Name:Rishabh Patil

SapID:60009200056

Branch:K/K2

```
import keras
import pickle

import pandas as pd

import numpy as np

from keras.models import Model,load_model

from keras.layers import Input,Dense

from keras.callbacks import ModelCheckpoint

from keras import regularizers

from keras.optimizers import Adam

from sklearn import datasets

from sklearn import decomposition

from sklearn.cluster import KMeans

from sklearn.preprocessing import MinMaxScaler

from sklearn import metrics

import matplotlib.pyplot as plt


RANDOM_SEED=37117

np.random.seed(RANDOM_SEED)
```

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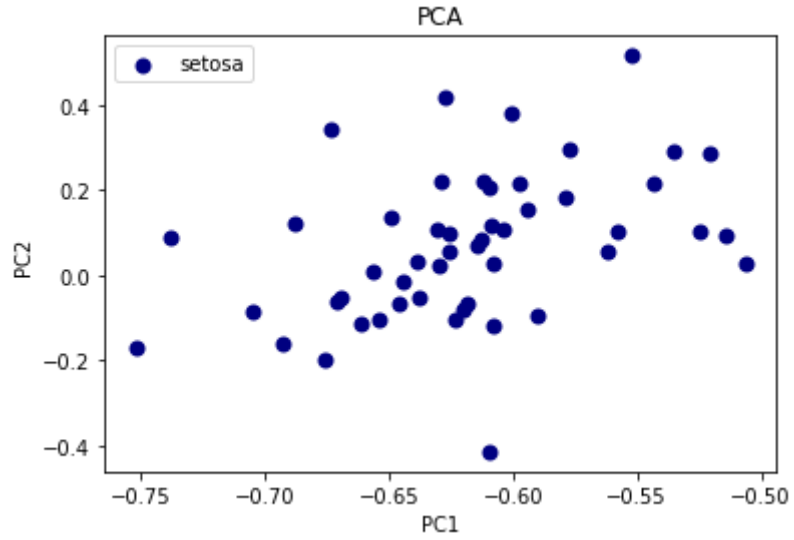
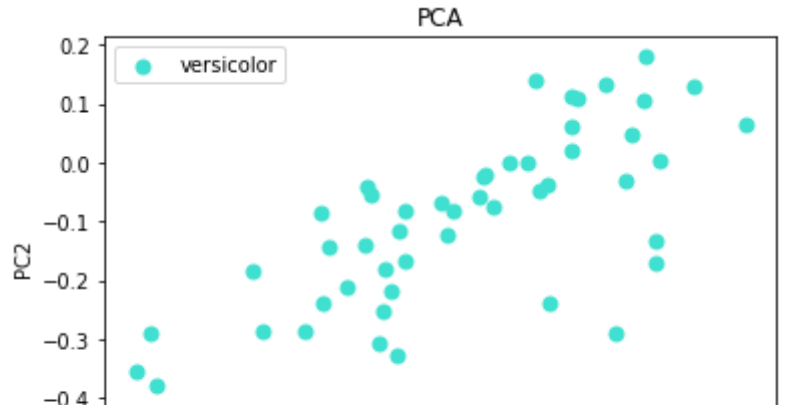
```
iris=datasets.load_iris()

X=iris.data
y=iris.target
print("X:",X[0])
target_names=iris.target_names

scaler=MinMaxScaler()
scaler.fit(X)
X_scaled=scaler.transform(X)


def plot3clusters(X,title,vtitle):
 plt.figure()
 colors=['navy','turquoise','darkorange']
 lw=2
 for color,i,target_name in zip(colors,[0,1,2],target_names):
  plt.scatter(X[y==i,0],X[y==i,1],color=color,alpha=1.,lw=lw,label=target_name)
  plt.legend(loc='best',shadow=False,scatterpoints=1)
  plt.title(title)
  plt.xlabel(vtitle+"1")
  plt.ylabel(vtitle+"2")
  plt.show()
pca=decomposition.PCA()
pca_transformed=pca.fit_transform(X_scaled)
print("pca_transformed: ",pca_transformed[0])
plot3clusters(pca_transformed[:,:2],'PCA','PC')
```

```
X: [5.1 3.5 1.4 0.2]
pca_transformed:  [-0.63070293  0.10757791 -0.0187191  -0.00730695]
```






```
#create an AE and fit it with our data using 3 neurons in the dense layer using keras' fun
input_dim=X_scaled.shape[1]
encoding_dim=2
input_img=Input(shape=(input_dim,))
encoded=Dense(encoding_dim,activation='linear')(input_img)
decoded=Dense(input_dim,activation='linear')(encoded)
autoencoder=Model(input_img,decoded)
autoencoder.compile(optimizer='adam',loss='mse')
print(autoencoder.summary())
```

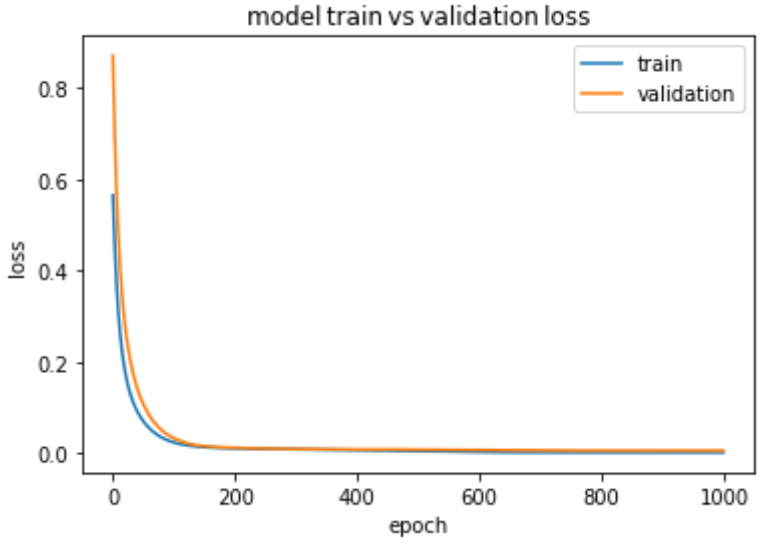
```
Model: "model_12"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_9 (InputLayer)        [(None, 4)]               0

 dense_8 (Dense)             (None, 2)                 10

 dense_9 (Dense)             (None, 4)                 12

=================================================================
Total params: 22
Trainable params: 22
Non-trainable params: 0
```

```
_________________________________________________________________
None
```

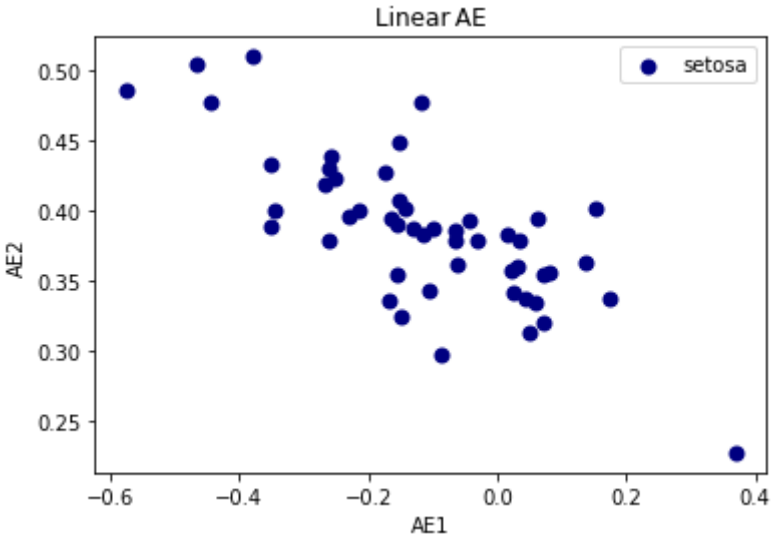
```
history=autoencoder.fit(X_scaled,X_scaled,epochs=1000,batch_size=16,shuffle=True,validatio
```

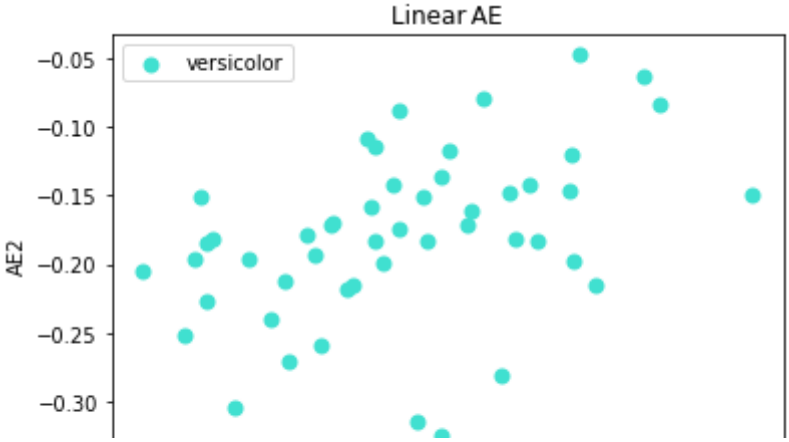
```
#plot our loss
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model train vs validation loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train','validation'],loc='upper right')
plt.show()
```

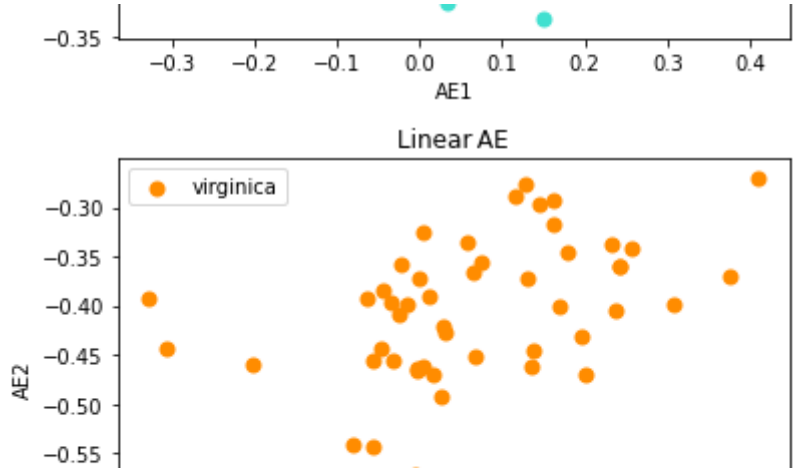
```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:11: MatplotlibDeprecatic
        best
        upper right
        upper left
        lower left
        lower right
        right
        center left
        center right
        lower center
        upper center
        center
This will raise an exception in 3.3.
  # This is added back by InteractiveShellApp.init_path()
```




```
5/5 [==============================] - 0s 3ms/step
```

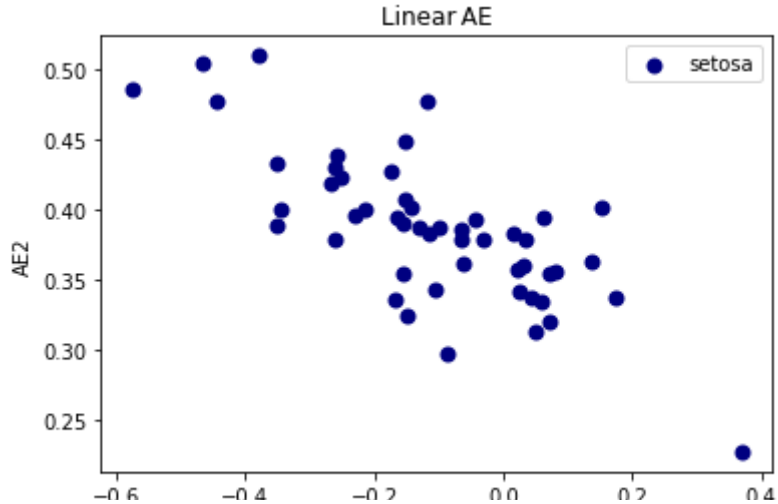







```
# use our encoded layer to encode the training input
encoder=Model(input_img,encoded)
encoded_input=Input(shape=(encoding_dim,))
decoder_layer=autoencoder.layers[-1]
decoder=Model(encoded_input,decoder_layer(encoded_input))
encoded_data=encoder.predict(X_scaled)
plot3clusters(encoded_data[:,:2],'Linear AE','AE')
```

```
5/5 [==============================] - 0s 3ms/step
```



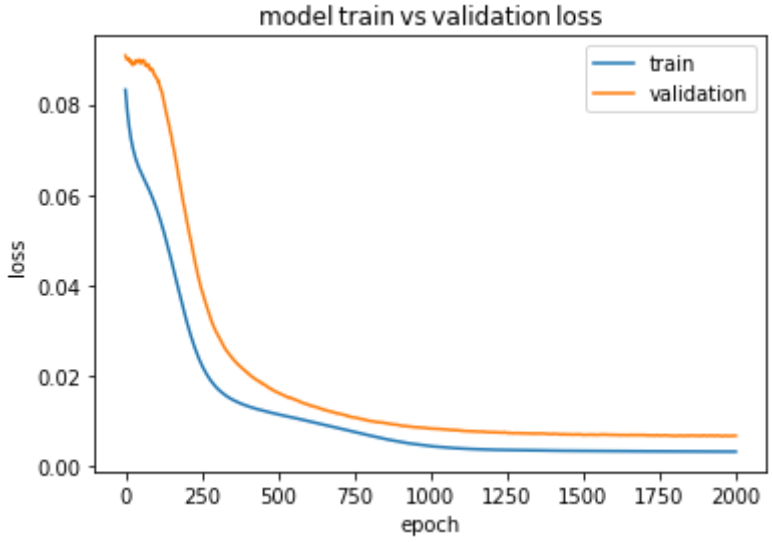

```
labels_true=y
titles=['PCA','Linear AE']

for n_clusters_ in [2]:
 estimators=[('PCA',KMeans(n_clusters=n_clusters_),pca_transformed),('AE linear',KMeans(n_
 print(type(y))
for name,est,data in estimators:
 X=data
 est.fit(X)
 labels=est.labels_
 print(name,':')
 print(labels[:])
 print('Estimated number of clusters: %d'%n_clusters_)
 print("Homogeneity: %0.3f"%metrics.homogeneity_score(labels_true,labels))
 print("Completeness: %0.3f"%metrics.completeness_score(labels_true,labels))
 print("V-measure: %0.3f"%metrics.v_measure_score(labels_true,labels))
 print("Adjusted Rand Index: %0.3f"%metrics.adjusted_rand_score(labels_true,labels))
 print("Adjusted Mutual Information: %0.3f"%metrics.adjusted_mutual_info_score(labels_true
 print("Silhouette Coefficient: %0.3f"%metrics.silhouette_score(X,labels))

print('----------------------------------------------------------------------------------'
```

```
<class 'numpy.ndarray'>
PCA :
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1]
Estimated number of clusters: 2
Homogeneity: 0.579
Completeness: 1.000
V-measure: 0.734
Adjusted Rand Index: 0.568
Adjusted Mutual Information: 0.732
Silhouette Coefficient: 0.630
AE linear :
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

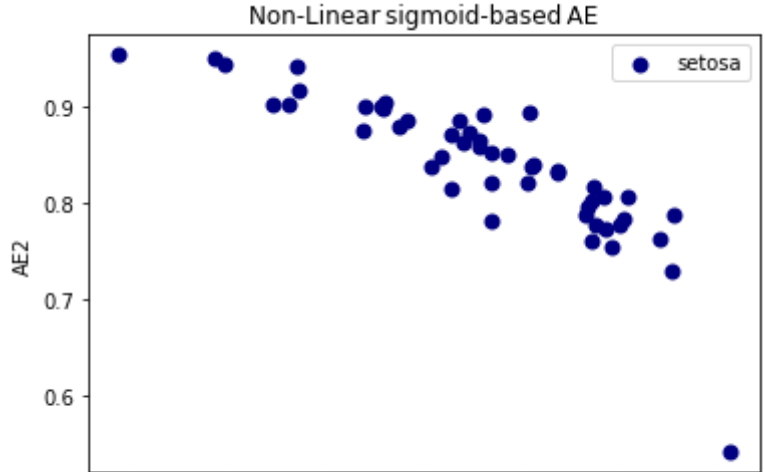
```
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1]
Estimated number of clusters: 2
Homogeneity: 0.579
Completeness: 1.000
V-measure: 0.734
Adjusted Rand Index: 0.568
Adjusted Mutual Information: 0.732
Silhouette Coefficient: 0.629
--------------------------------------------------------------------------------


#create an AE and fit it with our data using 3 neurons in the dense layer using keras' fun

input_dim2=X_scaled.shape[1]
encoding_dim2=2
input_img2=Input(shape=(input_dim2,))
encoded2=Dense(encoding_dim2,activation='sigmoid')(input_img2)
decoded2=Dense(input_dim2,activation='sigmoid')(encoded2)
autoencoder2=Model(input_img2,decoded2)
autoencoder2.compile(optimizer='adam',loss='mse')
print(autoencoder2.summary())
history2=autoencoder2.fit(X_scaled,X_scaled,epochs=2000,batch_size=16,shuffle=True,validat

#plot our loss

plt.plot(history2.history['loss'])
plt.plot(history2.history['val_loss'])
plt.title('model train vs validation loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train','validation'],loc='upper right')
plt.show()

# use our encoded layer to encode the training input
encoder2=Model(input_img2,encoded2)
encoded_input2=Input(shape=(encoding_dim2,))
decoder_layer2=autoencoder2.layers[-1]
decoder2=Model(encoded_input2,decoder_layer2(encoded_input2))
encoded_data2=encoder2.predict(X_scaled)

plot3clusters(encoded_data2[:,:2],'Non-Linear sigmoid-based AE','AE')

#create an AE and fit it with our data using 3 neurons in the dense layer using keras' fun
input_dim3=X_scaled.shape[1]
encoding_dim3=2
input_img3=Input(shape=(input_dim3,))
encoded3=Dense(encoding_dim3,activation='relu',activity_regularizer=regularizers.l1(10e-5)
decoded3=Dense(input_dim3,activation='sigmoid')(encoded3)
autoencoder3=Model(input_img3,decoded3)

autoencoder3.compile(optimizer='adam',loss='mse')
print(autoencoder3.summary())

history3=autoencoder3.fit(X_scaled,X_scaled,epochs=400,batch_size=16,shuffle=True,validati
#plot our loss
```

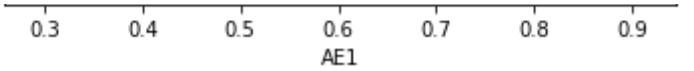
```
plt.plot(history3.history['loss'])
plt.plot(history3.history['val_loss'])
plt.title('model train vs validation loss')
plt.ylabel('loss')

plt.xlabel('epoch')
plt.legend(['train','validation'],loc='upper right')

plt.show()
# use our encoded layer to encode the training input
encoder3=Model(input_img3,encoded3)
encoded_input3=Input(shape=(encoding_dim3,))
decoder_layer3=autoencoder3.layers[-1]
decoder3=Model(encoded_input3,decoder_layer3(encoded_input3))
encoded_data3=encoder3.predict(X_scaled)
plot3clusters(encoded_data3[:,:2],'Non-Linear relu-based AE','AE')
plot3clusters(pca_transformed[:,:2],'PCA','PC')
plot3clusters(encoded_data[:,:2],'Linear AE','AE')
plot3clusters(encoded_data2[:,:2],'Non-Linear sigmoid-based AE','AE')
plot3clusters(encoded_data3[:,:2],'Non-Linear relu-based AE','AE')
```

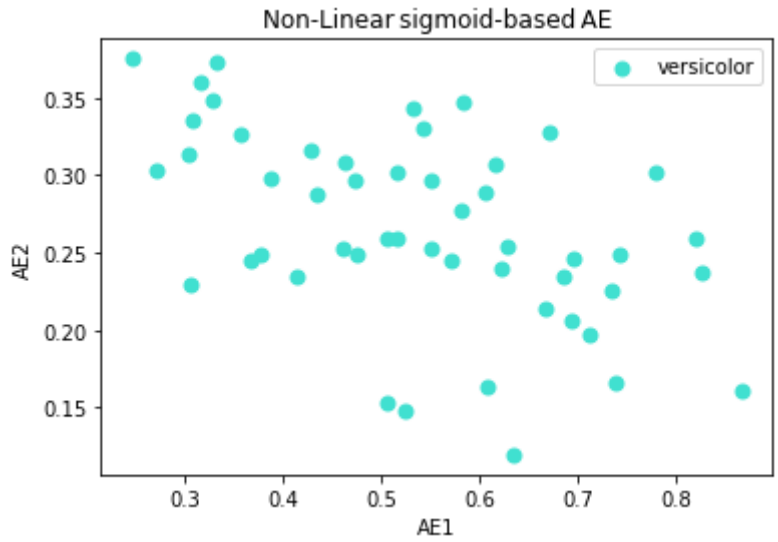
```
Model: "model_6"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_5 (InputLayer)        [(None, 4)]               0

 dense_4 (Dense)             (None, 2)                 10

 dense_5 (Dense)             (None, 4)                 12

=================================================================
Total params: 22
Trainable params: 22
Non-trainable params: 0
_________________________________________________________________
None
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:20: MatplotlibDeprecatic
        best
        upper right
        upper left
        lower left
        lower right
        right
        center left
        center right
        lower center
        upper center
        center
This will raise an exception in 3.3.
```

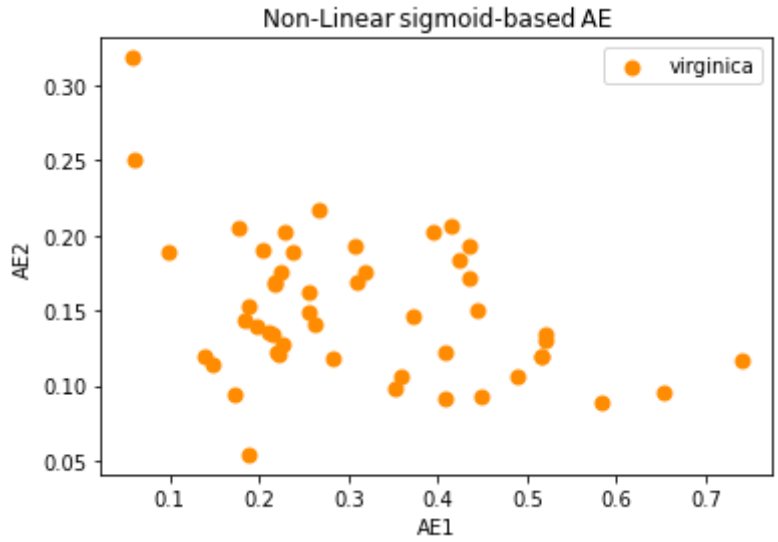



```
5/5 [==============================] - 0s 3ms/step
```



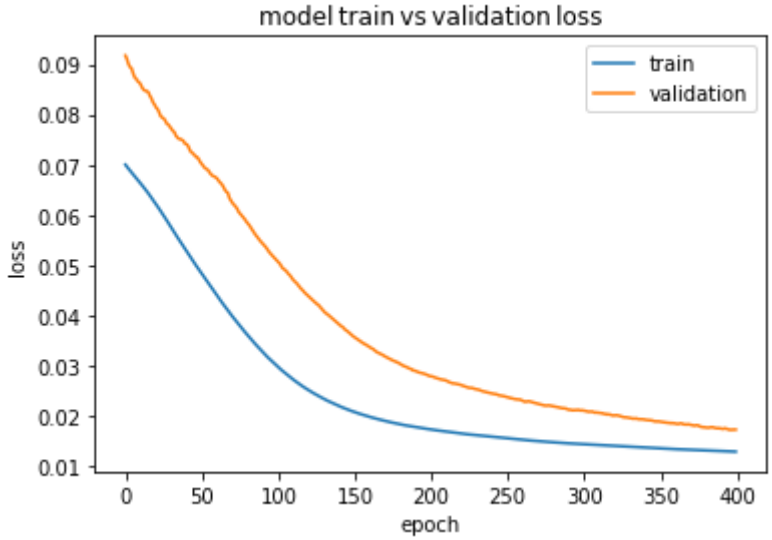




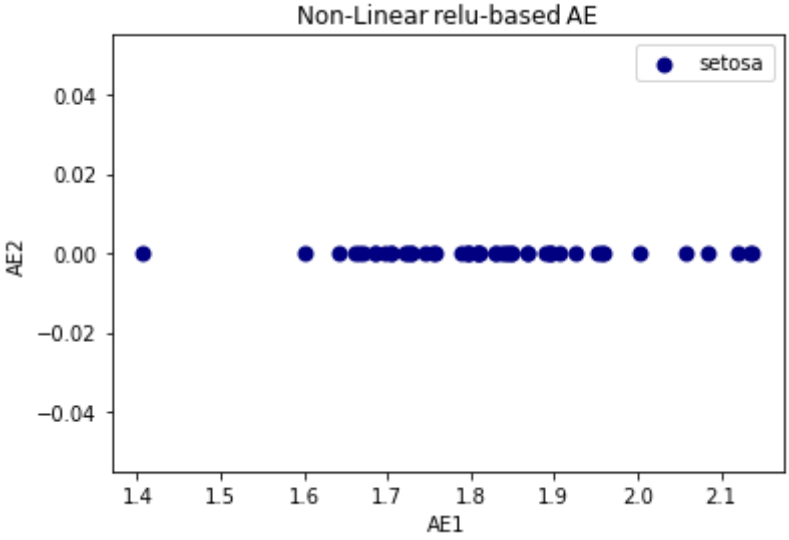


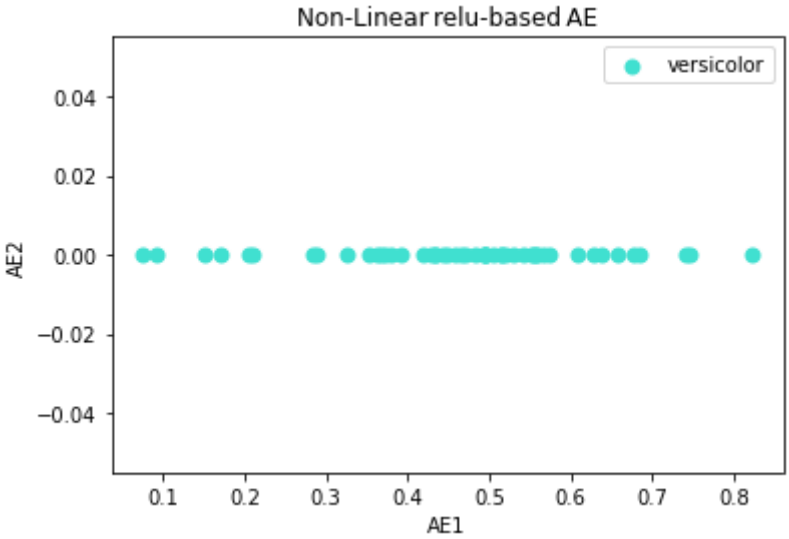

```
Model: "model_9"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_7 (InputLayer)        [(None, 4)]               0

 dense_6 (Dense)             (None, 2)                 10

 dense_7 (Dense)             (None, 4)                 12

=================================================================
Total params: 22
Trainable params: 22
Non-trainable params: 0
_________________________________________________________________
None
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:51: MatplotlibDeprecatic
        best
        upper right
        upper left
        lower left
        lower right
        right
        center left
        center right
        lower center
```

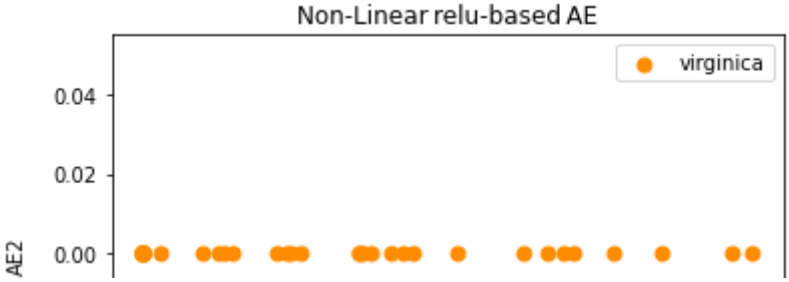
```
        upper center
        center
This will raise an exception in 3.3.
```

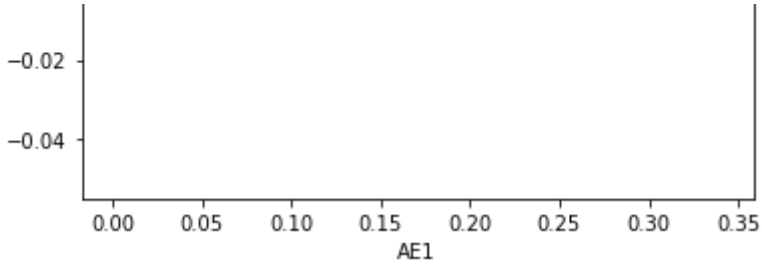


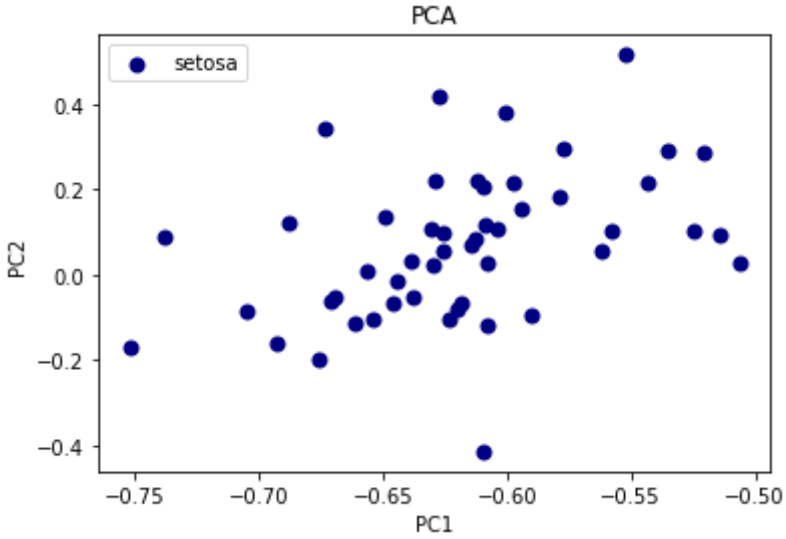

```
5/5 [==============================] - 0s 3ms/step
```

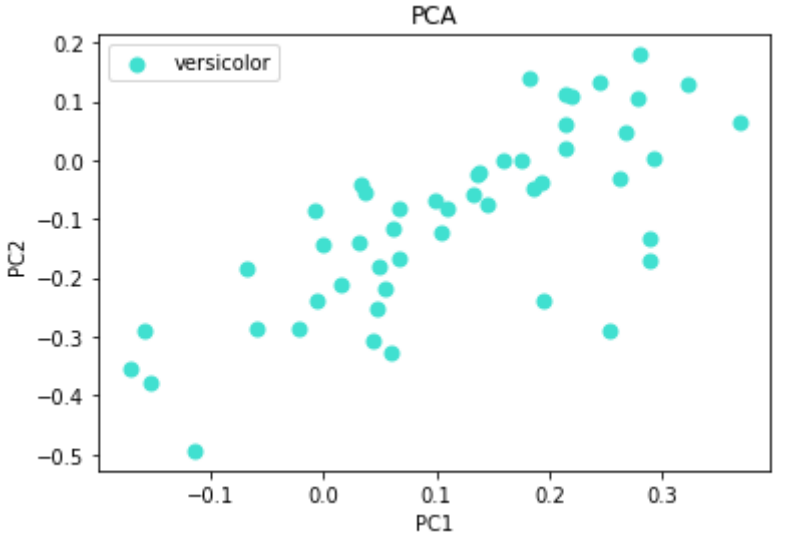


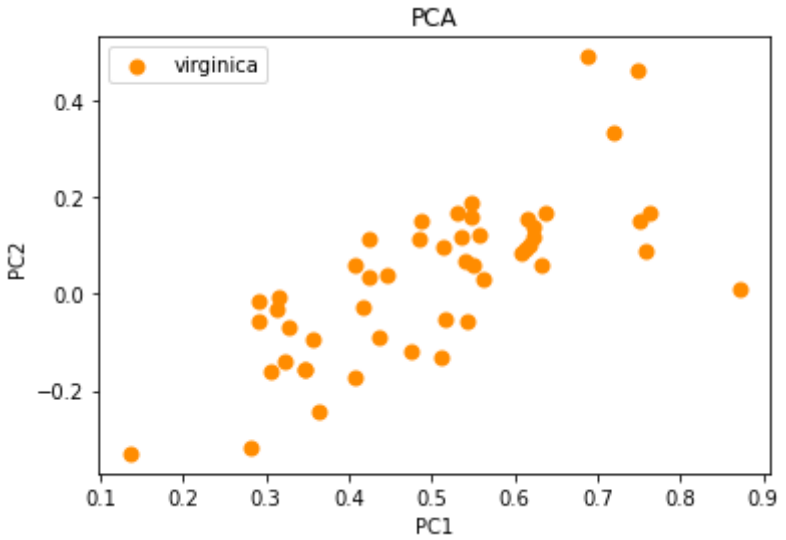


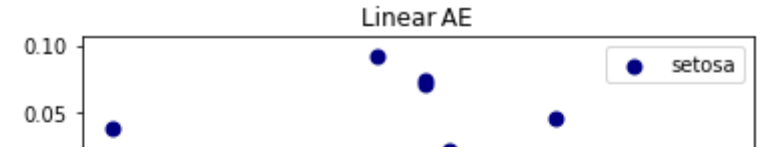


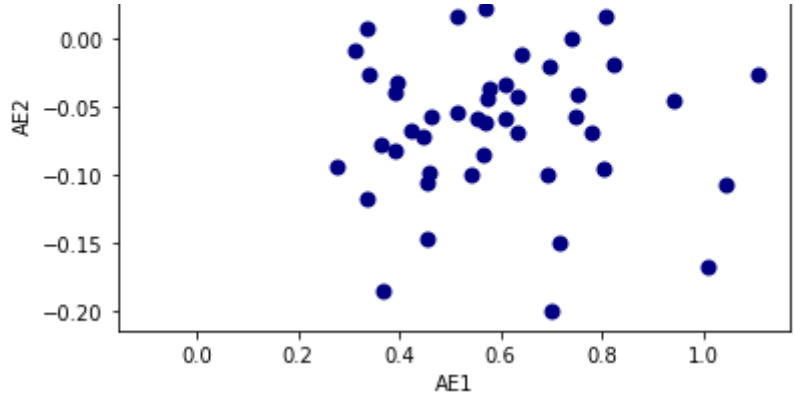

−0.02
−0.04
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
AE1

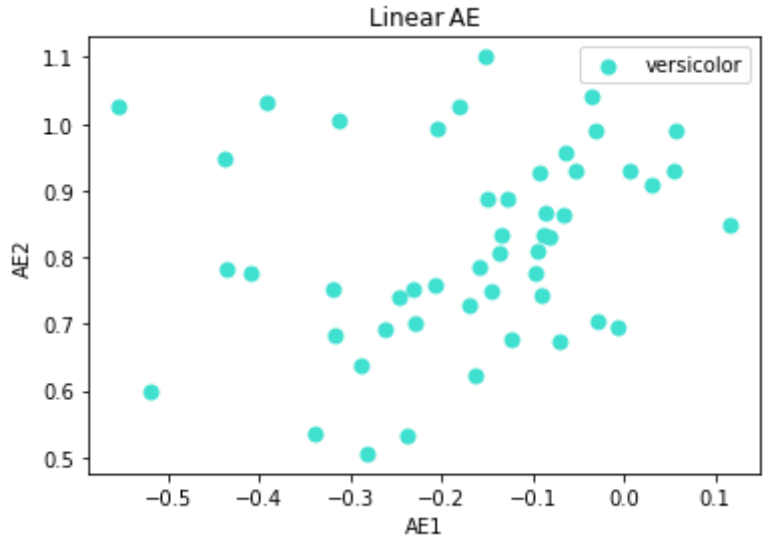

PCA
setosa
0.4
0.2
0.0
−0.2
−0.4
PC2
−0.75
−0.70
−0.65
−0.60
−0.55
−0.50
PC1

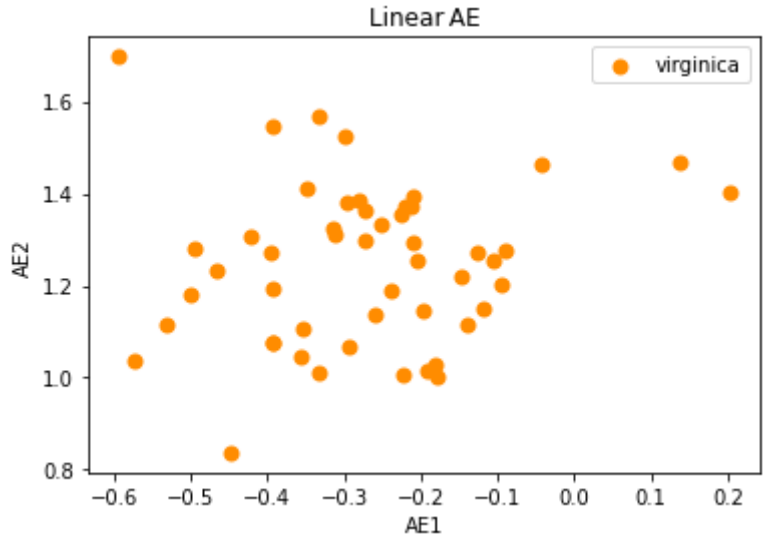

PCA
versicolor
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
PC2
−0.1
0.0
0.1
0.2
0.3
PC1

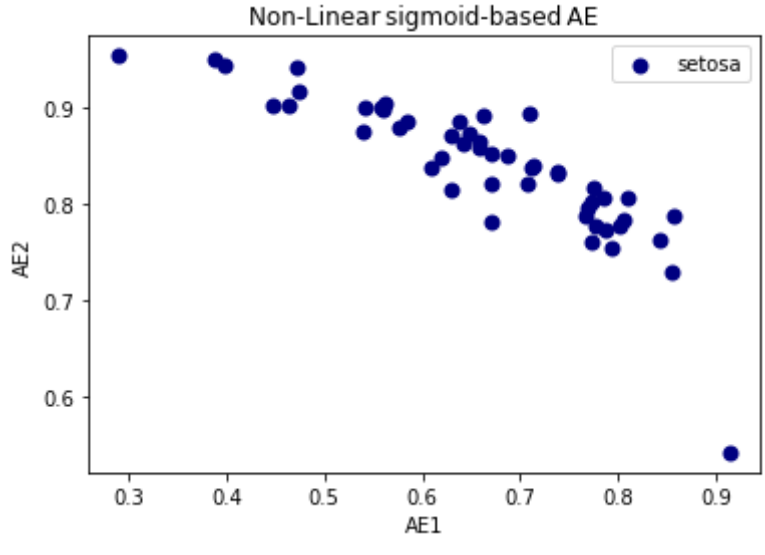

PCA
virginica
0.4
0.2
0.0
−0.2
PC2
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
PC1

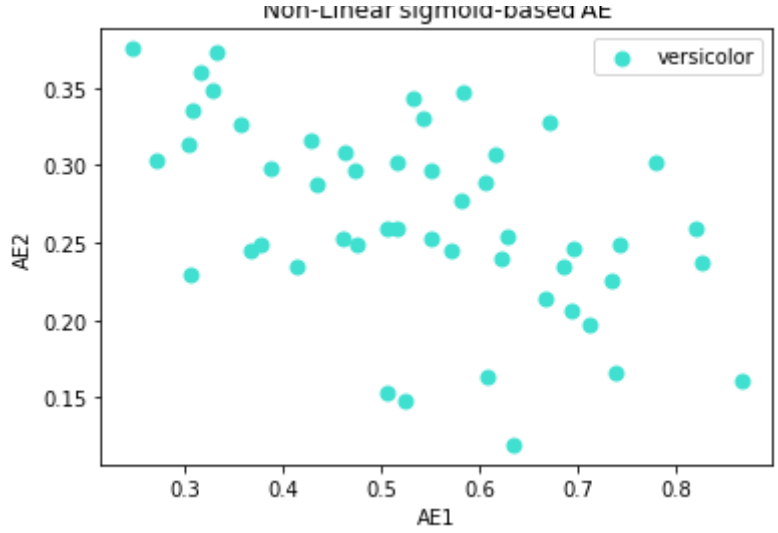

Linear AE
0.10
0.05
setosa

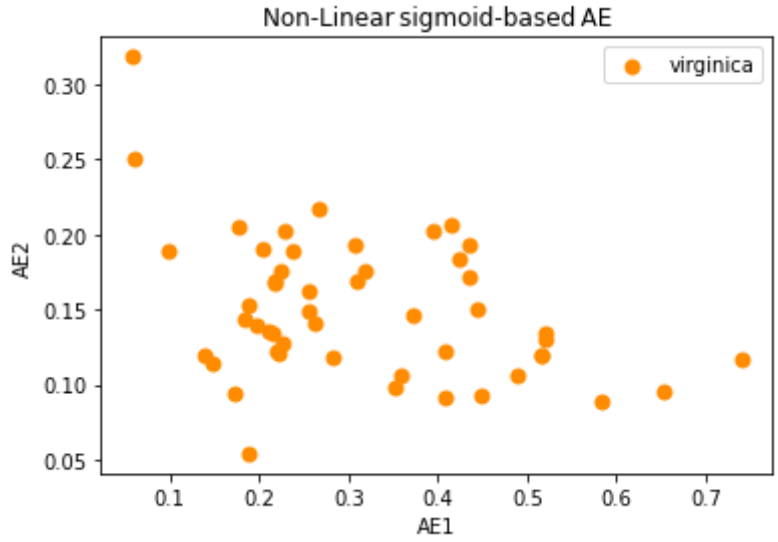

AE2
AE1

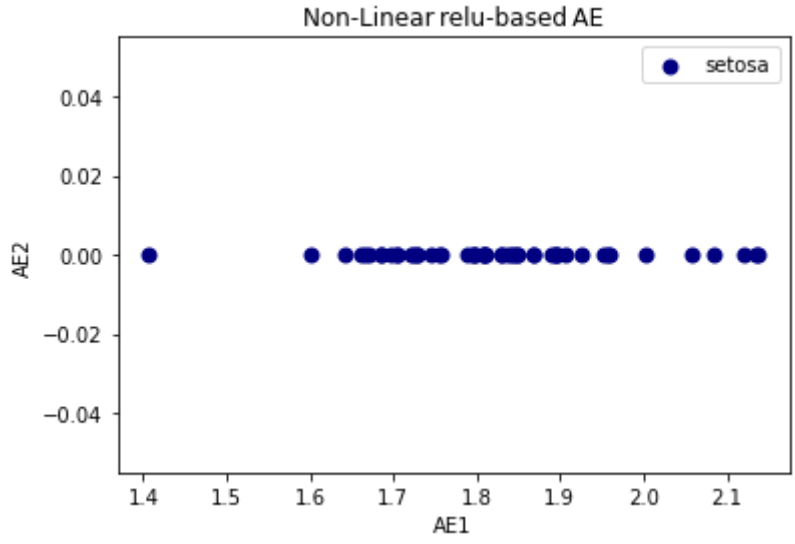

Linear AE
versicolor
AE2
AE1


Linear AE
virginica
AE2
AE1

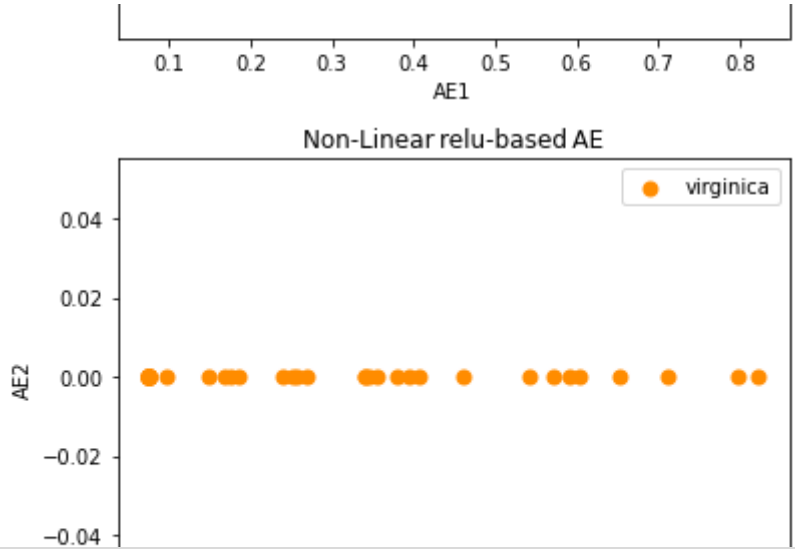

Non-Linear sigmoid-based AE
setosa
AE2
AE1


Non-Linear sigmoid-based AE
versicolor
AE2
AE1
0.35
0.30
0.25
0.20
0.15
0.3
0.4
0.5
0.6
0.7
0.8


Non-Linear sigmoid-based AE
virginica
AE2
AE1
0.30
0.25
0.20
0.15
0.10
0.05
0.1
0.2
0.3
0.4
0.5
0.6
0.7


Non-Linear relu-based AE
setosa
AE2
AE1
0.04
0.02
0.00
−0.02
−0.04
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1


AE2
0.04
0.02
0.00
−0.02
−0.04


0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
AE1
Non-Linear relu-based AE
virginica
0.04
0.02
0.00
−0.02
−0.04
AE2