

```
In [11]: import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import OrdinalEncoder
from sklearn.preprocessing import LabelEncoder
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
import matplotlib.pyplot as plt
from sklearn.feature_selection import mutual_info_classif
from sklearn.feature_selection import f_classif
```

```
In [3]: data = pd.read_csv("drug200.csv")
```

```
In [4]: dataset = data.values
dataset
```

```
Out[4]: array([[23, 'F', 'HIGH', 'HIGH', 25.355, 'DrugY'],
               [47, 'M', 'LOW', 'HIGH', 13.093, 'drugC'],
               [47, 'M', 'LOW', 'HIGH', 10.114, 'drugC'],
               ...,
               [52, 'M', 'NORMAL', 'HIGH', 9.894, 'drugX'],
               [23, 'M', 'NORMAL', 'NORMAL', 14.02, 'drugX'],
               [40, 'F', 'LOW', 'NORMAL', 11.349, 'drugX']], dtype=object)
```

```
In [5]: X = dataset[:, :-1]
X
```

```
Out[5]: array([[23, 'F', 'HIGH', 'HIGH', 25.355],
               [47, 'M', 'LOW', 'HIGH', 13.093],
               [47, 'M', 'LOW', 'HIGH', 10.114],
               [28, 'F', 'NORMAL', 'HIGH', 7.798],
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               [47, 'M', 'LOW', 'NORMAL', 30.568],
               [48, 'F', 'LOW', 'HIGH', 15.036],
               [33, 'F', 'LOW', 'HIGH', 33.486],
               [28, 'F', 'HIGH', 'NORMAL', 18.809],
               [31, 'M', 'HIGH', 'HIGH', 30.366],
               [49, 'F', 'NORMAL', 'NORMAL', 9.381],
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               [45, 'M', 'LOW', 'HIGH', 17.951],
               [18, 'F', 'NORMAL', 'NORMAL', 8.75],
               [74, 'M', 'HIGH', 'HIGH', 9.567],
               [49, 'M', 'LOW', 'NORMAL', 11.014],
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```

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[22, 'F', 'HIGH', 'NORMAL', 22.818],  
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[58, 'M', 'HIGH', 'HIGH', 18.991],  
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```
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[16, 'M', 'LOW', 'HIGH', 12.006],
[52, 'M', 'NORMAL', 'HIGH', 9.894],
[23, 'M', 'NORMAL', 'NORMAL', 14.02],
[40, 'F', 'LOW', 'NORMAL', 11.349]], dtype=object)
```

```
In [6]: Y = dataset[:, -1]
Y
```

```
Out[6]: array(['DrugY', 'drugC', 'drugC', 'drugX', 'DrugY', 'drugX', 'DrugY',
'drugC', 'DrugY', 'DrugY', 'drugC', 'DrugY', 'DrugY', 'DrugY',
'drugX', 'DrugY', 'drugX', 'drugA', 'drugC', 'DrugY', 'DrugY',
'DrugY', 'DrugY', 'DrugY', 'DrugY', 'DrugY', 'DrugY', 'drugX',
'DrugY', 'DrugY', 'drugX', 'drugB', 'drugX', 'DrugY', 'drugX',
'drugX', 'drugA', 'drugX', 'drugX', 'drugX', 'DrugY', 'drugB',
'DrugY', 'drugX', 'drugX', 'drugX', 'drugA', 'drugC', 'DrugY',
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'drugX', 'drugX', 'drugX', 'DrugY', 'drugB', 'DrugY', 'drugX',
'drugX', 'DrugY', 'DrugY', 'DrugY', 'DrugY', 'DrugY', 'drugB',
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'drugX', 'DrugY', 'DrugY', 'DrugY', 'DrugY', 'drugB', 'drugA',
'DrugY', 'DrugY', 'DrugY', 'DrugY', 'drugC', 'DrugY', 'drugC',
'drugC', 'drugX', 'drugX', 'drugX', 'drugX'], dtype=object)
```

```
In [7]: X_new = pd.DataFrame(X)
y_new = pd.DataFrame(Y)
```

```
In [8]: X_new = X_new.drop([0, 4], axis=1)
X_new
```

```
Out[8]:
```

	1	2	3
0	F	HIGH	HIGH
1	M	LOW	HIGH
2	M	LOW	HIGH
3	F	NORMAL	HIGH
4	F	LOW	HIGH
...	...	...	...
195	F	LOW	HIGH
196	M	LOW	HIGH
197	M	NORMAL	HIGH
198	M	NORMAL	NORMAL
199	F	LOW	NORMAL

200 rows x 3 columns

```
In [9]: x_train, X_test, y_train, y_test = train_test_split(X_new, y_new, test_size=
```

```
In [10]: print(f"The Train shape of X : {X_train.shape} and y: {y_train.shape}")
print(f"The Test shape of X: {X_test.shape} and y: {y_test.shape}")
```

```
The Train shape of X : (134, 3) and y: (134, 1)
The Test shape of X: (66, 3) and y: (66, 1)
```

```
In [17]: def prepare_inputs(X_train, X_test):
ordinal_encoder = OrdinalEncoder()
ordinal_encoder.fit(X_train)
X_train_enc = ordinal_encoder.transform(X_train)
X_test_enc = ordinal_encoder.transform(X_test)
return X_train_enc, X_test_enc
```

```
In [18]: def prepare_target(y_train, y_test):
label_encoder = LabelEncoder()
label_encoder.fit(y_train)
y_train_enc = label_encoder.transform(y_train)
y_test_enc = label_encoder.transform(y_test)
return y_train_enc, y_test_enc
```

```
In [19]: X_train_enc, X_test_enc = prepare_inputs(X_train, X_test)
```

```
In [20]: y_train_enc, y_test_enc = prepare_inputs(y_train, y_test)
```

## ANOVA F\_statistic score based feature selection

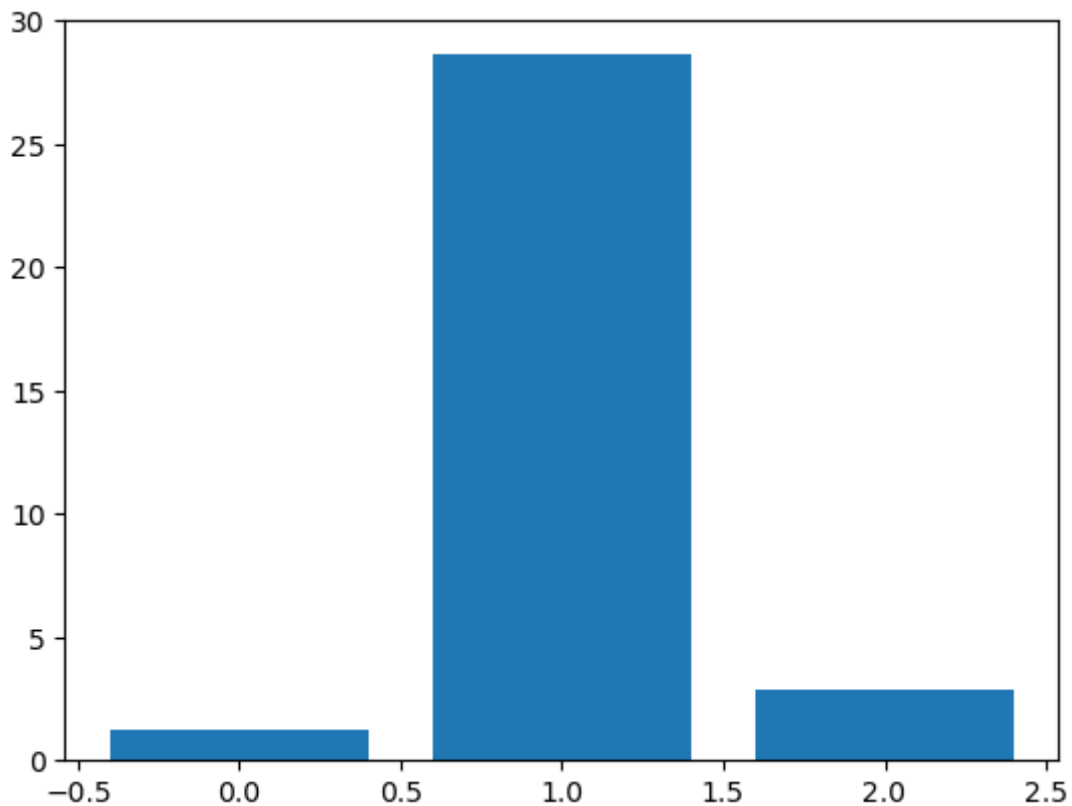
```
In [23]: def select_features(X_train,y_train,X_test):
fs=SelectKBest(score_func=f_classif,k=3)
fs.fit(X_train,y_train)
X_train_fs=fs.transform(X_train)
X_test_fs=fs.transform(X_test)
return X_train_fs,X_test_fs,fs
```

```
In [24]: #Selecting best features and plotting
X_train_fs,X_test_fs,fs=select_features(X_train_enc,y_train_enc,X_test_enc)
```

```
plt.bar([i for i in range(len(fs.scores_))],fs.scores_)
plt.show()
```

/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/utils/validation.py:1143: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n\_samples, ), for example using ravel().

```
y = column_or_1d(y, warn=True)
```



```
In [25]: #feature scores
fs.scores_
```

```
Out[25]: array([ 1.2711341 , 28.61641077,  2.8343434 ])
```

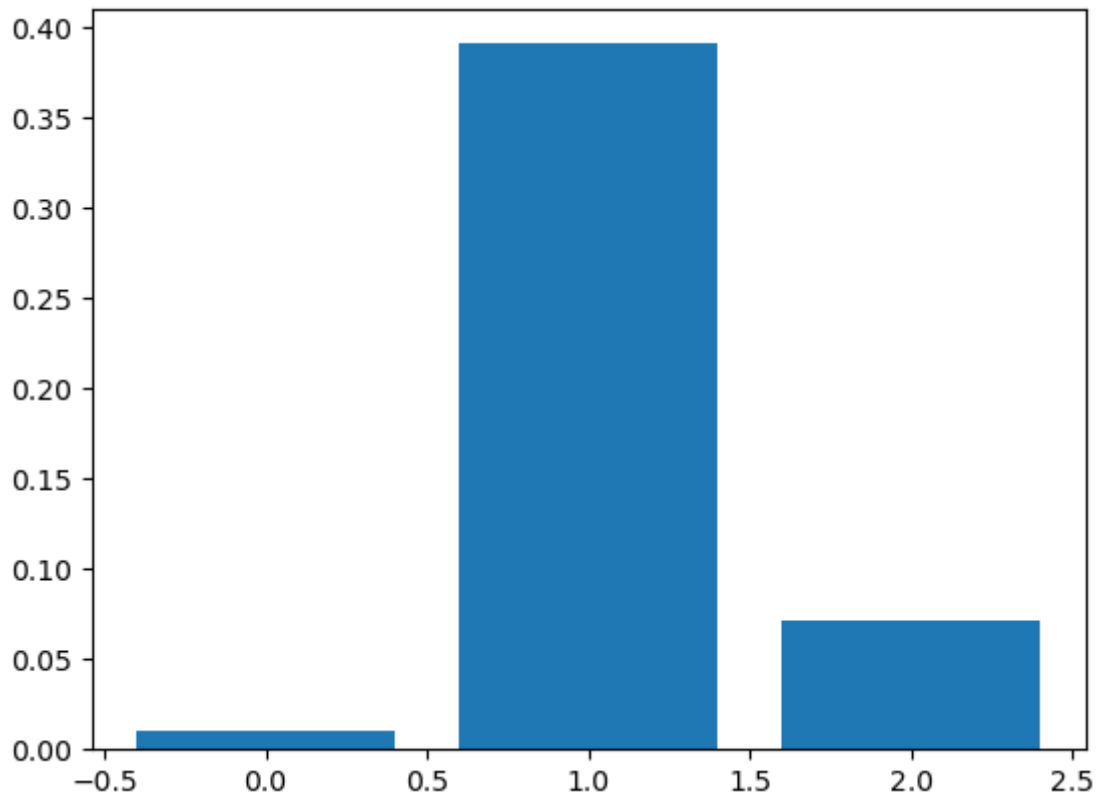
## Mutual information based feature selection

```
In [28]: def select_features_2(X_train,y_train,X_test):
fs=SelectKBest(score_func=mutual_info_classif,k=3)
fs.fit(X_train,y_train)
X_train_fs=fs.transform(X_train)
X_test_fs=fs.transform(X_test)
return X_train_fs,X_test_fs,fs
```

```
In [30]: #Selecting best features using MI and plotting
X_train_fs2,X_test_fs2,fs2=select_features_2(X_train_enc, y_train_enc, X_test_enc)
plt.bar([i for i in range(len(fs2.scores_))],fs2.scores_)
plt.show();
```

/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/utils/validation.py:1143: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n\_samples, ), for example using ravel().

```
y = column_or_1d(y, warn=True)
```



```
In [31]: #feature scores
fs2.scores_
```

```
Out[31]: array([0.00995744, 0.39129274, 0.07174999])
```

```
In [39]: from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
```

```
model1=RandomForestClassifier()
model1.fit(X_train_enc,y_train_enc)
yhat=model1.predict(X_test_enc)
accuracy=accuracy_score(y_test_enc,yhat)
print("Accuracy: %.2f" %(accuracy*100))
```

Accuracy: 51.52

/var/folders/nd/q79n0hd5lvqcq6swwmgkc95w0000gn/T/ipykernel\_76679/3588750476.py:5: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n\_samples,), for example using ravel().

```
model1.fit(X_train_enc,y_train_enc)
```

```
In [40]: model2=RandomForestClassifier()
model2.fit(X_train_fs,y_train_enc)
yhat=model1.predict(X_test_fs)
accuracy=accuracy_score(y_test_enc,yhat)
print("Accuracy: %.2f" %(accuracy*100))
```

Accuracy: 51.52

/var/folders/nd/q79n0hd5lvqcq6swwmgkc95w0000gn/T/ipykernel\_76679/3067022059.py:2: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n\_samples,), for example using ravel().

```
model2.fit(X_train_fs,y_train_enc)
```

```
In [42]: model3=RandomForestClassifier()
model3.fit(X_train_fs2,y_train_enc)
yhat=model1.predict(X_test_fs2)
```



```
accuracy=accuracy_score(y_test_enc,yhat)
print("Accuracy: %.2f" %(accuracy*100))
```

Accuracy: 51.52

```
/var/folders/nd/q79n0hd5lvqcq6swwgk95w0000gn/T/ipykernel_76679/4190157872.
py:2: DataConversionWarning: A column-vector y was passed when a 1d array wa
s expected. Please change the shape of y to (n_samples,), for example using
ravel()).
    model3.fit(X_train_fs2,y_train_enc)
```

```
In [43]: from sklearn.pipeline import Pipeline
        from sklearn.model_selection import RepeatedStratifiedKFold
        from sklearn.model_selection import GridSearchCV
```

```
In [44]: def load_dataset(fname):
        data=pd.read_csv(fname,header=None)
        dataset=data.values
        X=dataset[:, :-1]
        y=dataset[:, -1]
        return X,y
```

```
In [45]: X, y = load_dataset("drug200.csv")
```

```
In [46]: #define the evaluation method - k-fold cross validation & k=10
        cv=RepeatedStratifiedKFold(n_splits=10,n_repeats=3,random_state=1)
```

```
In [47]: #define the pipeline to evaluate
        model=RandomForestClassifier()
        fs=SelectKBest(score_func=f_classif)
        pipeline=Pipeline(steps=[('anova',fs),('lr',model)])
```

```
In [48]: #define the grid
        grid=dict()
        grid['anova__k']=[i+1 for i in range(X.shape[1])]
```

```
In [50]: #define the grid search
        search=GridSearchCV(pipeline, grid, scoring='accuracy',n_jobs=-1, cv=cv)
        results=search.fit(X_train_enc, y_train_enc)
```

```

/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/utils/validation.py:1143: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/pipeline.py:405: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  self._final_estimator.fit(Xt, y, **fit_params_last_step)
/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/utils/validation.py:1143: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
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/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/utils/validation.py:1143: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
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y = column_or_1d(y, warn=True)
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```

py:405: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n\_samples,), for example using `ravel()`.

```
self._final_estimator.fit(Xt, y, **fit_params_last_step)
/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/model_selection/_validation.py:378: FitFailedWarning:
60 fits failed out of a total of 150.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them by setting error_score='raise'.
```

Below are more details about the failures:

```
-----
----
30 fits failed with the following error:
Traceback (most recent call last):
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/model_selection/_validation.py", line 686, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/pipeline.py", line 401, in fit
    Xt = self._fit(X, y, **fit_params_steps)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/pipeline.py", line 359, in _fit
    X, fitted_transformer = fit_transform_one_cached(
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/joblib/memory.py", line 349, in __call__
    return self.func(*args, **kwargs)
           ^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/pipeline.py", line 893, in _fit_transform_one
    res = transformer.fit_transform(X, y, **fit_params)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/utils/_set_output.py", line 140, in wrapped
    data_to_wrap = f(self, X, *args, **kwargs)
                   ^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/base.py", line 881, in fit_transform
    return self.fit(X, y, **fit_params).transform(X)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/feature_selection/_univariate_selection.py", line 471, in fit
    self._check_params(X, y)
  File "/Users/selva/enter/envs/torch/lib/python3.11/site-packages/sklearn/feature_selection/_univariate_selection.py", line 672, in _check_params
    raise ValueError(
ValueError: k should be <= n_features = 3; got 4. Use k='all' to return all features.
-----
----
30 fits failed with the following error:
Traceback (most recent call last):
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    Xt = self._fit(X, y, **fit_params_steps)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```





```
In [59]: #enumerate each no. of feature
results=list()
for k in num_features:
    #create pipeline
    model=RandomForestClassifier()
    fs=SelectKBest(score_func=f_classif,k=3)
    pipeline=Pipeline(steps=[('anova',fs),('lr',model)])
```

```
In [60]: #evaluate the model
scores=evaluate_model(pipeline)
results.append(scores)
```

```

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```

```

In [61]: print('%d %.3f (%.3f)' % (k, mean(scores), std(scores)))

#5 0.521 (0.161)

```