```
0.1765 - val_loss: 0.0473 - val_mae: 0.1663
Epoch 72/75
48/48 [==============================] - 0s 876us/step - loss: 0.0538 - mae:
0.1826 - val_loss: 0.0475 - val_mae: 0.1668
Epoch 73/75
48/48 [==============================] - 0s 880us/step - loss: 0.0524 - mae:
0.1799 - val_loss: 0.0484 - val_mae: 0.1685
Epoch 74/75
48/48 [==============================] - 0s 875us/step - loss: 0.0552 - mae:
0.1820 - val_loss: 0.0492 - val_mae: 0.1698
Epoch 75/75
48/48 [==============================] - 0s 931us/step - loss: 0.0532 - mae:
0.1809 - val_loss: 0.0475 - val_mae: 0.1668
15/15 [==============================] - 0s 504us/step - loss: 0.0494 - mae:
0.1697
loss 0.04936393350362778
mae 0.16969530284404755
```

# 8. Dense + Dropout + Batch Normalization

Experiment 1: A single Dense Hidden Layer

In [ ]:

```python
dataset_1 = data.drop(columns=["StudentID","Gender","Ethnicity","Extracurric

X_1 = dataset_1.drop(columns=['GPA'])
y_1 = dataset_1['GPA'].values

X1_train, X1_test, y1_train, y1_test = train_test_split(X_1, y_1, test_size=

scaler = StandardScaler()
X3_train = scaler.fit_transform(X1_train)
X3_test = scaler.transform(X1_test)

model_1 = Sequential([
    Dense(64, activation='relu', input_dim=X1_train.shape[1]),
    Dense(32, activation='relu'),
    Dense(1)
])

model_1.compile(
    optimizer='adam',
    loss='mse',
    metrics=['mae']
)

history_1 = model_1.fit(X1_train, y1_train, epochs=75, batch_size=10, valida

loss1, mae1 = model_1.evaluate(X1_test, y1_test)
```

```
print("loss", loss1)
print("mae", mae1)
```

```
Epoch 1/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3215 - mae:
0.3841 - val_loss: 0.1394 - val_mae: 0.2972
Epoch 2/75
144/144 [==============================] - 0s 821us/step - loss: 0.1123 - ma
e: 0.2689 - val_loss: 0.1180 - val_mae: 0.2787
Epoch 3/75
144/144 [==============================] - 0s 842us/step - loss: 0.0949 - ma
e: 0.2478 - val_loss: 0.1178 - val_mae: 0.2760
Epoch 4/75
144/144 [==============================] - 0s 729us/step - loss: 0.0926 - ma
e: 0.2414 - val_loss: 0.0948 - val_mae: 0.2479
Epoch 5/75
144/144 [==============================] - 0s 723us/step - loss: 0.0881 - ma
e: 0.2379 - val_loss: 0.1160 - val_mae: 0.2749
Epoch 6/75
144/144 [==============================] - 0s 748us/step - loss: 0.0941 - ma
e: 0.2447 - val_loss: 0.1059 - val_mae: 0.2599
Epoch 7/75
144/144 [==============================] - 0s 702us/step - loss: 0.0911 - ma
e: 0.2430 - val_loss: 0.0975 - val_mae: 0.2535
Epoch 8/75
144/144 [==============================] - 0s 708us/step - loss: 0.0875 - ma
e: 0.2372 - val_loss: 0.0940 - val_mae: 0.2483
Epoch 9/75
144/144 [==============================] - 0s 714us/step - loss: 0.0999 - ma
e: 0.2527 - val_loss: 0.0950 - val_mae: 0.2464
Epoch 10/75
144/144 [==============================] - 0s 709us/step - loss: 0.0790 - ma
e: 0.2247 - val_loss: 0.0871 - val_mae: 0.2356
Epoch 11/75
144/144 [==============================] - 0s 700us/step - loss: 0.0794 - ma
e: 0.2254 - val_loss: 0.0921 - val_mae: 0.2437
Epoch 12/75
144/144 [==============================] - 0s 738us/step - loss: 0.0789 - ma
e: 0.2252 - val_loss: 0.0907 - val_mae: 0.2443
Epoch 13/75
144/144 [==============================] - 0s 731us/step - loss: 0.0913 - ma
e: 0.2426 - val_loss: 0.0842 - val_mae: 0.2341
Epoch 14/75
144/144 [==============================] - 0s 742us/step - loss: 0.0750 - ma
e: 0.2195 - val_loss: 0.0767 - val_mae: 0.2222
Epoch 15/75
144/144 [==============================] - 0s 695us/step - loss: 0.0814 - ma
e: 0.2279 - val_loss: 0.0827 - val_mae: 0.2328
Epoch 16/75
144/144 [==============================] - 0s 714us/step - loss: 0.0745 - ma
```

```
e: 0.2168 - val_loss: 0.0826 - val_mae: 0.2314
Epoch 17/75
144/144 [==============================] - 0s 837us/step - loss: 0.0784 - ma
e: 0.2219 - val_loss: 0.0785 - val_mae: 0.2259
Epoch 18/75
144/144 [==============================] - 0s 729us/step - loss: 0.0740 - ma
e: 0.2168 - val_loss: 0.0814 - val_mae: 0.2313
Epoch 19/75
144/144 [==============================] - 0s 691us/step - loss: 0.0772 - ma
e: 0.2217 - val_loss: 0.0763 - val_mae: 0.2236
Epoch 20/75
144/144 [==============================] - 0s 698us/step - loss: 0.0718 - ma
e: 0.2132 - val_loss: 0.0995 - val_mae: 0.2509
Epoch 21/75
144/144 [==============================] - 0s 704us/step - loss: 0.0720 - ma
e: 0.2121 - val_loss: 0.0746 - val_mae: 0.2197
Epoch 22/75
144/144 [==============================] - 0s 708us/step - loss: 0.0704 - ma
e: 0.2110 - val_loss: 0.0749 - val_mae: 0.2185
Epoch 23/75
144/144 [==============================] - 0s 704us/step - loss: 0.0701 - ma
e: 0.2105 - val_loss: 0.0842 - val_mae: 0.2333
Epoch 24/75
144/144 [==============================] - 0s 705us/step - loss: 0.0749 - ma
e: 0.2199 - val_loss: 0.0711 - val_mae: 0.2124
Epoch 25/75
144/144 [==============================] - 0s 694us/step - loss: 0.0671 - ma
e: 0.2037 - val_loss: 0.0876 - val_mae: 0.2367
Epoch 26/75
144/144 [==============================] - 0s 733us/step - loss: 0.0704 - ma
e: 0.2112 - val_loss: 0.0700 - val_mae: 0.2111
Epoch 27/75
144/144 [==============================] - 0s 696us/step - loss: 0.0684 - ma
e: 0.2096 - val_loss: 0.0866 - val_mae: 0.2347
Epoch 28/75
144/144 [==============================] - 0s 721us/step - loss: 0.0648 - ma
e: 0.2021 - val_loss: 0.0843 - val_mae: 0.2334
Epoch 29/75
144/144 [==============================] - 0s 709us/step - loss: 0.0743 - ma
e: 0.2171 - val_loss: 0.0823 - val_mae: 0.2296
Epoch 30/75
144/144 [==============================] - 0s 696us/step - loss: 0.0647 - ma
e: 0.2024 - val_loss: 0.0824 - val_mae: 0.2307
Epoch 31/75
144/144 [==============================] - 0s 720us/step - loss: 0.0674 - ma
e: 0.2051 - val_loss: 0.0692 - val_mae: 0.2103
Epoch 32/75
144/144 [==============================] - 0s 768us/step - loss: 0.0625 - ma
e: 0.1977 - val_loss: 0.0712 - val_mae: 0.2146
Epoch 33/75
```

```
144/144 [==============================] - 0s 800us/step - loss: 0.0622 - ma
e: 0.1983 - val_loss: 0.0699 - val_mae: 0.2124
Epoch 34/75
144/144 [==============================] - 0s 688us/step - loss: 0.0635 - ma
e: 0.2013 - val_loss: 0.0695 - val_mae: 0.2095
Epoch 35/75
144/144 [==============================] - 0s 731us/step - loss: 0.0609 - ma
e: 0.1958 - val_loss: 0.0652 - val_mae: 0.2041
Epoch 36/75
144/144 [==============================] - 0s 738us/step - loss: 0.0603 - ma
e: 0.1953 - val_loss: 0.0757 - val_mae: 0.2188
Epoch 37/75
144/144 [==============================] - 0s 714us/step - loss: 0.0608 - ma
e: 0.1956 - val_loss: 0.0755 - val_mae: 0.2223
Epoch 38/75
144/144 [==============================] - 0s 701us/step - loss: 0.0568 - ma
e: 0.1887 - val_loss: 0.0866 - val_mae: 0.2397
Epoch 39/75
144/144 [==============================] - 0s 803us/step - loss: 0.0563 - ma
e: 0.1880 - val_loss: 0.0611 - val_mae: 0.1993
Epoch 40/75
144/144 [==============================] - 0s 716us/step - loss: 0.0588 - ma
e: 0.1932 - val_loss: 0.0656 - val_mae: 0.2036
Epoch 41/75
144/144 [==============================] - 0s 705us/step - loss: 0.0583 - ma
e: 0.1904 - val_loss: 0.0592 - val_mae: 0.1929
Epoch 42/75
144/144 [==============================] - 0s 707us/step - loss: 0.0572 - ma
e: 0.1901 - val_loss: 0.0659 - val_mae: 0.2058
Epoch 43/75
144/144 [==============================] - 0s 708us/step - loss: 0.0558 - ma
e: 0.1882 - val_loss: 0.0640 - val_mae: 0.2034
Epoch 44/75
144/144 [==============================] - 0s 696us/step - loss: 0.0568 - ma
e: 0.1884 - val_loss: 0.0588 - val_mae: 0.1957
Epoch 45/75
144/144 [==============================] - 0s 713us/step - loss: 0.0632 - ma
e: 0.2031 - val_loss: 0.0589 - val_mae: 0.1953
Epoch 46/75
144/144 [==============================] - 0s 696us/step - loss: 0.0546 - ma
e: 0.1840 - val_loss: 0.0661 - val_mae: 0.2012
Epoch 47/75
144/144 [==============================] - 0s 698us/step - loss: 0.0532 - ma
e: 0.1820 - val_loss: 0.0600 - val_mae: 0.1927
Epoch 48/75
144/144 [==============================] - 0s 694us/step - loss: 0.0556 - ma
e: 0.1874 - val_loss: 0.0570 - val_mae: 0.1893
Epoch 49/75
144/144 [==============================] - 0s 714us/step - loss: 0.0550 - ma
e: 0.1855 - val_loss: 0.0575 - val_mae: 0.1904
```

```
Epoch 50/75
144/144 [==============================] - 0s 773us/step - loss: 0.0600 - ma
e: 0.1945 - val_loss: 0.0574 - val_mae: 0.1898
Epoch 51/75
144/144 [==============================] - 0s 727us/step - loss: 0.0526 - ma
e: 0.1821 - val_loss: 0.0565 - val_mae: 0.1875
Epoch 52/75
144/144 [==============================] - 0s 693us/step - loss: 0.0508 - ma
e: 0.1791 - val_loss: 0.0696 - val_mae: 0.2140
Epoch 53/75
144/144 [==============================] - 0s 685us/step - loss: 0.0520 - ma
e: 0.1806 - val_loss: 0.0549 - val_mae: 0.1863
Epoch 54/75
144/144 [==============================] - 0s 712us/step - loss: 0.0503 - ma
e: 0.1794 - val_loss: 0.0598 - val_mae: 0.1902
Epoch 55/75
144/144 [==============================] - 0s 728us/step - loss: 0.0554 - ma
e: 0.1859 - val_loss: 0.0711 - val_mae: 0.2187
Epoch 56/75
144/144 [==============================] - 0s 751us/step - loss: 0.0519 - ma
e: 0.1808 - val_loss: 0.0605 - val_mae: 0.1914
Epoch 57/75
144/144 [==============================] - 0s 798us/step - loss: 0.0477 - ma
e: 0.1715 - val_loss: 0.0557 - val_mae: 0.1862
Epoch 58/75
144/144 [==============================] - 0s 749us/step - loss: 0.0470 - ma
e: 0.1694 - val_loss: 0.0546 - val_mae: 0.1877
Epoch 59/75
144/144 [==============================] - 0s 844us/step - loss: 0.0475 - ma
e: 0.1740 - val_loss: 0.0643 - val_mae: 0.2009
Epoch 60/75
144/144 [==============================] - 0s 753us/step - loss: 0.0468 - ma
e: 0.1729 - val_loss: 0.0512 - val_mae: 0.1776
Epoch 61/75
144/144 [==============================] - 0s 777us/step - loss: 0.0492 - ma
e: 0.1734 - val_loss: 0.0659 - val_mae: 0.1999
Epoch 62/75
144/144 [==============================] - 0s 712us/step - loss: 0.0514 - ma
e: 0.1795 - val_loss: 0.0629 - val_mae: 0.1953
Epoch 63/75
144/144 [==============================] - 0s 834us/step - loss: 0.0484 - ma
e: 0.1739 - val_loss: 0.0667 - val_mae: 0.2003
Epoch 64/75
144/144 [==============================] - 0s 747us/step - loss: 0.0503 - ma
e: 0.1772 - val_loss: 0.0557 - val_mae: 0.1881
Epoch 65/75
144/144 [==============================] - 0s 742us/step - loss: 0.0482 - ma
e: 0.1745 - val_loss: 0.0641 - val_mae: 0.2031
Epoch 66/75
144/144 [==============================] - 0s 713us/step - loss: 0.0472 - ma
```

```
e: 0.1725 - val_loss: 0.0917 - val_mae: 0.2472
Epoch 67/75
144/144 [==============================] - 0s 713us/step - loss: 0.0482 - ma
e: 0.1741 - val_loss: 0.0515 - val_mae: 0.1770
Epoch 68/75
144/144 [==============================] - 0s 727us/step - loss: 0.0480 - ma
e: 0.1720 - val_loss: 0.0552 - val_mae: 0.1808
Epoch 69/75
144/144 [==============================] - 0s 770us/step - loss: 0.0450 - ma
e: 0.1693 - val_loss: 0.0473 - val_mae: 0.1698
Epoch 70/75
144/144 [==============================] - 0s 744us/step - loss: 0.0466 - ma
e: 0.1686 - val_loss: 0.0697 - val_mae: 0.2061
Epoch 71/75
144/144 [==============================] - 0s 726us/step - loss: 0.0461 - ma
e: 0.1699 - val_loss: 0.0582 - val_mae: 0.1957
Epoch 72/75
144/144 [==============================] - 0s 711us/step - loss: 0.0467 - ma
e: 0.1683 - val_loss: 0.0533 - val_mae: 0.1806
Epoch 73/75
144/144 [==============================] - 0s 708us/step - loss: 0.0432 - ma
e: 0.1639 - val_loss: 0.0487 - val_mae: 0.1718
Epoch 74/75
144/144 [==============================] - 0s 710us/step - loss: 0.0437 - ma
e: 0.1636 - val_loss: 0.0549 - val_mae: 0.1799
Epoch 75/75
144/144 [==============================] - 0s 715us/step - loss: 0.0447 - ma
e: 0.1668 - val_loss: 0.0563 - val_mae: 0.1825
15/15 [==============================] - 0s 521us/step - loss: 0.0593 - mae:
0.1851
loss 0.059342652559280396
mae 0.1851426661014557
```

Experiment 2: A set of three Dense Hidden Layers

In [ ]:

```
dataset_2 = data.drop(columns=["StudentID","Gender","Ethnicity","Extracurric

X_2 = dataset_2.drop(columns=['GPA'])
y_2 = dataset_2['GPA'].values

X2_train, X2_test, y2_train, y2_test = train_test_split(X_2, y_2, test_size=

scaler = StandardScaler()
X2_train = scaler.fit_transform(X2_train)
X2_test = scaler.transform(X2_test)

model_2 = Sequential([
    Dense(64, activation='relu', input_dim=X2_train.shape[1]),
    Dense(32, activation='relu'),
    Dense(16, activation='relu'),
```

```
    Dense(8, activation='relu'),
    Dense(1)
])

model_2.compile(
    optimizer='adam',
    loss='mse',
    metrics=['mae']
)

history_2 = model_2.fit(X2_train, y2_train, epochs=75, batch_size=10, valida

loss2, mae2 = model_2.evaluate(X2_test, y2_test)
print("loss", loss2)
print("mae", mae2)
```

```
Epoch 1/75
144/144 [==============================] - 0s 1ms/step - loss: 0.9862 - mae:
0.7012 - val_loss: 0.1659 - val_mae: 0.3262
Epoch 2/75
144/144 [==============================] - 0s 875us/step - loss: 0.1179 - ma
e: 0.2737 - val_loss: 0.1128 - val_mae: 0.2701
Epoch 3/75
144/144 [==============================] - 0s 789us/step - loss: 0.0872 - ma
e: 0.2368 - val_loss: 0.0862 - val_mae: 0.2317
Epoch 4/75
144/144 [==============================] - 0s 768us/step - loss: 0.0724 - ma
e: 0.2170 - val_loss: 0.0929 - val_mae: 0.2441
Epoch 5/75
144/144 [==============================] - 0s 790us/step - loss: 0.0630 - ma
e: 0.2021 - val_loss: 0.0697 - val_mae: 0.2102
Epoch 6/75
144/144 [==============================] - 0s 795us/step - loss: 0.0574 - ma
e: 0.1926 - val_loss: 0.0627 - val_mae: 0.1979
Epoch 7/75
144/144 [==============================] - 0s 742us/step - loss: 0.0509 - ma
e: 0.1803 - val_loss: 0.0601 - val_mae: 0.1941
Epoch 8/75
144/144 [==============================] - 0s 748us/step - loss: 0.0486 - ma
e: 0.1757 - val_loss: 0.0558 - val_mae: 0.1846
Epoch 9/75
144/144 [==============================] - 0s 743us/step - loss: 0.0455 - ma
e: 0.1685 - val_loss: 0.0578 - val_mae: 0.1886
Epoch 10/75
144/144 [==============================] - 0s 744us/step - loss: 0.0452 - ma
e: 0.1671 - val_loss: 0.0607 - val_mae: 0.1954
Epoch 11/75
144/144 [==============================] - 0s 742us/step - loss: 0.0447 - ma
e: 0.1670 - val_loss: 0.0613 - val_mae: 0.1952
Epoch 12/75
```

```
144/144 [==============================] - 0s 799us/step - loss: 0.0427 - ma
e: 0.1611 - val_loss: 0.0542 - val_mae: 0.1829
Epoch 13/75
144/144 [==============================] - 0s 805us/step - loss: 0.0416 - ma
e: 0.1589 - val_loss: 0.0548 - val_mae: 0.1826
Epoch 14/75
144/144 [==============================] - 0s 774us/step - loss: 0.0403 - ma
e: 0.1578 - val_loss: 0.0567 - val_mae: 0.1866
Epoch 15/75
144/144 [==============================] - 0s 768us/step - loss: 0.0398 - ma
e: 0.1563 - val_loss: 0.0589 - val_mae: 0.1910
Epoch 16/75
144/144 [==============================] - 0s 764us/step - loss: 0.0409 - ma
e: 0.1584 - val_loss: 0.0534 - val_mae: 0.1809
Epoch 17/75
144/144 [==============================] - 0s 768us/step - loss: 0.0398 - ma
e: 0.1552 - val_loss: 0.0539 - val_mae: 0.1794
Epoch 18/75
144/144 [==============================] - 0s 745us/step - loss: 0.0392 - ma
e: 0.1555 - val_loss: 0.0546 - val_mae: 0.1840
Epoch 19/75
144/144 [==============================] - 0s 743us/step - loss: 0.0386 - ma
e: 0.1543 - val_loss: 0.0565 - val_mae: 0.1844
Epoch 20/75
144/144 [==============================] - 0s 756us/step - loss: 0.0373 - ma
e: 0.1501 - val_loss: 0.0606 - val_mae: 0.1924
Epoch 21/75
144/144 [==============================] - 0s 757us/step - loss: 0.0369 - ma
e: 0.1501 - val_loss: 0.0607 - val_mae: 0.1895
Epoch 22/75
144/144 [==============================] - 0s 746us/step - loss: 0.0367 - ma
e: 0.1496 - val_loss: 0.0546 - val_mae: 0.1807
Epoch 23/75
144/144 [==============================] - 0s 751us/step - loss: 0.0363 - ma
e: 0.1488 - val_loss: 0.0568 - val_mae: 0.1862
Epoch 24/75
144/144 [==============================] - 0s 781us/step - loss: 0.0368 - ma
e: 0.1494 - val_loss: 0.0625 - val_mae: 0.1949
Epoch 25/75
144/144 [==============================] - 0s 786us/step - loss: 0.0360 - ma
e: 0.1497 - val_loss: 0.0564 - val_mae: 0.1814
Epoch 26/75
144/144 [==============================] - 0s 807us/step - loss: 0.0346 - ma
e: 0.1449 - val_loss: 0.0590 - val_mae: 0.1869
Epoch 27/75
144/144 [==============================] - 0s 772us/step - loss: 0.0351 - ma
e: 0.1468 - val_loss: 0.0549 - val_mae: 0.1795
Epoch 28/75
144/144 [==============================] - 0s 749us/step - loss: 0.0343 - ma
e: 0.1454 - val_loss: 0.0601 - val_mae: 0.1895
```

```
Epoch 29/75
144/144 [==============================] - 0s 772us/step - loss: 0.0340 - ma
e: 0.1449 - val_loss: 0.0533 - val_mae: 0.1776
Epoch 30/75
144/144 [==============================] - 0s 822us/step - loss: 0.0334 - ma
e: 0.1425 - val_loss: 0.0574 - val_mae: 0.1853
Epoch 31/75
144/144 [==============================] - 0s 806us/step - loss: 0.0336 - ma
e: 0.1427 - val_loss: 0.0601 - val_mae: 0.1856
Epoch 32/75
144/144 [==============================] - 0s 806us/step - loss: 0.0339 - ma
e: 0.1432 - val_loss: 0.0568 - val_mae: 0.1824
Epoch 33/75
144/144 [==============================] - 0s 761us/step - loss: 0.0327 - ma
e: 0.1423 - val_loss: 0.0597 - val_mae: 0.1915
Epoch 34/75
144/144 [==============================] - 0s 896us/step - loss: 0.0335 - ma
e: 0.1425 - val_loss: 0.0610 - val_mae: 0.1937
Epoch 35/75
144/144 [==============================] - 0s 766us/step - loss: 0.0327 - ma
e: 0.1429 - val_loss: 0.0591 - val_mae: 0.1902
Epoch 36/75
144/144 [==============================] - 0s 770us/step - loss: 0.0329 - ma
e: 0.1405 - val_loss: 0.0549 - val_mae: 0.1799
Epoch 37/75
144/144 [==============================] - 0s 798us/step - loss: 0.0312 - ma
e: 0.1380 - val_loss: 0.0589 - val_mae: 0.1859
Epoch 38/75
144/144 [==============================] - 0s 774us/step - loss: 0.0320 - ma
e: 0.1407 - val_loss: 0.0576 - val_mae: 0.1830
Epoch 39/75
144/144 [==============================] - 0s 786us/step - loss: 0.0330 - ma
e: 0.1434 - val_loss: 0.0592 - val_mae: 0.1889
Epoch 40/75
144/144 [==============================] - 0s 761us/step - loss: 0.0318 - ma
e: 0.1405 - val_loss: 0.0584 - val_mae: 0.1842
Epoch 41/75
144/144 [==============================] - 0s 776us/step - loss: 0.0316 - ma
e: 0.1400 - val_loss: 0.0583 - val_mae: 0.1873
Epoch 42/75
144/144 [==============================] - 0s 816us/step - loss: 0.0325 - ma
e: 0.1418 - val_loss: 0.0563 - val_mae: 0.1821
Epoch 43/75
144/144 [==============================] - 0s 828us/step - loss: 0.0310 - ma
e: 0.1389 - val_loss: 0.0569 - val_mae: 0.1830
Epoch 44/75
144/144 [==============================] - 0s 848us/step - loss: 0.0321 - ma
e: 0.1412 - val_loss: 0.0595 - val_mae: 0.1882
Epoch 45/75
144/144 [==============================] - 0s 795us/step - loss: 0.0293 - ma
```

```
e: 0.1339 - val_loss: 0.0567 - val_mae: 0.1826
Epoch 46/75
144/144 [==============================] - 0s 813us/step - loss: 0.0312 - ma
e: 0.1388 - val_loss: 0.0623 - val_mae: 0.1924
Epoch 47/75
144/144 [==============================] - 0s 772us/step - loss: 0.0297 - ma
e: 0.1343 - val_loss: 0.0568 - val_mae: 0.1801
Epoch 48/75
144/144 [==============================] - 0s 757us/step - loss: 0.0312 - ma
e: 0.1392 - val_loss: 0.0593 - val_mae: 0.1891
Epoch 49/75
144/144 [==============================] - 0s 751us/step - loss: 0.0295 - ma
e: 0.1340 - val_loss: 0.0591 - val_mae: 0.1876
Epoch 50/75
144/144 [==============================] - 0s 774us/step - loss: 0.0288 - ma
e: 0.1334 - val_loss: 0.0584 - val_mae: 0.1823
Epoch 51/75
144/144 [==============================] - 0s 817us/step - loss: 0.0292 - ma
e: 0.1342 - val_loss: 0.0578 - val_mae: 0.1822
Epoch 52/75
144/144 [==============================] - 0s 824us/step - loss: 0.0291 - ma
e: 0.1348 - val_loss: 0.0582 - val_mae: 0.1856
Epoch 53/75
144/144 [==============================] - 0s 764us/step - loss: 0.0277 - ma
e: 0.1295 - val_loss: 0.0615 - val_mae: 0.1885
Epoch 54/75
144/144 [==============================] - 0s 747us/step - loss: 0.0283 - ma
e: 0.1317 - val_loss: 0.0600 - val_mae: 0.1861
Epoch 55/75
144/144 [==============================] - 0s 747us/step - loss: 0.0282 - ma
e: 0.1317 - val_loss: 0.0599 - val_mae: 0.1890
Epoch 56/75
144/144 [==============================] - 0s 772us/step - loss: 0.0279 - ma
e: 0.1319 - val_loss: 0.0580 - val_mae: 0.1844
Epoch 57/75
144/144 [==============================] - 0s 750us/step - loss: 0.0279 - ma
e: 0.1320 - val_loss: 0.0594 - val_mae: 0.1864
Epoch 58/75
144/144 [==============================] - 0s 749us/step - loss: 0.0271 - ma
e: 0.1288 - val_loss: 0.0611 - val_mae: 0.1897
Epoch 59/75
144/144 [==============================] - 0s 753us/step - loss: 0.0280 - ma
e: 0.1307 - val_loss: 0.0600 - val_mae: 0.1870
Epoch 60/75
144/144 [==============================] - 0s 755us/step - loss: 0.0263 - ma
e: 0.1256 - val_loss: 0.0713 - val_mae: 0.2097
Epoch 61/75
144/144 [==============================] - 0s 766us/step - loss: 0.0279 - ma
e: 0.1304 - val_loss: 0.0586 - val_mae: 0.1845
Epoch 62/75
```

```
144/144 [==============================] - 0s 753us/step - loss: 0.0276 - ma
e: 0.1297 - val_loss: 0.0599 - val_mae: 0.1882
Epoch 63/75
144/144 [==============================] - 0s 741us/step - loss: 0.0264 - ma
e: 0.1279 - val_loss: 0.0611 - val_mae: 0.1879
Epoch 64/75
144/144 [==============================] - 0s 762us/step - loss: 0.0270 - ma
e: 0.1301 - val_loss: 0.0619 - val_mae: 0.1905
Epoch 65/75
144/144 [==============================] - 0s 739us/step - loss: 0.0253 - ma
e: 0.1248 - val_loss: 0.0597 - val_mae: 0.1875
Epoch 66/75
144/144 [==============================] - 0s 743us/step - loss: 0.0251 - ma
e: 0.1236 - val_loss: 0.0655 - val_mae: 0.1962
Epoch 67/75
144/144 [==============================] - 0s 794us/step - loss: 0.0260 - ma
e: 0.1272 - val_loss: 0.0610 - val_mae: 0.1882
Epoch 68/75
144/144 [==============================] - 0s 762us/step - loss: 0.0254 - ma
e: 0.1247 - val_loss: 0.0634 - val_mae: 0.1949
Epoch 69/75
144/144 [==============================] - 0s 767us/step - loss: 0.0259 - ma
e: 0.1260 - val_loss: 0.0591 - val_mae: 0.1847
Epoch 70/75
144/144 [==============================] - 0s 1ms/step - loss: 0.0251 - mae:
0.1225 - val_loss: 0.0613 - val_mae: 0.1895
Epoch 71/75
144/144 [==============================] - 0s 860us/step - loss: 0.0260 - ma
e: 0.1274 - val_loss: 0.0623 - val_mae: 0.1929
Epoch 72/75
144/144 [==============================] - 0s 771us/step - loss: 0.0242 - ma
e: 0.1207 - val_loss: 0.0607 - val_mae: 0.1892
Epoch 73/75
144/144 [==============================] - 0s 810us/step - loss: 0.0249 - ma
e: 0.1236 - val_loss: 0.0658 - val_mae: 0.1956
Epoch 74/75
144/144 [==============================] - 0s 801us/step - loss: 0.0243 - ma
e: 0.1229 - val_loss: 0.0653 - val_mae: 0.1974
Epoch 75/75
144/144 [==============================] - 0s 766us/step - loss: 0.0248 - ma
e: 0.1220 - val_loss: 0.0618 - val_mae: 0.1896
15/15 [==============================] - 0s 497us/step - loss: 0.0630 - mae:
0.1903
loss 0.0629812628030777
mae 0.19033977389335632
```

Experiment 3: Add a dropout layer after each Dense Hidden Layer

In [ ]:
```
dataset_3 = data.drop(columns=["StudentID","Gender","Ethnicity","Extracurric
```

```
X_3 = dataset_3.drop(columns=['GPA'])
y_3 = dataset_3['GPA'].values

X3_train, X3_test, y3_train, y3_test = train_test_split(X_3, y_3, test_size=

scaler = StandardScaler()
X3_train = scaler.fit_transform(X3_train)
X3_test = scaler.transform(X3_test)

model_3 = Sequential([
    Dense(64, activation='relu', input_dim=X3_train.shape[1]),
    Dropout(0.25),
    Dense(32, activation='relu'),
    Dropout(0.25),
    Dense(16, activation='relu'),
    Dropout(0.25),
    Dense(8, activation='relu'),
    Dropout(0.25),
    Dense(1)
])

model_3.compile(
    optimizer='adam',
    loss='mse',
    metrics=['mae']
)

history_3 = model_3.fit(X3_train, y3_train, epochs=75, batch_size=10, valida

loss3, mae3 = model_3.evaluate(X3_test, y3_test)
print("loss", loss3)
print("mae", mae3)
```

```
Epoch 1/75
144/144 [==============================] - 0s 1ms/step - loss: 2.3564 - mae:
1.2490 - val_loss: 0.6574 - val_mae: 0.7082
Epoch 2/75
144/144 [==============================] - 0s 816us/step - loss: 1.1868 - ma
e: 0.8357 - val_loss: 0.4883 - val_mae: 0.6086
Epoch 3/75
144/144 [==============================] - 0s 797us/step - loss: 0.9631 - ma
e: 0.7459 - val_loss: 0.4672 - val_mae: 0.5940
Epoch 4/75
144/144 [==============================] - 0s 771us/step - loss: 0.7980 - ma
e: 0.6821 - val_loss: 0.3154 - val_mae: 0.4891
Epoch 5/75
144/144 [==============================] - 0s 851us/step - loss: 0.6369 - ma
e: 0.6157 - val_loss: 0.1695 - val_mae: 0.3496
Epoch 6/75
144/144 [==============================] - 0s 808us/step - loss: 0.5530 - ma
```

```
e: 0.5605 - val_loss: 0.2324 - val_mae: 0.4183
Epoch 7/75
144/144 [==============================] - 0s 765us/step - loss: 0.5289 - ma
e: 0.5357 - val_loss: 0.1978 - val_mae: 0.3796
Epoch 8/75
144/144 [==============================] - 0s 769us/step - loss: 0.4867 - ma
e: 0.5222 - val_loss: 0.1825 - val_mae: 0.3617
Epoch 9/75
144/144 [==============================] - 0s 756us/step - loss: 0.4626 - ma
e: 0.5112 - val_loss: 0.1543 - val_mae: 0.3308
Epoch 10/75
144/144 [==============================] - 0s 764us/step - loss: 0.4194 - ma
e: 0.4869 - val_loss: 0.1517 - val_mae: 0.3268
Epoch 11/75
144/144 [==============================] - 0s 768us/step - loss: 0.3897 - ma
e: 0.4587 - val_loss: 0.1921 - val_mae: 0.3647
Epoch 12/75
144/144 [==============================] - 0s 765us/step - loss: 0.3392 - ma
e: 0.4325 - val_loss: 0.1474 - val_mae: 0.3177
Epoch 13/75
144/144 [==============================] - 0s 750us/step - loss: 0.3393 - ma
e: 0.4366 - val_loss: 0.1542 - val_mae: 0.3234
Epoch 14/75
144/144 [==============================] - 0s 780us/step - loss: 0.2950 - ma
e: 0.4093 - val_loss: 0.1439 - val_mae: 0.3145
Epoch 15/75
144/144 [==============================] - 0s 775us/step - loss: 0.2909 - ma
e: 0.4042 - val_loss: 0.1078 - val_mae: 0.2701
Epoch 16/75
144/144 [==============================] - 0s 780us/step - loss: 0.2706 - ma
e: 0.3909 - val_loss: 0.1466 - val_mae: 0.3174
Epoch 17/75
144/144 [==============================] - 0s 772us/step - loss: 0.2915 - ma
e: 0.4077 - val_loss: 0.1150 - val_mae: 0.2769
Epoch 18/75
144/144 [==============================] - 0s 761us/step - loss: 0.2436 - ma
e: 0.3741 - val_loss: 0.1436 - val_mae: 0.3128
Epoch 19/75
144/144 [==============================] - 0s 781us/step - loss: 0.2467 - ma
e: 0.3774 - val_loss: 0.1295 - val_mae: 0.2981
Epoch 20/75
144/144 [==============================] - 0s 780us/step - loss: 0.2315 - ma
e: 0.3658 - val_loss: 0.1463 - val_mae: 0.3128
Epoch 21/75
144/144 [==============================] - 0s 768us/step - loss: 0.2289 - ma
e: 0.3595 - val_loss: 0.1162 - val_mae: 0.2758
Epoch 22/75
144/144 [==============================] - 0s 766us/step - loss: 0.2322 - ma
e: 0.3614 - val_loss: 0.1380 - val_mae: 0.3073
Epoch 23/75
```

```
144/144 [==============================] - 0s 756us/step - loss: 0.2310 - ma
e: 0.3616 - val_loss: 0.1192 - val_mae: 0.2830
Epoch 24/75
144/144 [==============================] - 0s 750us/step - loss: 0.2202 - ma
e: 0.3515 - val_loss: 0.1179 - val_mae: 0.2777
Epoch 25/75
144/144 [==============================] - 0s 750us/step - loss: 0.2161 - ma
e: 0.3454 - val_loss: 0.1317 - val_mae: 0.2955
Epoch 26/75
144/144 [==============================] - 0s 762us/step - loss: 0.1959 - ma
e: 0.3355 - val_loss: 0.1270 - val_mae: 0.2888
Epoch 27/75
144/144 [==============================] - 0s 755us/step - loss: 0.2048 - ma
e: 0.3426 - val_loss: 0.1046 - val_mae: 0.2599
Epoch 28/75
144/144 [==============================] - 0s 766us/step - loss: 0.1886 - ma
e: 0.3345 - val_loss: 0.1365 - val_mae: 0.3016
Epoch 29/75
144/144 [==============================] - 0s 766us/step - loss: 0.1779 - ma
e: 0.3137 - val_loss: 0.0996 - val_mae: 0.2478
Epoch 30/75
144/144 [==============================] - 0s 754us/step - loss: 0.1909 - ma
e: 0.3296 - val_loss: 0.1051 - val_mae: 0.2596
Epoch 31/75
144/144 [==============================] - 0s 764us/step - loss: 0.1898 - ma
e: 0.3297 - val_loss: 0.0940 - val_mae: 0.2444
Epoch 32/75
144/144 [==============================] - 0s 766us/step - loss: 0.1958 - ma
e: 0.3334 - val_loss: 0.1281 - val_mae: 0.2886
Epoch 33/75
144/144 [==============================] - 0s 766us/step - loss: 0.1882 - ma
e: 0.3251 - val_loss: 0.1106 - val_mae: 0.2660
Epoch 34/75
144/144 [==============================] - 0s 763us/step - loss: 0.1861 - ma
e: 0.3215 - val_loss: 0.1121 - val_mae: 0.2703
Epoch 35/75
144/144 [==============================] - 0s 768us/step - loss: 0.1697 - ma
e: 0.3173 - val_loss: 0.0931 - val_mae: 0.2422
Epoch 36/75
144/144 [==============================] - 0s 769us/step - loss: 0.1656 - ma
e: 0.3126 - val_loss: 0.1373 - val_mae: 0.3007
Epoch 37/75
144/144 [==============================] - 0s 762us/step - loss: 0.1663 - ma
e: 0.3061 - val_loss: 0.1182 - val_mae: 0.2772
Epoch 38/75
144/144 [==============================] - 0s 767us/step - loss: 0.1639 - ma
e: 0.3041 - val_loss: 0.0938 - val_mae: 0.2448
Epoch 39/75
144/144 [==============================] - 0s 865us/step - loss: 0.1658 - ma
e: 0.3035 - val_loss: 0.1055 - val_mae: 0.2556
```

```
Epoch 40/75
144/144 [==============================] - 0s 768us/step - loss: 0.1749 - ma
e: 0.3139 - val_loss: 0.1127 - val_mae: 0.2681
Epoch 41/75
144/144 [==============================] - 0s 768us/step - loss: 0.1723 - ma
e: 0.3117 - val_loss: 0.1088 - val_mae: 0.2649
Epoch 42/75
144/144 [==============================] - 0s 768us/step - loss: 0.1684 - ma
e: 0.3081 - val_loss: 0.1063 - val_mae: 0.2632
Epoch 43/75
144/144 [==============================] - 0s 767us/step - loss: 0.1667 - ma
e: 0.3093 - val_loss: 0.1124 - val_mae: 0.2708
Epoch 44/75
144/144 [==============================] - 0s 762us/step - loss: 0.1552 - ma
e: 0.2968 - val_loss: 0.0841 - val_mae: 0.2329
Epoch 45/75
144/144 [==============================] - 0s 769us/step - loss: 0.1577 - ma
e: 0.2991 - val_loss: 0.1161 - val_mae: 0.2731
Epoch 46/75
144/144 [==============================] - 0s 763us/step - loss: 0.1694 - ma
e: 0.3079 - val_loss: 0.1087 - val_mae: 0.2650
Epoch 47/75
144/144 [==============================] - 0s 774us/step - loss: 0.1576 - ma
e: 0.2954 - val_loss: 0.0994 - val_mae: 0.2556
Epoch 48/75
144/144 [==============================] - 0s 764us/step - loss: 0.1566 - ma
e: 0.2952 - val_loss: 0.1085 - val_mae: 0.2669
Epoch 49/75
144/144 [==============================] - 0s 765us/step - loss: 0.1588 - ma
e: 0.2970 - val_loss: 0.1100 - val_mae: 0.2639
Epoch 50/75
144/144 [==============================] - 0s 749us/step - loss: 0.1517 - ma
e: 0.2934 - val_loss: 0.1097 - val_mae: 0.2671
Epoch 51/75
144/144 [==============================] - 0s 748us/step - loss: 0.1567 - ma
e: 0.2975 - val_loss: 0.0905 - val_mae: 0.2397
Epoch 52/75
144/144 [==============================] - 0s 760us/step - loss: 0.1496 - ma
e: 0.2956 - val_loss: 0.1030 - val_mae: 0.2563
Epoch 53/75
144/144 [==============================] - 0s 781us/step - loss: 0.1524 - ma
e: 0.2959 - val_loss: 0.1026 - val_mae: 0.2560
Epoch 54/75
144/144 [==============================] - 0s 777us/step - loss: 0.1647 - ma
e: 0.3073 - val_loss: 0.1190 - val_mae: 0.2796
Epoch 55/75
144/144 [==============================] - 0s 764us/step - loss: 0.1541 - ma
e: 0.2918 - val_loss: 0.1023 - val_mae: 0.2625
Epoch 56/75
144/144 [==============================] - 0s 747us/step - loss: 0.1554 - ma
```

```
e: 0.2936 - val_loss: 0.0808 - val_mae: 0.2260
Epoch 57/75
144/144 [==============================] - 0s 753us/step - loss: 0.1445 - ma
e: 0.2879 - val_loss: 0.1122 - val_mae: 0.2684
Epoch 58/75
144/144 [==============================] - 0s 763us/step - loss: 0.1629 - ma
e: 0.3055 - val_loss: 0.1128 - val_mae: 0.2718
Epoch 59/75
144/144 [==============================] - 0s 773us/step - loss: 0.1460 - ma
e: 0.2886 - val_loss: 0.0822 - val_mae: 0.2228
Epoch 60/75
144/144 [==============================] - 0s 768us/step - loss: 0.1469 - ma
e: 0.2901 - val_loss: 0.1065 - val_mae: 0.2633
Epoch 61/75
144/144 [==============================] - 0s 768us/step - loss: 0.1400 - ma
e: 0.2841 - val_loss: 0.0984 - val_mae: 0.2459
Epoch 62/75
144/144 [==============================] - 0s 765us/step - loss: 0.1452 - ma
e: 0.2899 - val_loss: 0.0964 - val_mae: 0.2485
Epoch 63/75
144/144 [==============================] - 0s 763us/step - loss: 0.1520 - ma
e: 0.2940 - val_loss: 0.0851 - val_mae: 0.2303
Epoch 64/75
144/144 [==============================] - 0s 760us/step - loss: 0.1493 - ma
e: 0.2916 - val_loss: 0.0954 - val_mae: 0.2481
Epoch 65/75
144/144 [==============================] - 0s 756us/step - loss: 0.1482 - ma
e: 0.2927 - val_loss: 0.0921 - val_mae: 0.2426
Epoch 66/75
144/144 [==============================] - 0s 762us/step - loss: 0.1427 - ma
e: 0.2845 - val_loss: 0.1019 - val_mae: 0.2582
Epoch 67/75
144/144 [==============================] - 0s 764us/step - loss: 0.1511 - ma
e: 0.2929 - val_loss: 0.1225 - val_mae: 0.2781
Epoch 68/75
144/144 [==============================] - 0s 766us/step - loss: 0.1467 - ma
e: 0.2914 - val_loss: 0.1047 - val_mae: 0.2525
Epoch 69/75
144/144 [==============================] - 0s 772us/step - loss: 0.1443 - ma
e: 0.2876 - val_loss: 0.1050 - val_mae: 0.2612
Epoch 70/75
144/144 [==============================] - 0s 761us/step - loss: 0.1363 - ma
e: 0.2791 - val_loss: 0.0874 - val_mae: 0.2301
Epoch 71/75
144/144 [==============================] - 0s 780us/step - loss: 0.1435 - ma
e: 0.2860 - val_loss: 0.0972 - val_mae: 0.2448
Epoch 72/75
144/144 [==============================] - 0s 773us/step - loss: 0.1458 - ma
e: 0.2863 - val_loss: 0.1060 - val_mae: 0.2569
Epoch 73/75
```

```
144/144 [==============================] - 0s 767us/step - loss: 0.1485 - ma
e: 0.2927 - val_loss: 0.0916 - val_mae: 0.2373
Epoch 74/75
144/144 [==============================] - 0s 771us/step - loss: 0.1513 - ma
e: 0.2932 - val_loss: 0.0998 - val_mae: 0.2543
Epoch 75/75
144/144 [==============================] - 0s 768us/step - loss: 0.1383 - ma
e: 0.2844 - val_loss: 0.1033 - val_mae: 0.2555
15/15 [==============================] - 0s 509us/step - loss: 0.1008 - mae:
0.2499
loss 0.10076762735843658
mae 0.24987000226974487
```

Experiment 4: Add a Batch Normalization Layer after each Dropout Layer.

In [ ]:
```
dataset_4 = data.drop(columns=["StudentID","Gender","Ethnicity","Extracurric

X_4 = dataset_4.drop(columns=['GPA'])
y_4 = dataset_4['GPA'].values

X4_train, X4_test, y4_train, y4_test = train_test_split(X_4, y_4, test_size=

scaler = StandardScaler()
X4_train = scaler.fit_transform(X4_train)
X4_test = scaler.transform(X4_test)

model_4 = Sequential([
    Dense(64, activation='relu', input_dim=X4_train.shape[1]),
    BatchNormalization(),
    Dropout(0.25),
    Dense(32, activation='relu'),
    BatchNormalization(),
    Dropout(0.25),
    Dense(16, activation='relu'),
    BatchNormalization(),
    Dropout(0.25),
    Dense(8, activation='relu'),
    BatchNormalization(),
    Dropout(0.25),
    Dense(1)
])

model_4.compile(
    optimizer='adam',
    loss='mse',
    metrics=['mae']
)

history_4 = model_4.fit(X4_train, y4_train, epochs=75, batch_size=10, valida
```

```
loss4, mae4 = model_4.evaluate(X4_test, y4_test)
print("loss", loss4)
print("mae", mae4)
```

```
Epoch 1/75
144/144 [==============================] - 1s 2ms/step - loss: 4.4734 - mae:
1.7957 - val_loss: 3.4301 - val_mae: 1.7099
Epoch 2/75
144/144 [==============================] - 0s 1ms/step - loss: 2.5992 - mae:
1.3585 - val_loss: 1.7462 - val_mae: 1.1938
Epoch 3/75
144/144 [==============================] - 0s 1ms/step - loss: 1.5085 - mae:
1.0029 - val_loss: 0.7968 - val_mae: 0.7834
Epoch 4/75
144/144 [==============================] - 0s 1ms/step - loss: 1.0194 - mae:
0.8040 - val_loss: 0.4334 - val_mae: 0.5546
Epoch 5/75
144/144 [==============================] - 0s 1ms/step - loss: 0.8328 - mae:
0.7236 - val_loss: 0.2706 - val_mae: 0.4302
Epoch 6/75
144/144 [==============================] - 0s 1ms/step - loss: 0.7169 - mae:
0.6700 - val_loss: 0.2428 - val_mae: 0.4067
Epoch 7/75
144/144 [==============================] - 0s 1ms/step - loss: 0.6404 - mae:
0.6383 - val_loss: 0.1929 - val_mae: 0.3588
Epoch 8/75
144/144 [==============================] - 0s 1ms/step - loss: 0.5593 - mae:
0.5900 - val_loss: 0.1878 - val_mae: 0.3564
Epoch 9/75
144/144 [==============================] - 0s 1ms/step - loss: 0.4871 - mae:
0.5577 - val_loss: 0.1616 - val_mae: 0.3287
Epoch 10/75
144/144 [==============================] - 0s 1ms/step - loss: 0.4582 - mae:
0.5345 - val_loss: 0.1387 - val_mae: 0.3022
Epoch 11/75
144/144 [==============================] - 0s 1ms/step - loss: 0.4601 - mae:
0.5381 - val_loss: 0.1398 - val_mae: 0.3066
Epoch 12/75
144/144 [==============================] - 0s 1ms/step - loss: 0.4267 - mae:
0.5155 - val_loss: 0.1189 - val_mae: 0.2793
Epoch 13/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3807 - mae:
0.4797 - val_loss: 0.1090 - val_mae: 0.2677
Epoch 14/75
144/144 [==============================] - 0s 1ms/step - loss: 0.4114 - mae:
0.5036 - val_loss: 0.1056 - val_mae: 0.2630
Epoch 15/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3684 - mae:
0.4774 - val_loss: 0.0995 - val_mae: 0.2549
Epoch 16/75
```

```
144/144 [==============================] - 0s 1ms/step - loss: 0.3680 - mae:
0.4695 - val_loss: 0.1000 - val_mae: 0.2553
Epoch 17/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3492 - mae:
0.4631 - val_loss: 0.0845 - val_mae: 0.2328
Epoch 18/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3385 - mae:
0.4614 - val_loss: 0.1001 - val_mae: 0.2569
Epoch 19/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3327 - mae:
0.4538 - val_loss: 0.0879 - val_mae: 0.2402
Epoch 20/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3096 - mae:
0.4394 - val_loss: 0.0950 - val_mae: 0.2516
Epoch 21/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3212 - mae:
0.4482 - val_loss: 0.0800 - val_mae: 0.2280
Epoch 22/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3057 - mae:
0.4370 - val_loss: 0.0741 - val_mae: 0.2172
Epoch 23/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3090 - mae:
0.4411 - val_loss: 0.0824 - val_mae: 0.2316
Epoch 24/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3073 - mae:
0.4397 - val_loss: 0.0820 - val_mae: 0.2306
Epoch 25/75
144/144 [==============================] - 0s 1ms/step - loss: 0.3208 - mae:
0.4448 - val_loss: 0.0785 - val_mae: 0.2247
Epoch 26/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2932 - mae:
0.4258 - val_loss: 0.0740 - val_mae: 0.2182
Epoch 27/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2740 - mae:
0.4145 - val_loss: 0.0827 - val_mae: 0.2324
Epoch 28/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2856 - mae:
0.4240 - val_loss: 0.0807 - val_mae: 0.2301
Epoch 29/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2738 - mae:
0.4152 - val_loss: 0.0805 - val_mae: 0.2306
Epoch 30/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2680 - mae:
0.4097 - val_loss: 0.0807 - val_mae: 0.2308
Epoch 31/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2689 - mae:
0.4130 - val_loss: 0.0771 - val_mae: 0.2253
Epoch 32/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2752 - mae:
0.4136 - val_loss: 0.0757 - val_mae: 0.2229
```

```
Epoch 33/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2620 - mae:
0.4070 - val_loss: 0.0781 - val_mae: 0.2247
Epoch 34/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2831 - mae:
0.4229 - val_loss: 0.0742 - val_mae: 0.2163
Epoch 35/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2626 - mae:
0.4059 - val_loss: 0.0686 - val_mae: 0.2070
Epoch 36/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2445 - mae:
0.3918 - val_loss: 0.0706 - val_mae: 0.2111
Epoch 37/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2720 - mae:
0.4110 - val_loss: 0.0641 - val_mae: 0.1995
Epoch 38/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2539 - mae:
0.3952 - val_loss: 0.0741 - val_mae: 0.2182
Epoch 39/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2597 - mae:
0.4017 - val_loss: 0.0712 - val_mae: 0.2133
Epoch 40/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2624 - mae:
0.4086 - val_loss: 0.0708 - val_mae: 0.2136
Epoch 41/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2546 - mae:
0.4042 - val_loss: 0.0653 - val_mae: 0.2030
Epoch 42/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2701 - mae:
0.4061 - val_loss: 0.0647 - val_mae: 0.2016
Epoch 43/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2561 - mae:
0.4020 - val_loss: 0.0766 - val_mae: 0.2232
Epoch 44/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2541 - mae:
0.3995 - val_loss: 0.0713 - val_mae: 0.2128
Epoch 45/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2569 - mae:
0.4049 - val_loss: 0.0714 - val_mae: 0.2124
Epoch 46/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2424 - mae:
0.3926 - val_loss: 0.0601 - val_mae: 0.1915
Epoch 47/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2581 - mae:
0.4005 - val_loss: 0.0692 - val_mae: 0.2076
Epoch 48/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2380 - mae:
0.3867 - val_loss: 0.0686 - val_mae: 0.2071
Epoch 49/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2448 - mae:
```

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0.3907 - val_loss: 0.0711 - val_mae: 0.2116
Epoch 50/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2488 - mae:
0.3958 - val_loss: 0.0657 - val_mae: 0.2020
Epoch 51/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2358 - mae:
0.3805 - val_loss: 0.0732 - val_mae: 0.2169
Epoch 52/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2500 - mae:
0.3927 - val_loss: 0.0640 - val_mae: 0.2003
Epoch 53/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2262 - mae:
0.3727 - val_loss: 0.0660 - val_mae: 0.2027
Epoch 54/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2398 - mae:
0.3793 - val_loss: 0.0722 - val_mae: 0.2143
Epoch 55/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2251 - mae:
0.3746 - val_loss: 0.0733 - val_mae: 0.2172
Epoch 56/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2296 - mae:
0.3785 - val_loss: 0.0628 - val_mae: 0.1985
Epoch 57/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2302 - mae:
0.3780 - val_loss: 0.0685 - val_mae: 0.2078
Epoch 58/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2441 - mae:
0.3982 - val_loss: 0.0684 - val_mae: 0.2079
Epoch 59/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2342 - mae:
0.3829 - val_loss: 0.0685 - val_mae: 0.2062
Epoch 60/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2225 - mae:
0.3736 - val_loss: 0.0710 - val_mae: 0.2107
Epoch 61/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2518 - mae:
0.4014 - val_loss: 0.0618 - val_mae: 0.1933
Epoch 62/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2040 - mae:
0.3579 - val_loss: 0.0672 - val_mae: 0.2051
Epoch 63/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2352 - mae:
0.3839 - val_loss: 0.0703 - val_mae: 0.2111
Epoch 64/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2322 - mae:
0.3863 - val_loss: 0.0646 - val_mae: 0.2009
Epoch 65/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2000 - mae:
0.3542 - val_loss: 0.0667 - val_mae: 0.2030
Epoch 66/75
```

```
144/144 [==============================] - 0s 1ms/step - loss: 0.2392 - mae:
0.3911 - val_loss: 0.0653 - val_mae: 0.2018
Epoch 67/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2179 - mae:
0.3653 - val_loss: 0.0645 - val_mae: 0.1992
Epoch 68/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2348 - mae:
0.3839 - val_loss: 0.0634 - val_mae: 0.1968
Epoch 69/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2201 - mae:
0.3720 - val_loss: 0.0655 - val_mae: 0.2001
Epoch 70/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2093 - mae:
0.3601 - val_loss: 0.0574 - val_mae: 0.1850
Epoch 71/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2122 - mae:
0.3646 - val_loss: 0.0591 - val_mae: 0.1893
Epoch 72/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2364 - mae:
0.3871 - val_loss: 0.0659 - val_mae: 0.2026
Epoch 73/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2084 - mae:
0.3602 - val_loss: 0.0630 - val_mae: 0.1966
Epoch 74/75
144/144 [==============================] - 0s 1ms/step - loss: 0.1975 - mae:
0.3488 - val_loss: 0.0649 - val_mae: 0.2008
Epoch 75/75
144/144 [==============================] - 0s 1ms/step - loss: 0.2356 - mae:
0.3882 - val_loss: 0.0619 - val_mae: 0.1954
15/15 [==============================] - 0s 577us/step - loss: 0.0604 - mae:
0.1904
loss 0.06040399521589279
mae 0.1904185265302658
```

Comparative Table

In [ ]:

```python
data = {
    'MAE': [mae1, mae2, mae3, mae4],
    'Loss': [loss1, loss2, loss3, loss4]
}
df = pd.DataFrame(data, index=['Modelo 1', 'Modelo 2', 'Modelo 3', 'Modelo 4

# Mostramos la tabla
print(df)
```

```
               MAE      Loss
Modelo 1  0.185143  0.059343
Modelo 2  0.190340  0.062981
Modelo 3  0.249870  0.100768
Modelo 4  0.190419  0.060404
```

Los modelos tienen una arquitectura similar, con 64 de input, 32, 16 y 8 layers en dense, con una ultima de 1, el dropout tendra un valor del 25%, y dentro del ultimo modelo se usa Batchnormalization.

El mejor modelo es el primero, ya que tiene el valor mas pequeño de MAE con 0.185143 y un Loss de 0.059343.