How to Stay Curious while avoiding Noisy TVs using Aleatoric Uncertainty Estimation

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Creative Machine Learning

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Exploration with Sparse Rewards

- When the environment does not provide us with rewards we must generate our own **intrinsic** rewards[1]
- Curiosity driven learning[1] uses **surprise** as intrinsic rewards

Image Source: Wikimedia Commons

Noisy TV Problem

- Things are often **impossible** to predict that doesn't mean they are meaningfully surprising...[2]
- These are **"Stochastic Traps"** - Shyam et al.[3] or 'Noisy TVs' - Schmidhuber et al.[4]

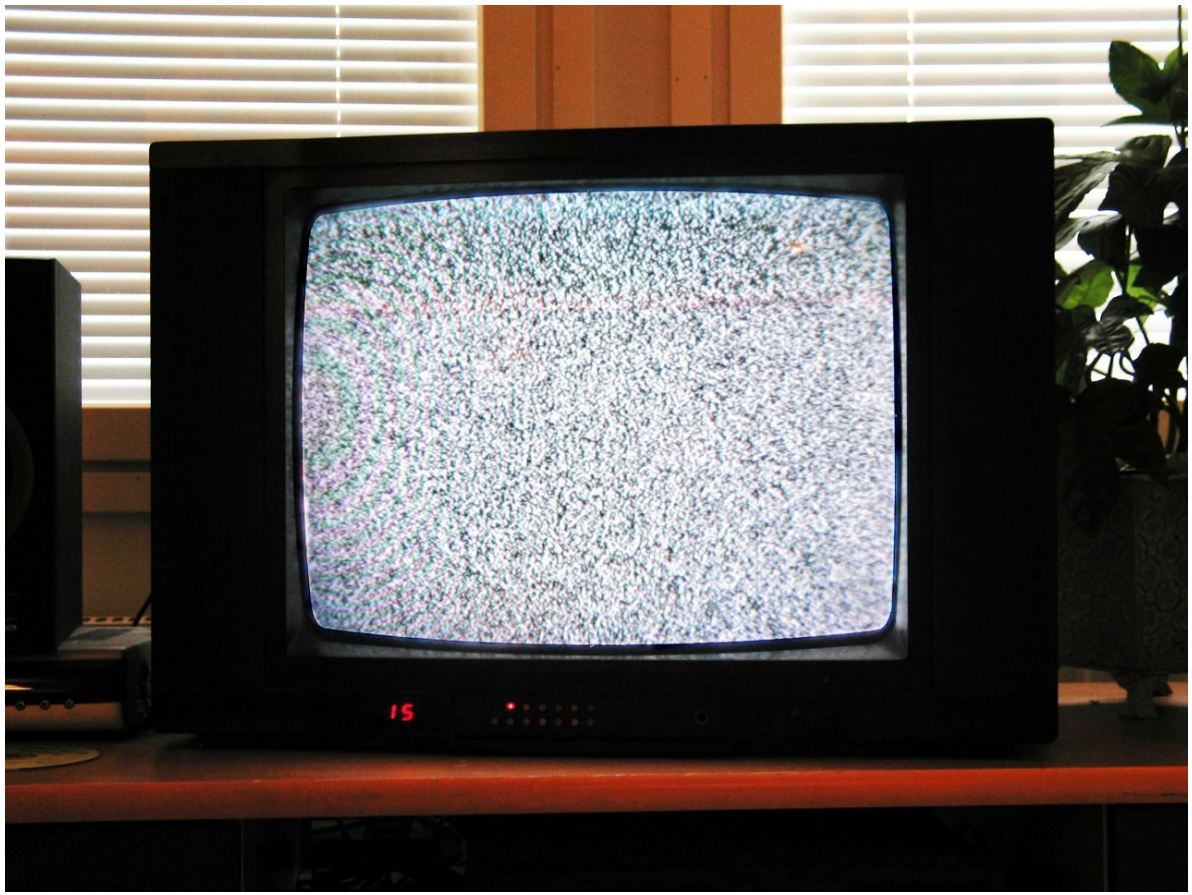
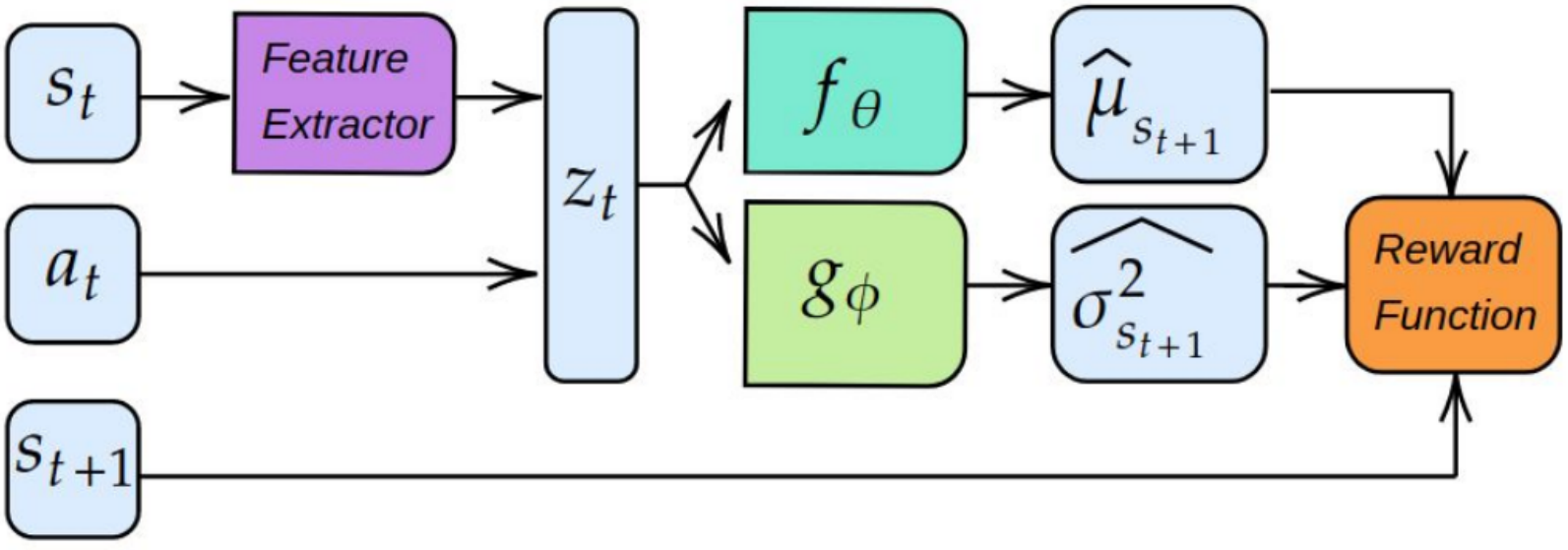


Image Source: Wikimedia Commons

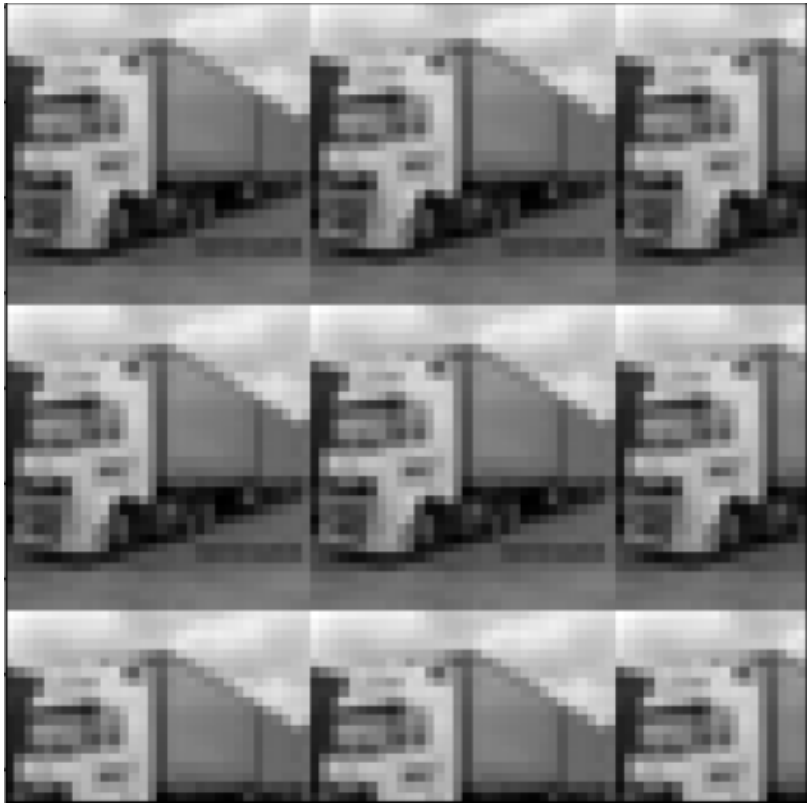
Aleatoric Mapping Agents

- Our intrinsic reward computation reduces surprise when there is high **aleatoric uncertainty**[5]
- s and a are states and actions, f and g are prediction networks for the mean and aleatoric variance of the next state



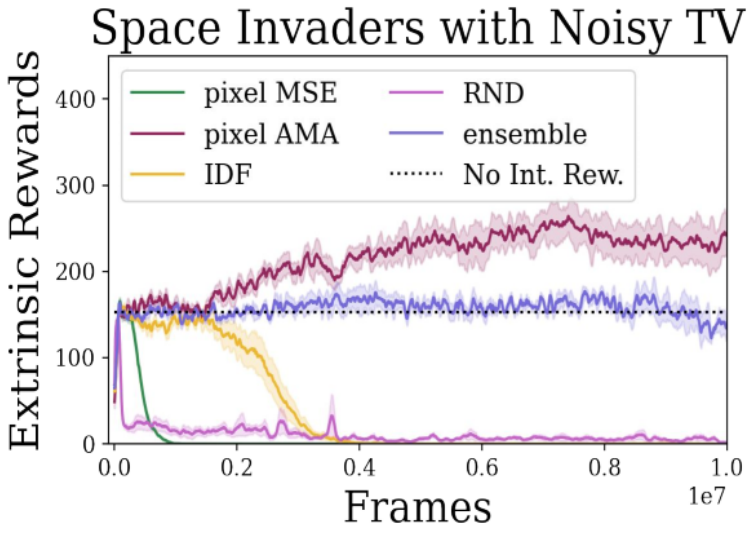
Play Retro Games or watch CIFAR-10 images?

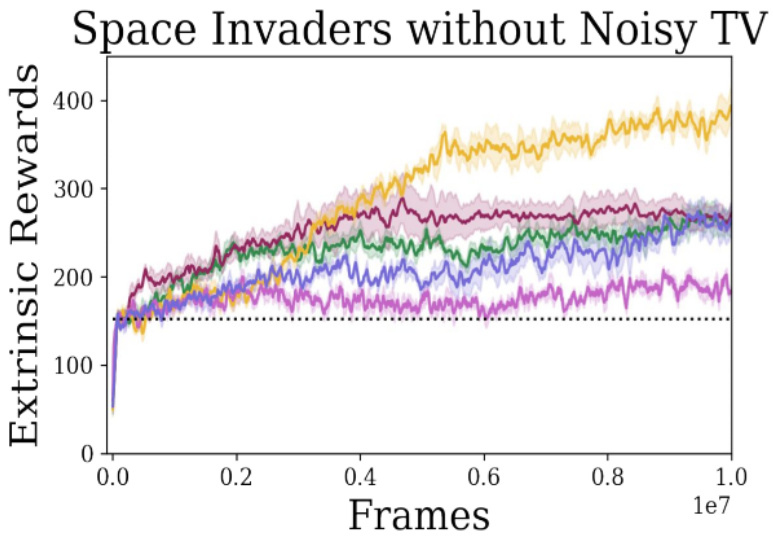
Image from gym-super-mario-bros documentation



Example CIFAR images tiled across game screen

Play Retro Games or watch CIFAR-10 images?





Takeaways

- AMAs can avoid **Noisy TVs** in curiosity driven learning
- We tested on artificial noisy TVs and isolated a natural noisy TV in Bank Heist
- This suggests a possible role for acetylcholine coding for **"expected" aleatoric uncertainties**[7]—future neuroscience research should compare the AMA model with **biological data**
- Future RL research should integrate AMA further into state of the art exploration algorithms and investigate how frequently Noisy TVs appear in real world applications

References

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7 - Angela, J.Y. and Dayan, P., 2005. Uncertainty, neuromodulation, and attention. Neuron, 46(4), pp.681-692.