

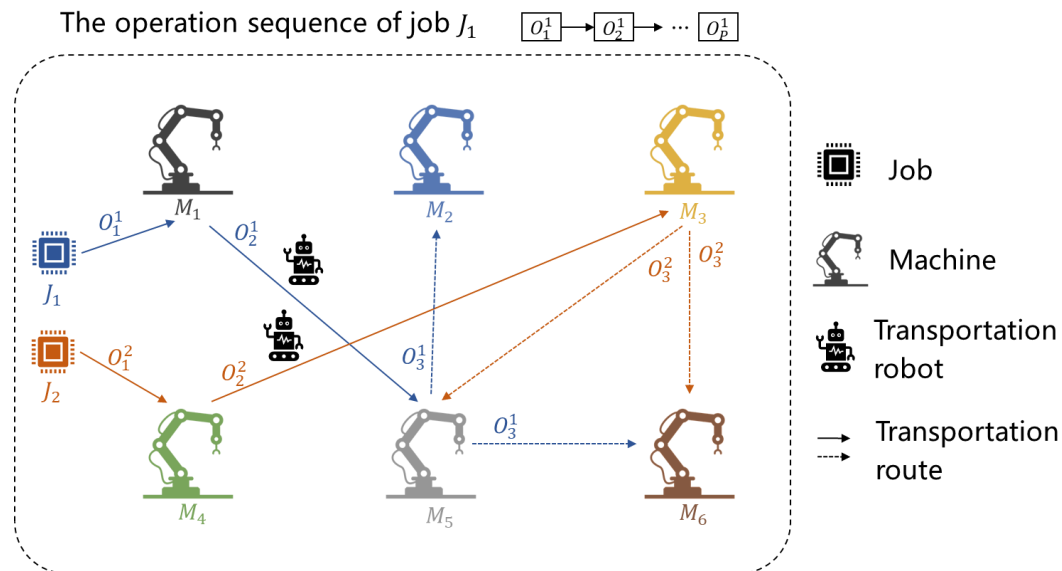
# Decentralized Multi-Agent Collaborating for Job Shop Scheduling with Spatial Constraints

**Guang LIU, Zhouhao WU, Shuping LI,  
Kai LV, Youfang LIN, Sheng HAN**

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# Problems & Ideas

- Problems of Flexible Job Shop Scheduling:
  - Existing methods ignore spatial constraints such as job mobility and machine spatial distribution.
  - How to achieve the shortest makespan under the condition of reducing the moving cost and collision risk.
- Ideas: Multiple rewards with time and space constraints are designed, and Multi-Agent Reinforcement Learning with dual attention is introduced to make the job pay more attention to the job collaboration related to the reward goal.



# Main Contributions

- Contributions:
  - A multi-agent distributed job shop scheduling environment characterized by temporal diversity, spatial limitations, and resource randomness;
  - Two types of combinable reward terms are introduced to regulate the scheduling process based on distance and density;
  - A MARL scheduling method that uses a dual attention network to dynamically construct scheduling relationships is proposed and a counterfactual baseline is used to evaluate the influence of each agent on the whole process to achieve effective scheduling..

Numbers of jobs	Evaluation metrics	PDR	GA	DE	MASA	VDN	Ours
6	makespan	129.4	148.95	143.82	153.35	146.45	<b>142.50</b>
	local density	0.31	0.18	0.26	0.27	0.15	<b>0.10</b>
	computation time	0.01	5.54	4.18	<b>0.17</b>	0.24	0.29
8	makespan	140.85	154.50	150.52	189.40	151.50	<b>146.60</b>
	local density	0.36	0.30	0.35	0.34	0.28	<b>0.24</b>
	computation time	0.02	7.46	5.34	<b>0.30</b>	0.42	0.48
10	makespan	147.45	167.35	<b>160.15</b>	188.90	165.40	163.05
	local density	0.44	0.40	0.44	0.44	0.38	<b>0.36</b>
	computation time	0.02	9.47	8.45	<b>0.55</b>	0.62	0.71
12	makespan	168.3	177.50	<b>175.43</b>	200.45	188.65	182.9
	local density	0.50	0.48	0.50	0.50	0.46	<b>0.45</b>
	computation time	0.03	11.02	10.57	<b>0.83</b>	0.90	0.97

Average test results of PDR, GA, DE, MASA, VDN and Ours for 20 epochs. Where the computation time represents the decision time of an epoch in seconds. Due to the rules of PDR, the result of PDR is an ideal case and is only used as a reference.