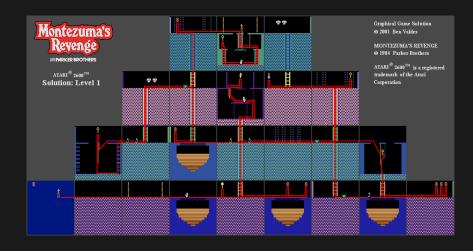


Montezuma's Revenge



Montezuma's Revenge



- very sparse rewards hundrets of steps
- huge state space
- hard exploration
- needs returns back

state of the art score

source: https://paperswithcode.com/sota/ atari-games-on-atari-2600-montezumas-revenge

year	name	score
2015	Deep Reinforcement Learning with Double Q-learning	0
2017	Curiosity-driven Exploration by Self-supervised Prediction ^a	0
2021	MuZero	2500
2018	Count-Based Exploration with Neural Density Models b	3705
2019	Exploration by Random Network Distillation ^c	8152

requires environment state saving/loading

GoExplore* d

2021

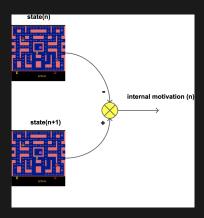
43 000

^ahttps://arxiv.org/abs/1705.05363 ^bhttps://arxiv.org/abs/1703.01310

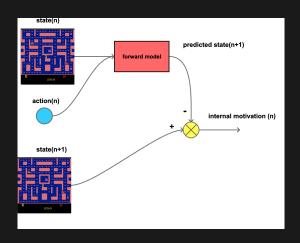
^chttps://arxiv.org/abs/1810.12894

dhttps://arxiv.org/abs/2004.12919

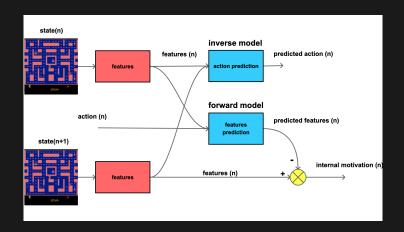
pixel change motivation

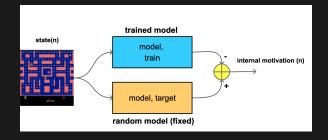


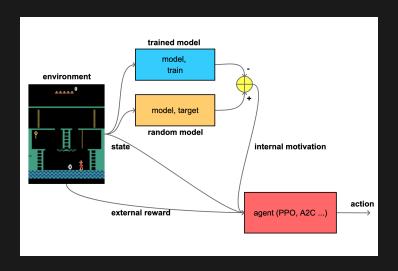
next state prediction

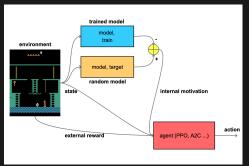


intrinsic curiosity module



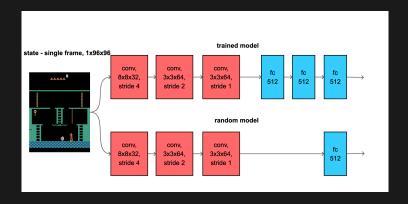




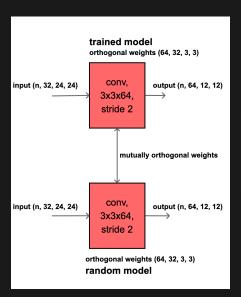


- neural network works as novelty detector
- model learns to imitate random (target) model
- less visited states produce bigger motivation signal
- orthogonal weights initialisation $(g = 2^{0.5})$ for strong signal
- lot of fully connected layers to avoid generalisation
- coupled orthogonal models

random network distillation architecture



coupled RND architecture

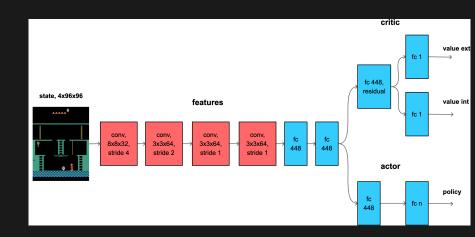


```
def coupled_ortohogonal_init(shape, gain):
    w = torch.zeros((2*shape[0], ) + shape[1:])
    torch.nn.init.orthogonal_(w, gain)

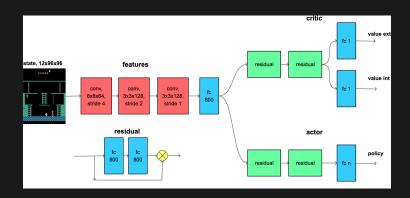
    w = w.reshape((2, ) + shape)
    return w[0], w[1]

wa, wb = coupled_ortohogonal_init((64, 32, 3, 3), 2.0**0.5)
```

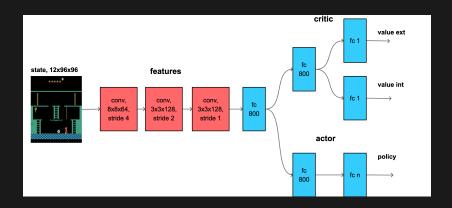
ppo model architecture A



ppo model architecture B



ppo model architecture C



loss

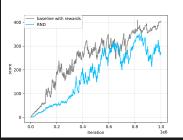
TODO

experiments

- Breakout, without rewards
- Pacman, without rewards
- Montezuma's rewenge (tons of experiments)

breakout

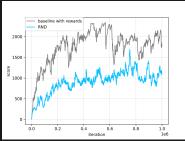




- 1M, 32parallel envs, total 32M steps
- PPO model A
- ext reward weight 2.0
- int reward weight 1.0

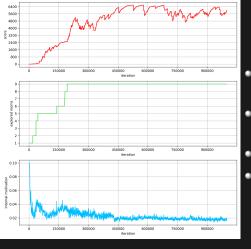
pacman





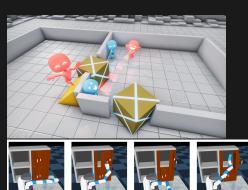
- 1M, 32parallel envs, total 32M steps
- PPO model A
- ext reward weight 2.0
- int reward weight 1.0

results



- 1M steps 20% of original paper
- 128 parallel envs = total128M steps
- score 6400
- 9 rooms explored

Emergent Tool Use From Multi-Agent Autocurricula



- multi-agent robotic environment
- hide and seek
- https:
 //openai.com/blog/
 emergent-tool-use/

https://arxiv.org/abs/1909.07528

Q&A



Michal CHOVANEC, PhD