InvAgent

A Large Language Model based Multi-Agent System for Inventory Management in Supply Chains

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Motivation

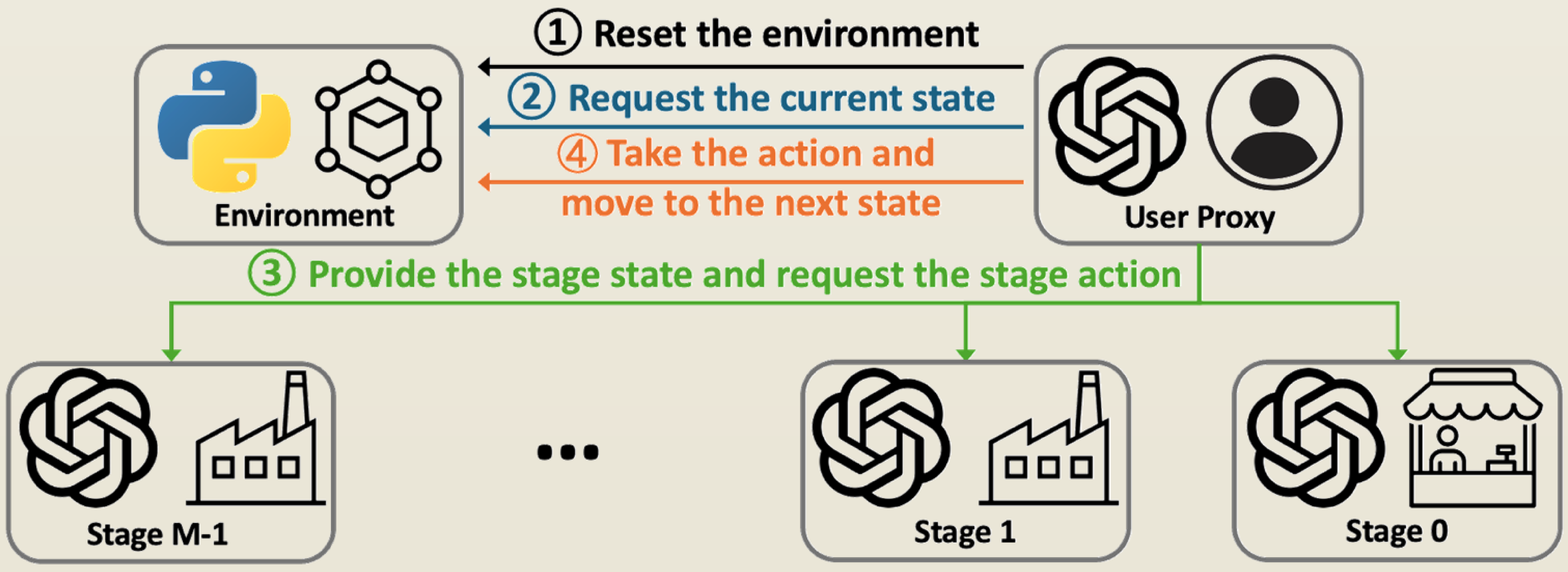
- **Zero-Shot Learning for Adaptability**: Leveraging LLMs as zero-shot learners to enable adaptive and informed decision-making in multi-agent systems for supply chain optimization without prior training or specific examples.
- **Interpretable and Explainable Decisions**: Enhancing trust and reliability by utilizing chain-of-thought reasoning to deliver interpretable and explainable solutions for inventory management.
- **Dynamic Demand Management**: Demonstrating the efficiency of multi-agent systems for supply chain optimization by adapting dynamically to varying demand scenarios, minimizing costs, and avoiding stockouts.

Sources

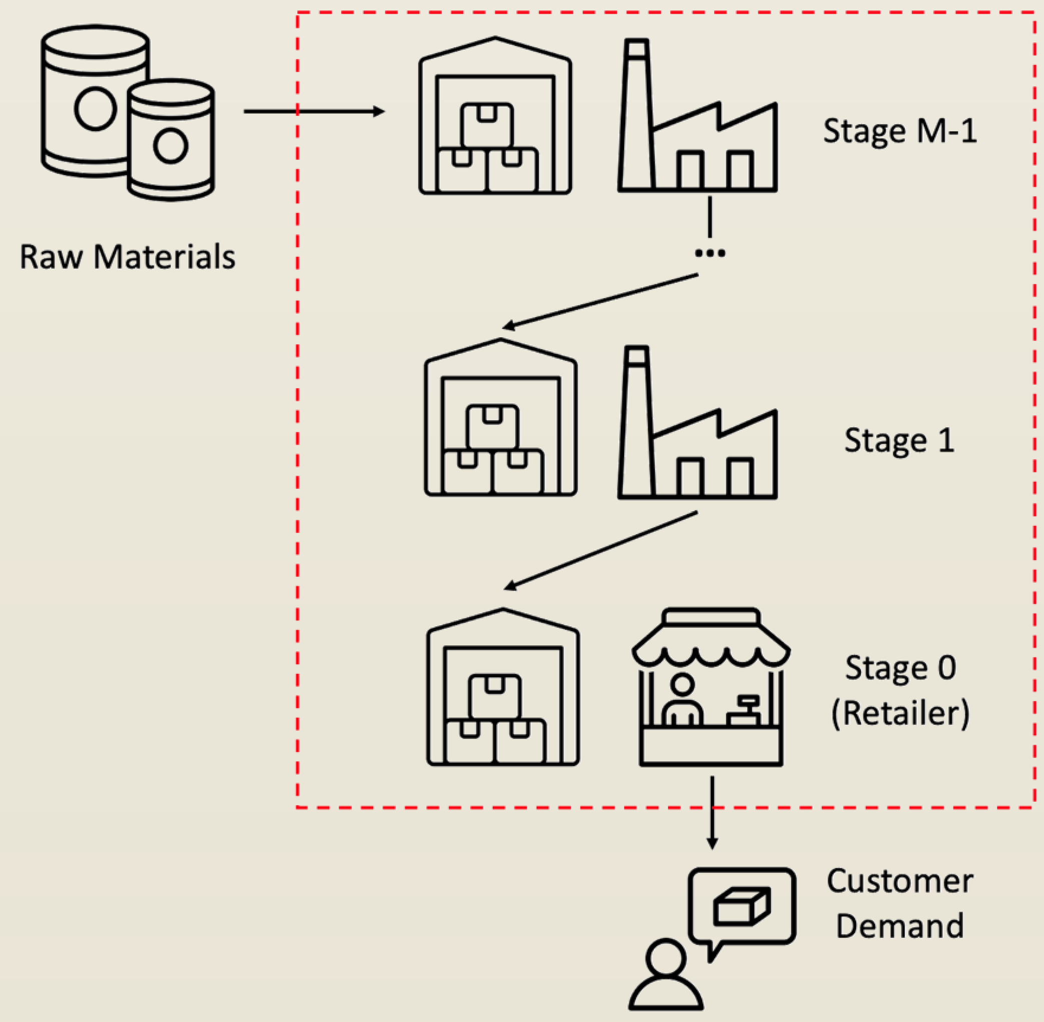
PAPER

CODE

InvAgent: How Does It Work?



The framework of InvAgent, a LLM-based zero-shot multi-agent inventory management system. Firstly, the user proxy resets the environment at the beginning of the first round. Secondly, the user proxy requests the state of the current round for each stage from the environment. Then, the user proxy provides the current state to each stage and requests the action from it. Finally, all agents take actions together and move to the next state.



The flowchart of multi-echelon supply chain inventory management.

How Does Prompts work in InvAgent?

Prompt:
Now this is the round {Period}, and you are at the stage {Stage} of {Number of Stages} in the supply chain. Given your current state: {State Description}

{Demand Description} {Downstream Order Description} What is your action (order quantity) for this round?

{Strategy Description}

Please state your reason in 1-2 sentences first and then provide your action as a non-negative integer within brackets (e.g. [0]).

- **State Description:** Provide a detailed snapshot of the current status of the supply chain stage. This includes information about inventory levels, backlog (current and upstream), recent sales, and incoming deliveries.
- **Demand Description:** Outline the expected customer demand at the retailer (stage 1). Scenarios can include constant, variable, seasonal, or normally distributed demand.
- **Downstream Order Description:** Specify the order placed by the downstream stage to the current stage.
- **Strategy Description:** Provide guidelines and principles for decision-making, such as aligning orders with expected downstream demand plus backlog and considering lead times.

Results

Model	Constant	Variable	Larger	Seasonal	Normal
Base-Stock	-296.00 (0.00)	-523.69 (49.15)	-392.21 (111.79)	-274.29 (40.75)	-322.44 (99.59)
Tracking-Demand	-360.00 (0.00)	-412.41 (41.76)	-265.07 (99.67)	-421.90 (55.18)	-232.20 (75.45)
IPPO	-132.17 (40.17)	-389.55 (40.28)	-202.39 (92.96)	-126.73 (183.63)	-102.90 (64.68)
MAPPO	**-129.81** (16.02)	-391.53 (34.09)	**-106.79** (109.86)	**-99.39** (126.09)	**-41.98** (75.22)
InvAgent (w/o strategy)	-156.00 (0.00)	**-336.60** (43.24)	-350.20 (149.57)	-488.00 (114.82)	-172.60 (104.70)
InvAgent (w/ strategy)	-200.00 (0.00)	-377.60 (53.50)	-357.60 (50.04)	-420.60 (225.42)	-192.40 (98.51)

Key Findings

- ✓ InvAgent excels in variable demand scenarios, achieving top performance without prior training.
- ✓ Outperforms heuristics and rivals RL models by minimizing costs and stockouts with explainable and stable decision-making.
- ✓ Human-crafted strategies improve performance in complex demand scenarios like seasonal patterns.