CoT-TL: Low-Resource Temporal Knowledge Representation of Planning Instructions Using Chain-of-Thought Reasoning

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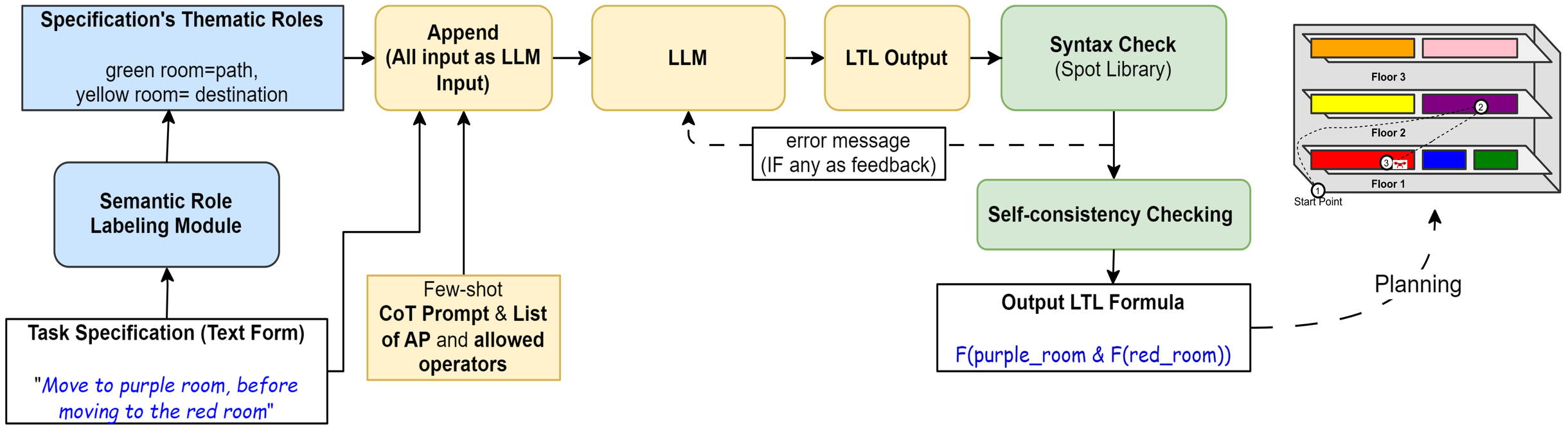


Fig: CoT-TL workflow from natural language to LTL for Planning

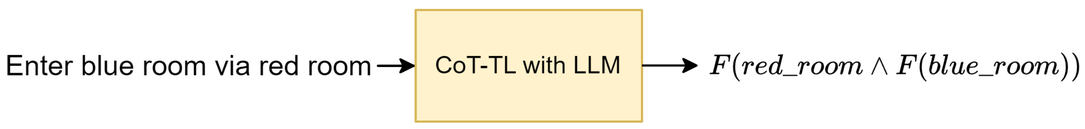
Motivation

- Autonomous agents for custom robotics need to follow user instructions.
- Natural language is ambiguous.
- Logical formalisms such as Linear Temporal Logic (**LTL**) are more concrete.
- CoT-TL bridges the gap between *human language and desired robot planning.*
- But LLMs need data and *we address this data scarcity problem and logical formalism via LLMs with other NLP tools!!*

Problem and Solution

Custom and diverse nature of robotic applications require tools that can translate human requirements into planning instructions understood by robots.

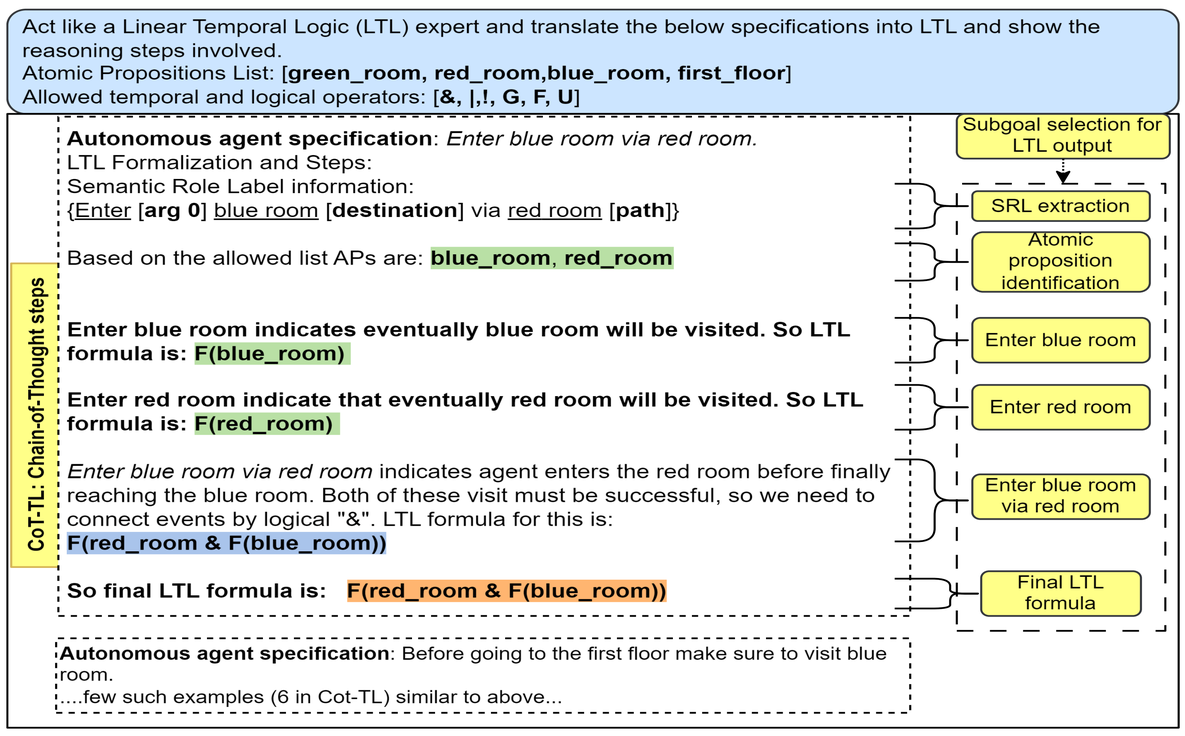
- Tool to translate English into LTL via LLM prompting and semantic roles labels
    - No need for LLM fine-tuning or multi-stage translation



- Assist LLM via chain of thought → Interpretable output
- Problem Hallucination ☹
    - Mitigation by Automata and syntax checking ☺

- **Automata Check by Spot :** Check if the CoT-TL generated formula is feasible for the autonomous agent.
- **Semantic Role Label (SRL):** Determine sequence of action and intermediate step

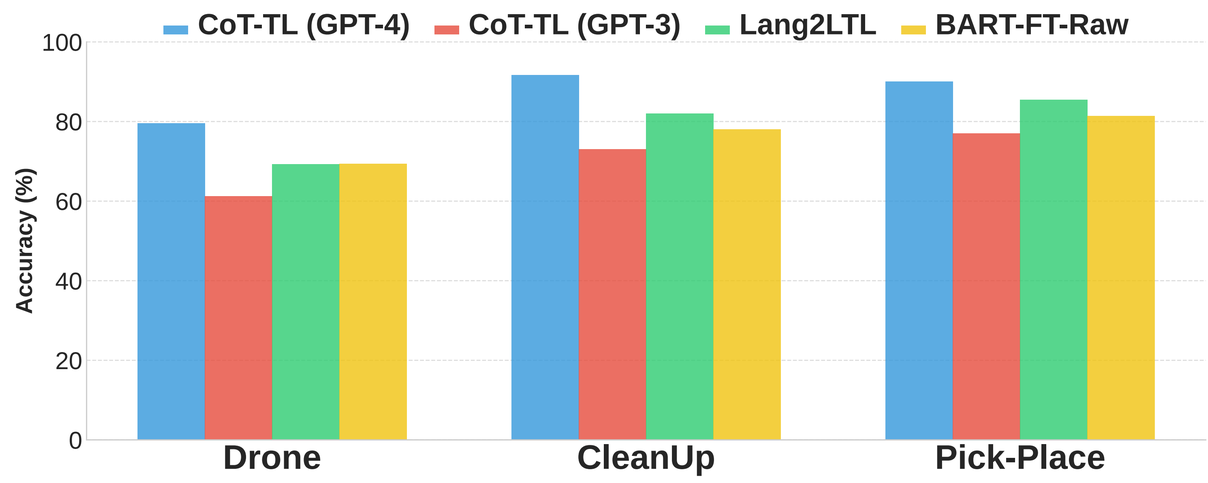
Prompt Design:



Results & Takeaway:

- Only 6 shot prompts are used to generate LTL translation.
- Use at least one prompt for each unique LTL structure.

E.g., if the prompt has only seen structure with 2 propositions, then the model might struggle with structure like F(A ∧ B v C).



References:

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2. Duret-Lutz, Alexandre et al. "From Spot 2.0 to Spot 2.10: What's New?" ArXiv abs/2206.11366 (2022).
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