```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import math
import cv2
from glob import glob
import itertools

from keras.utils import np_utils
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Dropout
from keras.layers import Flatten
from keras.layers.convolutional import Conv2D
from keras.layers.convolutional import MaxPooling2D
from keras.layers import BatchNormalization
from keras.callbacks import ModelCheckpoint,ReduceLROnPlateau,CSVLogger

from sklearn import preprocessing
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix


import tensorflow.compat.v1 as tf
tf.disable_v2_behavior()
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python
Instructions for updating:
non-resource variables are not supported in the long term
```

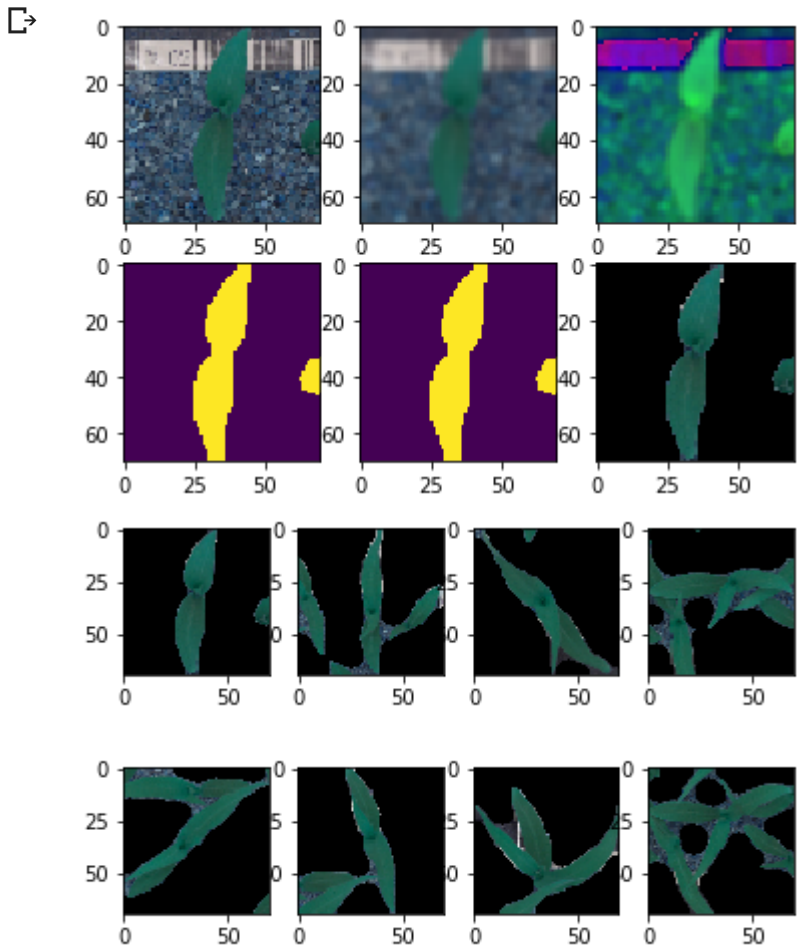
```
# GLOBAL VARIABLES
scale = 70
seed = 7


from google.colab import drive
drive.mount('/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=9473

Enter your authorization code:
··········
Mounted at /drive
```

```
path_to_images = '/drive/My Drive/7jan/train/*/*.png'


#   1. Read the images and generate the train and test dataset (5 points)


images = glob(path_to_images)
trainingset = []
```

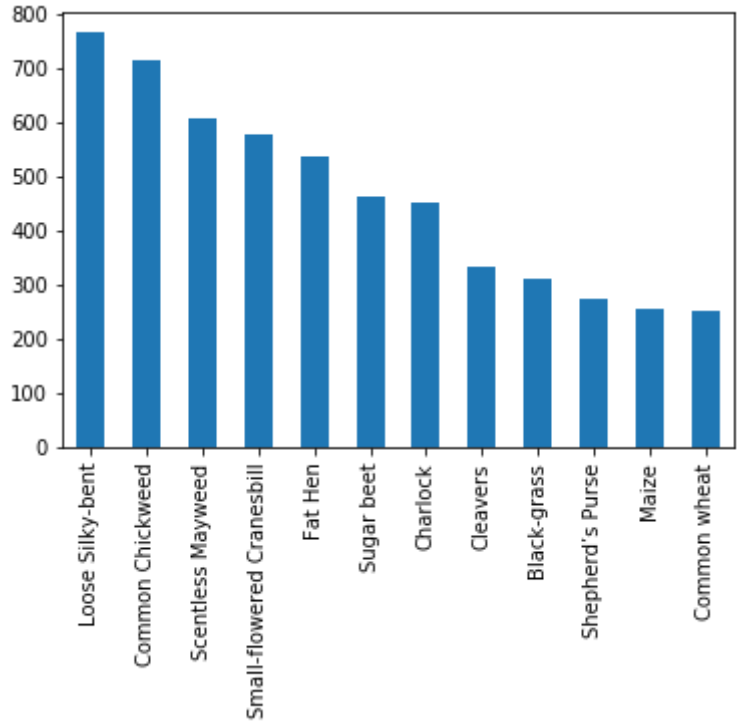
```
trainglabels = []
num = len(images)
count = 1


#READING IMAGES AND RESIZING THEM
for i in images:
    print(str(count)+'/'+str(num),end='\r')
    trainingset.append(cv2.resize(cv2.imread(i),(scale,scale)))
    trainglabels.append(i.split('/')[-2])
    count=count+1
trainingset = np.asarray(trainingset)
trainglabels = pd.DataFrame(trainglabels)
```

```
#Cleaning the images and removing the background: HSV Hue saturation value

Convert the RGB image into HSV.
We will have to blur the image to remove noise.
We will have to create a mask to remove the background.


new_train = []
sets = []; getEx = True
for i in trainingset:
    blurr = cv2.GaussianBlur(i,(5,5),0)
    hsv = cv2.cvtColor(blurr,cv2.COLOR_BGR2HSV)
    #GREEN PARAMETERS
    lower = (25,40,50)
    upper = (75,255,255)
    mask = cv2.inRange(hsv,lower,upper)
    struc = cv2.getStructuringElement(cv2.MORPH_ELLIPSE,(11,11))
    mask = cv2.morphologyEx(mask,cv2.MORPH_CLOSE,struc)
    boolean = mask>0
    new = np.zeros_like(i,np.uint8)
    new[boolean] = i[boolean]
    new_train.append(new)

    if getEx:
        plt.subplot(2,3,1);plt.imshow(i) # ORIGINAL
        plt.subplot(2,3,2);plt.imshow(blurr) # BLURRED
        plt.subplot(2,3,3);plt.imshow(hsv) # HSV CONVERTED
        plt.subplot(2,3,4);plt.imshow(mask) # MASKED
        plt.subplot(2,3,5);plt.imshow(boolean) # BOOLEAN MASKED
        plt.subplot(2,3,6);plt.imshow(new) # NEW PROCESSED IMAGE
        plt.show()
        getEx = False
new_train = np.asarray(new_train)

# CLEANED IMAGES
for i in range(8):
    plt.subplot(2,4,i+1)
    plt.imshow(new_train[i])
```



```
# convert class vectors to binary class matrices
labels = preprocessing.LabelEncoder()
labels.fit(traininglabels[0])
print('Classes'+str(labels.classes_))
encodedlabels = labels.transform(traininglabels[0])
clearalllabels = np_utils.to_categorical(encodedlabels)
classes = clearalllabels.shape[1]
print(str(classes))
traininglabels[0].value_counts().plot(kind='bar')
```

```
Classes['Black-grass' 'Charlock' 'Cleavers' 'Common Chickweed' 'Common wheat'
 'Fat Hen' 'Loose Silky-bent' 'Maize' 'Scentless Mayweed'
 'Shepherd’s Purse' 'Small-flowered Cranesbill' 'Sugar beet']
12
<matplotlib.axes._subplots.AxesSubplot at 0x7fa273436c88>
```




```
new_train = new_train/255
x_train,x_test,y_train,y_test = train_test_split(new_train,clearalllabels,test_size=0.1,ra


generator = ImageDataGenerator(rotation_range = 180,zoom_range = 0.1,width_shift_range = 0
generator.fit(x_train)
```

**3. Initialize & build the model (10 points) CNN **

```
np.random.seed(seed)

model = Sequential()

model.add(Conv2D(filters=64, kernel_size=(5, 5), input_shape=(scale, scale, 3), activation
model.add(BatchNormalization(axis=3))
model.add(Conv2D(filters=64, kernel_size=(5, 5), activation='relu'))
model.add(MaxPooling2D((2, 2)))
model.add(BatchNormalization(axis=3))
model.add(Dropout(0.1))

model.add(Conv2D(filters=128, kernel_size=(5, 5), activation='relu'))
model.add(BatchNormalization(axis=3))
model.add(Conv2D(filters=128, kernel_size=(5, 5), activation='relu'))
model.add(MaxPooling2D((2, 2)))
model.add(BatchNormalization(axis=3))
model.add(Dropout(0.1))

model.add(Conv2D(filters=256, kernel_size=(5, 5), activation='relu'))
```

```
model.add(Conv2D(filters=256, kernel_size=(5, 5), activation='relu'))
model.add(BatchNormalization(axis=3))
model.add(MaxPooling2D((2, 2)))
model.add(BatchNormalization(axis=3))
model.add(Dropout(0.1))

model.add(Flatten())

model.add(Dense(256, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.5))

model.add(Dense(256, activation='relu'))
model.add(BatchNormalization())
model.add(Dropout(0.5))

model.add(Dense(classes, activation='softmax'))

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

model.summary()
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

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WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:79

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_1 (Conv2D)            (None, 66, 66, 64)        4864      
_________________________________________________________________
batch_normalization_1 (Batch (None, 66, 66, 64)        256       
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 62, 62, 64)        102464    
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 31, 31, 64)        0         
_________________________________________________________________
batch_normalization_2 (Batch (None, 31, 31, 64)        256       
_________________________________________________________________
dropout_1 (Dropout)          (None, 31, 31, 64)        0         
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 27, 27, 128)       204928    
_________________________________________________________________
batch_normalization_3 (Batch (None, 27, 27, 128)       512       
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 23, 23, 128)       409728    
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 11, 11, 128)       0         
_________________________________________________________________
batch_normalization_4 (Batch (None, 11, 11, 128)       512       
_________________________________________________________________
dropout_2 (Dropout)          (None, 11, 11, 128)       0         
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 7, 7, 256)         819456    
_________________________________________________________________
```

```
batch_normalization_5 (Batch (None, 7, 7, 256)         1024
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 3, 3, 256)         1638656
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 1, 1, 256)         0
_________________________________________________________________
batch_normalization_6 (Batch (None, 1, 1, 256)         1024
_________________________________________________________________
dropout_3 (Dropout)          (None, 1, 1, 256)         0
_________________________________________________________________
flatten_1 (Flatten)          (None, 256)               0
_________________________________________________________________
dense_1 (Dense)              (None, 256)               65792
_________________________________________________________________
batch_normalization_7 (Batch (None, 256)               1024
_________________________________________________________________
dropout_4 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_2 (Dense)              (None, 256)               65792
_________________________________________________________________
batch_normalization_8 (Batch (None, 256)               1024
_________________________________________________________________
dropout_5 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_3 (Dense)              (None, 12)                3084
=================================================================
Total params: 3,320,396
Trainable params: 3,317,580
Non-trainable params: 2,816
_________________________________________________________________
```

```
from keras.utils.np_utils import to_categorical # convert to one-hot-encoding
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten, Conv2D, MaxPool2D, GlobalMaxPooling2D
from keras.optimizers import RMSprop
from keras.preprocessing.image import ImageDataGenerator
from keras.optimizers import Adam


#4. Optimize the model (8 points)


opt = Adam(lr=0.001)

optimizer = RMSprop(lr=0.001, rho=0.9, epsilon=1e-08, decay=0.0)
model.compile(optimizer = optimizer, loss = "categorical_crossentropy", metrics = ["accura


print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')
```

```
x_train shape: (4989, 70, 70, 3)
4989 train samples
555 test samples
```

```
batch_size = 128
num_classes = 10
epochs = 12
```

```
model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          verbose=1,
          validation_data=(x_test, y_test))
```

```
Train on 4989 samples, validate on 555 samples
Epoch 1/12
4989/4989 [==============================] - 703s 141ms/step - loss: 1.1764 - acc: 0.
Epoch 2/12
4989/4989 [==============================] - 697s 140ms/step - loss: 0.6262 - acc: 0.
Epoch 3/12
4989/4989 [==============================] - 703s 141ms/step - loss: 0.5894 - acc: 0.
Epoch 4/12
4989/4989 [==============================] - 702s 141ms/step - loss: 0.5021 - acc: 0.
Epoch 5/12
4989/4989 [==============================] - 704s 141ms/step - loss: 0.4299 - acc: 0.
Epoch 6/12
4989/4989 [==============================] - 703s 141ms/step - loss: 0.4062 - acc: 0.
Epoch 7/12
4989/4989 [==============================] - 700s 140ms/step - loss: 0.3647 - acc: 0.
Epoch 8/12
4989/4989 [==============================] - 695s 139ms/step - loss: 0.3151 - acc: 0.
Epoch 9/12
4989/4989 [==============================] - 696s 140ms/step - loss: 0.3187 - acc: 0.
Epoch 10/12
4989/4989 [==============================] - 697s 140ms/step - loss: 0.2760 - acc: 0.
Epoch 11/12
4989/4989 [==============================] - 712s 143ms/step - loss: 0.2527 - acc: 0.
Epoch 12/12
4989/4989 [==============================] - 693s 139ms/step - loss: 0.2596 - acc: 0.
<keras.callbacks.History at 0x7fa26c55beb8>
```

```
#Testing the model on test set
score = model.evaluate(x_test, y_test)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
555/555 [==============================] - 19s 35ms/step
Test loss: 0.7425039282790176
Test accuracy: 0.790990991420574
```