

# machine\_learning\_to\_identify\_beer\_by\_label- the\_twelve\_pack

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## 1 Machine Learning to Identify Beer by Label - The Twelve Pack

Six-Pick is a phone app that will be able to classify a beer by its label, as well as provide information about the beer such as the brewery, ingredients, and flavor profile. This concept program, The Twelve Pack, will demonstrate the potential of the app by classifying pictures of twelve beers and connecting to the [BreweryDB API](#) to provide information about each beer.

This concept program will utilize SciKit Learn, Tensorflow and Keras for the machine learning model, as well as OpenCV for image manipulation. Furthermore, Matplotlib, Pandas and Numpy will provide the backbone of visualization and data organization/exploration. A convolutional neural network (CNN) and a Random Forest Classifier (RFC) will be used to classify the beer labels.

500 pictures were taken of each beer on an iPhone 8, 250 in full lighting and 250 in dark lighting. The photos were then uploaded to a 1TB 'WD My Passport for Mac' external hard drive. The iPhone saves photos in the HEIC format, so all pictures were converted to jpg using the Automator app on a 2018 Macbook Pro.

The reason this method was used to provide the data is that the Six-Pic app would run on pictures taken from a smart phone. The reason for the different lighting is that pictures used in the app will likely be taken outside in a well-lit environment, or in a bar/brewery in a poorly-lit environment.

In order to train the model effectively, altered images will be created from the original images for each beer using the Keras ImageDataGenerator. This method will save time during data collection (less pictures will need to be taken) and automate the image generation process.

### 1.1 Types of Beer Used in Model and The Vessel

- 1) Stone Delicious IPA - Bottle
- 2) Allagash White Belgian Ale - Bottle
- 3) Alpine Duet - Bottle
- 4) Aurora Hoppyalis - Bottle
- 5) Ballast Point California Kolsch - Bottle
- 6) Bear Republic Racer 5 - Bottle

- 7) Sierra Nevada Pale Ale - Bottle
- 8) Green Flash West Coast IPA - Bottle
- 9) Lagunitas Secret Agenda - Bottle
- 10) Pizza Port Swami's IPA - Can
- 11) Coronado Mermaid's Republic - Can
- 12) Modern Times Orderville - Can

## 1.2 Data Loading and Wrangling

```
In [1]: import os
import numpy as np
import pandas as pd
import seaborn as sns
import random
import matplotlib.pyplot as plt
%matplotlib inline
# import cv2 for image shaping
import cv2
# import tensorflow
import tensorflow as tf
# import keras
import keras
# import data generator
from keras import preprocessing
from keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, ...
# Import various componenets for model building
from keras.models import Sequential
from keras.layers import Dense, Activation, Dropout, Flatten, Conv2D, MaxPooling2D, Dr...
from keras import regularizers, optimizers
from keras.optimizers import RMSprop
# Import the backend
from keras import backend as K
# import callbacks and f1 score necessities
from keras.callbacks import Callback
from sklearn.metrics import confusion_matrix, f1_score, precision_score, recall_score
# import random forest for second model test
from sklearn.ensemble import RandomForestClassifier
from sklearn.datasets import make_classification
# import classification report for categorical analysis
from sklearn.metrics import classification_report
# import learning curve to visualize random forest
from sklearn.model_selection import learning_curve
```

Using TensorFlow backend.

First, the original images will be loaded from the external drive:

```
In [2]: # declare number of types of beer
num_classes = 12
# declare path to external hard drive where photos are stored
base_path = r'/Volumes/My Passport for Mac/run_images'
# define function to get jpgs from path
def get_img(path):
    # create empty list to store jpgs
    all_jpgs = []
    for root, dirs, files in os.walk(path, topdown=True):
        for jpg in files:
            _, ext = os.path.splitext(jpg)
            if ext == '.jpg':
                all_jpgs.append(os.path.join(root, jpg))
            elif ext == '.jpeg':
                all_jpgs.append(os.path.join(root, jpg))
    return all_jpgs

# define function to extract beer name from filenames
def get_labels(path):
    path_list = []
    storage = []
    # iterate through jpeg files for generated images and extract beer names
    for root, dirs, files in os.walk(path, topdown=True):
        for file in files:
            path_list.append(file)
            parts = file.split('_')
            l = parts[0] + '_' + parts[1]
            # drop .DS_Store value from external hard drive
            if l == '.DS_Store':
                None
            else:
                storage.append(l)
    return storage

# call function to get jpgs
all_imgs = get_img(base_path)
# get labels from image names
labels = get_labels(base_path)
```

A pandas dataframe will be created from the image jpg files and the labels.

```
In [3]: # create pandas frame from lists
df = pd.DataFrame({'images': all_imgs, 'labels': labels})
# shuffle rows to eliminate bias from image groupings
df = df.sample(frac=1)
# reindex dataframe
```

```
df = df.reset_index()
df = df.drop(['index'], 1)
# show format
df.head()
```

```
Out[3]:
```

	images	labels
0	/Volumes/My Passport for Mac/run_images/laguni...	lagunitas_secretagenda
1	/Volumes/My Passport for Mac/run_images/corona...	coronado_mermaidsred
2	/Volumes/My Passport for Mac/run_images/pizzap...	pizzaport_swamisipa
3	/Volumes/My Passport for Mac/run_images/sierra...	sierranevada_paleale
4	/Volumes/My Passport for Mac/run_images/allaga...	allagash_white

### 1.3 Data Exploration

```
In [4]: # show sample image with opencv
im_path = r'/Volumes/My Passport for Mac/original_pics/stone_delicious/stone_delicious.'
img = cv2.imread(im_path)
height, width, channels = img.shape
plt.figure(figsize=(7,10))
plt.imshow(img)
print('The image shape is {}'.format(img.shape))
print('Minimum RGB value in this image {}'.format(img.min()))
print('The aspect ratio of the image is {}'.format(width/height))
```

```
The image shape is (4032, 3024, 3)
Minimum RGB value in this image 0
The aspect ratio of the image is 0.75
```



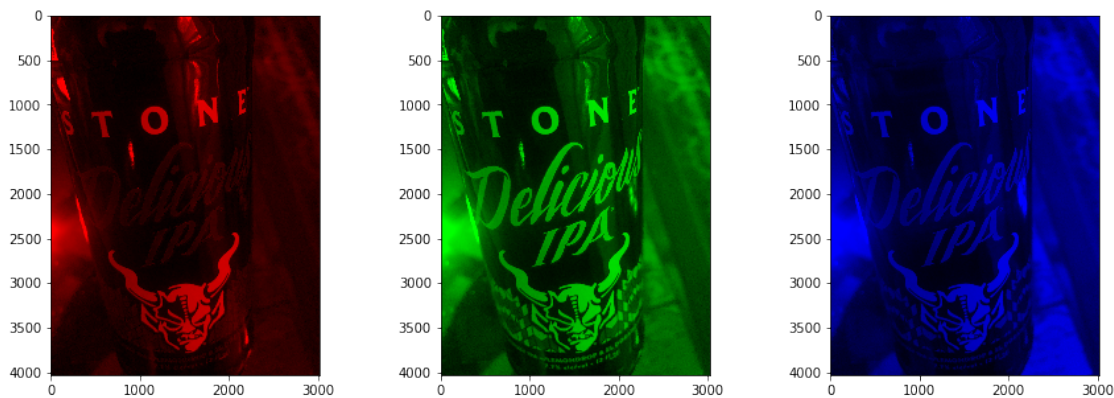
The first two dimensions of the image shape are the height and width, while the third is the number of channels for the image. The image has a height of 4032 and a width of 3024, the resolution on the iPhone 8, and 3 channels. A 3 channel image is color (one channel each for red, green and blue or RGB) and a 1 channel image is a black and white or gray image.

The minimum RGB value for the image is 0, showing that the images can be resized to any dimension for modeling. Since the aspect ratio is 0.75, this ratio will be maintained for any

resized images.

Since the images used in this report are taken in color (and the model should be tested on color images), the 3 channel images will be used. Below the blue, green, and red channels will be shown on the same image. The code for this display is borrowed from [Mohammed Innat](#).

```
In [5]: # show 3 pictures of same image, one for each color channel
fig,ax=plt.subplots(nrows=1,ncols=3,figsize=(15,5))
for c,ax in zip(range(3),ax):
    # create zero matrix
    split_img=np.zeros(img.shape,dtype="uint8")# 'dtype' by default: 'numpy.float64'
    # assigning each channel
    split_img[:, :,c]=img[:, :,c]
    # display each channel
    ax.imshow(split_img)
```



In the next section of the report all images will be converted to smaller images for the model. To show how the larger and smaller images differ, the image above will be converted to a (200, 150, 3) shape and shown.

```
In [6]: def resize_img(path):
    # read color photos
    im = cv2.imread(path)
    # resize images to save computational power and ensure same size across all images
    ## ratio
    resized_img = cv2.resize(im, (150, 200))
    height, width, channels = resized_img.shape
    return resized_img

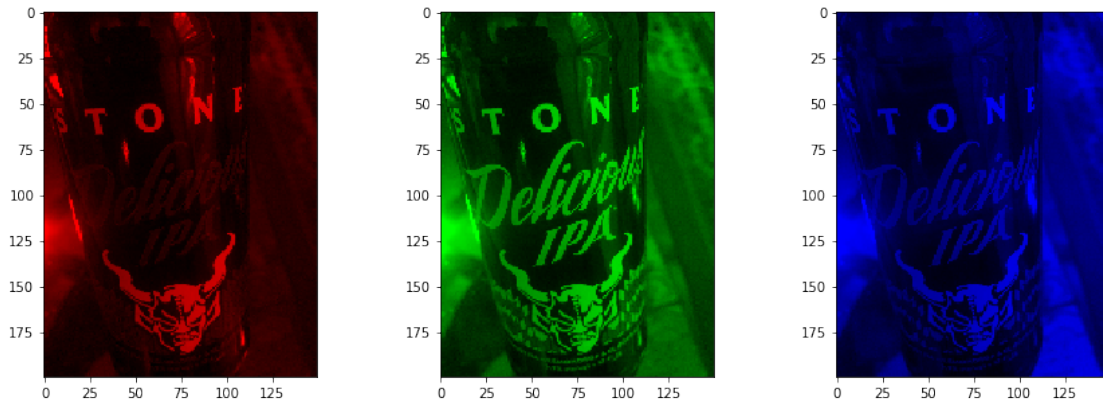
# resize image
r_img = resize_img(im_path)
plt.figure(figsize=(7,10))
plt.imshow(r_img)
print('The image shape is {}'.format(r_img.shape))
print('Minimum RGB value in this image {}'.format(r_img.min()))
print('The aspect ratio of the image is {}'.format(width/height))
```



The image shape is (200, 150, 3)  
Minimum RGB value in this image 0  
The aspect ratio of the image is 0.75



```
In [7]: # show 3 pictures of same image, one for each color channel
fig,ax=plt.subplots(nrows=1,ncols=3,figsize=(15,5))
for c,ax in zip(range(3),ax):
    # create zero matrix
    split_img=np.zeros(r_img.shape,dtype="uint8")# 'dtype' by default: 'numpy.float64'
    # assigning each channel
    split_img[:, :,c]=r_img[:, :,c]
    # display each channel
    ax.imshow(split_img)
```



## 2 Convolutional Neural Network to Predict Beer by Label

A [convolutional neural network \(CNN\)](#) from Keras will be used to classify the images. This model multiplies the matrix values of an image with a kernel. This kernel acts like a magnifying glass as a small neural network layer that lies on top of the larger image array layer. The smaller layer analyzes all pixels in the image array, much like a magnifying glass moving over a page.

New arrays will be created from the generated images, the labels will be assigned, and then the test and training sets created. Before the model is created, how can the model output the name of the beer instead of a dummy variable or keras one-hot-encoding array?

### 2.1 Prepare Data for Model

In order to properly label each category, the label for the test set will be converted to category codes and a dictionary pairing the numbers to the labels will be created.

First, a column called 'cats' will be added to the dataframe. This will act as the response variable for the model.

```
In [8]: # create test_labels list
cat_labels = df['labels'].astype('category').cat.codes
# concatenate back onto original dataframe
df = pd.concat([df, cat_labels], 1)
# rename concatenated column
```



```
df = df.rename(columns={0: 'cats'})
# convert cats columns to string for keras
df['cats'] = df['cats'].astype(str)
```

A dictionary will then be created from the cats column of the frame. This will allow the generators to be created with proper labeling that will match with the string name of each beer through the dictionary.

```
In [9]: # create dictionary for values in test_labels
dict_labels = dict(zip(df['cats'], df['labels']))
# create list of labels for cnn
model_labels = list(dict_labels.keys())
# show dictionary
dict_labels
```

```
Out[9]: {'7': 'lagunitas_secretagenda',
'5': 'coronado_mermaidsred',
'9': 'pizzaport_swamisipa',
'10': 'sierranevada_paleale',
'0': 'allagash_white',
'1': 'alpine_duet',
'4': 'bearrepublic_racer5',
'6': 'greenflash_westcoastipa',
'11': 'stone_delicious',
'3': 'ballastpoint_californiakolsch',
'2': 'aurora_hoppyalis',
'8': 'moderntimes_orderville'}
```

To ensure all labels are in the training, test and validation sets (the training set will be 60% of the total data, test 20%, and the validation 20%), the sets will be created and the number of labels in each set shown.

```
In [10]: # create test, training, and validation sets
train = df[:3600]
test = df[3600:4800]
valid = df[4800:]
# show the number of labels in each set
print('There are {} labels in the training set'.format(len(train['cats'].unique())))
print('There are {} labels in the test set'.format(len(test['cats'].unique())))
print('There are {} labels in the validation set'.format(len(valid['cats'].unique())))
```

```
There are 12 labels in the training set
There are 12 labels in the test set
There are 12 labels in the validation set
```

Then a list of labels for each model set will be created.

```
In [11]: # create labels for test, training and validation sets
train_labels = train['cats']
test_labels = test['cats']
valid_labels = valid['cats']
```

## 2.2 Image Generation

The [Keras ImageDataGenerator](#) is a powerful tool that allows the user to generate 'altered' images in order to create more data to train a machine learning model. The code used to create the generators and CNN model is borrowed from [Vijayabhaskar J.](#)

The target size of the image will be changed to (200, 150) as smaller images will allow the model to run faster while keeping the aspect ratio the same. The generator will also create altered images to train the model.

```
In [56]: # declare batch size
batch_size=32
# declare traind and test datagen
datagen=ImageDataGenerator(rescale=1./255., horizontal_flip = True, vertical_flip = False,
                           width_shift_range = 0.2, height_shift_range = 0.2, zoom_range = 0.2,
                           rotation_range = 10, shear_range=0.2, fill_mode='nearest')
test_datagen=ImageDataGenerator(rescale=1./255.)

# build train datagenerator
train_generator=datagen.flow_from_dataframe(
dataframe=train,
directory=base_path,
x_col='images',
y_col='cats',
batch_size=batch_size,
seed=42,
shuffle=True,
class_mode='categorical',
classes=model_labels,
target_size=(200, 150))

# build validation generator
valid_generator=test_datagen.flow_from_dataframe(
dataframe=valid,
directory=base_path,
x_col='images',
y_col='cats',
batch_size=batch_size,
seed=42,
shuffle=True,
class_mode='categorical',
classes=model_labels,
target_size=(200, 150))

# build test generator
test_generator=test_datagen.flow_from_dataframe(
dataframe=test,
directory=base_path,
x_col='images',
```

```

batch_size=1,
seed=42,
shuffle=False,
class_mode=None,
target_size=(200, 150))

```

Found 3600 images belonging to 12 classes.  
Found 1200 images belonging to 12 classes.  
Found 1200 images.

## 2.3 Compile the CNN Model

The model used to classify the labels is borrowed from the [Thinkful curriculum](#).

```

In [13]: # build the model
model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3),
                 activation='relu',
                 input_shape=(200, 150, 3)))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
# compile
model.compile(loss=keras.losses.categorical_crossentropy,
              optimizer=keras.optimizers.Adadelta(),
              metrics=['categorical_accuracy'])
# show summary
model.summary()

```

WARNING:tensorflow:From /anaconda3/lib/python3.6/site-packages/tensorflow/python/framework/op\_def\_registry.py:498: instructions\_for\_update (from tensorflow.python.ops.nn\_ops) is deprecated and will be removed in a future version.

Instructions for updating:

Colocations handled automatically by placer.

WARNING:tensorflow:From /anaconda3/lib/python3.6/site-packages/keras/backend/tensorflow\_backend.py:397: instructions\_for\_update (from tensorflow.python.ops.nn\_ops) is deprecated and will be removed in a future version.

Instructions for updating:

Please use `rate` instead of `keep\_prob`. Rate should be set to `rate = 1 - keep\_prob`.

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 198, 148, 32)	896
conv2d_2 (Conv2D)	(None, 196, 146, 64)	18496
max_pooling2d_1 (MaxPooling2D)	(None, 98, 73, 64)	0

dropout_1 (Dropout)	(None, 98, 73, 64)	0
-----		
flatten_1 (Flatten)	(None, 457856)	0
-----		
dense_1 (Dense)	(None, 128)	58605696
-----		
dropout_2 (Dropout)	(None, 128)	0
-----		
dense_2 (Dense)	(None, 12)	1548
=====		
Total params: 58,626,636		
Trainable params: 58,626,636		
Non-trainable params: 0		
-----		

In [14]: # size all generators and fit model

```

STEP_SIZE_TRAIN=train_generator.n//train_generator.batch_size
STEP_SIZE_VALID=valid_generator.n//valid_generator.batch_size
STEP_SIZE_TEST=test_generator.n//test_generator.batch_size
history = model.fit_generator(generator=train_generator,
                              steps_per_epoch=STEP_SIZE_TRAIN,
                              validation_data=valid_generator,
                              validation_steps=STEP_SIZE_VALID,
                              epochs=15)

```

WARNING:tensorflow:From /anaconda3/lib/python3.6/site-packages/tensorflow/python/ops/math\_ops.py:

Instructions for updating:

Use tf.cast instead.

Epoch 1/15

112/112 [=====] - 1612s 14s/step - loss: 2.4449 - categorical\_accuracy: 0.0000

Epoch 2/15

112/112 [=====] - 1915s 17s/step - loss: 1.6446 - categorical\_accuracy: 0.0000

Epoch 3/15

112/112 [=====] - 2227s 20s/step - loss: 1.2264 - categorical\_accuracy: 0.0000

Epoch 4/15

112/112 [=====] - 1814s 16s/step - loss: 0.9108 - categorical\_accuracy: 0.0000

Epoch 5/15

112/112 [=====] - 1472s 13s/step - loss: 0.7505 - categorical\_accuracy: 0.0000

Epoch 6/15

112/112 [=====] - 1402s 13s/step - loss: 0.5829 - categorical\_accuracy: 0.0000

Epoch 7/15

112/112 [=====] - 1401s 13s/step - loss: 0.5353 - categorical\_accuracy: 0.0000

Epoch 8/15

112/112 [=====] - 1406s 13s/step - loss: 0.4485 - categorical\_accuracy: 0.0000

Epoch 9/15

112/112 [=====] - 1410s 13s/step - loss: 0.4470 - categorical\_accuracy: 0.0000

Epoch 10/15

```

112/112 [=====] - 1412s 13s/step - loss: 0.4002 - categorical_accuracy: 0.85
Epoch 11/15
112/112 [=====] - 1456s 13s/step - loss: 0.3852 - categorical_accuracy: 0.86
Epoch 12/15
112/112 [=====] - 1417s 13s/step - loss: 0.3332 - categorical_accuracy: 0.88
Epoch 13/15
112/112 [=====] - 1416s 13s/step - loss: 0.3145 - categorical_accuracy: 0.89
Epoch 14/15
112/112 [=====] - 1447s 13s/step - loss: 0.3300 - categorical_accuracy: 0.89
Epoch 15/15
112/112 [=====] - 1440s 13s/step - loss: 0.3053 - categorical_accuracy: 0.90

```

Keras allows models to be saved for later use:

```

In [15]: # serialize model to JSON
         model_json = model.to_json()
         with open("model_twelvepack.json", "w") as json_file:
             json_file.write(model_json)
         # serialize weights to HDF5
         model.save_weights("model_twelvepack.h5")
         print("Saved model to disk")

```

Saved model to disk

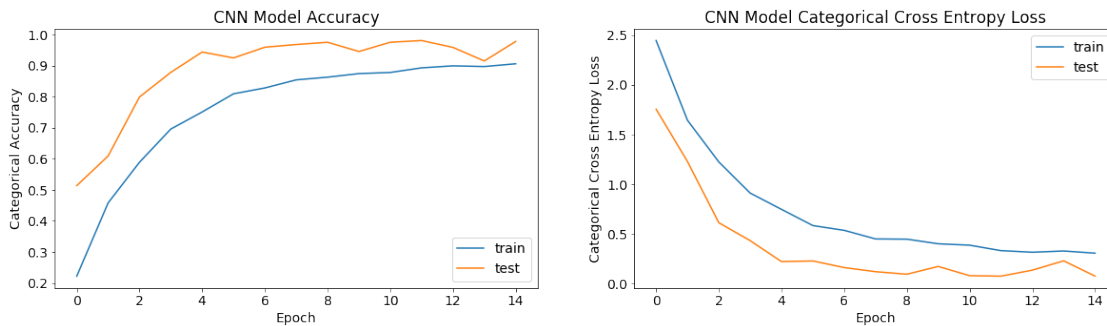
## 2.4 CNN Model Analysis

```

In [16]: # declare font dictionary so plots are easier to read
         font = {'family' : 'DejaVu Sans',
                 'weight' : 'normal',
                 'size'   : 14}
         # apply dictionary to plots
         plt.rc('font', **font)
         # create frames for plots
         f, (ax1, ax2) = plt.subplots(1, 2, figsize=(20,5))
         # summarize history for categorical accuracy
         ax1.plot(history.history['categorical_accuracy'])
         ax1.plot(history.history['val_categorical_accuracy'])
         ax1.set_title('CNN Model Accuracy')
         ax1.set_ylabel('Categorical Accuracy')
         ax1.set_xlabel('Epoch')
         ax1.legend(['train', 'test'], loc='lower right')
         # summarize history for loss
         ax2.plot(history.history['loss'])
         ax2.plot(history.history['val_loss'])
         ax2.set_title('CNN Model Categorical Cross Entropy Loss')
         ax2.set_ylabel('Categorical Cross Entropy Loss')
         ax2.set_xlabel('Epoch')

```

```
ax2.legend(['train', 'test'], loc='upper right')
plt.show()
```



The plots for model accuracy and categorical cross entropy loss show that the model is stable as the train and test sets increase in accuracy and decrease in loss. The model also has about 91% accuracy when predicting the beer by label, with 98% when predicting the validation set.

### 3 Random Forest Classifier to Predict Beer by Label

Sklearn's [Random Forest Classifier \(RFC\)](#) will be used to classify the beer by label as a second model test. This model will be compared to the CNN, and advantages and disadvantages will be discussed below. A random forest act like a black box, meaning the model parameters are hidden by design, but model analysis such as scoring plots will be shown.

In order to run the random forest model, all images will first be converted to a list of arrays by train, test and validation sets using the `get_imgs` function declared above. The arrays and label sets will then be reshaped to fit the random forest model, using code provided by [Hyperion Development](#).

```
In [17]: # define function to resize images in image sets and convert to a normalized array of
def get_arrays(data):
    all_pics = []
    all_arrs = []
    jpgs = []
    for jpg in data:
        jpgs.append(jpg)
    for jpg in jpgs:
        # read color photos
        im = cv2.imread(jpg)
        # resize images to save computational power and ensure same size across all i
        ## ratio
        resized_img = cv2.resize(im, (150, 200))
        all_pics.append(resized_img)
        # convert list to array
        all_arrs = np.asarray(all_pics)
        img_width, img_height = 150, 200
```



```

# reshape test and train arrays for keras, the code here will remain in case
## in the future
if K.image_data_format() == 'channels_first':
    all_arrs = all_arrs.reshape(all_arrs.shape[0], 3, img_height, img_width)
    input_shape = (3, img_height, img_width)
else:
    all_arrs = all_arrs.reshape(all_arrs.shape[0], img_height, img_width, 3)
    input_shape = (img_height, img_width, 3)
# normalize images
all_arrs = all_arrs.astype('float32')
all_arrs /= 255
return all_arr

# call get_arrays function on training and validation sets, train already collected
train_arrs = get_arrays(train['images'])
test_arrs = get_arrays(test['images'])
valid_arrs = get_arrays(valid['images'])

```

The RFC model only works with 2-dimensional arrays, so the arrays for each set will be transformed.

```

In [18]: # reshape arrays for random forest
X_train = train_arrs.reshape(train_arrs.shape[0], train_arrs.shape[1]*train_arrs.shape[2])
X_test = test_arrs.reshape(test_arrs.shape[0], test_arrs.shape[1]*test_arrs.shape[2])
val = valid_arrs.reshape(valid_arrs.shape[0], valid_arrs.shape[1]*valid_arrs.shape[2])
y_train = np.asarray(train_labels)
y_train = y_train.reshape(y_train.shape[0],)
y_test = np.asarray(test_labels)
y_test = y_test.reshape(y_test.shape[0],)
val_test = np.asarray(valid_labels)
val_test = val_test.reshape(valid_labels.shape[0],)

```

Next the model will be fit using sklearn's [model selection learning curve](#) and code provided by [Chris Albion](#).

```

In [19]: # declare RFC model parameters
rfc = RandomForestClassifier(bootstrap=True, class_weight=None, criterion='entropy',
                             max_features='auto', max_leaf_nodes=None, min_impurity_d
                             min_impurity_split=None, min_samples_leaf=1, min_samples
                             min_weight_fraction_leaf=0.2, n_jobs=4, oob_score=True,
                             random_state=None, verbose=0, warm_start=False, n_estimat

# set learning curve on training data
train_sizes, train_scores, test_scores = learning_curve(rfc,
                                                         X_train,
                                                         y_train,
                                                         cv=5,
                                                         scoring='accuracy',
                                                         # 50 different sizes of the t
                                                         train_sizes=np.linspace(0.01,

# create means and standard deviations of training set scores

```

```

train_mean = np.mean(train_scores, axis=1)
train_std = np.std(train_scores, axis=1)

# create means and standard deviations of test set scores
test_mean = np.mean(test_scores, axis=1)
test_std = np.std(test_scores, axis=1)

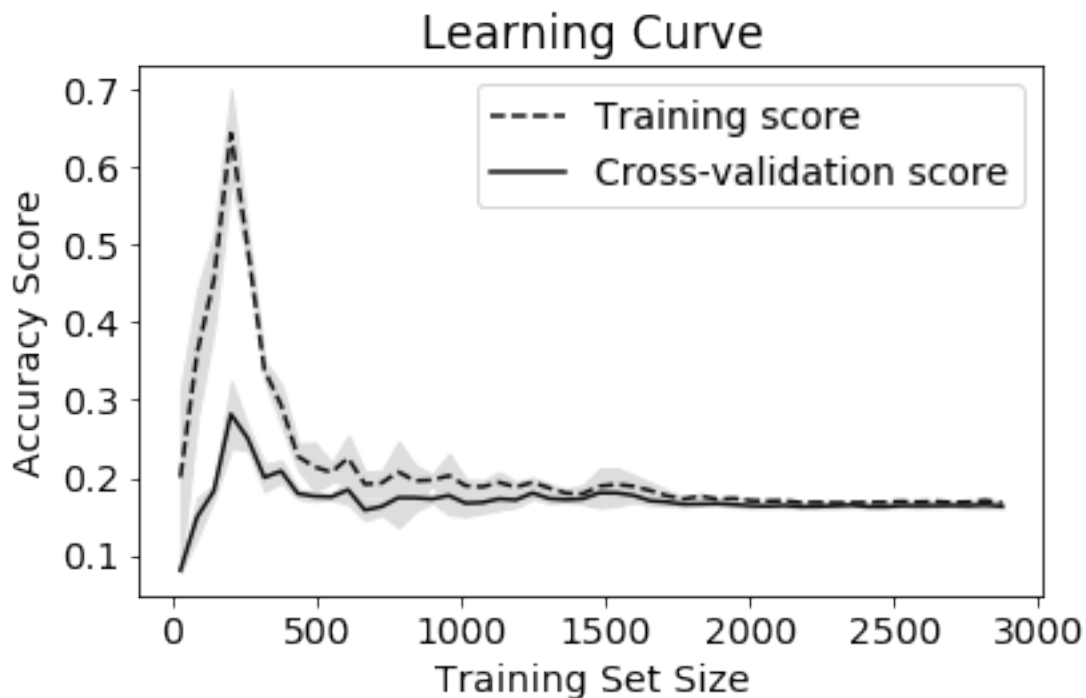
# plot lines
plt.plot(train_sizes, train_mean, '--', color="#111111", label="Training score")
plt.plot(train_sizes, test_mean, color="#111111", label="Cross-validation score")

# plot bands
plt.fill_between(train_sizes, train_mean - train_std, train_mean + train_std, color="#DDDDDD")
plt.fill_between(train_sizes, test_mean - test_std, test_mean + test_std, color="#DDDDDD")

# plot information
plt.title("Learning Curve")
plt.xlabel("Training Set Size"), plt.ylabel("Accuracy Score"), plt.legend(loc="best")
plt.tight_layout()
plt.show()

# get accuracy score on validation set
rfc.fit(val, val_test)
print('The RFC model is {}% accurate.'.format(rfc.score(val, val_test).mean()*100))

```



The RFC model is 0.19666666666666666% accurate.

This model is much less accurate than the CNN model, likely because neural networks are better suited to classify images. Also, since the image arrays need to be converted to two dimensional arrays for the RFC, some information may have been lost in the conversion process.

The accuracy of the RFC model is does not show promising results. For these reasons, the CNN Model will be used in further testing.

## 4 CNN Model Test

Now the model will be tested on an image of Racer 5 from the internet, and an API call to BreweryDB will be initiated to receive information on the beer.

```
In [44]: # show sample image with opencv
im_path = r'/Users/kyleknoebel/Desktop/download.jpeg'
new_img = cv2.imread(im_path)
height, width, channels = img.shape
plt.figure(figsize=(7,10))
plt.imshow(new_img)
print('The image shape is {}'.format(img.shape))
print('Minimum RGB value in this image {}'.format(img.min()))
print('The aspect ratio of the image is {}'.format(width/height))
```

The image shape is (4032, 3024, 3)

Minimum RGB value in this image 0

The aspect ratio of the image is 0.75



```
In [45]: # define function to load image
def get_beer_web(image):
    all_pics = []
    all_arrs = []
    all_pics.append(image)
```

```

# convert list to array
all_arrs = np.asarray(all_pics)
img_width, img_height = 200, 150
# reshape test and train arrays for keras, the code here will remain in case other
## in the future
if K.image_data_format() == 'channels_first':
    all_arrs = all_arrs.reshape(all_arrs.shape[0], 3, img_width, img_height)
    input_shape = (3, img_width, img_height)
else:
    all_arrs = all_arrs.reshape(all_arrs.shape[0], img_width, img_height, 3)
    input_shape = (img_width, img_height, 3)
# normalize images
all_arrs = all_arrs.astype('float32')
all_arrs /= 255
return all_arrs

# define function to predict beer label from image arrays
def get_beer(arrs):
    label = model.predict_classes(arrs)
    for k, v in dict_labels.items():
        # convert label to string
        if k == label.astype(str):
            return v

```

```

In [46]: import json
# resize test image
test_img = resize_img(im_path)
# get arrays of image
img_arrs = get_beer_web(test_img)
# predict beer using CNN model
beer = get_beer(img_arrs)
print('The model returned: {}'.format(beer))

```

The model returned: stone\_delicious

```

In [51]: import urllib
# declare api key
key = 'd5f2bab500facc767e336b3298151e79'
# empty list of urls
urls = []
# iterate through list of beers and get info
urls.append('https://api.brewerydb.com/v2/search?key={}&q={}'.format(key, beer))
for site in urls:
    with urllib.request.urlopen(site) as url:
        # Read the JSON
        data = json.loads(url.read().decode())

```

```

In [55]: # show output of api call
data

```

```

Out[55]: {'currentPage': 1,
          'numberOfPages': 10,
          'totalResults': 483,
          'data': [{'id': 'xjPpWf',
                    'name': 'Suspicious Delicious',
                    'nameDisplay': 'Suspicious Delicious',
                    'description': '100% Brett fermented Oak Aged Amber Saison',
                    'abv': '6.9',
                    'styleId': 132,
                    'isOrganic': 'N',
                    'isRetired': 'N',
                    'status': 'verified',
                    'statusDisplay': 'Verified',
                    'createDate': '2016-05-10 17:01:42',
                    'updateDate': '2016-05-12 12:21:10',
                    'style': {'id': 132,
                              'categoryId': 11,
                              'category': {'id': 11,
                                            'name': 'Hybrid/mixed Beer',
                                            'createDate': '2012-03-21 20:06:46'},
                              'name': 'Wood- and Barrel-Aged Beer',
                              'shortName': 'BBL Aged',
                              'description': 'A wood- or barrel-aged beer is any lager, ale or hybrid beer, either brewed with or without wood, and aged in wood barrels.',
                              'createDate': '2012-03-21 20:06:46',
                              'updateDate': '2015-04-07 15:46:27'},
                              'type': 'beer'},
                    {'id': 'ts89qU',
                      'name': 'Udderly Delicious',
                      'nameDisplay': 'Udderly Delicious',
                      'description': 'Smooth, clean and rather rich, with a depth of malt character. This beer is brewed with a high percentage of malted barley and is aged in oak barrels.',
                      'abv': '5',
                      'ibu': '21',
                      'styleId': 102,
                      'isOrganic': 'N',
                      'isRetired': 'N',
                      'status': 'verified',
                      'statusDisplay': 'Verified',
                      'createDate': '2017-09-01 13:22:03',
                      'updateDate': '2017-09-01 13:25:46',
                      'style': {'id': 102,
                                'categoryId': 8,
                                'category': {'id': 8,
                                              'name': 'North American Lager',
                                              'createDate': '2012-03-21 20:06:46'},
                                'name': 'American-Style Märzen / Oktoberfest',
                                'shortName': 'American Oktoberfest',
                                'description': 'The American style of these classic German beers is distinguished by a deep malt character and a high percentage of malted barley. The American style of these classic German beers is distinguished by a deep malt character and a high percentage of malted barley.',
                                'ibuMin': '20',
                                'ibuMax': '40',
                                'type': 'beer'}
                      ]}]

```



```

    'ibuMax': '30',
    'abvMin': '5.3',
    'abvMax': '5.9',
    'srmMin': '4',
    'srmMax': '15',
    'ogMin': '1.05',
    'fgMin': '1.012',
    'fgMax': '1.02',
    'createDate': '2012-03-21 20:06:46',
    'updateDate': '2015-04-07 15:41:38'},
    'type': 'beer'},
  {'id': 'JQLIxb',
    'name': 'Delicious Ambiguity',
    'nameDisplay': 'Delicious Ambiguity',
    'description': 'Raspberry and basil ale.',
    'abv': '5',
    'styleId': 119,
    'isOrganic': 'N',
    'isRetired': 'N',
    'status': 'verified',
    'statusDisplay': 'Verified',
    'createDate': '2017-09-08 18:12:30',
    'updateDate': '2017-09-08 18:12:30',
    'style': {'id': 119,
      'categoryId': 11,
      'category': {'id': 11,
        'name': 'Hybrid/mixed Beer',
        'createDate': '2012-03-21 20:06:46'},
      'name': 'Fruit Beer',
      'shortName': 'Fruit Beer',
      'description': 'Fruit beers are any beers using fruit or fruit extracts as an adj',
      'ibuMin': '5',
      'ibuMax': '70',
      'abvMin': '2.5',
      'abvMax': '12',
      'srmMin': '5',
      'srmMax': '50',
      'ogMin': '1.03',
      'fgMin': '1.006',
      'fgMax': '1.03',
      'createDate': '2012-03-21 20:06:46',
      'updateDate': '2015-04-07 15:44:21'},
    'type': 'beer'},
  {'id': 'D8YEU5',
    'name': 'Golden Delicious',
    'nameDisplay': 'Golden Delicious',
    'description': 'SXOLLIE Golden Delicious Cider is a pillar-stone of what a good ci',
    'abv': '4.5',

```

```

'styleId': 157,
'isOrganic': 'N',
'isRetired': 'N',
'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2017-09-12 18:42:22',
'updateDate': '2017-09-12 18:42:22',
'style': {'id': 157,
'categoryId': 12,
'category': {'id': 12,
'name': 'Mead, Cider, & Perry',
'createDate': '2012-03-21 20:06:46'},
'name': 'Other Specialty Cider or Perry',
'shortName': 'Specialty Cider',
'abvMin': '5',
'abvMax': '12',
'ogMin': '1.045',
'ogMax': '1.1',
'fgMin': '0.995',
'fgMax': '1.02',
'createDate': '2012-03-21 20:06:46',
'updateDate': '2015-04-07 15:49:22'},
'type': 'beer'},
{'id': 'f16hLl',
'name': 'Ruthlessly Delicious',
'nameDisplay': 'Ruthlessly Delicious',
'description': 'A well-rounded, highly drinkable IPA. A bit of Caramel Malt barley
'abv': '6.2',
'ibu': '52',
'styleId': 30,
'isOrganic': 'N',
'isRetired': 'N',
'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2016-05-05 22:41:07',
'updateDate': '2016-05-09 15:40:50',
'style': {'id': 30,
'categoryId': 3,
'category': {'id': 3,
'name': 'North American Origin Ales',
'createDate': '2012-03-21 20:06:45'},
'name': 'American-Style India Pale Ale',
'shortName': 'American IPA',
'description': 'American-style India pale ales are perceived to have medium-high t
'ibuMin': '50',
'ibuMax': '70',
'abvMin': '6.3',
'abvMax': '7.5',

```

```

'srmMin': '6',
'srmMax': '14',
'ogMin': '1.06',
'fgMin': '1.012',
'fgMax': '1.018',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:26:37'},
'type': 'beer'},
{'id': '396V5C',
 'name': 'Mr. Delicious',
 'nameDisplay': 'Mr. Delicious',
 'description': 'This beer leads off with a stiff round-house punch of citrusy hops',
 'abv': '9',
 'ibu': '90',
 'glasswareId': 5,
 'availableId': 2,
 'styleId': 31,
 'isOrganic': 'N',
 'isRetired': 'N',
 'labels': {'icon': 'https://brewerydb-images.s3.amazonaws.com/beer/396V5C/upload_D37ws6-me',
 'medium': 'https://brewerydb-images.s3.amazonaws.com/beer/396V5C/upload_D37ws6-me',
 'large': 'https://brewerydb-images.s3.amazonaws.com/beer/396V5C/upload_D37ws6-lar',
 'contentAwareIcon': 'https://brewerydb-images.s3.amazonaws.com/beer/396V5C/upload',
 'contentAwareMedium': 'https://brewerydb-images.s3.amazonaws.com/beer/396V5C/uploa',
 'contentAwareLarge': 'https://brewerydb-images.s3.amazonaws.com/beer/396V5C/uploa'},
 'status': 'verified',
 'statusDisplay': 'Verified',
 'foodPairings': 'Pairs with salty cured meats, strong stinky cheeses, whiskey and c',
 'originalGravity': '1.084',
 'createDate': '2013-05-05 00:42:41',
 'updateDate': '2015-12-17 04:00:50',
 'glass': {'id': 5, 'name': 'Pint', 'createDate': '2012-01-03 02:41:33'},
 'available': {'id': 2,
 'name': 'Limited',
 'description': 'Limited availability.'},
 'style': {'id': 31,
 'categoryId': 3,
 'category': {'id': 3,
 'name': 'North American Origin Ales',
 'createDate': '2012-03-21 20:06:45'},
 'name': 'Imperial or Double India Pale Ale',
 'shortName': 'Imperial IPA',
 'description': 'Imperial or Double India Pale Ales have intense hop bitterness, f',
 'ibuMin': '65',
 'ibuMax': '100',
 'abvMin': '7.5',
 'abvMax': '10.5',
 'srmMin': '5',

```

```

'srmMax': '13',
'ogMin': '1.075',
'fgMin': '1.012',
'fgMax': '1.02',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:26:46'},
'type': 'beer'},
{'id': 'Y4pdWL',
'name': 'Golden Delicious',
'nameDisplay': 'Golden Delicious',
'description': 'Theres nothing quite likes Moms apple pieBut I am willing to bet t',
'glasswareId': 2,
'availableId': 4,
'styleId': 59,
'isOrganic': 'N',
'isRetired': 'N',
'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2012-01-03 02:43:17',
'updateDate': '2017-01-09 18:42:12',
'glass': {'id': 2, 'name': 'Goblet', 'createDate': '2012-01-03 02:41:33'},
'available': {'id': 4,
'name': 'Seasonal',
'description': 'Available at the same time of year, every year.'},
'style': {'id': 59,
'categoryId': 5,
'category': {'id': 5,
'name': 'Belgian And French Origin Ales',
'createDate': '2012-03-21 20:06:46'},
'name': 'Belgian-Style Tripel',
'shortName': 'Belgian Tripel',
'description': 'Tripels are often characterized by a complex, sometimes mild spicy',
'ibuMin': '20',
'ibuMax': '45',
'abvMin': '7',
'abvMax': '10',
'srmMin': '4',
'srmMax': '9',
'ogMin': '1.07',
'fgMin': '1.01',
'fgMax': '1.018',
'createDate': '2012-03-21 20:06:46',
'updateDate': '2015-04-07 15:31:50'},
'type': 'beer'},
{'id': 'XbiEkZ',
'name': 'Utterly Delicious',
'nameDisplay': 'Utterly Delicious',
'description': 'Brooklyn-based chocolate-makers the Mast Brothers concocted this b

```

```

'abv': '5.5',
'ibu': '29',
'availableId': 2,
'styleId': 20,
'isOrganic': 'N',
'isRetired': 'N',
'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2012-08-27 20:33:49',
'updateDate': '2012-08-28 13:15:38',
'available': {'id': 2,
  'name': 'Limited',
  'description': 'Limited availability.'},
'style': {'id': 20,
  'categoryId': 1,
  'category': {'id': 1,
    'name': 'British Origin Ales',
    'createDate': '2012-03-21 20:06:45'},
  'name': 'Sweet or Cream Stout',
  'shortName': 'Sweet Stout',
  'description': 'Sweet stouts, also referred to as cream stouts, have less roasted
  'ibuMin': '15',
  'ibuMax': '25',
  'abvMin': '3',
  'abvMax': '6',
  'srmMin': '40',
  'srmMax': '40',
  'ogMin': '1.045',
  'fgMin': '1.012',
  'fgMax': '1.02',
  'createDate': '2012-03-21 20:06:45',
  'updateDate': '2015-04-07 15:24:41'},
'type': 'beer'},
{'id': '6E8Sbf',
  'name': 'Stones',
  'nameDisplay': 'Stones',
  'description': 'Esta pale ale inglesa es una Best Bitter, nuestra cerveza de acces
  'abv': '4.2',
  'ibu': '21',
  'styleId': 3,
  'isOrganic': 'N',
  'isRetired': 'N',
  'labels': {'icon': 'https://brewerydb-images.s3.amazonaws.com/beer/6E8Sbf/upload_ybKiQ4-me
  'medium': 'https://brewerydb-images.s3.amazonaws.com/beer/6E8Sbf/upload_ybKiQ4-me
  'large': 'https://brewerydb-images.s3.amazonaws.com/beer/6E8Sbf/upload_ybKiQ4-larg
  'contentAwareIcon': 'https://brewerydb-images.s3.amazonaws.com/beer/6E8Sbf/upload
  'contentAwareMedium': 'https://brewerydb-images.s3.amazonaws.com/beer/6E8Sbf/uploa
  'contentAwareLarge': 'https://brewerydb-images.s3.amazonaws.com/beer/6E8Sbf/uploa

```

```

'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2016-05-01 14:59:48',
'updateDate': '2017-03-06 16:14:29',
'style': {'id': 3,
'categoryId': 1,
'category': {'id': 1,
'name': 'British Origin Ales',
'createDate': '2012-03-21 20:06:45'},
'name': 'Ordinary Bitter',
'shortName': 'Bitter',
'description': "Ordinary bitter is gold to copper colored with medium bitterness,
'ibuMin': '20',
'ibuMax': '35',
'abvMin': '3',
'abvMax': '4.1',
'srmMin': '5',
'srmMax': '12',
'ogMin': '1.033',
'fgMin': '1.006',
'fgMax': '1.012',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:18:39'},
'type': 'beer'}},
{'id': 'tJs6bC',
'name': 'Stone Beer',
'nameDisplay': 'Stone Beer',
'styleId': 125,
'isOrganic': 'N',
'isRetired': 'N',
'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2012-01-03 02:44:18',
'updateDate': '2018-11-02 15:20:44',
'style': {'id': 125,
'categoryId': 11,
'category': {'id': 11,
'name': 'Hybrid/mixed Beer',
'createDate': '2012-03-21 20:06:46'},
'name': 'Specialty Beer',
'shortName': 'Specialty',
'description': 'These beers are brewed using unusual fermentable sugars, grains and
'ibuMax': '100',
'abvMin': '2.5',
'abvMax': '25',
'srmMin': '1',
'srmMax': '100',
'ogMin': '1.03',

```



```

    'fgMin': '1.006',
    'fgMax': '1.03',
    'createDate': '2012-03-21 20:06:46',
    'updateDate': '2015-04-07 15:44:53'},
    'type': 'beer'},
  {'id': 'qDxpI4',
    'name': 'Stone Beer',
    'nameDisplay': 'Stone Beer (2018)',
    'description': 'Each year under the night sky, we honour the ancient technique of c',
    'abv': '7.5',
    'styleId': 158,
    'isOrganic': 'N',
    'isRetired': 'N',
    'year': 2018,
    'status': 'verified',
    'statusDisplay': 'Verified',
    'createDate': '2018-08-31 11:52:29',
    'updateDate': '2019-02-20 21:01:10',
    'style': {'id': 158,
      'categoryId': 3,
      'category': {'id': 3,
        'name': 'North American Origin Ales',
        'createDate': '2012-03-21 20:06:45'},
      'name': 'American-Style Imperial Porter',
      'shortName': 'American Imperial Porter',
      'description': 'American-style imperial porters are black in color. No roast barley',
      'ibuMin': '35',
      'ibuMax': '50',
      'abvMin': '5.5',
      'abvMax': '9.5',
      'srmMin': '40',
      'srmMax': '40',
      'ogMin': '1.08',
      'ogMax': '1.1',
      'fgMin': '1.02',
      'fgMax': '1.03',
      'createDate': '2013-08-10 12:42:51',
      'updateDate': '2015-04-07 15:49:32'},
      'type': 'beer'},
    {'id': 'H3tA2N',
      'name': 'Magical & Delicious',
      'nameDisplay': 'Magical & Delicious',
      'description': 'The Magical aromatics from layered hop varietals create a balanced',
      'abv': '5.5',
      'styleId': 25,
      'isOrganic': 'N',
      'isRetired': 'N',
      'status': 'verified',

```

```

'statusDisplay': 'Verified',
'createDate': '2016-08-11 12:25:13',
'updateDate': '2016-08-11 12:25:13',
'style': {'id': 25,
'categoryId': 3,
'category': {'id': 3,
'name': 'North American Origin Ales',
'createDate': '2012-03-21 20:06:45'},
'name': 'American-Style Pale Ale',
'shortName': 'American Pale',
'description': 'American pale ales range from deep golden to copper in color. The
'ibuMin': '30',
'ibuMax': '42',
'abvMin': '4.5',
'abvMax': '5.6',
'srmMin': '6',
'srmMax': '14',
'ogMin': '1.044',
'fgMin': '1.008',
'fgMax': '1.014',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:25:18'},
'type': 'beer'}},
{'id': '6UpGqp',
'name': 'Delicious Red Apple Cider',
'nameDisplay': 'Delicious Red Apple Cider',
'description': 'Synchronized flavors and carbonation cultivate the palate without t
'abv': '6.9',
'styleId': 149,
'isOrganic': 'N',
'isRetired': 'N',
'status': 'verified',
'statusDisplay': 'Verified',
'createDate': '2016-11-22 16:12:01',
'updateDate': '2016-11-22 16:12:01',
'style': {'id': 149,
'categoryId': 12,
'category': {'id': 12,
'name': 'Mead, Cider, & Perry',
'createDate': '2012-03-21 20:06:46'},
'name': 'Common Cider',
'shortName': 'Common Cider',
'description': 'Variable, but should be a medium, refreshing drink. Sweet ciders m
'abvMin': '5',
'abvMax': '8',
'ogMin': '1.045',
'ogMax': '1.065',
'fgMin': '1',

```

```

    'fgMax': '1.02',
    'createDate': '2012-03-21 20:06:46',
    'updateDate': '2015-04-07 15:48:44'},
    'type': 'beer'},
  {'id': 'AevrdR',
    'name': "Brenner's Olde Delicious",
    'nameDisplay': "Brenner's Olde Delicious",
    'description': 'A dark rich stout made with 3 heavily roasted malts and a little b',
    'abv': '6.5',
    'styleId': 42,
    'isOrganic': 'N',
    'isRetired': 'N',
    'status': 'verified',
    'statusDisplay': 'Verified',
    'createDate': '2017-04-19 18:12:35',
    'updateDate': '2017-04-19 18:12:35',
    'style': {'id': 42,
      'categoryId': 3,
      'category': {'id': 3,
        'name': 'North American Origin Ales',
        'createDate': '2012-03-21 20:06:45'},
        'name': 'American-Style Stout',
        'shortName': 'American Stout',
        'description': 'Initial low to medium malt sweetness with a degree of caramel, ch',
        'ibuMin': '35',
        'ibuMax': '60',
        'abvMin': '5.7',
        'abvMax': '8.8',
        'srmMin': '40',
        'srmMax': '40',
        'ogMin': '1.05',
        'fgMin': '1.01',
        'fgMax': '1.022',
        'createDate': '2012-03-21 20:06:46',
        'updateDate': '2015-04-07 15:28:43'},
        'type': 'beer'},
    {'id': '2uklXk',
      'name': 'Skipping Stone',
      'nameDisplay': 'Skipping Stone',
      'abv': '4.8',
      'styleId': 25,
      'isOrganic': 'N',
      'isRetired': 'N',
      'status': 'verified',
      'statusDisplay': 'Verified',
      'createDate': '2015-08-06 14:01:23',
      'updateDate': '2015-08-06 14:37:02',
      'style': {'id': 25,

```

```

'categoryId': 3,
'category': {'id': 3,
  'name': 'North American Origin Ales',
  'createDate': '2012-03-21 20:06:45'},
'name': 'American-Style Pale Ale',
'shortName': 'American Pale',
'description': 'American pale ales range from deep golden to copper in color. The
'ibuMin': '30',
'ibuMax': '42',
'abvMin': '4.5',
'abvMax': '5.6',
'srmMin': '6',
'srmMax': '14',
'ogMin': '1.044',
'fgMin': '1.008',
'fgMax': '1.014',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:25:18'},
'type': 'beer'},
{'id': '7LnbnB',
  'name': 'Grinding Stone',
  'nameDisplay': 'Grinding Stone',
  'description': 'Deep in color, flavor, and complexity, our Oatmeal Stout achieves
  'abv': '5',
  'ibu': '38',
  'styleId': 21,
  'isOrganic': 'N',
  'isRetired': 'N',
  'status': 'verified',
  'statusDisplay': 'Verified',
  'originalGravity': '1.059',
  'createDate': '2015-08-18 23:28:21',
  'updateDate': '2016-06-23 18:10:57',
  'style': {'id': 21,
    'categoryId': 1,
    'category': {'id': 1,
      'name': 'British Origin Ales',
      'createDate': '2012-03-21 20:06:45'},
    'name': 'Oatmeal Stout',
    'shortName': 'Oatmeal Stout',
    'description': 'Oatmeal stouts include oatmeal in their grist, resulting in a ple
    'ibuMin': '20',
    'ibuMax': '40',
    'abvMin': '3.8',
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    'abv': '10',
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    'isRetired': 'N',
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        'name': 'Imperial or Double India Pale Ale',
        'shortName': 'Imperial IPA',
        'description': "Imperial or Double India Pale Ales have intense hop bitterness, f",
        'ibuMin': '65',
        'ibuMax': '100',
        'abvMin': '7.5',
        'abvMax': '10.5',
        'srmMin': '5',
        'srmMax': '13',
        'ogMin': '1.075',
        'fgMin': '1.012',
        'fgMax': '1.02',
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        'updateDate': '2015-04-07 15:26:46'},
        'type': 'beer'},
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      'name': 'Stone Mountain Brewery',
      'nameShortDisplay': 'Stone Mountain',
      'website': 'http://germanrestaurant.com/index.php/Pages/stone-mtn-brewery.html',
      'isOrganic': 'N',
      'images': {'icon': 'https://brewerydb-images.s3.amazonaws.com/brewery/Cmvjbq/upload_Bqtbrk-',
        'medium': 'https://brewerydb-images.s3.amazonaws.com/brewery/Cmvjbq/upload_Bqtbrk-',
        'large': 'https://brewerydb-images.s3.amazonaws.com/brewery/Cmvjbq/upload_Bqtbrk-',
        'squareMedium': 'https://brewerydb-images.s3.amazonaws.com/brewery/Cmvjbq/upload_Bqtbrk-',
        'squareLarge': 'https://brewerydb-images.s3.amazonaws.com/brewery/Cmvjbq/upload_Bqtbrk-'},
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    'createDate': '2015-07-25 21:18:55',
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    'isInBusiness': 'Y',
    'isVerified': 'N',
    'type': 'brewery'},
  {'id': '3RP43h',
    'name': 'Grind Stone',
    'nameDisplay': 'Grind Stone',
    'description': 'Rich amber colour, caramel overtones, balanced bitter-sweet finish',
    'abv': '4.8',
    'ibu': '25',
    'styleId': 32,
    'isOrganic': 'N',
    'isRetired': 'N',
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      'category': {'id': 3,
        'name': 'North American Origin Ales',
        'createDate': '2012-03-21 20:06:45'},
      'name': 'American-Style Amber/Red Ale',
      'shortName': 'Amber',
      'description': 'American amber/red ales range from light copper to light brown in',
      'ibuMin': '30',
      'ibuMax': '40',
      'abvMin': '4.5',
      'abvMax': '6',
      'srmMin': '11',
      'srmMax': '18',
      'ogMin': '1.048',
      'fgMin': '1.012',
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      'type': 'beer'}},
  {'id': 'zRawwQ',
    'name': 'Stone Kicker',
    'nameDisplay': 'Stone Kicker',
    'description': 'After a run of high alcohol special releases we wanted to do somet',
    'abv': '3.9',
    'styleId': 74,
    'isOrganic': 'N',
    'isRetired': 'N',
    'status': 'verified',

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'createDate': '2012-03-21 20:06:46'},
'name': 'Australian-Style Pale Ale',
'shortName': 'Australilian Pale',
'description': 'Australian-Style Pale Ales are light amber to light brown. Chill o
'ibuMin': '20',
'ibuMax': '40',
'abvMin': '4.2',
'abvMax': '6.2',
'srmMin': '5',
'srmMax': '14',
'ogMin': '1.04',
'fgMin': '1.006',
'fgMax': '1.012',
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'updateDate': '2015-04-07 17:14:09'},
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'name': 'Stone Corral Brewery',
'nameShortDisplay': 'Stone Corral',
'description': 'Stone Corral Brewery is a family operated micro brewery in Richmon
'website': 'http://stonecorral.com',
'isOrganic': 'N',
'images': {'icon': 'https://brewerydb-images.s3.amazonaws.com/brewery/ttAs6M/upload
'medium': 'https://brewerydb-images.s3.amazonaws.com/brewery/ttAs6M/upload_gDAqMv-
'large': 'https://brewerydb-images.s3.amazonaws.com/brewery/ttAs6M/upload_gDAqMv-
'squareMedium': 'https://brewerydb-images.s3.amazonaws.com/brewery/ttAs6M/upload_g
'squareLarge': 'https://brewerydb-images.s3.amazonaws.com/brewery/ttAs6M/upload_g
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'isVerified': 'Y',
'type': 'brewery'},
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'name': "Stone's Throw",
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'isRetired': 'N',
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'large': 'https://brewerydb-images.s3.amazonaws.com/beer/4g2r0o/upload_wR0ABx-lar
'contentAwareIcon': 'https://brewerydb-images.s3.amazonaws.com/beer/4g2r0o/upload
'contentAwareMedium': 'https://brewerydb-images.s3.amazonaws.com/beer/4g2r0o/uploa
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'name': 'British Origin Ales',
'createDate': '2012-03-21 20:06:45'},
'name': 'Scottish-Style Export Ale',
'shortName': 'Scottish Export',
'description': 'The overriding character of Scottish export ale is sweet, caramel
'ibuMin': '15',
'ibuMax': '25',
'abvMin': '4',
'abvMax': '5.3',
'srmMin': '10',
'srmMax': '19',
'ogMin': '1.04',
'fgMin': '1.01',
'fgMax': '1.018',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:19:56'},
'type': 'beer'},
{'id': '1RrfUF',
'name': 'Blarney Stone',
'nameDisplay': 'Blarney Stone',
'description': 'A medium bodied ale with caramel malt character, mild hop bitterne
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'ibu': '23',
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'styleId': 22,
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'isRetired': 'N',
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  'description': 'Available during the spring months.'},
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    'createDate': '2012-03-21 20:06:45'},
  'name': 'Irish-Style Red Ale',
  'shortName': 'Irish Red',
  'description': 'Irish-style red ales range from light red-amber-copper to light b',
  'ibuMin': '20',
  'ibuMax': '28',
  'abvMin': '4',
  'abvMax': '4.5',
  'srmMin': '11',
  'srmMax': '18',
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  'nameDisplay': 'Stone Fort',
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  'styleId': 37,
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  'isRetired': 'N',
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    'contentAwareIcon': 'https://brewerydb-images.s3.amazonaws.com/beer/PfKnfJ/upload',
    'contentAwareMedium': 'https://brewerydb-images.s3.amazonaws.com/beer/PfKnfJ/uploa',
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'shortName': 'American Brown',
'description': 'American brown ales range from deep copper to brown in color. Roas
'ibuMin': '25',
'ibuMax': '45',
'abvMin': '4',
'abvMax': '6.4',
'srmMin': '15',
'srmMax': '26',
'ogMin': '1.04',
'fgMin': '1.01',
'fgMax': '1.018',
'createDate': '2012-03-21 20:06:46',
'updateDate': '2015-04-07 15:27:35'},
'type': 'beer'},
{'id': 'UqML0t',
'name': 'Twilight Stone',
'nameDisplay': 'Twilight Stone',
'description': 'Porter with 30 pounds of plums added to each barrel',
'abv': '6.5',
'styleId': 18,
'isOrganic': 'N',
'isRetired': 'N',
'labels': {'icon': 'https://brewerydb-images.s3.amazonaws.com/beer/UqML0t/upload_x',
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'large': 'https://brewerydb-images.s3.amazonaws.com/beer/UqML0t/upload_xTXpZ7-larg',
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'contentAwareMedium': 'https://brewerydb-images.s3.amazonaws.com/beer/UqML0t/uploa',
'contentAwareLarge': 'https://brewerydb-images.s3.amazonaws.com/beer/UqML0t/uploa',
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'createDate': '2012-03-21 20:06:45'},
'name': 'Brown Porter',
'shortName': 'Brown Porter',
'description': 'Brown porters are mid to dark brown (may have red tint) in color.
'ibuMin': '20',
'ibuMax': '30',
'abvMin': '4.5',
'abvMax': '6',

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'srmMin': '20',
'srmMax': '35',
'ogMin': '1.04',
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 'nameDisplay': 'Grisetta Stone',
 'styleId': 72,
 'isOrganic': 'N',
 'isRetired': 'N',
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 'createDate': '2012-03-21 20:06:46'},
 'name': 'French & Belgian-Style Saison',
 'shortName': 'Saison',
 'description': 'Beers in this category are golden to deep amber in color. There ma
'ibuMin': '20',
'ibuMax': '40',
'abvMin': '4.5',
'abvMax': '8.5',
'srmMin': '4',
'srmMax': '14',
'ogMin': '1.055',
'fgMin': '1.004',
'fgMax': '1.016',
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'type': 'beer'},
{'id': 'YMd83W',
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 'nameDisplay': 'Sliding Stones',
 'description': 'An exploration into a style weve often overlooked. This beer was in
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'ibu': '22',
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'isRetired': 'N',
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'createDate': '2012-03-21 20:06:45'},
'name': 'Scottish-Style Export Ale',
'shortName': 'Scottish Export',
'description': 'The overriding character of Scottish export ale is sweet, caramel',
'ibuMin': '15',
'ibuMax': '25',
'abvMin': '4',
'abvMax': '5.3',
'srmMin': '10',
'srmMax': '19',
'ogMin': '1.04',
'fgMin': '1.01',
'fgMax': '1.018',
'createDate': '2012-03-21 20:06:45',
'updateDate': '2015-04-07 15:19:56'},
'type': 'beer'},
{'id': 'iepoWh',
'name': 'Stone Soup',
'nameDisplay': 'Stone Soup',
'description': "Who is qualified to judge one's contribution? Is it the pure Wisconsin",
'abv': '5.3',
'availableId': 3,
'styleId': 70,
'isOrganic': 'N',
'isRetired': 'Y',
'labels': {'icon': 'https://brewerydb-images.s3.amazonaws.com/beer/iepoWh/upload_LiBpVU-me',
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'large': 'https://brewerydb-images.s3.amazonaws.com/beer/iepoWh/upload_LiBpVU-lar',
'contentAwareIcon': 'https://brewerydb-images.s3.amazonaws.com/beer/iepoWh/upload',
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'contentAwareLarge': 'https://brewerydb-images.s3.amazonaws.com/beer/iepoWh/uploa',
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'description': 'Beer is not currently available.'},
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'categoryId': 5,
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    'updateDate': '2015-04-07 15:33:05'},
    'type': 'beer'},
  {'id': 'QfkgAx',
    'name': 'Philosophers Stone',
    'nameDisplay': 'Philosophers Stone',
    'description': 'The Czech Dark Lager or Tmavé Pivo is one of the oldest lager styles',
    'abv': '4.7',
    'availableId': 4,
    'styleId': 83,
    'isOrganic': 'N',
    'isRetired': 'N',
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      'large': 'https://brewerydb-images.s3.amazonaws.com/beer/QfkgAx/upload_LW416n-lar'},
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    'statusDisplay': 'Verified',
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    'updateDate': '2018-08-16 18:25:50',
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      'description': 'Available at the same time of year, every year.'},
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        'createDate': '2012-03-21 20:06:46'},
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      'shortName': 'Euro Dark',
      'description': 'These light brown to dark brown beers have a pronounced malty aroma',
      'ibuMin': '16',
      'ibuMax': '25',
      'abvMin': '4.5',
      'abvMax': '5',
      'srmMin': '15',
      'srmMax': '20',
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'name': 'Stone Cow Brewery',
'nameShortDisplay': 'Stone Cow',
'description': 'Here on the farm, we are brewing with a purpose. With a focus on s
'website': 'http://www.stonecowbrewery.com/',
'isOrganic': 'N',
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'large': 'https://brewerydb-images.s3.amazonaws.com/brewery/i7Ceoi/upload_EcUMrW-
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'isVerified': 'N',
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{'id': 'WcMT9i',
'name': 'Standing Stones',
'nameDisplay': 'Standing Stones',
'description': 'A very malty scotch ale with a slight smokiness.',
'abv': '6',
'styleId': 15,
'isOrganic': 'N',
'isRetired': 'N',
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'name': 'Scotch Ale',
'shortName': 'Scotch Ale',
'description': 'Scotch ales are overwhelmingly malty and full-bodied. Perception o
'ibuMin': '25',
'ibuMax': '35',
'abvMin': '6.2',
'abvMax': '8',
'srmMin': '15',
'srmMax': '30',
'ogMin': '1.072',
'fgMin': '1.016',

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    'type': 'beer'},
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    'name': 'Stone Free',
    'nameDisplay': 'Stone Free',
    'description': 'This Hendrix inspired Kettle Sour is fermented on apricots and has
    'abv': '4.4',
    'styleId': 40,
    'isOrganic': 'N',
    'isRetired': 'N',
    'status': 'verified',
    'statusDisplay': 'Verified',
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    'updateDate': '2018-07-23 17:30:00',
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      'category': {'id': 3,
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        'createDate': '2012-03-21 20:06:45'},
        'name': 'American-Style Sour Ale',
        'shortName': 'Sour',
        'description': 'American sour ales can be very light to black or take on the color
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        'updateDate': '2015-04-07 15:28:32'},
        'type': 'beer'},
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      'styleId': 60,
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      'isRetired': 'N',
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        'large': 'https://brewerydb-images.s3.amazonaws.com/beer/XWhPN2/upload_KOcAZN-lar',
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        'contentAwareMedium': 'https://brewerydb-images.s3.amazonaws.com/beer/XWhPN2/uploa',
        'contentAwareLarge': 'https://brewerydb-images.s3.amazonaws.com/beer/XWhPN2/uploa',
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        'statusDisplay': 'Verified',
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        'updateDate': '2015-12-16 22:21:28',
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      'abvMin': '6',
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      'ibuMax': '20',
      'abvMin': '4',
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      'srmMin': '14',
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    'isVerified': 'N',
    'type': 'brewery'},
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    'nameDisplay': 'Stone Xocoveza',
    'description': 'Harmoniously layered with cocoa, Mostra coffee, pasilla peppers, va
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'name': 'Sweet or Cream Stout',
'shortName': 'Sweet Stout',
'description': 'Sweet stouts, also referred to as cream stouts, have less roasted',
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'ibuMax': '25',
'abvMin': '3',
'abvMax': '6',
'srmMin': '40',
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'nameDisplay': 'Skipping Stone',
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              'ibuMin': '6',
              'ibuMax': '15',
              'abvMin': '4.3',
              'abvMax': '5',
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      'abvMax': '8',
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    'ogMin': '1.028',
    'fgMin': '1.004',
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        'createDate': '2012-03-21 20:06:45'},
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      'description': 'Oatmeal stouts include oatmeal in their grist, resulting in a ple
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      'ibuMax': '40',
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      'abvMax': '6',
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    'description': 'Bittersweet chocolate, nuttiness from English malts, and a dry finish',
    'abv': '6.5',
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    'isRetired': 'N',
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      'shortName': 'American Stout',
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      'ogMin': '1.05',
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      'type': 'beer'},
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      'nameShortDisplay': 'Stone & Wood',
      'description': 'We established Stone & Wood Brewing Company in Byron Bay in 2008 and',
      'website': 'http://stoneandwood.com.au',
      'established': '2008',
      'isOrganic': 'N',
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    'established': '2013',
    'isOrganic': 'N',
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    'medium': 'https://brewerydb-images.s3.amazonaws.com/brewery/yXowEG/upload_YTaCLi
    'large': 'https://brewerydb-images.s3.amazonaws.com/brewery/yXowEG/upload_YTaCLi-
    'squareMedium': 'https://brewerydb-images.s3.amazonaws.com/brewery/yXowEG/upload_
    'squareLarge': 'https://brewerydb-images.s3.amazonaws.com/brewery/yXowEG/upload_Y
    'status': 'verified',
    'statusDisplay': 'Verified',
    'createDate': '2013-08-01 18:38:57',
    'updateDate': '2018-11-08 22:19:07',
    'isMassOwned': 'N',
    'isInBusiness': 'Y',
    'brewersAssociation': { 'brewersAssociationId': 'GVHZ1R6K2I',
      'isCertifiedCraftBrewer': 'Y' },
    'isVerified': 'N',
    'type': 'brewery'},
  { 'id': 'KuH7Gy',
    'name': '5 Stones Artisan Brewery',
    'nameShortDisplay': '5 Stones Artisan',
    'description': 'We are a small batch nano-brewery located "down around" San Antone
    'website': 'http://5stonesbrewing.com/',
    'established': '2012',
    'isOrganic': 'N',
    'images': { 'icon': 'https://brewerydb-images.s3.amazonaws.com/brewery/KuH7Gy/uploa
    'medium': 'https://brewerydb-images.s3.amazonaws.com/brewery/KuH7Gy/upload_cqBrPB
    'large': 'https://brewerydb-images.s3.amazonaws.com/brewery/KuH7Gy/upload_cqBrPB-
    'squareMedium': 'https://brewerydb-images.s3.amazonaws.com/brewery/KuH7Gy/upload_
    'squareLarge': 'https://brewerydb-images.s3.amazonaws.com/brewery/KuH7Gy/upload_co
    'status': 'verified',
    'statusDisplay': 'Verified',
    'createDate': '2013-08-04 14:08:42',
    'updateDate': '2018-11-08 22:01:41',

```

```

    'isMassOwned': 'N',
    'isInBusiness': 'Y',
    'brewersAssociation': {'brewersAssociationId': 'D04NWPMJ9B',
    'isCertifiedCraftBrewer': 'Y'},
    'isVerified': 'N',
    'type': 'brewery'},
  {'id': 'HG6miY',
  'name': 'Stone Ship Stout',
  'nameDisplay': 'Stone Ship Stout',
  'abv': '7.8',
  'styleId': 21,
  'isOrganic': 'N',
  'isRetired': 'N',
  'status': 'verified',
  'statusDisplay': 'Verified',
  'createDate': '2013-01-25 11:59:23',
  'updateDate': '2013-01-25 11:59:24',
  'style': {'id': 21,
  'categoryId': 1,
  'category': {'id': 1,
  'name': 'British Origin Ales',
  'createDate': '2012-03-21 20:06:45'},
  'name': 'Oatmeal Stout',
  'shortName': 'Oatmeal Stout',
  'description': 'Oatmeal stouts include oatmeal in their grist, resulting in a ple
  'ibuMin': '20',
  'ibuMax': '40',
  'abvMin': '3.8',
  'abvMax': '6',
  'srmMin': '20',
  'srmMax': '20',
  'ogMin': '1.038',
  'fgMin': '1.008',
  'fgMax': '1.02',
  'createDate': '2012-03-21 20:06:45',
  'updateDate': '2015-04-07 15:22:53'},
  'type': 'beer'}],
  'status': 'success'}

```

Stone delicious does not show in the API call, but Stone as a brewery does.

## 5 Summary

Overall, the model shows comendable accuracy when predicting beers by labels of the twelve selected. The CNN model is the better option for this project, as it has better accuracy and can be saved for later use. How well does the CNN model predict the label in the unused test set?

The beers chosen for this report are from smaller, craft breweries. As such, many of the beers and the breweries themselves do not seem to be showing up in BreweryDB's API yet. More work

should be done to get better results from the API, but the output shows that retrieving ingredients, styles, and flavor profile is possible.

```
In [60]: # show correlation between the predicted and true labels
         y_true = test['cats'].astype(int)
         y_pred = model.predict_classes(test_arrs)
         df_corr = pd.DataFrame({'True Labels': y_true, 'Predicted Labels': y_pred})
         print('The correlation between the sets is {}%'.format(df_corr['True Labels'].corr(d
```

The correlation between the sets is 13.405231017895202%.

As of this report, the model only works when predicting high resolution images from the Internet, similar to iPhone images. These images are what the report is designed to work on, but the model can still be improved with some tweaks. To improve the model:

- more pictures should be taken of all beers to better train the model
- the model itself should be added to (creating more layers for example)
- the model should be trained on beers that are popular on BreweryDB so the API call works better

The reason these changes were not made here is that this report is due to a lack of time.