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Knowledge Discovery in Databases II

SS 2017

Exercise 3: Dimentionality Reduction

Exercise 3-1 Principal Component Analysis

Consider the following example on principal axis transformation.

Given:

$$\begin{aligned} X = \{&(-3,-2),(-2,-1),(-1,0),(0,1),(1,2),(2,3),\\ &(-2,-2),(-1,-1),(0,0),(1,1),(2,2),\\ &(-2,-3),(-1,-2),(0,-1),(1,0),(2,1),(3,2)\} \end{aligned}$$

(a) Calculate the covariance matrix M.

(b) Calculate eigenvalues and eigenvectors of M.

(c) Determine the smallest eigenvalue and remove its corresponding eigenvector. The remaining eigenvector is the basis of a new sub-space.

(d) Transform all vectors in X in this new sub-space by expressing all vectors in X in this new basis.

Exercise 3-2 Principal Component Analysis

Conduct a principal axis transformation on the following data set:

- $A(1,0,3)$, $B(0,0,3)$, $C(1,0,1)$, $D(0,0,1)$

What problem comes up? How can it be solved?

Exercise 3-3 Singular Value Decomposition

Another approach to feature reduction is Singular Value Decomposition. Given a Matrix M and its SVD decomposition:

$$M = T * S * D'$$

with

$$M = \begin{bmatrix} 1 & 2 \\ 6 & 3 \\ 0 & 2 \end{bmatrix} \qquad T = \begin{bmatrix} -0.2707 & 0.5458 \\ -0.9509 & -0.2797 \\ -0.1497 & 0.7899 \end{bmatrix}$$

$$S = \begin{bmatrix} 7.0257 & 0 \\ 0 & 2.1539 \end{bmatrix} \qquad D = \begin{bmatrix} -0.8507 & -0.5257 \\ -0.5257 & 0.8507 \end{bmatrix}$$

Reduce to one dimension using the approach described in the lecture script.