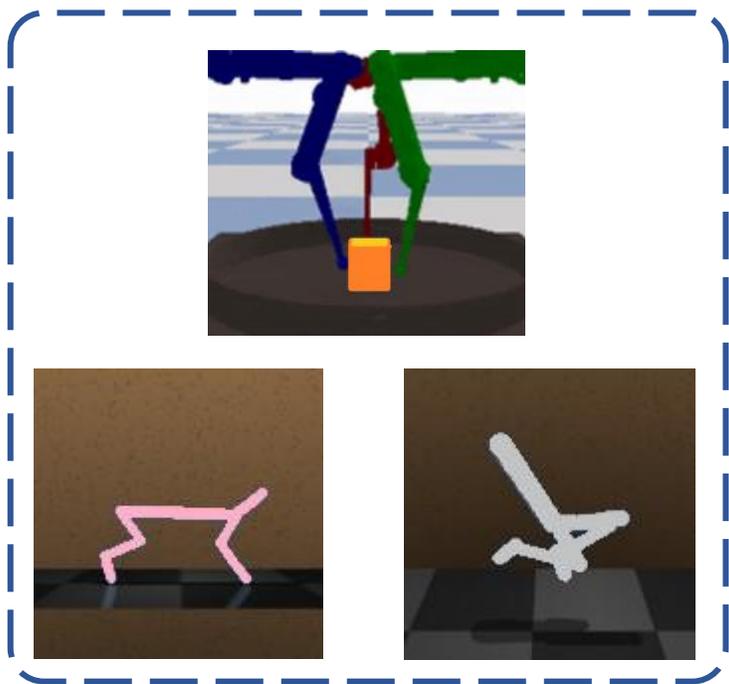


Learning Generalizable Agents via Saliency-Guided Features Decorrelation

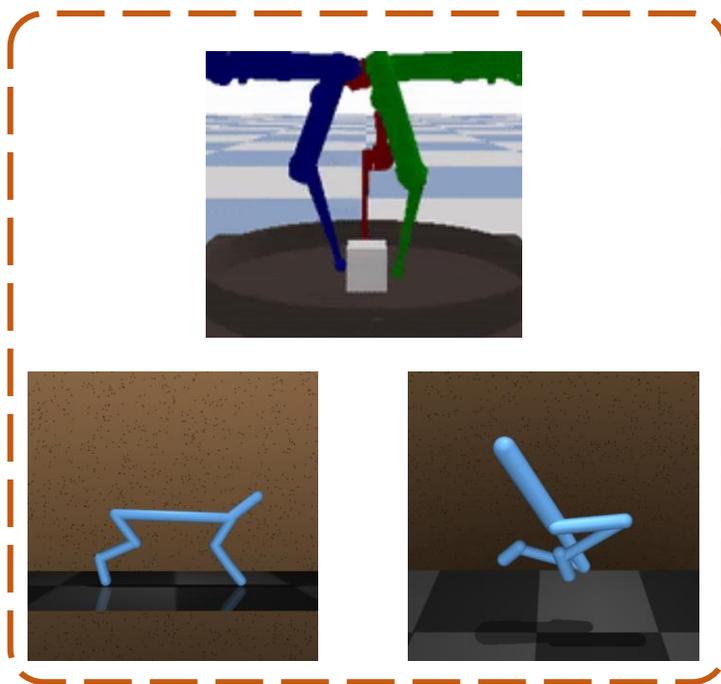
The different between training tasks and testing tasks

- Two types of variations
 - Task-irrelevant features: background noises
 - Task-relevant features: robot configurations



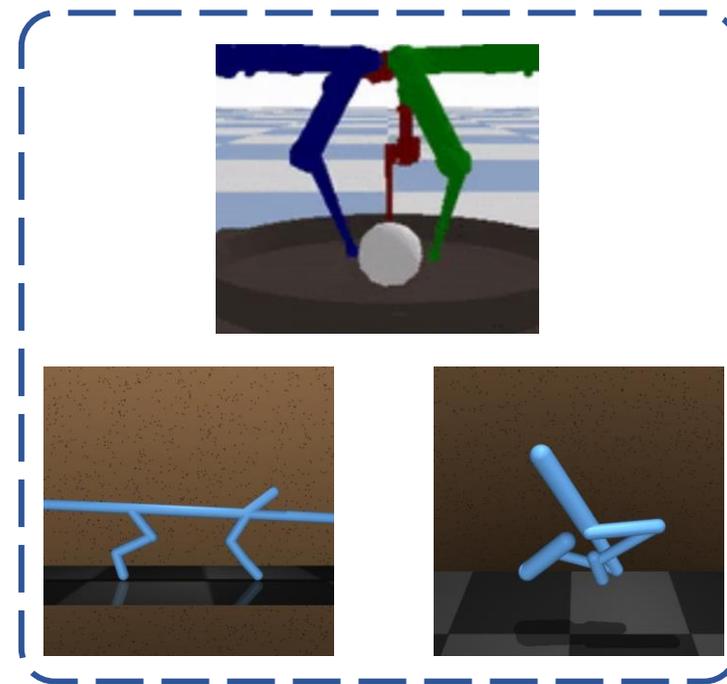
(a) Testing tasks with changed task-irrelevant features

\equiv
 a^*



(b) Training tasks

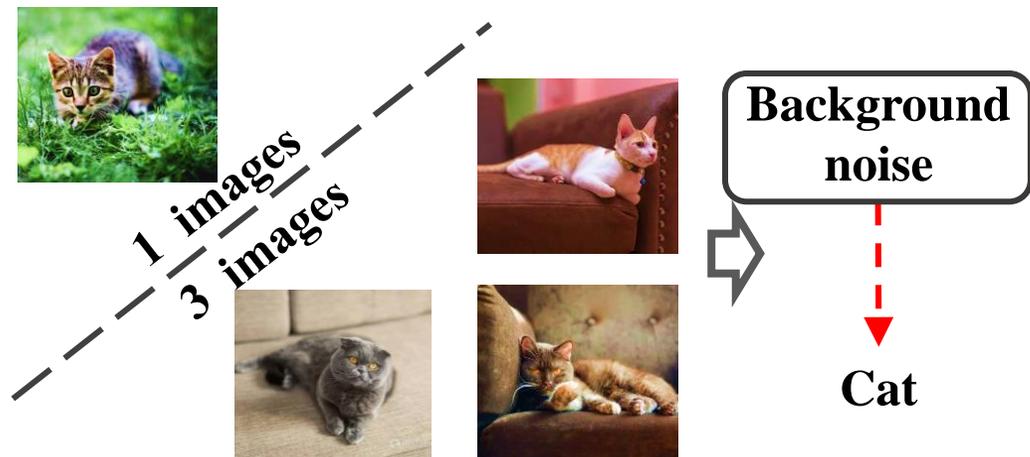
\neq
 a^*



(c) Testing tasks with changed task-relevant features

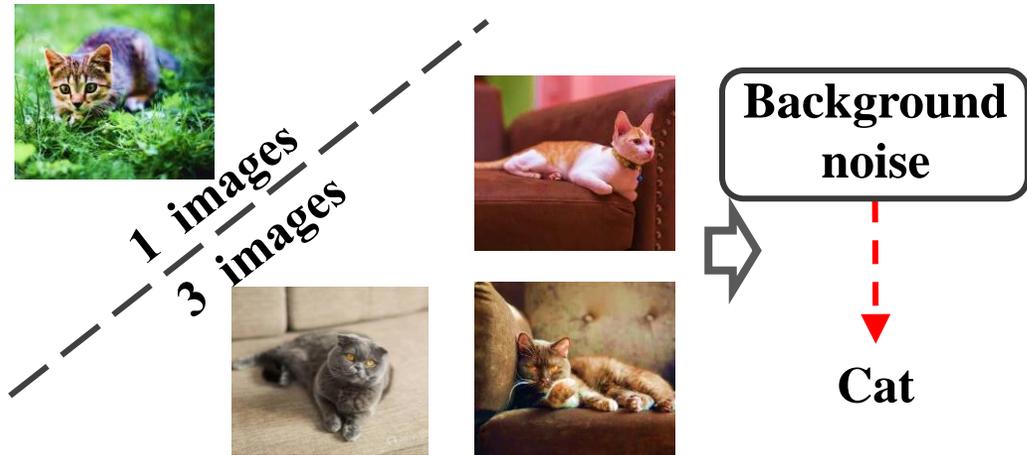
Motivation

- Spurious association \dashrightarrow



Motivation

- Spurious association \dashrightarrow



- True association \rightarrow

Sample reweighting

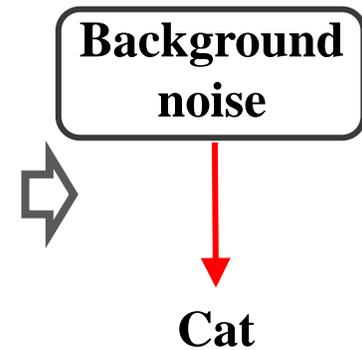
$\times 2$



Equivalent to 2 images

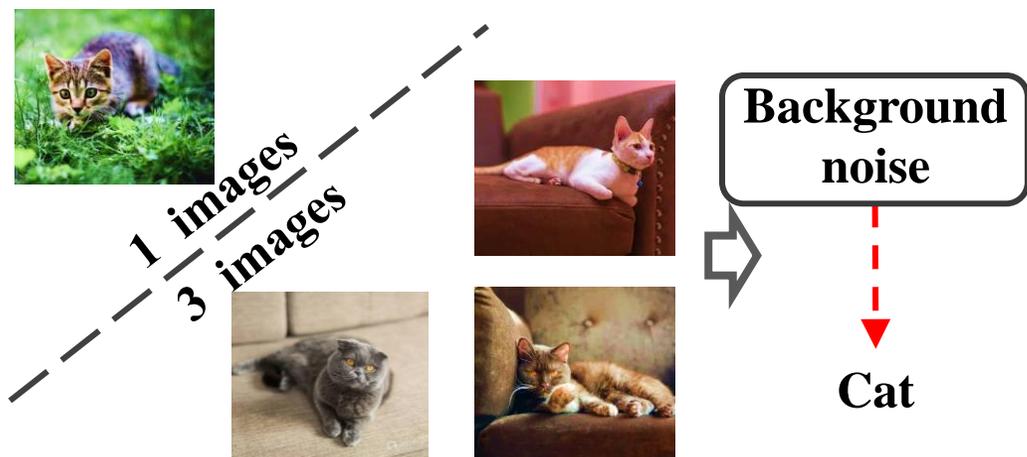
Equivalent to 2 images

$\times 2/3$

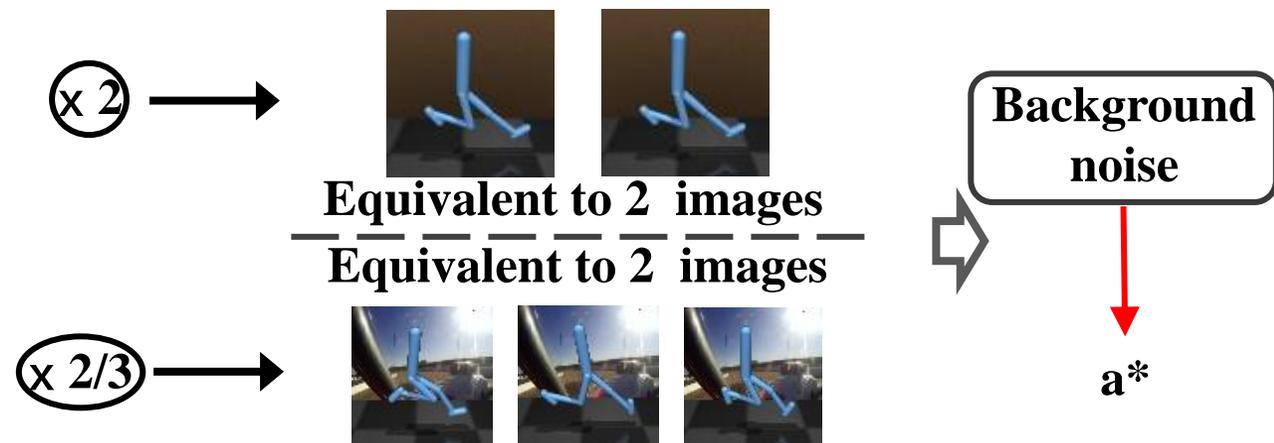
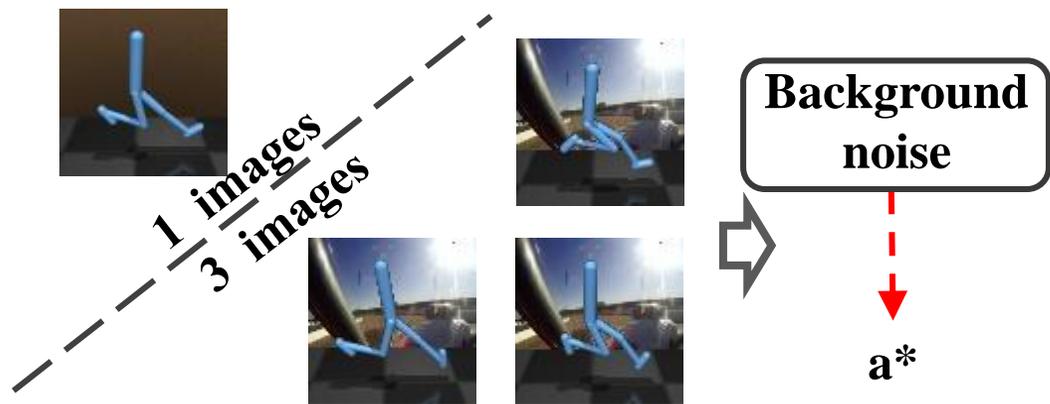
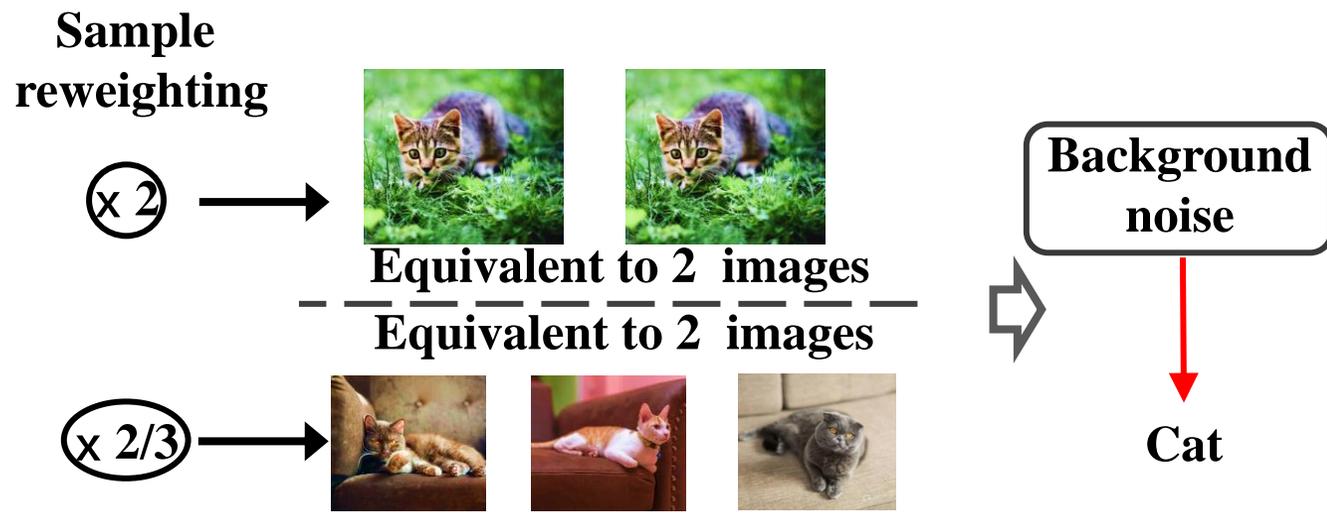


Motivation

- Spurious association \dashrightarrow



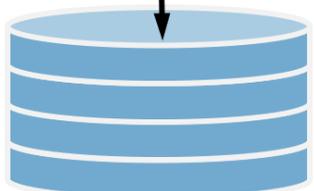
- True association \rightarrow



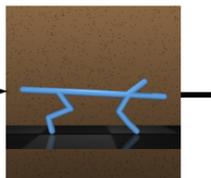
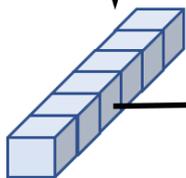
(a) Semantics of images are correlated with backgrounds (b) Semantics of images are independent of backgrounds

Saliency-guided Features Decorrelation

Multiple training environments

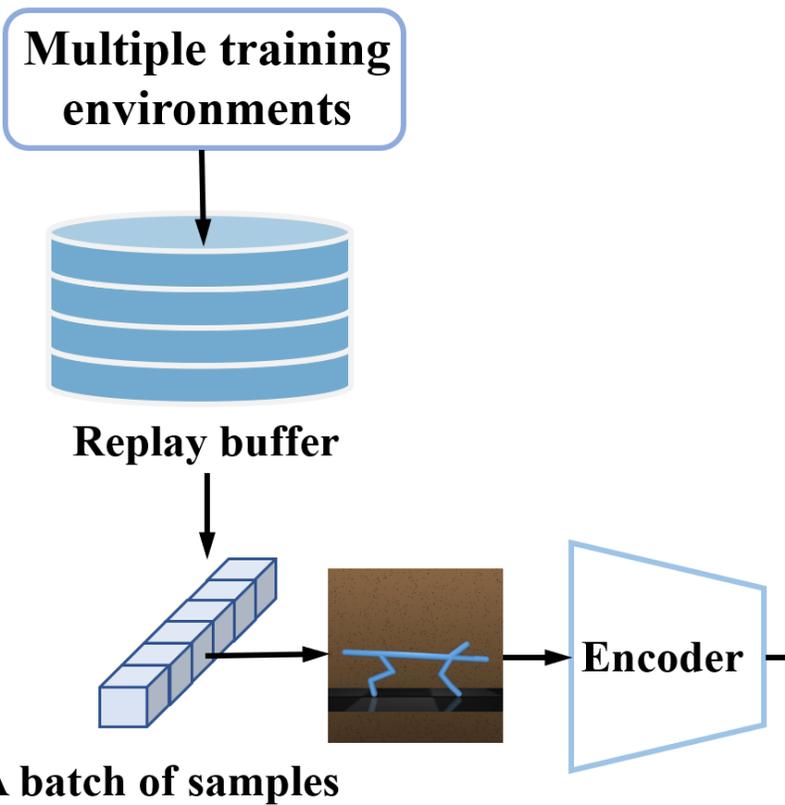


Replay buffer

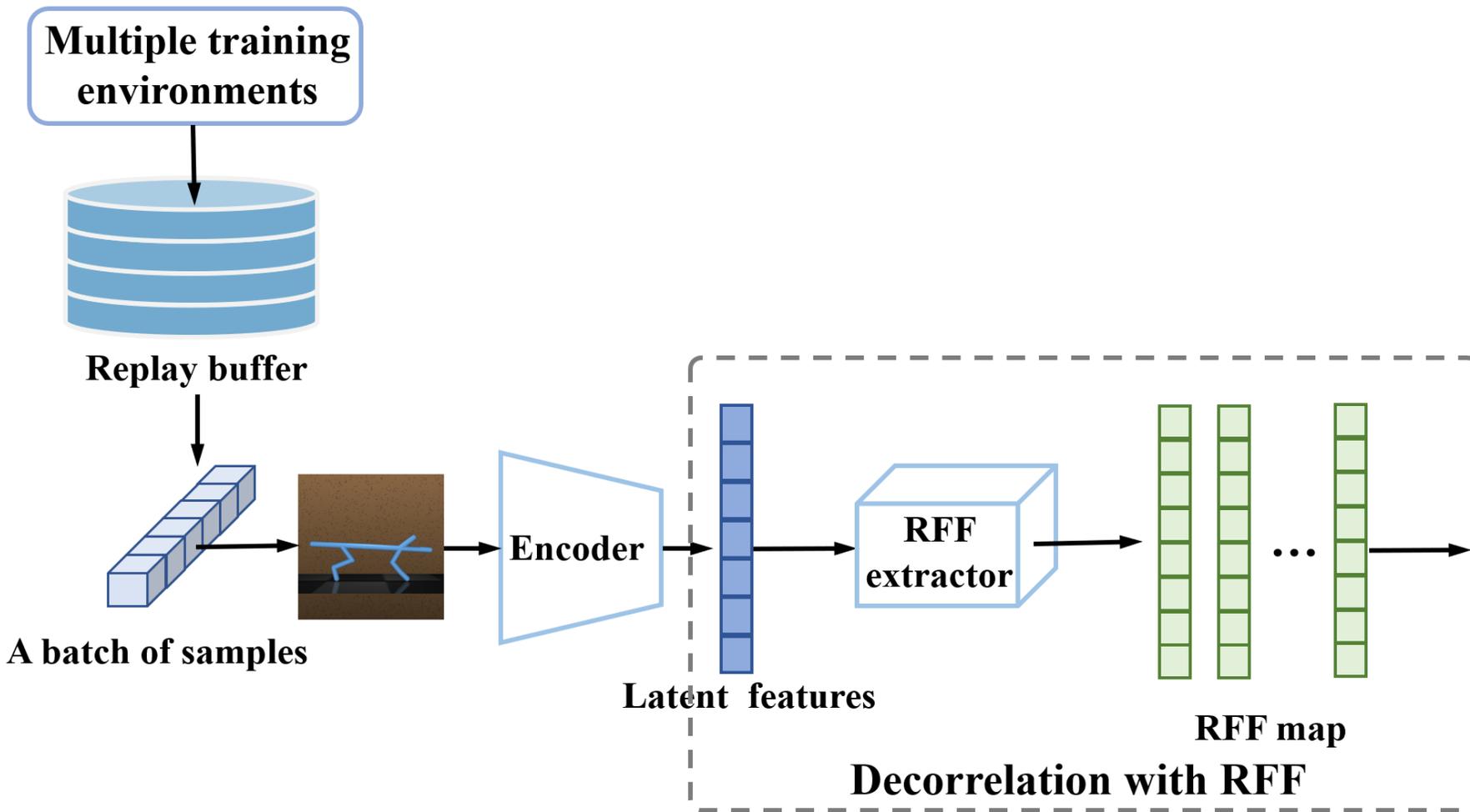


A batch of samples

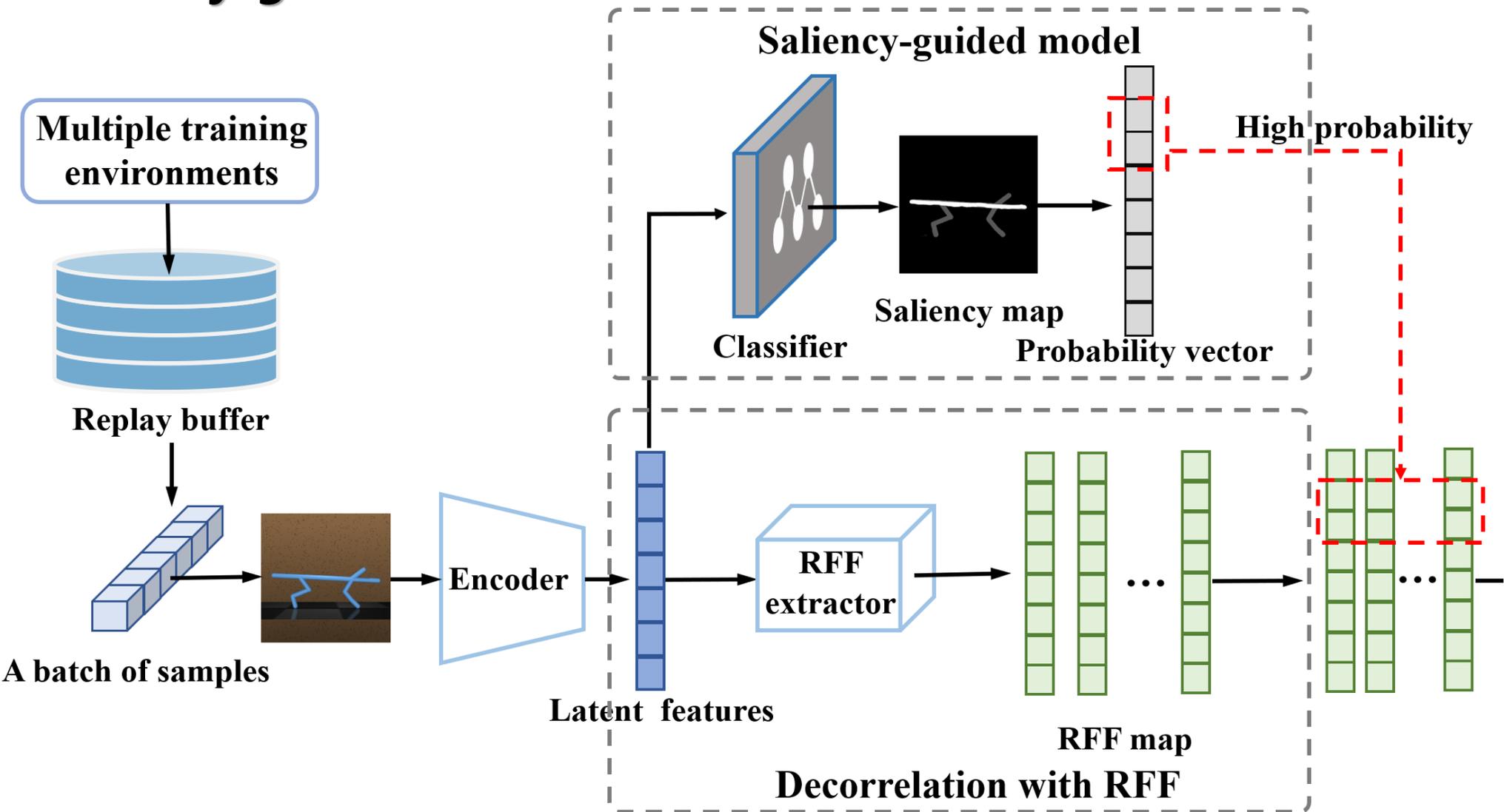
Saliency-guided Features Decorrelation



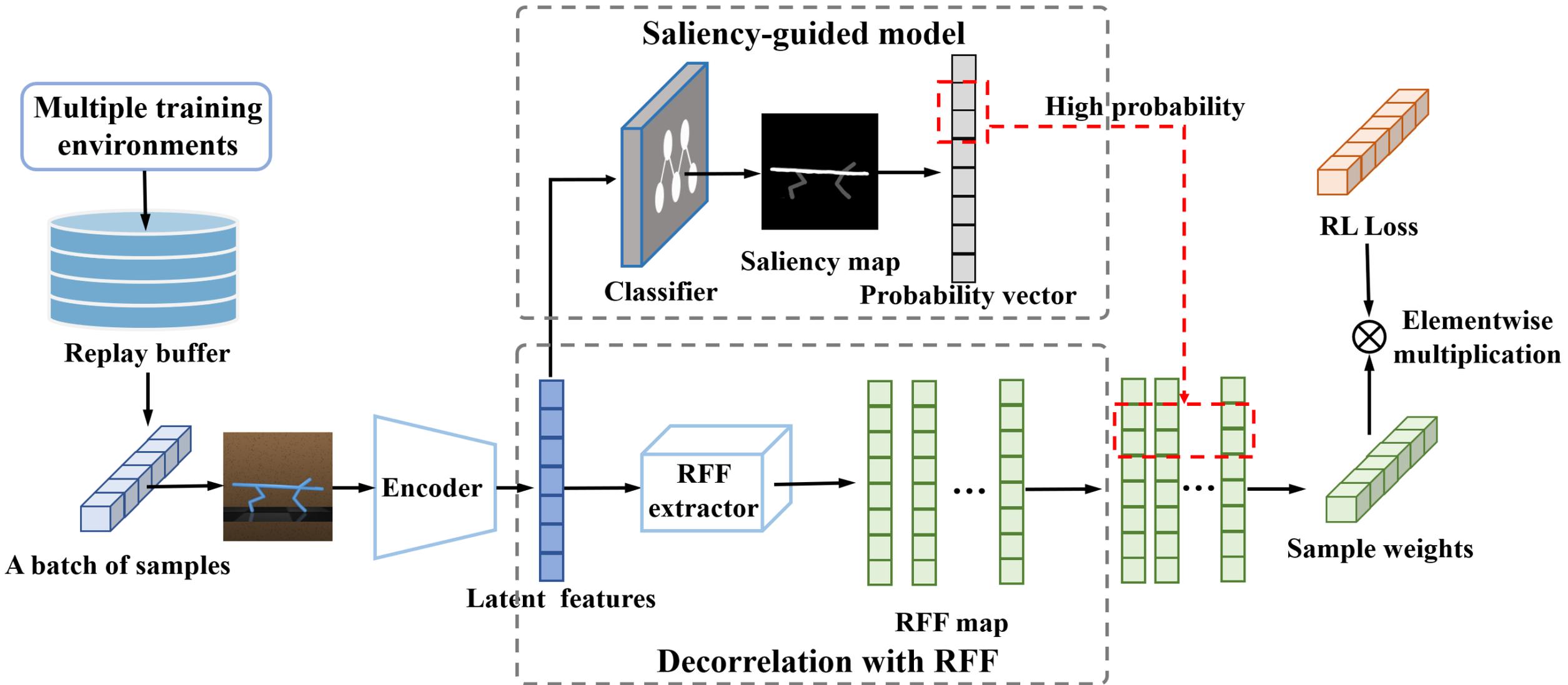
Saliency-guided Features Decorrelation



Saliency-guided Features Decorrelation



Saliency-guided Features Decorrelation



Experimental settings

- The visualizations of background noises

cheetah



finger



walker



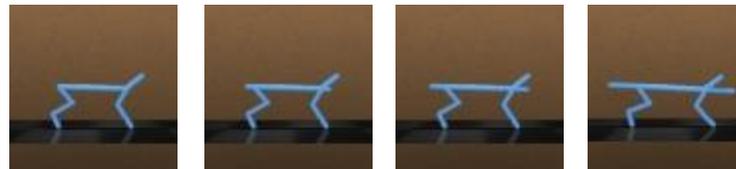
Training environments with different background



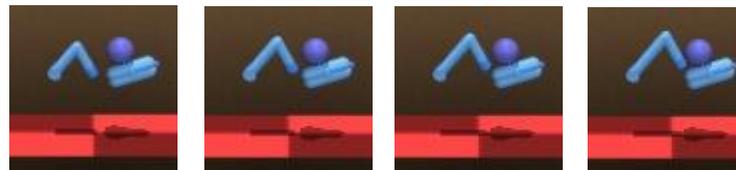
An testing environment with unseen robot parameters

- The visualizations of robot configurations

cheetah



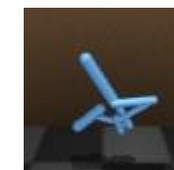
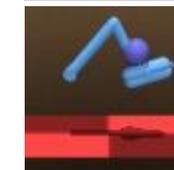
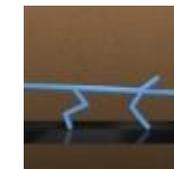
finger



walker



Training environments with different robot parameters



An testing environment with unseen robot parameters

Experimental results

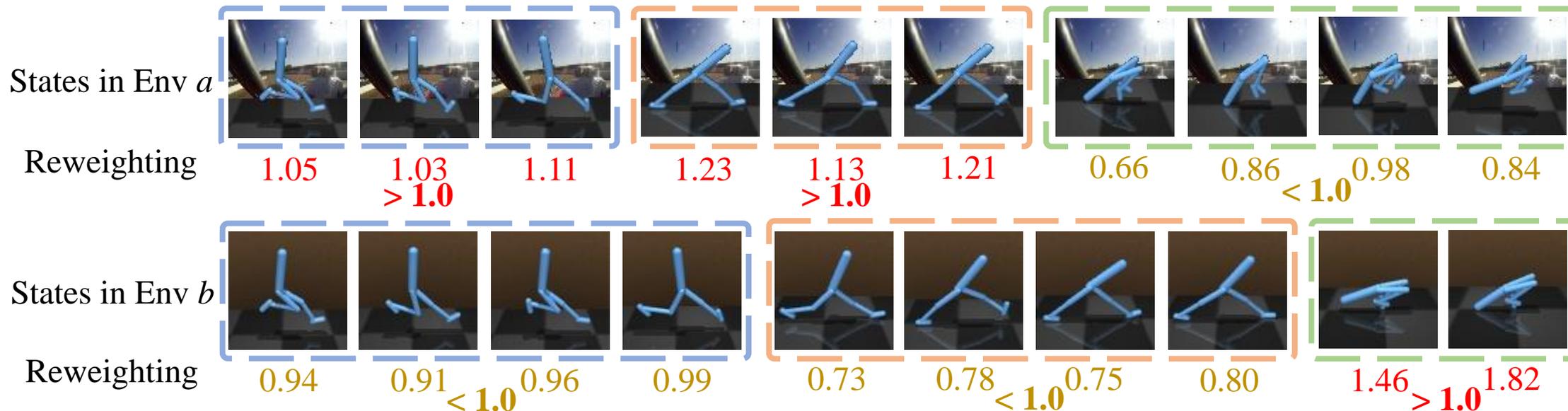
task-irrelevant
features

Tasks	SGFD	TED	AMBS	SGQN	DBC	DR
walker-walk	959.1 ± 26.3	871.5± 60.6	926.7± 53.2	815.1± 53.9	800.9± 41.4	712.4± 93.7
cheetah-run	599.6 ± 47.2	544.7± 22.9	517.7± 73.4	332.8± 55.1	312.1± 20.3	340.0± 44.0
finger-spin	965.7 ± 45.9	932.1± 71.0	925.1± 50.5	943.3± 46.2	663.7± 68.7	860.8± 42.1
walker-run	420.7 ± 39.2	387.8± 27.1	398.7± 32.0	317.2± 34.5	332.4± 37.1	231.3± 8.9
finger-turn	984.3 ± 11.5	963.9± 94.5	966.7± 37.0	971.3± 26.0	931.2± 41.6	947.2± 21.7
Total	3929.5	3700.0	3734.9	3379.7	3040.3	3091.7

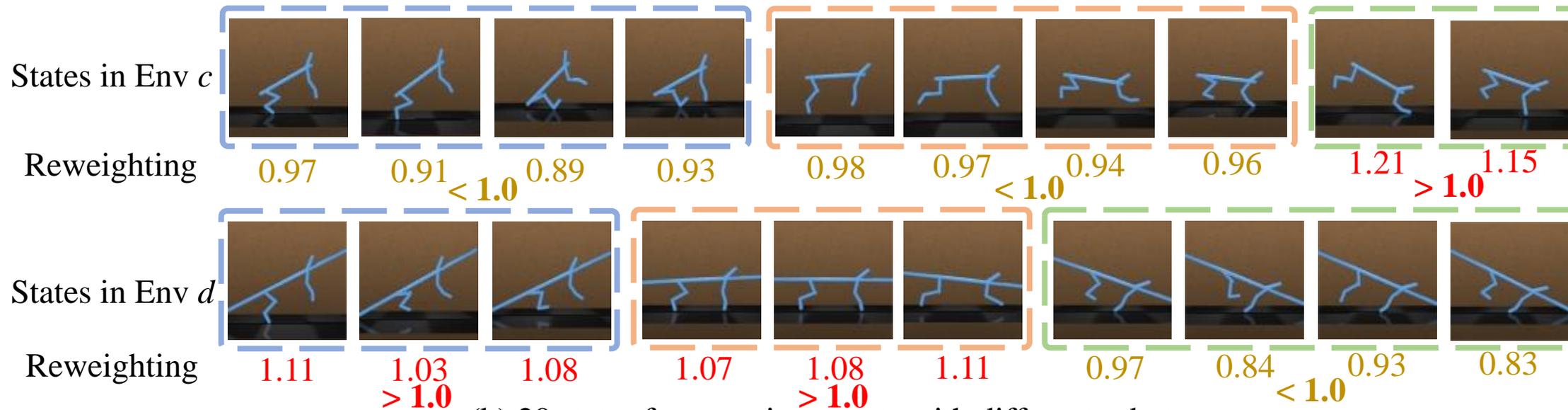
task-relevant
features

Tasks	SGFD	TED	AMBS	SGQN	DBC	DR	
Interpolation	MT-walker-walk	549.4 ± 42.5	471.9± 18.3	532.5± 81.7	287.1± 34.5	245.7± 47.4	343.8± 70.6
	MT-cheetah-run	395.9 ± 35.2	367.8± 42.2	298.6± 53.5	225.7± 40.9	191.7± 23.5	216.3± 33.1
	MT-finger-spin	234.1 ± 11.9	201.7± 17.9	161.3± 17.3	135.7± 16.9	221.6± 21.5	207.1± 28.2
	MT-walker-run	170.3 ± 05.7	125.6± 13.2	161.4± 06.7	126.3± 18.6	97.2± 19.0	160.3± 16.6
	MT-finger-turn	923.7 ± 26.1	748.9± 44.3	821.8± 52.3	786.6± 65.6	358.5± 83.9	704.7± 70.1
Total	2273.4	1910.6	1975.6	1561.4	1114.7	1632.2	
Extrapolation	MT-walker-walk	541.7 ± 65.4	365.9± 17.7	467.5± 91.7	271.2± 75.4	229.8± 89.9	307.8± 58.9
	MT-cheetah-run	392.3 ± 32.1	311.9± 52.7	270.2± 35.5	167.2± 39.1	174.0± 45.1	196.6± 49.8
	MT-finger-spin	231.8 ± 11.5	199.7± 18.0	160.2± 17.6	135.6± 11.3	221.4± 43.0	197.1± 21.5
	MT-walker-run	170.0 ± 07.2	126.7± 13.2	156.2± 07.5	118.9± 18.2	89.7± 19.7	156.9± 12.7
	MT-finger-turn	917.3 ± 22.6	743.6± 58.3	803.5± 57.4	653.3± 56.6	335.6± 56.5	611.7± 53.6
Total	2253.1	1747.8	1857.6	1346.2	1050.5	1470.1	

Visualization of the weighted data



(a) 20 states from environments with different background



(b) 20 states from environments with different robot parameters

Limitations

- SGFD relies on stacking consecutive frames to approximate a fully observable condition
- SGFD relies on a powerful encoder model to extract the features from the high-dimensional images

Future work

- How to generalize quickly when changing features cannot be directly observed (partially observable)?
- Can feature decorrelation assist encoder training?

Thanks for your listening

Email: huangsl21@mails.jlu.edu.cn