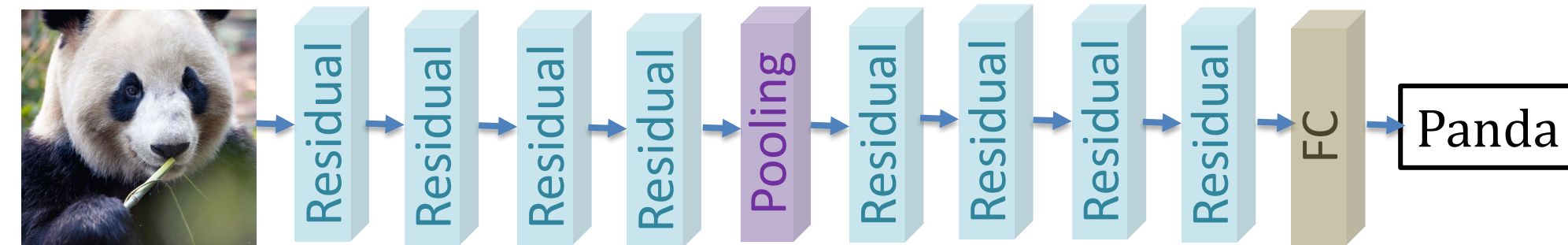




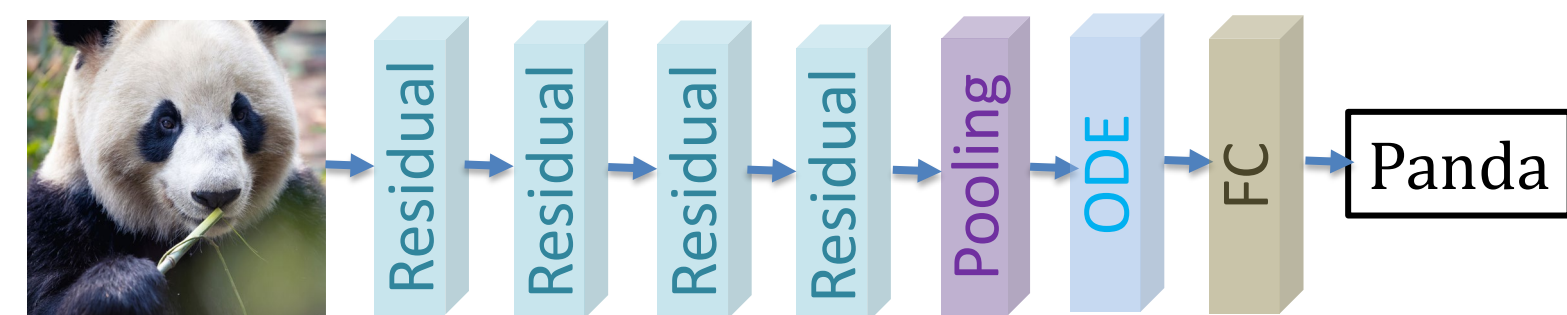
## Discrete CNNs (ResNet, EfficientNet)

- Repetitions are expensive : compute & storage



## ODE CNNs (Neural-ODE, NeuPDE)

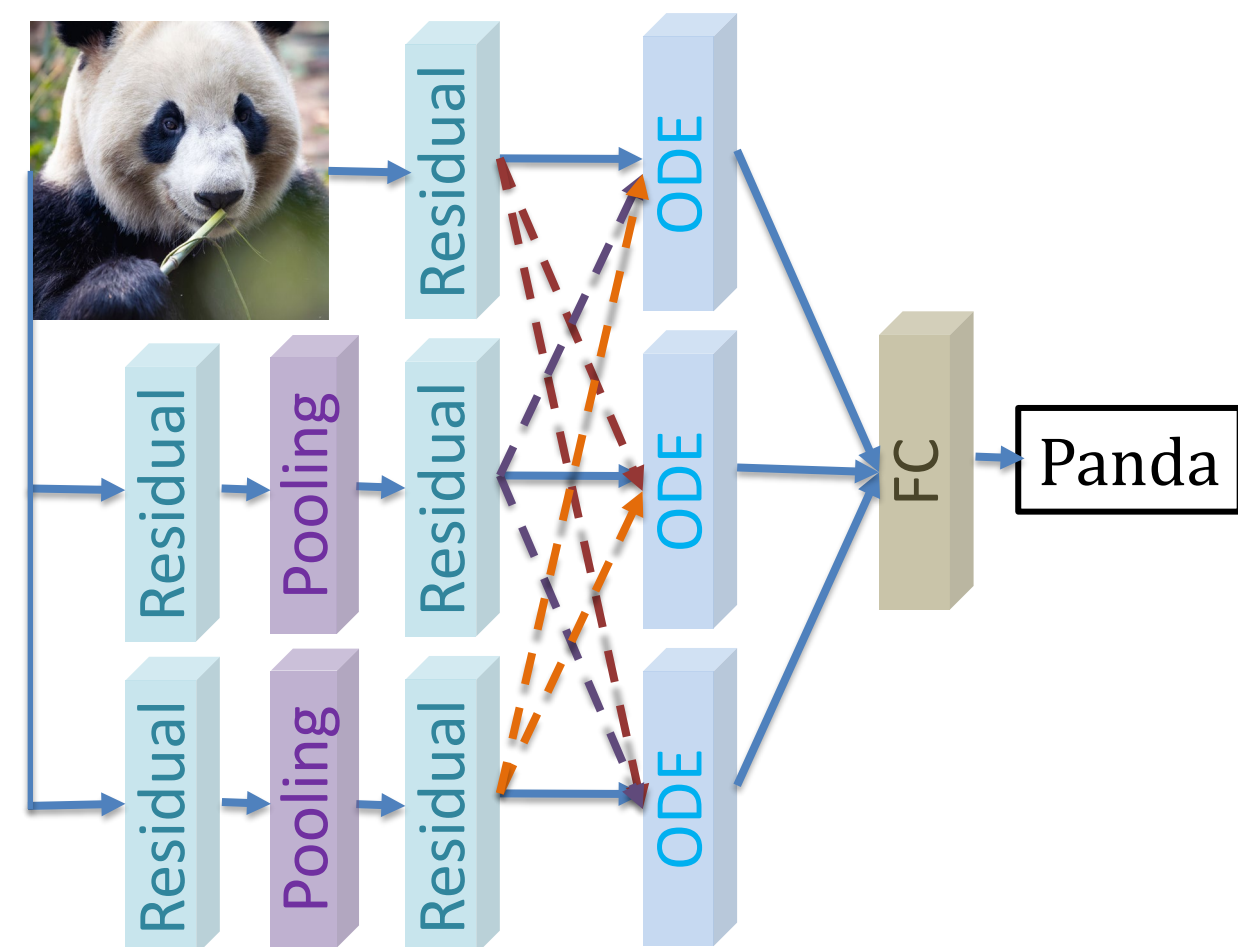
- Does not scale to large scale datasets



MNIST	Acc. (%)	#Params	#MACs
Neural-ODE	99.49	220K	100M
NeuPDE	99.49	180K	50M
ResNet	99.51	600K	30M

## ODE CNNs (MDEQ)

- Scales up to Imagenet, **But** computationally expensive



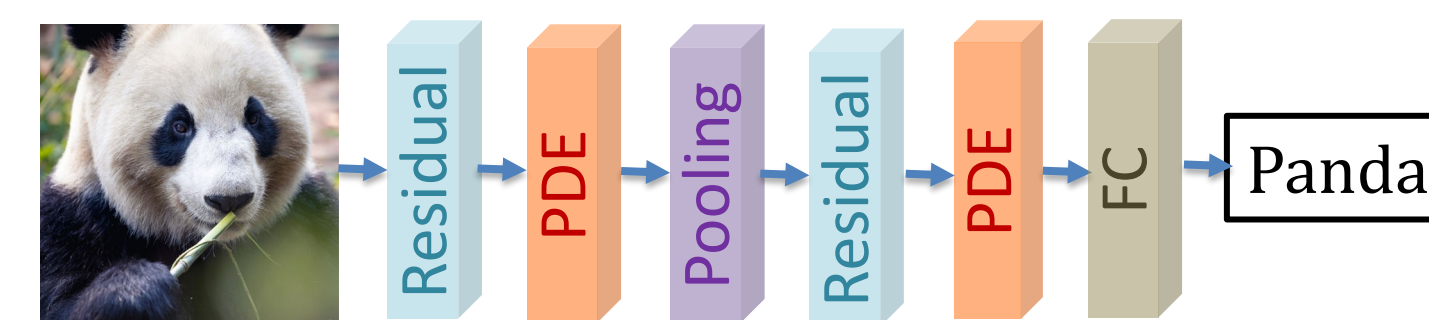
Imagenet-1K	Acc. (%)	#Params	#MACs
ResNet	77.8	60M	11B
DenseNet	76.3	14M	3.5B
MDEQ-Small	75.5	18M	21B

## Feature Comparison with Prior Work

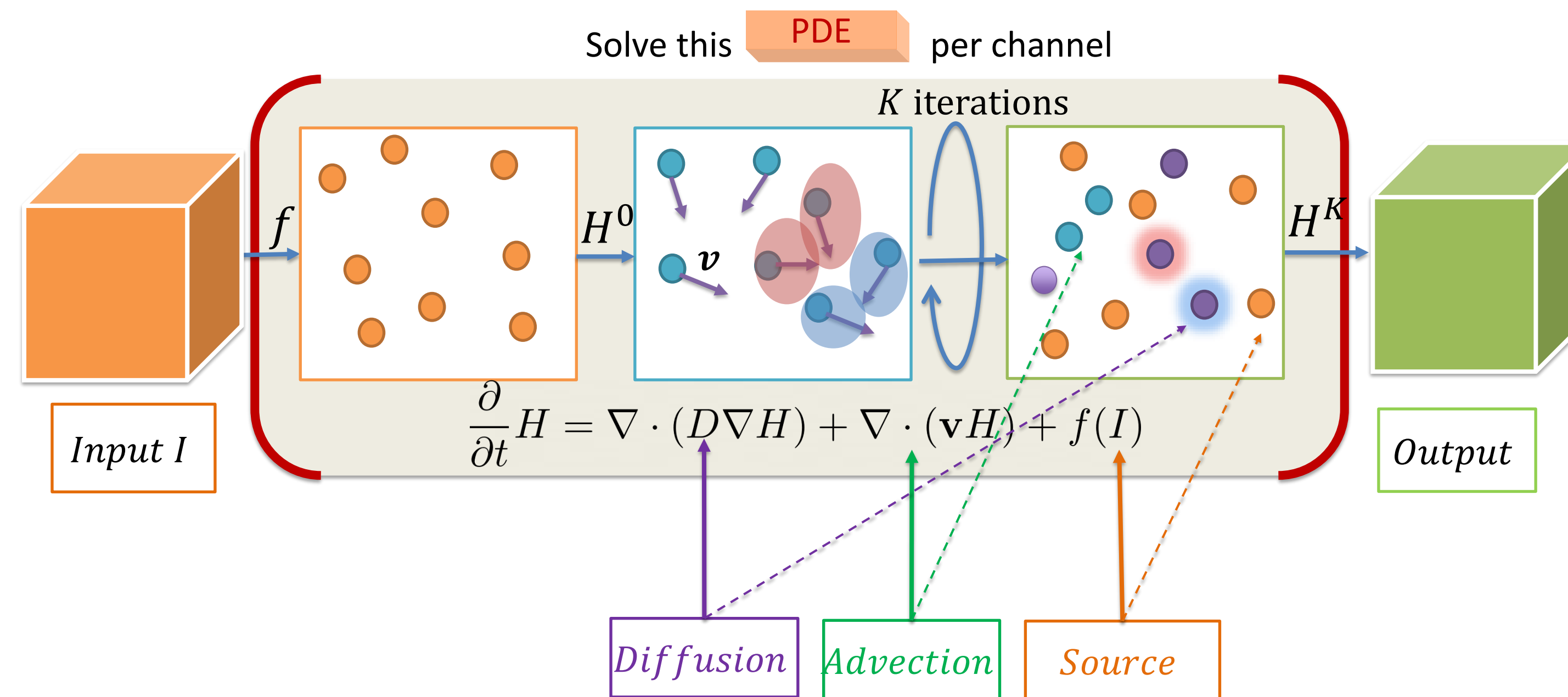
Architecture Type	Architecture	Storage Reduction	Compute Reduction	Large Scale Datasets
Discrete-CNNs	ResNet	1x	1x	✓
ODE-CNNs	Neural-ODE	✓	✗	✗
	NeuPDE	✓	✗	✗
	MDEQ	✓	✗	✓
Global-CNNs (ours)	ResNet-Global	✓	✓	✓

## Our Proposal : Global Layer based on PDEs

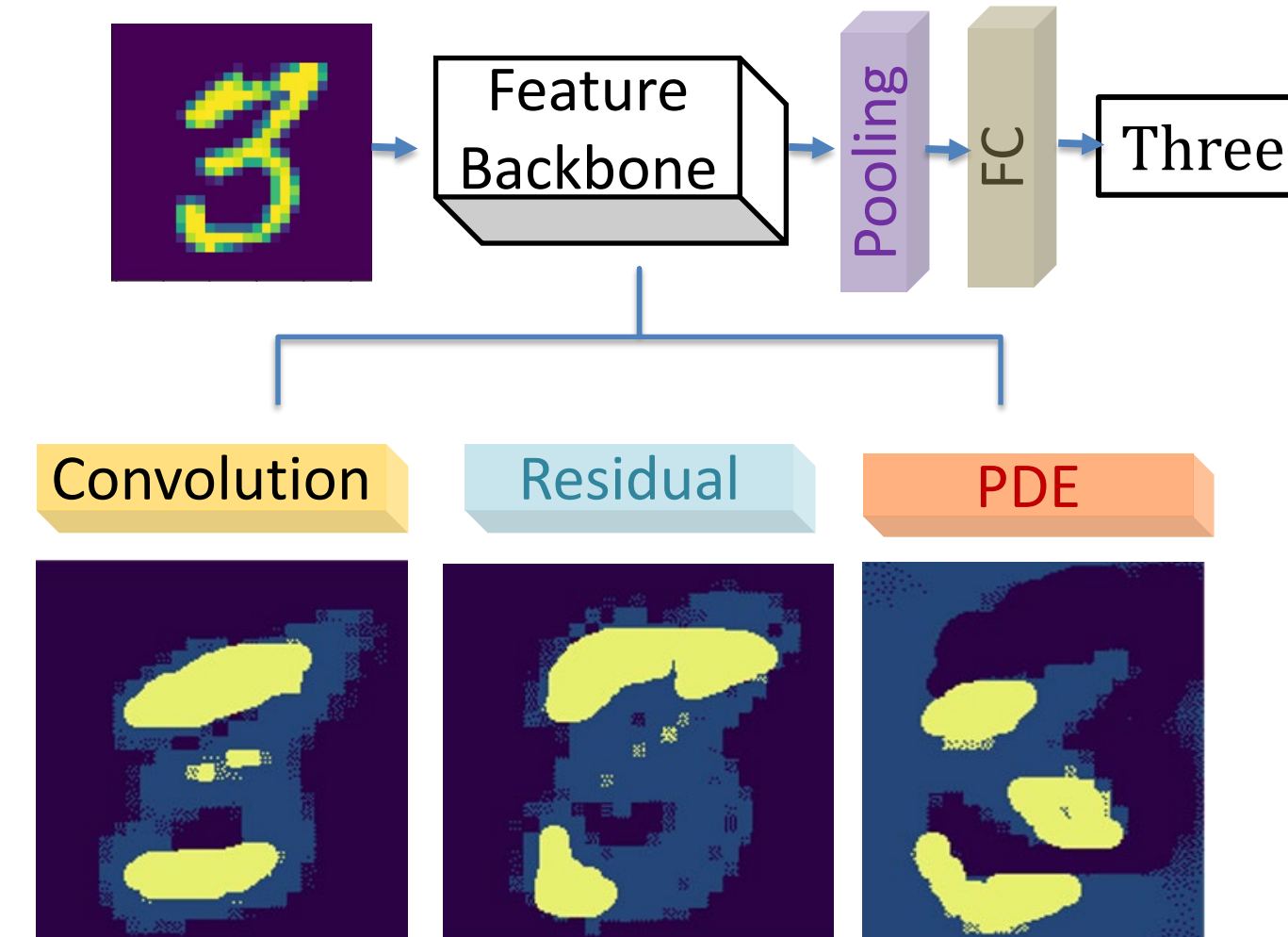
- Apply PDE instead of repetitions



- Shallow Networks
- Low Storage & Compute
- Integrable in any network



- Visualization : MNIST-10



Feature Backbone	Accuracy (%)	Confusion b/w 3 & 5
Convolution	92.01	27
Residual	92.53	30
Global	95.03	9

- Baseline Comparison : CIFAR-10

Architecture	Accuracy (%)	#Params	#MACs	Inference Time (s)	Depth
ResNet-32	92.49	460K	70M	4.5	15
MDEQ	92.28	1.1M	1.5B	23.3	-
ResNet-Global	91.93	162K	15M	1.9	6

## Empirical Evaluation Highlights

- Low Model Footprint @ Similar Accuracy

Architecture	CIFAR-10 Acc. (%)	CIFAR-100 Acc. (%)	#Params	#MACs
NeuPDE	95.4	76.4	9M	4.1B
MDEQ	93.8	71.1	10M	8.3B
ResNet-32	92.4	68.6	473K	70M
ResNet-Global	91.9	68.1	168K	15M
DenseNet	95.3	77.2	800K	297M
DenseNet-Global	95.0	75.7	481K	136M
DARTS	97.1	82.5	3.4M	539M
DARTS-Global	96.9	81.9	835K	213M

- High Accuracy @ Similar Model Footprint

Architecture	CIFAR-100 Acc. (%)	#Params	#MACs	Tiny Models		
				CIFAR-100 Acc. (%)	#Params	#MACs
ResNet-56	70.4	861K	127M	35.2	14K	3.4M
ResNet-Global	74.3	1.3M	119M	43.6	16K	3.6M
DenseNet	77.2	800K	297M	-	-	-
DenseNet-Global	78.9	922K	247M	-	-	-
Wide-ResNet	79.1	9M	1.3B	39	23K	9.8M
Wide-ResNet-Global	80.5	9M	1.3B	50.2	24K	8.7M
DARTS	82.5	3.4M	539M	54.6	43K	7.7M
DARTS-Global	84.2	2.4M	519M	60.7	41K	8.2M

- Scales easily to Imagenet-1K

Architecture	Top-1 Acc. (%)	#Params	#MACs
MDEQ-Small	75.5	18M	21B
MBV2	71.9	3.4M	300M
MBV2-Global	71.6	1.6M	193M
MBV3	75.2	5.4M	219M
MBV3-Global	74.1	3M	156M
EfficientNet-B0	77.1	5.3M	390M
EfficientNet-B0-Global	76.1	2.4M	244M

- [https://github.com/anilkagak2/PDE\\_GlobalLayer](https://github.com/anilkagak2/PDE_GlobalLayer)