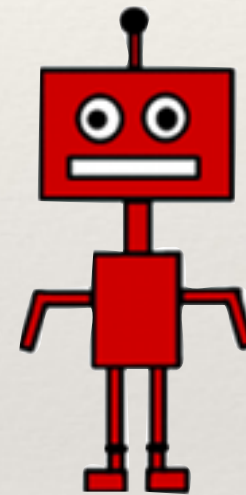


*Dave, Gabe, James, Stefanie*

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# Affordance Aware Planning

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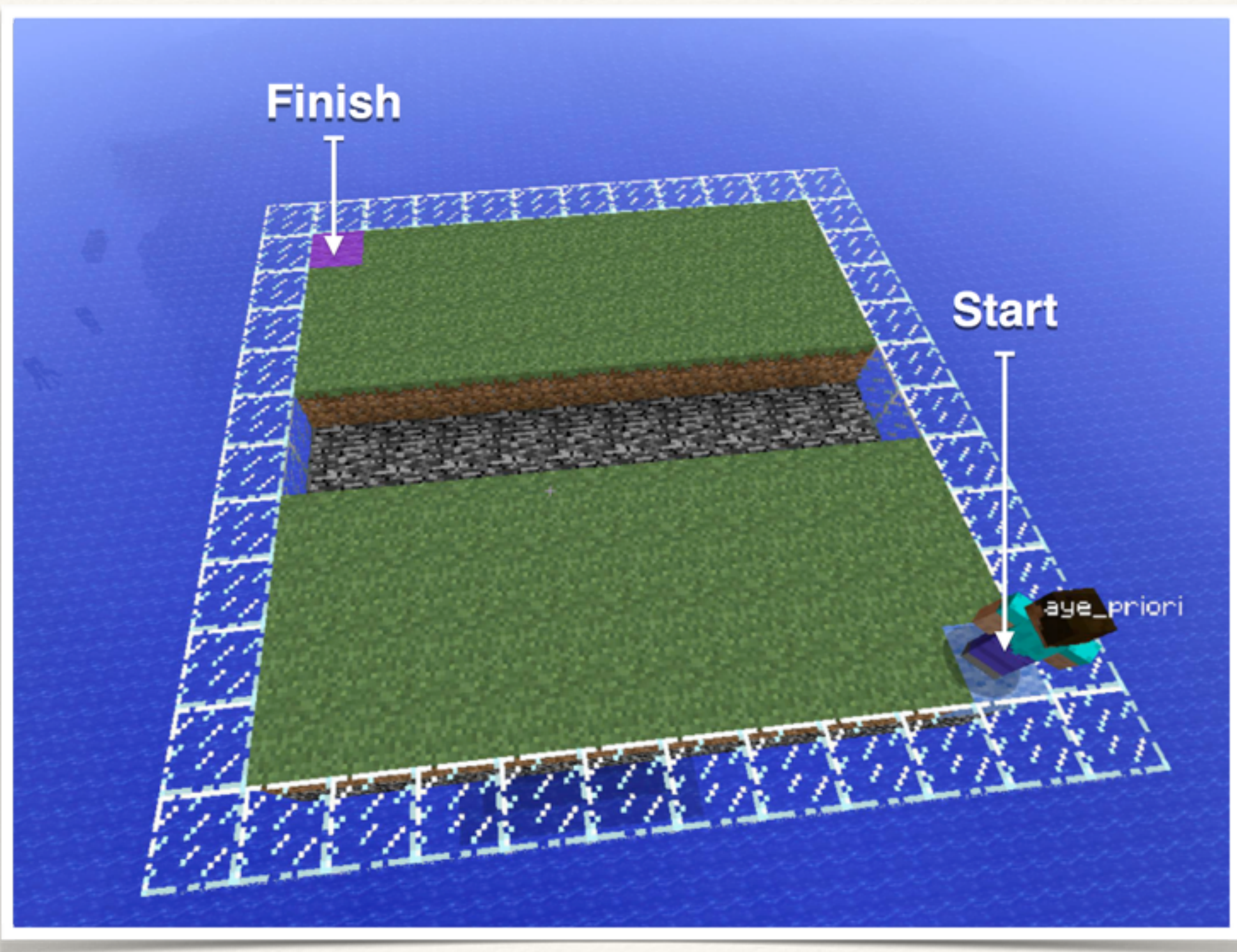
# Outline

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- ❖ **Motivation**
- ❖ Related Work
- ❖ Affordance-Aware Planning
- ❖ Results and Demo



# Bridgeworld





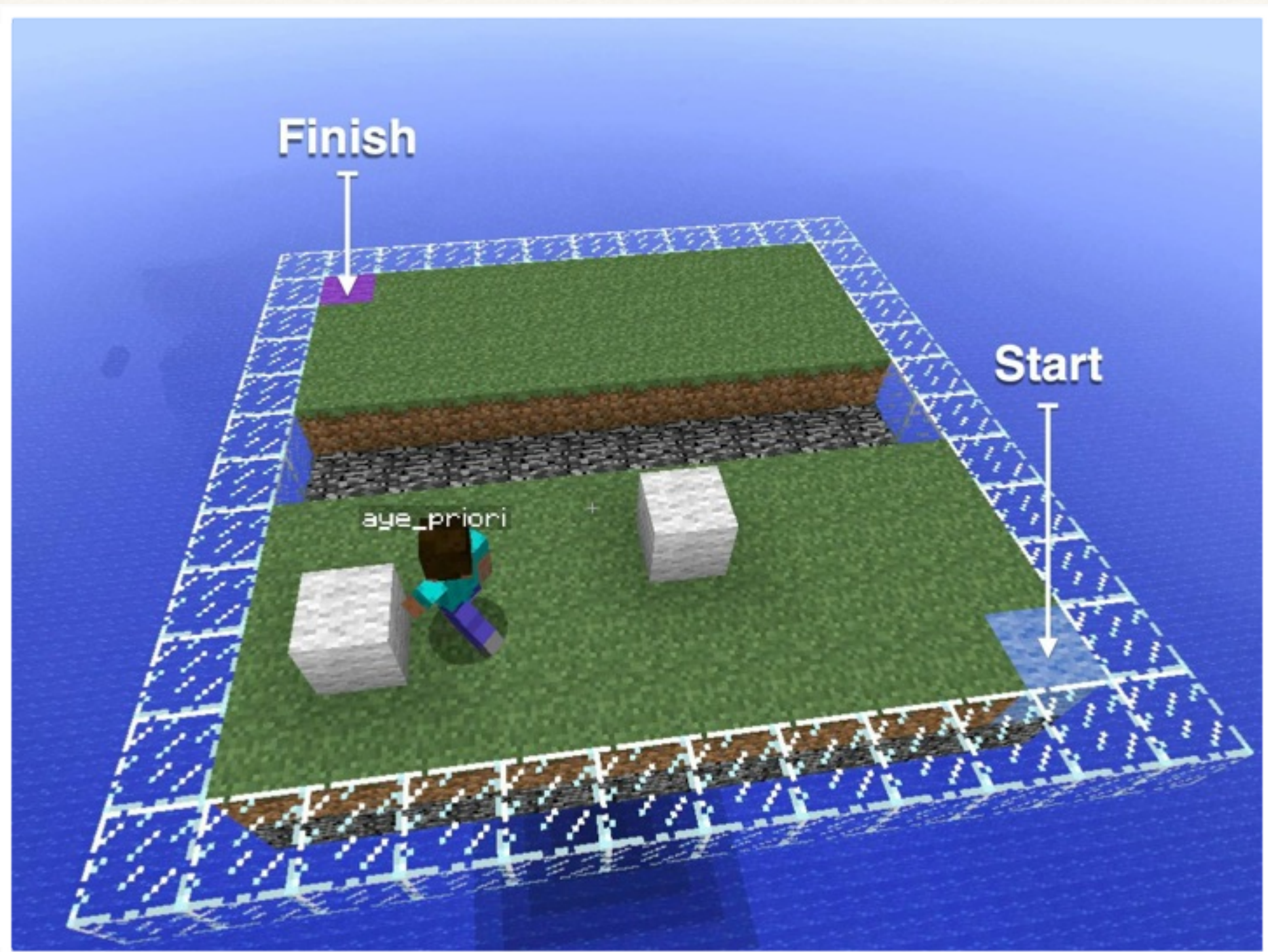
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# Planning Paradigms

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- ❖ Dynamic Programming
  - Value Iteration
- ❖ Rollout
  - Real Time Dynamic Programming (RTDP)
- ❖ Subgoals
  - BFS in Subgoal Space, Low-level plan between subgoals

# The Problem





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# Outline

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- ❖ The Problem
- ❖ **Related Work**
- ❖ Affordance-Aware Planning
- ❖ Results and Demo

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# Related Work: Heuristics

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- ❖  $A^*$ , UCS for simple deterministic domains
- ❖ Estimate Q-values (PROST)
- ❖ Reward Shaping

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# Related Work: Action Pruning

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- ❖ Sherstov and Stone (2005)
  - Prune away actions not used in optimal policies
- ❖ Rosman and Ramamoorthy (2012)
  - Dirichlet prior over state-action pairs



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# Related Work: Extended Actions

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- ❖ Options

- Add option policies to action set

- ❖ Macroactions

- Add common sequences of atomic actions to action set

- ❖ Problem: increases branching factor

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# Related Work: Affordances

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- ❖ Saxena, Koppula et. al (2013)
  - Robots, humans, and affordances
- ❖ Gorniak, Roy (2005, 2006)
  - Affordance-Based Concept (ABC)
- ❖ Steedman (2002)
  - Linear Dynamic Event Calculus (LDEC)
- ❖ Grasping Work



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# Outline

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- ❖ The Problem
- ❖ Related Work
- ❖ **Affordance-Aware Planning**
- ❖ Results and Demo

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# Affordance Formalism

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An Affordance is defined as:

$$\Delta_i = \langle p, g \rangle \longmapsto \alpha$$

Where:

$p$  = a predicate on states (*precondition*)

$g$  = an ungrounded predicate on states (*lifted goal description*)

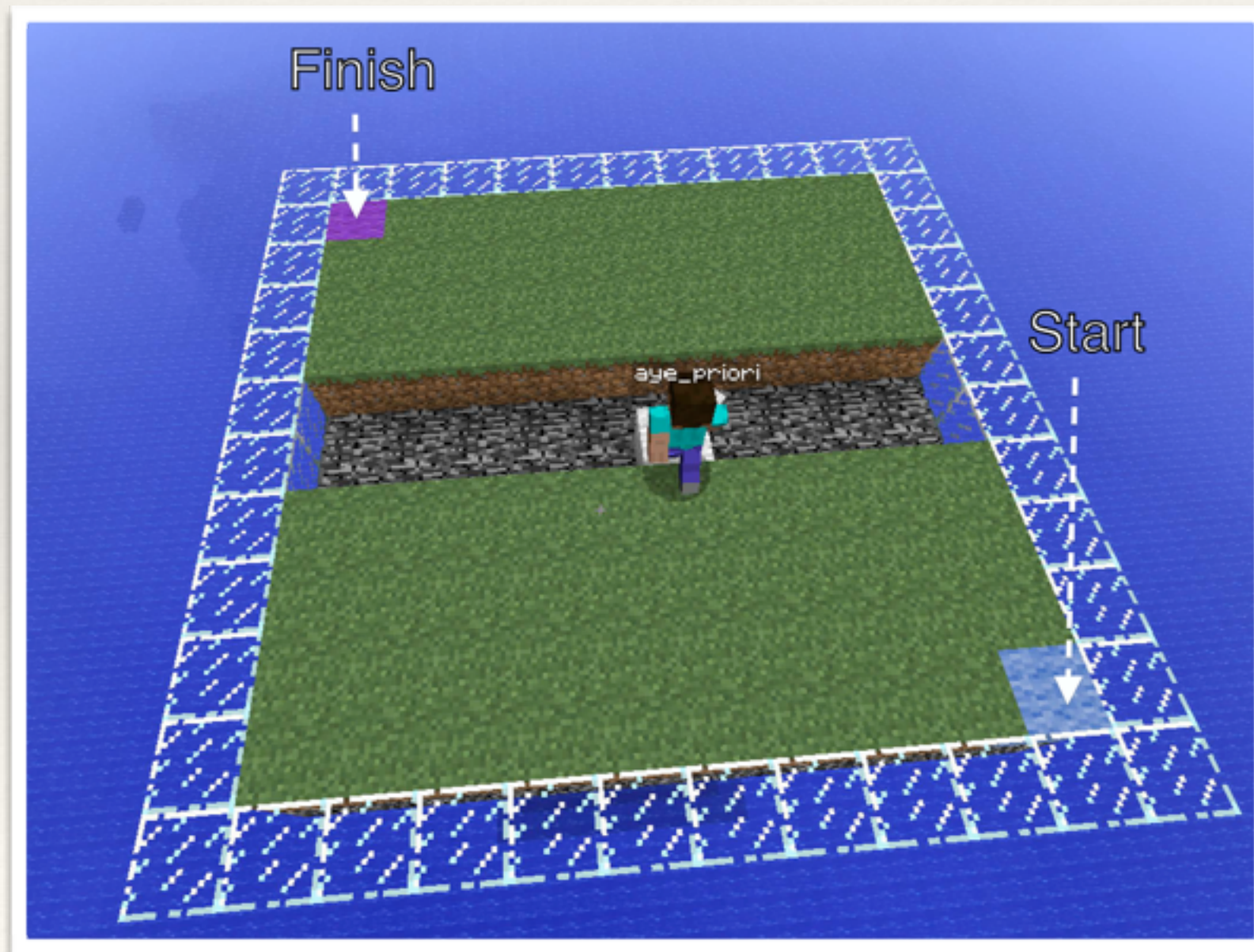
$\alpha$  = a subset of the agent's actions ( $A$ )



# Affordance-Formalism: Example

$\Delta_1 \quad \langle nearTrench, reachGoal \rangle \mapsto \{\square\}$

$\Delta_2 \quad \langle onPlane, reachGoal \rangle \mapsto \{\updownarrow\leftrightarrow\}$

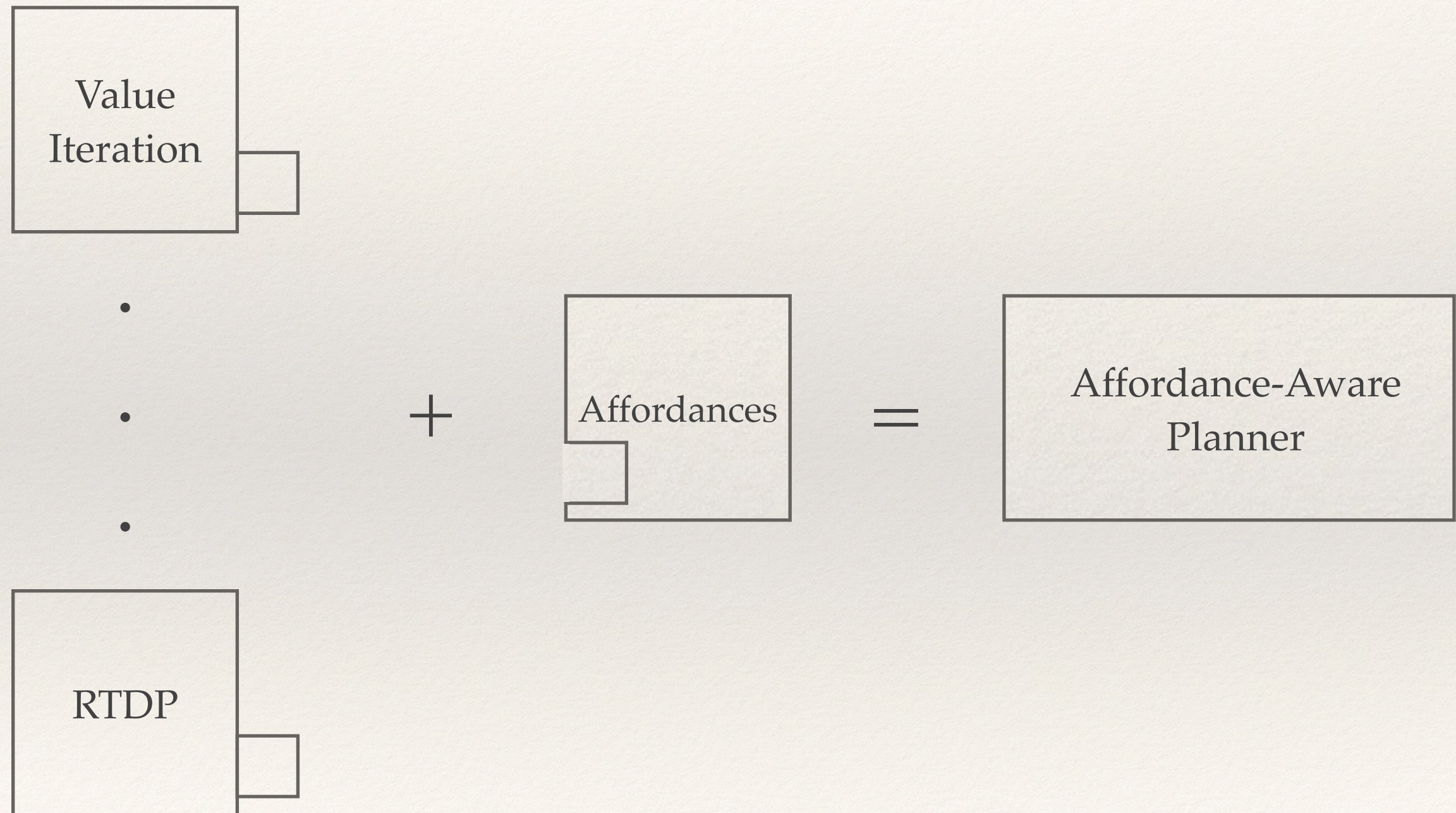




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# Affordance-Awareness

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# Outline

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- ❖ The Problem
- ❖ Related Work
- ❖ Affordance-Aware Planning
- ❖ **Results and Demo**



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# Experiments

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- ❖ Mutable Tasks

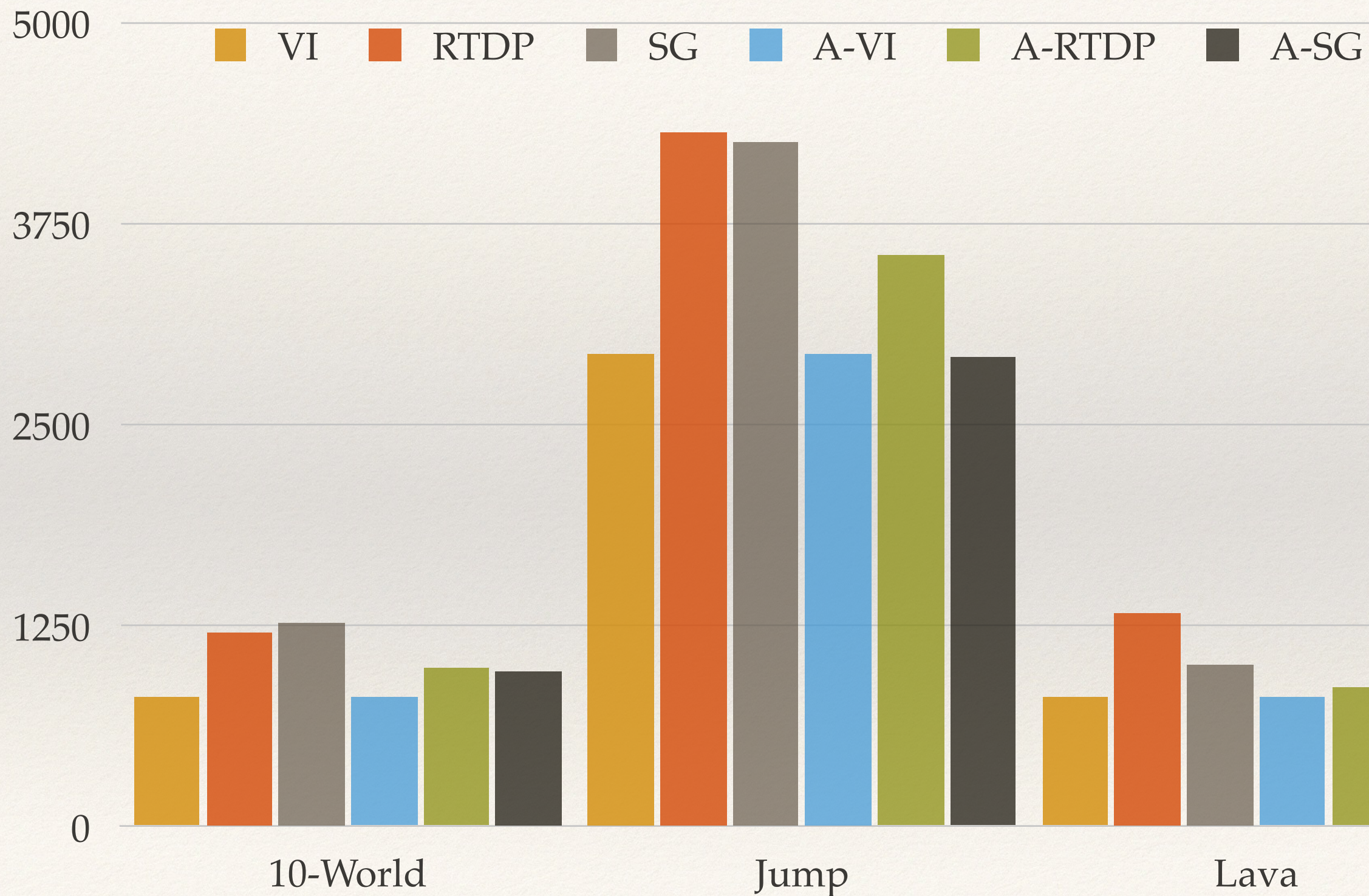
- Block placement, destruction, bread, smelting

- ❖ Static Tasks

- Path planning with obstacles

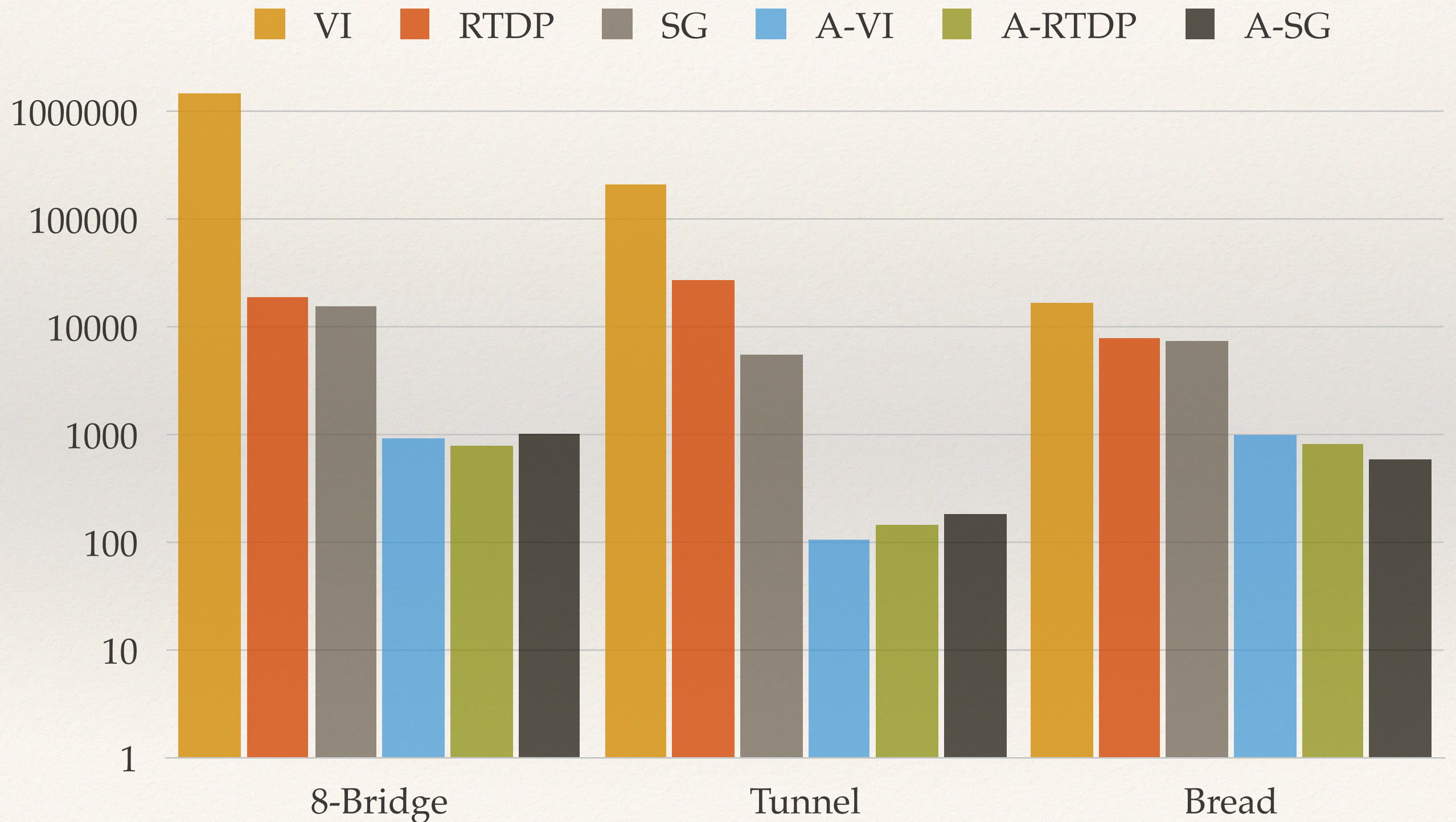


# Results: Static



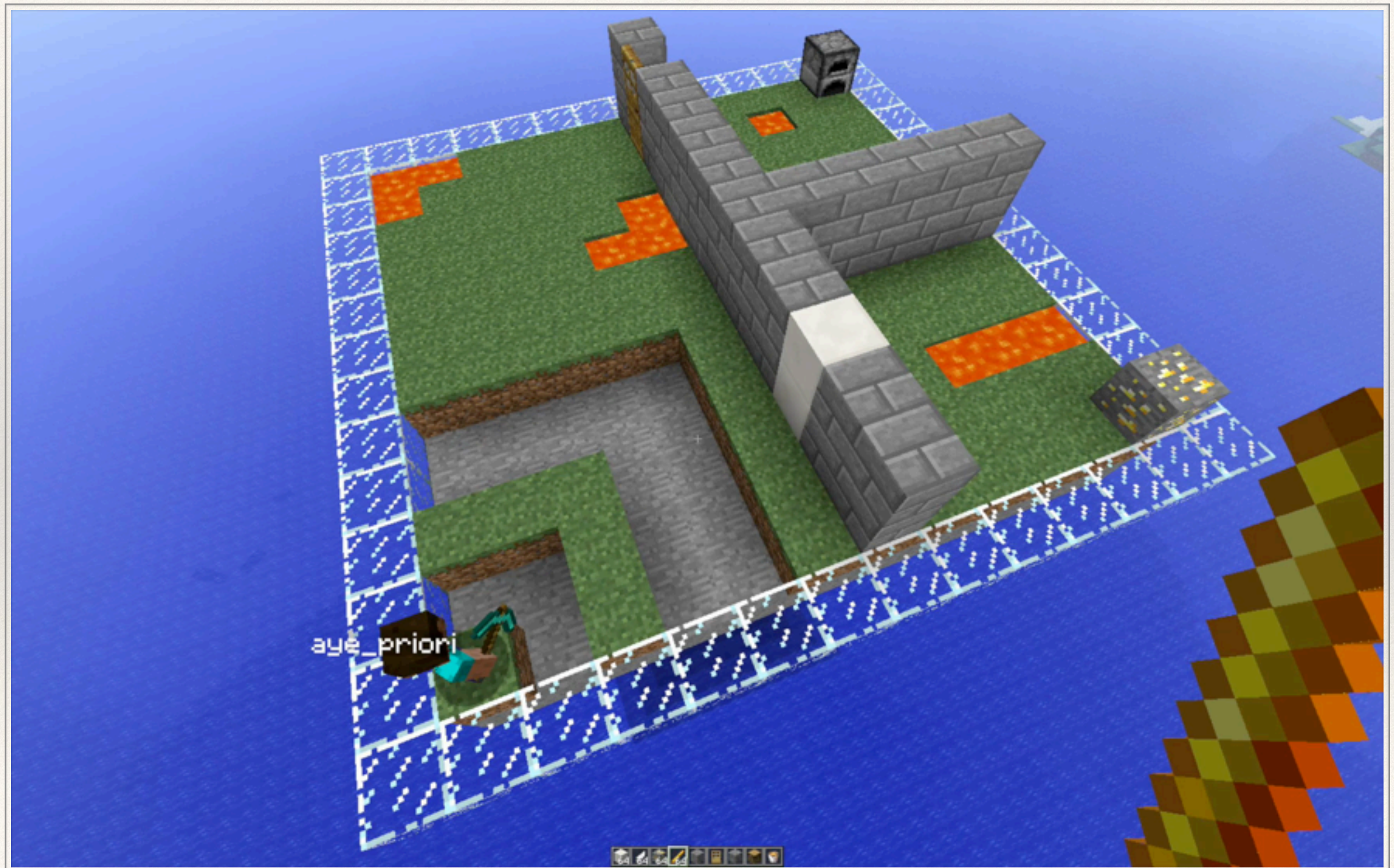


# Results: Mutable





# Epicworld





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# Future Work

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- ❖ Learning
- ❖ More informed pruning
- ❖ Get working on robot
- ❖ Extend for other planners ( $A^*$ , POMDPs)
- ❖ Natural Language extensions (learning, dialogue)



