

Unzip the data

In [1]:

```
# Extract data
```

```
! unzip '/content/Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectra  
1 Image Representation.zip'
```

```
Streaming output truncated to the last 5000 lines.
```

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```
inflating: data/train/Ventricular Fibrillation/VFEfig_53.png
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inflating: data/train/Ventricular Fibrillation/VFEfig_87.png
inflating: data/train/Ventricular Fibrillation/VFEfig_88.png
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inflating: data/train/Ventricular Fibrillation/VFEfig_91.png
inflating: data/train/Ventricular Fibrillation/VFEfig_92.png
inflating: data/train/Ventricular Fibrillation/VFEfig_93.png
inflating: data/train/Ventricular Fibrillation/VFEfig_94.png
inflating: data/train/Ventricular Fibrillation/VFEfig_95.png
inflating: data/train/Ventricular Fibrillation/VFEfig_96.png
inflating: data/train/Ventricular Fibrillation/VFEfig_97.png
inflating: data/train/Ventricular Fibrillation/VFEfig_98.png
inflating: data/train/Ventricular Fibrillation/VFEfig_99.png
```

Import The ImageDataGenerator Library

In [2]:

```
# Import necessary lib.

from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

Configure ImageDataGenerator Class

In [3]:

```
# Image augmentation on training variable

train_datagen = ImageDataGenerator(rescale=1./255,
                                   zoom_range=0.2,
                                   horizontal_flip=True)
```

In [4]:

```
# Image augmentation on testing variable
```

```
test_datagen = ImageDataGenerator(rescale=1./255)
```

Apply ImageDataGenerator functionality to Train set and Test set

In [5]:

```
# Image augmentation on training data
```

```
xtrain = train_datagen.flow_from_directory('/content/data/train',  
                                           target_size=(64,64),  
                                           class_mode='categorical',  
                                           batch_size=100)
```

Found 15341 images belonging to 6 classes.

In [6]:

```
# Image augmentation on testing data
```

```
xtest = test_datagen.flow_from_directory('/content/data/test',  
                                         target_size=(64,64),  
                                         class_mode='categorical',  
                                         batch_size=100)
```

Found 6825 images belonging to 6 classes.

Import the model building Libraries

In [7]:

```
# Importing req. lib.
```

```
from tensorflow.keras.models import Sequential  
from tensorflow.keras.layers import Convolution2D, MaxPooling2D, Flatten, Dense
```

Initialize The Model

In [8]:

```
# Build a CNN block
```

```
model = Sequential() # Initializing sequential model
```

Adding CNN Layers

In [9]:

```
model.add(Convolution2D(32, (3,3), activation='relu', input_shape=(64, 64, 3)))  
model.add(MaxPooling2D(pool_size=(2, 2)))
```

```
model.add(Flatten())
```

Adding Dense Layers

In [10]:

```
model.add(Dense(300, activation='relu')) # Hidden layer 1  
model.add(Dense(150, activation='relu')) # Hidden layer 2
```

```
model.add(Dense(6,activation='softmax')) # Output layer
```

In [11]:

```
model.summary() # summary of our model
```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 62, 62, 32)	896
max_pooling2d (MaxPooling2D)	(None, 31, 31, 32)	0
flatten (Flatten)	(None, 30752)	0
dense (Dense)	(None, 300)	9225900
dense_1 (Dense)	(None, 150)	45150
dense_2 (Dense)	(None, 6)	906
Total params: 9,272,852		
Trainable params: 9,272,852		
Non-trainable params: 0		

Compiling the model

In [12]:

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

Train The Model

In [13]:

```
# Train model
model.fit_generator(xtrain,
                    steps_per_epoch=len(xtrain),
                    epochs=10,
                    validation_data=xtest,
                    validation_steps=len(xtest))
```

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:6: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.

Epoch 1/10
154/154 [=====] - 35s 168ms/step - loss: 1.0850 - accuracy: 0.6225 - val_loss: 1.0577 - val_accuracy: 0.6328
Epoch 2/10
154/154 [=====] - 26s 166ms/step - loss: 0.4437 - accuracy: 0.8623 - val_loss: 0.6323 - val_accuracy: 0.8078
Epoch 3/10
154/154 [=====] - 25s 165ms/step - loss: 0.2844 - accuracy: 0.9145 - val_loss: 0.4974 - val_accuracy: 0.8472
Epoch 4/10
154/154 [=====] - 25s 166ms/step - loss: 0.2396 - accuracy: 0.9250 - val_loss: 0.5611 - val_accuracy: 0.8359
Epoch 5/10
154/154 [=====] - 25s 165ms/step - loss: 0.2043 - accuracy: 0.9376 - val_loss: 0.5012 - val_accuracy: 0.8418
Epoch 6/10
154/154 [=====] - 27s 176ms/step - loss: 0.1862 - accuracy: 0.9428 - val_loss: 0.4667 - val_accuracy: 0.8421


```
28 - val_loss: 0.4667 - val_accuracy: 0.8421
Epoch 7/10
154/154 [=====] - 25s 165ms/step - loss: 0.1653 - accuracy: 0.94
99 - val_loss: 0.4535 - val_accuracy: 0.8470
Epoch 8/10
154/154 [=====] - 27s 178ms/step - loss: 0.1500 - accuracy: 0.95
29 - val_loss: 0.5484 - val_accuracy: 0.8442
Epoch 9/10
154/154 [=====] - 26s 166ms/step - loss: 0.1344 - accuracy: 0.95
76 - val_loss: 0.5911 - val_accuracy: 0.8404
Epoch 10/10
154/154 [=====] - 25s 164ms/step - loss: 0.1159 - accuracy: 0.96
36 - val_loss: 0.5144 - val_accuracy: 0.8503
```

Out[13]:

```
<keras.callbacks.History at 0x7f8ca4539590>
```

Model tuning

In [14]:

```
from tensorflow.keras.callbacks import EarlyStopping, ReduceLRonPlateau
```

In [15]:

```
early_stop = EarlyStopping(monitor='val_accuracy',
                           patience=5)

lr = ReduceLRonPlateau(monitor='val_accuaracy',
                      factor=0.5,
                      min_lr=0.00001)

callback = [early_stop,lr]
```

In [16]:

```
# Train model

model.fit_generator(xtrain,
                   steps_per_epoch=len(xtrain),
                   epochs=100,
                   callbacks=callback,
                   validation_data=xtest,
                   validation_steps=len(xtest))
```

Epoch 1/100

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:8: UserWarning: `Model.fit_g
enerator` is deprecated and will be removed in a future version. Please use `Model.fit`,
which supports generators.
```

```
154/154 [=====] - ETA: 0s - loss: 0.1068 - accuracy: 0.9672
```

```
WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuaracy` which
is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr
```

```
154/154 [=====] - 25s 166ms/step - loss: 0.1068 - accuracy: 0.96
72 - val_loss: 0.4804 - val_accuracy: 0.8525 - lr: 0.0010
```

Epoch 2/100

```
154/154 [=====] - ETA: 0s - loss: 0.0956 - accuracy: 0.9683
```

```
WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuaracy` which
is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr
```

```
154/154 [=====] - 25s 163ms/step - loss: 0.0956 - accuracy: 0.96
83 - val_loss: 0.5639 - val_accuracy: 0.8498 - lr: 0.0010
```

Epoch 3/100

```
154/154 [=====] - ETA: 0s - loss: 0.0862 - accuracy: 0.9743
```

```
WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuaracy` which
```

is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 165ms/step - loss: 0.0862 - accuracy: 0.9743 - val_loss: 0.5918 - val_accuracy: 0.8557 - lr: 0.0010

Epoch 4/100

154/154 [=====] - ETA: 0s - loss: 0.0739 - accuracy: 0.9767

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 164ms/step - loss: 0.0739 - accuracy: 0.9767 - val_loss: 0.7010 - val_accuracy: 0.8626 - lr: 0.0010

Epoch 5/100

154/154 [=====] - ETA: 0s - loss: 0.0685 - accuracy: 0.9784

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 163ms/step - loss: 0.0685 - accuracy: 0.9784 - val_loss: 0.8279 - val_accuracy: 0.8653 - lr: 0.0010

Epoch 6/100

154/154 [=====] - ETA: 0s - loss: 0.0668 - accuracy: 0.9787

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 162ms/step - loss: 0.0668 - accuracy: 0.9787 - val_loss: 0.7362 - val_accuracy: 0.8692 - lr: 0.0010

Epoch 7/100

154/154 [=====] - ETA: 0s - loss: 0.0563 - accuracy: 0.9826

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 164ms/step - loss: 0.0563 - accuracy: 0.9826 - val_loss: 0.7953 - val_accuracy: 0.8637 - lr: 0.0010

Epoch 8/100

154/154 [=====] - ETA: 0s - loss: 0.0532 - accuracy: 0.9832

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 27s 175ms/step - loss: 0.0532 - accuracy: 0.9832 - val_loss: 0.7138 - val_accuracy: 0.8655 - lr: 0.0010

Epoch 9/100

154/154 [=====] - ETA: 0s - loss: 0.0504 - accuracy: 0.9853

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 164ms/step - loss: 0.0504 - accuracy: 0.9853 - val_loss: 0.7327 - val_accuracy: 0.8706 - lr: 0.0010

Epoch 10/100

154/154 [=====] - ETA: 0s - loss: 0.0462 - accuracy: 0.9864

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 27s 177ms/step - loss: 0.0462 - accuracy: 0.9864 - val_loss: 0.6193 - val_accuracy: 0.8778 - lr: 0.0010

Epoch 11/100

154/154 [=====] - ETA: 0s - loss: 0.0457 - accuracy: 0.9851

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 26s 166ms/step - loss: 0.0457 - accuracy: 0.9851 - val_loss: 0.7418 - val_accuracy: 0.8711 - lr: 0.0010

Epoch 12/100

154/154 [=====] - ETA: 0s - loss: 0.0416 - accuracy: 0.9862

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 165ms/step - loss: 0.0416 - accuracy: 0.9862 - val_loss: 0.8396 - val_accuracy: 0.8683 - lr: 0.0010

Epoch 13/100

154/154 [=====] - ETA: 0s - loss: 0.0407 - accuracy: 0.9872

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuaracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 164ms/step - loss: 0.0407 - accuracy: 0.9872 - val_loss: 0.7450 - val_accuracy: 0.8736 - lr: 0.0010

Epoch 14/100

154/154 [=====] - ETA: 0s - loss: 0.0384 - accuracy: 0.9879

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuaracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 164ms/step - loss: 0.0384 - accuracy: 0.9879 - val_loss: 0.9369 - val_accuracy: 0.8697 - lr: 0.0010

Epoch 15/100

154/154 [=====] - ETA: 0s - loss: 0.0347 - accuracy: 0.9888

WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_accuaracy` which is not available. Available metrics are: loss,accuracy,val_loss,val_accuracy,lr

154/154 [=====] - 25s 164ms/step - loss: 0.0347 - accuracy: 0.9888 - val_loss: 0.9085 - val_accuracy: 0.8610 - lr: 0.0010

Out[16]:

<keras.callbacks.History at 0x7f8ca4183310>

Save The Model

In [17]:

```
# Save model
```

```
model.save('ECG.h5')
```

```
!tar -zcvf ECG_arrhythmia-classification.tgz ECG.h5
```

ECG.h5

IBM Deployment

In [18]:

```
!pip install watson-machine-learning-client
```

Looking in indexes: <https://pypi.org/simple>, <https://us-python.pkg.dev/colab-wheels/public/simple/>

Collecting watson-machine-learning-client

Downloading watson_machine_learning_client-1.0.391-py3-none-any.whl (538 kB)

|████████████████████████████████████████| 538 kB 26.2 MB/s

Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (4.64.1)

Collecting ibm-cos-sdk

Downloading ibm-cos-sdk-2.12.0.tar.gz (55 kB)

|████████████████████████████████████████| 55 kB 3.9 MB/s

Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (2.23.0)

Collecting boto3

Downloading boto3-1.26.2-py3-none-any.whl (132 kB)

|████████████████████████████████████████| 132 kB 67.7 MB/s

Requirement already satisfied: certifi in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (2022.9.24)

Requirement already satisfied: urllib3 in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (1.24.3)

Collecting lomond

Downloading lomond-0.3.3-py2.py3-none-any.whl (35 kB)

Requirement already satisfied: tabulate in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (0.8.10)

Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (1.3.5)
Collecting s3transfer<0.7.0,>=0.6.0
 Downloading s3transfer-0.6.0-py3-none-any.whl (79 kB)
 |████████████████████████████████████████| 79 kB 7.7 MB/s
Collecting boto3<1.30.0,>=1.29.2
 Downloading boto3-1.29.2-py3-none-any.whl (9.8 MB)
 |████████████████████████████████████████| 9.8 MB 53.7 MB/s
Collecting jmespath<2.0.0,>=0.7.1
 Downloading jmespath-1.0.1-py3-none-any.whl (20 kB)
Collecting urllib3
 Downloading urllib3-1.26.12-py2.py3-none-any.whl (140 kB)
 |████████████████████████████████████████| 140 kB 66.8 MB/s
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /usr/local/lib/python3.7/dist-packages (from boto3->watson-machine-learning-client) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from python-dateutil<3.0.0,>=2.1->boto3->watson-machine-learning-client) (1.15.0)
Collecting ibm-cos-sdk-core==2.12.0
 Downloading ibm-cos-sdk-core-2.12.0.tar.gz (956 kB)
 |████████████████████████████████████████| 956 kB 62.2 MB/s
Collecting ibm-cos-sdk-s3transfer==2.12.0
 Downloading ibm-cos-sdk-s3transfer-2.12.0.tar.gz (135 kB)
 |████████████████████████████████████████| 135 kB 67.4 MB/s
Collecting jmespath<2.0.0,>=0.7.1
 Downloading jmespath-0.10.0-py2.py3-none-any.whl (24 kB)
Collecting requests
 Downloading requests-2.28.1-py3-none-any.whl (62 kB)
 |████████████████████████████████████████| 62 kB 1.4 MB/s
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/dist-packages (from requests->watson-machine-learning-client) (2.10)
Requirement already satisfied: charset-normalizer<3,>=2 in /usr/local/lib/python3.7/dist-packages (from requests->watson-machine-learning-client) (2.1.1)
Requirement already satisfied: numpy>=1.17.3 in /usr/local/lib/python3.7/dist-packages (from pandas->watson-machine-learning-client) (1.21.6)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (from pandas->watson-machine-learning-client) (2022.5)
Building wheels for collected packages: ibm-cos-sdk, ibm-cos-sdk-core, ibm-cos-sdk-s3transfer
 Building wheel for ibm-cos-sdk (setup.py) ... done
 Created wheel for ibm-cos-sdk: filename=ibm_cos_sdk-2.12.0-py3-none-any.whl size=73930 sha256=e3c1da9b18f5058aed98b7f58bca9eee64cd42b9edadbdbe31acc00796e3fa217
 Stored in directory: /root/.cache/pip/wheels/ec/94/29/2b57327cf00664b6614304f7958abd29d77ea0e5bbece2ea57
 Building wheel for ibm-cos-sdk-core (setup.py) ... done
 Created wheel for ibm-cos-sdk-core: filename=ibm_cos_sdk_core-2.12.0-py3-none-any.whl size=562962 sha256=b0896efd31d8ab462212a4c0d9d7ee664656823bbee9d869267fdcccbdc19308
 Stored in directory: /root/.cache/pip/wheels/64/56/fb/5cd6f4f40406c828a5289b95b2752a4d142a9afb359244ed8d
 Building wheel for ibm-cos-sdk-s3transfer (setup.py) ... done
 Created wheel for ibm-cos-sdk-s3transfer: filename=ibm_cos_sdk_s3transfer-2.12.0-py3-none-any.whl size=89778 sha256=f5ae425a240be4df1aa43ed70e74a955a89cf399482ead321115486b1518393d
 Stored in directory: /root/.cache/pip/wheels/57/79/6a/ffe3370ed7ebc00604f9f76766e1e0348dcdcad2b2e32df9e1
Successfully built ibm-cos-sdk ibm-cos-sdk-core ibm-cos-sdk-s3transfer
Installing collected packages: urllib3, requests, jmespath, ibm-cos-sdk-core, boto3, s3transfer, ibm-cos-sdk-s3transfer, lomond, ibm-cos-sdk, boto3, watson-machine-learning-client
 Attempting uninstall: urllib3
 Found existing installation: urllib3 1.24.3
 Uninstalling urllib3-1.24.3:
 Successfully uninstalled urllib3-1.24.3
 Attempting uninstall: requests
 Found existing installation: requests 2.23.0
 Uninstalling requests-2.23.0:
 Successfully uninstalled requests-2.23.0
Successfully installed boto3-1.26.2 boto3-1.29.2 ibm-cos-sdk-2.12.0 ibm-cos-sdk-core-2.12.0 ibm-cos-sdk-s3transfer-2.12.0 jmespath-0.10.0 lomond-0.3.3 requests-2.28.1 s3transfer-0.6.0 urllib3-1.26.12 watson-machine-learning-client-1.0.391

In [19]:

```
!pip install ibm_watson_machine_learning
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting ibm_watson_machine_learning
  Downloading ibm_watson_machine_learning-1.0.256-py3-none-any.whl (1.8 MB)
    |████████████████████| 1.8 MB 27.1 MB/s
Requirement already satisfied: certifi in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (2022.9.24)
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (2.28.1)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (1.26.12)
Requirement already satisfied: tabulate in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (0.8.10)
Requirement already satisfied: importlib-metadata in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (4.13.0)
Collecting ibm-cos-sdk==2.7.*
  Downloading ibm-cos-sdk-2.7.0.tar.gz (51 kB)
    |████████████████████| 51 kB 780 kB/s
Requirement already satisfied: pandas<1.5.0,>=0.24.2 in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (1.3.5)
Requirement already satisfied: lomond in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (0.3.3)
Requirement already satisfied: packaging in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (21.3)
Collecting ibm-cos-sdk-core==2.7.0
  Downloading ibm-cos-sdk-core-2.7.0.tar.gz (824 kB)
    |████████████████████| 824 kB 64.4 MB/s
Collecting ibm-cos-sdk-s3transfer==2.7.0
  Downloading ibm-cos-sdk-s3transfer-2.7.0.tar.gz (133 kB)
    |████████████████████| 133 kB 60.0 MB/s
Requirement already satisfied: jmespath<1.0.0,>=0.7.1 in /usr/local/lib/python3.7/dist-packages (from ibm-cos-sdk==2.7.*->ibm_watson_machine_learning) (0.10.0)
Collecting docutils<0.16,>=0.10
  Downloading docutils-0.15.2-py3-none-any.whl (547 kB)
    |████████████████████| 547 kB 56.1 MB/s
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /usr/local/lib/python3.7/dist-packages (from ibm-cos-sdk-core==2.7.0->ibm-cos-sdk==2.7.*->ibm_watson_machine_learning) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (from pandas<1.5.0,>=0.24.2->ibm_watson_machine_learning) (2022.5)
Requirement already satisfied: numpy>=1.17.3 in /usr/local/lib/python3.7/dist-packages (from pandas<1.5.0,>=0.24.2->ibm_watson_machine_learning) (1.21.6)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from python-dateutil<3.0.0,>=2.1->ibm-cos-sdk-core==2.7.0->ibm-cos-sdk==2.7.*->ibm_watson_machine_learning) (1.15.0)
Requirement already satisfied: charset-normalizer<3,>=2 in /usr/local/lib/python3.7/dist-packages (from requests->ibm_watson_machine_learning) (2.1.1)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/dist-packages (from requests->ibm_watson_machine_learning) (2.10)
Requirement already satisfied: typing-extensions>=3.6.4 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata->ibm_watson_machine_learning) (4.1.1)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata->ibm_watson_machine_learning) (3.10.0)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/dist-packages (from packaging->ibm_watson_machine_learning) (3.0.9)
Building wheels for collected packages: ibm-cos-sdk, ibm-cos-sdk-core, ibm-cos-sdk-s3transfer
  Building wheel for ibm-cos-sdk (setup.py) ... done
  Created wheel for ibm-cos-sdk: filename=ibm_cos_sdk-2.7.0-py2.py3-none-any.whl size=72564 sha256=e9d7c354f2ed3b9885e8cf9d7ebff9ce3add6927bc565bea4e0887ddf229464e
  Stored in directory: /root/.cache/pip/wheels/47/22/bf/e1154ff0f5de93cc477acd0ca69abfbb8b799c5b28a66b44c2
  Building wheel for ibm-cos-sdk-core (setup.py) ... done
  Created wheel for ibm-cos-sdk-core: filename=ibm_cos_sdk_core-2.7.0-py2.py3-none-any.whl size=501013 sha256=820f21503bb167dfd0cfa3bd8e76ac0878b89b347774850753c8348901c717d5
  Stored in directory: /root/.cache/pip/wheels/6c/a2/e4/c16d02f809a3ea998e17cfd02c13369281f3d232aaf5902c19
  Building wheel for ibm-cos-sdk-s3transfer (setup.py) ... done
```

Created wheel for ibm-cos-sdk-s3transfer: filename=ibm_cos_sdk_s3transfer-2.7.0-py2.py3-none-any.whl size=88619 sha256=79aa3a85861b1ee75e457b86e578f6a5f222140453ced60a20933d9cd1d27671

Stored in directory: /root/.cache/pip/wheels/5f/b7/14/fbe02bc1ef1af890650c7e51743d1c83890852e598d164b9da

Successfully built ibm-cos-sdk ibm-cos-sdk-core ibm-cos-sdk-s3transfer

Installing collected packages: docutils, ibm-cos-sdk-core, ibm-cos-sdk-s3transfer, ibm-cos-sdk, ibm-watson-machine-learning

Attempting uninstall: docutils

Found existing installation: docutils 0.17.1

Uninstalling docutils-0.17.1:

Successfully uninstalled docutils-0.17.1

Attempting uninstall: ibm-cos-sdk-core

Found existing installation: ibm-cos-sdk-core 2.12.0

Uninstalling ibm-cos-sdk-core-2.12.0:

Successfully uninstalled ibm-cos-sdk-core-2.12.0

Attempting uninstall: ibm-cos-sdk-s3transfer

Found existing installation: ibm-cos-sdk-s3transfer 2.12.0

Uninstalling ibm-cos-sdk-s3transfer-2.12.0:

Successfully uninstalled ibm-cos-sdk-s3transfer-2.12.0

Attempting uninstall: ibm-cos-sdk

Found existing installation: ibm-cos-sdk 2.12.0

Uninstalling ibm-cos-sdk-2.12.0:

Successfully uninstalled ibm-cos-sdk-2.12.0

Successfully installed docutils-0.15.2 ibm-cos-sdk-2.7.0 ibm-cos-sdk-core-2.7.0 ibm-cos-sdk-s3transfer-2.7.0 ibm-watson-machine-learning-1.0.256

In [20]:

```
from ibm_watson_machine_learning import APIClient

wml_credentials = {
    "url": "https://eu-gb.ml.cloud.ibm.com",
    "apikey": "G565mbpJlA5S9JVSvNwpBuQMhgBaRnVA-iOy3xiQKTAE"
}

client = APIClient(wml_credentials)
```

Python 3.7 and 3.8 frameworks are deprecated and will be removed in a future release. Use Python 3.9 framework instead.

In [21]:

```
client
```

Out[21]:

```
<ibm_watson_machine_learning.client.APIClient at 0x7f8ca417e290>
```

In [22]:

```
client.spaces.get_details()
```

Out[22]:

```
{'resources': [{'entity': {'compute': [{'crn': 'crn:v1:bluemix:public:pm-20:eu-gb:a/7972a1d9def74911a74fa19c69cf43a8:f9af0327-7ea9-4e8a-837f-3899f628f311::',
    'guid': 'f9af0327-7ea9-4e8a-837f-3899f628f311',
    'name': 'Watson Machine Learning-0v',
    'type': 'machine_learning'}]},
    'description': '',
    'name': 'ibm_deploy',
    'scope': {'bss_account_id': '7972a1d9def74911a74fa19c69cf43a8'},
    'stage': {'production': False},
    'status': {'state': 'active'},
    'storage': {'properties': {'bucket_name': '32e291eb-5bc8-4c7d-9821-e52018db7321',
    'bucket_region': 'eu-gb-standard',
    'credentials': {'admin': {'access_key_id': '21a25576ea3544a2a29f57a6d4b7b1bf',
    'api_key': '06VviGhk8JUevhUlKruFQ6k7LWa7ZdI700dYt6kddn7m',
    'secret_access_key': 'c68e06897f96335elf853d490b6be956146bbaac6e7c9b38',
    'service_id': 'ServiceId-80c7f8af-b96d-4c76-b834-6d30e83e07cd'},
    'editor': {'access_key_id': '7111e4245ed141f3a1527c6d855fc01c',
    'apikey': '14wl1raku17iARVpDL26 U73YdHZHR76P7KCIYE3E8s 1'}}
```

```

    'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/7972ald9
def74911a74fa19c69cf43a8:555827fd-3b82-4b63-8f7d-f15270d9735d::',
    'secret_access_key': '42d59d9041d00741b4b5d5f4d8464759896b5451a4d8cf6e',
    'service_id': 'ServiceId-165e54e4-a865-452f-a565-0947a5b49928'},
    'viewer': {'access_key_id': '87b9826e6cdb47109cca684c3c3837f7',
    'api_key': '3nDyFuIi0Rt4_0Rq2rCcZd8f6ubHrDwjvfvfJJJaHguVQC',
    'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/7972ald9
def74911a74fa19c69cf43a8:555827fd-3b82-4b63-8f7d-f15270d9735d::',
    'secret_access_key': '88bce919860bf44b0fd854152b248a6cbad5339e78e71a80',
    'service_id': 'ServiceId-ee317844-2cd1-45de-914e-b11850bfb2aa'}}},
    'endpoint_url': 'https://s3.eu-gb.cloud-object-storage.appdomain.cloud',
    'guid': '555827fd-3b82-4b63-8f7d-f15270d9735d',
    'resource_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/7972ald9def749
11a74fa19c69cf43a8:555827fd-3b82-4b63-8f7d-f15270d9735d::'},
    'type': 'bmcos_object_storage'}}},
    'metadata': {'created_at': '2022-11-03T13:59:37.128Z',
    'creator_id': 'IBMid-6640041DYK',
    'id': '069d3bdc-3323-4fde-9bde-315a19c18035',
    'updated_at': '2022-11-03T14:00:01.538Z',
    'url': '/v2/spaces/069d3bdc-3323-4fde-9bde-315a19c18035'}}}}}
```

In [23]:

```
client.spaces.list()
```

Note: 'limit' is not provided. Only first 50 records will be displayed if the number of records exceed 50

ID	NAME	CREATED
069d3bdc-3323-4fde-9bde-315a19c18035	ibm_deploy	2022-11-03T13:59:37.128Z

In [24]:

```
space_uid = "069d3bdc-3323-4fde-9bde-315a19c18035"
space_uid
```

Out[24]:

'069d3bdc-3323-4fde-9bde-315a19c18035'

In [25]:

```
client.set.default_space(space_uid)
```

Out[25]:

'SUCCESS'

In [26]:

```
client.software_specifications.list()
```

NAME	ASSET_ID	TYPE
default_py3.6	0062b8c9-8b7d-44a0-a9b9-46c416adcbd9	base
kernel-spark3.2-scala2.12	020d69ce-7ac1-5e68-ac1a-31189867356a	base
pytorch-onnx_1.3-py3.7-edt	069ea134-3346-5748-b513-49120e15d288	base
scikit-learn_0.20-py3.6	09c5a1d0-9c1e-4473-a344-eb7b665fff687	base
spark-mllib_3.0-scala_2.12	09f4cff0-90a7-5899-b9ed-1ef348aebdee	base
pytorch-onnx_rt22.1-py3.9	0b848dd4-e681-5599-be41-b5f6fccc6471	base
ai-function_0.1-py3.6	0cdb0f1e-5376-4f4d-92dd-da3b69aa9bda	base
shiny-r3.6	0e6e79df-875e-4f24-8ae9-62dcc2148306	base
tensorflow_2.4-py3.7-horovod	1092590a-307d-563d-9b62-4eb7d64b3f22	base
pytorch_1.1-py3.6	10ac12d6-6b30-4ccd-8392-3e922c096a92	base
tensorflow_1.15-py3.6-ddl	111e41b3-de2d-5422-a4d6-bf776828c4b7	base
runtime-22.1-py3.9	12b83a17-24d8-5082-900f-0ab31fbfd3cb	base
scikit-learn_0.22-py3.6	154010fa-5b3b-4ac1-82af-4d5ee5abbc85	base
default_r3.6	1b70aec3-ab34-4b87-8aa0-a4a3c8296a36	base
pytorch-onnx_1.3-py3.6	1bc6029a-cc97-56da-b8e0-39c3880dbbe7	base
kernel-spark3.3-r3.6	1c9e5454-f216-59dd-a20e-474a5cdf5988	base
pytorch-onnx_rt22.1-py3.9-edt	1d362186-7ad5-5b59-8b6c-9d0880bde37f	base
tensorflow_2.1-py3.6	1eb25b04-dc0d-5d3d-bc05-2fb35f6c65cc	base

tensorflow_2.1-py3.8	1eb25b84-d6ea-5dde-b6a5-31bd11663666	base
spark-mllib_3.2	20047f72-0a98-58c7-9ff5-a77b012eb8f5	base
tensorflow_2.4-py3.8-horovod	217c16f6-178f-56bf-824a-b19f20564c49	base
runtime-22.1-py3.9-cuda	26215f05-08c3-5a41-a1b0-da66306ce658	base
do_py3.8	295addb5-9ef9-547e-9bf4-92ae3563e720	base
autoai-ts_3.8-py3.8	2aa0c932-798f-5ae9-abd6-15e0c2402fb5	base
tensorflow_1.15-py3.6	2b73a275-7cbf-420b-a912-eae7f436e0bc	base
kernel-spark3.3-py3.9	2b7961e2-e3b1-5a8c-a491-482c8368839a	base
pytorch_1.2-py3.6	2c8ef57d-2687-4b7d-acce-01f94976dac1	base
spark-mllib_2.3	2e51f700-bca0-4b0d-88dc-5c6791338875	base
pytorch-onnx_1.1-py3.6-edt	32983cea-3f32-4400-8965-dde874a8d67e	base
spark-mllib_3.0-py37	36507ebe-8770-55ba-ab2a-eafe787600e9	base
spark-mllib_2.4	390d21f8-e58b-4fac-9c55-d7ceda621326	base
xgboost_0.82-py3.6	39e31acd-5f30-41dc-ae44-60233c80306e	base
pytorch-onnx_1.2-py3.6-edt	40589d0e-7019-4e28-8daa-fb03b6f4fe12	base
default_r36py38	41c247d3-45f8-5a71-b065-8580229facf0	base
autoai-ts_rt22.1-py3.9	4269d26e-07ba-5d40-8f66-2d495b0c71f7	base
autoai-obm_3.0	42b92e18-d9ab-567f-988a-4240baled5f7	base
pmml-3.0_4.3	493bcb95-16f1-5bc5-bee8-81b8af80e9c7	base
spark-mllib_2.4-r_3.6	49403dff-92e9-4c87-a3d7-a42d0021c095	base
xgboost_0.90-py3.6	4ff8d6c2-1343-4c18-85e1-689c965304d3	base
pytorch-onnx_1.1-py3.6	50f95b2a-bc16-43bb-bc94-b0bed208c60b	base
autoai-ts_3.9-py3.8	52c57136-80fa-572e-8728-a5e7cbb42cde	base
spark-mllib_2.4-scala_2.11	55a70f99-7320-4be5-9fb9-9edb5a443af5	base
spark-mllib_3.0	5c1b0ca2-4977-5c2e-9439-ffd44ea8ffe9	base
autoai-obm_2.0	5c2e37fa-80b8-5e77-840f-d912469614ee	base
spss-modeler_18.1	5c3cad7e-507f-4b2a-a9a3-ab53a21dee8b	base
cuda-py3.8	5d3232bf-c86b-5df4-a2cd-7bb870a1cd4e	base
autoai-kb_3.1-py3.7	632d4b22-10aa-5180-88f0-f52dfb6444d7	base
pytorch-onnx_1.7-py3.8	634d3cdc-b562-5bf9-a2d4-ea90a478456b	base
spark-mllib_2.3-r_3.6	6586b9e3-ccd6-4f92-900f-0f8cb2bd6f0c	base
tensorflow_2.4-py3.7	65e171d7-72d1-55d9-8ebb-f813d620c9bb	base
spss-modeler_18.2	687eddc9-028a-4117-b9dd-e57b36f1efa5	base

Note: Only first 50 records were displayed. To display more use 'limit' parameter.

In [27]:

```
software_space_uid = client.software_specifications.get_uid_by_name("tensorflow_rt22.1-py
3.9")
software_space_uid
```

Out[27]:

```
'acd9c798-6974-5d2f-a657-ce06e986df4d'
```

In [29]:

```
model_details = client.repository.store_model(model="ECG_arrhythmia-classification.tgz",
meta_props={
    client.repository.ModelMetaNames.NAME:"Arrhythmia Classification",
    client.repository.ModelMetaNames.TYPE:"tensorflow_2.7",
    client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_space_uid
})
```

In [30]:

```
model_details
```

Out[30]:

```
{'entity': {'hybrid_pipeline_software_specs': [],
'software_spec': {'id': 'acd9c798-6974-5d2f-a657-ce06e986df4d',
'name': 'tensorflow_rt22.1-py3.9'},
'type': 'tensorflow_2.7'},
'metadata': {'created_at': '2022-11-04T15:37:32.367Z',
'id': 'f52a14ba-c144-4328-a83a-cd9641aed076',
'modified_at': '2022-11-04T15:37:41.345Z',
'name': 'Arrhythmia Classification',
'owner': 'IBMid-6640041DYK',
'resource_key': '3a87f997-0ab6-4ccb-ac30-818ec0aed3e5',
'space_id': '069d3bdc-3323-4fde-9bde-315a19c18035'},
'system': {'warnings': []}}
```


In [31]:

```
model_id = client.repository.get_model_id(model_details)
model_id
```

Out[31]:

```
'f52a14ba-c144-4328-a83a-cd9641aed076'
```

In [32]:

```
client.repository.download(model_id, 'ECG_arrhythmia_classification.tgz')
```

Successfully saved model content to file: 'ECG_arrhythmia_classification.tgz'

Out[32]:

```
'/content/ECG_arrhythmia_classification.tgz'
```