
SEval-NAS: A Search-Agnostic Evaluation for Neural Architecture Search

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01 Motivation

02 Methodology

03 Experiment 1: Feasibility Testing

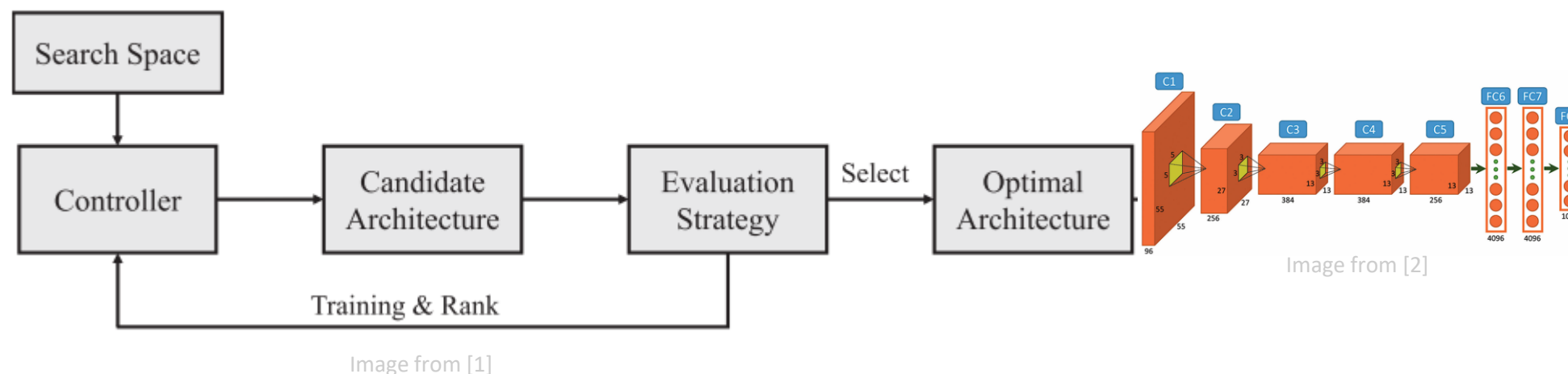
04 Experiment 2: Predicting Hardware Cost

05 Experiment 3: Ease of Integration

Conclusion and Future Works

Motivation

- Neural architectures at the foundation of AI innovation
- Designing these nets requires expert knowledge
- Neural architecture search (NAS) to automate network design



- Costly evaluation of architectures
- Inflexible design
 - hardcoded evaluation
 - fixed evaluation criteria

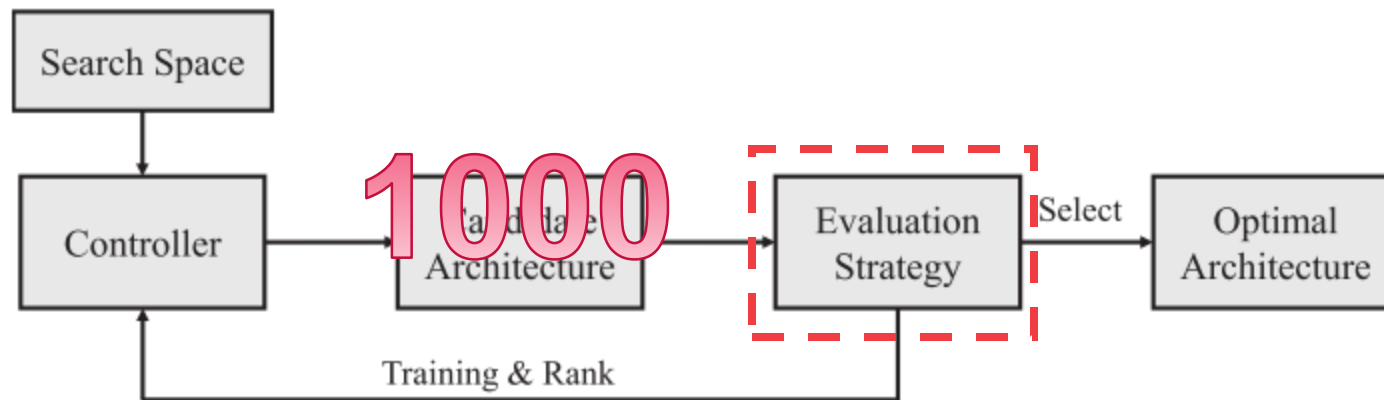
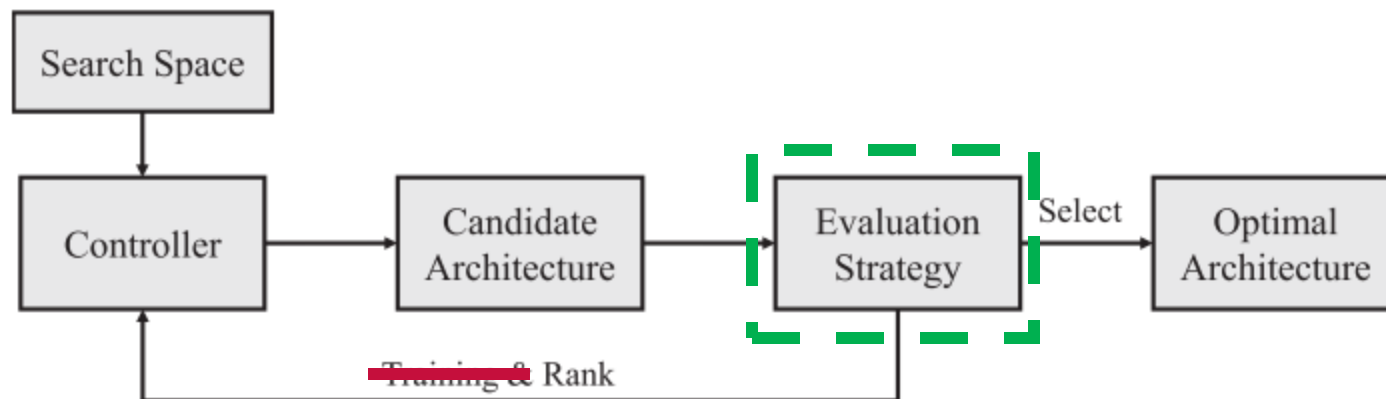


Image from [1]

- Search-agnostic evaluation for neural architecture search
- Supports different metrics and number of evaluation objectives
- Can also be integrated into an existing NAS algorithm



Methodology

2-step pipeline

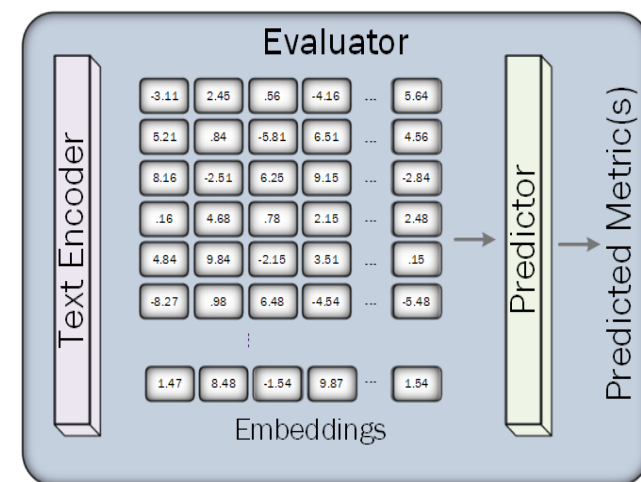
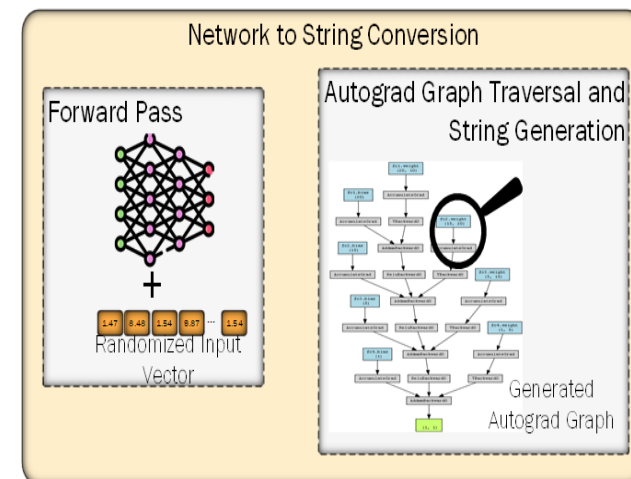
- Net-to-String Conversion
- Evaluator

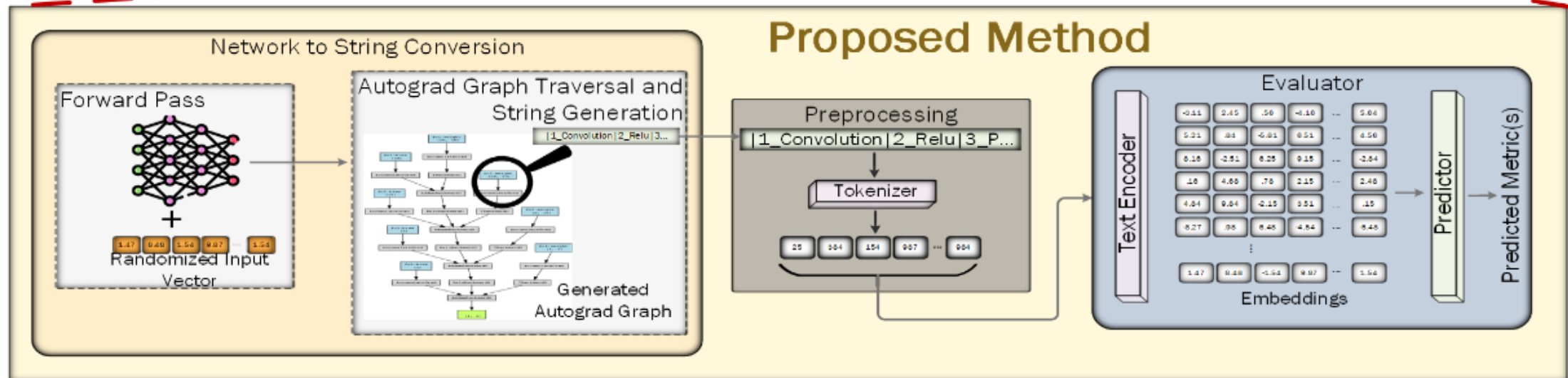
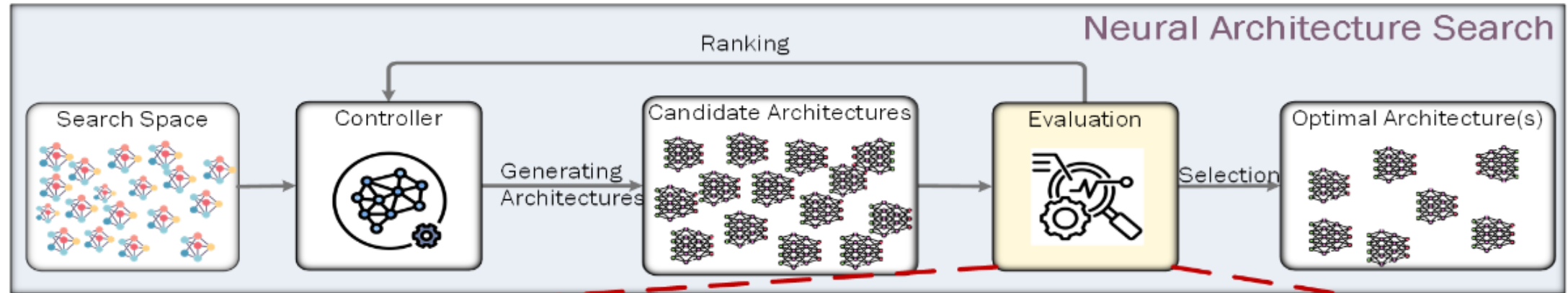
Net-to-String Conversion

- Builds a text representation of the network

Evaluator

- Encodes input tokens and predict the metric(s)





Network configuration

- T5 transformer encoder
- Single-layer prediction head

3 Experiments

1. NATS-Bench (feasibility testing)
2. HW-NAS-Bench (predicting hardware cost)
3. 'Plug-and-Play' Evaluation (ease of integration)

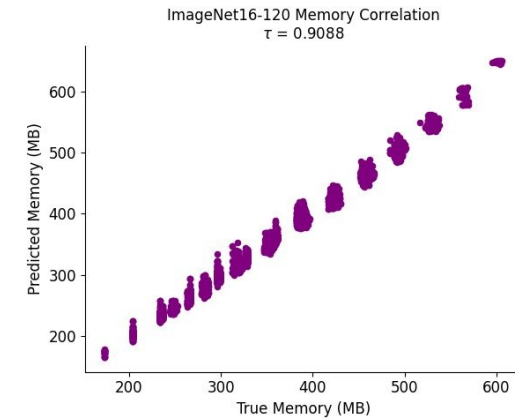
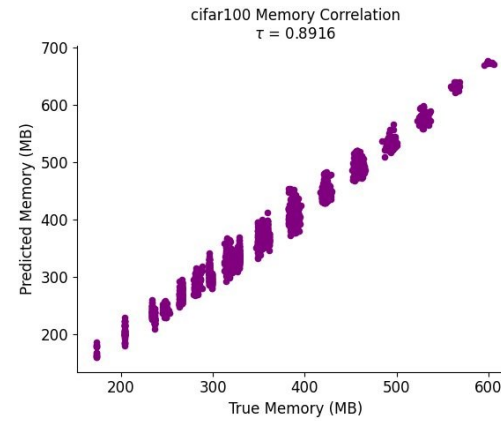
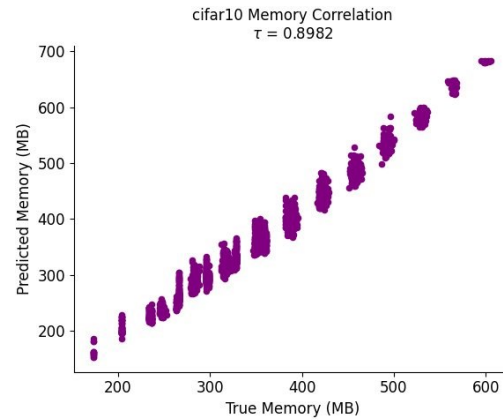
Metrics predicted: accuracy, memory, latency

Experiment 1: Feasibility Testing

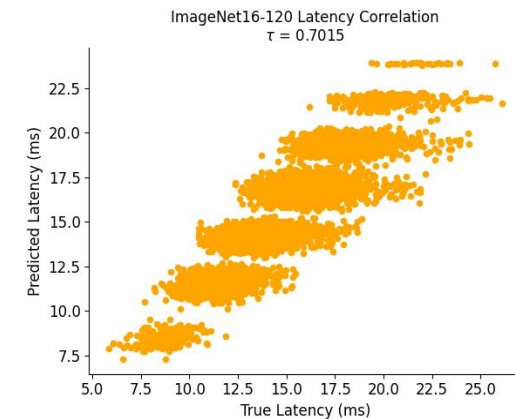
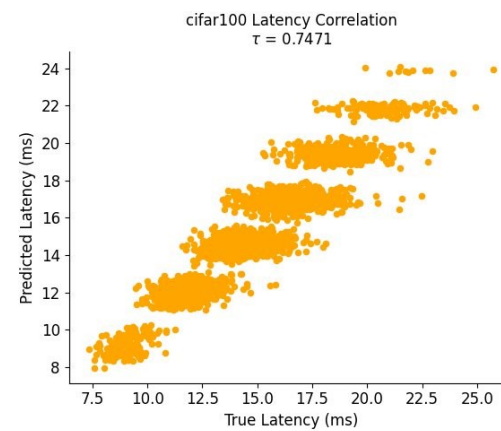
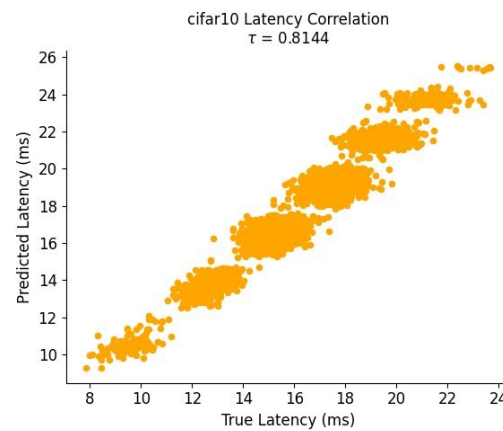
- Benchmark for search on topology (TSS) and size (SSS) search spaces
- Contains 15,625 (TSS) + 32,768 (SSS) archs reported for CIFAR10, CIFAR100, and ImageNet16-120
- Evaluator trained to predict (accuracy, **memory**) and (accuracy, **latency**) bi-objective setups

Experiment 1: Results – Topology Search Space

Memory



Latency

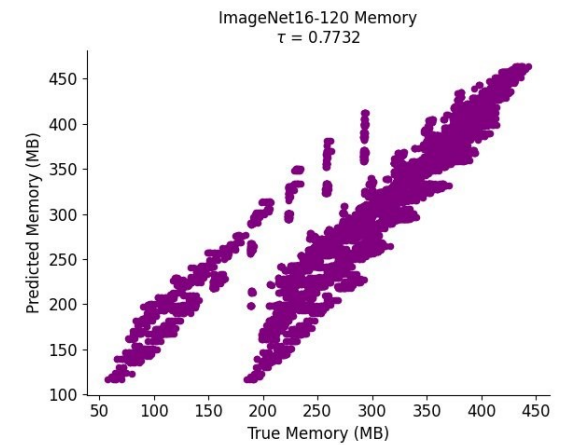
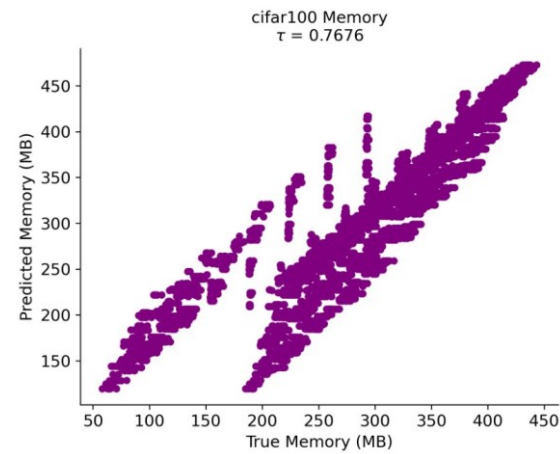
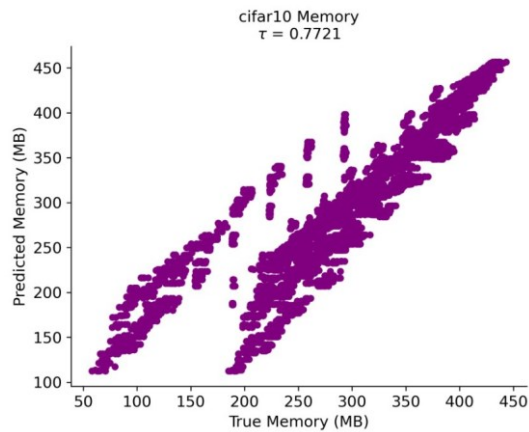


Kendall's τ correlation for memory and latency in TSS

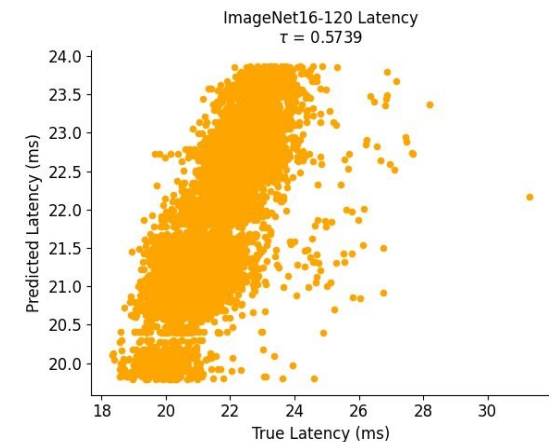
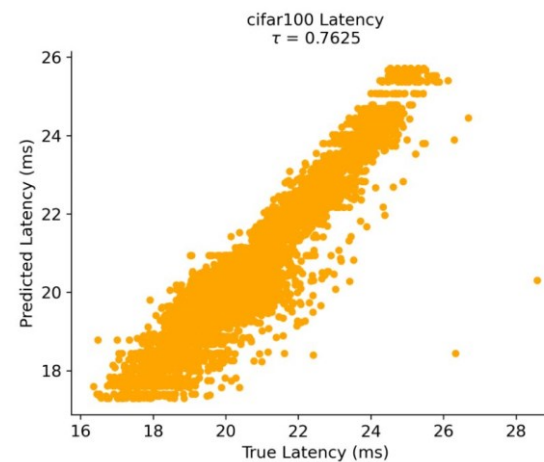
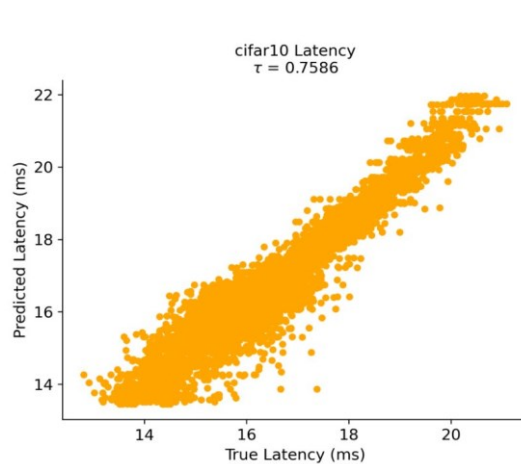
NATS-Bench

Experiment 1: Results – Size Search Space

Memory



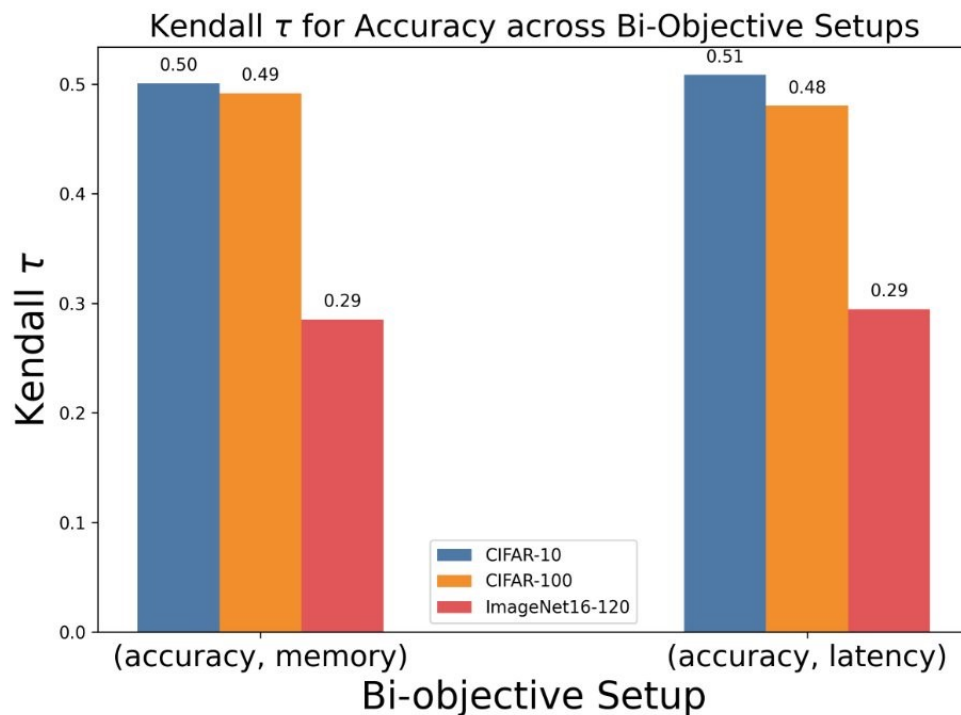
Latency



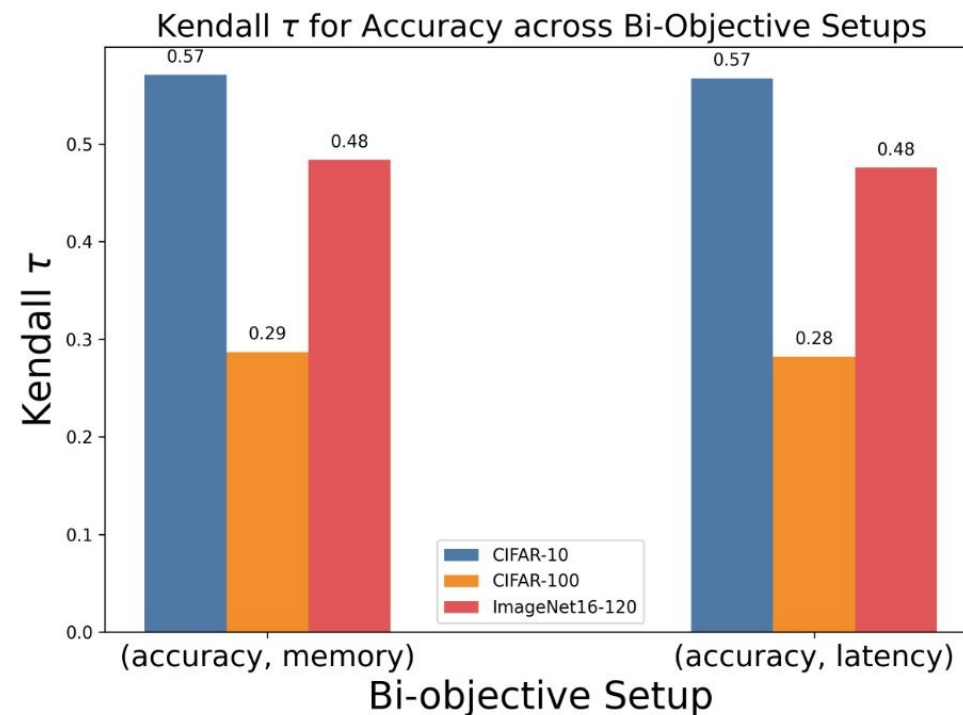
Kendall's τ correlation for memory and latency in SSS

NATS-Bench

Topology Search Space



Size Search Space

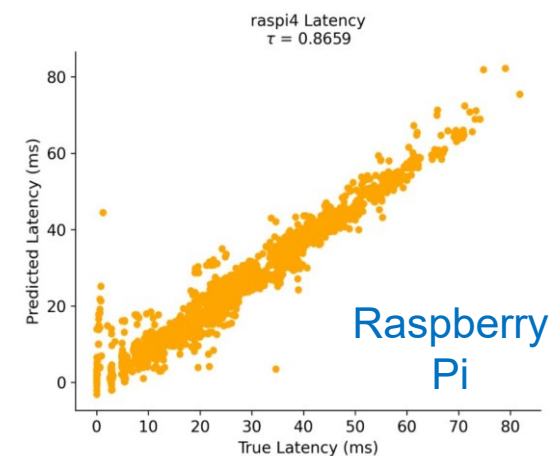
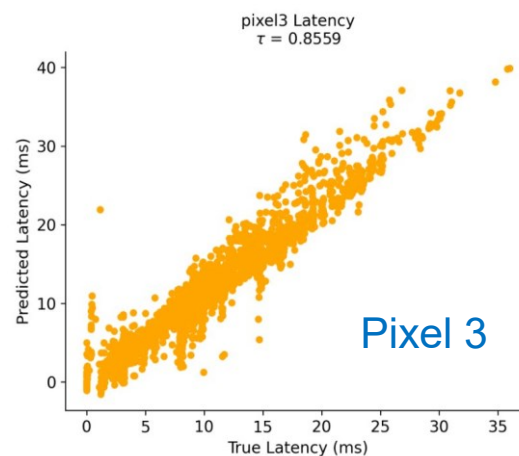
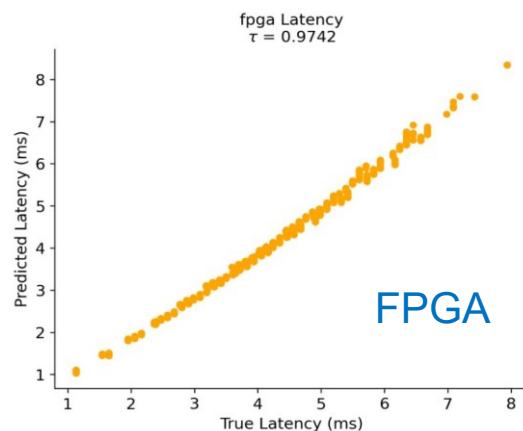
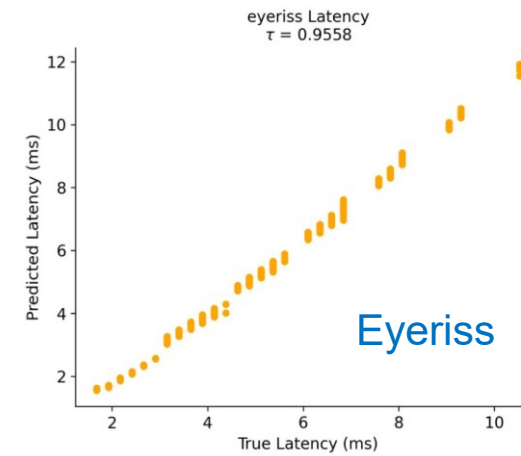
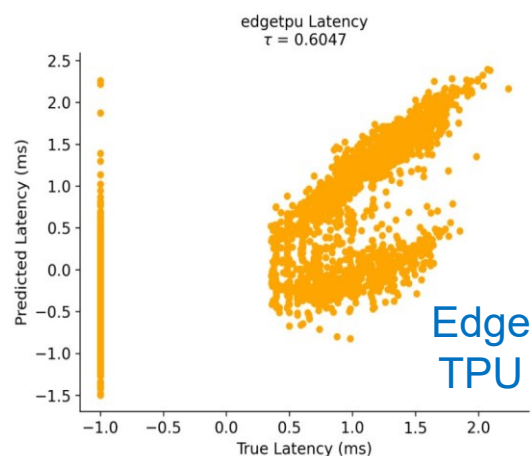
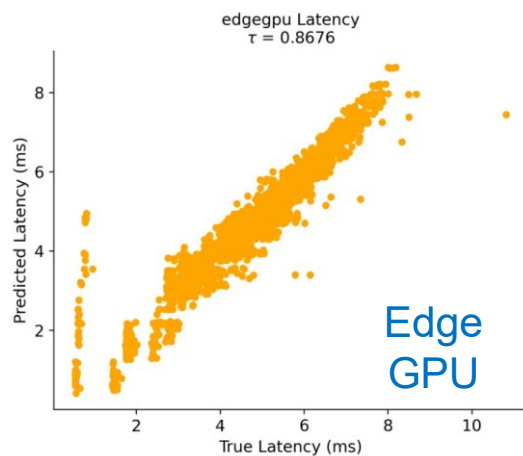


Accuracy correlation values for different bi-objective setups in TSS and SSS

Experiment 2: Predicting Hardware Cost

- Benchmark for hardware-aware NAS
- NASBench-201 search space reported on 6 edge devices
- Evaluator trained to predict latency

Experiment 2: Results

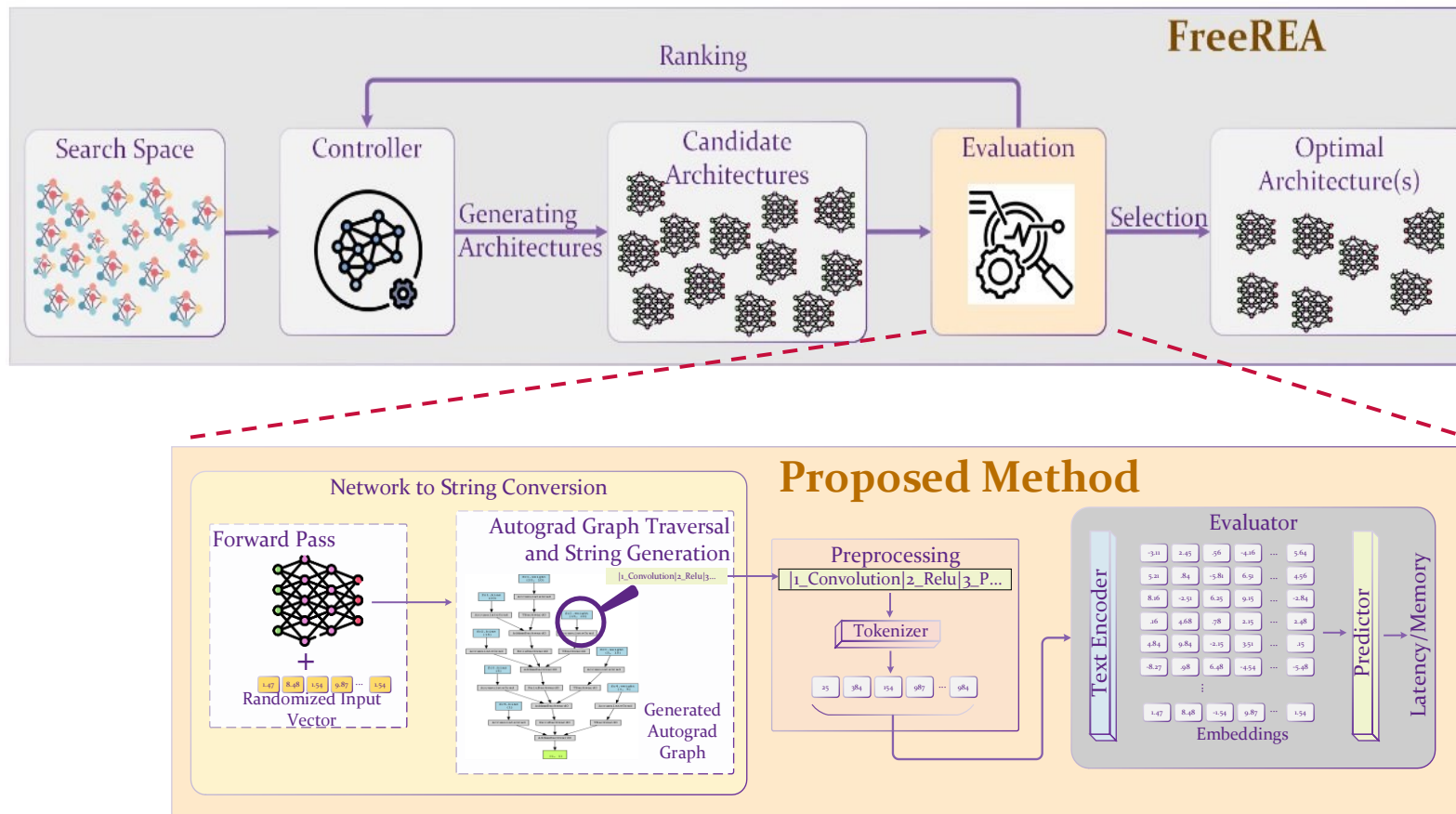


Kendall's τ correlation for latency in HW-NAS-Bench

HW-NAS-Bench

Experiment 3: Ease of Integration

- Evaluating on an existing NAS algorithm



'Plug-and-Play' Evaluation: Results

	CIFAR-10		CIFAR-100		ImageNet16-120	
Algorithm	Accuracy (%)	Time (s)	Accuracy (%)	Time (s)	Accuracy (%)	Time (s)
NASWOT	93.10±0.31	248	69.10±1.61	248	45.08±1.55	248
TENAS	93.9±0.47	1558	71.24±0.56	1558	42.38±4.06	1558
NASI	93.55±0.10	120	71.20±0.14	120	44.84±1.41	120
GA-NINASWOT	93.70±0.63	206	71.57±1.37	206	45.12±1.25	206
EPE-NAS	91.31±1.69	104	69.58±0.83	104	41.84±1.26	104
FreeREA	94.36±0.00	45	73.51±0.05	45	46.34±0.00	45
FreeREA + Latency	94.36±0.00	77	73.51±0.00	82	46.34±0.00	81
FreeREA + Memory	84.21±14.91	34	49.67±11.35	37	19.66±7.19	38

FreeREA

Conclusion and Future Works

- Proposed a neural network evaluation mechanism to evaluate a wide range of neural architectures
- Experimented on NATS-Bench and HW-NAS-Bench for different metrics and tested on FreeREA
- Precise hardware cost predictions and low impact on search time

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- Expand number of objectives
 - Take it to the edge for real-time on-device evaluation

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- [1] Ren, P., Xiao, Y., Chang, X., Huang, P. Y., Li, Z., Chen, X., & Wang, X. (2021). A comprehensive survey of neural architecture search: Challenges and solutions. In ACM Computing Surveys (Vol. 54, Issue 4). Association for Computing Machinery.
<https://doi.org/10.1145/3447582>
- [2] Klingler, N. (2024, April 29). AlexNet: A revolutionary deep learning architecture. Viso.ai. <https://viso.ai/deep-learning/alexnet/>

Thank you!

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Rene Richard, MSc

Students



Hung Nguyen



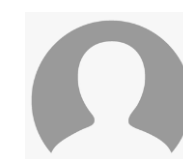
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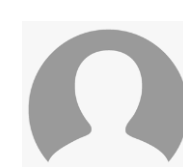
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