

```
In [1]: # Import our dependencies
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, OneHotEncoder, MinMaxScaler
import pandas as pd
import tensorflow as tf
import numpy as np

# Import our input dataset
df = pd.read_csv('../neural-network/pitcher_salaries_cleaned.csv')
df.head()
```

```
Out[1]:
```

	Year	Full Name	Age	Salary	ERA	Hits	Earned Runs	Strike Outs	Home Runs	Wins	Losses	Outs Pitched	Batters Faced by Pitcher	Games Finished	Weight	I
0	1990	AbbottJim	23	185000	4.51	246	106	105	16	10	14	635	925	0	200	
1	1990	AbbottPaul	23	100000	5.97	37	23	25	0	0	5	104	162	0	185	
2	1990	AldredScott	22	100000	3.77	13	6	7	0	1	2	43	63	0	195	
3	1990	AndersonAllan	26	300000	4.53	214	95	82	20	7	18	566	797	0	178	
4	1990	AppierKevin	23	100000	2.76	179	57	127	13	12	8	557	784	1	180	

```
In [2]: # create log transformed column for salary
df['sal-log'] = np.log10(df['Salary'])
df
```

```
Out[2]:
```

	Year	Full Name	Age	Salary	ERA	Hits	Earned Runs	Strike Outs	Home Runs	Wins	Losses	Outs Pitched	Batters Faced by Pitcher	Games Finished
0	1990	AbbottJim	23	185000	4.51	246	106	105	16	10	14	635	925	0
1	1990	AbbottPaul	23	100000	5.97	37	23	25	0	0	5	104	162	0
2	1990	AldredScott	22	100000	3.77	13	6	7	0	1	2	43	63	0
3	1990	AndersonAllan	26	300000	4.53	214	95	82	20	7	18	566	797	0
4	1990	AppierKevin	23	100000	2.76	179	57	127	13	12	8	557	784	1
...
4932	2016	WorleyVance	29	2600000	3.53	84	34	56	11	2	2	260	365	13
4933	2016	WrightMike	26	510500	5.79	81	48	50	12	3	4	224	328	5
4934	2016	WrightSteven	32	514500	3.33	138	58	127	12	13	6	470	656	0
4935	2016	YoungChris	37	4250000	6.19	104	61	94	28	3	9	266	406	7
4936	2016	ZimmermannJordan	30	18000000	4.87	118	57	66	14	9	7	316	450	1

4937 rows × 16 columns

Reduce down to top features

```
In [3]: df = df.drop(["Full Name", "Team", "League", "Age", "Earned Runs", "Home Runs", "Wins", "Losses", "Weight", "Height"])
df.head()
```

version of pandas all arguments of DataFrame.drop except for the argument 'labels' will be keyword-only
"""Entry point for launching an IPython kernel.

```
Out[3]:
```

	ERA	Hits	Strike Outs	Outs Pitched	Batters Faced by Pitcher	Games Finished	Games Started	sal-log
0	4.51	246	105	635	925	0	33	5.267172
1	5.97	37	25	104	162	0	7	5.000000
2	3.77	13	7	43	63	0	3	5.000000
3	4.53	214	82	566	797	0	31	5.477121
4	2.76	179	127	557	784	1	24	5.000000

Split Features/Target & Training/Testing Sets

Split into features and target

- **y variable:** Our target variable, Salary
- **X variable:** Our features; just drop Salary and Full Name

```
In [4]: # Split our preprocessed data into our features and target arrays
y = df["sal-log"].values
X = df.drop(["sal-log"],1).values

# Split the preprocessed data into a training and testing dataset
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=1)
```

C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\ipykernel_launcher.py:3: FutureWarning: In a future version of pandas all arguments of DataFrame.drop except for the argument 'labels' will be keyword-only
This is separate from the ipykernel package so we can avoid doing imports until

Build and Instantiate StandardScaler object, then standardize numerical features

```
In [5]: # Create a StandardScaler instance
scaler = MinMaxScaler()

# Fit the StandardScaler
X_scaler = scaler.fit(X_train)

# Scale the data
X_train_scaled = X_scaler.transform(X_train)
X_test_scaled = X_scaler.transform(X_test)
```

```
In [ ]: # see if data scaled properly
scaled_data=pd.DataFrame(X_train_scaled)
scaled_data.head()
```

```
In [ ]: # see if data scaled properly
scaled_y=pd.DataFrame(y_train_scaled)
scaled_y.head()
```

Build Neural Net Framework

```
In [27]: # Define the model - deep neural net
number_input_features = len(X_train[0])
```

```

hidden_nodes_layer1 = 100
hidden_nodes_layer2 = 70
hidden_nodes_layer3 = 50

nn = tf.keras.models.Sequential()

# First hidden layer
nn.add(
    tf.keras.layers.Dense(units=hidden_nodes_layer1, input_dim=number_input_features, activation="softmax")
)

# Second hidden layer
nn.add(tf.keras.layers.Dense(units=hidden_nodes_layer2, activation="relu"))

# Third hidden layer
nn.add(tf.keras.layers.Dense(units=hidden_nodes_layer2, activation="relu"))

# Fourth hidden layer
nn.add(tf.keras.layers.Dense(units=hidden_nodes_layer2, activation="relu"))

# Output Layer
nn.add(tf.keras.layers.Dense(units=10, activation="softmax"))

# Check the structure of the model
nn.summary()

```

Model: "sequential_4"

Layer (type)	Output Shape	Param #
dense_20 (Dense)	(None, 100)	800
dense_21 (Dense)	(None, 70)	7070
dense_22 (Dense)	(None, 70)	4970
dense_23 (Dense)	(None, 70)	4970
dense_24 (Dense)	(None, 10)	710
Total params: 18,520		
Trainable params: 18,520		
Non-trainable params: 0		

Compile the Model

```

In [28]: # Compile the model
nn.compile(loss="mean_squared_error", optimizer="adam", metrics=["accuracy"])

```

Train the model

```

In [29]: # Train the model
fit_model = nn.fit(X_train,y_train,epochs=500)

Epoch 1/500
116/116 [=====] - 1s 3ms/step - loss: 35.8782 - accuracy: 0.0011
Epoch 2/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 3/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 4/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 5/500

```

116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0014
Epoch 6/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0014
Epoch 7/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 5.4025e-04
Epoch 8/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0014
Epoch 9/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 10/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0011
Epoch 11/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 12/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 13/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 14/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 15/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 16/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 17/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0014
Epoch 18/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0024
Epoch 19/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 20/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 21/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 22/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 23/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 24/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 25/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 26/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 27/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0024
Epoch 28/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 29/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 30/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0011
Epoch 31/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 32/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 33/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 34/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 35/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 36/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 37/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 38/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 39/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 40/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 41/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 42/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 43/500

[illegible]

116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 82/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 83/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 84/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 85/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 86/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 87/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 88/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 89/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 90/500
116/116 [=====] - 0s 3ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 91/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 92/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 93/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 94/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 95/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 96/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 97/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 98/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 99/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 100/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 101/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 102/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 103/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 104/500
116/116 [=====] - 0s 3ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 105/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 106/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 107/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 108/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 109/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 110/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0057
Epoch 111/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 112/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 113/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 114/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 115/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 116/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 117/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 118/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 119/500

[illegible]

[illegible]

116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0041
Epoch 196/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0041
Epoch 197/500									
116/116 [=====]	-	0s	2ms/step	-	loss:	35.8782	-	accuracy:	0.0051
Epoch 198/500									
116/116 [=====]	-	0s	2ms/step	-	loss:	35.8782	-	accuracy:	0.0046
Epoch 199/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0038
Epoch 200/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0043
Epoch 201/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0035
Epoch 202/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0032
Epoch 203/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0032
Epoch 204/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0041
Epoch 205/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0046
Epoch 206/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0035
Epoch 207/500									
116/116 [=====]	-	0s	2ms/step	-	loss:	35.8782	-	accuracy:	0.0043
Epoch 208/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0051
Epoch 209/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0024
Epoch 210/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0049
Epoch 211/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0038
Epoch 212/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0057
Epoch 213/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0054
Epoch 214/500									
116/116 [=====]	-	0s	2ms/step	-	loss:	35.8782	-	accuracy:	0.0041
Epoch 215/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0046
Epoch 216/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0054
Epoch 217/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0022
Epoch 218/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0043
Epoch 219/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0049
Epoch 220/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0062
Epoch 221/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0059
Epoch 222/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0051
Epoch 223/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0038
Epoch 224/500									
116/116 [=====]	-	0s	1ms/step	-	loss:	35.8782	-	accuracy:	0.0051
Epoch 22									

[illegible]

116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 272/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 273/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 274/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 275/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 276/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 277/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 278/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 279/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 280/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 281/500
116/116 [=====] - 0s 3ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 282/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 283/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 284/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 285/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 286/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 287/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 288/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0057
Epoch 289/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 290/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 291/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 292/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 293/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 294/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 295/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 296/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 297/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 298/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 299/500
116/116 [=====] - 0s 991us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 300/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 301/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 302/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 303/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 304/500
116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 305/500
116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0035
Epoch 306/500
116/116 [=====] - 0s 991us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 307/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0024
Epoch 308/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0051
Epoch 309/500

116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 310/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 311/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 312/500
116/116 [=====] - 0s 991us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 313/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 314/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 315/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 316/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 317/500
116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0059
Epoch 318/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 319/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 320/500
116/116 [=====] - 0s 922us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 321/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 322/500
116/116 [=====] - 0s 959us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 323/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0016
Epoch 324/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0022
Epoch 325/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 326/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 327/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 328/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0051
Epoch 329/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 330/500
116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 331/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 332/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 333/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 334/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 335/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 336/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 337/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 338/500
116/116 [=====] - 0s 1000us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 339/500
116/116 [=====] - 0s 991us/step - loss: 35.8782 - accuracy: 0.0030
Epoch 340/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 341/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 342/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 343/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0024
Epoch 344/500
116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0068
Epoch 345/500
116/116 [=====] - 0s 922us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 346/500
116/116 [=====] - 0s 1000us/step - loss: 35.8782 - accuracy: 0.0054
Epoch 347/500

116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0035
Epoch 348/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 349/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 350/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 351/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 352/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 353/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 354/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 355/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 356/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 357/500
116/116 [=====] - 0s 835us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 358/500
116/116 [=====] - 0s 870us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 359/500
116/116 [=====] - 0s 887us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 360/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 361/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0059
Epoch 362/500
116/116 [=====] - 0s 930us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 363/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0035
Epoch 364/500
116/116 [=====] - 0s 930us/step - loss: 35.8782 - accuracy: 0.0030
Epoch 365/500
116/116 [=====] - 0s 922us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 366/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 367/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 368/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0022
Epoch 369/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 370/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 371/500
116/116 [=====] - 0s 861us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 372/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 373/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 374/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 375/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 376/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0057
Epoch 377/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 378/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 379/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0030
Epoch 380/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 381/500
116/116 [=====] - 0s 991us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 382/500
116/116 [=====] - 0s 843us/step - loss: 35.8782 - accuracy: 0.0049
Epoch 383/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 384/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 385/500

116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 386/500
116/116 [=====] - 0s 939us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 387/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 388/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 389/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 390/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0059
Epoch 391/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 392/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 393/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 394/500
116/116 [=====] - 0s 887us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 395/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0057
Epoch 396/500
116/116 [=====] - 0s 904us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 397/500
116/116 [=====] - 0s 870us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 398/500
116/116 [=====] - 0s 931us/step - loss: 35.8782 - accuracy: 0.0035
Epoch 399/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 400/500
116/116 [=====] - 0s 939us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 401/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 402/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 403/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 404/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 405/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 406/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 407/500
116/116 [=====] - 0s 930us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 408/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 409/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 410/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 411/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 412/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0057
Epoch 413/500
116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 414/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0062
Epoch 415/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 416/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 417/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 418/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 419/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 420/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 421/500
116/116 [=====] - 0s 852us/step - loss: 35.8782 - accuracy: 0.0054
Epoch 422/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 423/500

116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0022
Epoch 424/500
116/116 [=====] - 0s 896us/step - loss: 35.8782 - accuracy: 0.0035
Epoch 425/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0022
Epoch 426/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 427/500
116/116 [=====] - 0s 852us/step - loss: 35.8782 - accuracy: 0.0022
Epoch 428/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 429/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 430/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 431/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 432/500
116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 433/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 434/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 435/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 436/500
116/116 [=====] - 0s 922us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 437/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 438/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 439/500
116/116 [=====] - 0s 904us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 440/500
116/116 [=====] - 0s 939us/step - loss: 35.8782 - accuracy: 0.0049
Epoch 441/500
116/116 [=====] - 0s 957us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 442/500
116/116 [=====] - 0s 896us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 443/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 444/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 445/500
116/116 [=====] - 0s 896us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 446/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0024
Epoch 447/500
116/116 [=====] - 0s 922us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 448/500
116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 449/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 450/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 451/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 452/500
116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 453/500
116/116 [=====] - 0s 956us/step - loss: 35.8782 - accuracy: 0.0030
Epoch 454/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 455/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0049
Epoch 456/500
116/116 [=====] - 0s 861us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 457/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 458/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 459/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0019
Epoch 460/500
116/116 [=====] - 0s 861us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 461/500

116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0046
Epoch 462/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0043
Epoch 463/500
116/116 [=====] - 0s 930us/step - loss: 35.8782 - accuracy: 0.0027
Epoch 464/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 465/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 466/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 467/500
116/116 [=====] - 0s 948us/step - loss: 35.8782 - accuracy: 0.0051
Epoch 468/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 469/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0038
Epoch 470/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 471/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 472/500
116/116 [=====] - 0s 904us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 473/500
116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 474/500
116/116 [=====] - 0s 896us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 475/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 476/500
116/116 [=====] - 0s 983us/step - loss: 35.8782 - accuracy: 0.0043
Epoch 477/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 478/500
116/116 [=====] - 0s 826us/step - loss: 35.8782 - accuracy: 0.0024
Epoch 479/500
116/116 [=====] - 0s 896us/step - loss: 35.8782 - accuracy: 0.0038
Epoch 480/500
116/116 [=====] - 0s 852us/step - loss: 35.8782 - accuracy: 0.0051
Epoch 481/500
116/116 [=====] - 0s 861us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 482/500
116/116 [=====] - 0s 930us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 483/500
116/116 [=====] - 0s 939us/step - loss: 35.8782 - accuracy: 0.0032
Epoch 484/500
116/116 [=====] - 0s 861us/step - loss: 35.8782 - accuracy: 0.0030
Epoch 485/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 486/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0035
Epoch 487/500
116/116 [=====] - 0s 913us/step - loss: 35.8782 - accuracy: 0.0049
Epoch 488/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0051
Epoch 489/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0046
Epoch 490/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0027
Epoch 491/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 492/500
116/116 [=====] - 0s 965us/step - loss: 35.8782 - accuracy: 0.0041
Epoch 493/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0049
Epoch 494/500
116/116 [=====] - 0s 974us/step - loss: 35.8782 - accuracy: 0.0062
Epoch 495/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0030
Epoch 496/500
116/116 [=====] - 0s 1ms/step - loss: 35.8782 - accuracy: 0.0041
Epoch 497/500
116/116 [=====] - 0s 3ms/step - loss: 35.8782 - accuracy: 0.0024
Epoch 498/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0032
Epoch 499/500


```
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0054
Epoch 500/500
116/116 [=====] - 0s 2ms/step - loss: 35.8782 - accuracy: 0.0030
```

In [30]:

```
# Evaluate the model using the test data
model_loss, model_accuracy = nn.evaluate(X_test_scaled,y_test,verbose=2)
print(f"Loss: {model_loss}, Accuracy: {model_accuracy}")
```

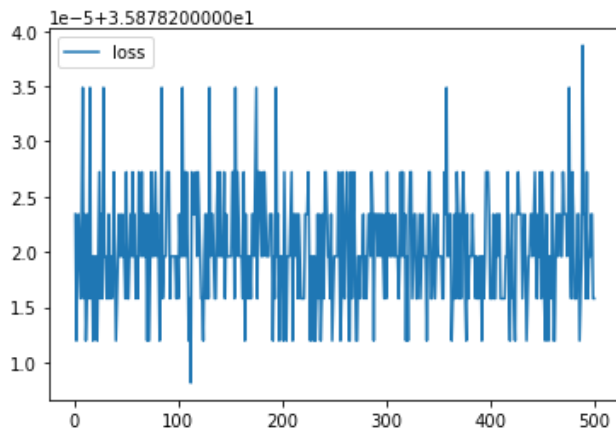
```
39/39 - 0s - loss: 35.6926 - accuracy: 0.0040 - 138ms/epoch - 4ms/step
Loss: 35.692649841308594, Accuracy: 0.004048583097755909
```

In [31]:

```
# Create a DataFrame containing training history
history_df = pd.DataFrame(fit_model.history, index=range(1,len(fit_model.history["loss"])+1))

# Plot the loss
history_df.plot(y="loss")
```

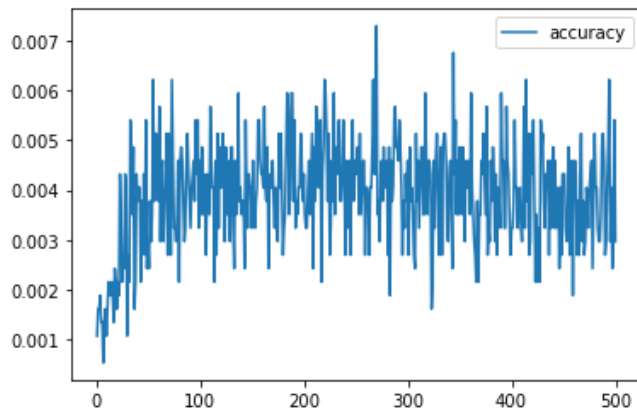
Out[31]: <AxesSubplot:>



In [32]:

```
# Plot the accuracy
history_df.plot(y="accuracy")
```

Out[32]: <AxesSubplot:>



In []: