

An aerial photograph of a city, likely Madison, Wisconsin, taken from a high vantage point looking down at the city and the surrounding water. The sun is setting behind a hill in the background, creating a warm, golden glow over the entire scene. The city is built on a peninsula, with numerous buildings and streets visible. The water is a deep blue, and several sailboats are scattered across it. A large, semi-transparent rectangular box is overlaid on the center of the image, containing the course title in large, black, sans-serif font.

# CS/ECE/ME 532 Matrix Methods in Machine Learning

*Welcome!*



# Seeing your assessment



- Today in class/after class
- During in-person office hours
- Make an appointment by email with me or the TAs
  - Note: if you emailed me and not received a response, let me know if class today!



# About sklearn...

- sklearn is great!
- However:
  - The focus of this course is on the MATH behind ML
  - sklearn makes grading difficult and uneven
  - Therefore:

**Do not use sklearn for 532**  
**(unless otherwise specified)**



# Activity 13

Hint for 1c:  $\|A\|_2 = \|A\|_{OP} = \max_{x \neq 0} \frac{\|Ax\|_2}{\|x\|_2} = \sigma_1$



Recall:

SVD gives the **\*best\*** rank- $r$  approximation:

$$A = U \Sigma V^T$$

$$\boxed{\begin{matrix} A \\ n \times m \end{matrix}}$$

$$A = \sum_{i=1}^n \sigma_i u_i v_i^T \rightarrow \hat{A} = \sum_{i=1}^r \sigma_i u_i v_i^T$$

## Applications of SVD

Image compression



Face recognition

[PDF] Face recognition using **eigenfaces**

M Turk, A Pentland - ... 1991 IEEE computer society conference on

We present an approach to the detection and identification of human faces in a working, near-real-time face recognition system which tracks a subject's face and recognizes the person by comparing characteristics of the face to those of a set of known faces.

☆ 77 Cited by 7662 Related articles All 65 versions »



## Bias-Variance Tradeoff

How far off is  $\hat{A}$ ?  $\|A - \hat{A}\|_F^2 = \sum_{i=r+1}^n \sigma_i^2$  *bias!*

Sum of squares of the singular values left out of approx.

What happens in the presence of noise?

$$A = S + N \leftarrow \text{noise often isotropic (singular values same)}$$

