Comparing Kernel-based Learning Methods for Face Recognition

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Outline

• Objective
• What is Kernel? Why Kernel? How to Kernel?
• Principal Component Analysis (PCA) vs. Fisher Discriminant Analysis (FDA)
• PCA vs. Kernel PCA (KPCA)
• Experiments
• Discussions and Conclusions
Objective

• I want to find out if the kernel versions of Principal Component Analysis (PCA) and Fisher Discriminant Analysis (FDA) are better than linear versions of PCA and FDA for face recognition?
What is Kernel?

• Kernel function: \( k(x, y) = \Phi(x) \cdot \Phi(y) \)

For example, polynomial kernel function:

\[
k(x, y) = (x \cdot y)^d
\]

What’s special? They can compute the dot products of two feature vectors without even knowing what they are!
Why Kernel?

- The original face data may not be linearly separable, so how about after nonlinear mapping? They may become linearly separable.
How to Kernelize?

• Any algorithm which can be expressed solely in terms of dot products, i.e. without explicitly usage of the variables themselves, the kernel method enables us to construct nonlinear versions of it.
PCA vs. FDA

- PCA seeks to find the projection that maximize the total scatter across all classes.
- FDA tries to find discriminant projection that maximize the between-class scatter and minimize the within-class scatter.
PCA vs. FDA
Linear PCA vs. Kernel PCA

• Kernel PCA: first do kernel mapping, from input space to feature space, then carry out PCA on the kernelized data.
Experiments

• Face Databases: public available
  • AT&T
  • FERET
  • Yale
Experiments

• AT&T
  40 subs, 10 imgs per sub

• FERET
  70 subs, 6 imgs per sub

• YALE
  15 subs, 11 imgs per sub
Discussions and Conclusions

• Discussions:
  – The selection of kernel function lacks theoretic scheme
  – Instead of using NN as classifier, SVM may achieve higher recognition rate

• Conclusions:
  – For face data, there is no big difference between Linear version methods and kernel version methods
  – FDA methods are better than PCA methods for face recognition