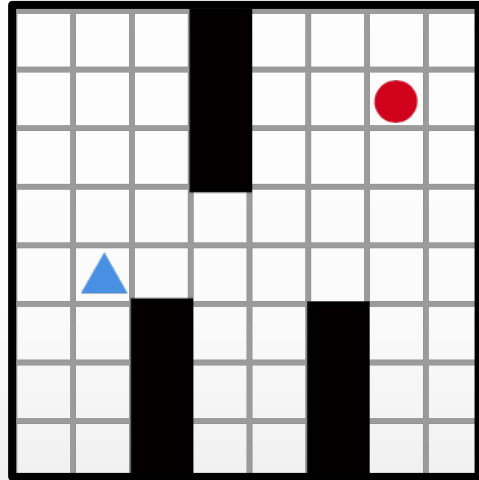




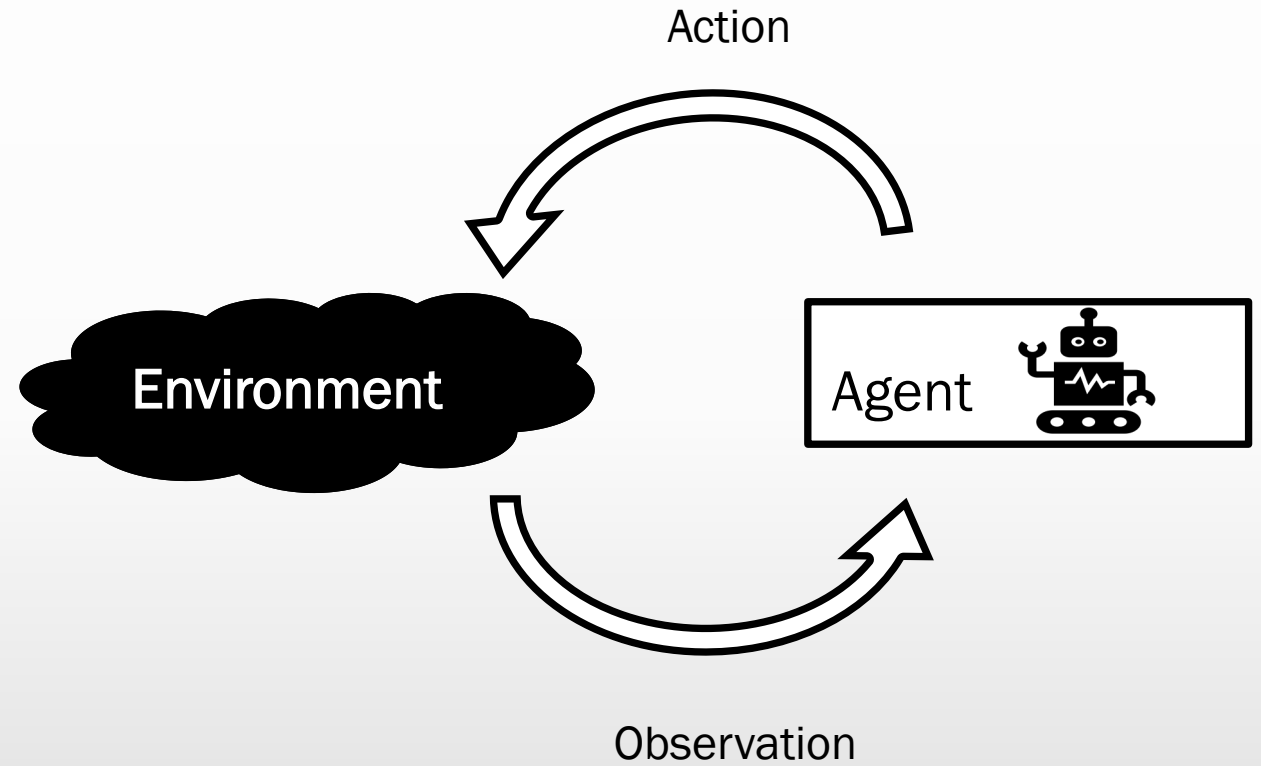
# Action Space Reduction for Planning Domains

Harsha Kokel, Junkyu Lee, Michael Katz,  
Shirin Sohrabi, Kavitha Srinivas

# Reinforcement learning



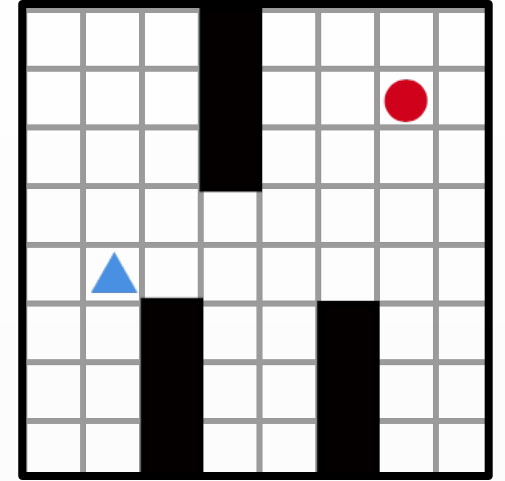
Action set: {East, West, North, South}



# Planning Domains

```
(:action move
  :parameters (?from - location ?to - location ?dir - direction)
  :precondition (and (conn ?from ?to ?dir)
    (robot-at ?from)
    (not (is-prob ?from)))
  :effect (and
    (not (robot-at ?from))
    (robot-at ?to))
)
```

move(from, to, direction)



Operator set of size 32:

```
{ move(c1, c2, East), move(c1, c2, West), move(c1, c2, North), move(c1, c2, South),
  move(c1, c3, East), move(c1, c3, West), move(c1, c3, North), move(c1, c3, South),
  ..... }
```

How to automatically reduce  
the action space when defining  
planning domains as RL Environments ?

# Less parameters

	# ground operators
move(from, to, direction)	$N^3$
XXX(from)	$N^1$

N: # objects

Reduce the number of parameters in the operators to only a seed set?

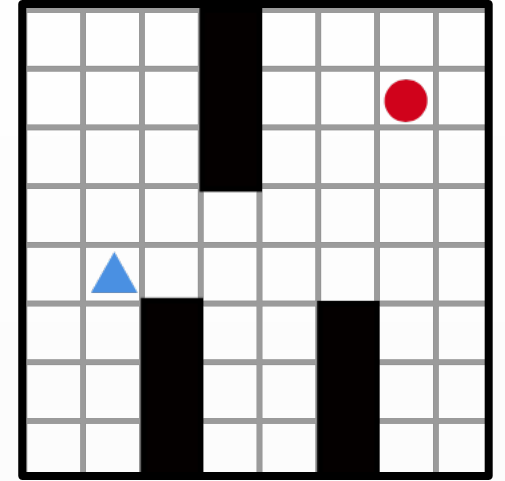
How to find the  
parameter seed set ?

# Approach

```
(:action move
  :parameters (?from - location ?to - location ?dir - direction)
  :precondition (and (conn ?from ?to ?dir)
    (robot-at ?from)
    (not (is-prob ?from)))
  :effect (and
    (not (robot-at ?from))
    (robot-at ?to))
)
```

Operator: move(from, to, direction)

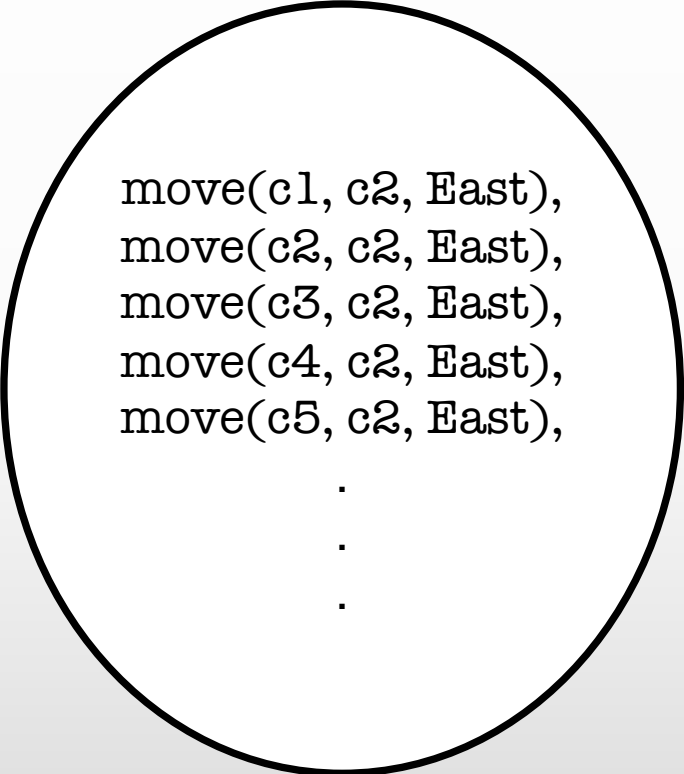
(robot-at c1) is mutually exclusive to (robot-at c2) and so on...



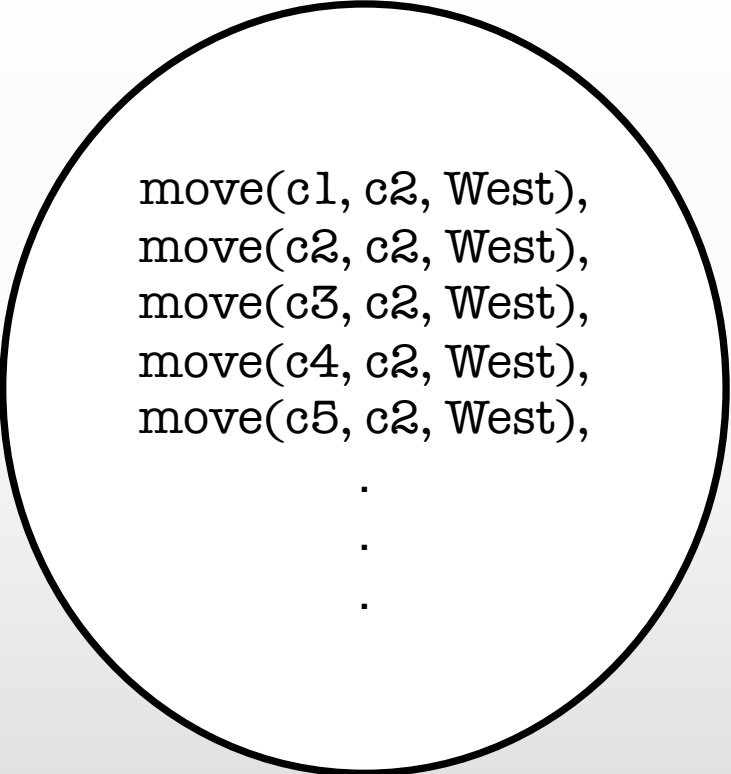


# Approach

(robot-at c1) is mutually exclusive to (robot-at c2) and so on.



move(c2, East)



move(c2, West)

move(from, to, direction)



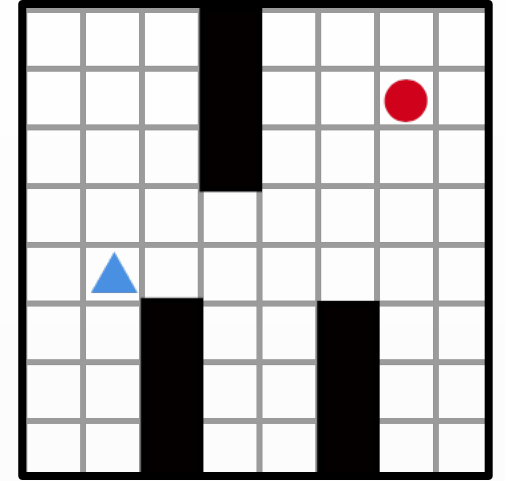
move(to, direction)

# Approach

```
(:action move
  :parameters (?from - location ?to - location ?dir - direction)
  :precondition (and (conn ?from ?to ?dir)
    (robot-at ?from)
    (not (is-prob ?from)))
  :effect (and
    (not (robot-at ?from))
    (robot-at ?to))
)
```

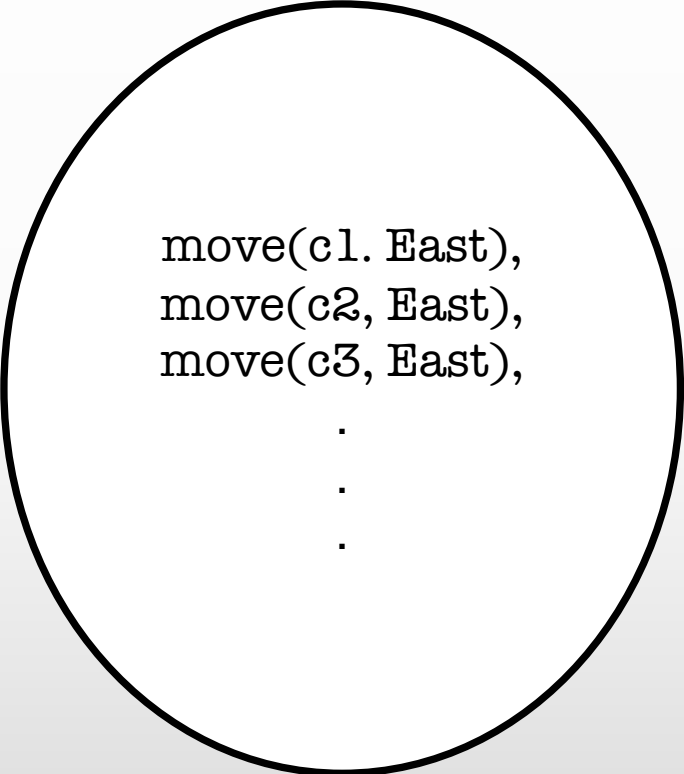
Operator: move(from, to, direction)

(conn c1 c2 East) is mutually exclusive to (conn c1 c3 East) and so on...

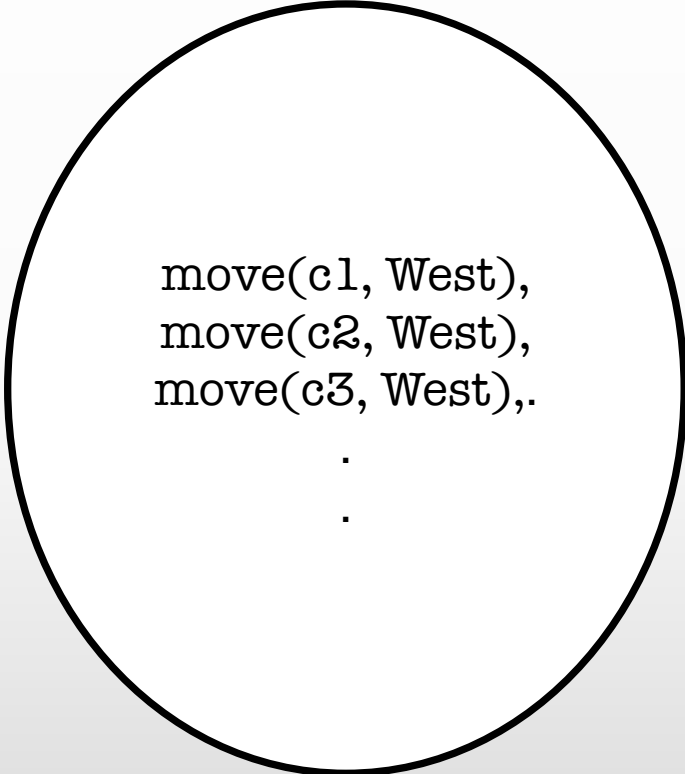


# Approach

(conn c1 c2 East) is mutually exclusive to (conn c1 c3 East) and so on..



move(East)



move(West)

move(from, to, direction)



move(to, direction)



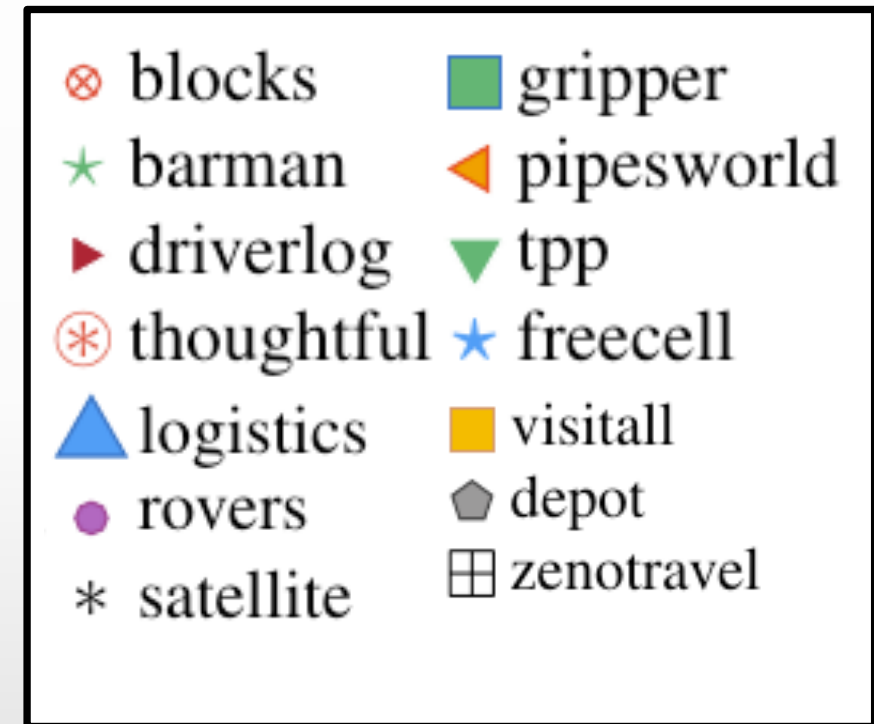
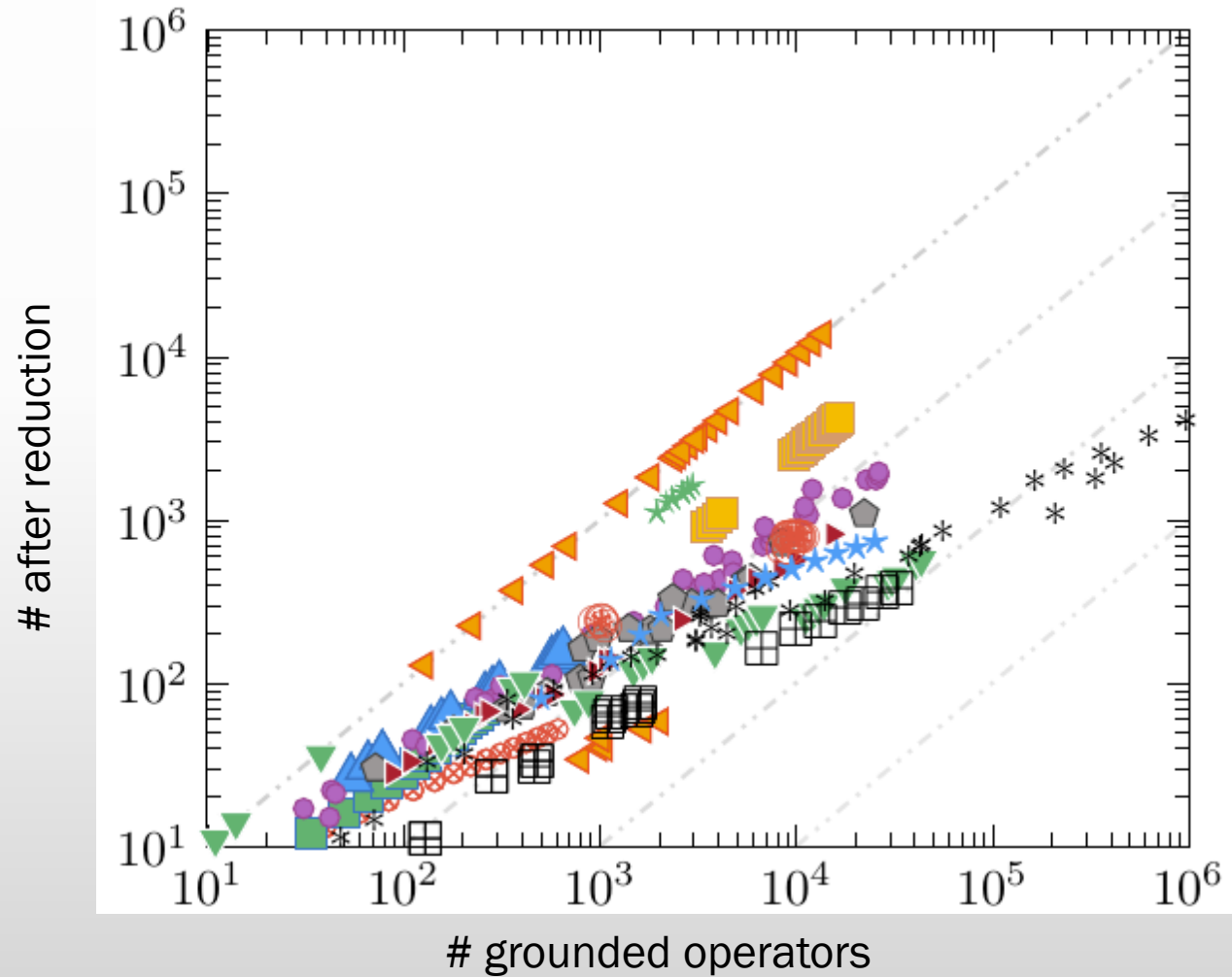
move(direction)

Use mutually exclusive facts in  
preconditions to identify  
Applicable Operator Mutex Groups  
and use that as action space

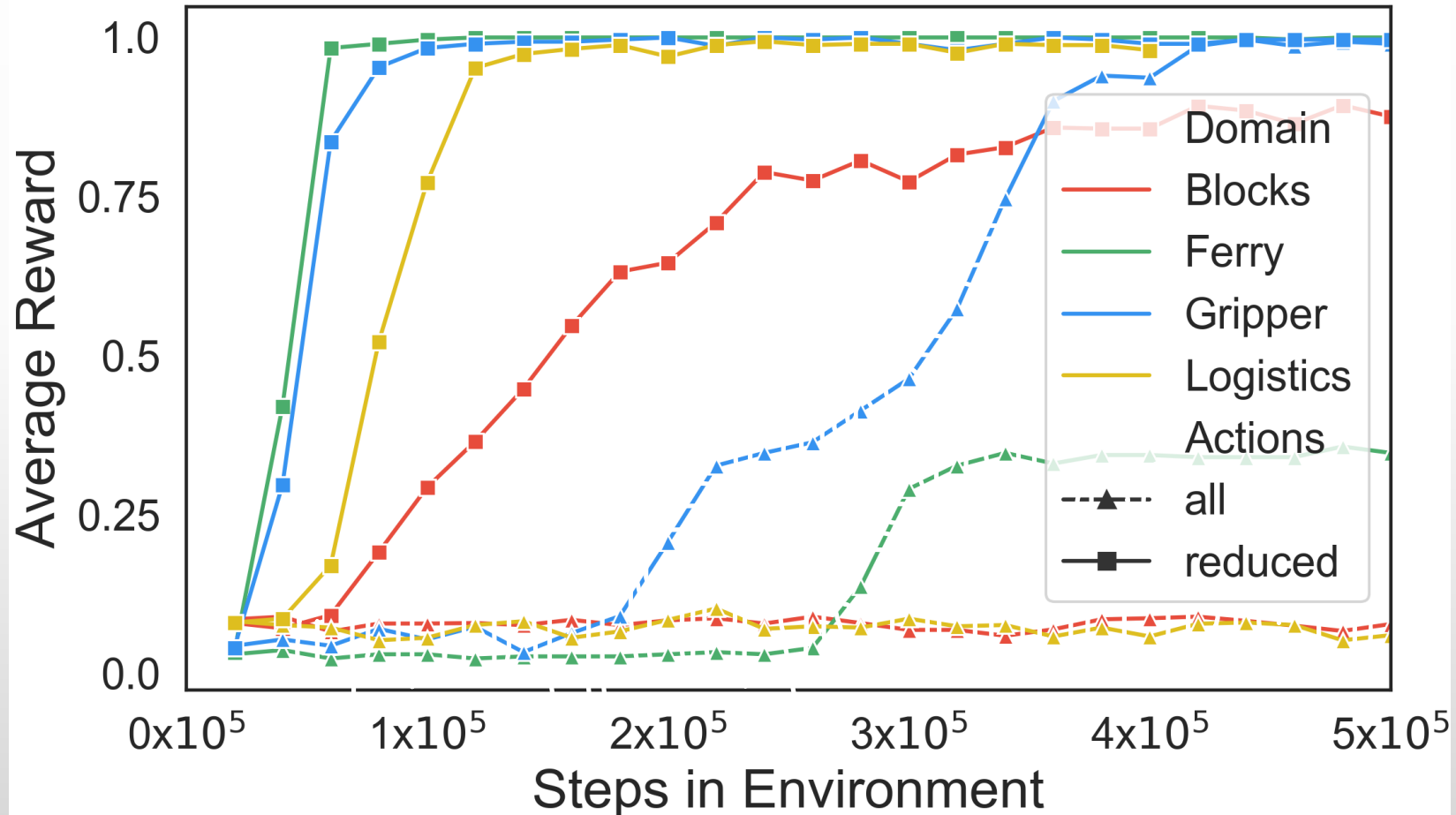
# Reduced operator parameters

Domain	# reduced operators	reducible parameters	
		max % (#)	mean % (#)
blocks	3/4	50% (0.75)	50% (0.75)
gripper	3/3	49% (1.33)	49% (1.33)
logistics	6/6	58% (1.83)	55% (1.76)
visitall	1/1	50% (1.00)	50% (1.00)
barman	10/12	42% (2.00)	42% (2.00)
pipesworld	6/6	79% (5.00)	60% (3.87)
rovers	9/9	63% (2.40)	54% (2.10)
depot	5/5	47% (1.80)	47% (1.80)
driverlog	6/6	47% (1.50)	47% (1.50)
tpp	4/4	62% (4.00)	62% (4.00)
satellite	5/5	93% (2.60)	52% (1.46)
zenotravel	5/5	79% (3.40)	62% (2.68)
thoughtful	20/21	73% (3.24)	73% (3.24)
freecell	10/10	65% (3.30)	65% (3.30)

# Reduction



# Results



THANK YOU

