Algorithms, Problems, and Metrics in MToP

Table S-1. Multitask evolutionary algorithms in MToP. Abbreviations: SO/MO = single-/multi-objective; MT/MaT = multi-/many-task; MF/MP = multifactorial/multi-population. Evolutionary operator types: GA = genetic algorithm; DE = differential evolution; SI = swarm intelligence; ES = evolution strategy; EDA = estimation of distribution algorithm; ND = non-dominated sorting; DC = decomposition. Knowledge transfer types: IG = individual gene; PD = population distribution; EB = evolutionary behavior.

Algorithm	Objective	Task	Framework	Category	Constraint	Description
MFEA [Gupta et al. 2016]	SO	MT	MF	GA+IG	✓	Multifactorial evolution-based GA for MTO
LDA-MFEA [Bali et al. 2017]	SO	MT	MF	GA+PD		Linearized domain adaptation in MFEA
MFDE&MFPSO [Feng et al. 2017]	SO	MT	MF	DE&SI+IG	✓	Multifactorial evolution-based DE and PSO
G-MFEA [Ding et al. 2019]	SO	MT	MF	GA+IG		Generalized MFEA with decision variable translation and shuffling
MFEA-GHS [Liang et al. 2019]	SO	MT	MF	GA+PD	✓	Genetic Transform and hyper-rectangle search in MFEA
MFEA-DV [Yin et al. 2019]	SO	MT	MF	GA+EB	✓	Enhanced MFEA with cross-task search direction
MFEA-II [Bali et al. 2020]	SO	MT	MF	GA+IG	✓	MFEA with online transfer parameter estimation
SREMTO [Zheng et al. 2020]	SO	MT	MF	GA+IG	✓	Self-regulated multitask framework for varying relatedness among tasks
TLTLA [Ma et al. 2020]	SO	MT	MF	GA+IG	✓	MFEA with two-level inter- and intra-task transfer learning
MFEA-AKT [Zhou et al. 2021]	SO	MT	MF	GA+IG		MFEA with adaptive knowledge transfer via multiple crossover operators
ASCMFDE [Tang et al. 2021]	SO	MT	MF	DE+PD	✓	Intertask transfer in aligned subspace for MFDE
AT-MFEA [Xue et al. 2022]	SO	MT	MF	GA+PD	✓	Affine transformation-enhanced domain adaptation for MFEA
MFEA-DGD [Liu et al. 2023]	SO	MT	MF	GA+EB		MFEA based on diffusion gradient descent
MFEA-VC [Wang et al. 2024]	SO	MT	MF	GA+PD		MFEA with contrastive variational auto-encoder
EMTO-AI [Zhou et al. 2024]	SO	MT	MF	DE+IG	✓	Adaptive intensity of knowledge transfer for MTO
IMEA [Hashimoto et al. 2018]	SO	MT	MP	GA+IG	✓	Multi-population framework for MTO through island model
EMEA [Feng et al. 2019b]	SO	MT	MP	GA+PD	✓	Explicit knowledge transfer for MTO via autoencoding
MFMP [Li et al. 2020]	SO	MT	MP	DE+IG	✓	Multi-population-based adaptive DE for MTO
DEORA [Li et al. 2022c]	SO	MT	MP	DE+IG		Adaptive task selection for competitive MTO
MKTDE [Li et al. 2022b]	SO	MT	MP	DE+IG	✓	Meta-knowledge transfer-based multitask DE
MTES [Bai et al. 2022]	SO	MT	MP	ES+EB	✓	Multitask OpenAI-ES via gradient-free evolution multitasking
BLKT-DE [Jiang et al. 2023b]	SO	MT	MP	DE+IG	✓	Multitask DE with block-level knowledge transfer
MTSRA [Li et al. 2023a]	SO	MT	MP	DE+IG		Improved adaptive DE with competitive task selection
MTDE-ADKT [Zhang et al. 2024a]	SO	MT	MP	DE+IG&PD	✓	Multitask DE with adaptive dual knowledge transfer
CEDA [Zhang et al. 2024b]	SO	MT	MF+MP	DE&GA+PD	✓	Constrained multitasking via co-evolution and domain adaptation
CMO-LKT [Ban et al. 2025]	SO	MT	MP	DE+IG	✓	Local knowledge transfer-based EA for constrained MTO
SSLT [Yuan et al. 2025]	SO	MT	MP	DE&GA+IG&PD	✓	Scenario-based self-learning transfer framework
MTEA-AD [Wang et al. 2022]	SO	MT/MaT	MP	GA+IG	✓	MTEA with adaptive knowledge transfer via anomaly detection
MTES-KG [Li et al. 2024c]	SO	MT/MaT	MP	ES+IG&PD	✓	Multitask ES with knowledge-guided external sampling
MTEA-HKTS [Zhao et al. 2024]	SO	MT/MaT	MP	DE&GA+IG	✓	MTEA for solving the problem of transfer targets
BoKT [Jiang et al. 2023a]	SO	MaT	MP	DE&GA+IG&PD		Bi-objective knowledge transfer framework for many-task optimization
TRADE [Wu et al. 2023]	SO	MaT	MP	DE+EB	✓	Transferable adaptive parameter DE for many-task optimization
TNG-NES [Li et al. 2024b]	SO	MaT	MP	ES+EB	✓	Transfer task-averaged natural gradient for efficient many-task optimization
DTSKT [Zhang et al. 2025]	SO	MaT	MP	EDA+EB	✓	Distribution direction-assisted two-stage knowledge transfer
MTEA-SaO [Li et al. 2023b]	SO+MO	MT/MaT	MP	DE&GA+IG	✓	Adaptive solver multitask framework with implicit knowledge transfer
KR-MTEA [Cui et al. 2023]	SO/MO	MT/MaT	MP	DE&GA+PD	✓	Adaptive multi-task EA based on knowledge reuse
MTEA-PAE [Gu et al. 2025]	SO/MO	MT/MaT	MP	DE&GA+PD	✓	Progressive auto-encoding for domain adaptation in MTO
SBO [Liaw and Ting 2019]	SO/MO	MaT	MP	GA+IG	✓	Symbiosis in biocoenosis framework for many-task optimization
MaTDE [Chen et al. 2020]	SO/MO	MaT	MP	DE+IG	✓	Many-task DE with adaptive archive-based knowledge transfer
EMaTO-MKT [Liang et al. 2022c]	SO/MO	MaT	MP	GA+PD		Multi-source knowledge transfer via local distribution estimation
MO-MFEA [Gupta et al. 2017]	MO	MT	MF	GA+IG	✓	Multiobjective MFEA with non-dominated sort and crowding distance
MO-MFEA-II [Bali et al. 2021]	MO	MT	MF	GA+IG	✓	Cognizant Multitasking for parameter estimation in MO-MFEA
EMT-PD [Liang et al. 2022b]	MO	MT	MF	GA+PD	✓	Two-stage adaptive knowledge transfer based on population distribution
EMT-GS [Liang et al. 2023]	MO	MT	MF	DE+PD	✓	Generative adversarial networks for knowledge transfer
MM-DE [Chen et al. 2018]	MO	MT	MP	ND+IG	✓	Fast memetic DE for multiobjective MTO
AMT-NSGA-II [Da et al. 2019]	MO	MT	MP	ND+PD	✓	Curbing negative influences online for seamless transfer
EMT-ET [Lin et al. 2021]	MO	MT	MP	ND+IG	✓	Effective knowledge transfer approach via non-dominated sort
MOMFEA-SADE [Liang et al. 2022a]	MO	MT	MP	ND+PD	✓	Subspace alignment and adaptive Differential Evolution
MTEA-D-DN [Wang et al. 2023]	MO	MT	MP	DC+IG		Neighborhood as a bridge for decomposition-based knowledge transfer
MTEA-D-TSD [Li et al. 2024a]	MO	MT	MP	DC+EB		Transfer search directions among decomposed subtasks
MTDE-MKTA [Li and Gong 2025]	MO	MT	MP	ND+IG&PD	✓	Multitask DE with multiple knowledge types and transfer adaptation
RVC-MTEA [Li et al. 2024e]	MO	MT	MP	DC+EB		Reference vector contribution based MTEA for competitive MO-MTO
MTEA-DCK [Li et al. 2025]	MO	MT	MP	ND+IG&PD	✓	Multiobjective MTEA with diversity and convergence knowledge transfer

Table S-2. Single-task evolutionary algorithms in MToP. Abbreviations: SO/MO = single-/multi-objective; ST/MT = single-/multi-task; GA = genetic algorithm; DE = differential evolution; SI = swarm intelligence; ES = evolution strategy; CH = constraint handling; ND = non-dominated sorting; ID = indicator-based; DC = decomposition; RV = reference vector.

Algorithms	Objective	Task	Category	Constraint	Description
GA [Zbigniew 1996]	SO	ST/MT	GA	✓	Genetic algorithm with SBX crossover and polynomial mutation
Global-GA [Bull and Liu 2024]	SO	ST/MT	GA	✓	GA with global crossover to replace cooperative coevolution
DE [Storn 1996]	SO	ST/MT	DE	✓	Differential evolution algorithm with DE/rand/1/bin operator
jDE [Brest et al. 2006]	SO	ST/MT	DE	✓	Self-adapting control parameters in DE
JADE [Zhang and Sanderson 2009]	SO	ST/MT	DE	✓	Adaptive DE with fast convergence performance
rank-DE [Gong and Cai 2013]	SO	ST/MT	DE	✓	Ranking-based mutation operators for DE
SHADE [Tanabe and Fukunaga 2013]	SO	ST/MT	DE	✓	Success-history based parameter adaptation for DE
L-SHADE [Tanabe and Fukunaga 2014]	SO	ST/MT	DE	✓	Linear population size reduction for SHADE
LSHADE44 [Poláková 2017]	SO	ST/MT	DE	✓	L-SHADE with competing strategies applied to constrained optimization
CAL-SHADE [Zamuda 2017]	SO	ST/MT	DE	✓	Adaptive constraint handling technique for L-SHADE
jSO [Brest et al. 2017]	SO	ST/MT	DE	✓	Champion of CEC 2017 numerical optimization competition via improved DE
NL-SHADE-RSP [Stanovov et al. 2021]	SO	ST/MT	DE		Champion of CEC 2021 numerical optimization competition via improved DE
PSO [Kennedy and Eberhart 1995]	SO	ST/MT	SI	✓	Particle swarm optimization with global and particle best update
CSO [Cheng and Jin 2015]	SO	ST/MT	SI	✓	Competitive swarm optimizer for large-scale optimization
MPA [Faramarzi et al. 2020a]	SO	ST/MT	SI	✓	Marine predators algorithm for numerical optimization
EO [Faramarzi et al. 2020b]	SO	ST/MT	SI	✓	Equilibrium optimizer for numerical optimization
AO [Abualigah et al. 2021]	SO	ST/MT	SI	✓	Aquila optimizer for numerical optimization
KLDE&KLPSO [Jiang et al. 2023c]	SO	ST/MT	DE/SI	✓	Knowledge learning-based DE and PSO for numerical optimization
CMA-ES [Hansen and Ostermeier 2001]	SO	ST/MT	ES	✓	Evolution strategy with derandomized covariance matrix adaptation
IPOP-CMA-ES [Auger and Hansen 2005]	SO	ST/MT	ES		Restart CMA-ES with increasing population size
sep-CMA-ES [Ros and Hansen 2008]	SO	ST/MT	ES	✓	Separable CMA-ES for large-scale optimization
xNES-as [Schaul 2012]	SO	ST/MT	ES	✓	Natural ES with adaptation sampling
R1-NES [Sun et al. 2013]	SO	ST/MT	ES	✓	A Linear Time natural ES for non-separable functions
xNES&SNES [Wierstra et al. 2014]	SO	ST/MT	ES	✓	ES with adaptive natural gradients to update distribution
OpenAI-ES [Salimans et al. 2017]	SO	ST/MT	ES	✓	Parallelized ES with standard normal distribution gradients
DES [Arabas and Jagodziński 2020]	SO	ST/MT	ES	✓	Matrix-free covariance matrix adaptation ES
MTV-DE [Mezura-Montes et al. 2007]	SO	ST/MT	CH	✓	Multiple trial vectors in DE for handling constraints
ECHT [Mallipeddi and Suganthan 2010b]	SO	ST/MT	CH	✓	Ensemble of constraint handling techniques
FROFI [Wang et al. 2016]	SO	ST/MT	CH	✓	Incorporating objective function information into the feasibility rule
C2oDE [Wang et al. 2019]	SO	ST/MT	CH	✓	Composite DE for constrained optimization
CORCO [Wang et al. 2020]	SO	ST/MT	CH	✓	Utilizing the correlation between constraints and objective function
DeCODE [Wang et al. 2021]	SO	ST/MT	CH	✓	Decomposition-based multiobjective approach for constrained optimization
VMCH [Wu et al. 2022]	SO	ST/MT	CH	✓	Voting-mechanism-based ensemble of constraint handling techniques
CEDE-DRL [Hu et al. 2023]	SO	ST/MT	CH	✓	Deep reinforcement learning assisted co-evolutionary DE
CCEF-ECHT [Li et al. 2024d]	SO	ST/MT	CH	✓	Competitive and cooperative ensemble of constraint handling techniques
SPEA2 [Zitzler et al. 2001]	MO	ST/MT	ND	✓	Improving the strength Pareto approach for multiobjective optimization
NSGA-II [Deb et al. 2002]	MO	ST/MT	ND	✓	Multiobjective GA with non-dominated sort and crowding distance
NSGA-III [Deb and Jain 2014]	MO	ST/MT	ND	✓	Reference-point-based nondominated sorting for multiobjective optimization
SMS-EMOA [Beume et al. 2007]	MO	ST/MT	ID	✓	Hypervolume-based selection for multiobjective optimization
MO-CMA-ES [Igel et al. 2007]	MO	ST/MT	ES		Covariance matrix adaptation for multiobjective optimization
MOEA/D [Zhang and Li 2007]	MO	ST/MT	DC		Decomposition-based multiobjective evolutionary algorithm
MOEA/D-DE [Li and Zhang 2009]	MO	ST/MT	DC		MOEA/D for complex Pareto sets in multiobjective optimization
RVEA [Cheng et al. 2016]	MO	ST/MT	RV		Reference vector-guided EA for many-objective optimization
AR-MOEA [Tian et al. 2018]	MO	ST/MT	ID		Adaptive reference points for MOEA/D in multiobjective optimization
MSEA [Tian et al. 2021a]	MO	ST/MT	ND		Multistage EA for better diversity preservation in multiobjective optimization
CCMO [Tian et al. 2021b]	MO	ST/MT	CH	✓	Coevolutionary framework for constrained multiobjective optimization
LMOCSO [Tian et al. 2020]	MO	ST/MT	SI	✓	Efficient large-scale multiobjective optimization based on CSO
CMOCSO [Ming et al. 2023]	MO	ST/MT	SI	✓	Competitive and cooperative swarm optimizer for multiobjective optimization

Table S-3. Benchmark and real-world optimization problems in MToP. Abbreviations: SO/MO = single-/multi-objective; ST/MT/MaT = single-/multi-/many-task.

Problem	Case	Task	Dimension	Objective	Task	Special	Description
CEC17-MTSO [Da et al. 2017]	9	2	50	SO	MT		Complete/partial/no global optima interaction and high/medium/low inter-task similarity
CEC19-MaTSO [Feng et al. 2019a]	6	2-50	50	SO	MaT		Single-objective many-task optimization problems
WCCI20-MTSO [Feng et al. 2020]	10	2	50	SO	MT		Complex single-objective MTO problems
WCCI20-MaTSO [Feng et al. 2020]	10	2-50	50	SO	MaT		Complex single-objective many-task optimization problems
CMT [Li et al. 2022a]	9	2	Any	SO	MT	Constrained	Large/partial/no feasible regions interaction and different inter-task similarity
C2TOP&C4TOP [Li et al. 2022c]	51	2/4	50	SO	MT	Competitive	Different optimal objective values among competitive tasks
C-CPLX [Li et al. 2023a]	20	2	50	SO	MT	Competitive	Complex competitive MTO problems
LSMaTSO [Li et al. 2024b]	5	2-50	300	SO	MaT		Large-scale many-task optimization problems
STOP [Xue et al. 2025]	12	2-50	50	SO	MaT		Scalable test problem generator for sequential transfer optimization
CEC17-MTMO [Yuan et al. 2017]	9	2	50	MO	MT		Complete/partial/no global optima interaction and high/medium/low inter-task similarity
CEC19-MTMO [Feng et al. 2019a]	10	2	50	MO	MT		Complex multi-objective MTO problems
CEC19-MaTMO [Feng et al. 2019a]	10	2-50	50	MO	MaT		Multi-objective many-task optimization problems
WCCI20-MaTMO [Feng et al. 2020]	10	2-50	50	MO	MaT		Complex multi-objective many-task optimization problems
CEC21-MTMO [Feng et al. 2021]	10	2	50	MO	MT		More complex multi-objective multi optimization problems
CMOMT [Li et al. 2024e]	12	2/3	30-60	MO	MT		Competitive multiobjective MTO problems
Synthetic Functions [Jamil and Yang 2013]	9	1	Any	SO	ST		Ackley, Elliptic, Griewank, Rastrigin, Rosenbrock Schwefel, Sphere, Weierstrass
CEC06-CSO [Liang et al. 2006]	24	1	2-24	SO	ST	Constrained	CEC 2006 competition on constrained single-objective optimization
CEC10-CSO [Mallipeddi and Suganthan 2010a]	18	1	10/30	SO	ST	Constrained	CEC 2010 competition on constrained single-objective optimization
CEC17-CSO [Wu et al. 2017]	28	1	2-100	SO	ST	Constrained	CEC 2017 competition on constrained single-objective optimization
CEC17-SO [Awad et al. 2017]	29	1	2-100	SO	ST		CEC 2017 competition on bound constrained single-objective optimization
CEC20-RWCO [Kumar et al. 2020]	57	1	2-158	SO	ST	Constrained	CEC 2020 competition on real-world constrained single-objective optimization
CEC22-SO [Kumar et al. 2022]	12	1	10/20	SO	ST		CEC 2022 competition on bound constrained single-objective optimization
PEPVM [Li et al. 2023b]	1	3	7	SO	MT		Parameter extraction of photovoltaic models as MTO problem
SCP [Li et al. 2022c]	1	Any	60-120	SO	MT	Competitive	Sensor coverage problem as competitive MTO problem
OPF [Li et al. 2024c]	5	2	24/33	SO	MT	Constrained	Optimal power flow as constrained MTO problem
MGA-GTOP [Yuan et al. 2025]	2	2/5	6-26	SO	MT		Multi-task global trajectory optimization
PKACP [Jiang et al. 2023a]	1	Any	Any	SO	MaT		Planar kinematic arm control problem as many-task optimization problem
MO-SCP [Li et al. 2023b]	2	Any	60-120	MO	MT	Competitive	Multiobjective sensor coverage problem as competitive multiobjective MTO problem
SOPM [Li and Gong 2025]	2	3	30	MO	MT	Constrained	Synchronous optimal pulse-width modulation as constrained multiobjective MTO problem
MO-OPF [Li and Gong 2025]	4	2	24/33	MO	MT	Constrained	Multiobjective optimal power flow as constrained multiobjective MTO problem
OPF-CMTMO [Li et al. 2024e]	4	2	11/24	MO	MT	Competitive	Competitive multitask optimal power flow with thermal and wind-solar power

Table S-4. Metrics in MToP. Abbreviations: SO/MO = single-/multi-objective; ST/MT = single-/multi-task; CV = constraint violation; FR = feasible rate; HV = hypervolume; IGD = inverted generational distance; IGD+ = improved IGD plus; AV/UV = average/unified average; MTS = multitask score; CMT = competitive multitask; NBR = number of best results.

Metric	Objective	Task	Description
Obj	SO	ST/MT	Objective value for each task
Obj (AV)	SO	MT	Average Obj for all tasks
Obj (UV)	SO	MT	Unified average Obj for all tasks
Obj (MTS)	SO	MT	Multitask score of Obj for all tasks
Obj (CMT)	SO	MT	Competitive multitask Obj for all tasks
Obj (NBR)	SO	MT	Number of best Obj result for all tasks
CV	SO	ST/MT	Constraint violation for each task
FR	SO	ST/MT	Feasible rate for each task
HV	MO	ST/MT	Hypervolume for each task
HV (MTS)	MO	MT	Multitask score of HV for all tasks
HV (CMT)	MO	MT	Competitive multitask HV for all tasks
IGD	MO	ST/MT	Inverted generational distance for each task
IGD (AV)	MO	MT	Average IGD for all tasks
IGD (MTS)	MO	MT	Multitask score of IGD for all tasks
IGD (CMT)	MO	MT	Competitive multitask IGD for all tasks
IGD+	MO	ST/MT	Improved IGD plus for each task
IGD+ (MTS)	MO	MT	Multitask score of IGD+ for all tasks
IGD+ (CMT)	MO	MT	Competitive multitask IGD+ for all tasks
Spread	MO	ST/MT	Spread metric for each task
Spread (CMT)	MO	MT	Competitive multitask spread for all tasks
Run Time	SO/MO	ST/MT	Algorithm running time for all tasks

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