Table 8. Average rank of different offline MOO methods on each type of task with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	Synthetic	MO-NAS	MORL	MOCO	Sci-Design	RE	Average Rank
$\mathcal{D}$(best)	11.77 ± 0.17	12.11 ± 0.21	8.75 ± 0.25	$\mathbf{2.23 \pm 0.31}$	9.00 ± 0.00	12.90 ± 0.03	10.07 ± 0.14
End-to-End	6.94 ± 0.00	8.18 ± 0.03	7.00 ± 2.00	6.31 ± 0.62	6.75 ± 0.88	7.40 ± 0.60	7.17 ± 0.01
End-to-End + GradNorm	8.28 ± 0.53	7.47 ± 0.11	5.75 ± 2.75	7.81 ± 0.04	8.50 ± 0.62	10.40 ± 0.07	8.33 ± 0.03
End-to-End + PcGrad	7.81 ± 0.00	7.03 ± 0.24	10.75 ± 1.25	5.81 ± 0.65	8.62 ± 2.75	8.13 ± 0.13	7.41 ± 0.06
Multi-Head	6.44 ± 0.44	5.24 ± 0.29	6.00 ± 2.00	8.38 ± 0.08	9.38 ± 0.50	8.20 ± 0.47	6.95 ± 0.33
Multi-Head + GradNorm	7.78 ± 0.53	9.96 ± 0.04	12.00 ± 2.00	10.13 ± 0.17	9.06 ± 0.94	10.50 ± 0.17	9.59 ± 0.08
Multi-Head + PcGrad	8.61 ± 0.20	6.84 ± 0.58	9.75 ± 3.25	8.12 ± 0.19	9.25 ± 0.62	8.37 ± 0.17	7.99 ± 0.26
Multiple Models	$\mathbf{4.02 \pm 0.14}$	4.93 ± 0.28	9.25 ± 0.75	6.67 ± 0.37	$\underline{5.50 \pm 0.88}$	4.40 ± 0.07	$\underline{5.01 \pm 0.02}$
Multiple Models + COMs	9.81 ± 0.31	6.47 ± 0.37	5.50 ± 3.00	5.69 ± 0.54	8.12 ± 1.75	10.40 ± 0.47	8.06 ± 0.34
Multiple Models + RoMA	8.98 ± 0.02	$\underline{4.92 \pm 0.03}$	6.50 ± 0.50	7.81 ± 0.35	7.88 ± 1.25	6.20 ± 0.07	7.00 ± 0.02
Multiple Models + IOM	$\underline{6.08 \pm 0.39}$	$\mathbf{4.76 \pm 0.39}$	$\mathbf{3.75 \pm 2.75}$	$\underline{3.58 \pm 0.04}$	7.12 ± 0.50	$\mathbf{3.17 \pm 0.03}$	$\mathbf{4.58 \pm 0.08}$
Multiple Models + ICT	9.17 ± 0.33	11.68 ± 0.42	$\underline{4.75 \pm 0.25}$	9.46 ± 0.46	8.38 ± 0.50	8.30 ± 0.30	9.46 ± 0.17
Multiple Models + Tri-Mentoring	7.89 ± 0.11	11.11 ± 0.37	5.00 ± 2.50	9.19 ± 0.04	9.12 ± 0.75	6.67 ± 0.20	8.62 ± 0.16
MOBO	8.72 ± 0.34	7.03 ± 0.66	10.25 ± 0.25	14.38 ± 0.12	$\mathbf{4.69 \pm 0.31}$	5.82 ± 0.18	8.57 ± 0.36
MOBO-ParEGO	10.05 ± 0.20	11.50 ± 0.13	N/A	14.22 ± 0.00	8.50 ± 1.50	12.62 ± 0.29	11.62 ± 0.05
MOBO-JES	12.05 ± 0.05	16.00 ± 0.00	N/A	N/A	7.50 ± 6.50	8.00 ± 0.42	9.95 ± 0.55

Table 9. Hypervolume results for synthetic functions with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	DTLZ1	DTLZ2	DTLZ3	DTLZ4	DTLZ5	DTLZ6	DTLZ7	OmniTest	VLMOP1	VLMOP2	VLMOP3	ZDT1	ZDT2	ZDT3	ZDT4	ZDT6
$\mathcal{D}$(best)	10.52	9.43	9.71	10.76	9.06	8.20	8.32	3.87	2.28	1.64	45.14	4.04	4.70	5.12	5.46	4.76
End-to-End	10.12 ± 0.02	$\mathbf{10.65 \pm 0.00}$	$\mathbf{10.65 \pm 0.00}$	10.70 ± 0.05	$\mathbf{10.65 \pm 0.00}$	$\mathbf{10.65 \pm 0.00}$	10.70 ± 0.01	$\mathbf{4.35 \pm 0.00}$	$\underline{2.57 \pm 2.26}$	4.24 ± 0.01	$\mathbf{46.93 \pm 0.00}$	2.69 ± 0.00	3.21 ± 0.03	5.50 ± 0.04	3.12 ± 0.09	$\mathbf{4.92 \pm 0.00}$
End-to-End + GradNorm	$\mathbf{10.65 \pm 0.00}$	10.65 ± 0.00	10.65 ± 0.00	$\underline{10.76 \pm 0.00}$	10.65 ± 0.00	10.64 ± 0.00	10.71 ± 0.00	3.76 ± 0.03	2.33 ± 2.33	42.23 ± 0.98	4.77 ± 0.01	5.63 ± 0.02	3.23 ± 0.03	3.81 ± 1.02	
End-to-End + PcGrad	$\underline{10.65 \pm 0.00}$	10.65 ± 0.00	10.65 ± 0.00	10.70 ± 0.05	9.02 ± 0.10	9.45 ± 0.15	10.52 ± 0.00	$\underline{4.35 \pm 0.00}$	2.57 ± 2.26	4.14 ± 0.07	46.79 ± 0.06	$\underline{4.84 \pm 0.01}$	$\underline{5.70 \pm 0.01}$	5.45 ± 0.00	3.12 ± 0.01	2.04 ± 0.22
Multi-Head	10.38 ± 0.25	10.65 ± 0.00	10.65 ± 0.00	10.70 ± 0.05	$\underline{10.65 \pm 0.00}$	$\underline{10.65 \pm 0.00}$	10.65 ± 0.00	4.30 ± 0.05	2.57 ± 2.26	$\underline{4.26 \pm 0.00}$	46.92 ± 0.02	2.69 ± 0.00	4.48 ± 1.27	5.50 ± 0.04	3.23 ± 0.16	$\underline{4.91 \pm 0.00}$
Multi-Head + GradNorm	10.65 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.76 ± 0.00	9.29 ± 0.86	10.62 ± 0.02	10.61 ± 0.10	4.34 ± 0.00	0.00 ± 0.00	4.13 ± 0.03	46.64 ± 0.22	4.83 ± 0.00	5.68 ± 0.05	5.26 ± 0.04	3.39 ± 0.00	4.87 ± 0.00
Multi-Head + PcGrad	10.64 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.76 ± 0.00	9.08 ± 0.35	10.59 ± 0.01	10.59 ± 0.01	4.35 ± 0.00	2.55 ± 2.24	4.01 ± 0.02	46.91 ± 0.00	2.73 ± 0.03	5.69 ± 0.03	5.45 ± 0.00	3.64 ± 0.17	2.17 ± 0.05
Multiple Models	10.65 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.76 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.73 ± 0.00	4.35 ± 0.00	2.57 ± 2.26	$\mathbf{4.28 \pm 0.00}$	$\underline{46.94 \pm 0.00}$	4.75 ± 0.00	5.58 ± 0.00	$\mathbf{5.80 \pm 0.01}$	4.14 ± 0.20	4.91 ± 0.00
Multiple Models + COMs	10.64 ± 0.01	10.39 ± 0.13	10.59 ± 0.05	10.70 ± 0.05	10.57 ± 0.06	10.26 ± 0.25	9.64 ± 0.22	4.29 ± 0.03	2.54 ± 2.25	1.90 ± 0.05	46.78 ± 0.07	4.24 ± 0.01	4.89 ± 0.07	5.54 ± 0.02	4.56 ± 0.04	4.57 ± 0.00
Multiple Models + RoMA	10.64 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.76 ± 0.00	10.18 ± 0.45	10.65 ± 0.00	10.63 ± 0.03	3.03 ± 0.03	2.54 ± 2.24	1.46 ± 0.00	44.15 ± 2.36	$\mathbf{4.87 \pm 0.00}$	5.65 ± 0.00	$\underline{5.78 \pm 0.02}$	3.18 ± 0.05	1.78 ± 0.02
Multiple Models + IOM	10.65 ± 0.00	10.61 ± 0.02	10.62 ± 0.02	10.76 ± 0.00	10.63 ± 0.01	10.50 ± 0.11	$\underline{10.74 \pm 0.08}$	4.34 ± 0.00	2.55 ± 2.24	3.77 ± 0.01	46.92 ± 0.00	$\mathbf{5.74 \pm 0.01}$	5.61 ± 0.01	4.65 ± 0.19	4.89 ± 0.02	
Multiple Models + ICT	10.64 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.76 ± 0.00	10.63 ± 0.01	10.65 ± 0.00	$\mathbf{10.75 \pm 0.02}$	4.30 ± 0.00	2.27 ± 2.07	1.46 ± 0.00	46.74 ± 0.09	4.39 ± 0.01	5.53 ± 0.00	4.37 ± 0.03	3.44 ± 0.16	2.33 ± 0.11
Multiple Models + Tri-Mentoring	10.64 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.76 ± 0.00	10.59 ± 0.04	10.65 ± 0.00	10.67 ± 0.01	$\mathbf{4.83 \pm 0.00}$	1.46 ± 0.00	46.82 ± 0.02	4.52 ± 0.02	5.55 ± 0.01	5.62 ± 0.09	3.47 ± 0.04	2.36 ± 0.28	
MOBO	10.65 ± 0.00	10.54 ± 0.10	10.51 ± 0.07	10.65 ± 0.00	10.17 ± 0.13	9.58 ± 0.13	10.56 ± 0.01	4.35 ± 0.00	0.32 ± 0.00	1.50 ± 0.02	46.89 ± 0.01	4.54 ± 0.01	5.15 ± 0.11	5.54 ± 0.01	4.43 ± 0.31	4.17 ± 0.51
MOBO-ParEGO	10.63 ± 0.00	9.73 ± 0.20	9.80 ± 0.19	10.76 ± 0.00	9.03 ± 0.24	9.16 ± 0.10	10.25 ± 0.05	4.33 ± 0.00	0.28 ± 0.00	2.93 ± 0.06	46.93 ± 0.00	4.32 ± 0.02	5.12 ± 0.17	5.20 ± 0.01	$\underline{4.81 \pm 0.10}$	3.31 ± 0.03
MOBO-JES	10.61 ± 0.00	/	/	/	/	/	9.36 ± 0.08	3.87 ± 0.00	N/A	1.46 ± 0.00	46.88 ± 0.00	3.97 ± 0.09	4.44 ± 0.07	5.17 ± 0.02	4.43 ± 0.08	3.09 ± 0.02

Table 10. Hypervolume results for MO-NAS with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	C-10/MOP1	C-10/MOP2	C-10/MOP3	C-10/MOP4	C-10/MOP5	C-10/MOP6	C-10/MOP7	C-10/MOP8	C-10/MOP9	IN-1K/MOP1	IN-1K/MOP2	IN-1K/MOP3	IN-1K/MOP4	IN-1K/MOP5	IN-1K/MOP6	IN-1K/MOP7	IN-1K/MOP8	IN-1K/MOP9	NasBench201-Test
$\mathcal{D}$(best)	4.78	10.49	9.78	21.15	40.51	92.43	358.27	4.55	10.59	4.97	5.00	11.21	16.63	17.26	44.43	4.69	11.42	21.50	9.24
End-to-End	4.84 ± 0.00	10.49 ± 0.02	10.84 ± 0.00	26.25 ± 0.07	50.20 ± 0.03	112.47 ± 0.01	523.26 ± 0.11	4.56 ± 0.07	10.50 ± 0.15	4.85 ± 0.07	4.70 ± 0.02	10.88 ± 0.10	17.07 ± 0.03	$\underline{17.93 \pm 0.13}$	45.89 ± 0.16	5.17 ± 0.02	11.15 ± 0.18	23.35 ± 0.30	10.30 ± 0.03
End-to-End + GradNorm	4.84 ± 0.00	10.54 ± 0.01	$\mathbf{10.86 \pm 0.01}$	26.46 ± 0.04	$\mathbf{50.64 \pm 0.00}$	112.27 ± 0.03	525.63 ± 0.10	4.56 ± 0.08	10.48 ± 0.23	5.21 ± 0.00	5.04 ± 0.02	10.87 ± 0.05	17.80 ± 0.09	45.40 ± 0.12	5.63 ± 0.02	10.73 ± 0.08	22.55 ± 0.13	9.94 ± 0.01	
End-to-End + PcGrad	4.84 ± 0.00	10.50 ± 0.01	10.81 ± 0.00	26.30 ± 0.04	50.54 ± 0.08	112.15 ± 0.01	526.46 ± 0.12	4.58 ± 0.04	11.10 ± 0.04	5.20 ± 0.03	5.11 ± 0.03	11.11 ± 0.03	16.82 ± 0.01	17.63 ± 0.01	44.47 ± 0.04	5.03 ± 0.07	11.20 ± 0.20	23.43 ± 0.24	10.45 ± 0.09
Multi-Head	4.83 ± 0.01	10.55 ± 0.00	10.59 ± 0.00	$\underline{26.59 \pm 0.01}$	50.45 ± 0.03	$\mathbf{112.72 \pm 0.00}$	$\mathbf{529.51 \pm 0.36}$	4.52 ± 0.09	9.88 ± 0.15	$\mathbf{5.37 \pm 0.00}$	5.05 ± 0.01	11.55 ± 0.01	17.03 ± 0.04	$\mathbf{18.00 \pm 0.06}$	46.01 ± 0.10	5.33 ± 0.00	11.73 ± 0.10	25.31 ± 0.14	10.36 ± 0.01
Multi-Head + GradNorm	$\mathbf{4.85 \pm 0.00}$	10.57 ± 0.02	10.23 ± 0.00	24.49 ± 0.06	50.24 ± 0.00	111.16 ± 0.09	525.72 ± 0.21	3.90 ± 0.05	9.43 ± 0.13	5.05 ± 0.01	4.41 ± 0.09	10.07 ± 0.07	17.03 ± 0.19	17.74 ± 0.08	45.25 ± 0.18	4.97 ± 0.01	8.61 ± 0.05	20.78 ± 0.20	10.35 ± 0.00
Multi-Head + PcGrad	$\mathbf{4.85 \pm 0.00}$	$\mathbf{10.58 \pm 0.03}$	10.86 ± 0.01	24.44 ± 0.11	50.53 ± 0.01	112.13 ± 0.19	520.43 ± 0.27	4.51 ± 0.09	10.51 ± 0.18	4.99 ± 0.10	5.18 ± 0.02	11.40 ± 0.13	17.01 ± 0.06	17.76 ± 0.15	45.14 ± 0.13	5.53 ± 0.05	10.95 ± 0.10	23.69 ± 0.29	10.35 ± 0.01
Multiple Models	4.82 ± 0.00	10.54 ± 0.00	10.83 ± 0.01	$\mathbf{26.62 \pm 0.02}$	50.20 ± 0.02	111.91 ± 0.03	525.80 ± 0.28	4.75 ± 0.04	$\underline{11.17 \pm 0.06}$	$\underline{5.34 \pm 0.00}$	$\underline{5.22 \pm 0.01}$	11.57 ± 0.01	17.19 ± 0.04	17.82 ± 0.00	$\mathbf{46.02 \pm 0.04}$	$\mathbf{5.64 \pm 0.11}$	11.77 ± 0.03	24.92 ± 0.24	10.34 ± 0.02
Multiple Models + COMs	4.84 ± 0.01	10.57 ± 0.03	10.66 ± 0.07	25.66 ± 0.12	50.42 ± 0.01	111.31 ± 0.50	527.32 ± 0.45	4.49 ± 0.01	10.77 ± 0.02	5.25 ± 0.04	$\mathbf{5.23 \pm 0.01}$	11.55 ± 0.04	17.09 ± 0.02	17.84 ± 0.00	45.38 ± 0.00	5.55 ± 0.00	$\underline{12.41 \pm 0.00}$	26.41 ± 0.00	10.33 ± 0.03
Multiple Models + RoMA	4.83 ± 0.00	10.43 ± 0.02	10.73 ± 0.00	26.04 ± 0.20	50.52 ± 0.01	112.47 ± 0.04	$\underline{527.83 \pm 0.01}$	4.88 ± 0.05	$\mathbf{11.50 \pm 0.02}$	5.28 ± 0.01	5.24 ± 0.00	$\mathbf{11.62 \pm 0.01}$	16.97 ± 0.01	17.81 ± 0.07	45.54 ± 0.00	4.77 ± 0.00	$\mathbf{12.38 \pm 0.00}$	$\mathbf{26.56 \pm 0.00}$	$\mathbf{10.54 \pm 0.00}$
Multiple Models + ICT	4.42 ± 0.36	10.49 ± 0.01	10.01 ± 0.03	25.82 ± 0.03	50.36 ± 0.09	108.86 ± 3.66	493.14 ± 0.99	3.62 ± 0.04	8.21 ± 0.14	4.75 ± 0.01	4.99 ± 0.02	9.60 ± 0.23	16.72 ± 0.02	16.85 ± 0.23	45.61 ± 0.01	4.79 ± 0.40	11.41 ± 0.24	21.48 ± 0.31	9.62 ± 0.29
Multiple Models + Tri-Mentoring	4.39 ± 0.33	7.77 ± 0.01	9.87 ± 0.55	25.34 ± 0.16	$\underline{50.62 \pm 0.04}$	111.60 ± 0.07	526.05 ± 0.78	3.61 ± 0.07	8.04 ± 0.25	4.86 ± 0.10	10.19 ± 0.06	16.75 ± 0.10	17.12 ± 0.15	44.75 ± 0.70	5.23 ± 0.02	10.60 ± 0.63	22.54 ± 0.04	10.17 ± 0.15	
MOBO	4.82 ± 0.02	$\underline{10.58 \pm 0.01}$	10.70 ± 0.00	26.35 ± 0.27	50.32 ± 0.01	111.28 ± 0.58	488.97 ± 4.01	4.71 ± 0.00	11.11 ± 0.03	5.25 ± 0.04	5.16 ± 0.02	11.24 ± 0.03	16.74 ± 0.05	17.56 ± 0.10	44.44 ± 0.06	5.21 ± 0.02	12.33 ± 0.14	25.65 ± 0.03	$\underline{10.49 \pm 0.01}$
MOBO-ParEGO	4.81 ± 0.00	10.51 ± 0.02	9.11 ± 0.00	20.14 ± 0.00	37.74 ± 0.00	101.32 ± 0.09	354.68 ± 0.00	4.56 ± 0.00	10.67 ± 0.00	4.63 ± 0.04	4.63 ± 0.00	10.49 ± 0.21	16.54 ± 0.00	17.41 ± 0.05	44.42 ± 0.03	4.87 ± 0.00	11.01 ± 0.09	23.93 ± 0.06	/
MOBO-JES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.16 ± 0.07

Table 11. Hypervolume results for MORL with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	MO-Hopper	MO-Swimmer
$\mathcal{D}$(best)	4.21	2.85
End-to-End	4.76 ± 0.25	2.77 ± 0.03
End-to-End + GradNorm	5.02 ± 0.04	0.54 ± 0.00
End-to-End + PcGrad	4.00 ± 0.33	0.52 ± 0.00
Multi-Head	4.57 ± 0.28	1.70 ± 1.17
Multi-Head + GradNorm	3.78 ± 0.05	2.89 ± 0.07
Multi-Head + PcGrad	4.27 ± 0.61	1.52 ± 1.00
Multiple Models	4.58 ± 0.19	2.61 ± 0.14
Multiple Models + COMs	4.84 ± 0.16	**2.94 ± 0.00**
Multiple Models + RoMA	5.07 ± 0.39	2.61 ± 0.00
Multiple Models + IOM	**5.32 ± 0.49**	2.94 ± 0.11
Multiple Models + ICT	4.67 ± 0.12	2.69 ± 0.02
Multiple Models + Tri-Mentoring	4.93 ± 0.11	2.82 ± 0.10
MOBO	4.43 ± 0.08	2.61 ± 0.02
MOBO-ParEGO	N/A	N/A
MOBO-JES	N/A	N/A

Table 12. Hypervolume results for MOCO with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	Bi-CVRP-20	Bi-CVRP-50	Bi-CVRP-100	Bi-KP-50	Bi-KP-100	Bi-KP-200	Bi-TSP-20	Bi-TSP-50	Bi-TSP-100	Bi-TSP-500	Tri-TSP-20	Tri-TSP-50	Tri-TSP-100
$\mathcal{D}$(best)	**5.37**	**5.11**	4.91	3.00	**3.45**	**4.68**	**5.05**	**4.89**	4.55	**4.52**	**11.88**	9.82	9.36
End-to-End	4.85 ± 0.18	4.70 ± 0.17	4.91 ± 0.02	2.98 ± 0.00	3.02 ± 0.00	3.71 ± 0.47	3.64 ± 0.08	4.57 ± 0.08	**4.60 ± 0.01**	4.20 ± 0.29	7.84 ± 0.37	4.67 ± 0.17	9.26 ± 0.23
End-to-End + GradNorm	4.77 ± 0.06	3.68 ± 0.20	3.84 ± 0.05	3.06 ± 0.00	2.84 ± 0.14	3.25 ± 0.01	3.12 ± 0.13	4.33 ± 0.00	4.04 ± 0.06	4.45 ± 0.02	7.84 ± 0.17	8.96 ± 0.07	9.41 ± 0.04
End-to-End + PcGrad	4.56 ± 0.06	4.32 ± 0.09	4.15 ± 0.34	**3.16 ± 0.02**	3.08 ± 0.03	3.52 ± 0.27	3.08 ± 0.03	4.68 ± 0.03	4.55 ± 0.02	4.17 ± 0.12	10.83 ± 0.03	8.15 ± 0.39	9.68 ± 0.15
Multi-Head	4.00 ± 0.06	4.03 ± 0.26	4.78 ± 0.16	3.11 ± 0.06	2.88 ± 0.04	4.03 ± 0.41	3.36 ± 0.14	4.60 ± 0.09	4.04 ± 0.09	3.70 ± 0.27	6.31 ± 0.14	6.43 ± 0.42	8.60 ± 0.13
Multi-Head + GradNorm	4.50 ± 0.51	3.69 ± 0.12	4.35 ± 0.57	2.88 ± 0.07	2.47 ± 0.01	2.98 ± 0.41	4.39 ± 0.17	3.40 ± 0.02	3.45 ± 0.35	3.83 ± 0.02	7.84 ± 0.20	6.48 ± 0.65	8.48 ± 0.23
Multi-Head + PcGrad	4.48 ± 0.48	4.24 ± 0.12	3.45 ± 0.11	3.13 ± 0.06	2.60 ± 0.37	4.34 ± 0.10	2.85 ± 0.10	3.89 ± 0.12	3.78 ± 0.00	2.62 ± 0.88	10.39 ± 0.14	7.46 ± 1.00	**10.10 ± 0.07**
Multiple Models	4.95 ± 0.06	4.88 ± 0.03	4.92 ± 0.00	3.03 ± 0.02	3.19 ± 0.07	3.84 ± 0.54	3.55 ± 0.05	3.27 ± 0.04	4.22 ± 0.18	4.51 ± 0.01	7.26 ± 0.09	6.90 ± 0.08	7.68 ± 0.38
Multiple Models + COMs	5.28 ± 0.00	4.27 ± 0.14	4.23 ± 0.10	2.97 ± 0.00	3.11 ± 0.05	4.05 ± 0.46	4.54 ± 0.06	4.30 ± 0.07	4.02 ± 0.10		10.94 ± 0.46	8.55 ± 0.40	8.84 ± 0.26
Multiple Models + RoMA	4.56 ± 0.01	4.22 ± 0.23	3.97 ± 0.15	2.80 ± 0.06	3.11 ± 0.09	3.74 ± 0.26	4.25 ± 0.36	4.48 ± 0.04	4.31 ± 0.01	2.51 ± 0.69	9.37 ± 0.51	7.77 ± 0.03	9.10 ± 0.09
Multiple Models + IOM	5.28 ± 0.01	5.11 ± 0.00	**4.93 ± 0.00**	2.98 ± 0.02	2.86 ± 0.05	4.12 ± 0.21	**4.85 ± 0.04**	4.79 ± 0.01	4.53 ± 0.00	4.39 ± 0.09	11.65 ± 0.03	**10.19 ± 0.05**	9.89 ± 0.02
Multiple Models + ICT	4.15 ± 0.21	4.29 ± 0.17	3.96 ± 0.08	2.75 ± 0.11	2.68 ± 0.14	3.56 ± 0.09	3.88 ± 0.24	3.75 ± 0.04	4.20 ± 0.11		7.09 ± 0.03	8.37 ± 0.02	7.50 ± 0.12
Multiple Models + Tri-Mentoring	4.12 ± 0.16	4.06 ± 0.20	4.09 ± 0.13	2.90 ± 0.10	2.88 ± 0.04	3.32 ± 0.05	3.96 ± 0.18	3.75 ± 0.11	4.17 ± 0.14	3.69 ± 0.39	7.50 ± 0.47	8.16 ± 0.23	8.23 ± 0.27
MOBO	3.38 ± 0.23	2.40 ± 0.09	1.58 ± 0.02	2.73 ± 0.14	2.33 ± 0.05	1.89 ± 0.06	2.42 ± 0.16	1.77 ± 0.01	1.56 ± 0.06	/	5.64 ± 0.04	3.36 ± 0.12	2.54 ± 0.03
MOBO-ParEGO	3.69 ± 0.13	2.77 ± 0.10	1.66 ± 0.02	/	/	N/A	2.70 ± 0.09	2.10 ± 0.01	1.75 ± 0.01	N/A	4.40 ± 0.14	3.54 ± 0.00	2.38 ± 0.01
MOBO-JES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 13. Hypervolume results for Sci-Design with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	Molecule	Regex	RFP	ZINC
$\mathcal{D}$(best)	2.26	2.82	3.36	4.01
End-to-End	2.30 ± 0.48	2.80 ± 0.00	3.80 ± 0.04	4.17 ± 0.00
End-to-End + GradNorm	1.10 ± 0.03	2.80 ± 0.00	4.11 ± 0.30	4.17 ± 0.00
End-to-End + PcGrad	1.54 ± 0.53	2.80 ± 0.00	3.84 ± 0.05	4.16 ± 0.08
Multi-Head	2.08 ± 0.00	2.80 ± 0.00	4.06 ± 0.29	4.16 ± 0.00
Multi-Head + GradNorm	1.62 ± 0.61	2.38 ± 0.00	4.08 ± 0.32	4.21 ± 0.05
Multi-Head + PcGrad	1.22 ± 0.10	2.80 ± 0.00	4.19 ± 0.22	4.12 ± 0.02
Multiple Models	**2.78 ± 0.00**	2.80 ± 0.00	4.40 ± 0.02	4.16 ± 0.00
Multiple Models + COMs	2.30 ± 0.00	2.21 ± 0.17	4.14 ± 0.35	4.12 ± 0.05
Multiple Models + RoMA	1.65 ± 0.02	2.80 ± 0.00	4.13 ± 0.29	4.16 ± 0.01
Multiple Models + IOM	1.75 ± 0.33	2.80 ± 0.00	4.13 ± 0.28	4.17 ± 0.00
Multiple Models + ICT	1.37 ± 0.17	2.80 ± 0.00	**4.41 ± 0.00**	4.10 ± 0.07
Multiple Models + Tri-Mentoring	2.03 ± 0.00	2.80 ± 0.00	4.12 ± 0.29	4.06 ± 0.01
MOBO	2.22 ± 0.08	**5.12 ± 0.17**	3.77 ± 0.00	**4.26 ± 0.00**
MOBO-ParEGO	2.16 ± 0.00	3.83 ± 0.00	/	4.05 ± 0.02
MOBO-JES	2.10 ± 1.04	N/A	N/A	N/A

Table 14. Hypervolume results for RE with 256 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	RE21	RE22	RE23	RE24	RE25	RE31	RE32	RE33	RE34	RE35	RE36	RE37	RE41	RE42	RE61
$\mathcal{D}$(best)	4.42	4.78	4.78	4.75	4.59	10.23	10.53	10.59	48.06	10.96	7.57	4.72	36.17	12.28	135.87
End-to-End	4.42 ± 0.00	**4.84 ± 0.00**	**4.84 ± 0.00**	4.38 ± 0.00	**4.84 ± 0.00**	10.56 ± 0.00	10.64 ± 0.00	**10.69 ± 0.00**	52.86 ± 0.05	11.69 ± 0.00	9.25 ± 1.00	6.21 ± 0.00	**44.13 ± 0.02**	20.04 ± 0.01	**144.30 ± 0.02**
End-to-End + GradNorm	4.81 ± 0.01	4.84 ± 0.00	2.64 ± 0.00	4.38 ± 0.00	4.84 ± 0.00	**10.65 ± 0.00**	10.63 ± 0.00	9.90 ± 0.00	51.38 ± 0.03	11.52 ± 0.00	9.16 ± 0.02	6.22 ± 0.01	41.26 ± 0.81	13.46 ± 0.00	141.37 ± 0.03
End-to-End + PcGrad	4.90 ± 0.05	4.84 ± 0.00	4.84 ± 0.00	4.38 ± 0.00	4.60 ± 0.24	**10.65 ± 0.00**	**10.65 ± 0.00**	10.41 ± 0.07	52.83 ± 0.08	11.68 ± 0.02	10.02 ± 0.00	5.52 ± 0.00	43.53 ± 0.37	14.27 ± 0.12	142.98 ± 0.38
Multi-Head	4.57 ± 0.15	4.84 ± 0.00	4.74 ± 0.00	4.78 ± 0.00	4.60 ± 0.24	10.65 ± 0.00	10.64 ± 0.00	**10.69 ± 0.00**	52.93 ± 0.01	11.74 ± 0.00	6.76 ± 0.00	5.78 ± 0.05	44.06 ± 0.02	20.71 ± 0.29	141.28 ± 1.13
Multi-Head + GradNorm	4.91 ± 0.00	4.83 ± 0.01	4.49 ± 0.09	2.64 ± 0.00	3.95 ± 0.00	10.65 ± 0.00	10.63 ± 0.00	5.85 ± 0.00	52.84 ± 0.01	11.52 ± 0.00	0.02 ± 0.00	6.36 ± 0.01	43.77 ± 0.09	19.01 ± 0.04	143.82 ± 0.20
Multi-Head + PcGrad	4.91 ± 0.01	4.84 ± 0.00	4.27 ± 0.12	**4.83 ± 0.00**	4.35 ± 0.00	7.66 ± 0.00	10.08 ± 0.00	10.61 ± 0.00	52.84 ± 0.00	11.60 ± 0.08	9.95 ± 0.14	6.42 ± 0.00	43.80 ± 0.08	20.39 ± 0.45	142.22 ± 0.38
Multiple Models	**4.94 ± 0.00**	4.84 ± 0.00	4.84 ± 0.00	4.82 ± 0.00	4.84 ± 0.00	10.65 ± 0.00	10.63 ± 0.00	10.67 ± 0.00	**54.16 ± 0.01**	11.70 ± 0.00	**10.52 ± 0.00**	6.49 ± 0.00	44.09 ± 0.12	**20.89 ± 0.07**	144.20 ± 0.02
Multiple Models + COMs	4.20 ± 0.38	4.84 ± 0.00	4.79 ± 0.01	4.59 ± 0.00	4.84 ± 0.00	5.28 ± 5.28	10.64 ± 0.00	10.56 ± 0.03	50.57 ± 1.05	11.55 ± 0.02	8.96 ± 0.02	5.99 ± 0.03	40.84 ± 0.30	15.12 ± 0.32	141.00 ± 0.81
Multiple Models + RoMA	4.92 ± 0.00	4.84 ± 0.00	4.84 ± 0.00	4.79 ± 0.02	4.69 ± 0.00	10.65 ± 0.00	**10.65 ± 0.00**	10.66 ± 0.00	52.73 ± 0.02	**11.78 ± 0.00**	8.08 ± 0.40	6.49 ± 0.01	43.80 ± 0.08	19.53 ± 0.21	143.61 ± 0.20
Multiple Models + IOM	4.94 ± 0.00	4.84 ± 0.00	4.84 ± 0.00	**4.84 ± 0.00**	4.84 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.68 ± 0.00	54.12 ± 0.02	11.75 ± 0.01	11.75 ± 0.01	6.54 ± 0.00	43.92 ± 0.01	20.78 ± 0.02	143.30 ± 0.14
Multiple Models + ICT	4.75 ± 0.17	4.84 ± 0.00	2.77 ± 0.00	4.67 ± 0.00	4.84 ± 0.00	10.65 ± 0.00	2.77 ± 0.00	10.51 ± 0.00	53.53 ± 0.01	11.70 ± 0.02	8.94 ± 0.01	6.25 ± 0.07	43.96 ± 0.11	20.59 ± 0.20	143.11 ± 0.23
Multiple Models + Tri-Mentoring	4.91 ± 0.00	4.84 ± 0.00	2.76 ± 0.00	4.83 ± 0.00	4.70 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.54 ± 0.00	53.39 ± 0.02	11.75 ± 0.00	9.72 ± 0.06	6.38 ± 0.06	43.81 ± 0.13	20.30 ± 0.11	143.82 ± 0.07
MOBO	4.66 ± 0.06	4.84 ± 0.00	4.84 ± 0.00	4.83 ± 0.00	4.84 ± 0.00	10.19 ± 0.00	/	10.69 ± 0.00	52.05 ± 0.00	11.75 ± 0.00	/	**6.60 ± 0.00**	/	16.03 ± 0.43	N/A
MOBO-ParEGO	4.65 ± 0.04	4.61 ± 0.00	4.84 ± 0.00	3.74 ± 0.00	4.71 ± 0.00	10.64 ± 0.01	9.77 ± 0.02	10.61 ± 0.03	49.27 ± 1.14	0.00 ± 0.00	0.00 ± 0.00	5.87 ± 0.05	N/A	N/A	N/A
MOBO-JES	4.85 ± 0.03	4.84 ± 0.00	4.83 ± 0.00	4.82 ± 0.00	4.84 ± 0.00	10.28 ± 0.00	**10.65 ± 0.00**	10.61 ± 0.03	50.30 ± 0.00	11.59 ± 0.02	9.43 ± 0.10	/	N/A	N/A	N/A

Table 15. Average rank of different offline MOO methods on each type of task with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	Synthetic	MO-NAS	MORL	MOCO	Sci-Design	RE	Average Rank
$\mathcal{D}$(best)	8.20 ± 0.30	9.45 ± 0.03	**1.75 ± 0.25**	**1.08 ± 0.00**	4.62 ± 0.12	10.07 ± 0.33	7.11 ± 0.12
End-to-End	8.00 ± 0.31	7.47 ± 0.21	9.75 ± 2.25	7.14 ± 0.53	8.62 ± 0.88	6.23 ± 0.17	7.33 ± 0.18
End-to-End + GradNorm	8.81 ± 0.31	8.05 ± 0.16	5.75 ± 1.75	8.41 ± 0.82	7.62 ± 0.12	9.40 ± 0.00	8.55 ± 0.14
End-to-End + PcGrad	8.11 ± 0.17	7.87 ± 0.39	9.25 ± 0.25	7.86 ± 0.61	7.06 ± 0.44	7.57 ± 0.57	7.91 ± 0.19
Multi-Head	7.09 ± 0.97	5.03 ± 0.03	5.75 ± 1.75	9.02 ± 0.40	6.81 ± 0.44	7.73 ± 0.47	6.90 ± 0.41
Multi-Head + GradNorm	8.08 ± 0.42	10.33 ± 0.06	13.00 ± 0.50	8.81 ± 0.50	11.62 ± 0.38	9.80 ± 0.33	9.56 ± 0.08
Multi-Head + PcGrad	7.52 ± 0.64	8.76 ± 0.66	6.75 ± 2.25	8.61 ± 0.14	11.21 ± 0.46	8.13 ± 0.13	8.30 ± 0.39
Multiple Models	**3.89 ± 0.42**	**3.96 ± 0.41**	9.00 ± 0.50	7.18 ± 0.57	8.94 ± 0.94	**4.20 ± 0.33**	4.98 ± 0.05
Multiple Models + COMs	8.41 ± 0.09	6.29 ± 0.03	8.00 ± 0.00	5.96 ± 0.88	7.00 ± 0.50	9.45 ± 0.18	7.51 ± 0.05
Multiple Models + RoMA	8.77 ± 0.33	5.05 ± 0.37	4.00 ± 0.00	6.81 ± 0.35	7.12 ± 0.62	7.93 ± 0.07	7.05 ± 0.16
Multiple Models + IOM	5.80 ± 0.39	4.39 ± 0.82	6.00 ± 1.00	3.69 ± 0.08	4.93 ± 0.40	4.93 ± 0.40	**4.89 ± 0.33**
Multiple Models + ICT	8.19 ± 0.34	12.71 ± 0.18	6.50 ± 0.00	8.69 ± 0.00	8.50 ± 0.25	8.20 ± 0.20	9.49 ± 0.09
Multiple Models + Tri-Mentoring	7.45 ± 0.08	11.92 ± 0.18	6.75 ± 0.25	8.42 ± 0.19	8.25 ± 0.00	5.10 ± 0.23	8.35 ± 0.10
MOBO	10.50 ± 1.50	6.08 ± 0.53	11.50 ± 0.50	12.62 ± 0.21	6.58 ± 0.08	8.50 ± 0.50	8.63 ± 0.39
MOBO-ParEGO	9.06 ± 0.19	10.80 ± 0.62	N/A	14.56 ± 0.00	**3.17 ± 0.17**	12.27 ± 0.44	10.93 ± 0.06
MOBO-JES	11.45 ± 0.45	14.00 ± 1.00	N/A	N/A	14.00 ± 0.00	10.17 ± 0.08	11.02 ± 0.19

Table 16. Hypervolume results for synthetic functions with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	DTLZ1	DTLZ2	DTLZ3	DTLZ4	DTLZ5	DTLZ6	DTLZ7	OmniTest	VLMOP1	VLMOP2	VLMOP3	ZDT1	ZDT2	ZDT3	ZDT4	ZDT6
$\mathcal{D}$(best)	10.52	9.43	9.71	10.76	9.06	8.20	8.32	3.87	2.28	1.64	45.14	4.04	4.70	5.12	5.46	4.76
End-to-End	10.06 ± 0.00	**10.65 ± 0.00**	**10.65 ± 0.00**	9.98 ± 0.35	8.63 ± 2.01	9.42 ± 0.00	6.37 ± 0.07	**4.35 ± 0.00**	0.00 ± 0.00	4.18 ± 0.02	46.76 ± 0.09	2.69 ± 0.00	3.21 ± 0.00	5.46 ± 0.00	3.04 ± 0.02	4.87 ± 0.02
End-to-End + GradNorm	**10.65 ± 0.00**	10.36 ± 0.28	10.63 ± 0.02	10.28 ± 0.48	8.50 ± 2.07	8.69 ± 0.68	8.62 ± 2.08	2.32 ± 0.04	0.00 ± 0.00	2.67 ± 1.21	38.20 ± 0.17	4.76 ± 0.00	4.01 ± 0.17	5.27 ± 0.03	3.02 ± 0.02	2.55 ± 0.23
End-to-End + PcGrad	10.62 ± 0.02	8.22 ± 1.99	**10.65 ± 0.00**	**10.76 ± 0.00**	8.01 ± 0.07	7.80 ± 0.80	10.52 ± 0.00	4.32 ± 0.03	1.36 ± 1.36	4.08 ± 0.10	34.65 ± 0.06	4.37 ± 0.29	5.70 ± 0.01	4.45 ± 0.94	2.99 ± 0.02	1.87 ± 0.10
Multi-Head	10.37 ± 0.24	10.64 ± 0.01	10.63 ± 0.01	10.14 ± 0.19	6.62 ± 0.00	9.39 ± 0.03	0.95 ± 0.95	4.18 ± 0.01	0.00 ± 0.00	4.48 ± 1.27	46.78 ± 0.16	2.69 ± 0.00	5.50 ± 0.03	2.94 ± 0.08	**4.90 ± 0.00**	
Multi-Head + GradNorm	10.64 ± 0.00	10.37 ± 0.13	10.50 ± 0.12	10.76 ± 0.00	7.97 ± 0.95	8.67 ± 0.78	9.58 ± 0.93	3.43 ± 0.90	0.00 ± 0.00	4.06 ± 0.01	29.52 ± 0.54	4.82 ± 0.01	4.32 ± 0.24	4.14 ± 1.07	3.16 ± 0.06	4.83 ± 0.03
Multi-Head + PcGrad	10.61 ± 0.01	10.64 ± 0.00	10.58 ± 0.04	10.76 ± 0.00	6.73 ± 0.51	9.22 ± 0.13	10.36 ± 0.02	4.34 ± 0.00	1.47 ± 1.47	2.66 ± 1.21	45.33 ± 1.58	2.69 ± 0.01	5.68 ± 0.04	3.49 ± 0.18	2.06 ± 0.15	
Multiple Models	10.64 ± 0.00	10.63 ± 0.02	10.64 ± 0.00	10.76 ± 0.00	8.52 ± 1.90	10.19 ± 0.37	10.56 ± 0.03	4.35 ± 0.00	0.56 ± 0.56	**4.22 ± 0.00**	**46.93 ± 0.00**	4.75 ± 0.00	5.56 ± 0.00	**5.71 ± 0.01**	3.70 ± 0.38	4.87 ± 0.01
Multiple Models + COMs	10.55 ± 0.04	9.83 ± 0.37	9.76 ± 0.10	10.72 ± 0.03	**9.93 ± 0.22**	9.10 ± 0.65	8.73 ± 0.01	4.35 ± 0.00	0.00 ± 0.00	1.68 ± 0.01	46.03 ± 0.26	3.82 ± 0.16	4.66 ± 0.11	5.44 ± 0.07	4.31 ± 0.05	4.33 ± 0.01
Multiple Models + RoMA	10.53 ± 0.06	10.47 ± 0.05	10.62 ± 0.01	10.76 ± 0.00	6.63 ± 0.01	**10.57 ± 0.02**	10.01 ± 0.08	2.60 ± 0.01	0.00 ± 0.00	1.46 ± 0.00	40.48 ± 0.34	**4.86 ± 0.01**	5.62 ± 0.01	5.40 ± 0.18	2.87 ± 0.09	1.76 ± 0.02
Multiple Models + IOM	10.61 ± 0.00	8.93 ± 0.23	9.63 ± 0.07	10.76 ± 0.00	**9.66 ± 0.36**	9.25 ± 0.27	10.55 ± 0.15	4.34 ± 0.00	0.58 ± 0.58	**46.92 ± 0.00**		4.62 ± 0.03	**5.72 ± 0.00**	5.50 ± 0.01	**4.39 ± 0.44**	4.30 ± 0.00
Multiple Models + ICT	10.63 ± 0.00	10.52 ± 0.01	10.63 ± 0.01	10.76 ± 0.00	9.61 ± 0.50	9.42 ± 0.00	9.94 ± 0.05	3.93 ± 0.00	1.57 ± 1.57	1.46 ± 0.00	43.55 ± 2.98	3.45 ± 0.07	5.50 ± 0.01	4.14 ± 0.12	3.27 ± 0.09	1.88 ± 0.01
Multiple Models + Tri-Mentoring	10.61 ± 0.01	**10.65 ± 0.00**	10.48 ± 0.07	10.76 ± 0.00	8.26 ± 0.02	9.42 ± 0.00	9.76 ± 0.01	**3.73 ± 0.07**	1.46 ± 0.00	46.56 ± 0.08		4.33 ± 0.05	5.53 ± 0.01	5.45 ± 0.04	3.21 ± 0.22	1.90 ± 0.00
MOBO	/	/	/	/	/	/	/	/	0.00 ± 0.00	/	/	/	/	/	/	/
MOBO-ParEGO	10.55 ± 0.08	8.62 ± 0.15	8.84 ± 0.48	10.76 ± 0.00	8.10 ± 0.10	7.55 ± 0.83		9.85 ± 0.14	4.19 ± 0.09	0.00 ± 0.00	1.46 ± 0.00	46.82 ± 0.03	4.11 ± 0.08	4.66 ± 0.06	4.96 ± 0.11	4.31 ± 0.07	2.51 ± 0.65
MOBO-JES	10.26 ± 0.10	/	/	/	/	/	/	8.75 ± 0.07	2.98 ± 0.00	/	1.46 ± 0.00	45.77 ± 0.64	3.87 ± 0.04	3.90 ± 0.02	4.72 ± 0.10	3.97 ± 0.24	1.87 ± 0.10

Table 17. Hypervolume results for MO-NAS with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	C-10/MOP1	C-10/MOP2	C-10/MOP3	C-10/MOP4	C-10/MOP5	C-10/MOP6	C-10/MOP7	C-10/MOP8	C-10/MOP9	IN-1K/MOP1	IN-1K/MOP2	IN-1K/MOP3	IN-1K/MOP4	IN-1K/MOP5	IN-1K/MOP6	IN-1K/MOP7	IN-1K/MOP8	IN-1K/MOP9	NasBench201-Test
$\mathcal{D}$(best)	4.78	10.49	9.78	21.15	40.51	92.43	358.27	4.55	10.59	4.97	5.00	11.21	16.63	17.26	44.43	4.69	11.42	21.50	9.24
End-to-End	**4.80 ± 0.00**	10.38 ± 0.10	10.66 ± 0.02	24.71 ± 0.03	48.81 ± 0.31	109.63 ± 0.09	513.62 ± 1.06	4.41 ± 0.07	9.29 ± 0.16	4.75 ± 0.01	4.04 ± 0.00	10.27 ± 0.13	16.81 ± 0.01	17.68 ± 0.06	45.13 ± 0.21	4.66 ± 0.22	10.33 ± 0.25	22.45 ± 0.31	10.22 ± 0.00
End-to-End + GradNorm	4.78 ± 0.00	10.51 ± 0.00	**10.72 ± 0.00**	24.11 ± 0.34	49.40 ± 0.08	110.13 ± 0.06	517.76 ± 1.15	4.25 ± 0.23	9.52 ± 0.34	5.11 ± 0.05	4.96 ± 0.03	10.29 ± 0.03	15.29 ± 0.00	17.40 ± 0.05	44.18 ± 0.00	4.60 ± 0.15	10.56 ± 0.24	22.07 ± 0.17	9.17 ± 0.03
End-to-End + PcGrad	**4.80 ± 0.00**	10.49 ± 0.01	10.65 ± 0.01	23.78 ± 0.15	**50.02 ± 0.08**	107.50 ± 0.05	512.26 ± 0.83	3.97 ± 0.01	10.72 ± 0.08	4.72 ± 0.01	5.16 ± 0.04	10.06 ± 0.57	15.42 ± 0.04	17.35 ± 0.02	43.51 ± 0.02	4.84 ± 0.01	10.15 ± 0.78	22.68 ± 0.10	10.01 ± 0.22
Multi-Head	4.80 ± 0.00	**10.52 ± 0.01**	10.36 ± 0.06	24.79 ± 0.47	49.91 ± 0.07	**111.62 ± 0.00**	519.26 ± 1.09	4.17 ± 0.04	9.03 ± 0.00	**5.31 ± 0.01**	4.93 ± 0.05	11.49 ± 0.02	16.72 ± 0.03	**17.69 ± 0.02**	45.25 ± 0.07	5.07 ± 0.01	11.33 ± 0.07	23.48 ± 0.53	9.99 ± 0.31
Multi-Head + GradNorm	4.79 ± 0.00	10.44 ± 0.05	9.05 ± 0.00	22.13 ± 0.41	48.51 ± 0.28	106.59 ± 0.06	515.87 ± 1.16	3.45 ± 0.06	7.92 ± 0.36	5.00 ± 0.03	4.30 ± 0.08	9.90 ± 0.05	16.76 ± 0.12	17.55 ± 0.08	41.23 ± 2.98	4.80 ± 0.02	7.93 ± 0.10	19.15 ± 0.26	10.24 ± 0.00
Multi-Head + PcGrad	4.80 ± 0.00	10.34 ± 0.18	9.71 ± 0.02	19.72 ± 0.19	49.20 ± 0.67	107.25 ± 0.06	504.65 ± 1.50	4.23 ± 0.06	9.36 ± 0.05	5.12 ± 0.01	11.30 ± 0.11	16.66 ± 0.08	16.87 ± 0.44	44.17 ± 0.05	**5.35 ± 0.07**	10.53 ± 0.11	22.51 ± 0.48	9.69 ± 0.07
Multiple Models	4.78 ± 0.01	**10.52 ± 0.01**	**10.72 ± 0.01**	**24.85 ± 0.08**	49.34 ± 0.09	109.68 ± 0.35	519.10 ± 0.05	4.56 ± 0.05	10.04 ± 0.19	5.30 ± 0.02	5.17 ± 0.01	11.54 ± 0.02	16.82 ± 0.02	17.67 ± 0.02	**45.30 ± 0.13**	**5.47 ± 0.08**	11.27 ± 0.36	22.29 ± 1.00	10.24 ± 0.00
Multiple Models + COMs	4.78 ± 0.03	10.51 ± 0.00	10.42 ± 0.05	24.42 ± 0.08	48.71 ± 0.56	108.69 ± 0.12	508.52 ± 1.36	**4.75 ± 0.01**	10.40 ± 0.00	5.14 ± 0.03	5.10 ± 0.01	11.43 ± 0.05	16.53 ± 0.00	17.56 ± 0.01	44.46 ± 0.00	4.17 ± 0.00	12.10 ± 0.00	25.93 ± 0.00	10.21 ± 0.02
Multiple Models + RoMA	4.80 ± 0.00	10.52 ± 0.00	10.44 ± 0.12	24.52 ± 0.04	47.08 ± 0.11	108.04 ± 0.10	517.85 ± 1.26	4.26 ± 0.10	10.21 ± 0.02	5.02 ± 0.05	**5.18 ± 0.03**	11.48 ± 0.05	**16.86 ± 0.03**	17.51 ± 0.01	44.78 ± 0.00	5.31 ± 0.00	**12.31 ± 0.00**	26.04 ± 0.00	10.23 ± 0.00
Multiple Models + IOM	4.80 ± 0.01	10.38 ± 0.00	10.53 ± 0.00	24.63 ± 0.24	48.43 ± 0.72	110.39 ± 1.00	518.27 ± 0.04	4.64 ± 0.13	**11.05 ± 0.06**	5.20 ± 0.03	5.14 ± 0.02	**11.57 ± 0.01**	16.76 ± 0.01	17.64 ± 0.08	45.03 ± 0.00	4.62 ± 0.00	**12.35 ± 0.00**	**26.43 ± 0.00**	**10.43 ± 0.08**
Multiple Models + ICT	2.31 ± 2.31	10.22 ± 0.24	8.34 ± 0.03	21.97 ± 0.06	48.94 ± 0.05	93.35 ± 2.86	447.32 ± 2.89	3.24 ± 0.07	7.31 ± 0.18	4.65 ± 0.02	4.91 ± 0.01	9.25 ± 0.11	15.14 ± 0.01	14.82 ± 0.26	43.05 ± 0.28	4.57 ± 0.39	10.44 ± 0.07	20.89 ± 0.17	9.14 ± 0.03
Multiple Models + Tri-Mentoring	4.38 ± 0.32	7.77 ± 0.01	8.65 ± 0.96	23.69 ± 0.01	48.86 ± 0.02	107.89 ± 0.47	506.44 ± 1.45	3.27 ± 0.02	7.32 ± 0.15	4.69 ± 0.01	4.43 ± 0.01	9.93 ± 0.10	15.24 ± 0.01	15.35 ± 0.37	41.14 ± 0.99	4.89 ± 0.00	9.65 ± 0.73	21.11 ± 0.99	9.74 ± 0.56
MOBO	4.79 ± 0.00	10.46 ± 0.02	10.56 ± 0.00	24.46 ± 0.48	**50.27 ± 0.02**	107.95 ± 2.80	482.04 ± 6.25	**4.66 ± 0.00**	10.97 ± 0.01	5.21 ± 0.01	5.12 ± 0.05	10.96 ± 0.06	16.44 ± 0.06	17.40 ± 0.06	45.03 ± 0.00	5.17 ± 0.03	12.12 ± 0.27	25.10 ± 0.18	/
MOBO-ParEGO	4.70 ± 0.00	10.44 ± 0.00	8.56 ± 0.00	17.50 ± 0.00	35.62 ± 0.00	88.02 ± 0.00	353.38 ± 0.00	4.38 ± 0.00	10.24 ± 0.00	4.56 ± 0.05	4.31 ± 0.07	10.45 ± 0.19	16.54 ± 0.00	17.29 ± 0.16	44.11 ± 0.03	4.71 ± 0.01	10.95 ± 0.11	22.59 ± 1.28	/
MOBO-JES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.96 ± 0.16

Table 18. Hypervolume results for MORL with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	MO-Hopper	MO-Swimmer
$\mathcal{D}$(best)	<u>4.21</u>	**2.85**
End-to-End	3.68 ± 0.00	2.04 ± 0.10
End-to-End + GradNorm	3.94 ± 0.23	2.06 ± 0.00
End-to-End + PcGrad	3.72 ± 0.01	1.95 ± 0.00
Multi-Head	3.74 ± 0.07	<u>2.66 ± 0.04</u>
Multi-Head + GradNorm	3.67 ± 0.00	1.87 ± 0.00
Multi-Head + PcGrad	3.86 ± 0.18	2.08 ± 0.02
Multiple Models	3.76 ± 0.01	1.91 ± 0.02
Multiple Models + COMs	3.72 ± 0.02	1.97 ± 0.00
Multiple Models + RoMA	**4.74 ± 0.00**	2.00 ± 0.00
Multiple Models + IOM	4.17 ± 0.18	1.96 ± 0.06
Multiple Models + ICT	3.70 ± 0.01	2.38 ± 0.11
Multiple Models + Tri-Mentoring	3.82 ± 0.03	1.98 ± 0.01
MOBO	3.68 ± 0.00	/
MOBO-ParEGO	N/A	N/A
MOBO-JES	N/A	N/A

Table 19. Hypervolume results for MOCO with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	Bi-CVRP-20	Bi-CVRP-50	Bi-CVRP-100	Bi-KP-50	Bi-KP-100	Bi-KP-200	Bi-TSP-20	Bi-TSP-50	Bi-TSP-100	Bi-TSP-500	Tri-TSP-20	Tri-TSP-50	Tri-TSP-100
$\mathcal{D}$(best)	**5.37**	**5.11**	**4.91**	**3.00**	**3.45**	**4.68**	**5.05**	**4.89**	**4.55**	**4.52**	**11.88**	**9.82**	<u>9.36</u>
End-to-End	3.48 ± 0.08	3.30 ± 0.22	4.14 ± 0.02	2.40 ± 0.03	1.87 ± 0.00	<u>3.69 ± 0.00</u>	2.54 ± 0.22	4.12 ± 0.01	3.83 ± 0.58	3.35 ± 0.01	4.70 ± 0.08	3.69 ± 0.04	6.27 ± 0.56
End-to-End + GradNorm	3.26 ± 0.05	2.93 ± 0.15	2.95 ± 0.02	2.23 ± 0.30	<u>2.35 ± 0.22</u>	1.90 ± 0.00	2.26 ± 0.10	3.21 ± 0.27	3.03 ± 0.18	4.19 ± 0.06	4.84 ± 0.36	4.66 ± 0.30	8.02 ± 0.11
End-to-End + PcGrad	3.15 ± 0.07	3.39 ± 0.05	3.14 ± 0.24	2.02 ± 0.05	1.95 ± 0.04	2.35 ± 0.00	2.29 ± 0.03	3.86 ± 0.24	3.32 ± 0.02	3.65 ± 0.09	7.04 ± 1.00	5.06 ± 0.93	8.50 ± 0.48
Multi-Head	3.09 ± 0.11	3.21 ± 0.01	3.84 ± 0.26	**2.45 ± 0.01**	1.75 ± 0.04	2.49 ± 0.00	2.45 ± 0.07	4.00 ± 0.08	3.25 ± 0.05	3.04 ± 0.09	3.90 ± 0.14	4.22 ± 0.14	6.29 ± 0.94
Multi-Head + GradNorm	3.10 ± 0.14	3.12 ± 0.22	2.64 ± 0.16	2.21 ± 0.02	2.18 ± 0.17	2.20 ± 0.17	3.23 ± 0.05	2.80 ± 0.04	3.08 ± 0.27	3.18 ± 0.03	4.50 ± 0.09	5.43 ± 0.47	6.52 ± 0.51
Multi-Head + PcGrad	2.97 ± 0.15	3.11 ± 0.03	2.97 ± 0.03	2.33 ± 0.03	2.06 ± 0.14	2.35 ± 0.00	2.24 ± 0.02	3.20 ± 0.05	3.20 ± 0.01	2.27 ± 0.78	6.97 ± 0.02	4.75 ± 0.27	**9.39 ± 0.00**
Multiple Models	3.37 ± 0.03	3.38 ± 0.13	4.24 ± 0.03	2.42 ± 0.05	2.07 ± 0.01	2.47 ± 0.00	2.45 ± 0.09	2.48 ± 0.20	3.40 ± 0.19	<u>4.34 ± 0.03</u>	4.32 ± 0.13	4.63 ± 0.20	6.34 ± 0.42
Multiple Models + COMs	<u>3.89 ± 0.00</u>	3.49 ± 0.14	3.27 ± 0.22	2.14 ± 0.03	2.10 ± 0.06	2.30 ± 0.00	3.06 ± 0.05	3.93 ± 0.05	3.35 ± 0.20	3.71 ± 0.13	7.18 ± 0.37	5.88 ± 0.92	7.31 ± 0.23
Multiple Models + RoMA	3.23 ± 0.03	3.41 ± 0.08	2.95 ± 0.05	2.17 ± 0.13	2.01 ± 0.09	2.49 ± 0.03	2.90 ± 0.14	3.60 ± 0.20	3.84 ± 0.03	1.53 ± 0.03	6.08 ± 0.11	6.04 ± 0.07	7.67 ± 0.11
Multiple Models + IOM	3.50 ± 0.22	<u>3.54 ± 0.02</u>	<u>4.55 ± 0.14</u>	2.15 ± 0.03	2.02 ± 0.02	2.45 ± 0.10	<u>3.62 ± 0.30</u>	<u>4.54 ± 0.03</u>	<u>4.33 ± 0.03</u>	4.01 ± 0.26	<u>9.25 ± 0.08</u>	<u>9.07 ± 0.21</u>	9.17 ± 0.05
Multiple Models + ICT	3.16 ± 0.02	3.23 ± 0.20	3.19 ± 0.04	2.01 ± 0.15	2.03 ± 0.22	2.46 ± 0.11	2.67 ± 0.01	2.89 ± 0.11	2.97 ± 0.08	3.38 ± 0.10	4.72 ± 0.16	5.71 ± 0.04	5.96 ± 0.20
Multiple Models + Tri-Mentoring	3.10 ± 0.06	3.03 ± 0.01	3.26 ± 0.20	2.25 ± 0.02	1.97 ± 0.00	2.35 ± 0.31	2.69 ± 0.03	2.98 ± 0.26	3.57 ± 0.16	3.31 ± 0.14	4.53 ± 0.30	5.74 ± 0.35	5.65 ± 0.18
MOBO	2.77 ± 0.05	2.26 ± 0.14	1.42 ± 0.07	2.38 ± 0.05	1.97 ± 0.12	2.04 ± 0.07	2.14 ± 0.24	1.61 ± 0.05	1.51 ± 0.05	/	3.47 ± 0.16	2.69 ± 0.03	2.20 ± 0.07
MOBO-ParEGO	2.79 ± 0.01	2.21 ± 0.01	1.20 ± 0.01	/	/	N/A	2.18 ± 0.07	1.71 ± 0.01	1.52 ± 0.00	N/A	3.52 ± 0.02	2.70 ± 0.02	2.11 ± 0.02
MOBO-JES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 20. Hypervolume results for Sci-Design with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	Molecule	Regex	RFP	ZINC
$\mathcal{D}$(best)	**2.26**	2.82	3.36	**4.01**
End-to-End	1.07 ± 0.07	2.05 ± 0.00	3.64 ± 0.05	3.95 ± 0.04
End-to-End + GradNorm	1.07 ± 0.07	2.05 ± 0.00	3.73 ± 0.04	3.92 ± 0.00
End-to-End + PcGrad	<u>2.12 ± 0.04</u>	2.05 ± 0.00	3.70 ± 0.05	3.89 ± 0.06
Multi-Head	2.08 ± 0.00	2.05 ± 0.00	3.74 ± 0.00	3.86 ± 0.02
Multi-Head + GradNorm	1.00 ± 0.00	2.05 ± 0.00	3.69 ± 0.01	3.82 ± 0.01
Multi-Head + PcGrad	1.00 ± 0.00	2.05 ± 0.00	3.68 ± 0.02	3.86 ± 0.01
Multiple Models	1.10 ± 0.09	2.05 ± 0.00	3.70 ± 0.01	3.84 ± 0.00
Multiple Models + COMs	1.76 ± 0.14	2.38 ± 0.33	3.70 ± 0.00	3.86 ± 0.02
Multiple Models + RoMA	1.03 ± 0.00	2.05 ± 0.00	**3.79 ± 0.04**	3.91 ± 0.02
Multiple Models + IOM	1.02 ± 0.01	2.05 ± 0.00	<u>3.76 ± 0.03</u>	3.91 ± 0.02
Multiple Models + ICT	1.02 ± 0.02	2.05 ± 0.00	3.67 ± 0.00	3.96 ± 0.07
Multiple Models + Tri-Mentoring	1.41 ± 0.17	2.05 ± 0.00	3.75 ± 0.03	3.75 ± 0.00
MOBO	1.02 ± 0.02	<u>3.42 ± 0.25</u>	/	3.90 ± 0.01
MOBO-ParEGO	1.84 ± 0.00	**3.44 ± 0.00**	/	<u>4.00 ± 0.03</u>
MOBO-JES	1.00 ± 0.00	N/A	N/A	N/A

Table 21. Hypervolume results for RE with 256 solutions and 50th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	RE21	RE22	RE23	RE24	RE25	RE31	RE32	RE33	RE34	RE35	RE36	RE37	RE41	RE42	RE61
$\mathcal{D}$(best)	4.42	4.78	4.59	4.75	4.59	4.79	10.23	10.53	10.59	48.06	10.96	7.57	4.72	36.17	12.28	135.87
End-to-End	4.42±0.00	**4.84±0.00**	**4.84±0.00**	4.38±0.00	4.73±0.04	10.56±0.00	10.64±0.00	**10.68±0.00**	50.27±0.40	11.69±0.00	8.86±0.79	4.67±0.35	**43.75±0.07**	19.89±0.05	**143.86±0.14**
End-to-End + GradNorm	4.39±0.02	4.84±0.00	2.64±0.00	4.29±0.00	4.84±0.00	**10.65±0.00**	10.61±0.00	9.72±0.03	47.25±3.23	11.47±0.01	5.74±0.00	6.02±0.07	40.63±1.01	13.46±0.00	137.59±3.59
End-to-End + PcGrad	4.61±0.32	4.52±0.32	**4.84±0.00**	4.22±0.02	4.35±0.00	**10.65±0.00**	10.64±0.00	9.86±0.36	52.17±0.55	11.67±0.01	9.46±0.03	4.00±0.18	41.87±0.01	15.81±1.68	140.21±2.41
Multi-Head	4.56±0.14	4.83±0.01	4.59±0.10	4.11±0.01	3.82±0.30	10.64±0.00	10.64±0.00	6.12±0.49	51.24±0.12	11.73±0.00	6.76±0.00	4.43±0.01	43.62±0.02	20.20±0.15	140.38±0.56
Multi-Head + GradNorm	4.84±0.01	3.75±0.06	3.70±0.09	2.64±0.00	3.14±0.01	10.65±0.00	10.62±0.01	6.12±0.49	52.50±0.14	11.51±0.00	0.02±0.00	5.90±0.44	43.41±0.16	15.25±1.79	142.41±0.63
Multi-Head + PcGrad	4.79±0.03	4.84±0.00	3.42±0.57	3.77±0.00	4.35±0.00	7.64±0.00	10.08±0.00	10.11±0.35	52.48±0.05	11.50±0.00	<u>9.64±0.00</u>	6.32±0.05	43.60±0.02	19.69±0.96	139.81±2.17
Multiple Models	**4.93±0.00**	4.84±0.00	4.84±0.00	<u>4.79±0.01</u>	4.83±0.01	10.63±0.00	10.63±0.00	9.62±0.62	**54.02±0.00**	11.65±0.01	**10.31±0.03**	6.45±0.01	42.97±0.42	**20.55±0.01**	<u>143.59±0.17</u>
Multiple Models + COMs	3.90±0.10	4.83±0.00	4.76±0.02	4.59±0.00	**4.84±0.00**	5.28±5.28	10.62±0.00	10.26±0.31	48.14±2.03	11.41±0.02	8.18±0.15	5.68±0.20	39.96±0.64	13.00±0.06	138.74±0.89
Multiple Models + RoMA	4.88±0.00	4.84±0.00	4.83±0.00	3.66±0.01	3.40±0.01	10.60±0.00	10.64±0.00	10.11±0.05	50.37±0.46	**11.76±0.01**	3.76±0.05	<u>6.37±0.04</u>	43.33±0.04	17.14±0.23	131.51±4.58
Multiple Models + IOM	<u>4.93±0.01</u>	4.84±0.00	4.81±0.02	4.28±0.01	4.14±0.01	10.65±0.00	<u>10.64±0.03</u>		53.83±0.06	11.68±0.05	9.33±0.09	6.33±0.08	42.93±0.11	<u>20.54±0.02</u>	141.76±0.13
Multiple Models + ICT	4.70±0.15	4.84±0.00	2.76±0.00	3.23±0.00	4.74±0.00	10.62±0.01	2.77±0.09	9.80±0.50	53.26±0.07	11.68±0.04	8.00±0.16	6.14±0.09	43.33±0.15	16.04±0.41	142.65±0.50
Multiple Models + Tri-Mentoring	4.89±0.01	4.84±0.00	2.76±0.00	**4.81±0.01**	4.70±0.00	10.65±0.00	<u>10.65±0.00</u>	10.54±0.00	50.66±0.02	<u>11.75±0.00</u>	8.47±0.15	6.35±0.07	43.25±0.23	18.95±0.91	143.33±0.31
MOBO		4.84±0.00		3.32±0.02	4.83±0.00	10.03±0.00	/	/	/	11.42±0.07	/	/	/	N/A	N/A	N/A
MOBO-ParEGO	4.44±0.15	4.21±0.40	4.75±0.01	0.00±0.00	4.12±0.29	5.31±5.31	8.82±0.37	10.46±0.09	43.07±0.74	0.00±0.00	0.00±0.00	5.52±0.04	N/A	N/A	N/A
MOBO-JES	3.89±0.03	4.57±0.03	4.66±0.05	4.54±0.00	4.80±0.00	10.01±0.01	10.63±0.00	10.52±0.03	48.52±0.00	11.12±0.03	6.46±0.34	5.24±0.17	N/A	N/A	N/A

Table 22. Average rank of different offline MOO methods on each type of task with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	Synthetic	MO-NAS	MORL	MOCO	Sci-Design	RE	Average Rank
$\mathcal{D}$(best)	10.66 ± 0.16	9.11 ± 0.32	3.50 ± 0.50	**1.23 ± 0.15**	6.12 ± 0.12	12.37 ± 0.03	8.30 ± 0.13
End-to-End	6.69 ± 0.06	5.89 ± 0.11	6.50 ± 1.00	5.31 ± 0.54	**3.06 ± 0.31**	8.13 ± 0.13	6.31 ± 0.09
End-to-End + GradNorm	7.33 ± 0.05	6.76 ± 0.18	5.25 ± 1.25	7.92 ± 0.08	10.54 ± 0.21	10.03 ± 0.50	8.01 ± 0.02
End-to-End + PcGrad	7.58 ± 0.64	6.18 ± 0.24	<u>3.25 ± 0.75</u>	6.88 ± 0.04	5.52 ± 0.35	7.97 ± 0.03	6.96 ± 0.21
Multi-Head	6.05 ± 0.27	5.34 ± 0.66	10.00 ± 0.50	7.63 ± 0.37	4.94 ± 0.44	8.07 ± 0.00	6.65 ± 0.06
Multi-Head + GradNorm	7.55 ± 0.17	7.74 ± 0.21	9.50 ± 0.50	10.69 ± 0.23	11.75 ± 0.50	9.70 ± 0.70	8.96 ± 0.33
Multi-Head + PcGrad	8.05 ± 0.27	6.28 ± 0.28	8.50 ± 1.50	8.49 ± 0.42	9.50 ± 0.12	7.40 ± 0.13	7.59 ± 0.26
Multiple Models	**4.98 ± 0.14**	**3.76 ± 0.50**	10.00 ± 0.50	5.42 ± 0.58	9.25 ± 0.00	5.45 ± 0.08	<u>5.22 ± 0.02</u>
Multiple Models + COMs	8.31 ± 0.06	<u>4.75 ± 0.31</u>	**1.50 ± 0.00**	5.46 ± 0.38	9.00 ± 1.00	9.45 ± 0.05	6.93 ± 0.07
Multiple Models + RoMA	8.52 ± 0.27	5.15 ± 0.22	6.00 ± 0.00	8.54 ± 0.92	7.50 ± 0.12	7.13 ± 0.40	7.29 ± 0.39
Multiple Models + IOM	6.44 ± 0.09	4.77 ± 0.15	6.75 ± 1.25	<u>3.17 ± 0.21</u>	5.06 ± 0.44	**3.87 ± 0.13**	**4.69 ± 0.05**
Multiple Models + ICT	7.45 ± 0.35	10.30 ± 0.20	6.25 ± 0.25	9.66 ± 0.11	<u>4.88 ± 1.25</u>	7.43 ± 0.10	8.33 ± 0.04
Multiple Models + Tri-Mentoring	<u>5.92 ± 0.52</u>	9.39 ± 1.35	10.50 ± 0.00	10.15 ± 0.23	6.88 ± 0.00	6.30 ± 0.30	7.88 ± 0.05
MOBO	9.57 ± 0.00	/	/	13.15 ± 0.69	6.50 ± 0.50	8.00 ± 0.17	10.68 ± 0.25
MOBO-ParEGO	7.38 ± 0.38	11.00 ± 1.00	N/A	13.70 ± 0.50	/	<u>5.17 ± 0.00</u>	8.95 ± 0.16
MOBO-JES	11.21 ± 0.01	13.50 ± 0.50	N/A	N/A	7.00 ± 5.00	7.29 ± 0.12	9.12 ± 0.30

Table 23. Hypervolume results for synthetic functions with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	DTLZ1	DTLZ2	DTLZ3	DTLZ4	DTLZ5	DTLZ6	DTLZ7	OmniTest	VLMOP1	VLMOP2	VLMOP3	ZDT1	ZDT2	ZDT3	ZDT4	ZDT6
$\mathcal{D}$(best)	10.52	9.43	9.71	10.76	9.06	8.20	8.32	3.87	2.28	1.64	45.14±0.87	4.04	4.70	5.12	5.46	4.76
End-to-End	**10.64±0.00**	**10.65±0.00**	10.64±0.00	<u>10.76±0.00</u>	**10.64±0.01**	10.62±0.03	10.60±0.09	4.35±0.00	2.54±2.25	4.05±0.05	46.90±0.01	2.70±0.00	3.19±0.01	5.33±0.03	3.72±0.36	**4.90±0.00**
End-to-End + GradNorm	<u>10.63±0.01</u>	10.64±0.01	**10.65±0.00**	10.76±0.00	10.54±0.09	10.64±0.00	**10.71±0.00**	3.76±0.03	1.26±1.08	2.79±1.34	42.23±0.98	4.77±0.01	5.63±0.02	5.22±0.02	3.23±0.03	4.73±0.11
End-to-End + PcGrad	10.63±0.01	10.57±0.04	**10.65±0.00**	10.76±0.00	9.02±0.10	9.45±0.15	10.52±0.00	4.35±0.00	<u>4.80±0.02</u>	4.06±0.01	46.79±0.06	**4.84±0.01**	<u>5.70±0.01</u>	5.45±0.00	3.12±0.01	2.04±0.22
Multi-Head	10.37±0.26	**10.65±0.00**	10.64±0.00	10.76±0.00	10.61±0.03	**10.65±0.00**	10.52±0.00	4.24±0.00	2.57±2.25	4.08±0.01	46.93±0.00	2.72±0.00	**5.72±0.00**	5.41±0.10	3.70±0.23	4.87±0.01
Multi-Head + GradNorm	10.62±0.01	10.63±0.01	10.64±0.00	10.76±0.00	9.29±0.86	10.62±0.02	10.61±0.10	4.33±0.00	0.00±0.00	<u>4.13±0.03</u>	46.64±0.22	<u>4.83±0.00</u>	5.68±0.05	5.26±0.04	3.39±0.00	4.87±0.01
Multi-Head + PcGrad	10.63±0.00	10.63±0.00	10.61±0.03	10.76±0.00	9.08±0.35	10.59±0.01	10.49±0.01	4.35±0.00	3.99±0.01	4.00±0.00	46.91±0.00	2.72±0.04	5.69±0.03	5.45±0.00	3.64±0.73	2.05±0.18
Multiple Models	10.61±0.01	10.64±0.01	10.65±0.00	10.76±0.00	<u>10.63±0.01</u>	**10.65±0.00**	<u>10.67±0.03</u>	4.35±0.00	2.52±2.21	4.09±0.02	**46.97±0.00**	4.80±0.03	5.51±0.01	5.51±0.14	4.26±0.07	<u>4.88±0.00</u>
Multiple Models + COMs	10.63±0.00	10.48±0.08	10.55±0.04	10.76±0.00	9.14±0.44	9.50±0.15	9.14±0.03	4.41±0.04	**4.87±0.00**	4.21±0.07	46.81±0.12	4.21±0.07	4.85±0.02	5.25±0.24	3.99±0.10	4.80±0.01
Multiple Models + RoMA	10.63±0.01	10.57±0.03	10.64±0.00	10.76±0.00	9.10±0.48	10.60±0.00	10.12±0.05	3.97±0.06	1.46±0.00	44.15±2.36	4.83±0.01	5.65±0.00	**5.80±0.00**	3.18±0.05	1.84±0.07
Multiple Models + IOM	10.62±0.01	10.56±0.08	10.46±0.02	10.76±0.00	10.08±0.04	10.15±0.45	10.48±0.00	4.41±0.00	4.79±0.00	3.29±1.58	**46.97±0.00**	4.73±0.00	5.45±0.02	5.52±0.05	**4.84±0.00**	4.87±0.02
Multiple Models + ICT	10.63±0.00	10.62±0.01	10.56±0.09	10.76±0.00	7.98±0.53	10.61±0.01	10.54±0.01	4.41±0.00	/	1.46±0.00	**46.97±0.00**	4.25±0.15	5.54±0.01	4.35±0.08	**4.84±0.00**	2.79±0.56
Multiple Models + Tri-Mentoring	10.63±0.01	**10.65±0.00**	10.63±0.01	10.76±0.00	9.48±0.20	10.62±0.02	10.62±0.02	**4.82±0.00**	1.46±0.00	**46.97±0.00**	4.51±0.01	5.55±0.01	<u>5.59±0.16</u>	**4.84±0.00**	2.31±0.01
MOBO	/	/	/	/	/	/	10.34±0.01	/	0.30±0.00	2.73±0.02	46.92±0.04	4.30±0.04	5.08±0.00	5.26±0.01	/	/
MOBO-ParEGO	/	/	/	10.76±0.00	/	/	/	/	/	46.92±0.01	/	/	/	/	/
MOBO-JES	10.61±0.00	/	/	/	/	/	9.36±0.08	3.87±0.00	/	1.46±0.00	46.88±0.00	3.97±0.09	4.44±0.07	5.17±0.02	4.43±0.08	3.09±0.02

Table 24. Hypervolume results for MO-NAS with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	C-10/MOP1	C-10/MOP2	C-10/MOP3	C-10/MOP4	C-10/MOP5	C-10/MOP6	C-10/MOP7	C-10/MOP8	C-10/MOP9	IN-1K/MOP1	IN-1K/MOP2	IN-1K/MOP3	IN-1K/MOP4	IN-1K/MOP5	IN-1K/MOP6	IN-1K/MOP7	IN-1K/MOP8	IN-1K/MOP9	NasBench201-Test
$\mathcal{D}$(best)	4.78	10.49	9.78±0.06	21.15	40.51	92.43	358.27	4.55	10.59	4.97	5.00	11.21	16.63	17.26	44.43	4.69	11.42	21.50	9.24
End-to-End	4.82±0.00	10.22±0.26	10.63±0.00	24.21±0.12	49.48±0.00	109.05±0.00	**512.31±1.40**	4.61±0.07	10.68±0.00	4.80±0.02	5.11±0.00	10.93±0.06	16.88±0.04	17.68±0.03	45.39±0.33	5.07±0.07	11.07±0.04	22.38±0.37	10.28±0.01
End-to-End + GradNorm	4.83±0.00	10.49±0.03	10.45±0.06	24.96±0.30	**50.35±0.02**	108.57±0.41	508.72±0.60	4.55±0.01	10.26±0.17	5.14±0.00	4.88±0.03	10.62±0.07	16.87±0.16	17.49±0.25	44.38±0.63	4.97±0.09	10.44±0.06	22.71±0.19	9.39±0.32
End-to-End + PcGrad	4.83±0.00	10.53±0.00	10.53±0.06	25.30±0.15	50.57±0.02	108.22±0.52	501.11±0.00	4.34±0.18	**10.93±0.27**	5.05±0.01	5.01±0.00	11.14±0.13	16.16±0.61	17.44±0.04	44.07±0.26	4.93±0.00	10.95±0.01	23.39±0.00	10.32±0.02
Multi-Head	4.83±0.01	10.53±0.01	9.59±0.00	**25.78±0.15**	49.77±0.07	109.47±0.83	493.13±4.07	4.31±0.04	9.73±0.40	5.15±0.07	4.84±0.04	11.35±0.04	16.79±0.10	**17.80±0.02**	44.91±0.45	5.15±0.07	11.26±0.17	**24.00±0.06**	**10.39±0.09**
Multi-Head + GradNorm	**4.84±0.00**	10.54±0.00	9.59±0.01	23.47±0.12	49.49±0.62	107.76±0.09	499.69±3.16	4.41±0.21	10.19±0.61	4.66±0.02	4.37±0.02	10.40±0.24	16.80±0.09	17.74±0.00	45.10±0.00	4.90±0.07	8.11±0.27	17.78±0.01	9.99±0.09
Multi-Head + PcGrad	**4.84±0.00**	**10.55±0.00**	10.64±0.06	23.50±1.02	49.62±0.09	108.33±1.09	480.47±0.00	4.28±0.08	10.46±0.00	4.90±0.00	5.16±0.00	11.32±0.05	**16.91±0.14**	17.45±0.18	44.78±0.05	<u>5.25±0.07</u>	10.32±0.35	21.32±0.14	10.18±0.15
Multiple Models	4.83±0.01	10.53±0.02	**10.67±0.03**	25.56±0.01	49.96±0.00	110.94±0.29	<u>509.96±1.58</u>	4.69±0.17	10.38±0.32	5.13±0.04	5.07±0.03	11.26±0.02	16.84±0.11	17.70±0.04	**45.82±0.14**	**5.30±0.09**	<u>11.40±0.22</u>	23.48±0.51	10.28±0.00
Multiple Models + COMs	4.82±0.00	10.53±0.00	10.59±0.00	24.66±0.12	49.96±0.14	110.40±0.19	507.19±2.53	4.77±0.01	10.77±0.03	5.19±0.04	5.11±0.00	11.33±0.00	16.84±0.00	17.59±0.07	45.20±0.20	/	/	/	10.27±0.06
Multiple Models + RoMA	4.81±0.00	10.51±0.00	10.56±0.00	24.89±0.09	50.04±0.07	108.37±0.28	506.10±2.55	4.37±0.04	10.30±0.00	**5.23±0.02**	**5.17±0.01**	**11.39±0.02**	**16.97±0.06**	17.77±0.05	45.35±0.03	/	/	/	10.03±0.03
Multiple Models + IOM	4.82±0.00	10.44±0.01	10.65±0.04	24.55±0.00	50.23±0.06	**111.25±0.08**	493.81±15.32	**4.78±0.02**	10.80±0.07	5.15±0.01	5.07±0.00	**11.40±0.00**	16.57±0.08	17.71±0.02	45.73±0.11	/	/	/	10.13±0.16
Multiple Models + ICT	4.06±0.00	10.51±0.01	10.01±0.03	24.16±0.00	48.33±0.35	104.07±1.17	477.25±1.44	3.65±0.00	7.93±0.22	4.71±0.06	4.65±0.02	9.96±0.05	16.03±0.00	16.57±0.08	45.34±0.11	4.59±0.39	9.53±0.07	20.68±0.03	9.99±0.19
Multiple Models + Tri-Mentoring	4.06±0.00		9.48±0.17	23.83±0.10	49.02±0.00	110.23±0.25	481.97±1.83	3.27±0.13	8.22±0.00	4.97±0.19		9.82±0.00	15.61±0.00	15.88±0.00	44.90±0.00	4.63±0.51	10.66±0.04	21.85±1.10	8.09±2.16
MOBO	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9.43±0.02
MOBO-ParEGO	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9.16±0.07
MOBO-JES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.16±0.07

Table 25. Hypervolume results for MORL with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	MO-Hopper	MO-Swimmer
$\mathcal{D}$(best)	4.21	**2.85**
End-to-End	4.04 ± 0.24	2.56 ± 0.13
End-to-End + GradNorm	4.42 ± 0.36	2.65 ± 0.00
End-to-End + PcGrad	4.51 ± 0.27	2.75 ± 0.00
Multi-Head	3.81 ± 0.04	2.36 ± 0.13
Multi-Head + GradNorm	3.71 ± 0.03	2.55 ± 0.00
Multi-Head + PcGrad	4.40 ± 0.24	2.18 ± 0.19
Multiple Models	3.87 ± 0.00	2.28 ± 0.11
Multiple Models + COMs	**4.90 ± 0.06**	<u>2.81 ± 0.00</u>
Multiple Models + RoMA	4.18 ± 0.03	/
Multiple Models + IOM	<u>4.63 ± 0.33</u>	2.23 ± 0.02
Multiple Models + ICT	3.95 ± 0.03	2.69 ± 0.02
Multiple Models + Tri-Mentoring	3.70 ± 0.01	2.41 ± 0.02
MOBO	/	/
MOBO-ParEGO	N/A	N/A
MOBO-JES	N/A	N/A

Table 26. Hypervolume results for MOCO with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	Bi-CVRP-20	Bi-CVRP-50	Bi-CVRP-100	Bi-KP-50	Bi-KP-100	Bi-KP-200	Bi-TSP-20	Bi-TSP-50	Bi-TSP-100	Bi-TSP-500	Tri-TSP-20	Tri-TSP-50	Tri-TSP-100
$\mathcal{D}$(best)	**5.37**	**5.11**	<u>4.91</u>	**3.00**	**3.45**	**4.68**	**5.05**	**4.89**	**4.55**	**4.52**	**11.88**	**9.82**	**9.36**
End-to-End	5.05 ± 0.17	4.30 ± 0.12	4.53 ± 0.36	2.70 ± 0.04	2.33 ± 0.30	3.37 ± 0.00	3.44 ± 0.03	4.68 ± 0.12	<u>4.48 ± 0.02</u>	<u>4.48 ± 0.05</u>	6.87 ± 1.32	5.56 ± 0.70	<u>9.07 ± 0.04</u>
End-to-End + GradNorm	4.02 ± 0.27	3.75 ± 0.21	3.63 ± 0.00	2.67 ± 0.01	2.67 ± 0.02	2.69 ± 0.00	3.06 ± 0.30	3.87 ± 0.13	3.53 ± 0.00	4.11 ± 0.16	5.61 ± 0.01	6.29 ± 0.00	8.47 ± 0.12
End-to-End + PcGrad	3.59 ± 0.17	3.52 ± 0.40	3.63 ± 0.12	2.75 ± 0.00	2.58 ± 0.22	2.84 ± 0.15	3.14 ± 0.24	4.49 ± 0.02	4.18 ± 0.17	3.98 ± 0.02	9.31 ± 0.08	8.11 ± 0.00	8.54 ± 0.18
Multi-Head	4.65 ± 0.00	3.75 ± 0.12	4.88 ± 0.01	2.73 ± 0.03	2.45 ± 0.14	2.99 ± 0.24	3.10 ± 0.14	4.50 ± 0.02	3.48 ± 0.32	3.19 ± 0.04	5.14 ± 0.05	6.65 ± 1.16	8.34 ± 0.32
Multi-Head + GradNorm	3.77 ± 0.33	3.21 ± 0.07	3.04 ± 0.17	2.29 ± 0.16	2.24 ± 0.22	1.64 ± 0.00	3.69 ± 0.08	3.23 ± 0.01	3.27 ± 0.17	3.18 ± 0.08	5.96 ± 0.47	5.53 ± 0.30	6.73 ± 0.00
Multi-Head + PcGrad	4.22 ± 0.23	3.53 ± 0.73	3.09 ± 0.05	2.81 ± 0.00	2.35 ± 0.12	3.54 ± 0.00	3.78 ± 1.21	2.91 ± 0.15	3.26 ± 0.08	3.03 ± 0.20	6.93 ± 1.64	6.73 ± 0.27	8.67 ± 0.20
Multiple Models	5.01 ± 0.27	4.64 ± 0.13	4.62 ± 0.27	<u>2.84 ± 0.10</u>	<u>2.73 ± 0.27</u>	<u>3.63 ± 0.58</u>	2.71 ± 0.03	4.12 ± 0.54	4.23 ± 0.20	4.45 ± 0.00	6.36 ± 1.17	7.16 ± 0.68	8.65 ± 0.68
Multiple Models + COMs	<u>5.28 ± 0.00</u>	4.21 ± 0.23	3.52 ± 0.24	2.66 ± 0.02	2.73 ± 0.07	2.79 ± 0.38	4.60 ± 0.15	4.63 ± 0.07	3.96 ± 0.24	3.76 ± 0.15	<u>10.28 ± 0.86</u>	8.07 ± 0.15	8.11 ± 0.02
Multiple Models + RoMA	4.63 ± 0.11	3.55 ± 0.03	3.03 ± 0.20	2.57 ± 0.08	2.51 ± 0.33	2.38 ± 0.13	4.14 ± 0.11	3.72 ± 0.42	3.85 ± 0.23	1.76 ± 0.07	8.40 ± 0.76	5.89 ± 0.72	7.85 ± 0.69
Multiple Models + IOM	5.28 ± 0.00	<u>5.11 ± 0.00</u>	**4.92 ± 0.00**	2.64 ± 0.12	2.68 ± 0.23	3.39 ± 0.22	<u>4.86 ± 0.01</u>	<u>4.70 ± 0.01</u>	4.46 ± 0.06	4.00 ± 0.36	9.79 ± 0.09	<u>8.91 ± 0.24</u>	9.01 ± 0.37
Multiple Models + ICT	3.55 ± 0.17	4.01 ± 0.01	4.01 ± 0.37	2.36 ± 0.15	2.12 ± 0.00	2.31 ± 0.15	3.37 ± 0.21	3.09 ± 0.18	3.13 ± 0.07	4.11 ± 0.00	5.60 ± 0.15	6.12 ± 0.25	5.85 ± 0.20
Multiple Models + Tri-Mentoring	3.48 ± 0.20	3.82 ± 0.05	3.65 ± 0.00	2.04 ± 0.04	2.44 ± 0.11	2.45 ± 0.31	3.19 ± 0.20	2.99 ± 0.33	3.31 ± 0.10	3.34 ± 0.05	5.85 ± 0.97	6.15 ± 0.44	5.70 ± 0.19
MOBO	3.19 ± 0.38	2.50 ± 0.04	1.34 ± 0.02	2.50 ± 0.04	2.17 ± 0.14	2.08 ± 0.05	2.33 ± 0.08	1.81 ± 0.09	1.62 ± 0.01	1.26 ± 0.00	4.18 ± 0.37	3.20 ± 0.04	2.20 ± 0.09
MOBO-ParEGO	3.45 ± 0.03	2.63 ± 0.00	1.46 ± 0.01	/	/	N/A	/	1.96 ± 0.01	/	N/A	/	3.14 ± 0.01	/
MOBO-JES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 27. Hypervolume results for Sci-Design with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and <u>underlined</u>, respectively.

Methods	Molecule	Regex	RFP	ZINC
$\mathcal{D}$(best)	2.26	**2.82**	3.36	4.01
End-to-End	1.95 ± 0.13	<u>2.80 ± 0.00</u>	**4.34 ± 0.03**	<u>4.12 ± 0.01</u>
End-to-End + GradNorm	1.05 ± 0.00	2.38 ± 0.00	3.46 ± 0.08	4.00 ± 0.01
End-to-End + PcGrad	**3.33 ± 0.00**	2.47 ± 0.00	3.62 ± 0.00	4.04 ± 0.04
Multi-Head	2.20 ± 0.38	2.80 ± 0.00	3.67 ± 0.00	4.12 ± 0.00
Multi-Head + GradNorm	1.06 ± 0.05	2.38 ± 0.00	3.67 ± 0.00	3.82 ± 0.00
Multi-Head + PcGrad	1.04 ± 0.00	2.47 ± 0.00	3.71 ± 0.00	3.92 ± 0.00
Multiple Models	1.19 ± 0.14	2.38 ± 0.00	3.70 ± 0.00	4.01 ± 0.01
Multiple Models + COMs	2.16 ± 0.09	2.05 ± 0.00	3.65 ± 0.00	3.97 ± 0.10
Multiple Models + RoMA	1.84 ± 0.10	2.47 ± 0.00	3.71 ± 0.00	3.95 ± 0.00
Multiple Models + IOM	1.72 ± 0.36	2.47 ± 0.00	<u>4.06 ± 0.35</u>	4.08 ± 0.03
Multiple Models + ICT	<u>2.65 ± 1.31</u>	2.47 ± 0.00	3.76 ± 0.00	4.05 ± 0.02
Multiple Models + Tri-Mentoring	2.03 ± 0.00	2.47 ± 0.00	3.75 ± 0.00	3.94 ± 0.00
MOBO	1.15 ± 0.02	/	/	**4.18 ± 0.08**
MOBO-ParEGO	/	/	/	/
MOBO-JES	2.10 ± 1.04	N/A	N/A	N/A

Table 28. Hypervolume results for RE with 32 solutions and 100th percentile evaluations, where the best and runner-up results are **bolded** and underlined, respectively.

Methods	RE21	RE22	RE23	RE24	RE25	RE31	RE32	RE33	RE34	RE35	RE36	RE37	RE41	RE42	RE61
$\mathcal{D}$(best)	4.42	4.78	4.75	4.59	4.79	10.23	10.53	10.59	48.06	10.96	7.57	4.72	36.17	12.28	135.87
End-to-End	4.42 ± 0.00	**4.84 ± 0.00**	**4.84 ± 0.00**	4.38 ± 0.00	4.82 ± 0.02	10.58 ± 0.03	10.56 ± 0.08	**10.68 ± 0.00**	52.82 ± 0.05	11.61 ± 0.01	8.24 ± 0.00	6.20 ± 0.00	42.53 ± 0.05	17.09 ± 2.14	140.13 ± 1.42
End-to-End + GradNorm	4.81 ± 0.01	4.84 ± 0.00	2.64 ± 0.00	4.38 ± 0.00	**4.84 ± 0.00**	**10.65 ± 0.00**	10.63 ± 0.00	9.90 ± 0.00	51.98 ± 0.63	11.51 ± 0.00	8.63 ± 0.71	6.11 ± 0.10	39.21 ± 0.12	13.46 ± 0.00	140.24 ± 0.25
End-to-End + PcGrad	4.86 ± 0.01	4.84 ± 0.00	4.84 ± 0.00	4.40 ± 0.00	4.35 ± 0.00	10.65 ± 0.00	**10.65 ± 0.00**	10.41 ± 0.07	52.78 ± 0.04	11.66 ± 0.01	9.76 ± 0.11	5.52 ± 0.00	41.64 ± 0.31	15.92 ± 1.75	139.60 ± 0.28
Multi-Head	4.61 ± 0.13	4.84 ± 0.00	4.70 ± 0.04	4.78 ± 0.00	4.35 ± 0.00	10.65 ± 0.00	10.64 ± 0.00	10.65 ± 0.01	52.63 ± 0.22	11.70 ± 0.00	6.76 ± 0.00	5.72 ± 0.00	42.45 ± 0.40	19.30 ± 0.32	141.50 ± 0.03
Multi-Head + GradNorm	4.91 ± 0.00	4.65 ± 0.12	4.83 ± 0.00	3.51 ± 0.87	4.31 ± 0.53	10.65 ± 0.00	10.63 ± 0.00	5.82 ± 0.02	52.81 ± 0.00	11.51 ± 0.00	0.02 ± 0.00	6.26 ± 0.01	**42.56 ± 0.11**	15.82 ± 2.36	140.23 ± 0.66
Multi-Head + PcGrad	4.91 ± 0.01	4.84 ± 0.00	4.39 ± 0.01	**4.83 ± 0.00**	4.35 ± 0.00	7.66 ± 0.00	10.08 ± 0.00	10.52 ± 0.04	52.77 ± 0.01	11.71 ± 0.02	9.76 ± 0.18	**6.34 ± 0.03**	42.23 ± 0.17	20.19 ± 0.14	140.00 ± 0.12
Multiple Models	4.89 ± 0.01	4.84 ± 0.00	4.84 ± 0.00	4.82 ± 0.00	4.82 ± 0.00	10.65 ± 0.00	10.63 ± 0.00	10.61 ± 0.00	**53.58 ± 0.08**	11.61 ± 0.07	**10.38 ± 0.04**	6.30 ± 0.01	42.04 ± 0.28	20.70 ± 0.98	141.04 ± 0.60
Multiple Models + COMs	**5.19 ± 0.00**	4.82 ± 0.00	4.80 ± 0.00	4.59 ± 0.00	4.84 ± 0.00	10.56 ± 0.00	10.64 ± 0.00	10.39 ± 0.07	51.15 ± 0.13	11.57 ± 0.01	8.57 ± 0.20	5.85 ± 0.07	39.82 ± 0.10	21.13 ± 0.55	134.26 ± 1.43
Multiple Models + RoMA	4.81 ± 0.04	4.84 ± 0.00	4.84 ± 0.00	4.77 ± 0.05	4.69 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.46 ± 0.04	52.07 ± 0.16	**11.74 ± 0.00**	8.95 ± 0.01	6.31 ± 0.01	41.87 ± 0.20	16.32 ± 0.06	139.91 ± 0.72
Multiple Models + IOM	5.19 ± 0.00	4.84 ± 0.00	4.84 ± 0.00	4.83 ± 0.01	4.84 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	**10.67 ± 0.00**	53.55 ± 0.08	11.72 ± 0.02	9.79 ± 0.07	**6.34 ± 0.01**	42.46 ± 0.20	**21.68 ± 0.00**	139.47 ± 1.09
Multiple Models + ICT	5.19 ± 0.00	4.84 ± 0.00	2.87 ± 0.03	4.67 ± 0.00	4.82 ± 0.00	10.65 ± 0.00	2.77 ± 0.00	10.51 ± 0.00	52.81 ± 0.18	11.67 ± 0.00	9.75 ± 0.19	6.08 ± 0.05	42.06 ± 0.03	21.68 ± 0.00	139.24 ± 1.09
Multiple Models + Tri-Mentoring	5.19 ± 0.00	4.84 ± 0.00	2.65 ± 0.00	4.78 ± 0.03	4.74 ± 0.00	10.65 ± 0.00	10.65 ± 0.00	10.49 ± 0.00	52.91 ± 0.40	11.73 ± 0.01	8.92 ± 0.24	6.06 ± 0.12	42.18 ± 0.26	21.68 ± 0.00	**141.87 ± 0.26**
MOBO	/	4.84 ± 0.00	/	4.81 ± 0.01	4.84 ± 0.00	9.50 ± 0.00	/	/	/	11.61 ± 0.02	/	/	/	13.77 ± 0.13	N/A
MOBO-ParEGO	/	4.84 ± 0.00	4.84 ± 0.00	4.82 ± 0.00	4.84 ± 0.00	/	/	/	/	11.60 ± 0.00	10.19 ± 0.23	/	N/A	N/A	N/A
MOBO-JES	4.85 ± 0.03	4.84 ± 0.00	4.83 ± 0.00	4.82 ± 0.00	4.84 ± 0.00	10.28 ± 0.00	10.65 ± 0.00	10.61 ± 0.03	50.30 ± 0.00	11.59 ± 0.02	9.43 ± 0.10	6.20 ± 0.03	N/A	N/A	N/A