1. Input matrix is X which is ~~AX~~ $n \times d$ dimensional

2. From we first mean center X and get X'

$X' = X - \mu$

3. Calculate co-variance of X'. In matrix operation, it is $X'^T X$. Call it Z

$Z = X'^T X$ → verify yourself that this is co-variance

$X' \rightarrow n \times d$

$X'^T \rightarrow d \times n$

$Z \rightarrow d \times d$

4. Do eigendecomposition of Z

Use SVD to do it.

So, Z can be written as

$Z = P D P^{-1}$ | $P \rightarrow$ eigenvectors, $D \rightarrow$ diagonal matrix with eigenvalues on the diagonal

$$D = \begin{bmatrix} \lambda_1 & & \\ & \lambda_2 & \\ & & \lambda_{p \ldots n} \end{bmatrix}$$

$P \rightarrow d \times d$

$D \rightarrow$ Sort the diagonal elements and order P accordingly

Call this sorted matrix as P^*

E.g. if λ_3 is the largest eigenvalue then consider ~~second~~ the third column of P and make this the first column in P^*

P^* usually contains just first r column based on the r highest eigenvalues.

$$\underline{\underline{r < d}}$$

Now the new features will be–

$$X_{new} = X' P^*$$

$X' \rightarrow n \times d$

$P^* \rightarrow d \times r$

$X_{new} \rightarrow n \times r$

Reconstruction:

We can go back to the original feature space $n \times \underline{d}$.

How?

Ans: - reverse the steps shown above

$$X_{recon} = X_{new} P^{*T} + mean$$

This refers to the figures in the slide

$X_{new} \rightarrow n \times r$

$P^* \rightarrow d \times r$

$P^{*T} \rightarrow r \times d$

$X_{recon} \rightarrow \underline{n \times d}$
original dimension

Tf-idf computation

$$tf(\text{"this"}, d_1) = \frac{1}{2}$$

~~As~~ "a" is the most common word in d_1 and

~~#(~~ '#("a", d_1) = 2

Another way to normalize is to divide by the count of all words in the document.

In that case,

$$tf(\text{"this"}, d_1) = \frac{1}{5}$$

$$tf(\text{"this"}, d_2) = \frac{1}{3}$$

$$idf(\text{"this"}, D) = \log\left(\frac{2}{2}\right)$$

$$= \log 1$$

$$= 0$$

$$tfidf(\text{"this"}, d_1, D) = 0.5 \times 0 = 0$$

$$tfidf(\text{"this"}, d_2, D) = 0.34 \times 0 = 0$$

~~Similarly~~,

~~tfidf~~(

Similarly,

$$tf(\text{"example"}, d_1) = \frac{0}{2} = 0$$

$$tf(\text{"example"}, d_2) = \frac{3}{3} = \underline{1}$$

$$idf(\text{"example"}, D) = \log\left(\frac{2}{1}\right)$$
$$= \log 2$$
$$= 0.301$$

$$tfidf(\text{"example"}, d_1, D) = 0 \times 0.301$$
$$= 0$$

$$tfidf(\text{"example"}, d_2, D = 1 \times 0.301$$
$$= 0.301$$