Week 4

Multiclass Classifications

LEE SEUNGWOO

주 1

완료하는 데 4시간 필요

Exploring a Larger Dataset

In the first course in this specialization, you had an introduction to TensorFlow, and how, with its high level APIs you could do basic image classification, an you learned a little bit about Convolutional Neural Networks (ConvNets). In this course you'll go deeper into using ConvNets will real-world data, and learn about techniqu... 모두 표시

8 videos (Total 18 min), 5 readings, 3 quizzes 모두 보기

주 2

완료하는 데 4시간 필요

Augmentation: A technique to avoid overfitting

You've heard the term overfitting a number of times to this point. Overfitting is simply the concept of being over specialized in training -- namely that your model is very good at classifying what it is trained for, but not so good at classifying things that it hasn't seen. In order to generalize your model more effectively, you will ... 모두 표시

7 videos (Total 14 min), 6 readings, 3 quizzes 모두 보기

주 3

완료하는 데 4시간 필요

Transfer Learning

Building models for yourself is great, and can be very powerful. But, as you've seen, you can be limited by the data you have on hand. Not everybody has access to massive datasets or the compute power that's needed to train them effectively. Transfer learning can help solve this -- where people with models trained on... 모두 표시

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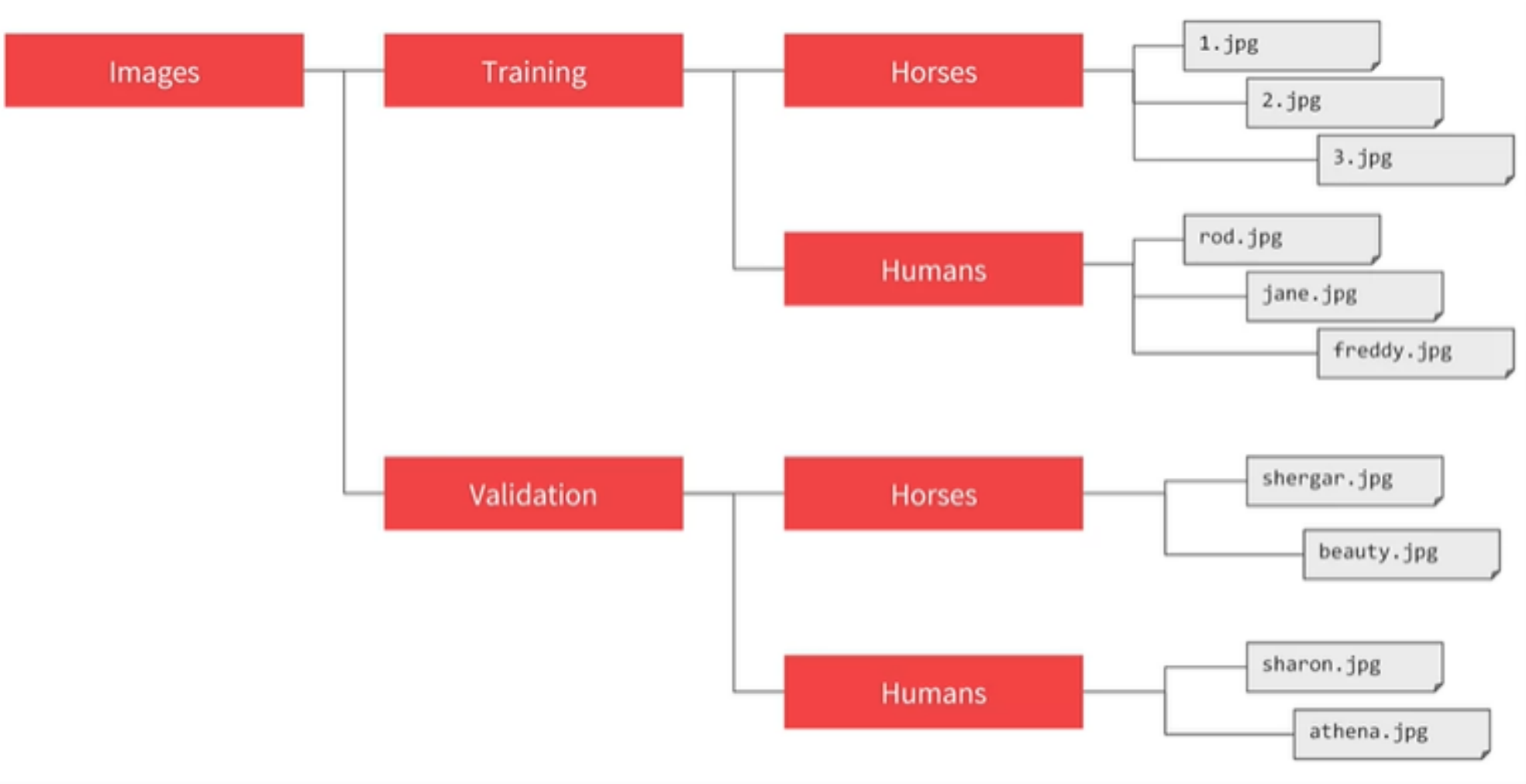
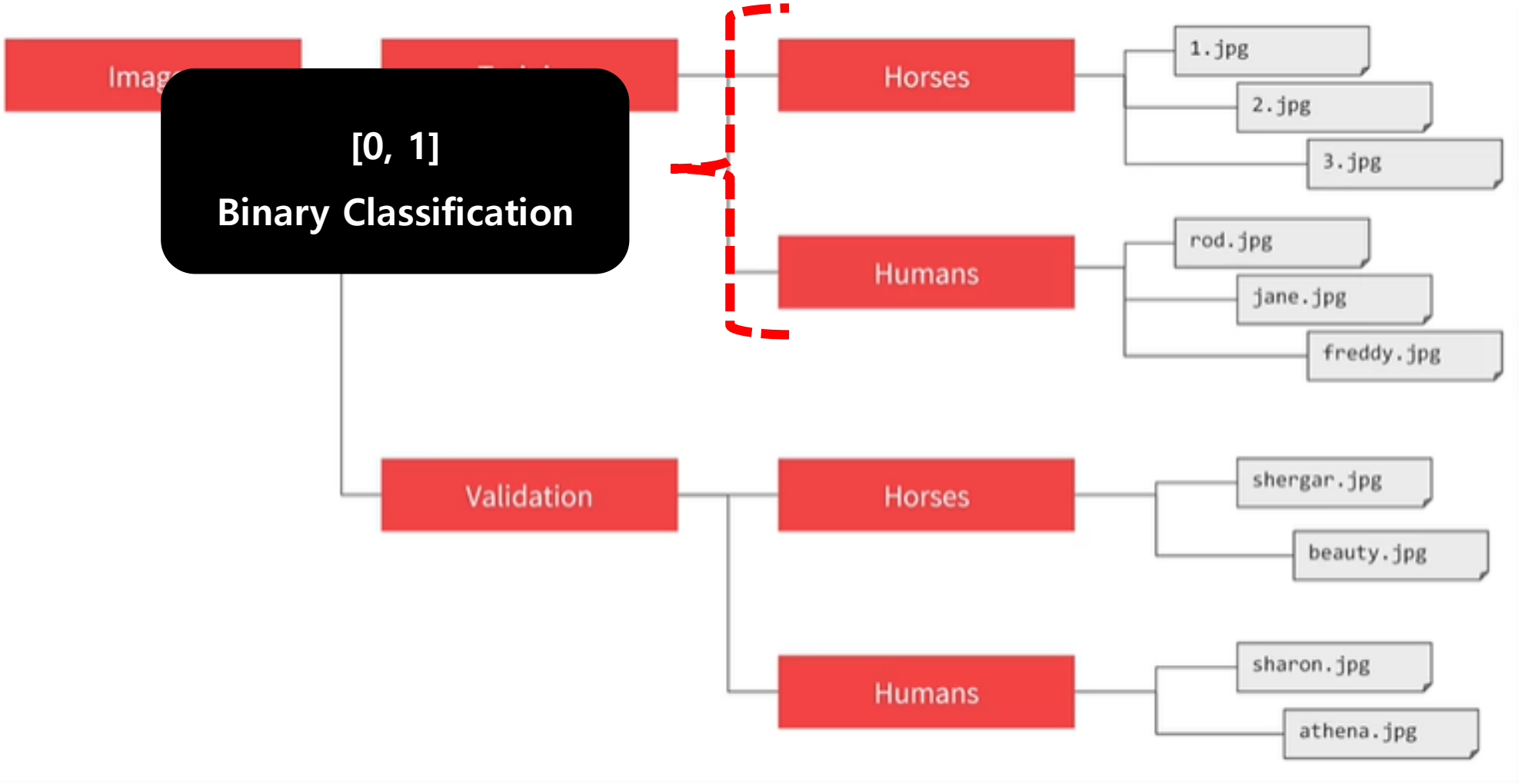
Table Of Contents

Moving from Binary to multi-class classification



Moving from Binary to multi-class classification



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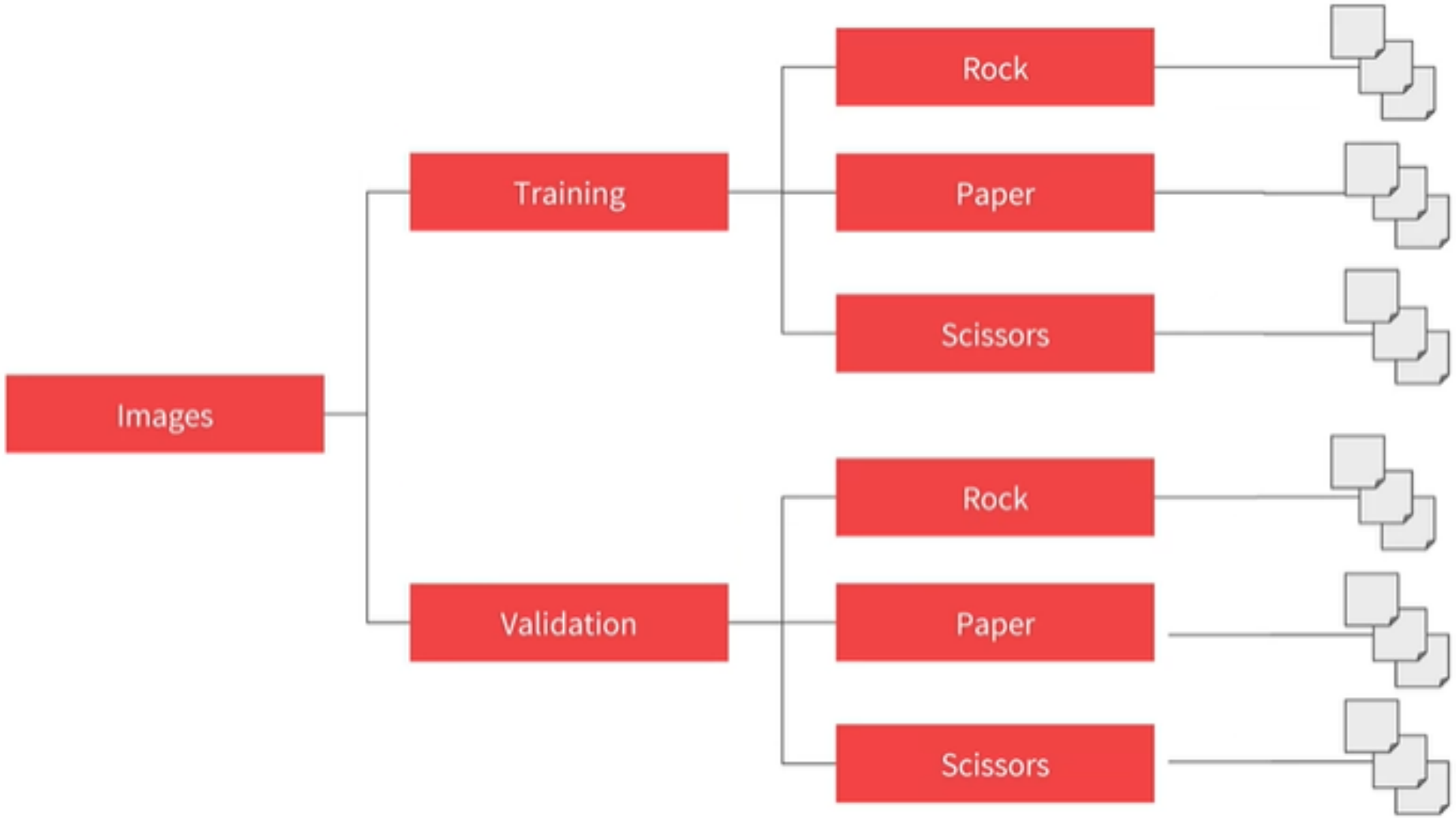

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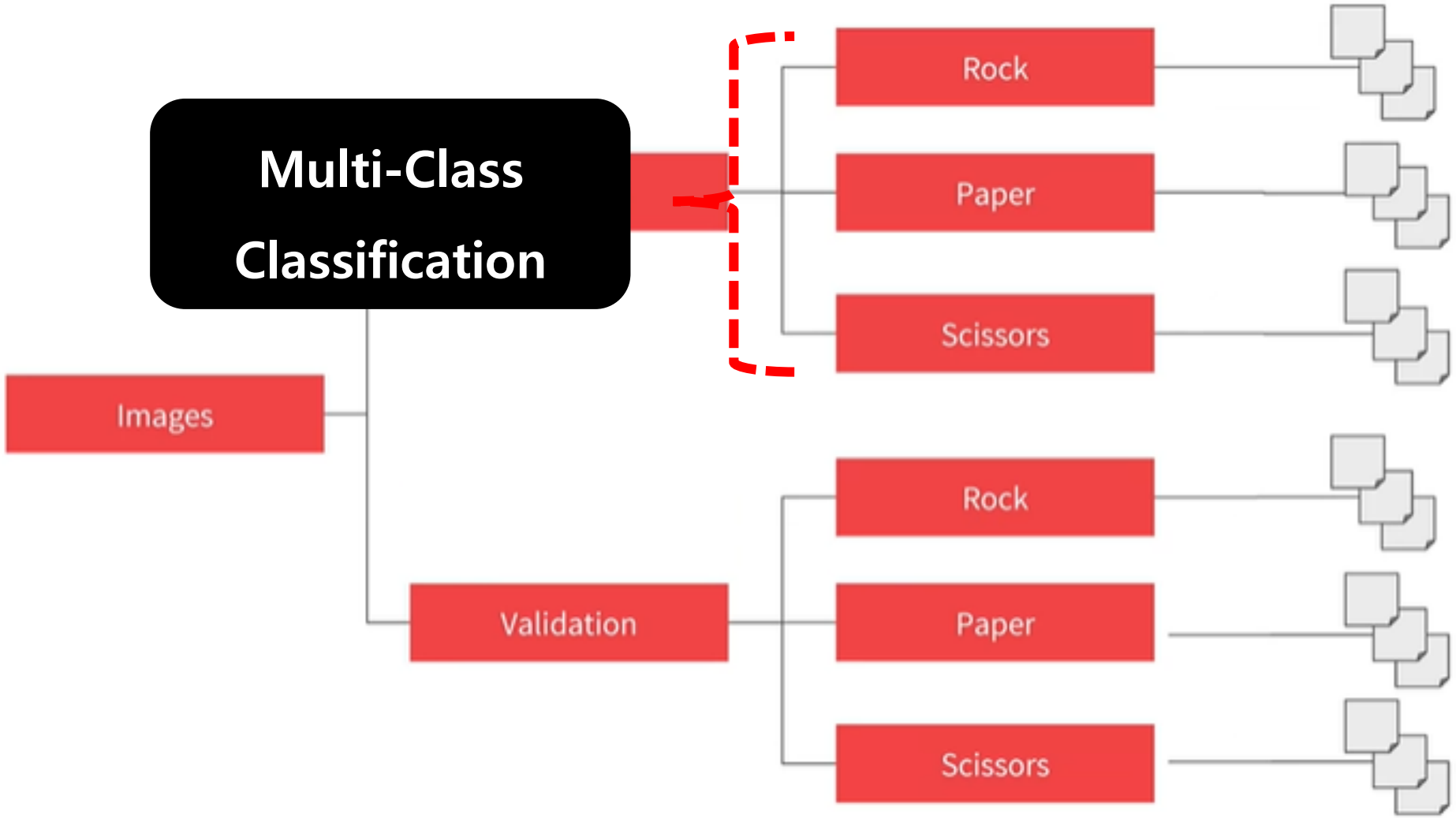

Explore multi-class with Rock Paper Scissors dataset

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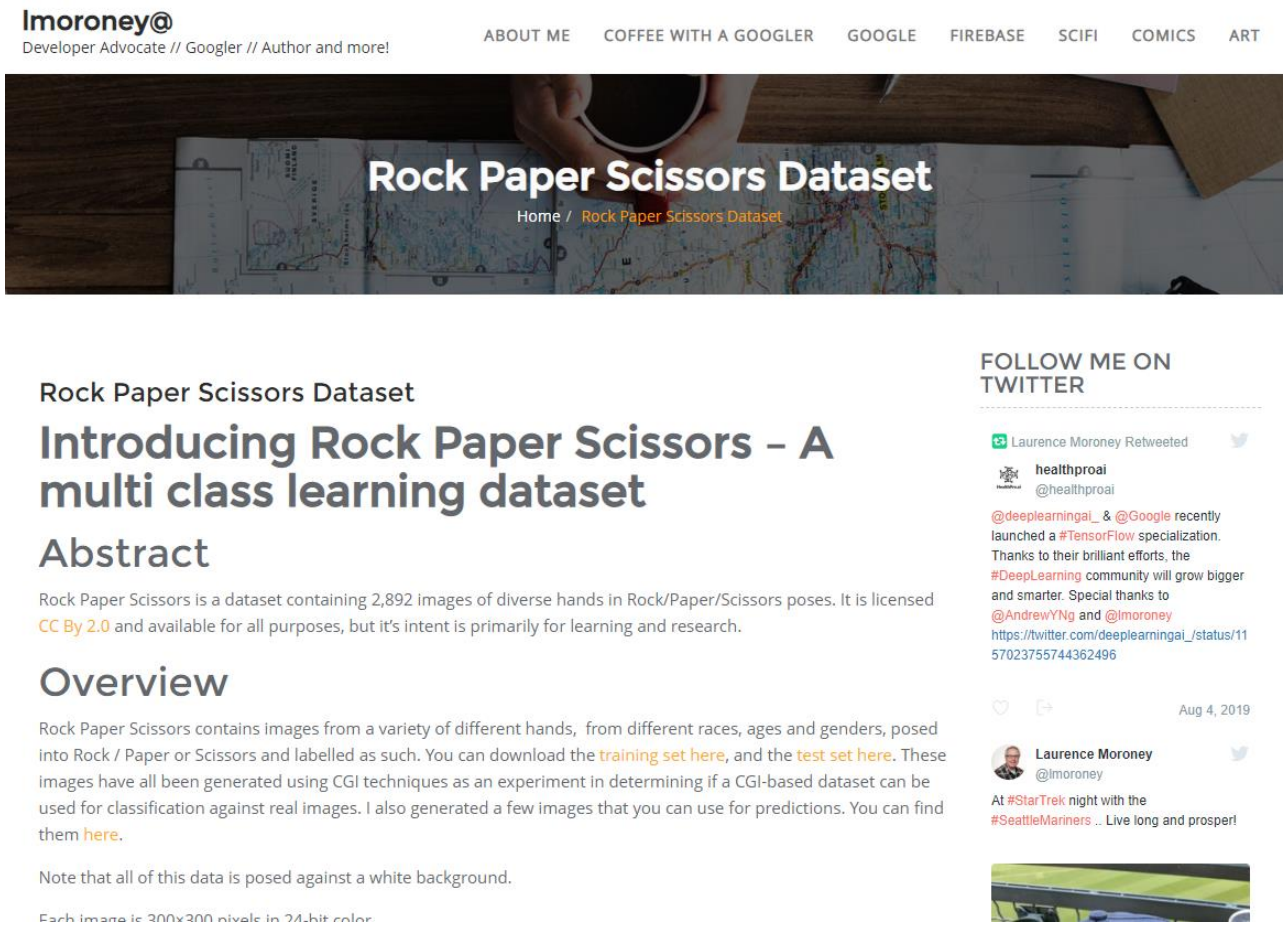

http://www.laurencemoroney.com/rock-paper-scissors-dataset/

Explore multi-class with Rock Paper Scissors dataset

```
1
2  from tensorflow.keras.preprocessing.image import ImageDataGenerator
3
4  train_datagen = ImageDataGenerator(rescale=1./255)
5
6  train_generator = train_datagen.flow_from_directory(
7      train_dir,
8      target_size=(300, 300), # 300 * 300 사이즈
9      batch_size=128,         # 배치 사이즈 128개
10     class_mode='binary'     # Binary
11 )
```

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Explore multi-class with Rock Paper Scissors dataset

```
13  import tensorflow as tf
14
15  model = tf.keras.models.Sequential([
16      tf.keras.layers.Conv2D(16, (3, 3), activation='relu', input_shape=(300, 300, 3))
17      tf.keras.layers.MaxPooling2D(2, 2),
18      tf.keras.layers.Conv2D(32, (3, 3), activation='relu'),
19      tf.keras.layers.MaxPooling2D(2, 2),
20      tf.keras.layers.Conv2D(64, (3, 3), activation='relu'),
21      tf.keras.layers.MaxPooling2D(2, 2),
22      tf.keras.layers.Flatten(),
23      tf.keras.layers.Dense(512, activation='relu'),
24      tf.keras.layers.Dense(1, activation='sigmoid')
25  ])
```

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22      tf.keras.layers.Flatten(),
23      tf.keras.layers.Dense(512, activation='relu'),
24      tf.keras.layers.Dense(3, activation='softmax')
25  ])
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25  ])
```

Q: Why Activation Function is “Softmax”?

How does Sigmoid activation work in multi-class classification problems

Asked 10 months ago Active 6 months ago Viewed 3k times

3

I know that for a problem with multiple classes we usually use softmax, but can we also use sigmoid? I have tried to implement digit classification with sigmoid at the output layer, it works. What I don't understand is how does it work?

machine-learning neural-network deep-learning multiclass-classification activation-function

2

share improve this question

edited Oct 6 '18 at 19:56
Vaalizaadeh
8,548 ●6 ●25 ●68

asked Oct 6 '18 at 8:41
bharath chandra
16 ●1 ●3

add a comment

Blog

What Every D
Early On

DEF CON and
Traffic Says A

Featured on Meta

https://datascience.stackexchange.com/questions/39264/how-does-sigmoid-activation-work-in-multi-class-classification-problems

Q: Why Activation Function is “Softmax”?

Hov

Asked

2

softmax() will give you the probability distribution which means all output will sum to 1. While, sigmoid() will make sure the output value of neuron is between 0 to 1.

In case of digit classification and sigmoid(), you will have output of 10 output neurons between 0 to 1. Then, you can take biggest one of them and classify as that digit.

share improve this answer

answered Oct 6 '18 at 19:01

Preet

458 ●5

s

3

2

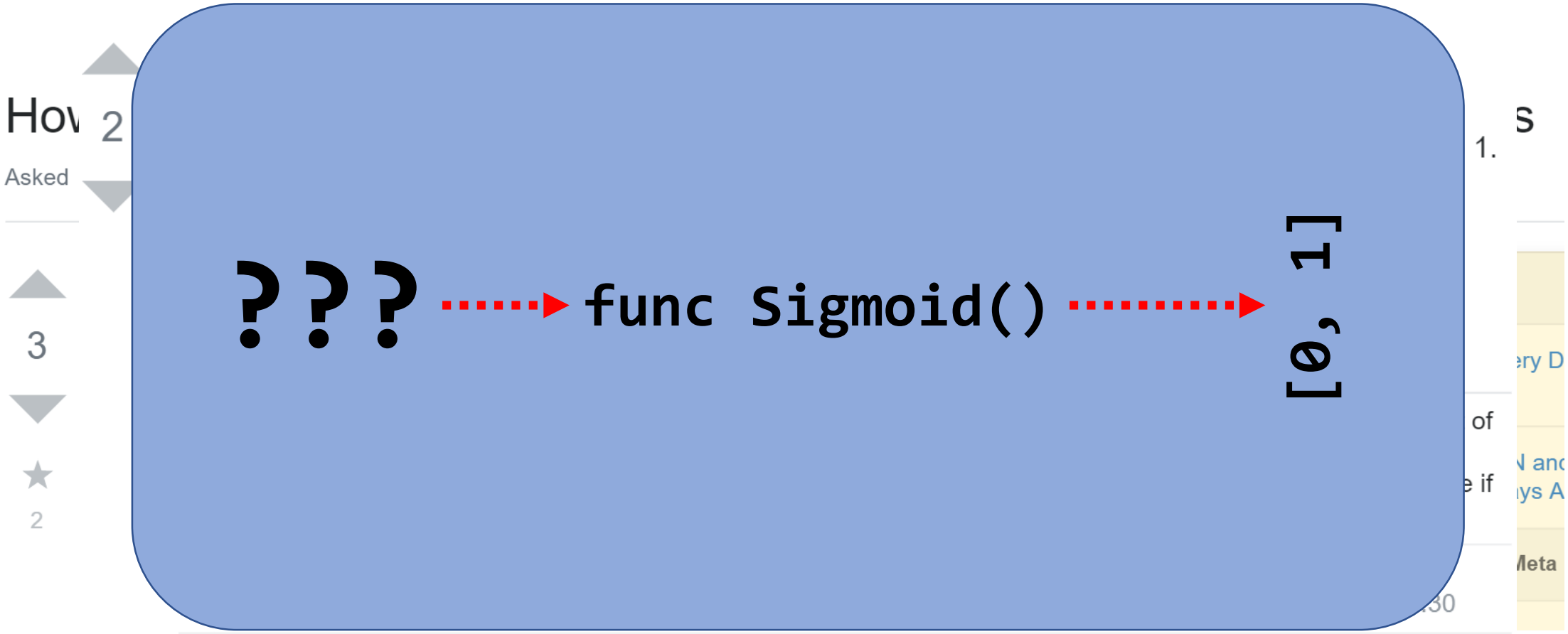
So what you are saying is both works same? So softmax calculates the probability of one neuron with respect of all others and then returns neuron that has maximum probability whereas when using sigmoid it generates output for each neuron independently and the neuron that has maximum output is returned. Please correct me if I am wrong.. – bharath chandra Oct 7 '18 at 3:00

Yes, both work the same way. Softmax is an extension of sigmoid for multi-class classifications problem. Softmax in multiclass logistic regression with K=2 takes the form of sigmoid function. – Preet Feb 10 at 11:30

add a comment

https://datascience.stackexchange.com/questions/39264/how-does-sigmoid-activation-work-in-multi-class-classification-problems

Q: Why Activation Function is “Softmax”?



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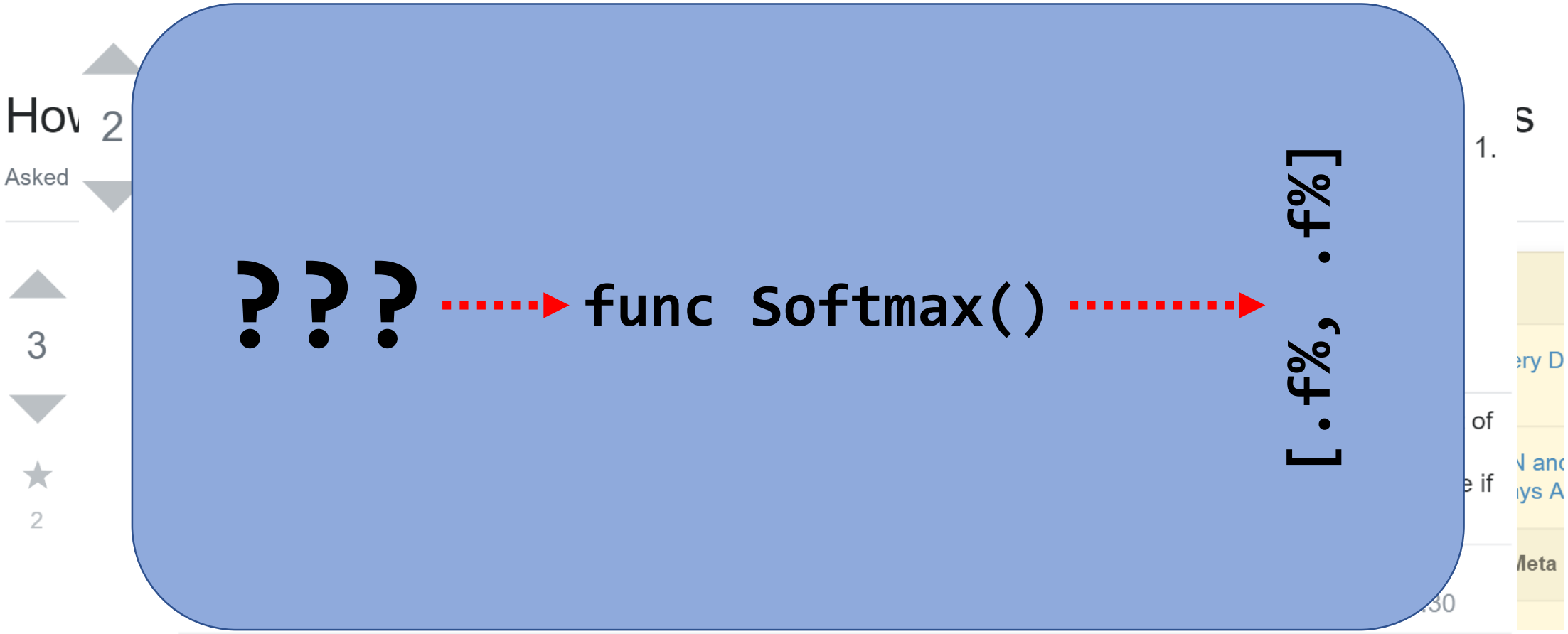

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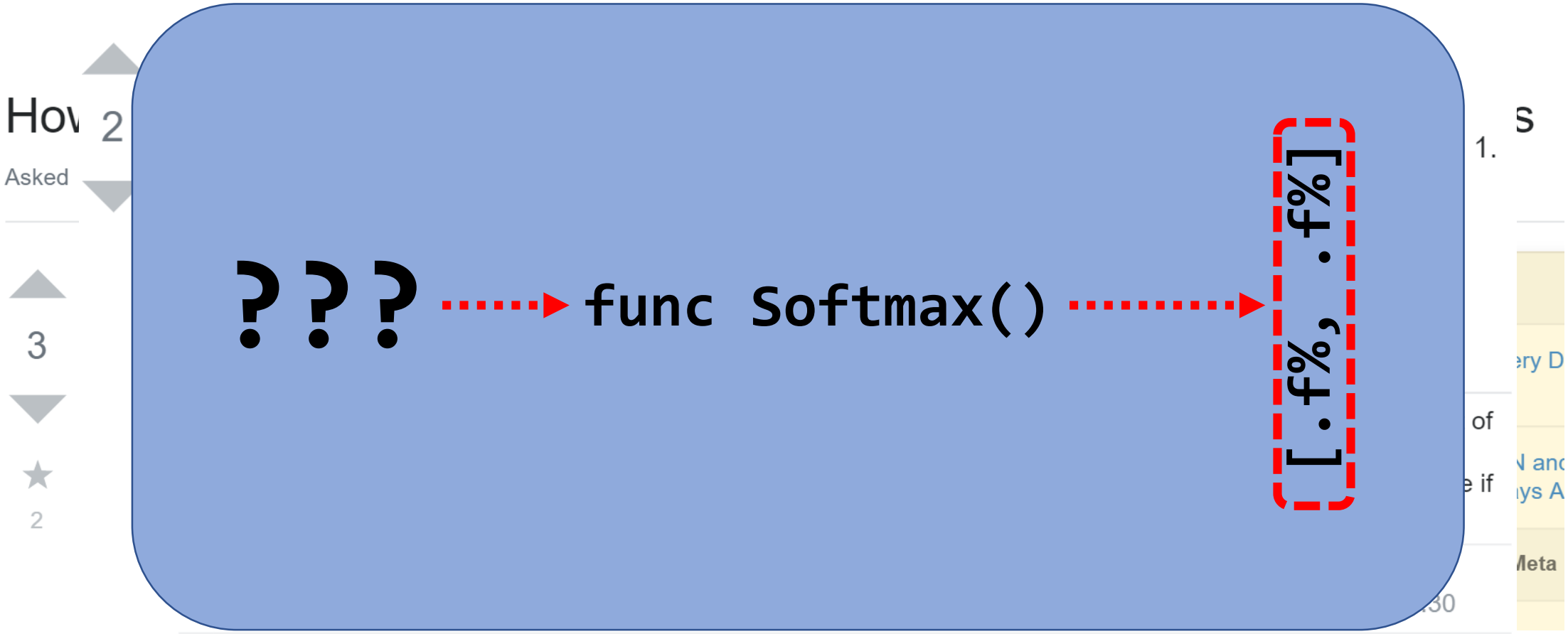

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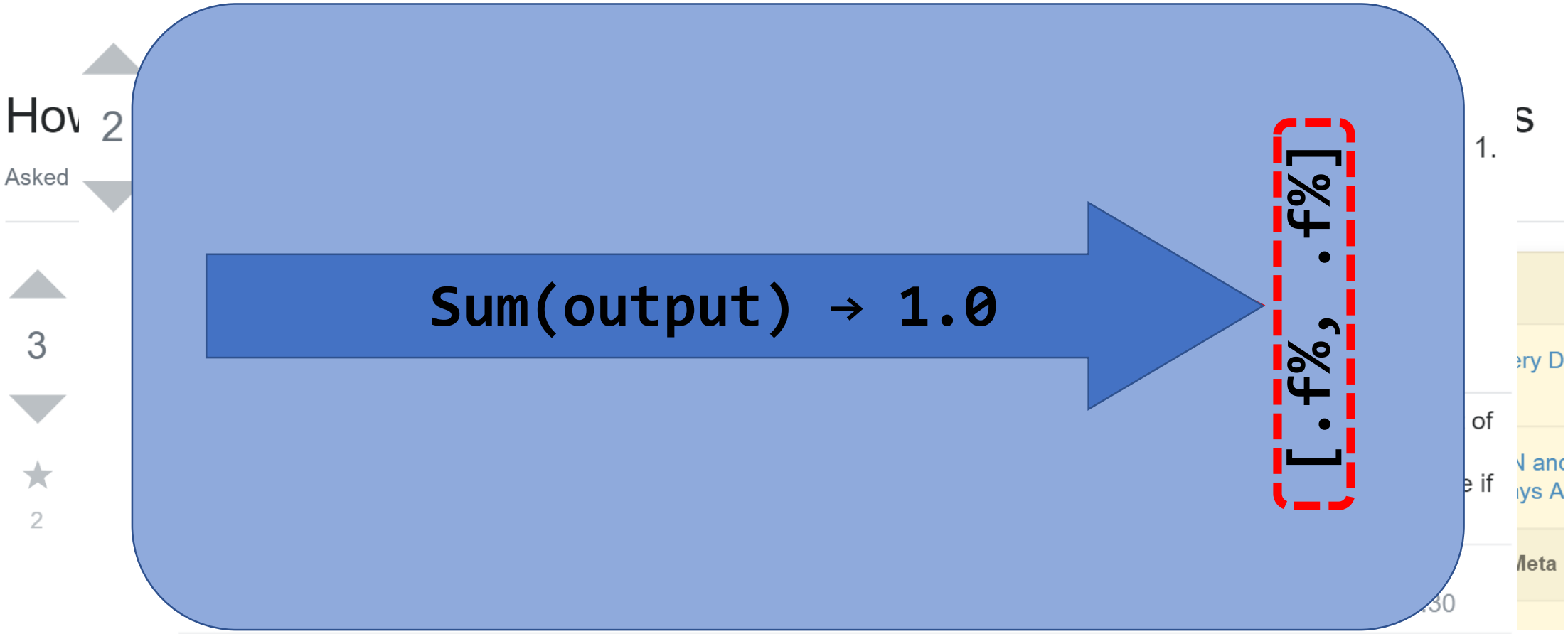

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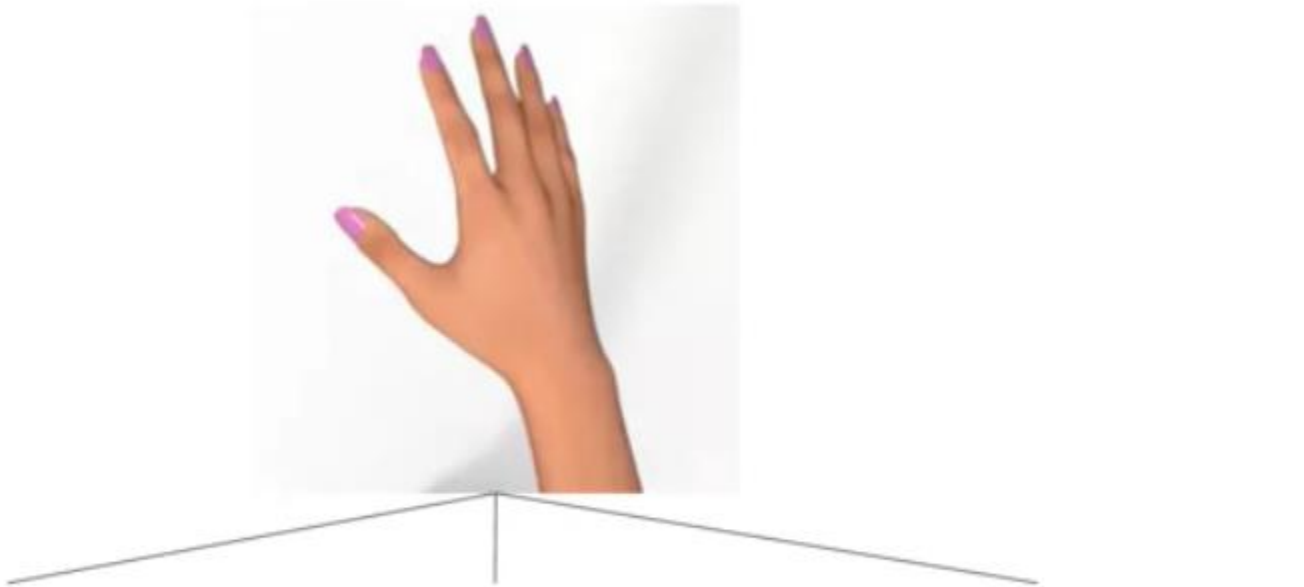
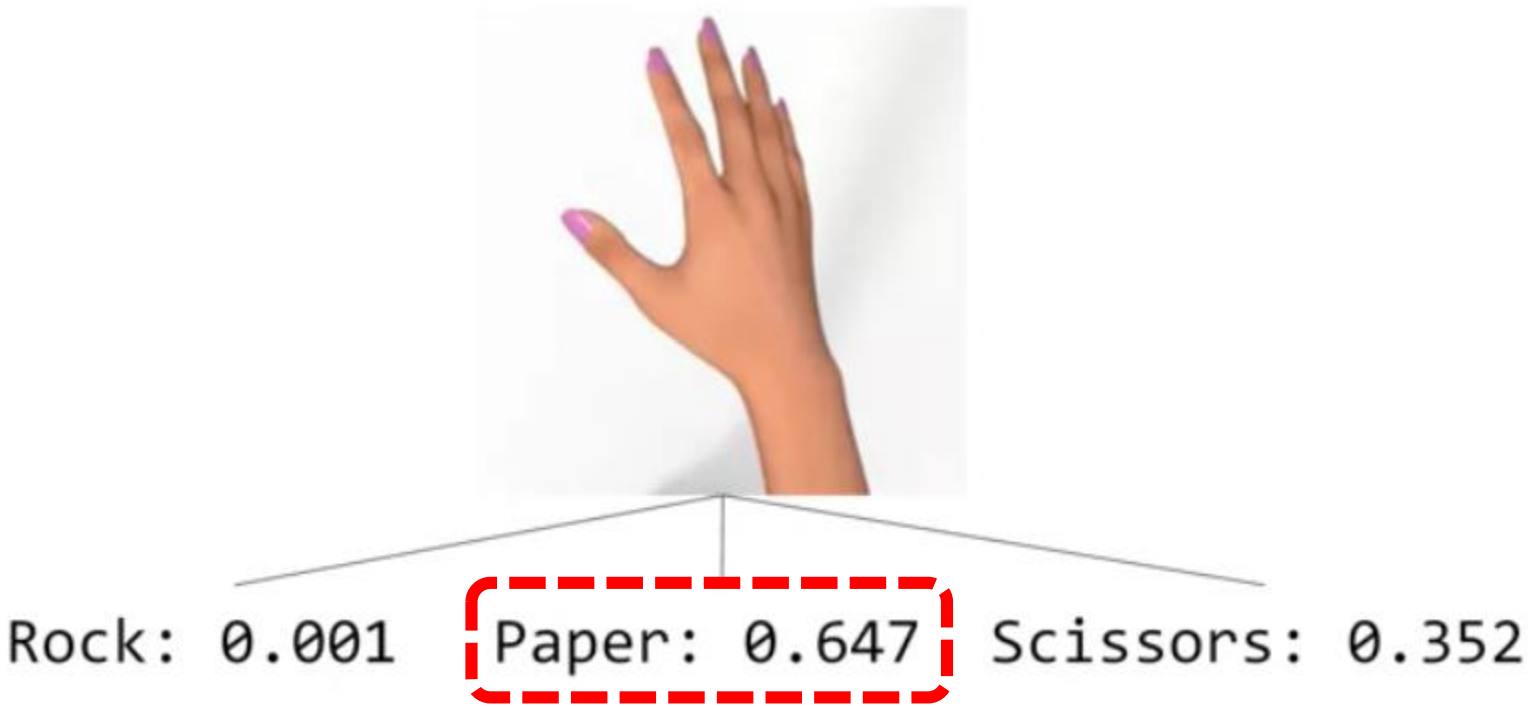


Rock: 0.001 Paper: 0.647 Scissors: 0.352

Explore multi-class with Rock Paper Scissors dataset



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27  from tensorflow.keras.optimizers import RMSprop
28
29  model.compile(
30      loss = 'binary_crossentropy',
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33  )
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```

Explor

taset

prop

Methods

compile

View source

```
compile(
    optimizer,
    loss=None,
    metrics=None,
    loss_weights=None,
    sample_weight_mode=None,
    weighted_metrics=None,
    target_tensors=None,
    distribute=None,
    **kwargs
)
```

Configures the model for training.

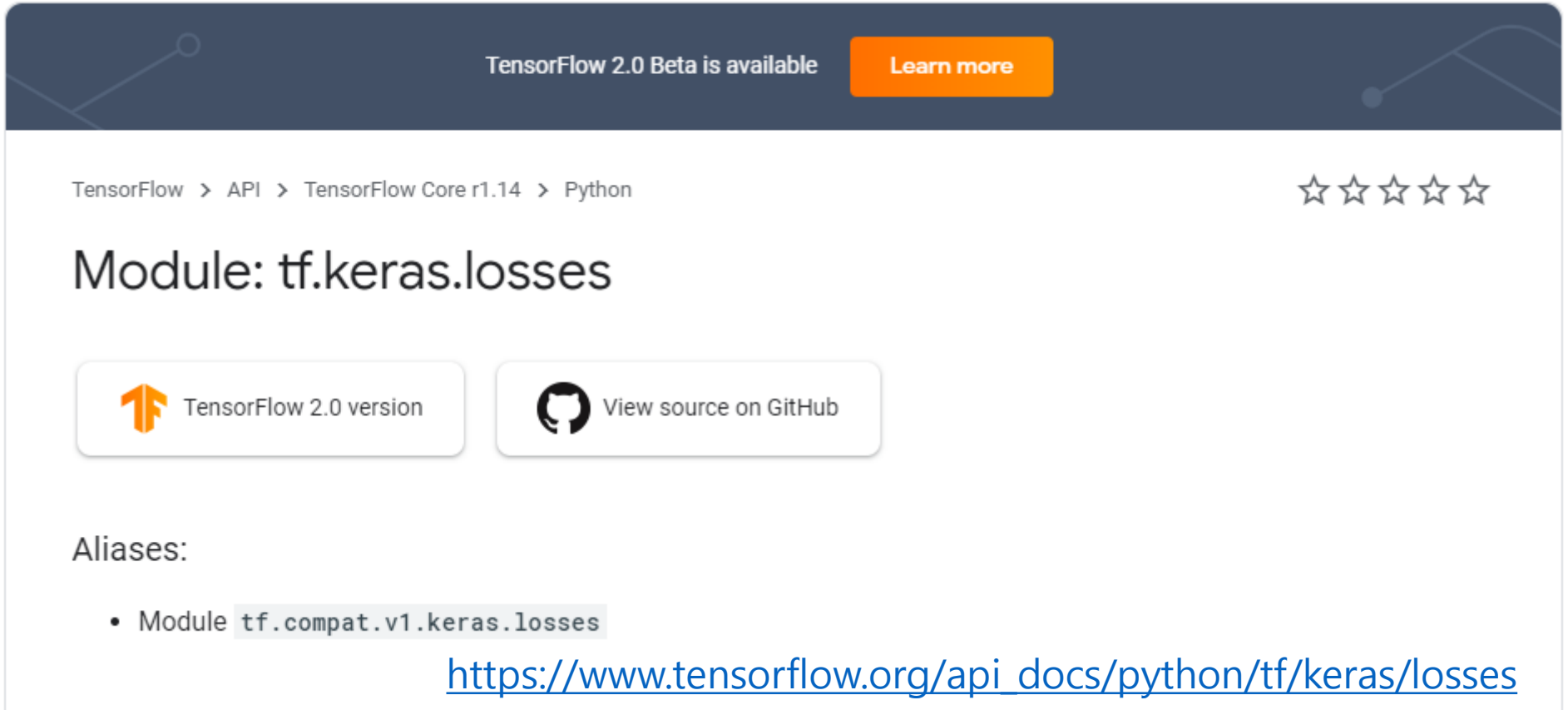
Arguments:

- **`optimizer`**: String (name of optimizer) or optimizer instance. See `tf.keras.optimizers`.
- **`loss`**: String (name of objective function), objective function or `tf.losses.Loss` instance. See `tf.losses`. If the model has multiple outputs, you can use a different loss on each output by passing a dictionary or a list of losses. The loss value that will be minimized by the model will then be the sum of all individual losses.

https://www.tensorflow.org/api_docs/python/tf/keras/Model

Explor Methods taset

compile



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Explor taset

Classes

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`class CategoricalCrossentropy`: Computes the crossentropy loss between the labels and predictions.

`class CategoricalHinge`: Computes the categorical hinge loss between `y_true` and `y_pred`.

`class CosineSimilarity`: Computes the cosine similarity between `y_true` and `y_pred`.

`class Hinge`: Computes the hinge loss between `y_true` and `y_pred`.

`class Huber`: Computes the Huber loss between `y_true` and `y_pred`.

`class KLDivergence`: Computes Kullback Leibler divergence loss between `y_true` and `y_pred`.

`class LogCosh`: Computes the logarithm of the hyperbolic cosine of the prediction error.

`class Loss`: Loss base class.

`class MeanAbsoluteError`: Computes the mean of absolute difference between labels and predictions.

`class MeanAbsolutePercentageError`: Computes the mean absolute percentage error between `y_true` and `y_pred`.

`class MeanSquaredError`: Computes the mean of squares of errors between labels and predictions.

`class MeanSquaredLogarithmicError`: Computes the mean squared logarithmic error between `y_true` and `y_pred`.

`class Poisson`: Computes the Poisson loss between `y_true` and `y_pred`.

`class SparseCategoricalCrossentropy`: Computes the crossentropy loss between the labels and predictions.

`class SquaredHinge`: Computes the squared hinge loss between `y_true` and `y_pred`.

python/tf/keras/Model

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TensorFlow

Modu

Aliases:

- Modu

as/losses

. If

of

python/tf/keras/Model

Explore multi-class with Rock Paper Scissors dataset

```
27  from tensorflow.keras.optimizers import RMSprop
28
29  model.compile(
30      loss = 'cartegorical_crossentropy',
31      optimizer = RMSprop(lr=0.001),
32      metrics=['acc']
33  )
```

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```

Explore multi-class with Rock Paper Scissors dataset

Train a classifier with Rock Paper Scissors

```
!wget --no-check-certificate \
    https://storage.googleapis.com/laurencemoroney-blog.appspot.com/rps.zip \
    -O /tmp/rps.zip

!wget --no-check-certificate \
    https://storage.googleapis.com/laurencemoroney-blog.appspot.com/rps-test-set.zip \
    -O /tmp/rps-test-set.zip
```

```
--2019-02-13 22:46:40--  https://storage.googleapis.com/laurencemoroney-blog.appspot.com/rps.zip
Resolving storage.googleapis.com... 2607:f8b0:4003:c0a::80, 64.233.171.128
Connecting to storage.googleapis.com|2607:f8b0:4003:c0a::80|:443... connected.
WARNING: cannot verify storage.googleapis.com's certificate, issued by 'CN=Google Internet Authority G3,O=Google Trust Services,C=US':
  Unable to locally verify the issuer's authority.
HTTP request sent, awaiting response... 200 OK
Length: 200682221 (191M) [application/zip]
Saving to: '/tmp/rps.zip'

/tmp/rps.zip        100%[===================>] 191.38M   168MB/s    in 1.1s

2019-02-13 22:46:41 (168 MB/s) - '/tmp/rps.zip' saved [200682221/200682221]

--2019-02-13 22:46:42--  https://storage.googleapis.com/laurencemoroney-blog.appspot.com/rps-test-set.zip
Resolving storage.googleapis.com... 2607:f8b0:4003:c11::80, 74.125.127.128
Connecting to storage.googleapis.com|2607:f8b0:4003:c11::80|:443... connected.
WARNING: cannot verify storage.googleapis.com's certificate, issued by 'CN=Google Internet Authority G3,O=Google Trust Services,C=US':
  Unable to locally verify the issuer's authority.
HTTP request sent, awaiting response... 200 OK
Length: 29516758 (28M) [application/zip]
Saving to: '/tmp/rps-test-set.zip'

/tmp/rps-test-set.z 100%[===================>]  28.15M   128MB/s    in 0.2s

2019-02-13 22:46:43 (128 MB/s) - '/tmp/rps-test-set.zip' saved [29516758/29516758]
```

Train a classifier with Rock Paper Scissors

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```

!wget 명령을 사용하여 파일 다운로드

Train a classifier with Rock Paper Scissors

```
import os
import zipfile

local_zip = '/tmp/rps.zip'
zip_ref = zipfile.ZipFile(local_zip, 'r')
zip_ref.extractall('/tmp/')
zip_ref.close()

local_zip = '/tmp/rps-test-set.zip'
zip_ref = zipfile.ZipFile(local_zip, 'r')
zip_ref.extractall('/tmp/')
zip_ref.close()
```

Train a classifier with Rock Paper Scissors

```
rock_dir = os.path.join('/tmp/rps/rock')
paper_dir = os.path.join('/tmp/rps/paper')
scissors_dir = os.path.join('/tmp/rps/scissors')

print('total training rock images:', len(os.listdir(rock_dir)))
print('total training paper images:', len(os.listdir(paper_dir)))
print('total training scissors images:', len(os.listdir(scissors_dir)))

rock_files = os.listdir(rock_dir)
print(rock_files[:10])

paper_files = os.listdir(paper_dir)
print(paper_files[:10])

scissors_files = os.listdir(scissors_dir)
print(scissors_files[:10])
```

```
('total training rock images:', 840)
('total training paper images:', 840)
('total training scissors images:', 840)
['rock06ck02-084.png', 'rock01-024.png', 'rock06ck02-069.png', 'rock03-086.png', 'rock06ck02-033.png', 'rock01-058.png', 'rock03-036.png', 'rock01-086.png', 'rock07-
['paper01-079.png', 'paper03-059.png', 'paper04-108.png', 'paper02-048.png', 'paper02-007.png', 'paper04-022.png', 'paper01-103.png', 'paper07-043.png', 'paper03-017
['scissors04-003.png', 'testscissors03-082.png', 'scissors03-102.png', 'scissors02-004.png', 'testscissors02-080.png', 'scissors01-081.png', 'scissors02-053.png', 's
```

Train a classifier with Rock Paper Scissors

```
%matplotlib inline

import matplotlib.pyplot as plt
import matplotlib.image as mpimg

pic_index = 2

next_rock = [os.path.join(rock_dir, fname)
                for fname in rock_files[pic_index-2:pic_index]]
next_paper = [os.path.join(paper_dir, fname)
                for fname in paper_files[pic_index-2:pic_index]]
next_scissors = [os.path.join(scissors_dir, fname)
                for fname in scissors_files[pic_index-2:pic_index]]

for i, img_path in enumerate(next_rock+next_paper+next_scissors):
  #print(img_path)
  img = mpimg.imread(img_path)
  plt.imshow(img)
  plt.axis('Off')
  plt.show()
```

Train a classifier with Rock Paper Scissors

```
[16] import tensorflow as tf
     import keras_preprocessing
     from keras_preprocessing import image
     from keras_preprocessing.image import ImageDataGenerator

     TRAINING_DIR = "/tmp/rps/"
     training_datagen = ImageDataGenerator(
           rescale = 1./255,
         rotation_range=40,
           width_shift_range=0.2,
           height_shift_range=0.2,
           shear_range=0.2,
           zoom_range=0.2,
           horizontal_flip=True,
           fill_mode='nearest')

     VALIDATION_DIR = "/tmp/rps-test-set/"
     validation_datagen = ImageDataGenerator(rescale = 1./255)

     train_generator = training_datagen.flow_from_directory(
       TRAINING_DIR,
       target_size=(150,150),
       class_mode='categorical'
     )

     validation_generator = validation_datagen.flow_from_directory(
       VALIDATION_DIR,
       target_size=(150,150),
       class_mode='categorical'
     )

     model = tf.keras.models.Sequential([
         # Note the input shape is the desired size of the image 150x150 with 3 bytes color
         # This is the first convolution
         tf.keras.layers.Conv2D(64, (3,3), activation='relu', input_shape=(150, 150, 3)),
         tf.keras.layers.MaxPooling2D(2, 2),
         # The second convolution
         tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
         tf.keras.layers.MaxPooling2D(2,2),
         # The third convolution
         tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
         tf.keras.layers.MaxPooling2D(2,2),
         # The fourth convolution
         tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
         tf.keras.layers.MaxPooling2D(2,2),
         # Flatten the results to feed into a DNN
         tf.keras.layers.Flatten(),
         tf.keras.layers.Dropout(0.5),
         # 512 neuron hidden layer
```

Train a classifier with Rock Paper Scissors

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       class_mode='categorical'
     )

     validation_generator = validation_datagen.flow_from_directory(
       VALIDATION_DIR,
       target_size=(150,150),
       class_mode='categorical'
     )

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```

학습 데이터 정의

Train a classifier with Rock Paper Scissors

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[16] import tensorflow as tf
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           width_shift_range=0.2,
           height_shift_range=0.2,
           shear_range=0.2,
           zoom_range=0.2,
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     VALIDATION_DIR = "/tmp/rps-test-set/"
     validation_datagen = ImageDataGenerator(rescale = 1./255)

     train_generator = training_datagen.flow_from_directory(
       TRAINING_DIR,
       target_size=(150,150),
       class_mode='categorical'
     )

     validation_generator = validation_datagen.flow_from_directory(
       VALIDATION_DIR,
       target_size=(150,150),
       class_mode='categorical'
     )

     model = tf.keras.models.Sequential([
         # Note the input shape is the desired size of the image 150
         # This is the first convolution
         tf.keras.layers.Conv2D(64, (3,3), activation='relu', input_
         tf.keras.layers.MaxPooling2D(2, 2),
         # The second convolution
         tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
         tf.keras.layers.MaxPooling2D(2,2),
         # The third convolution
         tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
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         # 512 neuron hidden layer
```

```
35  from keras_preprocessing.image import ImageDataGenerator
36
37  TRAINING_DIR = "/tmp/rps/"
38
39  training_datagen = ImageDataGenerator(
40      rescale=1./255,
41      rotation_range=40,
42      width_shift_range=0.2,
43      height_shift_range=0.2,
44      shear_range=0.2,
45      zoom_range=0.2,
46      horizontal_flip=True,
47      fill_mode='nearest'
48  )
```

Train a classifier with Rock Paper Scissors

```
[16] import tensorflow as tf
     import keras_preprocessing
     from keras_preprocessing import image
     from keras_preprocessing.image import ImageDataGenerator

     TRAINING_DIR = "/tmp/rps/"
     training_datagen = ImageDataGenerator(
           rescale = 1./255,
         rotation_range=40,
           width_shift_range=0.2,
           height_shift_range=0.2,
```

```
35  from keras_preprocessing.image import ImageDataGenerator
36
37  TRAINING_DIR = "/tmp/rps/"
```

```
model.summary()

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

history = model.fit_generator(train_generator, epochs=25, validation_data = validation_generator, verbose = 1)

model.save("rps.h5")
```

```
       VALIDATION_DIR,
       target_size=(150,150),
       class_mode='categorical'
     )

     model = tf.keras.models.Sequential([
         # Note the input shape is the desired size of the image 150
         # This is the first convolution
         tf.keras.layers.Conv2D(64, (3,3), activation='relu', input_
         tf.keras.layers.MaxPooling2D(2, 2),
         # The second convolution
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         # Flatten the results to feed into a DNN
         tf.keras.layers.Flatten(),
         tf.keras.layers.Dropout(0.5),
         # 512 neuron hidden layer
```

```
44      shear_range=0.2,
45      zoom_range=0.2,
46      horizontal_flip=True,
47      fill_mode='nearest'
48  )
```

Train a classifier with Rock Paper Scissors

```
[16] import tensorflow as tf
     import keras_preprocessing
     from keras_preprocessing import image
     from keras_preprocessing.image import ImageDataGenerator

     TRAINING_DIR = "/tmp/rps/"
     training_datagen = ImageDataGenerator(
           rescale = 1./255,
         rotation_range=40,
           width_shift_range=0.2,
           height_shift_range=0.2,
```

```
35  from keras_preprocessing.image import ImageDataGenerator
36
37  TRAINING_DIR = "/tmp/rps/"
```

```
model.summary()

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

history = model.fit_generator(train_generator, epochs=25, validation_data = validation_generator, verbose = 1)

model.save("rps.h5")
```

모델을 h5 파일로 저장

```
      VALIDATION_DIR,
      target_size=(150,150),
      class_mode='categorical'
    )

    model = tf.keras.models.Sequential([
        # Note the input shape is the desired size of the image 150
        # This is the first convolution
        tf.keras.layers.Conv2D(64, (3,3), activation='relu', input_
        tf.keras.layers.MaxPooling2D(2, 2),
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        tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
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        tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
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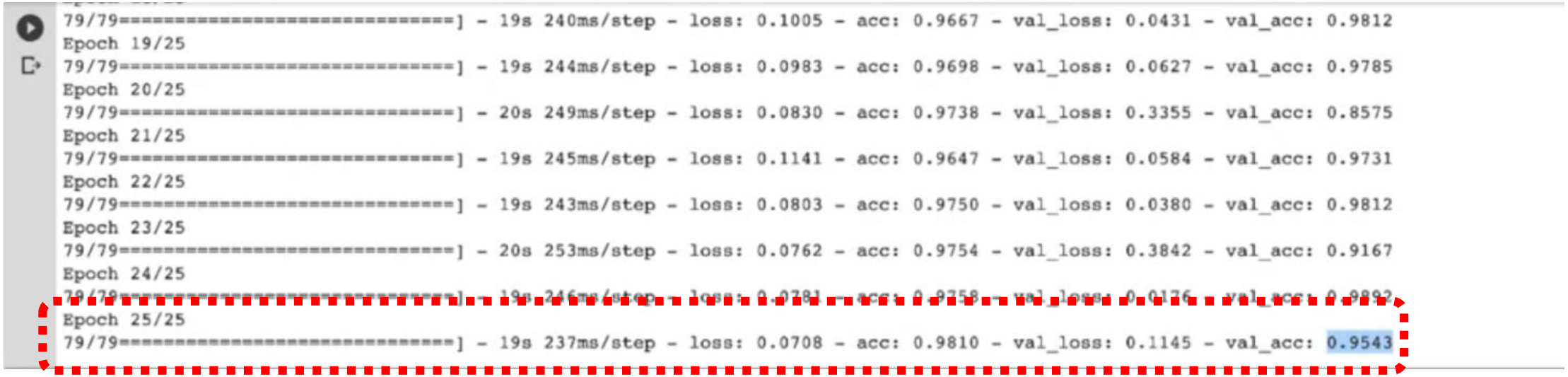
```
44      shear_range=0.2,
45      zoom_range=0.2,
46      horizontal_flip=True,
47      fill_mode='nearest'
48  )
```

Train a classifier with Rock Paper Scissors

```
79/79==============================] - 19s 240ms/step - loss: 0.1005 - acc: 0.9667 - val_loss: 0.0431 - val_acc: 0.9812
Epoch 19/25
79/79==============================] - 19s 244ms/step - loss: 0.0983 - acc: 0.9698 - val_loss: 0.0627 - val_acc: 0.9785
Epoch 20/25
79/79==============================] - 20s 249ms/step - loss: 0.0830 - acc: 0.9738 - val_loss: 0.3355 - val_acc: 0.8575
Epoch 21/25
79/79==============================] - 19s 245ms/step - loss: 0.1141 - acc: 0.9647 - val_loss: 0.0584 - val_acc: 0.9731
Epoch 22/25
79/79==============================] - 19s 243ms/step - loss: 0.0803 - acc: 0.9750 - val_loss: 0.0380 - val_acc: 0.9812
Epoch 23/25
79/79==============================] - 20s 253ms/step - loss: 0.0762 - acc: 0.9754 - val_loss: 0.3842 - val_acc: 0.9167
Epoch 24/25
79/79==============================] - 19s 246ms/step - loss: 0.0781 - acc: 0.9758 - val_loss: 0.0176 - val_acc: 0.9892
Epoch 25/25
79/79==============================] - 19s 237ms/step - loss: 0.0708 - acc: 0.9810 - val_loss: 0.1145 - val_acc: 0.9543
```

Train a classifier with Rock Paper Scissors



Train a classifier with Rock Paper Scissors

```
import matplotlib.pyplot as plt
acc = history.history['acc']
val_acc = history.history['val_acc']
loss = history.history['loss']
val_loss = history.history['val_loss']

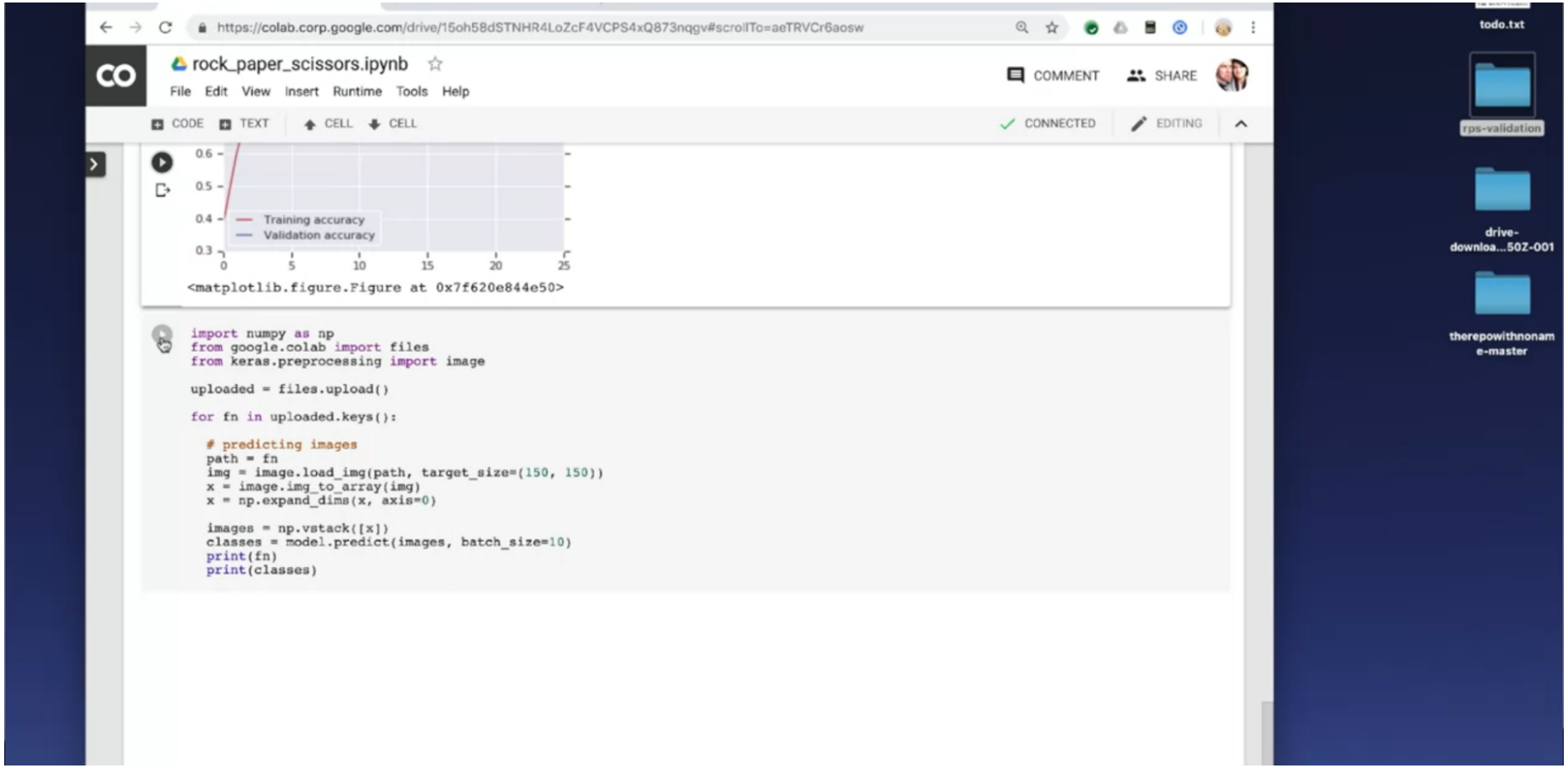
epochs = range(len(acc))

plt.plot(epochs, acc, 'r', label='Training accuracy')
plt.plot(epochs, val_acc, 'b', label='Validation accuracy')
plt.title('Training and validation accuracy')
plt.legend(loc=0)
plt.figure()

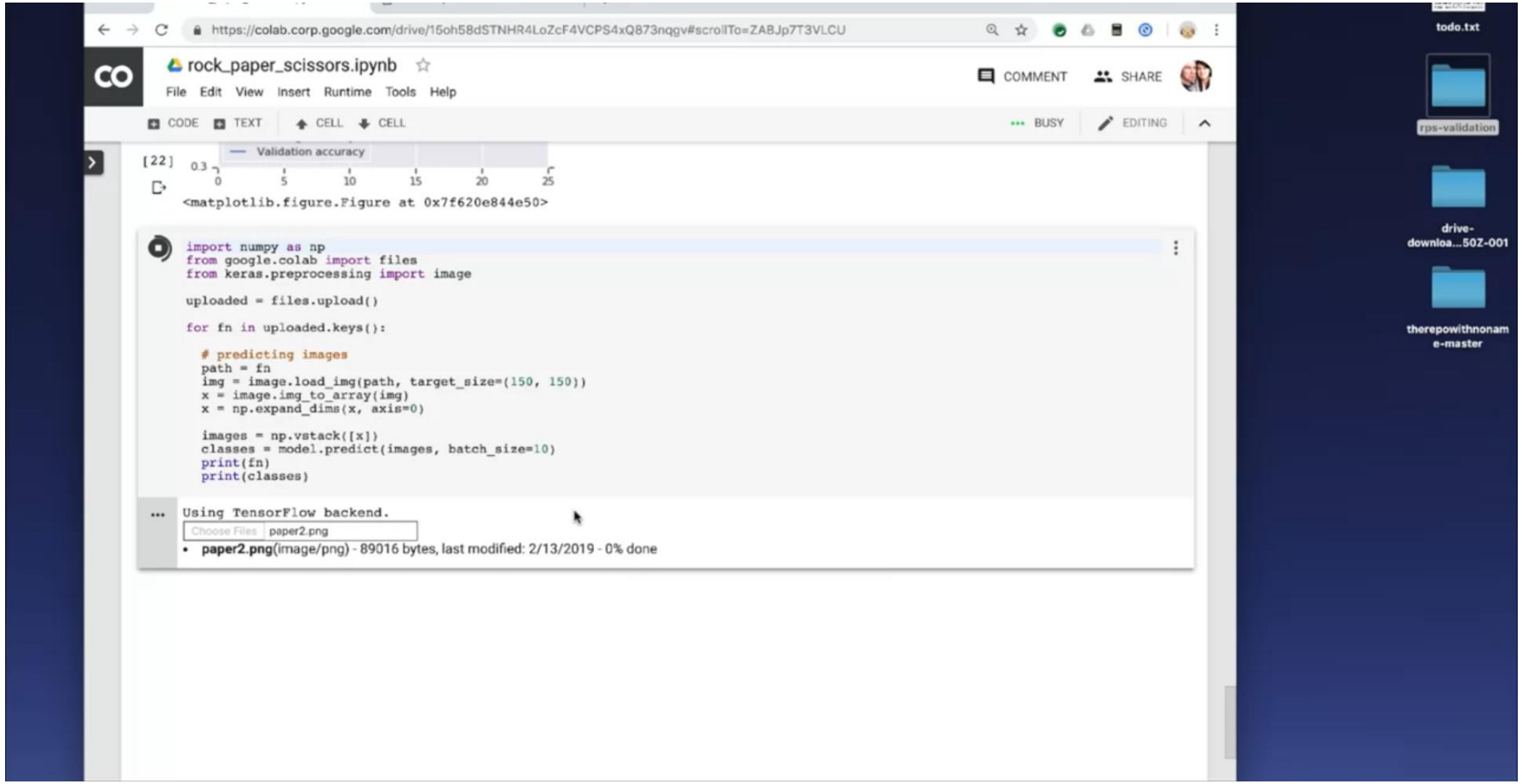

plt.show()
```


```
<matplotlib.figure.Figure at 0x7f620e844e50>
```

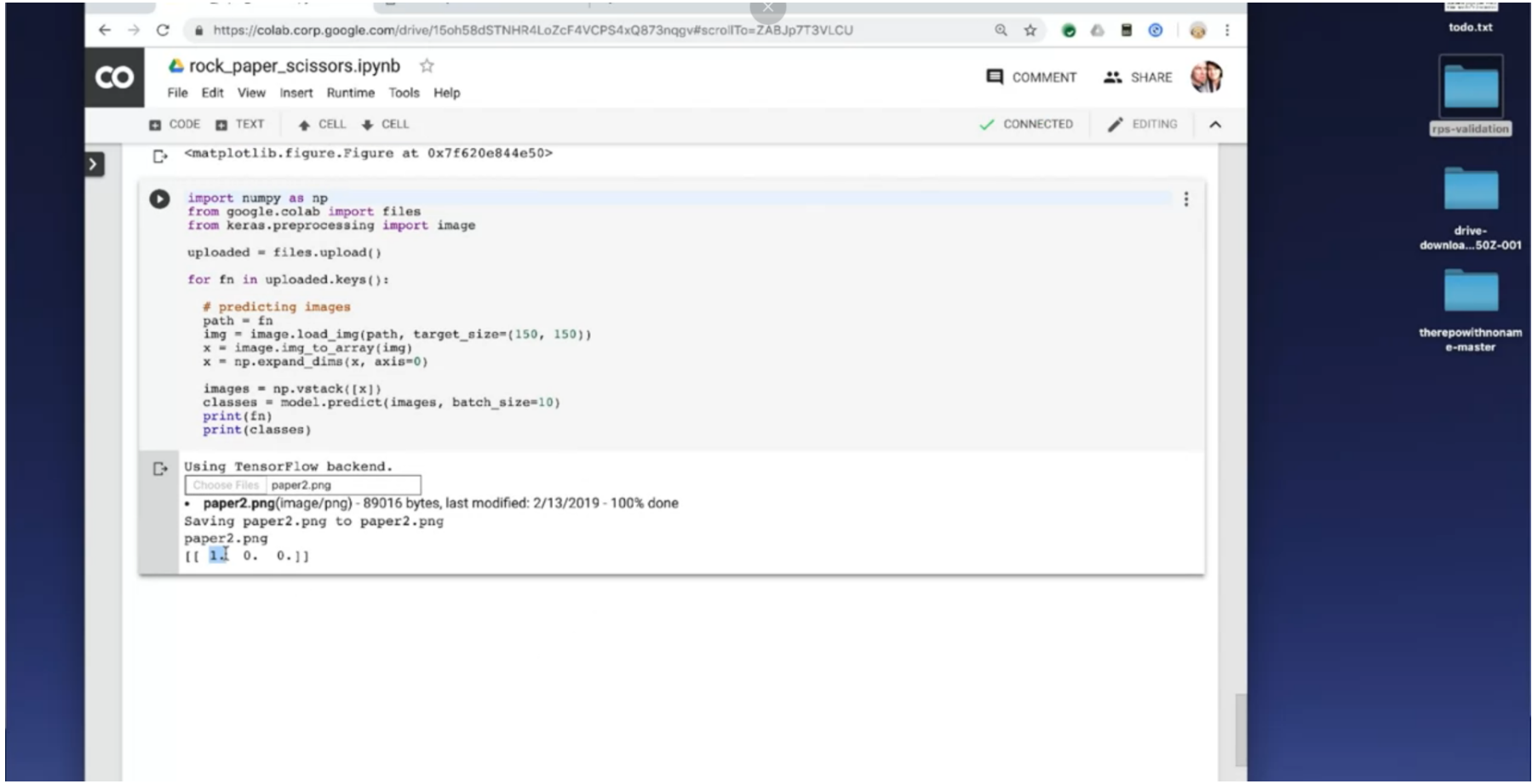
Test the Rock Paper Scissors classifier



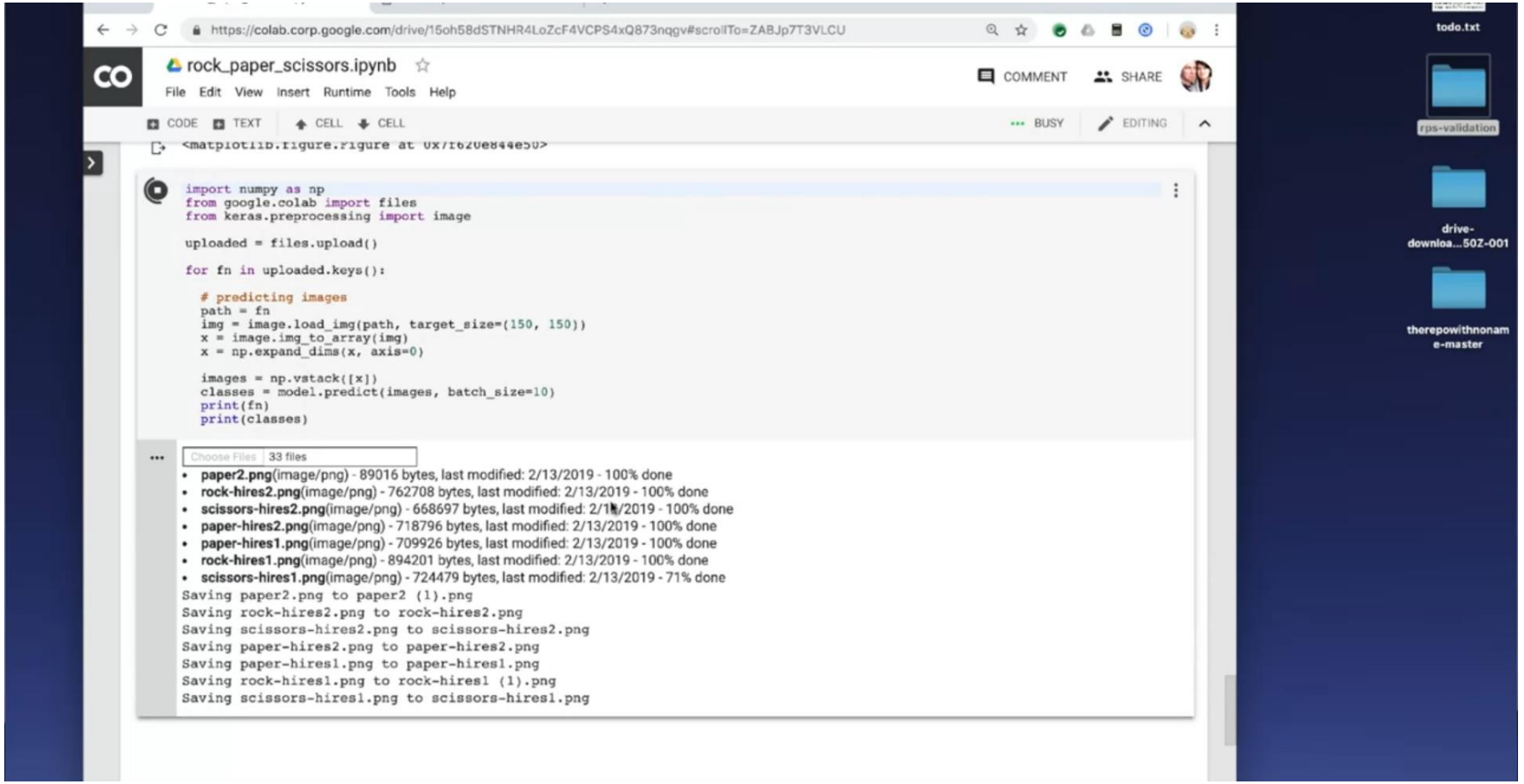
Test the Rock Paper Scissors classifier



Test the Rock Paper Scissors classifier



Test the Rock Paper Scissors classifier



Test the Rock Paper Scissors classifier