Principal Component Analysis is a dimension reduction technique which is usually used when we have a large number of variables. Of these variables some might be correlated which brings redundancy in information. So, to reduce the computational cost and complexities, we make use of PCA to transform original variables into linear combination of these variables which are independent.

PCA does not have any disadvantages. If used correctly it filters the noise and we will be left with stronger signal. However, there are certain limitations on PCA through which we can get erroneous results.

Limitations:

1) Covariance and variance are extremely sensitive to large values. So, if we forget to standardize the attributes then if an attribute represents a larger scale. Then that attribute will dominate the covariance matrix and it will look as a principal component. This is because it will look to PCA as that attribute is most spread out across all attributes. So, it is very important to normalize the variance across all attributes.

2) PCA assumes that principal components are a linear combination of original features. If the underlying subspace is not linear then PCA will give not give a good projection of the data.

3) PCA makes use of variance as a measure on how important a particular dimension is. So it classifies high variance axes as principle components and low variance axes as noise.

4) PCA assumes that the principal components are orthogonal.

Example:

A close up of a map

Description generated with high confidence

We can see that PCA fails as the data set is non-Gaussian distributed and the axes are non-orthogonal. The axes with the largest variance do not correspond to the appropriate answer.

Hence it is important that we make sure that the data set is in accordance to the above limitations if not then PCA will not give a good projection of the data.

Reference:

Shlens, J. (April 7, 2014). A Tutorial on Principal Component Analysis. Mountain View CA. Retrieved from https://arxiv.org/pdf/1404.1100.pdf