Internal Causal Mechanisms Robustly Predict Language Model Out-of-Distribution Behaviors

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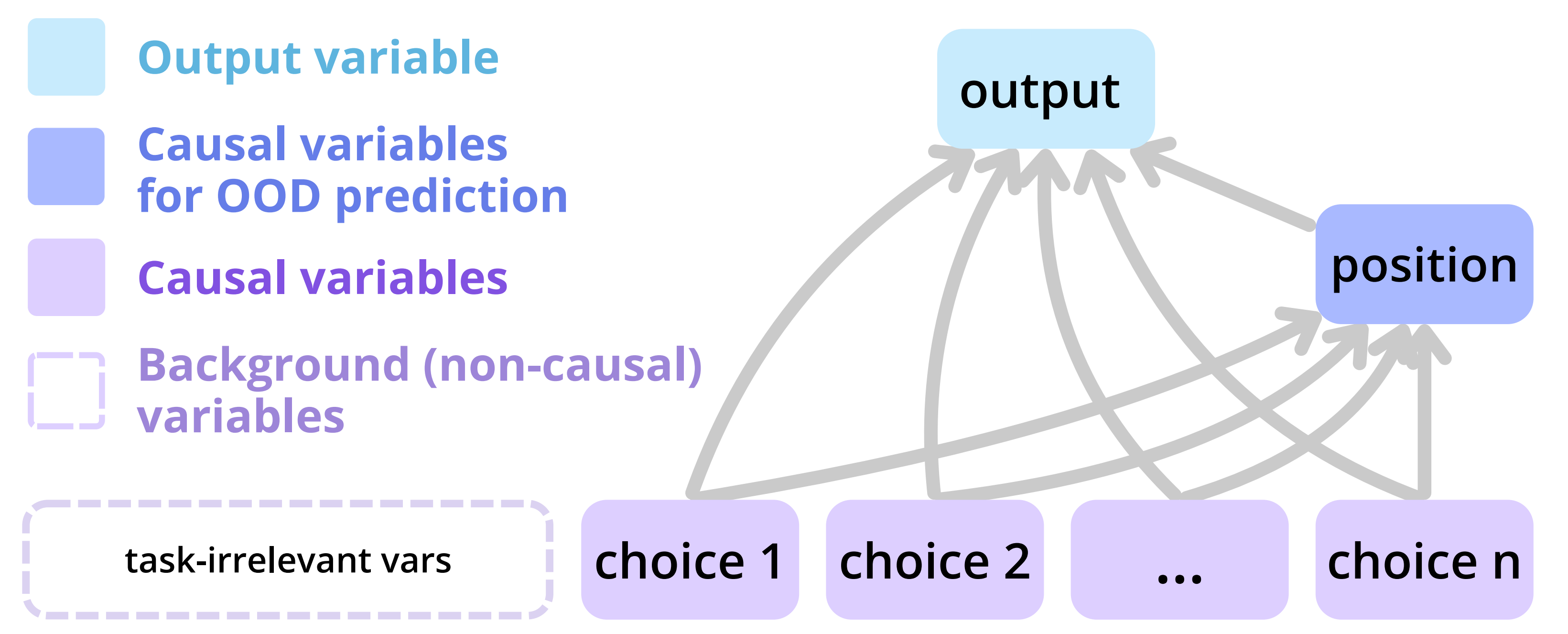
Interp Finding: Causal Mechanisms of MCQA



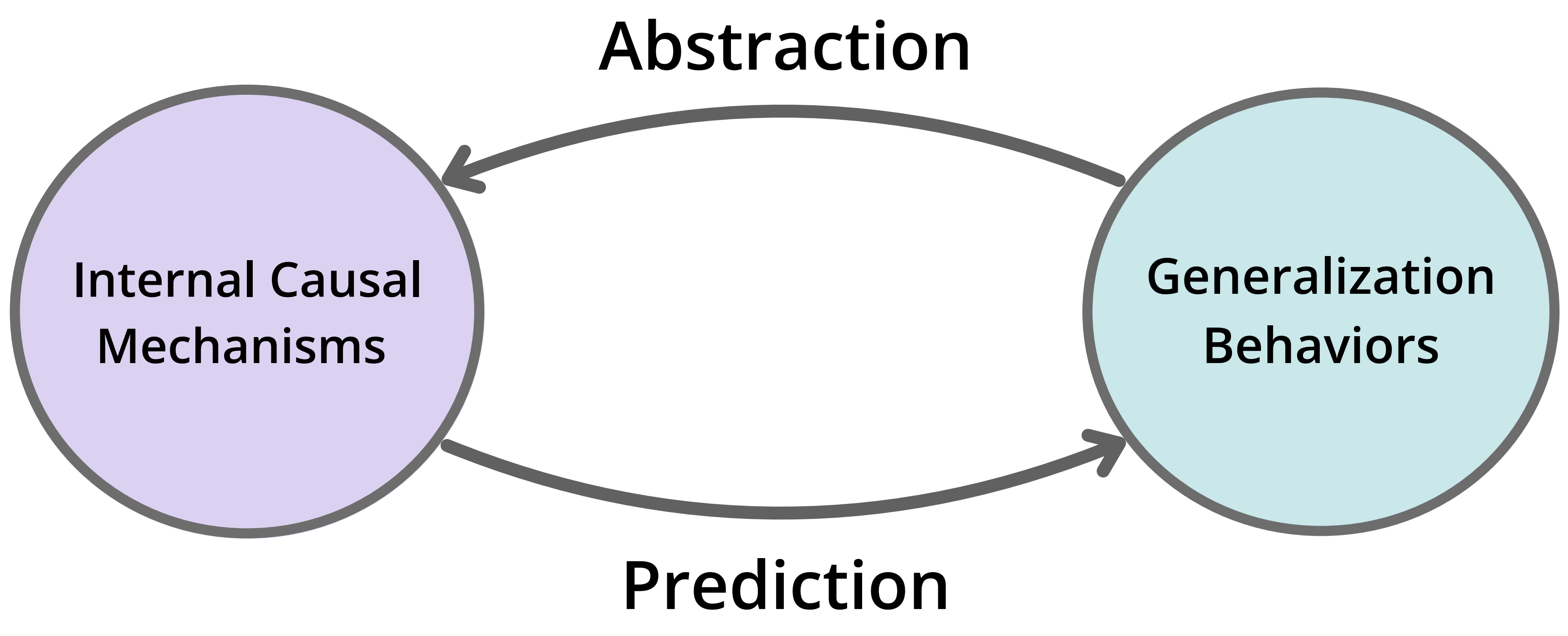
Task: Predict OOD Behaviors on MMLU

Find the degree for the given field extension Q(sqrt(2), sqrt(3), sqrt(18)) over Q.

ID Scenario	***OOD Scenario***
A. 0	Alpha. 0
B. 4	Bravo. 4
C. 2	Charlie. 2
D. 6	Delta. 6
Answer: B.	**Answer: *Delta.***

Methods: Abstraction → Prediction

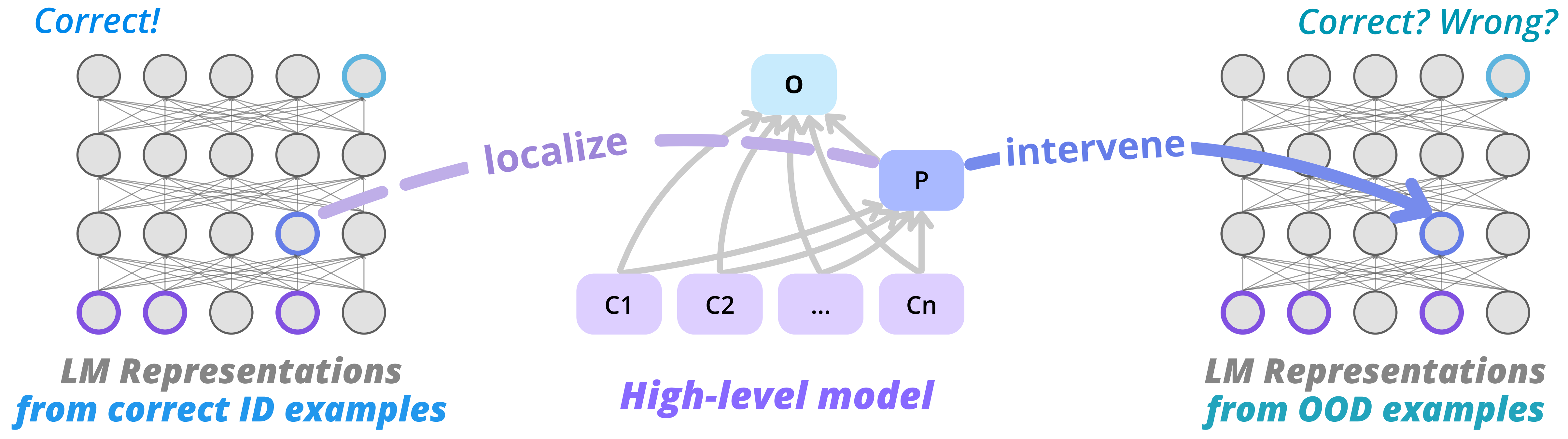
The model solves a task successfully → it likely implements a **systematic solution, i.e. a causal mechanism**



The model implements the same causal mechanism on an OOD example → it likely predicts the OOD example **correctly**

Abstract the high-level causal model from **ID examples that model correctly solves**

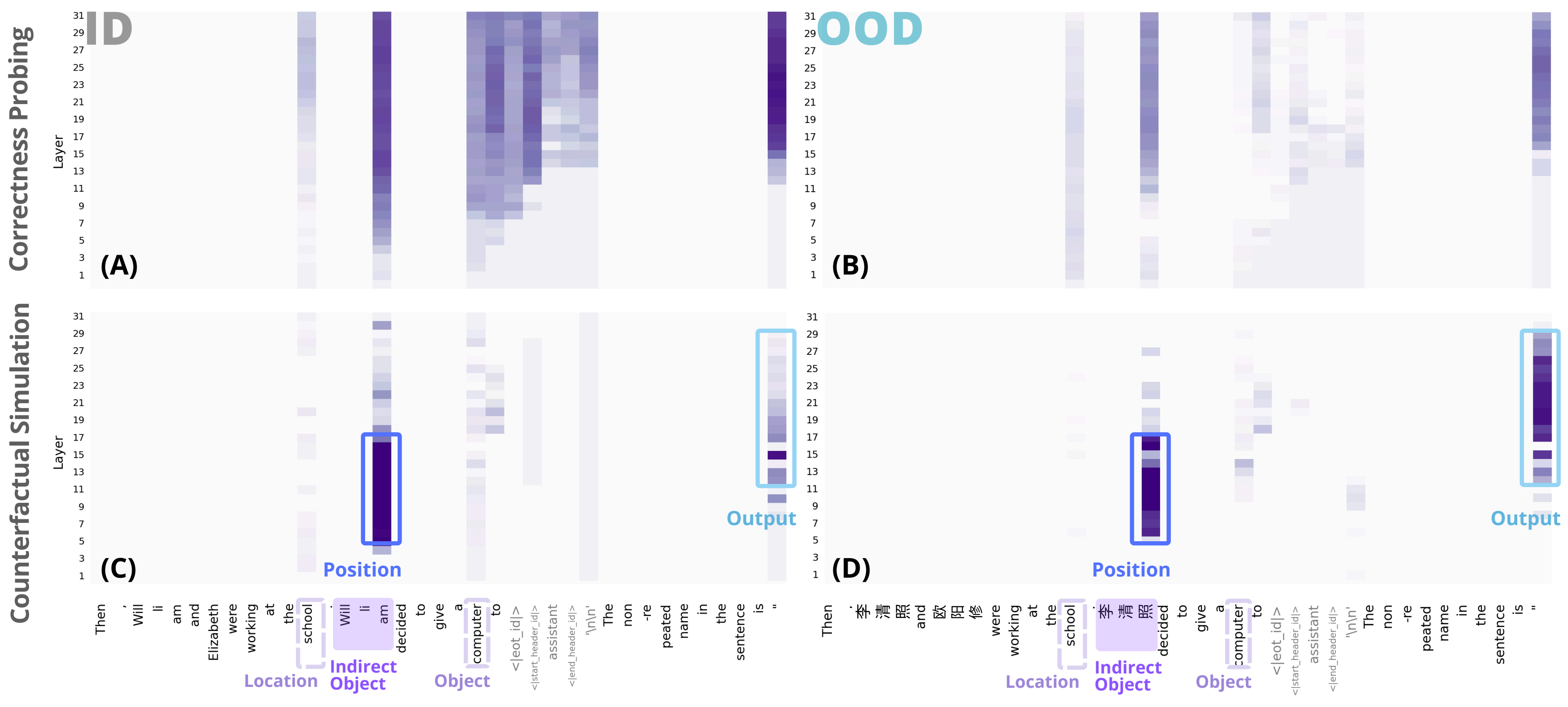
Predict the output correctness by checking **the implementation of key causal variables**


Correct!
localize
O
P
C1
C2
...
Cn
intervene
Correct? Wrong?
LM Representations from correct ID examples
High-level model
LM Representations from OOD examples

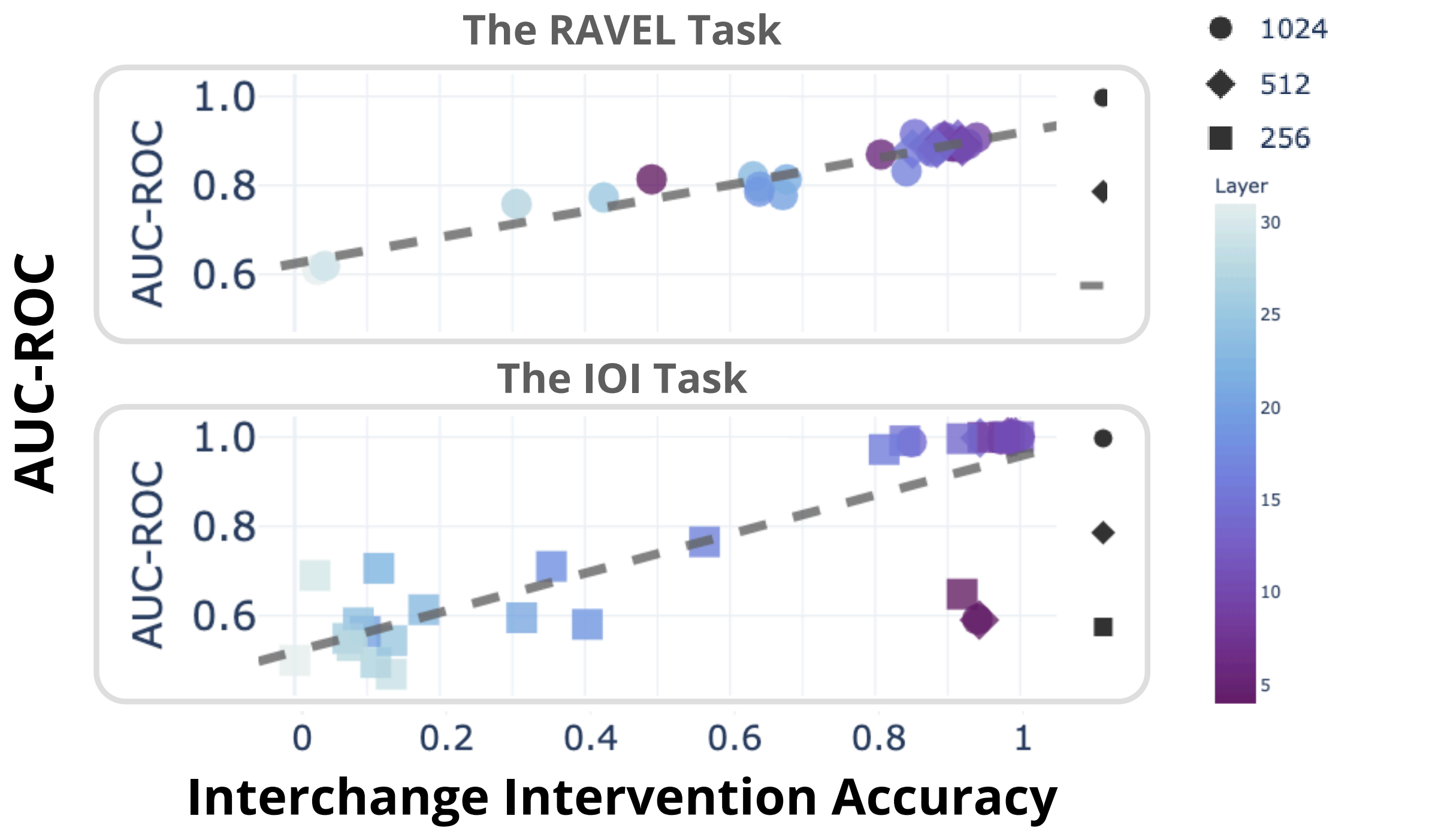
Measure the extent to which an abstraction exists via **interchange intervention accuracy**

Experiment Results

The **most robust features** for correctness prediction are those that play a **causal** role in the model's behavior.



ID and OOD Probing and Intervention Results



Interchange Intervention accuracy reliably predicts model output **correctness**.