CS/ECE/ME 532 Activity 13

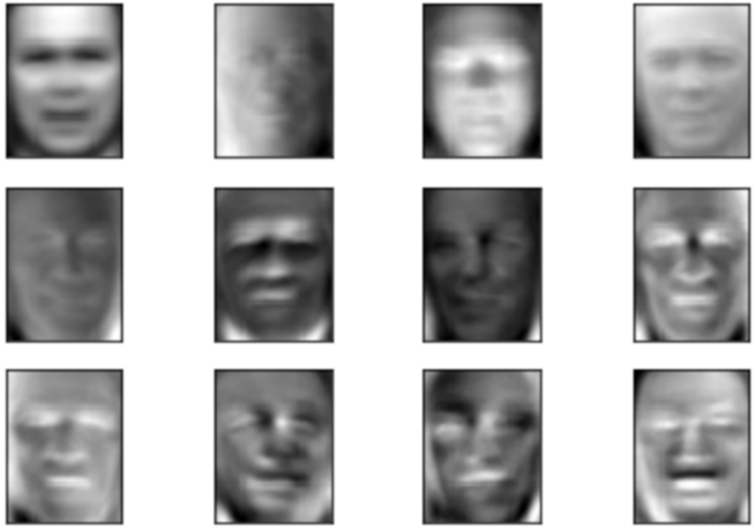
- Today - unit 4 continued
    - Bias-variance tradeoff

- Note about handing in code:
    - limit what you print out
    - indicate where a question is answered:

```
########################
#   problem 2c
########################
    some_code = ...
```

- Applications of SVD
    - Image compression
    - Face recognition
    - Demo's of both ***bonus notebooks***

Eigenfaces for face recognition



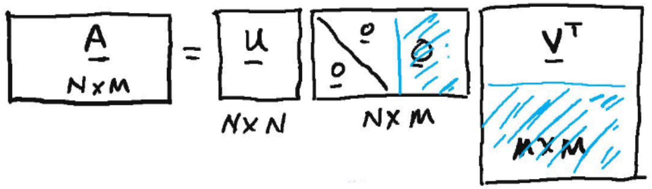
[PDF] Face recognition using **eigenfaces**
M Turk, A Pentland - ... . 1991 IEEE computer society conference
We present an approach to the detection and identification of huma
working, near-real-time face recognition system which tracks a sub
recognizes the person by comparing characteristics of the face to t
Cited by 7662 Related articles All 65 versions

Original Image

Rank 100 approximation

Today – More SVD – bias, variance trade-off

$\boldsymbol{A} =$



Bias

SVD defines the '**best**' rank r approximation (EY, 1936):

$$\min ||\boldsymbol{A} - \widehat{\boldsymbol{A}}||_F^2$$

over all matrices $\widehat{\boldsymbol{A}}$ with rank $\leq r$

given by $\widehat{\boldsymbol{A}} = \sum_{i=1}^{r} \sigma_i \boldsymbol{u}_i \boldsymbol{v}_i^T$

sum of outer products

How far off is $\widehat{\boldsymbol{A}}$? $\quad ||\boldsymbol{A} - \widehat{\boldsymbol{A}}||_F^2 \quad = \sum_{r+1}^{n} \sigma_i^2$

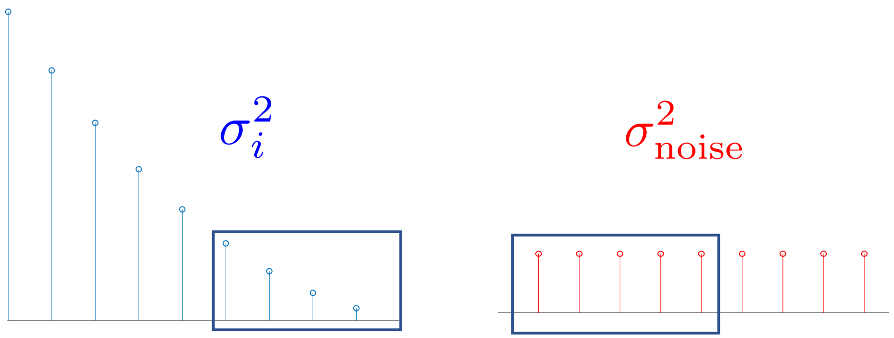
bias!

Sum of the singular values not used in approximation

Variance

noise often isotropic (singular values same)

$$\boldsymbol{A} = \boldsymbol{S} + \boldsymbol{N}$$



bias

variance

$$\sum_{r+1}^{n} \sigma_i^2 \quad \text{vs.} \quad r\sigma^2_{\text{noise}}$$