Cell-Free Latent Go-Explore

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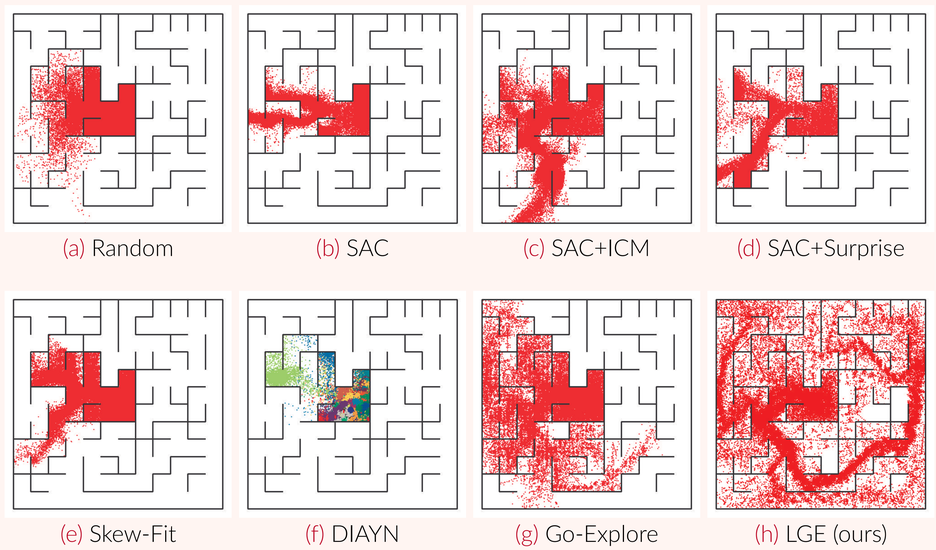
LGE in a Nutshell

- LGE is a new **exploration algorithm** that **generalizes Go-Explore**.
- It operates **without reward**, and is meant to be used as a pre-training.
- It **drops cells** in favor of **learned latent representation**. Representation learning methods used: (1) Inverse dynamic (2) Forward dynamic (3) Vector Quantized Variational Autoencoder (VQ-VAE)
- It estimates latent visitation density using a particle-based entropy estimator.
- It samples **goals in areas of low latent density**, following a geometric law on rank in latent density sorting R_i: $\mathbb{P}(G = s_i) = (1-p)^{R_i - 1} p$
- It selects **intermediate subgoals** based on previous experience to assist the agent in pursuing distant goals, ensuring an sufficient latent distance from the previous subgoal according to a predetermined threshold.
- LGE **outperforms SOTA** algorithms in various hard-exploration environments.



(a) Random (b) SAC (c) SAC+ICM (d) SAC+Surprise

(e) Skew-Fit (f) DIAYN (g) Go-Explore (h) LGE (ours)

Figure 1. Space coverage after 100k timesteps

Links

arXiv

```python
from sb3_contrib import QRDQN
from lge import LatentGoExplore

lge = LatentGoExplore(QRDQN, "MontezumaRevengeNoFrameskip-v4")
lge.explore(total_timesteps=1_000_000)
```

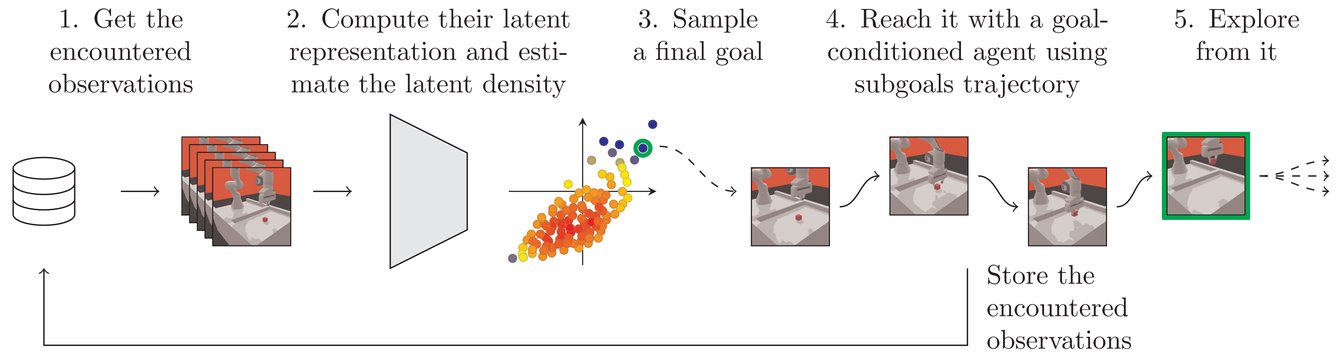


Figure 2. LGE exploration workflow. The encountered observations are encoded in a latent space. A latent density is estimated. A final goal is sampled from the states already reached, by skewing the distribution with the density. A goal-conditioned agent is trained to reach this goal by pursuing a sequence of subgoals, derived from the experiment that led to the final goal. Once the agent has reached the final goal, it explores from it with any exploration strategy.

Experiments and Results

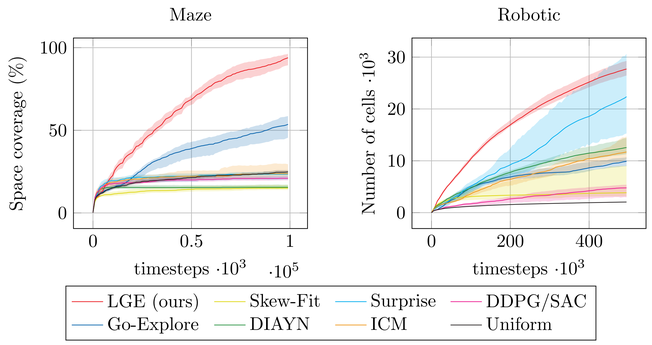


Figure 3. Exploration results for maze and robotic environments

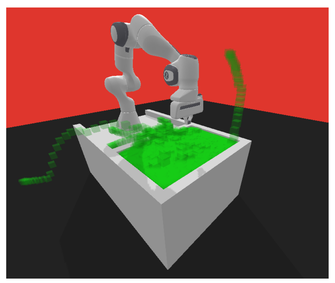


Figure 4. After a few steps, and without any reward, LGE learned to move the cube all over the table and even grab it to lift it.

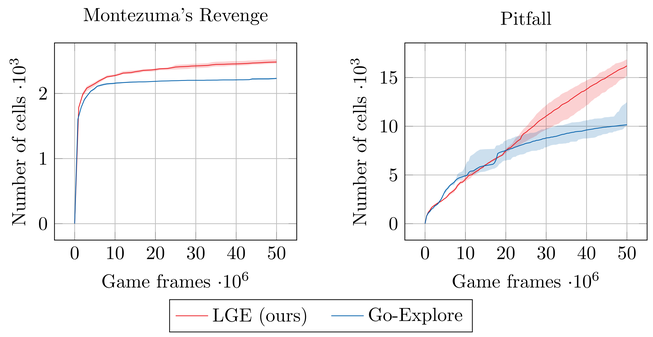


Figure 5. Exploration results for Atari's hardest exploration environments

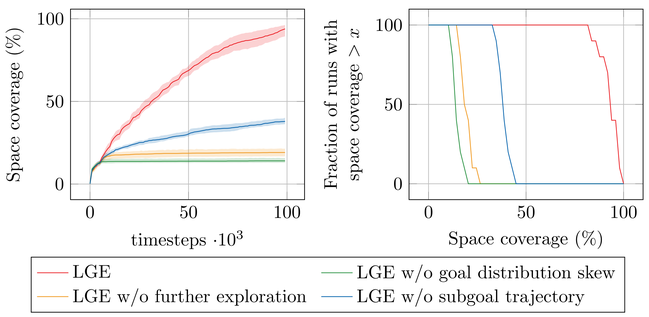


Figure 6. Ablation study (Maze)