Training CNNs: AlexNet & ResNet

Lesson 4

AlexNet

A Neural Network introduced in the paper: Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." *Advances in neural information processing systems* (2012).

- 227x227 inputs
- 5 Convolutional layers
- Max pooling
- 3 fully-connected layers
- ReLU non-linearities

AlexNet

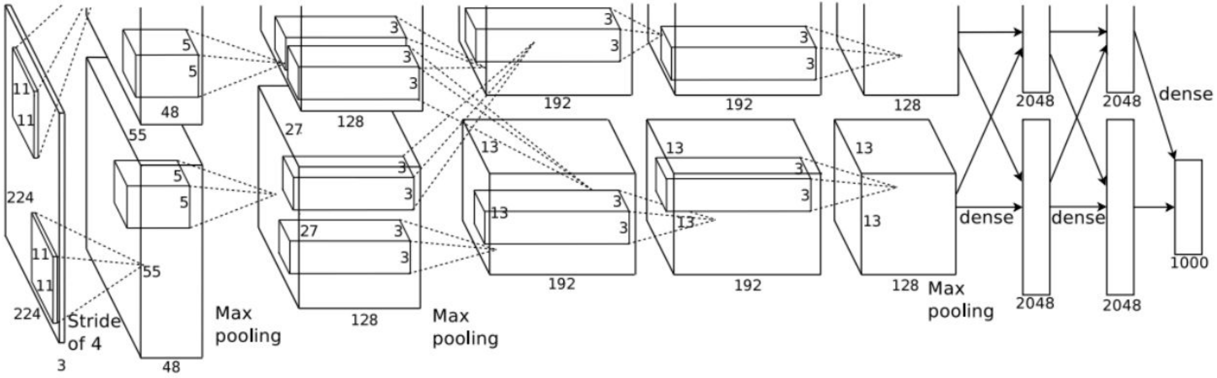


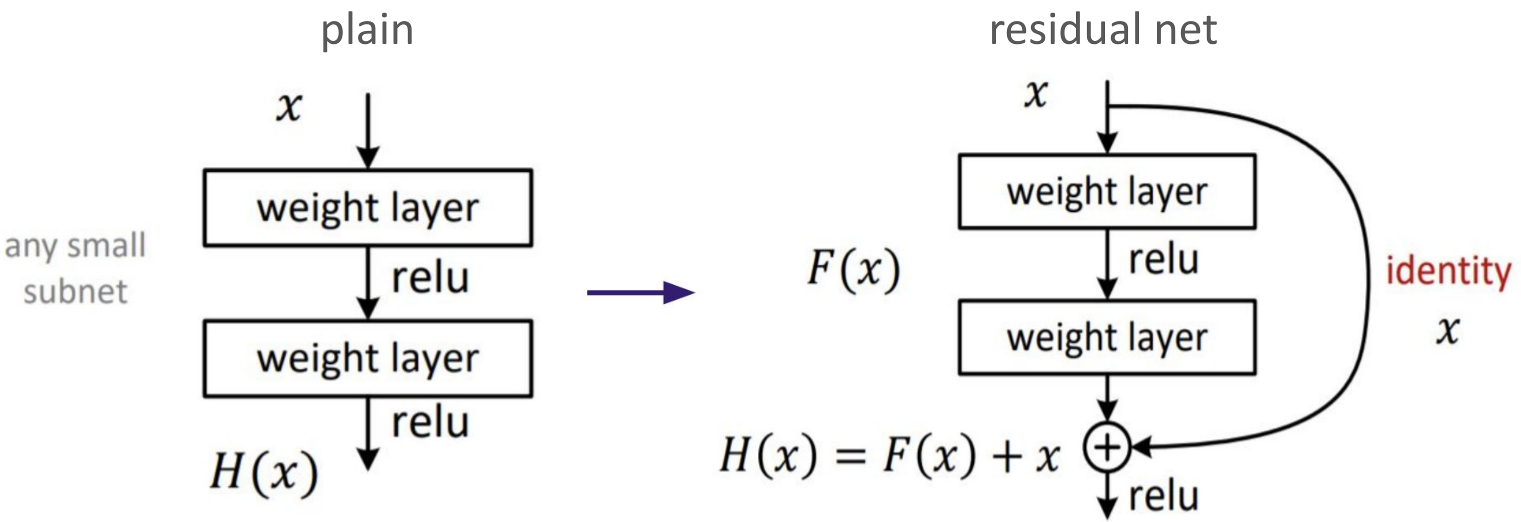
Figure 2: An illustration of the architecture of our CNN, explicitly showing the delineation of responsibilities between the two GPUs. One GPU runs the layer-parts at the top of the figure while the other runs the layer-parts at the bottom. The GPUs communicate only at certain layers. The network's input is 150,528-dimensional, and the number of neurons in the network's remaining layers is given by 253,440–186,624–64,896–64,896–43,264–4096–4096–1000.

AlexNet

	Input size		Layer				Output size				
Layer	C	H / W	filters	kernel	stride	pad	C	H / W	memory (KB)	params (k)	flop (M)
conv1	3	227	64	11	4	2	64	56	784	23	73
pool1	64	56		3	2	0	64	27	182	0	0
conv2	64	27	192	5	1	2	192	27	547	307	224
pool2	192	27		3	2	0	192	13	127	0	0
conv3	192	13	384	3	1	1	384	13	254	664	112
conv4	384	13	256	3	1	1	256	13	169	885	145
conv5	256	13	256	3	1	1	256	13	169	590	100
pool5	256	13		3	2	0	256	6	36	0	0
flatten	256	6					9216		36	0	0

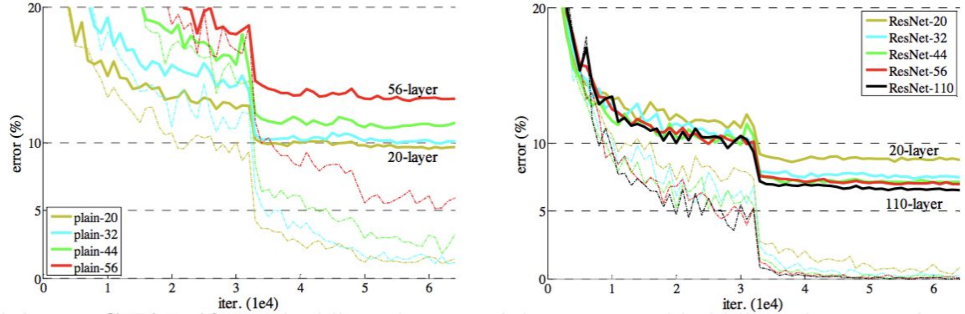
Deep Residual Network

- Residual unit: each layer adds something (i.e. a residual) to the previous value, rather than producing an entirely new value.
- Note: the network for F can have multiple layers, be convolutional, etc.



Deep Residual Network

- Deep Residual Networks (ResNets) consist of many layers of residual units.
- For vision tasks, the F functions are usually 2- or 3-layer conv nets.
- Performance on CIFAR-10, a small object recognition dataset:



- For a regular convnet, performance declines with depth, but for a ResNet, it keeps improving

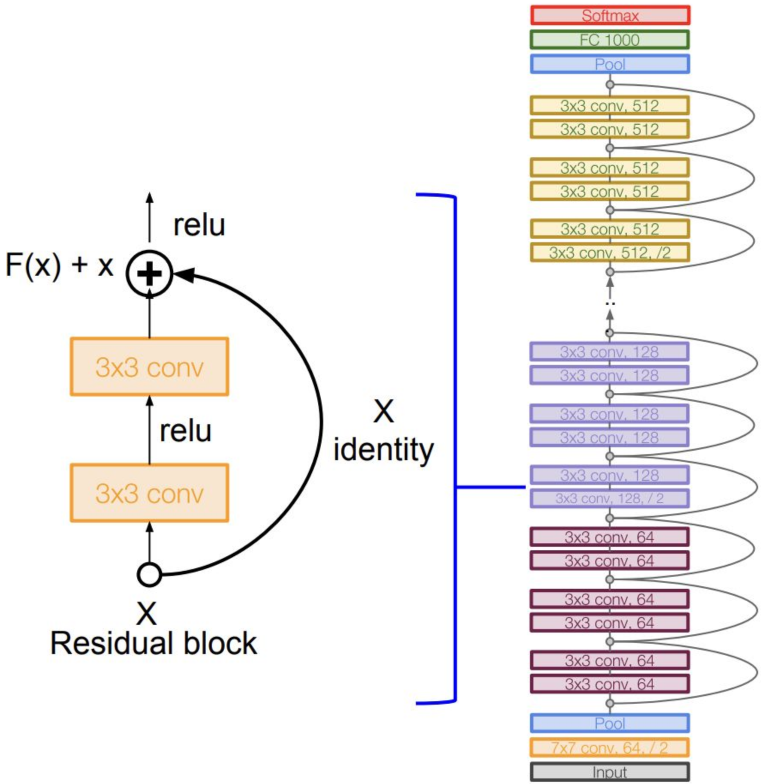
Easier and Faster Optimization

- Hypothesis: the problem is an optimization problem, deeper models are harder to optimize
- The deeper model should be able to perform at least as well as the shallower model.
- A solution by construction is copying the learned layers from the shallower model and setting additional layers to identity mapping.

ResNet

Full ResNet architecture:

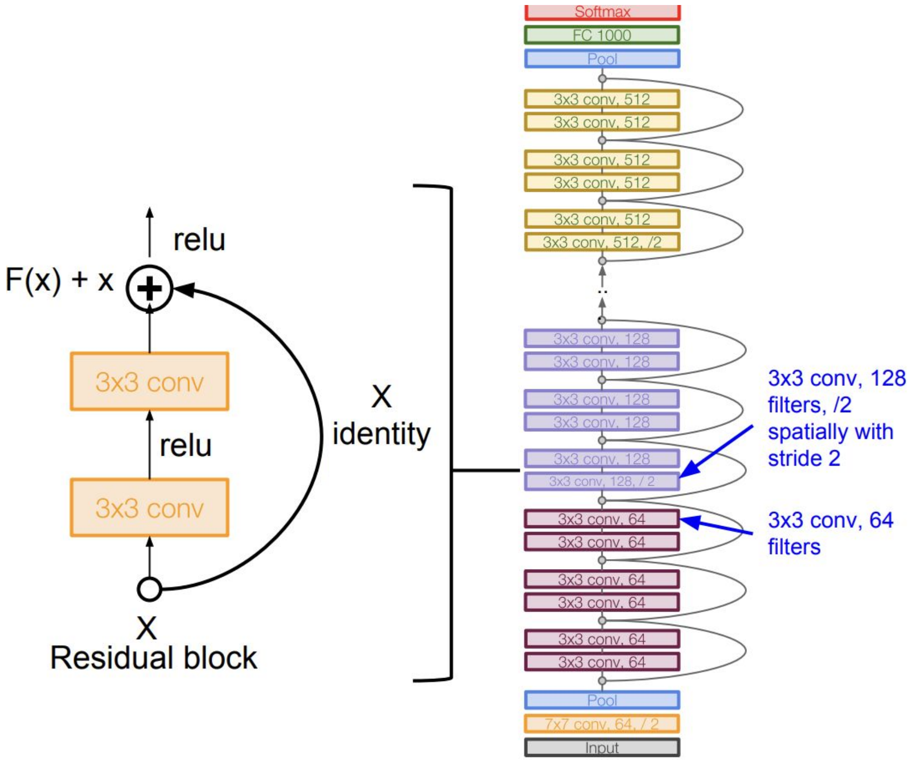
- Stack residual blocks
- Every residual block has two 3x3 conv layers



ResNet

Full ResNet architecture:

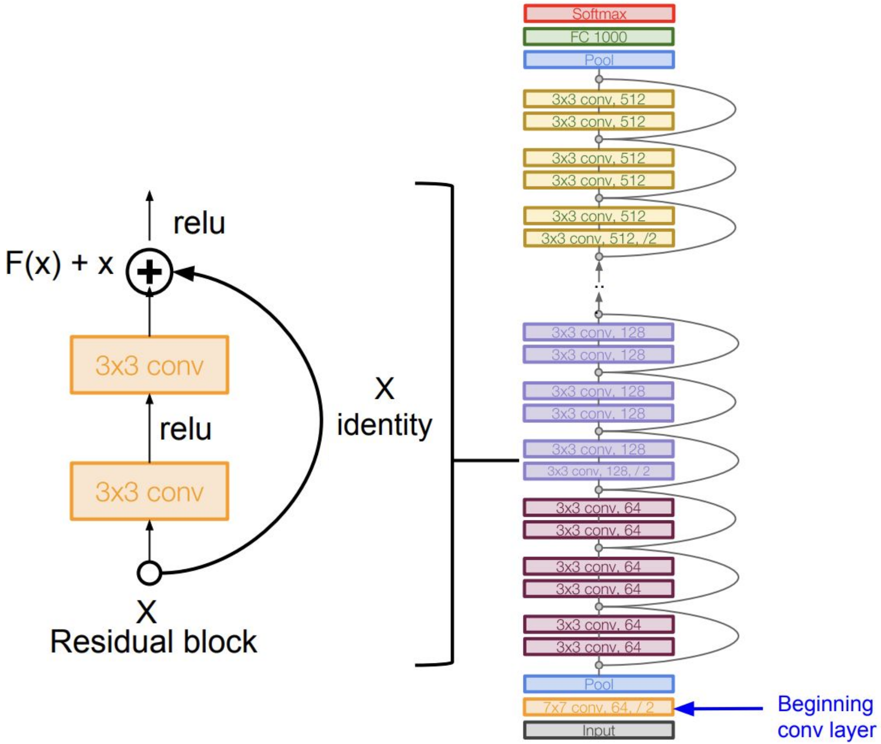
- Stack residual blocks
- Every residual block has two 3x3 conv layers
- Periodically, double # of filters and downsample spatially using stride 2 (/2 in each dimension)



ResNet

Full ResNet architecture:

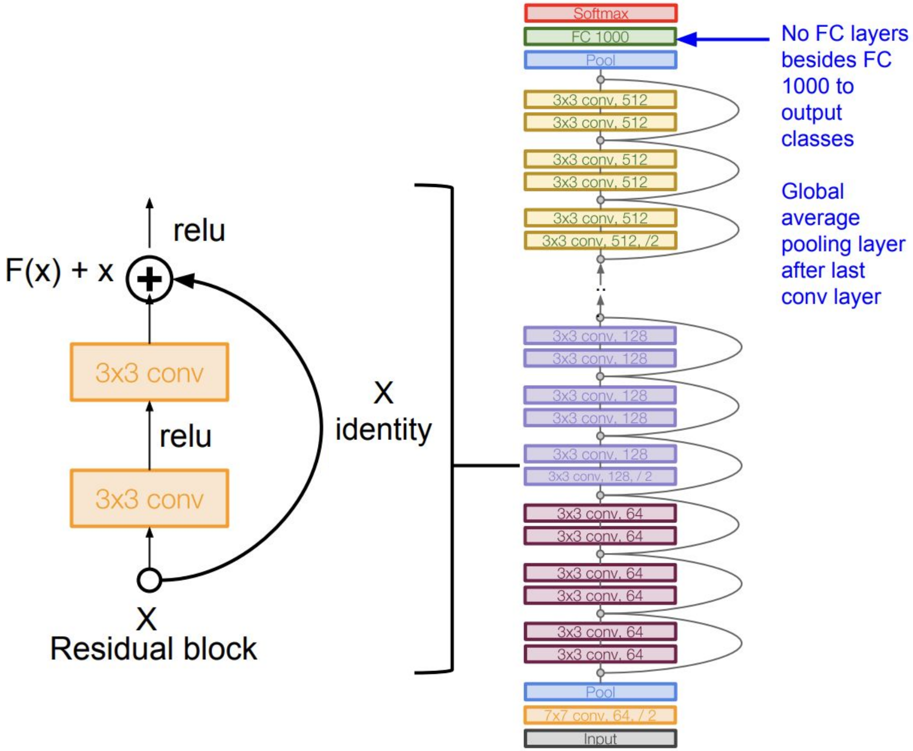
- Stack residual blocks
- Every residual block has two 3x3 conv layers
- Periodically, double # of filters and downsample spatially using stride 2 (/2 in each dimension)
- Additional conv layer at the beginning



ResNet

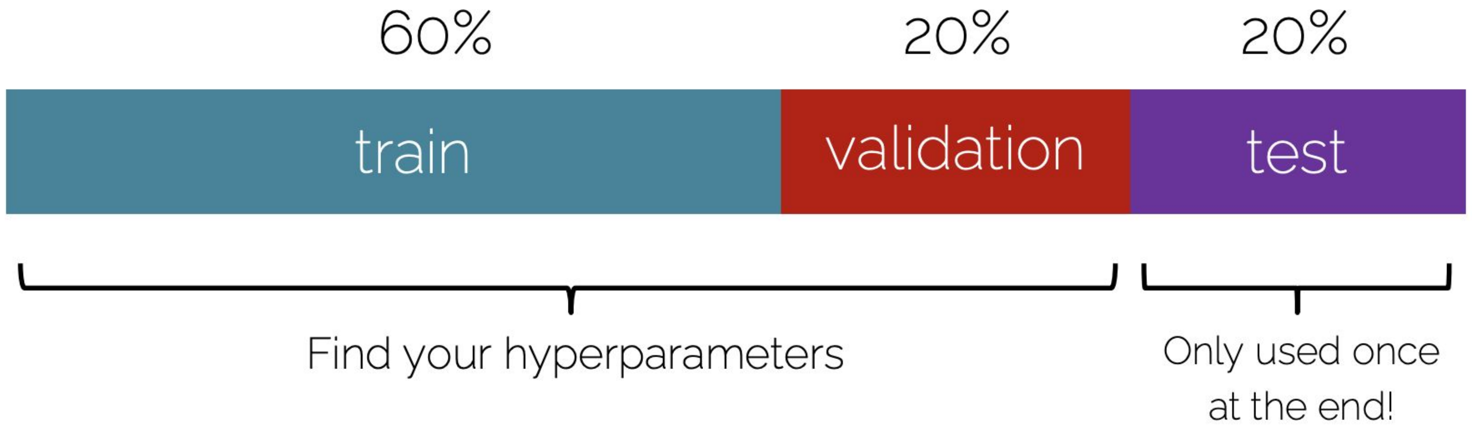
Full ResNet architecture:

- Stack residual blocks
- Every residual block has two 3x3 conv layers
- Periodically, double # of filters and downsample spatially using stride 2 (/2 in each dimension)
- Additional conv layer at the beginning
- No FC layers at the end (only FC 1000 to output classes)



How to find good hyperparameters?

- Split your data!



How to find good hyperparameters?

- Network architecture (e.g., num layers, hidden layer, activation function)
- Number of iterations (i.e., epochs)
- Learning rate(s)
- Regularization (i.e., decay, etc.)
- Batch size

Your turn!

- At this link http://cs231n.stanford.edu/tiny-imagenet-200.zip you can find the TinyImageNet dataset.
- Train an AlexNet network on it, by performing an hyper-parameter search.
- Report results for:
  - LR: 0.1, 0.001, 0.0001
  - Batch Size: 16, 32, 64
- What is the effect of changing the decay to the optimizer?
- Do the same analysis for the ResNet architecture.

Notebook @ https://colab.research.google.com/drive/1CN3ogAYfF2YZ8BybmDAOS3gfCqfvGFm_?