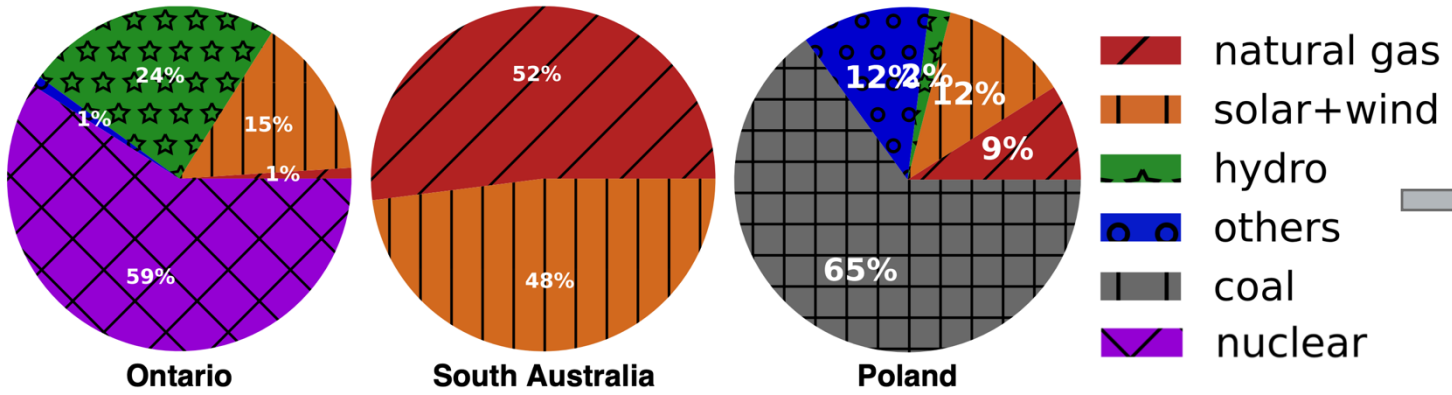
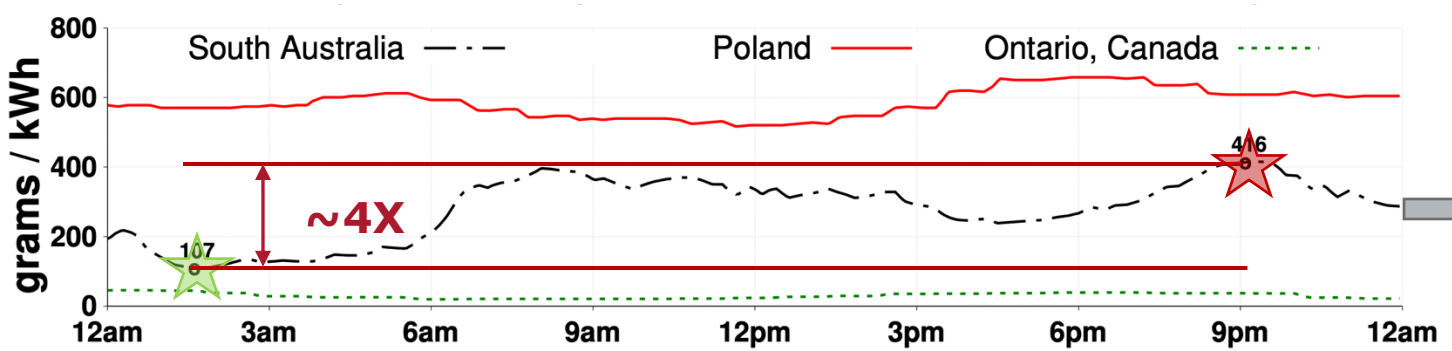
CE-NAS: An End-to-End Carbon-Aware Neural Architecture Search Framework

Statistics of Carbon Emissions[1]



Varying mix of generator in different regions



Hourly carbon emissions vary by 4x over a single day

1. Enabling Sustainable Clouds: The Case for Virtualizing the Energy System. Noman Bashir, Tian Guo, Mohammad Hajiesmaili, David Irwin, Prashant Shenoy, Ramesh Sitaraman, Abel Souza, Adam Wierman. ACM Symposium on Cloud Computing 2021.

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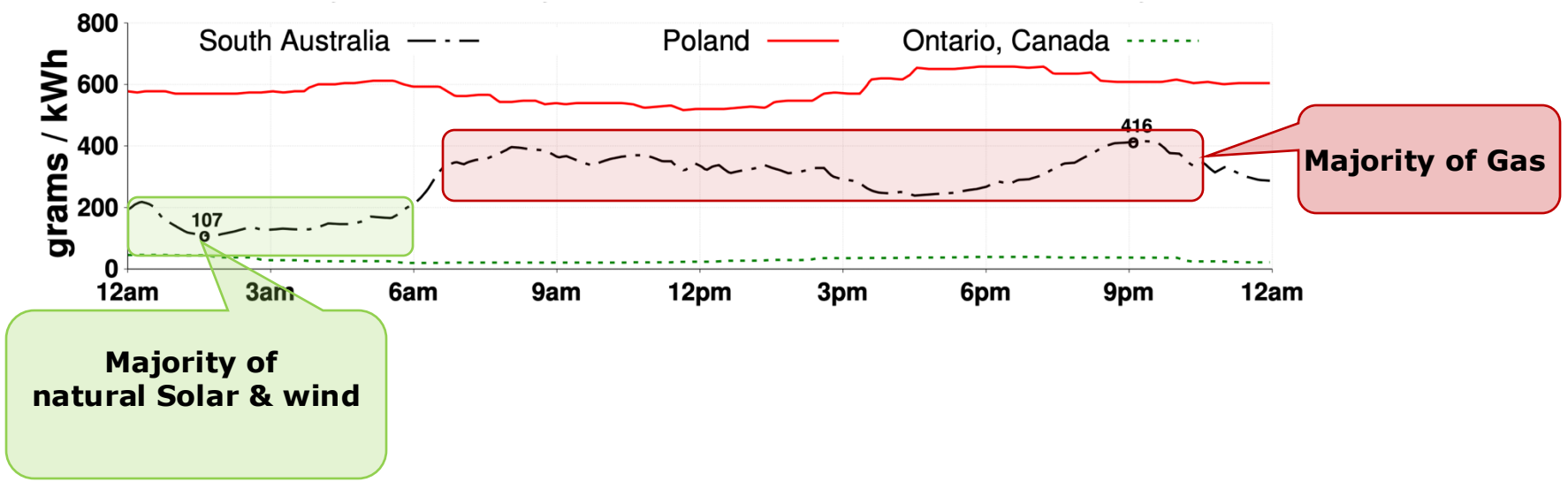

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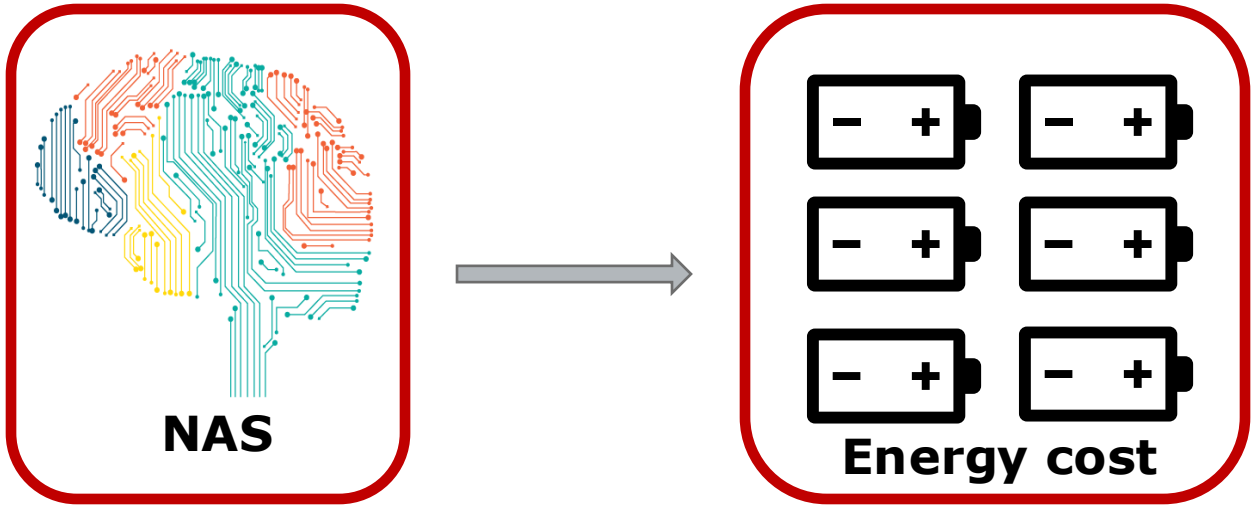
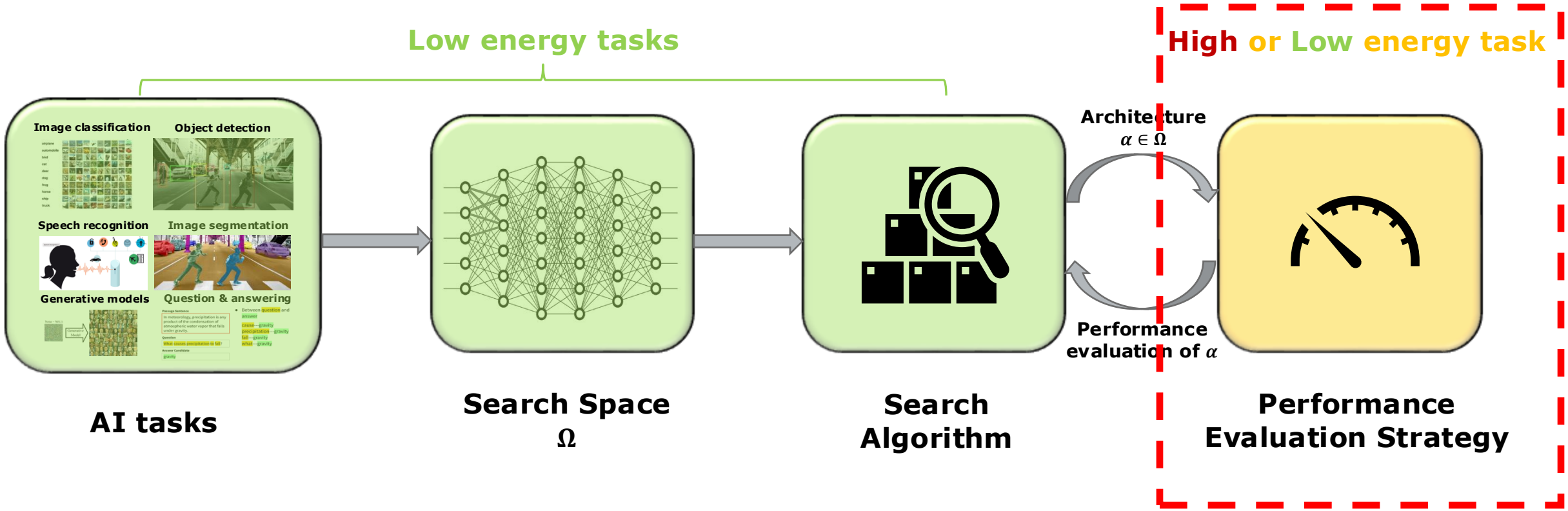
Problem Statement



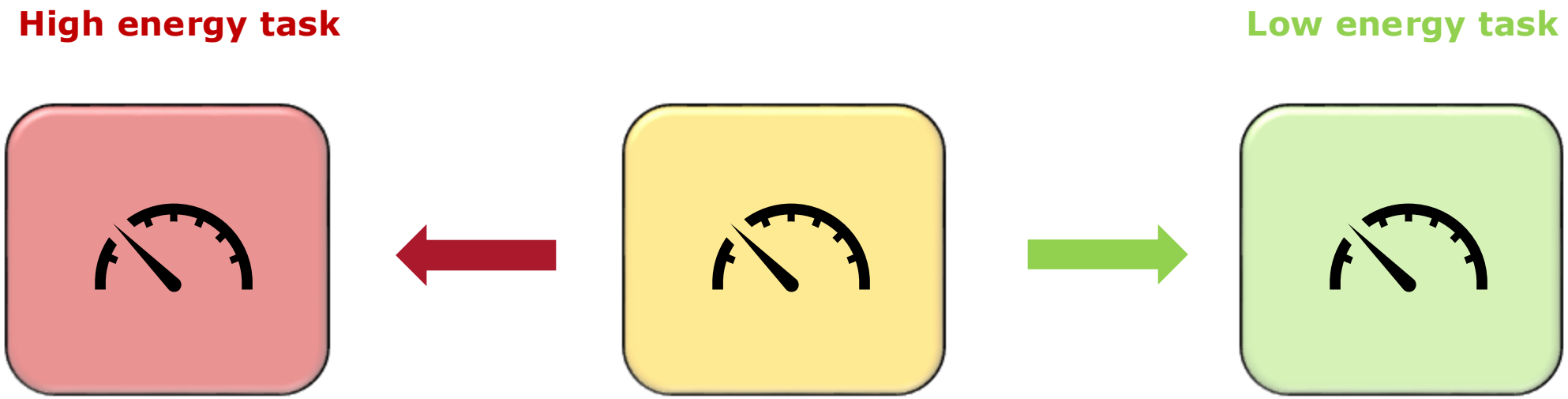
NAS can be energy consuming

But not all NAS steps are equally energy consuming, and different NAS strategies will also have different energy requirements

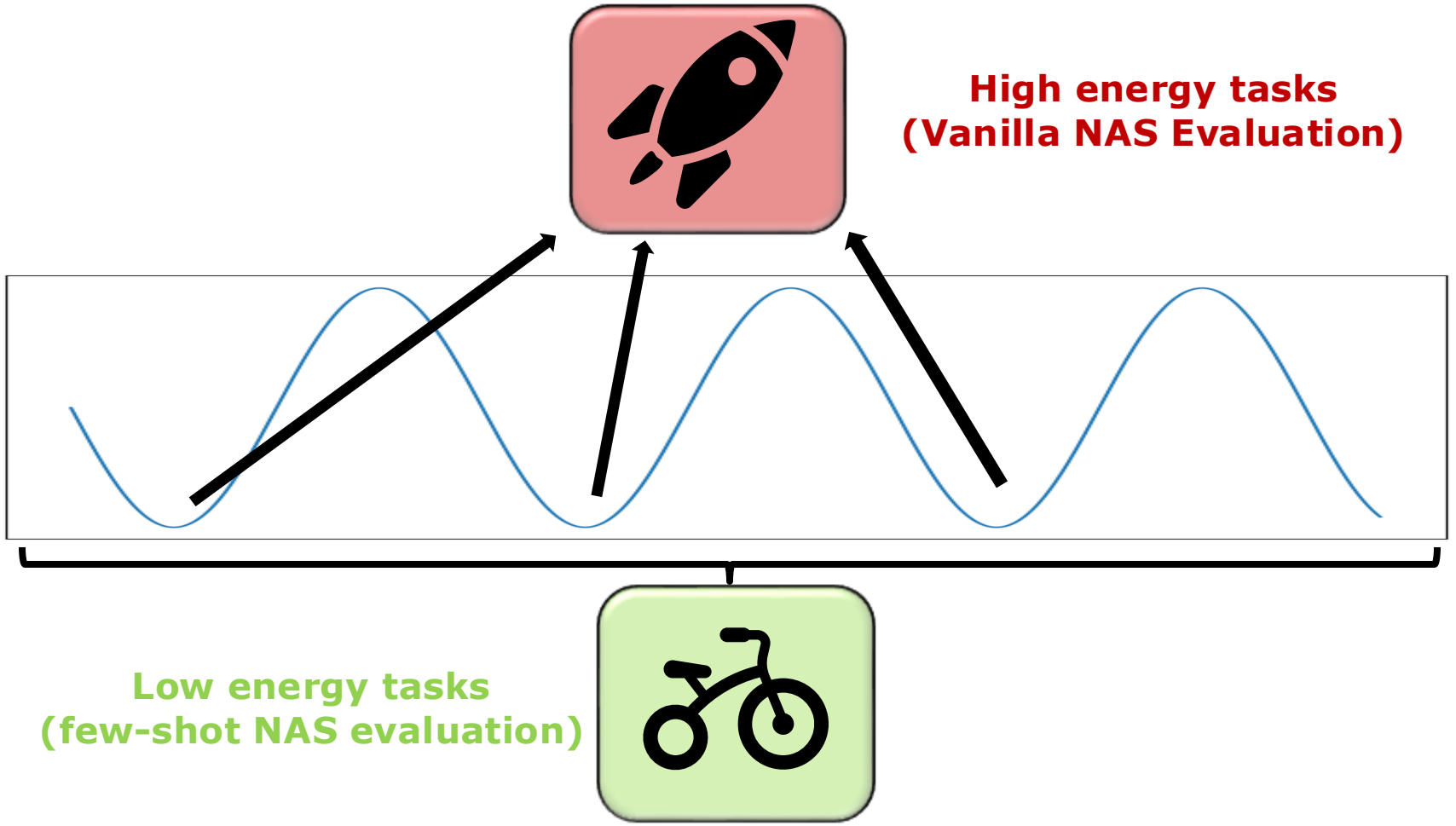
Task Energy Requirement Disparity



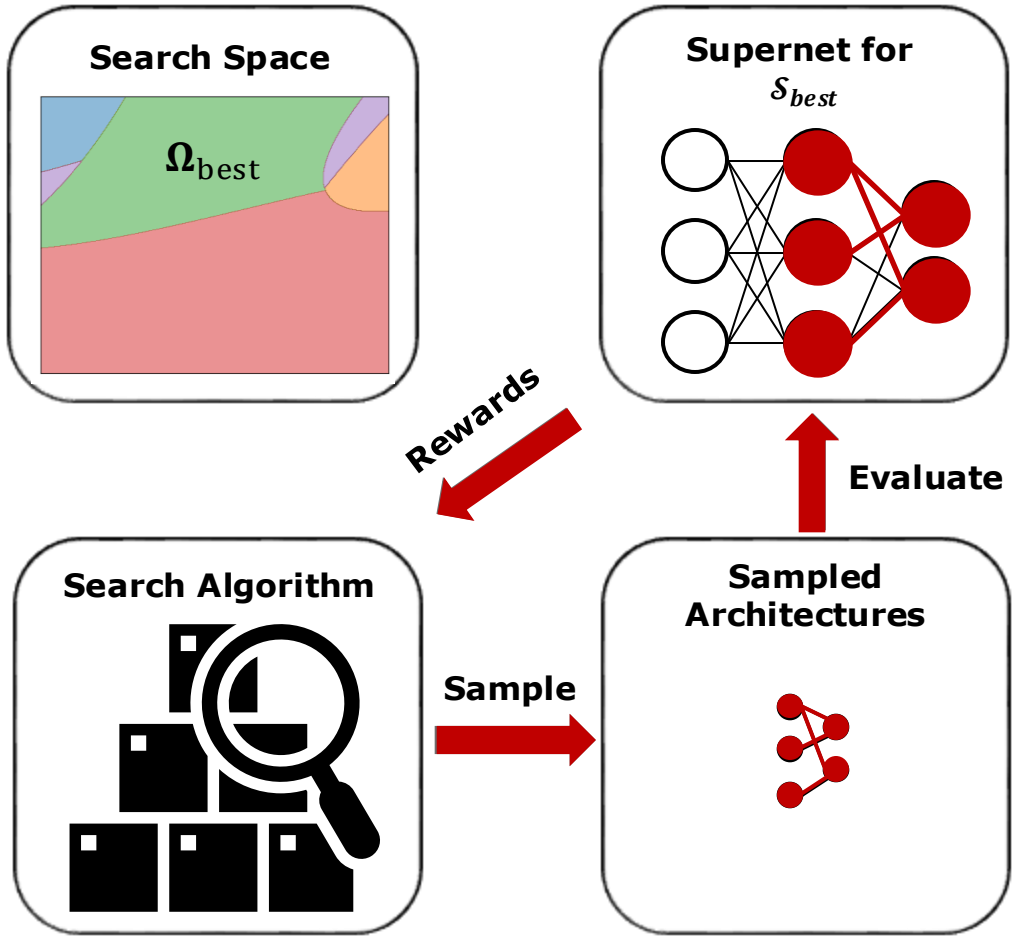
Evaluation Energy Requirement Disparity



Our Key Idea


High energy tasks
(Vanilla NAS Evaluation)
CO_2 emissions
with the same
energy intensity
Low energy tasks
(few-shot NAS evaluation)

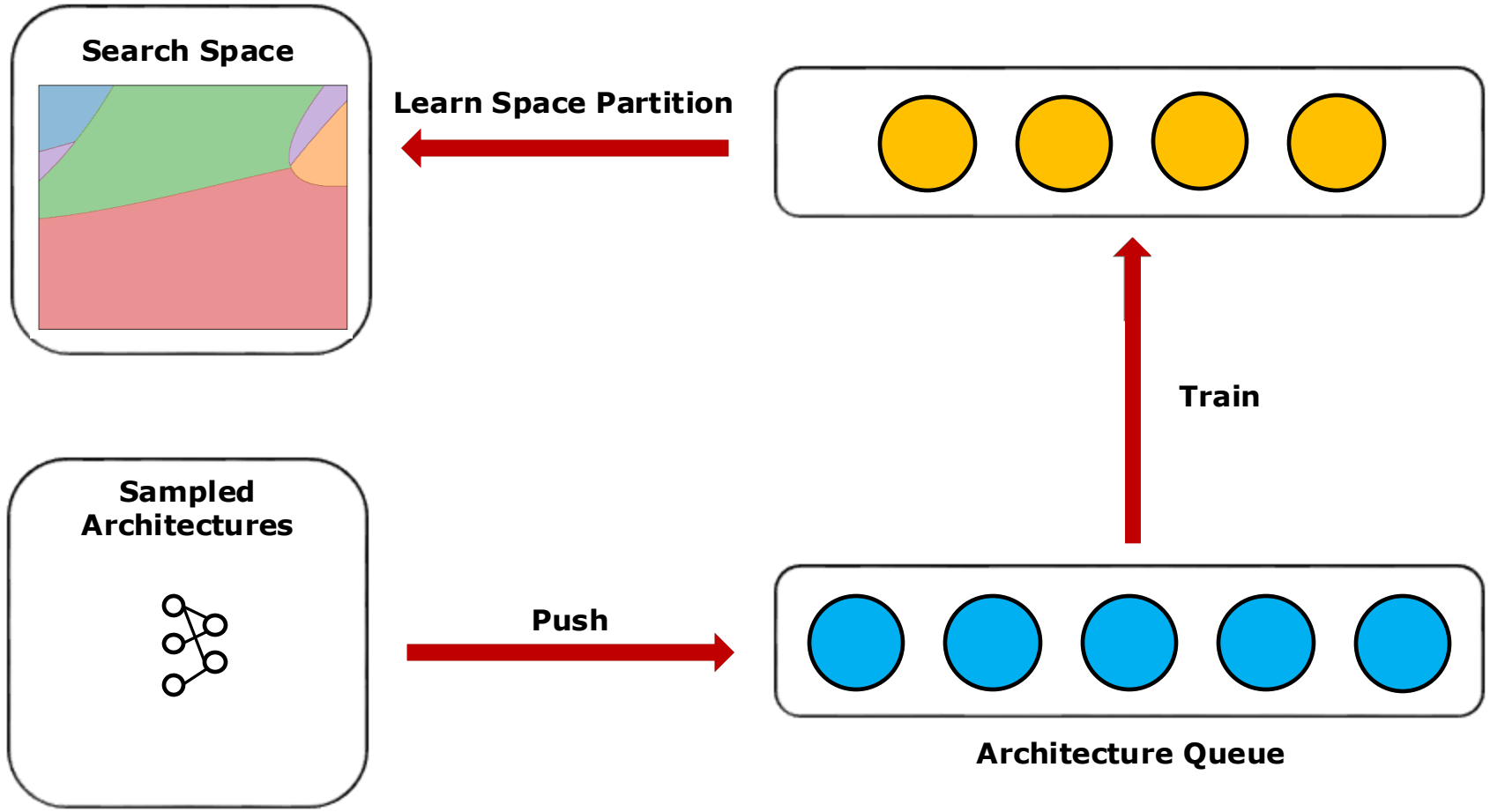
Low Energy Component



Low energy component in our NAS framework, will run during the high carbon periods

Low energy Component

High Energy Component

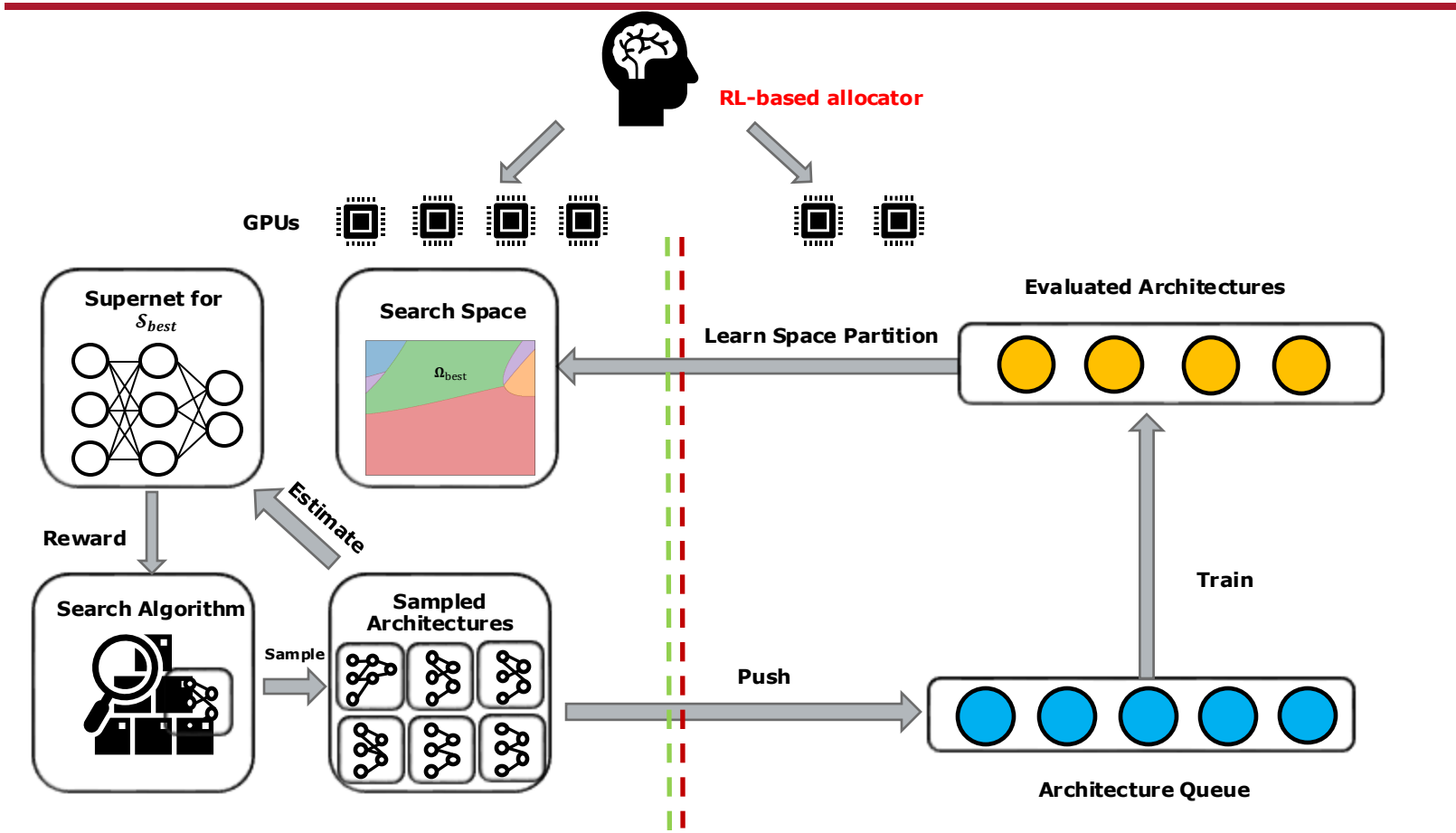


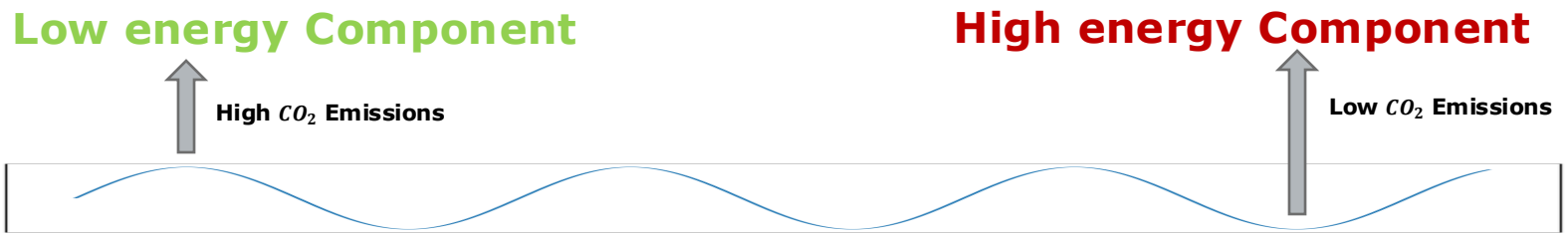
[Multi-objective Optimization by Learning Space Partitions]

High energy component in our NAS framework, will run during the low carbon periods

High energy Component

How to allocate GPU resource





Reinforcement learning(RL)-based allocation method

Reinforcement Learning -- State

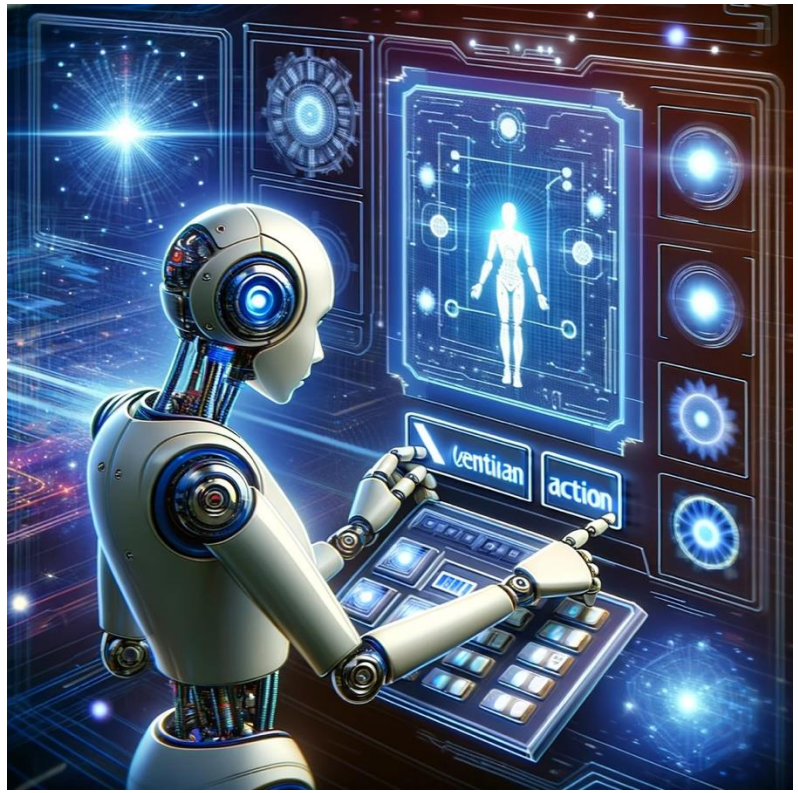
Trace Forecasting

Carbon Budget

Searched Architecture

Hypervolume

Reinforcement Learning -- Action



RL agent

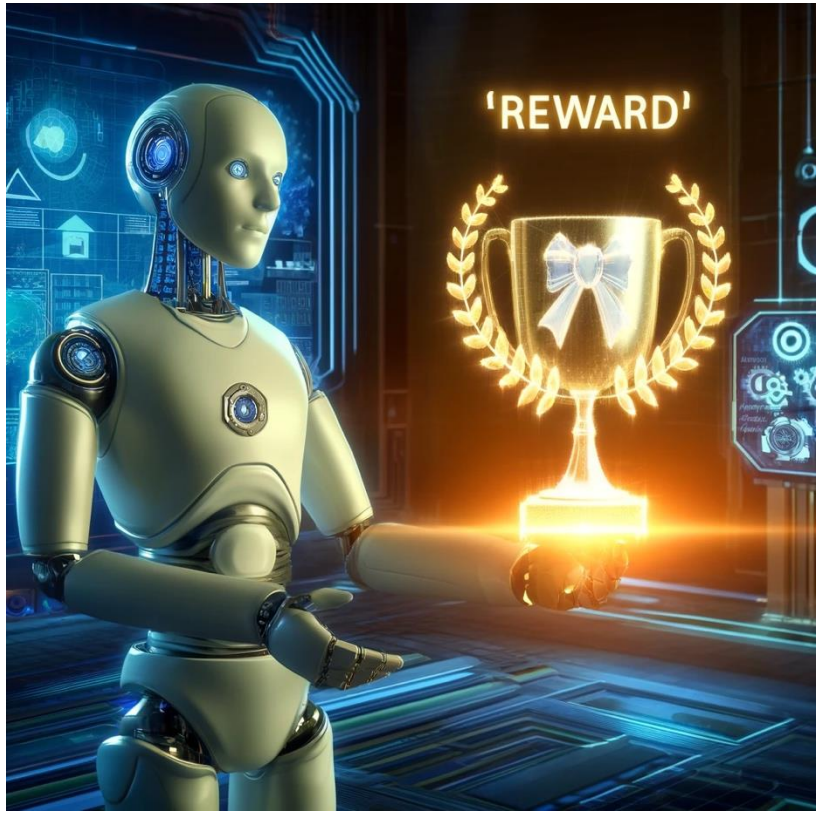
Ratio calculation

GPUs

High energy tasks

Low energy tasks

Reinforcement Learning -- Reward

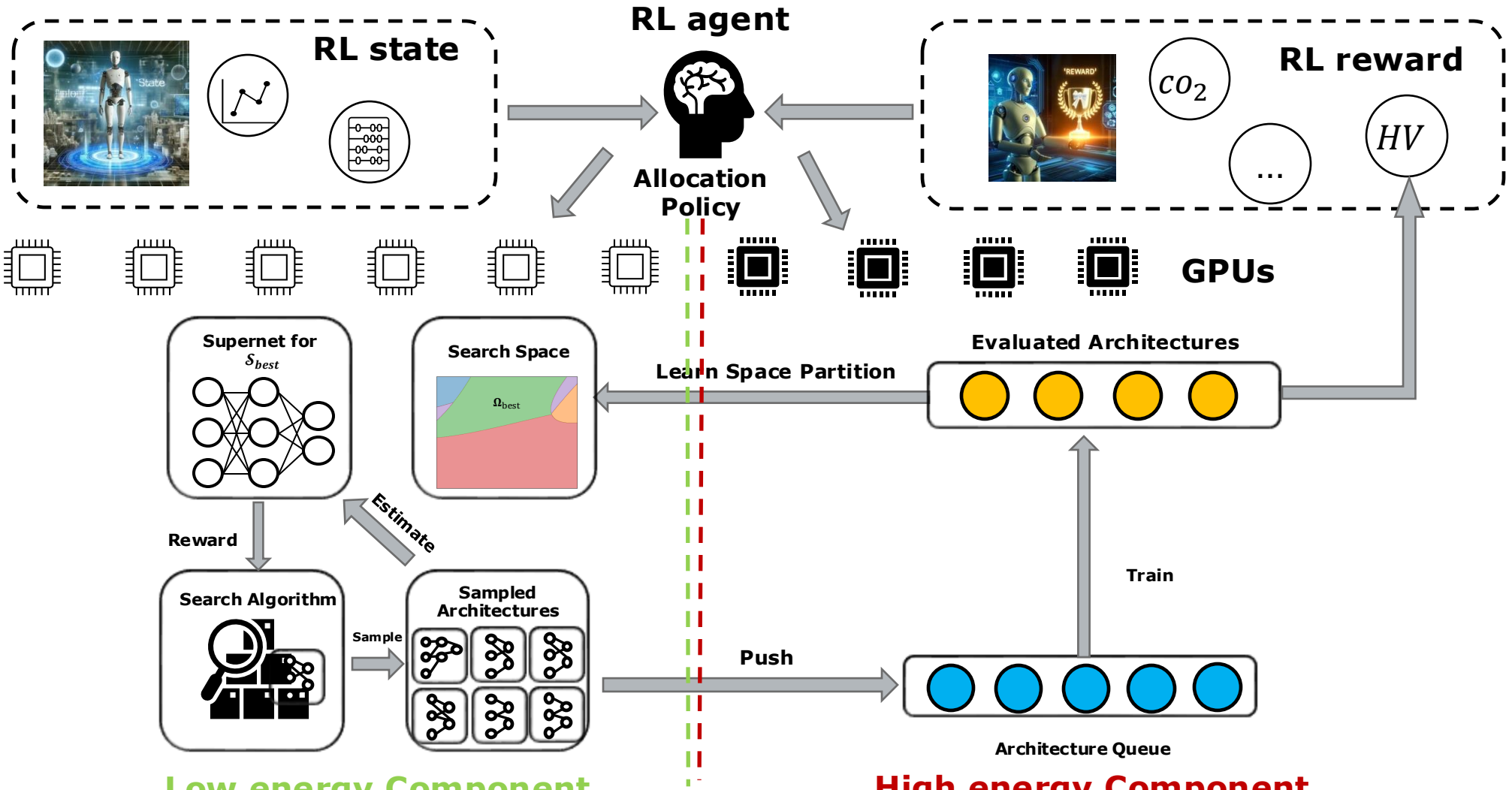


Carbon Cost

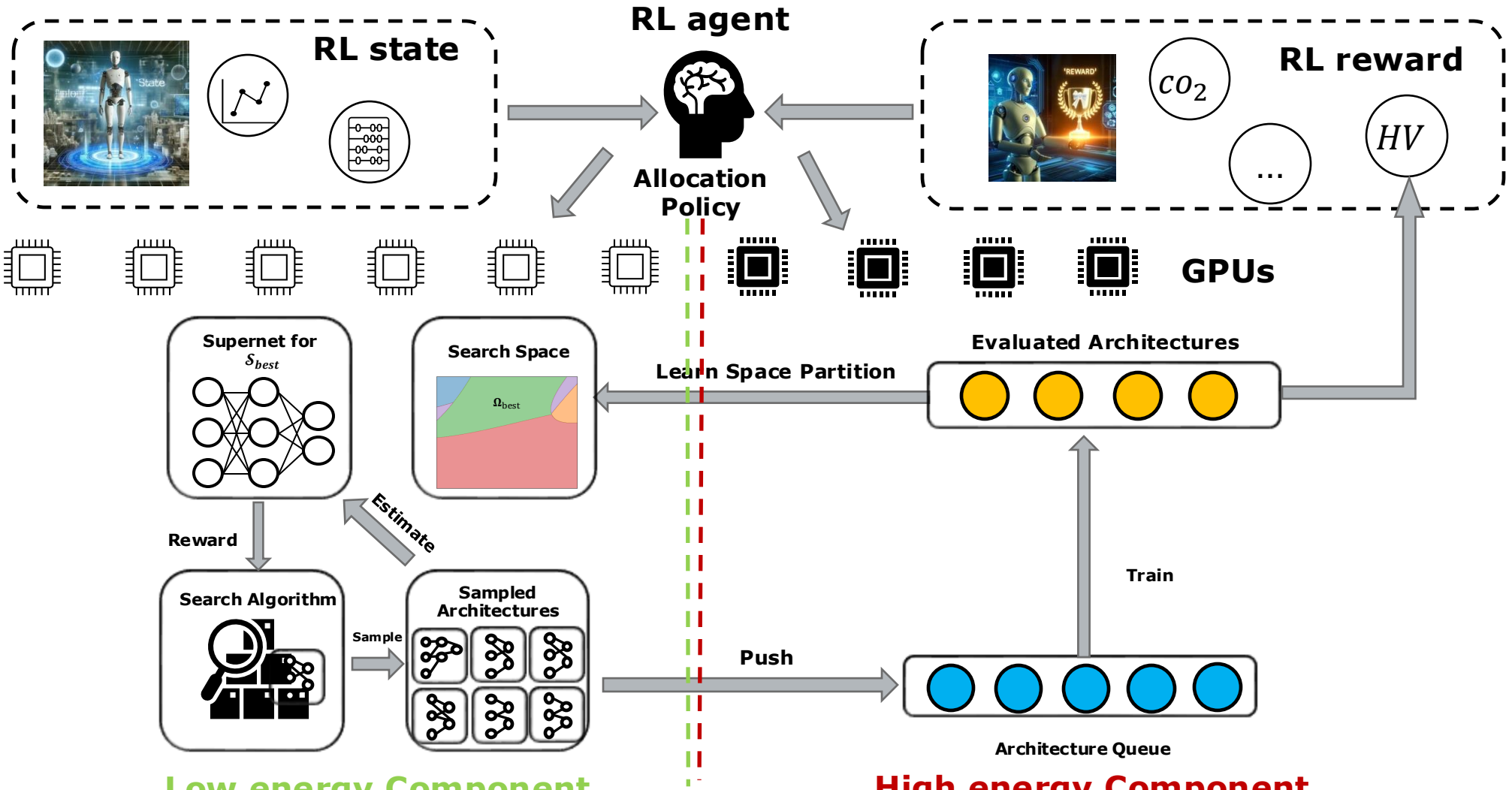
Hypervolume Increase

#New Samples

How to allocate GPU resource



How to allocate GPU resource



THANK YOU