In [27]:
```
import pandas as pd
import numpy as np
```

In [28]:
```
df = pd.read_csv(r'C:\Users\Churn_test.csv')
```

In [29]:
```
import os
os.getcwd()
```

Out[29]:
```
'C:\\Users\\user'
```

In [30]:
```
df
```

Out[30]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines
0	8879-ZKJOF	Female	0	No	No	41	Yes	No
1	0201-MIBOL	Female	1	No	No	66	Yes	Yes
2	1600-DILPE	Female	0	No	No	12	Yes	No
3	8601-QACRS	Female	0	No	No	5	Yes	Yes
4	7919-ZODZZ	Female	0	Yes	Yes	10	Yes	No
...	...	...	...	...	...	...	...	...
1404	5130-IEKQT	Male	1	No	No	25	Yes	Yes
1405	4452-ROHMO	Female	0	No	No	15	Yes	No
1406	6164-HAQTX	Male	0	No	No	71	No	No phone service
1407	3982-DQLUS	Male	1	Yes	Yes	65	Yes	Yes
1408	9874-QLCLH	Female	0	Yes	Yes	17	Yes	Yes

1409 rows × 20 columns

In [31]:
```
df2 = pd.read_csv(r'C:\Users\Churn_train.csv')
```

In [32]:
```
df2
```

Out[32]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines
0	5442-PPTJY	Male	0	Yes	Yes	12	Yes	No
1	6261-RCVNS	Female	0	No	No	42	Yes	No
2	2176-OSJUV	Male	0	Yes	No	71	Yes	Yes
3	6161-ERDGD	Male	0	Yes	Yes	71	Yes	Yes
4	2364-UFROM	Male	0	No	No	30	Yes	No
...	...	...	...	...	...	...	...	...
5629	0781-LKXBR	Male	1	No	No	9	Yes	Yes
5630	3507-GASNP	Male	0	No	Yes	60	Yes	No
5631	8868-WOZGU	Male	0	No	No	28	Yes	Yes
5632	1251-KRREG	Male	0	No	No	2	Yes	Yes
5633	5840-NVDCG	Female	0	Yes	Yes	16	Yes	No

5634 rows × 21 columns

In [33]:
```
df2.describe()
```

Out[33]:

	SeniorCitizen	tenure	MonthlyCharges
count	5634.000000	5634.000000	5634.000000
mean	0.161874	32.277955	64.779127
std	0.368368	24.555211	30.104993
min	0.000000	0.000000	18.250000
25%	0.000000	9.000000	35.400000
50%	0.000000	29.000000	70.375000
75%	0.000000	55.000000	89.850000
max	1.000000	72.000000	118.650000

In [34]:
```
type(df2)
```

Out[34]:
```
pandas.core.frame.DataFrame
```

In [35]:
```
df2.dtypes
```

Out[35]:
```
customerID          object
gender              object
SeniorCitizen        int64
Partner             object
Dependents          object
tenure               int64
PhoneService        object
MultipleLines       object
InternetService     object
OnlineSecurity      object
OnlineBackup        object
DeviceProtection    object
TechSupport         object
StreamingTV         object
StreamingMovies     object
Contract            object
PaperlessBilling    object
PaymentMethod       object
MonthlyCharges     float64
TotalCharges        object
Churn               object
dtype: object
```

In [36]:
```
df2.head(4)
```

Out[36]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	Ir
0	5442-PPTJY	Male	0	Yes	Yes	12	Yes	No	
1	6261-RCVNS	Female	0	No	No	42	Yes	No	
2	2176-OSJUV	Male	0	Yes	No	71	Yes	Yes	
3	6161-ERDGD	Male	0	Yes	Yes	71	Yes	Yes	

4 rows × 21 columns

In [37]:
```
df2.columns
```

Out[37]:
```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [38]:
```
df2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5634 entries, 0 to 5633
Data columns (total 21 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   customerID        5634 non-null   object 
 1   gender            5634 non-null   object 
 2   SeniorCitizen     5634 non-null   int64  
 3   Partner           5634 non-null   object 
 4   Dependents        5634 non-null   object 
 5   tenure            5634 non-null   int64  
 6   PhoneService      5634 non-null   object 
 7   MultipleLines     5634 non-null   object 
 8   InternetService   5634 non-null   object 
 9   OnlineSecurity    5634 non-null   object 
 10  OnlineBackup      5634 non-null   object 
 11  DeviceProtection  5634 non-null   object 
 12  TechSupport       5634 non-null   object 
 13  StreamingTV       5634 non-null   object 
 14  StreamingMovies   5634 non-null   object 
 15  Contract          5634 non-null   object 
 16  PaperlessBilling  5634 non-null   object 
 17  PaymentMethod     5634 non-null   object 
 18  MonthlyCharges    5634 non-null   float64
 19  TotalCharges      5634 non-null   object 
 20  Churn             5634 non-null   object 
dtypes: float64(1), int64(2), object(18)
memory usage: 924.5+ KB
```

In [39]:
```
num_male=sum(df2['gender'] == 'Male')
```

In [40]:
```
num_male
```

Out[40]: 2838

In [41]:
```
num_female=sum(df2['gender'] == 'Female')
num_female
```

Out[41]: 2796

In [42]:
```
num_equal=sum(df2['gender'] == 'Female')
num_equal
```

Out[42]: 2796

In [43]:
```
df2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5634 entries, 0 to 5633
Data columns (total 21 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   customerID        5634 non-null   object 
 1   gender            5634 non-null   object 
 2   SeniorCitizen     5634 non-null   int64  
 3   Partner           5634 non-null   object 
 4   Dependents        5634 non-null   object 
 5   tenure            5634 non-null   int64  
 6   PhoneService      5634 non-null   object 
 7   MultipleLines     5634 non-null   object 
 8   InternetService   5634 non-null   object 
 9   OnlineSecurity    5634 non-null   object 
 10  OnlineBackup      5634 non-null   object 
 11  DeviceProtection  5634 non-null   object 
 12  TechSupport       5634 non-null   object 
 13  StreamingTV       5634 non-null   object 
 14  StreamingMovies   5634 non-null   object 
 15  Contract          5634 non-null   object 
 16  PaperlessBilling  5634 non-null   object 
 17  PaymentMethod     5634 non-null   object 
 18  MonthlyCharges    5634 non-null   float64
 19  TotalCharges      5634 non-null   object 
 20  Churn             5634 non-null   object 
dtypes: float64(1), int64(2), object(18)
memory usage: 924.5+ KB
```

In [44]:
```
df2.columns
```

Out[44]:
```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [45]:
```
max_monthlycharge=max(df2['MonthlyCharges'])
```

In [46]:
```
max_monthlycharge
```

Out[46]:
```
118.65
```

In [47]:
```
import matplotlib.pyplot as plt
```

In [48]:
```
import seaborn as sns
```

In [49]:
```
df2['Churn'].value_counts()
```

Out[49]:
```
No     4113
Yes    1521
Name: Churn, dtype: int64
```

In [50]:
```
df2.columns
```

Out[50]:
```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [26]:
```
df2.columns('Contract')
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Input In [26], in <cell line: 1>()
----> 1 df2.columns('Contract')

TypeError: 'Index' object is not callable
```

In [ ]:
```
df2.head(2)
```

In [ ]:
```
min_tenure= min(df2['tenure'])
max_tenure= max(df2['tenure'])
min_tenure
max_tenure
```

In [ ]:
```
max_tenure
```

In [ ]:
```
sns.pairplot(df2);
```

In [51]:
```
df2.columns
```

Out[51]:
```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [56]:
```
df4 = df2[['customerID', 'Churn', index= False] ]
```

```
  Input In [56]
    df4 = df2[['customerID', 'Churn', index= False] ]
                                                    ^

SyntaxError: invalid syntax
```

In [57]:
```
df4
```

Out[57]:

	customerID	Churn
0	5442-PPTJY	No
1	6261-RCVNS	Yes
2	2176-OSJUV	No
3	6161-ERDGD	No
4	2364-UFROM	No
...	...	...
5629	0781-LKXBR	Yes
5630	3507-GASNP	No
5631	8868-WOZGU	Yes
5632	1251-KRREG	Yes
5633	5840-NVDCG	No

5634 rows × 2 columns

In [64]:
```
df5 = df4.head(1409)
```

In [65]:
```
df5
```

Out[65]:

	customerID	Churn
0	5442-PPTJY	No
1	6261-RCVNS	Yes
2	2176-OSJUV	No
3	6161-ERDGD	No
4	2364-UFROM	No
...	...	...
1404	7838-LAZFO	No
1405	9975-SKRNR	No
1406	9483-GCPWE	No
1407	0674-EYYZV	No
1408	2511-ALLCS	No

1409 rows × 2 columns

In [66]:
```
df5.to_csv('customer churn prediction.csv', index = False, header = False)
```

In [67]:
```
df2.head(4)
```

Out[67]:

lineSecurity	...	DeviceProtection	TechSupport	StreamingTV	StreamingMovies	Contract	PaperlessB
No internet service	...	No internet service	No internet service	No internet service	No internet service	Two year	
Yes	...	Yes	Yes	No	Yes	One year	
Yes	...	No	Yes	No	No	Two year	
Yes	...	Yes	Yes	Yes	Yes	One year	

In [68]:
```
df2.shape
```

Out[68]:
```
(5634, 21)
```

In [70]:
```
df.dtypes
```

Out[70]:
```
customerID           object
gender               object
SeniorCitizen         int64
Partner              object
Dependents           object
tenure                int64
PhoneService         object
MultipleLines        object
InternetService      object
OnlineSecurity       object
OnlineBackup         object
DeviceProtection     object
TechSupport          object
StreamingTV          object
StreamingMovies      object
Contract             object
PaperlessBilling     object
PaymentMethod        object
MonthlyCharges      float64
TotalCharges         object
dtype: object
```

In [71]:
```
def changeColumnsToString(df2):
    columnsNames=['Partner','Dependents','PhoneService','MultipleLines','OnlineSe
    for col in columnsNames:
        df2[col]=df2[col].astype('str').str.replace('Yes','1').replace('No','0').

changeColumnsToString(df2)

df2['SeniorCitizen']=df2['SeniorCitizen'].astype(bool)
df2['TotalCharges']=pd.to_numeric(df2['TotalCharges'],errors='coerce')
```

In [72]:
```
df2.head(4)
```

Out[72]:

lineSecurity	...	DeviceProtection	TechSupport	StreamingTV	StreamingMovies	Contract	PaperlessB
0	...	0	0	0	0	Two year	
1	...	1	1	0	1	One year	
1	...	0	1	0	0	Two year	
1	...	1	1	1	1	One year	

In [73]:
```
df2.dtypes
```

Out[73]:
```
customerID           object
gender               object
SeniorCitizen          bool
Partner              object
Dependents           object
tenure                int64
PhoneService         object
MultipleLines        object
InternetService      object
OnlineSecurity       object
OnlineBackup         object
DeviceProtection     object
TechSupport          object
StreamingTV          object
StreamingMovies      object
Contract             object
PaperlessBilling     object
PaymentMethod        object
MonthlyCharges      float64
TotalCharges        float64
Churn                object
dtype: object
```

In [74]:
```
df2.columns
```

Out[74]:
```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [75]:
```
print("gender: ", df2.gender.unique())
print("Contract: ", df2.Contract.unique())
print("SeniorCitizen: ",df2.SeniorCitizen.unique())
print("InternetService: ", df2.InternetService.unique())
print("PaymentMethod: ", df2.PaymentMethod.unique())
```

```
gender:  ['Male' 'Female']
Contract:  ['Two year' 'One year' 'Month-to-month']
SeniorCitizen:  [False  True]
InternetService:  ['No' 'DSL' 'Fiber optic']
PaymentMethod:  ['Mailed check' 'Credit card (automatic)' 'Bank transfer (autom
atic)'
 'Electronic check']
```

In [77]:
```
df2['gender']=df2['gender'].astype('category')
df2['Contract']=df2['Contract'].astype('category')
df2['SeniorCitizen']=df2['SeniorCitizen'].astype('category')
df2['InternetService']=df2['InternetService'].astype('category')
df2['InternetService']=df2['InternetService'].astype('category')
df2.dtypes
```

Out[77]:
```
customerID           object
gender             category
SeniorCitizen      category
Partner              object
Dependents           object
tenure                int64
PhoneService         object
MultipleLines        object
InternetService    category
OnlineSecurity       object
OnlineBackup         object
DeviceProtection     object
TechSupport          object
StreamingTV          object
StreamingMovies      object
Contract           category
PaperlessBilling     object
PaymentMethod        object
MonthlyCharges      float64
TotalCharges        float64
Churn                object
dtype: object
```

In [78]:
```
df2PaymentDummies = pd.get_dummies(df2['PaymentMethod'], prefix = 'payment')
df2ContractDummies = pd.get_dummies(df2['Contract'], prefix = 'contract')
df2GenderDummies = pd.get_dummies(df2['gender'], prefix = 'gender')
df2SeniorCitizenDummies = pd.get_dummies(df2['SeniorCitizen'], prefix = 'SC')
df2InternetServiceDummies = pd.get_dummies(df2['InternetService'], prefix = 'IS')

print(df2PaymentDummies.head(3))
print(df2ContractDummies.head(3))
print(df2GenderDummies.head(3))
print(df2SeniorCitizenDummies.head(3))
print(df2InternetServiceDummies.head(3))
```

```
   payment_Bank transfer (automatic)  payment_Credit card (automatic)  \
0                                  0                                 0
1                                  0                                 1
2                                  1                                 0

   payment_Electronic check  payment_Mailed check
0                         0                     1
1                         0                     0
2                         0                     0
   contract_Month-to-month  contract_One year  contract_Two year
0                        0                  0                  1
1                        0                  1                  0
2                        0                  0                  1
   gender_Female  gender_Male
0              0            1
1              1            0
2              0            1
   SC_False  SC_True
0         1        0
1         1        0
2         1        0
   IS_DSL  IS_Fiber optic  IS_No
0       0               0      1
1       1               0      0
2       1               0      0
```

In [83]:
```
df2 = pd.concat([df2, df2PaymentDummies], axis=1)
df2 = pd.concat([df2, df2ContractDummies], axis=1)
df2 = pd.concat([df2, df2GenderDummies], axis=1)
df2 = pd.concat([df2, df2SeniorCitizenDummies], axis=1)
df2 = pd.concat([df2, df2InternetServiceDummies], axis=1)
df2.head(2)
```

Out[83]:

	customerID	Partner	Dependents	tenure	PhoneService	MultipleLines	OnlineSecurity	OnlineBa
0	5442-PPTJY	1	1	12	1	0	0	
1	6261-RCVNS	0	0	42	1	0	1	

2 rows × 30 columns

In [85]:
```
df2.columns = ['customerID', 'Partner', 'Dependents', 'tenure', 'PhoneService',
       'MultipleLines', 'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
       'TechSupport', 'StreamingTV', 'StreamingMovies', 'PaperlessBilling',
       'MonthlyCharges', 'TotalCharges', 'Churn',
       'payment_Bank transfer (automatic)', 'payment_Credit card (automatic)',
       'payment_Electronic check', 'payment_Mailed check',
       'contract_Month-to-month', 'contract_One year', 'contract_Two year',
       'gender_Female', 'gender_Male', 'SC_False', 'SC_True', 'IS_DSL',
       'IS_Fiber optic', 'IS_No']
```

In [82]:
```
df2.head
```

Out[82]:
```
<bound method NDFrame.head of       customerID Partner Dependents  tenure Phone
Service MultipleLines  \
0     5442-PPTJY       1          1      12            1             0
1     6261-RCVNS       0          0      42            1             0
2     2176-OSJUV       1          0      71            1             1
3     6161-ERDGD       1          1      71            1             1
4     2364-UFROM       0          0      30            1             0
...          ...     ...        ...     ...          ...           ...
5629  0781-LKXBR       0          0       9            1             1
5630  3507-GASNP       0          1      60            1             0
5631  8868-WOZGU       0          0      28            1             1
5632  1251-KRREG       0          0       2            1             1
5633  5840-NVDCG       1          1      16            1             0

     OnlineSecurity OnlineBackup DeviceProtection TechSupport StreamingTV  \
0                 0            0                 0           0           0
1                 1            1                 1           1           0
2                 1            1                 0           1           0
3                 1            0                 1           1           1
4                 1            1                 0           1           1
...             ...          ...               ...         ...         ...
5629              0            0                 1           0           1
5630              0            0                 0           0           0
5631              0            1                 1           0           1
5632              0            1                 0           0           0
5633              1            1                 0           1           0

     StreamingMovies PaperlessBilling  MonthlyCharges  TotalCharges Churn
0                  0                0           19.70        258.35     0
1                  1                0           73.90       3160.55     1
2                  0                0           65.15       4681.75     0
3                  1                0           85.45       6300.85     0
4                  0                0           70.40       2044.75     0
...              ...              ...             ...           ...   ...
5629               1                1          100.50        918.60     1
5630               0                0           19.95       1189.90     0
5631               1                1          105.70       2979.50     1
5632               0                1           54.40        114.10     1
5633               1                0           68.25       1114.85     0

[5634 rows x 16 columns]>
```

In [89]:
```
df2.columns = ['customerID', 'Partner', 'Dependents', 'tenure', 'PhoneService',
       'MultipleLines', 'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
       'TechSupport', 'StreamingTV', 'StreamingMovies', 'PaperlessBilling',
       'MonthlyCharges', 'TotalCharges', 'Churn',
       'payment_Bank transfer (automatic)', 'payment_Credit card (automatic)',
       'payment_Electronic check', 'payment_Mailed check',
       'contract_Month-to-month', 'contract_One year', 'contract_Two year',
       'gender_Female', 'gender_Male', 'SC_False', 'SC_True', 'IS_DSL',
       'IS_Fiber optic', 'IS_No']
```

In [91]:
```
df2.columns
```

Out[91]:
```
Index(['customerID', 'Partner', 'Dependents', 'tenure', 'PhoneService',
       'MultipleLines', 'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
       'TechSupport', 'StreamingTV', 'StreamingMovies', 'PaperlessBilling',
       'MonthlyCharges', 'TotalCharges', 'Churn',
       'payment_Bank transfer (automatic)', 'payment_Credit card (automatic)',
       'payment_Electronic check', 'payment_Mailed check',
       'contract_Month-to-month', 'contract_One year', 'contract_Two year',
       'gender_Female', 'gender_Male', 'SC_False', 'SC_True', 'IS_DSL',
       'IS_Fiber optic', 'IS_No'],
      dtype='object')
```

In [92]:
```
numericColumns=np.array(['Partner', 'Dependents', 'tenure', 'PhoneService',
       'MultipleLines', 'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
       'TechSupport', 'StreamingTV', 'StreamingMovies', 'PaperlessBilling',
       'MonthlyCharges', 'TotalCharges', 'Churn',
       'payment_Bank transfer (automatic)', 'payment_Credit card (automatic)',
       'payment_Electronic check', 'payment_Mailed check',
       'contract_Month-to-month', 'contract_One year', 'contract_Two year',
       'gender_Female', 'gender_Male', 'SC_False', 'SC_True', 'IS_DSL',
       'IS_Fiber optic', 'IS_No'])

for columnName in numericColumns:
    df2[columnName]=pd.to_numeric(df2[columnName],errors='coerce')
df2.dtypes
```

Out[92]:
```
customerID                            object
Partner                                int64
Dependents                             int64
tenure                                 int64
PhoneService                           int64
MultipleLines                          int64
OnlineSecurity                         int64
OnlineBackup                           int64
DeviceProtection                       int64
TechSupport                            int64
StreamingTV                            int64
StreamingMovies                        int64
PaperlessBilling                       int64
MonthlyCharges                       float64
TotalCharges                         float64
Churn                                  int64
payment_Bank transfer (automatic)      uint8
payment_Credit card (automatic)        uint8
payment_Electronic check               uint8
payment_Mailed check                   uint8
contract_Month-to-month                uint8
contract_One year                      uint8
contract_Two year                      uint8
gender_Female                          uint8
gender_Male                            uint8
SC_False                               uint8
SC_True                                uint8
IS_DSL                                 uint8
IS_Fiber optic                         uint8
IS_No                                  uint8
dtype: object
```

In [93]:
```
modelData = df2.loc[:, df2.columns != 'customerID']
modelData.to_csv('modelData.csv')
```

In [95]:
```
modelData=pd.read_csv('modelData.csv')

modelData[modelData==np.inf]=np.nan
modelData.fillna(modelData.mean(), inplace=True)

x=np.asarray(modelData.loc[:,modelData.columns != 'Churn'])
y=np.asarray(modelData['Churn'])

print(x[:2])
print(y[:2])
```

```
[[0.00000e+00 1.00000e+00 1.00000e+00 1.20000e+01 1.00000e+00 0.00000e+00
  0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00
  0.00000e+00 1.97000e+01 2.58350e+02 0.00000e+00 0.00000e+00 0.00000e+00
  1.00000e+00 0.00000e+00 0.00000e+00 1.00000e+00 0.00000e+00 1.00000e+00
  1.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 1.00000e+00]
 [1.00000e+00 0.00000e+00 0.00000e+00 4.20000e+01 1.00000e+00 0.00000e+00
  1.00000e+00 1.00000e+00 1.00000e+00 1.00000e+00 0.00000e+00 1.00000e+00
  0.00000e+00 7.39000e+01 3.16055e+03 0.00000e+00 1.00000e+00 0.00000e+00
  0.00000e+00 0.00000e+00 1.00000e+00 0.00000e+00 1.00000e+00 0.00000e+00
  1.00000e+00 0.00000e+00 1.00000e+00 0.00000e+00 0.00000e+00]]
[0 1]
```

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