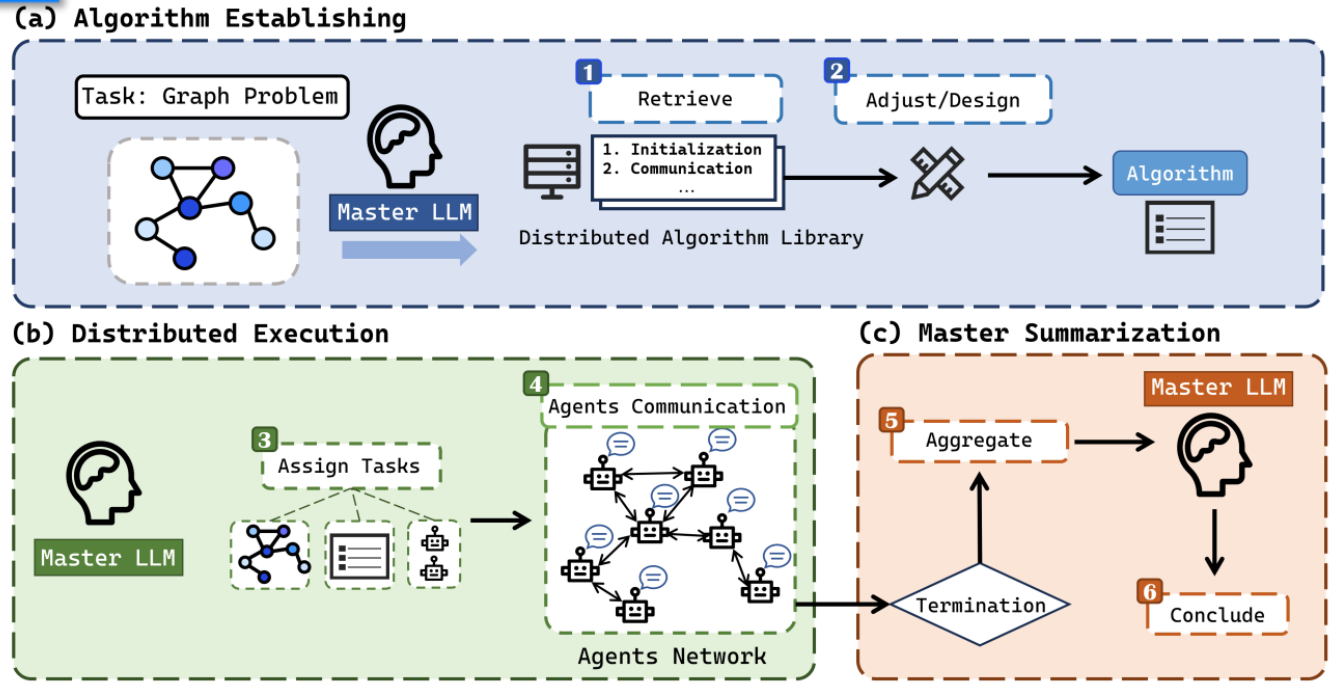
Scalable and Accurate Graph Reasoning with LLM-Based Multi-Agents

Method



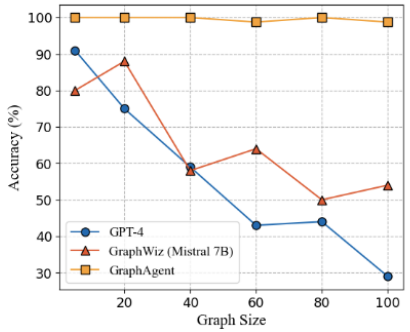
Algorithm 1: Distributed Paradigm

Input: Agent Nodes $\mathcal{A}$, each agent $a \in \mathcal{A}$ maintains a state S_a, the maximum iterations I_{max} given by the Master LLM
Output: Final state S_a for $a \in \mathcal{A}$

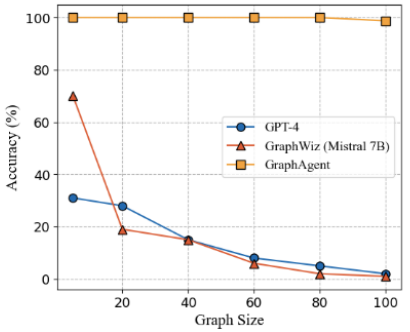
/ Initialization */*
Each agent $a \in \mathcal{A}$ initializes its state S_a based on **Initialization** rules.
Each agent a sends an initial message $M_{a \to v}$ to each of its neighbors $v \in \text{Neighbors}(a)$ based on its current state S_a and **Send** rules.
/ Communication */*
while *Iteration* $i < I_{max}$ *and* **Termination** *not met* **do**
  / Receive */*
  Each agent a receives messages $M_{u \to a}$ from all neighboring agents u.
  / Update */*
  Each agent a updates its state S_a based on the received messages M and its own current state S_a according to **Update** rules.
  / Send */*
  Each agent a sends updated messages $M_{a \to v}$ to each of its neighbors v based on the updated state S_a according to **Send** rules.
end while
return the final state S_a for all agents $a \in \mathcal{A}$

Experiments

Models	Linear				Polynomial		Average
	cycle	connect	bipartite	topology	shortest	triangle	
Closed-source Models							
GPT-4 (zero-shot)	38.75	17.00	65.25	5.00	9.25	5.75	23.50
GhatGPT (2-shot)	51.25	43.75	70.75	4.50	3.50	17.25	31.83
GPT-4 (2-shot)	52.50	62.75	74.25	25.25	18.25	31.00	44.00
Fine-tuned Open-source Models							
Naive SFT (LLaMA 2-7B)	73.75	83.50	41.25	4.00	9.50	30.00	40.17
Naive SFT (Mistral-7B)	73.75	83.50	78.50	1.00	23.00	47.00	51.13
GraphWiz (LLaMA 2-7B)	91.50	87.00	74.00	18.00	28.00	38.25	56.13
GraphWiz (Mistral-7B)	92.00	89.50	72.00	19.00	31.25	38.75	57.08
GraphWiz-DPO (LLaMA 2-7B)	89.00	82.50	84.75	46.75	24.00	52.75	63.29
GraphWiz-DPO (Mistral-7B)	85.50	79.50	85.50	85.25	12.50	29.00	62.88
GraphAgent-Reasoner	**99.50**	**100.00**	**100.00**	**96.50**	**99.75**	**93.25**	**98.00**



(a) Cycle Detection



(b) Shortest Path