Sensitivity Characterization

Back propagation is used to characterize the sensitivity of application accuracy to the output of each neuron

DNNs
ResNet
AlexNet
Inception v4
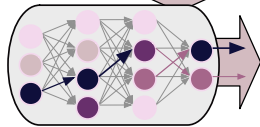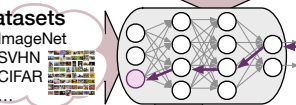GoogLeNet
DenseNet
VGG16
...

Backpropagation determines error contributed by each neuron

Datasets
ImageNet
SVHN
CIFAR
...

Sens. Map		
Layer	Neuro	Sens
1	1	.15
1	2	.12
1	3	.3
⋮	⋮	⋮
3	1	.41
3	2	.17
⋮	⋮	⋮
6	3	.46

Less Sensitive → More Sensitive

Selective Error Protection

High Protection Factor

Low Protection Factor

Sens. Map		
Layer	Neuro	Sens
1	1	.15
1	2	.12
1	3	.3
⋮	⋮	⋮
3	1	.41
3	2	.17
⋮	⋮	⋮
6	3	.46

Neural network with selective error protection applied
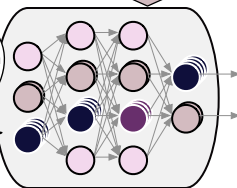
Error protection is selectively applied to neural operations proportional to their sensitivity

Optimization

Adjust Protection Factors

Evaluate Accuracy

Implement

Protection Factors
4X
1X

Fault Injection

Cost Model

Accuracy constr.

Fault injection provides error characterization

Accuracy Constraint met?

N

Y

Config. Map		
Layer	Neuro	PF
1	1	1
1	2	1
1	3	3
⋮	⋮	⋮
3	1	4
3	2	1
⋮	⋮	⋮
6	3	4

Optimization adjusts protection factors for each class of neuron sensitivity until accuracy constraint is met