1.) Preprocess your data into scaled input variables and an output variable

In [24]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import datetime
from sklearn.neural_network import MLPRegressor
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import GridSearchCV, KFold, cross_val_sco
from sklearn.metrics import mean_squared_error
```

In [15]:
```
df = pd.read_csv("CLV.csv")
df
```

Out[15]:

	Unnamed: 0	Customer Lifetime Value	Income	Number of Policies	Total Claim Amount	Months Since Last Claim	Vehicle Size_Large	Size
0	0	2763.519279	56274	1	384.811147	32	0	
1	1	6979.535903	0	8	1131.464935	13	0	
2	2	12887.431650	48767	2	566.472247	18	0	
3	3	7645.861827	0	7	529.881344	18	0	
4	4	2813.692575	43836	1	138.130879	12	0	
...	...	...	...	...	...	...	...	
9129	9129	23405.987980	71941	2	198.234764	18	0	
9130	9130	3096.511217	21604	1	379.200000	14	0	
9131	9131	8163.890428	0	2	790.784983	9	0	

In [16]:
```
df.columns
```

Out[16]:
```
Index(['Unnamed: 0', 'Customer Lifetime Value', 'Income', 'Number of Poli
cies',
       'Total Claim Amount', 'Months Since Last Claim', 'Vehicle Size_Lar
ge',
       'Vehicle Size_Medsize', 'Gender_M', 'EmploymentStatus_Employed',
       'EmploymentStatus_Medical Leave', 'EmploymentStatus_Retired',
       'EmploymentStatus_Unemployed', 'Policy Type_Corporate Auto',
       'Policy Type_Personal Auto', 'Marital Status_Divorced',
       'Marital Status_Married', 'Marital Status_Single'],
      dtype='object')
```

In [17]:
```
X = df.drop(['Unnamed: 0','Customer Lifetime Value'], axis = 1)
y = df['Customer Lifetime Value']
```

In [18]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size =
```

In [20]:
```
x_train, x_test, y_train, y_test= train_test_split(X,y, test_size=.25,
```

In [21]:
```
from sklearn.preprocessing import StandardScaler
Standard= StandardScaler()
```

In [30]:
```
x_test = Standard.fit_transform(x_test)
```

In [31]:
```
x_train = Standard.fit_transform(x_train)
```

2.) Run a GridSearch CV on at least 10 possible combinations of hyper parameters

In [15]:
```
from sklearn.neural_network import MLPRegressor
from sklearn.metrics import mean_squared_error, r2_score
```

In [26]:
```
clf = MLPRegressor()

params = {'hidden_layer_sizes': [(10,),(5,20,), (10,50,), (10,100,10),
                                 (50,100,25,5,)],
          'activation': ['relu', 'tanh', 'logistic'],
          'alpha': [0.0001, 0.001, 0.01]}
```

3.) Train a model with the optimal solution from GridSearch

In [32]:
```
grid = GridSearchCV(clf, params, cv=5, scoring='neg_root_mean_squared_
grid.fit(x_train,y_train)
```

```
  warnings.warn(
C:\Users\parzu\anaconda3\lib\site-packages\sklearn\neural_network\_mul
tilayer_perceptron.py:692: ConvergenceWarning: Stochastic Optimizer: M
aximum iterations (200) reached and the optimization hasn't converged
yet.
  warnings.warn(
C:\Users\parzu\anaconda3\lib\site-packages\sklearn\neural_network\_mul
tilayer_perceptron.py:692: ConvergenceWarning: Stochastic Optimizer: M
aximum iterations (200) reached and the optimization hasn't converged
yet.
  warnings.warn(
C:\Users\parzu\anaconda3\lib\site-packages\sklearn\neural_network\_mul
tilayer_perceptron.py:692: ConvergenceWarning: Stochastic Optimizer: M
aximum iterations (200) reached and the optimization hasn't converged
yet.
  warnings.warn(
C:\Users\parzu\anaconda3\lib\site-packages\sklearn\neural_network\_mul
tilayer_perceptron.py:692: ConvergenceWarning: Stochastic Optimizer: M
aximum iterations (200) reached and the optimization hasn't converged
```

In [34]:
```
print('Best parameters:', grid.best_params_)
print('Best score:', grid.best_score_)
```

```
Best parameters: {'activation': 'relu', 'alpha': 0.01, 'hidden_layer_size
s': (50, 100, 25, 5)}
Best score: -5844.840894707309
```

In [35]:
```
print('best score:', grid.best_score_)
```

```
best score: -5844.840894707309
```

4.) What are the in-sample and out of sample MSEs

In [38]:
```
MLPRegressor2 = MLPRegressor(hidden_layer_sizes=(50, 100, 25, 5), acti
```

In [39]:
```
MLPRegressor2.fit(x_train, y_train)
```

```
C:\Users\parzu\anaconda3\lib\site-packages\sklearn\neural_network\_multil
ayer_perceptron.py:692: ConvergenceWarning: Stochastic Optimizer: Maximum
iterations (200) reached and the optimization hasn't converged yet.
  warnings.warn(
```

Out[39]:
```
MLPRegressor(hidden_layer_sizes=(50, 100, 25, 5))
```

In [43]:
```
y_pred = MLPRegressor2.predict(x_test)
out_mse = mean_squared_error(y_test, y_pred)
out_mse
```

Out[43]:
```
41598673.651320234
```

5.) Build a Keras with the architecture defined by GridSearchCV

In [45]:
```
pip install keras
```

```
Collecting keras
  Downloading keras-2.11.0-py2.py3-none-any.whl (1.7 MB)
Installing collected packages: keras
Successfully installed keras-2.11.0
Note: you may need to restart the kernel to use updated packages.
```

In [48]:
```
1 pip install tensorflow
```

```
Collecting tensorflow
  Downloading tensorflow-2.11.0-cp39-cp39-win_amd64.whl (1.9 kB)
Collecting tensorflow-intel==2.11.0
  Downloading tensorflow_intel-2.11.0-cp39-cp39-win_amd64.whl (266.3 MB)
Collecting tensorboard<2.12,>=2.11
  Downloading tensorboard-2.11.2-py3-none-any.whl (6.0 MB)
Collecting absl-py>=1.0.0
  Downloading absl_py-1.4.0-py3-none-any.whl (126 kB)
Requirement already satisfied: protobuf<3.20,>=3.9.2 in c:\users\parzu\an
aconda3\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow) (3.
19.1)
Collecting opt-einsum>=2.3.2
  Downloading opt_einsum-3.3.0-py3-none-any.whl (65 kB)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\parzu\anac
onda3\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow) (1.4
2.0)
Requirement already satisfied: keras<2.12,>=2.11.0 in c:\users\parzu\anac
onda3\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow) (2.1
1.0)
Requirement already satisfied: h5py>=2.9.0 in c:\users\parzu\anaconda3\li
b\site-packages (from tensorflow-intel==2.11.0->tensorflow) (3.6.0)
Collecting google-pasta>=0.1.1
  Downloading google_pasta-0.2.0-py3-none-any.whl (57 kB)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\parzu
\anaconda3\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow)
(4.1.1)
Collecting libclang>=13.0.0
  Downloading libclang-15.0.6.1-py2.py3-none-win_amd64.whl (23.2 MB)
Note: you may need to restart the kernel to use updated packages.
Requirement already satisfied: six>=1.12.0 in c:\users\parzu\anaconda3\li
b\site-packages (from tensorflow-intel==2.11.0->tensorflow) (1.16.0)
Collecting tensorflow-estimator<2.12,>=2.11.0
  Downloading tensorflow_estimator-2.11.0-py2.py3-none-any.whl (439 kB)
Collecting flatbuffers>=2.0
  Downloading flatbuffers-23.1.21-py2.py3-none-any.whl (26 kB)
Collecting gast<=0.4.0,>=0.2.1
  Downloading gast-0.4.0-py3-none-any.whl (9.8 kB)
Collecting termcolor>=1.1.0
  Downloading termcolor-2.2.0-py3-none-any.whl (6.6 kB)
Collecting tensorflow-io-gcs-filesystem>=0.23.1
  Downloading tensorflow_io_gcs_filesystem-0.30.0-cp39-cp39-win_amd64.whl
(1.5 MB)
Requirement already satisfied: packaging in c:\users\parzu\anaconda3\lib
\site-packages (from tensorflow-intel==2.11.0->tensorflow) (21.3)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\parzu\anaconda3
\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow) (1.12.1)
Collecting astunparse>=1.6.0
  Downloading astunparse-1.6.3-py2.py3-none-any.whl (12 kB)
Requirement already satisfied: numpy>=1.20 in c:\users\parzu\anaconda3\li
b\site-packages (from tensorflow-intel==2.11.0->tensorflow) (1.21.5)
Requirement already satisfied: setuptools in c:\users\parzu\anaconda3\lib
\site-packages (from tensorflow-intel==2.11.0->tensorflow) (61.2.0)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\parzu\anaco
nda3\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.11.0-
>tensorflow) (0.37.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\parzu\an
aconda3\lib\site-packages (from tensorboard<2.12,>=2.11->tensorflow-intel
```

```
==2.11.0->tensorflow) (1.33.0)
Collecting google-auth-oauthlib<0.5,>=0.4.1
  Downloading google_auth_oauthlib-0.4.6-py2.py3-none-any.whl (18 kB)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\parzu\anac
onda3\lib\site-packages (from tensorboard<2.12,>=2.11->tensorflow-intel==
2.11.0->tensorflow) (2.27.1)
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\parzu\anaconda
3\lib\site-packages (from tensorboard<2.12,>=2.11->tensorflow-intel==2.1
1.0->tensorflow) (2.0.3)
Requirement already satisfied: markdown>=2.6.8 in c:\users\parzu\anaconda
3\lib\site-packages (from tensorboard<2.12,>=2.11->tensorflow-intel==2.1
1.0->tensorflow) (3.3.4)
Collecting tensorboard-plugin-wit>=1.6.0
  Downloading tensorboard_plugin_wit-1.8.1-py3-none-any.whl (781 kB)
Collecting tensorboard-data-server<0.7.0,>=0.6.0
  Downloading tensorboard_data_server-0.6.1-py3-none-any.whl (2.4 kB)
Requirement already satisfied: cachetools<5.0,>=2.0.0 in c:\users\parzu\a
naconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.12,
>=2.11->tensorflow-intel==2.11.0->tensorflow) (4.2.2)
Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\parzu\an
aconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.12,>
=2.11->tensorflow-intel==2.11.0->tensorflow) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\parzu\anaconda3
\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->
tensorflow-intel==2.11.0->tensorflow) (4.7.2)
Collecting requests-oauthlib>=0.7.0
  Downloading requests_oauthlib-1.3.1-py2.py3-none-any.whl (23 kB)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in c:\users\parzu\ana
conda3\lib\site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.
6.3->tensorboard<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow) (0.4.
8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\parzu\an
aconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=
2.11->tensorflow-intel==2.11.0->tensorflow) (1.26.9)
Requirement already satisfied: idna<4,>=2.5 in c:\users\parzu\anaconda3\l
ib\site-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=2.11->tens
orflow-intel==2.11.0->tensorflow) (3.3)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\parz
u\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.1
2,>=2.11->tensorflow-intel==2.11.0->tensorflow) (2.0.4)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\parzu\anaco
nda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=2.11
->tensorflow-intel==2.11.0->tensorflow) (2021.10.8)
Collecting oauthlib>=3.0.0
  Downloading oauthlib-3.2.2-py3-none-any.whl (151 kB)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in c:\users\parzu
\anaconda3\lib\site-packages (from packaging->tensorflow-intel==2.11.0->t
ensorflow) (3.0.4)
Installing collected packages: oauthlib, requests-oauthlib, tensorboard-p
lugin-wit, tensorboard-data-server, google-auth-oauthlib, absl-py, termco
lor, tensorflow-io-gcs-filesystem, tensorflow-estimator, tensorboard, opt
-einsum, libclang, google-pasta, gast, flatbuffers, astunparse, tensorflo
w-intel, tensorflow
Successfully installed absl-py-1.4.0 astunparse-1.6.3 flatbuffers-23.1.21
gast-0.4.0 google-auth-oauthlib-0.4.6 google-pasta-0.2.0 libclang-15.0.6.
1 oauthlib-3.2.2 opt-einsum-3.3.0 requests-oauthlib-1.3.1 tensorboard-2.1
1.2 tensorboard-data-server-0.6.1 tensorboard-plugin-wit-1.8.1 tensorflow
```

```
-2.11.0 tensorflow-estimator-2.11.0 tensorflow-intel-2.11.0 tensorflow-io
-gcs-filesystem-0.30.0 termcolor-2.2.0
```

In [49]:
```
import keras.models
from keras.optimizers import Adam
from keras.models import Sequential
from keras.layers import Dense
```

In [51]:
```
model = Sequential()


model.add(Dense(12, input_dim=X_train.shape[1], activation='relu'))
model.add(Dense(12, activation='relu'))
model.add(Dense(12, activation='softmax'))
```

In [53]:
```
model.compile(loss='mse', optimizer=Adam(lr=0.01))
model.fit(x_train, y_train, batch_size=32, epochs=100)
```

```
Epoch 62/100
215/215 [==============================] - 1s 2ms/step - loss: 1113396
48.0000
Epoch 63/100
215/215 [==============================] - 0s 2ms/step - loss: 1113395
92.0000
Epoch 64/100
215/215 [==============================] - 0s 2ms/step - loss: 1113395
92.0000
Epoch 65/100
215/215 [==============================] - 0s 1ms/step - loss: 1113396
48.0000
Epoch 66/100
215/215 [==============================] - 0s 1ms/step - loss: 1113396
88.0000
Epoch 67/100
215/215 [==============================] - 0s 2ms/step - loss: 1113396
16.0000
Epoch 68/100
215/215 [==============================] - 0s 1ms/step - loss: 1113396
```

6.) Make two visualizations of your NN using “plot_model” and “ann_viz”

In [ ]:
```

```

In [ ]:
```

```

In [ ]:
```

```

In [ ]:

```
1
```