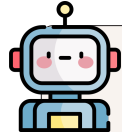
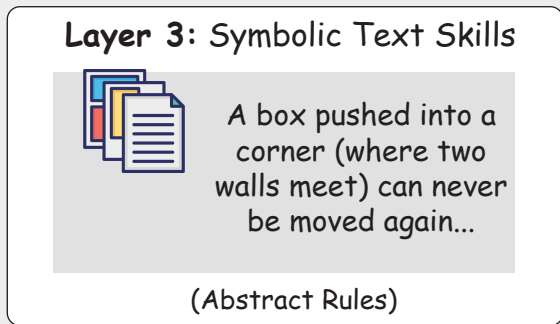
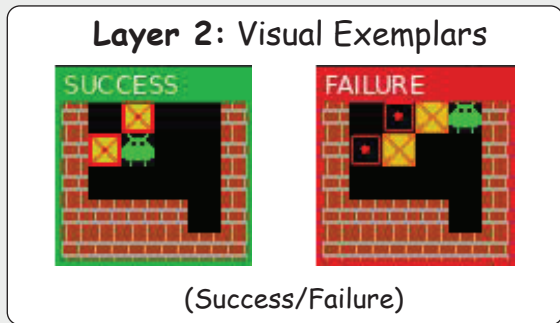
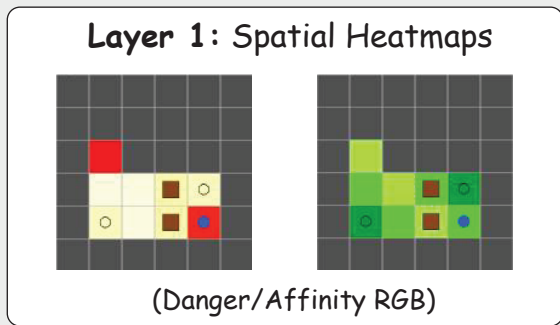


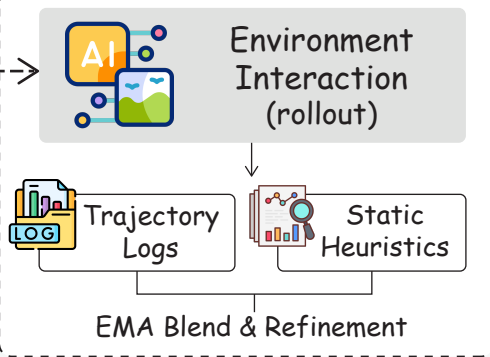
(a) Three-Layer Visual Memory (VSM)



VLM Prompt&Policy

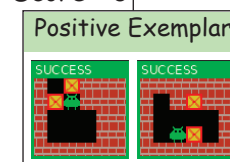
(b) Teacher-Free Visual Atlas Evolution

Action



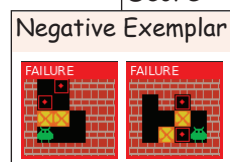
Episode Screenshots

Score > 0



Success → replicate this outcome

Score < 0



Failure → avoid this case

Label Sample

(c) Atlas-Grounded Dense Visual Reward Shaping



**Danger Penalty**

$$r_{\text{danger}} = -\text{DangerMap}$$

+



**Affinity Gain**

$$r_{\text{affinity}} = \text{Delta}(\text{AffinityMap})$$

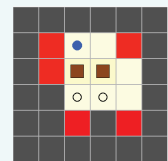
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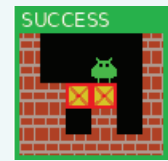
**Augmented Reward**

Sparse + Dense

Dense Reward Shaping



Heatmaps



Exemplars

Evolved Visual Atlas

Update VSM (Self-Evolution)

Refresh Heatmaps



Add Exemplars



Policy Optimization

Augmented Reward

$r_{\text{visual}} + r_{\text{env}}$

(d) Optimization