Dreaming with TensorFlow

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Software For Lab

SSH Access Software: PuTTy and pscp for Windows can be downloaded from www.putty.org

- Alternatively you may use a browser-based SSH option

You can copy files (Linux/Mac/Cygwin) to your computer using the following command and the generated password:

```
scp ubuntu@<ec2-address>:/file/location .
```

Or use Winscp from here: www.winscp.net

What we'll do today

- Introduction to machine learning and deep neural networks
- Introduction to convolutional neural networks
- Use a pre-trained model to classify images
- Visualize the features that this model has learned
  - Naive feature visualization
  - Using various optimizations
- Enhance images to look more like what the network expects

What to take away from this CodeLab

- Understand how image classification networks learn
- Play with TensorFlow
- Pretty pictures (and videos)

Connection Instructions

- Navigate to nvlabs.qwiklab.com
- Login or create a new account
- Select the “Instructor-Led Hands-on Labs” Class
- Find the lab called “Machine Learning Using TensorFlow”, select it, click *Select* and then *Start*

After a short wait, lab instance Connection information will be shown

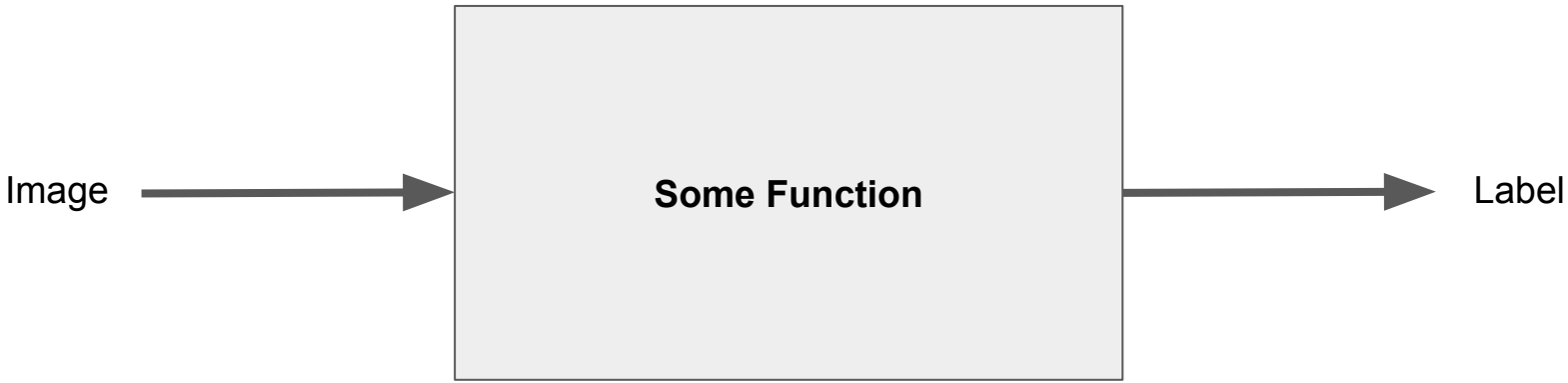
Please ask Lab Assistants for help!

TensorFlow

- Framework for distributed numerical computation
  - Operations similar to numpy
  - Special functionality for neural networks
  - Automatic differentiation
- Support for CPU and (multi-) GPU
- Computations can be distributed on many workers
- Support for mobile and web deployment
- Open-source: tensorflow.org or github.com/tensorflow/tensorflow

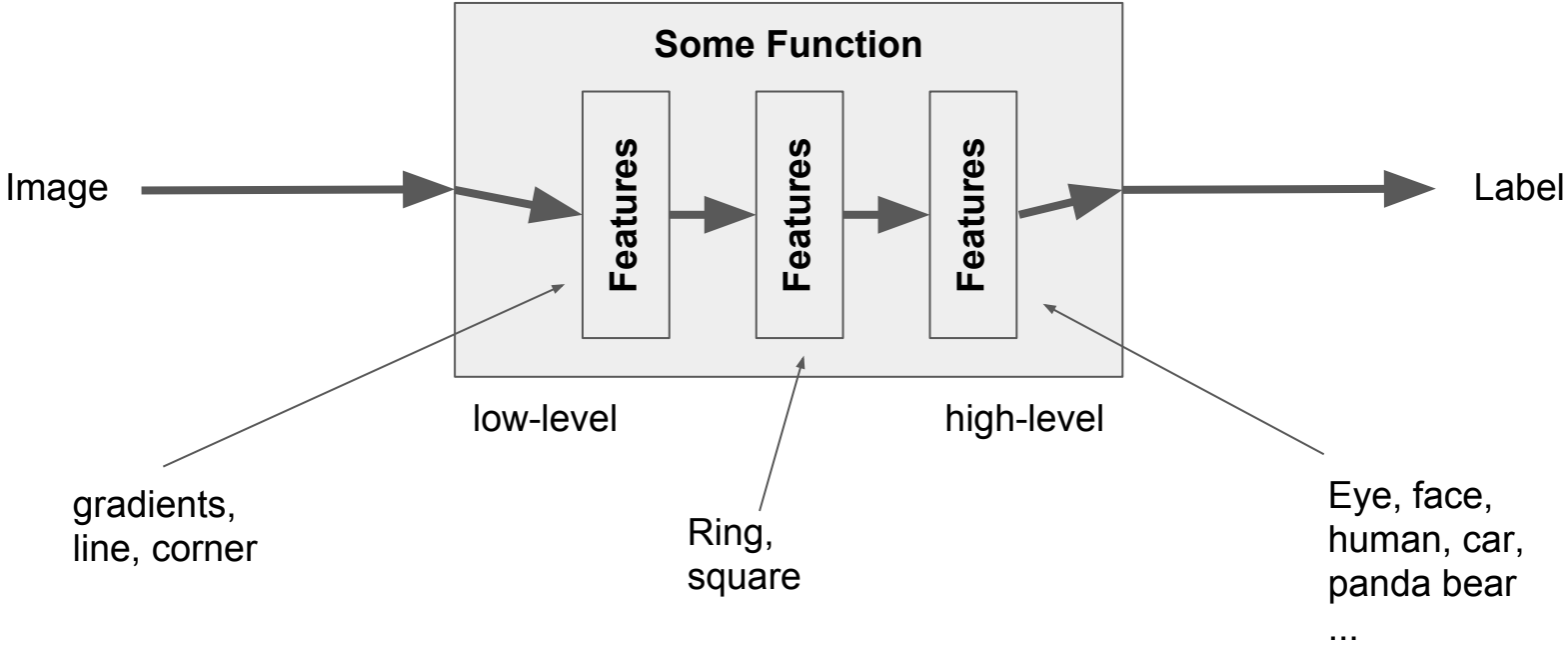
Machine Learning

- Learning some function from data

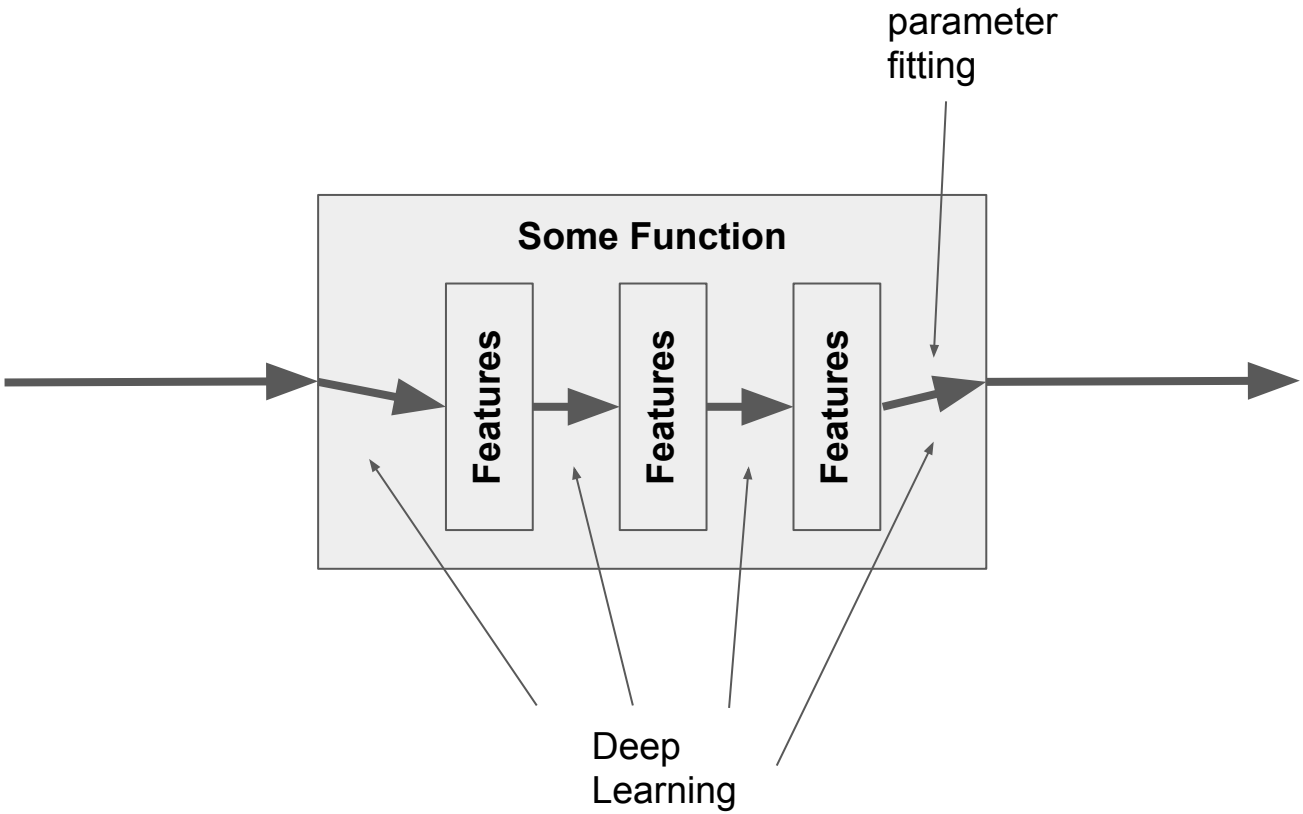


- Supervised learning: Learning some function from examples

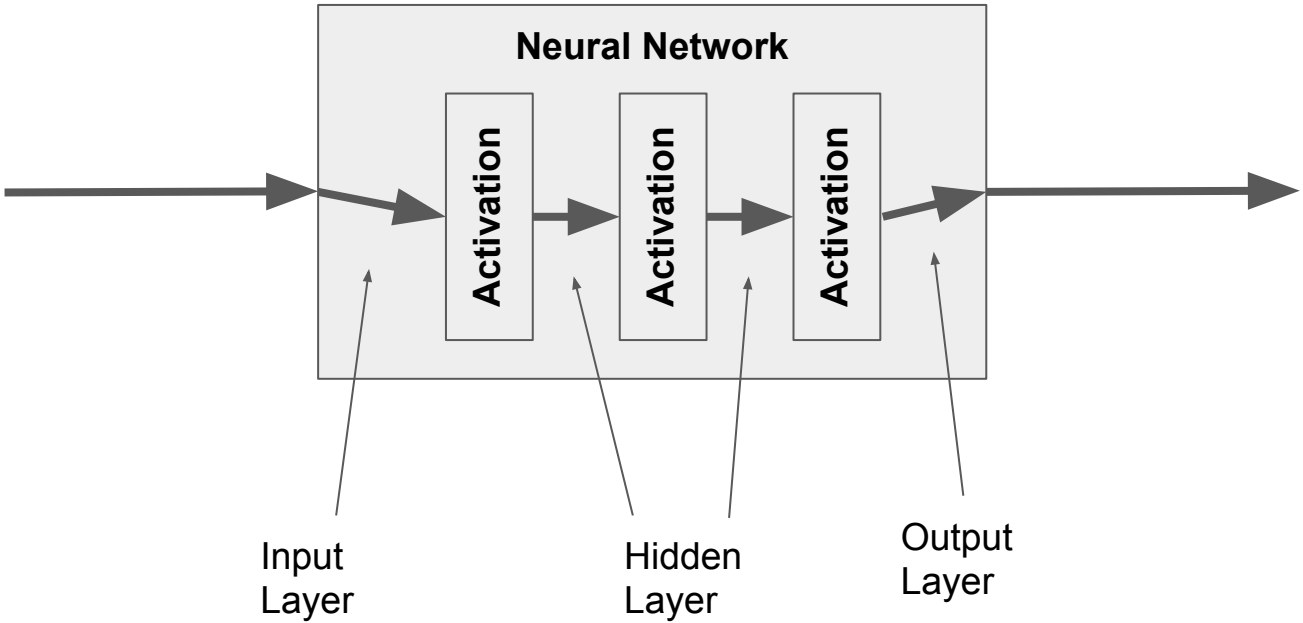
Features


Some Function
Features
Features
Features
Image
Label
low-level
high-level
gradients,
line, corner
Ring,
square
Eye, face,
human, car,
panda bear
...

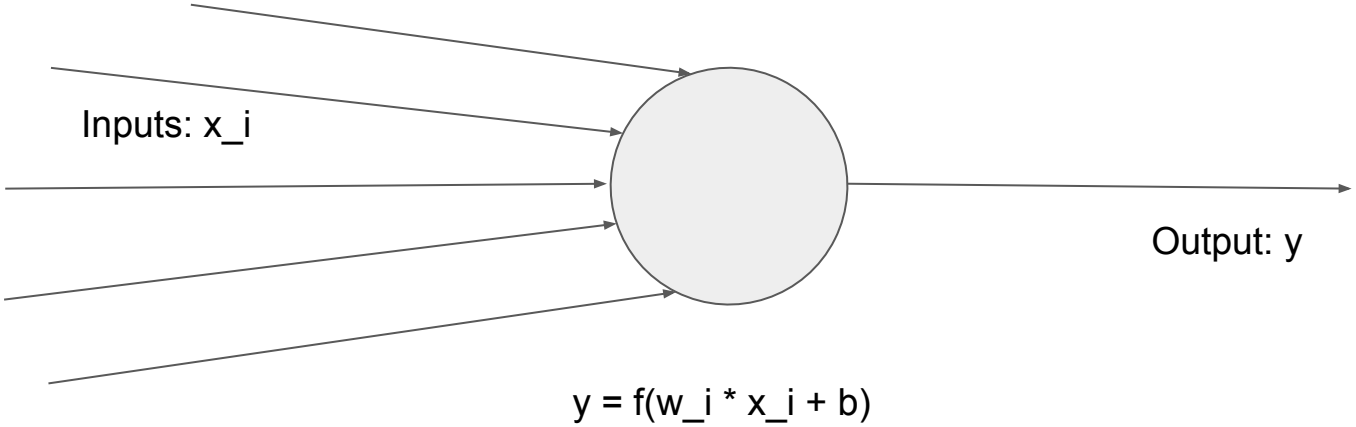
Deep Learning



(Deep) Neural Networks

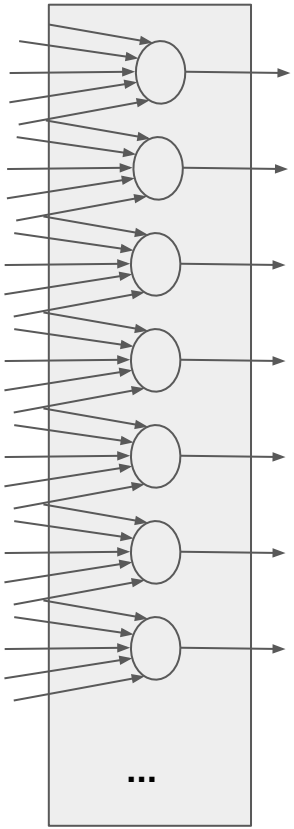


What is a neuron?



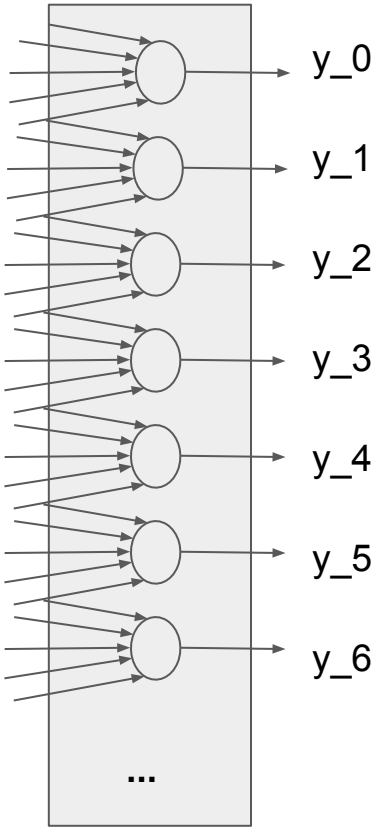
- Computes weighted sum of the inputs + bias + activation function

Neural Network Layer



- Computes y = f(A*x + b)
- Large matrix multiplication in each layer
- We learn A and b, many parameters
- GPUs are very good at this

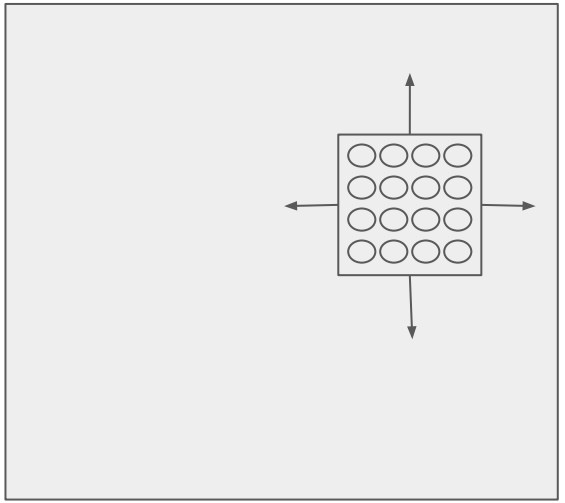
How do we compute Labels



- Last layer has a special activation function: *softmax*
- Outputs probabilities: y_3 = 0.5 means 50% chance that this image should be labeled “3”
- Translate numerical IDs to strings

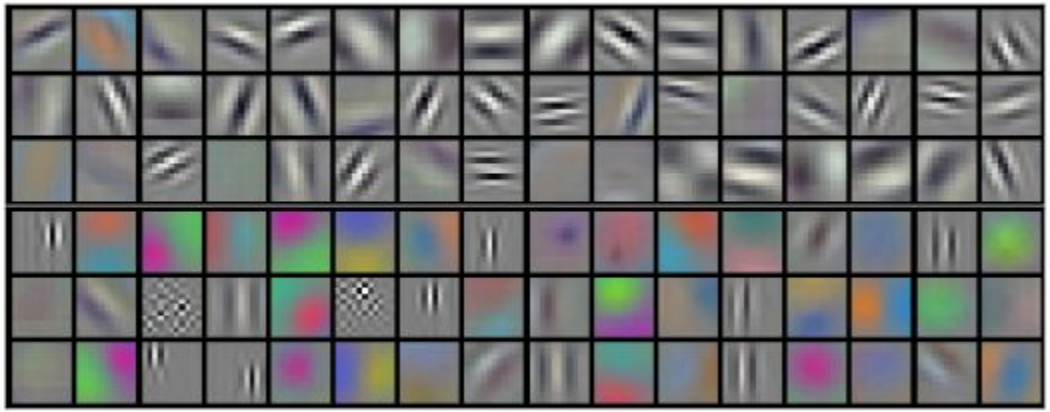
Convolutional Layer

- Input has repetitive structure (for example, image)
- Feature has local support (for example, corner)
- Neurons can share parameters
- Drastically reduces number of parameters to learn
- Drastically increases the amount of training data



The first Convolutional Layer

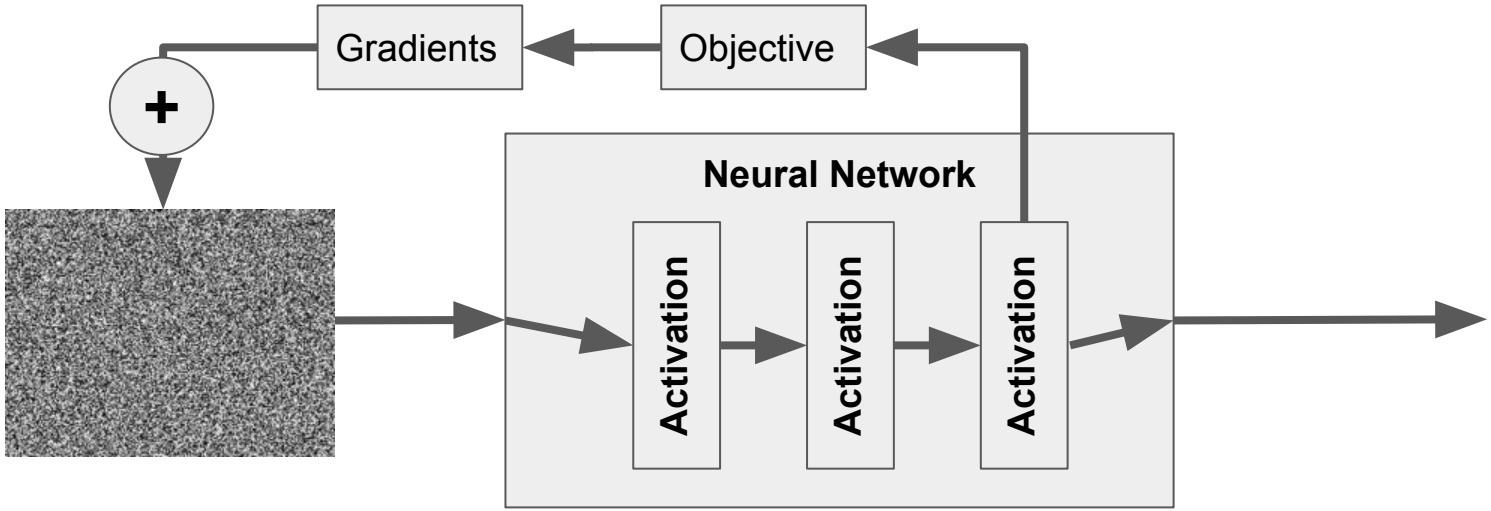
- Computes low-level features
- 7x7 convolution, for each pixel, looks only +/- 3 pixels around
- 7x7x3 parameters per feature
- Learned kernels can look like this, but usually don’t:



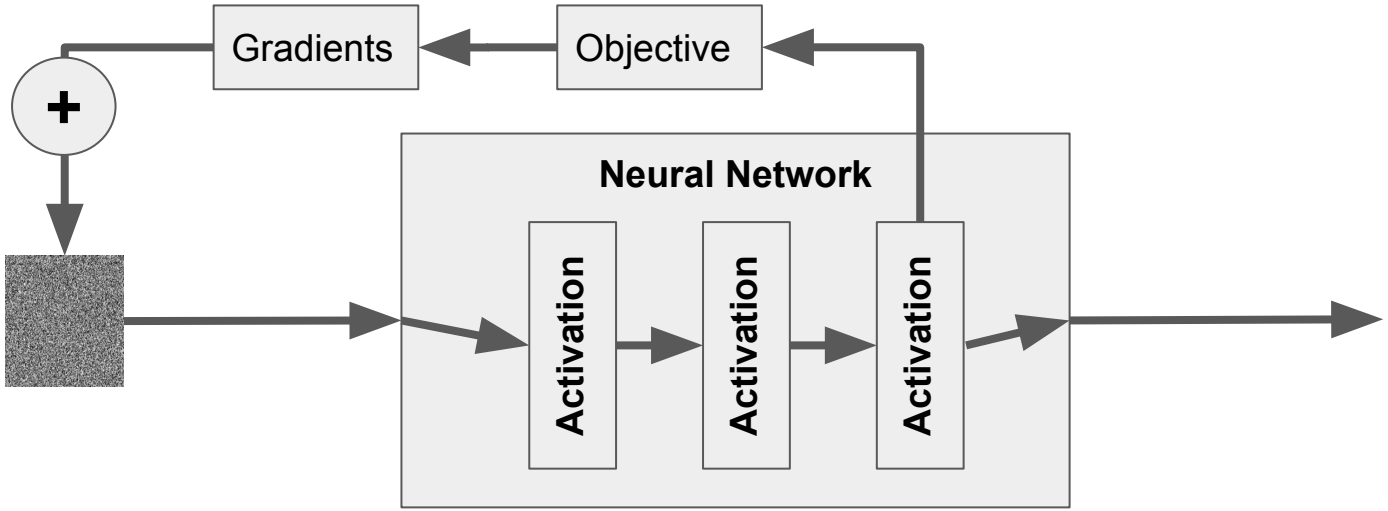
Krizehvsky *et al.* (2012)

Visualization by Optimization

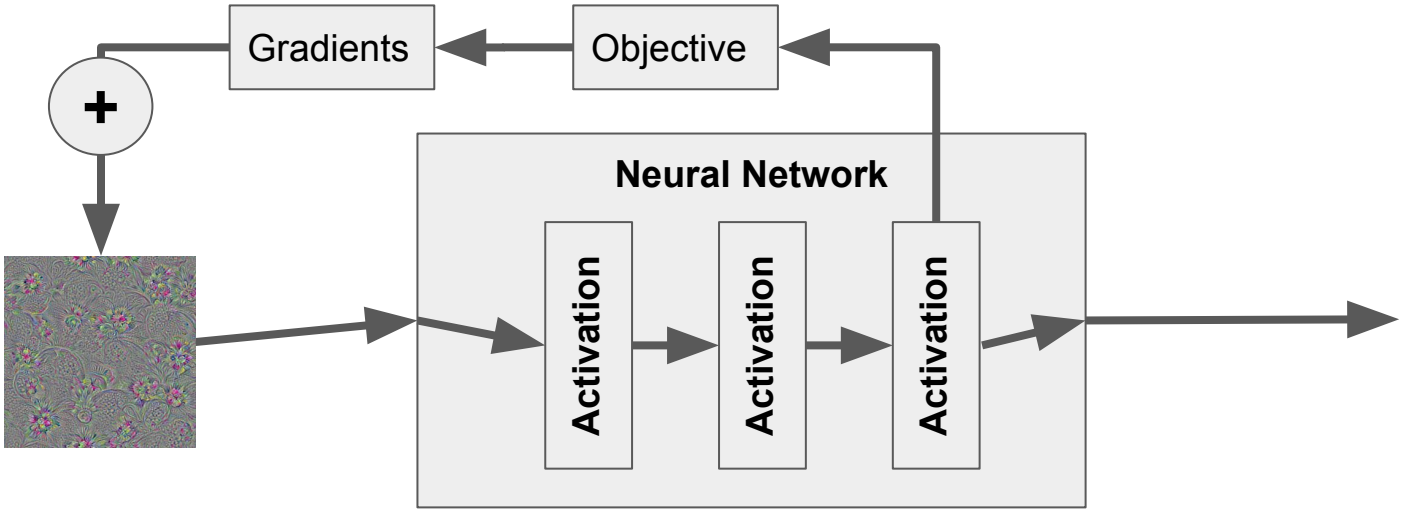
- Use the network to create images corresponding to features
- **Make this image look more like whatever this layer measures**
- Usually, start from random noise



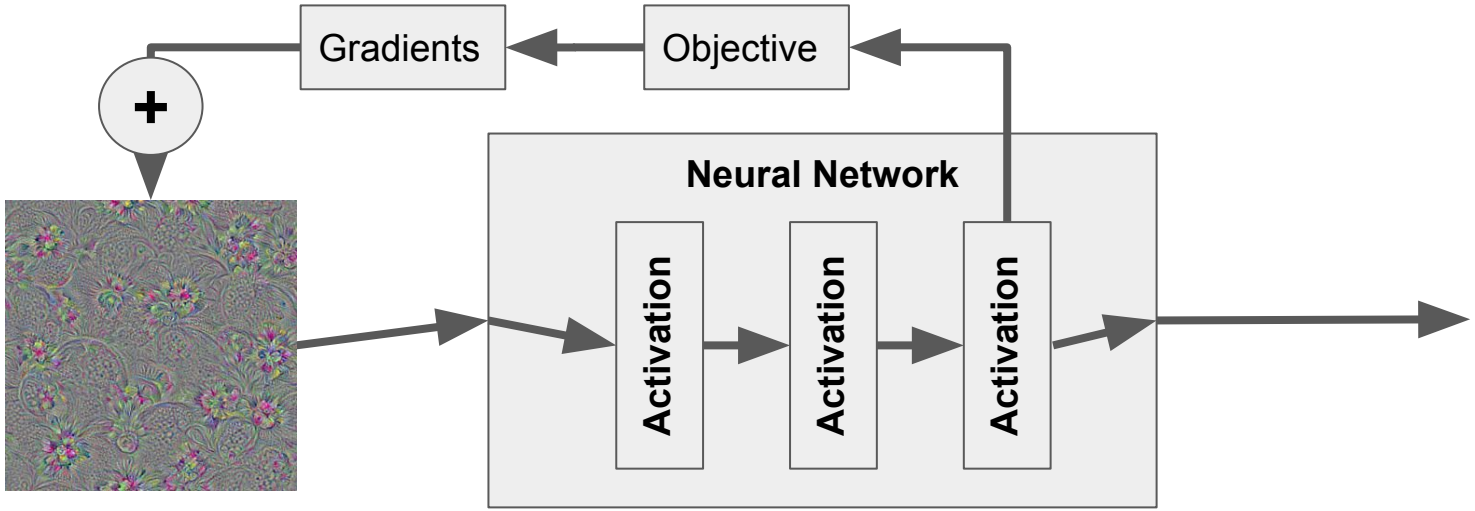
Multiscale Optimization



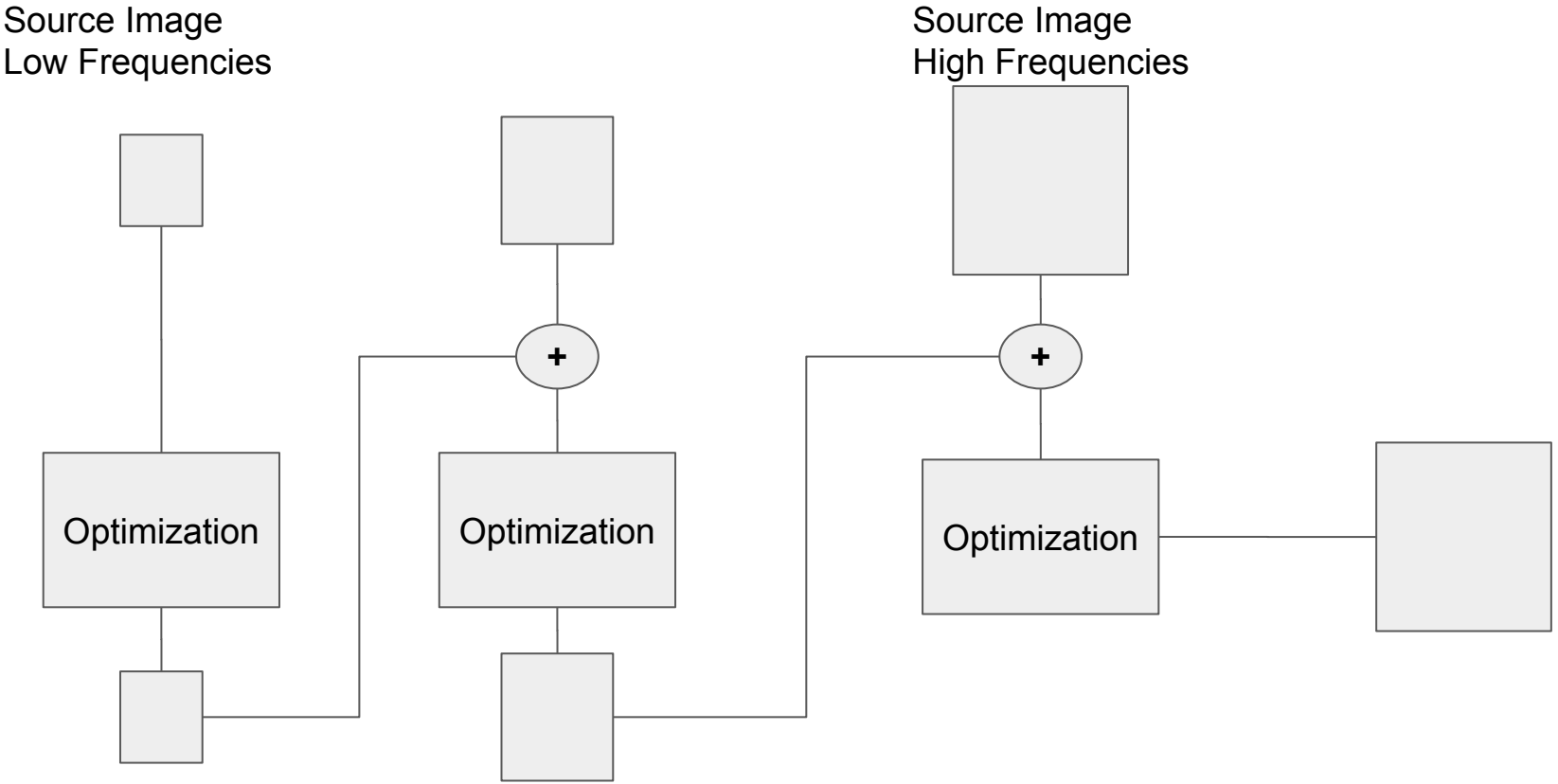
Multiscale Optimization



Multiscale Optimization



Deep Dream


Source Image
Low Frequencies
Source Image
High Frequencies
+
+
Optimization
Optimization
Optimization

More fun!

- Play with the objective function
- Make pretty pictures
- Make videos
  - Using video input
  - Using infinite zoom

- Do more tutorials on tensorflow.org

Further Hands-On Training

Check out the Self-Paced labs at the conference.

- Deep Learning, CUDA, OpenACC, Tools and more!
- Just grab a seat and take any available lab
- Located in the lower-level outside of LL20C

You will also receive Credits to take additional labs at nvidia.qwiklab.com

- Log in using the same account you used in this lab