



@SPREKELERLAB



@ECNBERLIN



@TUBERLIN



@SCIOI

# On Lottery Tickets and Minimal Task Representations in Deep Reinforcement Learning



Marc A. Vischer\*



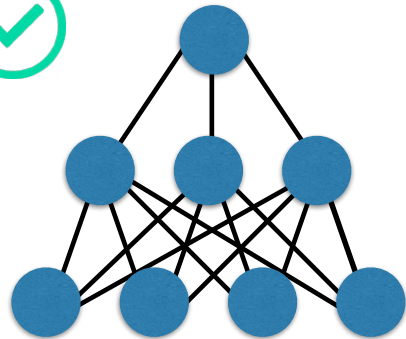
Robert T. Lange\*



Henning Sprekeler

# On The Trainability of Sparse Neural Networks

What is the role of over-parametrization in Deep Learning?

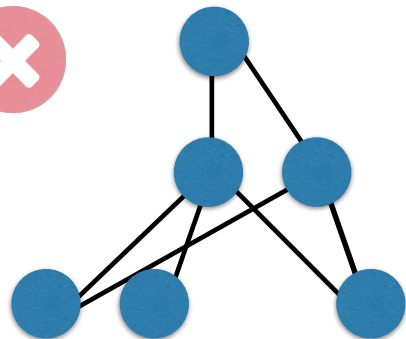


⇒ Information Bottleneck

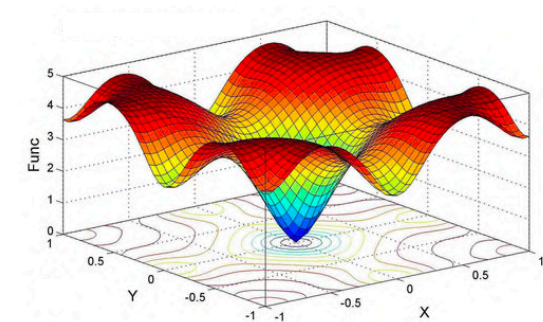
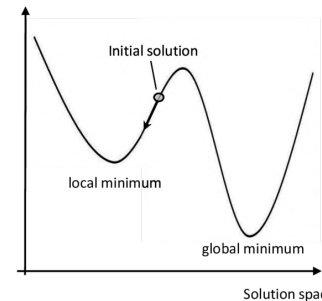
Memorize



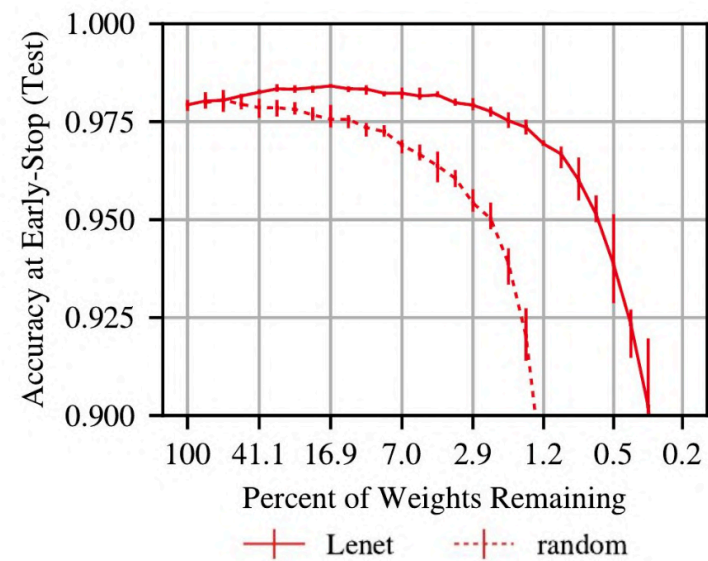
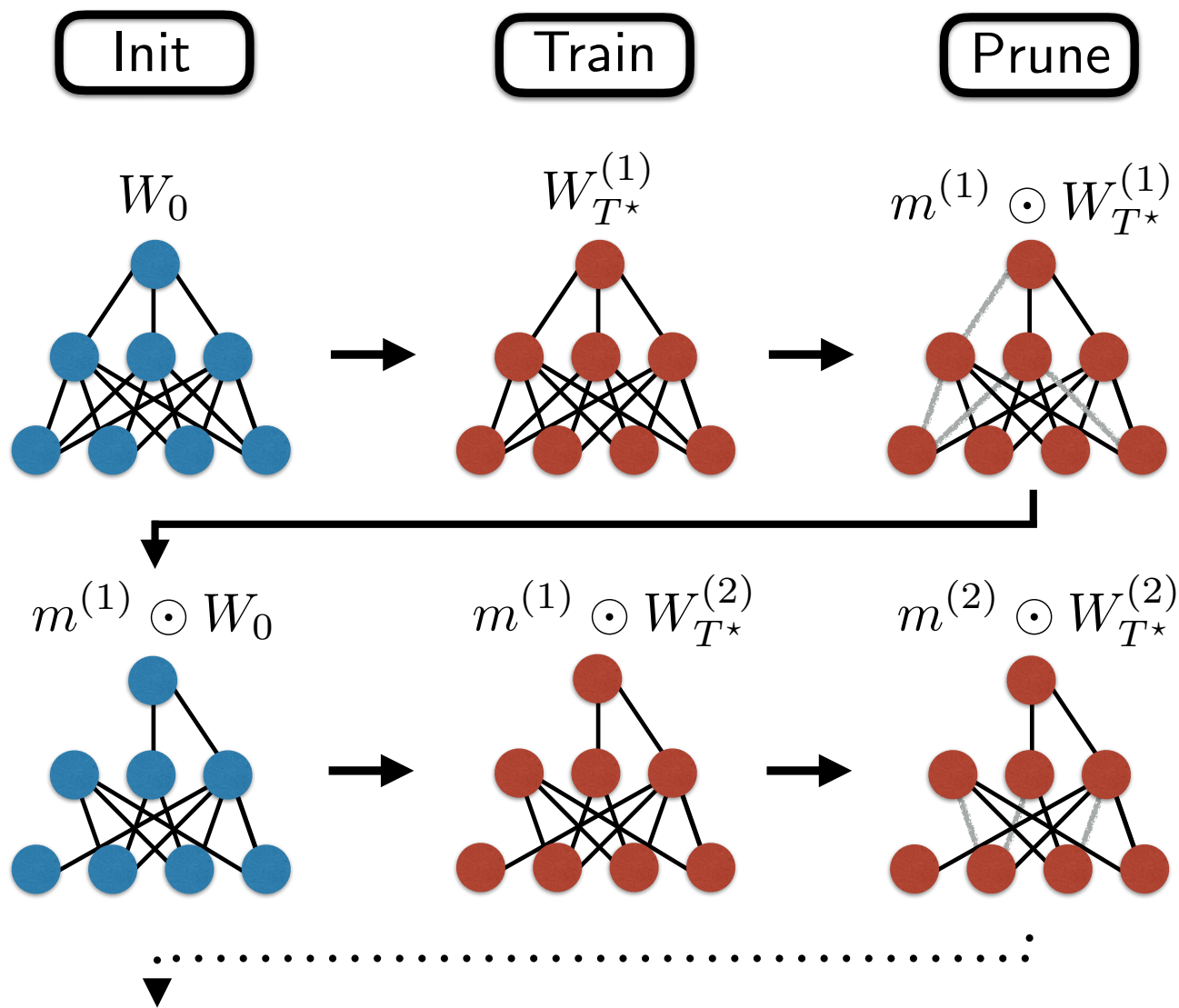
Compress



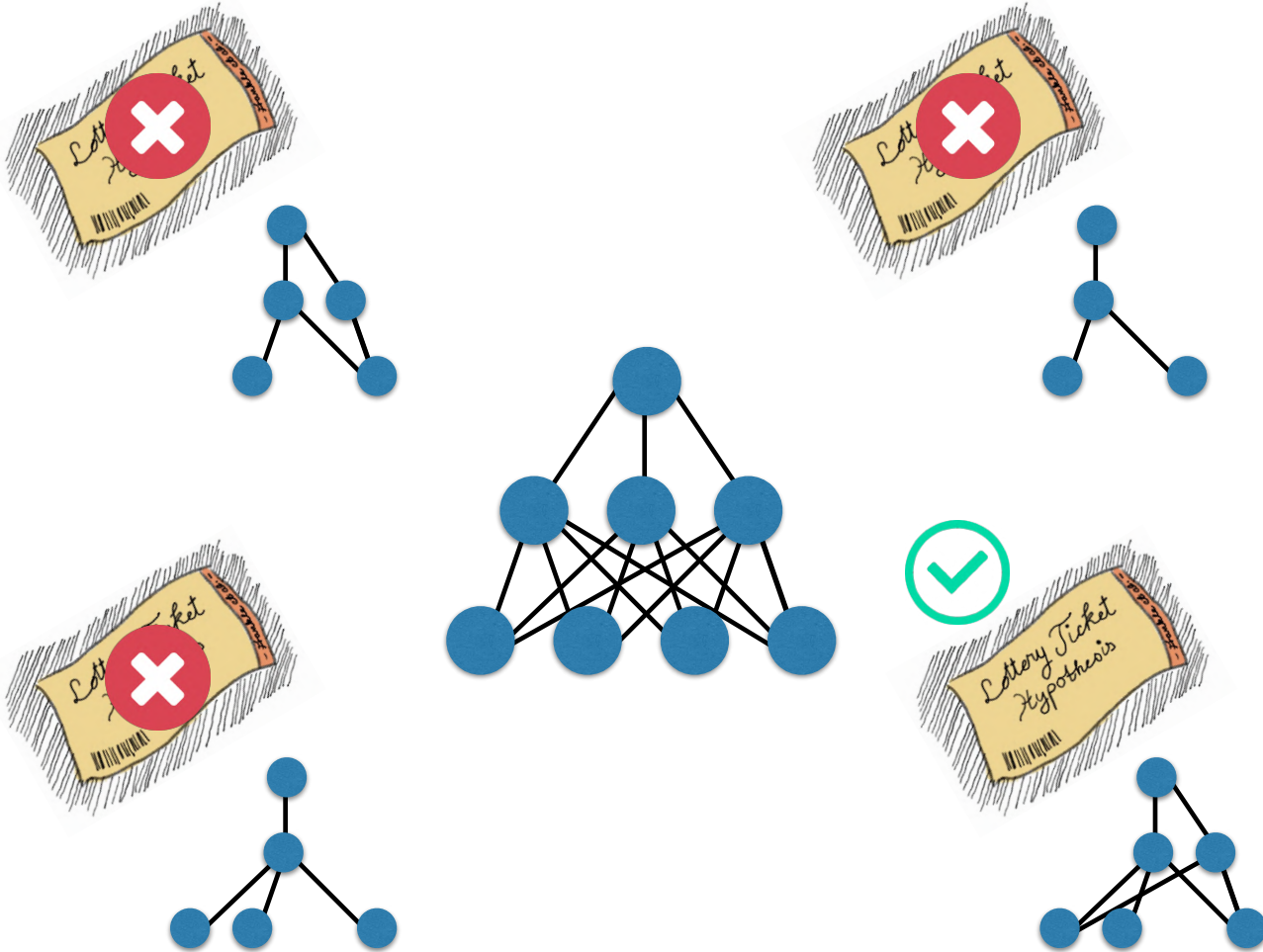
⇒ Optimization View



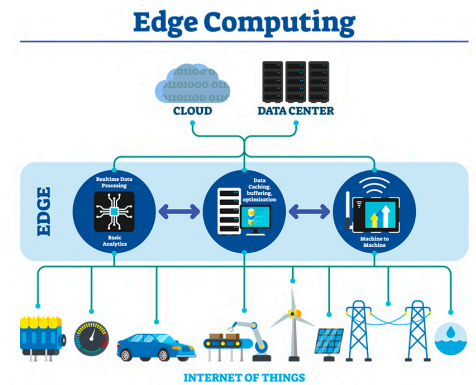
⇒ Iterative Magnitude Pruning. Is that so?



# The Lottery Ticket Hypothesis



⇒ Many Implications



# The Lottery Ticket Hypothesis in ,XYZ' Learning

## The Lottery Tickets Hypothesis for Supervised and Self-supervised Pre-training in Computer Vision Models

Tianlong Chen<sup>1</sup>, Jonathan Frankle<sup>2</sup>, Shiyu Chang<sup>3</sup>, Sijia Liu<sup>3</sup>, Yang Zhang<sup>3</sup>, Michael Carbin<sup>2</sup>, Zhangyang Wang<sup>1</sup>

## The Lottery Ticket Hypothesis for Object Recognition

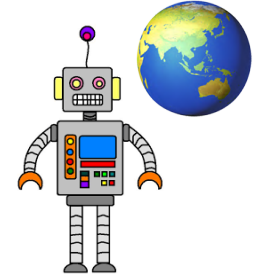
Sharath Girish\*      Shishira R. Maiya\*      Kamal Gupta      Hao Chen  
sgirish@cs.umd.edu      shishira@umd.edu      kampta@umd.edu      chenh@umd.edu

## The Lottery Ticket Hypothesis for Pre-trained BERT Networks

Tianlong Chen<sup>1</sup>, Jonathan Frankle<sup>2</sup>, Shiyu Chang<sup>3</sup>, Sijia Liu<sup>3</sup>, Yang Zhang<sup>3</sup>, Zhangyang Wang<sup>1</sup>, Michael Carbin<sup>2</sup>

## PLAYING THE LOTTERY WITH REWARDS AND MULTIPLE LANGUAGES: LOTTERY TICKETS IN RL AND NLP

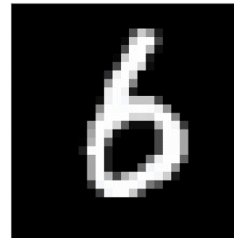
Haonan Yu\*, Sergey Edunov, Yuandong Tian, and Ari S. Morcos†  
Facebook AI Research  
haonanu@gmail.com, {edunov, yuandong, arimorcos}@fb.com



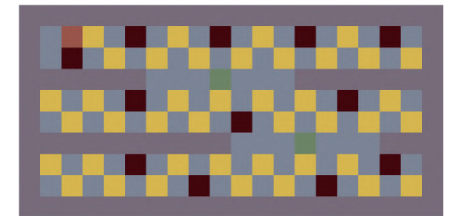
Supervised

Deep RL

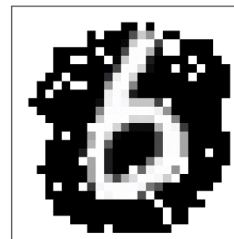
IMP Iteration 0



IMP Iteration 0



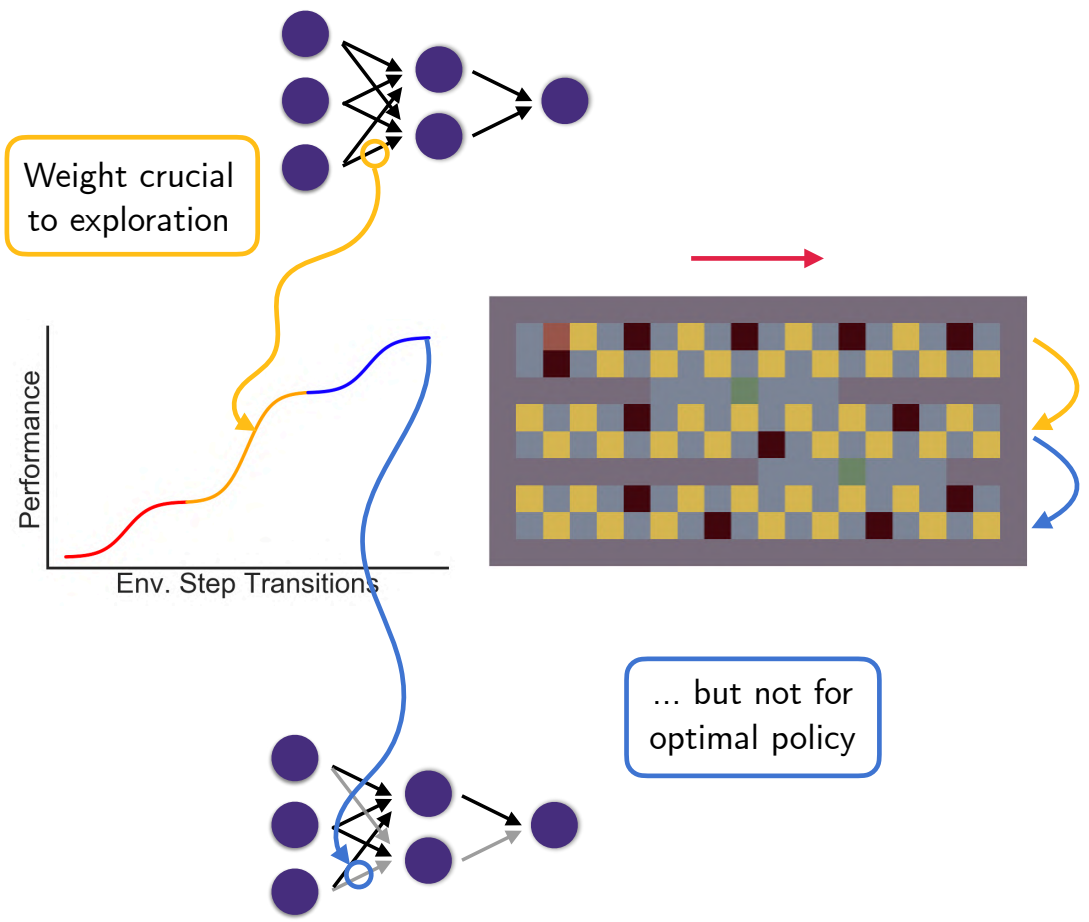
IMP Iteration 20



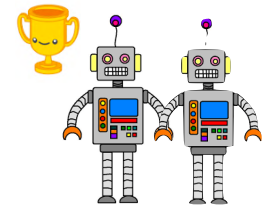
IMP Iteration 20



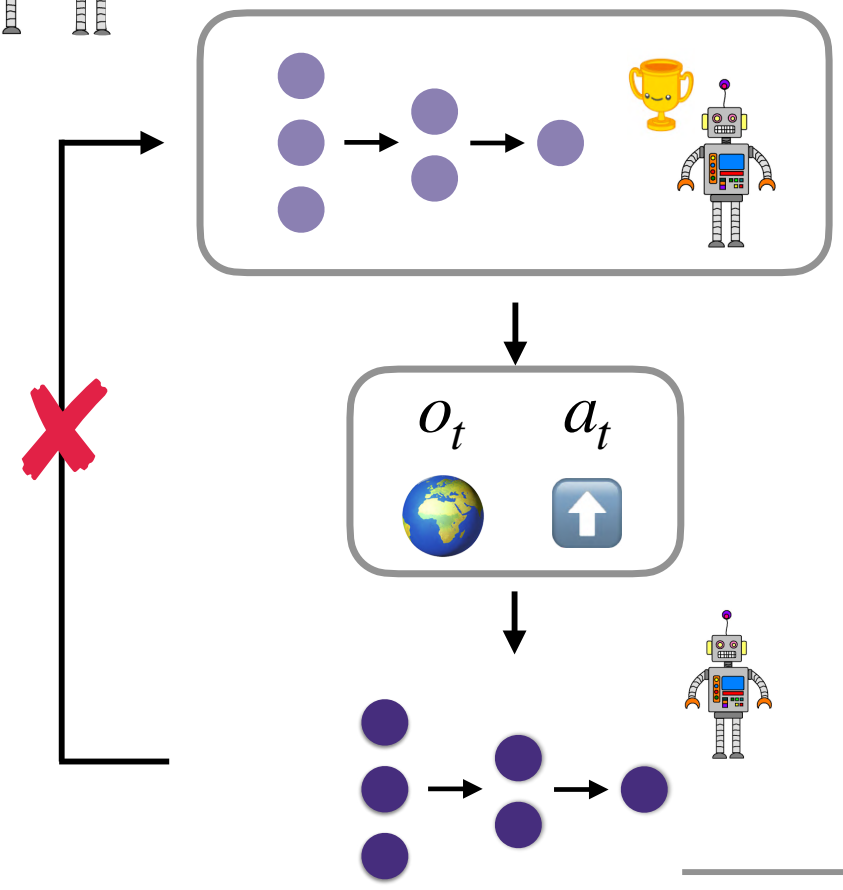
# How Could the RL Distribution Shift Affect the Hypothesis?



Schaul et al. (2019)

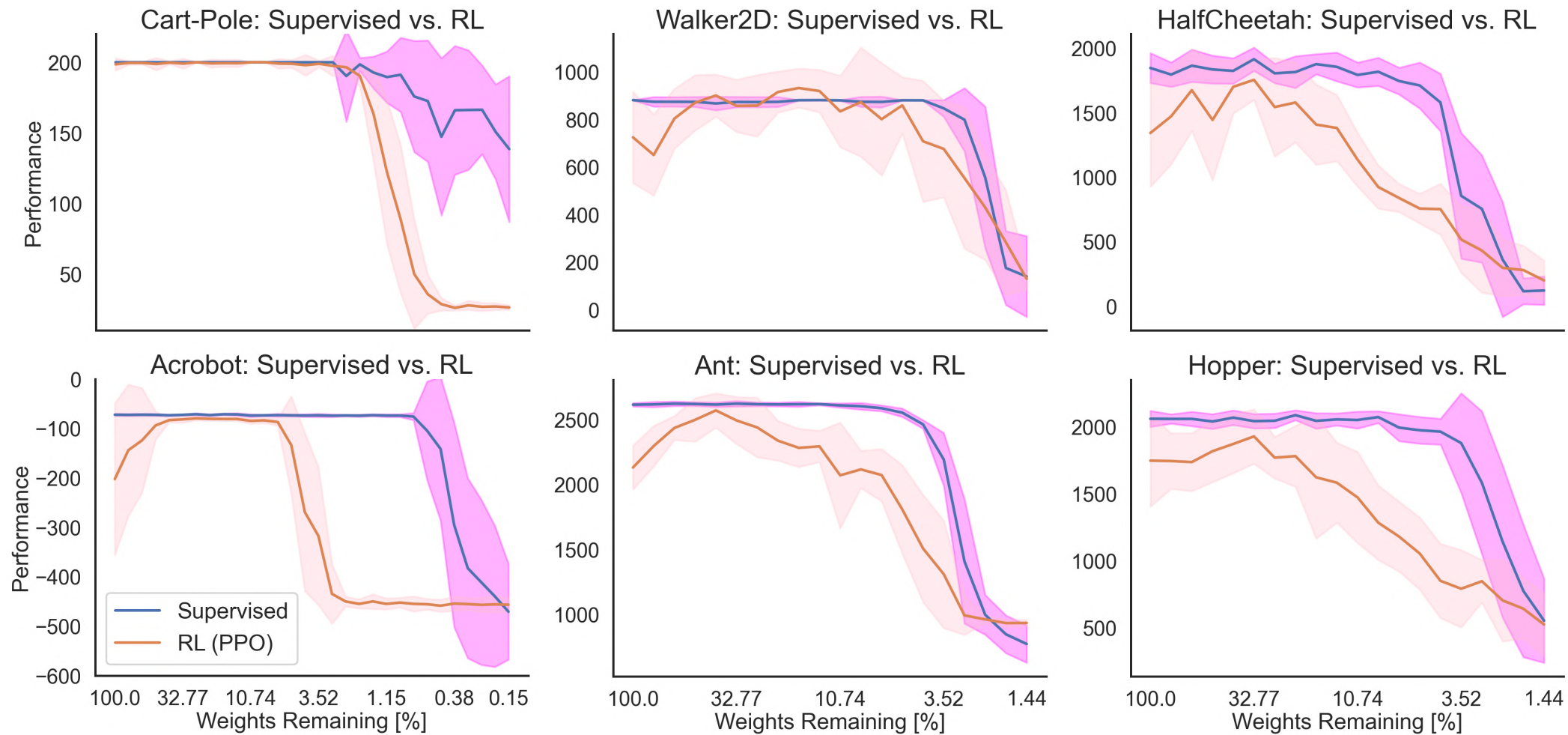
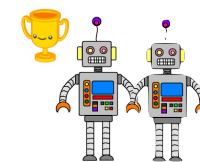


## Supervised Behavioural Cloning

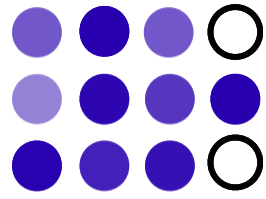


Rusu et al. (2015)

# Winning Tickets in RL Require More Parameters

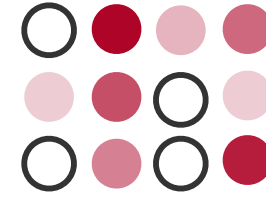


# Disentangling Contributions: Mask, Weights & Pruning Ratios



$m \odot W$

"mask/weights"  
(full lottery ticket)



$\tilde{m} \odot \tilde{W}$

"random/reinit"

permute mask  
and weights



permute  
weights only

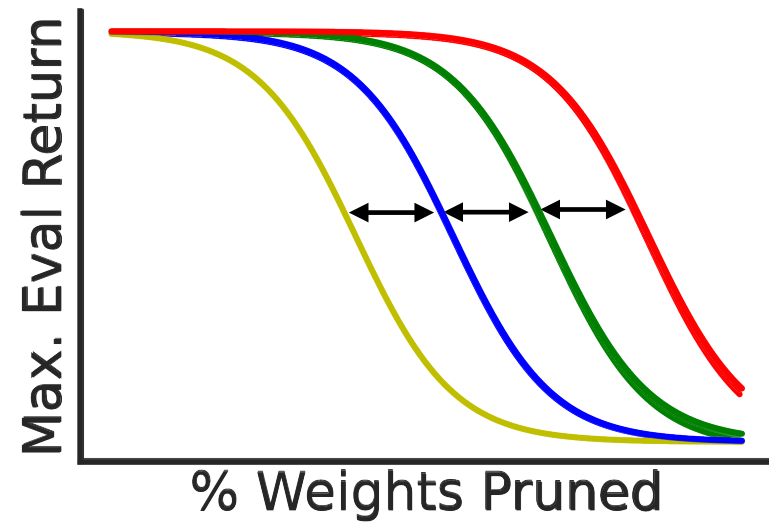


$m' \odot W'$

"permuted/permuted"

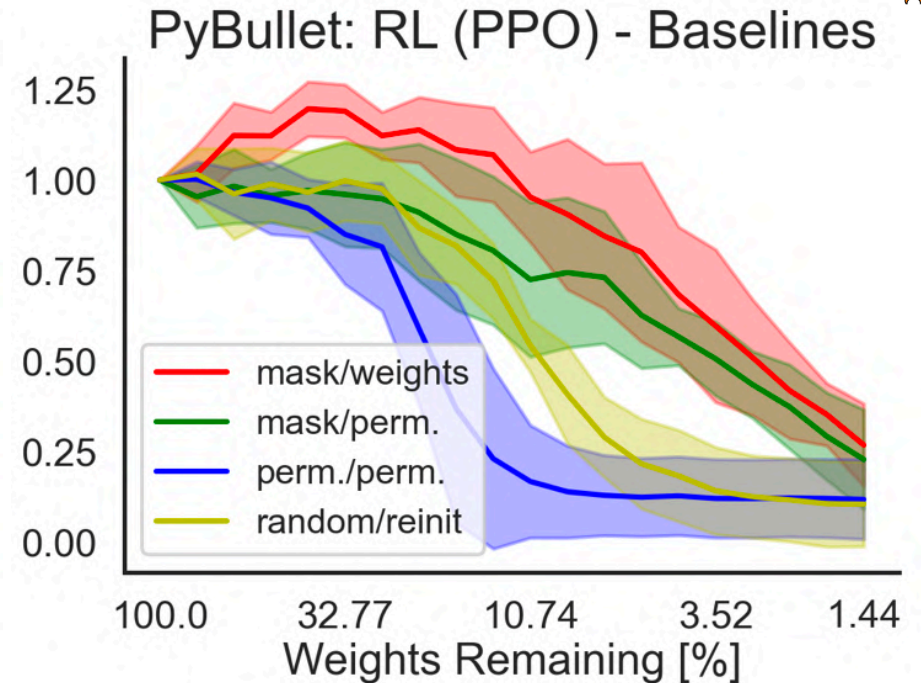
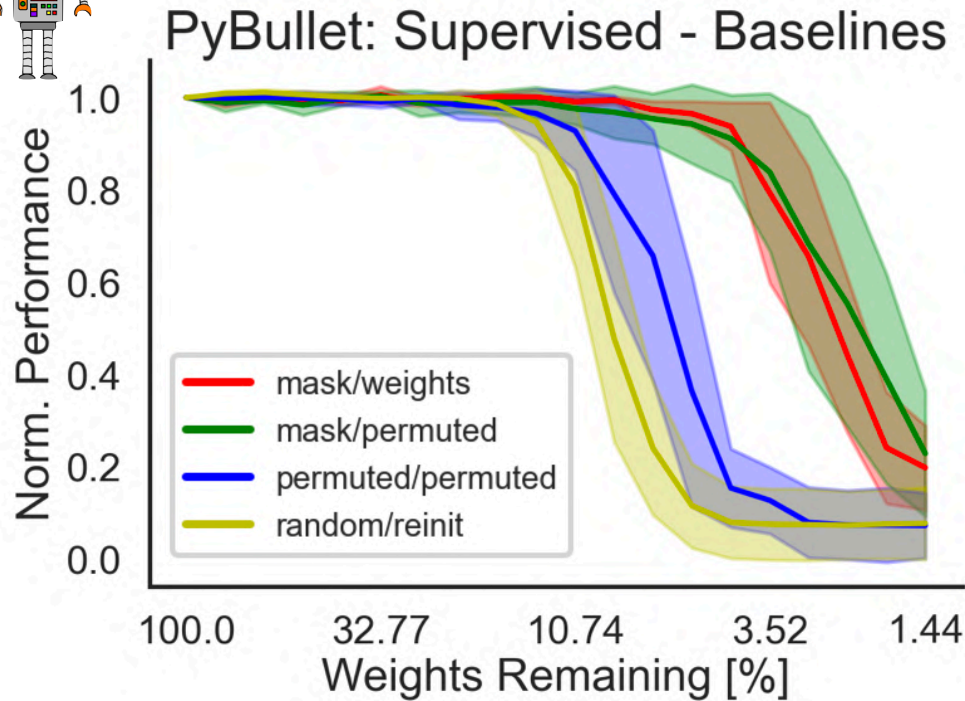
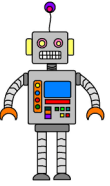
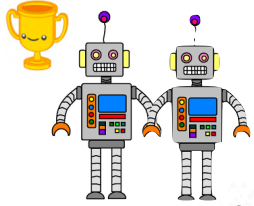
$m \odot W'$

"mask/permuted"





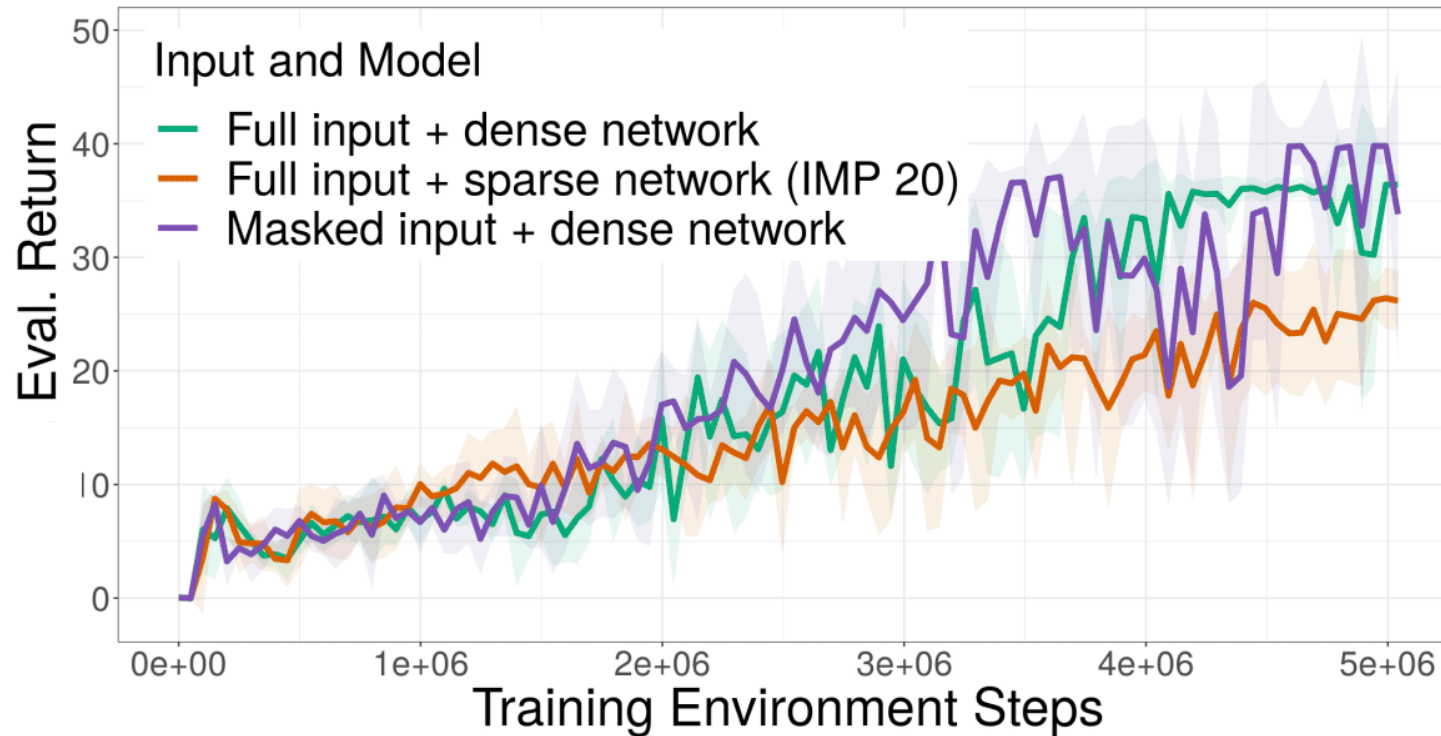
# Mask Accounts for Most of Ticket Effect in RL: Toy Envs



Permuting initial weights of lottery ticket does not impair effect.

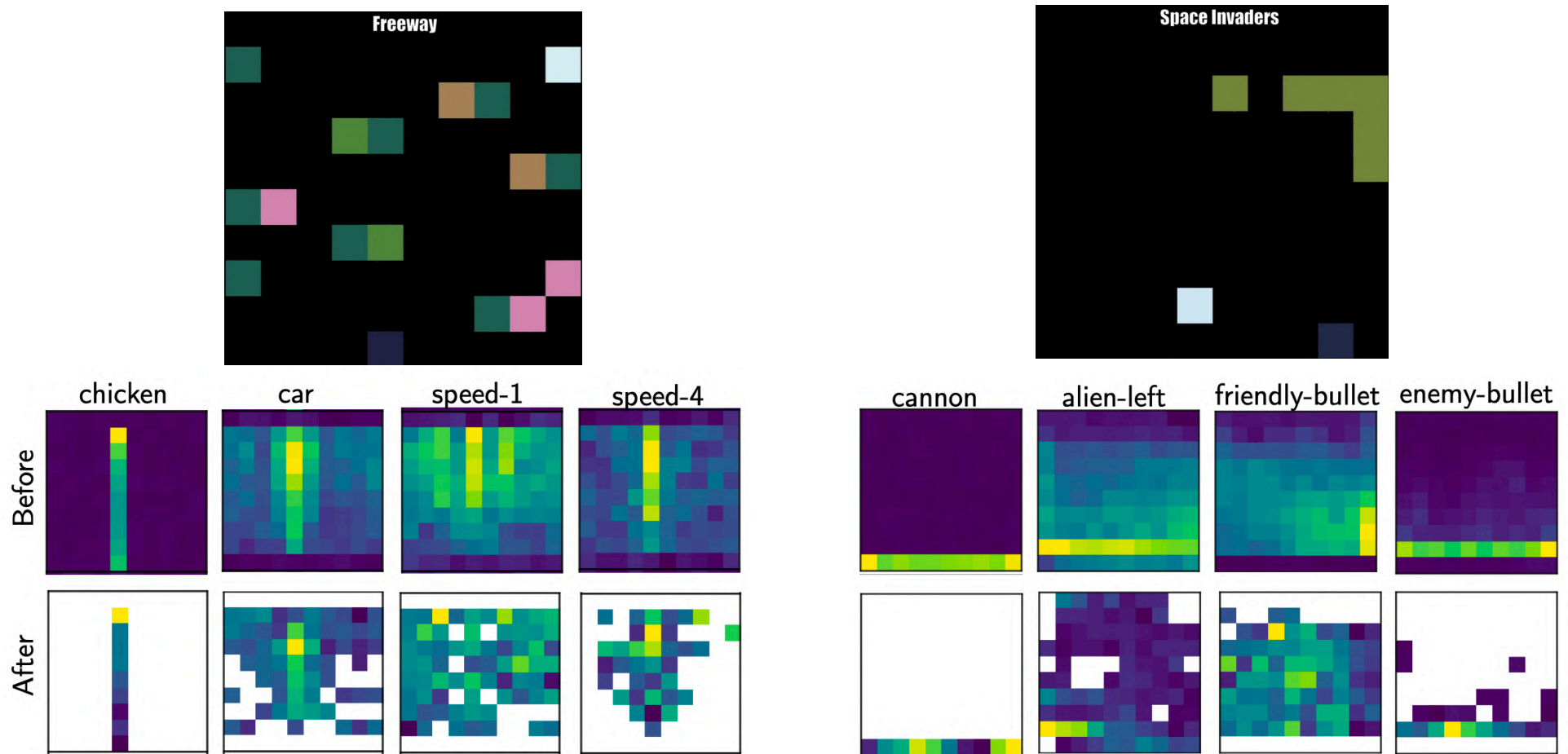
# Tickets Identify Minimal Task-Relevant Dimensions (I)

## Training Curves for Sparsified Gridworld



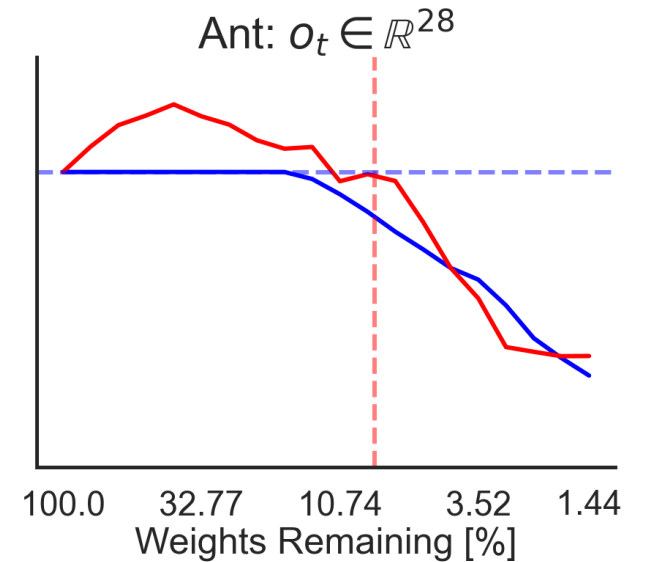
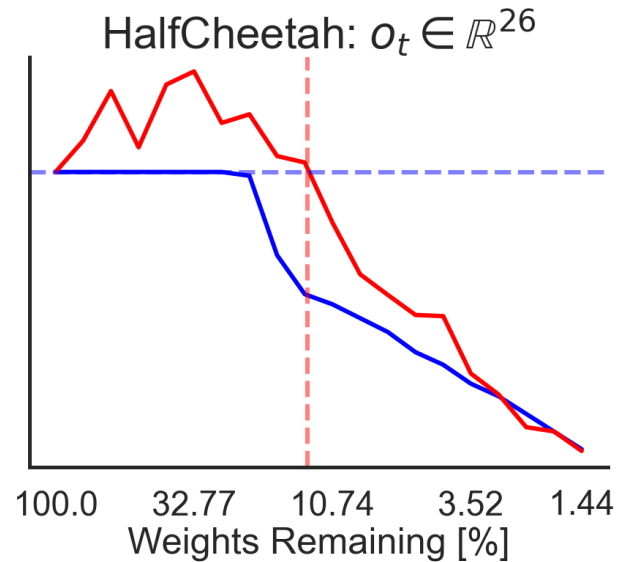
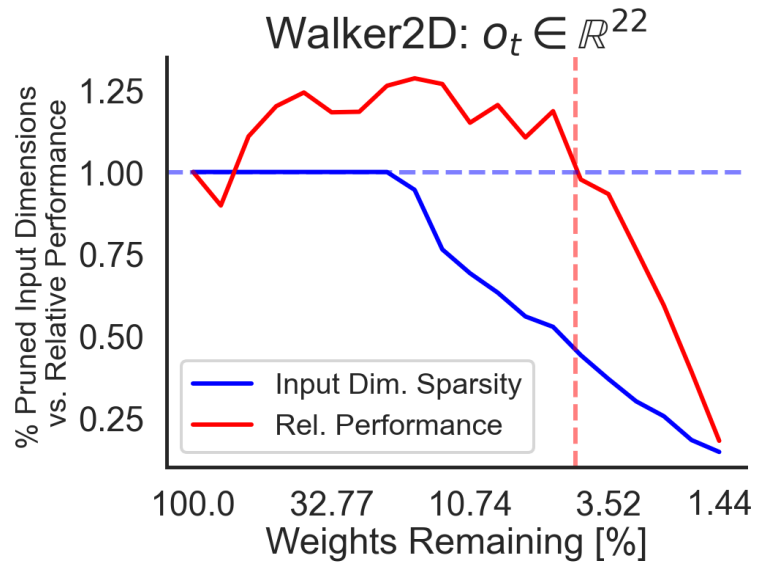
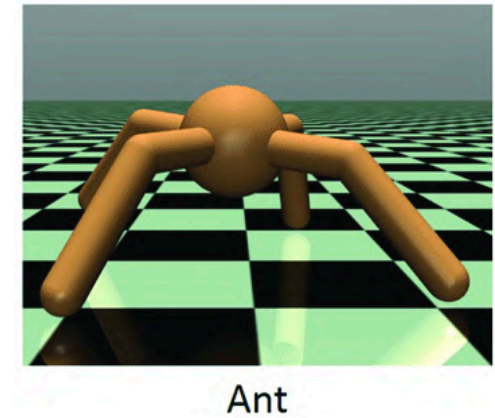
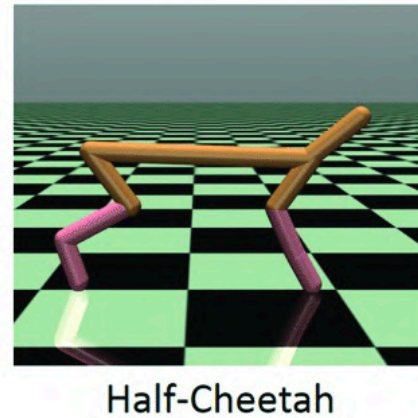
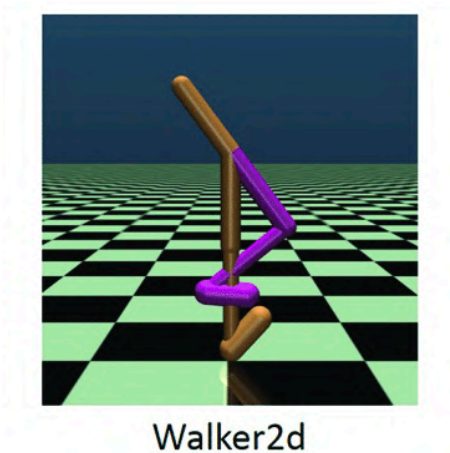
Task relevant pixels are preserved & redundant info is pruned.

# Tickets Identify Minimal Task-Relevant Dimensions (II)

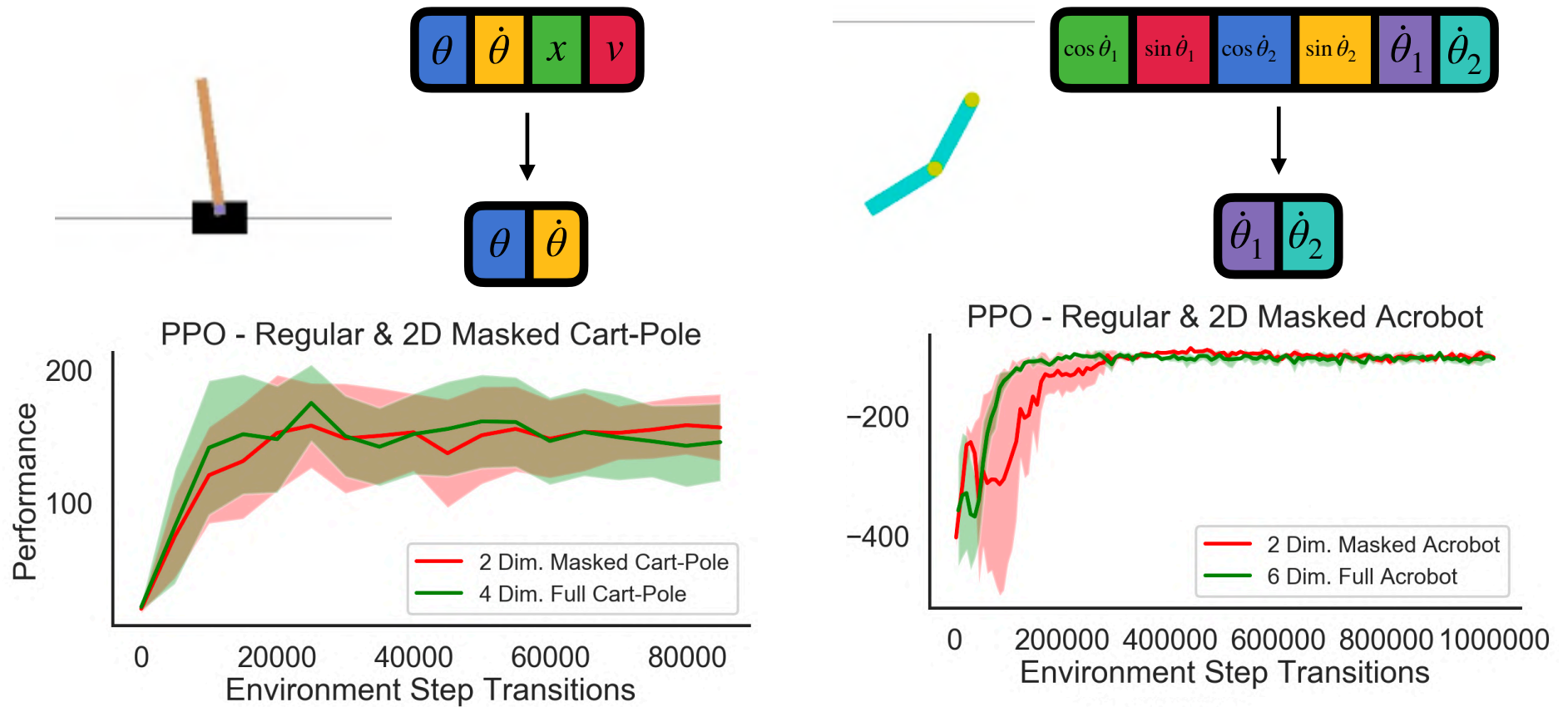


Ticket masks identify core dynamics (e.g. velocity, proximity).

# Tickets Identify Minimal Task-Relevant Dimensions (III)

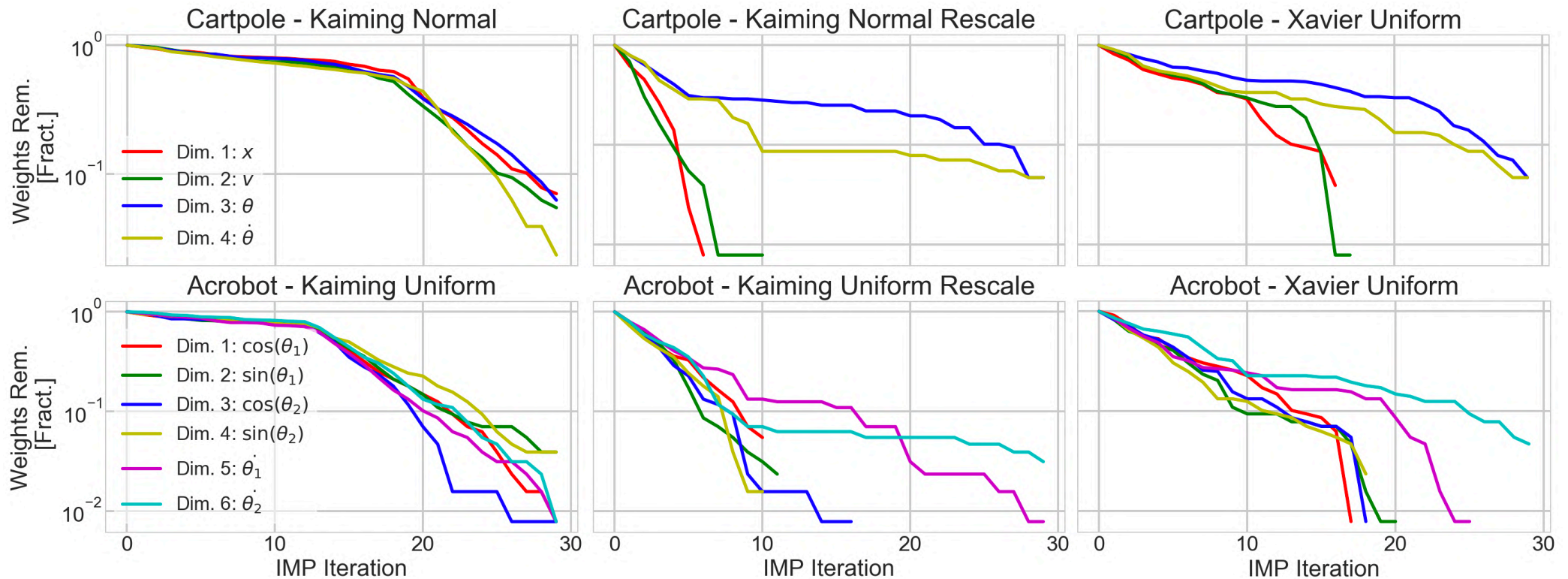


# Tickets Identify Minimal Task-Relevant Dimensions (IV)



IMP extracts relevant physical state dimensions in low-D tasks.

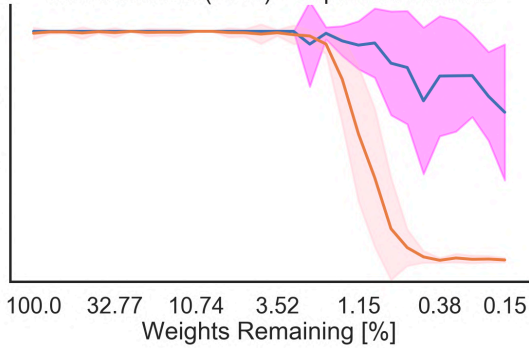
# Tickets Identify Minimal Task-Relevant Dimensions (Extra)



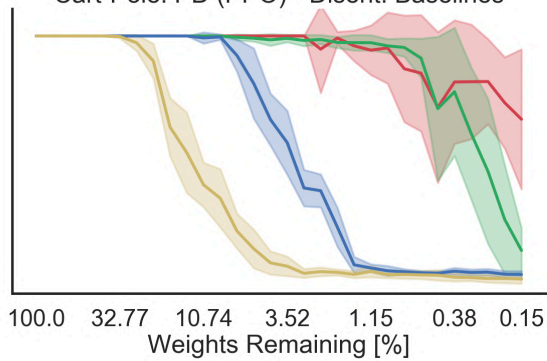
Layer init. biases interpretability of IMP-extracted representations.

# Summary

Cart-Pole: PD (PPO) - Supervised vs. RL



Cart-Pole: PD (PPO) - Disent. Baselines



The Ticket Effect in RL  
requires more params

The Ticket Effect in RL is  
due to the identified mask

The ticket mask encodes  
minimal task representations

