

Principal component analysis

Principal component analysis is essentially boiling down multidimensional data with a lot of dimensions (aka columns) into a few dimensions while keeping **most** of the information.

Given n m -dimensional vectors, steps to find the top k principal components:

1. Calculate the component-wise average of all of the vectors $\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$
2. Form $m \times m$ matrix $S = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})(x_i - \bar{x})^T$
3. Calculate the m -dimensional eigenvectors associated with the largest k eigenvalues of S : v_1, \dots, v_k associated with $\lambda_1, \dots, \lambda_k$
4. The k dimensional representation of x_i is then $\hat{x}_i = (x_i^T v_1, \dots, x_i^T v_k)$

Another way to state the objective:

$$\min \sum_{i=1}^n \|x_i - \hat{x}_i\|^2$$

$$\max \sum_{i=1}^n \|\hat{x}_i\|^2$$

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