CONVOLUTIONAL NEURAL NETWORKS FOR IMAGE PROCESSING

# Introduction to CNNs

Ariel Rokem
Senior Data Scientist, University of Washington


STOP

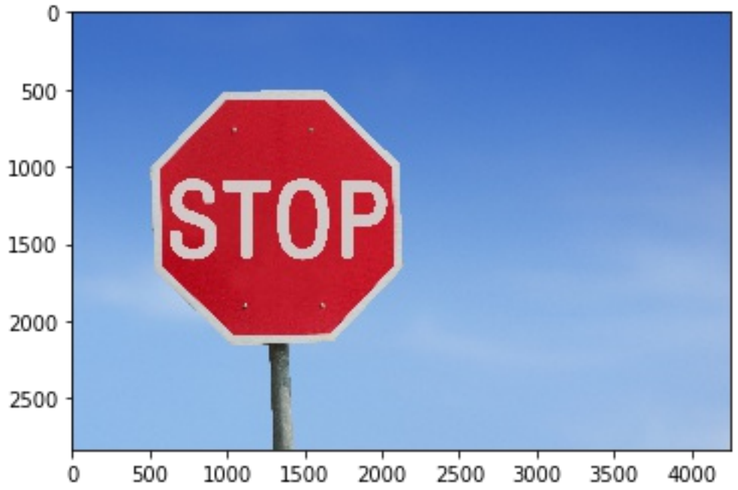

YIELD

# Software and pre-requisites

- DataCamp's Deep Learning course
- Machine learning:
  - Overfitting
  - Model evaluation
  - Cross-validation

# Images as data

```
import matplotlib.pyplot as plt
data = plt.imread('stop_sign.jpg')
plt.imshow(data)
plt.show()
```



# Images as data

```
data.shape
```

```
(2832, 4256, 3)
```

# Images as data

```
data[1000, 1500]
```

```
array([0.73333333, 0.07843137, 0.14509804])
```

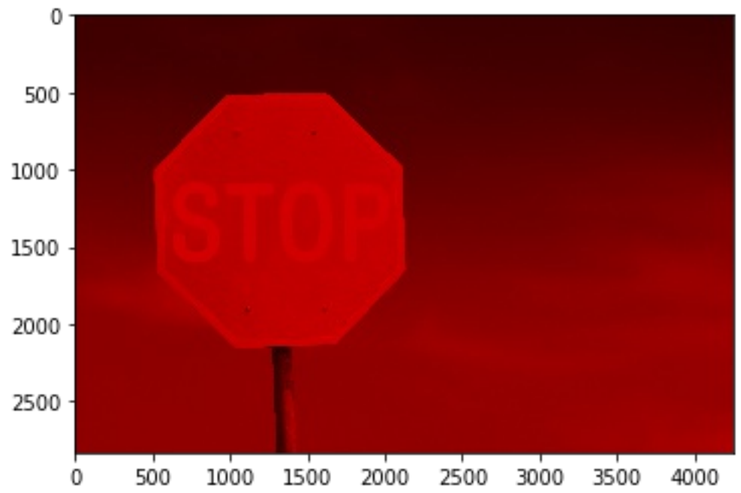
# Images as data

```
data[250, 3500]
```

```
array([0.25882353, 0.43921569, 0.77254902])
```

# Modifying image data

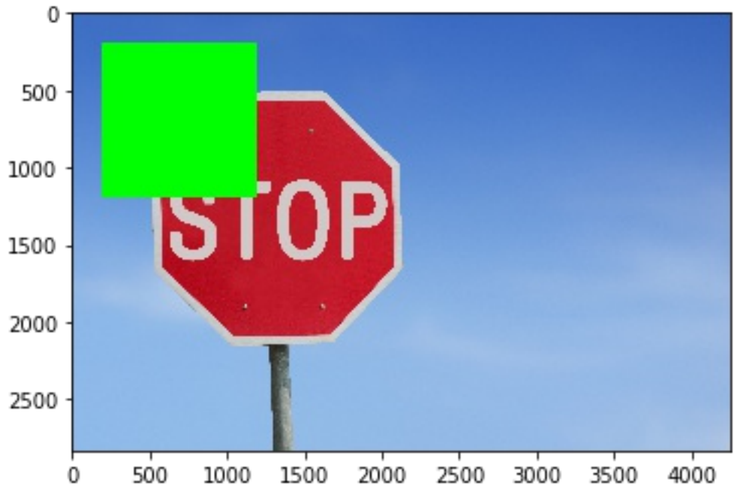
```
data[:, :, 1] = 0
data[:, :, 2] = 0
plt.imshow(data)
plt.show()
```



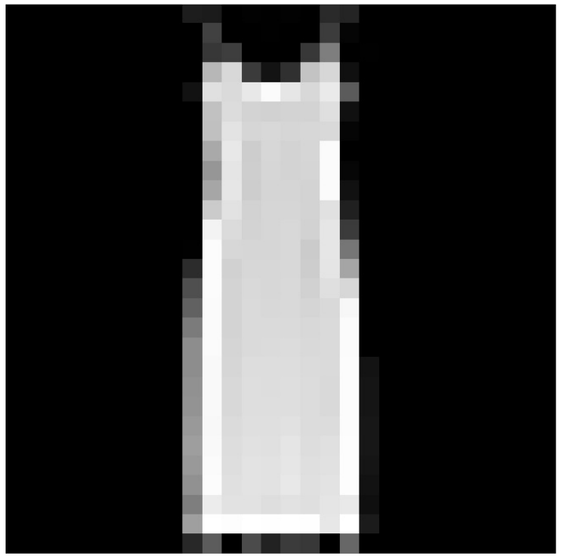
# Changing an image

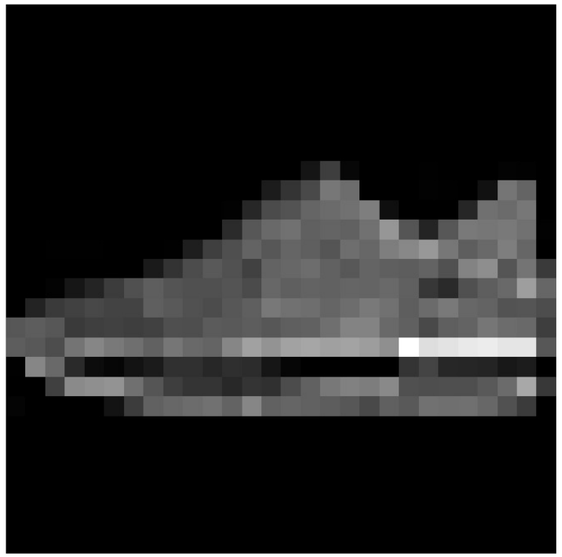
```
data[200:1200, 200:1200, :] = [0, 1, 0]

plt.imshow(data)
plt.show()
```

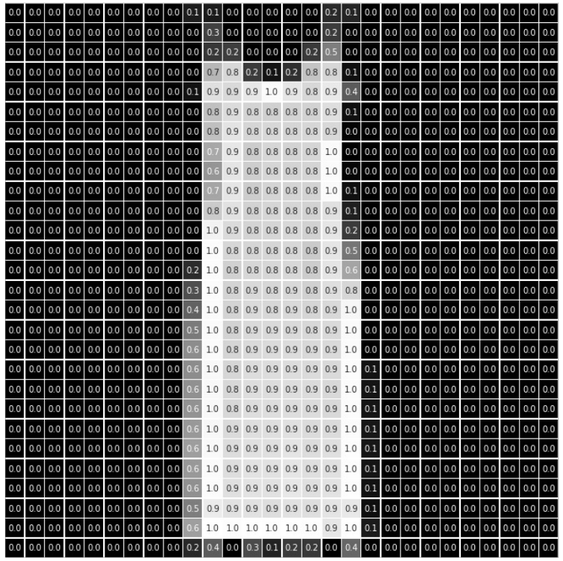


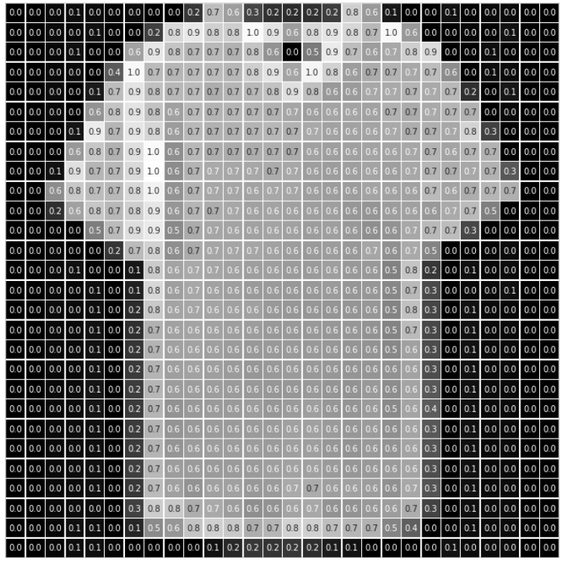
# Black and white images

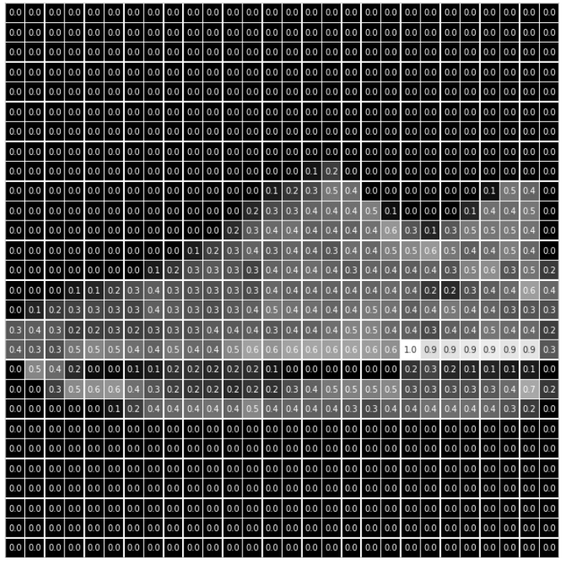




# Black and white images



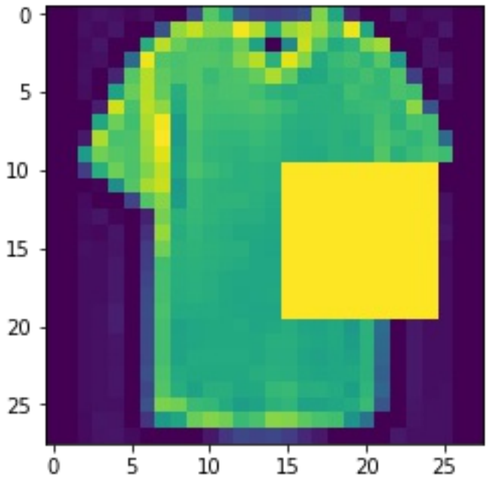




# Black and white images

```
tshirt[10:20, 15:25] = 1

plt.imshow(tshirt)
plt.show()
```



CONVOLUTIONAL NEURAL NETWORKS FOR IMAGE PROCESSING

# Let's practice!

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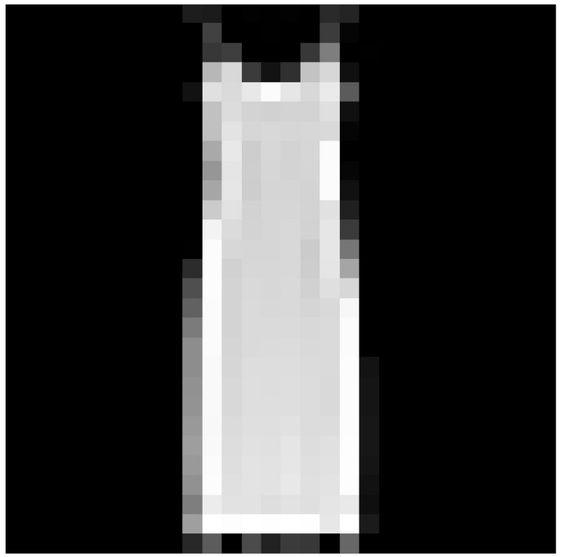
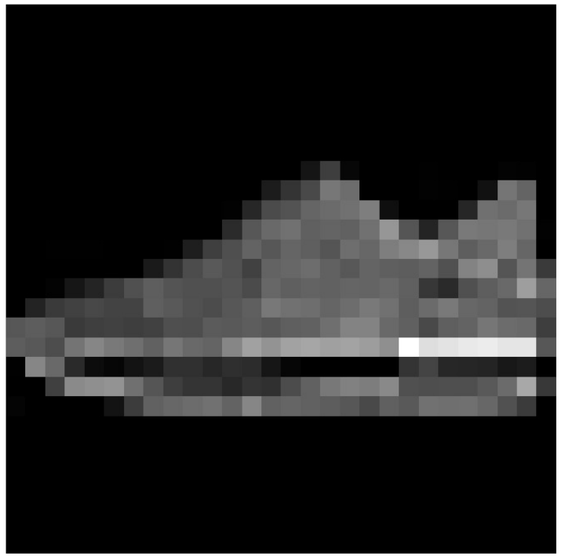
# Classifying images

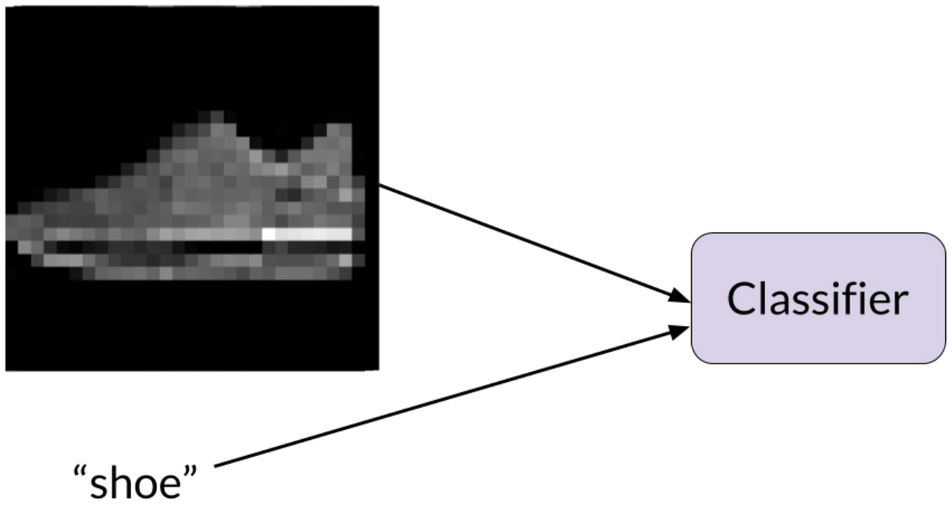
Ariel Rokem
Senior Data Scientist, University of Washington

# Image classification

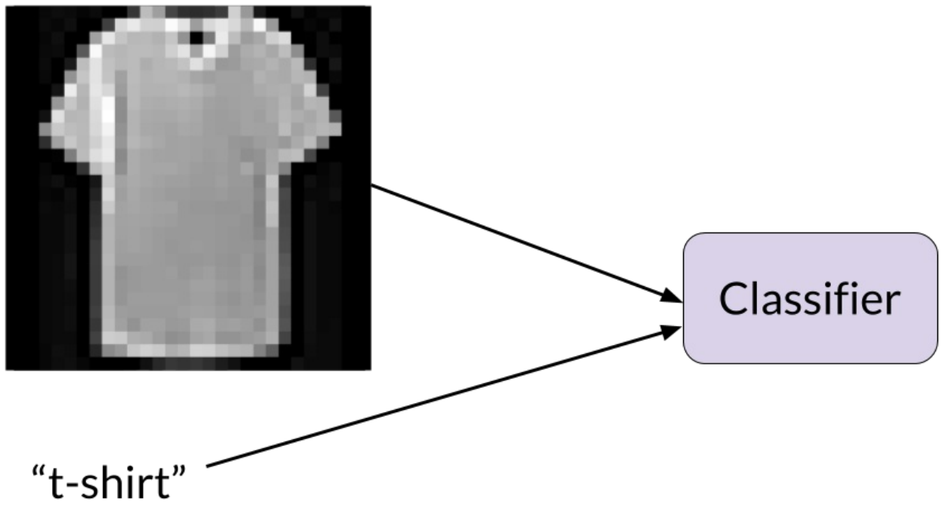




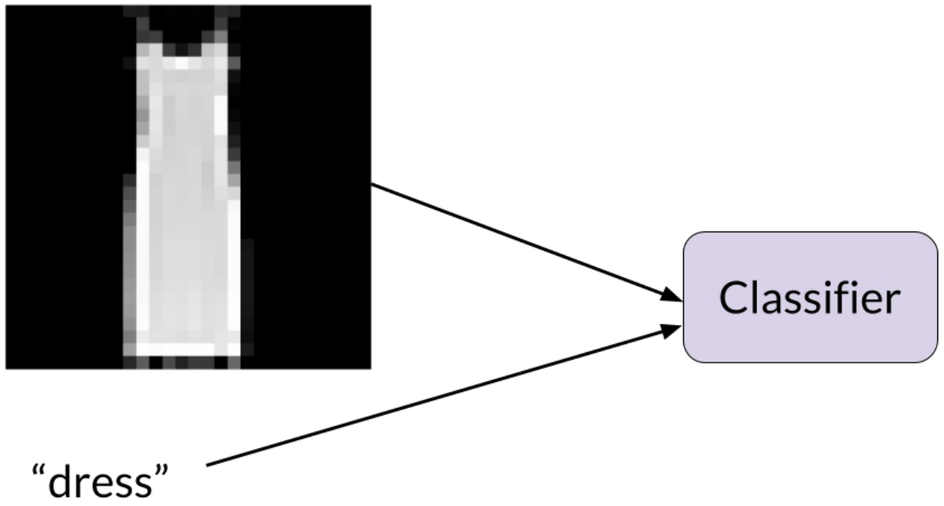
# Image classification: training



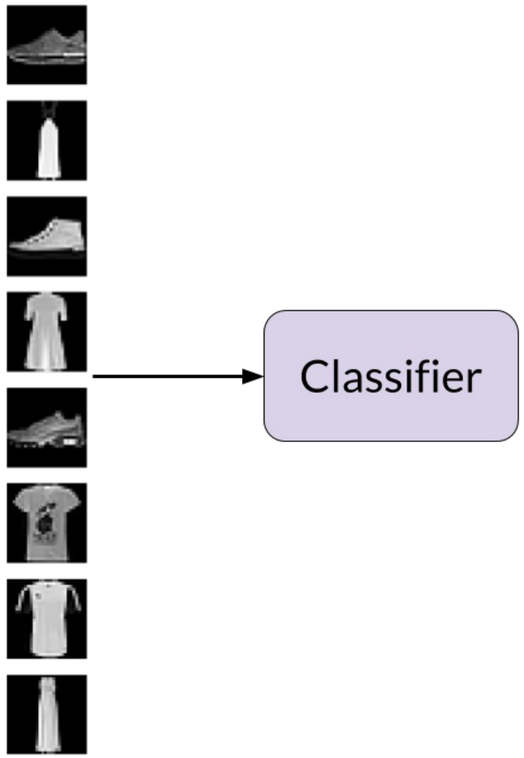
# Image classification: training



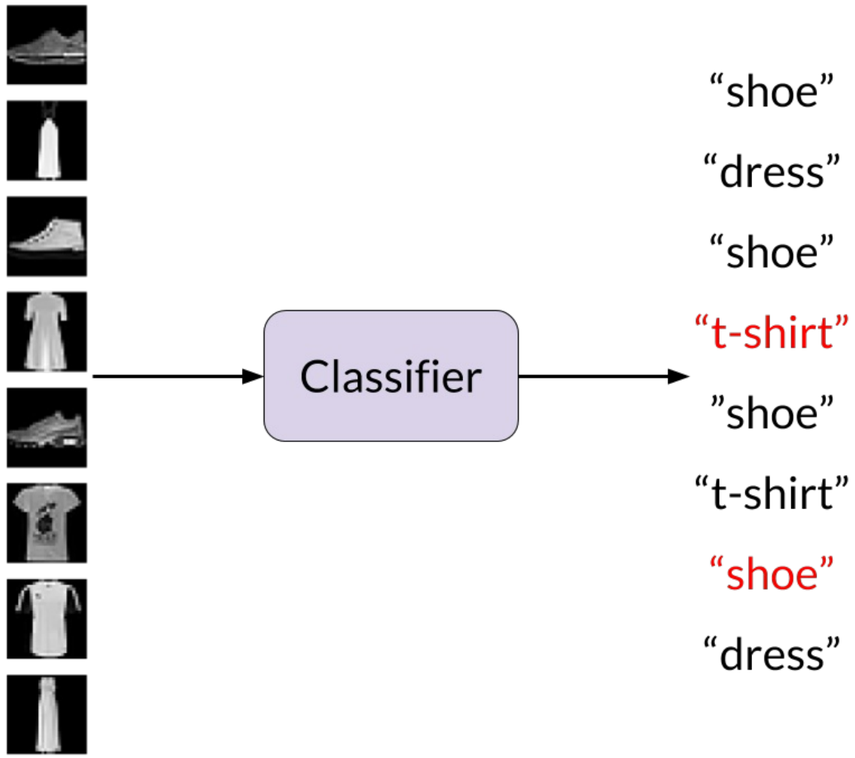
# Image classification: training



# Image classification: evaluation



# Image classification: evaluation



# Representing class data: one-hot encoding

```
labels = ["shoe", "dress", "shoe", "t-shirt",
          "shoe", "t-shirt", "shoe", "dress"]
```

# Representing class data: one-hot encoding

```
array([[0., 0., 1.],    <= shoe
       [0., 1., 0.],    <= dress
       [0., 0., 1.],    <= shoe
       [1., 0., 0.],    <= t-shirt
       [0., 0., 1.],    <= shoe
       [1., 0., 0.],    <= t-shirt
       [0., 0., 1.],    <= shoe
       [0., 1., 0.]])   <= dress
```

# One-hot encoding

```
categories = np.array(["t-shirt", "dress", "shoe"])

n_categories = 3
ohe_labels = np.zeros((len(labels), n_categories))

for ii in range(len(labels)):

    jj = np.where(categories == labels[ii])

    ohe_labels[ii, jj] = 1
```

# One-hot encoding: testing predictions

```
test

array([[0., 0., 1.],
       [0., 1., 0.],
       [0., 0., 1.],
       [0., 1., 0.],
       [0., 0., 1.],
       [0., 0., 1.],
       [0., 0., 1.],
       [0., 1., 0.]])
```

```
(test * predicition).sum()

6.0
```

```
prediction

array([[0., 0., 1.],
       [0., 1., 0.],
       [0., 0., 1.],
       [1., 0., 0.], <= incorrect
       [0., 0., 1.],
       [1., 0., 0.],
       [0., 0., 1.], <= incorrect
       [0., 1., 0.]])
```

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# Image classification with Keras

Ariel Rokem
Senior Data Scientist, University of Washington

# Keras for image classification

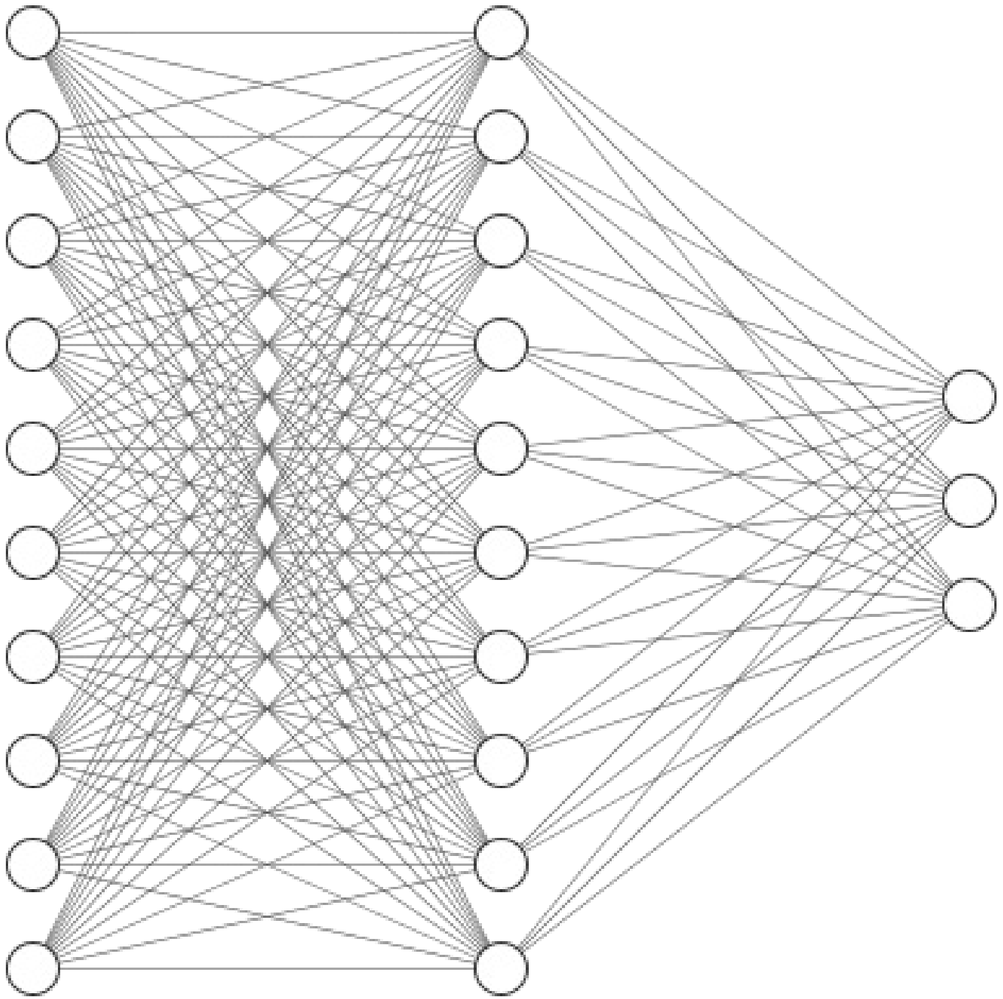
```
from keras.models import Sequential

model = Sequential()
```

# Keras for image classification

```
from keras.layers import Dense

train_data.shape

(50, 28, 28, 1)
```

# Keras for image classification

```
model.add(Dense(10, activation='relu',
          input_shape=(784,)))

model.add(Dense(10, activation='relu'))

model.add(Dense(3, activation='softmax'))
```



Input Layer $\in \mathbb{R}^{10}$ Hidden Layer $\in \mathbb{R}^{10}$ Output Layer $\in \mathbb{R}^{3}$

# Keras for image classification

```
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])
```

# Keras for image classification

```
train_data = train_data.reshape((50, 784))
```

# Keras for image classification

```
model.fit(train_data, train_labels,
          validation_split=0.2,
          epochs=3)
```

# Keras for image classification

```
model.fit(train_data, train_labels,
          validation_split=0.2,
          epochs=3)

Train on 40 samples, validate on 10 samples
Epoch 1/3

32/40 [=======================>......] - ETA: 0s - loss: 1.0117 - acc: 0.4688
40/40 [==============================] - 0s 4ms/step - loss: 1.0438 - acc: 0.4250 - val_loss: 0.9668 - val_acc: 0.4000
Epoch 2/3

32/40 [=======================>......] - ETA: 0s - loss: 0.9556 - acc: 0.5312
40/40 [==============================] - 0s 195us/step - loss: 0.9404 - acc: 0.5750 - val_loss: 0.9068 - val_acc: 0.4000
Epoch 3/3

32/40 [=======================>......] - ETA: 0s - loss: 0.9143 - acc: 0.5938
40/40 [==============================] - 0s 189us/step - loss: 0.8726 - acc: 0.6750 - val_loss: 0.8452 - val_acc: 0.4000
```

# Keras for image classification

```
test_data = test_data.reshape((10, 784))
model.evaluate(test_data, test_labels)

10/10 [==============================] - 0s 335us/step
[1.0191701650619507, 0.4000000059604645]
```

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