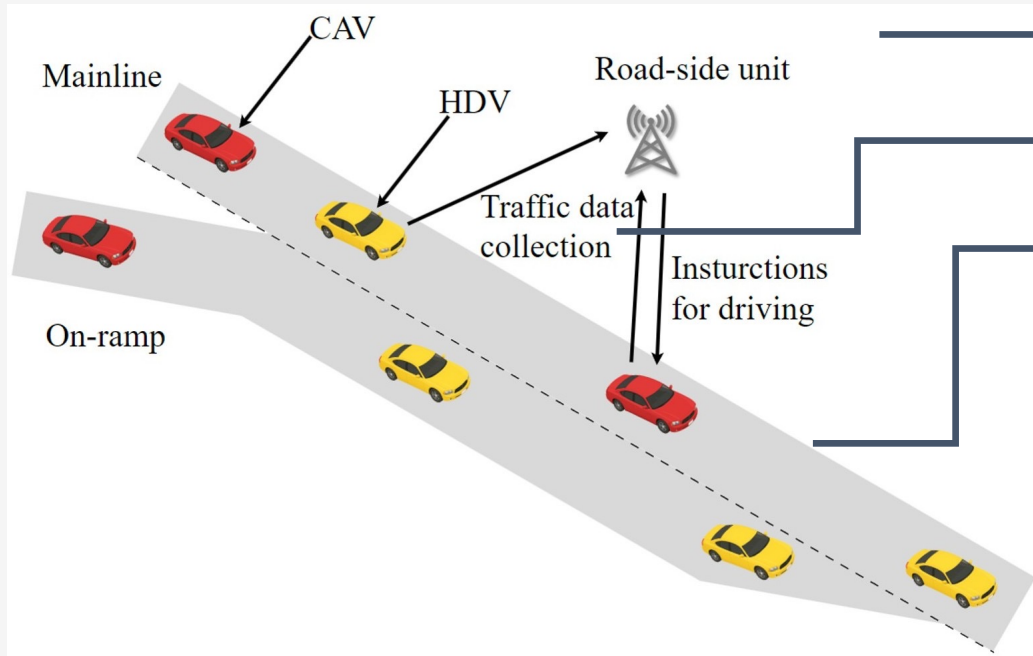

LLM-Driven Composite Neural Architecture Search for Multi-Source RL State Encoding

**Yu Yu, Qian Xie, Junping Li, Aghamatlab Akbarzade,
Nairen Cao, Li Jin**

The background of the slide is a light gray line drawing of a traditional Chinese gate. The gate has a large, ornate roof with multiple ridges and decorative elements. It is flanked by two stone pillars topped with lanterns. In front of the gate are two stone lion statues (shishi) on pedestals. The entire scene is rendered in a minimalist, sketch-like style.

Introduction



Temporal Context

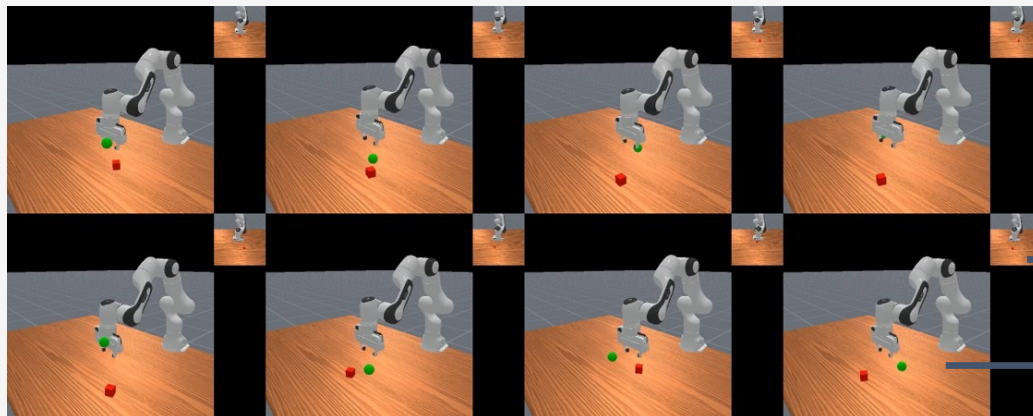
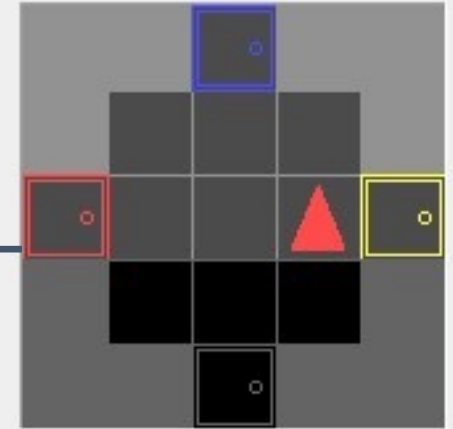
Traffic State

Sequence History

Text Information

Image Observation

Mission: go to the red door

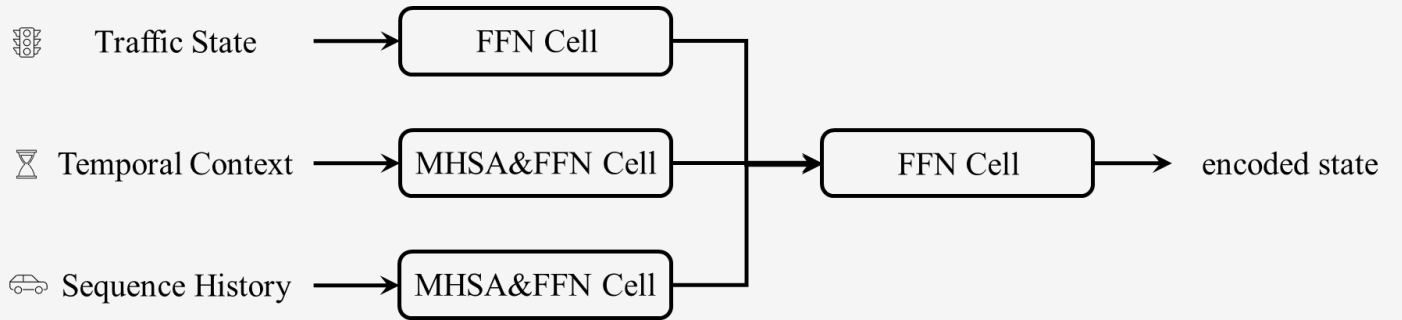


State Information

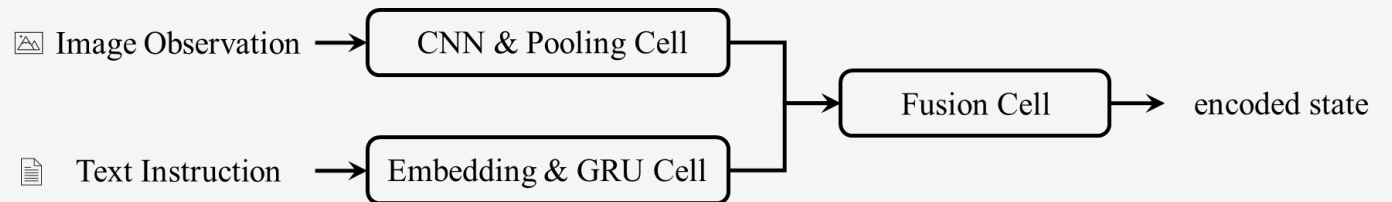
RGB Observation

Multi-Source RL State Encoding

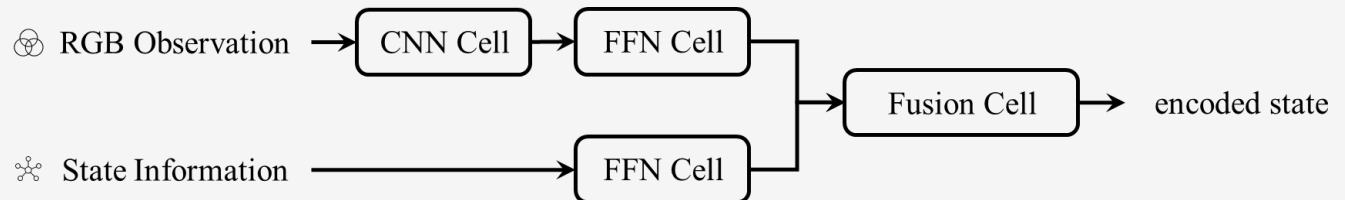
Mixed-autonomy traffic control



MiniGrid goal-oriented tasks



ManiSkill robotic control



 Designing state encoders for multi-source-RL remains underexplored.

Composite Neural Architecture Search

NAS for supervised learning

Neural architecture

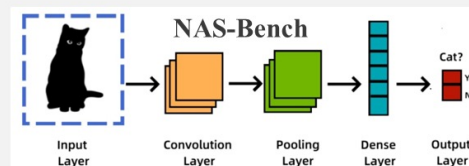


Black-box function
(Supervised learning)



Performance metric

CNN config



Validation accuracy

Multi-source state

Composite neural architecture



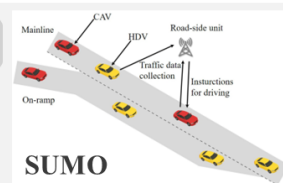
Black-box function
(RL training & evaluation)



Performance metric

traffic state temporal context sequence history

FFN & Transformer config

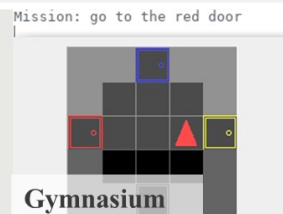


Mixed-autonomy traffic control

Average speed

image observation text instruction

CNN & GRU config

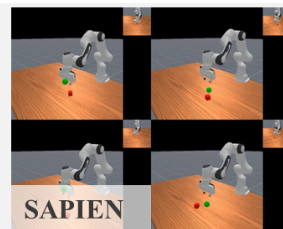


MiniGrid goal-oriented tasks

Average return

RGB observation state information


CNN & FFN config



ManiSkill robotic control

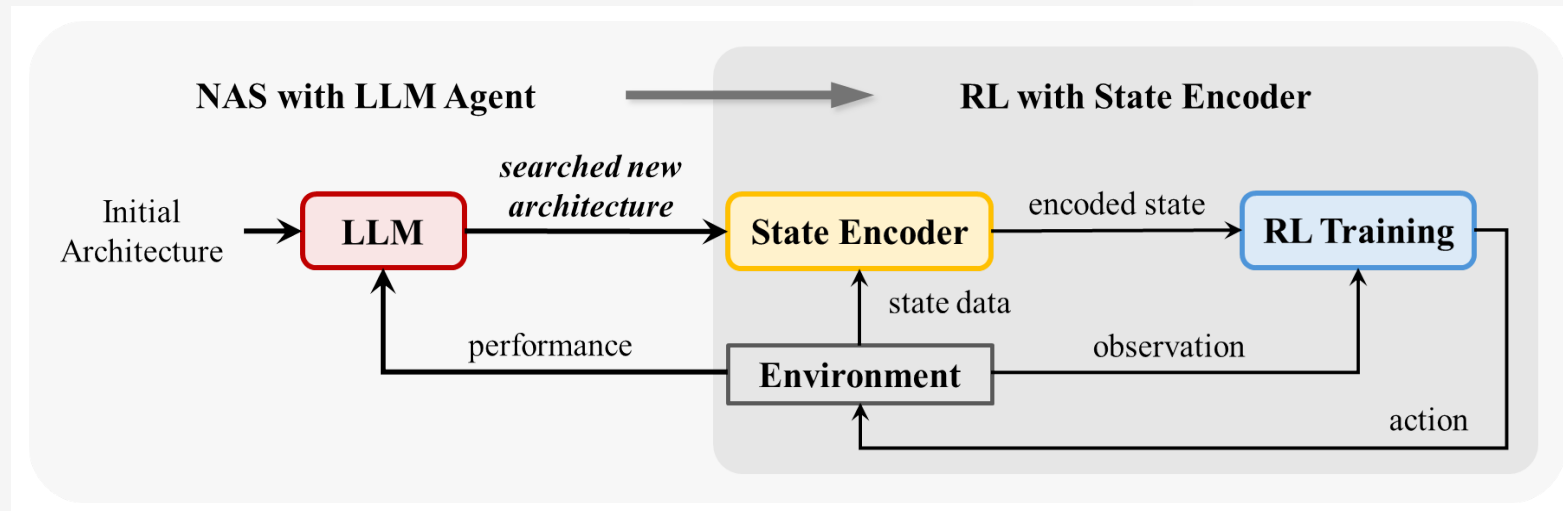
Success rate

NAS for multi-source RL state encoding

-  Unlike supervised learning, multi-source RL requires composite NAS.

LACER: An LLM → State Encoder → RL Pipeline

LLM-driven Neural Architecture Search for Composite State Encoders in RL



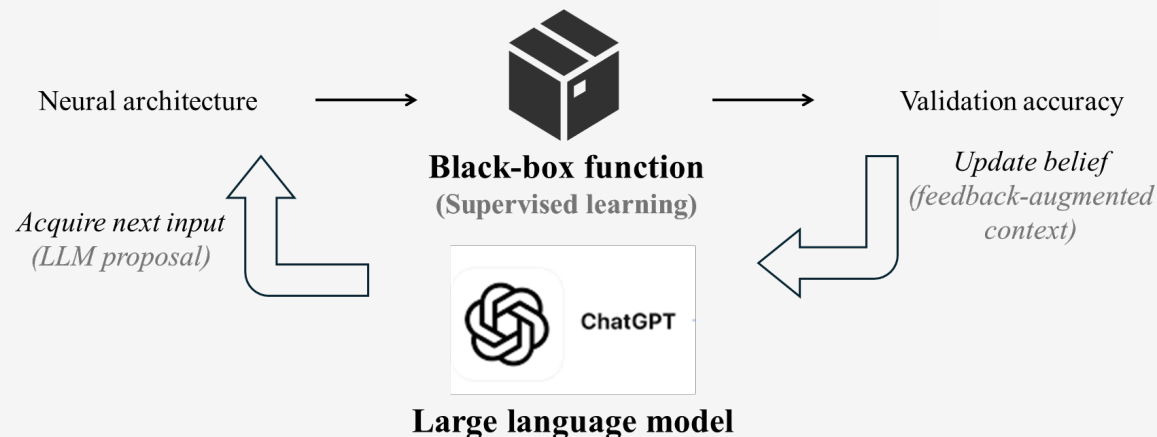
Module-specific search space

Table 1: Module-specific search spaces where bold values denote the configurations used by the Expert baseline.

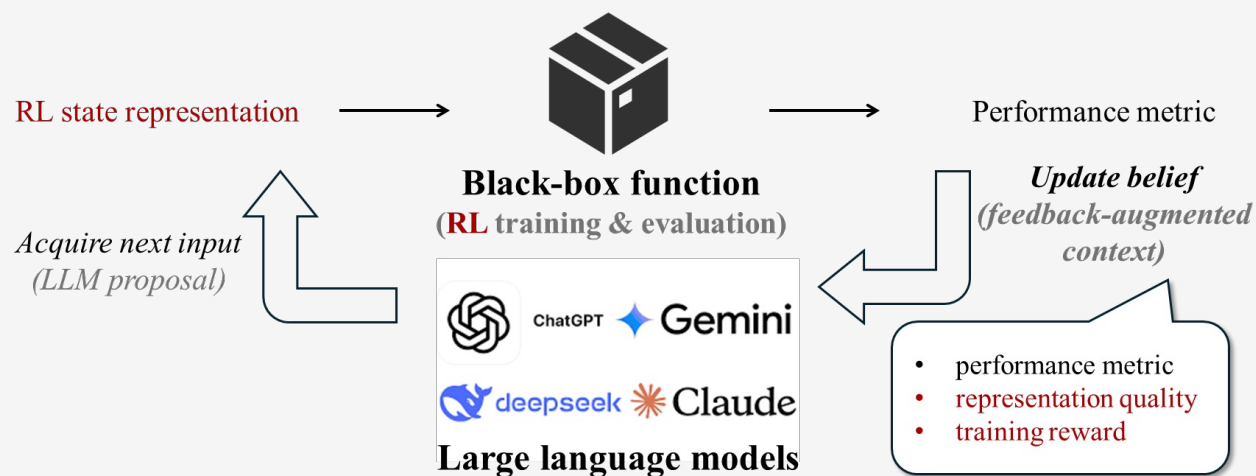
Module	Operation	Heads / Activation	Dimension	Ratio	Depth
Time	MHSA, FFN	{ 2 , 4, 8}	{ 8 , 16, 32}	{1, 2 , 4}	{1, 2 , 3}
Traffic	FFN	{ relu , gelu, swish}	{16, 32 , 64}	{ 1 , 2, 4}	{ 1 , 2, 3}
Sequence	MHSA, FFN	{2, 4 , 8}	{8, 16 , 32}	{1, 2 , 4}	{1, 2 , 3}
Fusion	FFN	{ relu , gelu, swish}	{64, 128 , 256}	{ 1 , 2, 4}	{ 1 , 2, 3}

Pipeline comparison

GENIUS (existing LLM-based NAS)



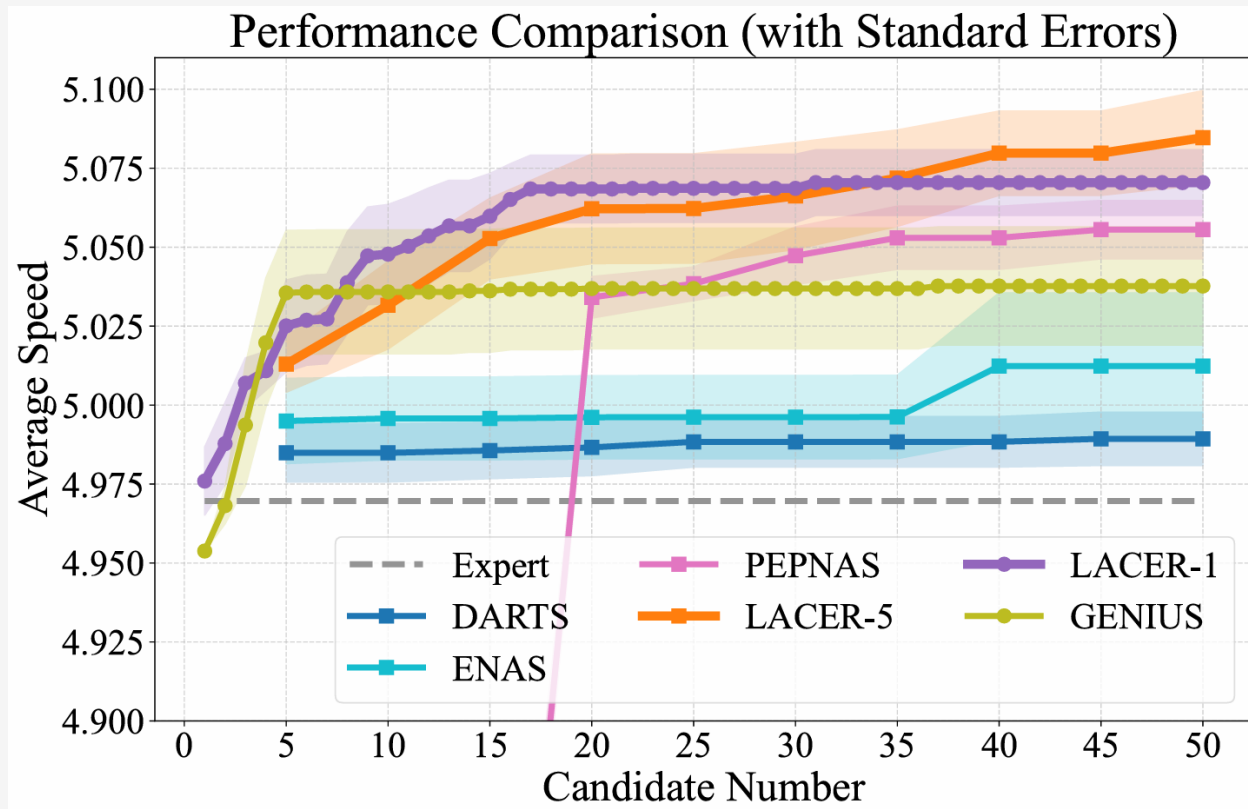
LACER (ours)



Exploit side info on source-specific encoders beyond performance metric.

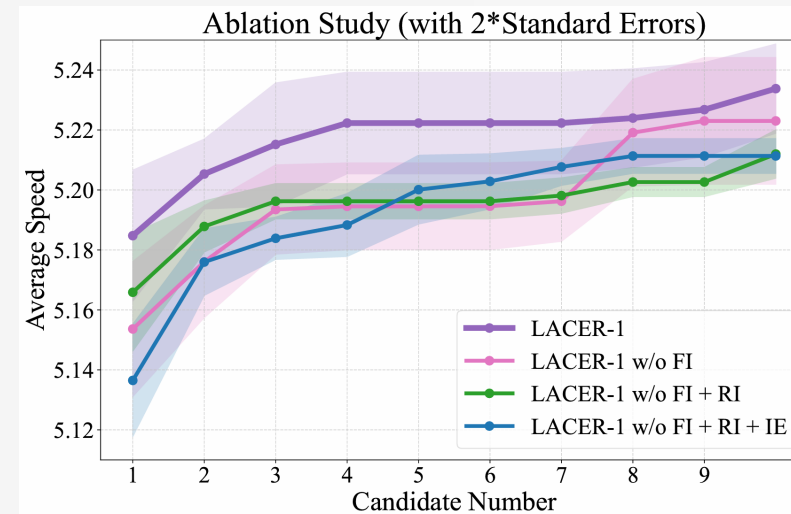
Results

Comparison between LACER and baselines

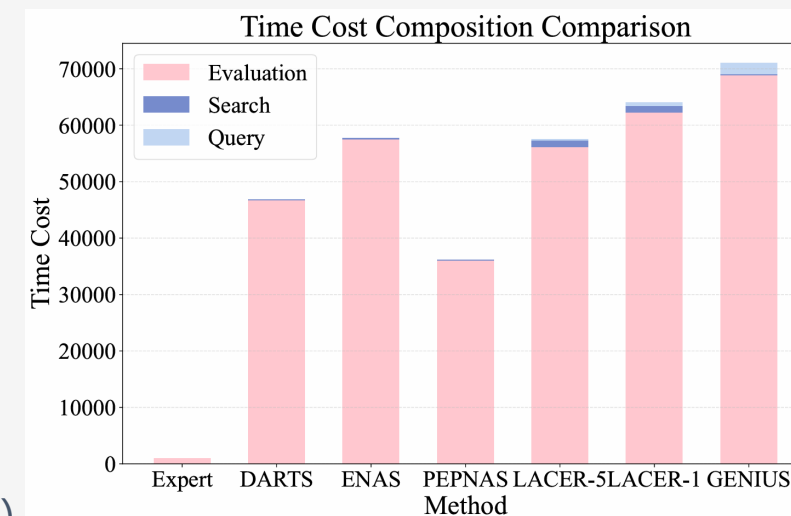


LACER-5 denotes the batch variant (5 candidates per iteration).

Ablation studies



Computation time



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