In [1]:
```python
import pandas as pd
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```python
df = pd.read_csv('E:\GetFreeCourses.Co-Udemy-Complete Tensorflow 2 and Keras Deep Learning Bootcamp\DATA\cance
```

In [3]:
```python
df.head()
```

Out[3]:

	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity	mean concave points	mean symmetry	mean fractal dimension	...	worst texture	worst perimeter	worst area
0	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.3001	0.14710	0.2419	0.07871	...	17.33	184.60	2019.0
1	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.0869	0.07017	0.1812	0.05667	...	23.41	158.80	1956.0
2	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.1974	0.12790	0.2069	0.05999	...	25.53	152.50	1709.0
3	11.42	20.38	77.58	386.1	0.14250	0.28390	0.2414	0.10520	0.2597	0.09744	...	26.50	98.87	567.7
4	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.1980	0.10430	0.1809	0.05883	...	16.67	152.20	1575.0

5 rows × 31 columns

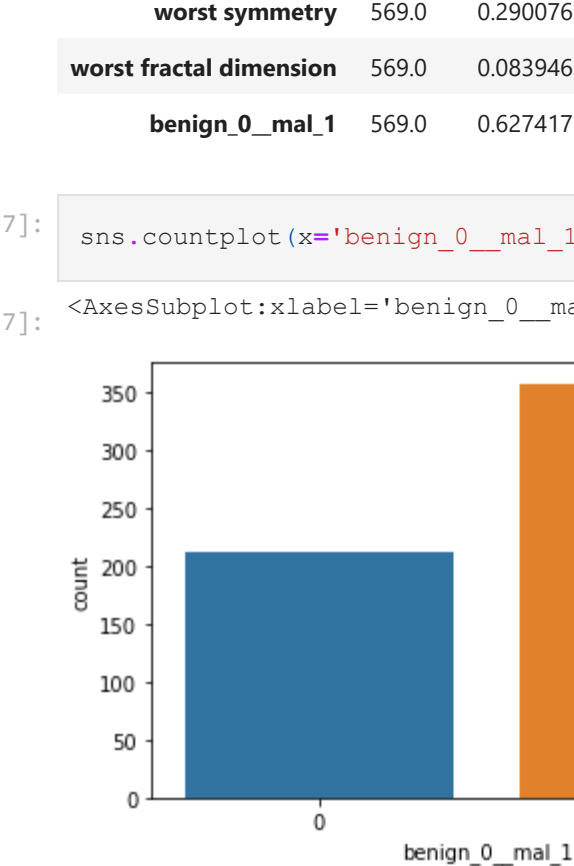
In [6]:
```python
df.describe().transpose()
```

Out[6]:

	count	mean	std	min	25%	50%	75%	max
mean radius	569.0	14.127292	3.524049	6.981000	11.700000	13.370000	15.780000	28.11000
mean texture	569.0	19.289649	4.301036	9.710000	16.170000	18.840000	21.800000	39.28000
mean perimeter	569.0	91.969033	24.298981	43.790000	75.170000	86.240000	104.100000	188.50000
mean area	569.0	654.889104	351.914129	143.500000	420.300000	551.100000	782.700000	2501.00000
mean smoothness	569.0	0.096360	0.014064	0.052630	0.086370	0.095870	0.105300	0.16340
mean compactness	569.0	0.104341	0.052813	0.019380	0.064920	0.092630	0.130400	0.34540
mean concavity	569.0	0.088799	0.079720	0.000000	0.029560	0.061540	0.130700	0.42680
mean concave points	569.0	0.048919	0.038803	0.000000	0.020310	0.033500	0.074000	0.20120
mean symmetry	569.0	0.181162	0.027414	0.106000	0.161900	0.179200	0.195700	0.30400
mean fractal dimension	569.0	0.062798	0.007060	0.049960	0.057700	0.061540	0.066120	0.09744
radius error	569.0	0.405172	0.277313	0.111500	0.232400	0.324200	0.478900	2.87300
texture error	569.0	1.216853	0.551648	0.360200	0.833900	1.108000	1.474000	4.88500
perimeter error	569.0	2.866059	2.021855	0.757000	1.606000	2.287000	3.357000	21.98000
area error	569.0	40.337079	45.491006	6.802000	17.850000	24.530000	45.190000	542.20000
smoothness error	569.0	0.007041	0.003003	0.001713	0.005169	0.006380	0.008146	0.03113
compactness error	569.0	0.025478	0.017908	0.002252	0.013080	0.020450	0.032450	0.13540
concavity error	569.0	0.031894	0.030186	0.000000	0.015090	0.025890	0.042050	0.39600
concave points error	569.0	0.011796	0.006170	0.000000	0.007638	0.010930	0.014710	0.05279
symmetry error	569.0	0.020542	0.008266	0.007882	0.015160	0.018730	0.023480	0.07895
fractal dimension error	569.0	0.003795	0.002646	0.000895	0.002248	0.003187	0.004558	0.02984
worst radius	569.0	16.269190	4.833242	7.930000	13.010000	14.970000	18.790000	36.04000
worst texture	569.0	25.677223	6.146258	12.020000	21.080000	25.410000	29.720000	49.54000
worst perimeter	569.0	107.261213	33.602542	50.410000	84.110000	97.660000	125.400000	251.20000
worst area	569.0	880.583128	569.356993	185.200000	515.300000	686.500000	1084.000000	4254.00000
worst smoothness	569.0	0.132369	0.022832	0.071170	0.116600	0.131300	0.146000	0.22260
worst compactness	569.0	0.254265	0.157336	0.027290	0.147200	0.211900	0.339100	1.05800
worst concavity	569.0	0.272188	0.208624	0.000000	0.114500	0.226700	0.382900	1.25200
worst concave points	569.0	0.114606	0.065732	0.000000	0.064930	0.099930	0.161400	0.29100
worst symmetry	569.0	0.290076	0.061867	0.156500	0.250400	0.282200	0.317900	0.66380
worst fractal dimension	569.0	0.083946	0.018061	0.055040	0.071460	0.080040	0.092080	0.20750
benign_0__mal_1	569.0	0.627417	0.483918	0.000000	0.000000	1.000000	1.000000	1.00000

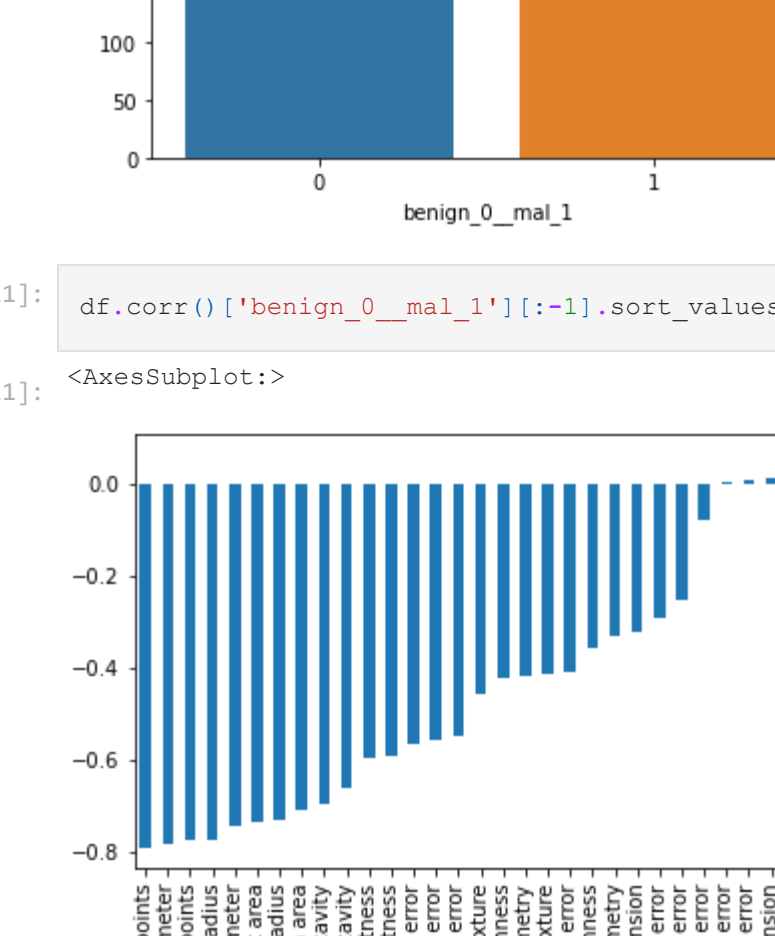
In [7]:
```python
sns.countplot(x='benign_0__mal_1',data=df)
```

Out[7]: <AxesSubplot:xlabel='benign_0__mal_1', ylabel='count'>



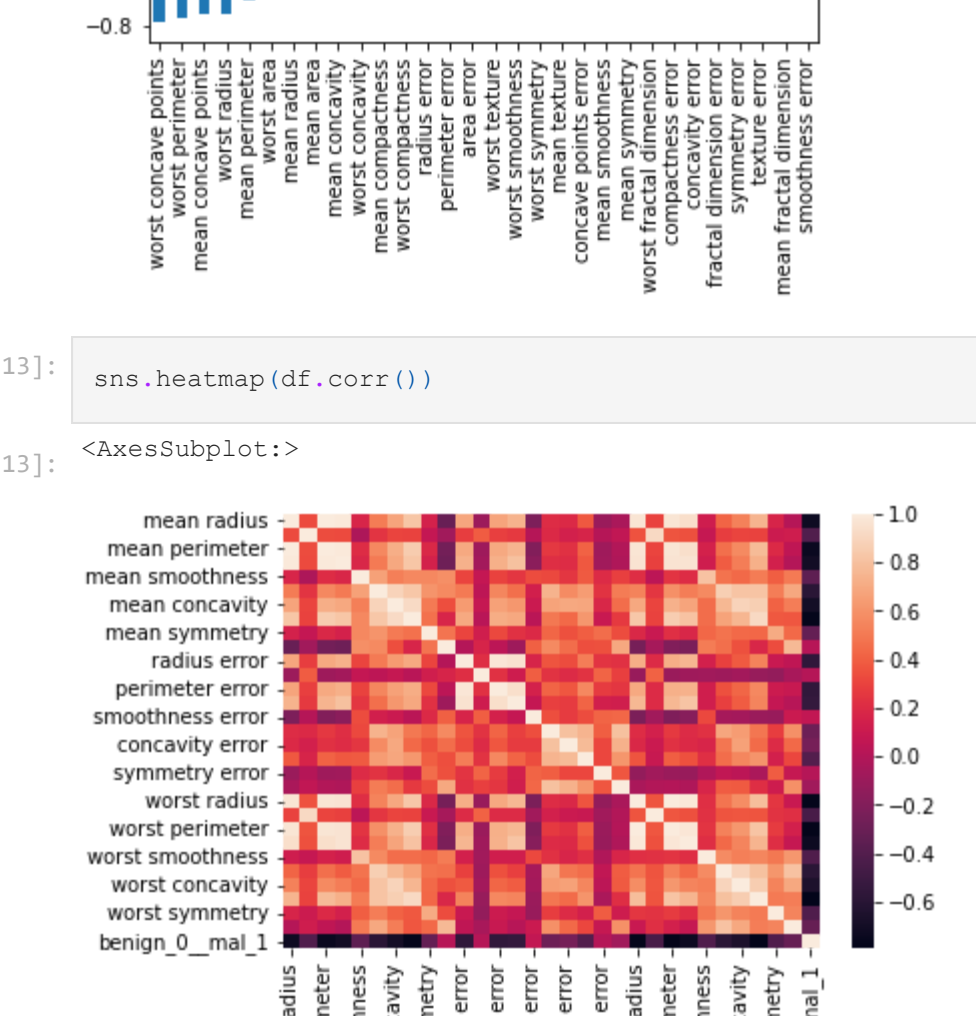
In [11]:
```python
df.corr()['benign_0__mal_1'][:-1].sort_values().plot(kind='bar')
```

Out[11]: <AxesSubplot:>



In [13]:
```python
sns.heatmap(df.corr())
```

Out[13]: <AxesSubplot:>



In [14]:
```python
X = df.drop('benign_0__mal_1',axis=1).values
y = df['benign_0__mal_1'].values
```

In [16]:
```python
from sklearn.model_selection import train_test_split
```

In [17]:
```python
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_state=101)
```

In [18]:
```python
from sklearn.preprocessing import MinMaxScaler
```

In [19]:
```python
scaler = MinMaxScaler()
```

In [20]:
```python
X_train = scaler.fit_transform(X_train)
```

In [21]:
```python
X_test = scaler.transform(X_test)
```

In [23]:
```python
from tensorflow.keras.models import Sequential
```

In [24]:
```python
from tensorflow.keras.layers import Dense,Dropout
```

In [25]:
```python
X_train.shape
```

Out[25]: (426, 30)

In [27]:
```python
model = Sequential()

model.add(Dense(30,activation='relu'))

model.add(Dense(15,activation='relu'))

#Binary class
model.add(Dense(1,activation='sigmoid'))

model.compile(loss='binary_crossentropy',optimizer='adam')
```

In [29]:
```python
model.fit(x=X_train,y=y_train,epochs=600,validation_data=(X_test,y_test))
```

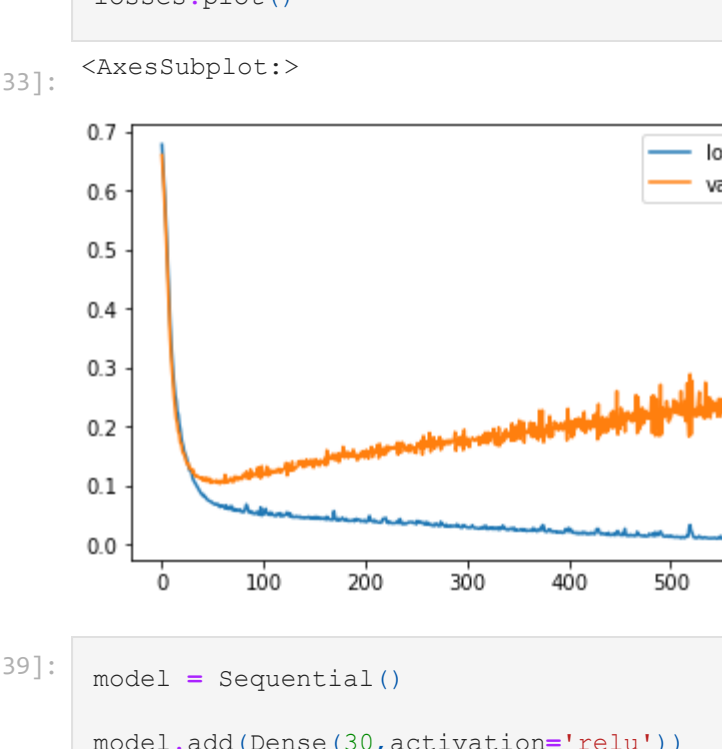
```
Epoch 451/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0155 - val_loss: 0.1956
Epoch 452/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0155 - val_loss: 0.2313
Epoch 453/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0161 - val_loss: 0.2210
Epoch 454/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0153 - val_loss: 0.2030
Epoch 455/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0206 - val_loss: 0.2143
Epoch 456/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0260 - val_loss: 0.1903
Epoch 457/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0149 - val_loss: 0.2227
Epoch 458/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0151 - val_loss: 0.2093
Epoch 459/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0141 - val_loss: 0.2243
Epoch 460/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0147 - val_loss: 0.2152
Epoch 461/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0163 - val_loss: 0.2202
Epoch 462/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0148 - val_loss: 0.2119
Epoch 463/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0148 - val_loss: 0.2079
Epoch 464/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0152 - val_loss: 0.2228
Epoch 465/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0142 - val_loss: 0.2182
Epoch 466/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0141 - val_loss: 0.2096
Epoch 467/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0145 - val_loss: 0.2529
Epoch 468/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0210 - val_loss: 0.1881
Epoch 469/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0158 - val_loss: 0.2493
Epoch 470/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0162 - val_loss: 0.1945
Epoch 471/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0146 - val_loss: 0.2286
Epoch 472/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0142 - val_loss: 0.2021
Epoch 473/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0138 - val_loss: 0.2313
Epoch 474/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0136 - val_loss: 0.2103
Epoch 475/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0151 - val_loss: 0.2053
Epoch 476/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0140 - val_loss: 0.2269
Epoch 477/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0134 - val_loss: 0.2138
Epoch 478/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0132 - val_loss: 0.2140
Epoch 479/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0142 - val_loss: 0.2223
Epoch 480/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0178 - val_loss: 0.2133
Epoch 481/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0160 - val_loss: 0.2190
Epoch 482/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0149 - val_loss: 0.2499
Epoch 483/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0149 - val_loss: 0.1881
Epoch 484/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0184 - val_loss: 0.2522
Epoch 485/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0139 - val_loss: 0.1959
Epoch 486/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0203 - val_loss: 0.1837
Epoch 487/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0180 - val_loss: 0.2464
Epoch 488/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0145 - val_loss: 0.1983
Epoch 489/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0161 - val_loss: 0.2272
Epoch 490/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0200 - val_loss: 0.1833
Epoch 491/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0216 - val_loss: 0.2705
Epoch 492/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0179 - val_loss: 0.1865
Epoch 493/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0143 - val_loss: 0.2323
Epoch 494/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0135 - val_loss: 0.2255
Epoch 495/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0129 - val_loss: 0.2152
Epoch 496/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0129 - val_loss: 0.2210
Epoch 497/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0143 - val_loss: 0.2426
Epoch 498/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0135 - val_loss: 0.2285
Epoch 499/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0129 - val_loss: 0.2071
Epoch 500/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0123 - val_loss: 0.2298
Epoch 501/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0144 - val_loss: 0.2146
Epoch 502/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0127 - val_loss: 0.2230
Epoch 503/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0129 - val_loss: 0.2296
Epoch 504/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0121 - val_loss: 0.2448
Epoch 505/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0118 - val_loss: 0.2237
Epoch 506/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0119 - val_loss: 0.2420
Epoch 507/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0128 - val_loss: 0.2219
Epoch 508/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0120 - val_loss: 0.2321
Epoch 509/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0120 - val_loss: 0.2369
Epoch 510/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0119 - val_loss: 0.2198
Epoch 511/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0105 - val_loss: 0.2596
Epoch 512/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0124 - val_loss: 0.2189
Epoch 513/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0119 - val_loss: 0.2333
Epoch 514/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0114 - val_loss: 0.2177
Epoch 515/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0109 - val_loss: 0.2434
Epoch 516/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0128 - val_loss: 0.2084
Epoch 517/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0135 - val_loss: 0.2727
Epoch 518/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0131 - val_loss: 0.2094
Epoch 519/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0267 - val_loss: 0.1824
Epoch 520/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0324 - val_loss: 0.2884
Epoch 521/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0225 - val_loss: 0.1861
Epoch 522/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0194 - val_loss: 0.2772
Epoch 523/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0140 - val_loss: 0.2194
Epoch 524/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0111 - val_loss: 0.2205
Epoch 525/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0117 - val_loss: 0.2170
Epoch 526/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0104 - val_loss: 0.2298
Epoch 527/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0105 - val_loss: 0.2171
Epoch 528/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0117 - val_loss: 0.2369
Epoch 529/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0137 - val_loss: 0.2582
Epoch 530/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0116 - val_loss: 0.2187
Epoch 531/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0106 - val_loss: 0.2338
Epoch 532/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0107 - val_loss: 0.2272
Epoch 533/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0101 - val_loss: 0.2277
Epoch 534/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0115 - val_loss: 0.2133
Epoch 535/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0115 - val_loss: 0.2743
Epoch 536/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0108 - val_loss: 0.2152
Epoch 537/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0103 - val_loss: 0.2436
Epoch 538/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0102 - val_loss: 0.2195
Epoch 539/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0101 - val_loss: 0.2489
Epoch 540/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0098 - val_loss: 0.2140
Epoch 541/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0104 - val_loss: 0.2435
Epoch 542/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0101 - val_loss: 0.2308
Epoch 543/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0100 - val_loss: 0.2247
Epoch 544/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0108 - val_loss: 0.2263
Epoch 545/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0102 - val_loss: 0.2404
Epoch 546/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0096 - val_loss: 0.2333
Epoch 547/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0093 - val_loss: 0.2165
Epoch 548/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0103 - val_loss: 0.2466
Epoch 549/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0108 - val_loss: 0.2322
Epoch 550/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0136 - val_loss: 0.2165
Epoch 551/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0101 - val_loss: 0.2464
Epoch 552/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0099 - val_loss: 0.2414
Epoch 553/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0090 - val_loss: 0.2224
Epoch 554/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0099 - val_loss: 0.2446
Epoch 555/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0091 - val_loss: 0.2227
Epoch 556/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0111 - val_loss: 0.2419
Epoch 557/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0144 - val_loss: 0.3005
Epoch 558/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0158 - val_loss: 0.1876
Epoch 559/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0171 - val_loss: 0.2675
Epoch 560/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0098 - val_loss: 0.2148
Epoch 561/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0133 - val_loss: 0.2524
Epoch 562/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0113 - val_loss: 0.2266
Epoch 563/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0096 - val_loss: 0.2235
Epoch 564/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0100 - val_loss: 0.2482
Epoch 565/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0091 - val_loss: 0.2379
Epoch 566/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0087 - val_loss: 0.2300
Epoch 567/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0085 - val_loss: 0.2460
Epoch 568/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0090 - val_loss: 0.2388
Epoch 569/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0115 - val_loss: 0.2153
Epoch 570/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0091 - val_loss: 0.2497
Epoch 571/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0083 - val_loss: 0.2390
Epoch 572/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0102 - val_loss: 0.2714
Epoch 573/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0094 - val_loss: 0.2412
Epoch 574/600
14/14 [==============================] - 0s 3ms/step - loss: 0.0083 - val_loss: 0.2391
Epoch 575/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0085 - val_loss: 0.2576
Epoch 576/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0084 - val_loss: 0.2251
Epoch 577/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0097 - val_loss: 0.2733
Epoch 578/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0087 - val_loss: 0.2088
Epoch 579/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0114 - val_loss: 0.3572
Epoch 580/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0171 - val_loss: 0.1987
Epoch 581/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0266 - val_loss: 0.3060
Epoch 582/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0146 - val_loss: 0.2474
Epoch 583/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0094 - val_loss: 0.2414
Epoch 584/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0077 - val_loss: 0.2426
Epoch 585/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0078 - val_loss: 0.2460
Epoch 586/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0079 - val_loss: 0.2341
Epoch 587/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0088 - val_loss: 0.2878
Epoch 588/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0092 - val_loss: 0.2105
Epoch 589/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0140 - val_loss: 0.2881
Epoch 590/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0134 - val_loss: 0.2767
Epoch 591/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0152 - val_loss: 0.2100
Epoch 592/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0127 - val_loss: 0.2285
Epoch 593/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0106 - val_loss: 0.2928
Epoch 594/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0121 - val_loss: 0.2179
Epoch 595/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0079 - val_loss: 0.2605
Epoch 596/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0076 - val_loss: 0.2367
Epoch 597/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0073 - val_loss: 0.2472
Epoch 598/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0077 - val_loss: 0.2622
Epoch 599/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0076 - val_loss: 0.2279
Epoch 600/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0076 - val_loss: 0.2492
```

Out[29]: <keras.callbacks.History at 0x2a0f7670e50>

In [31]:
```
losses = pd.DataFrame(model.history.history)
```

In [32]:
```
losses.plot()
```

Out[32]: <AxesSubplot:>



In [39]:
```
model = Sequential()

model.add(Dense(30,activation='relu'))

model.add(Dense(15,activation='relu'))

#Binary class
model.add(Dense(1,activation='sigmoid'))

model.compile(loss='binary_crossentropy',optimizer='adam')
```

In [40]:
```
from tensorflow.keras.callbacks import EarlyStopping
```

In [41]:
```
#help(EarlyStopping)
```

In [42]:
```
early_stop = EarlyStopping(monitor='val_loss',mode='min',verbose=1,patience=25)
```

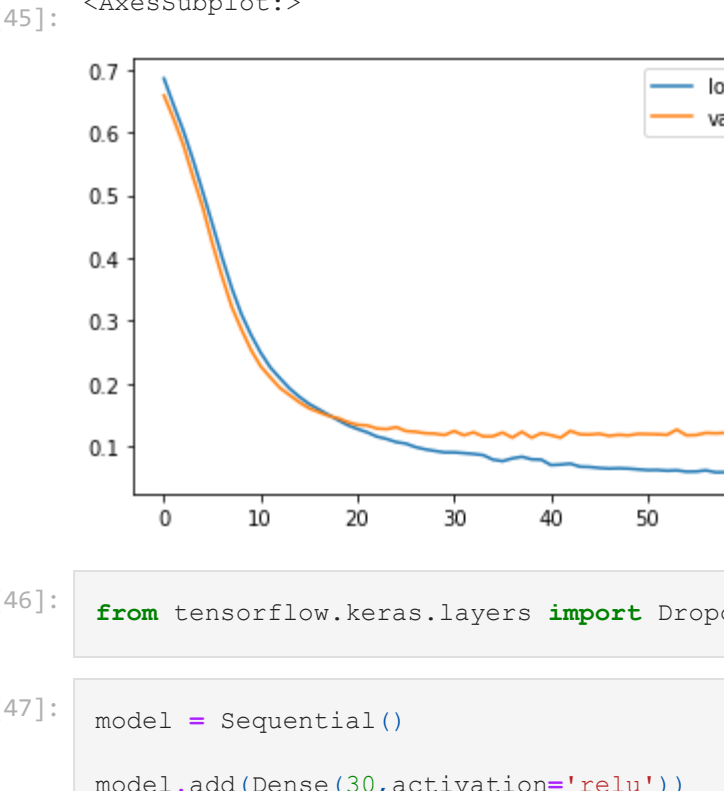
In [43]:
```
model.fit(x=X_train,y=y_train,epochs=600,validation_data=(X_test,y_test),callbacks=[early_stop])
```

```
Epoch 1/600
14/14 [==============================] - 1s 12ms/step - loss: 0.6855 - val_loss: 0.6586
Epoch 2/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6432 - val_loss: 0.6211
Epoch 3/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6026 - val_loss: 0.5797
Epoch 4/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5563 - val_loss: 0.5289
Epoch 5/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5057 - val_loss: 0.4807
Epoch 6/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4541 - val_loss: 0.4231
Epoch 7/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4013 - val_loss: 0.3703
Epoch 8/600
14/14 [==============================] - 0s 4ms/step - loss: 0.3526 - val_loss: 0.3222
Epoch 9/600
14/14 [==============================] - 0s 4ms/step - loss: 0.3106 - val_loss: 0.2864
Epoch 10/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2775 - val_loss: 0.2536
Epoch 11/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2491 - val_loss: 0.2276
Epoch 12/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2255 - val_loss: 0.2057
Epoch 13/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2083 - val_loss: 0.1929
Epoch 14/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1919 - val_loss: 0.1815
Epoch 15/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1788 - val_loss: 0.1701
Epoch 16/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1676 - val_loss: 0.1606
Epoch 17/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1590 - val_loss: 0.1545
Epoch 18/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1503 - val_loss: 0.1486
Epoch 19/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1418 - val_loss: 0.1449
Epoch 20/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1337 - val_loss: 0.1387
Epoch 21/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1277 - val_loss: 0.1342
Epoch 22/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1225 - val_loss: 0.1333
Epoch 23/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1156 - val_loss: 0.1285
Epoch 24/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1119 - val_loss: 0.1275
Epoch 25/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1069 - val_loss: 0.1306
Epoch 26/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1044 - val_loss: 0.1244
Epoch 27/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0989 - val_loss: 0.1232
Epoch 28/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0953 - val_loss: 0.1209
Epoch 29/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0928 - val_loss: 0.1202
Epoch 30/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0905 - val_loss: 0.1180
Epoch 31/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0905 - val_loss: 0.1244
Epoch 32/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0893 - val_loss: 0.1176
Epoch 33/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0880 - val_loss: 0.1224
Epoch 34/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0861 - val_loss: 0.1260
Epoch 35/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0790 - val_loss: 0.1160
Epoch 36/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0765 - val_loss: 0.1220
Epoch 37/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0809 - val_loss: 0.1140
Epoch 38/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0835 - val_loss: 0.1232
Epoch 39/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0794 - val_loss: 0.1138
Epoch 40/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0789 - val_loss: 0.1210
Epoch 41/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0703 - val_loss: 0.1178
Epoch 42/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0711 - val_loss: 0.1138
Epoch 43/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0725 - val_loss: 0.1244
Epoch 44/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0678 - val_loss: 0.1192
Epoch 45/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0672 - val_loss: 0.1188
Epoch 46/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0656 - val_loss: 0.1201
Epoch 47/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0647 - val_loss: 0.1167
Epoch 48/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0652 - val_loss: 0.1185
Epoch 49/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0646 - val_loss: 0.1175
Epoch 50/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0636 - val_loss: 0.1194
Epoch 51/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0622 - val_loss: 0.1196
Epoch 52/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0628 - val_loss: 0.1193
Epoch 53/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0613 - val_loss: 0.1183
Epoch 54/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0619 - val_loss: 0.1267
Epoch 55/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0597 - val_loss: 0.1177
Epoch 56/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0600 - val_loss: 0.1181
Epoch 57/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0619 - val_loss: 0.1215
Epoch 58/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0588 - val_loss: 0.1208
Epoch 59/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0589 - val_loss: 0.1215
Epoch 60/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0581 - val_loss: 0.1236
Epoch 61/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0577 - val_loss: 0.1235
Epoch 62/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0566 - val_loss: 0.1247
Epoch 63/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0578 - val_loss: 0.1284
Epoch 64/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0563 - val_loss: 0.1256
Epoch 64: early stopping
```

Out[43]: <keras.callbacks.History at 0x2a03b58c520>

In [45]:
```
model_loss = pd.DataFrame(model.history.history)
model_loss.plot()
```

Out[45]: <AxesSubplot:>



In [46]:
```
from tensorflow.keras.layers import Dropout
```

In [47]:
```
model = Sequential()

model.add(Dense(30,activation='relu'))

model.add(Dropout(0.5))

model.add(Dense(15,activation='relu'))

model.add(Dropout(0.5))

#Binary class
model.add(Dense(1,activation='sigmoid'))

model.compile(loss='binary_crossentropy',optimizer='adam')
```

In [48]:
```
model.fit(x=X_train,y=y_train,epochs=600,validation_data=(X_test,y_test),callbacks=[early_stop])
```

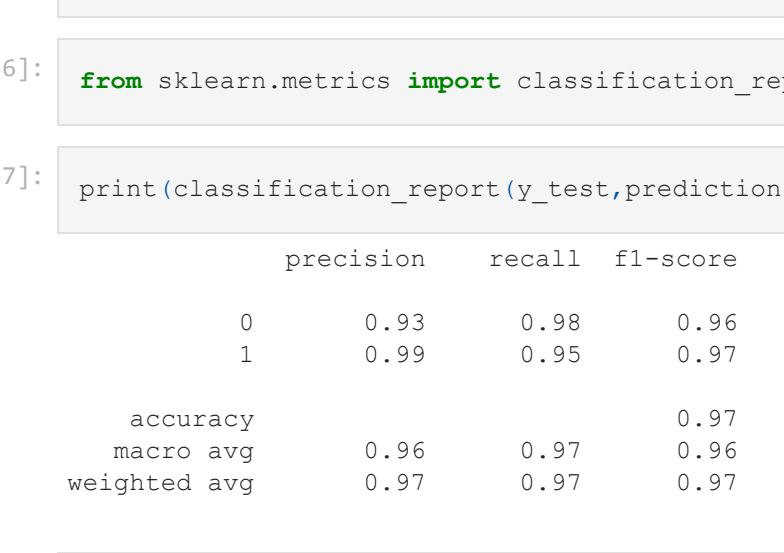
```
Epoch 1/600
14/14 [==============================] - 1s 12ms/step - loss: 0.7548 - val_loss: 0.7197
Epoch 2/600
14/14 [==============================] - 0s 4ms/step - loss: 0.7198 - val_loss: 0.7002
Epoch 3/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6898 - val_loss: 0.6860
Epoch 4/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6916 - val_loss: 0.6742
Epoch 5/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6811 - val_loss: 0.6618
Epoch 6/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6709 - val_loss: 0.6512
Epoch 7/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6565 - val_loss: 0.6375
Epoch 8/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6418 - val_loss: 0.6224
Epoch 9/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6291 - val_loss: 0.6086
Epoch 10/600
14/14 [==============================] - 0s 4ms/step - loss: 0.6060 - val_loss: 0.5909
Epoch 11/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5892 - val_loss: 0.5648
Epoch 12/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5529 - val_loss: 0.5421
Epoch 13/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5479 - val_loss: 0.5187
Epoch 14/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5305 - val_loss: 0.4972
Epoch 15/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5195 - val_loss: 0.4740
Epoch 16/600
14/14 [==============================] - 0s 4ms/step - loss: 0.5385 - val_loss: 0.4574
Epoch 17/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4974 - val_loss: 0.4366
Epoch 18/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4615 - val_loss: 0.4015
Epoch 19/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4574 - val_loss: 0.3725
Epoch 20/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4145 - val_loss: 0.3522
Epoch 21/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4183 - val_loss: 0.3280
Epoch 22/600
14/14 [==============================] - 0s 4ms/step - loss: 0.4072 - val_loss: 0.3095
Epoch 23/600
14/14 [==============================] - 0s 3ms/step - loss: 0.3692 - val_loss: 0.2882
Epoch 24/600
14/14 [==============================] - 0s 5ms/step - loss: 0.3511 - val_loss: 0.2677
Epoch 25/600
14/14 [==============================] - 0s 5ms/step - loss: 0.3438 - val_loss: 0.2489
Epoch 26/600
14/14 [==============================] - 0s 4ms/step - loss: 0.3439 - val_loss: 0.2361
Epoch 27/600
14/14 [==============================] - 0s 5ms/step - loss: 0.3403 - val_loss: 0.2307
Epoch 28/600
14/14 [==============================] - 0s 5ms/step - loss: 0.3055 - val_loss: 0.2097
Epoch 29/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2958 - val_loss: 0.2031
Epoch 30/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2976 - val_loss: 0.1983
Epoch 31/600
14/14 [==============================] - 0s 4ms/step - loss: 0.3061 - val_loss: 0.1854
Epoch 32/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2779 - val_loss: 0.1802
Epoch 33/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2768 - val_loss: 0.1803
Epoch 34/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2900 - val_loss: 0.1699
Epoch 35/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2550 - val_loss: 0.1607
Epoch 36/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2494 - val_loss: 0.1590
Epoch 37/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2286 - val_loss: 0.1477
Epoch 38/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2483 - val_loss: 0.1498
Epoch 39/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2434 - val_loss: 0.1481
Epoch 40/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2680 - val_loss: 0.1505
Epoch 41/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2069 - val_loss: 0.1381
Epoch 42/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2358 - val_loss: 0.1362
Epoch 43/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2153 - val_loss: 0.1445
Epoch 44/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1890 - val_loss: 0.1288
Epoch 45/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2170 - val_loss: 0.1300
Epoch 46/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2121 - val_loss: 0.1241
Epoch 47/600
14/14 [==============================] - 0s 5ms/step - loss: 0.2196 - val_loss: 0.1273
Epoch 48/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2055 - val_loss: 0.1197
Epoch 49/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1923 - val_loss: 0.1172
Epoch 50/600
14/14 [==============================] - 0s 4ms/step - loss: 0.2120 - val_loss: 0.1184
Epoch 51/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1836 - val_loss: 0.1119
Epoch 52/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1736 - val_loss: 0.1141
Epoch 53/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1861 - val_loss: 0.1212
Epoch 54/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1722 - val_loss: 0.1189
Epoch 55/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1614 - val_loss: 0.1147
Epoch 56/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1903 - val_loss: 0.1120
Epoch 57/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1480 - val_loss: 0.1018
Epoch 58/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1733 - val_loss: 0.1060
Epoch 59/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1878 - val_loss: 0.1008
Epoch 60/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1714 - val_loss: 0.1133
Epoch 61/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1549 - val_loss: 0.1012
Epoch 62/600
14/14 [==============================] - 0s 5ms/step - loss: 0.1435 - val_loss: 0.0985
Epoch 63/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1621 - val_loss: 0.1064
Epoch 64/600
14/14 [==============================] - 0s 5ms/step - loss: 0.1868 - val_loss: 0.1079
Epoch 65/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1471 - val_loss: 0.0925
Epoch 66/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1463 - val_loss: 0.1055
Epoch 67/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1463 - val_loss: 0.0981
Epoch 68/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1516 - val_loss: 0.0903
Epoch 69/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1451 - val_loss: 0.1009
Epoch 70/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1440 - val_loss: 0.1041
Epoch 71/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1683 - val_loss: 0.1029
Epoch 72/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1467 - val_loss: 0.1093
Epoch 73/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1454 - val_loss: 0.0938
Epoch 74/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1468 - val_loss: 0.0973
Epoch 75/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1482 - val_loss: 0.0915
Epoch 76/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1176 - val_loss: 0.0932
Epoch 77/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1485 - val_loss: 0.1031
Epoch 78/600
14/14 [==============================] - 0s 5ms/step - loss: 0.1478 - val_loss: 0.0930
Epoch 79/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1312 - val_loss: 0.0918
Epoch 80/600
14/14 [==============================] - 0s 5ms/step - loss: 0.1276 - val_loss: 0.0921
Epoch 81/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1410 - val_loss: 0.0900
Epoch 82/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1210 - val_loss: 0.0887
Epoch 83/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1255 - val_loss: 0.0903
Epoch 84/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1248 - val_loss: 0.1071
Epoch 85/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1293 - val_loss: 0.0953
Epoch 86/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1382 - val_loss: 0.0946
Epoch 87/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1157 - val_loss: 0.1030
Epoch 88/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1392 - val_loss: 0.0839
Epoch 89/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1186 - val_loss: 0.0914
Epoch 90/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1290 - val_loss: 0.0985
Epoch 91/600
14/14 [==============================] - 0s 5ms/step - loss: 0.1154 - val_loss: 0.0909
Epoch 92/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1185 - val_loss: 0.0877
Epoch 93/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1314 - val_loss: 0.0892
Epoch 94/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1338 - val_loss: 0.0984
Epoch 95/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1112 - val_loss: 0.0911
Epoch 96/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1280 - val_loss: 0.0840
Epoch 97/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1066 - val_loss: 0.0910
Epoch 98/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1056 - val_loss: 0.1001
Epoch 99/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1063 - val_loss: 0.0862
Epoch 100/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1116 - val_loss: 0.1078
Epoch 101/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1170 - val_loss: 0.0956
Epoch 102/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1267 - val_loss: 0.0883
Epoch 103/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0925 - val_loss: 0.0917
Epoch 104/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0990 - val_loss: 0.1020
Epoch 105/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0897 - val_loss: 0.0906
Epoch 106/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1117 - val_loss: 0.0980
Epoch 107/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1061 - val_loss: 0.1042
Epoch 108/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1098 - val_loss: 0.0896
Epoch 109/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1114 - val_loss: 0.0953
Epoch 110/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1073 - val_loss: 0.0875
Epoch 111/600
14/14 [==============================] - 0s 4ms/step - loss: 0.0938 - val_loss: 0.0840
Epoch 112/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1176 - val_loss: 0.0884
Epoch 113/600
14/14 [==============================] - 0s 4ms/step - loss: 0.1138 - val_loss: 0.0955
Epoch 113: early stopping
```

Out[48]: <keras.callbacks.History at 0x2a0f6b2c8c40>

In [49]:
```
model_loss = pd.DataFrame(model.history.history)
```

In [50]:
```
model_loss.plot()
```

Out[50]: <AxesSubplot:>



In [54]:
```
predictions = (model.predict(X_test) > 0.5).astype("int32")
```

In [56]:
```
from sklearn.metrics import classification_report,confusion_matrix
```

In [57]:
```
print(classification_report(y_test,predictions))
```

```
              precision    recall  f1-score   support

           0       0.93      0.98      0.96        55
           1       0.99      0.95      0.97        88

    accuracy                           0.97       143
   macro avg       0.96      0.97      0.96       143
weighted avg       0.97      0.97      0.97       143
```

In [58]:
```
print(confusion_matrix(y_test,predictions))
```

```
[[54  1]
 [ 4 84]]
```

In [ ]: