In [6]:

```python
# 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('../pitcher_salaries_cleaned.csv')
df.head()
```

Out[6]:

	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	

Create Salary Brackets

In [10]:

```python
# look at distribution of salaries (suppressing scientific notation)
df['Salary'].describe().apply(lambda x: format(x, 'f'))
```

Out[10]:

```
count        4937.000000
mean      3011304.443387
std       4265619.190449
min        100000.000000
25%        327000.000000
50%        980000.000000
75%       4000000.000000
max      33000000.000000
Name: Salary, dtype: object
```

In [24]:

```python
# create salary brackets and labels
bins = [0, 499999, 4999999, 9999999, 34999999]
labels = ['low', 'mid', 'high', 'top']
```

In [32]:

```python
# apply salary brackets
df['Salary Bin'] = pd.cut(df['Salary'], bins=bins, labels=labels)
df
```

Out[32]:

	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

	Year	Full Name	Age	Salary	ERA	Hits	Earned Runs	Strike Outs	Home Runs	Wins	Losses	Outs Pitched	Batters Faced by Pitcher	Games Finished
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
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 × 20 columns

Encode Salary Bins column

In [39]:

```
# encode object features
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
encoded_df = df.copy()
df['Salary Bin'] = le.fit_transform(df['Salary Bin'])

df.head()
```

Out[39]:

	ERA	Hits	Earned Runs	Strike Outs	Home Runs	Wins	Losses	Outs Pitched	Batters Faced by Pitcher	Games Finished	Weight	Height	Games Started	Salary Bin
0	4.51	246	106	105	16	10	14	635	925	0	200	75	33	1
1	5.97	37	23	25	0	0	5	104	162	0	185	75	7	1
2	3.77	13	6	7	0	1	2	43	63	0	195	76	3	1
3	4.53	214	95	82	20	7	18	566	797	0	178	71	31	1
4	2.76	179	57	127	13	12	8	557	784	1	180	74	24	1

In [33]:

```
# drop unnecessary columns
df= df.drop(["Full Name","Team","League","Age","Year","Salary"],1)
df.head()
```

```
C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\ipykernel_launcher.py:1: FutureWarning: In a future
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[33]:

	ERA	Hits	Earned Runs	Strike Outs	Home Runs	Wins	Losses	Outs Pitched	Batters Faced by Pitcher	Games Finished	Weight	Height	Games Started	Salary Bin
0	4.51	246	106	105	16	10	14	635	925	0	200	75	33	low
1	5.97	37	23	25	0	0	5	104	162	0	185	75	7	low
2	3.77	13	6	7	0	1	2	43	63	0	195	76	3	low
3	4.53	214	95	82	20	7	18	566	797	0	178	71	31	low
4	2.76	179	57	127	13	12	8	557	784	1	180	74	24	low

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 [40]:

```
# Split our preprocessed data into our features and target arrays
y = df["Salary Bin"].values
X = df.drop(["Salary Bin"],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 [41]:

```
# Create a StandardScaler instance
scaler = StandardScaler()

# 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)
```

Build Neural Net Framework

HL1:

- 50 neurons
- activation fxn: `relu`

HL2:

- 40 neurons
- activation fxn: `relu`

HL3:

- 30 neurons
- activation fxn: `relu`

output layer:

- 4 neurons
    - same as number of salary bins, suggested from (https://machinelearningmastery.com/loss-and-loss-functions-for-training-deep-learning-neural-networks/)
- activation fxn: `softmax`
    - suggested for multiclass classification problems per (https://machinelearningmastery.com/loss-and-loss-functions-for-training-deep-learning-neural-networks/)

In [58]:

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

```
hidden_nodes_layer1 = 50
hidden_nodes_layer2 = 40
hidden_nodes_layer3 = 30


nn = tf.keras.models.Sequential()

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

# 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_layer3, activation="relu"))

# Output layer
nn.add(tf.keras.layers.Dense(units=4, activation="softmax"))

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

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_12 (Dense)            (None, 50)                700

 dense_13 (Dense)            (None, 40)                2040

 dense_14 (Dense)            (None, 30)                1230

 dense_15 (Dense)            (None, 4)                 124

=================================================================
Total params: 4,094
Trainable params: 4,094
Non-trainable params: 0
_________________________________________________________________
```

Compile the Model

- loss function: `CategoricalCrossentropy`
  - suggested from website (https://machinelearningmastery.com/loss-and-loss-functions-for-training-deep-learning-neural-networks/) as good for multi-class classification problems

In [59]:

```
# Compile the model
nn.compile(loss="CategoricalCrossentropy", optimizer="adam", metrics=["accuracy"])
```

Train the model

In [60]:

```
# Train the model
fit_model = nn.fit(X_train,y_train,epochs=200)
```

```
Epoch 1/200
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
~\AppData\Local\Temp/ipykernel_20400/1285725684.py in <module>
      1 # Train the model
----> 2 fit_model = nn.fit(X_train,y_train,epochs=200)

~\anaconda3\envs\mlenv\lib\site-packages\keras\utils\traceback_utils.py in error_handler(*args, **kwargs)
```

```
     65     except Exception as e:  # pylint: disable=broad-except
     66       filtered_tb = _process_traceback_frames(e.__traceback__)
---> 67       raise e.with_traceback(filtered_tb) from None
     68     finally:
     69       del filtered_tb

~\anaconda3\envs\mlenv\lib\site-packages\tensorflow\python\framework\func_graph.py in autograph_handler(*args, **kwargs)
   1145           except Exception as e:  # pylint:disable=broad-except
   1146             if hasattr(e, "ag_error_metadata"):
-> 1147               raise e.ag_error_metadata.to_exception(e)
   1148             else:
   1149               raise

ValueError: in user code:

    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\engine\training.py", line 1021, in train_function  *
        return step_function(self, iterator)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\engine\training.py", line 1010, in step_function  **
        outputs = model.distribute_strategy.run(run_step, args=(data,))
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\engine\training.py", line 1000, in run_step  **
        outputs = model.train_step(data)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\engine\training.py", line 860, in train_step
        loss = self.compute_loss(x, y, y_pred, sample_weight)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\engine\training.py", line 919, in compute_loss
        y, y_pred, sample_weight, regularization_losses=self.losses)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\engine\compile_utils.py", line 201, in __call__
        loss_value = loss_obj(y_t, y_p, sample_weight=sw)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\losses.py", line 141, in __call__
        losses = call_fn(y_true, y_pred)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\losses.py", line 245, in call  **
        return ag_fn(y_true, y_pred, **self._fn_kwargs)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\losses.py", line 1790, in categorical_crossentropy
        y_true, y_pred, from_logits=from_logits, axis=axis)
    File "C:\Users\alyss\anaconda3\envs\mlenv\lib\site-packages\keras\backend.py", line 5083, in categorical_crossentropy
        target.shape.assert_is_compatible_with(output.shape)

    ValueError: Shapes (None, 1) and (None, 4) are incompatible
```

In [56]:

```
# 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*100:.2f}%, Accuracy: {model_accuracy*100:.2f}%")
```

```
39/39 - 0s - loss: 0.0000e+00 - accuracy: 0.3887 - 32ms/epoch - 825us/step
Loss: 0.00%, Accuracy: 38.87%
```

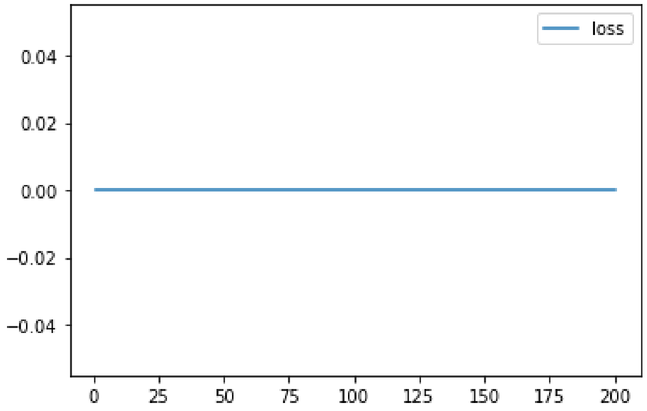
In [50]:

```
# 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[50]:

```
<AxesSubplot:>
```

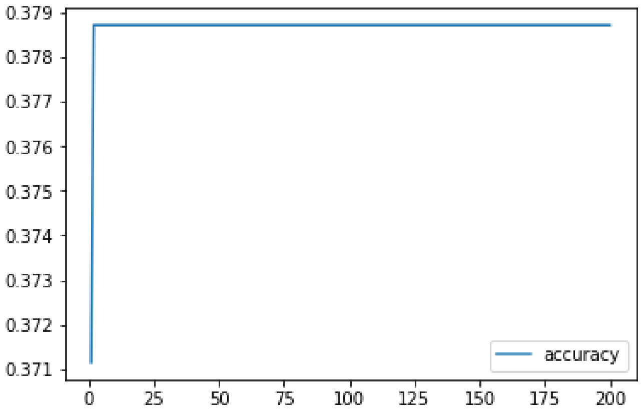


In [51]:

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

Out[51]:

```
<AxesSubplot:>
```



In [ ]: