



# ICML

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# Agent Conductor: Topology Evolution for Multi-Agent Competition-Level Code Generation

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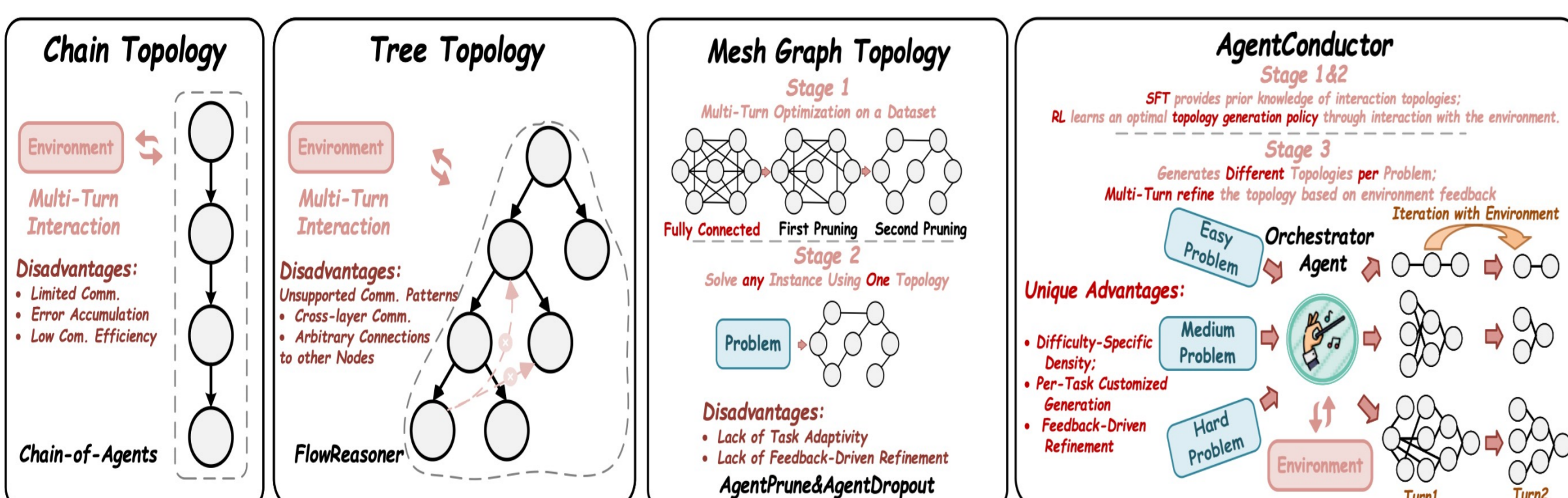
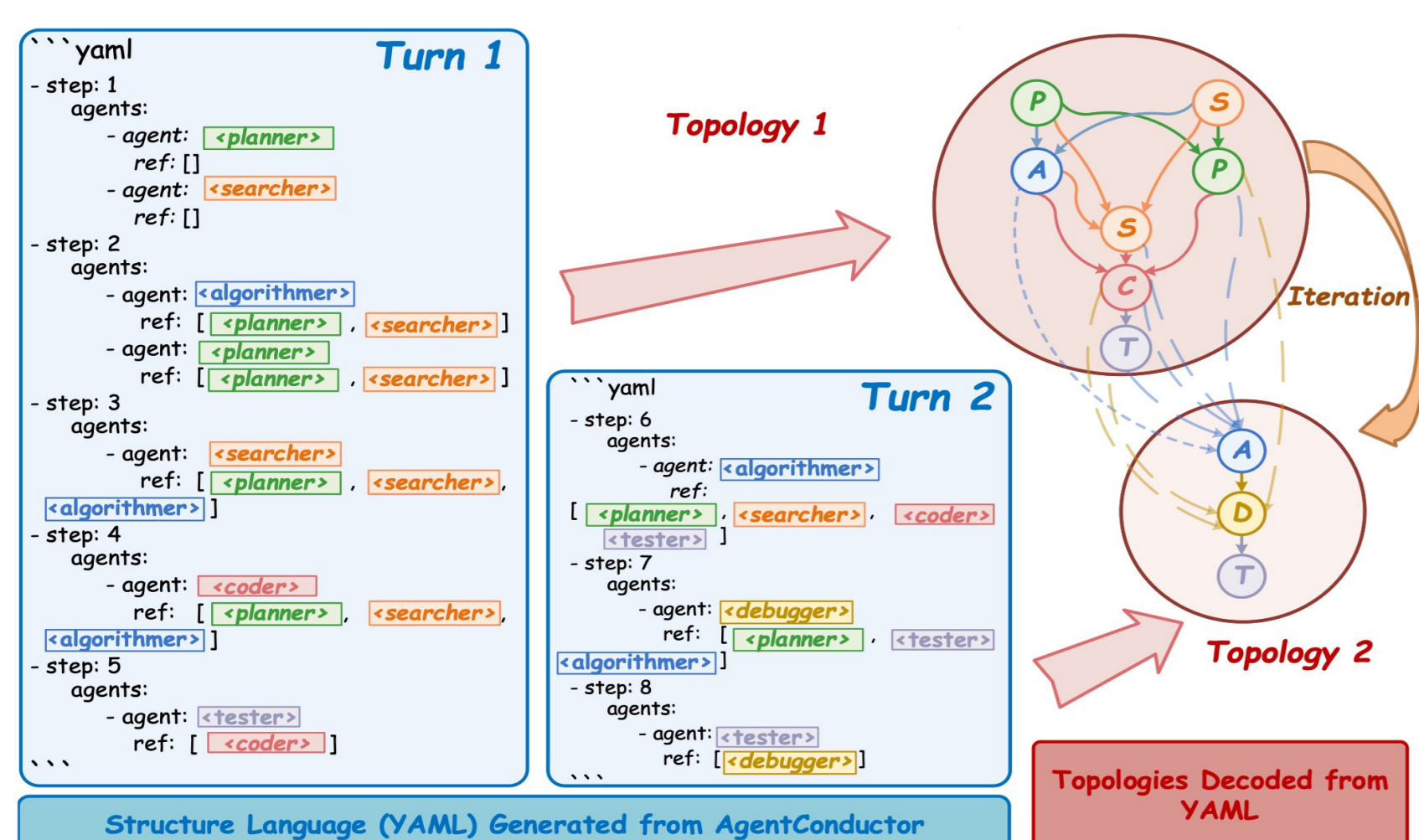
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## Motivation

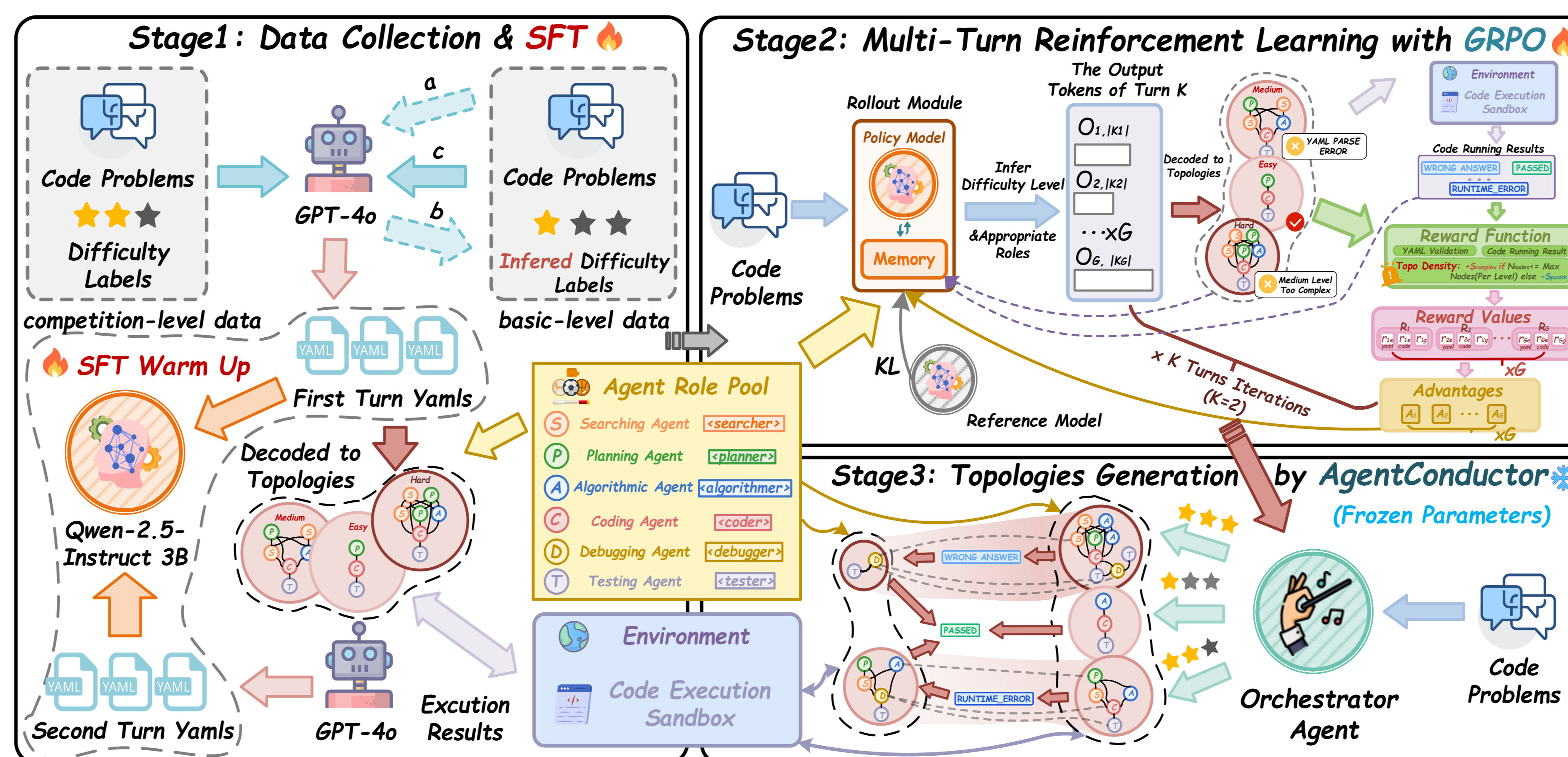
- Fixed MAS topologies waste computation on diverse tasks.
- Existing methods lack difficulty-aware density control.
- Execution feedback is rarely used to evolve interaction graphs.

## Contributions



- Human-readable layered DAG topology for flexible multi-agent interaction.
- RL-optimized LLM orchestrator agent for difficulty-aware topology generation.
- Density-aware reward for balancing accuracy, sparsity, and cost.

## Method



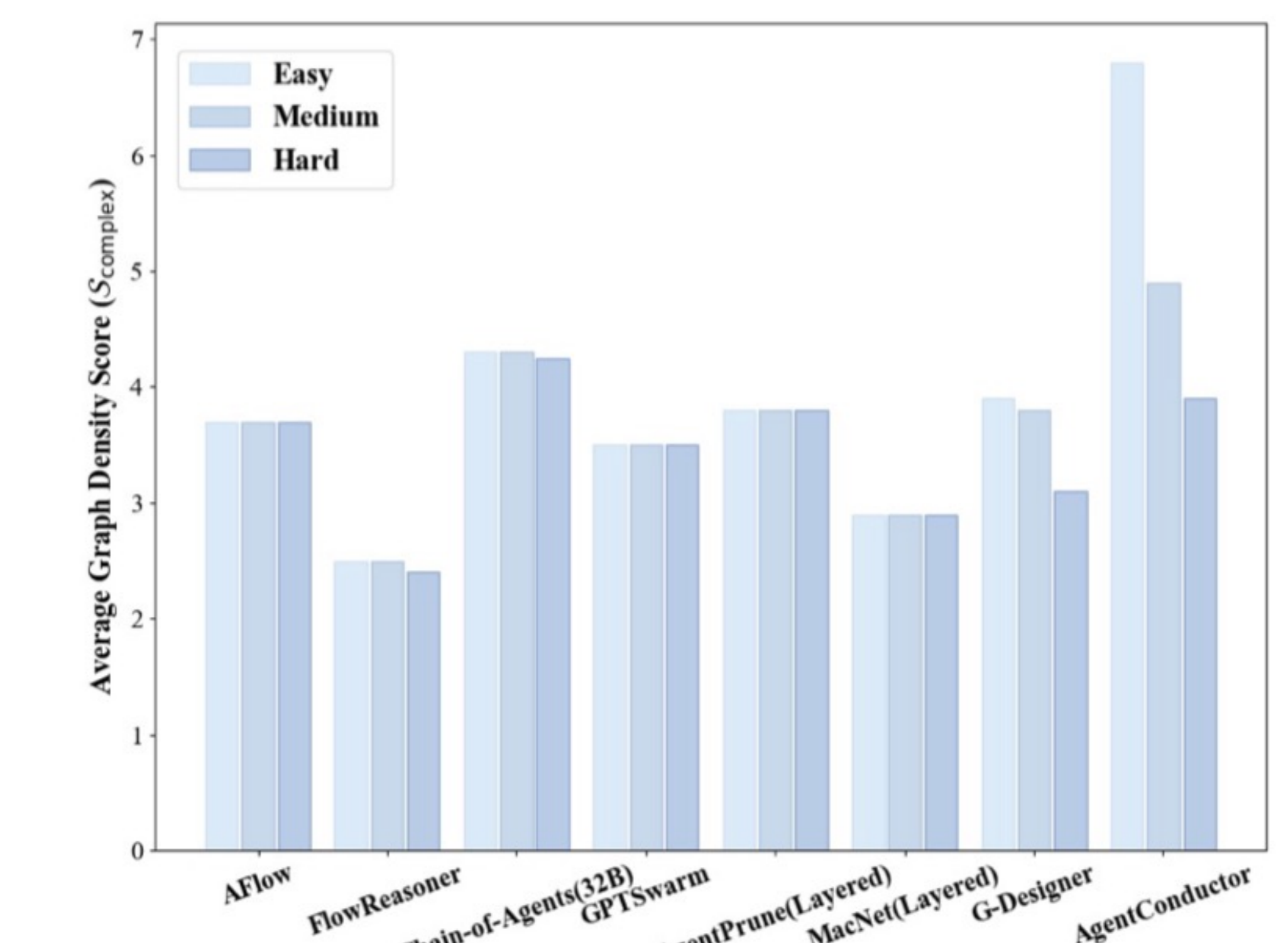
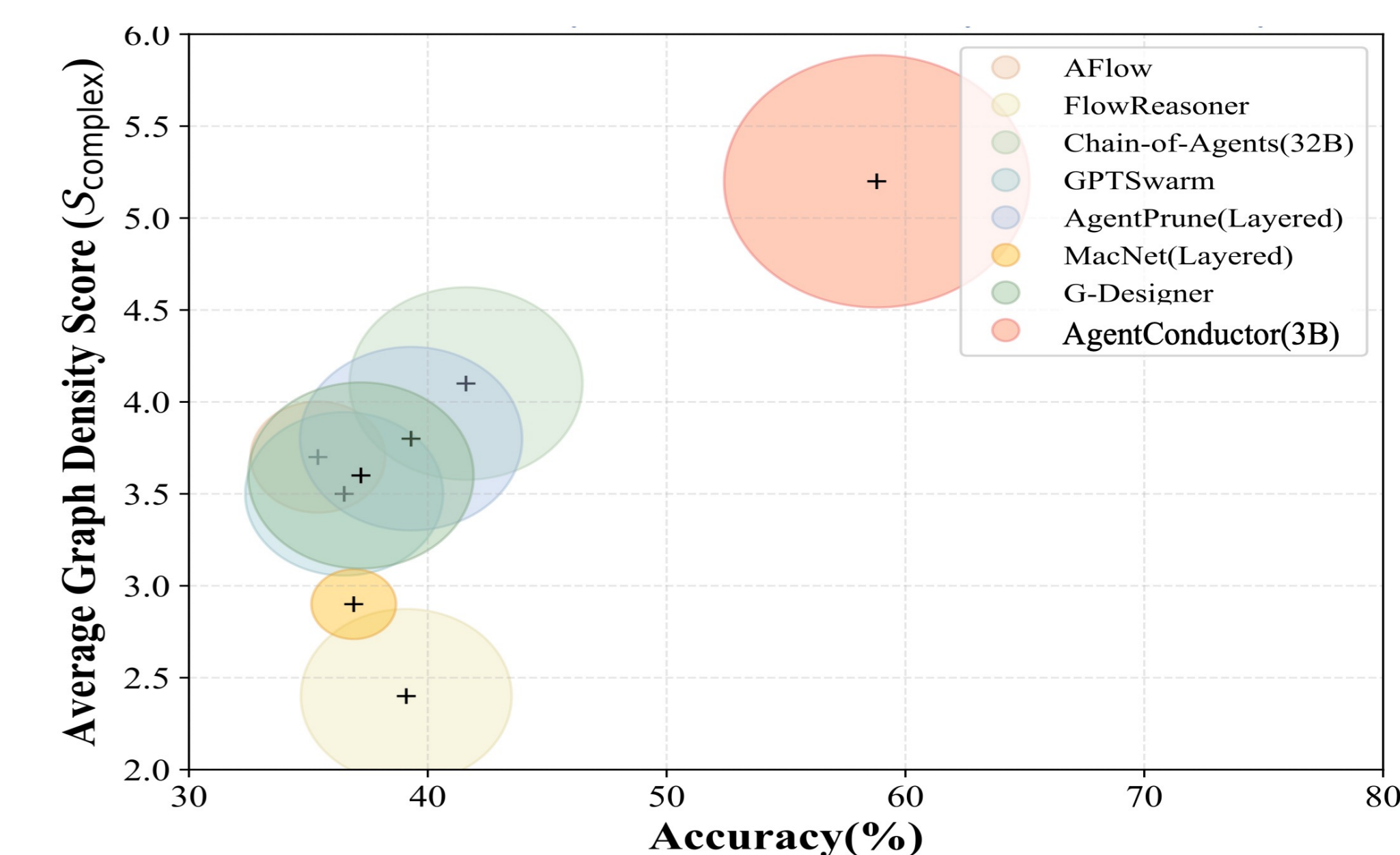
- We collect difficulty-aware code problems and generate YAML-based interaction graphs to fine-tune the orchestrator with structural topology priors.
- The orchestrator is optimized with GRPO using trajectory-level feedback from YAML validation, code execution, and topology-density rewards.
- At inference, the frozen orchestrator predicts task difficulty, selects agent roles, generates a layered-DAG topology, and refines it across turns using execution feedback.

## Performance(Pass@1)

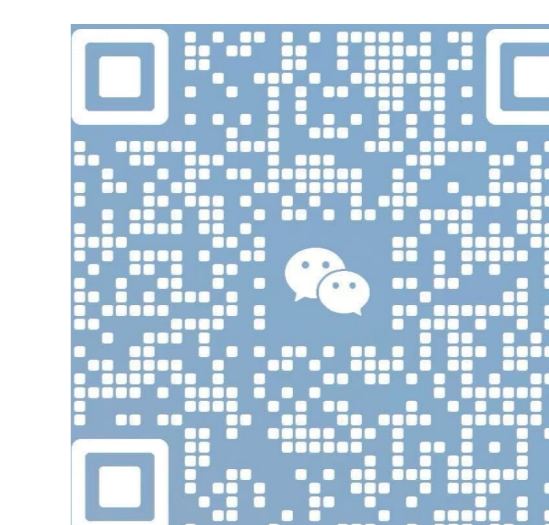
Method	Contest-level Code Generation				Basic Code Generation			Avg.
	APPs	LiveCodeBench	CodeContests	Avg.	HumanEval	MBPP	Avg.	
<b>Vanilla</b>								
GPT-4o-mini	20.3(±0.2)	26.3(±0.2)	18.6(±0.4)	21.7(±0.3)	87.6(±0.2)	73.5(±0.1)	80.5(±0.1)	51.1(±0.2)
<b>Classical Multi-Agent Systems (No Workflow/Topology Optimization)</b>								
AutoGen	23.6(±2.3)	30.2(±1.5)	20.8(±1.9)	24.9(±1.9)	90.4(±0.8)	92.3(±0.4)	91.4(±0.6)	58.1(±1.3)
MetaGPT	51.3(±1.4)	42.8(±1.3)	35.6(±1.2)	43.2(±1.3)	95.8(±0.2)	92.3(±0.3)	94.1(±0.2)	68.7(±0.6)
MapCoder	40.2(±0.9)	37.4(±1.1)	36.3(±0.7)	38.0(±0.9)	96.4(±0.5)	94.1(±0.4)	95.3(±0.5)	66.6(±0.7)
<b>Multi-Agent Systems with Workflow Optimization</b>								
AFlow	35.4(±1.7)	24.6(±1.1)	21.4(±1.5)	27.1(±1.4)	94.2(±0.3)	82.4(±0.1)	88.3(±0.2)	57.7(±0.8)
FlowReasoner	39.1(±1.9)	43.8(±2.1)	37.7(±1.6)	40.2(±1.9)	97.3(±0.5)	93.9(±0.7)	95.6(±0.6)	67.5(±1.3)
Chain-of-Agents(32B)	41.6(±1.3)	44.9(±2.3)	34.6(±1.3)	40.3(±1.6)	95.3(±0.2)	90.2(±0.3)	92.8(±0.2)	67.9(±0.6)
<b>Multi-Agent Systems with Topology Optimization</b>								
GPTSwarm	36.5(±2.1)	40.8(±2.5)	31.6(±3.0)	36.3(±2.5)	94.8(±1.1)	91.6(±1.3)	93.2(±1.2)	64.8(±1.9)
AgentPrune(Complex)	38.6(±1.9)	41.7(±2.1)	33.5(±0.8)	37.9(±1.6)	96.1(±0.5)	91.8(±0.8)	94.0(±0.7)	65.9(±1.1)
AgentPrune(Layered)	39.3(±1.6)	41.9(±1.8)	31.4(±0.9)	37.5(±1.4)	96.6(±0.7)	92.3(±0.3)	94.5(±0.5)	66.0(±1.0)
MacNet(Complex)	37.6(±0.8)	39.4(±0.7)	28.7(±0.7)	35.2(±0.7)	95.8(±0.4)	89.4(±0.2)	92.6(±0.3)	63.9(±0.5)
MacNet(Layered)	36.9(±0.6)	40.3(±0.5)	30.3(±0.8)	35.4(±0.8)	95.2(±0.2)	90.3(±0.3)	92.8(±0.3)	64.1(±0.5)
G-Designer	37.2(±1.5)	38.8(±1.3)	26.9(±1.2)	34.3(±1.3)	95.6(±0.9)	90.9(±0.8)	93.2(±0.9)	63.7(±1.1)
<b>AgentConductor(3B)</b>	<b>58.8(±0.3)</b>	<b>46.3(±0.4)</b>	<b>38.8(±0.5)</b>	<b>48.0(±0.3)</b>	<b>97.5(±0.1)</b>	<b>95.1(±0.2)</b>	<b>96.3(±0.2)</b>	<b>72.1(±0.3)</b>

## Costs

Dataset	Method	Perf.	Prompt	Comp.	S <sub>complex</sub> (↑)
	AFlow	35.4	531450	184800	3.7
	FlowReasoner	39.1	437250	148050	2.4
	Chain-of-Agents (32B)	41.6	334650	134250	4.1
APPS	GPTSwarm	36.5	381450	155400	3.5
	AgentPrune (Layered)	39.3	364950	141150	3.8
	MacNet (Layered)	36.9	472950	200100	2.9
	G-Designer	37.2	320550	139200	3.6
	<b>AgentConductor (3B)</b>	<b>58.8</b>	<b>277600</b>	<b>79800</b>	<b>5.2</b>



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