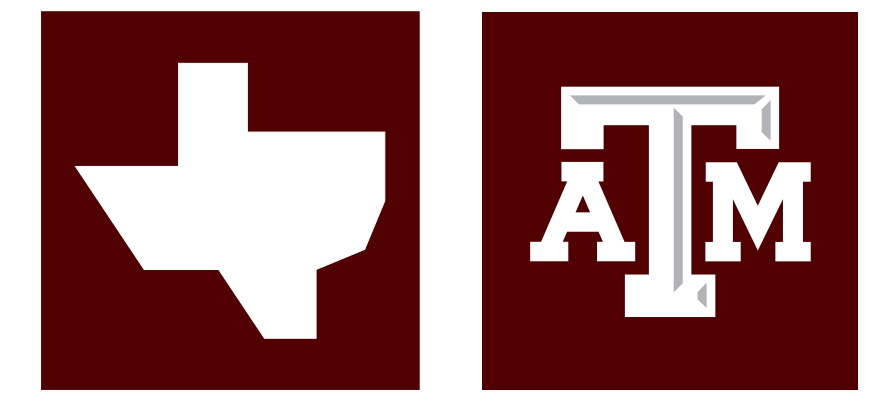


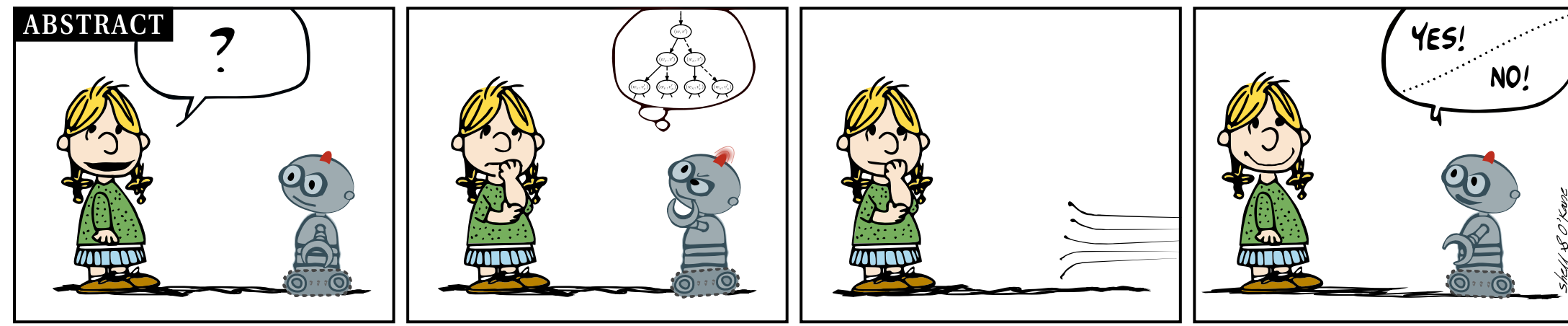
# Decision Diagrams As Plans: Answering Observation-Grounded Queries

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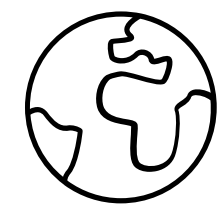


## Overview



Given:

? A **query** about the situation in the world, whose answer is 'Yes' or 'No'.



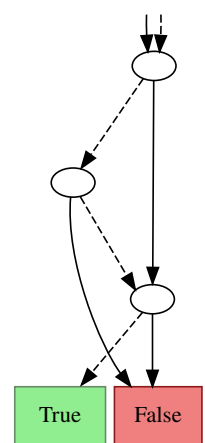
A **world model** with knowledge about objects in the world and situations that may occur.

Find:



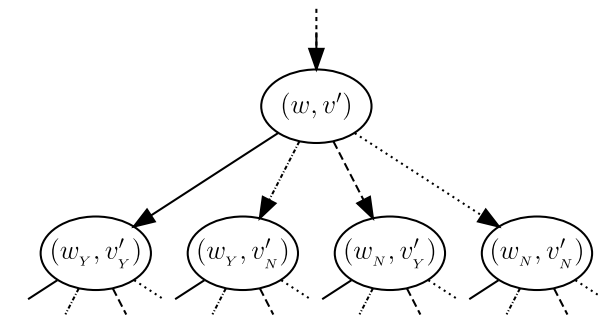
A branching **observation plan** that resolves the query with minimal worst-case execution cost.

## Main Ideas



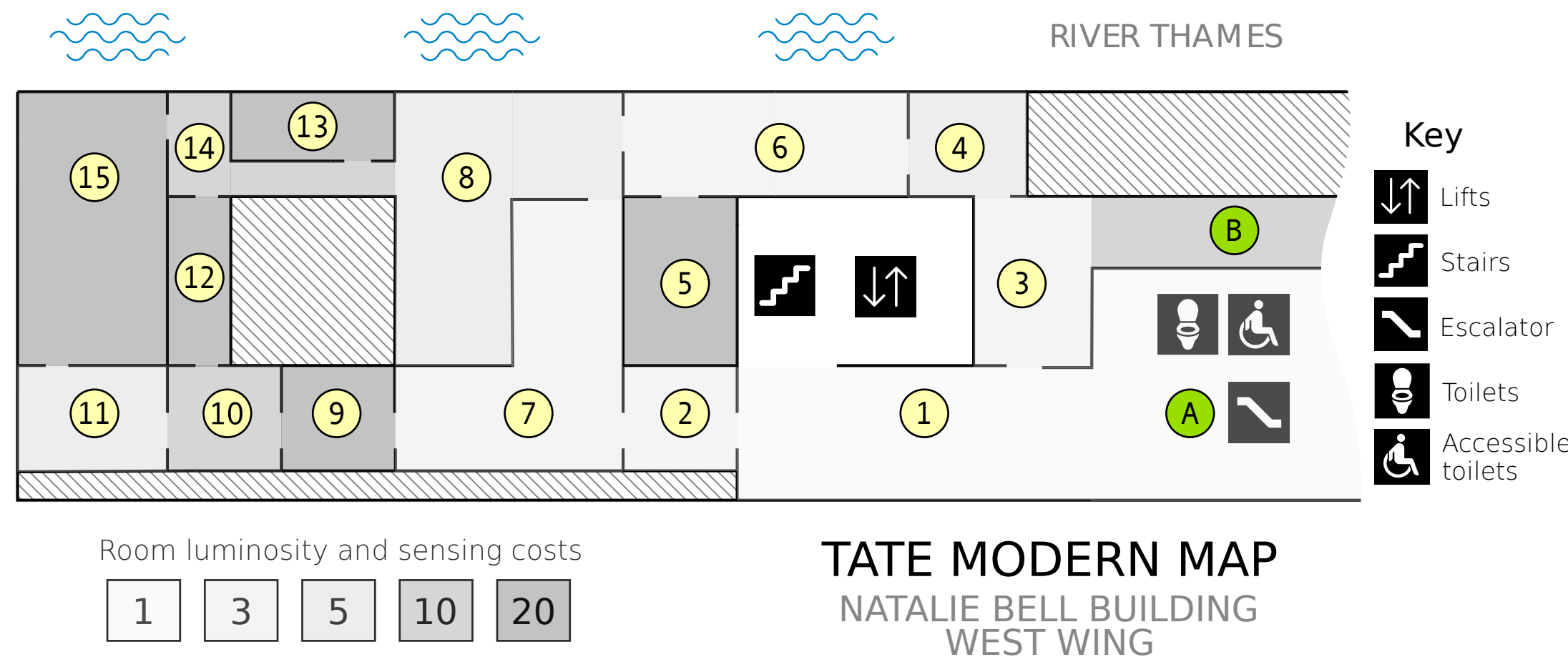
Represent world models, queries, and plans using ordered reduced **binary decision diagrams**.

Compute an **output-conditioned product** of the world model and the query.



Apply variations of **Rudell's sifting algorithm** to improve the variable ordering, indirectly optimizing execution cost.

## Example Queries



Query 0



? Are there any paintings on exhibit?  
 $\exists x: \text{painting}(x)$

Query 1



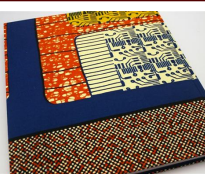
? Is Warhol's *Marilyn Diptych* on exhibit in location 15?  
 $\text{marilyn-diptych}(\text{loc15})$

Query 2



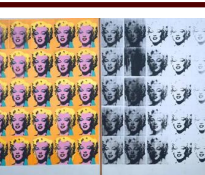
? Is *Marilyn* on exhibit in some L-shaped room?  
 $\forall x: \text{marilyn-diptych}(x) \Rightarrow \neg \text{ell-shaped}(x)$

Query 3



? Is any art by Yinka Shonibare on display?  
 $\exists x: \text{yinka-shonibare}(x)$

Query 4



? *Marilyn* in location 15 and Yinka anywhere at all?  
 $\exists x: \text{yinka-shonibare}(x) \text{ AND } \text{marilyn-diptych}(\text{loc15})$

Query 5



? Are the sculptures in corner or non-L-shaped rooms?  
 $\forall x: \text{sculpture}(x) \Rightarrow (\neg \text{ell-shaped}(x) \text{ OR } \text{corner}(x))$

Query 6

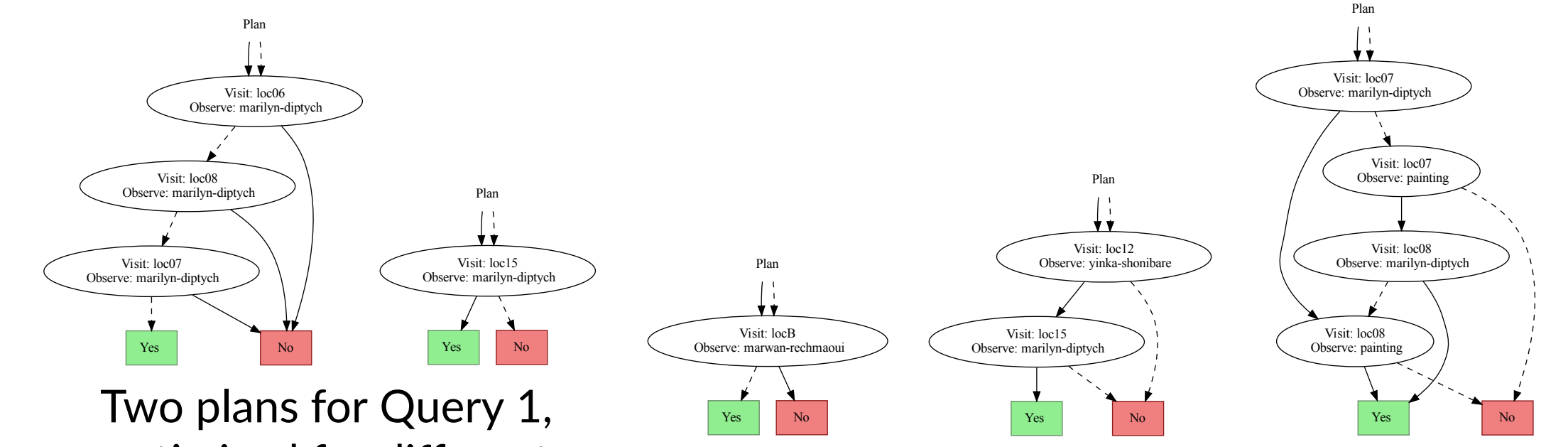


? Any sculptures in non-L-shaped rooms?  
 $\exists x: \text{sculpture}(x) \text{ AND } \neg \text{ell-shaped}(x)$

## Algorithms

Generate and evaluate swaps within the BDD variable ordering.  
**Alg. 1:** Rudell's algorithm [Rudell, ICCAD 1993], reducing the BDD size.  
**Alg. 2:** Rudell's algorithm but with **execution cost**.  
**Alg. 3:** Shift entire **blocks of variables** tied to a single location.  
**Alg. 4:** Alg. 3, then Alg. 1 within blocks.  
**Alg. 5:** Alg. 1 within blocks, then Alg. 3.  
 Repeat until timeout or convergence.

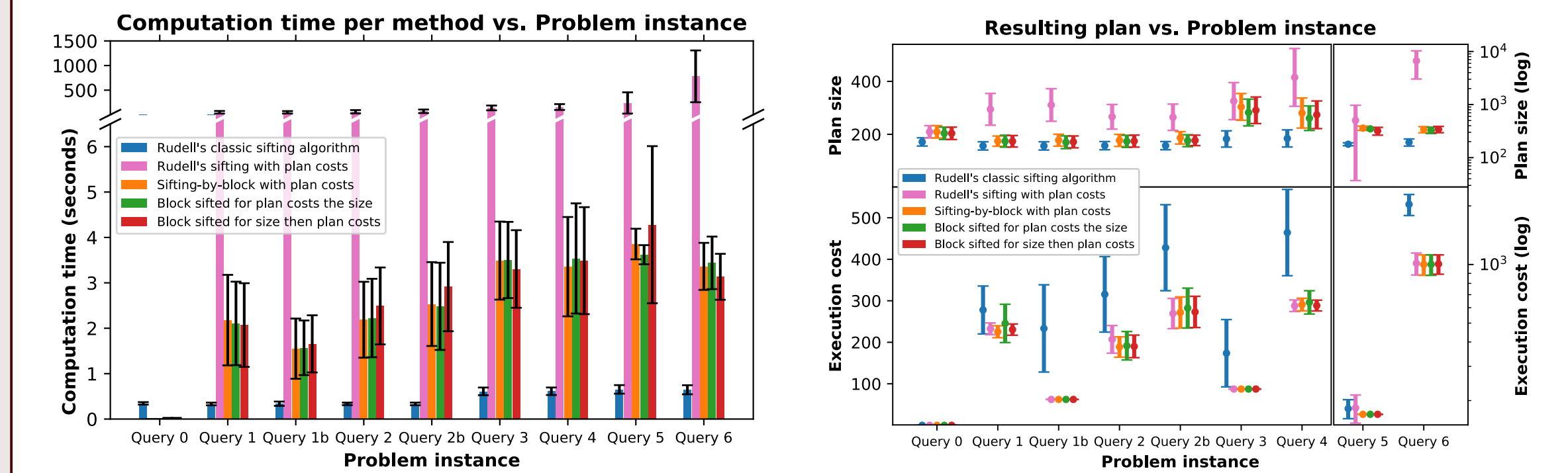
## Computed Plans



Two plans for Query 1, optimized for different starting locations.

Efficient plans for Queries 3, 4, and 5 respectively.

## Evaluation



## Acknowledgement

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