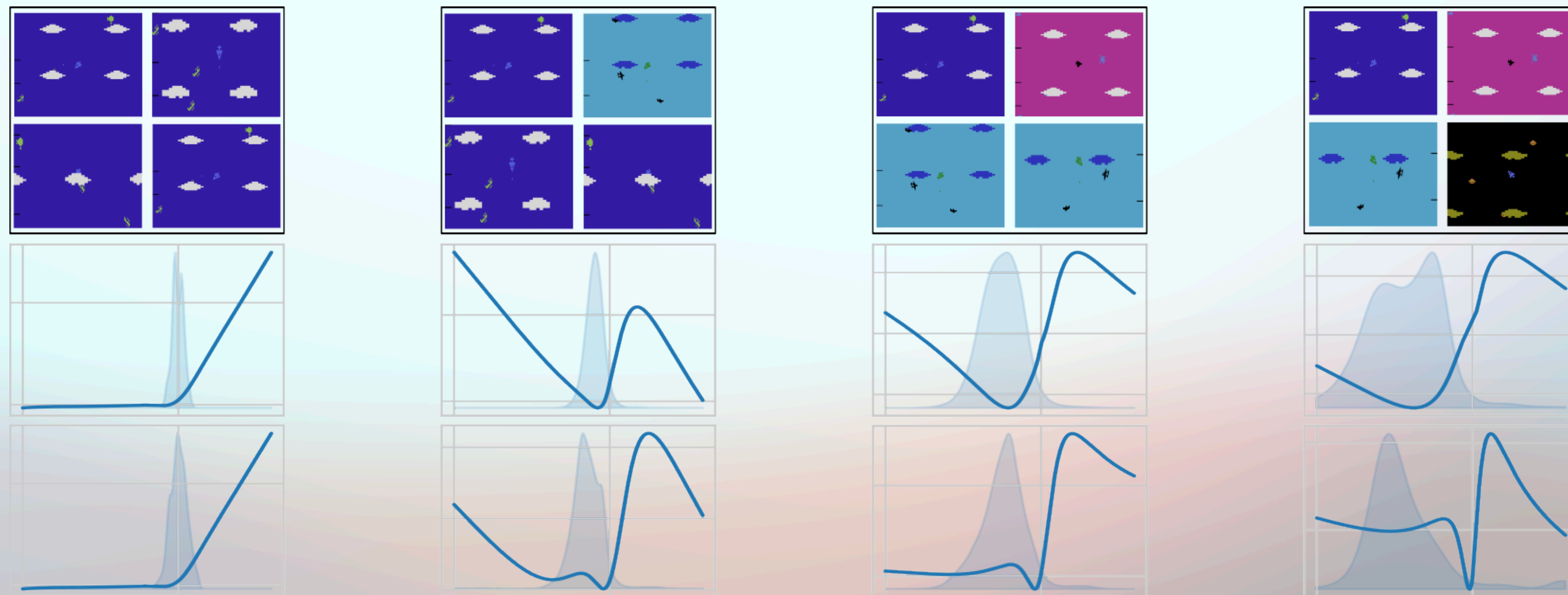
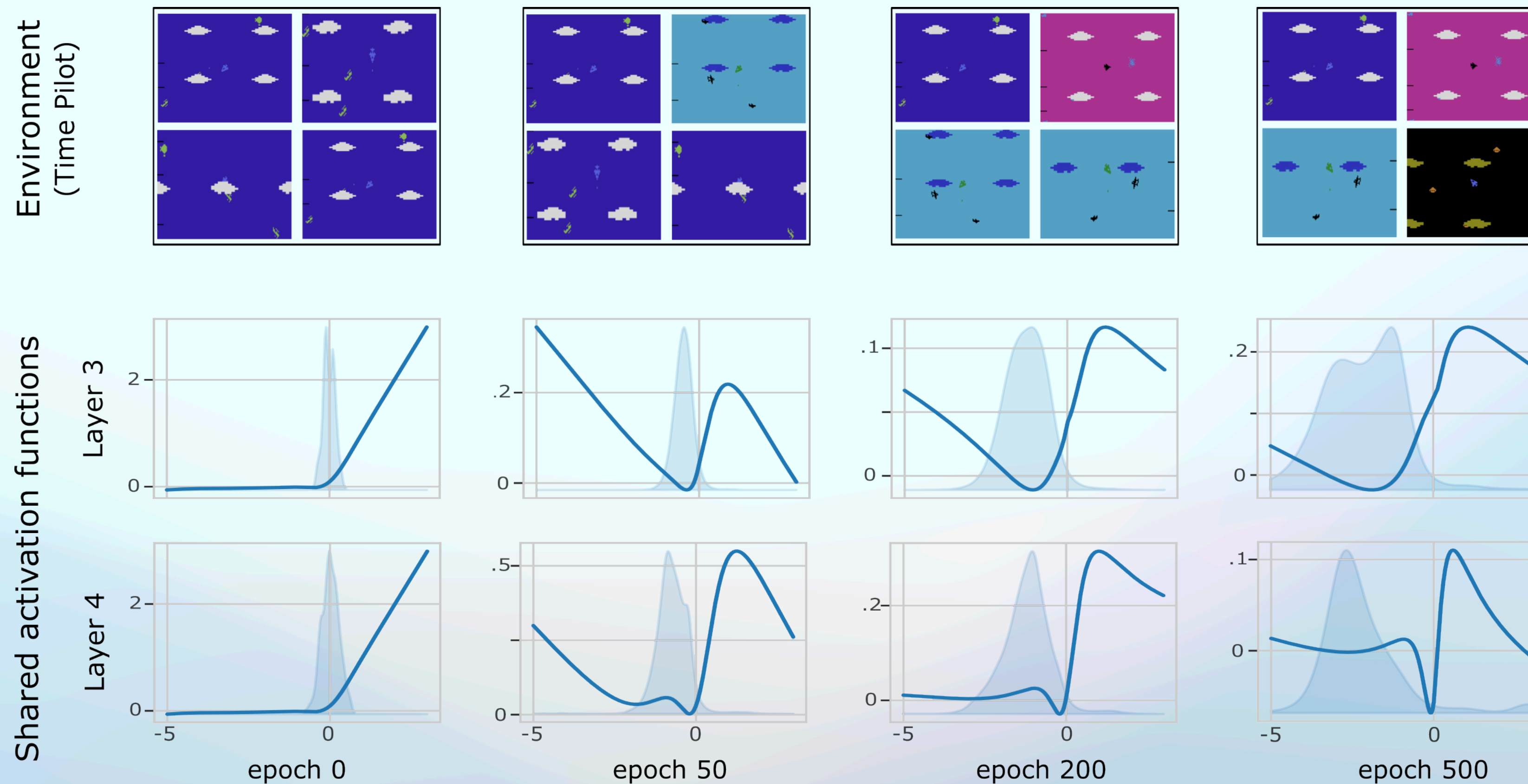


Adaptive Rational Activation to Boost Deep Reinforcement Learning



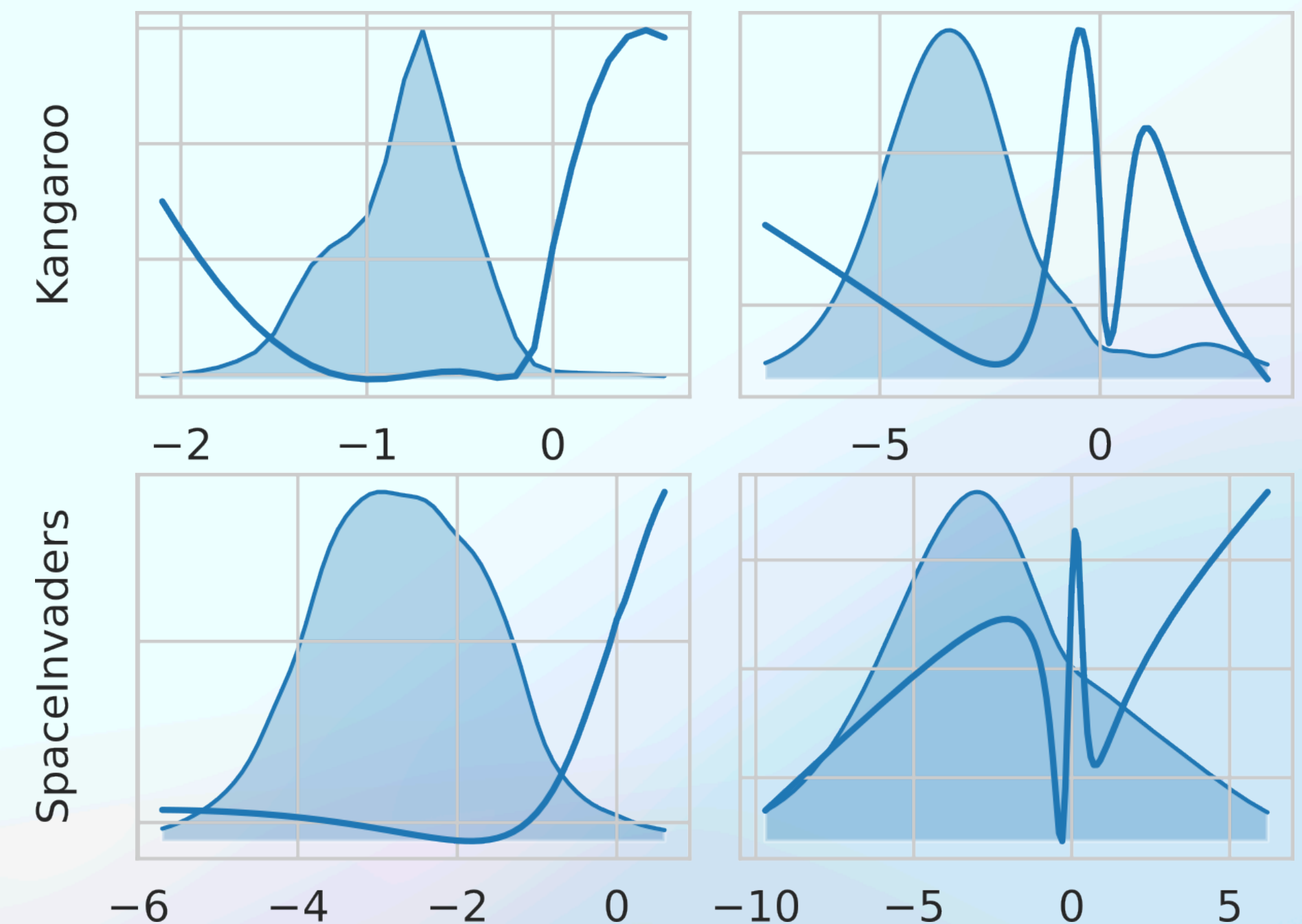
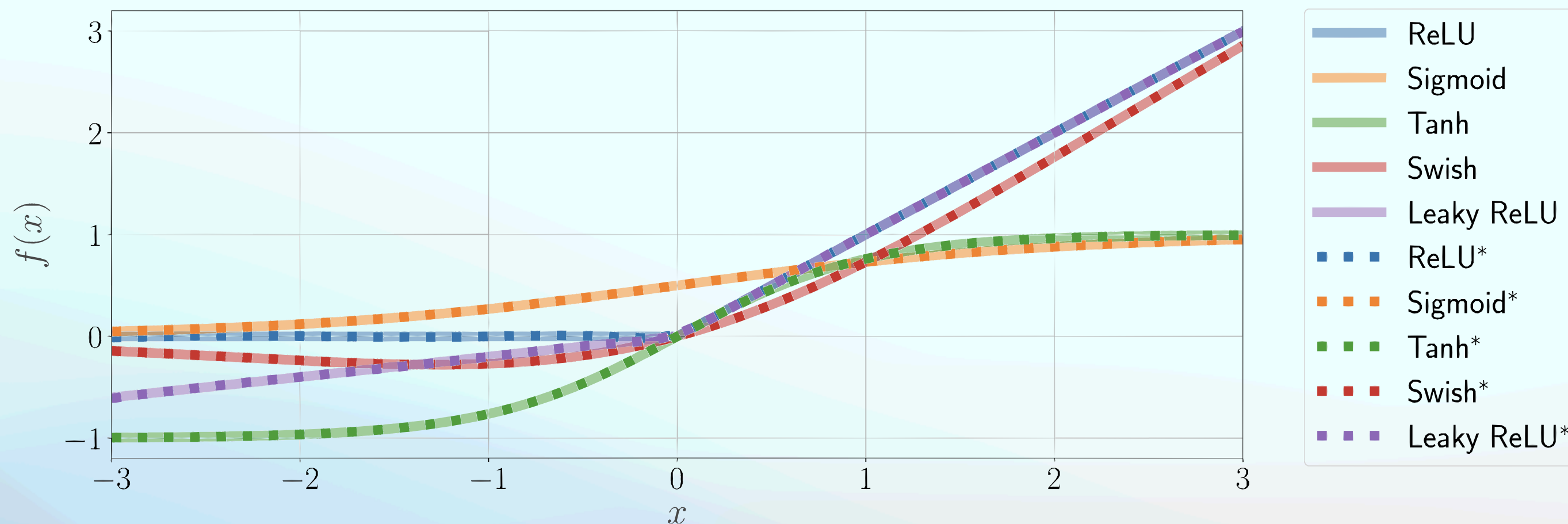
RL agents need plasticity

Distributional shifts in RL



Rational activation function

$$R(x) = \frac{P(x)}{Q(x)} = \frac{\sum_{j=0}^m a_j x^j}{1 + \sum_{k=1}^n b_k x^k}$$



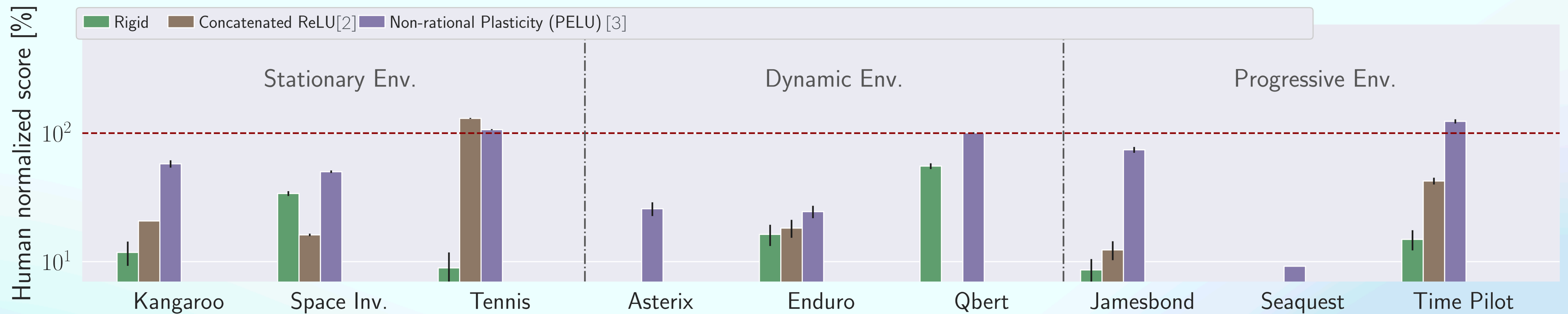
[1] Molina, Alejandro et al. "Padé Activation Units: End-to-end Learning of Flexible Activation Functions in Deep Networks." ICLR 2020

Rational activation augment plasticity

Architecture		VGG4		VGG6		VGG8	
Activation function		LReLU	Rational	LReLU	Rational	LReLU	Rational
CIFAR 10	Training Acc@1	83.0±.3	87.1±.6	86.9±.2	89.2±.2	90.1±.1	92.4±.2
	Testing Acc@1	80.0±1.	84.3±.5	83.1±.6	85.4±.6	85.0±1.	86.9±.3
CIFAR 100	Training Acc@1	64.6±.8	70.4±.9	70.7±.6	86.0±.9	87.7±.2	87.8±.1
	Testing Acc@1	56.5±.9	58.9±.6	59.0±.5	59.9±.9	60.0±.9	59.9±.4
# Network parameters		1.37M		4.71M		9.27M	

[1] Molina, Alejandro et al. "Padé Activation Units: End-to-end Learning of Flexible Activation Functions in Deep Networks." ICLR 2020

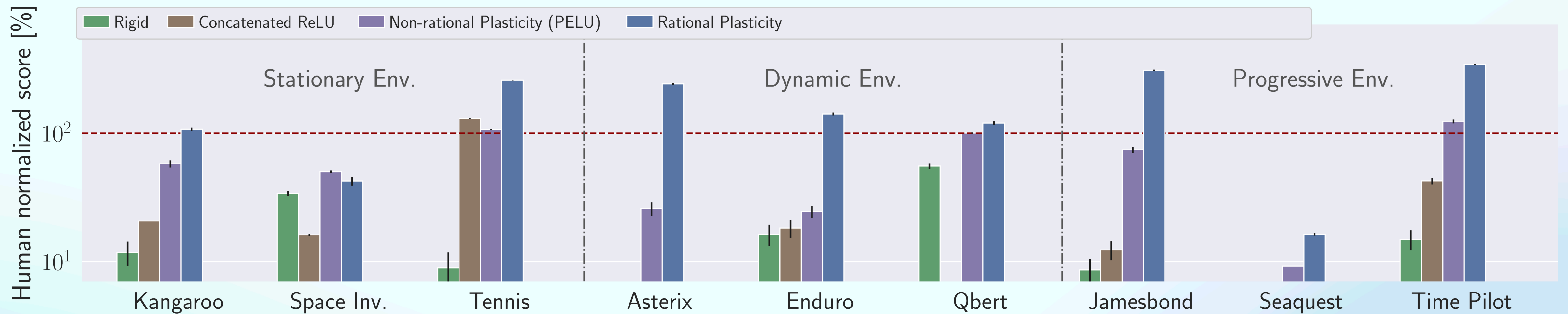
Augmenting RL agents' plasticity



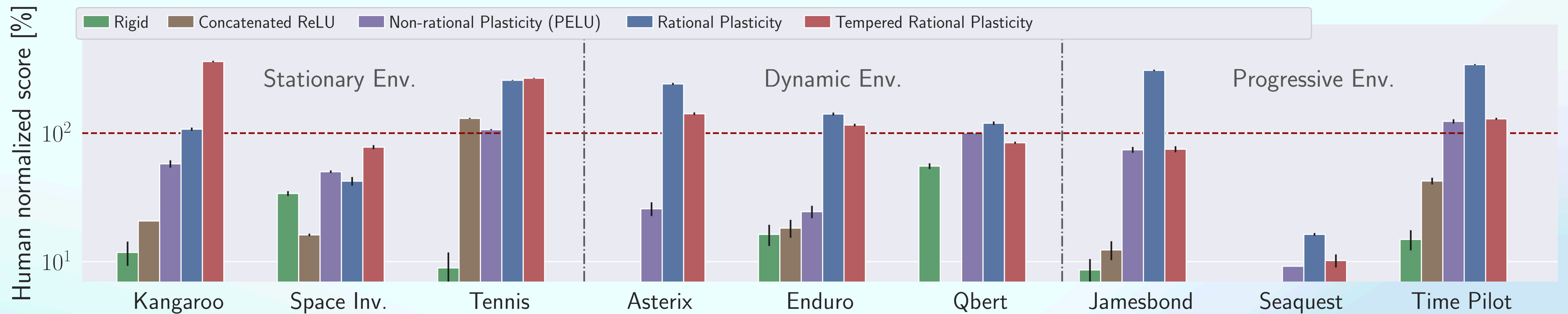
[2] Shang, W., Sohn, K., Almeida, D., & Lee, H. (2016). Understanding and improving convolutional neural networks via concatenated rectified linear units. ICML

[3] Trottier, L., Giguere, P., & Chaib-Draa, B. (2017). Parametric exponential linear unit for deep convolutional neural networks. ICMLA

Augmenting RL agents' plasticity



Augmenting RL agents' plasticity

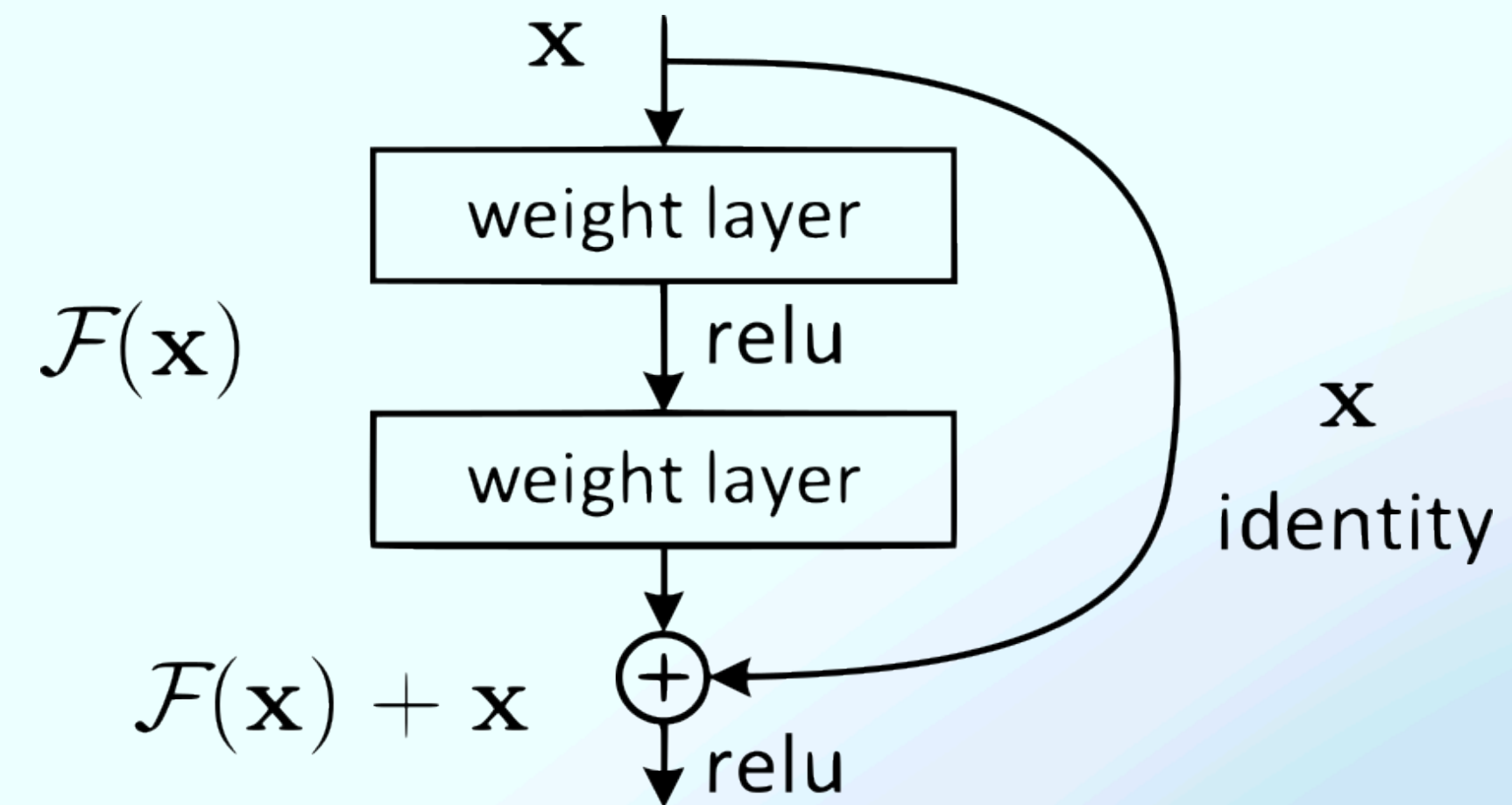


Residual Rational activations

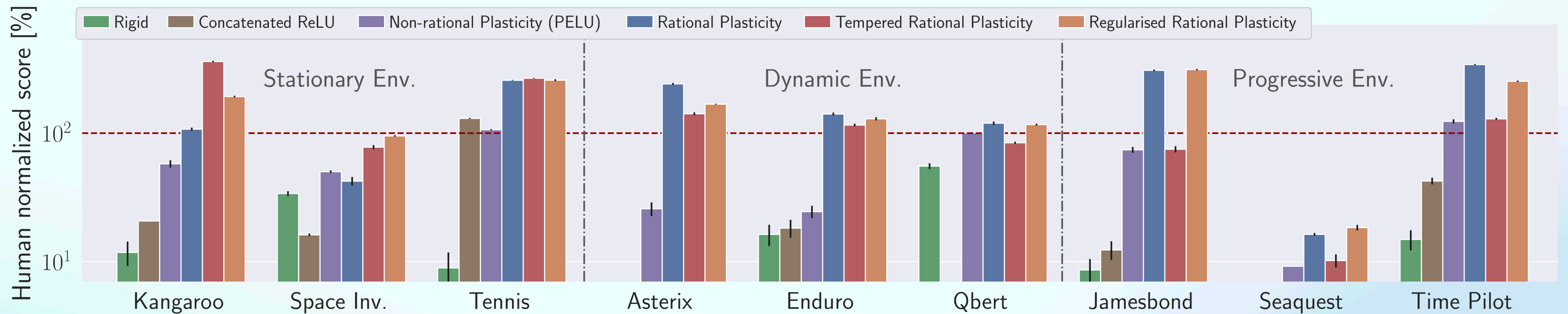
$$R(x) = \frac{P(x)}{Q(x)} = \frac{\sum_{j=0}^m a_j x^j}{1 + \sum_{k=1}^n b_k x^k}$$

Theorem

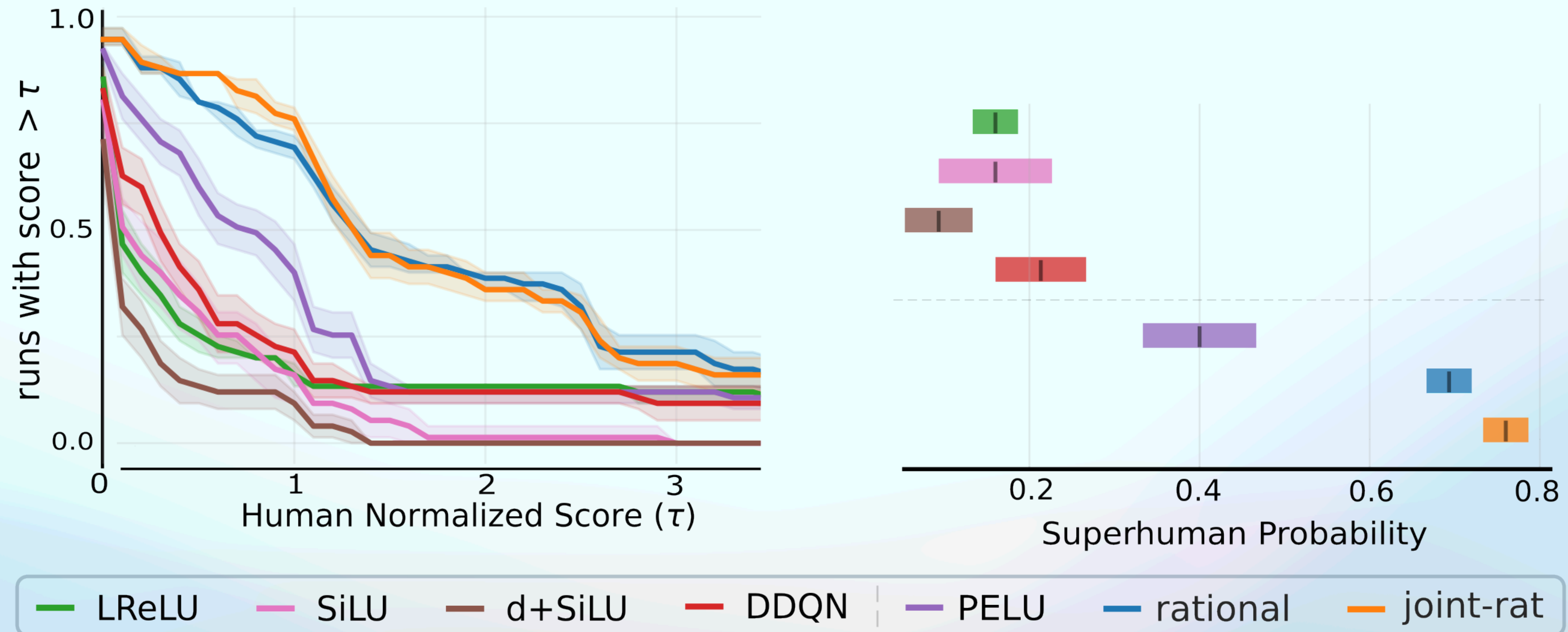
Let R be a rational function of order (m, n) .
 R embeds a residual connection $\Leftrightarrow m > n$.



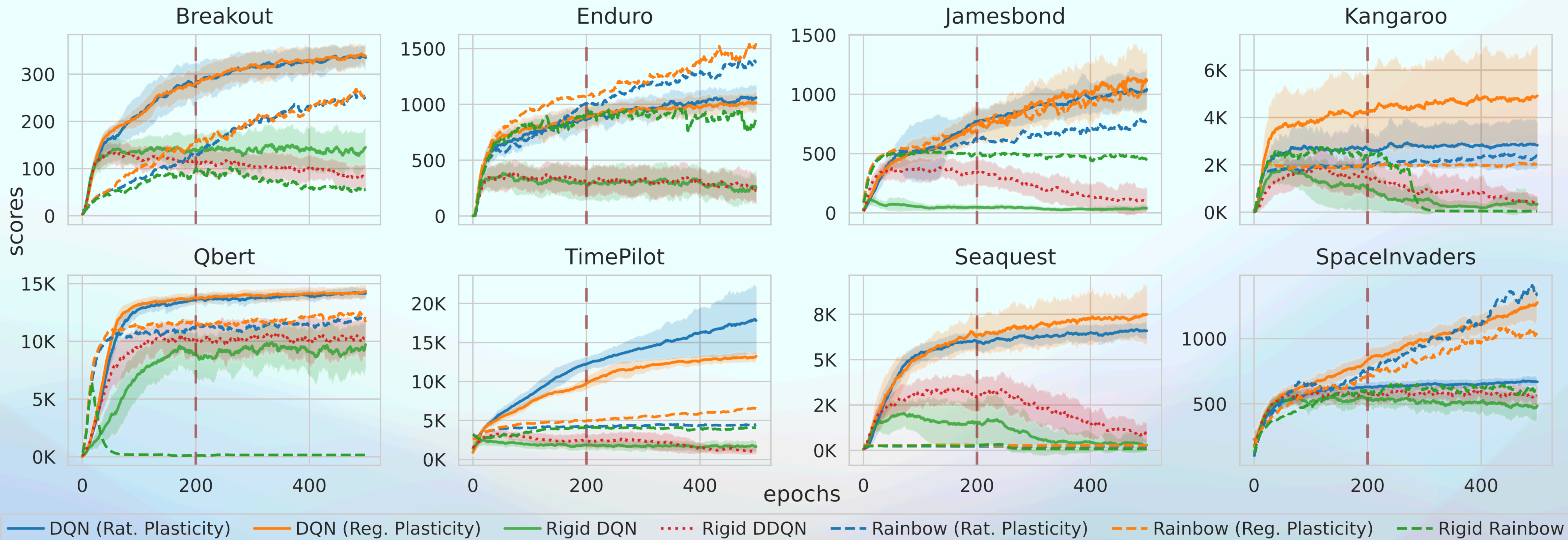
RL agents' with rationals' weight sharing



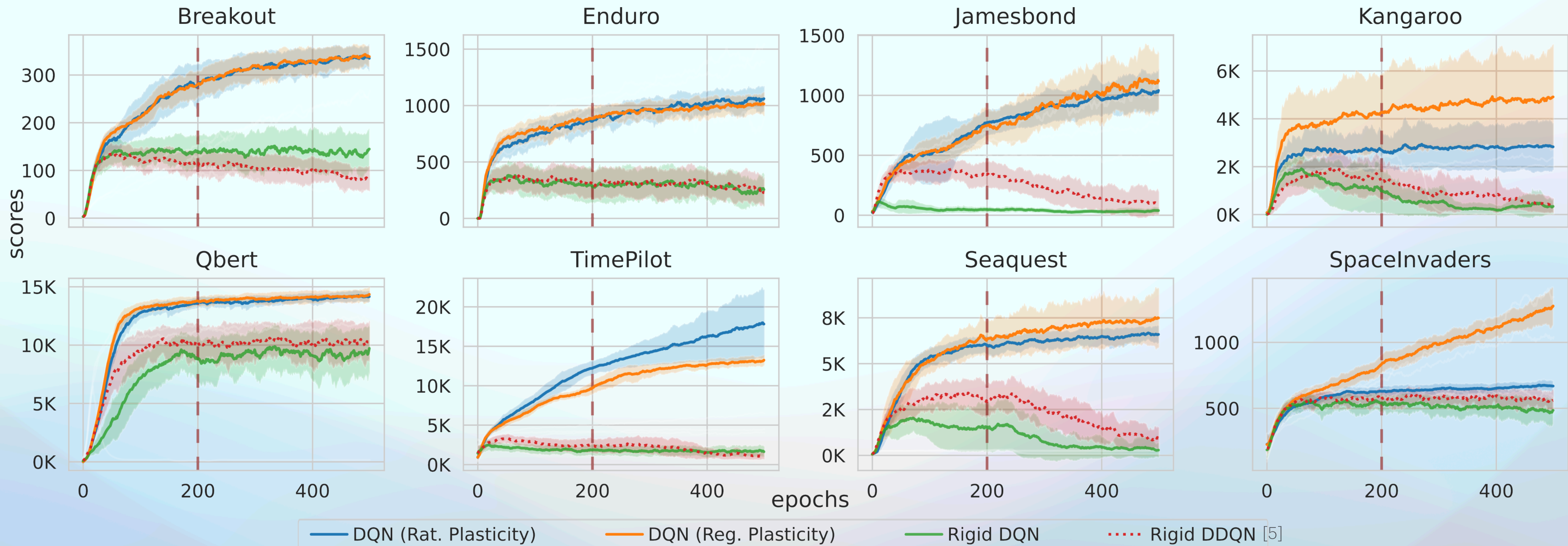
Augmenting RL agents' plasticity



More plasticity > better algorithm

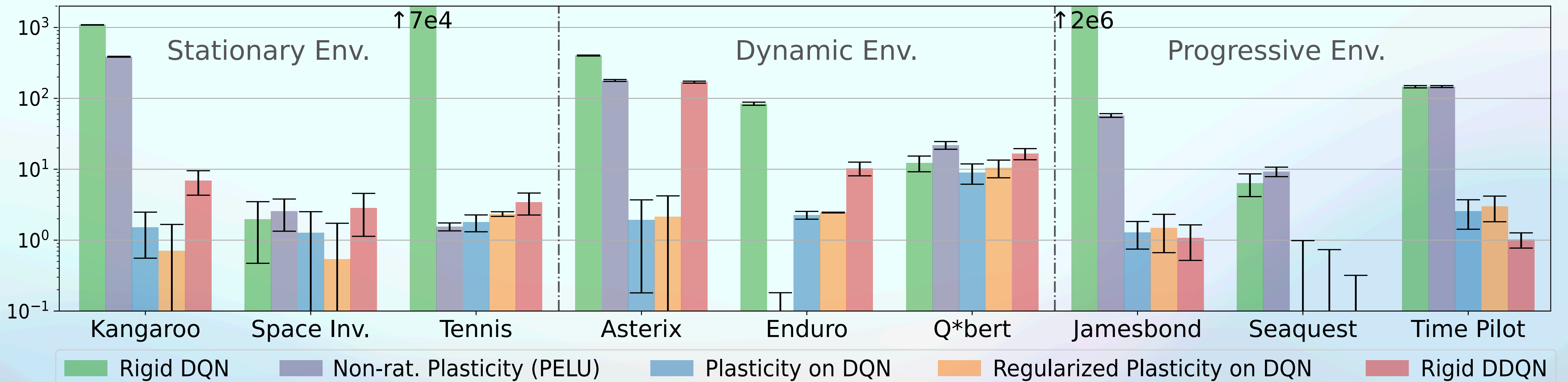


Overestimation



[5] Van Hasselt, H., Guez, A., & Silver, D. (2016). Deep reinforcement learning with double q-learning. AAAI

Augmented plasticity for overestimation



Rational plasticity for Continual Learning

