CaPo: Cooperative Plan Optimization for Efficient Embodied Multi-Agent Cooperation

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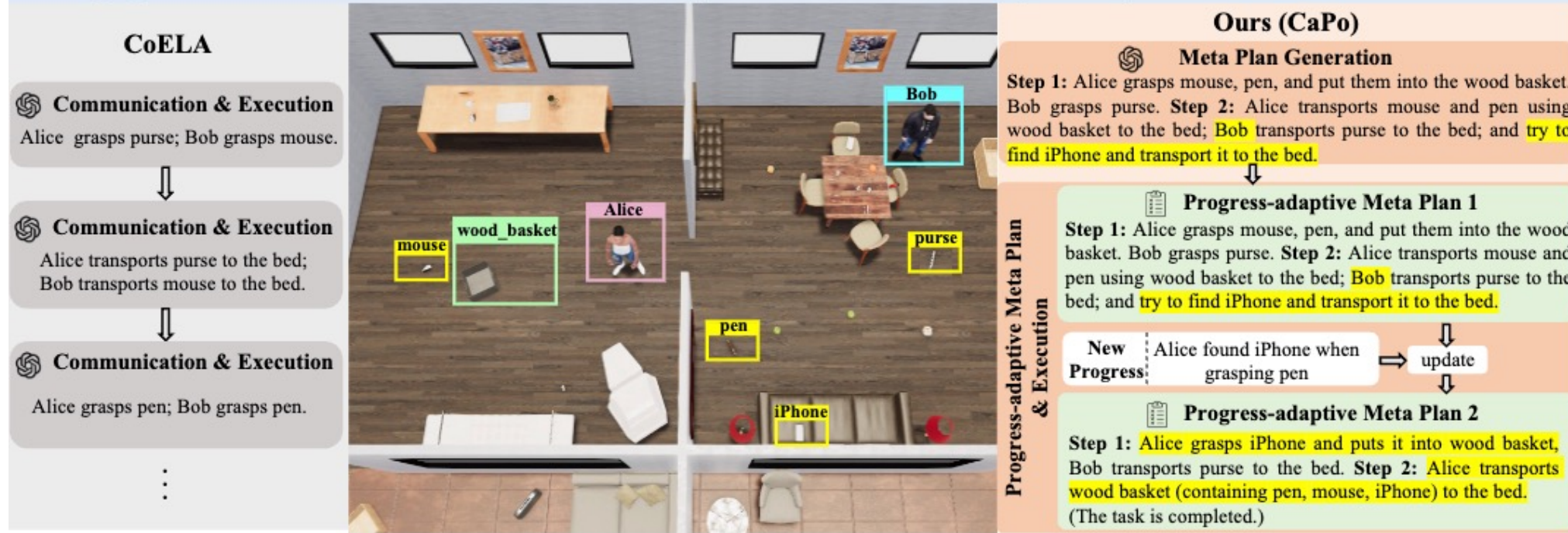
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Background

Task Description: Transport 1 mouses, 1 pen, 1 iPhone, and 1 purse to the bed.
Existing Agent Information: Alice knows the location of mouse, pen; Bob knows the location of purse. They don't know the location of iPhone.
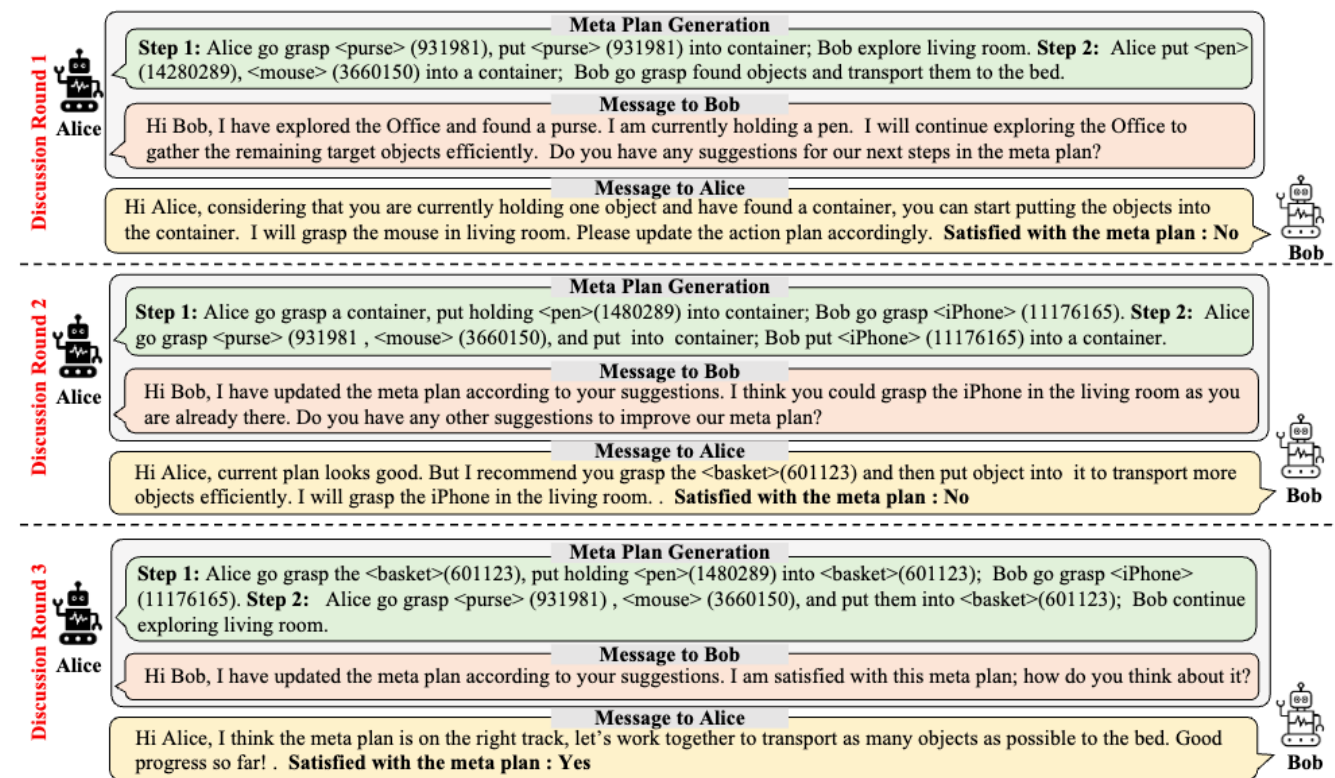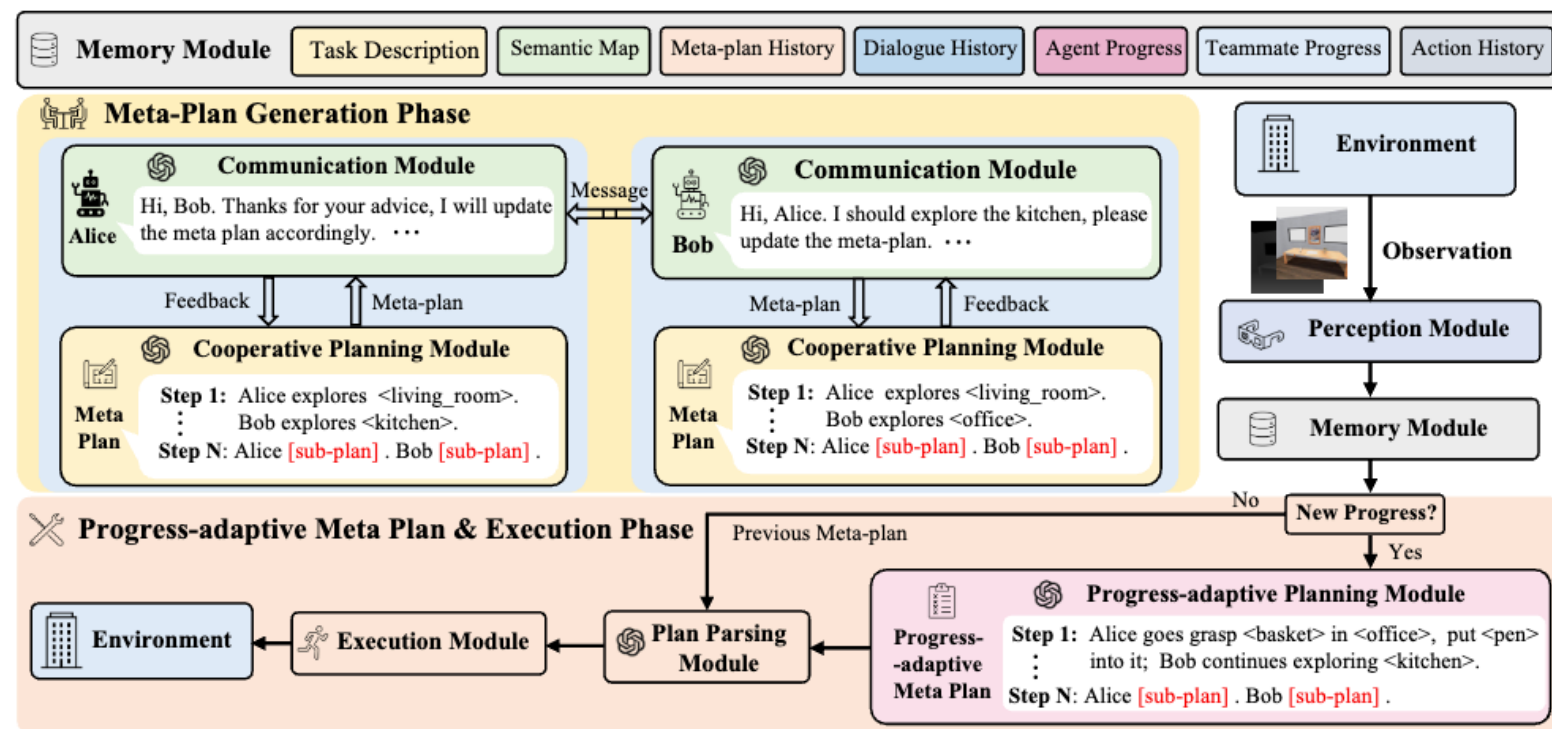
- Incoherent action execution with short-term plan during cooperation usually leads to redundant steps.

- We propose cooperative plan optimization to generate meta-plan for embodied agents.

- Such long-term strategic and cooperative planning enables efficient cooperation between embodied agents.

Methods

- Agents generate a meta-plan through multi-turn discussions.
- Agents execute actions under the guidance of the meta-plan.
- New progress triggers a new discussion to update the meta-plan
- The meta-plan is dynamically updated, and all agents execute actions under the guidance of the updated meta-plan.

Examples of the evaluation and optimization process of meta-plan via multi-turn discussion between agents. The discussion is triggered by new progress, i.e., Alice founds new object 'purse'. Here, Alice acts as the meta-plan designer, while Bob serves as the meta-plan evaluator.

Experiments

Quantitative results on TDW-MAT

	Classic Agents		GPT-3.5 Agents		LLAMA-2 Agents		GPT-4 Agents			
	RHP*[†]	RHP[†]	CoELA	CaPo(ours)	CoELA[†]	CaPo(ours)	CoELA[†]	ProAgent	RoCo	CaPo(ours)
w/o Oracle Perception										
Food (↑)	49	67 +25%	67 +23%	70 +31%	57 +9%	66 +17%	82 +38%	82 +27%	83 34%	85 +43%
Stuff (↑)	36	54 +34%	39 +18%	45 +27%	48 +11%	56 +22%	61 +41%	57 +35%	60 +39%	64 +40%
Avg. (↑)	43	61 +29%	52 +20%	57 +29%	53 +10%	61 +19%	71 +39%	69 +31%	71 +36%	74 +41%
w/ Oracle Perception										
Food (↑)	52	76 +33%	72 +29%	85 +38%	60 +3%	66 +14%	87 +41%	84 +37%	88 +42%	90 +40%
Stuff (↑)	49	74 +34%	73 +32%	84 +39%	63 +19%	76 +23%	83 +41%	85 +34%	82 +35%	87 +38%
Avg. (↑)	50	75 +34%	72 +30%	84 +38%	62 +8%	71 +18%	85 +41%	84 +35%	85 +39%	89 +39%

Cooperation Efficiency
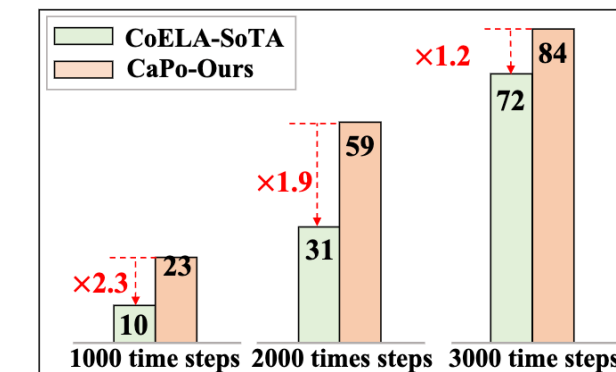
Benefits of Meta-plan

Method	Food (↑)	Stuff (↑)	Avg. (↑)
CaPo_1 (No MP + No Pro. MP)	72	75	73
CaPo_2 (MP Initialization + No Pro. MP)	73	76	74
CaPo_3 (MP Generation + No Pro. MP)	74	80	77
CaPo (MP Generation + Pro. MP)	85	84	84

Cooperative Behavior with Meta-plan