Supplementary Material: MOTA: a Many Objective Tuning Algorithm Specialized for Tuning under Multiple Objective Function Evaluation Budgets

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Contents

1 IGD tables

Table 1: The Nadir and Utopia points of the respective NSGA-II tuning problems, which were used by tPSO to compare performances. IGD values are multiplied by 10^3 for readability.

	ZDT_1	ZDT_2	ZDT_3	ZDT_4	ZDT_6
max.	78.830	121.652	85.624	3197.750	279.499
min.	0.387	0.422	0.473	1.387	0.661

	$DTLZ_1$	$DTLZ_2$	$DTLZ_3$	$DTLZ_4$	$DTLZ_5$	$DTLZ_6$	$DTLZ_7$
max.	18222.560	47.663	52108.309	13.593	46.092	677.292	182.925
min.	17.100	0.243	460.708	0.108	0.234	7.668	0.336

Table 2: The Nadir and Utopia points used to compare the NSGA-II based tuning problems. IGD values are multiplied by 10^3 for readability.

	ZDT_1	ZDT_2	ZDT_3	ZDT_4	ZDT_6
max.	78.746	121.304	85.624	3140.462	275.842
min.	0.364	0.402	0.471	1.204	0.620

	$DTLZ_1$	$DTLZ_2$	$DTLZ_3$	$DTLZ_4$	$DTLZ_5$	$DTLZ_6$	$DTLZ_7$
max.	17557.518	45.638	51911.085	13.593	45.951	673.232	174.187
min.	12.777	0.232	363.496	0.086	0.231	6.189	0.335

	WFG_1	WFG_2	WFG_3	WFG_4	WFG_5	WFG_6	WFG_7	WFG_8	WFG_9
max.	12.397	4.845	1.655	3.474	5.766	6.889	4.640	3.620	6.516
min.	3.483	0.171	0.714	0.092	0.605	0.679	0.081	0.745	0.180

Table 3: The Nadir and Utopia points used to compare the MOEA/D based tuning problems. IGD values are multiplied by 10^3 for readability.

	ZDT_1	ZDT_2	ZDT_3	ZDT_4	ZDT_6
max.	81.068	123.746	88.729	3236.527	280.509
min.	0.129	0.112	0.402	0.797	0.056

	$DTLZ_1$	$DTLZ_2$	$DTLZ_3$	$DTLZ_4$	$DTLZ_5$	$DTLZ_6$	$DTLZ_7$
max.	18895.532	47.975	54699.749	13.922	47.198	680.422	182.987
min.	2.101	0.174	228.864	0.063	0.177	0.120	0.194

	WFG_1	WFG_2	WFG_3	WFG_4	WFG_5	WFG_6	WFG_7	WFG_8	WFG_9
max.	12.434	5.066	1.699	3.740	6.059	7.189	4.864	3.743	6.863
min.	1.820	0.285	0.707	0.172	0.557	0.251	0.118	0.714	0.209

2 Specialist tuning problem τ results

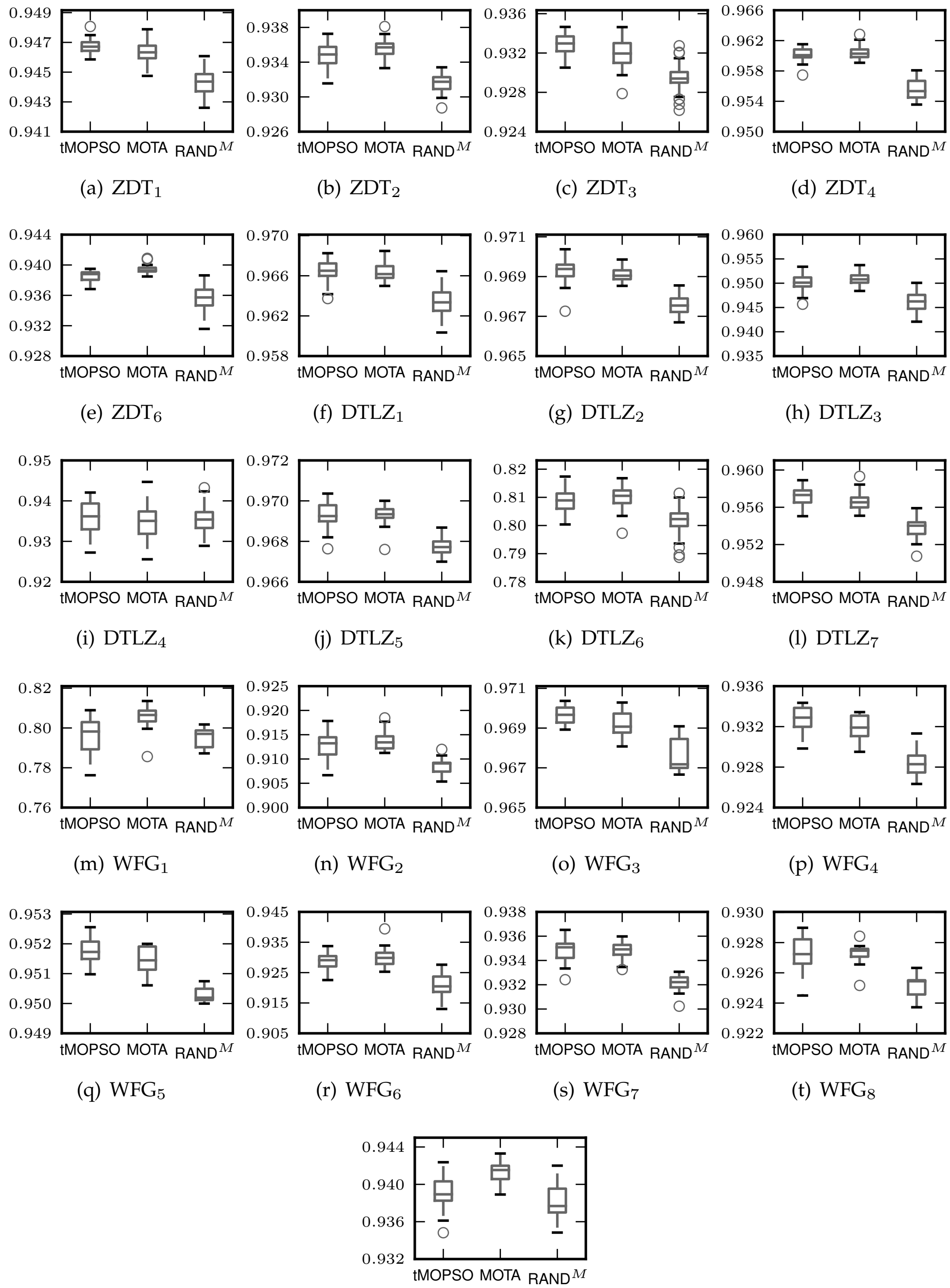
Table 4: Performances on the NSGA-II specialist tuning problems.

		$\tau(\times 10^3)$		
suite	problem	tMOPSO	MOTA	RAND^M
ZDT	1	**946.743**†	946.265	944.384
	2	*934.845*‡	**935.562**	931.651
	3	**932.770**	931.857	929.537
	4	*960.120*	**960.496**	955.470
	6	938.548	**939.447**	935.492
DTLZ	1	**966.481**	*966.385*	963.242
	2	**969.295**	969.101	967.557
	3	950.034	**950.824**	946.185
	4	**936.064**	*934.882*	*935.222*
	5	*969.339*	**969.345**	967.734
	6	*808.841*	**810.097**	801.350
	7	**957.173**	956.581	953.861
WFG	1	795.679	**805.681**	793.968
	2	*912.616*	**913.655**	908.411
	3	**969.683**	969.162	967.491
	4	**932.710**	*931.937*	928.284
	5	**951.742**	*951.456*	950.191
	6	*928.772*	**930.064**	921.503
	7	**934.793**	*934.787*	932.267
	8	**927.275**	*927.262*	924.992
	9	939.018	**941.294**	938.045

Friedman test: χ^2 24.100, p-value 5.8×10^{-6}

† **bold entries** indicate the best value in each row.

‡ *Italic entries* indicate samples whose difference in mean relative to the sample with the best mean is not statistically significant according to Mann-Whitney U-test with a 95% confidence.



(a) ZDT_1 (b) ZDT_2 (c) ZDT_3 (d) ZDT_4

(e) ZDT_6 (f) $DTLZ_1$ (g) $DTLZ_2$ (h) $DTLZ_3$

(i) $DTLZ_4$ (j) $DTLZ_5$ (k) $DTLZ_6$ (l) $DTLZ_7$

(m) WFG_1 (n) WFG_2 (o) WFG_3 (p) WFG_4

(q) WFG_5 (r) WFG_6 (s) WFG_7 (t) WFG_8

(u) WFG_9

Figure 1: τ distributions for the NSGA-II specialist problems

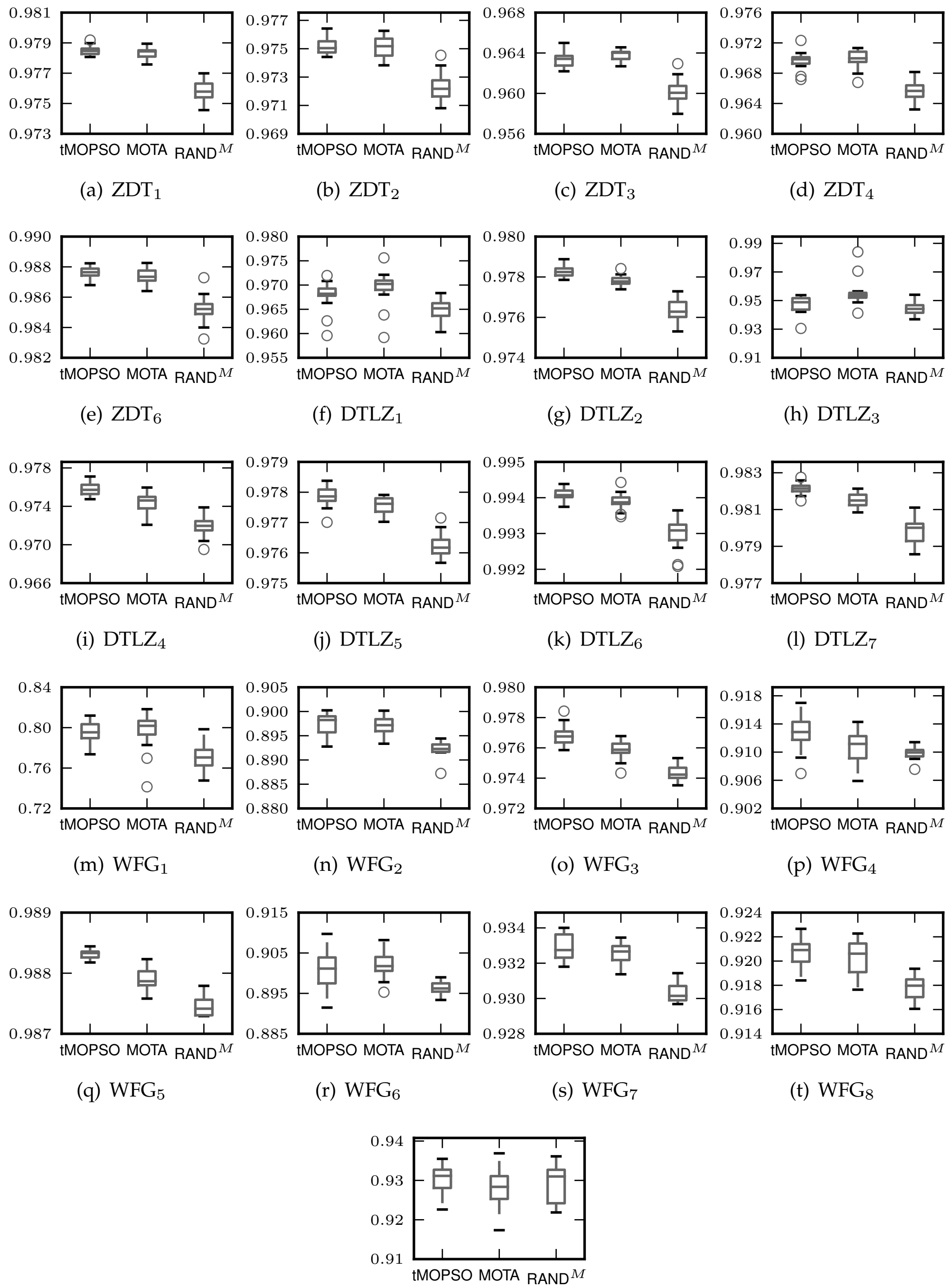
Table 5: Performances on the MOEA/D specialist tuning problems.

suite	problem	$\tau(\times 10^3)$ tMOPSO	MOTA	RAND^M
ZDT	1	**978.496**†	*978.324*‡	975.777
	2	*975.150*	**975.154**	972.183
	3	*963.370*	**963.768**	960.094
	4	*969.652*	**969.875**	965.638
	6	**987.639**	*987.392*	985.198
DTLZ	1	967.943	**969.541**	965.065
	2	**978.276**	977.818	976.321
	3	947.300	**955.056**	944.539
	4	**975.730**	974.372	971.954
	5	**977.851**	977.553	976.276
	6	**994.090**	993.891	993.032
	7	**982.132**	981.473	979.793
WFG	1	*795.654*	**796.439**	773.524
	2	**897.245**	*897.224*	892.643
	3	**976.787**	975.889	974.403
	4	**912.752**	910.685	909.565
	5	**988.313**	987.905	987.498
	6	*900.856*	**902.272**	898.140
	7	**932.921**	*932.576*	930.612
	8	**920.745**	*920.254*	917.489
	9	**930.300**	*928.280*	*927.276*

Friedman test: χ^2 25.200, p-value 3.4×10^{-6}

† **bold entries** indicate the best value in each row.

‡ *Italic entries* indicate samples whose difference in mean relative to the sample with the best mean is not statistically significant according to Mann-Whitney U-test with a 95% confidence.



(a) ZDT_1 (b) ZDT_2 (c) ZDT_3 (d) ZDT_4

(e) ZDT_6 (f) $DTLZ_1$ (g) $DTLZ_2$ (h) $DTLZ_3$

(i) $DTLZ_4$ (j) $DTLZ_5$ (k) $DTLZ_6$ (l) $DTLZ_7$

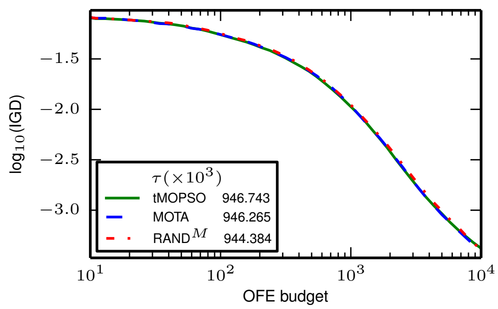
(m) WFG_1 (n) WFG_2 (o) WFG_3 (p) WFG_4

(q) WFG_5 (r) WFG_6 (s) WFG_7 (t) WFG_8

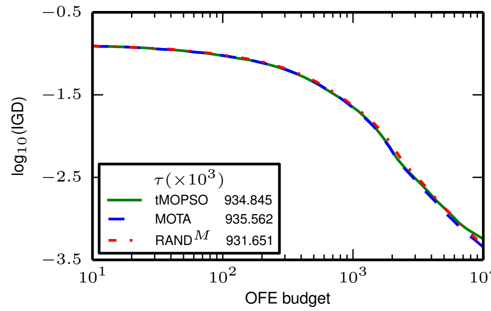
(u) WFG_9

Figure 2: τ distributions for the MOEA/D specialist problems

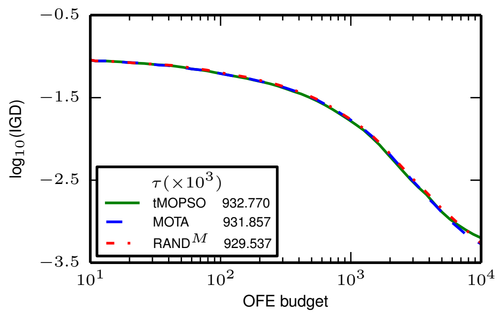
3 Specialist tuning problems IGD versus OFE



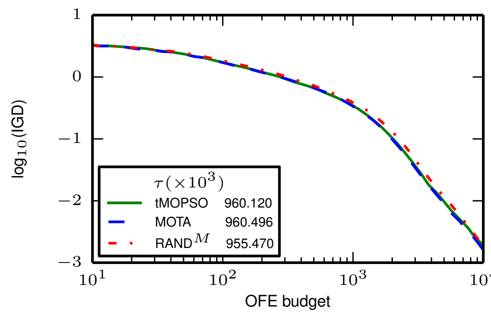
(a) ZDT_1



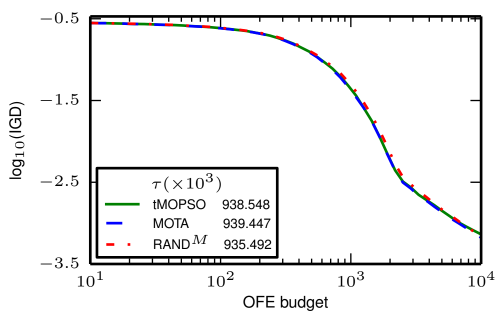
(b) ZDT_2



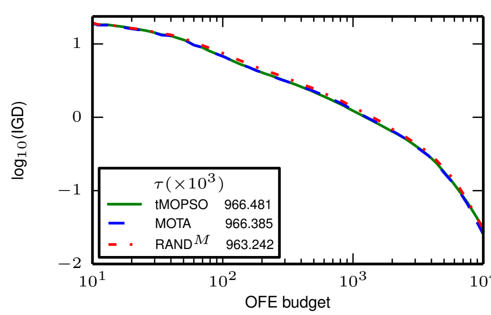
(c) ZDT_3



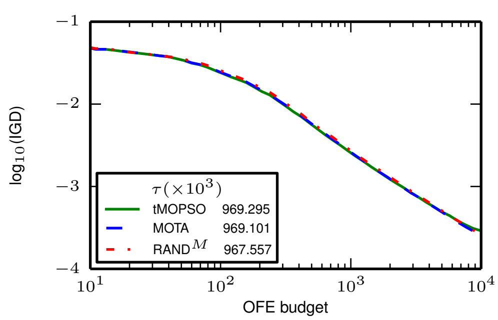
(d) ZDT_4



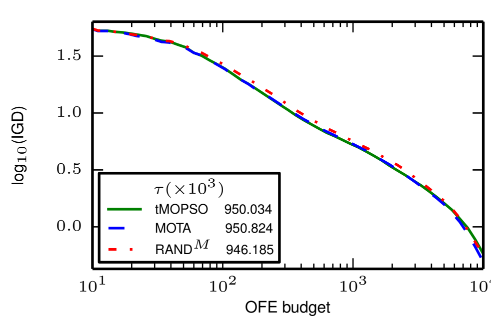
(e) ZDT_6



(f) $DTLZ_1$

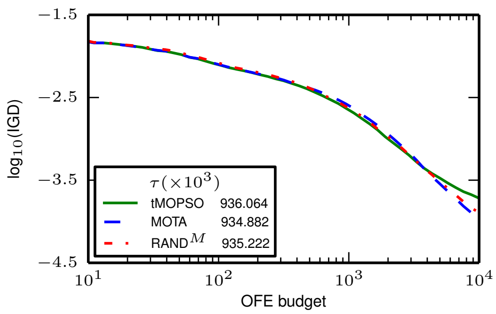


(g) $DTLZ_2$

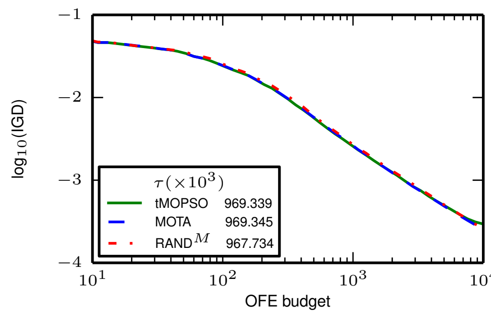


(h) $DTLZ_3$

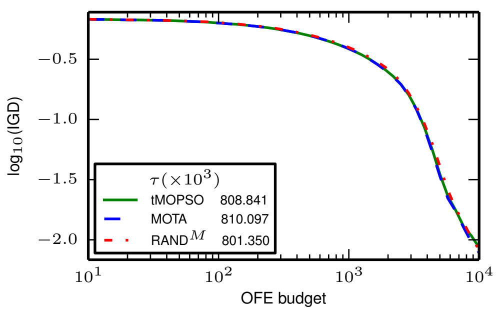
Figure 3: NSGA-II specialist results ($\gamma = 10^7$), IGD versus OFE budget (table 1/3)



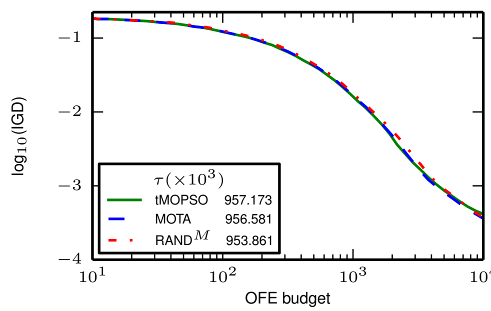
(a) DTLZ_4



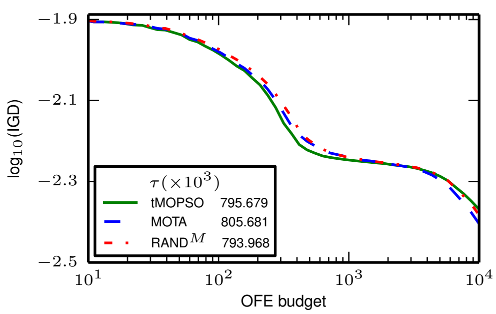
(b) DTLZ_5



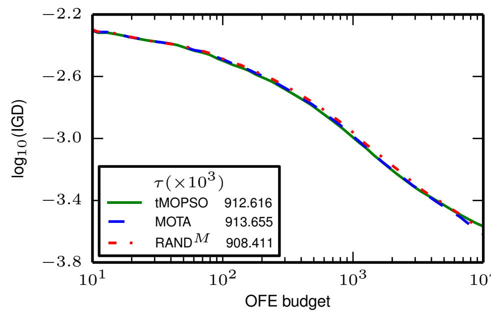
(c) DTLZ_6



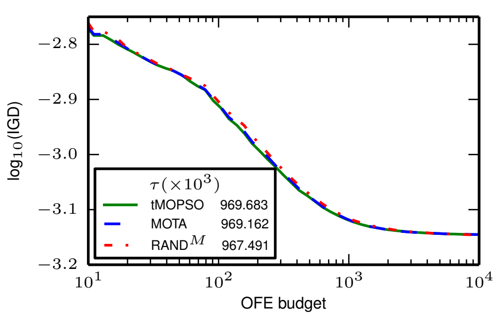
(d) DTLZ_7



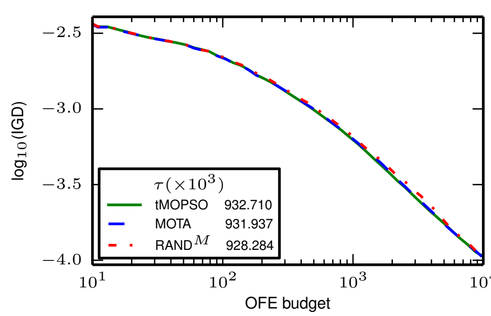
(e) WFG_1



(f) WFG_2

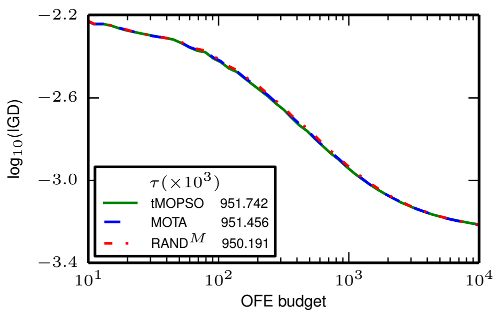


(g) WFG_3

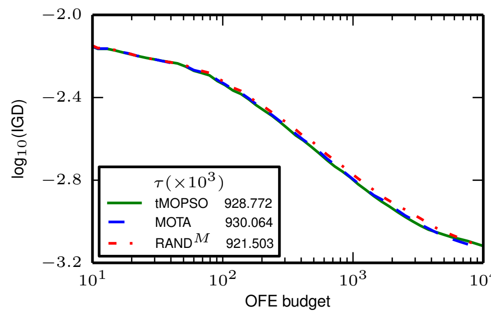


(h) WFG_4

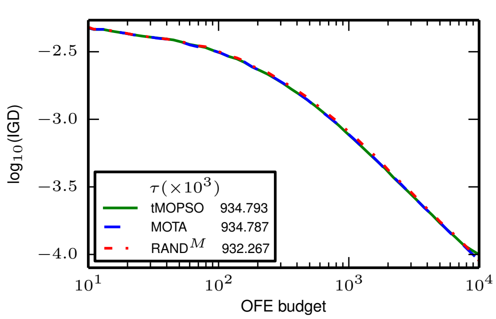
Figure 4: NSGA-II specialist results ($\gamma = 10^7$), IGD versus OFE budget (table 2/3)



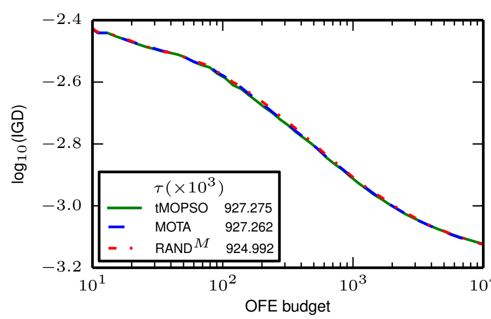
(a) WFG_5



(b) WFG_6

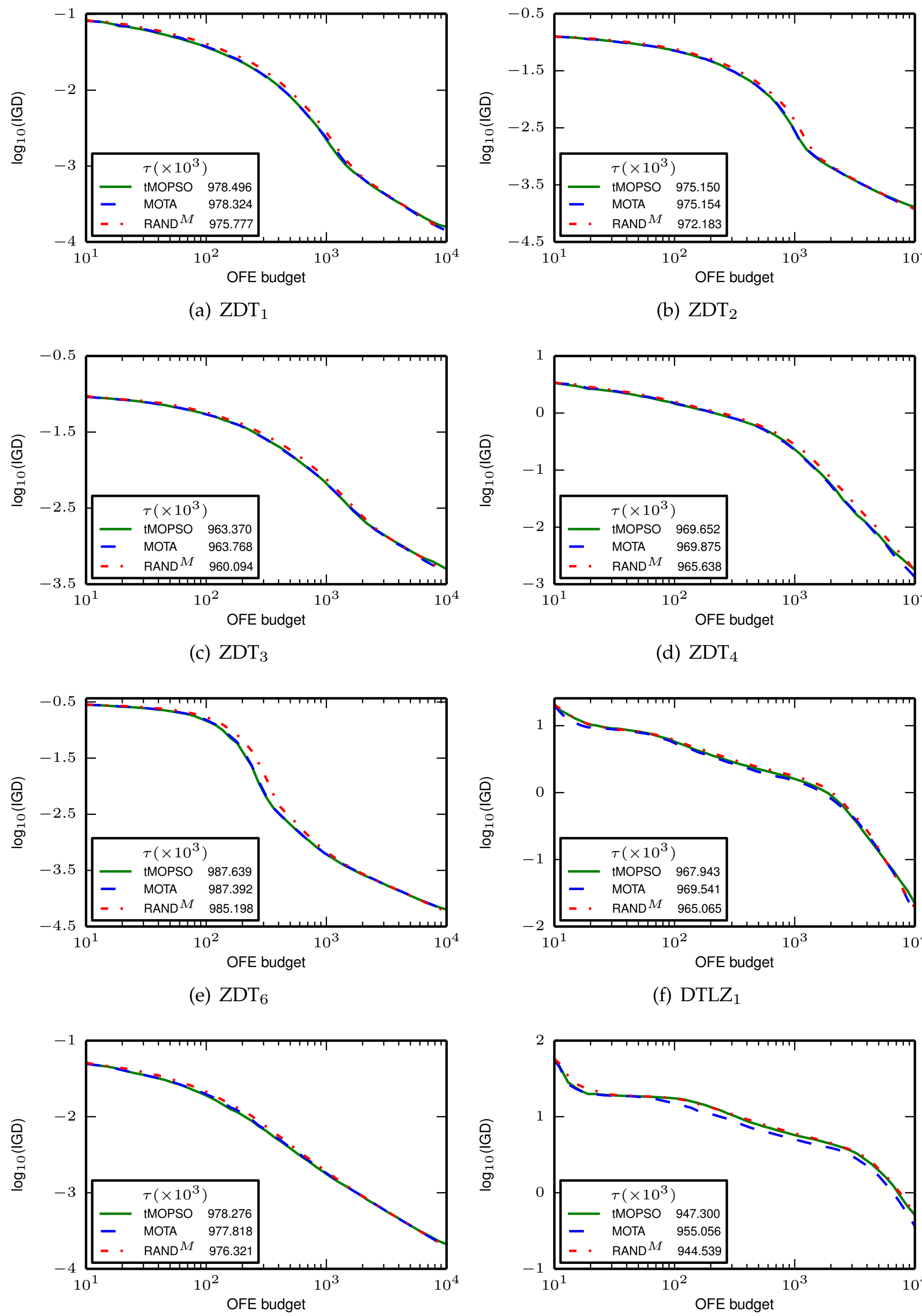


(c) WFG_7



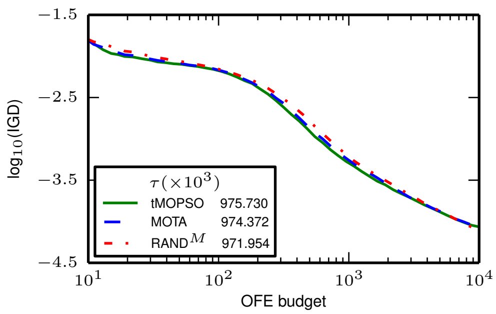
(d) WFG_8

Figure 5: NSGA-II specialist results ($\gamma = 10^7$), IGD versus OFE budget (table 3/3)

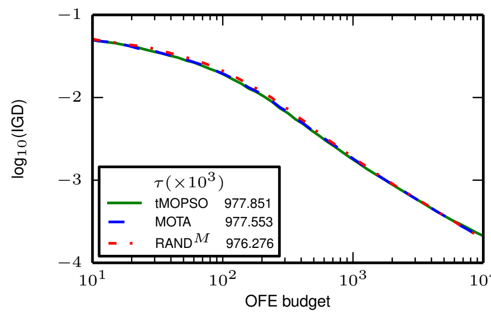


(a) ZDT_1 (b) ZDT_2 (c) ZDT_3 (d) ZDT_4 (e) ZDT_6 (f) $DTLZ_1$ (g) $DTLZ_2$ (h) $DTLZ_3$

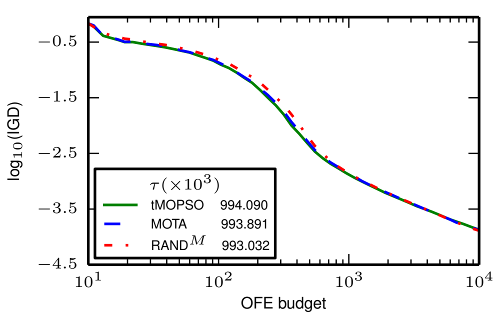
Figure 6: MOEA/D specialist results ($\gamma = 10^7$), IGD versus OFE budget (table 1/3)



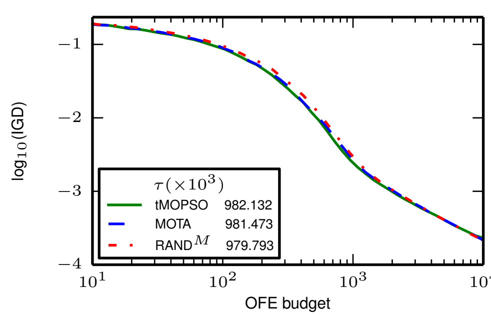
(a) DTLZ_4



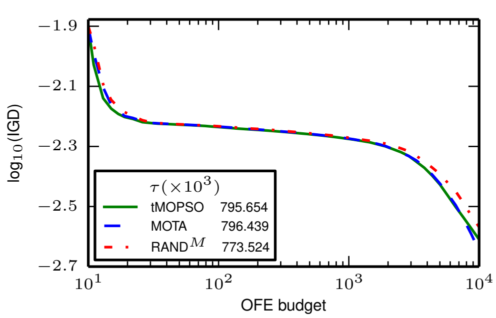
(b) DTLZ_5



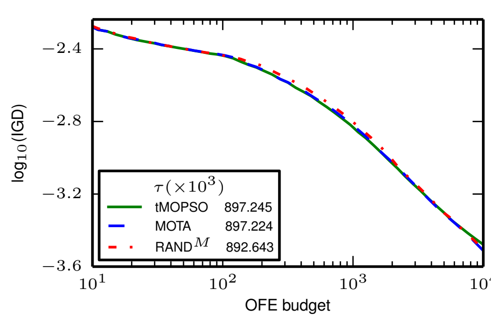
(c) DTLZ_6



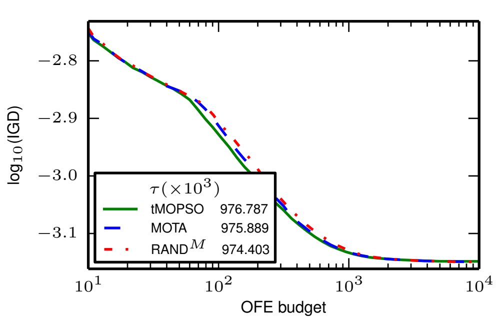
(d) DTLZ_7



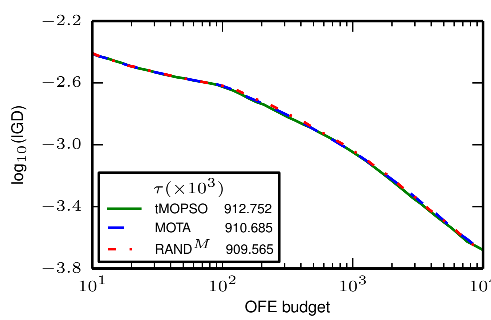
(e) WFG_1



(f) WFG_2

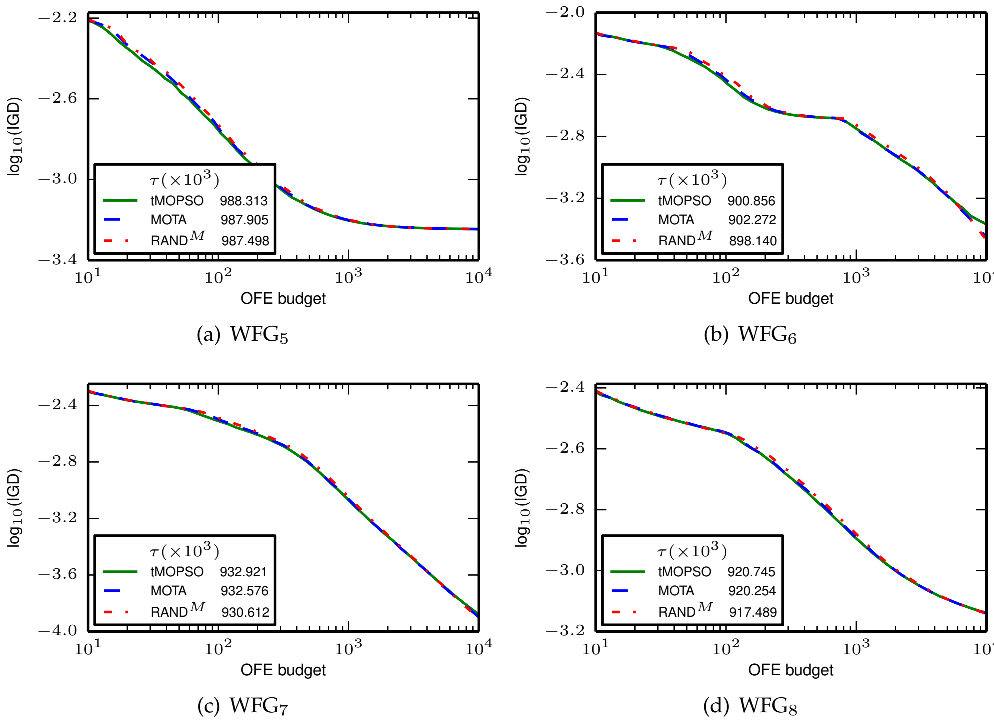


(g) WFG_3



(h) WFG_4

Figure 7: MOEA/D specialist results ($\gamma = 10^7$), IGD versus OFE budget (table 2/3)

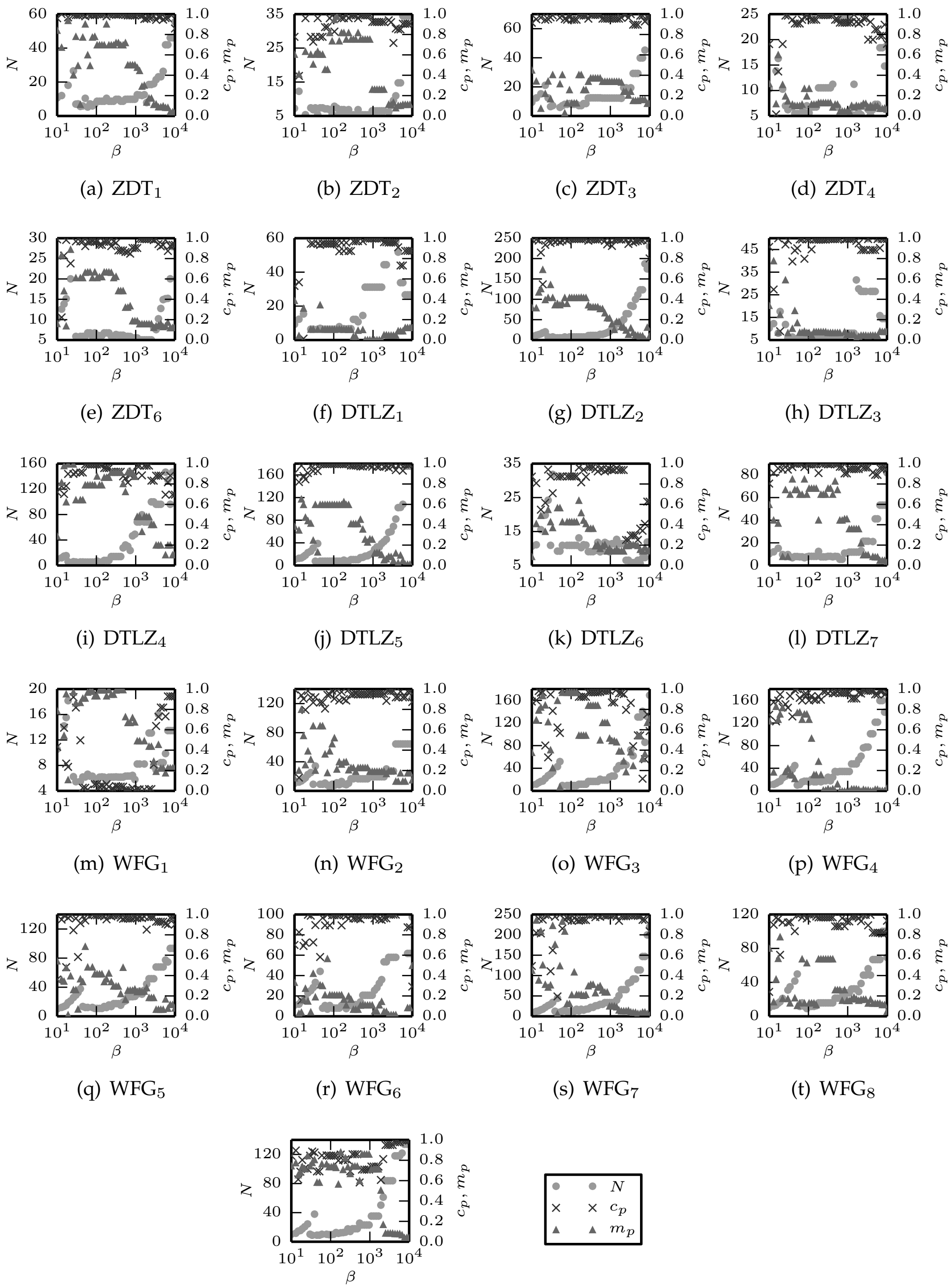


(a) WFG_5 (b) WFG_6

(c) WFG_7 (d) WFG_8

Figure 8: MOEA/D specialist results ($\gamma = 10^7$), IGD versus OFE budget (table 3/3)

4 tMOPSO results for the specialist problems



(a) ZDT_1 (b) ZDT_2 (c) ZDT_3 (d) ZDT_4

(e) ZDT_6 (f) $DTLZ_1$ (g) $DTLZ_2$ (h) $DTLZ_3$

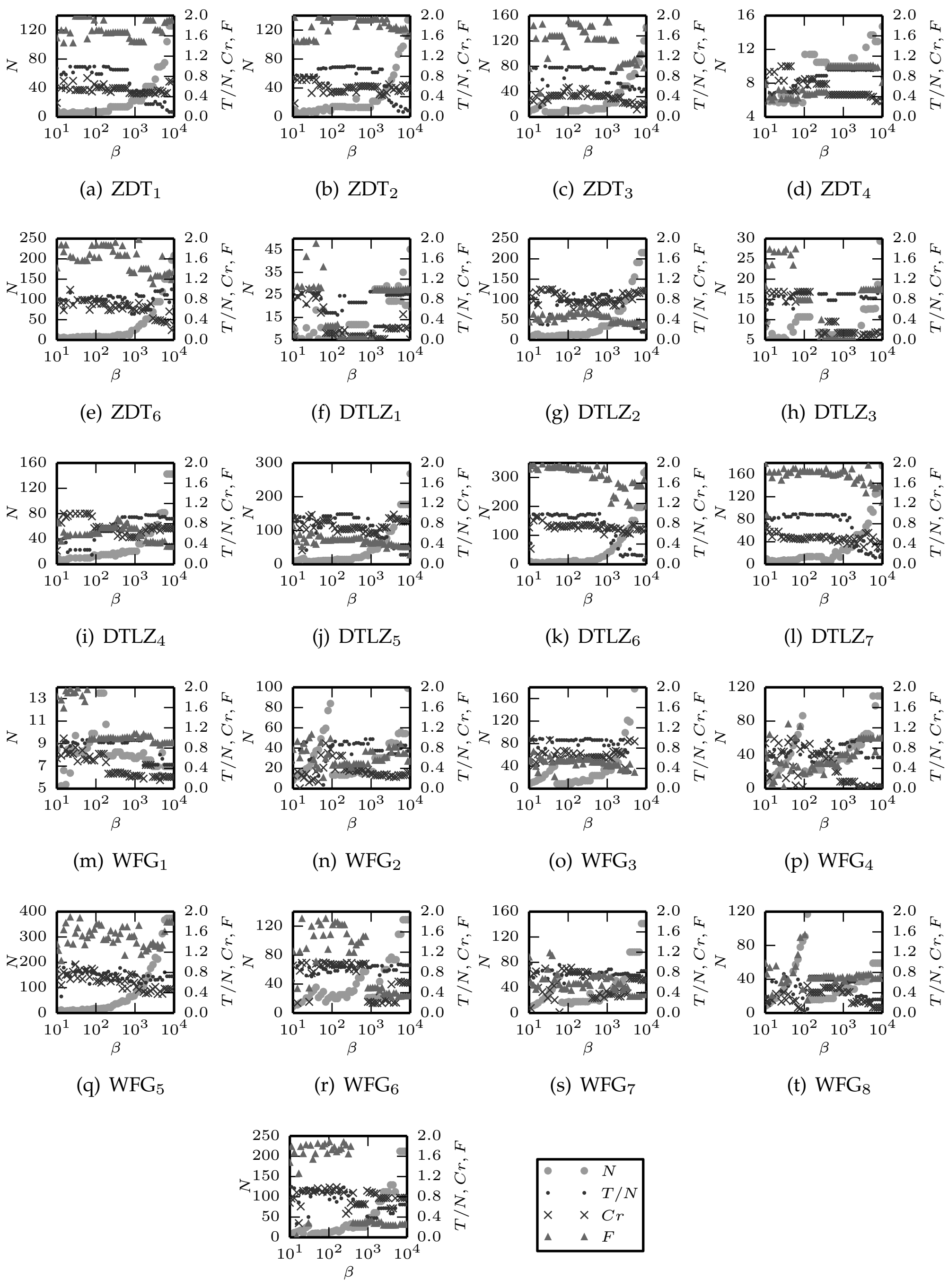
(i) $DTLZ_4$ (j) $DTLZ_5$ (k) $DTLZ_6$ (l) $DTLZ_7$

(m) WFG_1 (n) WFG_2 (o) WFG_3 (p) WFG_4

(q) WFG_5 (r) WFG_6 (s) WFG_7 (t) WFG_8

(u) WFG_9 (v) Legend

Figure 9: The best tMOPSO results for the NSGA-II specialist tuning problems. The recommended CPVs are shown for differing OFE budgets, β.



(a) ZDT_1 (b) ZDT_2 (c) ZDT_3 (d) ZDT_4

(e) ZDT_6 (f) $DTLZ_1$ (g) $DTLZ_2$ (h) $DTLZ_3$

(i) $DTLZ_4$ (j) $DTLZ_5$ (k) $DTLZ_6$ (l) $DTLZ_7$

(m) WFG_1 (n) WFG_2 (o) WFG_3 (p) WFG_4

(q) WFG_5 (r) WFG_6 (s) WFG_7 (t) WFG_8

(u) WFG_9 (v) Legend

Figure 10: The best tMOPSO results for the MOEA/D specialist tuning problems. The recommended CPVs are shown for differing OFE budgets, β.

5 Generalist tuning problems τ results

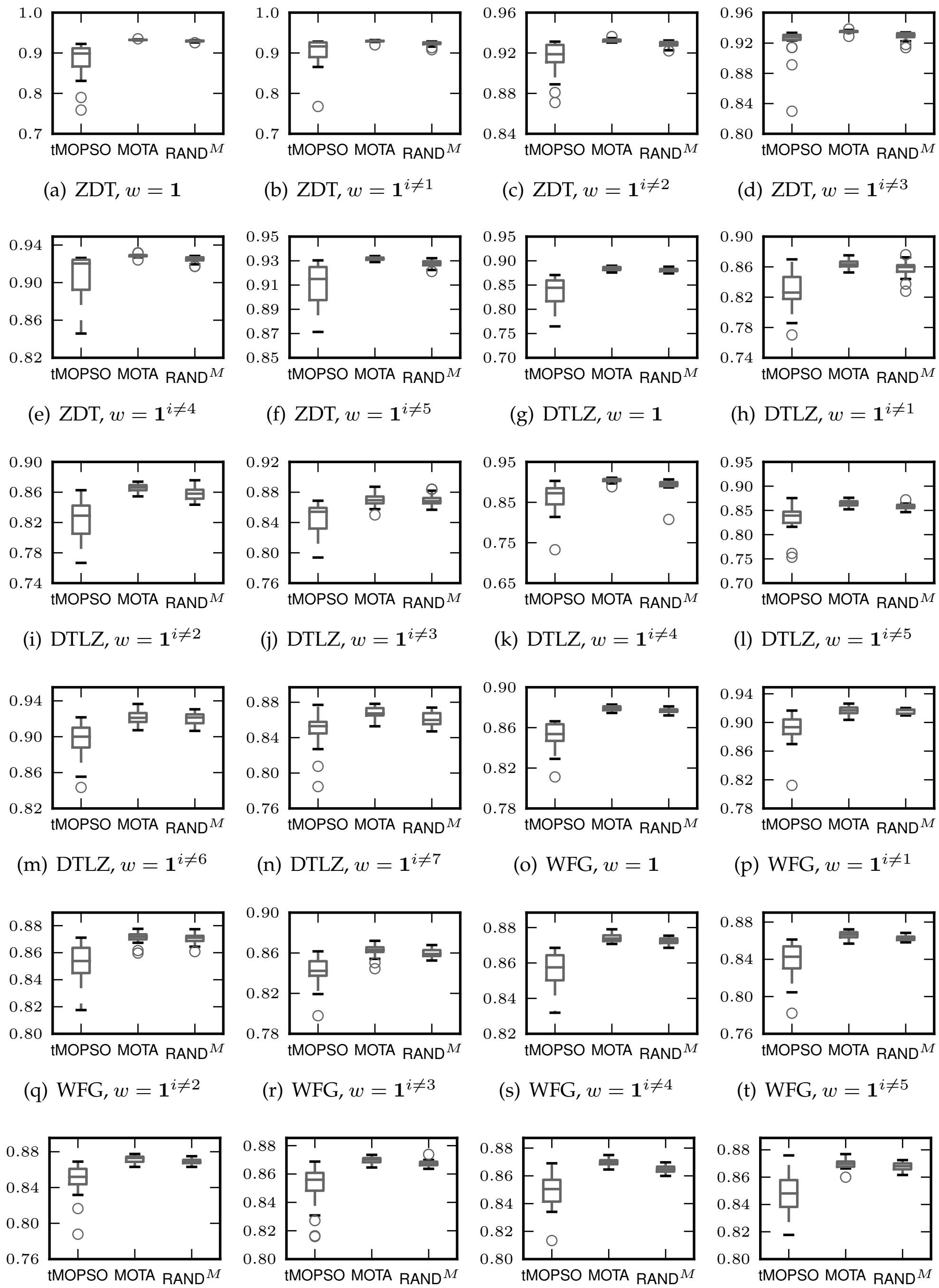
Table 6: Performances on the NSGA-II generalist tuning problems. The $\mathbf{1}^{i \neq j}$ notation indicates a vector whose elements are all equal to 1, with exception to the j'th element which is equal to 0.

		$\tau \times 10^3$		
suite	$\mathbf{w}$	tMOPSO	MOTA	RAND^M
ZDT	$\mathbf{1}$	882.125	**932.601**†	929.575
	$\mathbf{1}^{i \neq 1}$	902.718	**929.089**	923.368
	$\mathbf{1}^{i \neq 2}$	913.863	**932.617**	928.565
	$\mathbf{1}^{i \neq 3}$	920.730	**935.314**	929.664
	$\mathbf{1}^{i \neq 4}$	907.071	**928.597**	925.018
	$\mathbf{1}^{i \neq 5}$	908.475	**931.625**	927.993
DTLZ	$\mathbf{1}$	834.185	**884.049**	880.356
	$\mathbf{1}^{i \neq 1}$	826.849	**864.007**	857.315
	$\mathbf{1}^{i \neq 2}$	823.796	**865.996**	857.257
	$\mathbf{1}^{i \neq 3}$	844.050	**869.802**	*869.114*‡
	$\mathbf{1}^{i \neq 4}$	858.144	**904.283**	891.732
	$\mathbf{1}^{i \neq 5}$	832.369	**864.767**	857.945
	$\mathbf{1}^{i \neq 6}$	894.699	**921.736**	*920.040*
	$\mathbf{1}^{i \neq 7}$	847.747	**868.590**	859.925
WFG	$\mathbf{1}$	851.983	**879.122**	876.701
	$\mathbf{1}^{i \neq 1}$	890.162	**916.305**	*915.295*
	$\mathbf{1}^{i \neq 2}$	852.251	**870.980**	*870.457*
	$\mathbf{1}^{i \neq 3}$	840.971	**861.910**	*860.170*
	$\mathbf{1}^{i \neq 4}$	856.030	**874.207**	872.268
	$\mathbf{1}^{i \neq 5}$	839.367	**866.008**	862.065
	$\mathbf{1}^{i \neq 6}$	848.161	**871.661**	868.776
	$\mathbf{1}^{i \neq 7}$	850.533	**869.538**	867.419
	$\mathbf{1}^{i \neq 8}$	848.610	**869.767**	865.051
	$\mathbf{1}^{i \neq 9}$	847.614	**869.408**	*866.949*

Friedman test: χ^2 39.000, p-value 3.4×10^{-9}

† **bold entries** indicate the best value in each row.

‡ *Italic entries* indicate samples whose difference in mean relative to the sample with the best mean is not statistically significant according to Mann-Whitney U-test with a 95% confidence.



(a) ZDT, $w = \mathbf{1}$ (b) ZDT, $w = \mathbf{1}^{i\neq1}$ (c) ZDT, $w = \mathbf{1}^{i\neq2}$ (d) ZDT, $w = \mathbf{1}^{i\neq3}$

(e) ZDT, $w = \mathbf{1}^{i\neq4}$ (f) ZDT, $w = \mathbf{1}^{i\neq5}$ (g) DTLZ, $w = \mathbf{1}$ (h) DTLZ, $w = \mathbf{1}^{i\neq1}$

(i) DTLZ, $w = \mathbf{1}^{i\neq2}$ (j) DTLZ, $w = \mathbf{1}^{i\neq3}$ (k) DTLZ, $w = \mathbf{1}^{i\neq4}$ (l) DTLZ, $w = \mathbf{1}^{i\neq5}$

(m) DTLZ, $w = \mathbf{1}^{i\neq6}$ (n) DTLZ, $w = \mathbf{1}^{i\neq7}$ (o) WFG, $w = \mathbf{1}$ (p) WFG, $w = \mathbf{1}^{i\neq1}$

(q) WFG, $w = \mathbf{1}^{i\neq2}$ (r) WFG, $w = \mathbf{1}^{i\neq3}$ (s) WFG, $w = \mathbf{1}^{i\neq4}$ (t) WFG, $w = \mathbf{1}^{i\neq5}$

(u) WFG, $w = \mathbf{1}^{i\neq6}$ (v) WFG, $w = \mathbf{1}^{i\neq7}$ (w) WFG, $w = \mathbf{1}^{i\neq8}$ (x) WFG, $w = \mathbf{1}^{i\neq9}$

Figure 11: τ distributions for the NSGA-II generalist problems

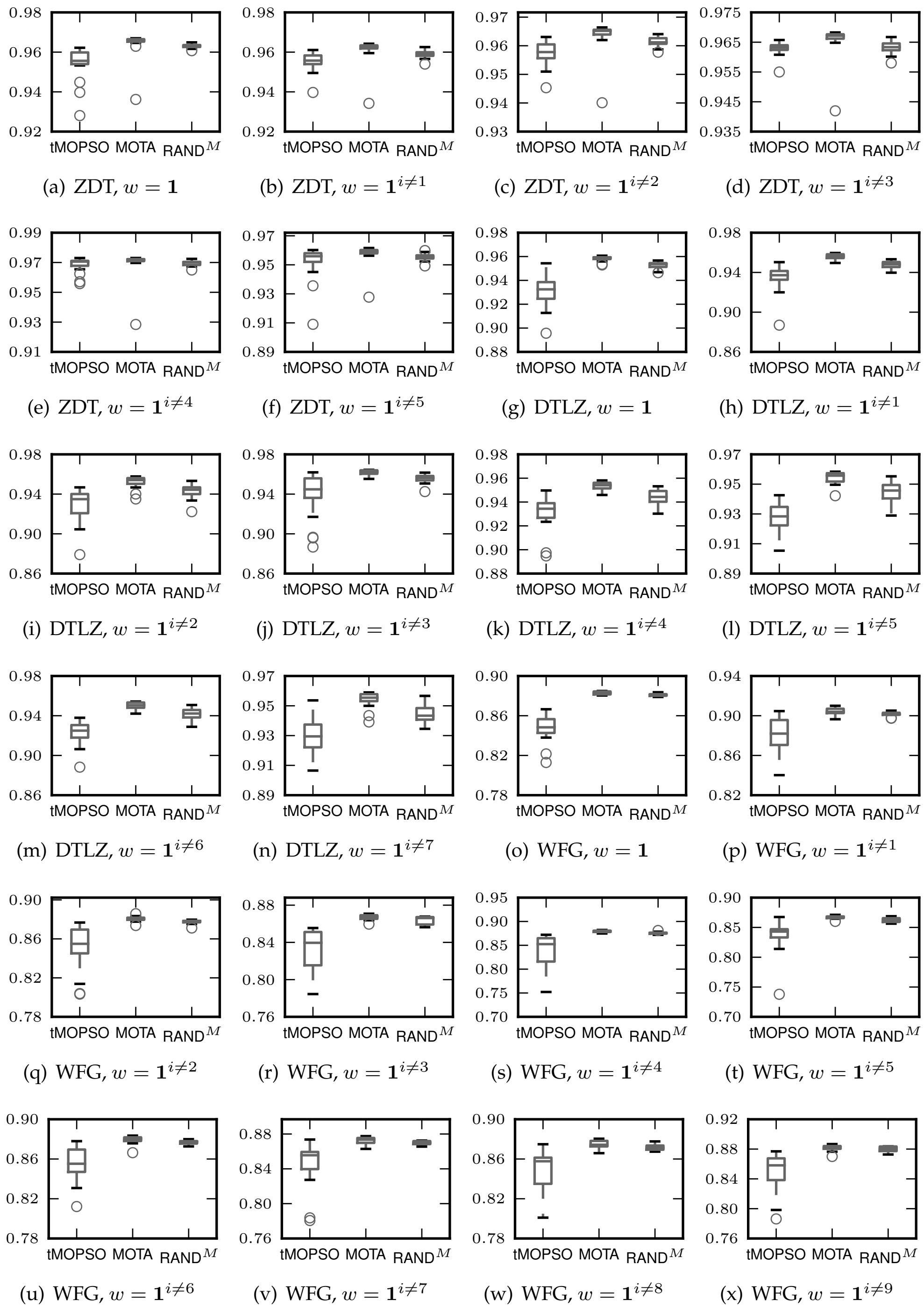
Table 7: Performances on the MOEA/D generalist tuning problems. The $\mathbf{1}^{i \neq j}$ notation indicates a vector whose elements are all equal to 1, with exception to the j'th element which is equal to 0.

		$\tau \times 10^3$		
suite	$\mathbf{w}$	tMOPSO	MOTA	RAND^M
ZDT	$\mathbf{1}$	954.444	**964.325**†	963.128
	$\mathbf{1}^{i \neq 1}$	955.393	**961.119**	958.943
	$\mathbf{1}^{i \neq 2}$	957.256	**963.529**	961.398
	$\mathbf{1}^{i \neq 3}$	962.893	**965.680**	963.138
	$\mathbf{1}^{i \neq 4}$	*968.530*‡	969.579	**969.613**
	$\mathbf{1}^{i \neq 5}$	951.967	**957.607**	955.255
DTLZ	$\mathbf{1}$	930.843	**958.360**	953.098
	$\mathbf{1}^{i \neq 1}$	934.621	**955.802**	948.353
	$\mathbf{1}^{i \neq 2}$	929.119	**952.000**	944.280
	$\mathbf{1}^{i \neq 3}$	939.228	**962.001**	956.258
	$\mathbf{1}^{i \neq 4}$	930.771	**953.190**	944.010
	$\mathbf{1}^{i \neq 5}$	927.883	**954.376**	944.924
	$\mathbf{1}^{i \neq 6}$	923.124	**950.179**	941.941
	$\mathbf{1}^{i \neq 7}$	929.391	**954.263**	944.859
WFG	$\mathbf{1}$	847.868	**882.793**	880.510
	$\mathbf{1}^{i \neq 1}$	881.356	**904.044**	898.567
	$\mathbf{1}^{i \neq 2}$	850.824	**880.573**	877.219
	$\mathbf{1}^{i \neq 3}$	831.903	**866.881**	864.155
	$\mathbf{1}^{i \neq 4}$	836.309	**878.954**	876.121
	$\mathbf{1}^{i \neq 5}$	836.376	**866.981**	863.358
	$\mathbf{1}^{i \neq 6}$	854.657	**879.328**	876.132
	$\mathbf{1}^{i \neq 7}$	845.944	**872.224**	868.259
	$\mathbf{1}^{i \neq 8}$	850.214	**874.633**	870.659
	$\mathbf{1}^{i \neq 9}$	849.236	**881.582**	878.529

Friedman test: χ^2 40.333, p-value 1.7×10^{-9}

† **bold entries** indicate the best value in each row.

‡ *Italic entries* indicate samples whose difference in mean relative to the sample with the best mean is not statistically significant according to Mann-Whitney U-test with a 95% confidence.



(a) ZDT, $w = \mathbf{1}$ (b) ZDT, $w = \mathbf{1}^{i \neq 1}$ (c) ZDT, $w = \mathbf{1}^{i \neq 2}$ (d) ZDT, $w = \mathbf{1}^{i \neq 3}$

(e) ZDT, $w = \mathbf{1}^{i \neq 4}$ (f) ZDT, $w = \mathbf{1}^{i \neq 5}$ (g) DTLZ, $w = \mathbf{1}$ (h) DTLZ, $w = \mathbf{1}^{i \neq 1}$

(i) DTLZ, $w = \mathbf{1}^{i \neq 2}$ (j) DTLZ, $w = \mathbf{1}^{i \neq 3}$ (k) DTLZ, $w = \mathbf{1}^{i \neq 4}$ (l) DTLZ, $w = \mathbf{1}^{i \neq 5}$

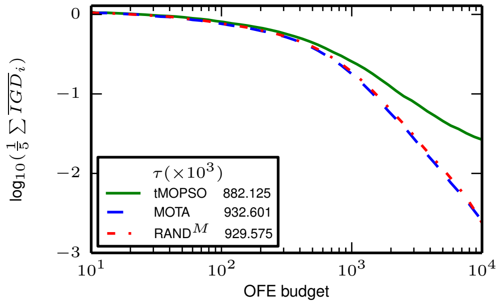
(m) DTLZ, $w = \mathbf{1}^{i \neq 6}$ (n) DTLZ, $w = \mathbf{1}^{i \neq 7}$ (o) WFG, $w = \mathbf{1}$ (p) WFG, $w = \mathbf{1}^{i \neq 1}$

(q) WFG, $w = \mathbf{1}^{i \neq 2}$ (r) WFG, $w = \mathbf{1}^{i \neq 3}$ (s) WFG, $w = \mathbf{1}^{i \neq 4}$ (t) WFG, $w = \mathbf{1}^{i \neq 5}$

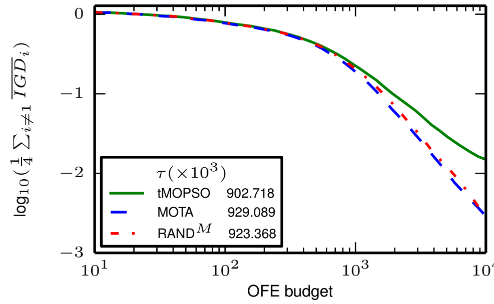
(u) WFG, $w = \mathbf{1}^{i \neq 6}$ (v) WFG, $w = \mathbf{1}^{i \neq 7}$ (w) WFG, $w = \mathbf{1}^{i \neq 8}$ (x) WFG, $w = \mathbf{1}^{i \neq 9}$

Figure 12: τ distributions for the MOEAD generalist problems

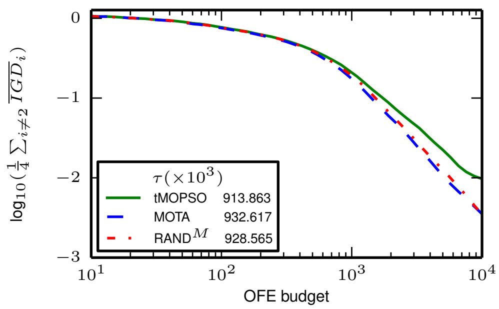
6 Generalist tuning problems IGD versus OFE



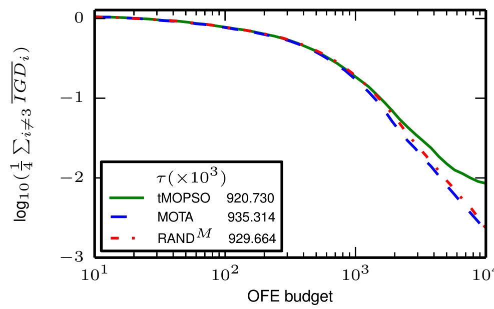
(a) ZDT, $w = \mathbf{1}$



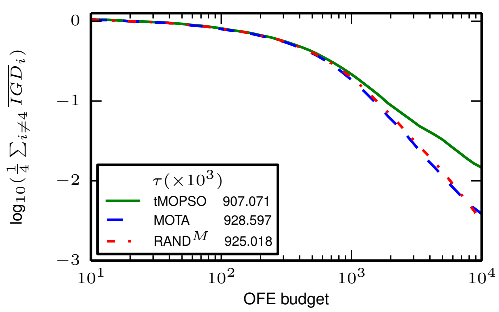
(b) ZDT, $w = \mathbf{1}^{i\neq 1}$



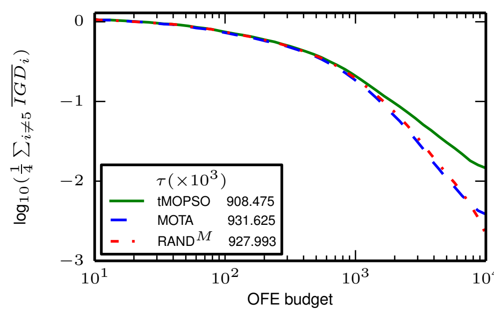
(c) ZDT, $w = \mathbf{1}^{i\neq 2}$



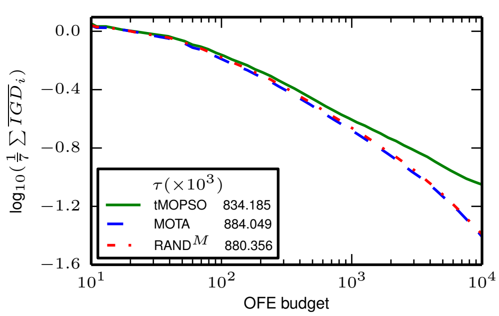
(d) ZDT, $w = \mathbf{1}^{i\neq 3}$



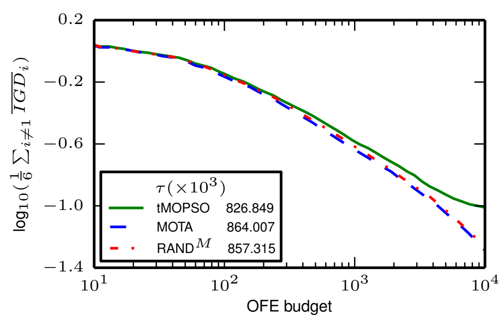
(e) ZDT, $w = \mathbf{1}^{i\neq 4}$



(f) ZDT, $w = \mathbf{1}^{i\neq 5}$

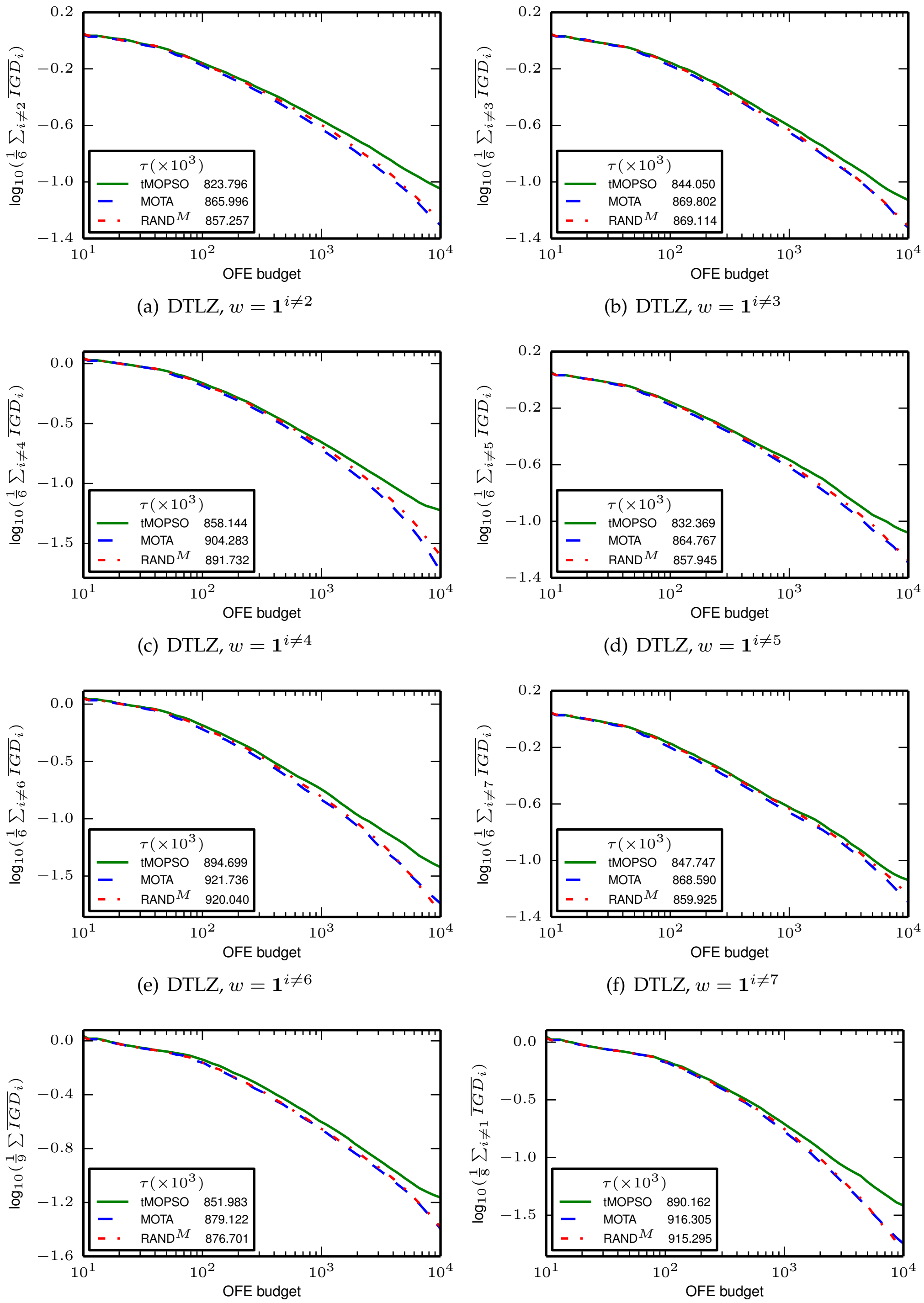


(g) DTLZ, $w = \mathbf{1}$



(h) DTLZ, $w = \mathbf{1}^{i\neq 1}$

Figure 13: NSGA-II generalist results ($\gamma = 10^7$), Weighted sum of normalized IGD values ($\overline{IGD}$) versus OFE budget, with $\overline{IGD}$ normalized between the Nadir and Utopia point. (table 1/3)



(a) DTLZ, $w = \mathbf{1}^{i \neq 2}$

(b) DTLZ, $w = \mathbf{1}^{i \neq 3}$

(c) DTLZ, $w = \mathbf{1}^{i \neq 4}$

(d) DTLZ, $w = \mathbf{1}^{i \neq 5}$

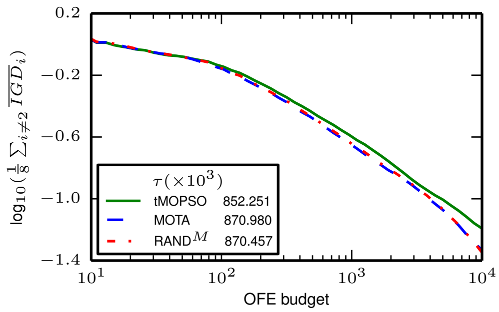
(e) DTLZ, $w = \mathbf{1}^{i \neq 6}$

(f) DTLZ, $w = \mathbf{1}^{i \neq 7}$

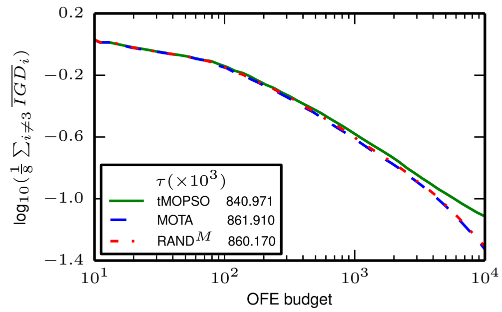
(g) WFG, $w = \mathbf{1}$

(h) WFG, $w = \mathbf{1}^{i \neq 1}$

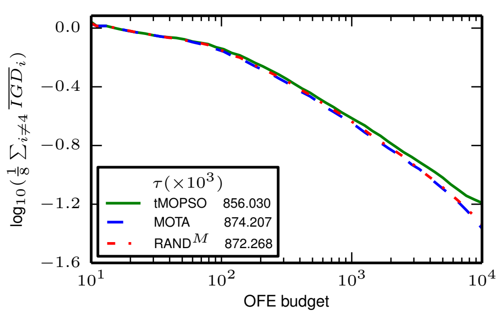
Figure 14: NSGA-II generalist results ($\gamma = 10^7$), Weighted sum of normalized IGD values ($\overline{IGD}$) versus OFE budget, with $\overline{IGD}$ normalized between the Nadir and Utopia point. (table 2/3)



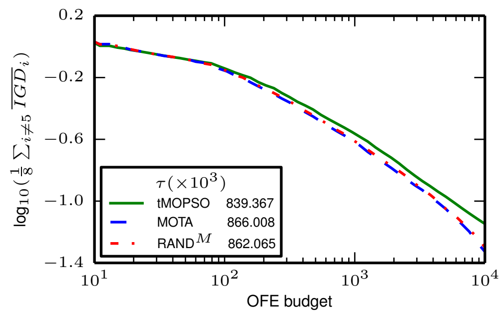
(a) WFG, $w = \mathbf{1}^{i\neq2}$



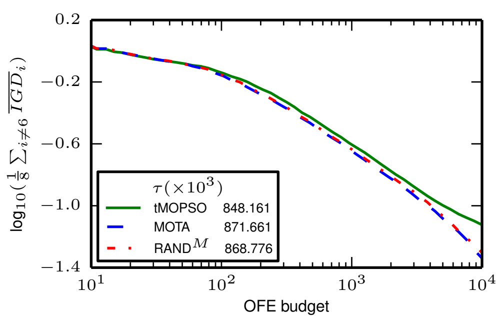
(b) WFG, $w = \mathbf{1}^{i\neq3}$



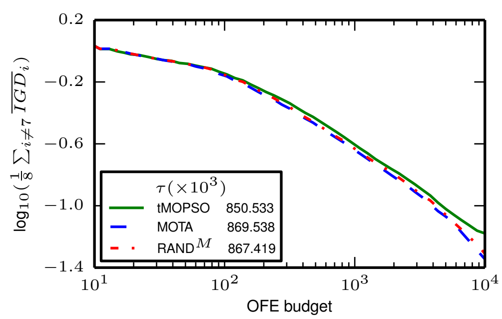
(c) WFG, $w = \mathbf{1}^{i\neq4}$



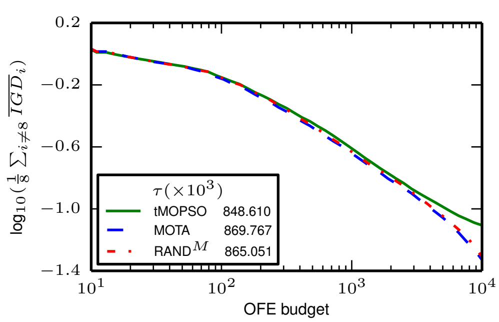
(d) WFG, $w = \mathbf{1}^{i\neq5}$



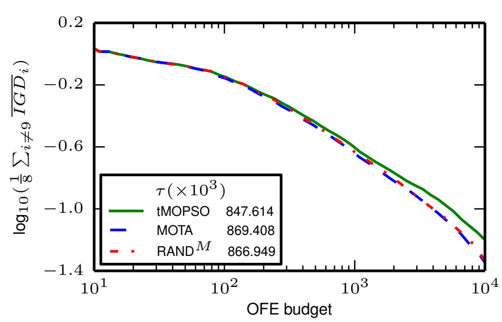
(e) WFG, $w = \mathbf{1}^{i\neq6}$



(f) WFG, $w = \mathbf{1}^{i\neq7}$

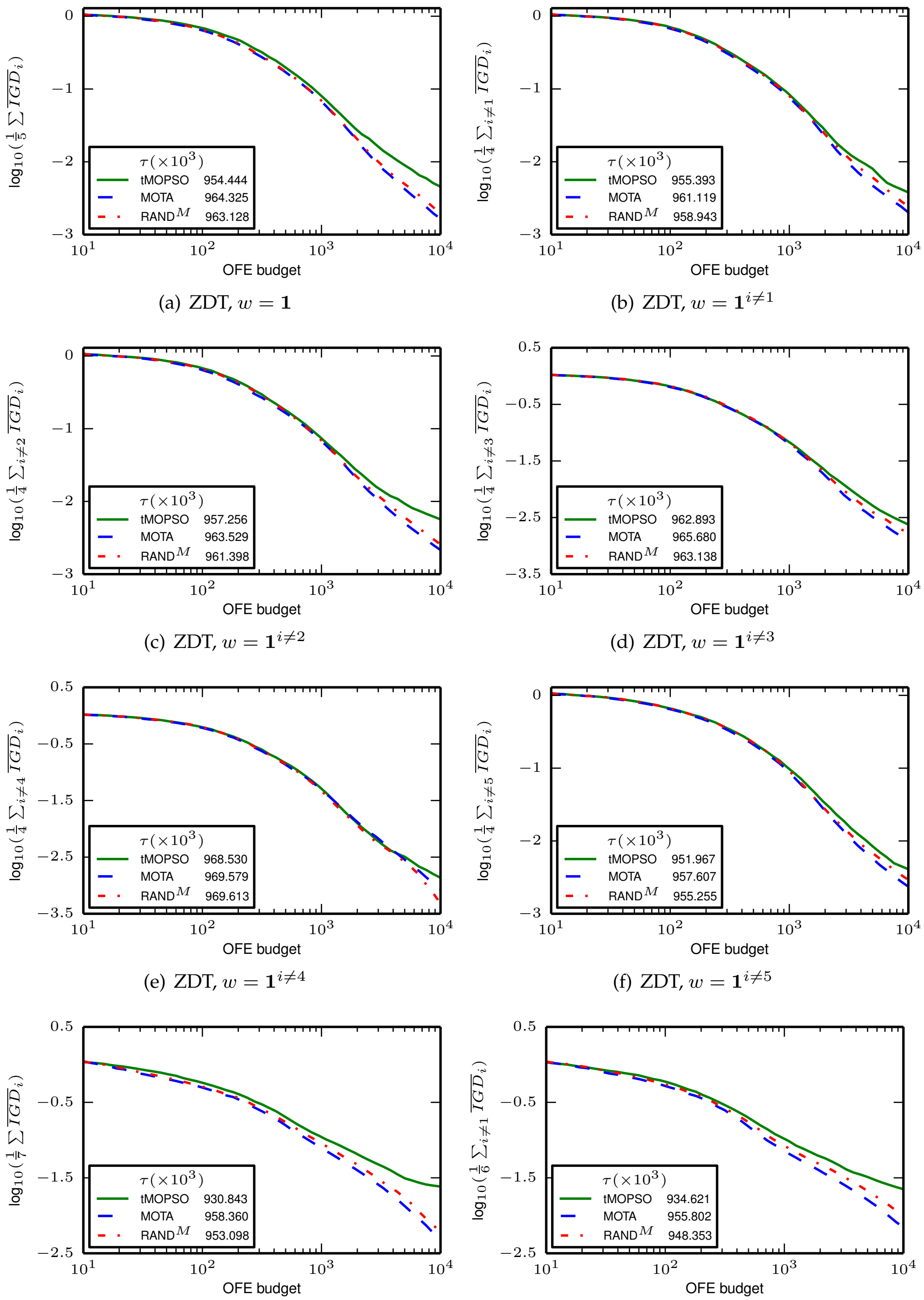


(g) WFG, $w = \mathbf{1}^{i\neq8}$



(h) WFG, $w = \mathbf{1}^{i\neq9}$

Figure 15: NSGA-II generalist results ($\gamma = 10^7$), Weighted sum of normalized IGD values ($\overline{IGD}$) versus OFE budget, with $\overline{IGD}$ normalized between the Nadir and Utopia point. (table 3/3)



(a) ZDT, $w = \mathbf{1}$

(b) ZDT, $w = \mathbf{1}^{i\neq 1}$

(c) ZDT, $w = \mathbf{1}^{i\neq 2}$

(d) ZDT, $w = \mathbf{1}^{i\neq 3}$

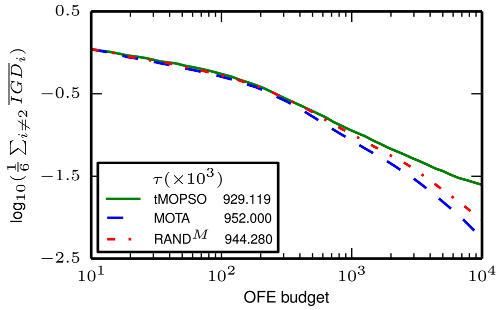
(e) ZDT, $w = \mathbf{1}^{i\neq 4}$

(f) ZDT, $w = \mathbf{1}^{i\neq 5}$

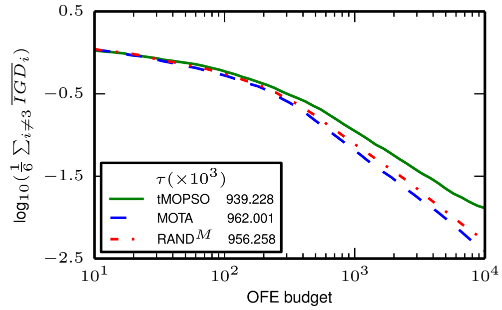
(g) DTLZ, $w = \mathbf{1}$

(h) DTLZ, $w = \mathbf{1}^{i\neq 1}$

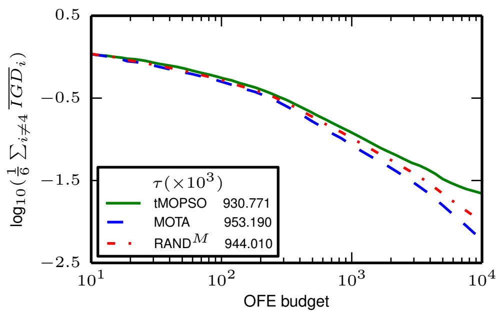
Figure 16: MOEA/D generalist results ($\gamma = 10^7$), Weighted sum of normalized IGD values ($\overline{IGD}$) versus OFE budget, with $\overline{IGD}$ normalized between the Nadir and Utopia point. (table 1/3)



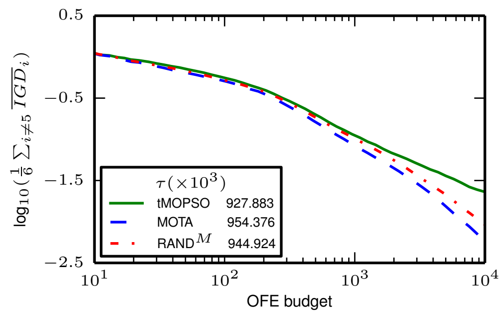
(a) DTLZ, $w = \mathbf{1}^{i\neq 2}$



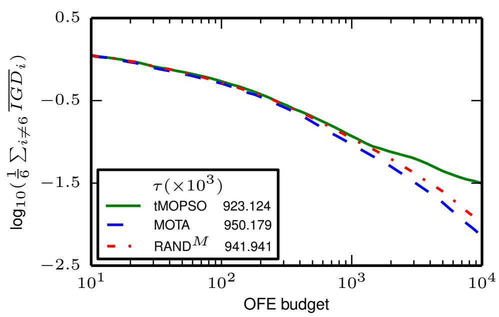
(b) DTLZ, $w = \mathbf{1}^{i\neq 3}$



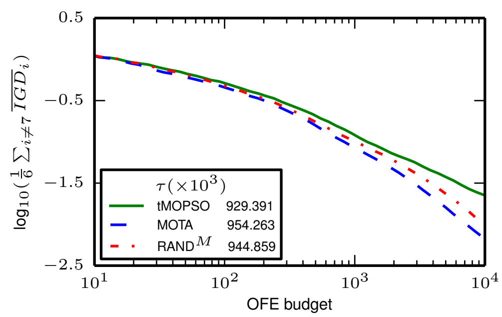
(c) DTLZ, $w = \mathbf{1}^{i\neq 4}$



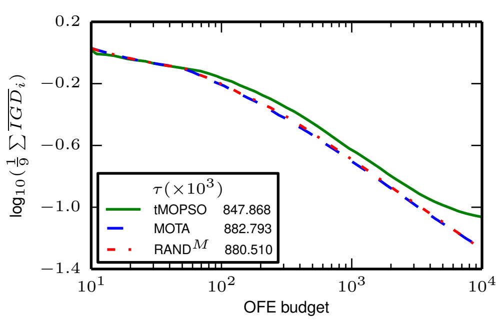
(d) DTLZ, $w = \mathbf{1}^{i\neq 5}$



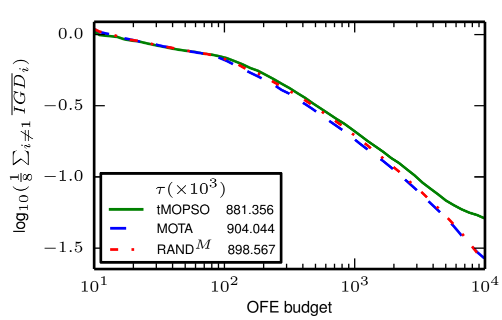
(e) DTLZ, $w = \mathbf{1}^{i\neq 6}$



(f) DTLZ, $w = \mathbf{1}^{i\neq 7}$

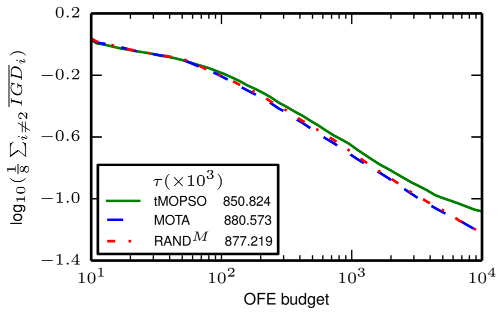


(g) WFG, $w = \mathbf{1}$

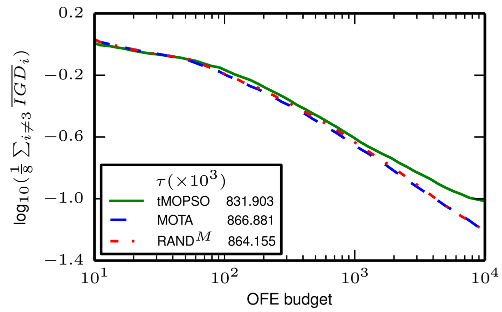


(h) WFG, $w = \mathbf{1}^{i\neq 1}$

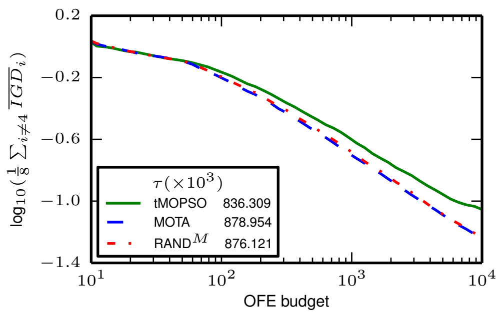
Figure 17: MOEA/D generalist results ($\gamma = 10^7$), Weighted sum of normalized IGD values ($\overline{IGD}$) versus OFE budget, with $\overline{IGD}$ normalized between the Nadir and Utopia point. (table 2/3)



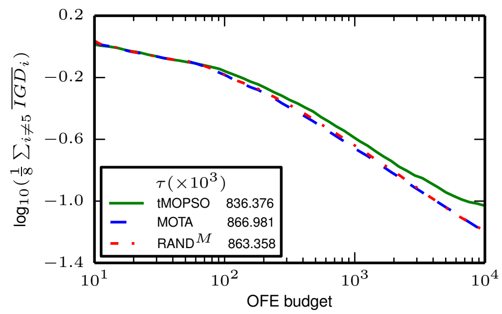
(a) WFG, $w = \mathbf{1}^{i\neq 2}$



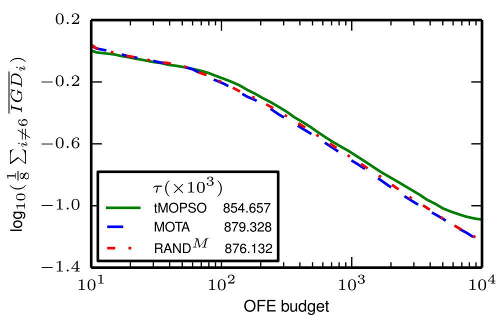
(b) WFG, $w = \mathbf{1}^{i\neq 3}$



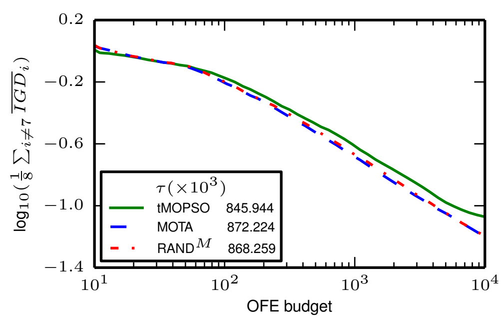
(c) WFG, $w = \mathbf{1}^{i\neq 4}$



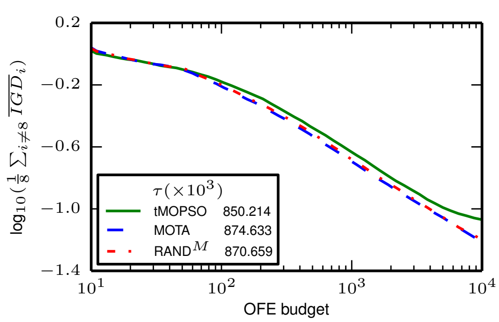
(d) WFG, $w = \mathbf{1}^{i\neq 5}$



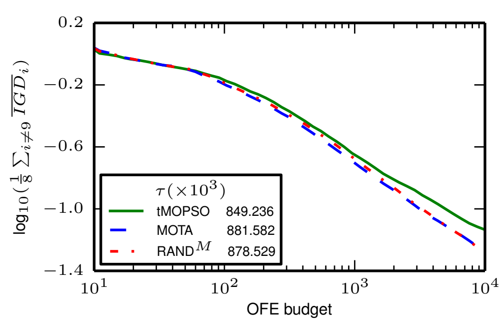
(e) WFG, $w = \mathbf{1}^{i\neq 6}$



(f) WFG, $w = \mathbf{1}^{i\neq 7}$



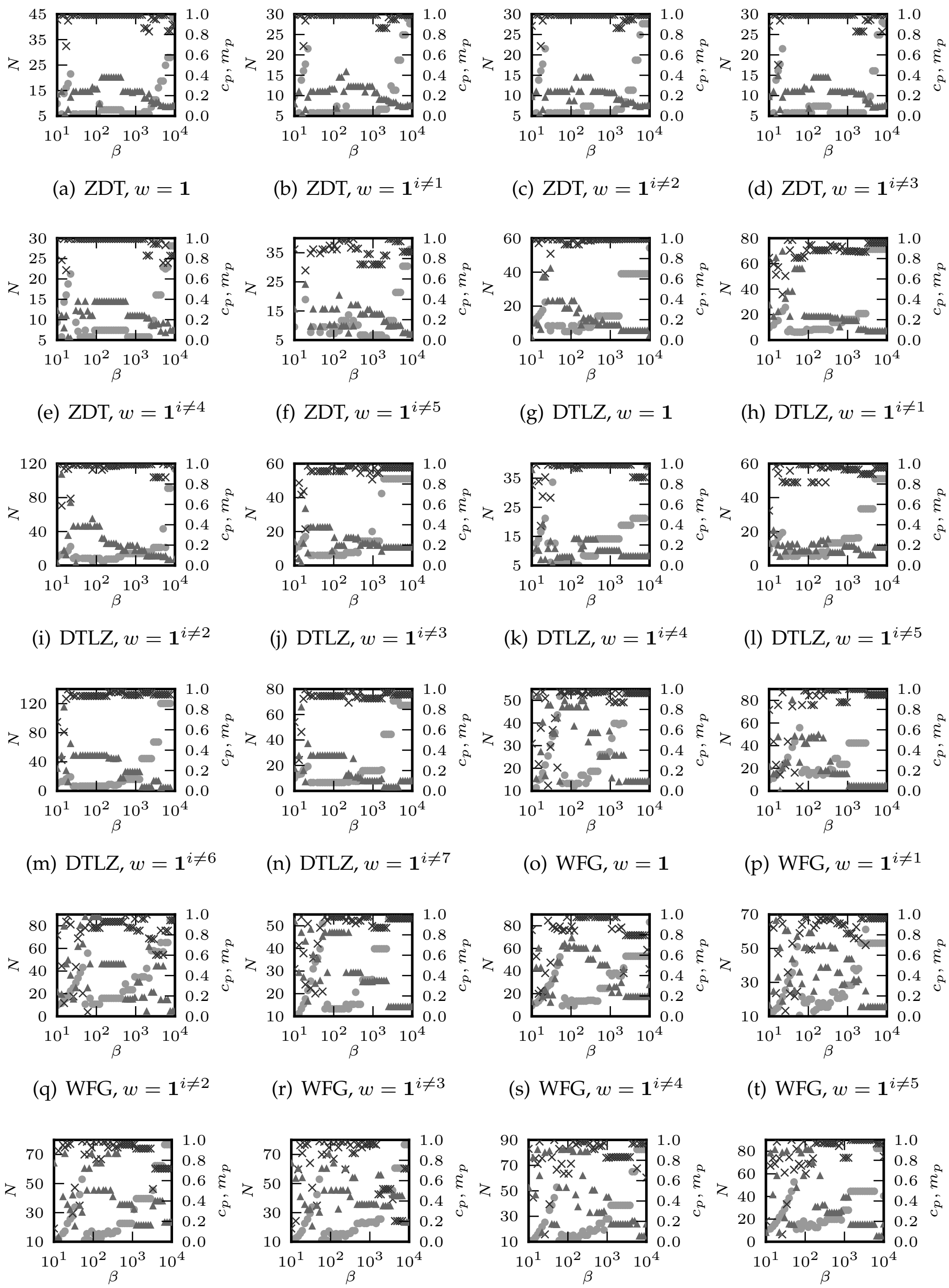
(g) WFG, $w = \mathbf{1}^{i\neq 8}$



(h) WFG, $w = \mathbf{1}^{i\neq 9}$

Figure 18: MOEA/D generalist results ($\gamma = 10^7$), Weighted sum of normalized IGD values ($\overline{IGD}$) versus OFE budget, with $\overline{IGD}$ normalized between the Nadir and Utopia point. (table 3/3)

7 MOTA's results for the generatlist problems



(a) ZDT, $w = \mathbf{1}$ (b) ZDT, $w = \mathbf{1}^{i\neq 1}$ (c) ZDT, $w = \mathbf{1}^{i\neq 2}$ (d) ZDT, $w = \mathbf{1}^{i\neq 3}$

(e) ZDT, $w = \mathbf{1}^{i\neq 4}$ (f) ZDT, $w = \mathbf{1}^{i\neq 5}$ (g) DTLZ, $w = \mathbf{1}$ (h) DTLZ, $w = \mathbf{1}^{i\neq 1}$

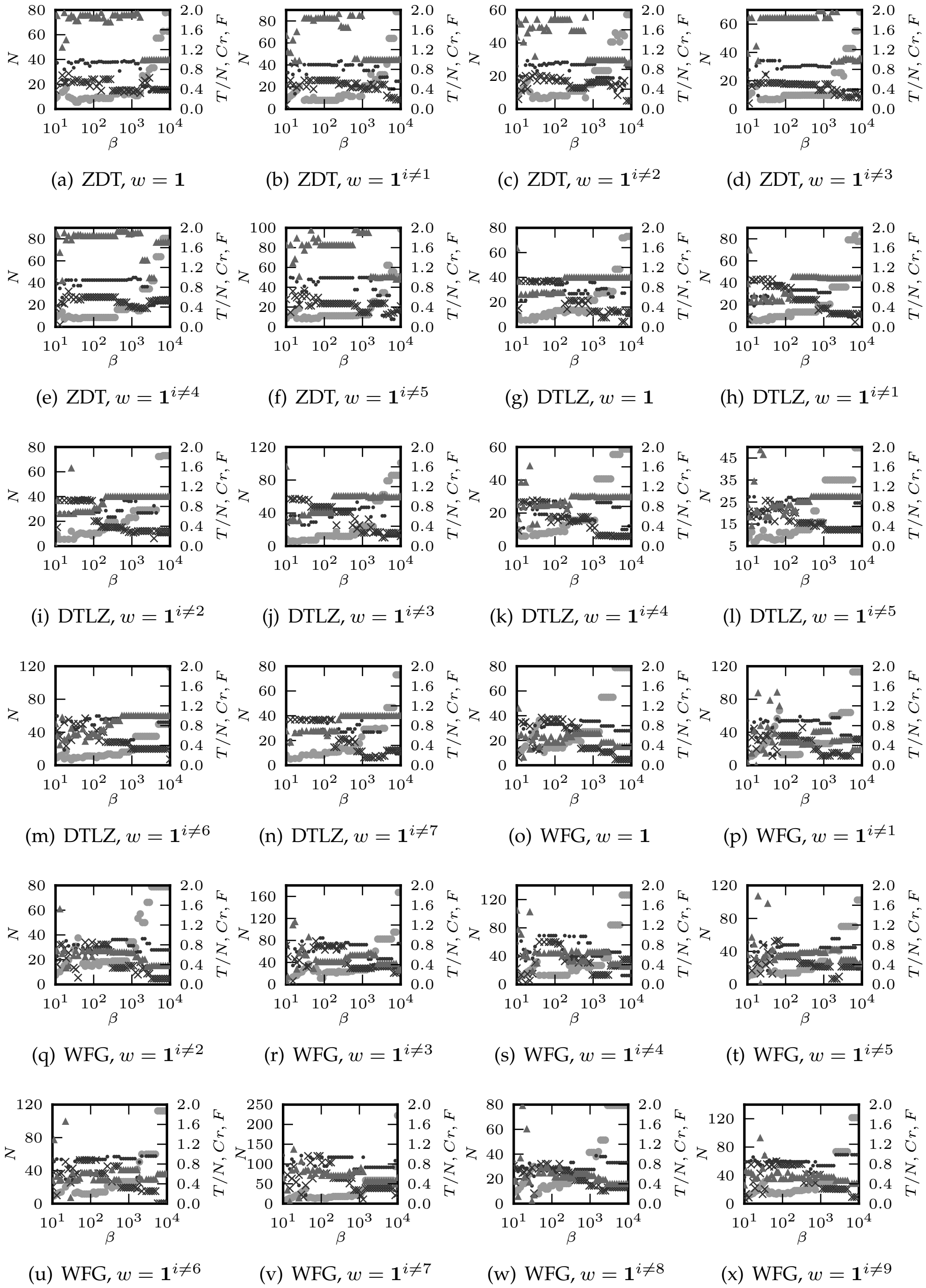
(i) DTLZ, $w = \mathbf{1}^{i\neq 2}$ (j) DTLZ, $w = \mathbf{1}^{i\neq 3}$ (k) DTLZ, $w = \mathbf{1}^{i\neq 4}$ (l) DTLZ, $w = \mathbf{1}^{i\neq 5}$

(m) DTLZ, $w = \mathbf{1}^{i\neq 6}$ (n) DTLZ, $w = \mathbf{1}^{i\neq 7}$ (o) WFG, $w = \mathbf{1}$ (p) WFG, $w = \mathbf{1}^{i\neq 1}$

(q) WFG, $w = \mathbf{1}^{i\neq 2}$ (r) WFG, $w = \mathbf{1}^{i\neq 3}$ (s) WFG, $w = \mathbf{1}^{i\neq 4}$ (t) WFG, $w = \mathbf{1}^{i\neq 5}$

(u) WFG, $w = \mathbf{1}^{i\neq 6}$ (v) WFG, $w = \mathbf{1}^{i\neq 7}$ (w) WFG, $w = \mathbf{1}^{i\neq 8}$ (x) WFG, $w = \mathbf{1}^{i\neq 9}$

Figure 19: The best MOTA results for the NSGA-II generalist tuning problems. The recommended CPVs are shown for differing OFE budgets, β. The legend for the above subfigures is the same as in Figure 9



(a) ZDT, $w = \mathbf{1}$ (b) ZDT, $w = \mathbf{1}^{i \neq 1}$ (c) ZDT, $w = \mathbf{1}^{i \neq 2}$ (d) ZDT, $w = \mathbf{1}^{i \neq 3}$

(e) ZDT, $w = \mathbf{1}^{i \neq 4}$ (f) ZDT, $w = \mathbf{1}^{i \neq 5}$ (g) DTLZ, $w = \mathbf{1}$ (h) DTLZ, $w = \mathbf{1}^{i \neq 1}$

(i) DTLZ, $w = \mathbf{1}^{i \neq 2}$ (j) DTLZ, $w = \mathbf{1}^{i \neq 3}$ (k) DTLZ, $w = \mathbf{1}^{i \neq 4}$ (l) DTLZ, $w = \mathbf{1}^{i \neq 5}$

(m) DTLZ, $w = \mathbf{1}^{i \neq 6}$ (n) DTLZ, $w = \mathbf{1}^{i \neq 7}$ (o) WFG, $w = \mathbf{1}$ (p) WFG, $w = \mathbf{1}^{i \neq 1}$

(q) WFG, $w = \mathbf{1}^{i \neq 2}$ (r) WFG, $w = \mathbf{1}^{i \neq 3}$ (s) WFG, $w = \mathbf{1}^{i \neq 4}$ (t) WFG, $w = \mathbf{1}^{i \neq 5}$

(u) WFG, $w = \mathbf{1}^{i \neq 6}$ (v) WFG, $w = \mathbf{1}^{i \neq 7}$ (w) WFG, $w = \mathbf{1}^{i \neq 8}$ (x) WFG, $w = \mathbf{1}^{i \neq 9}$

Figure 20: The best MOTA results for the MOEA/D generalist tuning problems. The recommended CPVs are shown for differing OFE budgets, β. The legend for the above subfigures is the same as in Figure 10