

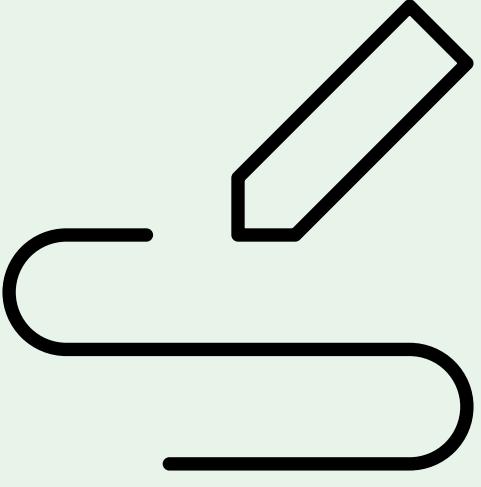
# Exploring the Use of LLMs for Agent Planning Strengths and Weaknesses

DAVIDE MODOLO  
20/03/2025  
*Supervisor PAOLO GIORGINI*



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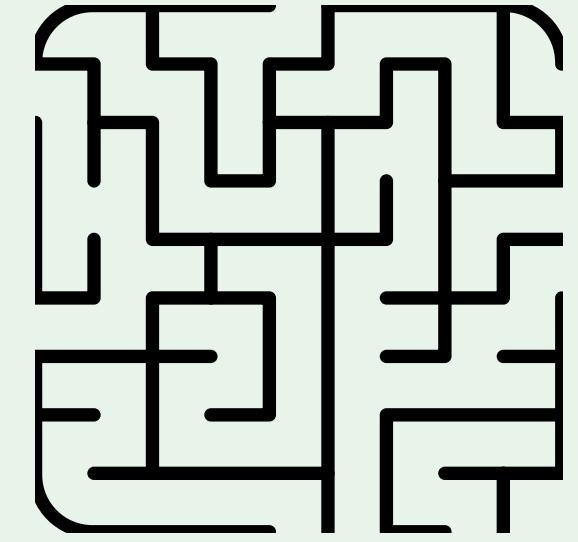
# Large Language Models' Capabilities



Text  
Generation

$$\begin{matrix} + & = \\ - & \times \end{matrix}$$

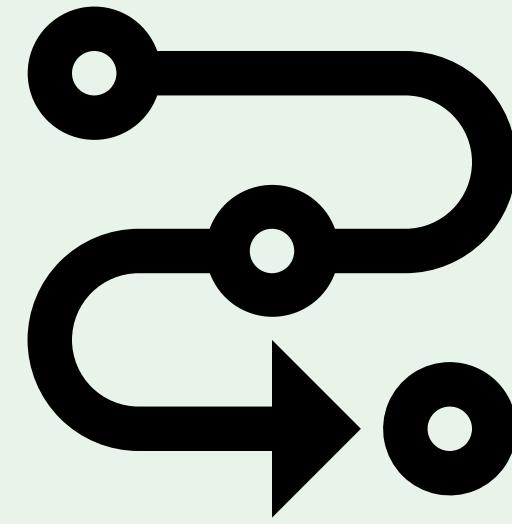
Math  
Abilities



Planning

...

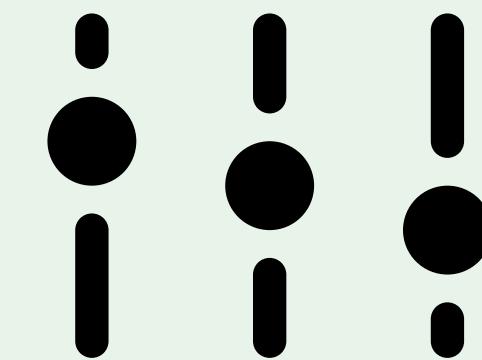
# LLM-based Planning



Chain of  
Thought



Few-Shots



Fine-Tuning

...

<sup>1</sup> Chain-of-thought prompting elicits reasoning in large language models - Wei et al., 2022

<sup>2</sup> PDDL planning with pretrained large language models - Silver et al., 2022

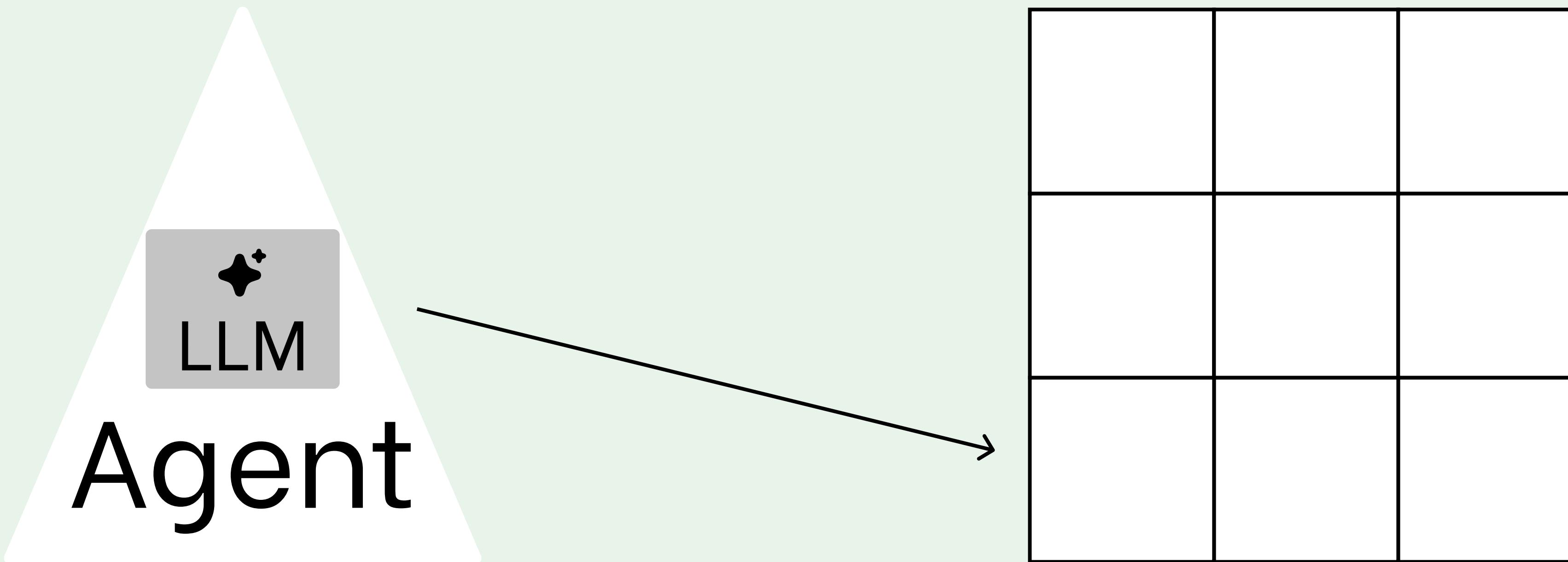
<sup>3</sup> Unlocking Large Language Model's Planning Capabilities with Maximum Diversity Fine-tuning - Wenjun Li et al., 2024

But what happens if we strip anything prior away?

Can an LLM, without additional training or frameworks, effectively plan and navigate in an unknown environment?

How well can LLMs make sequential decisions in unknown environments?

# IDEA

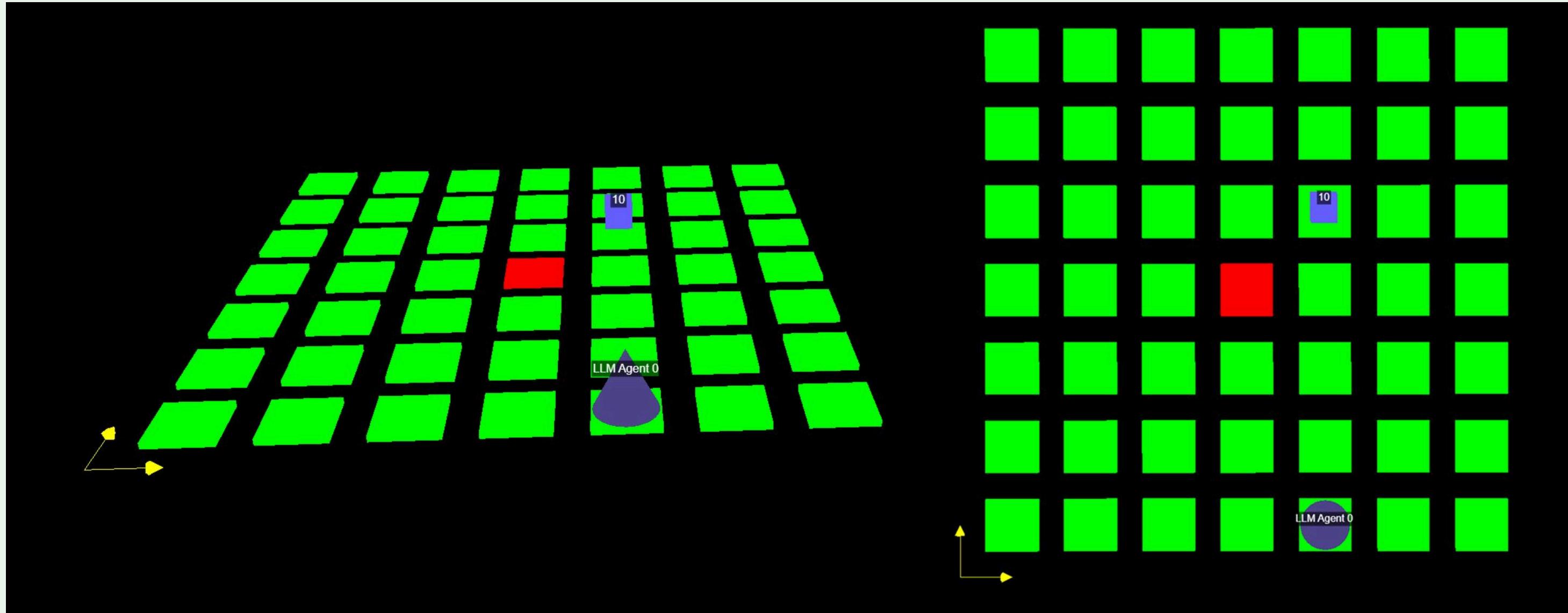


2. Setting



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# Deliveroo.js



Educational Game developed by Marco Robol for Autonomous Software Agents course by Prof. Paolo Giorgini

Parcels spawns all around the map. Goal is to pickup and deliver them.

## 2. Setting

# KnowNo Uncertainty

## Prompt

*Environment description*

- A) action 1
- B) action 2
- C) action 3
- D) action 4
- E) none of the above

*Bias towards A, B, C, D, E*

## LogProbs

|     |    |       |
|-----|----|-------|
| “A” | -> | -0.01 |
| “B” | -> | -11.1 |
| “C” | -> | -0.1  |
| “D” | -> | -5.3  |
| “E” | -> | -4.0  |

*Softmax + Flitering*

## Result

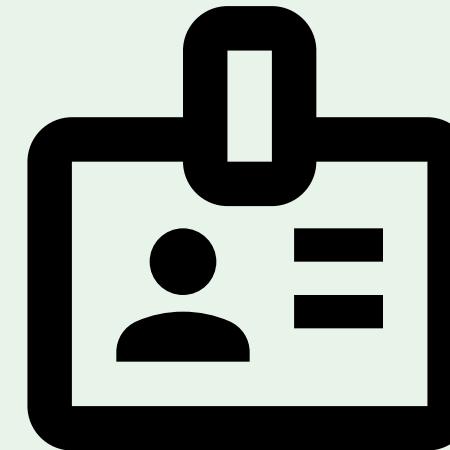
|     |    |     |
|-----|----|-----|
| “A” | -> | 60% |
| “B” | -> | 1%  |
| “C” | -> | 30% |
| “D” | -> | 4%  |
| “E” | -> | 5%  |

## 2. Setting



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# Prompting Strategy



[ ROLE ]



[ MAP ]



2. Setting



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# Model

- OpenAI models
- GPT-4o was the best
- GPT-4o-mini selected for price/performance

|       | GPT-4o | GPT-4o-mini |
|-------|--------|-------------|
| top1% | 77%    | 84%         |
| top2% | 95%    | 91%         |
| top3% | 96%    | 92%         |

## 2. Setting





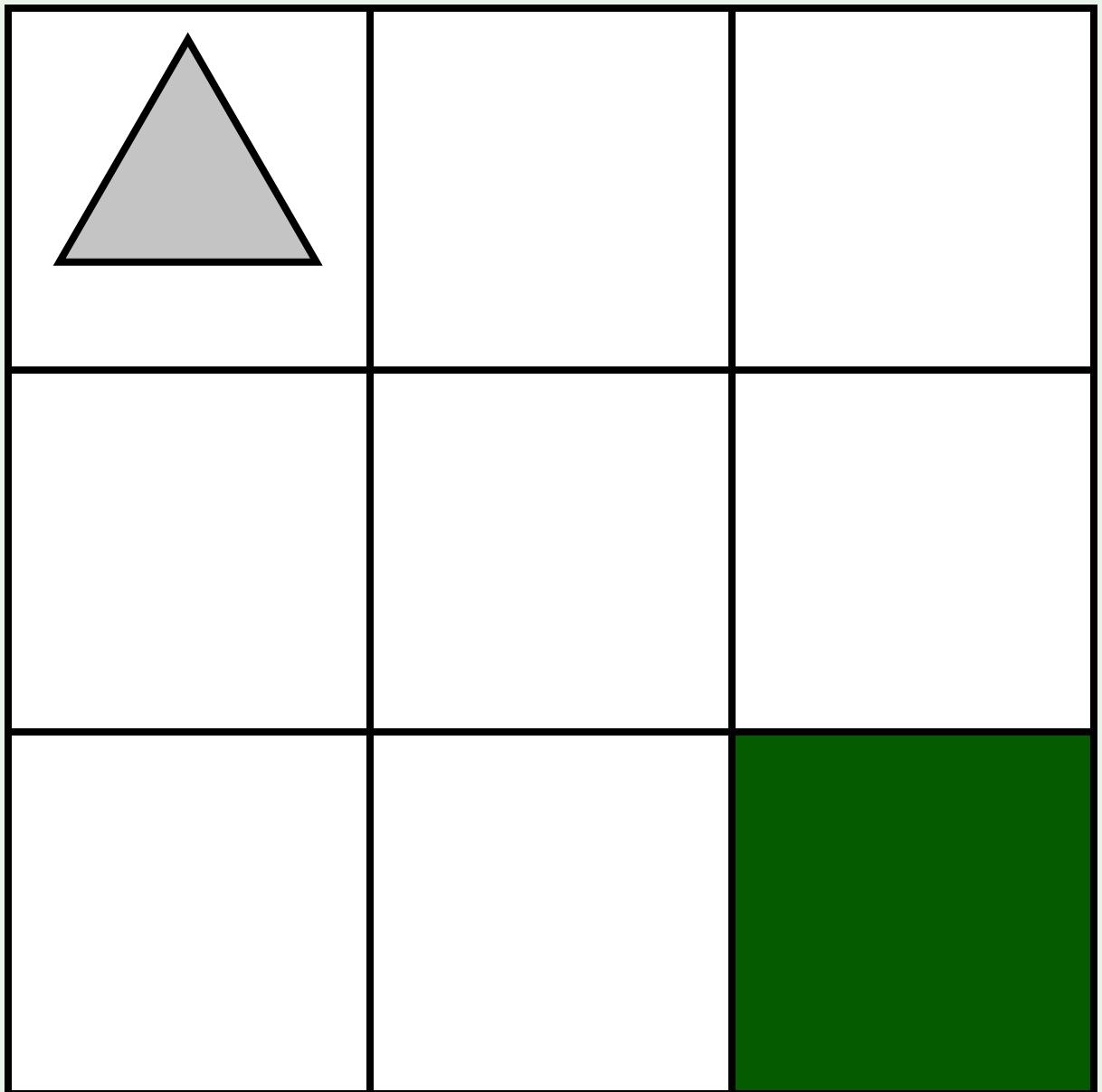
# Data Collection

**DAVIDE MODOLO**  
20/03/2025  
*Supervisor PAOLO GIORGINI*



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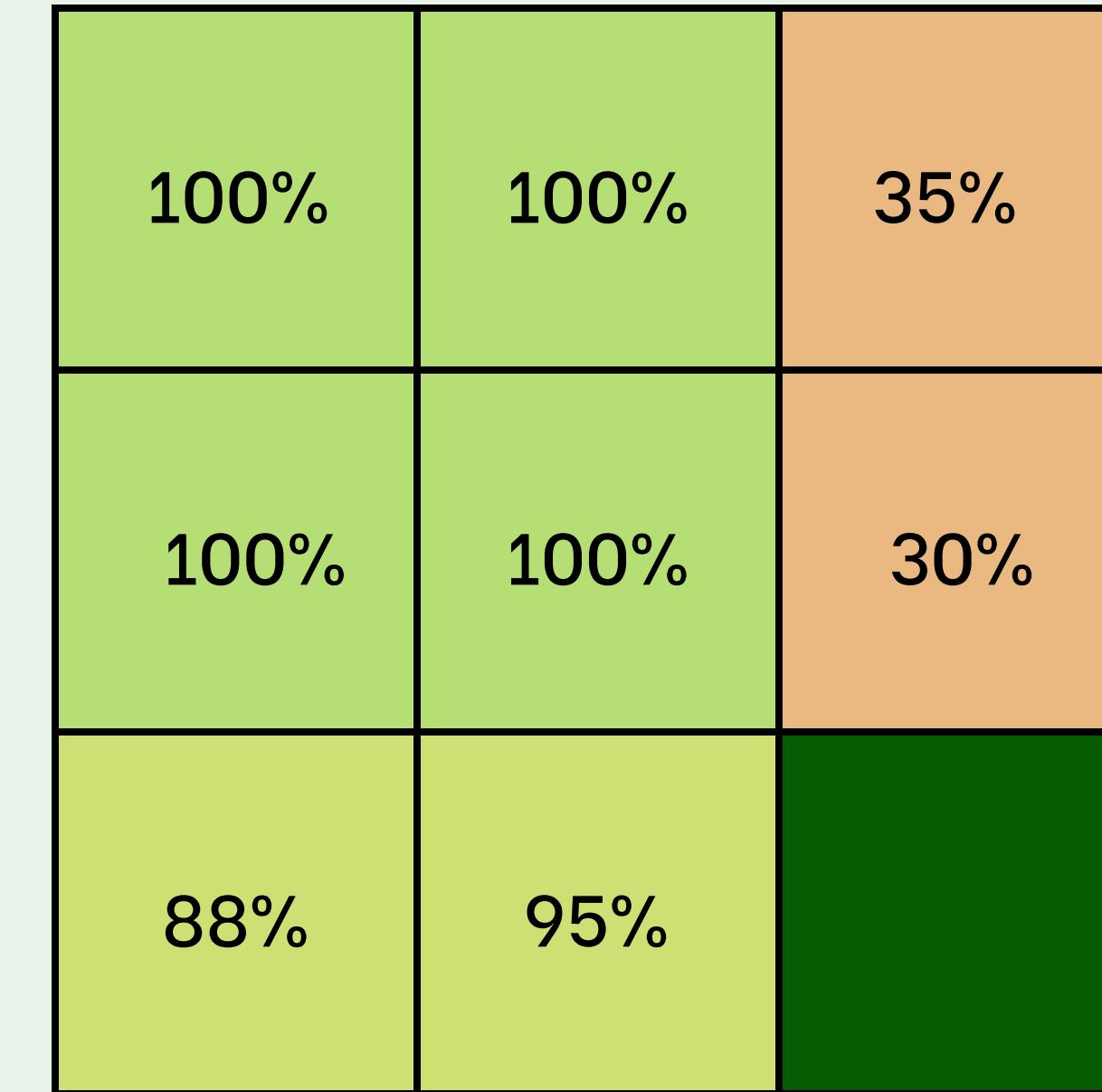
# HeatMap Creation #1



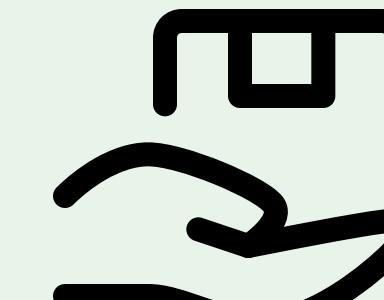
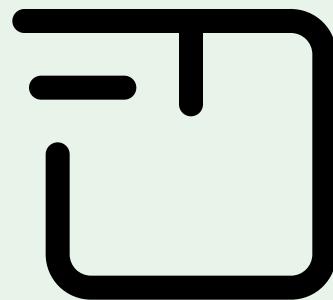
|                       |                |                |
|-----------------------|----------------|----------------|
| R 100%                | D 40%<br>R 60% | D 35%<br>R 65% |
| D 5%<br>R 95%         | D 5%<br>R 95%  | D 30%<br>R 70% |
| D 5%<br>U 7%<br>R 88% | D 5%<br>R 95%  |                |

# HeatMap Creation #2

|                       |                |                |
|-----------------------|----------------|----------------|
| R 100%                | D 40%<br>R 60% | D 35%<br>R 65% |
| D 5%<br>R 95%         | D 5%<br>R 95%  | D 30%<br>R 70% |
| D 5%<br>U 7%<br>R 88% | D 5%<br>R 95%  |                |



# Testing Strategy



- Deliver or Pickup
- Stateless
- Stateful

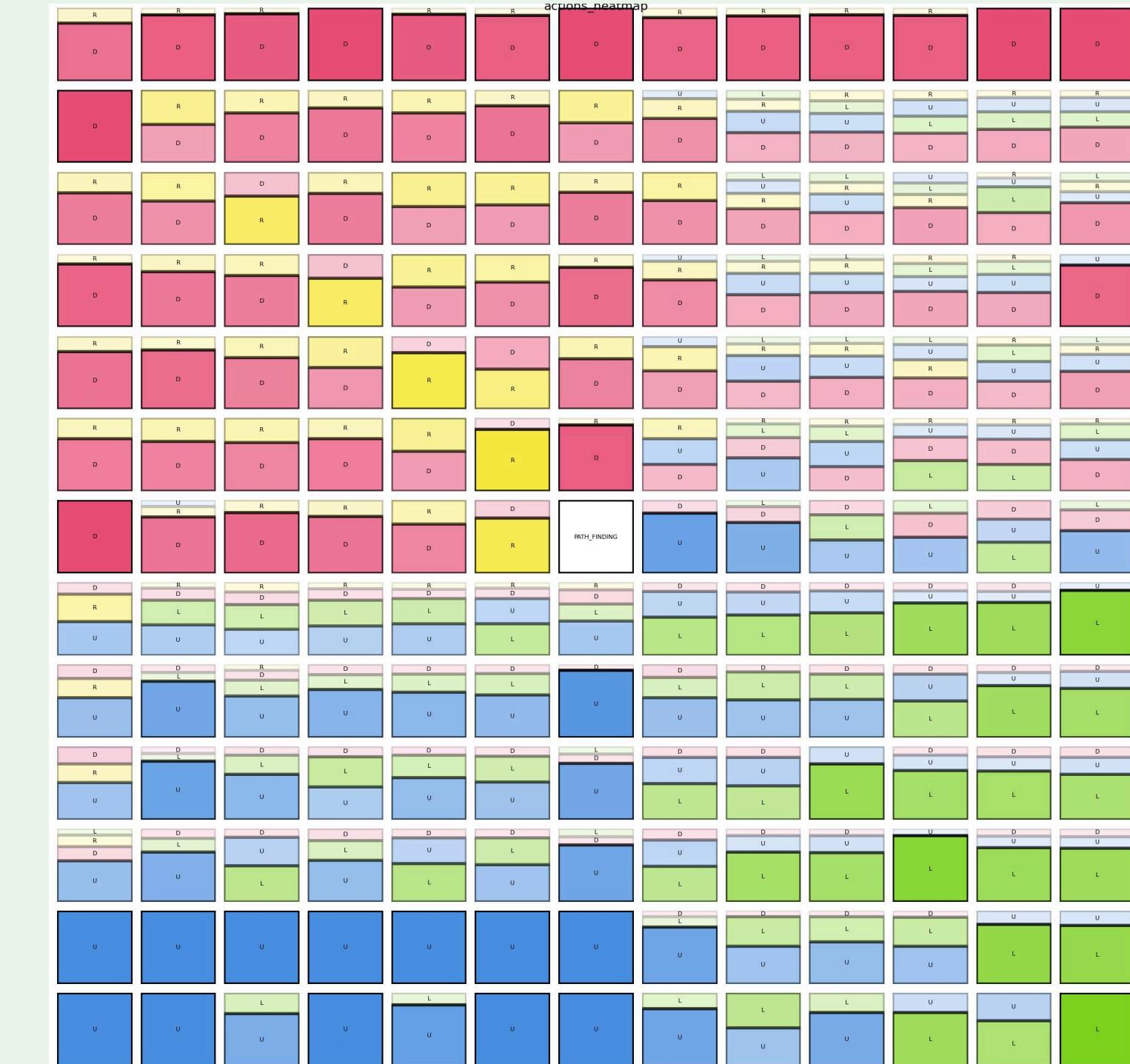
# Our Findings

# Orientation

“Since we did not provide  
any info about the  
orientation, how does the  
LLM perceive it?”

# Orientation

## (0,0)



(0,0)

Up  
Down  
Left  
Right

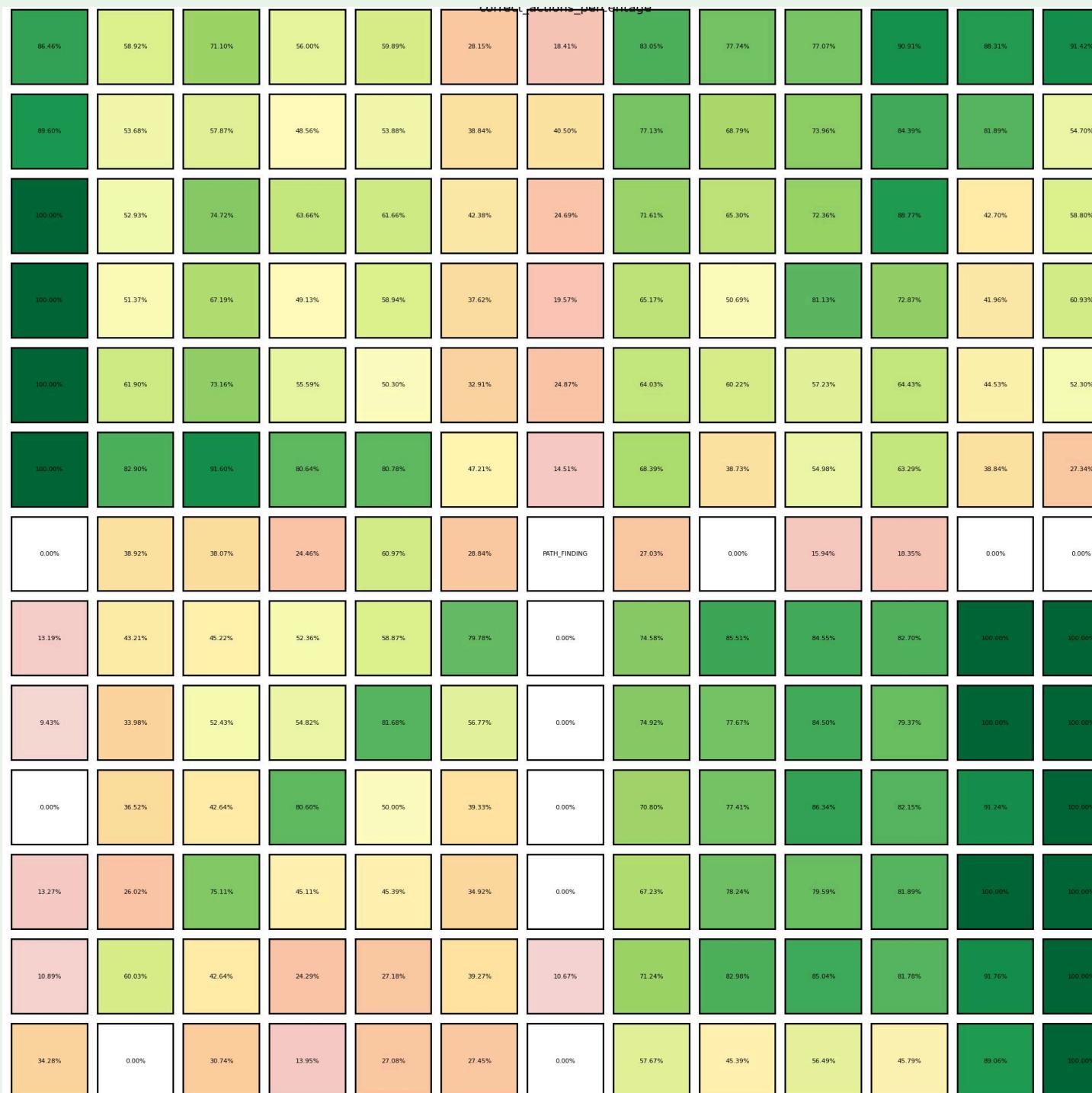
## 3. Results



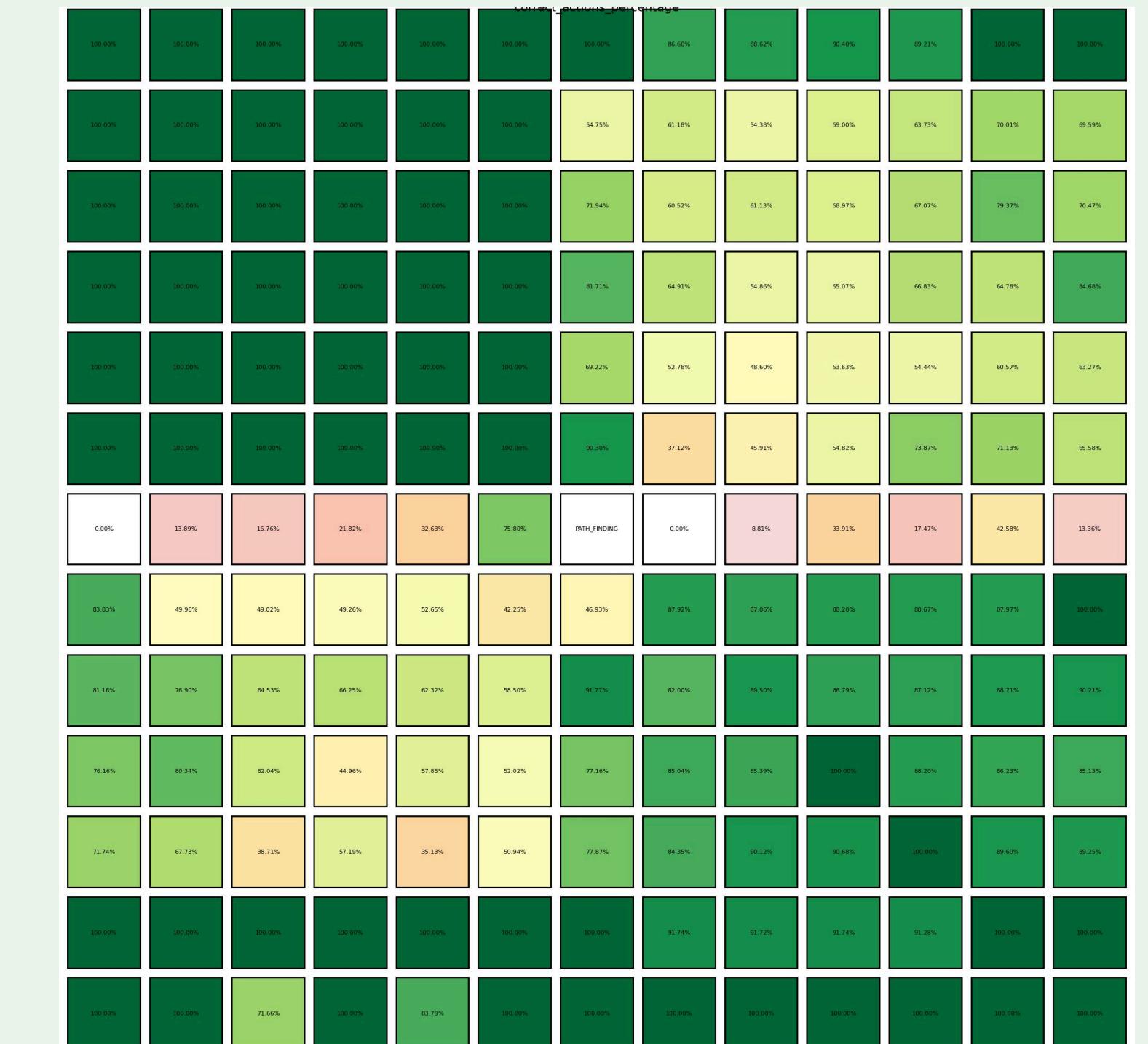
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# Orientation

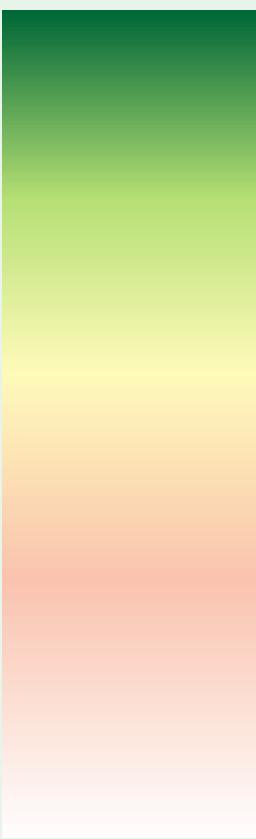
(0,0)



(0,0)



100%



0%

## 3. Results



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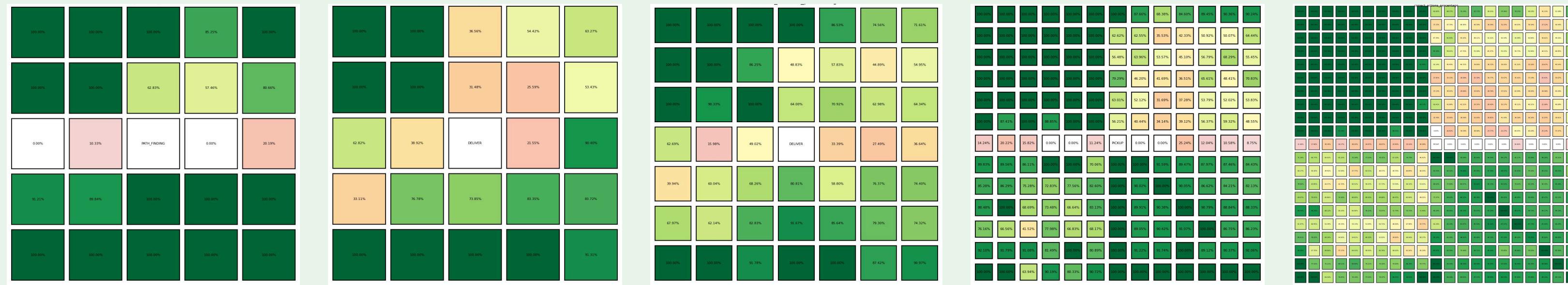
# Orientation

|       | Bottom-Left Origin | Top-Left Origin |
|-------|--------------------|-----------------|
| top1% | 62%                | 92%             |
| top2% | 92%                | 97%             |
| top3% | 93%                | 99%             |

## 3. Results



# Common Uncertainty Patterns #1



|     |     |
|-----|-----|
| 98% | 63% |
| 80% | 88% |

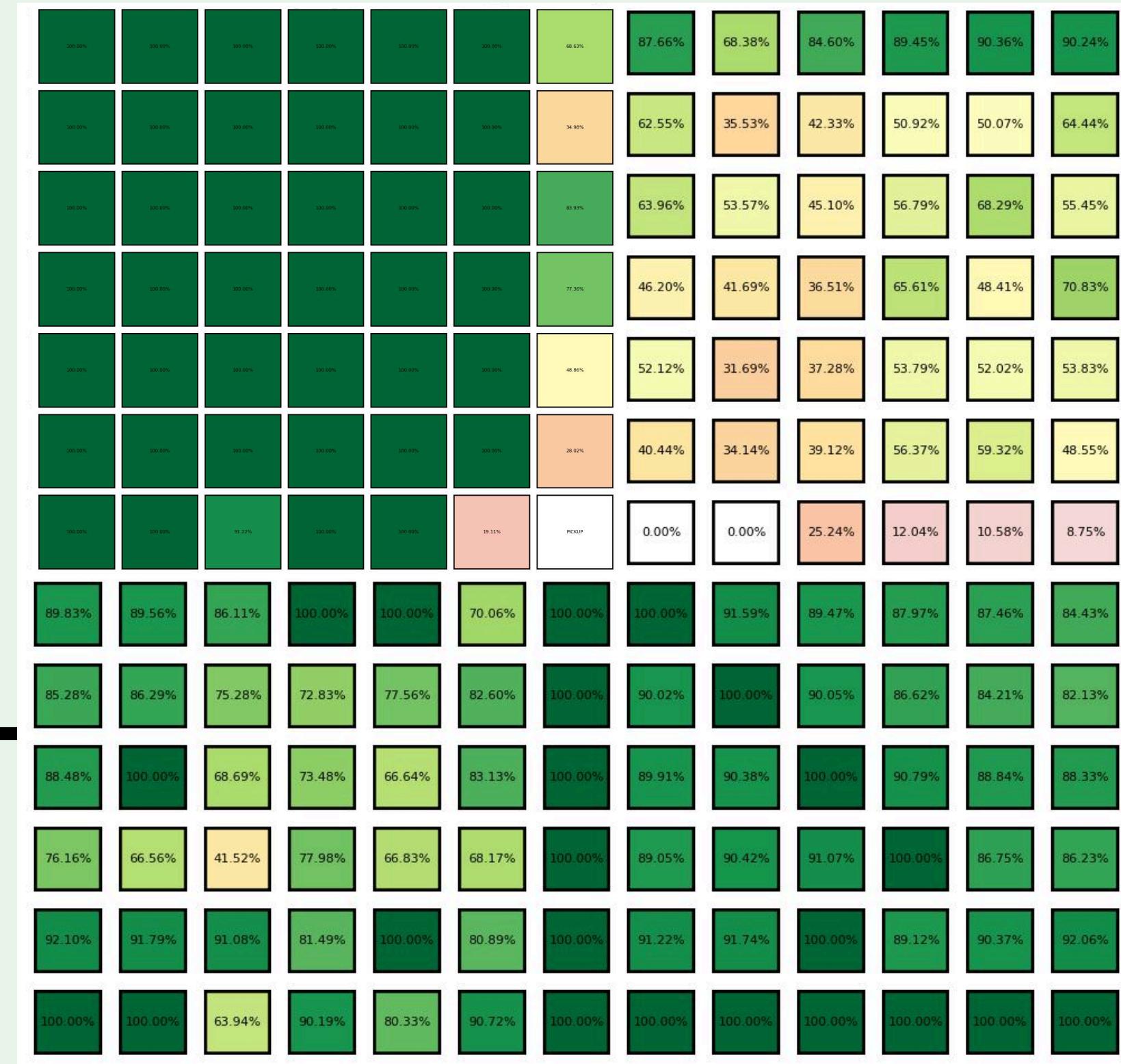
3. Results



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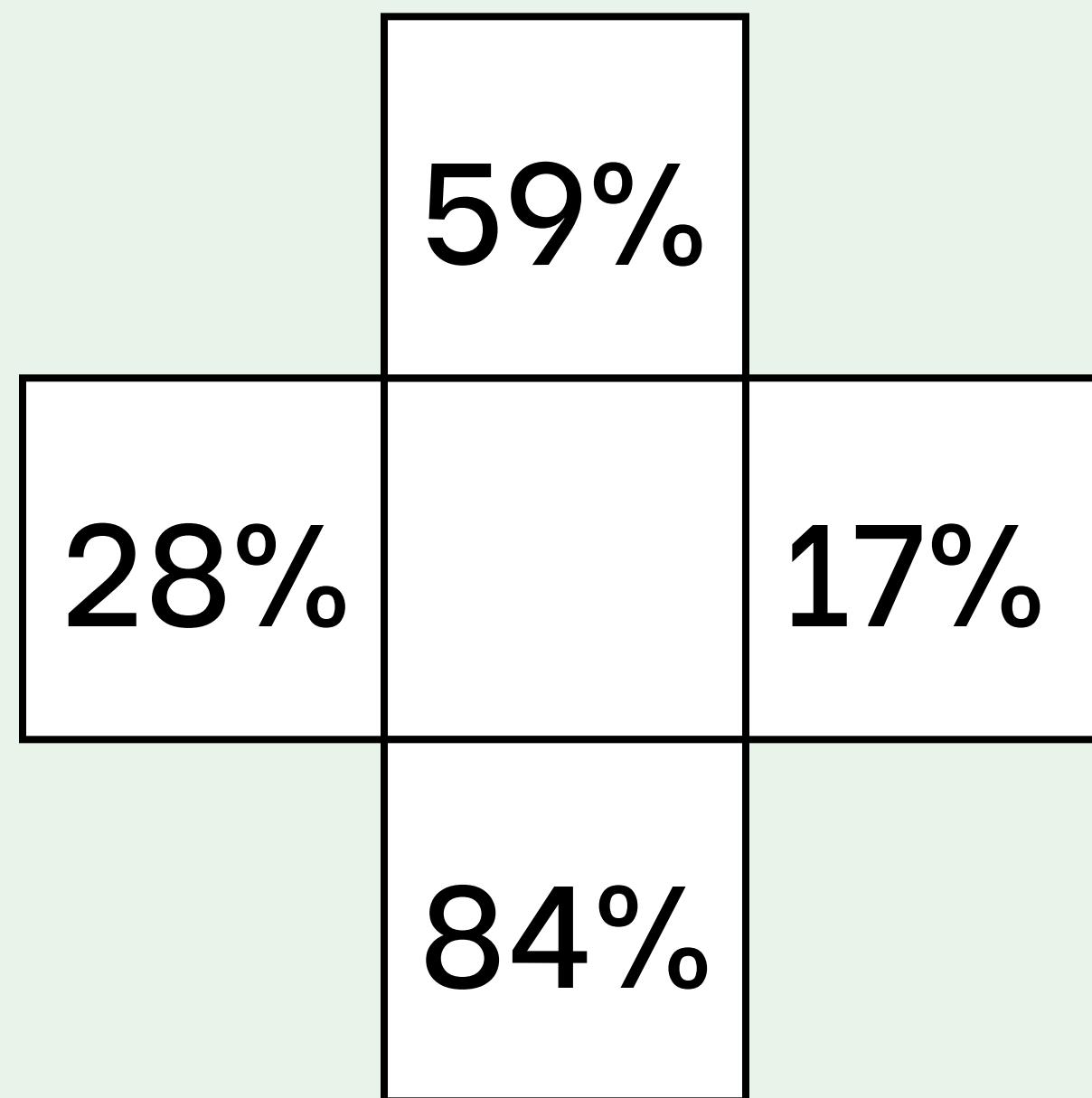
# Common Uncertainty Patterns #1.1

sub-



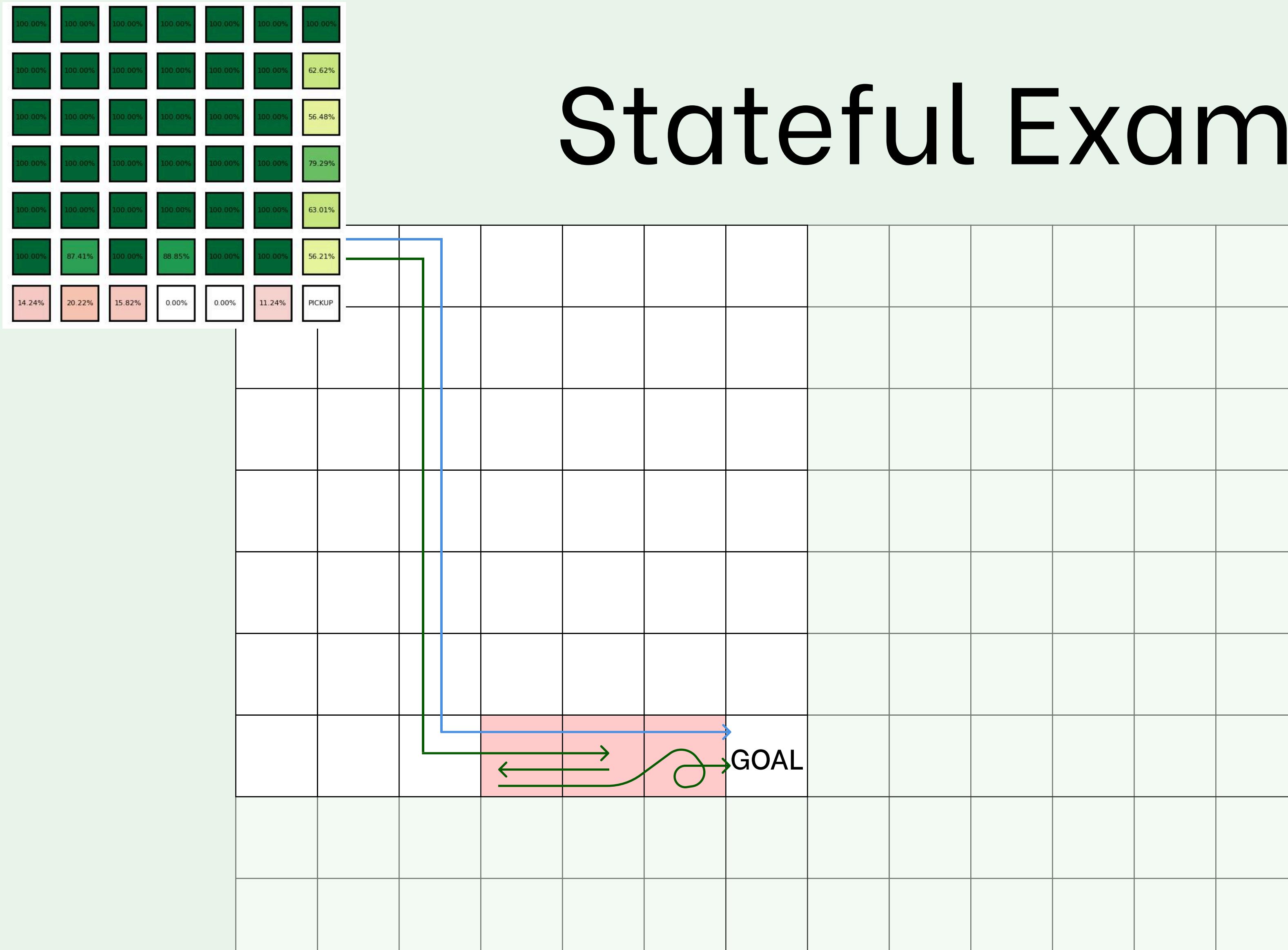
## 3. Results

# Common Uncertainty Patterns #2



## 3. Results





# 3. Results

# Shared Nodes: 100%

## Ratio: 81%



## Optimal path

## Our path

# Ability to retrieve the goal tile

|          | top1 | top2 | top3 | top1% | top2% | top3% |
|----------|------|------|------|-------|-------|-------|
| 21x21_TR | 378  | 429  | 433  | 0.859 | 0.975 | 0.984 |
| 21x21_CN | 294  | 394  | 428  | 0.668 | 0.895 | 0.973 |
| 21x21_BR | 371  | 416  | 417  | 0.843 | 0.945 | 0.948 |

## 3. Results

# Central difference

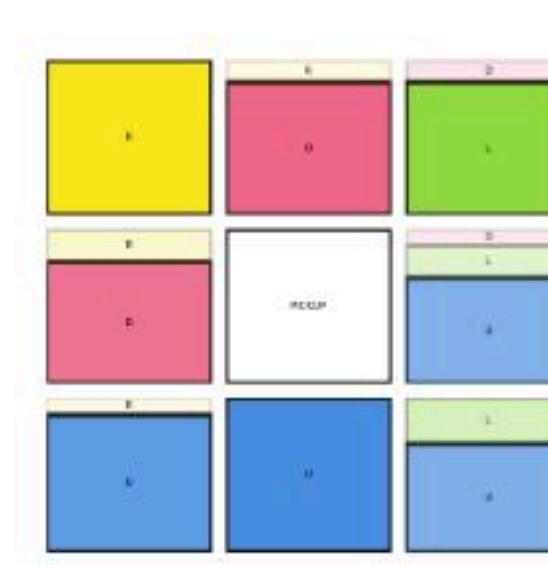


Figure 6.35: 3x3

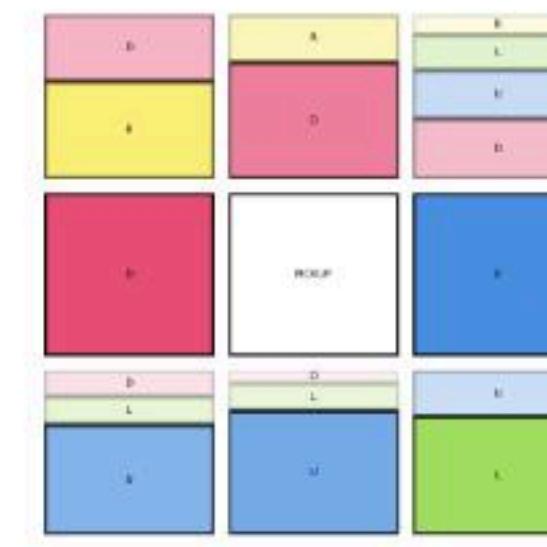


Figure 6.36: 5 × 5

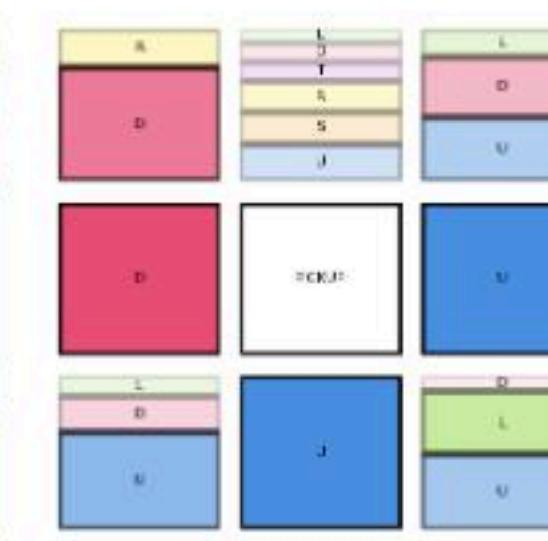


Figure 6.37: 7 × 7

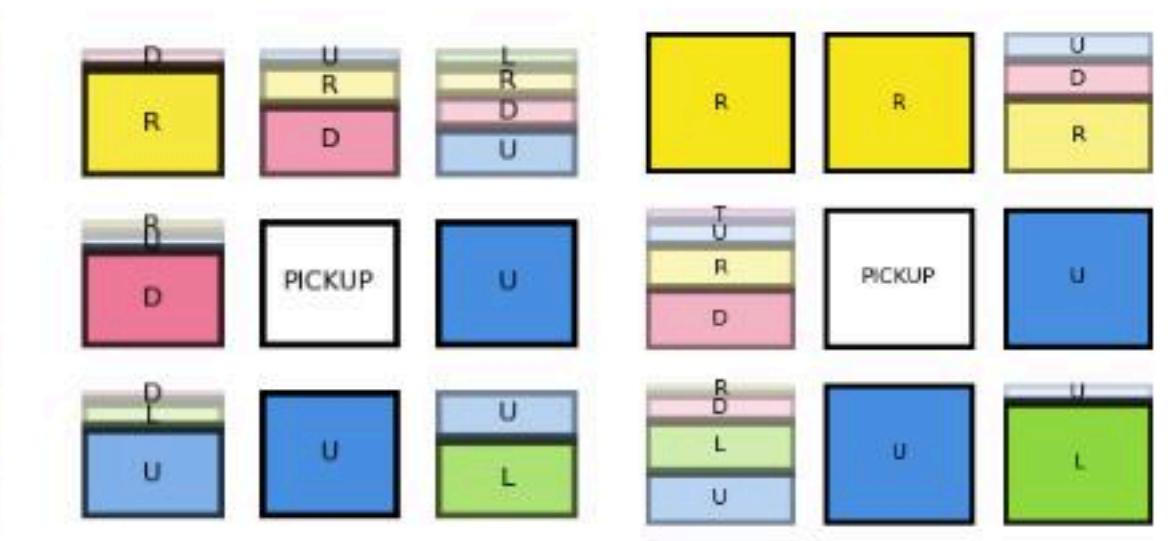


Figure 6.38: 13 × 13 Figure 6.39: 21x21

TODO: Variance of the cells

TODO: Avg uncert per size

# Stateless vs Stateful

| Map Size | Stateless  | Stateful   | Manhattan Distance |
|----------|------------|------------|--------------------|
| 13 × 13  | 41 actions | 39 actions | 25 actions         |
| 7 × 7    | 27 actions | 21 actions | 13 actions         |
| 5 × 5    | 14 actions | 11 actions | 9 actions          |
| 3x3      | 11 actions | 9 actions  | 5 actions          |

%

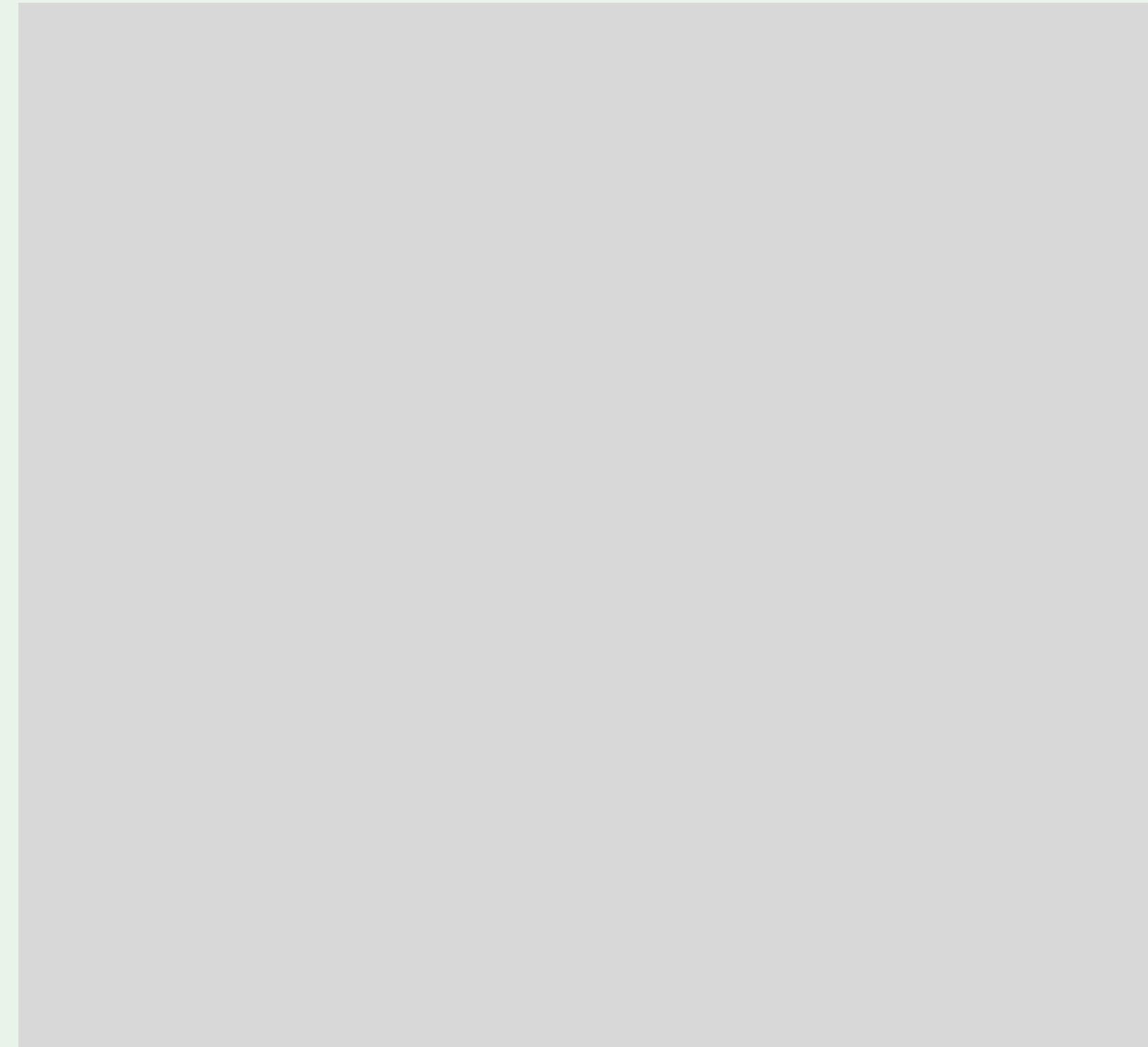
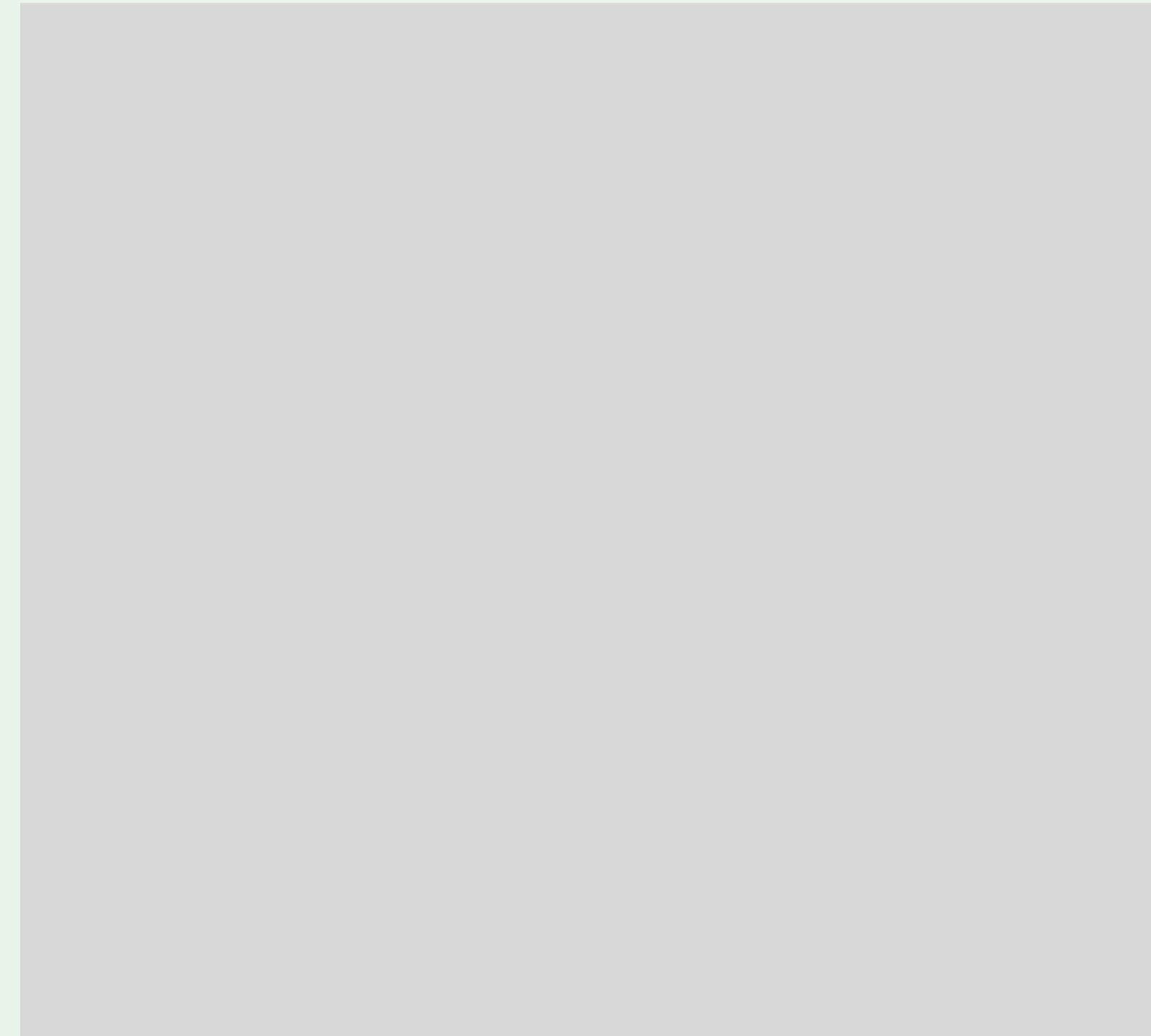
problems

## 3. Results



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# Strengths & Weaknesses



## 3. Results



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# Thank You

## Exploring the Use of LLMs for Agent Planning: Strengths and Weaknesses