ImageClassification

April 11, 2023

0.1 Binary Classification of ALL cancer cells

- Folder composition
  - testing_data
  - training_data
  - validation_data

[1]:

```
import os
os.environ['KMP_DUPLICATE_LIB_OK'] = 'TRUE'
```

[2]:

```
# from keras.utils import np_utils

import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import time

#sklearn libraries
from sklearn.model_selection import train_test_split

#tensorflow libraries
import tensorflow as tf
from tensorflow.keras.initializers import RandomNormal
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.optimizers import Adam, Adamax
from tensorflow.keras.metrics import categorical_crossentropy
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Activation, Dropout, BatchNormalization
from tensorflow.keras import regularizers

import cv2
```

0.1.1 Importing Training Data

- Class 0 = ALL (cancer)

- Class 1 = Normal

[48]:

```
data_dir = 'C-NMC_Leukemia/training_data'


# define the paths in the training_data folder
files = []
classes = []

folds = os.listdir(data_dir)
for fold in folds:
    foldpath = os.path.join(data_dir, fold)
    filelist = os.listdir(foldpath)

    for fold_ in filelist:
        foldpath_ = os.path.join(foldpath, fold_)
        filelist_ = os.listdir(foldpath_)

        for file_ in filelist_:
            fpath = os.path.join(foldpath_, file_)
            files.append(fpath)
            classes.append(fold_)
# path to easy individual files
```

[4]:

```
# Concatenate data paths with labels into one dataframe ( to later be fitted␣
 ↪into the model
Fseries = pd.Series(files, name= 'filepaths')
Lseries = pd.Series(classes, name='labels')
df = pd.concat([Fseries, Lseries], axis= 1)
df
```

[4]:

```
                                               filepaths labels
0      C-NMC_Leukemia/training_data/fold_2/hem/UID_H4...    hem
1      C-NMC_Leukemia/training_data/fold_2/hem/UID_H4...    hem
2      C-NMC_Leukemia/training_data/fold_2/hem/UID_H4...    hem
3      C-NMC_Leukemia/training_data/fold_2/hem/UID_H1...    hem
4      C-NMC_Leukemia/training_data/fold_2/hem/UID_H2...    hem
...                                                  ...    ...
10656  C-NMC_Leukemia/training_data/fold_1/all/UID_38...    all
10657  C-NMC_Leukemia/training_data/fold_1/all/UID_34...    all
10658  C-NMC_Leukemia/training_data/fold_1/all/UID_30...    all
10659  C-NMC_Leukemia/training_data/fold_1/all/UID_51...    all
10660  C-NMC_Leukemia/training_data/fold_1/all/UID_51...    all

[10661 rows x 2 columns]
```

[5]:
```
strat = df['labels']
train_df, dummy_df = train_test_split(df, train_size=0.7, shuffle=True,␣
 ↪random_state=123, stratify=strat)

# test dataframe
strat = dummy_df['labels']
valid_df, test_df= train_test_split(dummy_df, train_size=0.5, shuffle=True,␣
 ↪random_state=123, stratify=strat)
```

[6]:
```
    batch_size = 40
    # define model parameters
    img_size = (224, 224)
    channels = 3 # either BGR or Grayscale
    color = 'rgb'
    img_shape = (img_size[0], img_size[1], channels)

    # Recommended : use custom function for test data batch size, else we can␣
 ↪use normal batch size.
    ts_length = len(test_df)
    test_batch_size = max(sorted([ts_length // n for n in range(1, ts_length +␣
 ↪1) if ts_length%n == 0 and ts_length/n <= 80]))
    test_steps = ts_length // test_batch_size

    # This function which will be used in image data generator for data␣
 ↪augmentation, it just take the image and return it again.
    # no data augmentation
    def scalar(img):
        return img
    tr_gen = ImageDataGenerator(preprocessing_function= scalar, horizontal_flip=␣
 ↪True)
    ts_gen = ImageDataGenerator(preprocessing_function= scalar)

    train_gen = tr_gen.flow_from_dataframe( train_df, x_col= 'filepaths', y_col=␣
 ↪'labels', target_size= img_size, class_mode= 'categorical',
                                        color_mode= color, shuffle= True,␣
 ↪batch_size= batch_size)

    valid_gen = ts_gen.flow_from_dataframe( valid_df, x_col= 'filepaths', y_col=␣
 ↪'labels', target_size= img_size, class_mode= 'categorical',
                                        color_mode= color, shuffle= True,␣
 ↪batch_size= batch_size)

    # Note: we will use custom test_batch_size, and make shuffle= false
    test_gen = ts_gen.flow_from_dataframe( test_df, x_col= 'filepaths', y_col=␣
 ↪'labels', target_size= img_size, class_mode= 'categorical',
                                        color_mode= color, shuffle= False,␣
 ↪batch_size= test_batch_size)
```

```
Found 7462 validated image filenames belonging to 2 classes.
Found 1599 validated image filenames belonging to 2 classes.
Found 1600 validated image filenames belonging to 2 classes.
```

[7]:

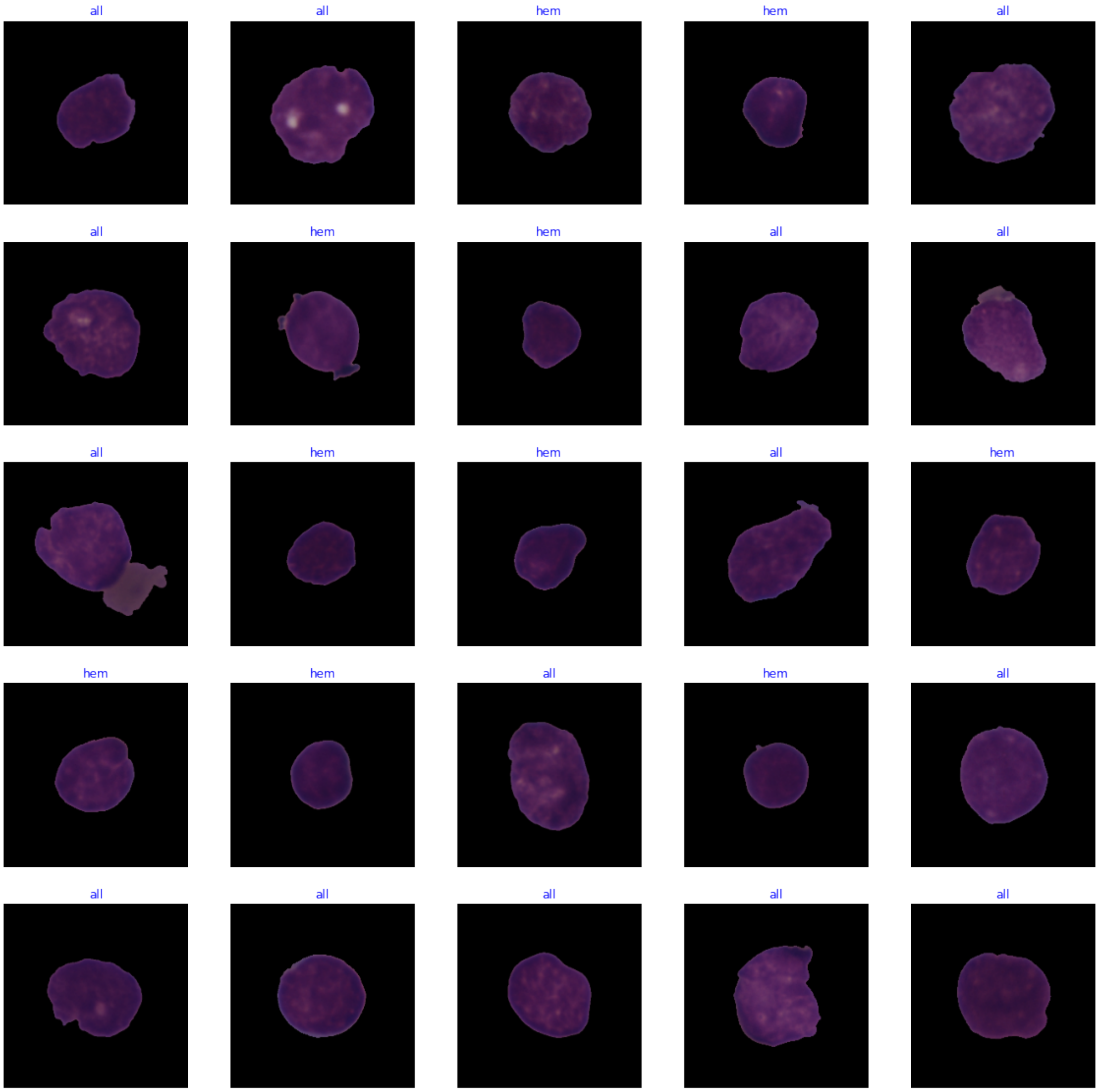
```
print(f'Train: X={train_df.shape} ')
print(f'Test: X={test_df.shape}')
print(f'Validation: X={valid_df.shape}')
```

```
Train: X=(7462, 2)
Test: X=(1600, 2)
Validation: X=(1599, 2)
```

[8]:

```
# display sample images from training

g_dict = train_gen.class_indices        # defines dictionary {'class': index}
print(g_dict)
classes = list(g_dict.keys()) # defines list of dictionary's kays (classes),␣
 ↪classes names : string
print(classes)
images, labels = next(train_gen)        # get a batch size samples from the␣
 ↪generator

# calculate number of displayed samples
length = len(labels)        # length of batch size
sample = min(length, 25)    # check if sample less than 25 images

plt.figure(figsize= (20, 20))

for i in range(sample):
    plt.subplot(5, 5, i + 1)
    image = images[i] / 255       # scales data to range (0 - 255)
    plt.imshow(image)
    index = np.argmax(labels[i])  # get image index
    class_name = classes[index]   # get class of image
    plt.title(class_name, color= 'blue', fontsize= 12)
    plt.axis('off')
plt.show()
```

```
{'all': 0, 'hem': 1}
['all', 'hem']
```



[9]:

```
from keras.layers import Activation, Dense
from keras.models import Sequential

base_model = tf.keras.applications.efficientnet.EfficientNetB3(include_top=␣
 ↪False, weights= "imagenet", input_shape= img_shape, pooling= 'max')
model = Sequential([
    base_model,
    Dense(2, activation= 'softmax')
])

# model.compile(Adamax(learning_rate= 0.001), loss= 'categorical_crossentropy',␣
 ↪metrics= ['accuracy'])
```

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

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 efficientnetb3 (Functional)  (None, 1536)             10783535

 dense (Dense)               (None, 2)                 3074

=================================================================
Total params: 10,786,609
Trainable params: 10,699,306
Non-trainable params: 87,303
_________________________________________________________________
```

[10]:
```
training = model.fit(x= train_gen, epochs= 5, verbose= True,
                    validation_data= valid_gen, validation_steps= None, shuffle=␣
 ↪False)
```

```
Epoch 1/5
187/187 [==============================] - 2188s 12s/step - loss: 1.2050 -
accuracy: 0.8026 - val_loss: 1.0861 - val_accuracy: 0.7223
Epoch 2/5
187/187 [==============================] - 2226s 12s/step - loss: 0.3205 -
accuracy: 0.8747 - val_loss: 0.4792 - val_accuracy: 0.7705
Epoch 3/5
187/187 [==============================] - 2198s 12s/step - loss: 0.2596 -
accuracy: 0.8951 - val_loss: 0.6157 - val_accuracy: 0.6879
Epoch 4/5
187/187 [==============================] - 2091s 11s/step - loss: 0.2221 -
accuracy: 0.9125 - val_loss: 0.3400 - val_accuracy: 0.8543
Epoch 5/5
187/187 [==============================] - 2190s 12s/step - loss: 0.1951 -
accuracy: 0.9251 - val_loss: 0.5274 - val_accuracy: 0.7530
```

[12]:
```
preds = model.predict(test_gen)
y_pred = np.argmax(preds, axis=1)
y_pred
```

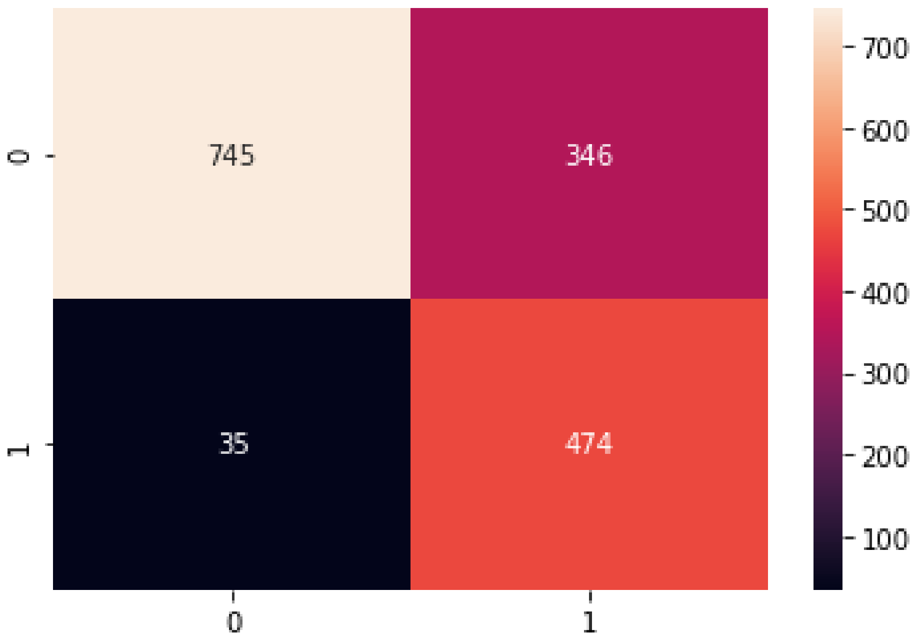
```
20/20 [==============================] - 83s 4s/step
```

[12]:
```
array([1, 0, 1, ..., 1, 1, 0])
```

[14]:

```
#confusion matrix
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score

cm = confusion_matrix(test_gen.classes, y_pred)

sns.heatmap(cm, annot=True,annot_kws={"size": 10},fmt="d")
print(accuracy_score(test_gen.classes, y_pred))
```

```
0.761875
```



[17]:

```
# Classification report
g_dict = test_gen.class_indices
classes = list(g_dict.keys())
from sklearn.metrics import classification_report
print(classification_report(test_gen.classes, y_pred,target_names= classes))
```

```
              precision    recall  f1-score   support

         all       0.96      0.68      0.80      1091
         hem       0.58      0.93      0.71       509

    accuracy                           0.76      1600
   macro avg       0.77      0.81      0.75      1600
weighted avg       0.84      0.76      0.77      1600
```

```
[35]: # print(len(test_gen.classes))
      test_arr = np.array(test_gen.classes)
      # print(y_pred.type)
      pd.crosstab(test_arr, y_pred, rownames = ['Actual'], colnames =['Predicted'],␣
       ↪margins = True)
```

```
[35]: Predicted    0    1   All
      Actual
      0          745  346  1091
      1           35  474   509
      All        780  820  1600
```

```
[39]: g_dict = test_gen.class_indices
      g_dict
```

```
[39]: {'all': 0, 'hem': 1}
```

```
[47]: from sklearn.metrics import  roc_auc_score
      uc_roc = roc_auc_score(test_gen.classes, y_pred, multi_class='ovr')
      uc_roc
```

```
[47]: 0.8070487413540686
```

```
[ ]:
```