Experiment No. 7
Apply Dimensionality Reduction on Adult Census Income Dataset and analyze the performance of the model
Date of Performance: 11-09-2023
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Aim: Apply Dimensionality Reduction on Adult Census Income Dataset and analyze the performance of the model.

Objective: Able to perform various feature engineering tasks, perform dimetionality reduction on the given dataset and maximize the accuracy, Precision, Recall, F1 score.

Theory:

In machine learning classification problems, there are often too many factors on the basis of which the final classification is done. These factors are basically variables called features. The higher the number of features, the harder it gets to visualize the training set and then work on it. Sometimes, most of these features are correlated, and hence redundant. This is where dimensionality reduction algorithms come into play. Dimensionality reduction is the process of reducing the number of random variables under consideration, by obtaining a set of principal variables. It can be divided into feature selection and feature extraction.

Dataset:

Predict whether income exceeds $50K/yr based on census data. Also known as "Adult" dataset.

Attribute Information:

Listing of attributes:

>50K, <=50K.

age: continuous.

workclass: Private, Self-emp-not-inc, Self-emp-inc, Federal-gov, Local-gov, State-gov, Without-pay, Never-worked.

fnlwgt: continuous.

education: Bachelors, Some-college, 11th, HS-grad, Prof-school, Assoc-acdm, Assoc-voc, 9th, 7th-8th, 12th, Masters, 1st-4th, 10th, Doctorate, 5th-6th, Preschool.

education-num: continuous.

marital-status: Married-civ-spouse, Divorced, Never-married, Separated, Widowed, Married-spouse-absent, Married-AF-spouse.

occupation: Tech-support, Craft-repair, Other-service, Sales, Exec-managerial, Prof-specialty, Handlers-cleaners, Machine-op-inspct, Adm-clerical, Farming-fishing, Transport-moving, Priv-house-serv, Protective-serv, Armed-Forces.

relationship: Wife, Own-child, Husband, Not-in-family, Other-relative, Unmarried.

race: White, Asian-Pac-Islander, Amer-Indian-Eskimo, Other, Black.

sex: Female, Male.

capital-gain: continuous.

capital-loss: continuous.

hours-per-week: continuous.

native-country: United-States, Cambodia, England, Puerto-Rico, Canada, Germany, Outlying-US(Guam-USVI-etc), India, Japan, Greece, South, China, Cuba, Iran, Honduras, Philippines, Italy, Poland, Jamaica, Vietnam, Mexico, Portugal, Ireland, France, Dominican-Republic, Laos, Ecuador, Taiwan, Haiti, Columbia, Hungary, Guatemala, Nicaragua, Scotland, Thailand, Yugoslavia, El-Salvador, Trinadad & Tobago, Peru, Hong, Holand-Netherlands.

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import os
for dirname, _, filenames in os.walk('/kaggle/input'):
  for filename in filenames:
    print(os.path.join(dirname, filename))
df=pd.read_csv("adult_dataset.csv")
```

```
df.head()
```

	age	workclass	fnlwgt	education	education.num	marital.status	occupation	relationship	race	s
0	90	?	77053	HS-grad	9	Widowed	?	Not-in-family	White	Fema
1	82	Private	132870	HS-grad	9	Widowed	Exec-managerial	Not-in-family	White	Fema
2	66	?	186061	Some-college	10	Widowed	?	Unmarried	Black	Fema
3	54	Private	140359	7th-8th	4	Divorced	Machine-op-inspct	Unmarried	White	Fema
4	41	Private	264663	Some-college	10	Separated	Prof-specialty	Own-child	White	Fema

```
df.describe().T
```

	count	mean	std	min	25%	50%	75%	max
age	32561.0	38.581647	13.640433	17.0	28.0	37.0	48.0	90.0
fnlwgt	32561.0	189778.366512	105549.977697	12285.0	117827.0	178356.0	237051.0	1484705.0
education.num	32561.0	10.080679	2.572720	1.0	9.0	10.0	12.0	16.0
capital.gain	32561.0	1077.648844	7385.292085	0.0	0.0	0.0	0.0	99999.0
capital.loss	32561.0	87.303830	402.960219	0.0	0.0	0.0	0.0	4356.0
hours.per.week	32561.0	40.437456	12.347429	1.0	40.0	40.0	45.0	99.0

```
df.shape
```

```
(32561, 15)
```

```
df.columns
```

```
Index(['age', 'workclass', 'fnlwgt', 'education', 'education.num',
       'marital.status', 'occupation', 'relationship', 'race', 'sex',
       'capital.gain', 'capital.loss', 'hours.per.week', 'native.country',
       'income'],
      dtype='object')
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32561 entries, 0 to 32560
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype 
---  ------          --------------  ----- 
 0   age             32561 non-null  int64 
 1   workclass       32561 non-null  object
 2   fnlwgt          32561 non-null  int64 
 3   education       32561 non-null  object
 4   education.num   32561 non-null  int64 
 5   marital.status  32561 non-null  object
 6   occupation      32561 non-null  object
 7   relationship    32561 non-null  object
 8   race            32561 non-null  object
 9   sex             32561 non-null  object
 10  capital.gain    32561 non-null  int64 
 11  capital.loss    32561 non-null  int64 
 12  hours.per.week  32561 non-null  int64 
 13  native.country  32561 non-null  object
 14  income          32561 non-null  object
dtypes: int64(6), object(9)
memory usage: 3.7+ MB
```

```
df[df == '?'] = np.nan
df.isnull().sum()
```

```
age                  0
workclass         1836
fnlwgt               0
education            0
education.num        0
marital.status       0
occupation        1843
relationship         0
race                 0
sex                  0
capital.gain         0
capital.loss         0
hours.per.week       0
native.country     583
income               0
dtype: int64
```

```
for col in ['workclass', 'occupation', 'native.country']:
    df[col].fillna(df[col].mode()[0], inplace=True)

df.isnull().sum()
```

```
age               0
workclass         0
fnlwgt            0
education         0
education.num     0
marital.status    0
occupation        0
relationship      0
race              0
sex               0
capital.gain      0
capital.loss      0
hours.per.week    0
native.country    0
income            0
dtype: int64
```

```
# converting categorical Columns
df.replace({'Sex':{'male':0,'female':1}, 'Embarked':{'S':0,'C':1,'Q':2}}, inplace=True)
```

```
X = df.drop(['income'], axis=1)
y = df['income']
```

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, random_state = 0)
from sklearn import preprocessing
categorical = ['workclass', 'education', 'marital.status', 'occupation', 'relationship', 'race', 'sex', 'native.country']
for feature in categorical:
      label = preprocessing.LabelEncoder()
      X_train[feature] = label.fit_transform(X_train[feature])
      X_test[feature] = label.transform(X_test[feature])
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
X_train = pd.DataFrame(scaler.fit_transform(X_train), columns = X.columns)
X_test = pd.DataFrame(scaler.transform(X_test), columns = X.columns)
X_train.head()
```

	age	workclass	fnlwgt	education	education.num	marital.status	occupation	relationship	r
0	0.101484	2.600478	-1.494279	-0.332263	1.133894	-0.402341	-0.782234	2.214196	0.39
1	0.028248	-1.884720	0.438778	0.184396	-0.423425	-0.402341	-0.026696	-0.899410	0.39
2	0.247956	-0.090641	0.045292	1.217715	-0.034095	0.926666	-0.782234	-0.276689	0.39
3	-0.850587	-1.884720	0.793152	0.184396	-0.423425	0.926666	-0.530388	0.968753	0.39
4	-0.044989	-2.781760	-0.853275	0.442726	1.523223	-0.402341	-0.782234	-0.899410	0.39

```
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
```

```
LR = LogisticRegression()
LR.fit(X_train,y_train)
```

```
▾ LogisticRegression
LogisticRegression()
```

```
y_pred = LR.predict(X_test)
accuracy_score(y_test, y_pred)
```

```
0.8216808271061521
```

```
from sklearn.decomposition import PCA
pca = PCA()
```

```
X_train = pca.fit_transform(X_train)
pca.explained_variance_ratio_
```

```
array([0.14757168, 0.10182915, 0.08147199, 0.07880174, 0.07463545,
       0.07274281, 0.07009602, 0.06750902, 0.0647268 , 0.06131155,
       0.06084207, 0.04839584, 0.04265038, 0.02741548])
```

```
X = df.drop(['income'], axis=1)
y = df['income']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, random_state = 0)
```

```
categorical = ['workclass', 'education', 'marital.status', 'occupation', 'relationship', 'race', 'sex', 'native.country']
for feature in categorical:
        lable = preprocessing.LabelEncoder()
        X_train[feature] = label.fit_transform(X_train[feature])
        X_test[feature] = label.transform(X_test[feature])
X_train = pd.DataFrame(scaler.fit_transform(X_train), columns = X.columns)
```

```
pca= PCA()
pca.fit(X_train)
cumsum = np.cumsum(pca.explained_variance_ratio_)
dim = np.argmax(cumsum >= 0.90) + 1
print('The number of dimensions required to preserve 90% of variance is',dim)
```

```
The number of dimensions required to preserve 90% of variance is 12
```

```
X = df.drop(['income','native.country', 'hours.per.week'], axis=1)
y = df['income']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, random_state = 0)
```

```
categorical = ['workclass', 'education', 'marital.status', 'occupation', 'relationship', 'race', 'sex']
for feature in categorical:
      label = preprocessing.LabelEncoder()
      X_train[feature] = label.fit_transform(X_train[feature])
      X_test[feature] = label.transform(X_test[feature])
```

```
X_train = pd.DataFrame(scaler.fit_transform(X_train), columns = X.columns)
X_test = pd.DataFrame(scaler.transform(X_test), columns = X.columns)
```

```
LR2 = LogisticRegression()
LR2.fit(X_train, y_train)
```

```
▾ LogisticRegression
LogisticRegression()
```

```
y_pred = LR2.predict(X_test)
accuracy_score(y_test, y_pred)
```

```
0.8227044733340158
```

```
_matrix
```

```
y_pred)
, columns=['Predicted No', 'Predicted Yes'], index=['Actual No', 'Actual Yes'])
```

```
from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

       <=50K       0.84      0.95      0.89      7410
        >50K       0.72      0.43      0.54      2359

    accuracy                           0.82      9769
   macro avg       0.78      0.69      0.72      9769
weighted avg       0.81      0.82      0.81      9769
```

Conclusion:

1. The accuracy of the logistic regression model after dimensionality reduction is approximately 0.8227.
2. The precision for the >50K class is 0.72, recall is 0.43, and F1-score is 0.54.
3. The precision for the <=50K class is 0.84, recall is 0.95, and F1-score is 0.89.
4. Dimensionality reduction has a positive impact by reducing the complexity of the model (fewer features to consider), making it computationally efficient, while still maintaining a reasonable level of predictive performance.