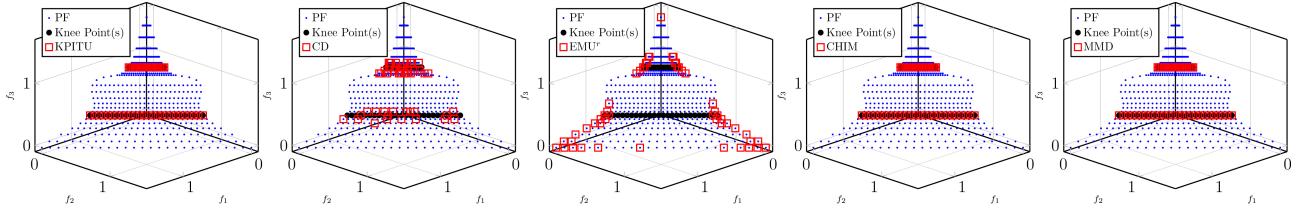


Figure 126: Knee points obtained by different KPI methods on 3-objective PMOP14 with two knee regions.

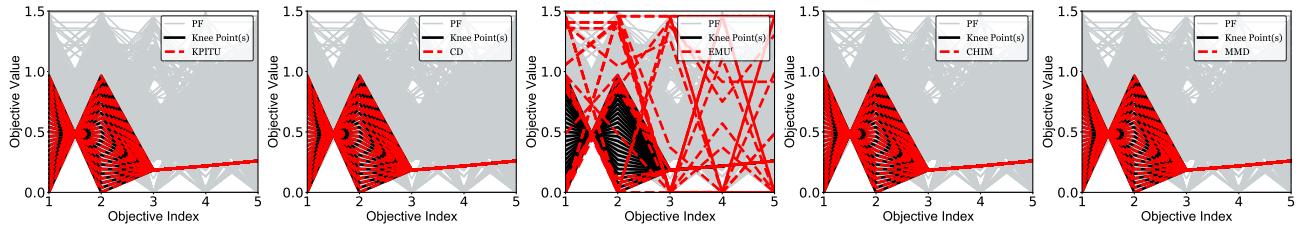


Figure 127: Knee points obtained by different KPI methods on 5-objective PMOP13 with one knee region.

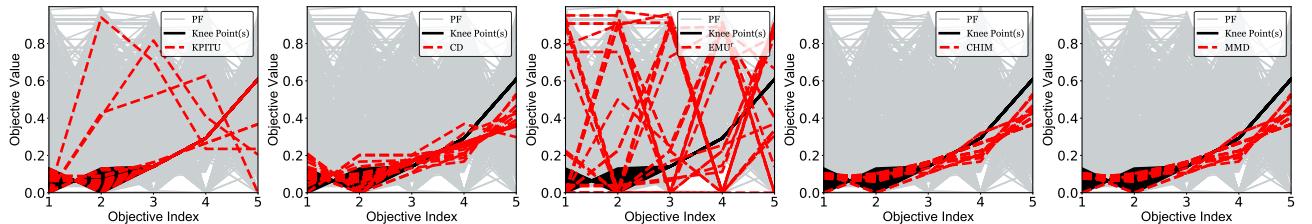


Figure 128: Knee points obtained by different KPI methods on 5-objective PMOP14 with one knee region.

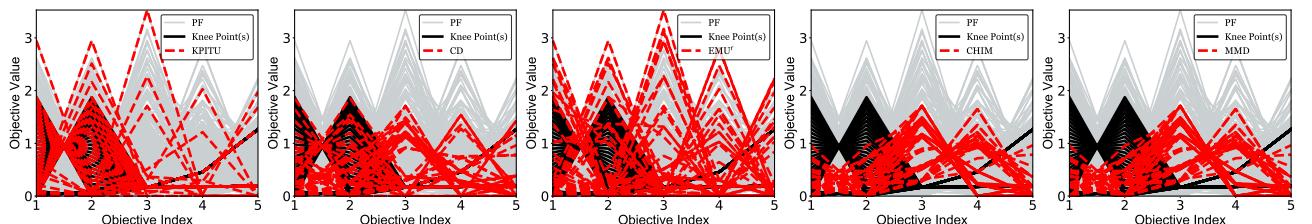


Figure 129: Knee points obtained by different KPI methods on 5-objective PMOP13 with two knee regions.

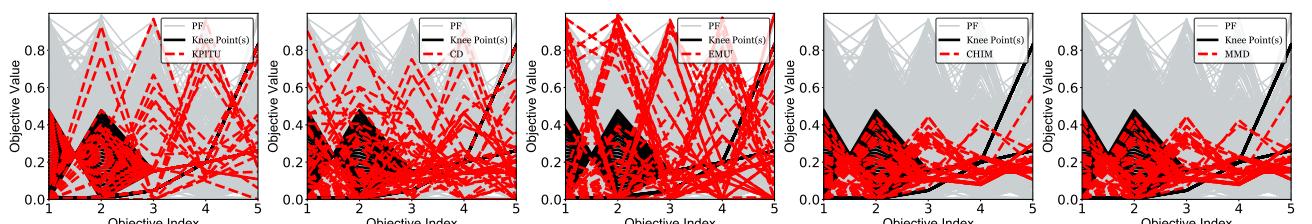


Figure 130: Knee points obtained by different KPI methods on 5-objective PMOP14 with two knee regions.

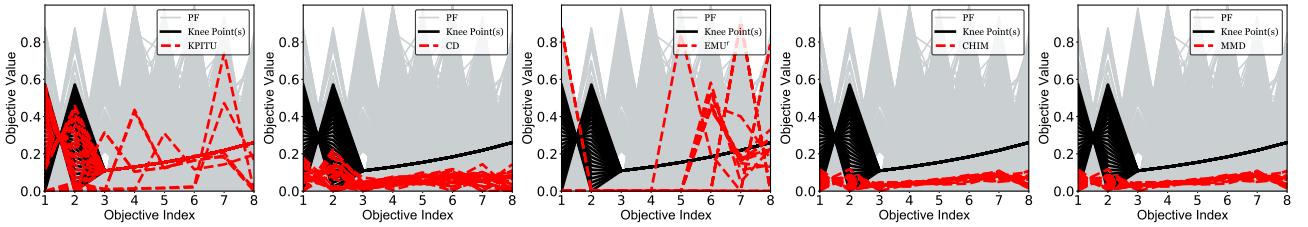


Figure 131: Knee points obtained by different KPI methods on 8-objective PMOP13 with one knee region.

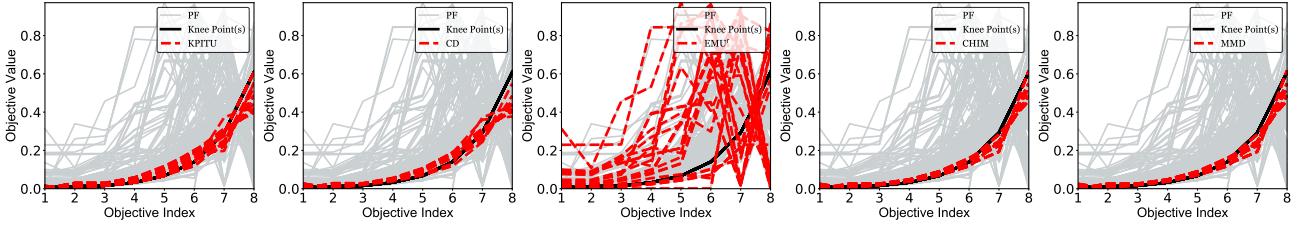


Figure 132: Knee points obtained by different KPI methods on 8-objective PMOP14 with one knee region.

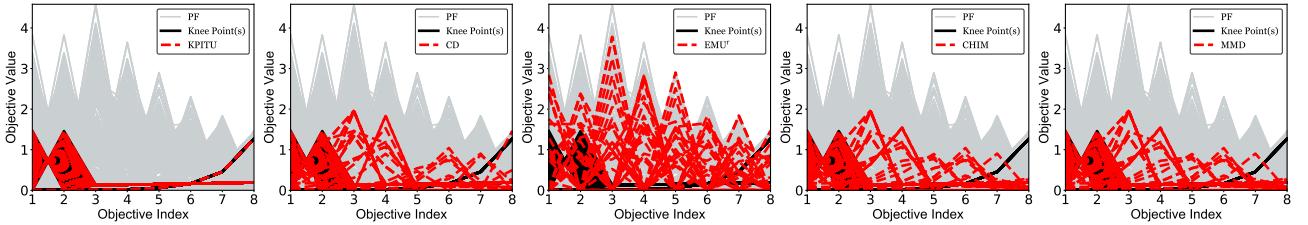


Figure 133: Knee points obtained by different KPI methods on 8-objective PMOP13 with two knee regions.

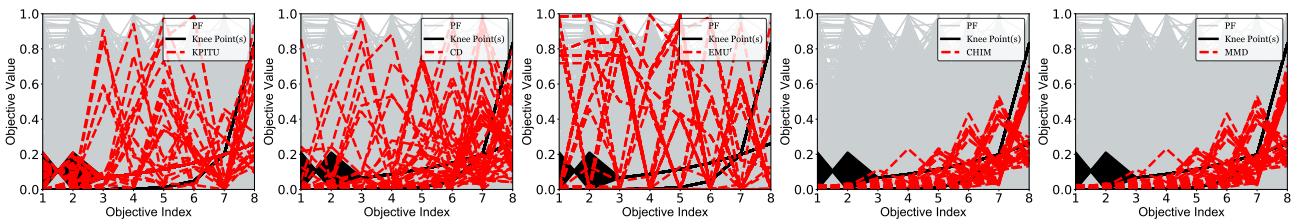


Figure 134: Knee points obtained by different KPI methods on 8-objective PMOP14 with two knee regions.

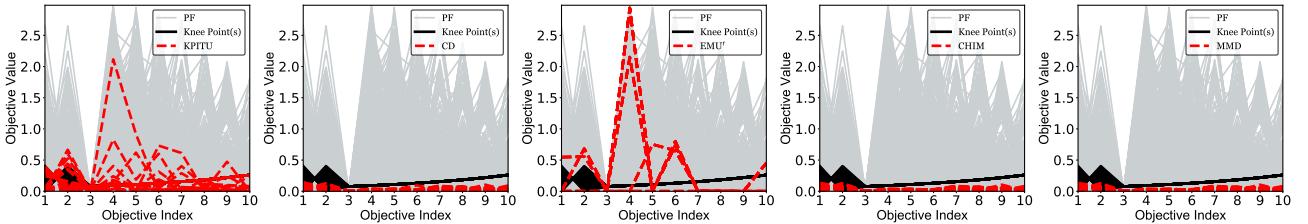


Figure 135: Knee points obtained by different KPI methods on 10-objective PMOP13 with one knee region.

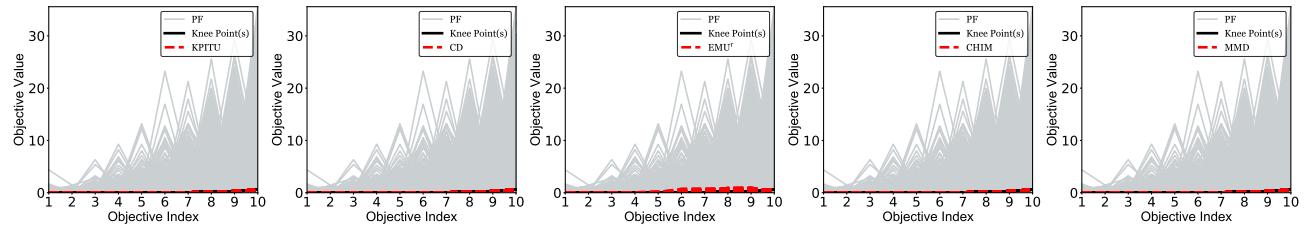


Figure 136: Knee points obtained by different KPI methods on 10-objective PMOP14 with one knee region.

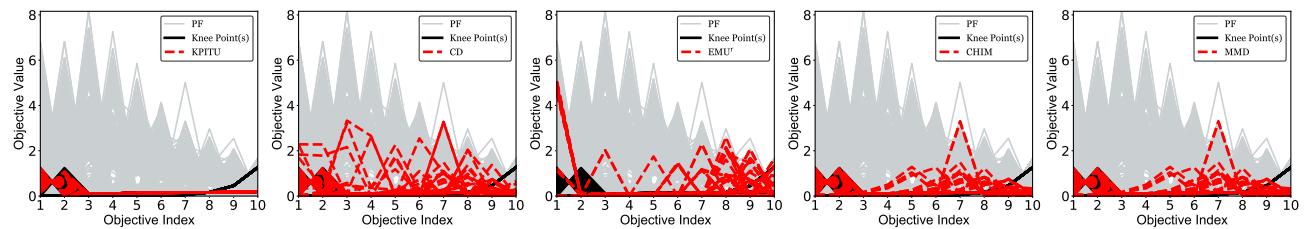


Figure 137: Knee points obtained by different KPI methods on 10-objective PMOP13 with two knee regions.

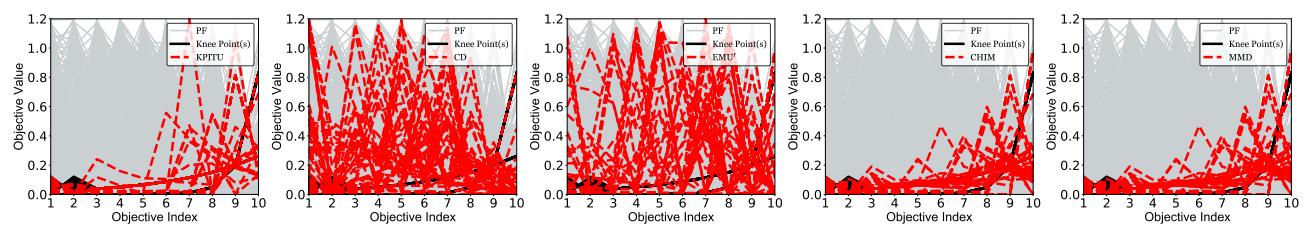


Figure 138: Knee points obtained by different KPI methods on 10-objective PMOP14 with two knee regions.

4 Plots of population distribution of solutions found by different knee point driven algorithms

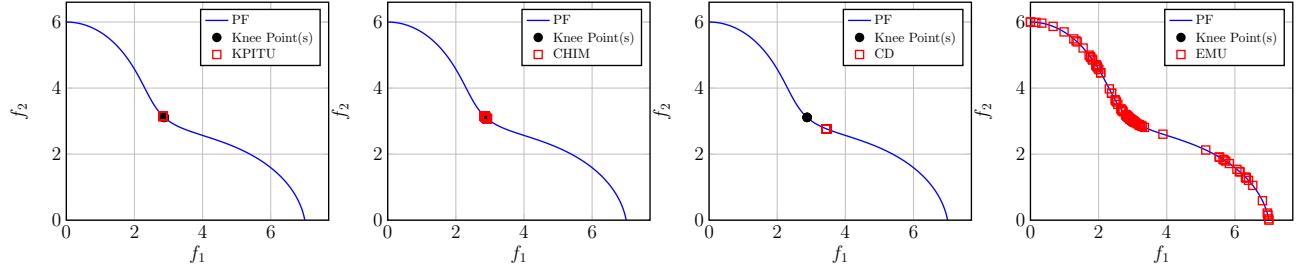


Figure 139: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on CKP with one global knee point.

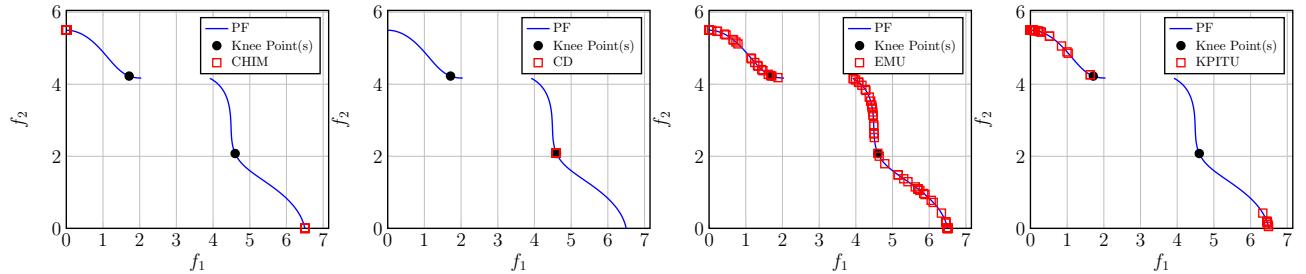


Figure 140: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on CKP with two local knee points.

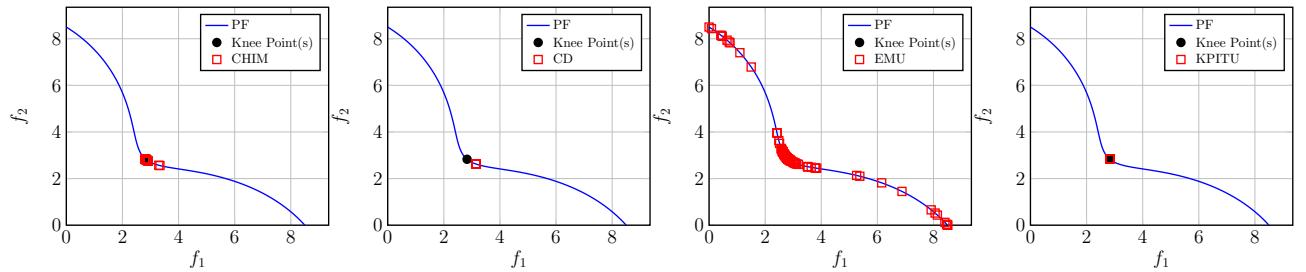


Figure 141: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective DEB with one global knee point.

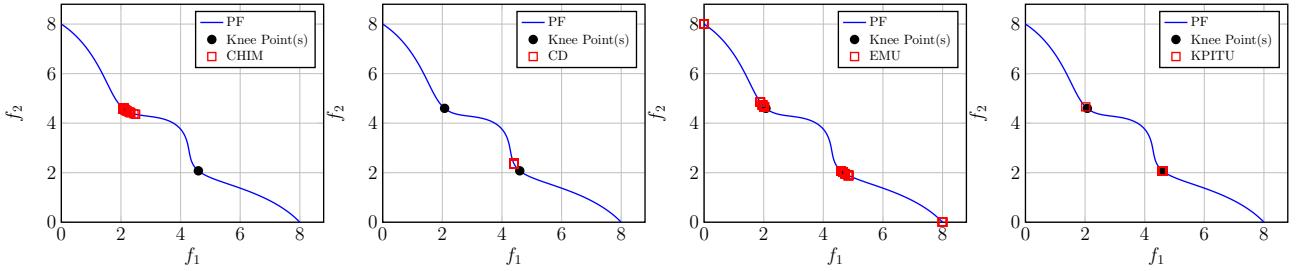


Figure 142: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective DEB with two local knee points.

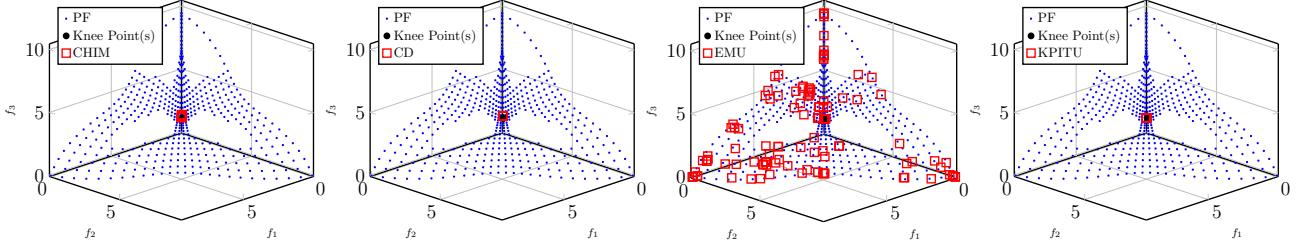


Figure 143: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective DEB with one global knee point.

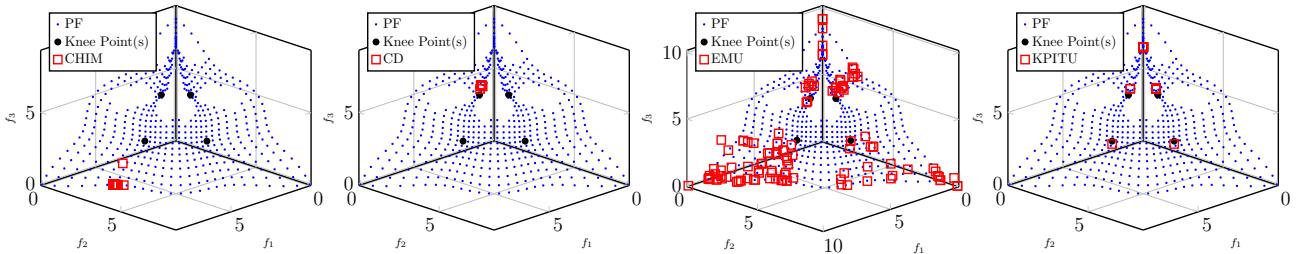


Figure 144: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective DEB with two local knee points.

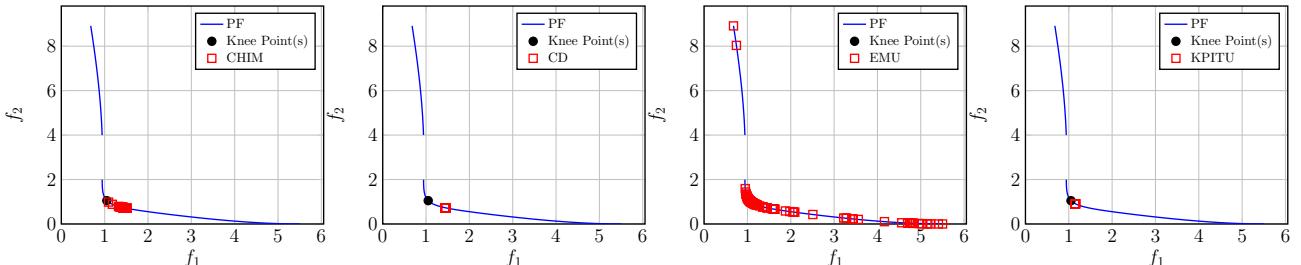


Figure 145: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on DO2DK with one global knee point.

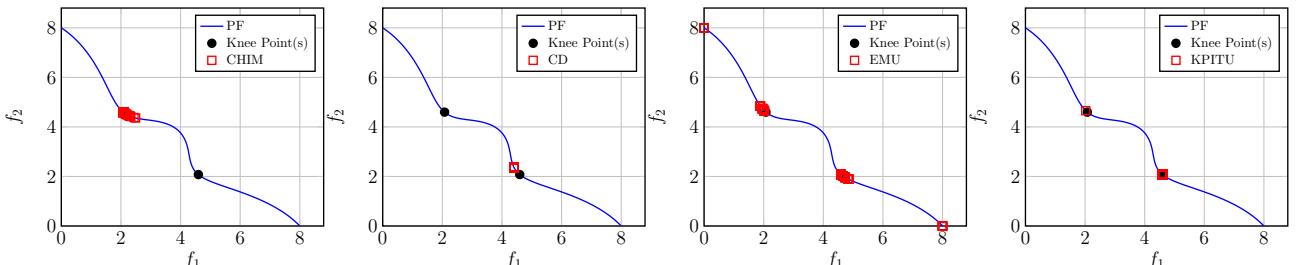


Figure 146: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on DO2DK with two local knee points.

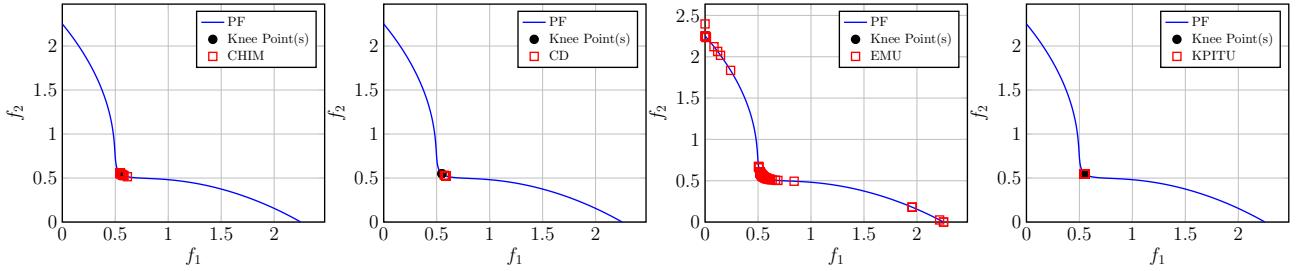


Figure 147: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP1 with one global knee point.

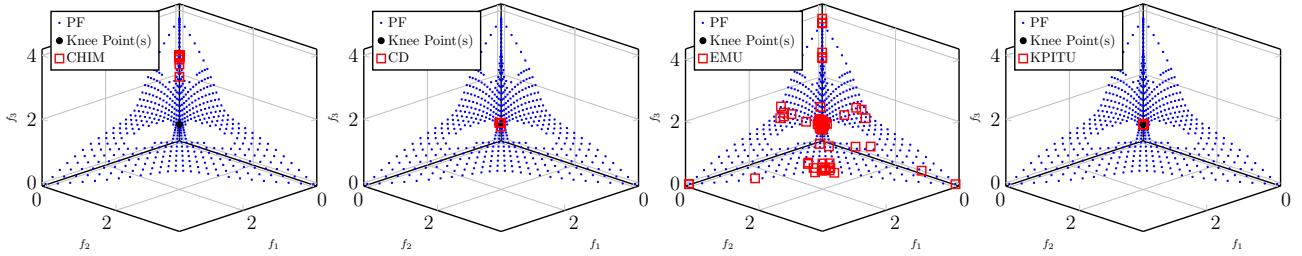


Figure 148: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP1 with one global knee point.

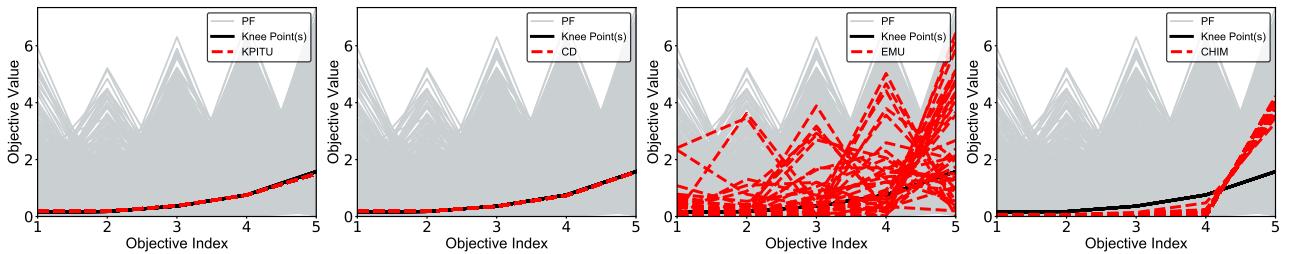


Figure 149: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP1 with one global knee point.

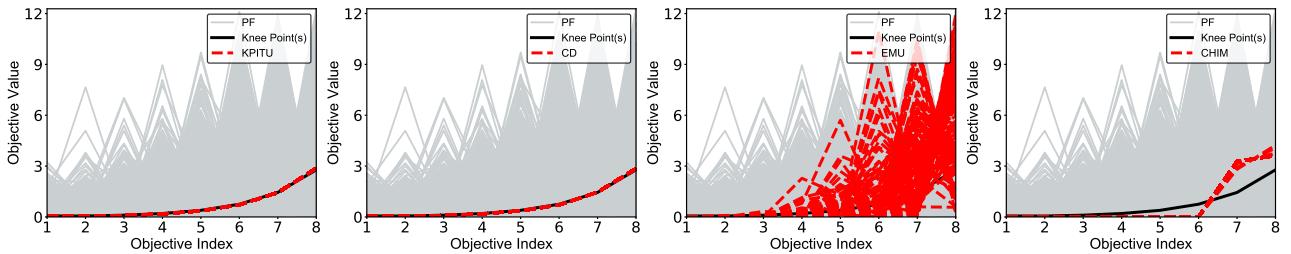


Figure 150: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP1 with one global knee point.

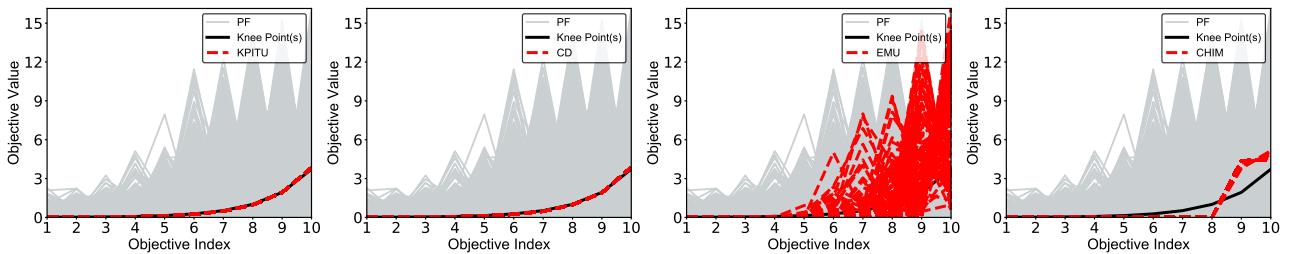


Figure 151: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP1 with one global knee point.

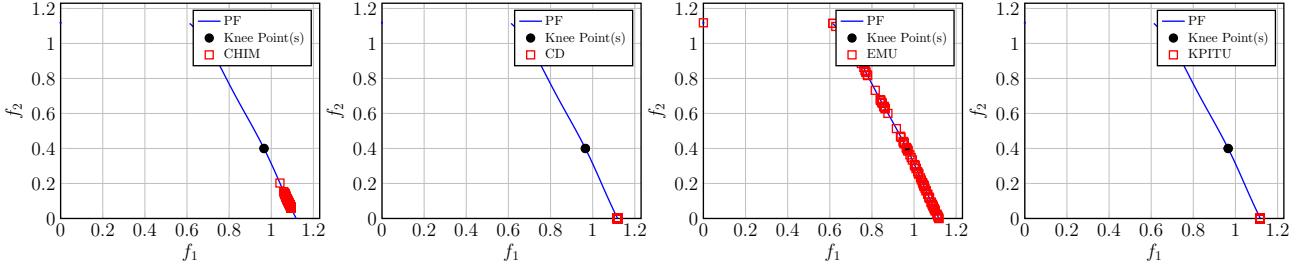


Figure 152: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP2 with one global knee point.

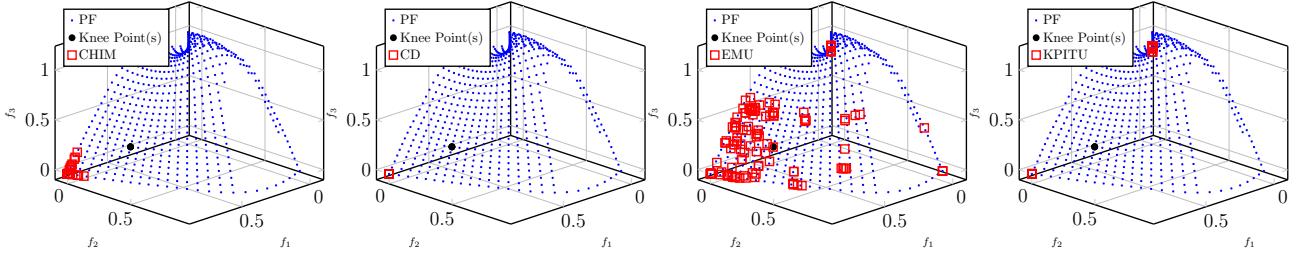


Figure 153: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP2 with one global knee point.

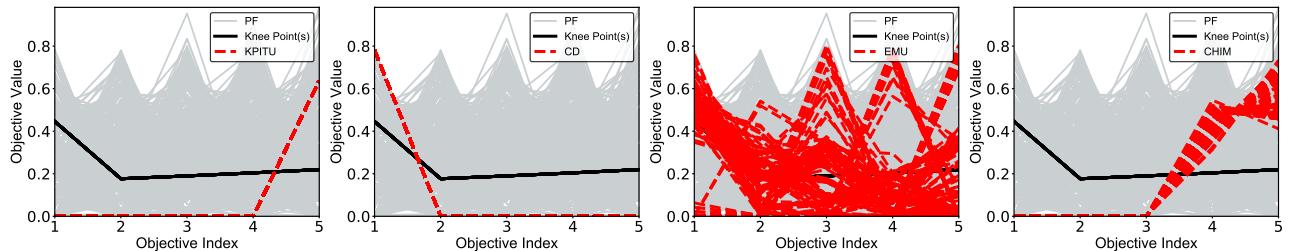


Figure 154: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP2 with one global knee point.

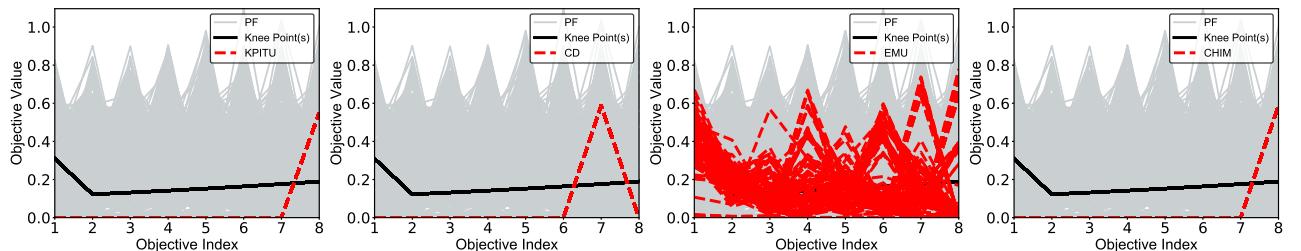


Figure 155: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP2 with one global knee point.

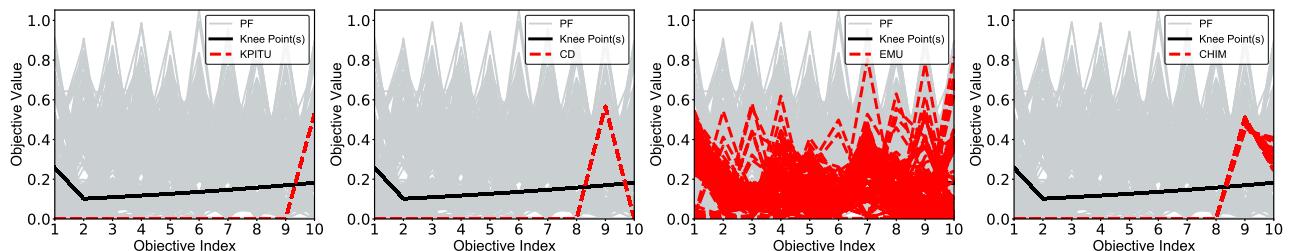


Figure 156: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP2 with one global knee point.

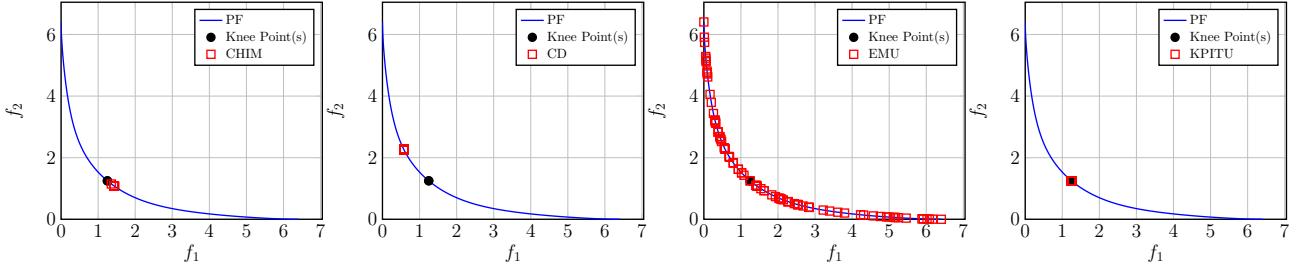


Figure 157: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP3 with one global knee point.

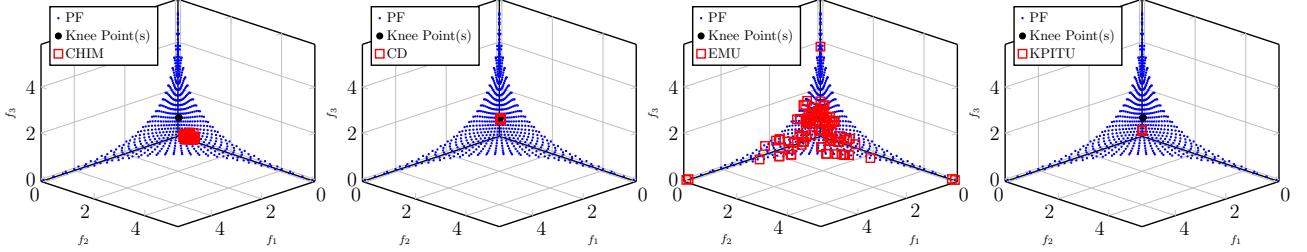


Figure 158: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP3 with one global knee point.

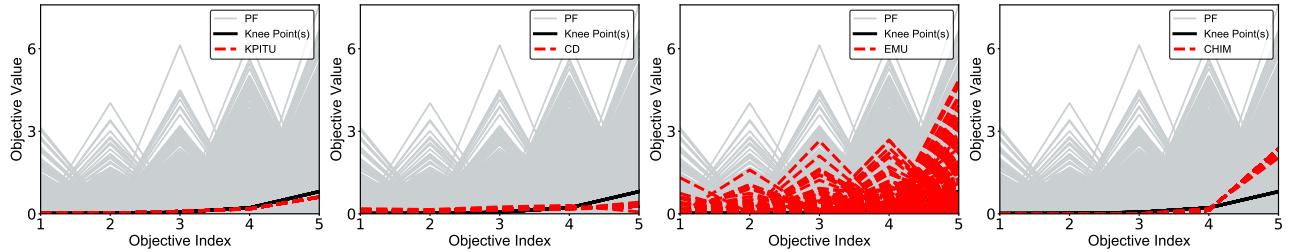


Figure 159: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP3 with one global knee point.

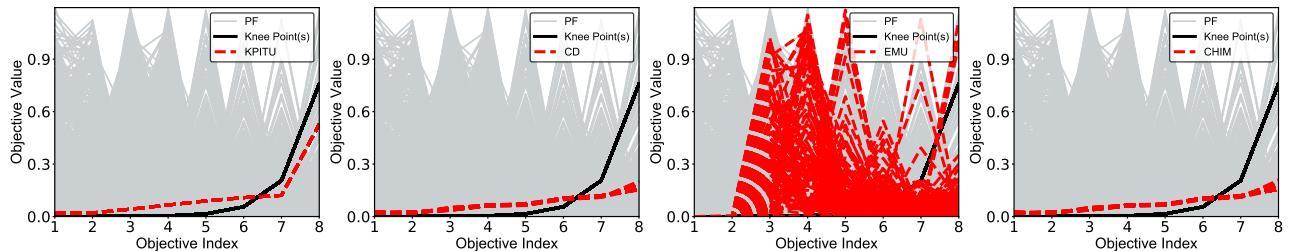


Figure 160: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP3 with one global knee point.

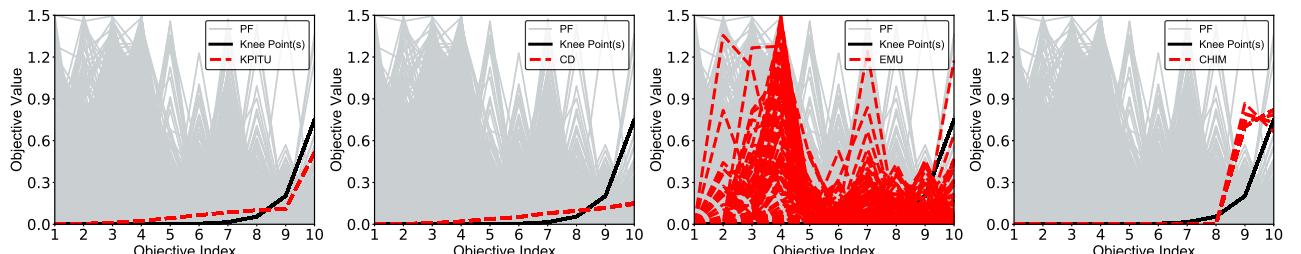


Figure 161: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP3 with one global knee point.

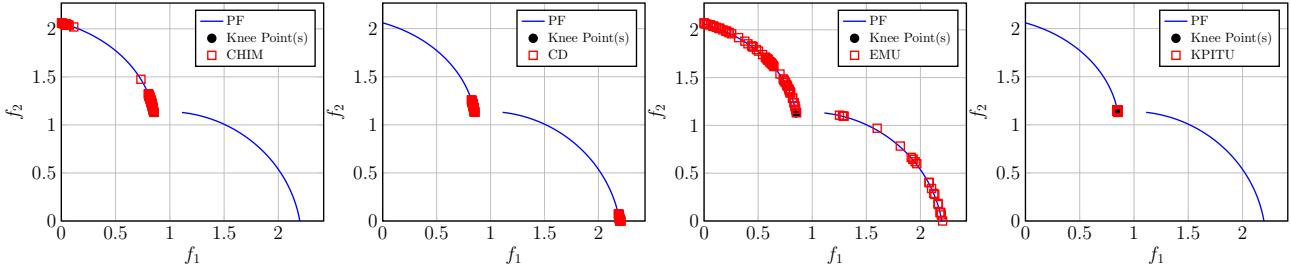


Figure 162: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP4 with one global knee point.

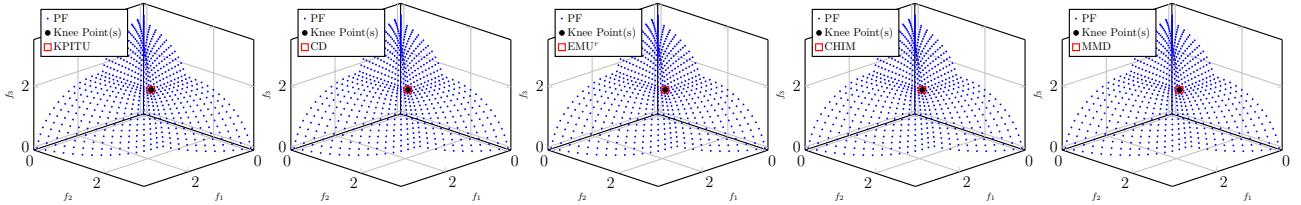


Figure 163: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP4 with one global knee point.

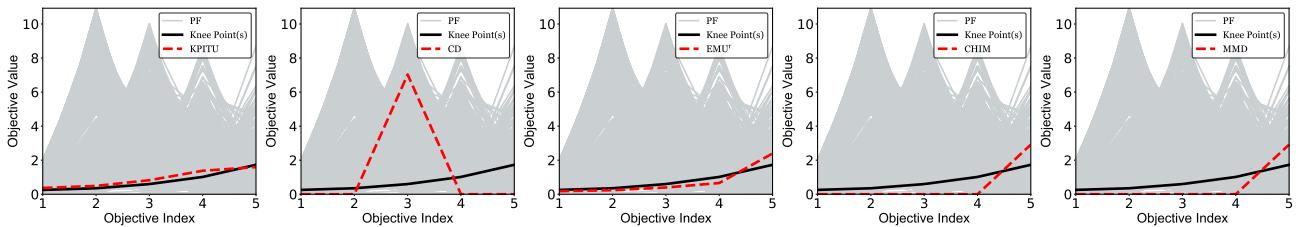


Figure 164: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP4 with one global knee point.

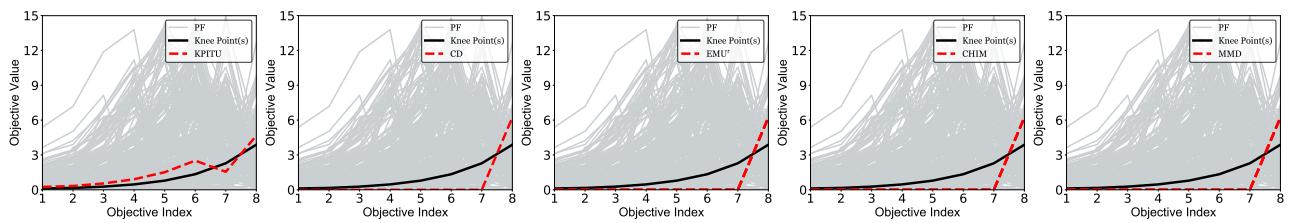


Figure 165: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP4 with one global knee point.

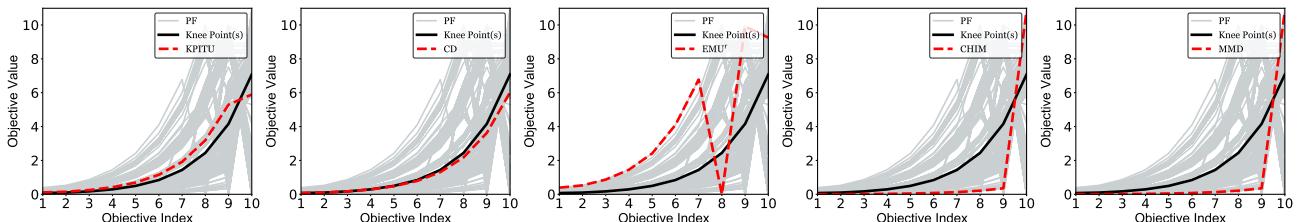


Figure 166: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP4 with one global knee point.

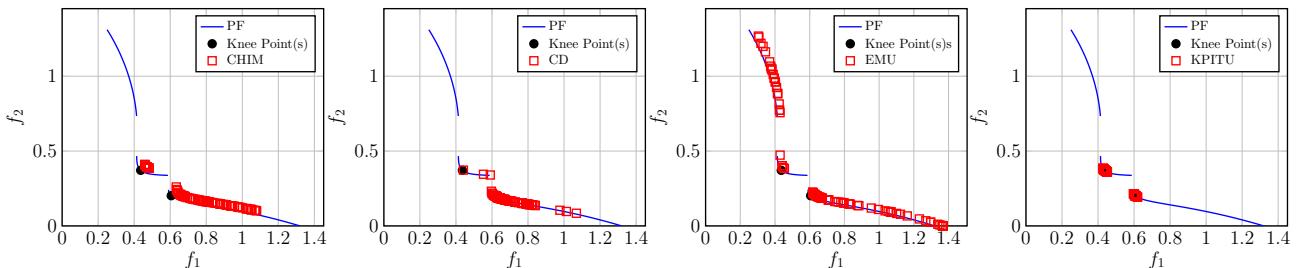


Figure 167: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP5 with one global knee point.

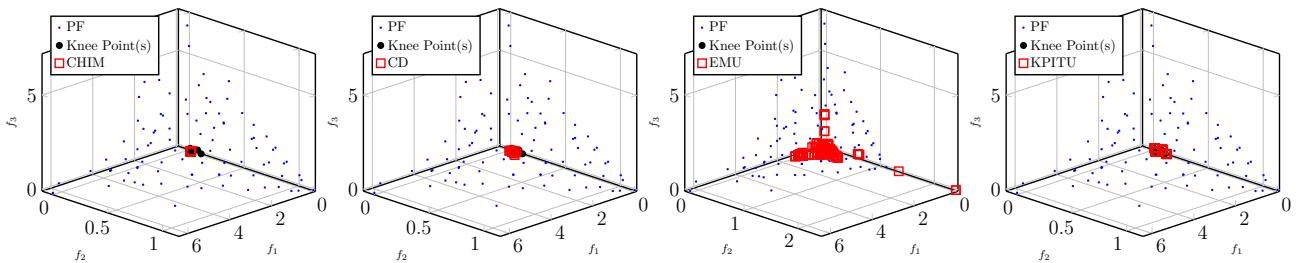


Figure 168: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP5 with one global knee point.

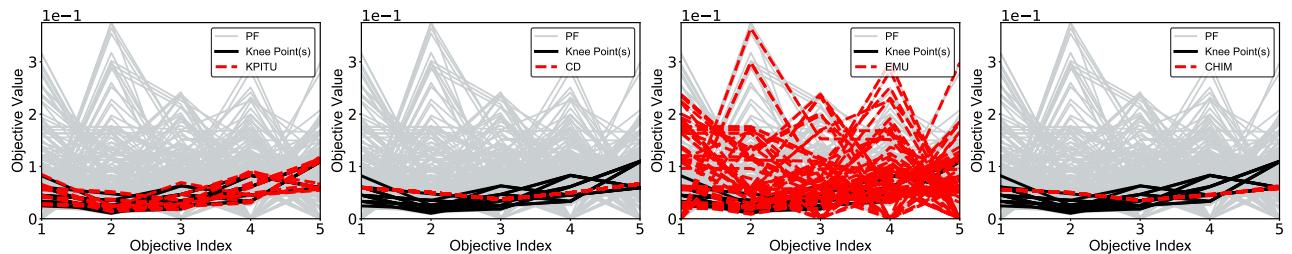


Figure 169: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP5 with one global knee point.

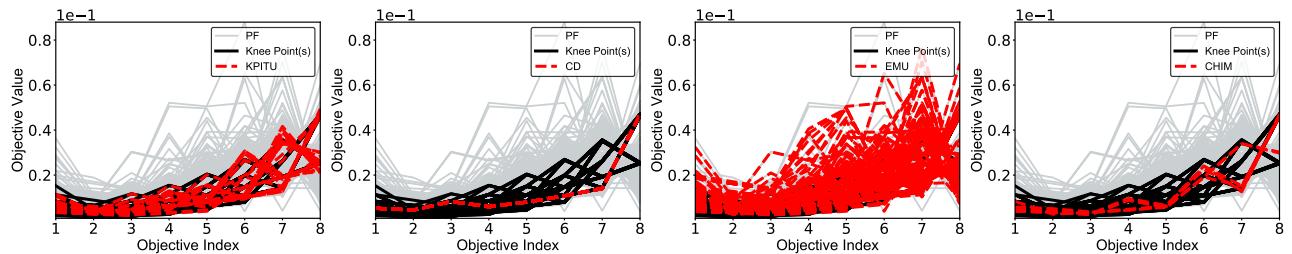


Figure 170: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP5 with one global knee point.

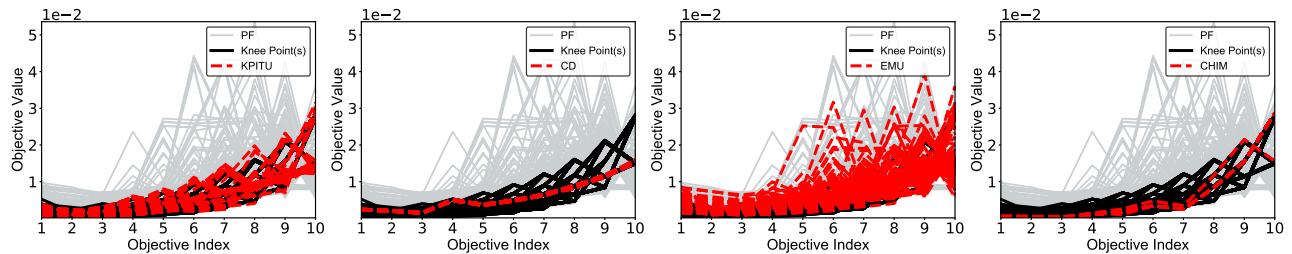


Figure 171: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP5 with one global knee point.

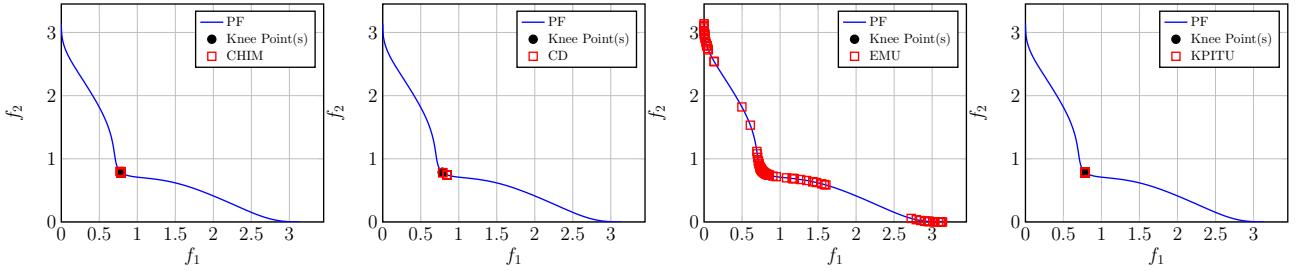


Figure 172: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP6 with one global knee point.

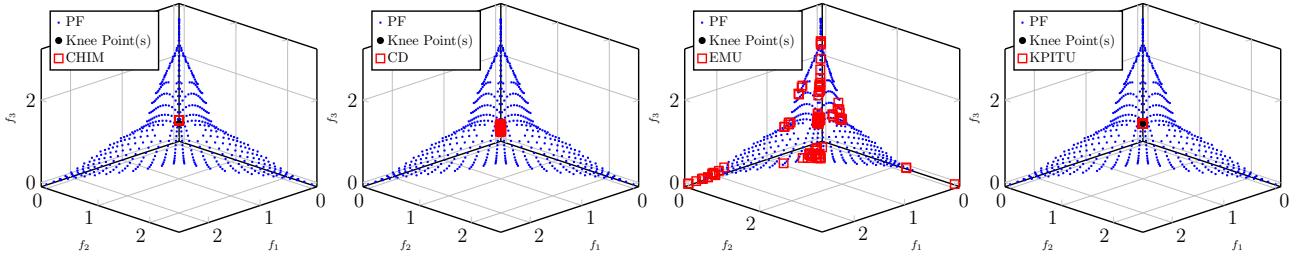


Figure 173: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP6 with one global knee point.

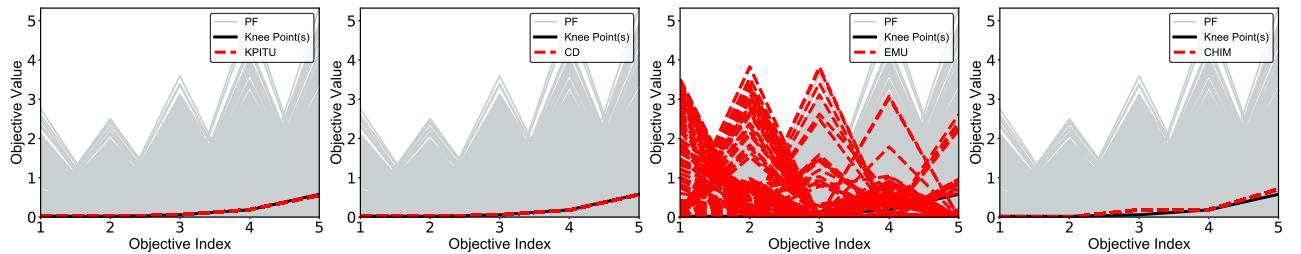


Figure 174: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP6 with one global knee point.

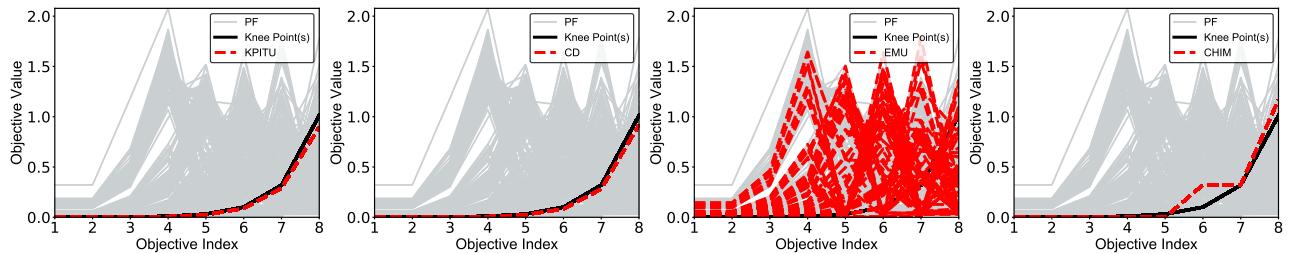


Figure 175: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP6 with one global knee point.

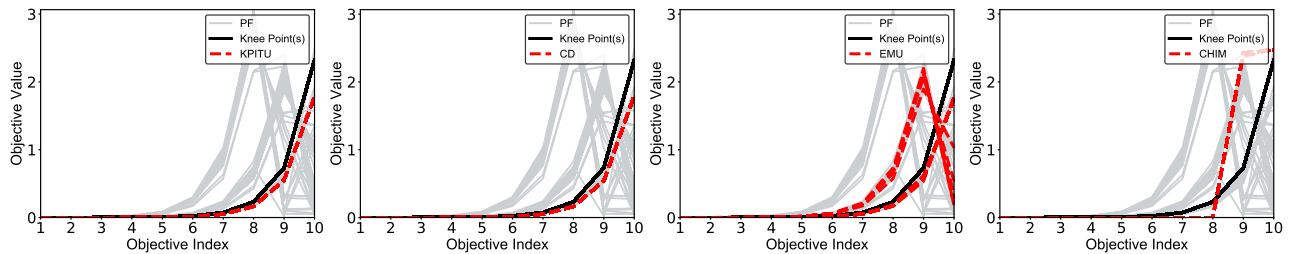


Figure 176: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP6 with one global knee point.

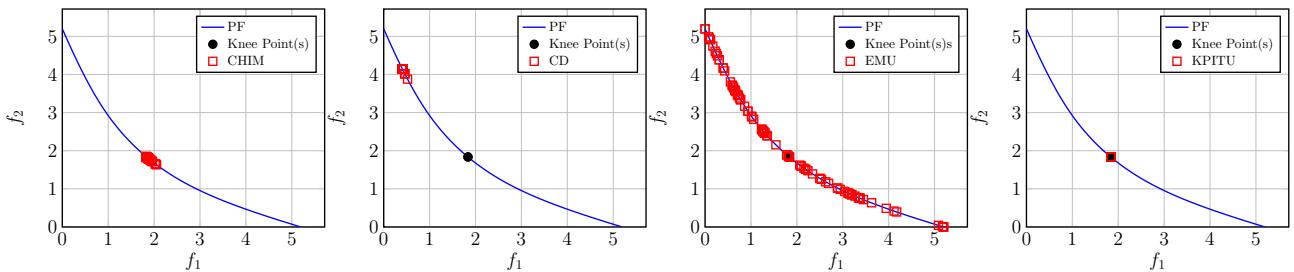


Figure 177: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP7 with one global knee point.

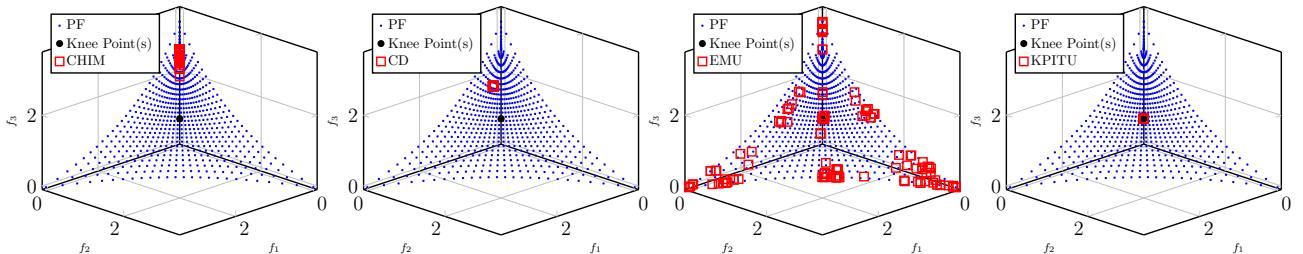


Figure 178: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP7 with one global knee point.

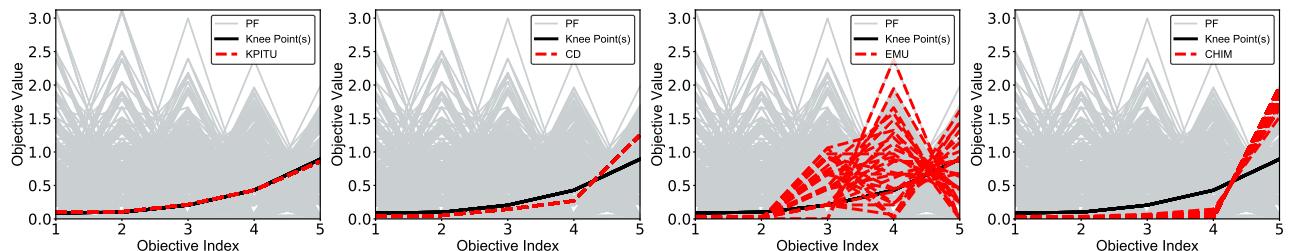


Figure 179: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP7 with one global knee point.

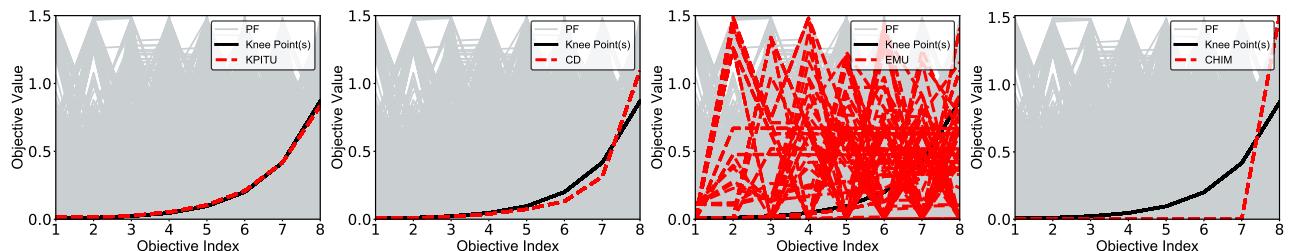


Figure 180: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP7 with one global knee point.

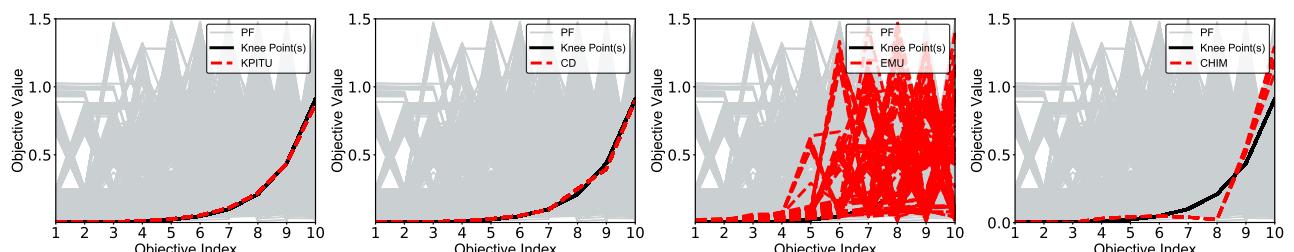


Figure 181: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP7 with one global knee point.

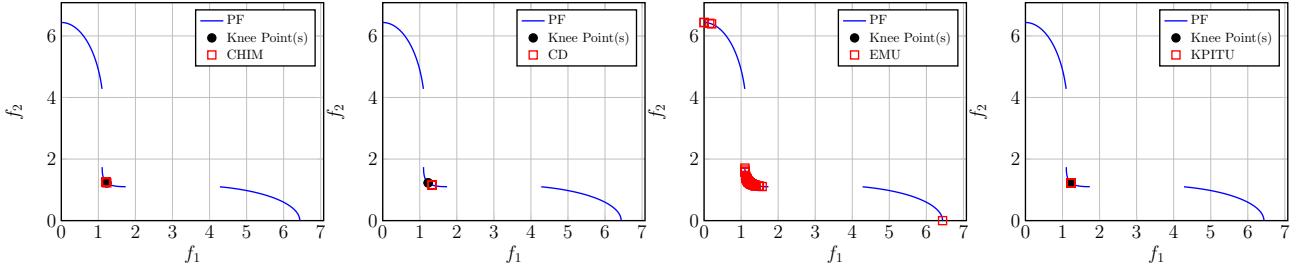


Figure 182: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP8 with one global knee point.

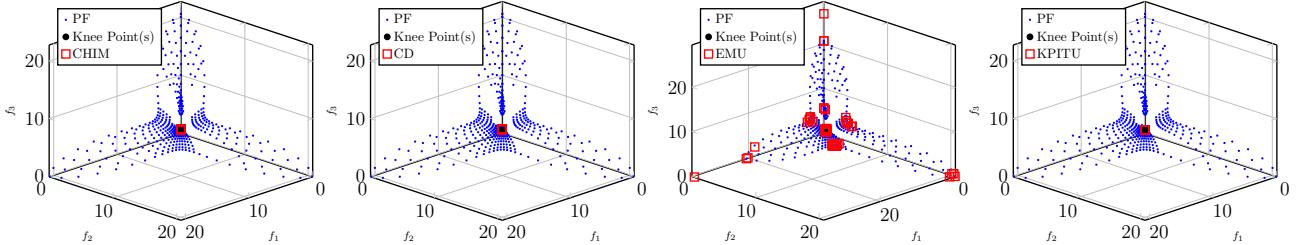


Figure 183: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP8 with one global knee point.

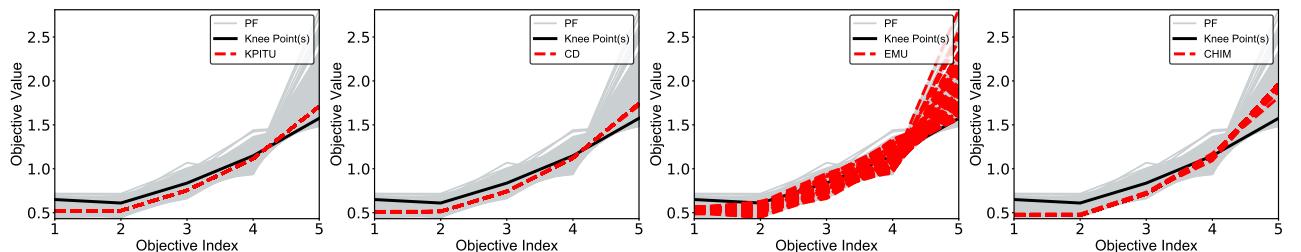


Figure 184: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP8 with one global knee point.

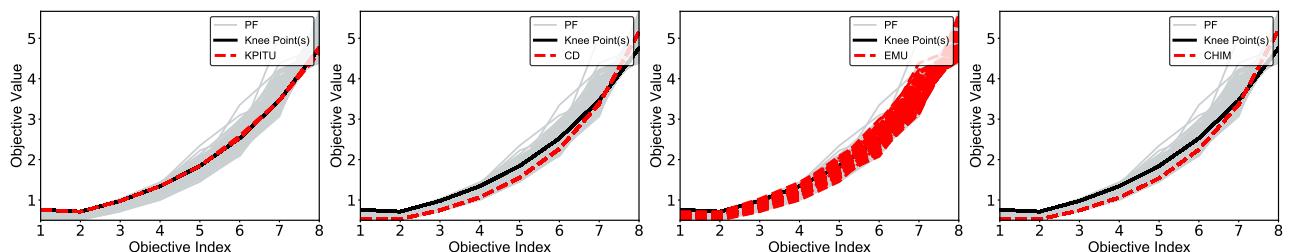


Figure 185: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP8 with one global knee point.

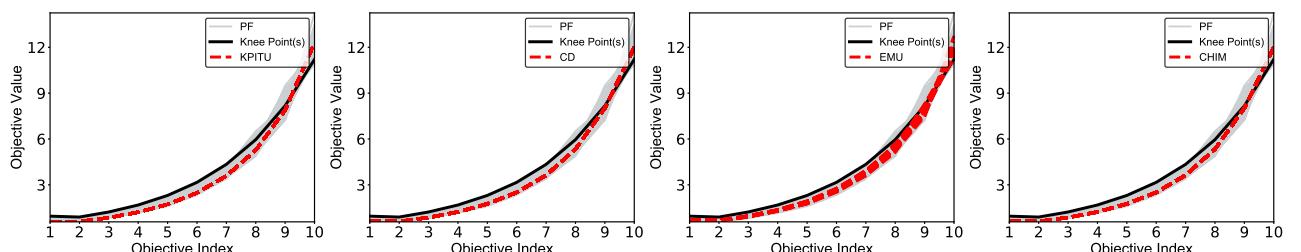


Figure 186: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP8 with one global knee point.

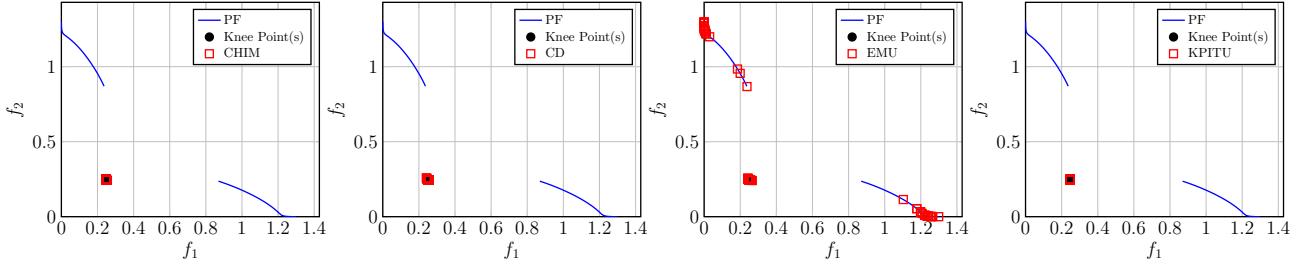


Figure 187: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP9 with one global knee point.

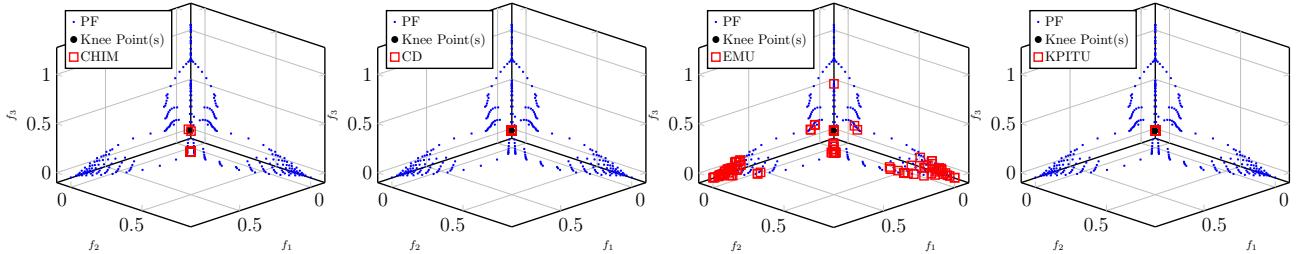


Figure 188: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP9 with one global knee point.

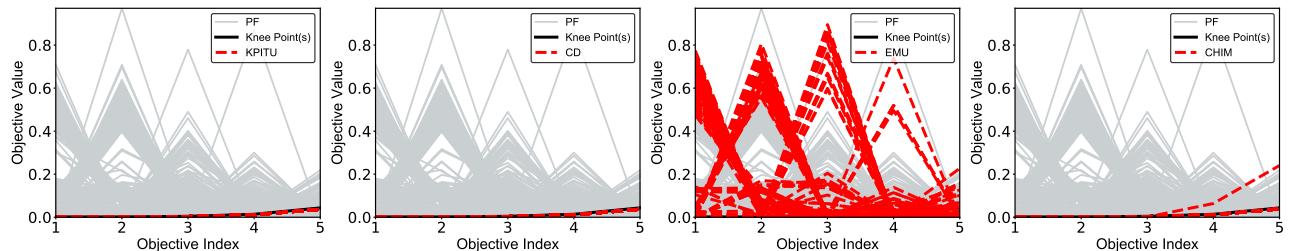


Figure 189: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP9 with one global knee point.

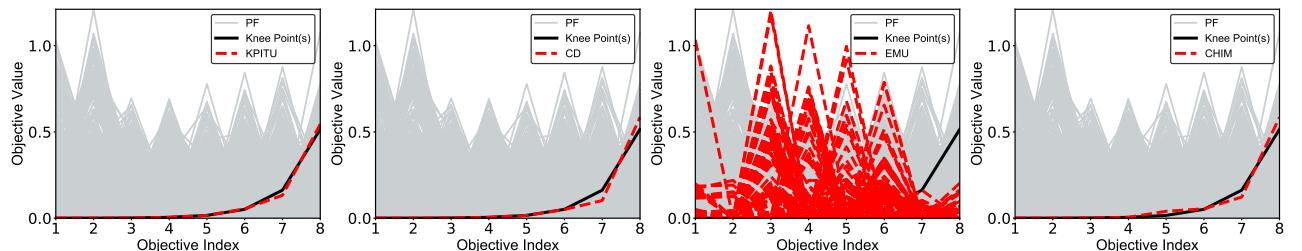


Figure 190: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP9 with one global knee point.

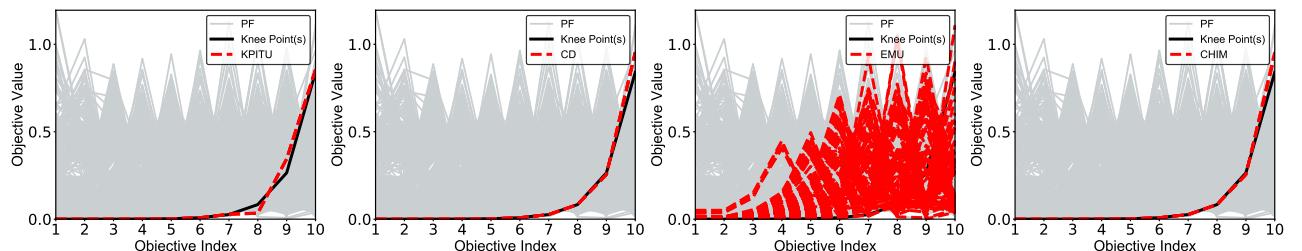


Figure 191: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP9 with one global knee point.

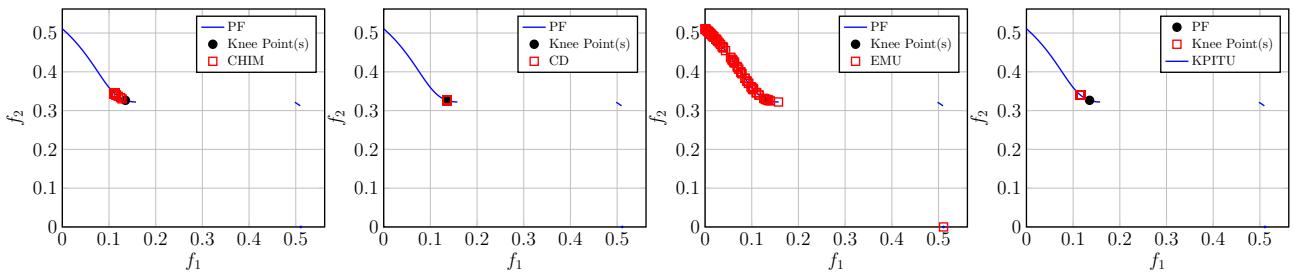


Figure 192: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP11 with one global knee point.

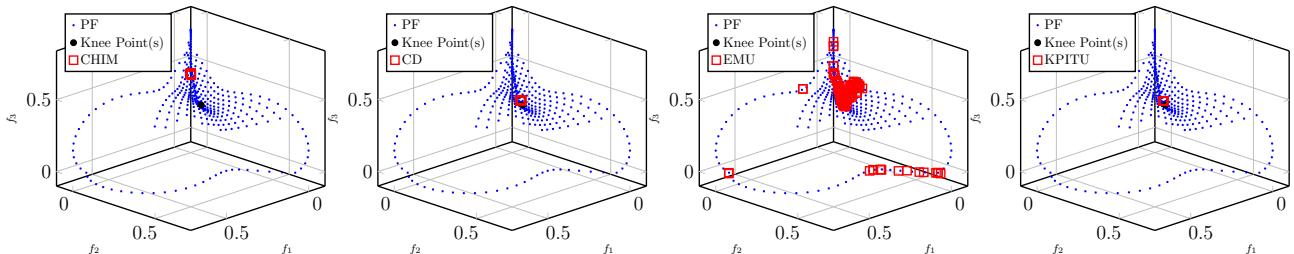


Figure 193: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP11 with one global knee point.

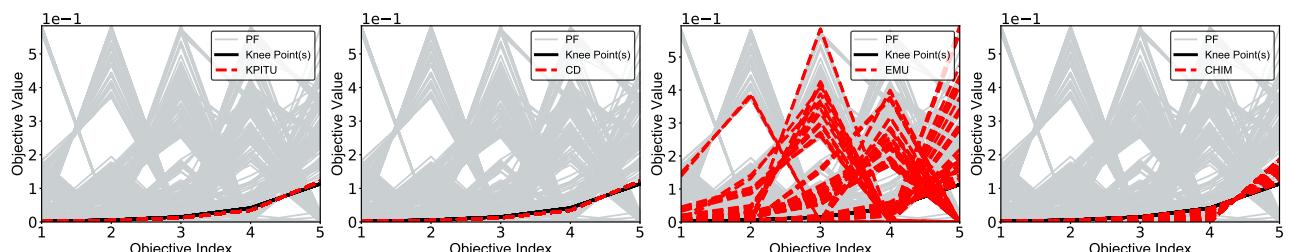


Figure 194: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP11 with one global knee point.

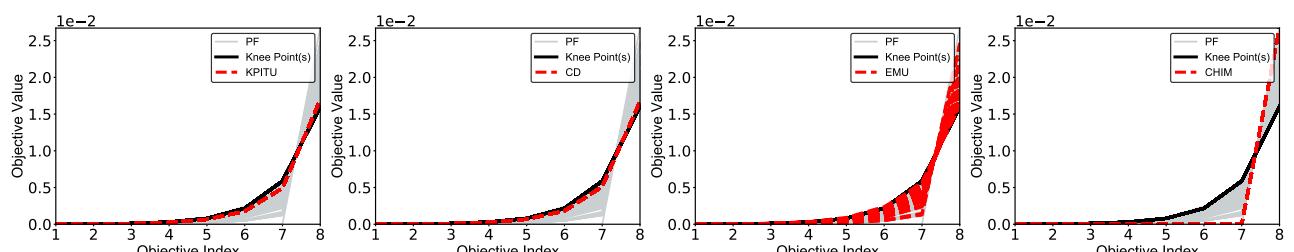


Figure 195: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP11 with one global knee point.

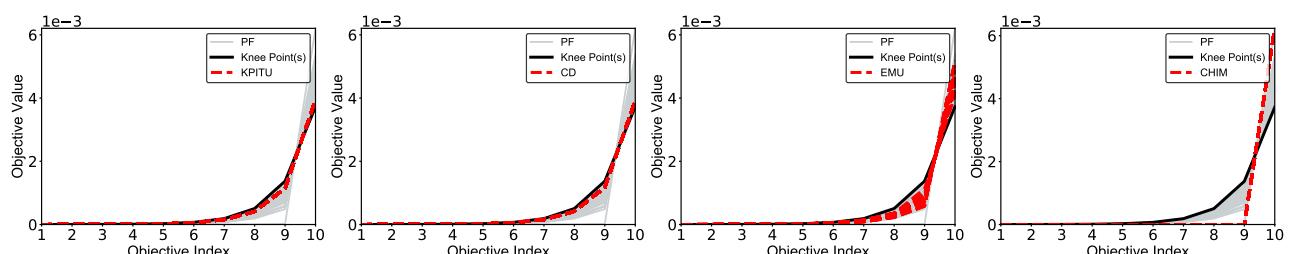


Figure 196: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP11 with one global knee point.

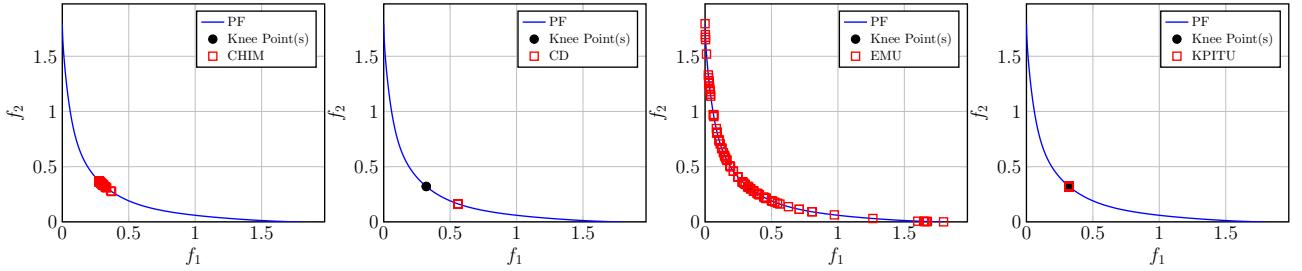


Figure 197: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP11 with one global knee point.

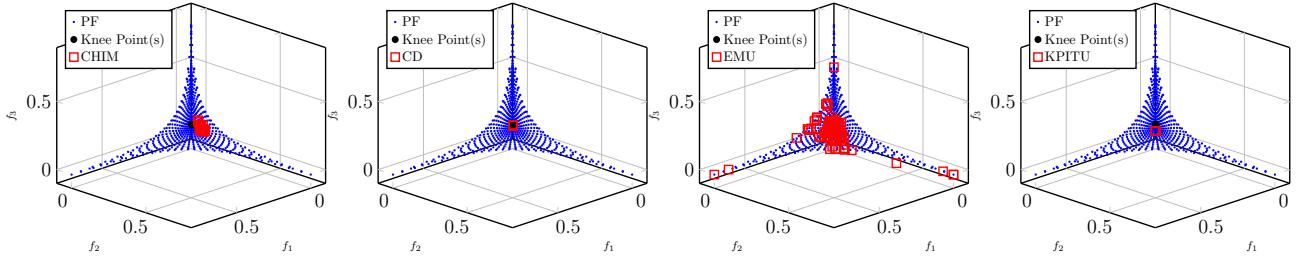


Figure 198: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP11 with one global knee point.

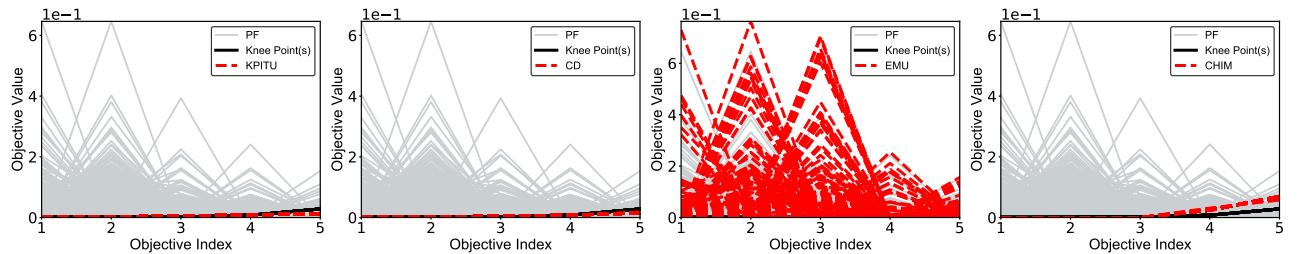


Figure 199: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP11 with one global knee point.

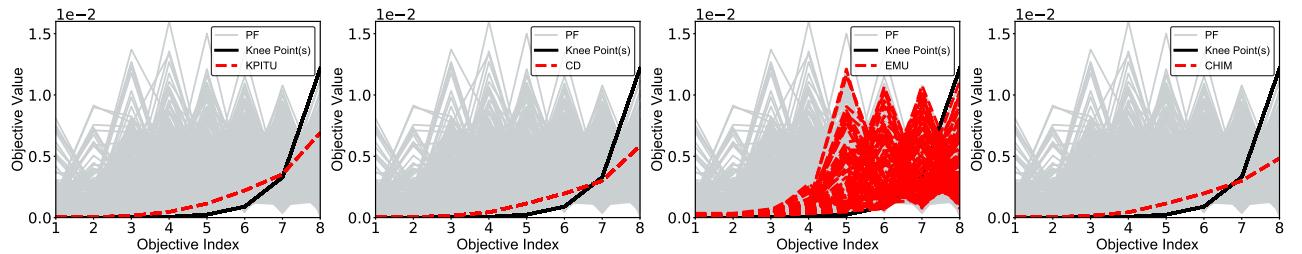


Figure 200: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP11 with one global knee point.

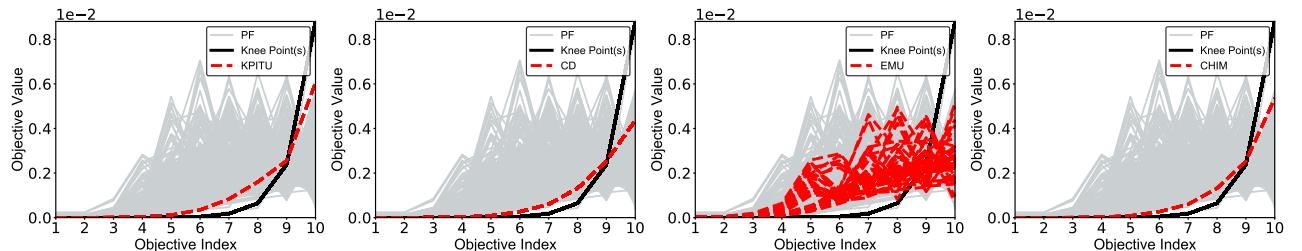


Figure 201: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP11 with one global knee point.

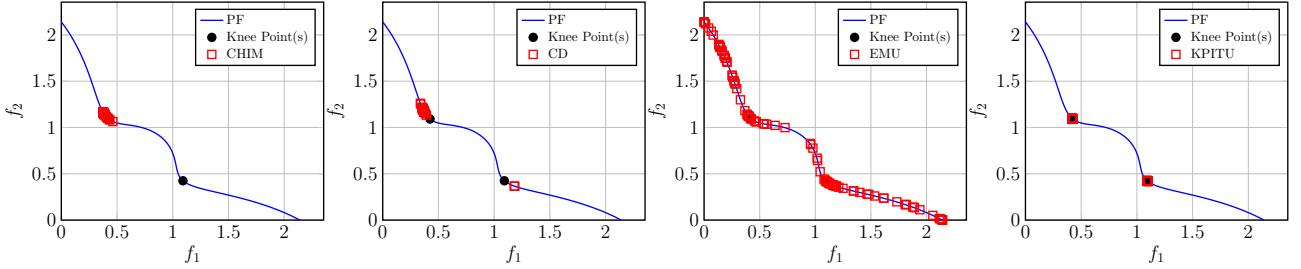


Figure 202: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP1 with local knee points.

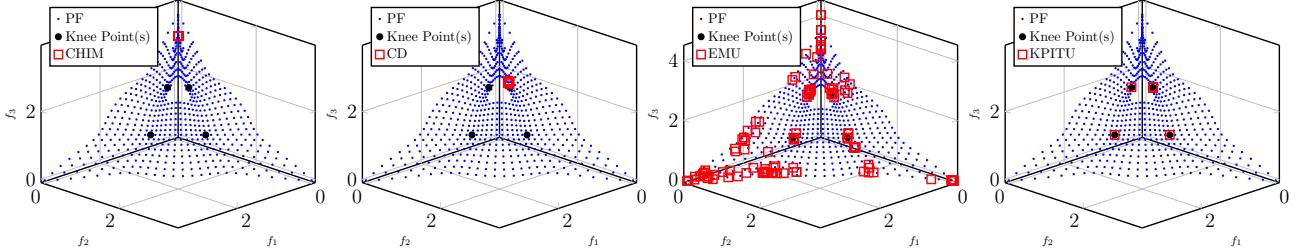


Figure 203: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP1 with local knee points.

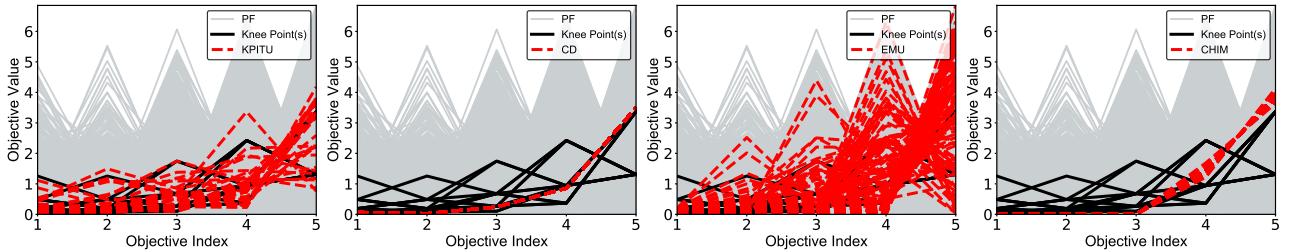


Figure 204: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP1 with local knee points.

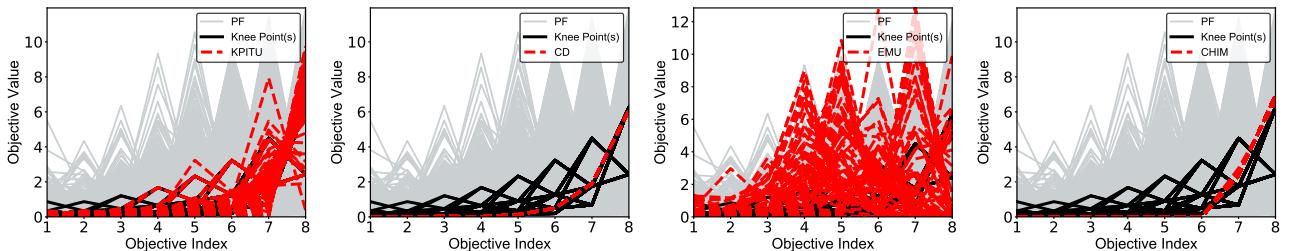


Figure 205: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP1 with local knee points.

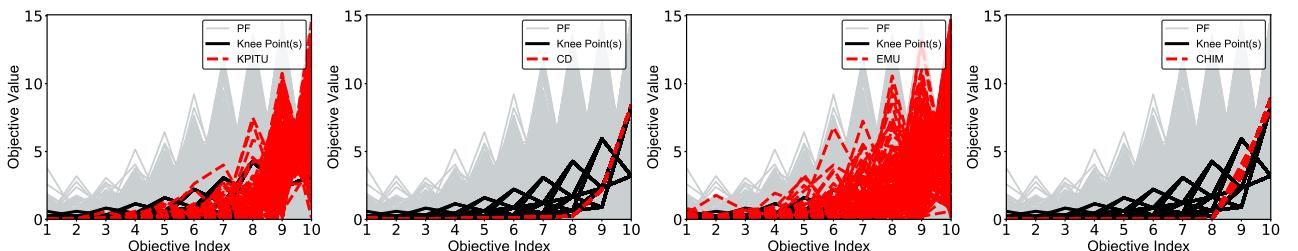


Figure 206: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP1 with local knee points.

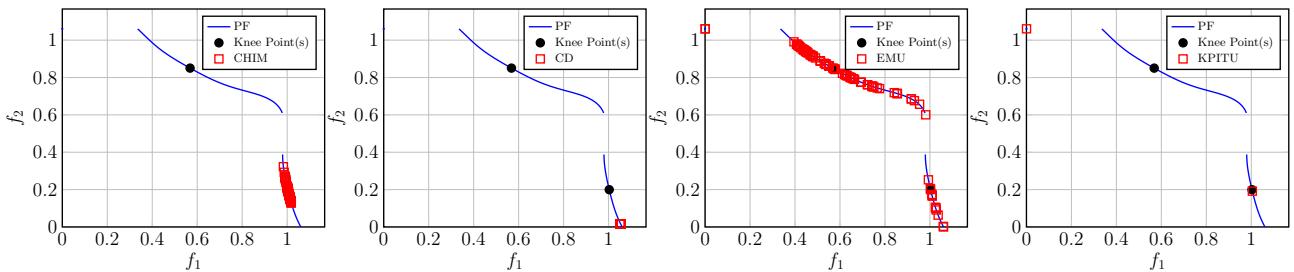


Figure 207: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP2 with local knee points.

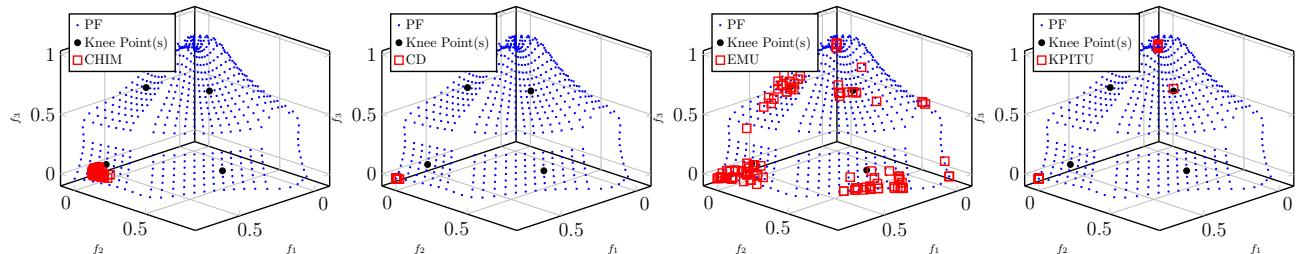


Figure 208: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP2 with local knee points.

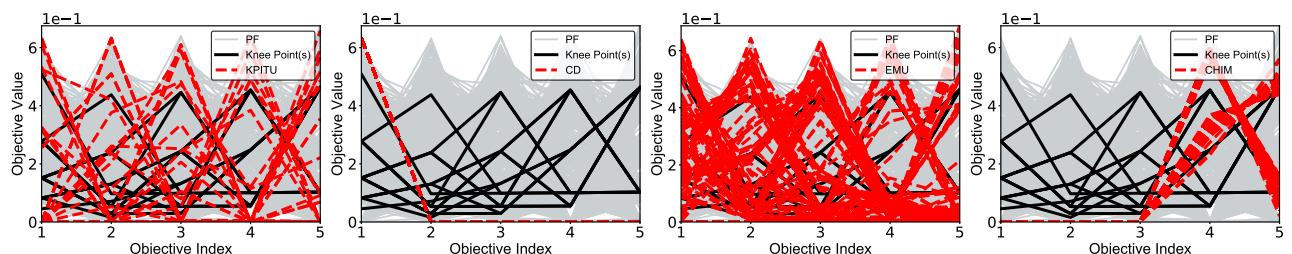


Figure 209: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP2 with local knee points.

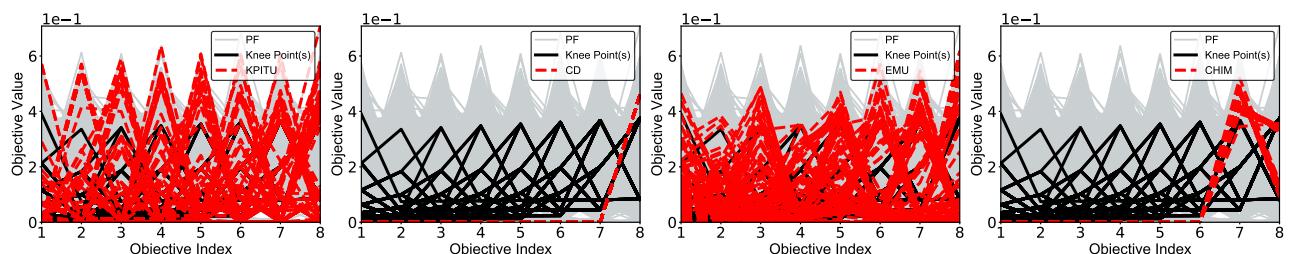


Figure 210: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP2 with local knee points.

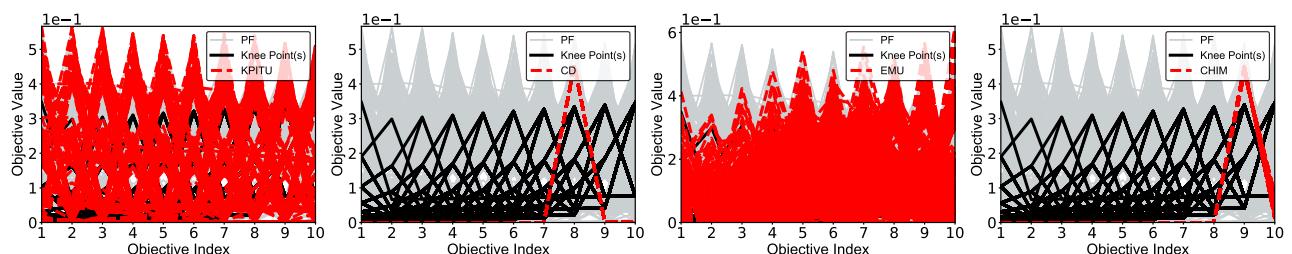


Figure 211: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP2 with local knee points.

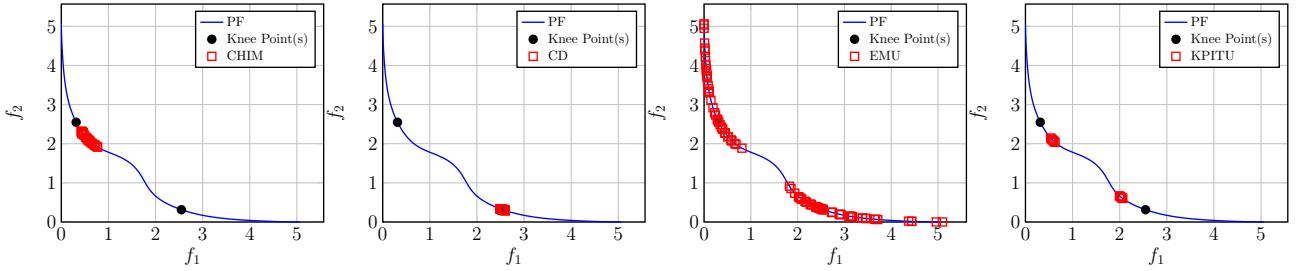


Figure 212: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP3 with local knee points.

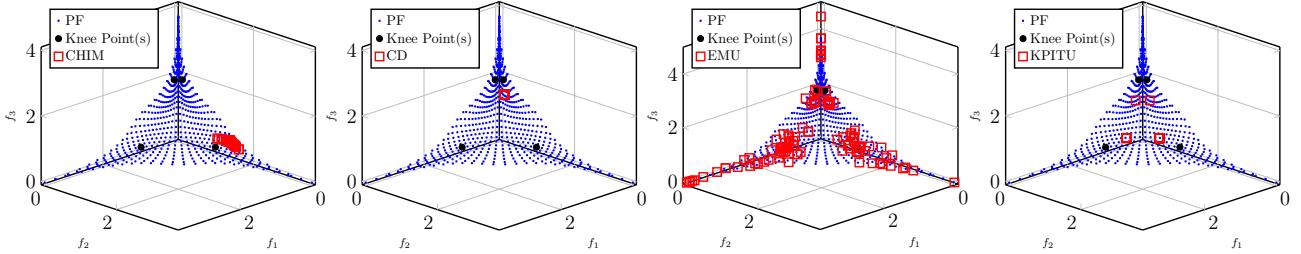


Figure 213: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP3 with local knee points.

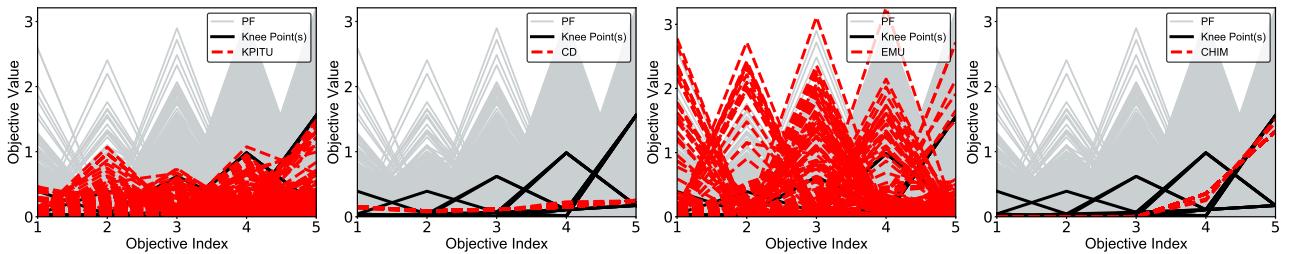


Figure 214: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP3 with local knee points.

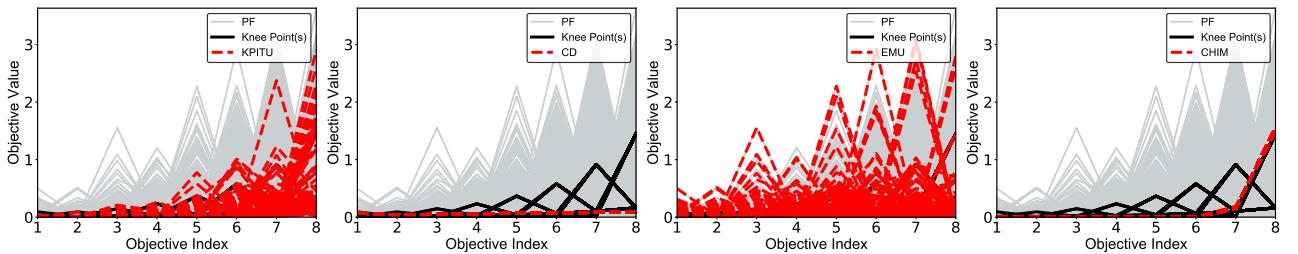


Figure 215: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP3 with local knee points.

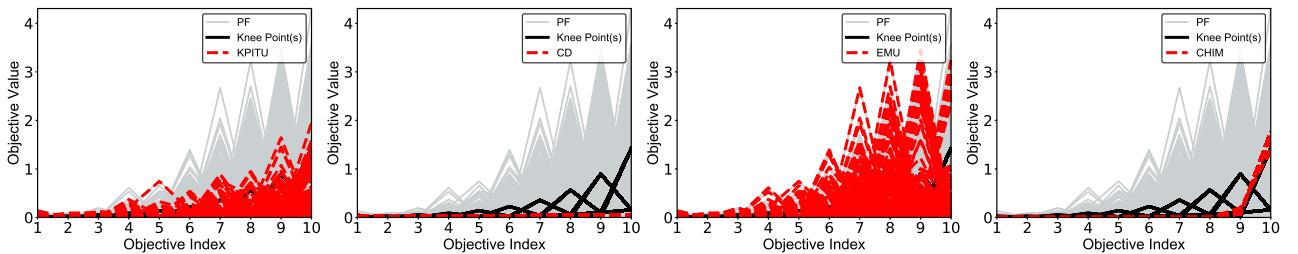


Figure 216: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP3 with local knee points.

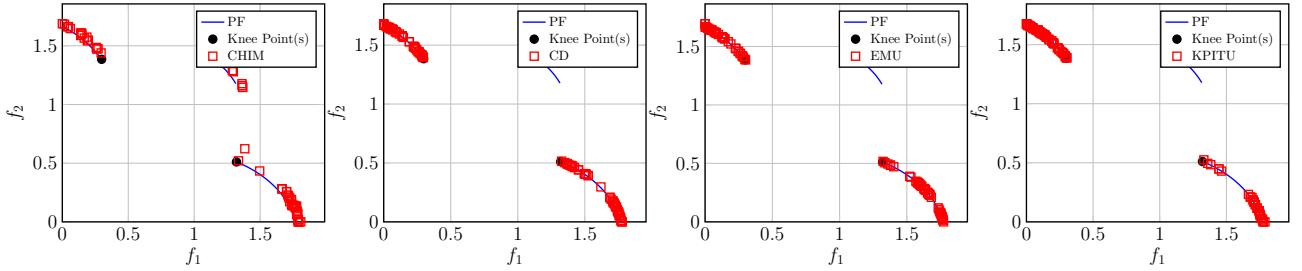


Figure 217: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP4 with local knee points.

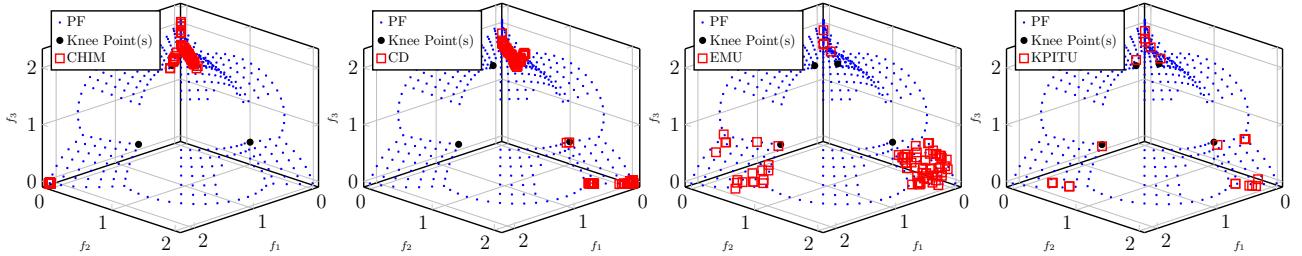


Figure 218: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP4 with local knee points.

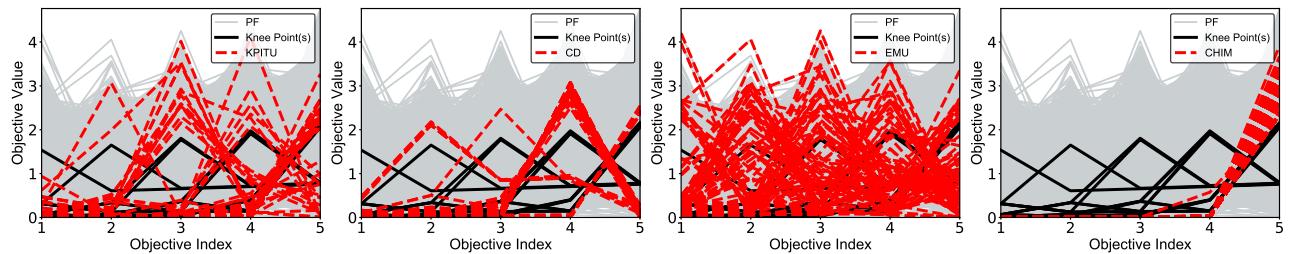


Figure 219: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP4 with local knee points.

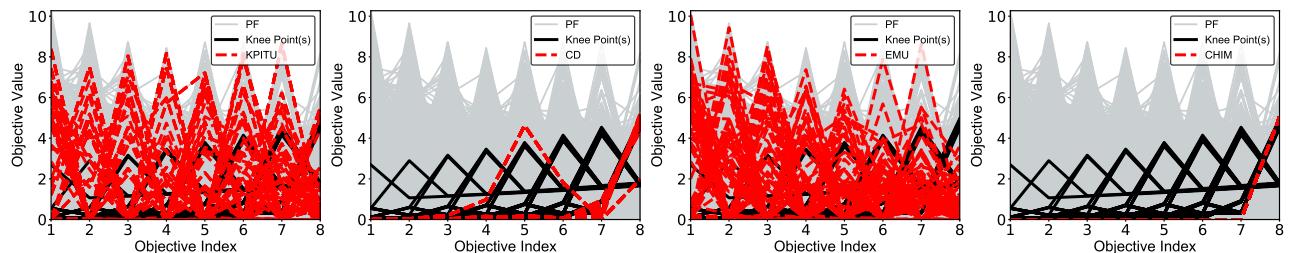


Figure 220: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP4 with local knee points.

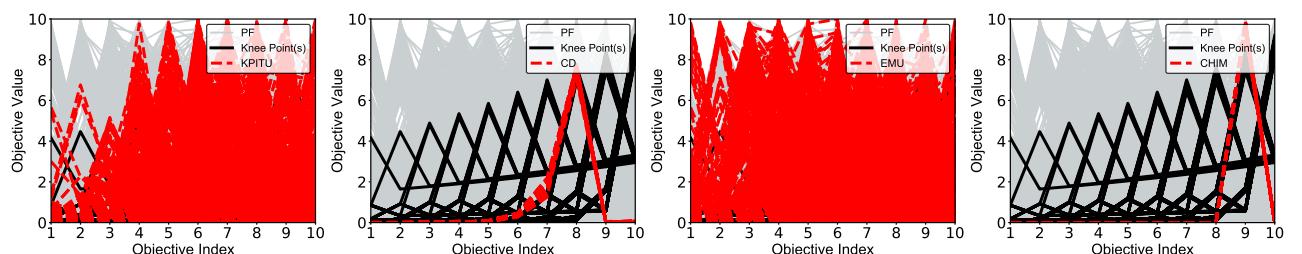


Figure 221: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP4 with local knee points.

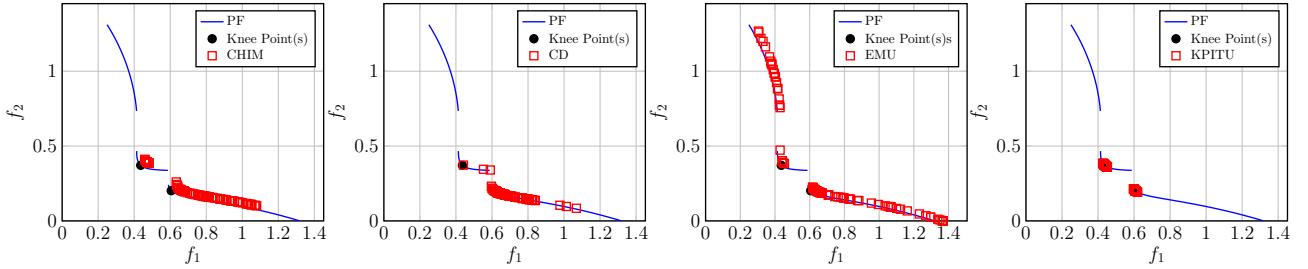


Figure 222: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP5 with local knee points.

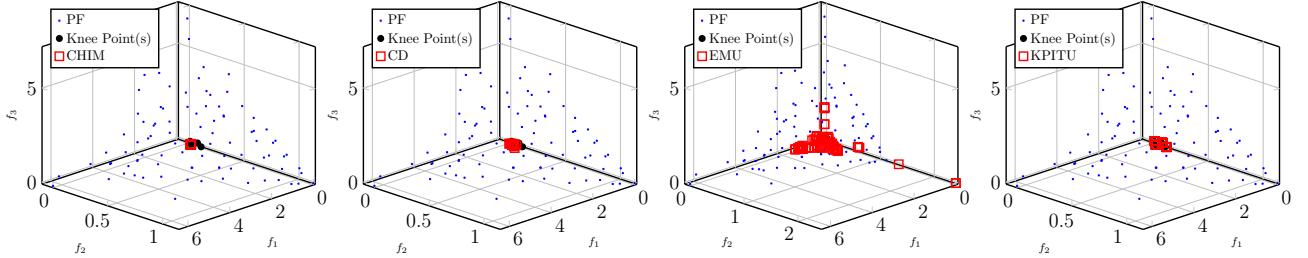


Figure 223: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP5 with local knee points.

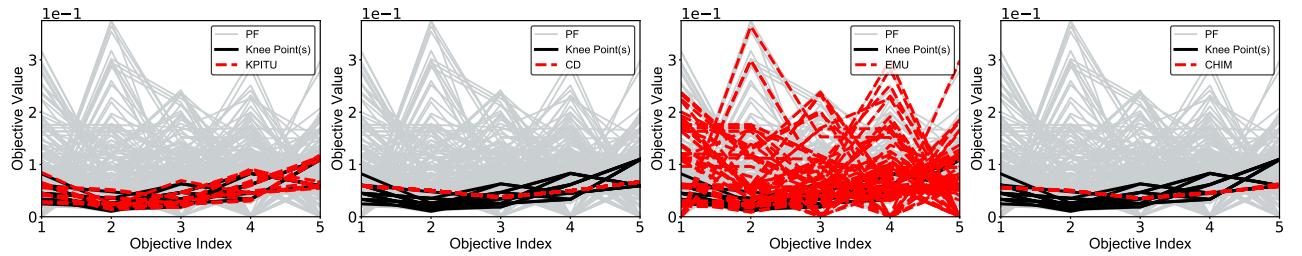


Figure 224: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP5 with local knee points.

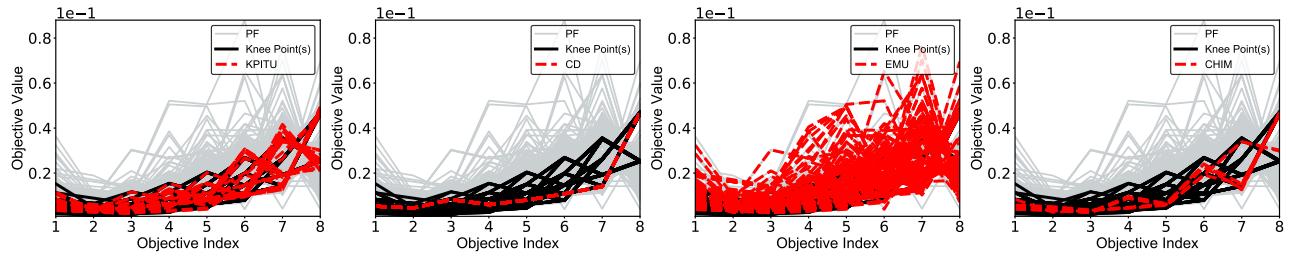


Figure 225: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP5 with local knee points.

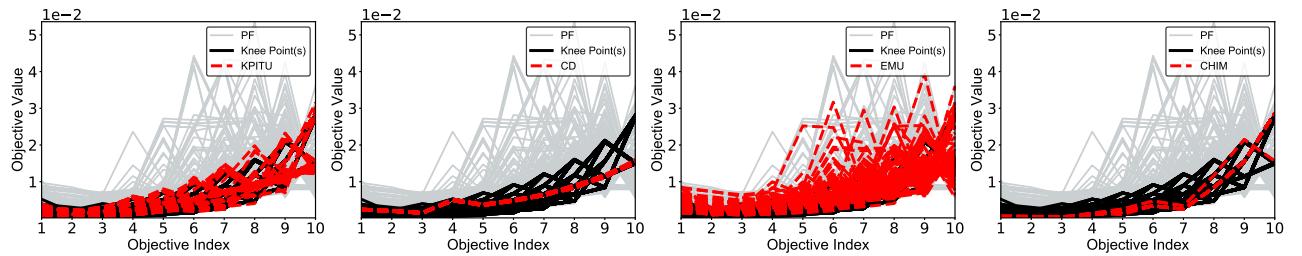


Figure 226: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP5 with local knee points.

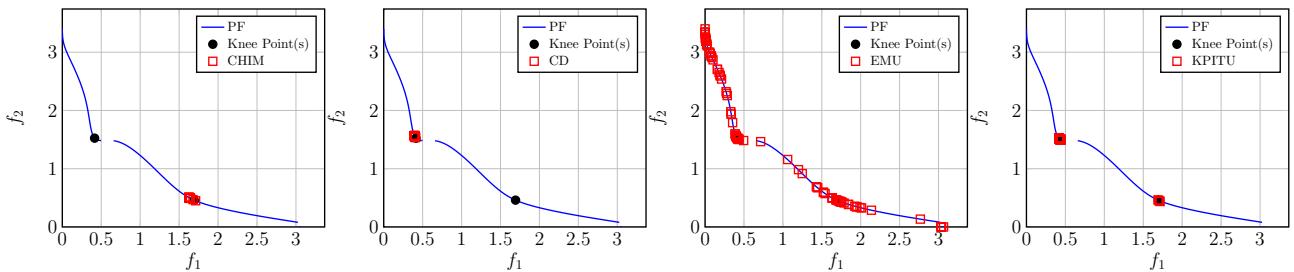


Figure 227: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP6 with local knee points.

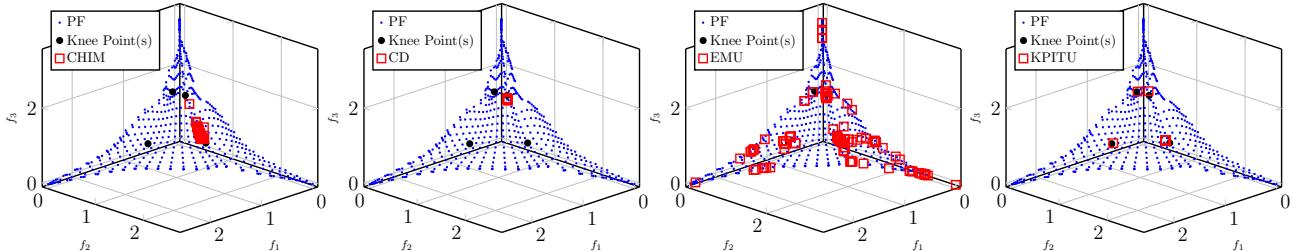


Figure 228: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP6 with local knee points.

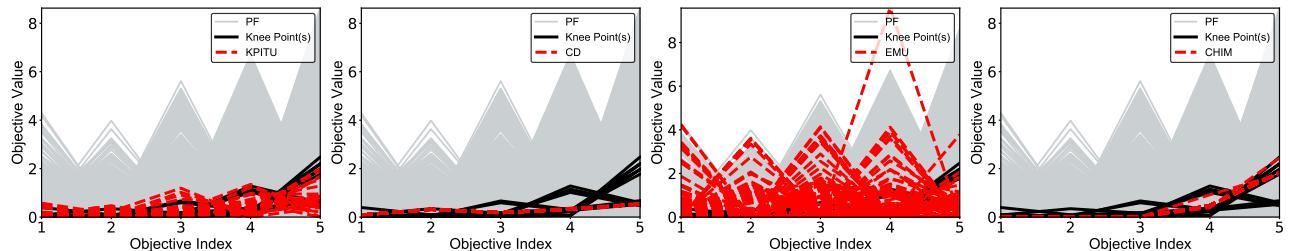


Figure 229: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP6 with local knee points.

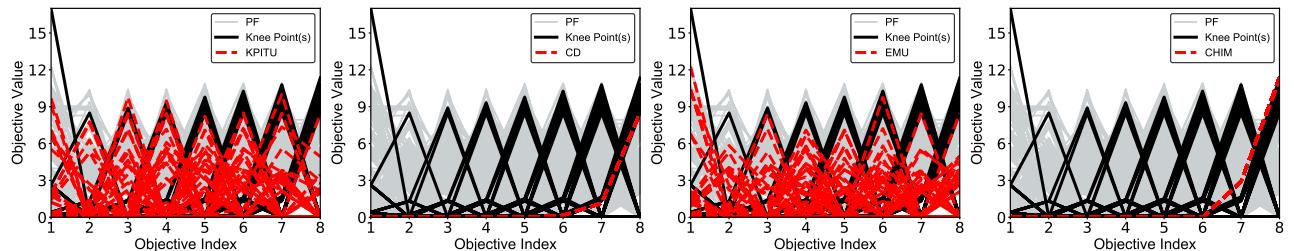


Figure 230: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP6 with local knee points.

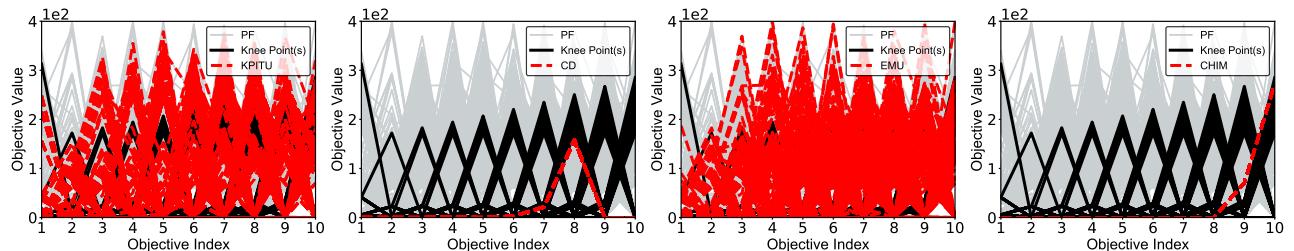


Figure 231: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP6 with local knee points.

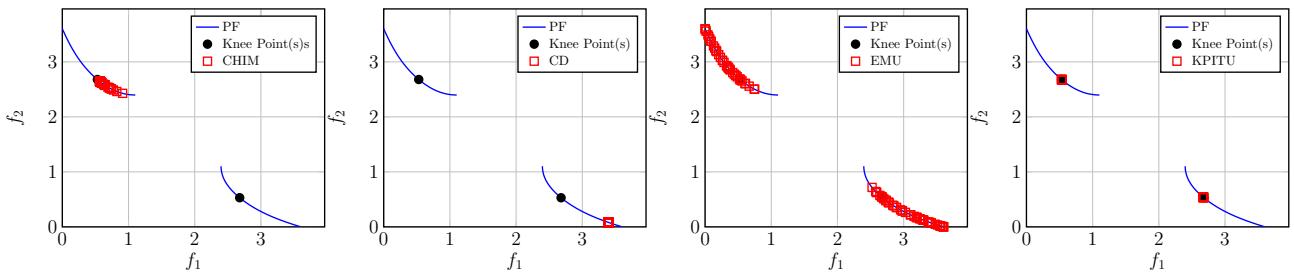


Figure 232: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP7 with local knee points.

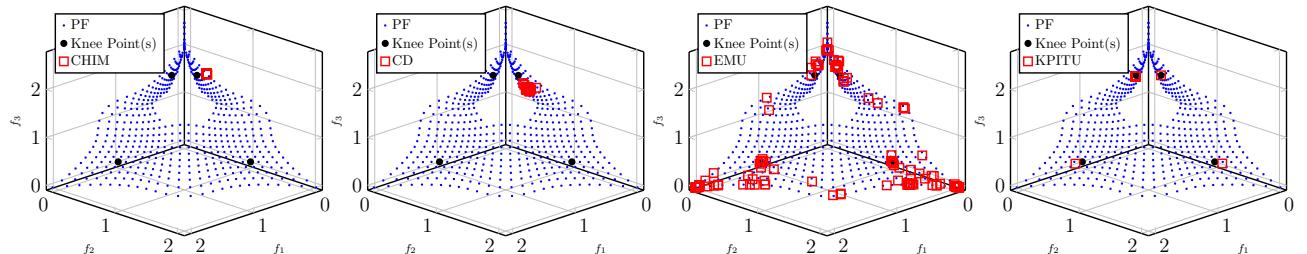


Figure 233: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP7 with local knee points.

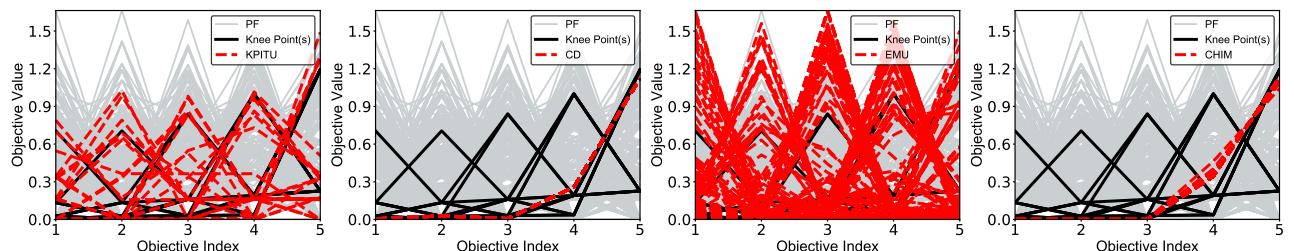


Figure 234: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP7 with local knee points.

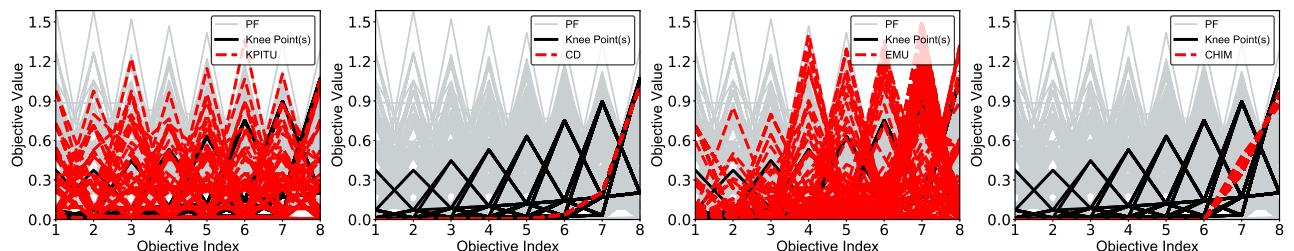


Figure 235: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP7 with local knee points.

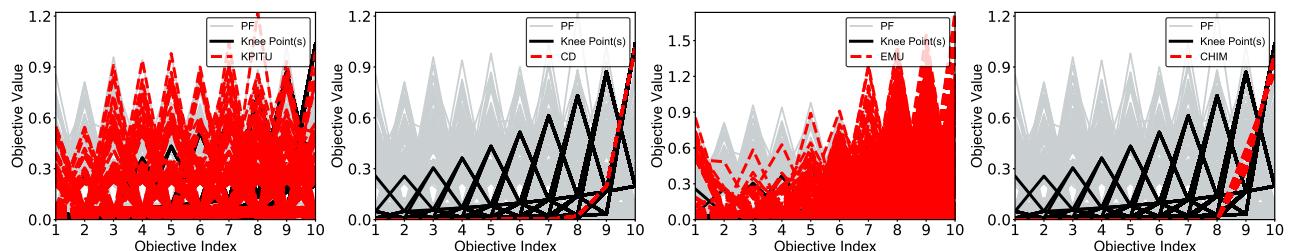


Figure 236: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP7 with local knee points.

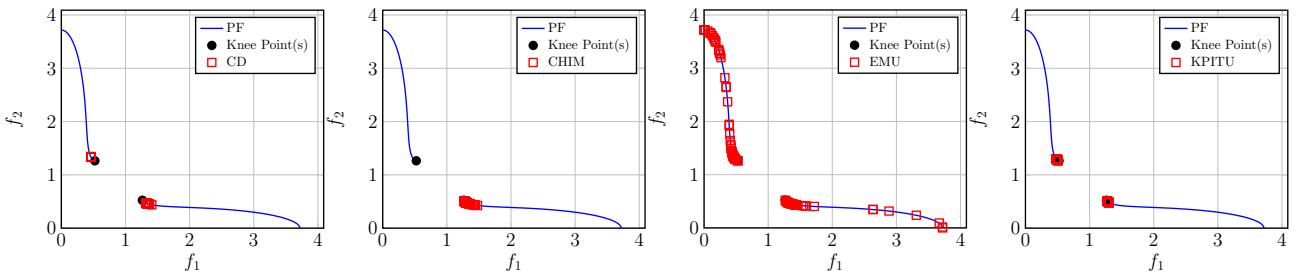


Figure 237: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP8 with local knee points.

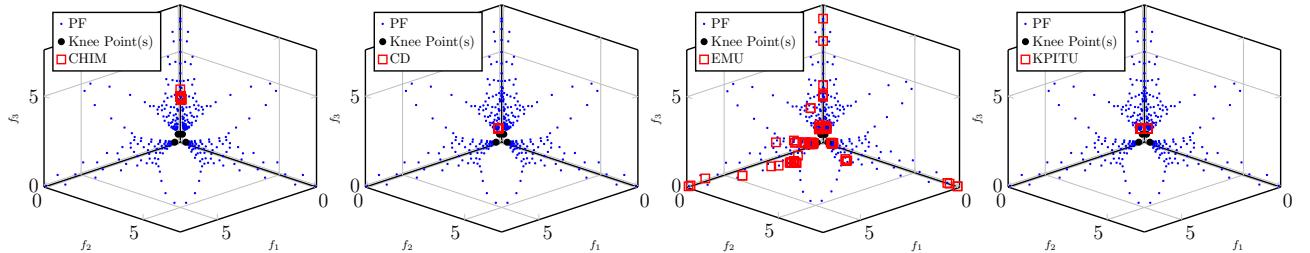


Figure 238: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP8 with local knee points.

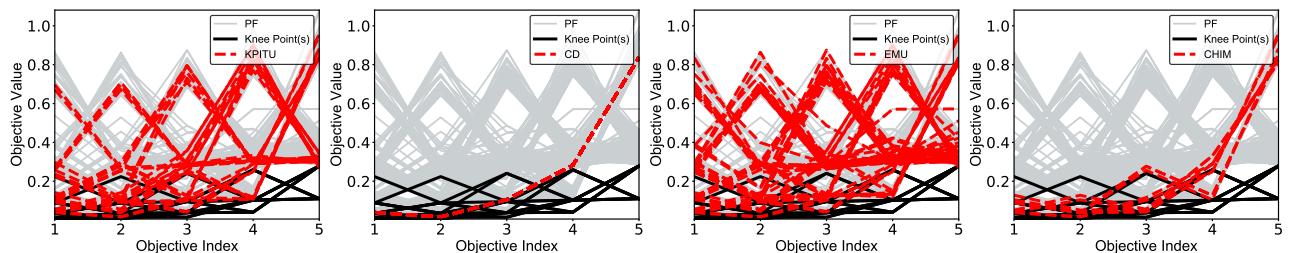


Figure 239: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP8 with local knee points.

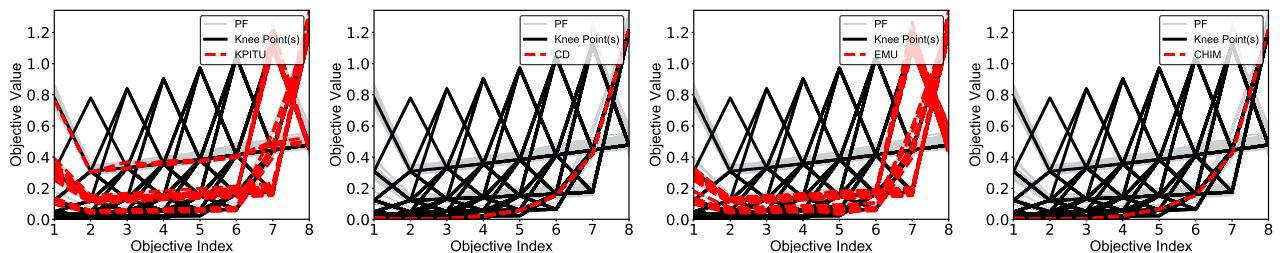


Figure 240: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP8 with local knee points.

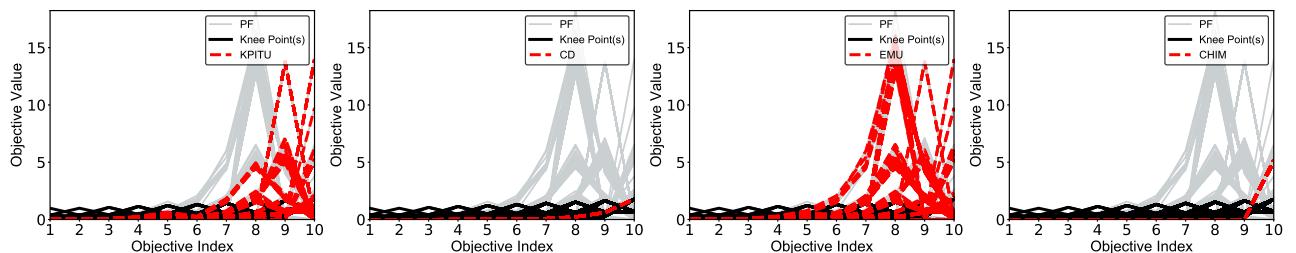


Figure 241: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP8 with local knee points.

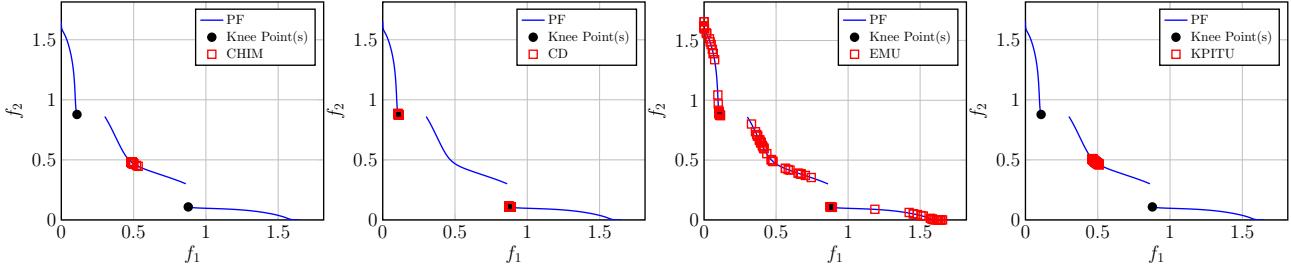


Figure 242: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP9 with local knee points.

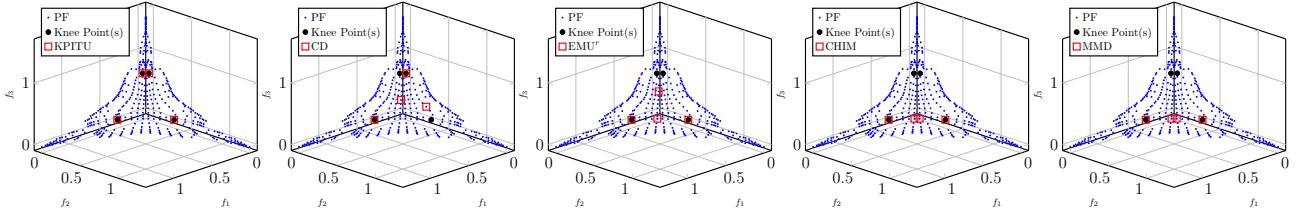


Figure 243: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP9 with local knee points.

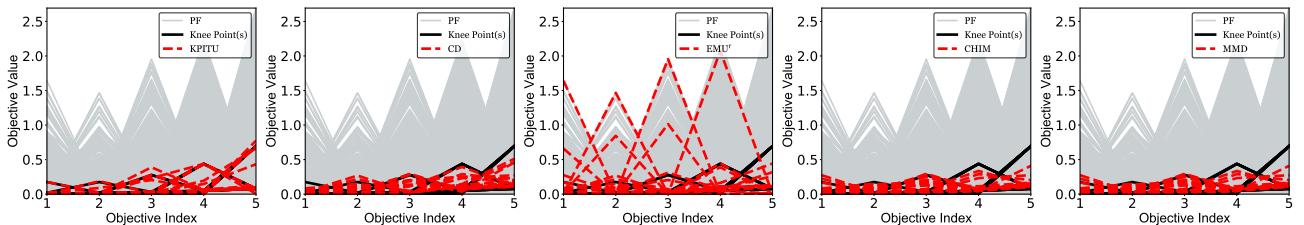


Figure 244: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP9 with local knee points.

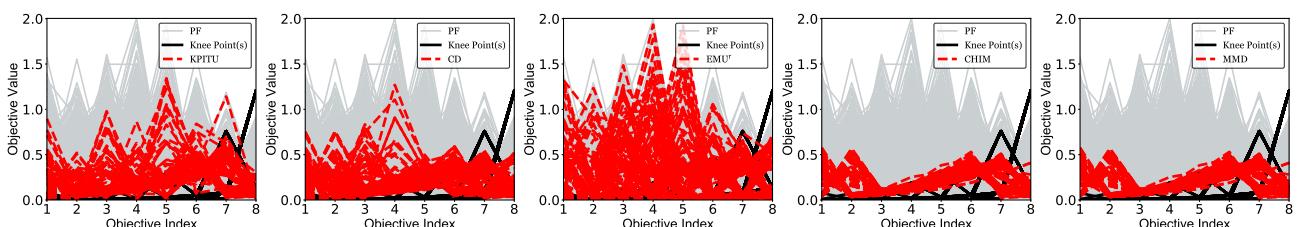


Figure 245: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP9 with local knee points.

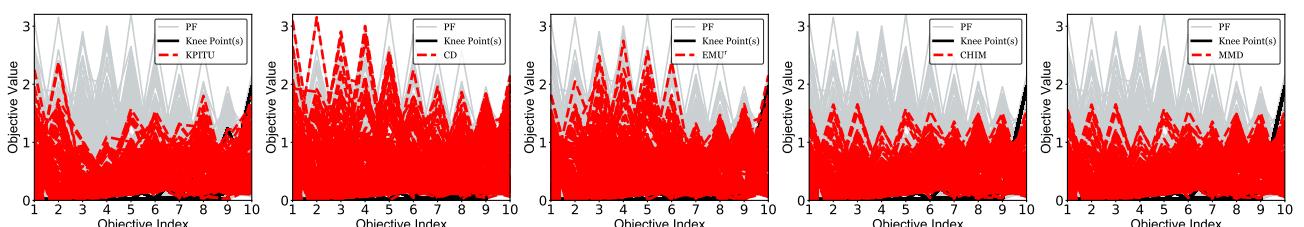


Figure 246: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP9 with local knee points.

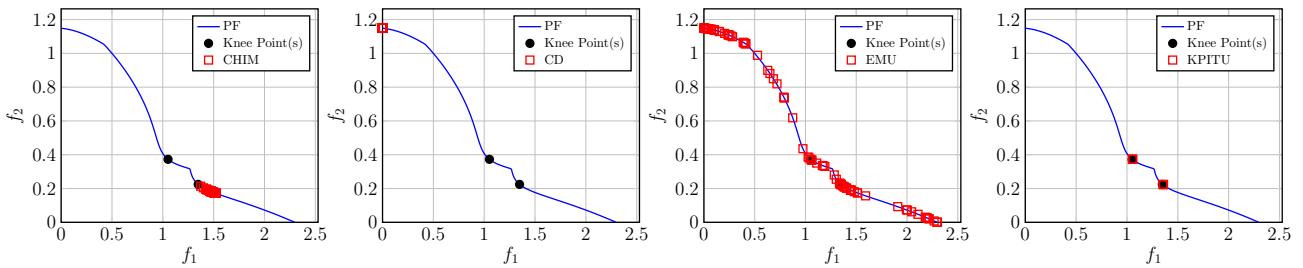


Figure 247: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP10 with local knee points.

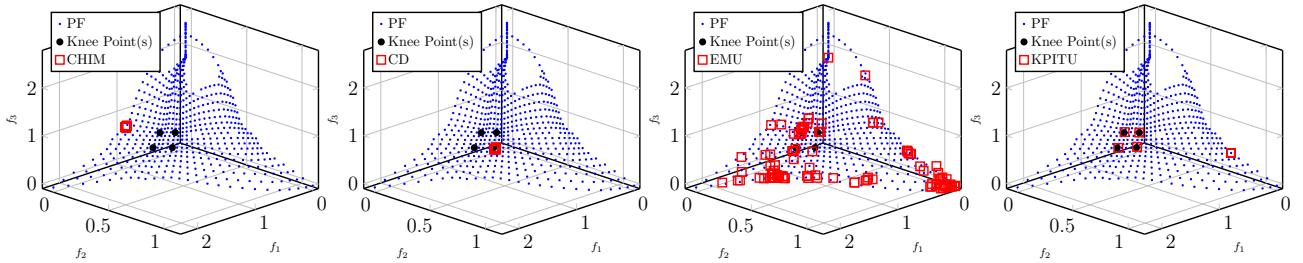


Figure 248: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP10 with local knee points.

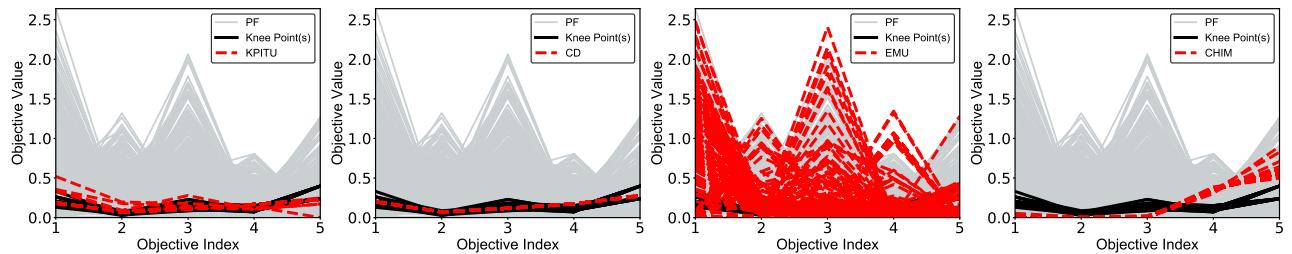


Figure 249: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP10 with local knee points.

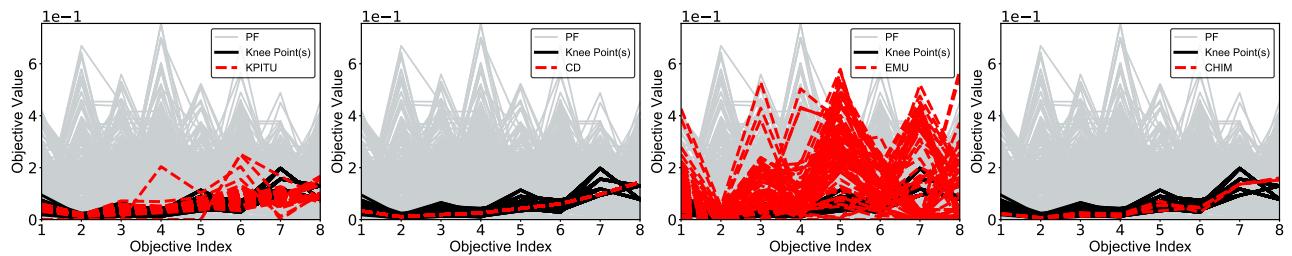


Figure 250: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP10 with local knee points.

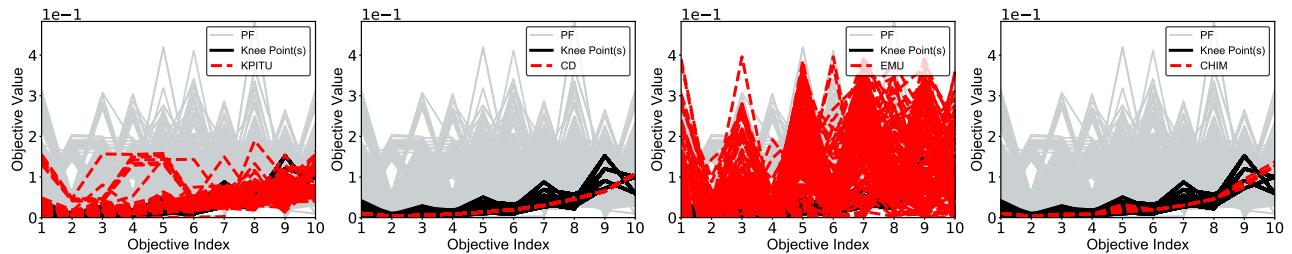


Figure 251: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP10 with local knee points.

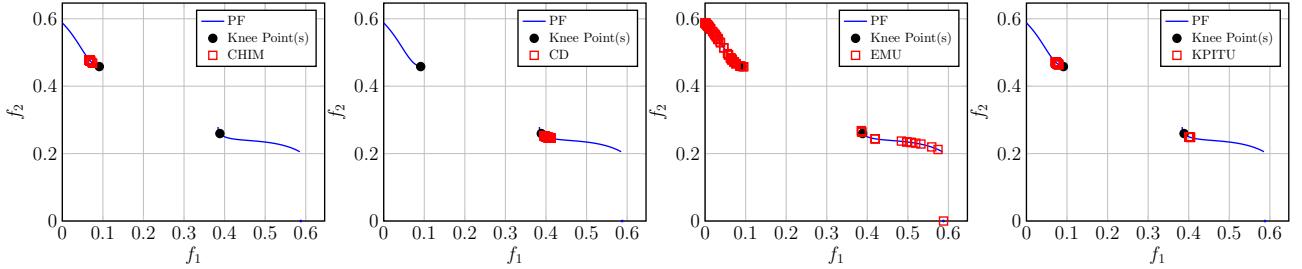


Figure 252: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP11 with local knee points.

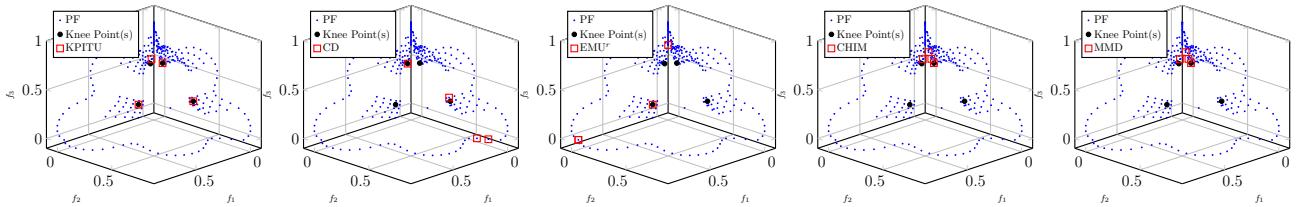


Figure 253: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP11 with local knee points.

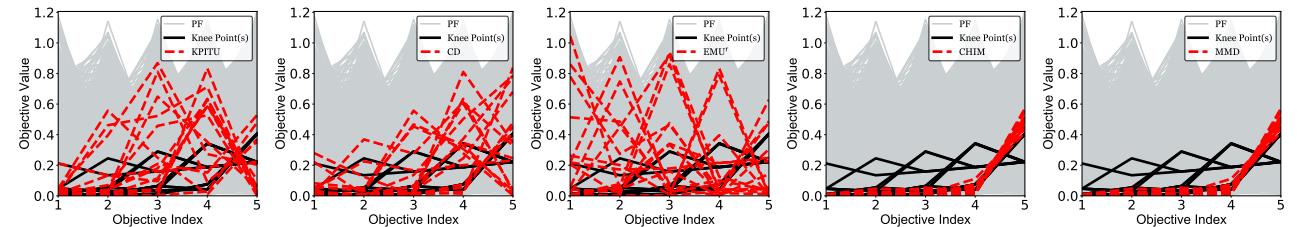


Figure 254: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP11 with local knee points.

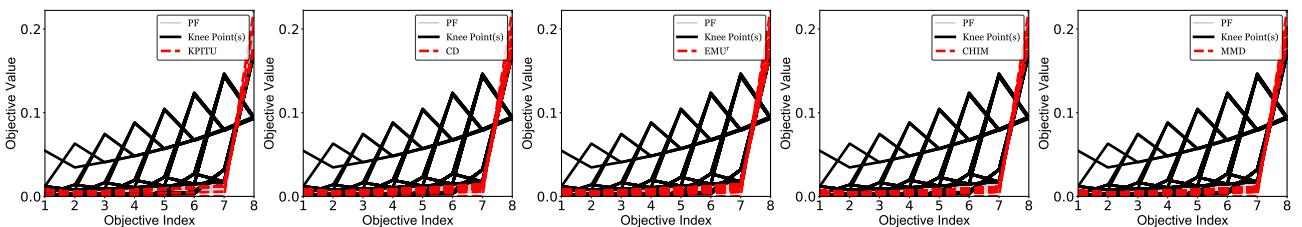


Figure 255: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP11 with local knee points.

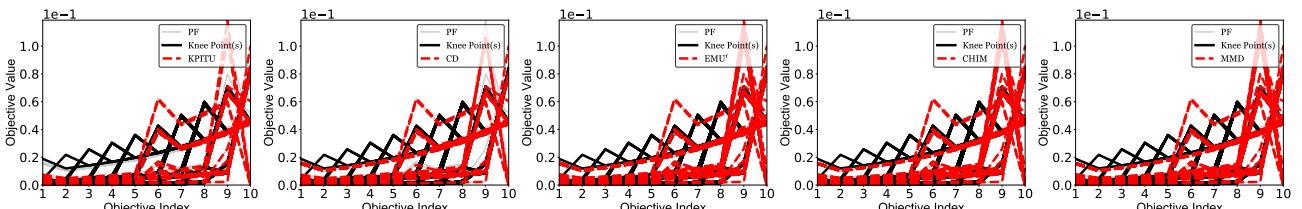


Figure 256: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP11 with local knee points.

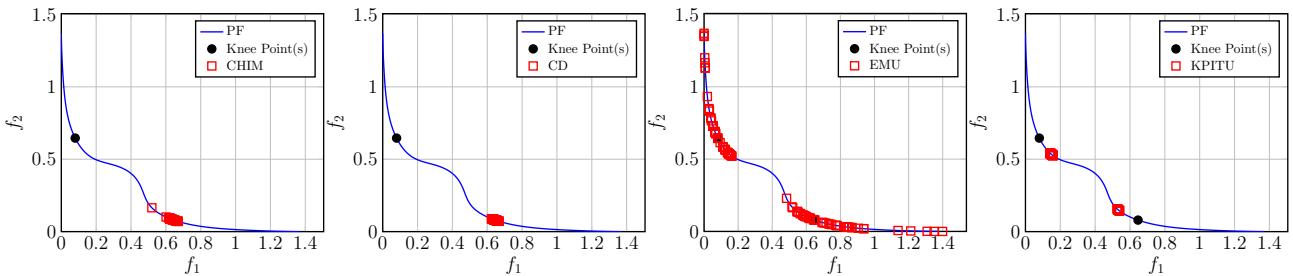


Figure 257: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 2-objective PMOP12 with local knee points.

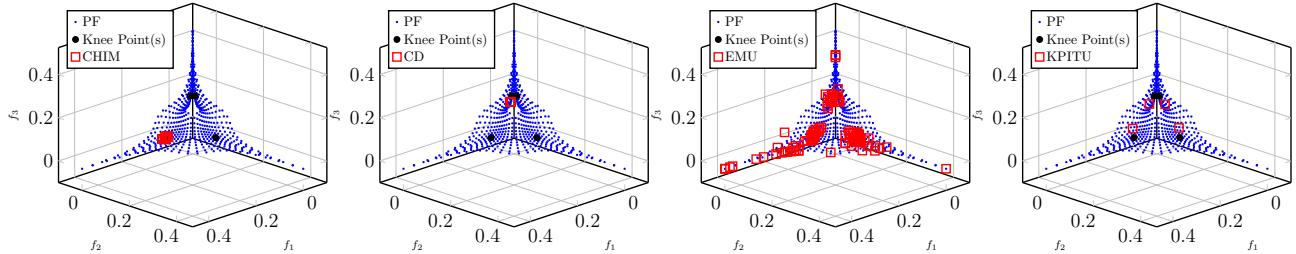


Figure 258: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP12 with local knee points.

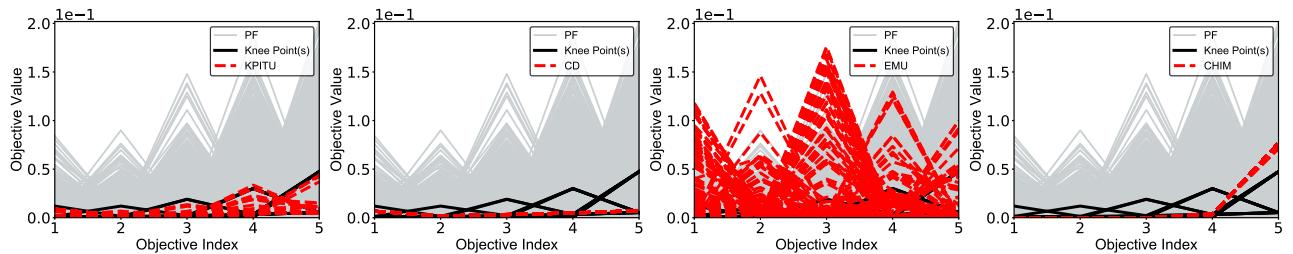


Figure 259: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP12 with local knee points.

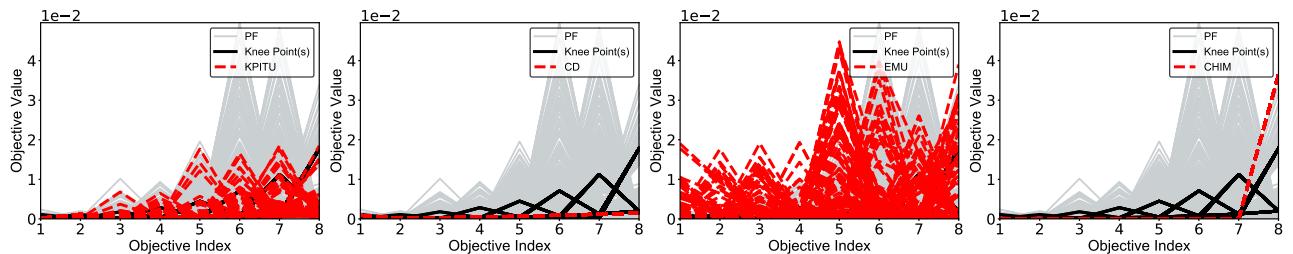


Figure 260: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP12 with local knee points.

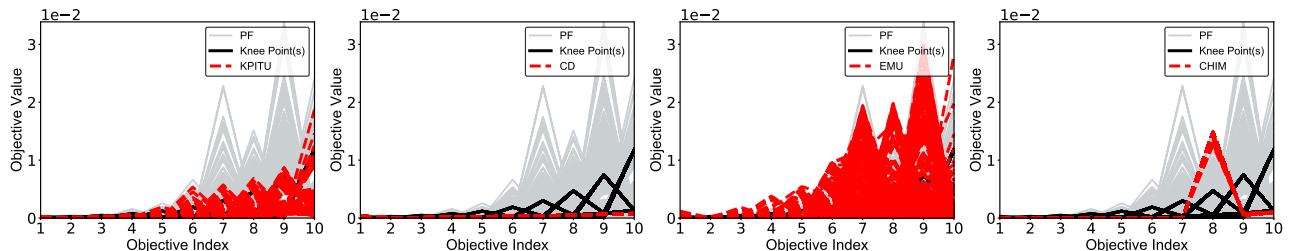


Figure 261: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP12 with local knee points.

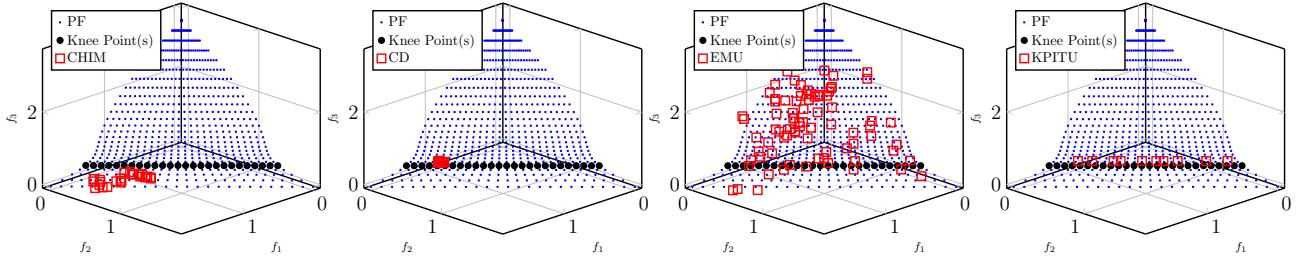


Figure 262: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP13 with one knee region.

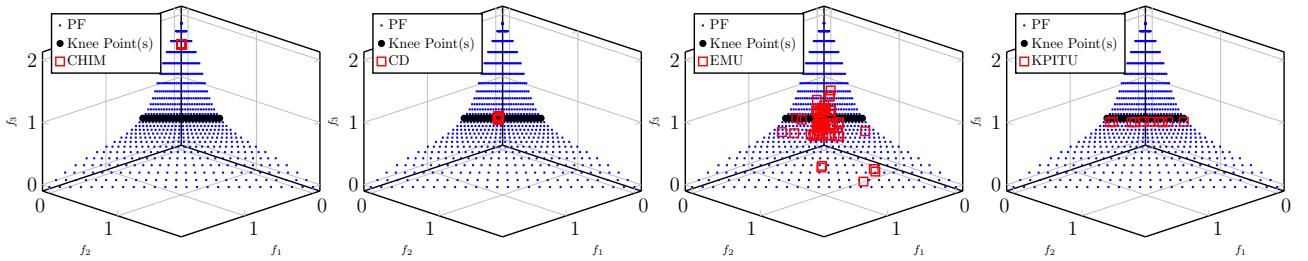


Figure 263: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP14 with one knee region.

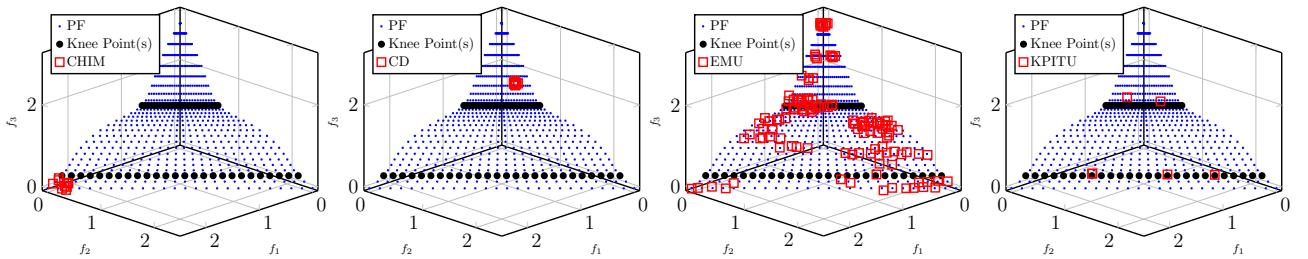


Figure 264: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP13 with local knee regions.

Acknowledgment

K. Li was supported by UKRI Future Leaders Fellowship (Grant No. MR/S017062/1) and Royal Society (Grant No. IEC/NSFC/170243). X. Yao was supported by EPSRC (Grant No. EP/P005578/1), the Program for Guangdong Introducing Innovative and Enterpreneurial Teams (Grant No. 2017ZT07X386), Shenzhen Peacock Plan (Grant No. KQTD2016112514355531) and the Program for University Key Laboratory of Guangdong Province (Grant No. 2017KSYS008).

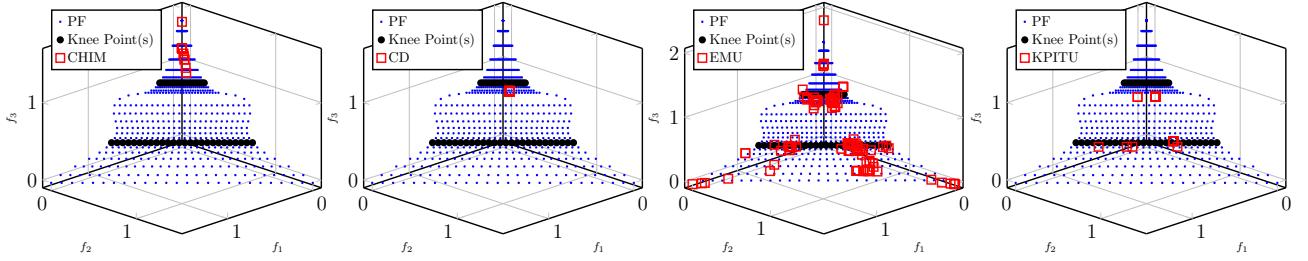


Figure 265: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 3-objective PMOP14 with local knee regions.

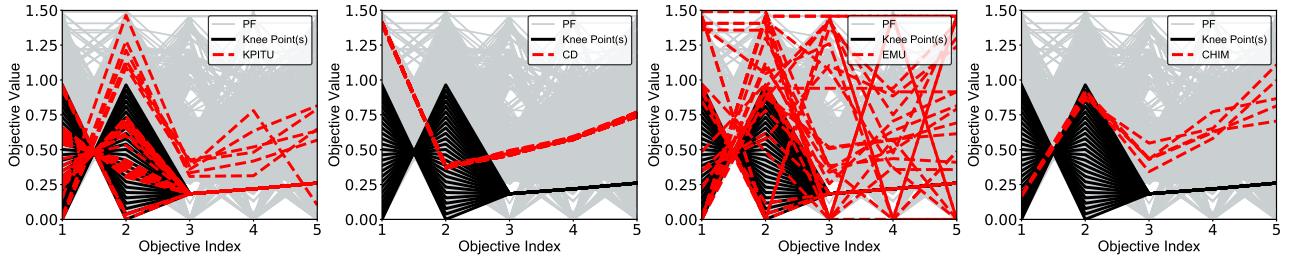


Figure 266: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP13 with one knee region.

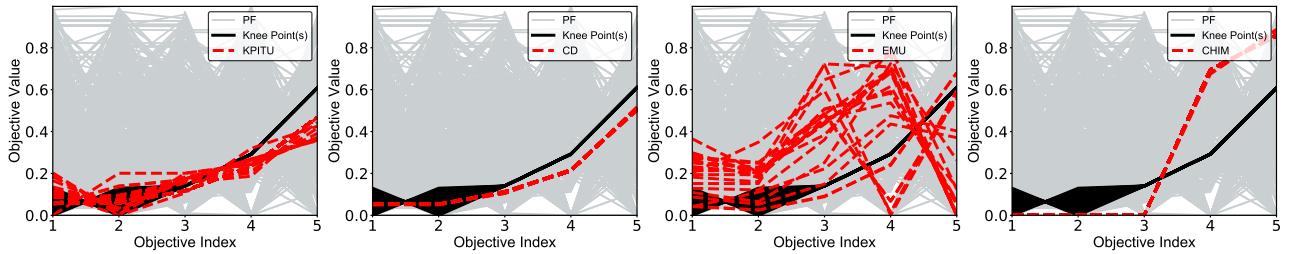


Figure 267: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP14 with one knee region.

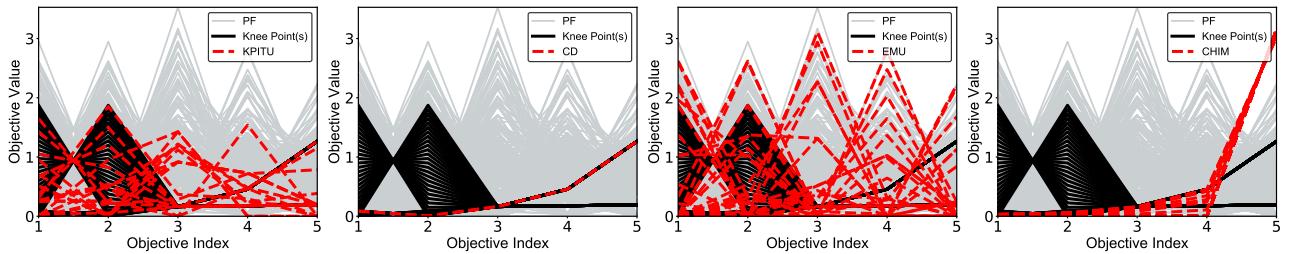


Figure 268: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP13 with two knee regions.

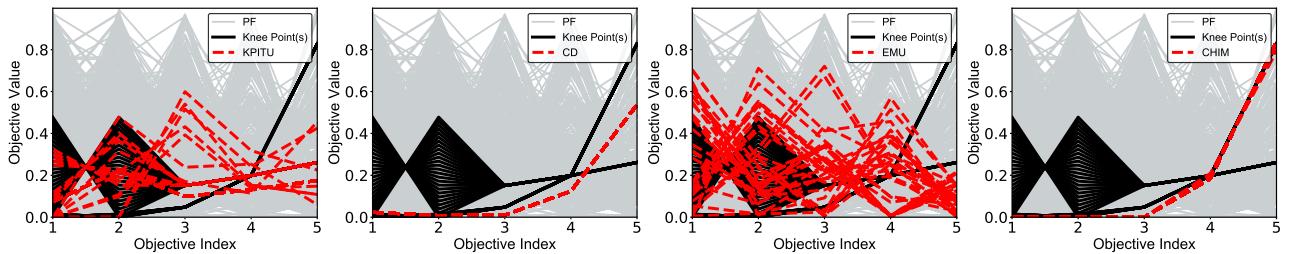


Figure 269: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 5-objective PMOP14 with two knee regions.

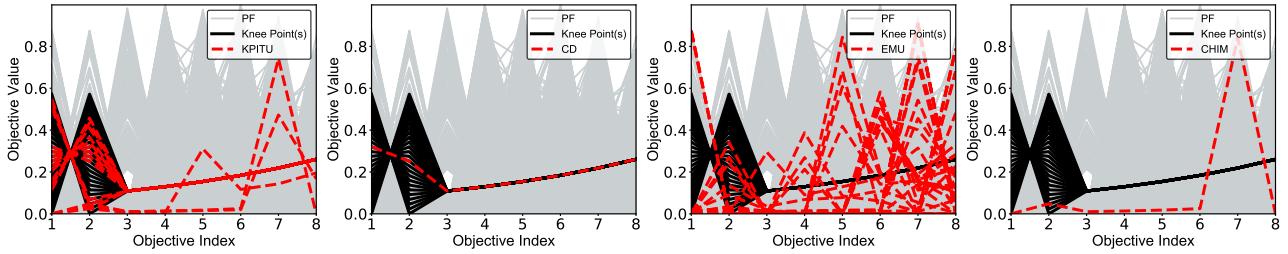


Figure 270: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP13 with one knee region.

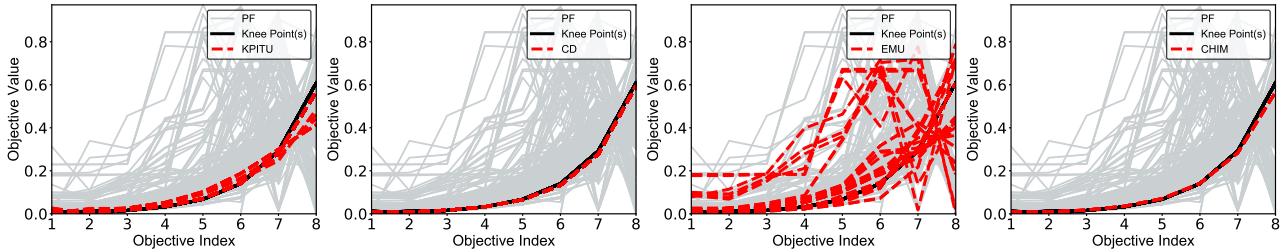


Figure 271: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP14 with one knee region.

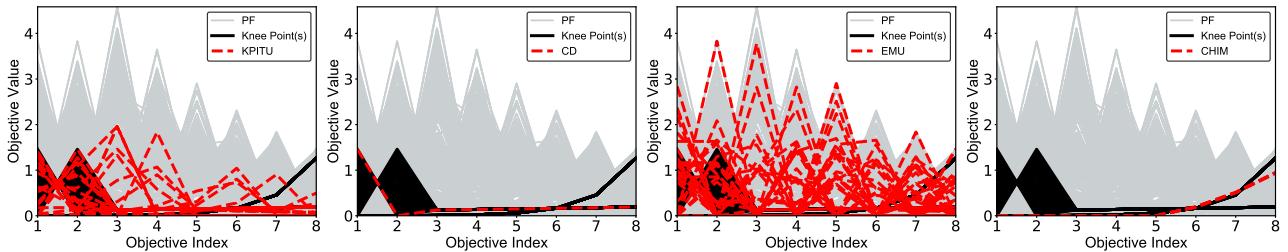


Figure 272: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP13 with two knee regions.

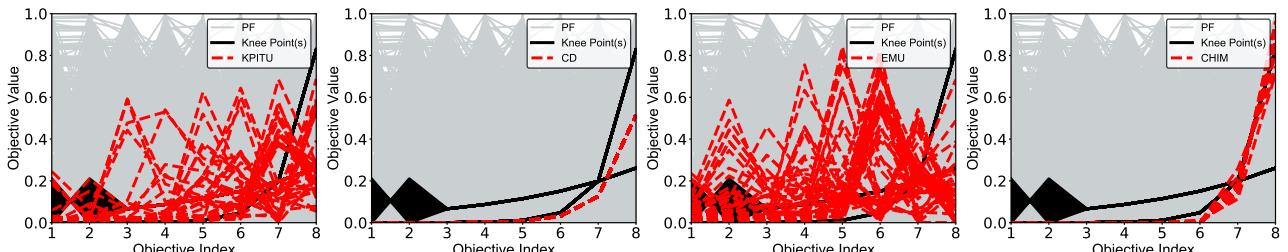


Figure 273: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 8-objective PMOP14 with two knee regions.

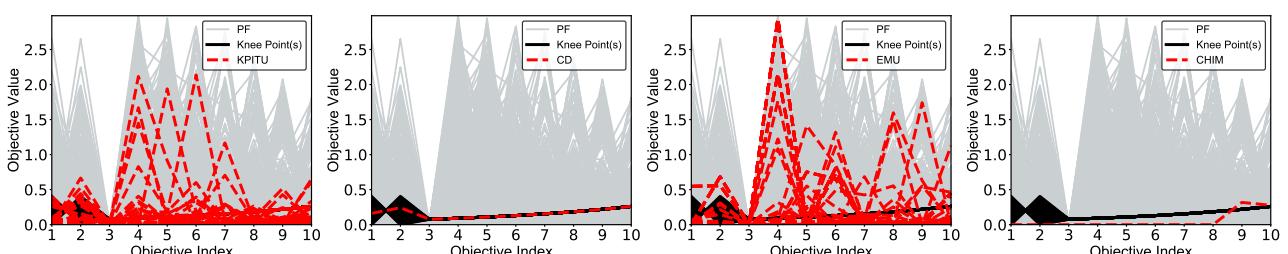


Figure 274: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP13 with one knee region.

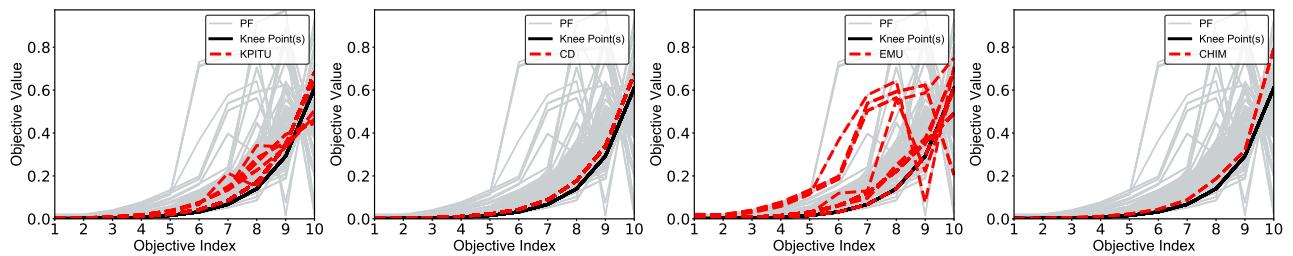


Figure 275: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP14 with one knee region.

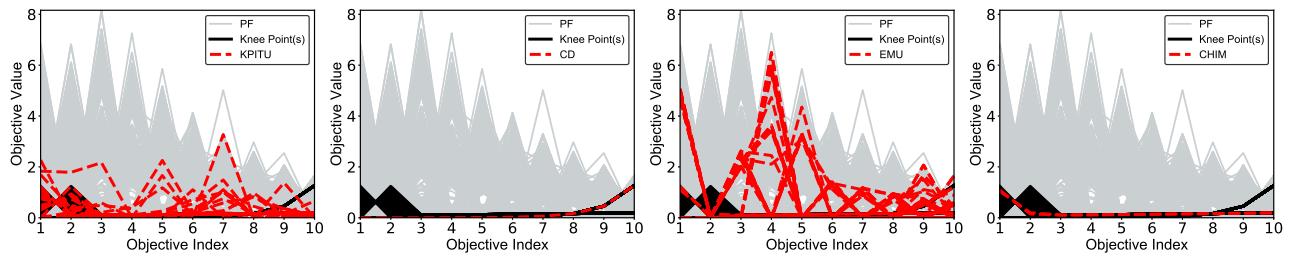


Figure 276: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP13 with two knee regions.

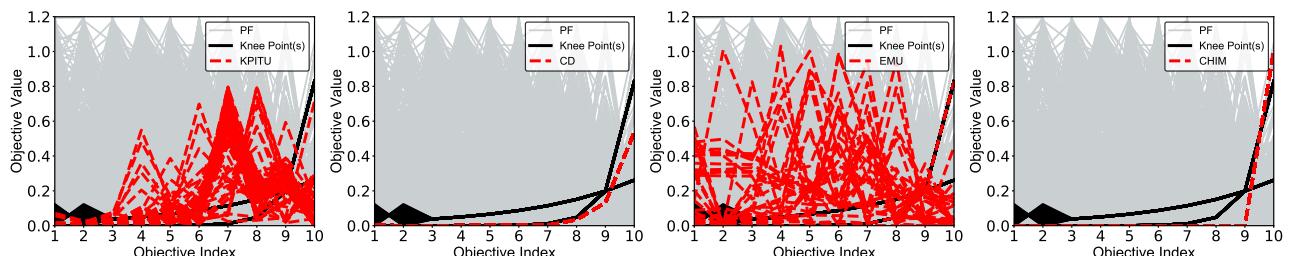


Figure 277: Population distribution of solutions found by NSGA-II-KPITU, NSGA-II-EMU, NSGA-II-CHIM and NSGA-II-CD on 10-objective PMOP14 with two knee regions.