Import the libraries

In [1]:
```
#importing the libraries
import tensorflow as tf
from tensorflow import keras
import numpy as np
import pandas as pd
```

```
WARNING:tensorflow:From C:\Users\Teo Boon Kean\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\losses.py:2976: The name tf.losses.sparse_softmax_cross_entropy is deprecated. Please use tf.compat.v1.losses.sparse_softmax_cross_entropy instead.
```

Load the data and data pre-processing

In [2]:
```
#load the datasets
baseline_df = pd.read_excel('extracted_features_baseline.xlsx')
toolwear_df = pd.read_excel('extracted_features_toolwear.xlsx')
```

In [3]:
```
#concantanate the datasets
combined_df = pd.concat([baseline_df, toolwear_df], axis=0)
```

In [4]:
```
features = combined_df.values
```

In [5]:
```
print(features.shape[1])
```

```
66
```

In [8]:
```
#train test split
from sklearn.model_selection import train_test_split
X_train, X_test = train_test_split(features, test_size=0.2, random_state=50)
```

In [9]:
```
#data scalling
from sklearn.preprocessing import StandardScaler

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

Construct and train the Autoencoder

In [10]:
```
#specify the number of condensed features. This will be the number of neurons in the hidden layer
condensed_f = 10
```

In [11]:
```
#constructing the model

#input layer which number of neurons equals the number of original features
l_in = keras.Input(features.shape[1])

#hidden layer which condenses the feature into the specified number of condensed features
l_condensed = keras.layers.Dense(condensed_f)(l_in)

#output layer which is the same as the input
l_out = keras.layers.Dense(features.shape[1])(l_condensed)
```

```
WARNING:tensorflow:From C:\Users\Teo Boon Kean\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\backend.py:1398: The name tf.executing_eagerly_outside_functions is deprecated. Please use tf.compat.v1.executing_eagerly_outside_functions instead.
```

In [12]:
```
#defining the autoencode
autoencoder = keras.Model(l_in, l_out)
```

In [13]:
```
autoencoder.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 66)]              0

 dense (Dense)               (None, 10)                670

 dense_1 (Dense)             (None, 66)                726

=================================================================
Total params: 1396 (5.45 KB)
Trainable params: 1396 (5.45 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [14]:
```
#compile the model
autoencoder.compile(optimizer='adam', loss='mse')
#train the model
autoencoder.fit(X_train, X_train, epochs = 50, batch_size = 8, validation_split = 0.1)
```

```
WARNING:tensorflow:From C:\Users\Teo Boon Kean\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\optimizers\__init__.py:309: The name tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

Epoch 1/50
WARNING:tensorflow:From C:\Users\Teo Boon Kean\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue is deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.

76/76 [==============================] - 1s 5ms/step - loss: 1.0560 - val_loss: 0.7014
Epoch 2/50
76/76 [==============================] - 0s 2ms/step - loss: 0.6715 - val_loss: 0.4666
Epoch 3/50
76/76 [==============================] - 0s 2ms/step - loss: 0.4783 - val_loss: 0.3769
Epoch 4/50
76/76 [==============================] - 0s 2ms/step - loss: 0.3933 - val_loss: 0.3327
Epoch 5/50
76/76 [==============================] - 0s 2ms/step - loss: 0.3482 - val_loss: 0.3010
Epoch 6/50
76/76 [==============================] - 0s 2ms/step - loss: 0.3174 - val_loss: 0.2754
Epoch 7/50
76/76 [==============================] - 0s 2ms/step - loss: 0.2925 - val_loss: 0.2522
Epoch 8/50
76/76 [==============================] - 0s 3ms/step - loss: 0.2703 - val_loss: 0.2314
Epoch 9/50
76/76 [==============================] - 0s 2ms/step - loss: 0.2501 - val_loss: 0.2126
Epoch 10/50
76/76 [==============================] - 0s 2ms/step - loss: 0.2324 - val_loss: 0.1981
Epoch 11/50
76/76 [==============================] - 0s 2ms/step - loss: 0.2176 - val_loss: 0.1864
Epoch 12/50
76/76 [==============================] - 0s 2ms/step - loss: 0.2057 - val_loss: 0.1773
Epoch 13/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1962 - val_loss: 0.1705
Epoch 14/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1880 - val_loss: 0.1645
Epoch 15/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1809 - val_loss: 0.1596
Epoch 16/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1751 - val_loss: 0.1550
Epoch 17/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1700 - val_loss: 0.1513
Epoch 18/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1656 - val_loss: 0.1490
Epoch 19/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1617 - val_loss: 0.1461
Epoch 20/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1581 - val_loss: 0.1440
Epoch 21/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1558 - val_loss: 0.1427
Epoch 22/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1532 - val_loss: 0.1414
Epoch 23/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1511 - val_loss: 0.1406
Epoch 24/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1498 - val_loss: 0.1403
Epoch 25/50
76/76 [==============================] - 0s 3ms/step - loss: 0.1483 - val_loss: 0.1397
Epoch 26/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1475 - val_loss: 0.1387
Epoch 27/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1469 - val_loss: 0.1385
Epoch 28/50
```

```
76/76 [==============================] - 0s 2ms/step - loss: 0.1462 - val_loss: 0.1389
Epoch 29/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1455 - val_loss: 0.1381
Epoch 30/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1452 - val_loss: 0.1385
Epoch 31/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1448 - val_loss: 0.1379
Epoch 32/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1444 - val_loss: 0.1377
Epoch 33/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1442 - val_loss: 0.1374
Epoch 34/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1441 - val_loss: 0.1377
Epoch 35/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1437 - val_loss: 0.1371
Epoch 36/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1437 - val_loss: 0.1371
Epoch 37/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1435 - val_loss: 0.1374
Epoch 38/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1433 - val_loss: 0.1372
Epoch 39/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1433 - val_loss: 0.1376
Epoch 40/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1432 - val_loss: 0.1369
Epoch 41/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1433 - val_loss: 0.1365
Epoch 42/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1429 - val_loss: 0.1361
Epoch 43/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1429 - val_loss: 0.1362
Epoch 44/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1431 - val_loss: 0.1366
Epoch 45/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1427 - val_loss: 0.1363
Epoch 46/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1428 - val_loss: 0.1367
Epoch 47/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1427 - val_loss: 0.1364
Epoch 48/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1428 - val_loss: 0.1370
Epoch 49/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1426 - val_loss: 0.1361
Epoch 50/50
76/76 [==============================] - 0s 2ms/step - loss: 0.1427 - val_loss: 0.1362
```

Out[14]: <keras.src.callbacks.History at 0x1fe3afee110>

Evaluate Autoencoder with training dataset

In [15]:
```
from sklearn.metrics import mean_absolute_error

#Predict with the model and record the MSE between the output and input features
pred = autoencoder.predict(X_test)
print(mean_absolute_error(X_test,pred))
```

```
6/6 [==============================] - 0s 2ms/step
0.2751215868966251
```