Logistic Regression

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, classification_report, confusion_m
```

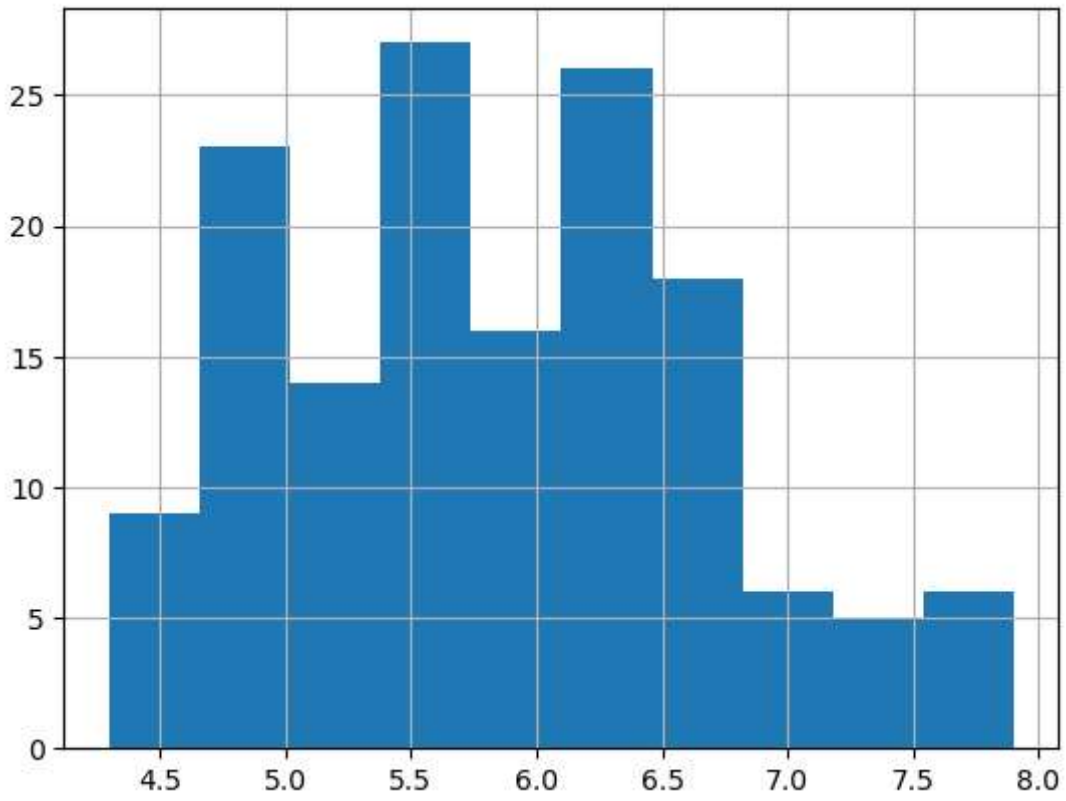
In [2]:
```
df = pd.read_csv('E:\\MCA\\sem_3\\ML_Lab\\programs\\week4\\iris.csv')
df.head()
```

Out[2]:

	id	SepalLengthCm	SepalWidthCm	petallengthcm	petalwidthcm	species
0	1	5.1	3.5	1.4	0.2	Iris-setosa
1	2	4.9	3.0	1.4	0.2	Iris-setosa
2	3	4.7	3.2	1.3	0.2	Iris-setosa
3	4	4.6	3.1	1.5	0.2	Iris-setosa
4	5	5.0	3.6	1.4	0.2	Iris-setosa

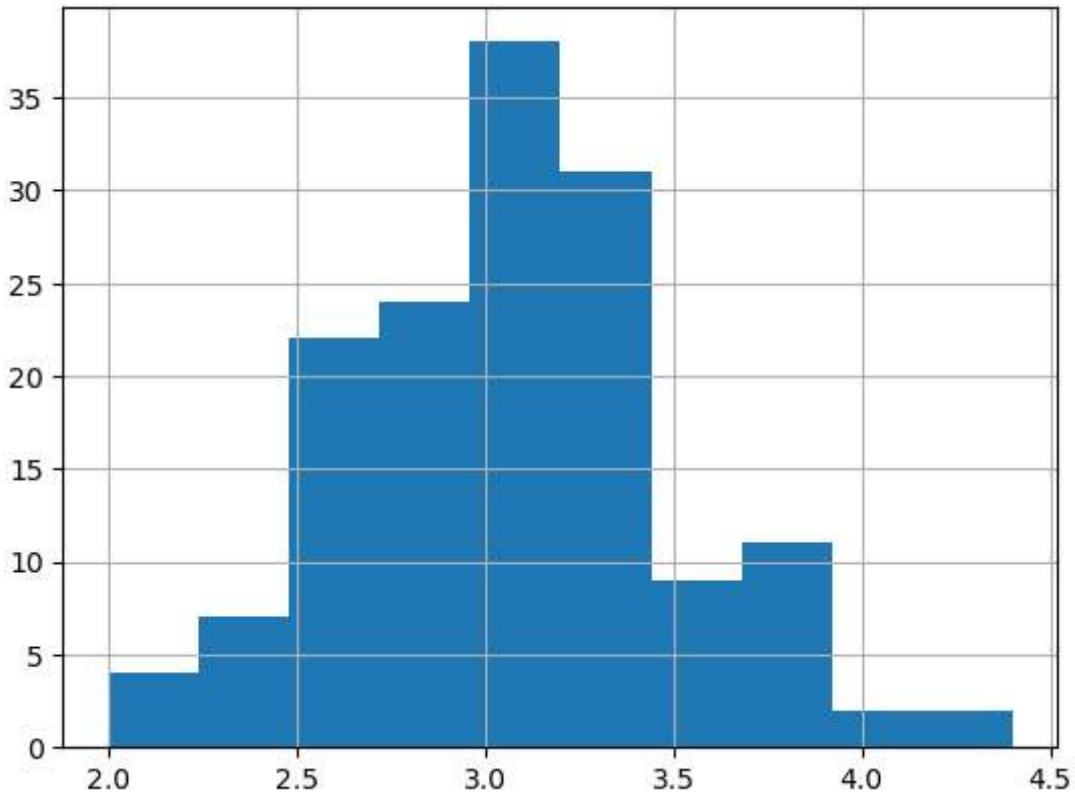
In [3]:
```
df['SepalLengthCm'].hist()
```

Out[3]: <Axes: >



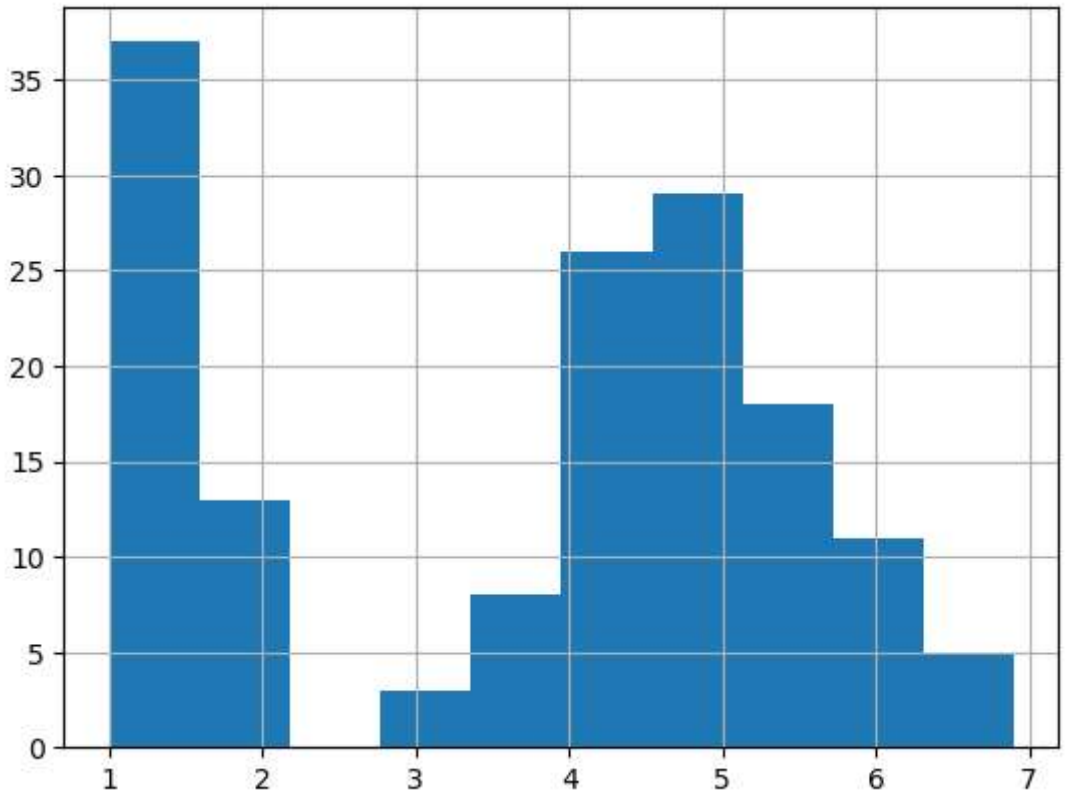
In [4]:
```
df['SepalWidthCm'].hist()
```

Out[4]: <Axes: >



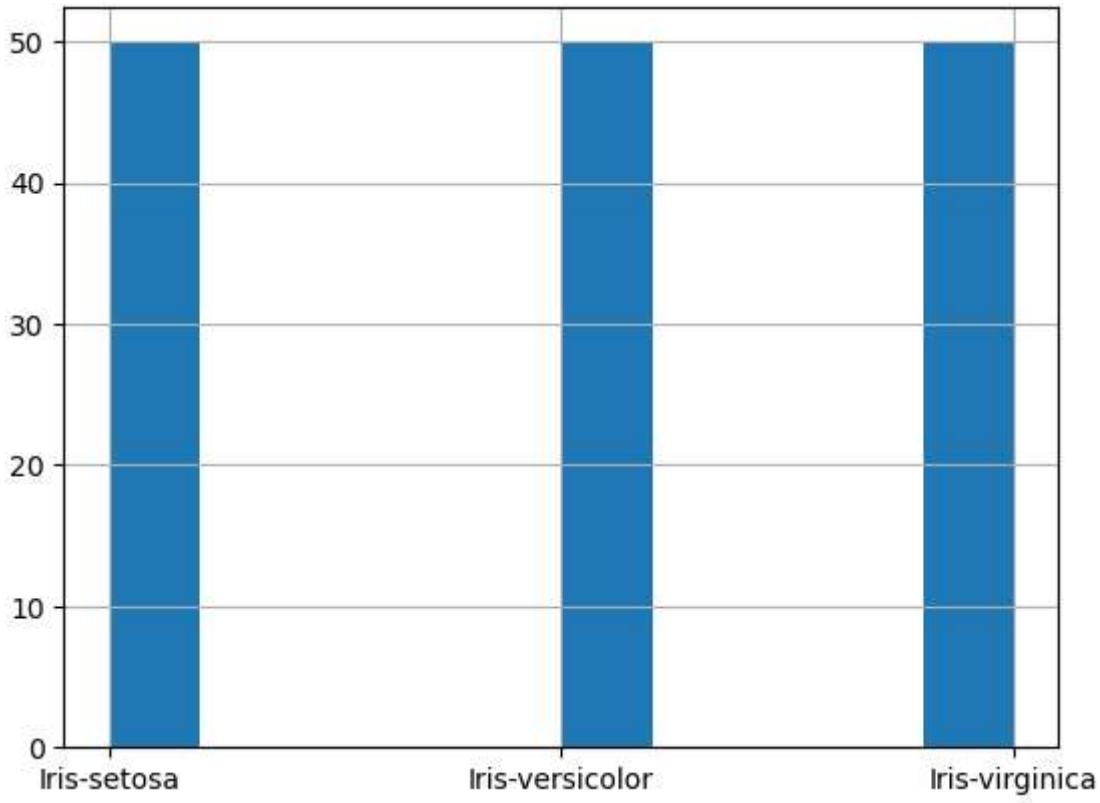
In [5]:
```
df['petallengthcm'].hist()
```

Out[5]: <Axes: >



In [6]:
```
df['species'].hist()
```

Out[6]: <Axes: >



In [7]:
```
df.corr()
```

```
C:\Users\Dell\AppData\Local\Temp\ipykernel_4856\1134722465.py:1: FutureWarnin
g: The default value of numeric_only in DataFrame.corr is deprecated. In a fu
ture version, it will default to False. Select only valid columns or specify
the value of numeric_only to silence this warning.
  df.corr()
```

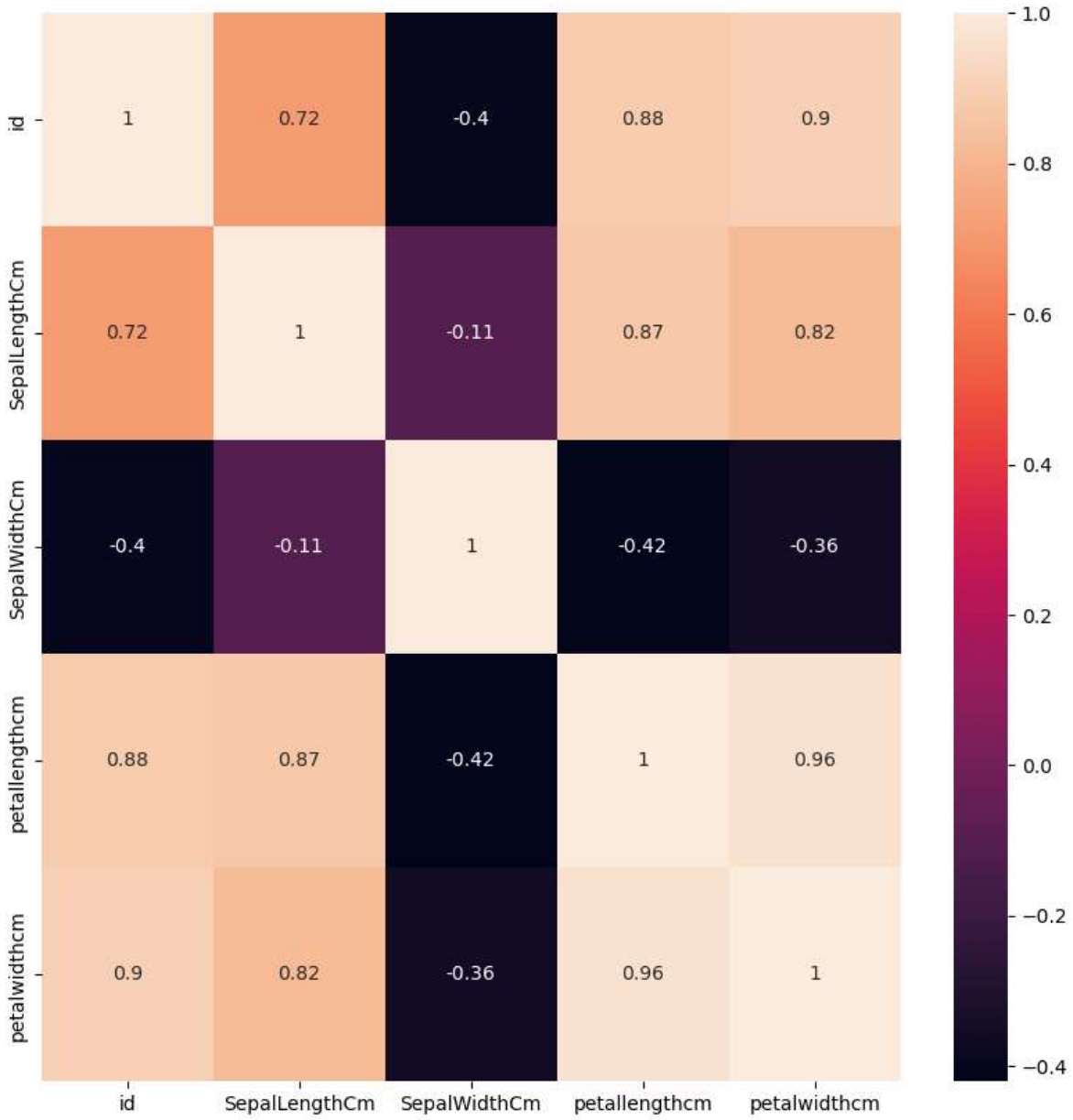
Out[7]:

	id	SepalLengthCm	SepalWidthCm	petallengthcm	petalwidthcm
id	1.000000	0.716676	-0.397729	0.882747	0.899759
SepalLengthCm	0.716676	1.000000	-0.109369	0.871754	0.817954
SepalWidthCm	-0.397729	-0.109369	1.000000	-0.420516	-0.356544
petallengthcm	0.882747	0.871754	-0.420516	1.000000	0.962757
petalwidthcm	0.899759	0.817954	-0.356544	0.962757	1.000000

In [8]:
```
import seaborn as sns
corr = df.corr()
fig, ax = plt.subplots(figsize=(10,10))
sns.heatmap(corr,annot=True,ax=ax)
```

```
C:\Users\Dell\AppData\Local\Temp\ipykernel_4856\3565827497.py:2: FutureWarnin
g: The default value of numeric_only in DataFrame.corr is deprecated. In a fu
ture version, it will default to False. Select only valid columns or specify
the value of numeric_only to silence this warning.
  corr = df.corr()
```

Out[8]: <Axes: >



In [9]:
```
x = df.drop(['species'],axis = 1).values
x
```

Out[9]:
```
array([[1.00e+00, 5.10e+00, 3.50e+00, 1.40e+00, 2.00e-01],
       [2.00e+00, 4.90e+00, 3.00e+00, 1.40e+00, 2.00e-01],
       [3.00e+00, 4.70e+00, 3.20e+00, 1.30e+00, 2.00e-01],
       [4.00e+00, 4.60e+00, 3.10e+00, 1.50e+00, 2.00e-01],
       [5.00e+00, 5.00e+00, 3.60e+00, 1.40e+00, 2.00e-01],
       [6.00e+00, 5.40e+00, 3.90e+00, 1.70e+00, 4.00e-01],
       [7.00e+00, 4.60e+00, 3.40e+00, 1.40e+00, 3.00e-01],
       [8.00e+00, 5.00e+00, 3.40e+00, 1.50e+00, 2.00e-01],
       [9.00e+00, 4.40e+00, 2.90e+00, 1.40e+00, 2.00e-01],
       [1.00e+01, 4.90e+00, 3.10e+00, 1.50e+00, 1.00e-01],
       [1.10e+01, 5.40e+00, 3.70e+00, 1.50e+00, 2.00e-01],
       [1.20e+01, 4.80e+00, 3.40e+00, 1.60e+00, 2.00e-01],
       [1.30e+01, 4.80e+00, 3.00e+00, 1.40e+00, 1.00e-01],
       [1.40e+01, 4.30e+00, 3.00e+00, 1.10e+00, 1.00e-01],
       [1.50e+01, 5.80e+00, 4.00e+00, 1.20e+00, 2.00e-01],
       [1.60e+01, 5.70e+00, 4.40e+00, 1.50e+00, 4.00e-01],
       [1.70e+01, 5.40e+00, 3.90e+00, 1.30e+00, 4.00e-01],
       [1.80e+01, 5.10e+00, 3.50e+00, 1.40e+00, 3.00e-01],
       [1.90e+01, 5.70e+00, 3.80e+00, 1.70e+00, 3.00e-01],
```

In [10]:
```
df[['species']] = df[['species']].replace(to_replace={'Iris-setosa':0,'Iris-ve
```

In [11]:
```
y = df['species'].values
y
```

Out[11]:
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2], dtype=int64)
```

Iteration 1

i. test_size = 0.3 random_state = 0

In [12]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.3,random
```

In [13]:
```
model = LogisticRegression(max_iter=1000)
```

In [14]:
```
model.fit(x_train,y_train)
```

Out[14]:
```
LogisticRegression(max_iter=1000)
```
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In [15]:
```
y_pred = model.predict(x_test)
```

In [16]:
```
y_pred
```

Out[16]:
```
array([2, 1, 0, 2, 0, 2, 0, 1, 1, 1, 2, 1, 1, 1, 1, 0, 1, 1, 0, 0, 2, 1,
       0, 0, 2, 0, 0, 1, 1, 0, 2, 1, 0, 2, 2, 1, 0, 1, 1, 1, 2, 0, 2, 0,
       0], dtype=int64)
```

In [17]:
```
model.score(x,y)
```

Out[17]:
```
1.0
```

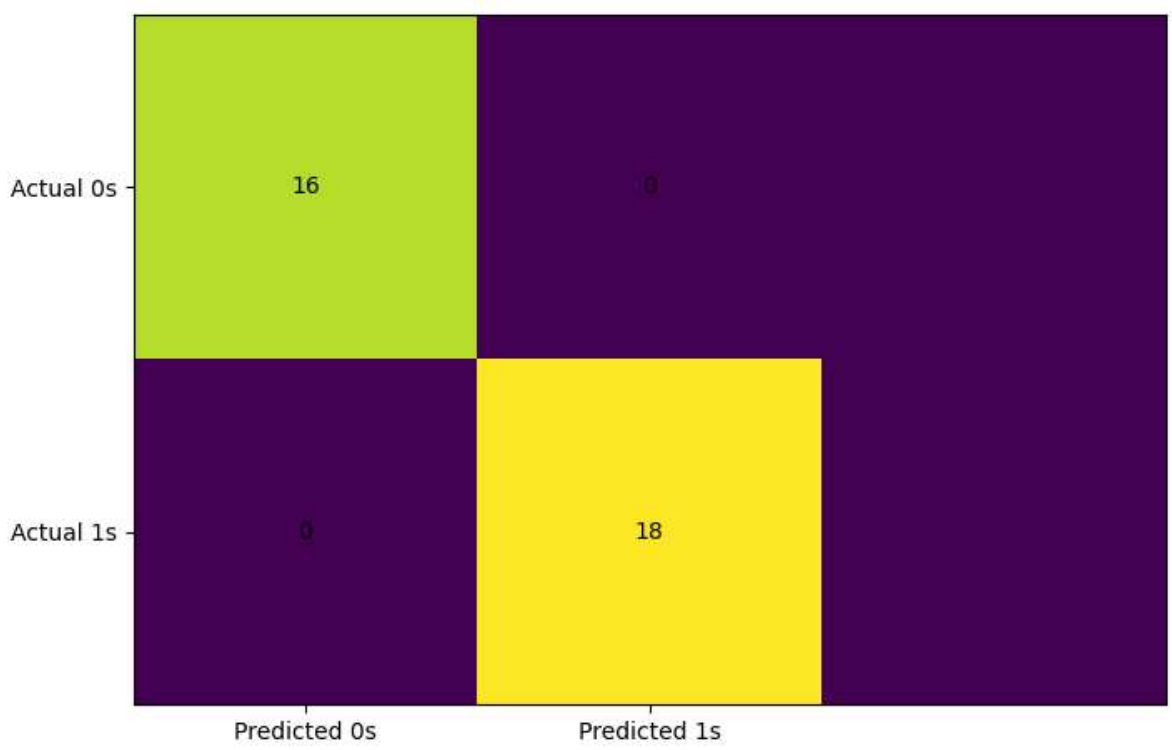
In [18]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R-squared: {r2:.2f}")
```

```
Mean Squared Error: 0.00
R-squared: 1.00
```

In [19]:
```
confusion_matrix(y_test, y_pred)
```

Out[19]:
```
array([[16,  0,  0],
       [ 0, 18,  0],
       [ 0,  0, 11]], dtype=int64)
```

In [20]:
```
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='black')
plt.show()
```



In [21]:
```
accuracy = accuracy_score(y_test, y_pred)
classification_report_result = classification_report(y_test, y_pred)
confusion_matrix_result = confusion_matrix(y_test, y_pred)

print("Accuracy:", accuracy)
print("Classification Report:\n", classification_report_result)
print("Confusion Matrix:\n", confusion_matrix_result)
```

```
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      1.00      1.00        18
           2       1.00      1.00      1.00        11

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45

Confusion Matrix:
 [[16  0  0]
 [ 0 18  0]
 [ 0  0 11]]
```

ii. test_size = 0.3 random_state = 42

In [22]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.3,random
```

In [23]:
```
model = LogisticRegression(max_iter=1000)
```

In [24]:
```
model.fit(x_train,y_train)
```

Out[24]:
```
LogisticRegression(max_iter=1000)
```

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In [25]:
```
y_pred = model.predict(x_test)
```

In [26]:
```
y_pred
```

Out[26]:
```
array([1, 0, 2, 1, 1, 0, 1, 2, 1, 1, 2, 0, 0, 0, 0, 1, 2, 1, 1, 2, 0, 2,
       0, 2, 2, 2, 2, 2, 0, 0, 0, 0, 1, 0, 0, 2, 1, 0, 0, 0, 2, 1, 1, 0,
       0], dtype=int64)
```

In [27]:
```
model.score(x,y)
```

Out[27]:
```
1.0
```

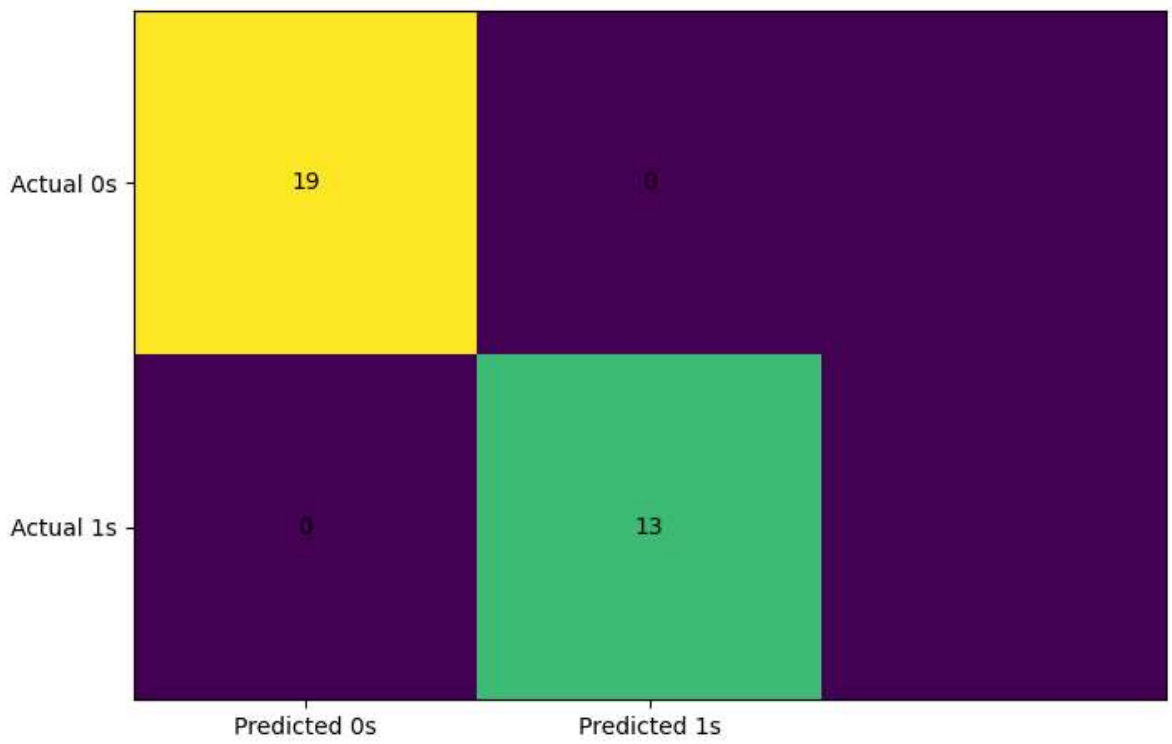
In [28]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R-squared: {r2:.2f}")
```

```
Mean Squared Error: 0.00
R-squared: 1.00
```

In [29]:
```
confusion_matrix(y_test, y_pred)
```

Out[29]:
```
array([[19,  0,  0],
       [ 0, 13,  0],
       [ 0,  0, 13]], dtype=int64)
```

In [30]:
```
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='black')
plt.show()
```



In [31]:
```
accuracy = accuracy_score(y_test, y_pred)
classification_report_result = classification_report(y_test, y_pred)
confusion_matrix_result = confusion_matrix(y_test, y_pred)

print("Accuracy:", accuracy)
print("Classification Report:\n", classification_report_result)
print("Confusion Matrix:\n", confusion_matrix_result)
```

```
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        19
           1       1.00      1.00      1.00        13
           2       1.00      1.00      1.00        13

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45

Confusion Matrix:
 [[19  0  0]
 [ 0 13  0]
 [ 0  0 13]]
```

Iteration 2

i. test_size = 0.4 random_state = 0

In [32]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.4,random
```

In [33]:
```
model = LogisticRegression(max_iter=1000)
```

In [34]:
```
model.fit(x_train,y_train)
```

Out[34]:
```
LogisticRegression(max_iter=1000)
```

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In [35]:
```
y_pred = model.predict(x_test)
```

In [36]:
```
y_pred
```

Out[36]:
```
array([2, 1, 0, 2, 0, 2, 0, 1, 1, 1, 2, 1, 1, 1, 1, 0, 1, 1, 0, 0, 2, 1,
       0, 0, 2, 0, 0, 1, 1, 0, 2, 1, 0, 2, 2, 1, 0, 1, 1, 1, 2, 0, 2, 0,
       0, 1, 2, 2, 2, 2, 1, 2, 1, 1, 2, 2, 2, 2, 1, 2], dtype=int64)
```

In [37]:
```
model.score(x,y)
```

Out[37]:
```
1.0
```

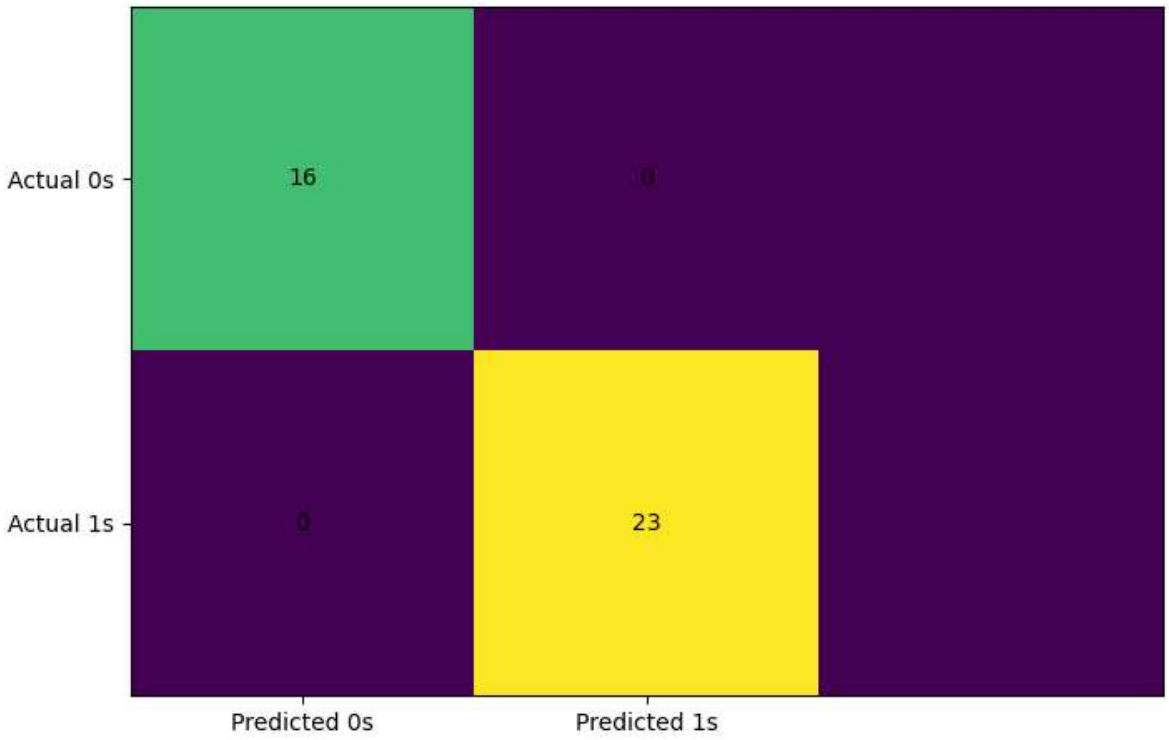
In [38]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R-squared: {r2:.2f}")
```

```
Mean Squared Error: 0.00
R-squared: 1.00
```

In [39]:
```
confusion_matrix(y_test, y_pred)
```

Out[39]:
```
array([[16,  0,  0],
       [ 0, 23,  0],
       [ 0,  0, 21]], dtype=int64)
```

In [40]:
```
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='black')
plt.show()
```



In [41]:
```
accuracy = accuracy_score(y_test, y_pred)
classification_report_result = classification_report(y_test, y_pred)
confusion_matrix_result = confusion_matrix(y_test, y_pred)

print("Accuracy:", accuracy)
print("Classification Report:\n", classification_report_result)
print("Confusion Matrix:\n", confusion_matrix_result)
```

```
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        16
           1       1.00      1.00      1.00        23
           2       1.00      1.00      1.00        21

    accuracy                           1.00        60
   macro avg       1.00      1.00      1.00        60
weighted avg       1.00      1.00      1.00        60

Confusion Matrix:
 [[16  0  0]
 [ 0 23  0]
 [ 0  0 21]]
```

ii. test_size = 0.4 random_state = 42

In [42]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.4,random
```

In [43]:
```
model = LogisticRegression(max_iter=1000)
```

In [44]:
```
model.fit(x_train,y_train)
```

Out[44]:
```
LogisticRegression(max_iter=1000)
```

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In [45]:
```
y_pred = model.predict(x_test)
```

In [46]:
```
y_pred
```

Out[46]:
```
array([1, 0, 2, 1, 1, 0, 1, 2, 1, 1, 2, 0, 0, 0, 0, 1, 2, 1, 1, 2, 0, 2,
       0, 2, 2, 2, 2, 2, 0, 0, 0, 0, 1, 0, 0, 2, 1, 0, 0, 0, 2, 1, 1, 0,
       0, 1, 2, 2, 1, 2, 1, 2, 1, 0, 2, 1, 0, 0, 0, 1], dtype=int64)
```

In [47]:
```
model.score(x,y)
```

Out[47]:
```
1.0
```

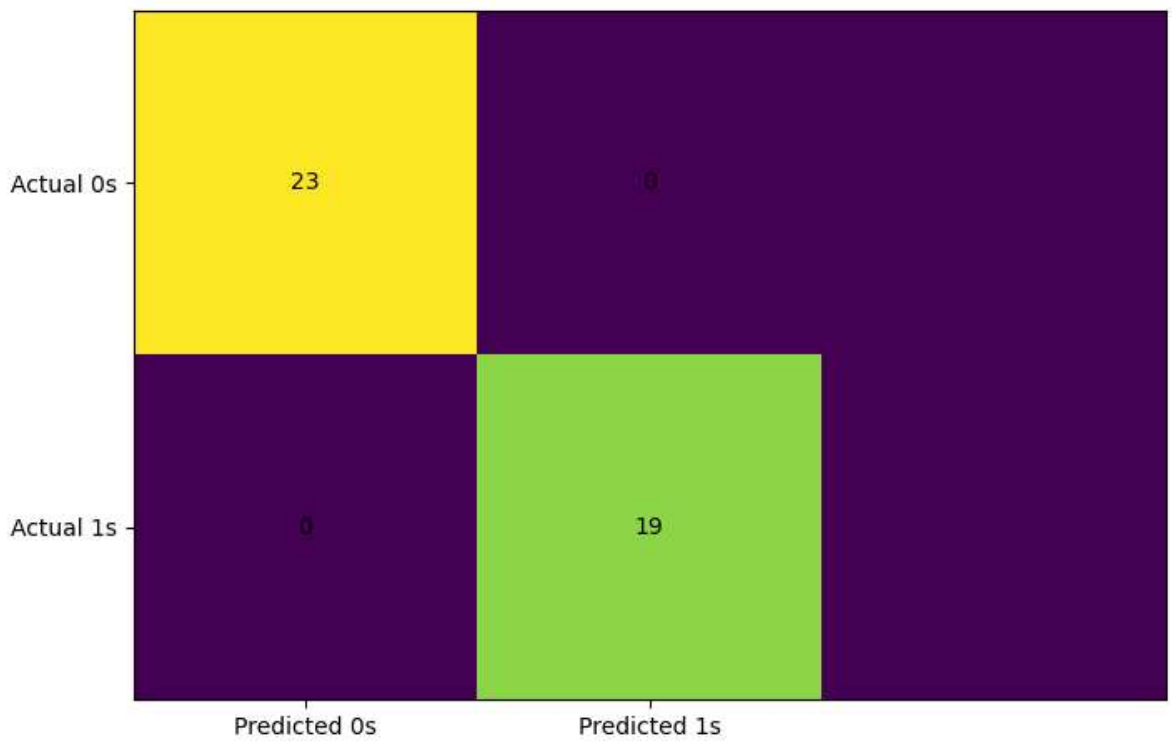
In [48]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R-squared: {r2:.2f}")
```

```
Mean Squared Error: 0.00
R-squared: 1.00
```

In [49]:
```
confusion_matrix(y_test, y_pred)
```

Out[49]:
```
array([[23,  0,  0],
       [ 0, 19,  0],
       [ 0,  0, 18]], dtype=int64)
```

In [50]:
```
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='black')
plt.show()
```



In [51]:
```
accuracy = accuracy_score(y_test, y_pred)
classification_report_result = classification_report(y_test, y_pred)
confusion_matrix_result = confusion_matrix(y_test, y_pred)

print("Accuracy:", accuracy)
print("Classification Report:\n", classification_report_result)
print("Confusion Matrix:\n", confusion_matrix_result)
```

```
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        23
           1       1.00      1.00      1.00        19
           2       1.00      1.00      1.00        18

    accuracy                           1.00        60
   macro avg       1.00      1.00      1.00        60
weighted avg       1.00      1.00      1.00        60

Confusion Matrix:
 [[23  0  0]
 [ 0 19  0]
 [ 0  0 18]]
```

Iteration 3

i. test_size = 0.5 random_state = 0

In [52]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.5,random
```

In [53]:
```
model = LogisticRegression(max_iter=1000)
```

In [54]:
```
model.fit(x_train,y_train)
```

Out[54]:
```
LogisticRegression(max_iter=1000)
```

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In [55]:
```
y_pred = model.predict(x_test)
```

In [56]:
```
y_pred
```

Out[56]:
```
array([2, 1, 0, 2, 0, 2, 0, 1, 1, 1, 2, 1, 1, 1, 1, 0, 1, 1, 0, 0, 2, 1,
       0, 0, 2, 0, 0, 1, 1, 0, 2, 1, 0, 2, 2, 1, 0, 1, 1, 1, 2, 0, 2, 0,
       0, 1, 2, 2, 2, 2, 1, 2, 1, 1, 2, 2, 2, 2, 0, 2, 1, 0, 2, 1, 1, 1,
       1, 2, 0, 0, 2, 1, 0, 0, 1], dtype=int64)
```

In [57]:
```
model.score(x,y)
```

Out[57]:
```
0.9933333333333333
```

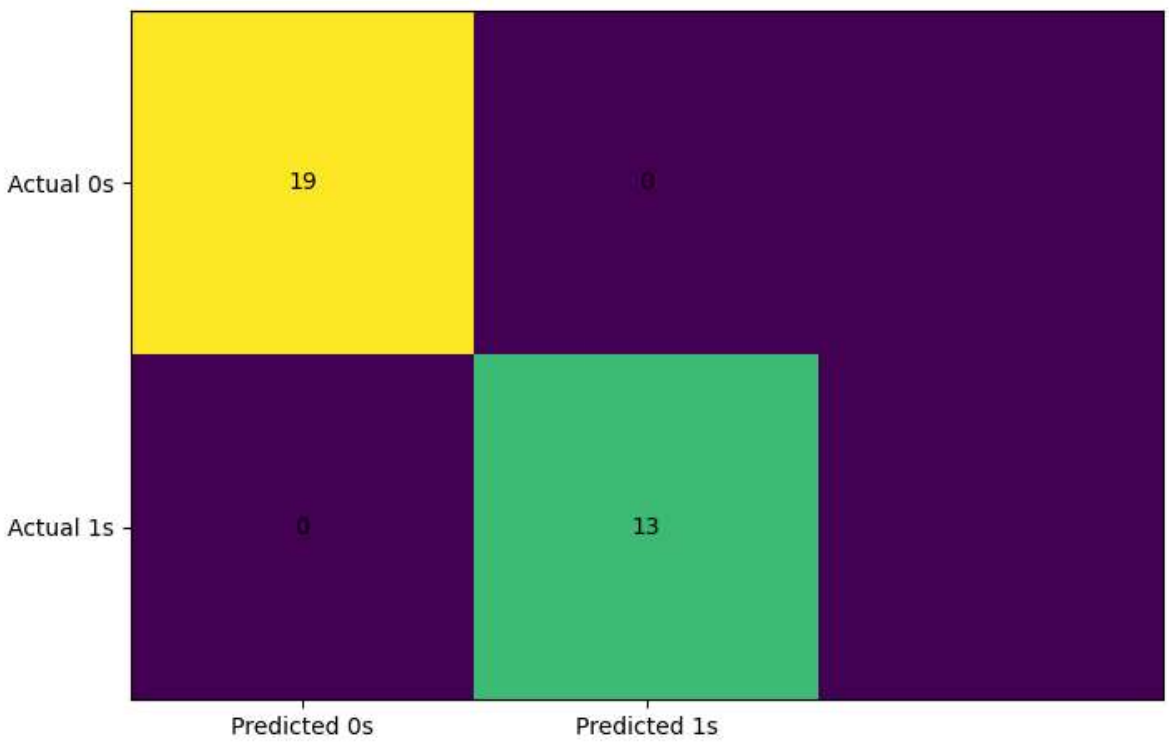
In [58]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R-squared: {r2:.2f}")
```

```
Mean Squared Error: 0.01
R-squared: 0.98
```

In [59]:
```
confusion_matrix(y_test, y_pred)
```

Out[59]:
```
array([[21,  0,  0],
       [ 1, 29,  0],
       [ 0,  0, 24]], dtype=int64)
```

In [74]:
```
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='black')
plt.show()
```



In [61]:
```
accuracy = accuracy_score(y_test, y_pred)
classification_report_result = classification_report(y_test, y_pred)
confusion_matrix_result = confusion_matrix(y_test, y_pred)

print("Accuracy:", accuracy)
print("Classification Report:\n", classification_report_result)
print("Confusion Matrix:\n", confusion_matrix_result)
```

```
Accuracy: 0.9866666666666667
Classification Report:
              precision    recall  f1-score   support

           0       0.95      1.00      0.98        21
           1       1.00      0.97      0.98        30
           2       1.00      1.00      1.00        24

    accuracy                           0.99        75
   macro avg       0.98      0.99      0.99        75
weighted avg       0.99      0.99      0.99        75

Confusion Matrix:
 [[21  0  0]
 [ 1 29  0]
 [ 0  0 24]]
```

ii. test_size = 0.5 random_state = 42

In [62]:
```
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size = 0.3,random
```

In [63]:
```
model = LogisticRegression(max_iter=1000)
```

In [64]:
```
model.fit(x_train,y_train)
```

Out[64]:
```
LogisticRegression(max_iter=1000)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [65]:
```
y_pred = model.predict(x_test)
```

In [66]:
```
y_pred
```

Out[66]:
```
array([1, 0, 2, 1, 1, 0, 1, 2, 1, 1, 2, 0, 0, 0, 0, 1, 2, 1, 1, 2, 0, 2,
       0, 2, 2, 2, 2, 2, 0, 0, 0, 0, 1, 0, 0, 2, 1, 0, 0, 0, 2, 1, 1, 0,
       0], dtype=int64)
```

In [67]:
```
model.score(x,y)
```

Out[67]:
```
1.0
```

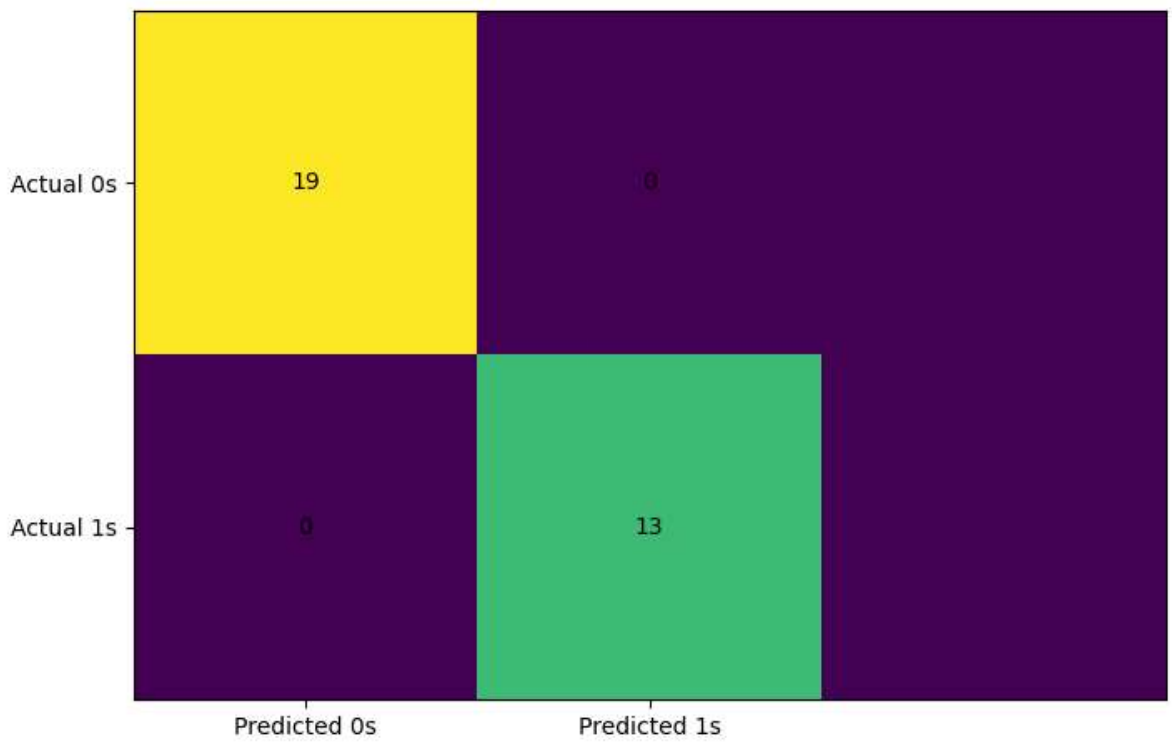
In [68]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R-squared: {r2:.2f}")
```

```
Mean Squared Error: 0.00
R-squared: 1.00
```

In [69]:
```
confusion_matrix(y_test, y_pred)
```

Out[69]:
```
array([[19,  0,  0],
       [ 0, 13,  0],
       [ 0,  0, 13]], dtype=int64)
```

In [70]:
```
cm = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8, 8))
ax.imshow(cm)
ax.grid(False)
ax.xaxis.set(ticks=(0, 1), ticklabels=('Predicted 0s', 'Predicted 1s'))
ax.yaxis.set(ticks=(0, 1), ticklabels=('Actual 0s', 'Actual 1s'))
ax.set_ylim(1.5, -0.5)
for i in range(2):
    for j in range(2):
        ax.text(j, i, cm[i, j], ha='center', va='center', color='black')
plt.show()
```



In [71]:
```
accuracy = accuracy_score(y_test, y_pred)
classification_report_result = classification_report(y_test, y_pred)
confusion_matrix_result = confusion_matrix(y_test, y_pred)

print("Accuracy:", accuracy)
print("Classification Report:\n", classification_report_result)
print("Confusion Matrix:\n", confusion_matrix_result)
```

```
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        19
           1       1.00      1.00      1.00        13
           2       1.00      1.00      1.00        13

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45

Confusion Matrix:
 [[19  0  0]
 [ 0 13  0]
 [ 0  0 13]]
```

In [72]:
```
df.shape
```

Out[72]:
```
(150, 6)
```

In [ ]:
```

```