When NAS Meets Robustness:

In Search of Robust Architectures against Adversarial Attacks

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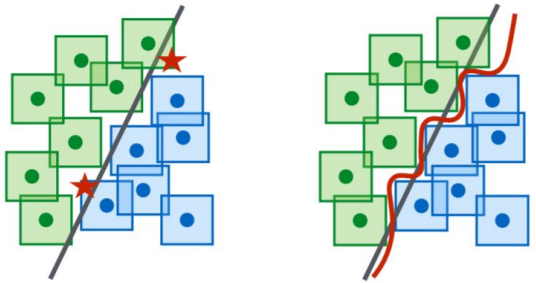
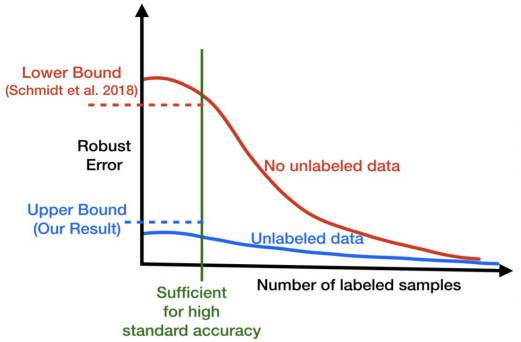
(* indicates equal contribution)

Studies on Improving Adversarial Robustness

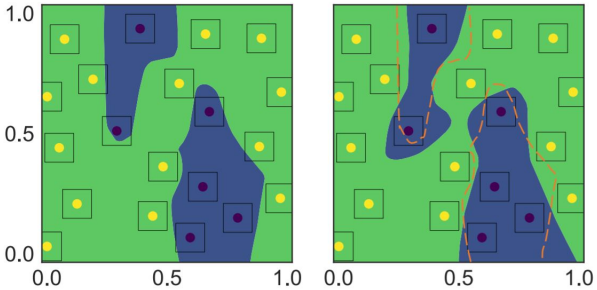
- Specialized learning algorithms / loss functions / data preprocessing / unlabeled data ...



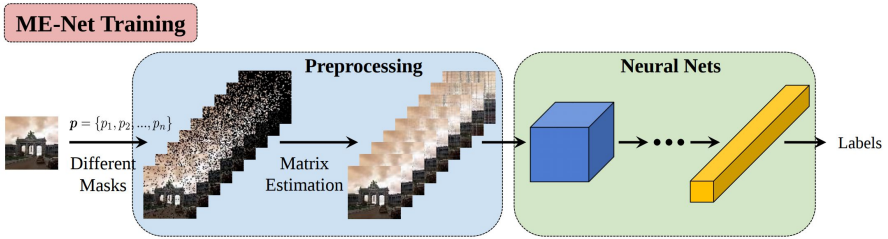
Mądry, Makelov, Schmidt, Tsipras, Vladu. ICLR'18



Carmon, Raghunathan, Schmidt, Liang, Duchi. NeurIPS'19



Zhang, Yu, Jiao, Xing, Ghaoui, Jordan. ICML'19



Yang, Zhang, Katabi, Xu. ICML'19

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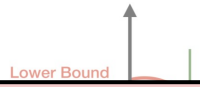
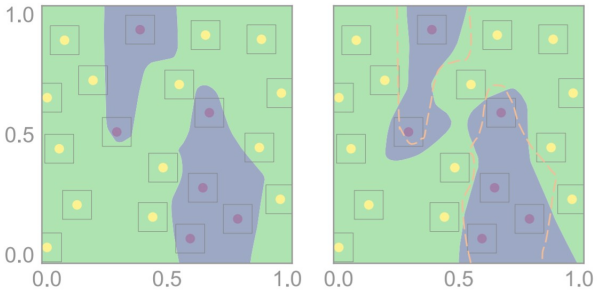


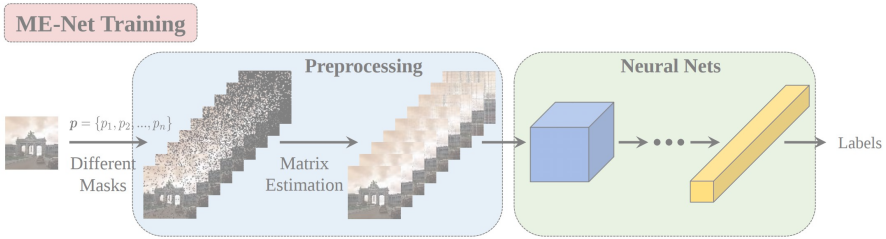
Intrinsic influence of neural network architectures on adversarial robustness?



Zhang, Yu, Jiao, Xing, Ghaoui, Jordan. ICML'19

standard accuracy

Carmon, Raghunathan, Schmidt, Liang, Duchi. NeurIPS'19



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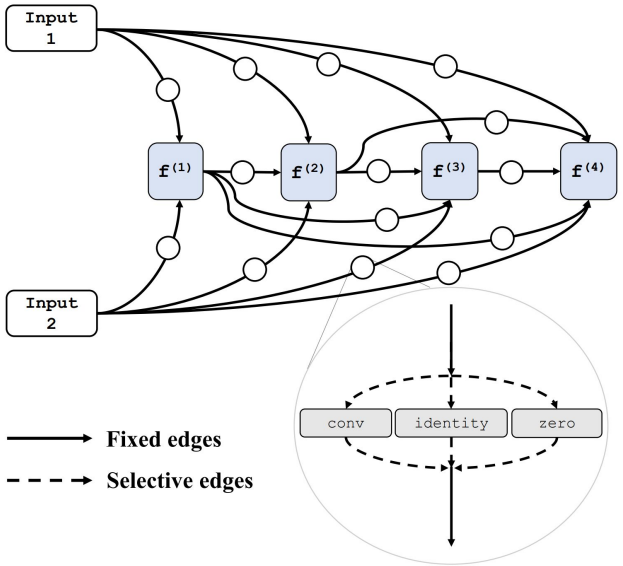
Robust Architecture Search Framework

Robust Architecture Search Framework

One-shot robust NAS

- PGD adversarial training for supernet



Robust Architecture Search Framework

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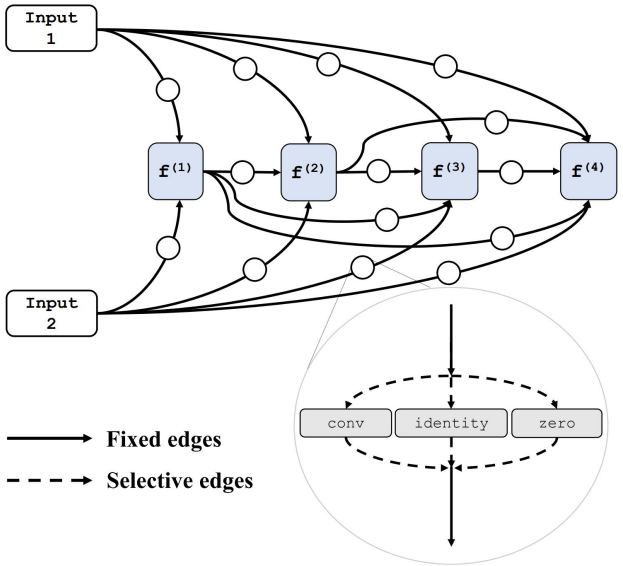
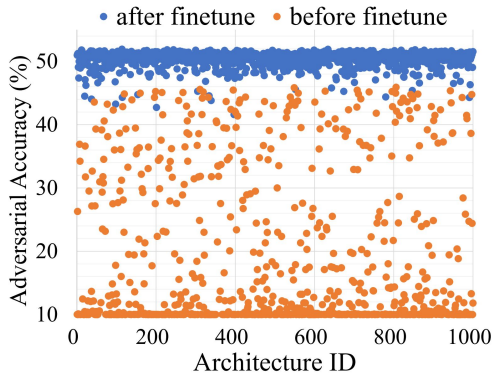
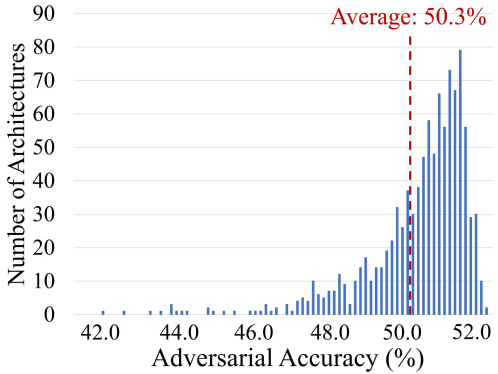


Robustness evaluation

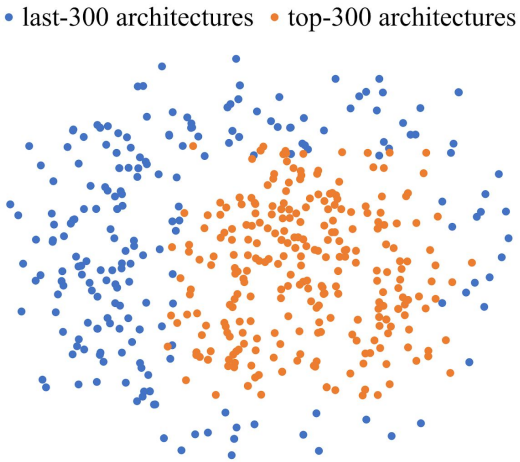
- 1,000 randomly sampled candidates
- finetune a few epochs for individual candidate architecture

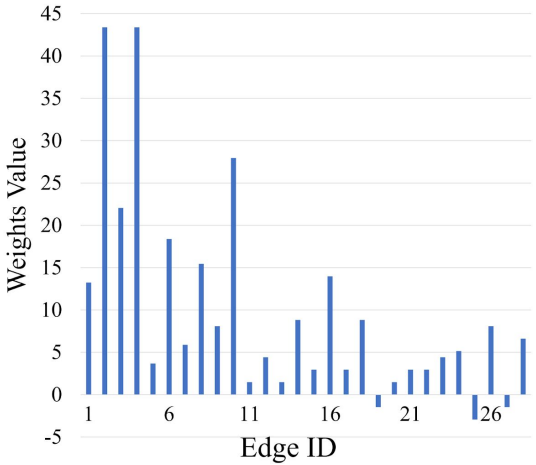


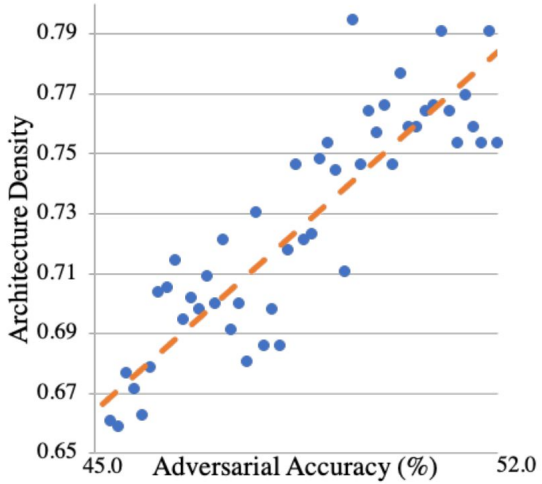


Observation #1:
Densely connected pattern benefits network robustness

Strong correlation between **Architecture Density** & **Robustness**

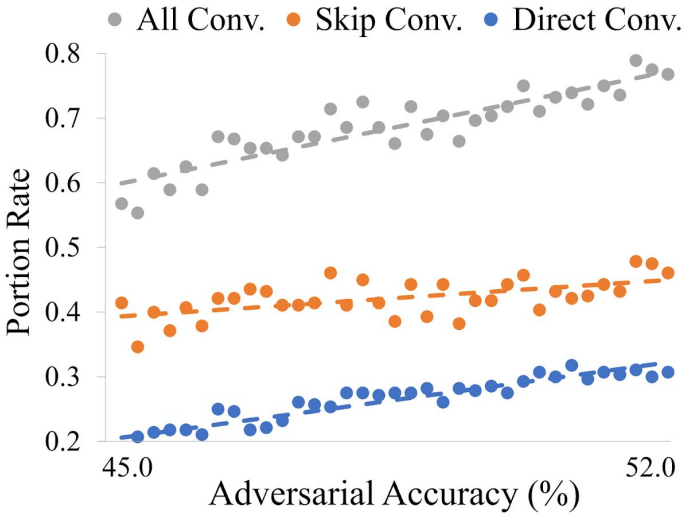


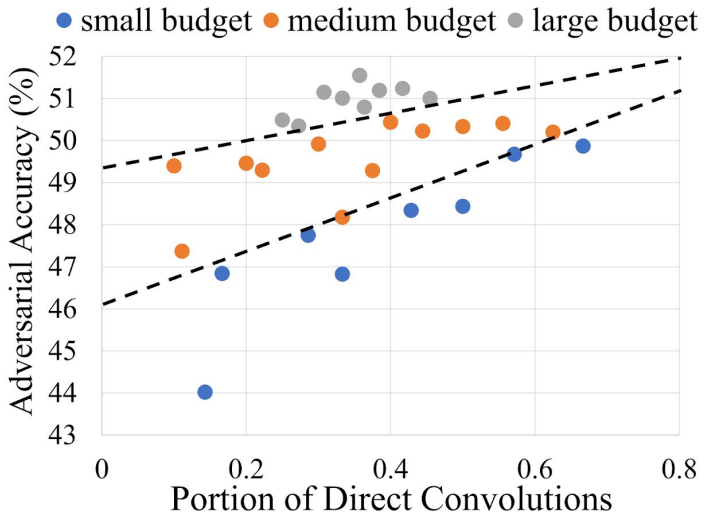




Observation #2:
Architecture strategy under computational budget

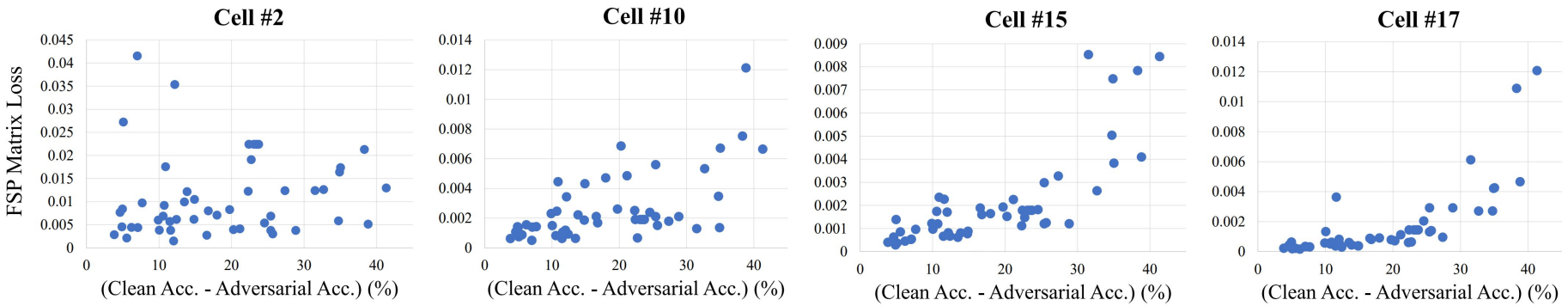
Under small computational budget,
adding convolution operations to direct edges is more effective





Observation #3:
FSP matrix distance as robustness indicator

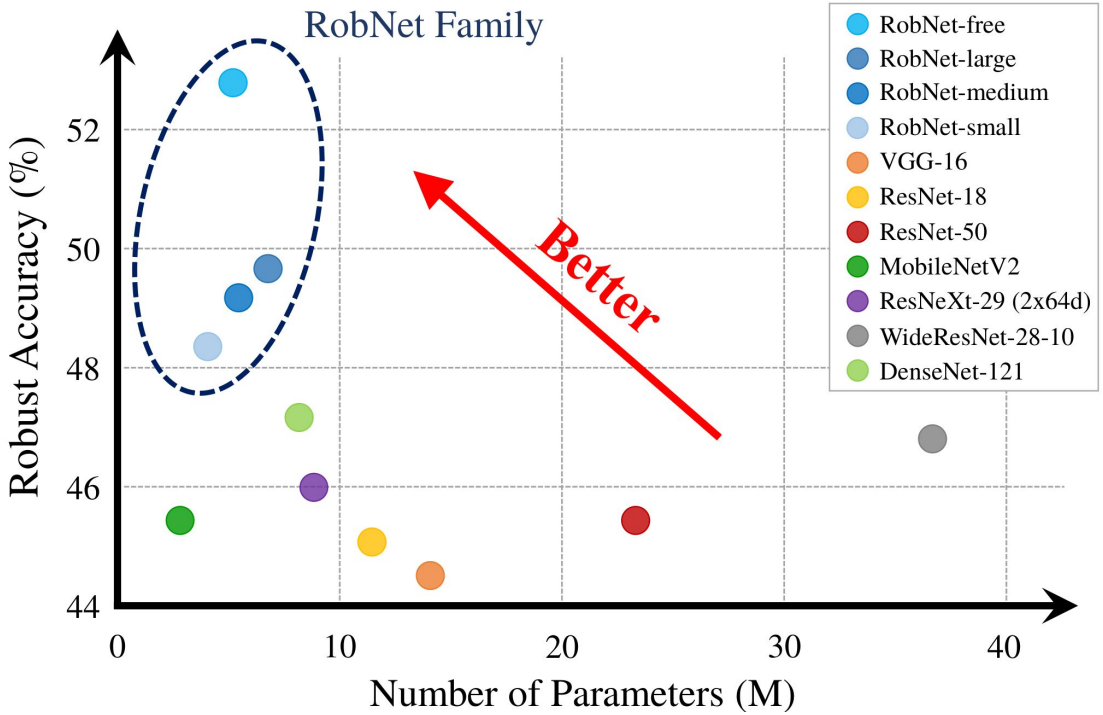
A robust network has a **lower FSP matrix loss** in the **deeper** cells of network



(Flow of solution procedure (FSP) matrix: $G_l(x;\theta) = \sum_{s=1}^{h}\sum_{t=1}^{w} \frac{F^{in}_{l,s,t}(x;\theta) \times F^{out}_{l,s,t}(x;\theta)}{h \times w}$)

Family of Robust Architectures (RobNets)

- RobNets exhibit superior robustness on CIFAR, SVHN, ImageNet, etc. with fewer parameters



Check out our models at...

https://github.com/gmh14/RobNets

https://www.mit.edu/~yuzhe/robnets.html