Feature Selection with PCA

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Outline

- What is feature selection?
- Feature selection methods in python
- Principle Components Analysis (PCA)
- Feature selection with PCA
- Time analysis of PCA

Feature Selection

- Feature selection is a process where you automatically select those features in your data that contribute most to the prediction variable or output in which you are interested.

- Three benefits of performing feature selection before modeling:
  - **Reduces Overfitting**: Less redundant data means less opportunity to make decisions based on noise.
  - **Improves Accuracy**: Less misleading data means modeling accuracy improves.
  - **Reduces Training Time**: Less data means that algorithms train faster.

Feature Selection Techniques

Automatic Feature Selection

1. Removing features with low variance
2. Univariant statistics
   - SelectKBest
   - SelectPercentile
3. Recursive feature elimination
4. Model-based selection

Scikit Library: sklearn.feature_selection

Removing features with low variance

- **VarianceThreshold** is a simple baseline approach to feature selection. It removes all features whose variance doesn't meet some threshold. By default, it removes all zero-variance features, i.e. features that have the same value in all samples.

from sklearn.feature_selection import VarianceThreshold

Let's see the example

Univariant Statistics

- Determine if statistically significant relationship between each feature and the output.
- Each feature is studied in isolation.

- Univariant statistics
  - SelectKBest: Select features according to the k highest scores.
  - SelectPercentile: Select features according to a percentile of the highest scores.

Recursive Feature Elimination

sklearn.feature_selection.RFE

The goal of recursive feature elimination (RFE) is to select features by recursively considering smaller and smaller sets of features.

Recursive feature elimination with cross-validation

sklearn.feature_selection.RFECV

- Feature ranking with recursive feature elimination and cross-validated selection of the best number of features.

Model-based Feature Selection

Meta-transformer for selecting features based on importance weights.

- RFE removes least significant features over iterations.
- SelectFromModel is a little less robust as it just removes less important features based on a threshold given as a parameter. There is no iteration involved.

Reminder: Standardize the Data

- Feature scaling is an important preprocessing step for many machine learning algorithms.
- Rescale the features such to have the properties of a standard normal distribution with a **mean of zero** and a **standard deviation of one**.
- The standard score of a sample x is calculated as:

$$z = \frac{(x - u)}{z}$$

u: mean of the training data
z: standard deviation of the training sample

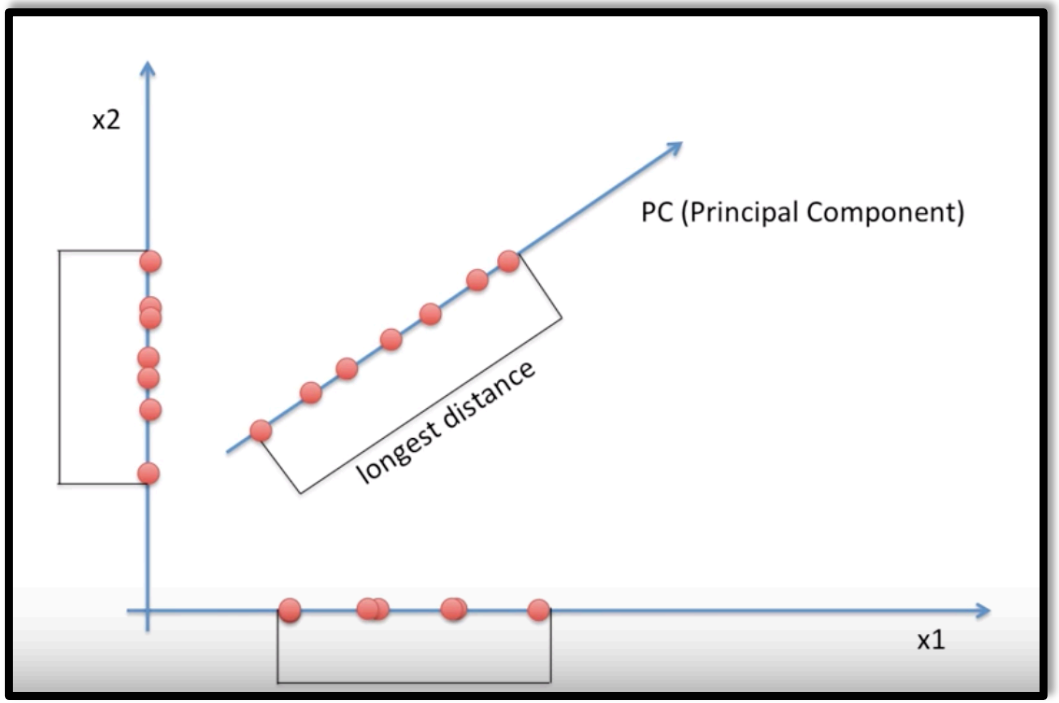
PCA

Principle Component Analysis (PCA)

- PCA is a statistical method for dimensionality reduction and feature extraction that transforms the data from a d-dimensional space into a new coordinate system of dimension p, where p<= d (the worst case would be to have p = d).

PCA: Goal

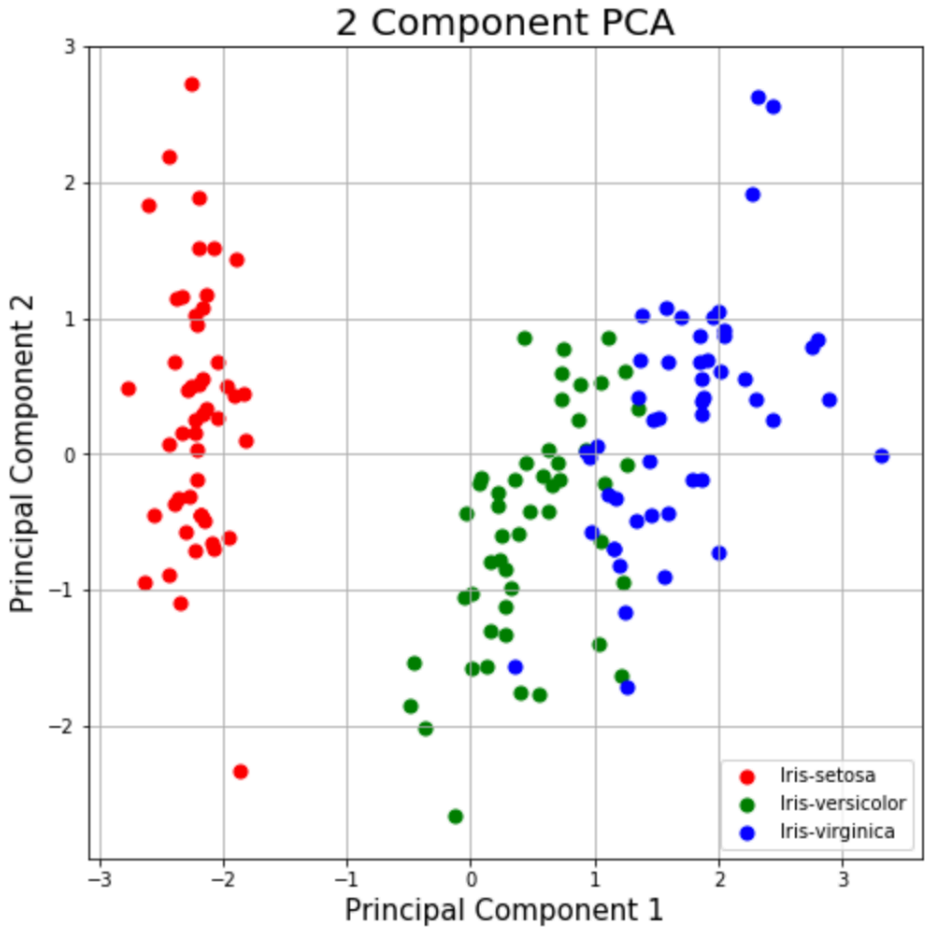
- **Goal**: to preserve as much of the variance in the original data as possible in the new coordinate systems.



Explained Variance

- The amount of variance explained by each of the selected components.

PCA for Visualization



PCA for Speeding

- PCA with Regression

Variance Retained	Number of Components	Time (mSec)	Accuracy
0.99	54	3731	0.968
0.95	40	3,692	0.967
0.90	31	3,571	0.96
0.85	25	2,372	0.94

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