

Note

- Today's activity:
 - 2 (e) is optional.
 - Eigen Faces and Color Image compression notebooks for self-exploration.
 - Add the following lines to your notebook before the headers (for Google Colab notebooks)

```
!pip install ipyml
```

```
%matplotlib widget
```

```
from google.colab import output
```

```
output.enable_custom_widget_manager()
```

Enables the necessary matplotlib backend for interactive plots.

- Applicable for Activity 12* and other activities/assignments when needed.
- Plotly library is the other alternative(used in Activity 12)
 - Features and plots are more user-friendly than Matplotlib, but code snippets usually come in Matplotlib. So, some additional effort will be needed.

Low rank approximation with Bucky

Recall:

Truncated SVD gives the **best** rank- r approximation:

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

$\boxed{\begin{smallmatrix} A \\ n \times p \end{smallmatrix}}$ SVD $A = U \Sigma V^T$

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
working, near-real-time face recognition system which tracks a subject
recognizes the person by comparing characteristics of the face to tho:
☆ ⓘ Cited by 7662 Related articles All 65 versions ⓘ



Demos of both in *bonus notebooks*

Bias-Variance Tradeoff

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

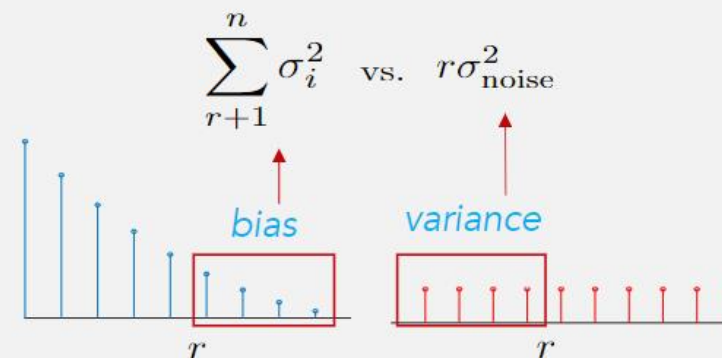
bias!

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

What happens in the presence of noise?

$$A = S + N$$

noise often isotropic (singular values same)



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