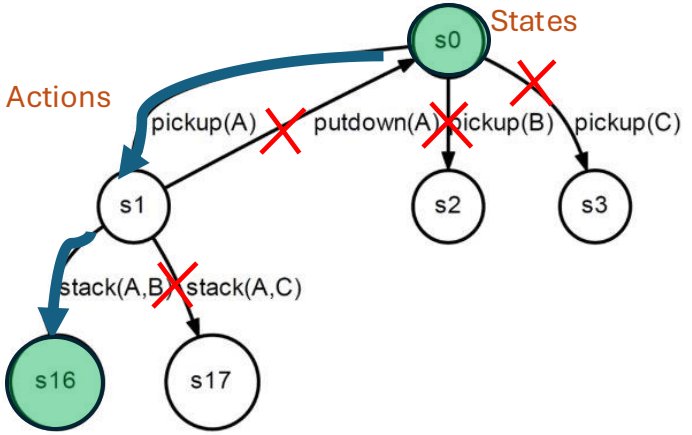
Graph Neural Network Based Action Ranking for Planning

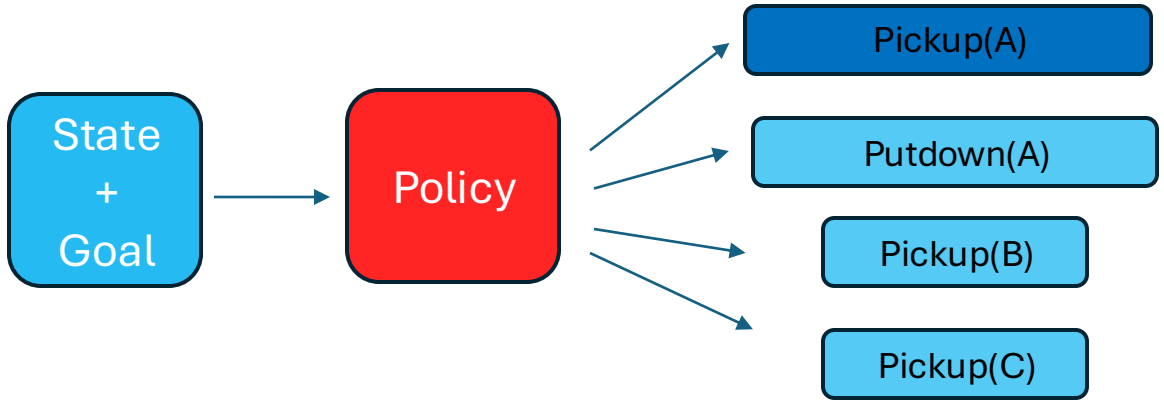
Rajesh Mangannavar, Stefan Lee, Alan Fern, Prasad Tadepalli

Oregon State University

Introduction

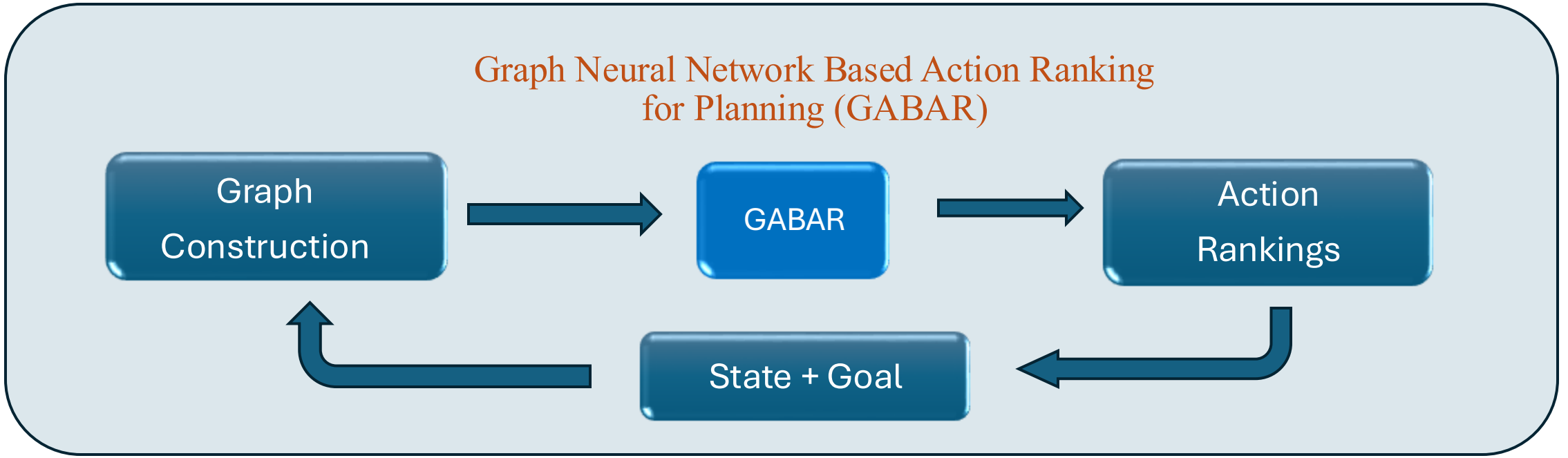
- Task Planning – Large Search Space
- Learning Policy
  - Learning to rank actions
  - Avoid searching large number of paths
  - Learn from small problems and generalize to large problems



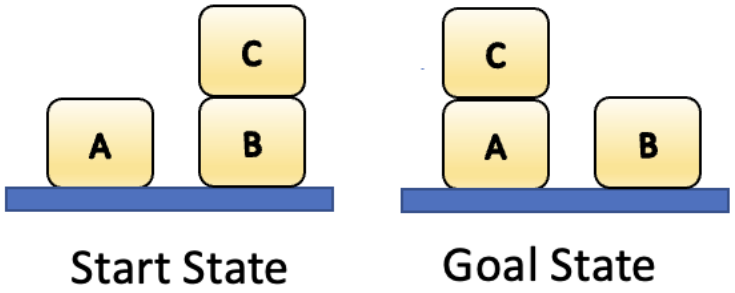


Contributions and Method

- Action-centric graph representation of state
- GNN + Decoder architecture for action decoding and ranking



State Graph Construction

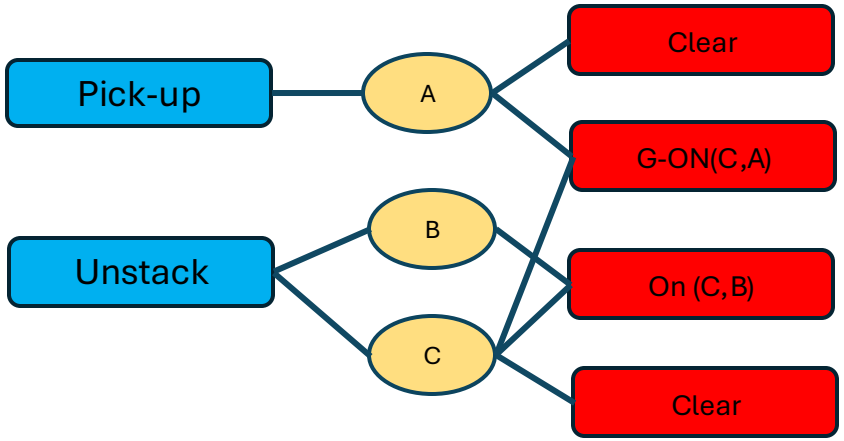



```
(define (problem block-world-example)
  (:domain blocks-world)
  (:objects a b c - block)

  (:init                          (:goal
    (clear a)                       (and
    (clear c)                         (clear c)
    (on c b))                         (clear b)
                                      (on c a)))
)
```

State Predicates

Goal Predicates



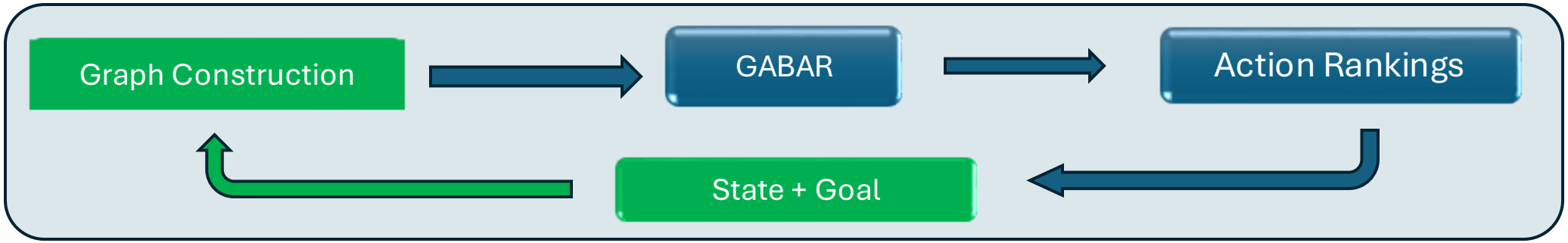
Action node

Predicate node

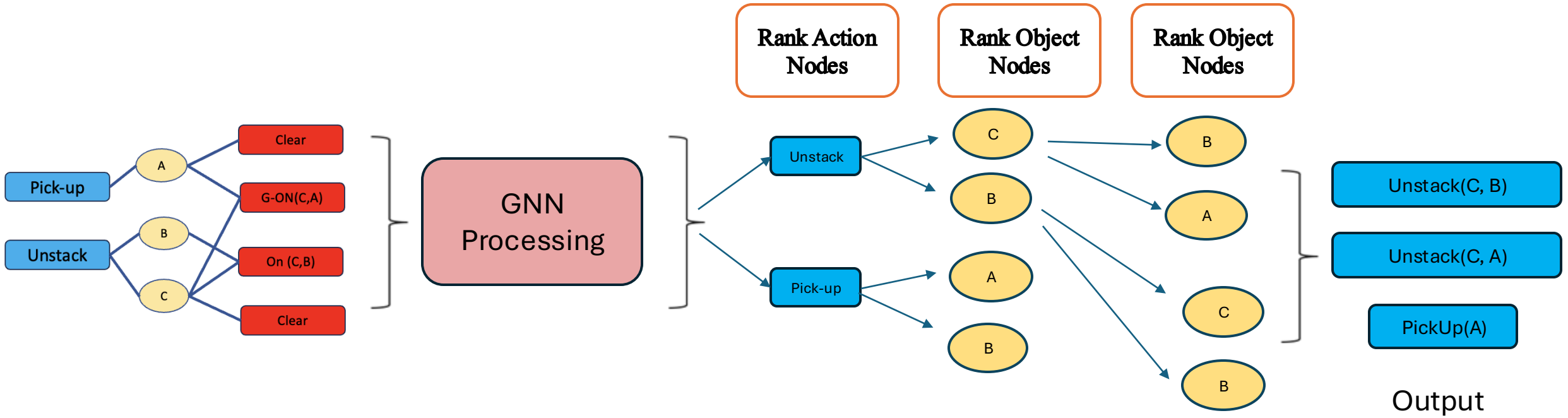
Object node

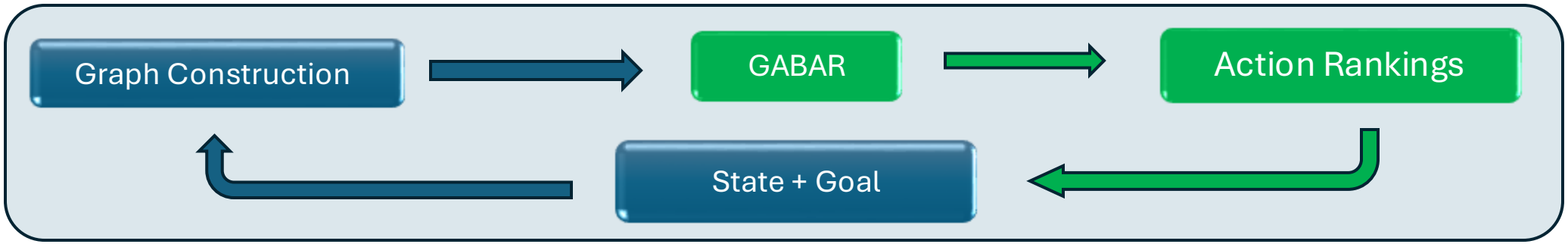
Predicate-object edge

Action-object edge



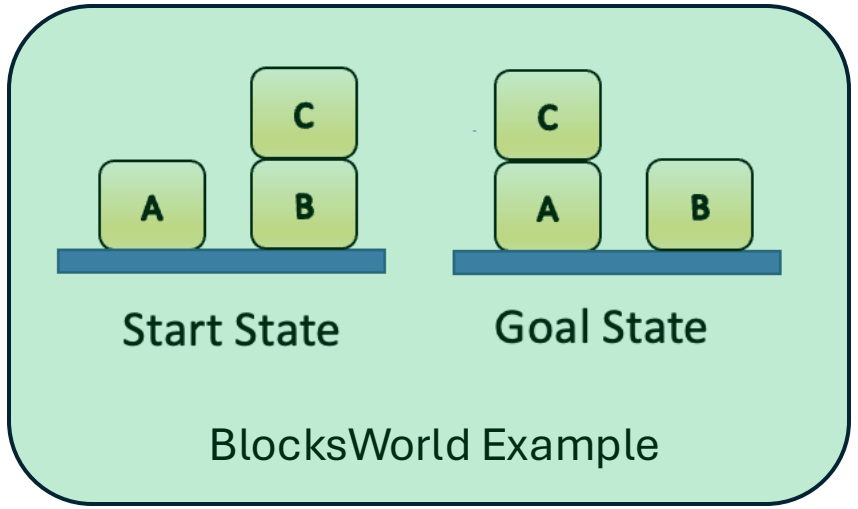
Action Ranking Using GNN + Decoder





Experiment Domains

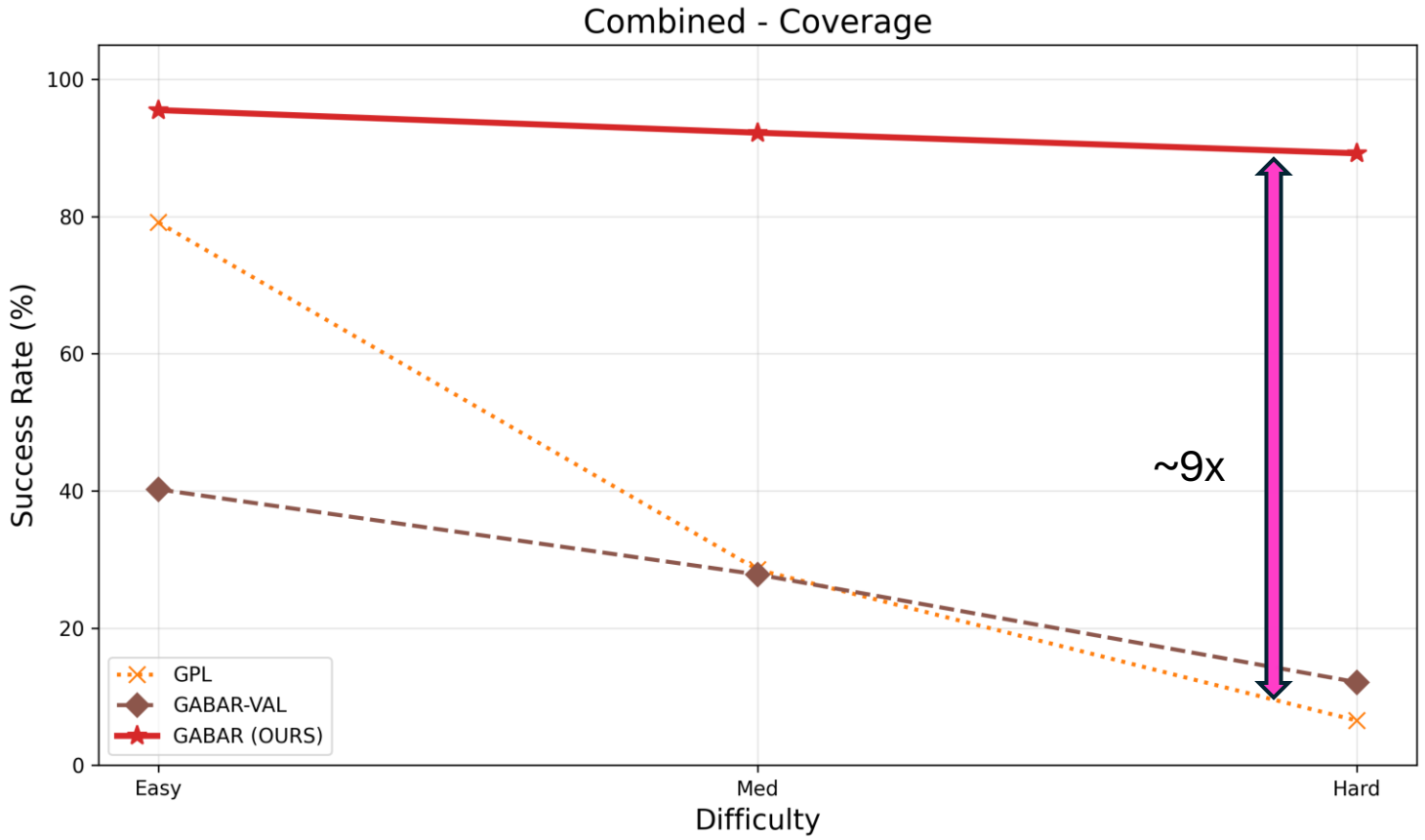
domain	Train	Val	Test		
			easy	medium	hard
Blocks	[6, 9]	[10]	[11, 20]	[21, 30]	[31, 40]
Gripper	[5, 15]	[17]	[20, 40]	[41, 60]	[61, 100]
Miconic	[1, 9]	[10]	[20, 40]	[41, 60]	[61, 100]
Spanner	[2, 9]	[10]	[11, 20]	[21, 30]	[31, 40]
Rovers	[3, 9]	[10]	[11, 30]	[31, 50]	[51, 70]
Visitall*	[9, 36]	[49]	[50, 100]	[101, 200]	[201, 400]
Grid*	[25, 49]	[63]	[64, 100]	[100, 125]	[100, 154]
Logistics	[4, 7]	[8]	[15, 20]	[21, 25]	[26, 30]



Distribution of problem sizes across train, validation, and test datasets. For the test set, problems are divided into three difficulty levels. The ranges indicate the number of objects/variables defining each domain's problem complexity

Results – Value function v/s Action Ranking

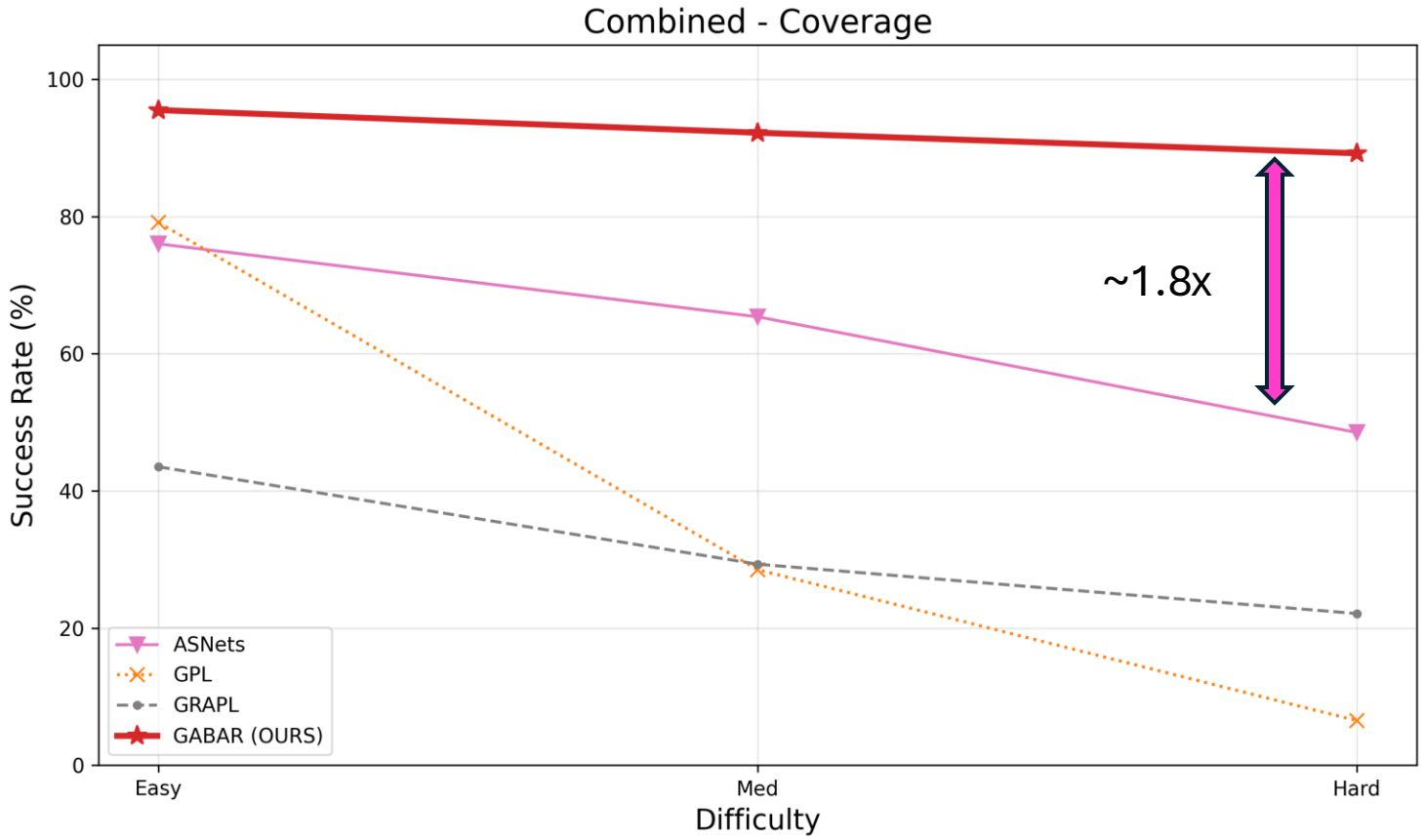
- Learn value function using GNN
  - **Generalized Policy Learning**
  - **GABAR-VAL**
- Action ranking does better than value function learning



Results – Action-centric graph

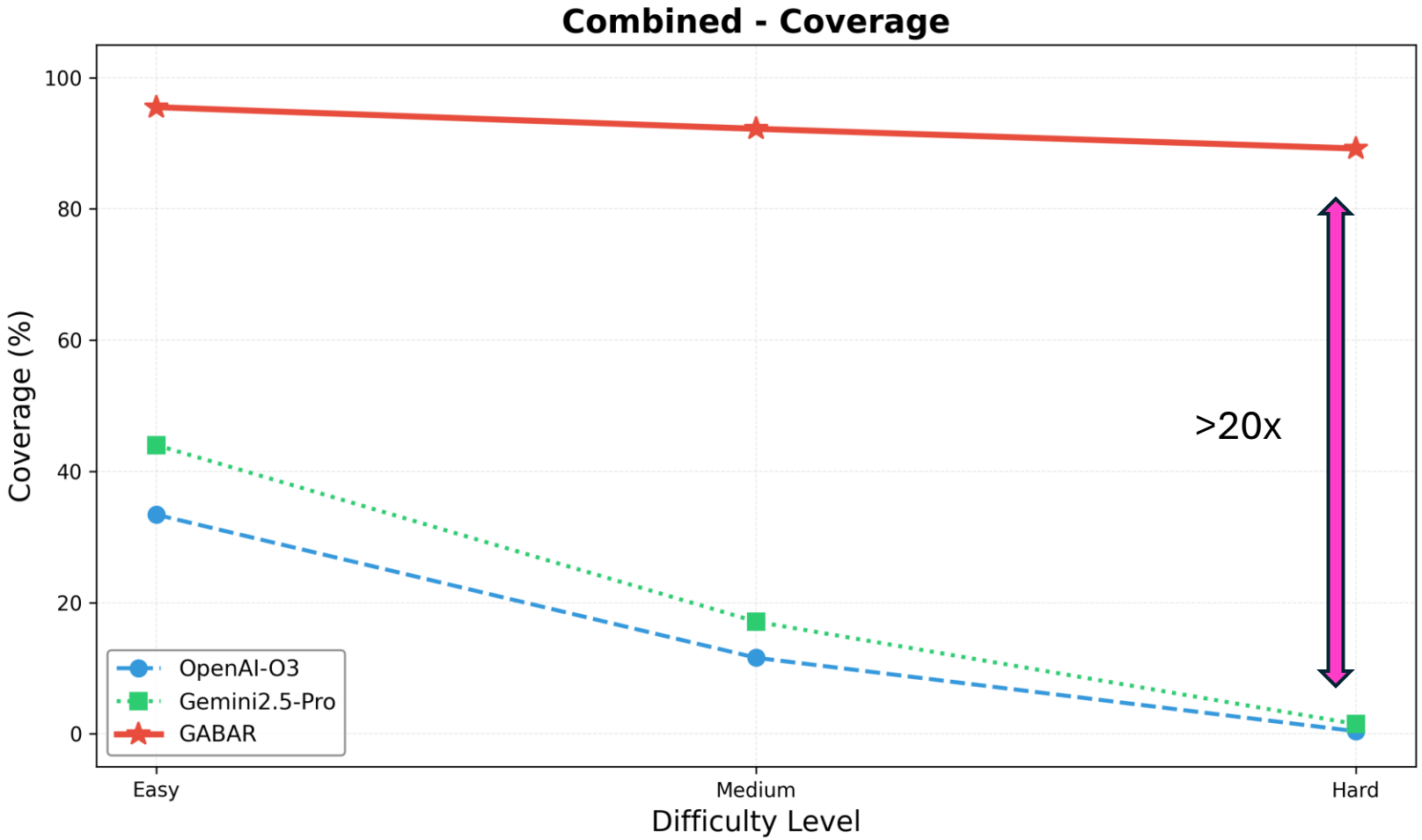
- Action Information in Representation
  - **ASNets**

- Action schema information in graph performs better



Results – GABAR v/s LLMs

- GABAR outperforms LLMs
- LLMs can solve small problems but fail on large problems



Conclusions and Takeaways

- Action schema information in graph helps learning for planning
- Action Ranking does better than value functions
- Generalizes to larger sizes
- GABAR outperforms LLMs at planning tasks
- Applicable widely -> Robotics etc.