Many-to-Many Assignment Algorithm and Its Collaborative Optimization Under Complex Multi-Dimensional Conflicts

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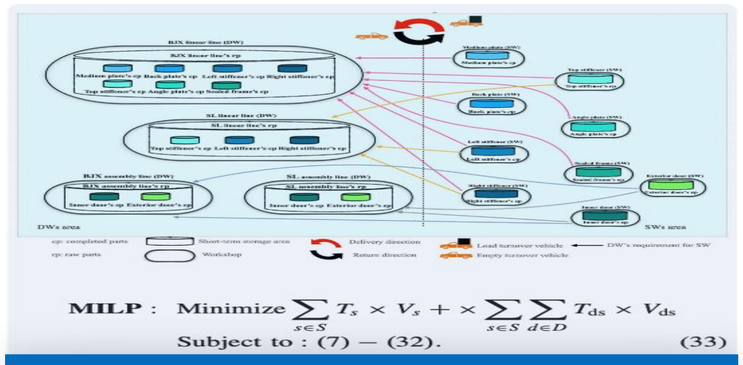
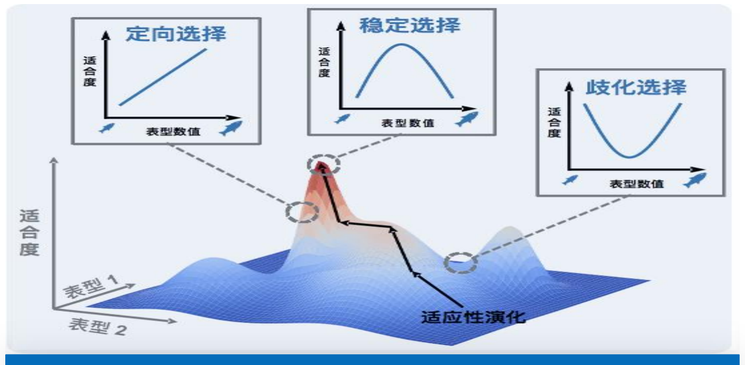
INTRODUCTION

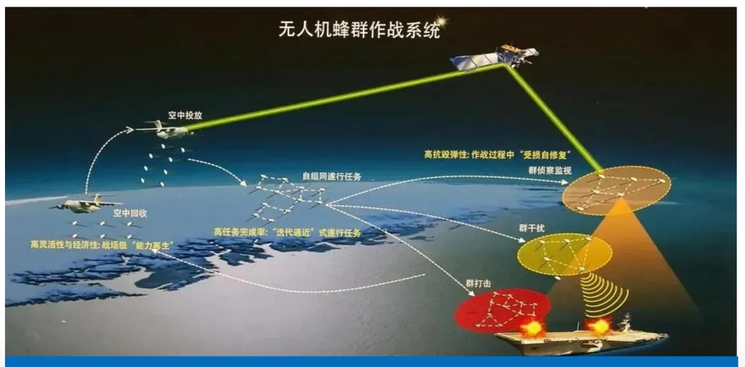
In the intelligent era, the three-dimensional coordination of human-machine-thing systems is a key factor in achieving a smart society. However, with the increasing complexity of business processes and the emergence of multi-dimensional conflicting constraints, existing system optimization strategies face challenges such as difficulty in model generalization, low solution accuracy, and slow adaptive evolution.



1. Difficulty in Model Generalization

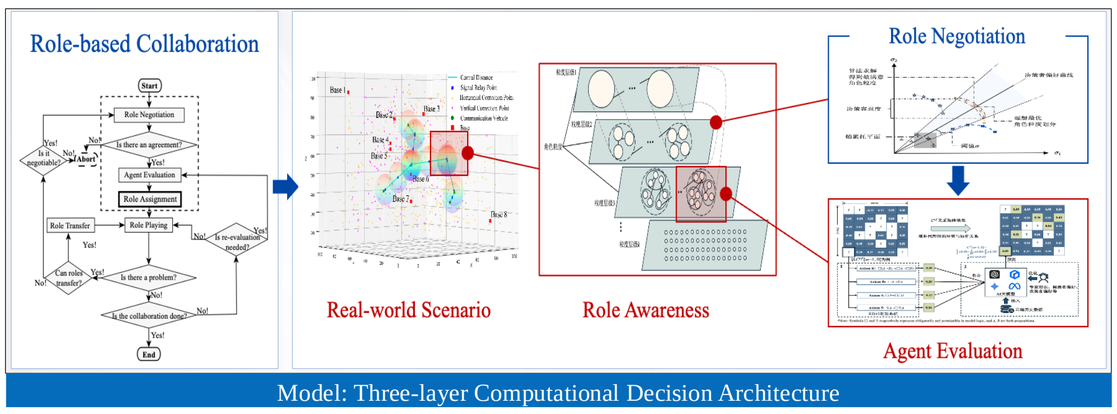


2. Low Solution Accuracy

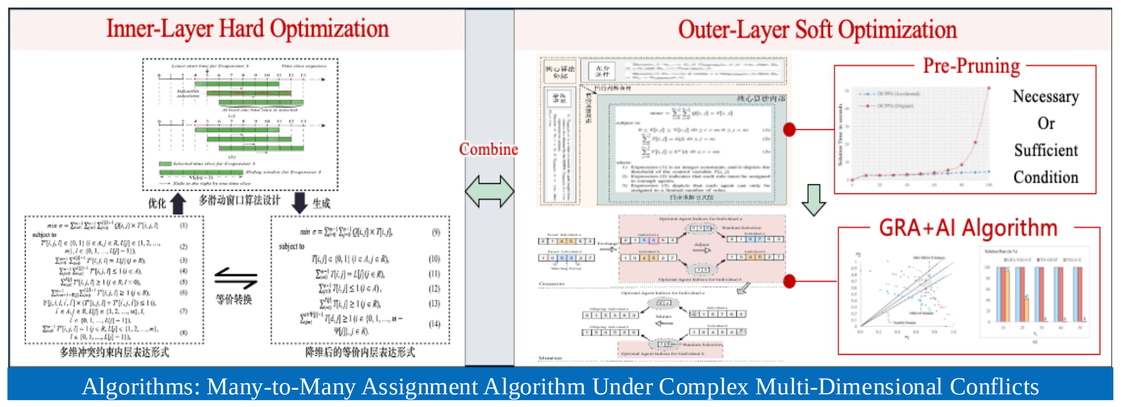


3. Slow Adaptive Evolution

METHODS

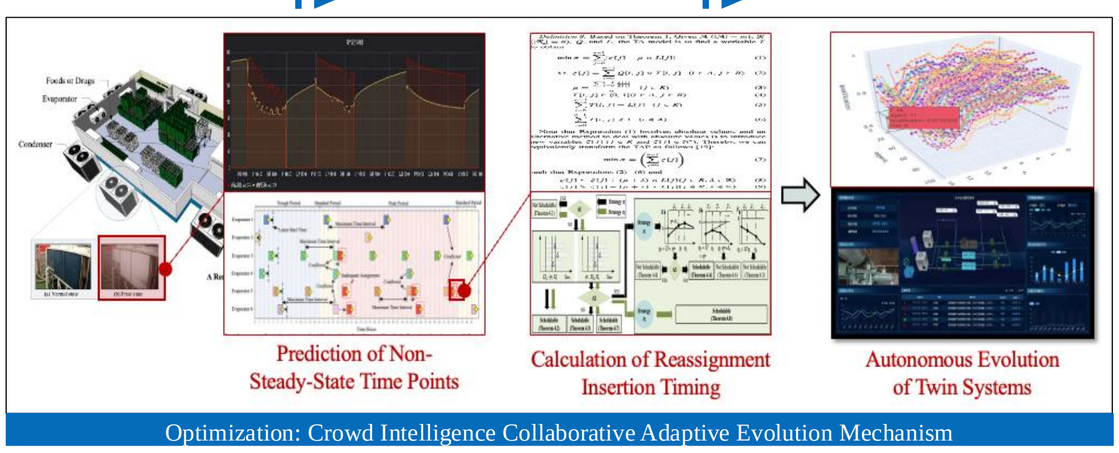


Model: Three-layer Computational Decision Architecture



Algorithms: Many-to-Many Assignment Algorithm Under Complex Multi-Dimensional Conflicts

Evolution ⇅ Control Promotion ⇅ Technique



Optimization: Crowd Intelligence Collaborative Adaptive Evolution Mechanism

1.**Three-layer computational decision architecture** exhibits **high cohesion and low coupling**, ensuring strong transferability even under complex multi-dimensional conflicting constraints.

2. **Σ2P and NP-Class** Many-to-Many Assignment Algorithms: An Optimization Framework Integrating Algorithm Theory and Proof Theory.

3. **Flexible and robust dynamic reassignment scheduling strategy**, integrating scheduling policies with an adaptive collaborative evolution mechanism, achieving **top-down control and bottom-up evolution**.

RESULTS AND CONCLUSIONS

1. The proposed three-layer computational architecture guides **the evolution of intelligent algorithms** to achieve precise task assignment.
2. Applying hierarchical abstraction further compresses the solution space, reducing invalid solutions, **alleviating computational burden, and accelerating solving**.

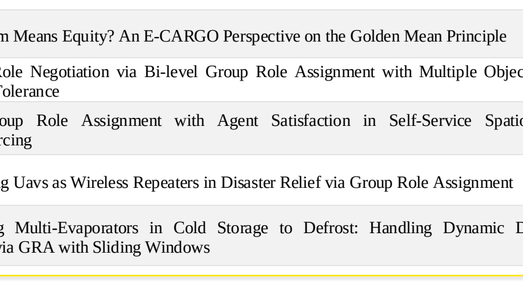


Fig. 1 GRA-NSGA-II vs NSGA-II in MOOP.

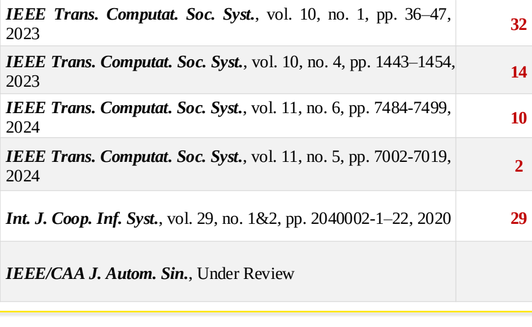


Fig. 2 Performance comparison between the proposed algorithms and state-of-the-art (SOTA) algorithms.

Table I. Performance of the algorithms under different comparison criteria.

Scale (m_n)	GRA [a] (Ideal Solution)					GRACAG					GRAMAC				
	σ	t			c	σ	t			c	σ	t			c
		Max.	*Min.*	*Ave.* [b]			*Max.*	*Min.*	*Ave.*			*Max.*	*Min.*	*Ave.*	
20_10	9.62	0.02s	0.01s	0.01s	5	9.43	0.13s	0.10s	0.10s	0	9.43	0.51s	0.49s	0.50s	0
40_10	19.18	0.01s	0.01s	0.01s	9	18.69	0.41s	0.37s	0.38s	0	18.69	2.17s	2.03s	2.08s	0
60_10	28.32	0.02s	0.01s	0.02s	15	27.47	0.89s	0.84s	0.87s	0	27.47	4.84s	4.69s	4.74s	0
80_10	38.47	0.02s	0.02s	0.02s	21	37.46	1.55s	1.50s	1.52s	0	37.46	8.74s	8.54s	8.62s	0
100_10	**47.87**	0.03s	0.02s	0.03s	**25**	**46.51**	2.41s	2.35s	2.38s	**0**	**46.51**	14.13s	13.71s	13.87s	**0**
40_20	19.68	0.05s	0.01s	0.02s	9	19.48	1.54s	1.48s	1.51s	0	19.48	8.60s	8.24s	8.44s	0
80_20	39.49	0.04s	0.03s	0.03s	22	38.89	6.03s	5.89s	5.96s	0	38.89	36.60s	36.08s	36.35s	0
120_20	59.37	0.05s	0.04s	0.05s	31	58.74	13.70s	13.35s	13.54s	0	58.74	85.25s	83.81s	84.54s	0
160_20	78.72	0.07s	0.05s	0.06s	42	77.72	24.73s	23.17s	23.81s	0	77.72	155.95s	148.33s	150.87s	0
200_20	**98.53**	0.08s	0.06s	0.07s	**50**	**97.37**	36.89s	36.04s	36.46s	**0**	**97.37**	233.45s	231.07s	232.26s	**0**

[a] GRA represents the optimal assignment where agent conflicts are not considered. [b] Average. Symbol σ denotes the group performance, symbol t stands for the time required to find a solution, and symbol c signifies the number of existing agent conflicts obtained for each model.

ACHIEVEMENT

No.	Authors	Title	Journal/Volume/Issue/Year	Citations
1	**Qian Jiang**, Haibin Zhu, Yan Qiao, Zhiwei He, Dongning Liu, and Baoying Huang	Agent Evaluation in Deployment of Multi-SUAVs for Communication Recovery	***IEEE Trans. Syst. Man, Cybern. Syst.***, vol. 52, no. 11, pp. 6968–6982, 2022	35
2	**Qian Jiang**, Dongning Liu, Haibin Zhu, Baoying Huang, Naiqi Wu, and Yan Qiao	Group Role Assignment with Minimized Agent Conflicts	***IEEE Trans. Syst. Man, Cybern. Syst.***, early access, Nov. 29, 2024, doi: 10.1109/TSMC.2024.3510588	
3	**Qian Jiang**, Dongning Liu, Haibin Zhu, Yan Qiao, and Baoying Huang	Quasi Group Role Assignment with Role Awareness in Self-Service Spatiotemporal Crowdsourcing	***IEEE Trans. Computat. Soc. Syst.***, vol. 9, no. 5, pp. 1456–1468, 2022	33
4	**Qian Jiang**, Haibin Zhu, Yan Qiao, Dongning Liu, and Baoying Huang	Extending Group Role Assignment With Cooperation and Conflict Factors via KD45 Logic	***IEEE Trans. Computat. Soc. Syst.***, vol. 10, no. 1, pp. 178–191, 2023	25
5	**Qian Jiang**, Haibin Zhu, Yan Qiao, Dongning Liu, and Baoying Huang	Refugee Resettlement by Extending Group Multirole Assignment	***IEEE Trans. Computat. Soc. Syst.***, vol. 10, no. 1, pp. 36–47, 2023	32
6	**Qian Jiang**, Dongning Liu, Haibin Zhu, Yan Qiao, and Baoying Huang	Equilibrium Means Equity? An E-CARGO Perspective on the Golden Mean Principle	***IEEE Trans. Computat. Soc. Syst.***, vol. 10, no. 4, pp. 1443–1454, 2023	14
7	**Qian Jiang**, Dongning Liu, Haibin Zhu, Shijue Wu, Naiqi Wu, Xin Luo, and Yan Qiao	Iterative Role Negotiation via Bi-level Group Role Assignment with Multiple Objectives and Decision Tolerance	***IEEE Trans. Computat. Soc. Syst.***, vol. 11, no. 6, pp. 7484-7499, 2024	10
8	**Qian Jiang**, Dongning Liu, Haibin Zhu, Baoying Huang, Naiqi Wu, and Yan Qiao	Quasi Group Role Assignment with Agent Satisfaction in Self-Service Spatiotemporal Crowdsourcing	***IEEE Trans. Computat. Soc. Syst.***, vol. 11, no. 5, pp. 7002-7019, 2024	2
9	Dongning Liu, **Qian Jiang**, Haibin Zhu, and Baoying Huang	Distributing Uavs as Wireless Repeaters in Disaster Relief via Group Role Assignment	***Int. J. Coop. Inf. Syst.***, vol. 29, no. 1&2, pp. 2040002-1–22, 2020	29
10	**Qian Jiang**, Haibin Zhu, Fuyan Wen, Dongning Liu, Naiqi Wu, and Yan Qiao	Scheduling Multi-Evaporators in Cold Storage to Defrost: Handling Dynamic Defrosting Conflicts via GRA with Sliding Windows	***IEEE/CAA J. Autom. Sin.***, Under Review	

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