

MUXConv: Information Multiplexing in Convolutional Neural Networks

Zhichao Lu, Kalyanmoy Deb and Vishnu Naresh Boddeti
Michigan State University

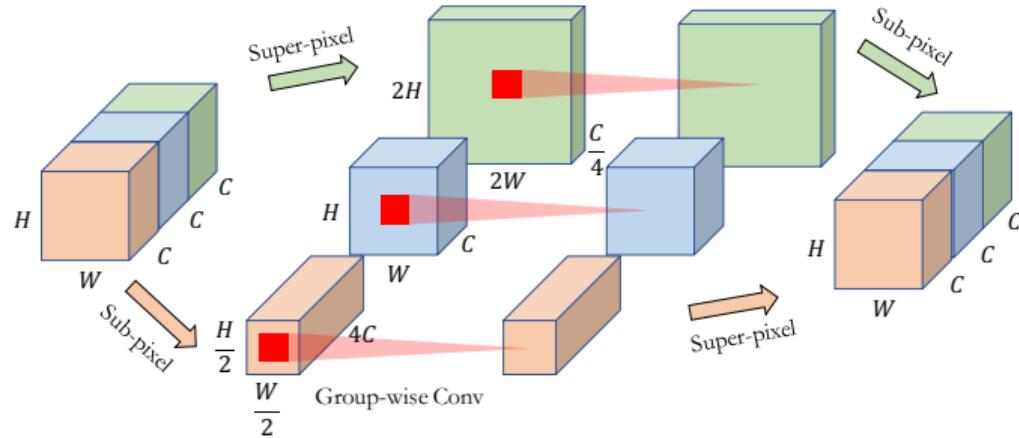
{luzhicha, kdeb, vishnu}@msu.edu

<https://github.com/human-analysis/MUXConv>

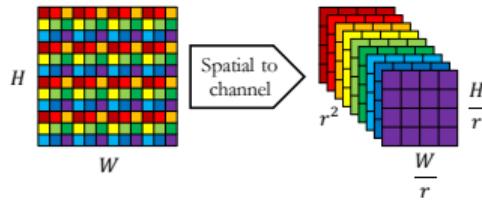
MUXConv

- ▶ New layer: Multiplexed Convolutions (Spatial + Channel Multiplexing)
- ▶ Idea: increase flow of information between space and channels
- ▶ Goal: smaller model size, increased efficiency, maintain/increase performance

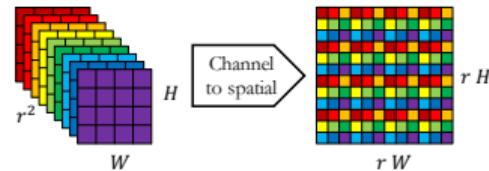
Spatial Multiplexing: Idea



Spatial Multiplexing

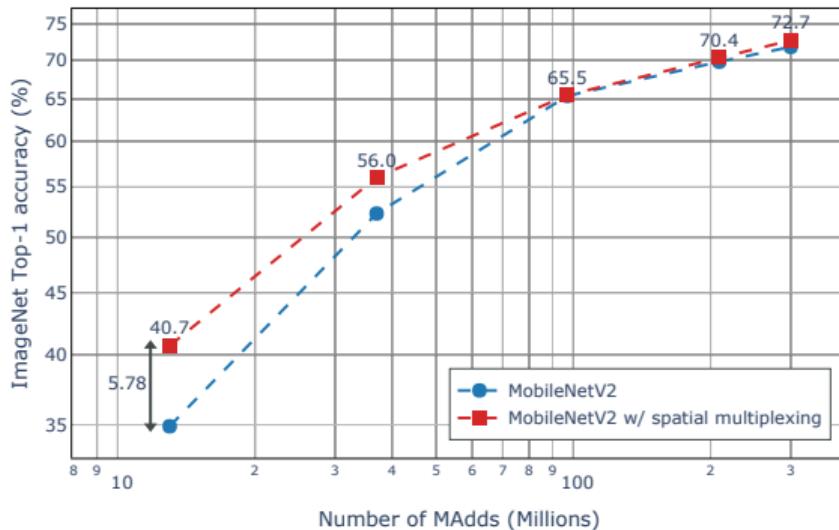


Subpixel



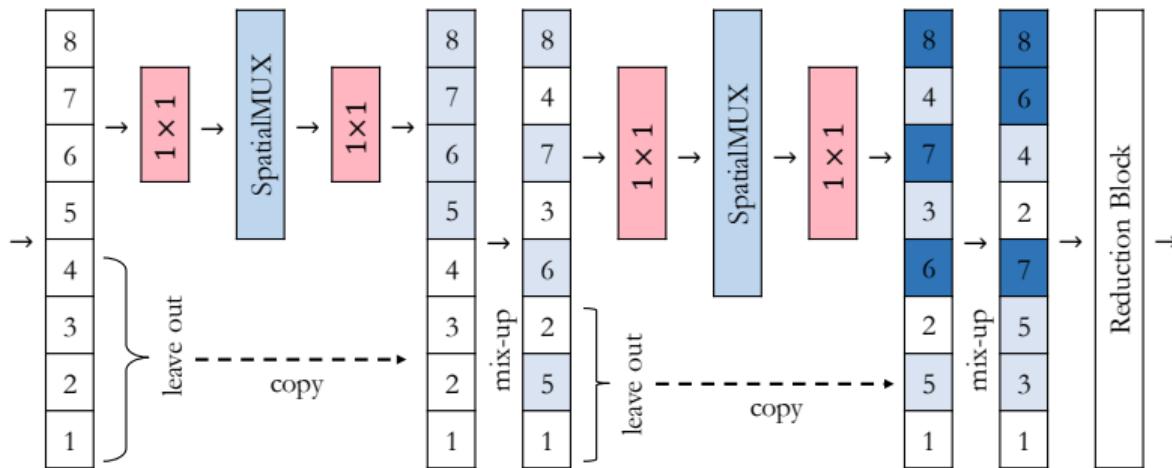
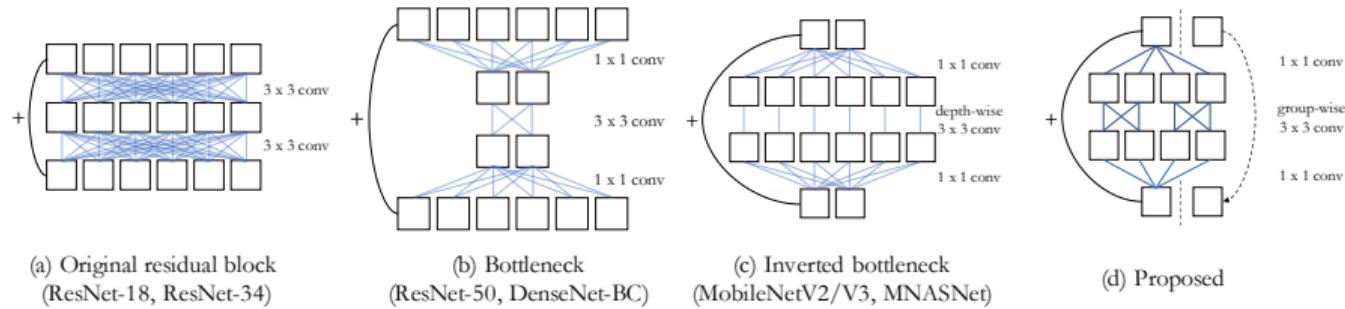
Superpixel

Spatial Multiplexing: Evaluation

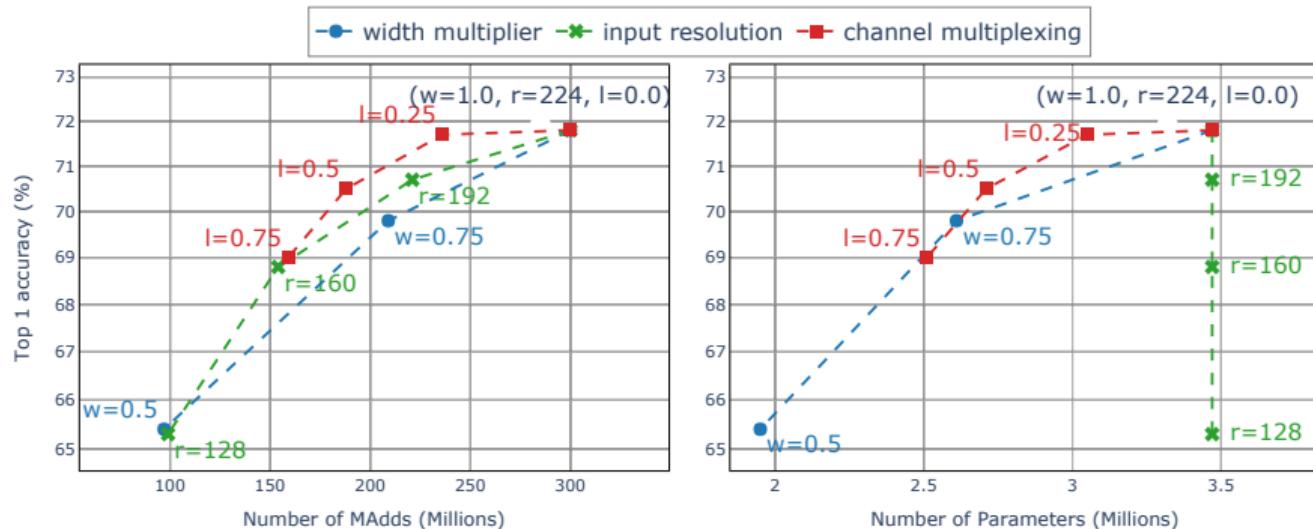


- ▶ Consistent improvement on accuracy over the original *depth-wise separable convolution*
- ▶ Particularly effective in low MAdds Regime

Channel Multiplexing:Idea

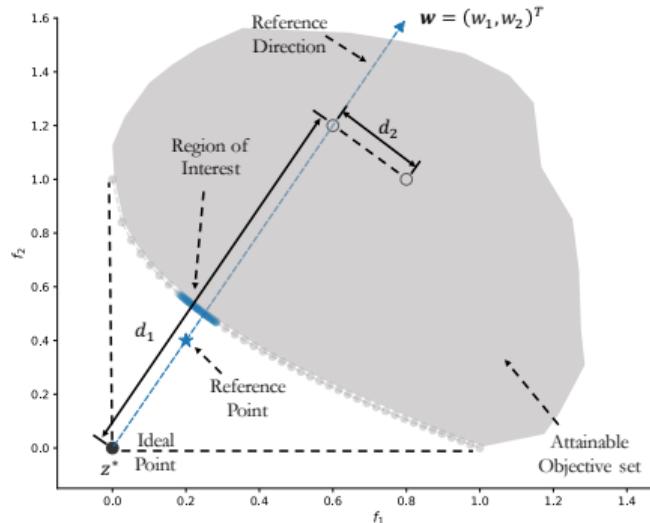
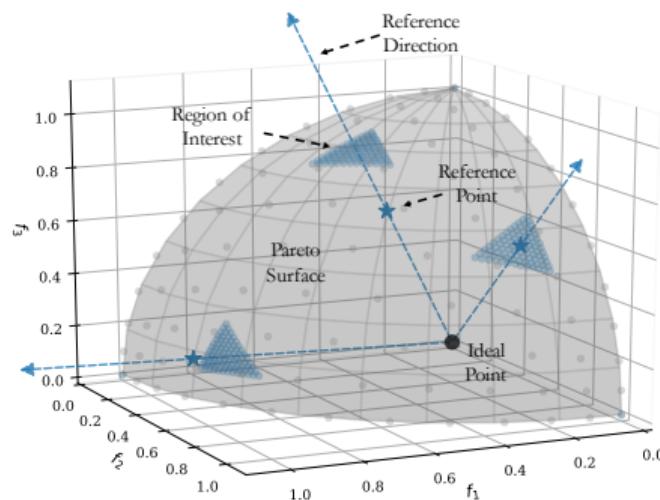


Channel Multiplexing: Evaluation



- ▶ Consistently outperforming existing scaling methods

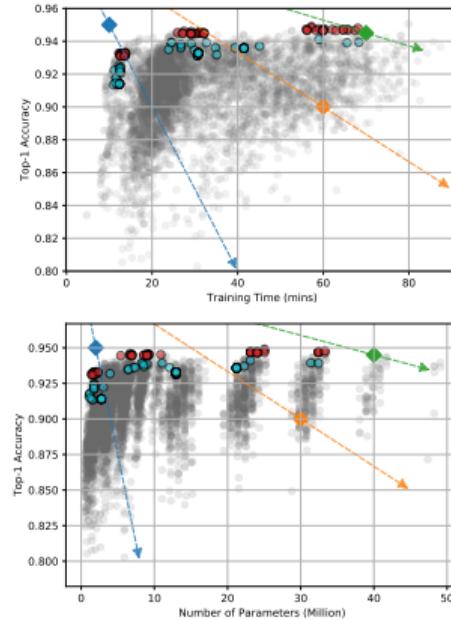
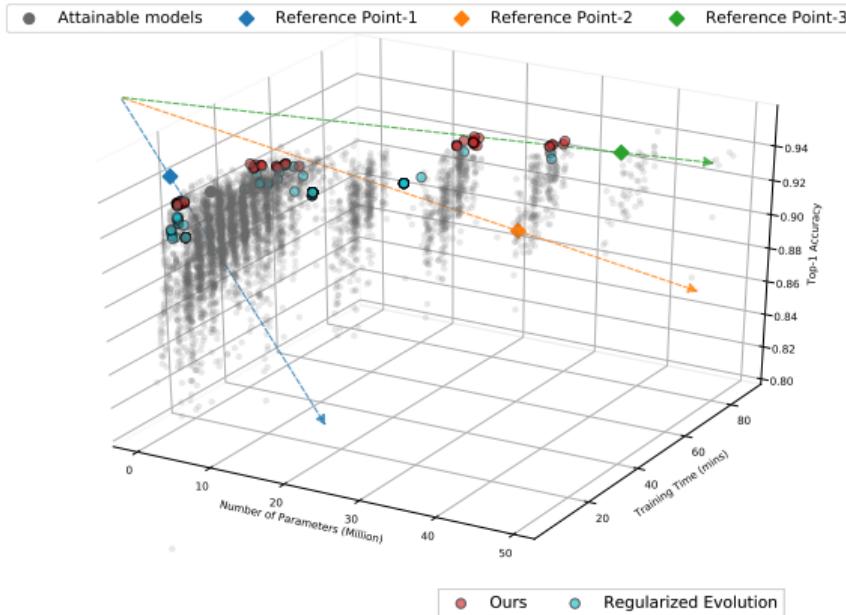
Tri-Objective Search: Idea



- ▶ Simultaneously optimize for accuracy (\uparrow), #Params (\downarrow), and #MAdds (\downarrow)
- ▶ User preference guided search through PBI¹ decomposition

¹ Qingfu Zhang and Hui Li. Moea/d: A multiobjective evolutionary algorithm based on decomposition. *IEEE Transactions on Evolutionary Computation*, 11(6):712731, 2007

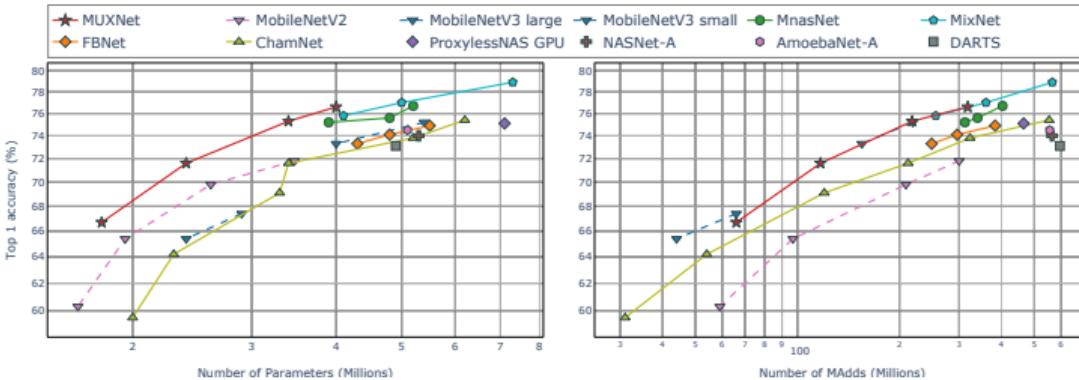
Tri-Objective Search: Evaluation



- ▶ NASBench101: our search is more efficient than regularized evolution²

² Esteban Real, Alok Aggarwal, Yanping Huang, and Quoc VLe. Regularized evolution for image classifier architecture search. In AAAI, 2019

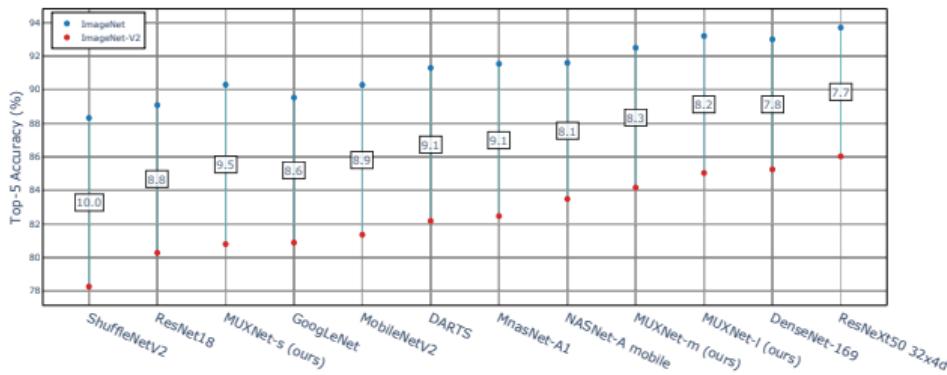
ImageNet-1K Classification



[‡] indicates the objective that the method explicitly optimizes through NAS.

Additional Experiments

Generalization to ImageNet-V2



PASCAL VOC2007 Detection

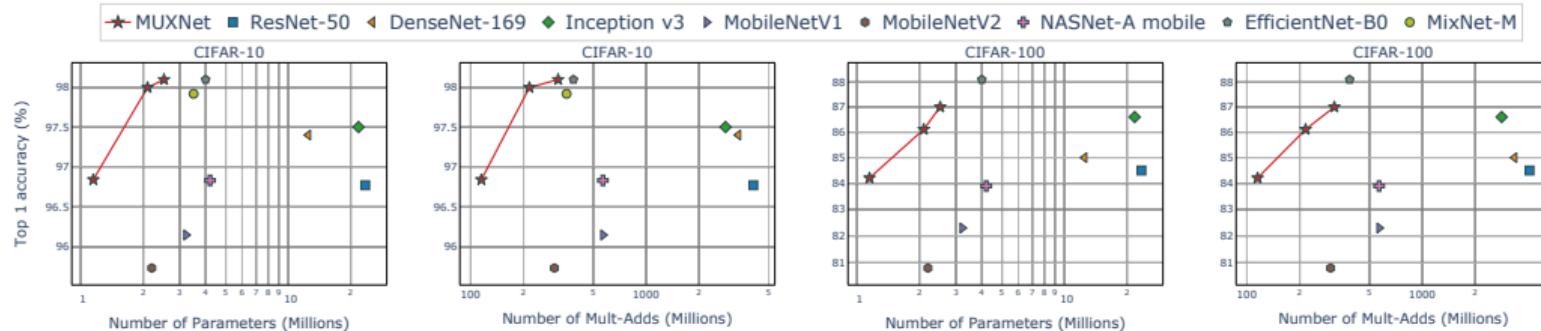
Network	#MAdds	#Params	mAP (%)
VGG16 + SSD	35B	26.3M	74.3
MobileNet + SSD	1.6B	9.5M	67.6
MobileNetV2 + SSDLite	0.7B	3.4M	67.4
MobileNetV2 + SSD	1.4B	8.9M	73.2
MUXNet-m + SSDLite	0.5B	3.2M	68.6
MUXNet-l + SSD	1.4B	9.9M	73.8

ADE20K Semantic Segmentation

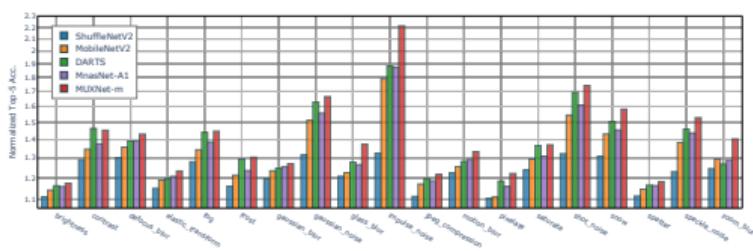
Network	#MAdds	#Params	mIoU (%)	Acc (%)
ResNet18 + C1	1.8B	11.7M	33.82	76.05
MobileNetV2 + C1	0.3B	3.5M	34.84	75.75
MUXNet-m + C1	0.2B	3.4M	32.42	75.00
ResNet18 + PPM	1.8B	11.7M	38.00	78.64
MobileNetV2 + PPM	0.3B	3.5M	35.76	77.77
MUXNet-m + PPM	0.2B	3.4M	35.80	76.33

Additional Experiments

Transfer Learning on CIFAR



Robustness to Degradations



Visualization on Segmentation Results

