Unsupervised NAS

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Neural Architecture Search: Unsupervised Learning of Features and Neural Architectures.

- There is work on learning visual features by exploiting a range of signals of techniques –rotation, colorization, jigsaw puzzle.
- Unsupervised features are very useful. E.g., (i) to enable a simple classifier for classification given these features as input, (ii) to perform domain transfer, (iii) even to model how an infant learns image features?
- But what about learning the neural architecture? There is much recent work on Neural Architecture Search (NAS). But can this be learnt in an unsupervised manner?
- Yes! Chenxi Liu et al. “Are Labels Necessary for Neural Architecture Search”? Arxiv. 2020.

Signals to Exploit ofr Unsupervised Learning

In this project, we rely on self-supervised objectives

- We will use “unsupervised” and “self-supervised” interchangeably
- These objectives were originally developed to transfer learned weights
- We study their ability to transfer learned architecture

Rotation

Colorization

Jigsaw Puzzle

Gidaris, Spyros, Praveer Singh, and Nikos Komodakis. "Unsupervised representation learning by predicting image rotations." In ICLR. 2018.
Zhang, Richard, Phillip Isola, and Alexei A. Efros. "Colorful image colorization." In ECCV. 2016.
Noroozi, Mehdi, and Paolo Favaro. "Unsupervised learning of visual representations by solving jigsaw puzzles." In ECCV. 2016.

Signals to Exploit for Unsupervised Learning

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Using these self-supervised objectives, we conduct two sets of experiments of complementary nature

- Sample-Based
- Search-Based

Sample-Based Experiments

Experimental design:

- Sample 500 unique architectures from a search space
- Train them using Rotation, Colorization, Jigsaw Puzzle, and (supervised) Classification
- Measure rank correlation between pretext task accuracy and target task accuracy

Advantage:

- Each network is trained and evaluated individually

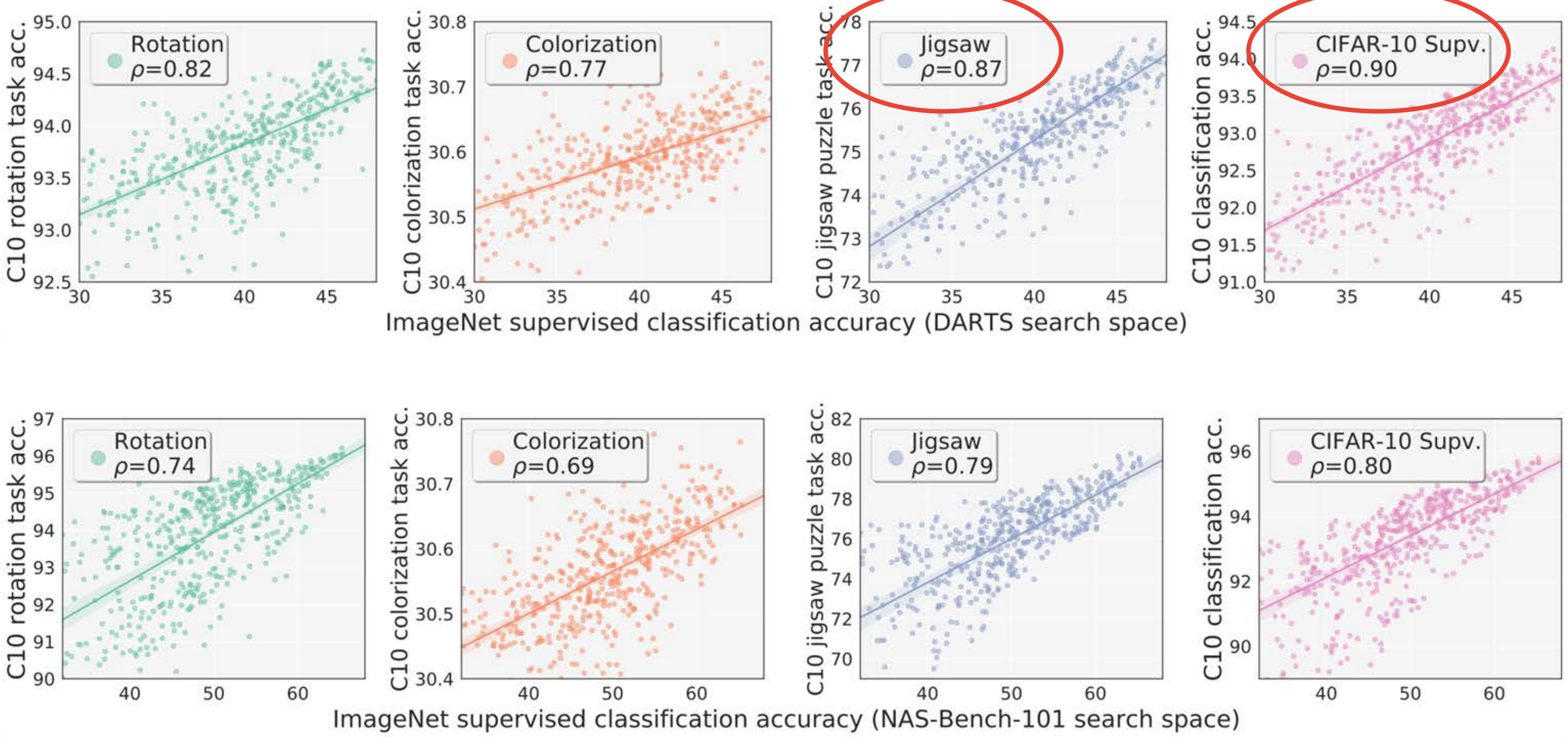
Disadvantage:

- Only consider a small, random subset of the search space

Sample-Based Experiments

Correlation is high!

Commonly used proxy in NAS



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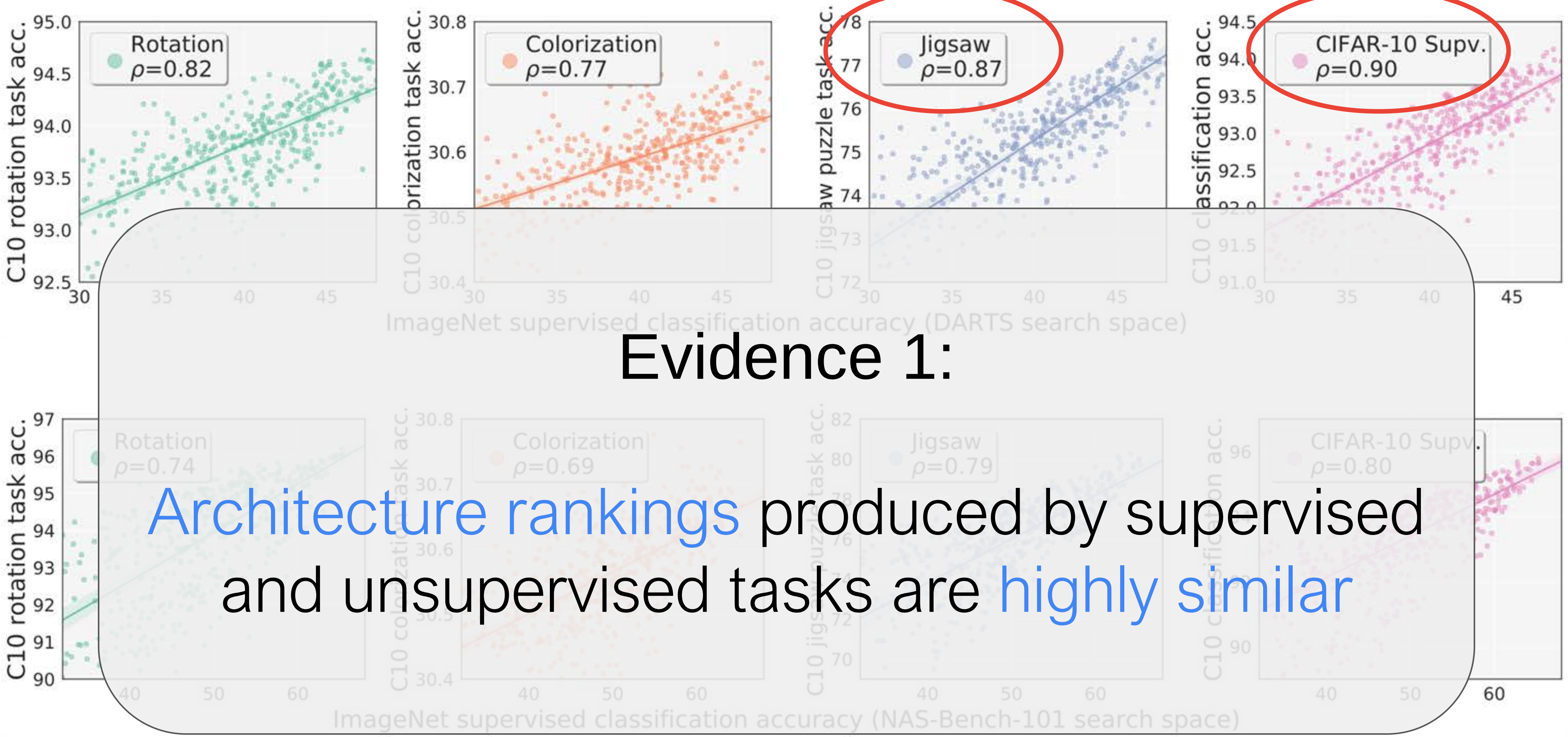


Evidence 1:

Architecture rankings produced by supervised and unsupervised tasks are highly similar

Search-Based Experiments

Experimental design:

- Take a well-established NAS algorithm (DARTS)
- Replace its search objective with Rotation, Colorization, Jigsaw Puzzle
- Train from scratch the searched architecture on target data and task

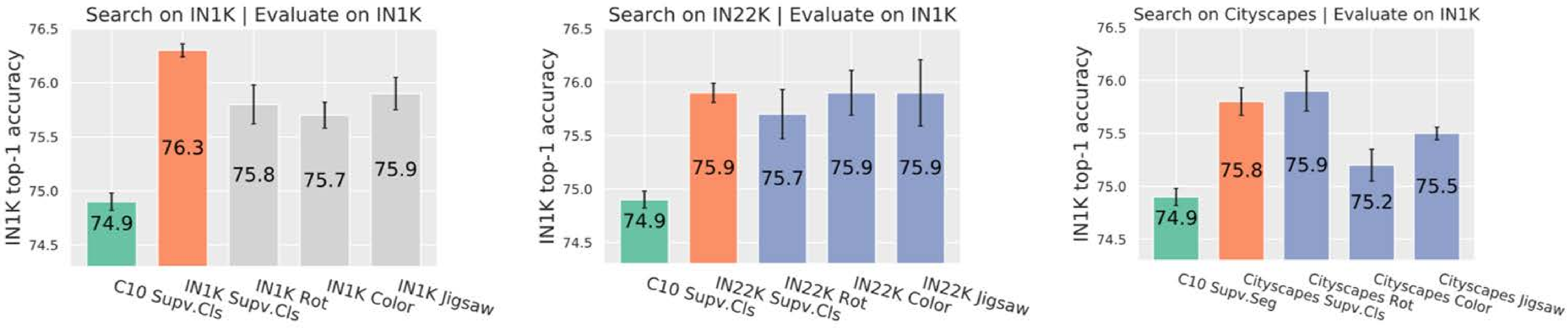
Advantage:

- Explore the entire search space

Disadvantage:

- Training dynamics mismatch between search phase and evaluation phase

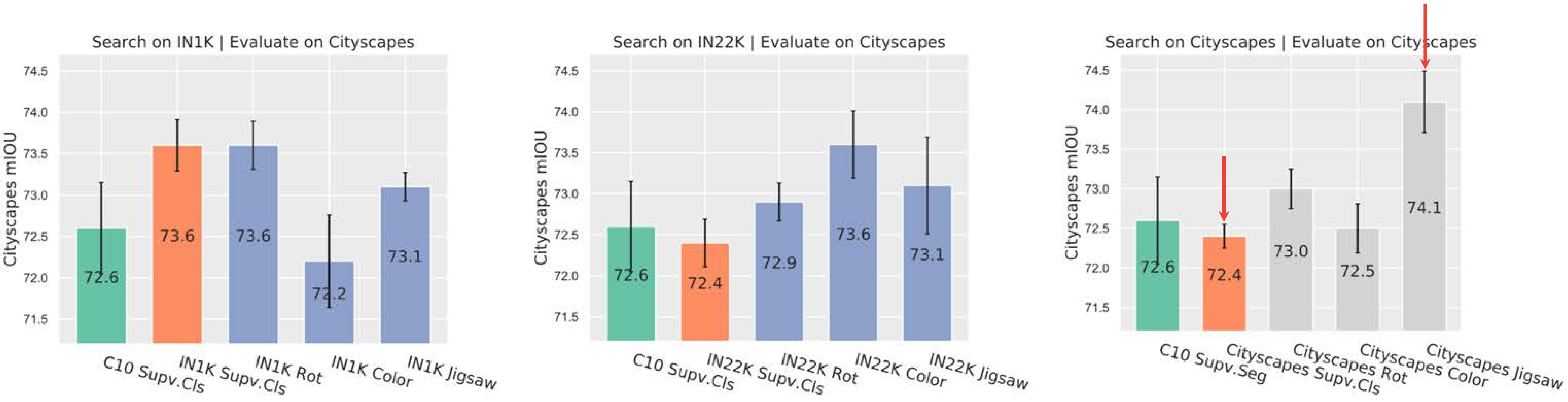
Search-Based Experiments: ImageNet Classification



- UnNAS is better than the commonly used CIFAR-10 supervised proxy
- UnNAS is comparable to (supervised) NAS across search tasks and datasets
- UnNAS even outperforms the state-of-the-art (75.8) which uses a more sophisticated algorithm

Xu, Yuhui, et al. "Pc-darts: Partial channel connections for memory-efficient differentiable architecture search." In ICLR. 2020.

Search-Based Experiments: Cityscapes Sem. Seg.



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- Even a case where UnNAS is clearly better than supervised NAS

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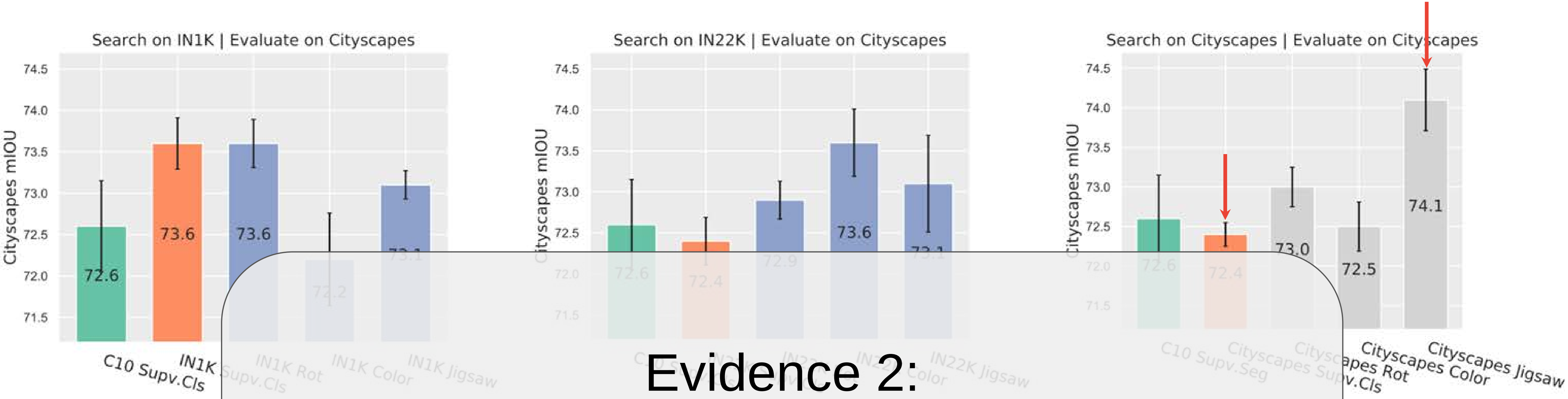

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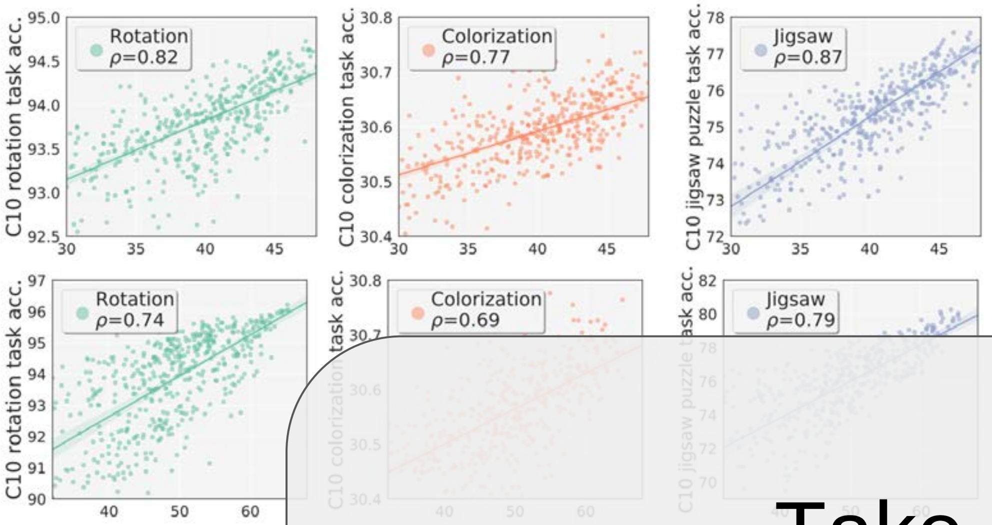
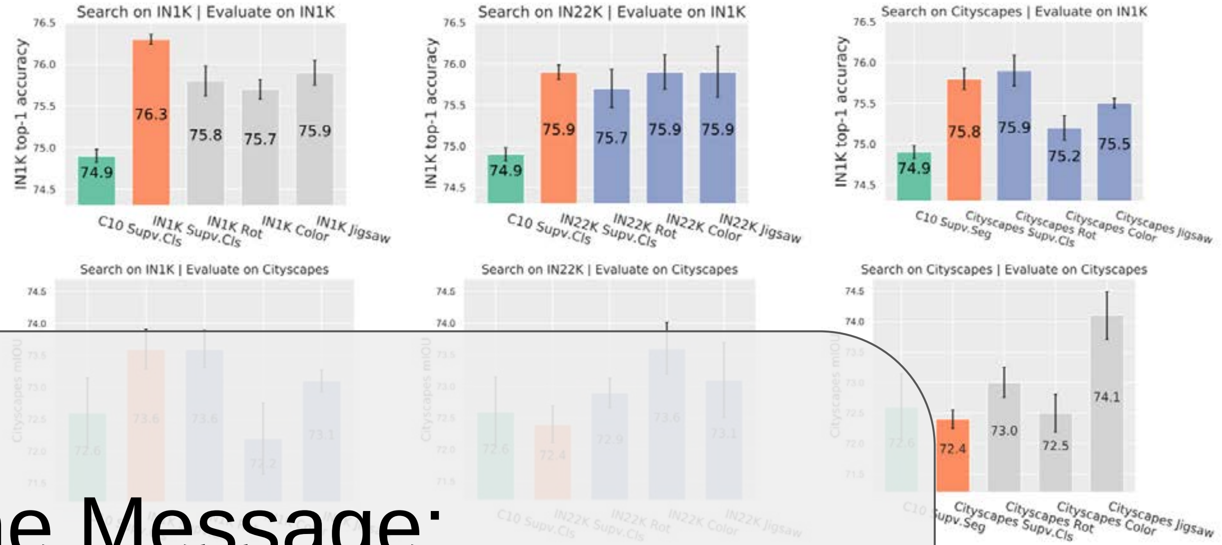
Evidence 2:

UnNAS architectures are comparable in performance to their supervised counterpart

Evidence 1 + Evidence 2





Take-Home Message:

To perform NAS *successfully*,
labels are *not necessary*