

Evaluating Critical Points in Trajectories

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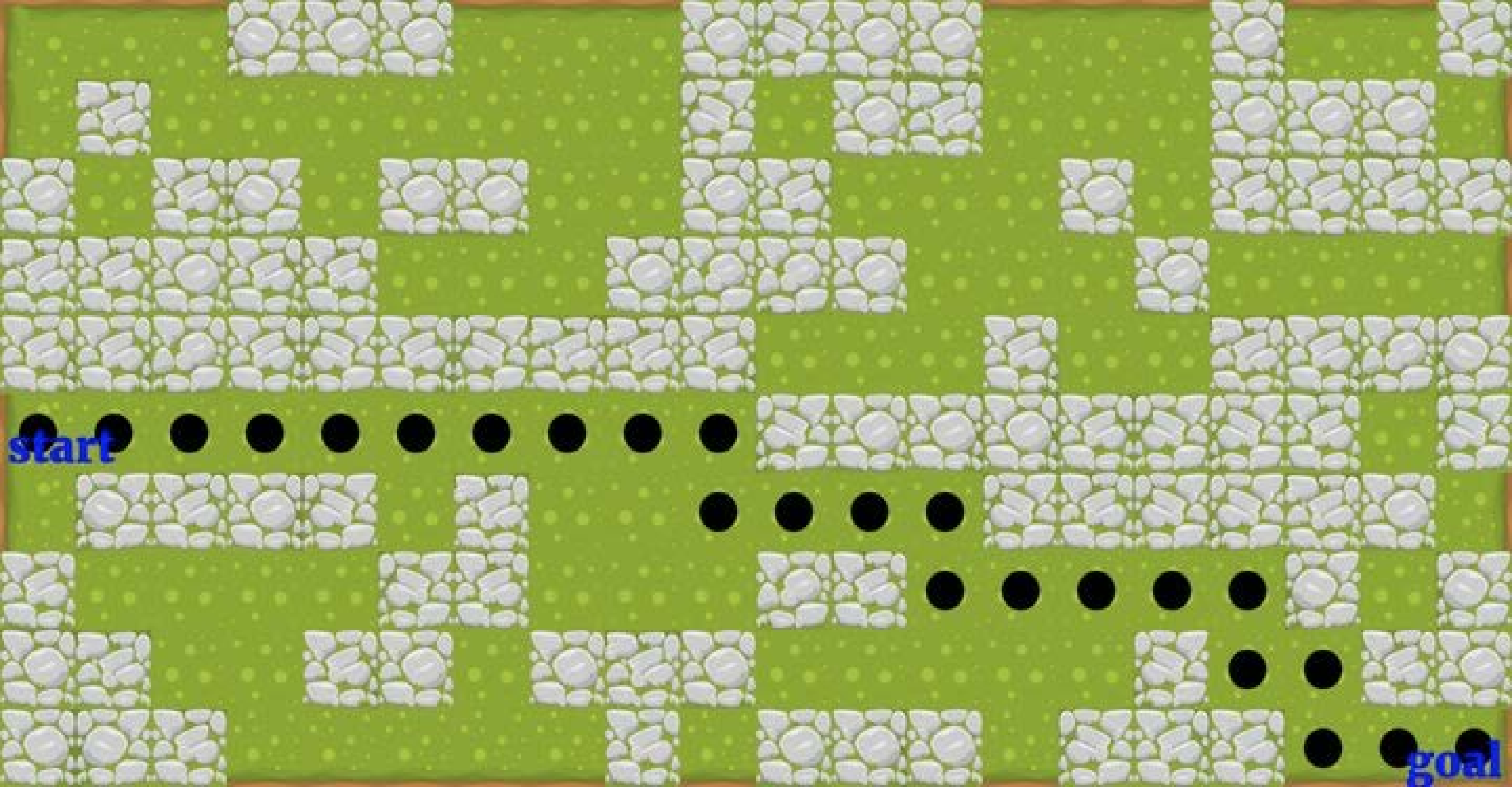
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Introduction

- Understanding robot behavior is important
- Understanding robot behavior is hard
- People form beliefs about robot behavior through observation
- Robots do not execute actions with the intent of conveying state preferences

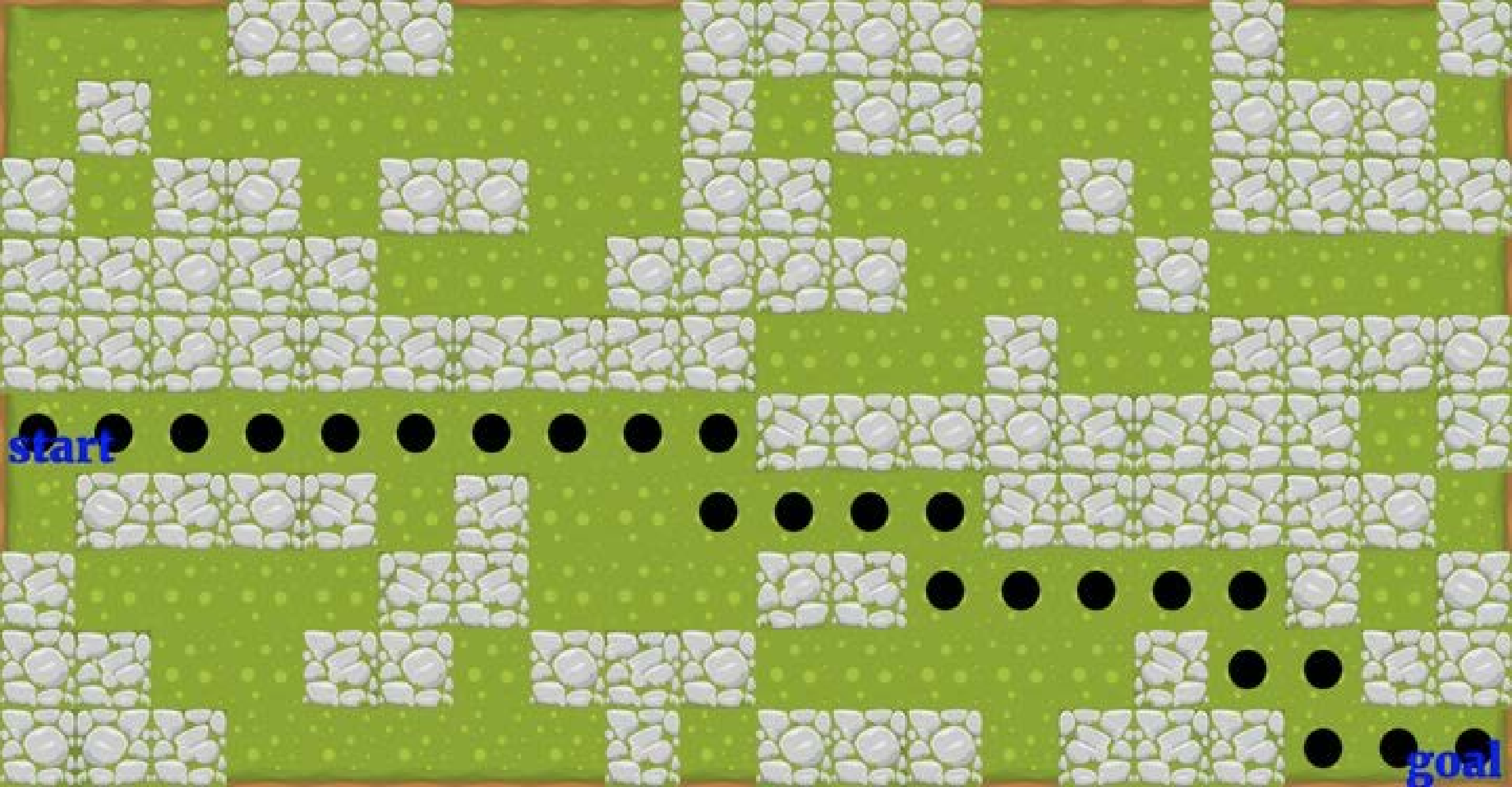




How can we convey state preference?

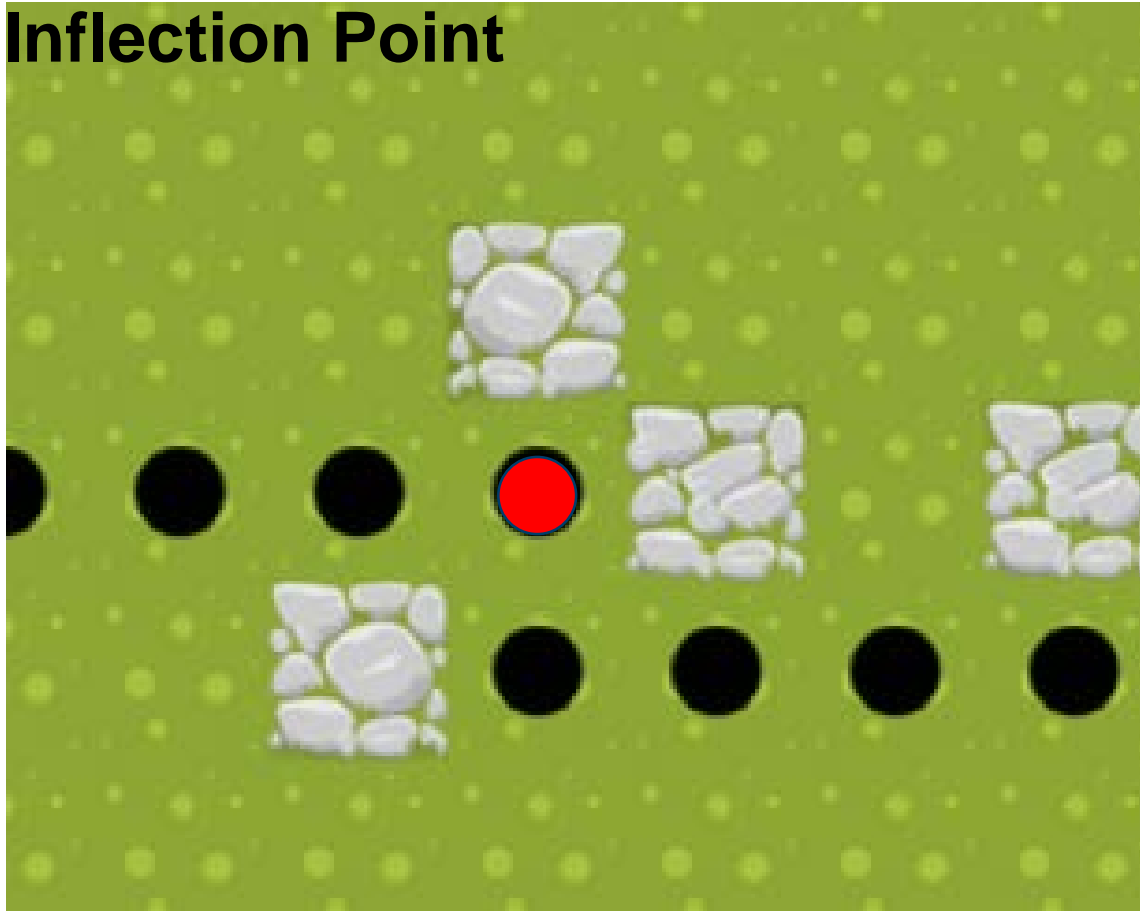
- Prior work focuses on the robot conveying capabilities and goals
- We focused our work on conveying the object function and state preferences



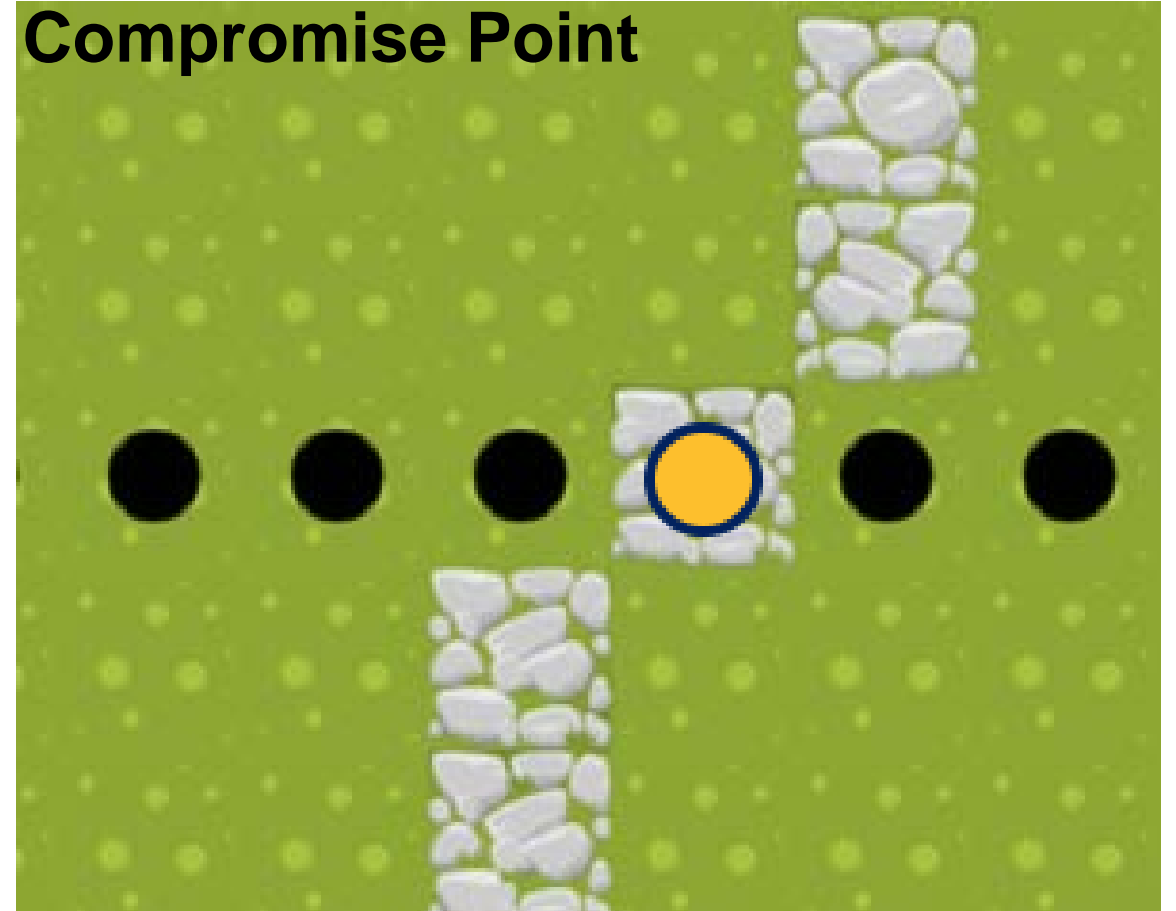


Critical Points - Definitions

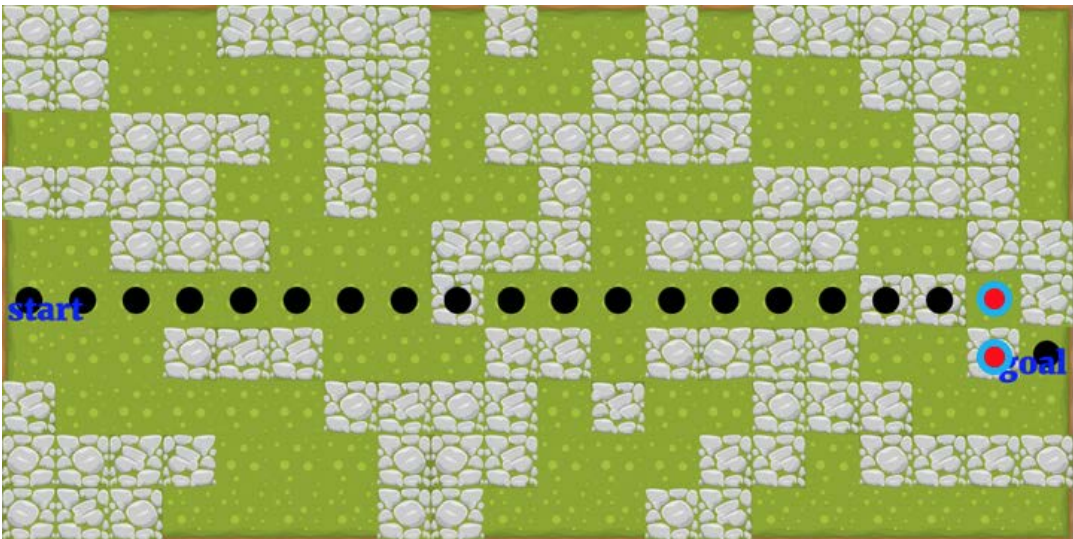
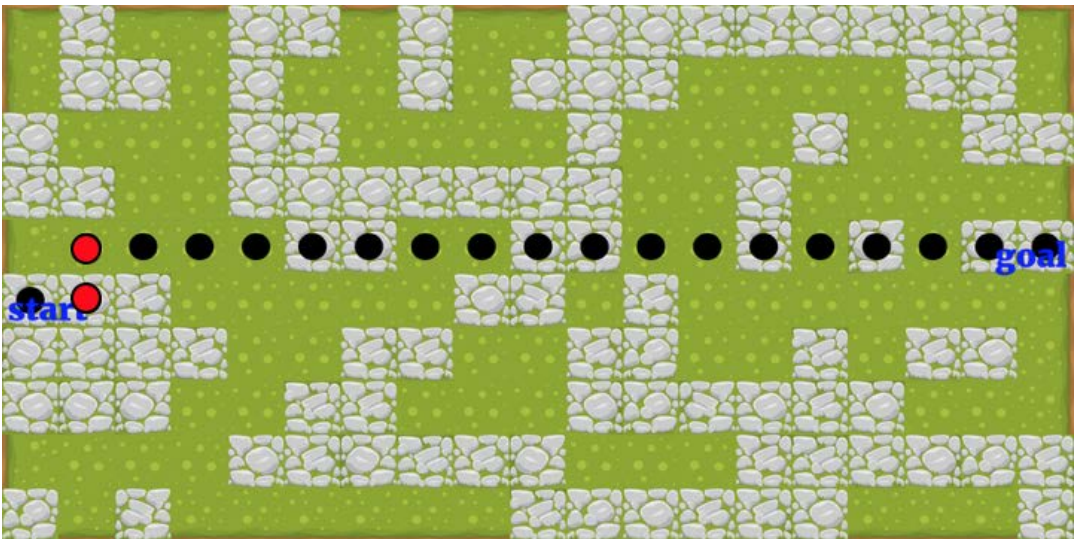
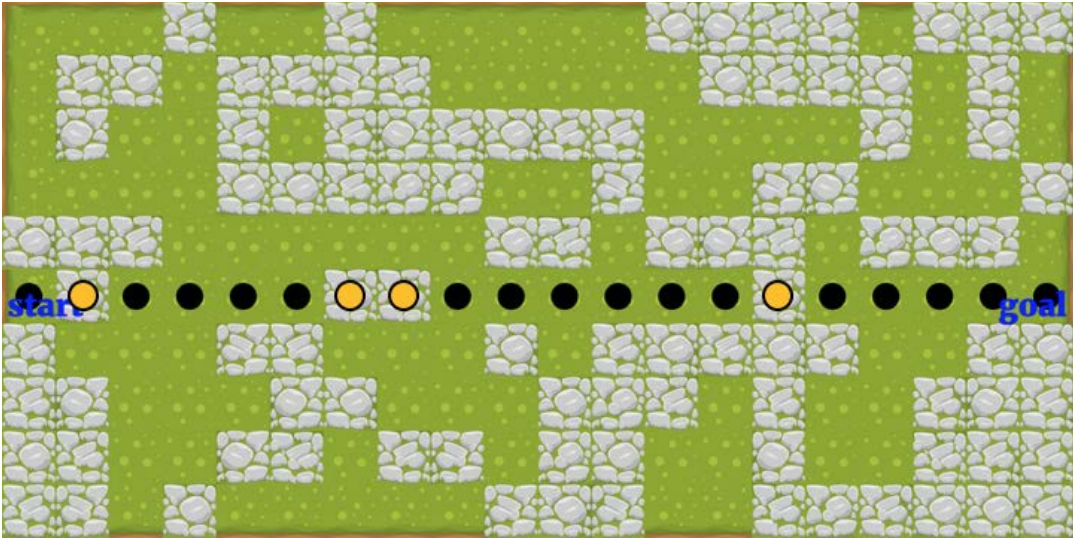
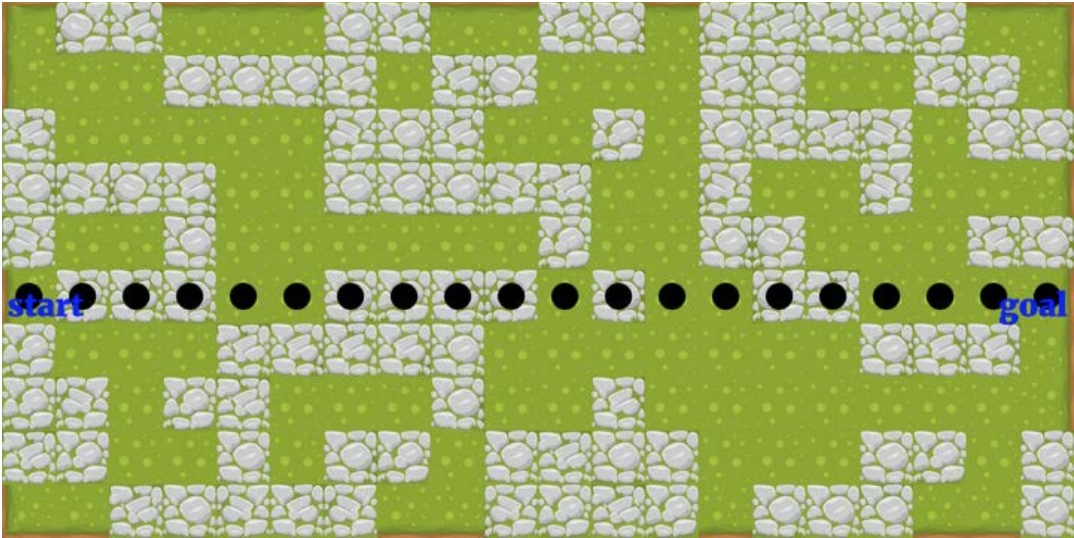
Inflection Point



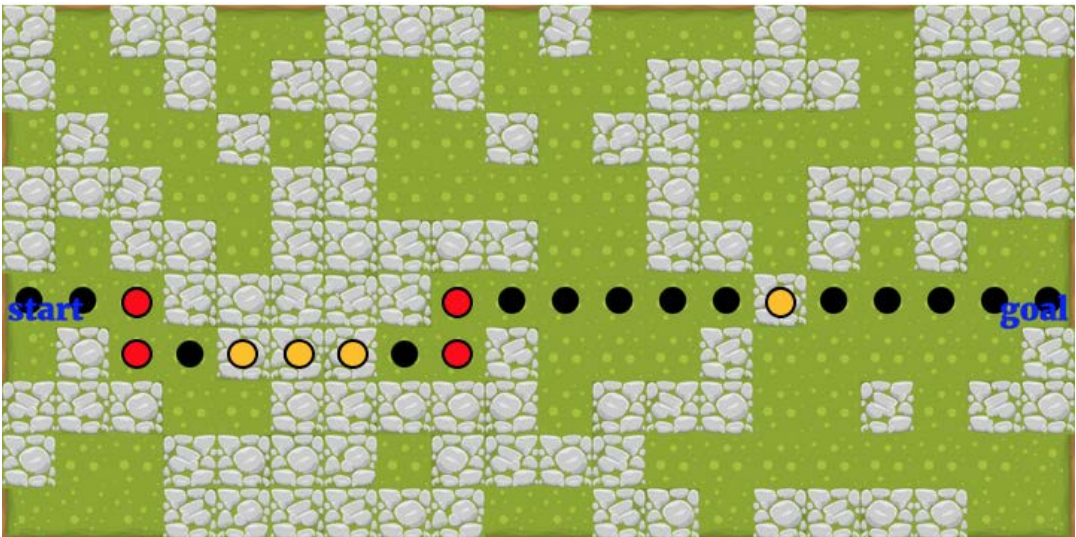
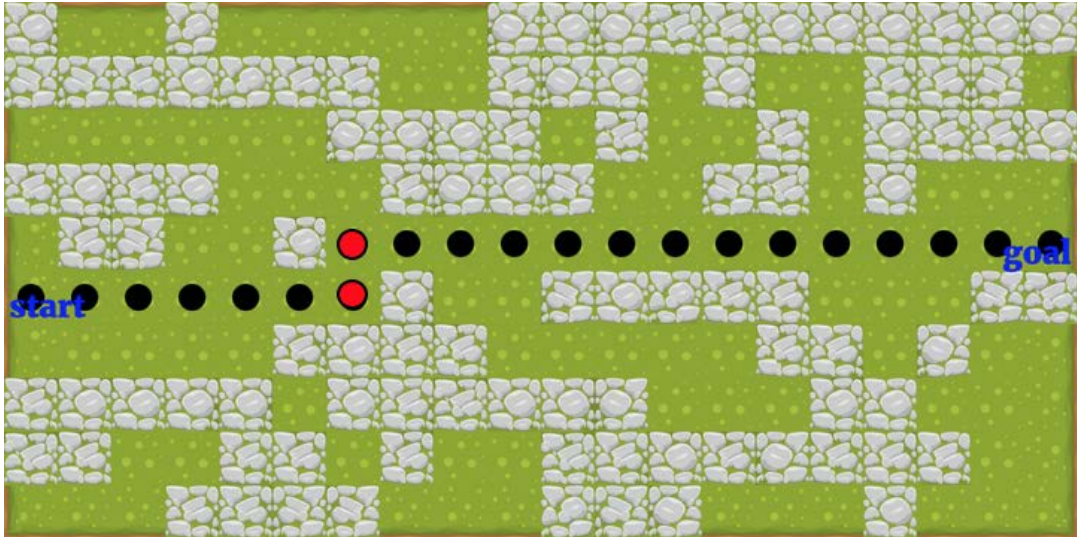
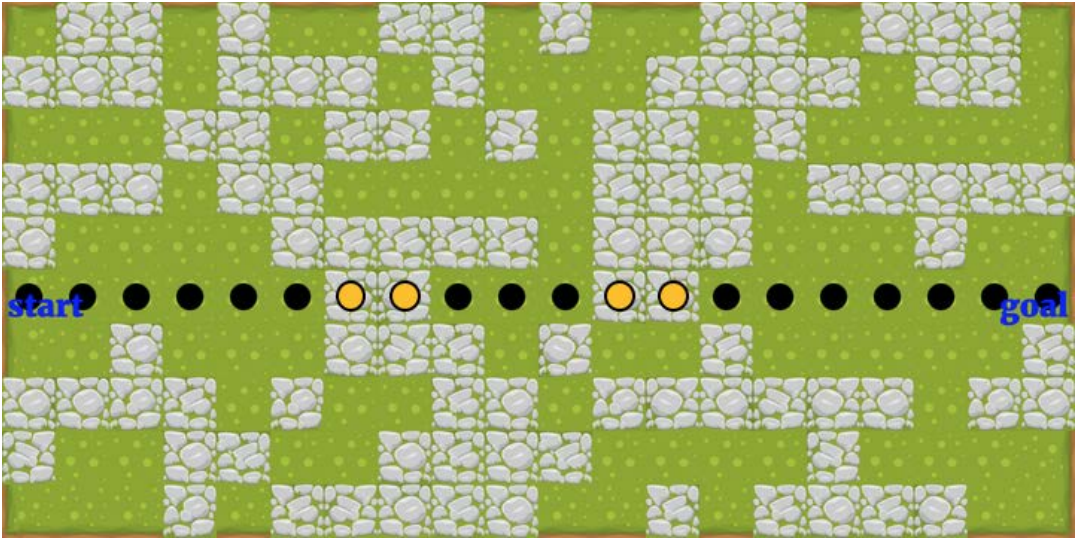
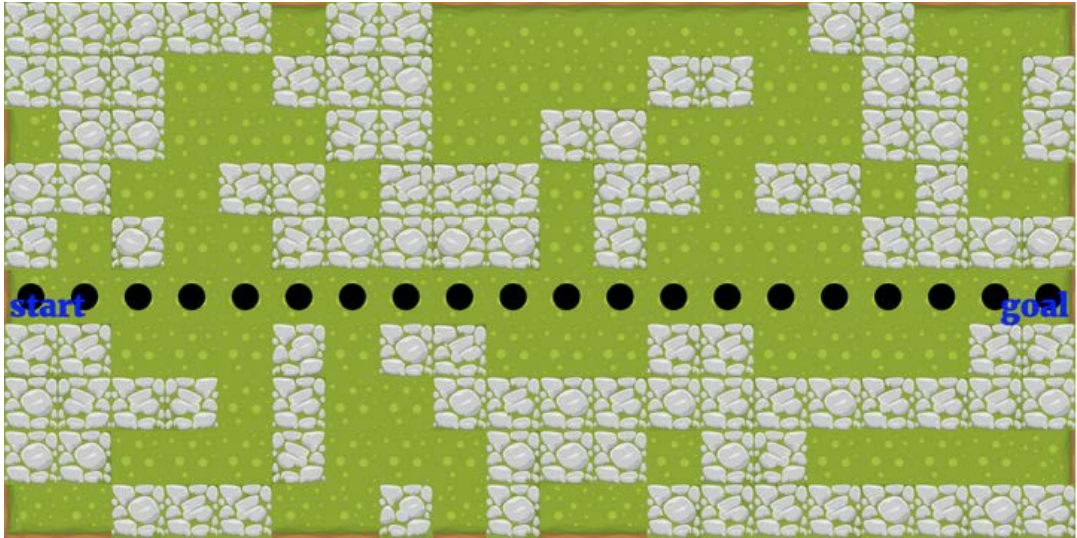
Compromise Point



Example – Robot has NO preference

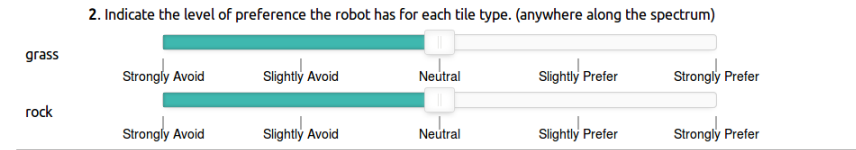


Example – Robot has a preference



Data Collection

- Amazon Mechanical Turk
- Within-subjects design
 - 16 conditions (6+10) in same order
 - Predetermined order to ensure no three consecutive conditions had the same terrain preference



3. Explain the reasoning this robot uses when planning its paths. Your explanation should be a full, complete sentence.

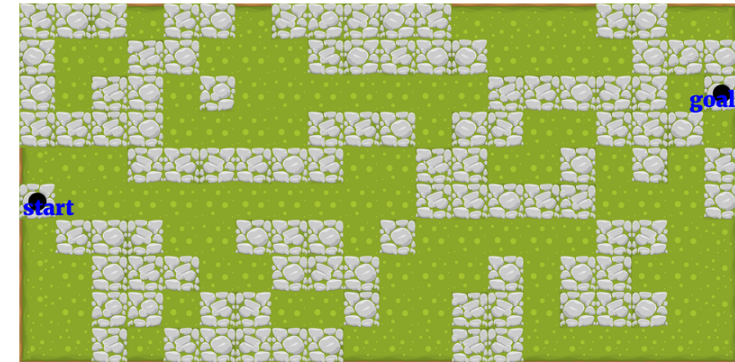
Enter your answer here...

4. In the map below, find the black dot labeled 'start' in blue text. From this start position, please plan the path you think the robot you just observed would take to the black dot labeled 'goal', assuming it is following the same reasoning as the demonstration shown at the top of the page.

Tips for Using the Drawing Interface:

Start by hovering your mouse over the start position. You will notice a blue circle appears. Click this blue circle to turn it into a blue dot and confirm it as part of the path you have planned. Next, hover your mouse over an adjacent tile (the interface will limit you to only selecting an adjacent tile) and click the tile you think the robot would travel to next. Repeat this process until you reach a tile on the goal position. Ensure you have clicked the goal tile of the map so that a solid blue dot appears.

If at any time you want to undo a selection, click on the solid blue dot at the end of the path to undo it and select a different tile or continue undoing past actions by clicking the solid blue dots. Think very carefully about what the robot will do based on the reasoning you extracted from the demonstration map at the top of the page.



5. How confident are you that the path you drew is the same path the robot would take on this map?

- Completely Confident
- Very Confident
- Moderately Confident
- Somewhat Confident
- Not At All Confident

Measures

Optimality Ratio

Ratio of *total cost of optimal trajectory* to *total cost of drawn trajectory*

As Optimality Ratio increases, so does subject understanding of robot reward function.

Preference Range

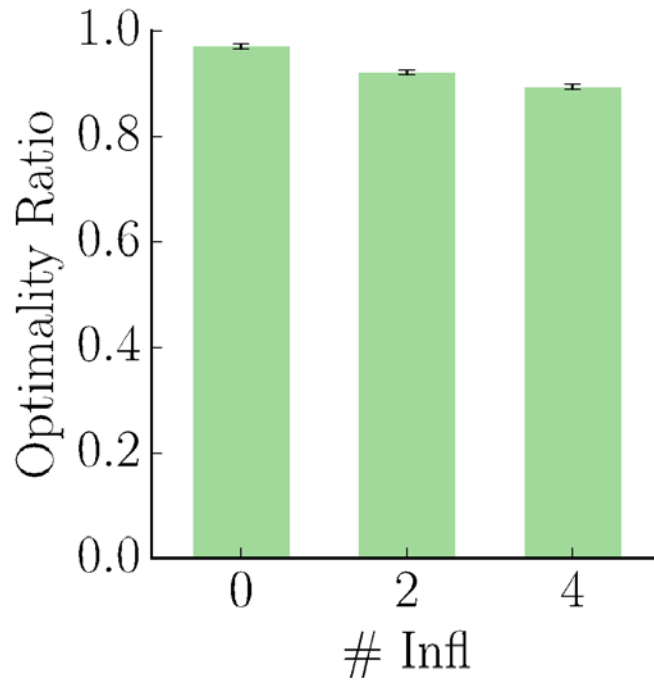
Range [0,2000]. 0 indicating user inferring no preference difference between the two conditions (rock & grass). 2000 indicating user inferring preference with high certainty, regardless of robot preference.

Subjective Confidence

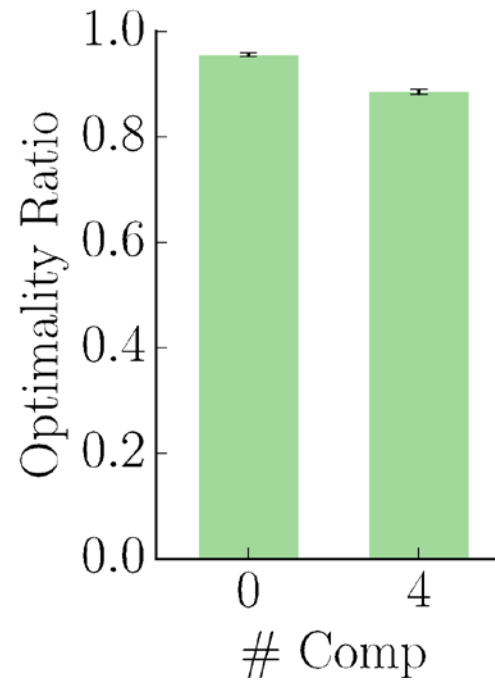
Self-reported confidence in understanding robot reasoning.

Results – Optimality Ratio (w/o preference)

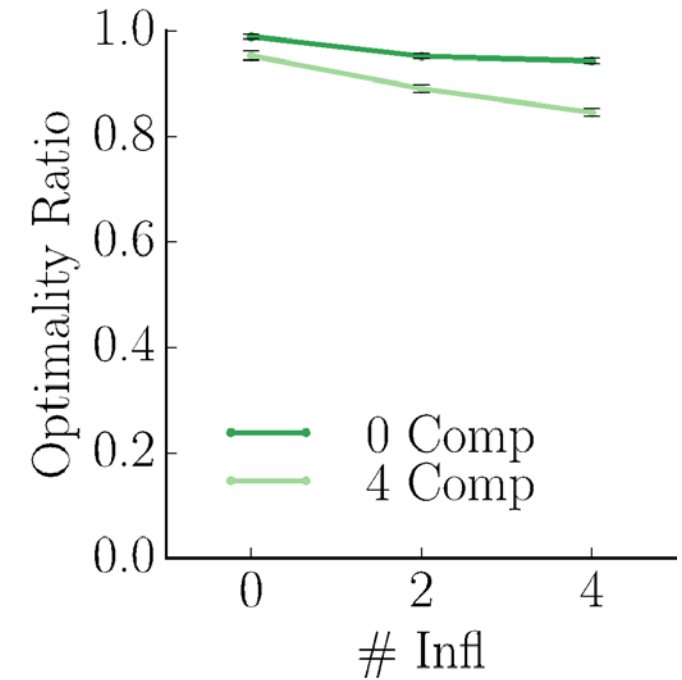
Effect of Inflection Points



Effect of Compromise Points

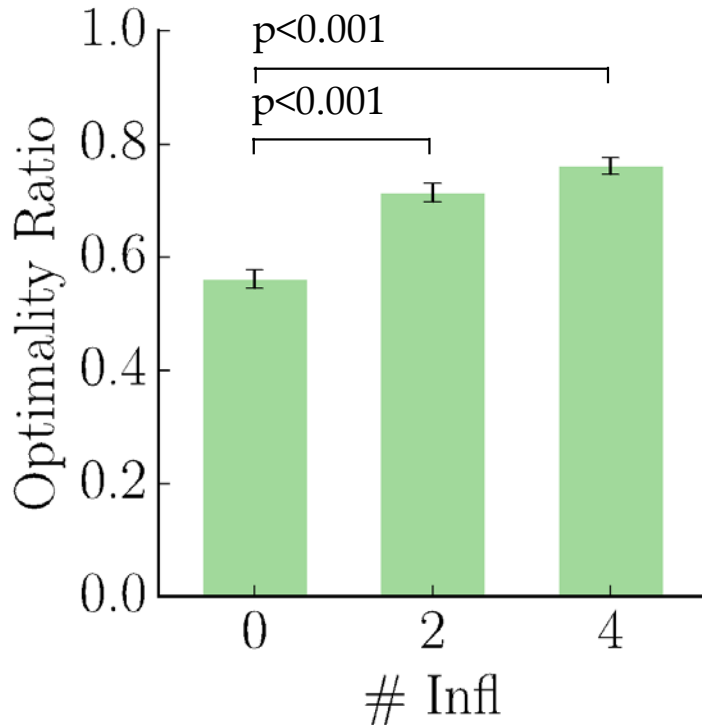


Interaction between Inflection & Compromise Points

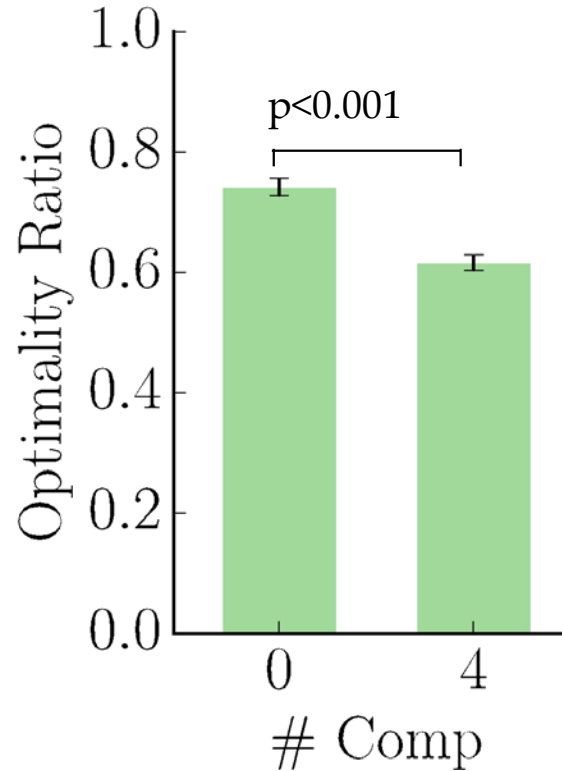


Results – Optimality Ratio (w/ preference)

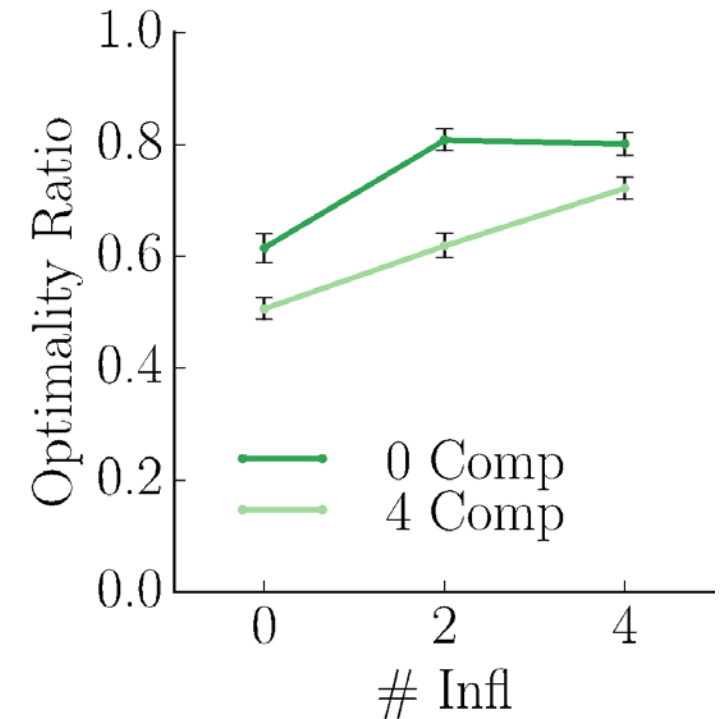
Effect of Inflection Points



Effect of Compromise Points



Interaction between Inflection & Compromise Points



Results

Preference Range

Increase in Inflection Points
increased Preference Range

Increase in Compromise Points
decreased Preference Range

No other significant effects.

Subjective Confidence

Increase in Inflection Points
increased Subjective Confidence

Increase in Compromise Points
increased Subjective Confidence

No other significant effects.

Potential Future Work

- Investigate whether conclusions hold for more complex terrain (greater than two terrain types).
 - Additional critical points necessary to disambiguate each pair of features, but complexity may overwhelm users.
- How will real-world scenarios affect the ability to convey critical points?
 - We only simulated and generated maps; we did not execute on a real platform. A real-world system may not be able to generate the necessary critical points.

Questions?

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