

An aerial photograph of a city, likely Madison, Wisconsin, taken at sunset. The sun is low on the horizon, casting a warm, golden glow over the city and the water. The city's buildings are visible on the left, and the water is filled with several sailboats. A large, semi-transparent rectangular box is overlaid on the center of the image, containing the course title in black text.

CS/ECE/ME 532 Matrix Methods in Machine Learning

Welcome!



Assessment 2



- Thursday, February 29, in class.
 - 70-minutes long
 - Bring your wiscard
 - No calculators
 - **Formula Sheet**
 - You **must** bring one 8.5"x11" sheet of paper to the assessment
 - Write your name on the top right corner of the formula sheet.
 - The formula sheet must be **handwritten** (written by **you**)
 - You may use both sides of the paper.
 - You may use a tablet to compose the formula sheet (you must print the formula sheet)
 - You must turn in your formula sheet with the assessment (you can get it back afterward)
- How to prepare:
 - Revisit past exercises
 - Do the problems without looking the solutions!
 - Unit 2 Practice Problems
 - Attend class on Tuesday, February 27

Activity 10

Low rank decompositions:

$$A = \begin{bmatrix} 3 & 3 & 3 & -1 & -1 & -1 \\ 1 & 1 & 1 & -3 & -3 & -3 \\ 1 & 1 & 1 & -3 & -3 & -3 \\ 3 & 3 & 3 & -1 & -1 & -1 \end{bmatrix} \approx TW^T = \begin{bmatrix} t_{1,1} & t_{1,2} \\ t_{2,1} & t_{2,2} \\ t_{3,1} & t_{3,2} \\ t_{4,1} & t_{4,2} \end{bmatrix} \begin{bmatrix} w_{1,1} & \dots & w_{1,6} \\ w_{2,1} & \dots & w_{2,6} \end{bmatrix}$$

taste vectors or patterns

Before:

taste vectors were given or found using Gram-Schmidt

Unit 3:

find them in a more data-centric way: the SVD (or K-means)

Clustering with K-means:

- columns of A are points in \mathbb{R}^4
- each column of T is a cluster center
- each column of W^T has a single 1 indicating cluster center



Numpy Tip

Picking columns of a matrix A:

```
cols = [3, 1, 2, 3]
A[:, cols]
```

The Singular Value Decomposition:

$$\begin{bmatrix} \underline{A} \\ N \times M \end{bmatrix} = \begin{bmatrix} \underline{U} \\ N \times N \end{bmatrix} \begin{bmatrix} \sigma & & \\ & \sigma & \\ & & \sigma \end{bmatrix} \begin{bmatrix} \underline{V}^T \\ K \times M \end{bmatrix}$$

- Singular values $\sigma_1 \geq \sigma_2 \geq \dots \geq \sigma_N \geq 0$
- “Importance” of patterns in \mathbf{U}, \mathbf{V} ranked by σ_i
- Optimal low rank approximation

$$A \approx \sum_{i=1}^r \sigma_i \mathbf{u}_i \mathbf{v}_i^T$$