APPENDIX A
SUMMARY OF RESULTS AND ANALYSES

In this section, we provide detailed results and analyses.

A.1 Experiment Results for RQ1

This section provides a summary of statistics comparing the selected MuOSAs to RS (Table 1) and cases that the selected MuOSAs underperform RS (Table 2).

TABLE 1: Summary of Results for Selected MuOSAs Compared to RS

Metric	Comparison					
	Better Number	Better Rate	Equal Number	Equal Rate	Worse Number	Worse Rate
HV	1949	97.45%	9	0.45%	42	2.1%
IGD	1628	81.4%	372	18.6%	0	0%

TABLE 2: Summary of Worse Results Compared to RS for Selected MuOSAs Based on HV

Use Case	Problem	Time Budget	AlgorithmA	AlgorithmB	A12	p-value
AW4	*Prob.3 f(PET,PTR,ANU)*	TB020	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.3 f(PET,PTR,ANU)*	TB030	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.3 f(PET,PTR,ANU)*	TB040	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.6 f(PET,PTR,AUM,ANU)*	TB070	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.6 f(PET,PTR,AUM,ANU)*	TB100	SPEA2	SimpleRS	<0.5	<0.05
AW4	*Prob.8 f(PET,PTR,PUS,ANU)*	TB010	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.8 f(PET,PTR,PUS,ANU)*	TB020	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.8 f(PET,PTR,PUS,ANU)*	TB030	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.8 f(PET,PTR,PUS,ANU)*	TB040	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.8 f(PET,PTR,PUS,ANU)*	TB050	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB010	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB020	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB030	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB040	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB050	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB060	SPEA2	SimpleRS	<0.1	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB070	SPEA2	SimpleRS	<0.5	<0.01
AW4	*Prob.10 f(PET,PTR,ANU,PUU)*	TB080	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.3 f(PET,PTR,ANU)*	TB020	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.3 f(PET,PTR,ANU)*	TB030	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.3 f(PET,PTR,ANU)*	TB040	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.3 f(PET,PTR,ANU)*	TB050	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.6 f(PET,PTR,AUM,ANU)*	TB040	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.6 f(PET,PTR,AUM,ANU)*	TB050	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.6 f(PET,PTR,AUM,ANU)*	TB060	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.6 f(PET,PTR,AUM,ANU)*	TB070	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.6 f(PET,PTR,AUM,ANU)*	TB080	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.6 f(PET,PTR,AUM,ANU)*	TB090	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.8 f(PET,PTR,PUS,ANU)*	TB020	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.8 f(PET,PTR,PUS,ANU)*	TB030	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.8 f(PET,PTR,PUS,ANU)*	TB040	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.8 f(PET,PTR,PUS,ANU)*	TB050	SPEA2	SimpleRS	<0.5	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB010	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB020	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB030	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB040	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB050	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB060	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB070	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB080	SPEA2	SimpleRS	<0.1	<0.01

Use Case	Problem	Time Budget	AlgorithmA	AlgorithmB	A12	p-value
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB090	SPEA2	SimpleRS	<0.1	<0.01
GS1	*Prob.10 f(PET,PTR,ANU,PUU)*	TB100	SPEA2	SimpleRS	<0.5	<0.01

A.2 Experiment Results for RQ2

This section provides, in terms of *HV* and *IGD*, the best MuOSA in solving each problem within each time budget for each use case (i.e., Table 3 with *HV* and Table 4) with *IGD*. In addition, we provide a summary table (i.e., Table 5) that considers both results of *HV* and *IGD*.

TABLE 3: Summary of the Best MuOSA(s) for Each Use Case under Each Problem with Each Time Budget Based on HV

UC	Prob.	Time Budget										Prob.	Time Budget									
		10	20	30	40	50	60	70	80	90	100		10	20	30	40	50	60	70	80	90	100
AW1	1	N/S	S	S	S	S	S	S	S	S	S	6	S	S	S	S	S	S	S	S	S	S
AW2		N/S	S	S	S	S	S	S	S	S	S		M	M	M	M	M/S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		M	N/M	M	M	M	M	N/M	M	M	N/M
AW4		N/S	S	S	N/S	N/S	N/S	N/S	N	N/S	N/S		M	M	M	M	M	M	M	M	M/C	M/C
GS		S	S	S	S	S	S	S	S	S	S		M	M	M	M	M	M	M	M	M	M
AW1	2	S	S	S	N/S	S	S	S	S	S	S	7	N	N	N/S	N/S	S	S	S	S	S	S
AW2		S	S	S	S	S	S	S	S	S	S		N	N	N/S	N/S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW4		S	S	S	S	S	S	S	S	N/S	N/S		N	S	S	N/S	N/S	N/S	N/S	N/S	N	N
GS		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW1	3	S	N/S	S	S	S	S	S	S	S	S	8	N/S	N/S	S	N/S	S	S	S	S	N/M/S	S
AW2		N	N	S	S	S	S	S	S	S	S		N	N	N	S	S	S	S	S	S	S
AW3		N	N/S	S	S	S	S	S	S	S	S		N	S	S	S	S	S	S	S	S	S
AW4		M	M	M	M	M	M	M	M	M	M/C		M	M	M	M	M	M	M	M	M	M
GS		M	M	M	M	M	M	M	M	N/M	N/M		M	M	M	M	M	M	M	M	N/M	M
AW1	4	S	S	S	S	S	S	S	S	S	S	9	S	S	S	N/S	S	S	S	N/S	S	N/S
AW2		S	N/S	S	S	S	S	S	S	S	S		S	N/S	S	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW4		S	S	S	S	S	S	S	N/S	N/S	N/S		S	S	S	S	S	S	S	S	N/S	N/S
GS		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW1	5	N	N	N/S	N/S	S	S	S	S	S	S	10	N/S	N/S	S	N/S	S	S	S	S	S	S
AW2		N	N	N	N/S	S	S	S	S	S	S		N	N	S	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		N	N	S	S	S	S	S	S	S	S
AW4		N	N/S	S	N/S	N/S	N/S	N/S	N/S	N	N		M	M	M/C	M/C	M/C	C	C	C	C	C
GS		S	S	S	S	S	S	S	S	S	S		M	M	M	M	M	M	M	M	M	M

* Note that **Prob.**: Problems, **N:** NSGA-II, **M:** MOCell, **S:** SPEA2, and **C:** CellDE

TABLE 4: Summary of the Best MuOSA(s) for Each Use Case under Each Problem with Each Time Budget Based on IGD

UC	Prob.	Time Budget										Prob.	Time Budget									
		10	20	30	40	50	60	70	80	90	100		10	20	30	40	50	60	70	80	90	100
AW1	1	N	N	S	N/S	S	S	N/S	N/S	S	S	6	S	S	S	S	S	S	S	S	S	S
AW2		N/S	S	S	S	S	S	S	S	S	S		N	N/S	N	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		N	N	N/S	S	N/S	N/S	S	S	S	S
AW4		S	S	S	N/S	N/S	N/S	N/S	N	N/S	N		N	M	M	N/M	N/M	M	M	M	M	M
GS		S	S	S	S	S	S	S	S	S	S		N	N/M	N/M	N/M	N/M	M	M	M	M	N/M
AW1	2	S	S	N/S	N/S	S	ALL	ALL	ALL	ALL	ALL	7	N/M	N/M	N	N/S	N/S	N/S	N/S	N/S	N/S	N/S
AW2		S	S	S	S	S	S	S	S	S	S		N	S	S	S	S	S	S	S	S	S
AW3		ALL	S	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL		S	S	S	S	S	S	S	S	S	S
AW4		S	S	S	S	ALL	S	ALL	ALL	ALL	ALL		S	S	S	N/S	N/S	N/S	N/S	N/S	N	N
GS		ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL		S	S	S	S	S	S	S	S	S	S
AW1	3	S	S	S	S	S	S	S	S	S	S	8	S	S	N/S	N/S	S	ALL	ALL	ALL	ALL	S
AW2		S	S	S	S	S	S	S	S	S	S		S	N/S	S	S	S	S	S	S	S	S
AW3		N	S	S	S	S	S	S	S	S	S		N/S	S	S	S	S	S	S	ALL	S	S
AW4		N/M/C	N/M	M	M	M	M	M	M	M	N/M		N/M	M	M	M	M	M	M	M	N/M	N
GS		N	N	N	N	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N
AW1	4	S	S	S	N/S	S	ALL	ALL	ALL	ALL	S	9	S	S	S	N/S	ALL	ALL	ALL	ALL	ALL	ALL
AW2		S	S	S	S	S	S	S	S	S	S		S	N/S	S	S	S	S	S	S	S	S
AW3		S	ALL	ALL	ALL	S	S	S	ALL	S	ALL		ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL
AW4		S	S	S	S	S	S	ALL	ALL	N/S	N/S		S	S	S	S	ALL	ALL	ALL	ALL	N/S	ALL
GS		S	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL		ALL	ALL	S	S	ALL	ALL	ALL	ALL	ALL	ALL
AW1	5	N/M	N/M	N	N	N/S	N/S	N/S	N	N/S	N/S	10	S	S	S	S	S	S	S	S	S	S
AW2		N	N/S	S	S	S	S	S	S	S	S		S	N/S	S	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		N	N/S	S	N/S	S	S	S	S	S	S
AW4		S	S	S	S	N/S	N/S	N/S	N	N	N		C	N/M	M	M	M	M	M	M	M	M
GS		S	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL		N	N	N	N/M	M	N/M	N/M	N/M	N/M	N

* Note that **Prob.**: Problems, **N:** NSGA-II, **M:** MOCell, **S:** SPEA2, **C:** CellDE, and **ALL:** N/M/S/C

TABLE 5: Summary of the Best MuOSA(s) for Each Use Case under Each Problem with Each Time Budget Based on HV and IGD

UC	Prob.	Time Budget										Prob.	Time Budget									
		10	20	30	40	50	60	70	80	90	100		10	20	30	40	50	60	70	80	90	100
AW1	1	N	N	S	S	S	S	S	S	S	S	6	S	S	S	S	S	S	S	S	S	S
AW2		N/S	S	S	S	S	S	S	S	S	S		M	M/S	M	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		M	N	M/S	S	M/S	M/S	S	S	S	S
AW4		S	S	S	N/S	N/S	N/S	N/S	N	N/S	N		M	M	M	M	M	M	M	M	M	M
GS		S	S	S	S	S	S	S	S	S	S		M	M	M	M	M	M	M	M	M	M
AW1	2	S	S	S	N/S	S	S	S	S	S	S	7	N	N	N	N/S	S	S	S	S	S	S
AW2		S	S	S	S	S	S	S	S	S	S		N	S	S	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW4		S	S	S	S	S	S	S	S	N/S	N/S		S	S	S	N/S	N/S	N/S	N/S	N/S	N	N/S
GS		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW1	3	S	S	S	S	S	S	S	S	S	S	8	S	S	S	N/S	S	S	S	S	N/M/S	S
AW2		S	S	S	S	S	S	S	S	S	S		S	N	S	S	S	S	S	S	S	S
AW3		N	S	S	S	S	S	S	S	S	S		N	S	S	S	S	S	S	S	S	S
AW4		M	M	M	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M
GS		M	M	M	M	M	M	M	M	N	N		M	M	M	M	M	M	M	M	N	M
AW1	4	S	S	S	S	S	S	S	S	S	S	9	S	S	S	N/S	S	S	S	N/S	S	N/S
AW2		S	S	S	S	S	S	S	S	S	S		S	N/S	S	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW4		S	S	S	S	S	S	S	N/S	N/S	N/S		S	S	S	S	S	S	S	S	N/S	N/S
GS		S	S	S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	S
AW1	5	N	N	N	N	S	S	S	N	S	S	10	S	S	S	S	S	S	S	S	S	S
AW2		N	N	S	S	S	S	S	S	S	S		S	N	S	S	S	S	S	S	S	S
AW3		S	S	S	S	S	S	S	S	S	S		N	N	S	S	S	S	S	S	S	S
AW4		S	S	S	S	N/S	N/S	N/S	N	N	N		C	M	M	M	M	M	M	M	M	M
GS		S	S	S	S	S	S	S	S	S	S		M	M	M	M	M	M	M	M	M	M

* Note that **Prob.**: Problems, **N:** NSGA-II, **M:** MOCell, **S:** SPEA2, and **C:** CellDE

A.3 Experiment Results for RQ3

This section provides detailed *p*-values of applying the Spearman Correlation Coefficient between various time budgets and *ANOU* with the best MuOSA(s) for each problem on all case studies.

TABLE 6: Results of the Spearman Correlation Coefficient between various time budgets and *ANOU* with the best MuOSA(s) for each problem on all case studies

Problem	AW1		AW2		AW3		AW4		GS1	
	ρ	*p*-value	ρ	*p*-value	ρ	*p*-value	ρ	*p*-value	ρ	*p*-value
Prob.1 f(PET,PTR,AUM)	0.58	<0.01	0.93	<0.01	-0.25	<0.01	0.99	<0.01	0.96	<0.01
Prob.2 f(PET,PTR,PUS)	0.96	<0.01	0.94	<0.01	-0.12	<0.01	0.99	<0.01	0.99	<0.01
Prob.3 f(PET,PTR,ANU)	0.96	<0.01	0.98	<0.01	-0.95	<0.01	0.04	<0.01	-0.06	<0.01
Prob.4 f(PET,PTR,PUU)	0.96	<0.01	0.94	<0.01	-0.18	<0.01	0.99	<0.01	0.98	<0.01
Prob.5 f(PET,PTR,AUM,PUS)	0.41	<0.01	0.89	<0.01	-0.21	<0.01	0.99	<0.01	0.96	<0.01
Prob.6 f(PET,PTR,AUM,ANU)	0.26	<0.01	0.45	<0.01	-0.52	<0.01	-0.01	<0.01	-0.06	<0.01
Prob.7 f(PET,PTR,AUM,PUU)	0.50	<0.01	0.89	<0.01	-0.20	<0.01	0.99	<0.01	0.95	<0.01
Prob.8 f(PET,PTR,PUS,ANU)	0.96	<0.01	0.97	<0.01	-0.96	<0.01	0.07	<0.01	<u>0.00</u>	<u>0.23</u>
Prob.9 f(PET,PTR,PUS,PUU)	0.96	<0.01	0.94	<0.01	-0.09	<0.01	0.99	<0.01	0.98	<0.01
Prob.10 f(PET,PTR,ANU,PUU)	0.96	<0.01	0.98	<0.01	-0.95	<0.01	0.03	<0.01	-0.08	<0.01

* Note that an underlined <u>value</u> means that the correlation is not statistically significant (i.e., *p*-value > 0.05); otherwise, significant (i.e., *p*-value < 0.05).