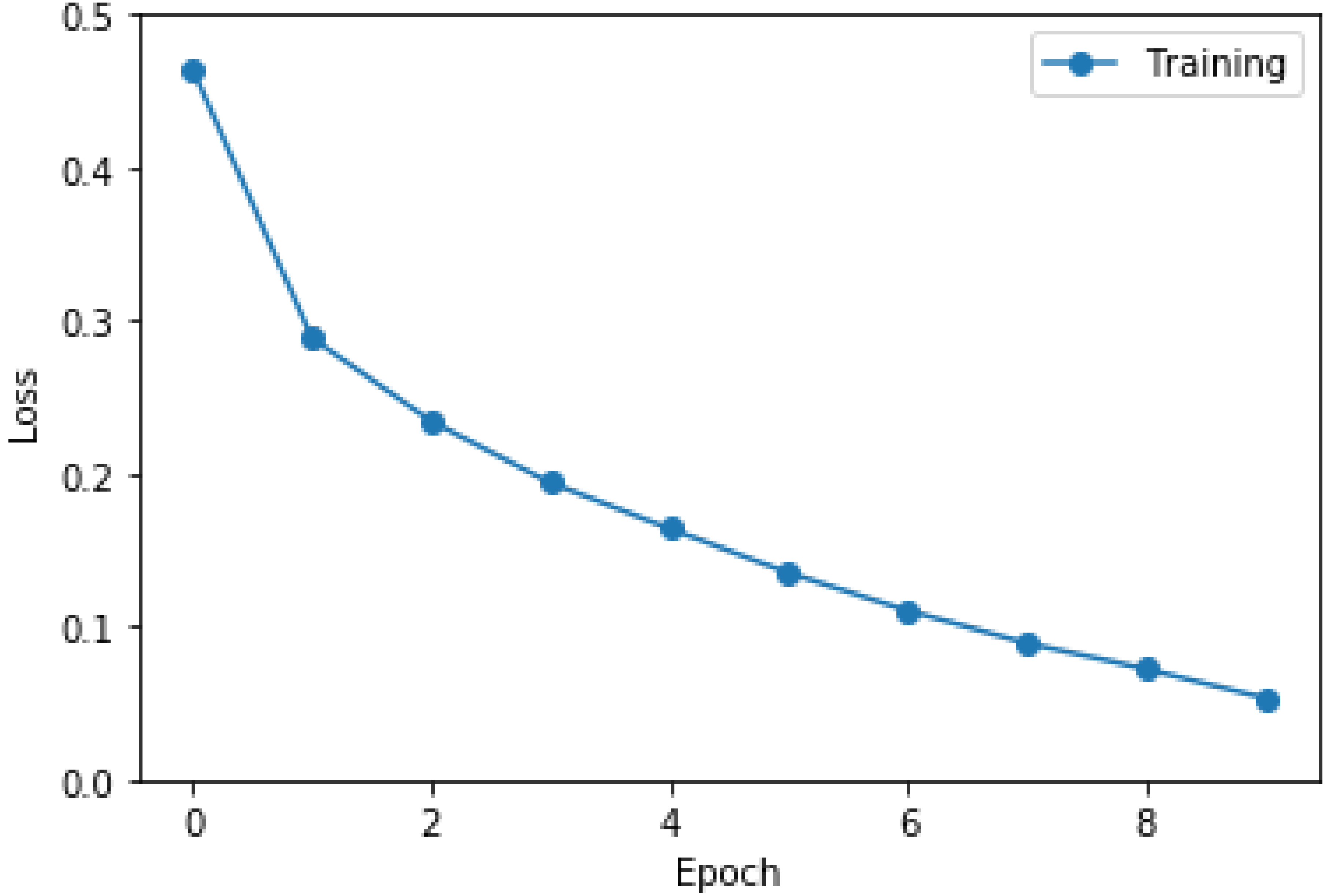
Tracking learning

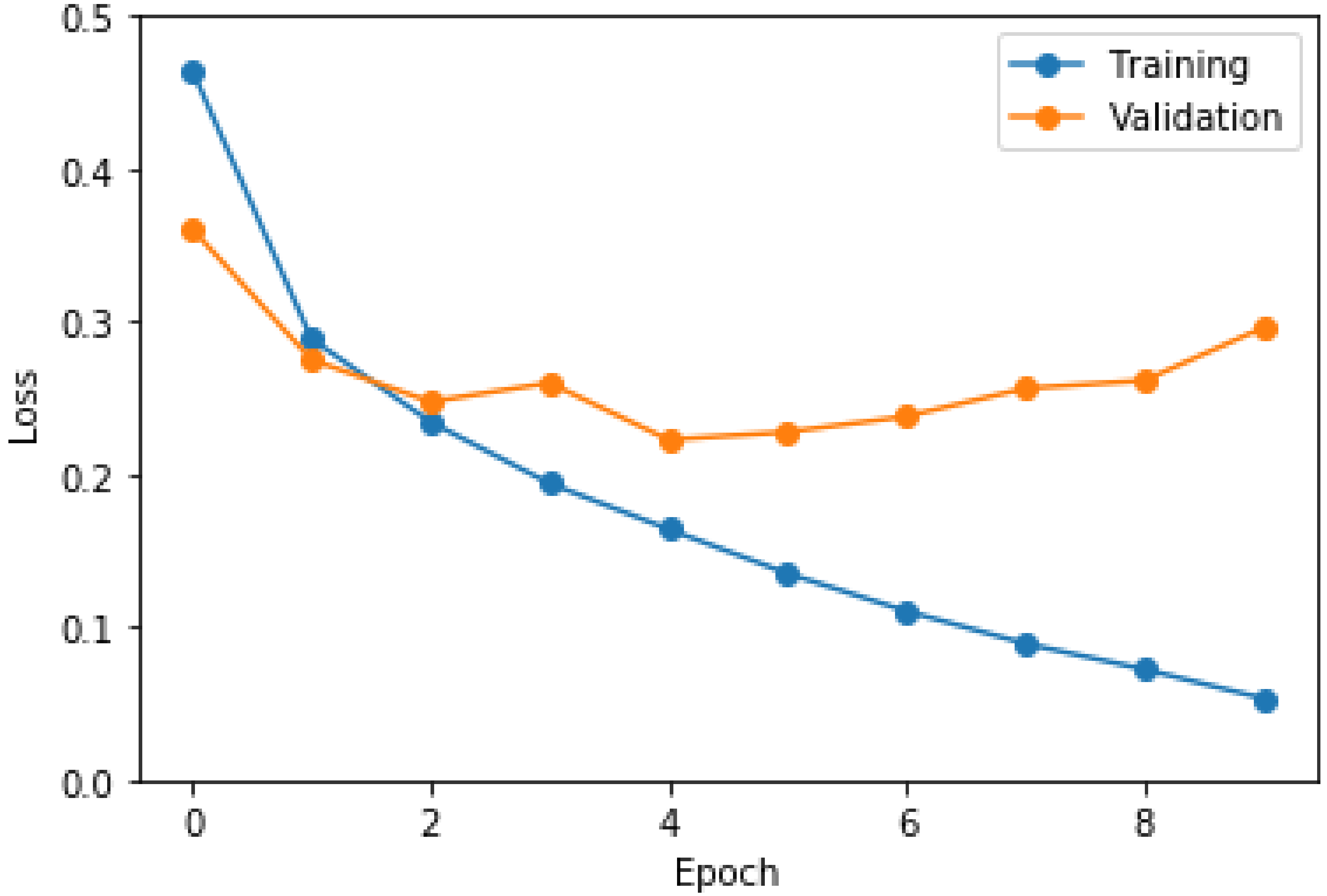
IMAGE MODELING WITH KERAS

Ariel Rokem
Senior Data Scientist, University of Washington

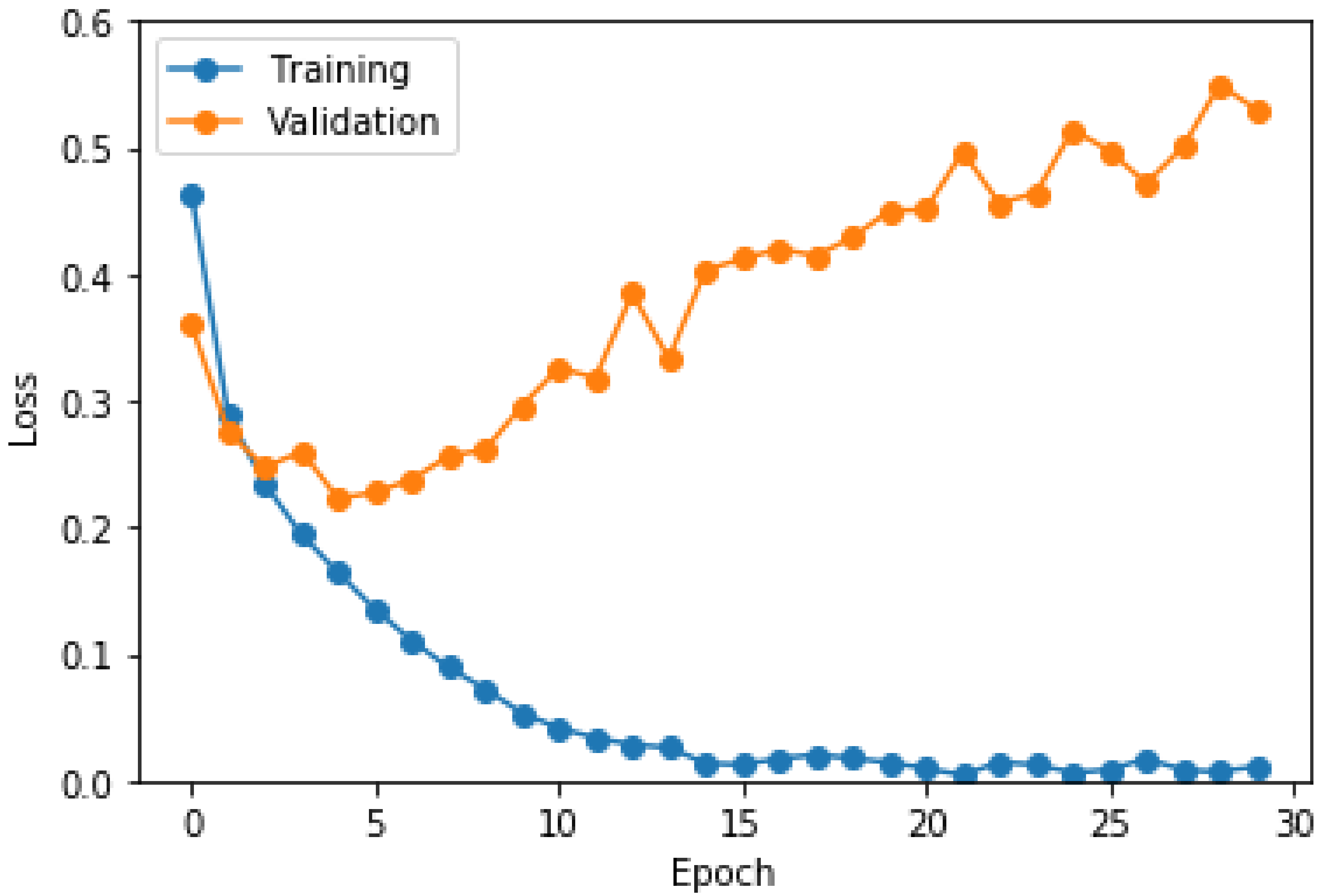
Learning curves: training



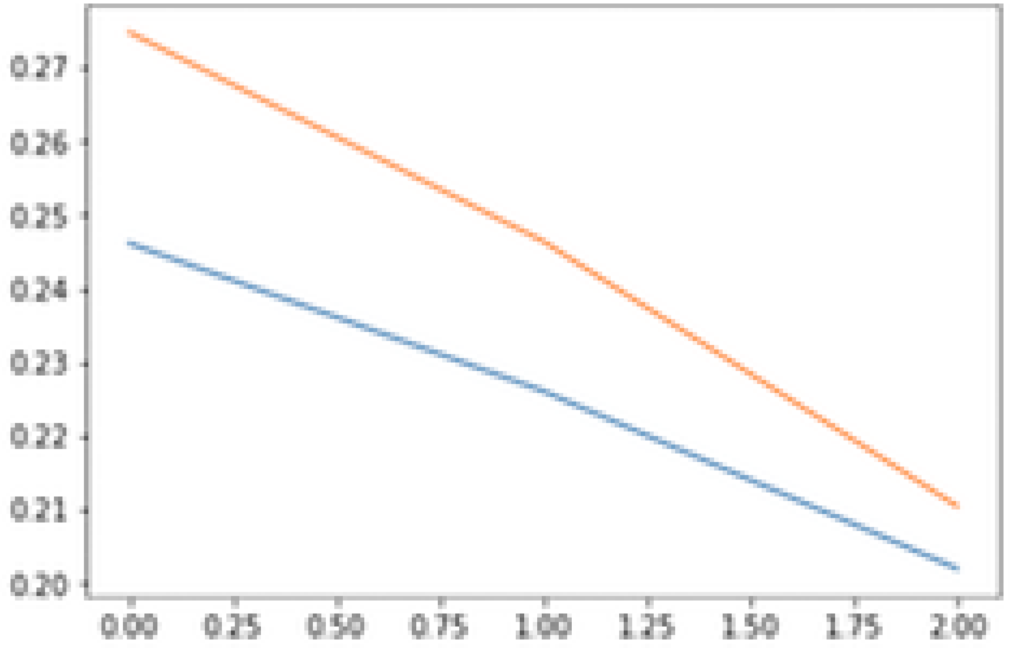
Learning curves: validation



Learning curves: overfitting



```
training = model.fit(train_data, train_labels,
                     epochs=3, validation_split=0.2)
import matplotlib.pyplot as plt
plt.plot(training.history['loss'])
plt.plot(training.history['val_loss'])
plt.show()
```



Storing the optimal parameters

```
from keras.callbacks import ModelCheckpoint

# This checkpoint object will store the model parameters
# in the file "weights.hdf5"
checkpoint = ModelCheckpoint('weights.hdf5', monitor='val_loss',
                             save_best_only=True)
# Store in a list to be used during training
callbacks_list = [checkpoint]
# Fit the model on a training set, using the checkpoint as a
#callback
model.fit(train_data, train_labels, validation_split=0.2,
          epochs=3, callbacks=callbacks_list)
```

Loading stored parameters

```
model.load_weights('weights.hdf5')
model.predict_classes(test_data)
array([2, 2, 1, 2, 0, 1, 0, 1, 2, 0])
```

Let's practice!

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Neural network regularization

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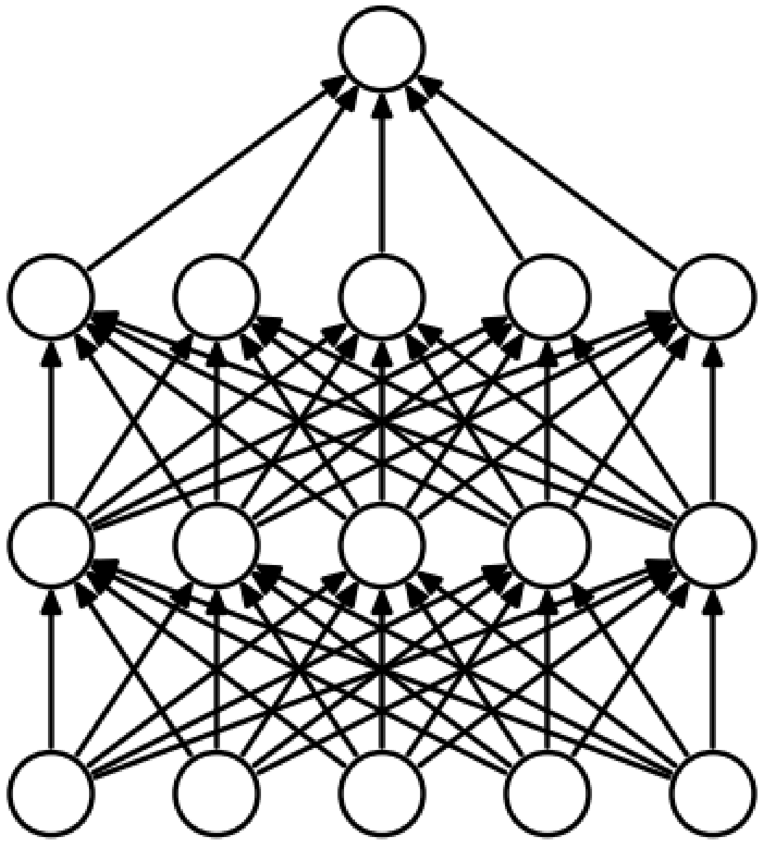
Dropout

In each learning step:

- Select a subset of the units
- Ignore it in the forward pass
- And in the back-propagation of error

Dropout



(a) Standard Neural Net

(b) After applying dropout.

Dropout in Keras

```
from keras.models import Sequential
from keras.layers import Dense, Conv2D, Flatten, Dropout
model = Sequential()
model.add(Conv2D(5, kernel_size=3, activation='relu',
                 input_shape=(img_rows, img_cols, 1)))
model.add(Dropout(0.25))
model.add(Conv2D(15, kernel_size=3, activation='relu'))
model.add(Flatten())
model.add(Dense(3, activation='softmax'))
```

Batch normalization

- Rescale the outputs

Batch Normalization in Keras

```
from keras.models import Sequential
from keras.layers import Dense, Conv2D, Flatten, BatchNormalization

model = Sequential()
model.add(Conv2D(5, kernel_size=3, activation='relu',
              input_shape=(img_rows, img_cols, 1)))
model.add(BatchNormalization())
model.add(Conv2D(15, kernel_size=3, activation='relu'))
model.add(Flatten())
model.add(Dense(3, activation='softmax'))
```

Be careful when using them together!

The disharmony between dropout and batch normalization

Let's practice!

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Interpreting the model

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Selecting layers

```
model.layers
```

```
[<keras.layers.convolutional.Conv2D at 0x109f10c18>,
 <keras.layers.convolutional.Conv2D at 0x109ec5ba8>,
 <keras.layers.core.Flatten at 0x1221ffcc0>,
 <keras.layers.core.Dense at 0x1221ffef0>]
```

Getting model weights

```
conv1 = model.layers[0]
weights1 = conv1.get_weights()
len(weights1)
```

```
2
```

```
kernels1 = weights1[0]
kernels1.shape
```

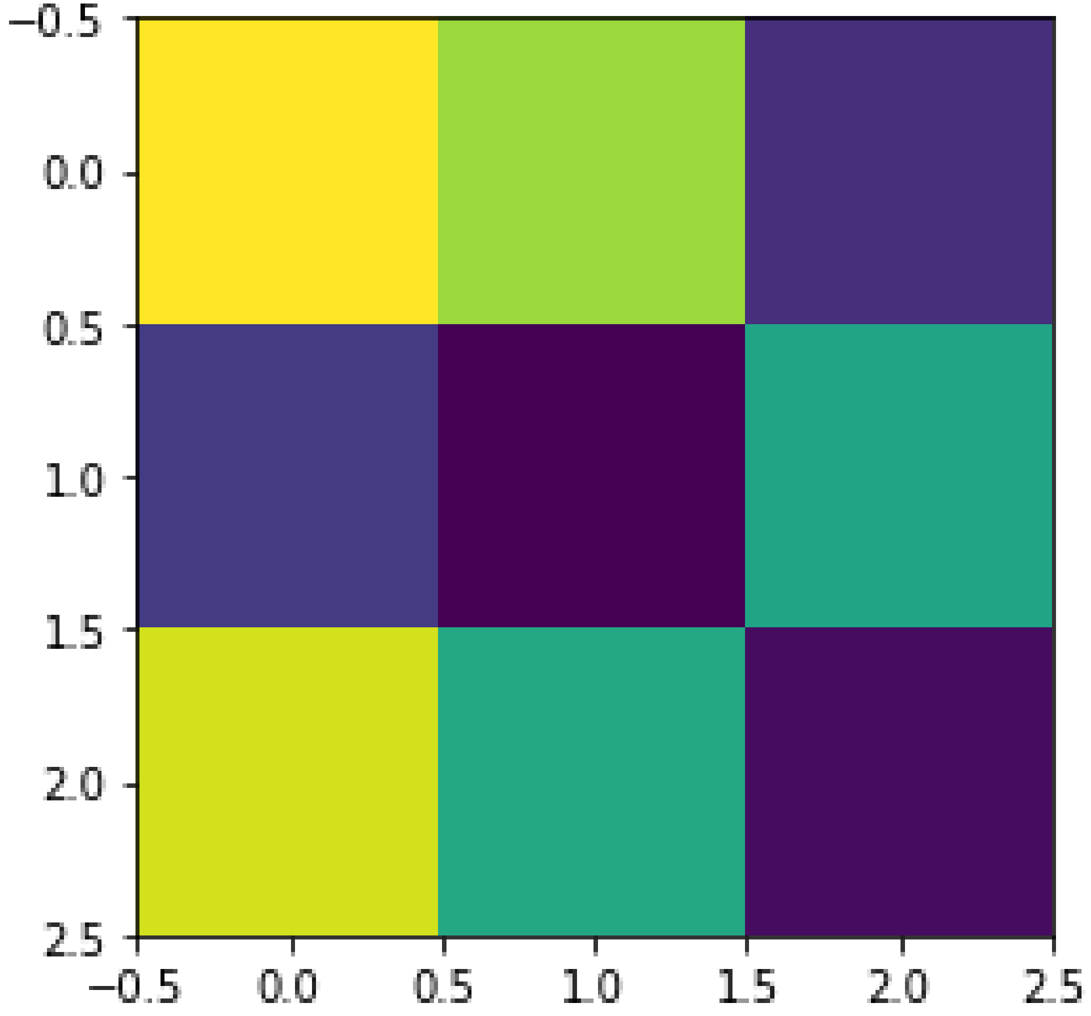
```
(3, 3, 1, 5)
```

```
kernel1_1 = kernels1[:, :,
                     0, 0]
kernel1_1.shape
```

```
(3, 3)
```

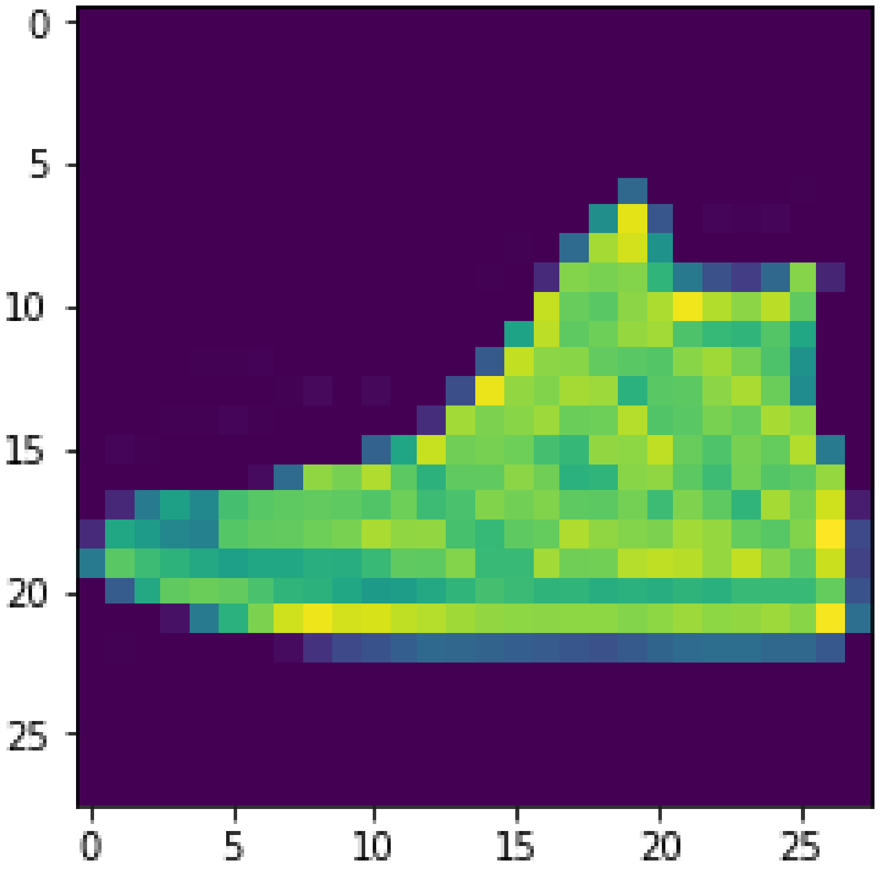
Visualizing the kernel

```
plt.imshow(kernel1_1)
```



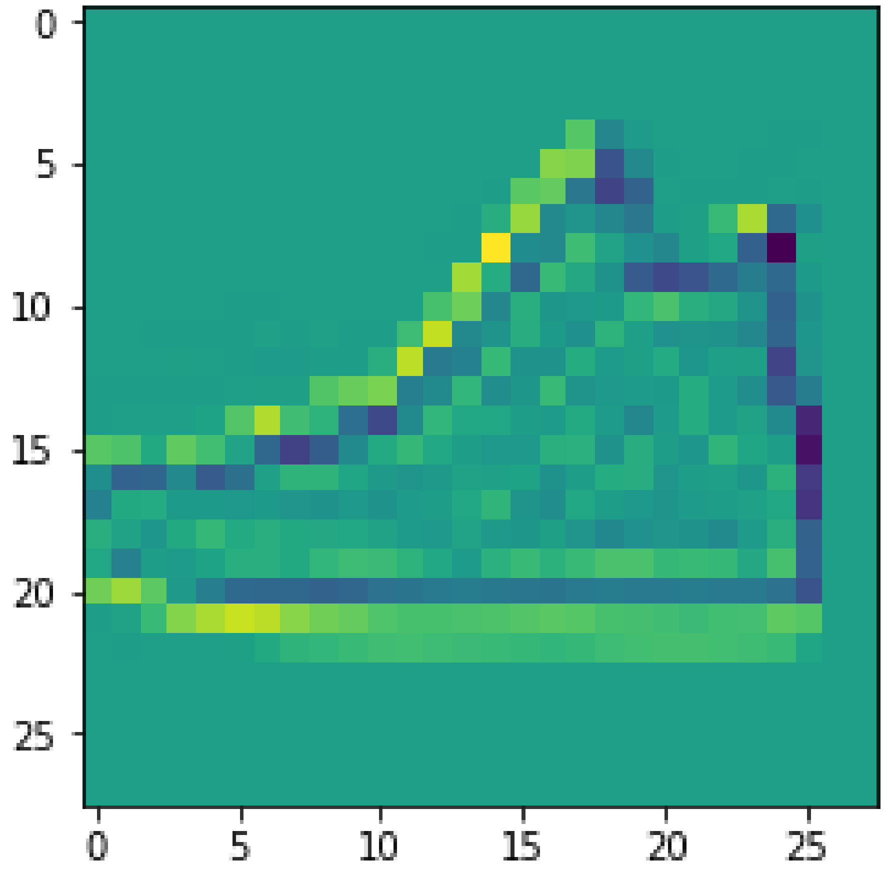
Visualizing the kernel responses

```
test_image = test_data[3, :, :, 0]
plt.imshow(test_image)
```



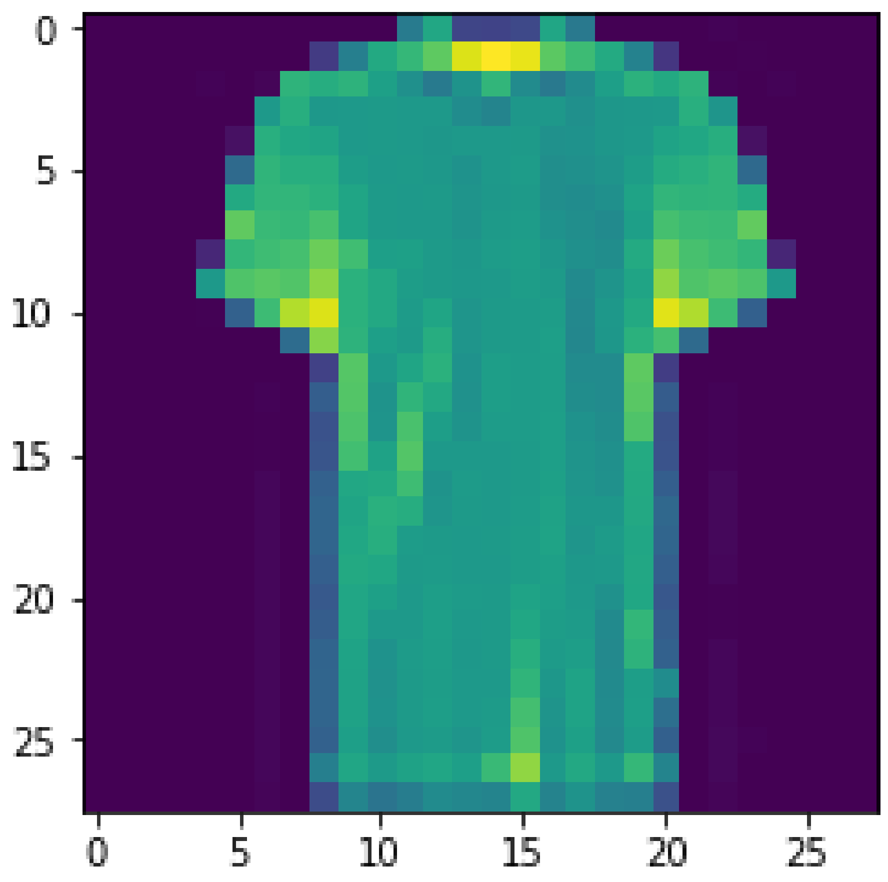
Visualizing the kernel responses

```
filtered_image = convolution(test_image, kernel1_1)
plt.imshow(filtered_image)
```



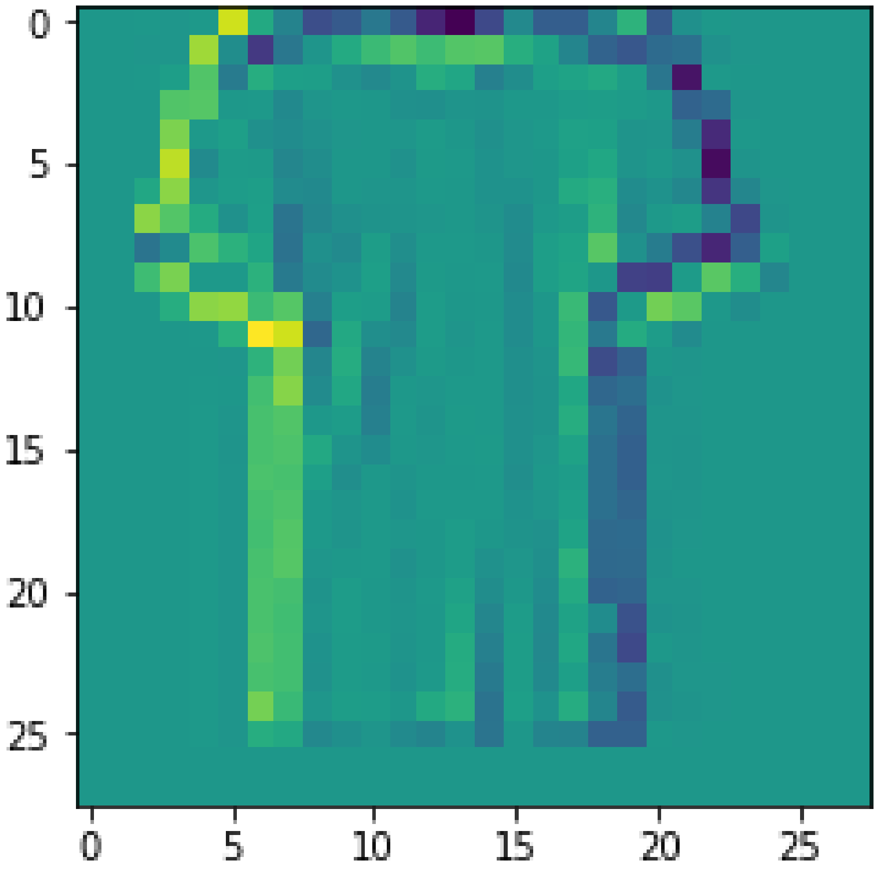
Visualizing the kernel responses

```
test_image = test_data[4, :, :, 1]
plt.imshow(test_image)
```



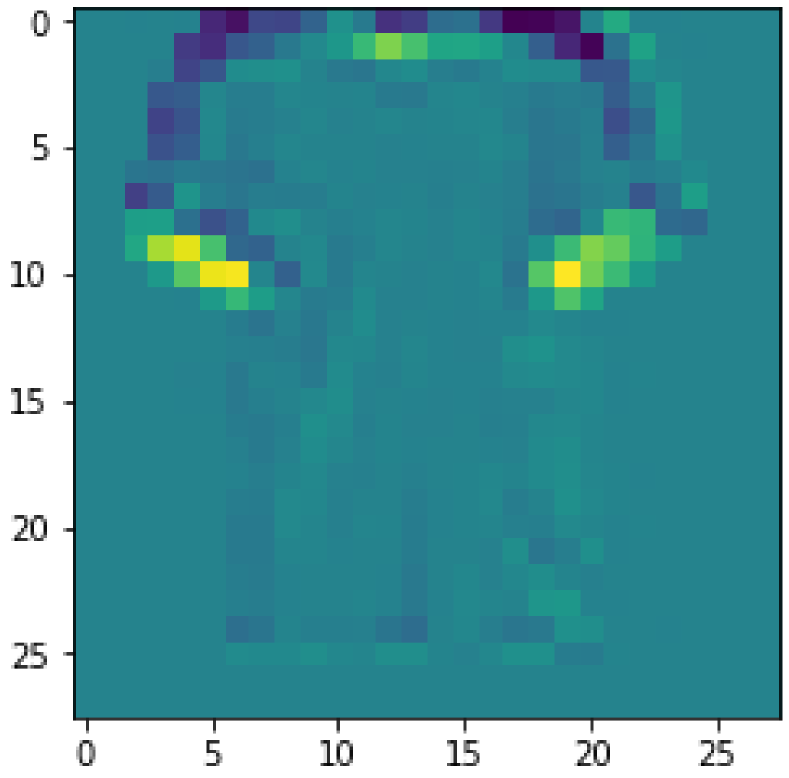
Visualizing the kernel responses

```
filtered_image = convolution(test_image, kernel1_1)
plt.imshow(filtered_img)
```



Visualizing the kernel responses

```
kernel1_2 = kernels[:, :, 0, 1]
filtered_image = convolution(test_image, kernel1_2)
plt.imshow(filtered_img)
```



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Wrapping up

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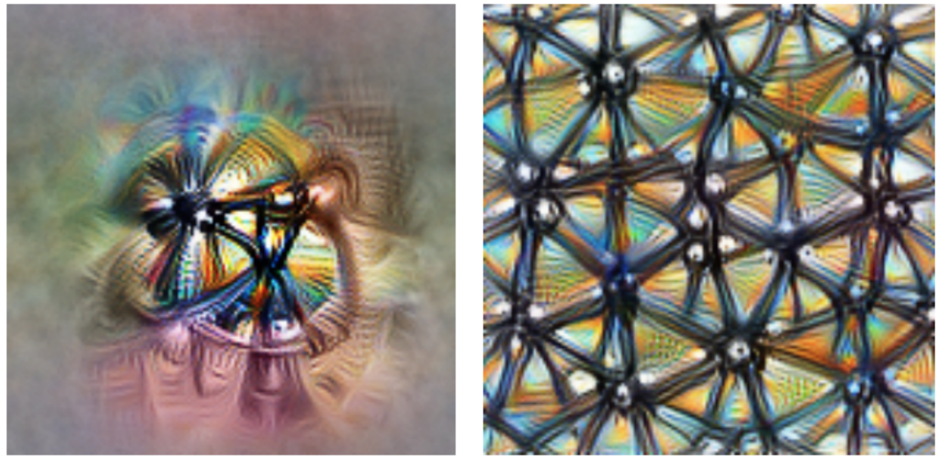
What did we learn?

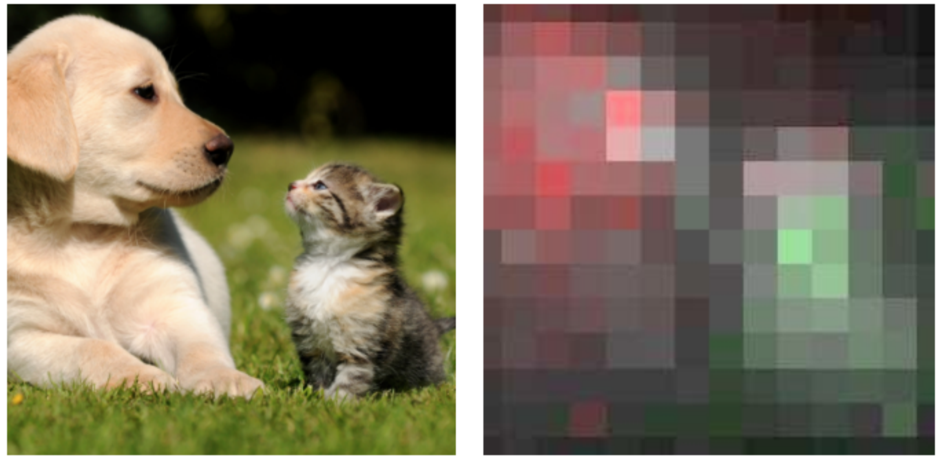
- Image classification
- Convolutions
- Reducing the number of parameters
  - Tweaking your convolutions
  - Adding pooling layers
- Improving your network
  - Regularization
- Understanding your network
  - Monitoring learning
  - Interpreting the parameters

Model interpretation

https://distill.pub/2017/feature-visualization/



Feature visualization answers questions about what a network — or parts of a network — are looking for by generating examples.

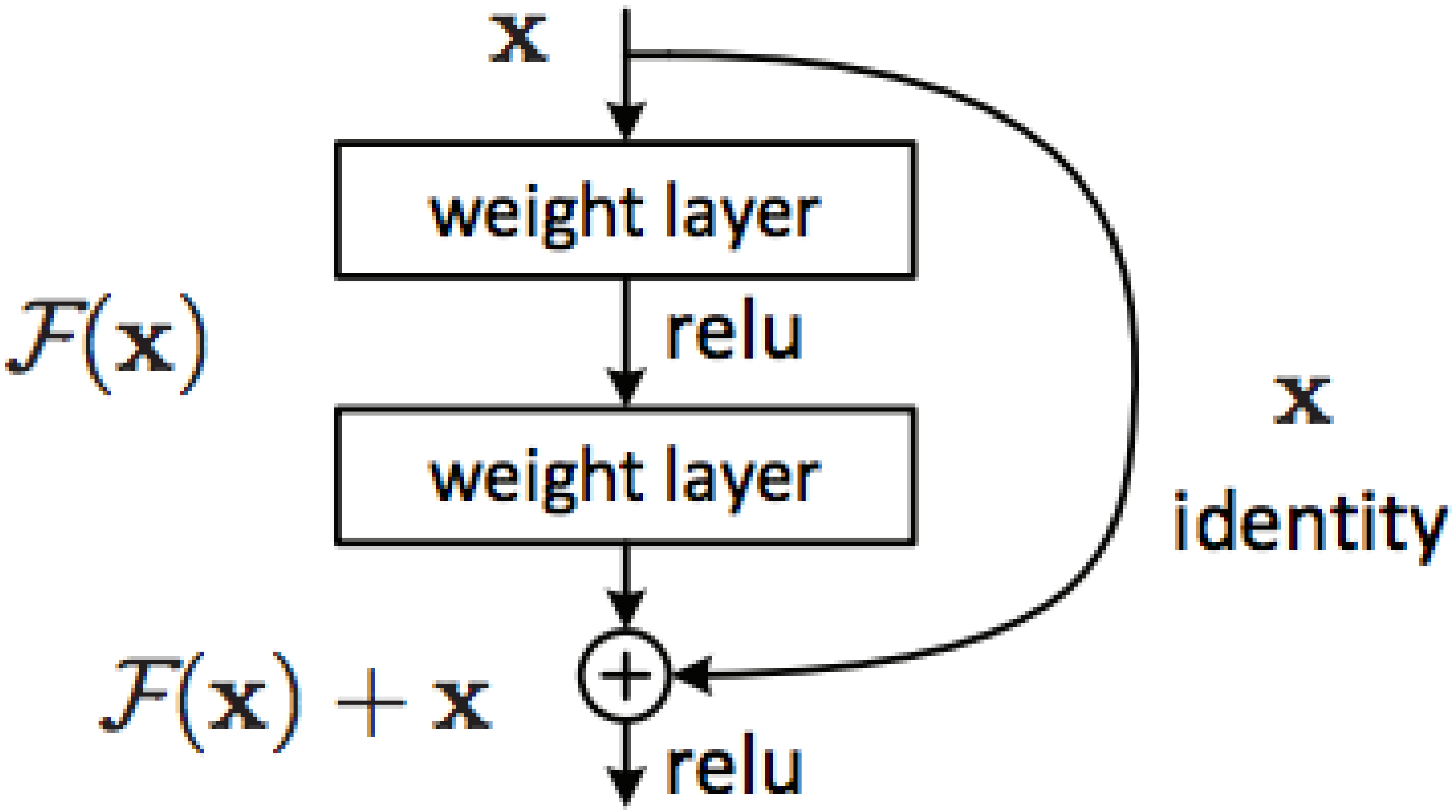


Attribution [1] studies what part of an example is responsible for the network activating a particular way.

What next?

- Even deeper networks
- Residual networks

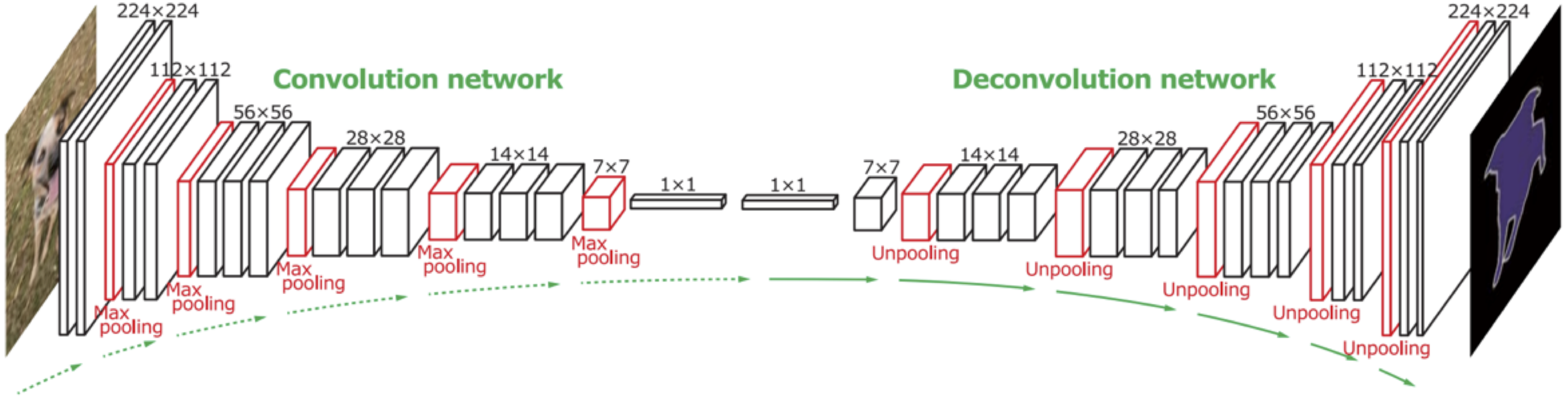
Residual networks



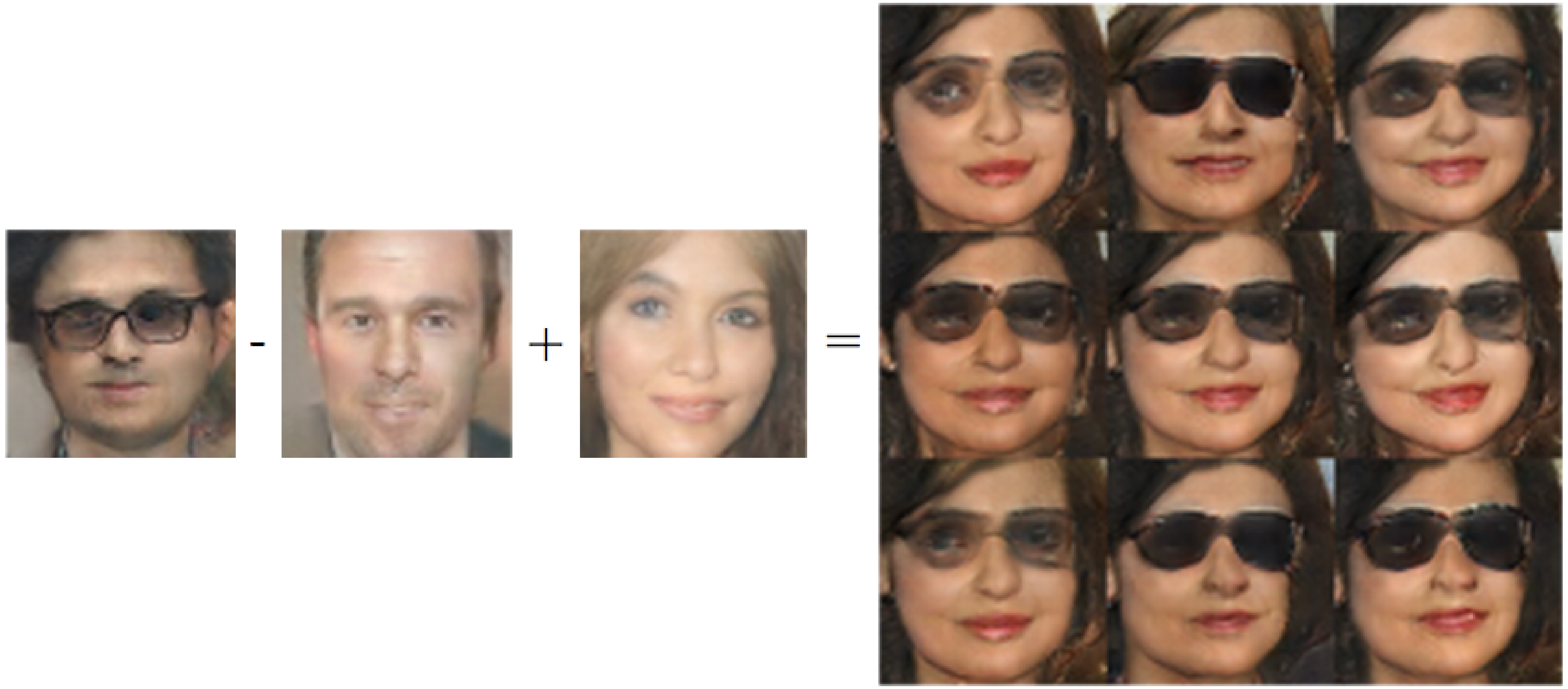
What next?

- Even deeper networks
- Residual networks
- Transfer learning
- Fully convolutional networks

Fully convolutional networks



Generative adversarial networks



What next?

- Even deeper networks
- Residual networks
- Transfer learning
- Fully convolutional networks
- Generative adversarial networks
- ...

Good luck!

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