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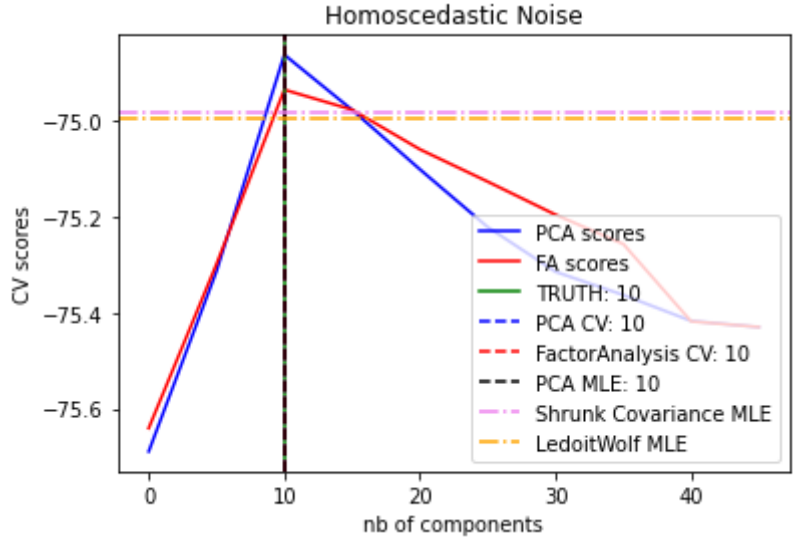
SECTION : 5ISE01

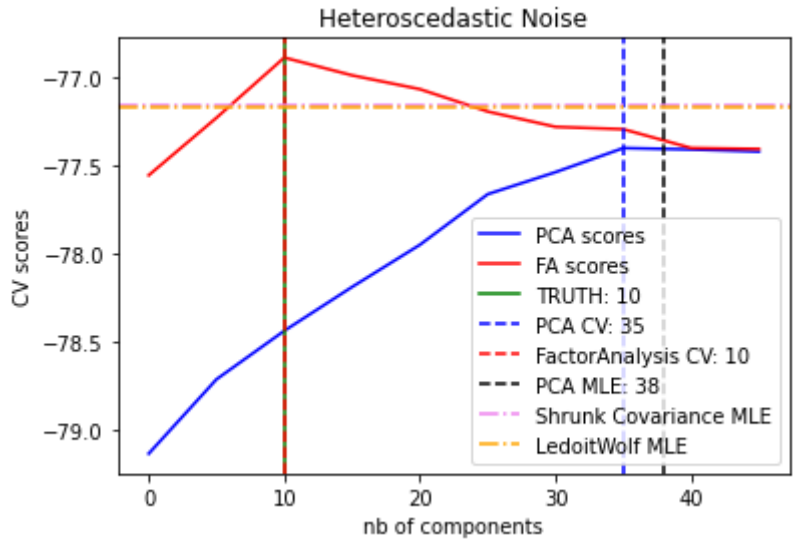
ROLL NUMBER: 20191ISE0034

```
import numpy as np
import matplotlib.pyplot as plt
from scipy import linalg

from sklearn.decomposition import PCA, FactorAnalysis
from sklearn.covariance import ShrunkCovariance, LedoitWolf
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV

print(__doc__)

# #############################################################################
# Create the data

n_samples, n_features, rank = 1000, 50, 10
sigma = 1.
rng = np.random.RandomState(42)
U, _, _ = linalg.svd(rng.randn(n_features, n_features))
X = np.dot(rng.randn(n_samples, rank), U[:, :rank].T)

# Adding homoscedastic noise
X_homo = X + sigma * rng.randn(n_samples, n_features)

# Adding heteroscedastic noise
sigmas = sigma * rng.rand(n_features) + sigma / 2.
X_hetero = X + rng.randn(n_samples, n_features) * sigmas

# #############################################################################
# Fit the models

n_components = np.arange(0, n_features, 5)  # options for n_components


def compute_scores(X):
    pca = PCA(svd_solver='full')
    fa = FactorAnalysis()

    pca_scores, fa_scores = [], []
    for n in n_components:
        pca.n_components = n
        fa.n_components = n
        pca_scores.append(np.mean(cross_val_score(pca, X)))
        fa_scores.append(np.mean(cross_val_score(fa, X)))

    return pca_scores, fa_scores
```

```
    def shrunk_cov_score(X):
        shrinkages = np.logspace(-2, 0, 30)
        cv = GridSearchCV(ShrunkCovariance(), {'shrinkage': shrinkages})
        return np.mean(cross_val_score(cv.fit(X).best_estimator_, X))


    def lw_score(X):
        return np.mean(cross_val_score(LedoitWolf(), X))


    for X, title in [(X_homo, 'Homoscedastic Noise'),
                     (X_hetero, 'Heteroscedastic Noise')]:
        pca_scores, fa_scores = compute_scores(X)
        n_components_pca = n_components[np.argmax(pca_scores)]
        n_components_fa = n_components[np.argmax(fa_scores)]

        pca = PCA(svd_solver='full', n_components='mle')
        pca.fit(X)
        n_components_pca_mle = pca.n_components_

        print("best n_components by PCA CV = %d" % n_components_pca)
        print("best n_components by FactorAnalysis CV = %d" % n_components_fa)
        print("best n_components by PCA MLE = %d" % n_components_pca_mle)

        plt.figure()
        plt.plot(n_components, pca_scores, 'b', label='PCA scores')
        plt.plot(n_components, fa_scores, 'r', label='FA scores')
        plt.axvline(rank, color='g', label='TRUTH: %d' % rank, linestyle='-')
        plt.axvline(n_components_pca, color='b',
                    label='PCA CV: %d' % n_components_pca, linestyle='--')
        plt.axvline(n_components_fa, color='r',
                    label='FactorAnalysis CV: %d' % n_components_fa,
                    linestyle='--')
        plt.axvline(n_components_pca_mle, color='k',
                    label='PCA MLE: %d' % n_components_pca_mle, linestyle='--')

        # compare with other covariance estimators
        plt.axhline(shrunk_cov_score(X), color='violet',
                    label='Shrunk Covariance MLE', linestyle='-.')
        plt.axhline(lw_score(X), color='orange',
                    label='LedoitWolf MLE' % n_components_pca_mle, linestyle='-.')

        plt.xlabel('nb of components')
        plt.ylabel('CV scores')
        plt.legend(loc='lower right')
        plt.title(title)

    plt.show()
```

```
Automatically created module for IPython interactive environment
best n_components by PCA CV = 10
best n_components by FactorAnalysis CV = 10
best n_components by PCA MLE = 10
best n_components by PCA CV = 35
best n_components by FactorAnalysis CV = 10
best n_components by PCA MLE = 38
```





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