Process Monitoring

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Chapter 3a
Principal Component Analysis

Process Monitoring

Chapter Description

- Aims
  - Understand the basic principles of multivariate techniques.
- Expected Outcomes
  - Comprehensively explain in writing as well as solve mathematically the principles of multivariate analysis based on complex monitoring problem of MSPM framework.
- Other related Information

Subtopics

3.1 Objectives

3.2 Classification of Multivariate Techniques

3.3 Multivariate Dimensional Reduction Approach

3.1 Objectives

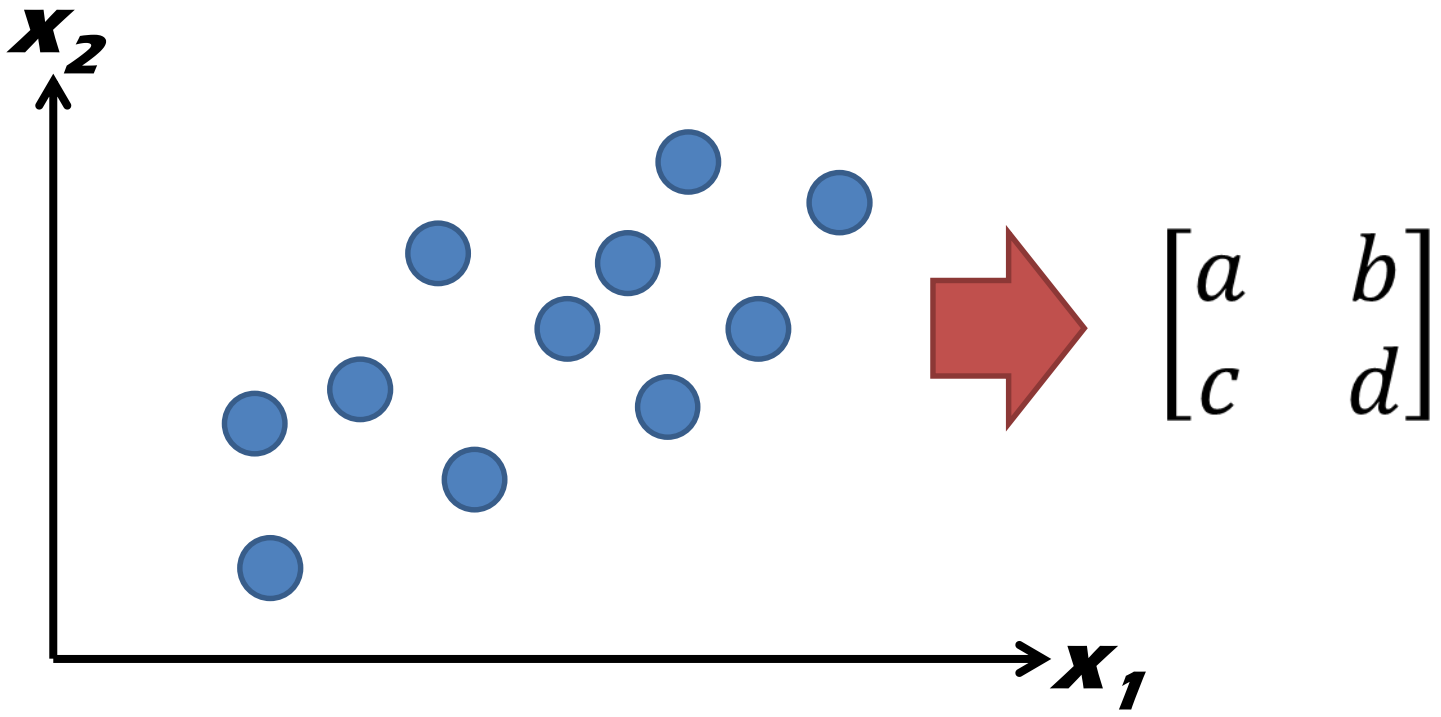
2 Objectives (Green and Caroll , 1976):

i. Discover regularities on the behavior of 2 or more variables => exploratory.
ii. Testing alternative models of association between 2 or more variables => confirmatory.

3.1 Objectives

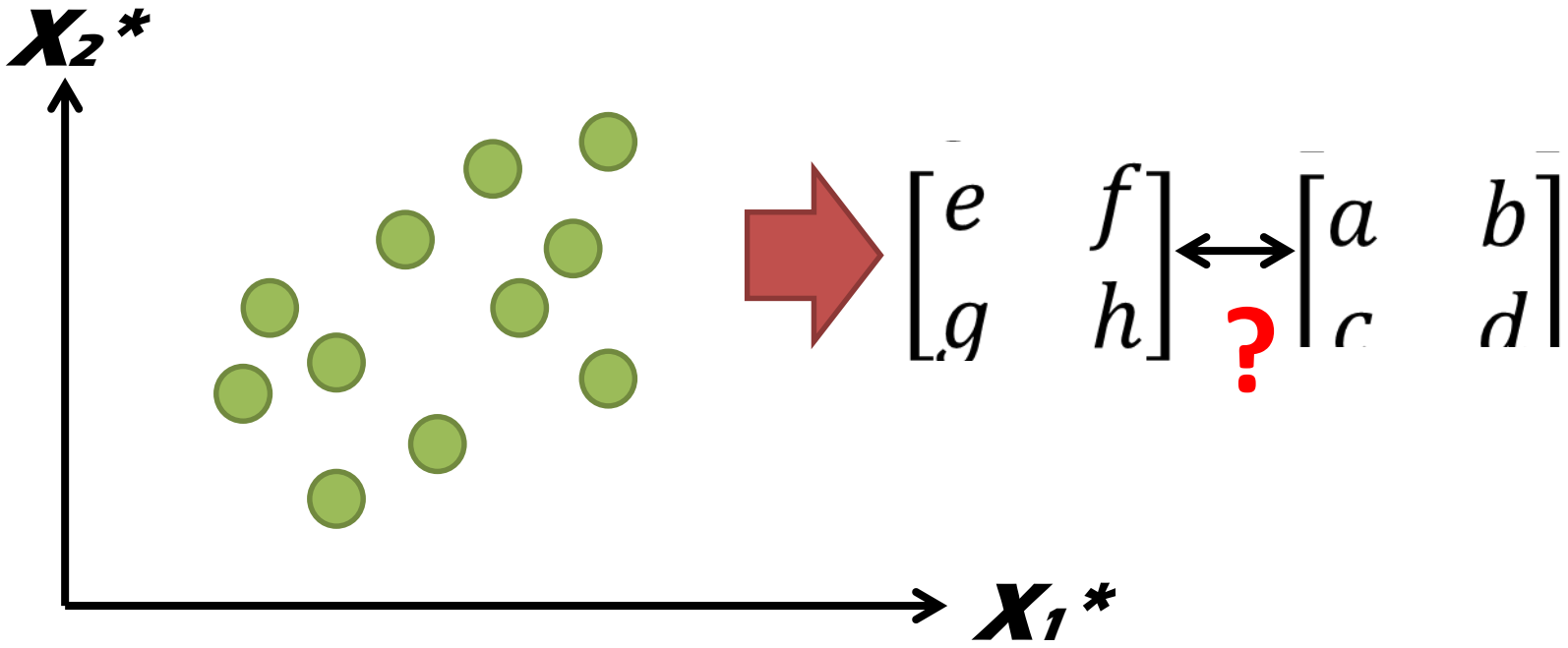
Discover regularities on the behavior of 2 or more variables

=> exploratory



3.1 Objectives

Testing alternative models of association between 2 or more variables => **confirmatory**.



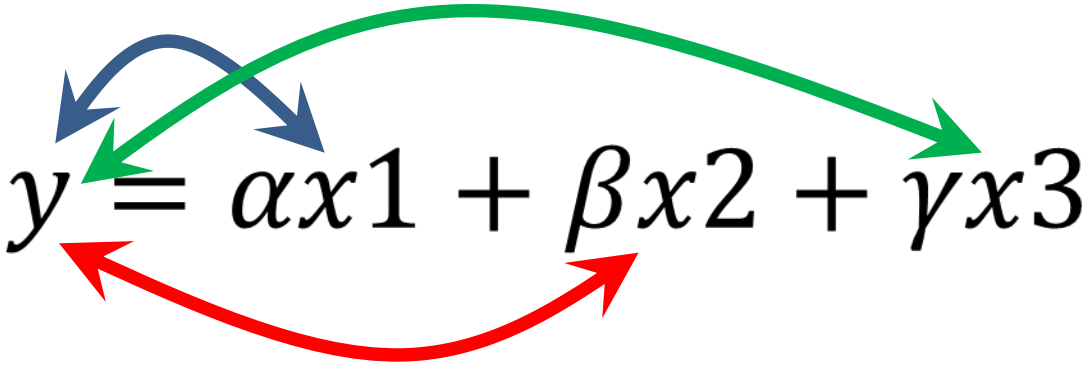
3.2 Classification of Multivariate Techniques

Techniques (Green and Caroll , 1976):

1. Single criterion, multiple predictor association.
2. Multiple criterion, multiple predictor association.
3. Analysis of variable interdependence.
4. Analysis of inter-object similarity.

3.2 Classification of Multivariate Techniques

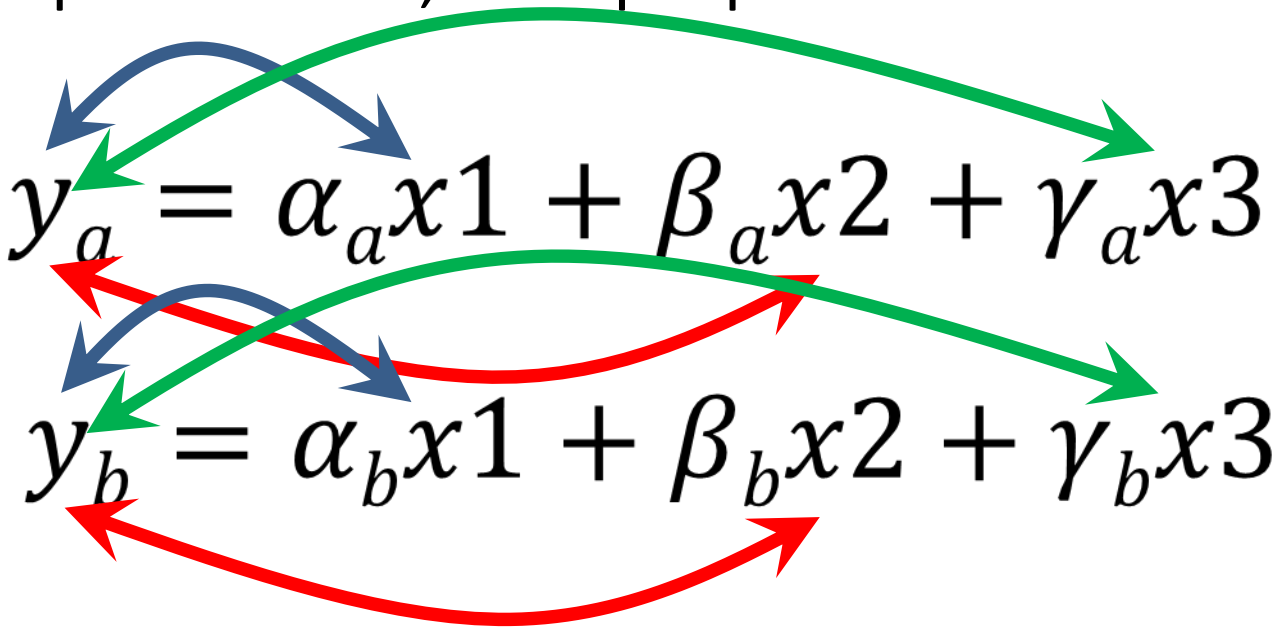
1. Single criterion, multiple predictor association



Linear Regression

3.2 Classification of Multivariate Techniques

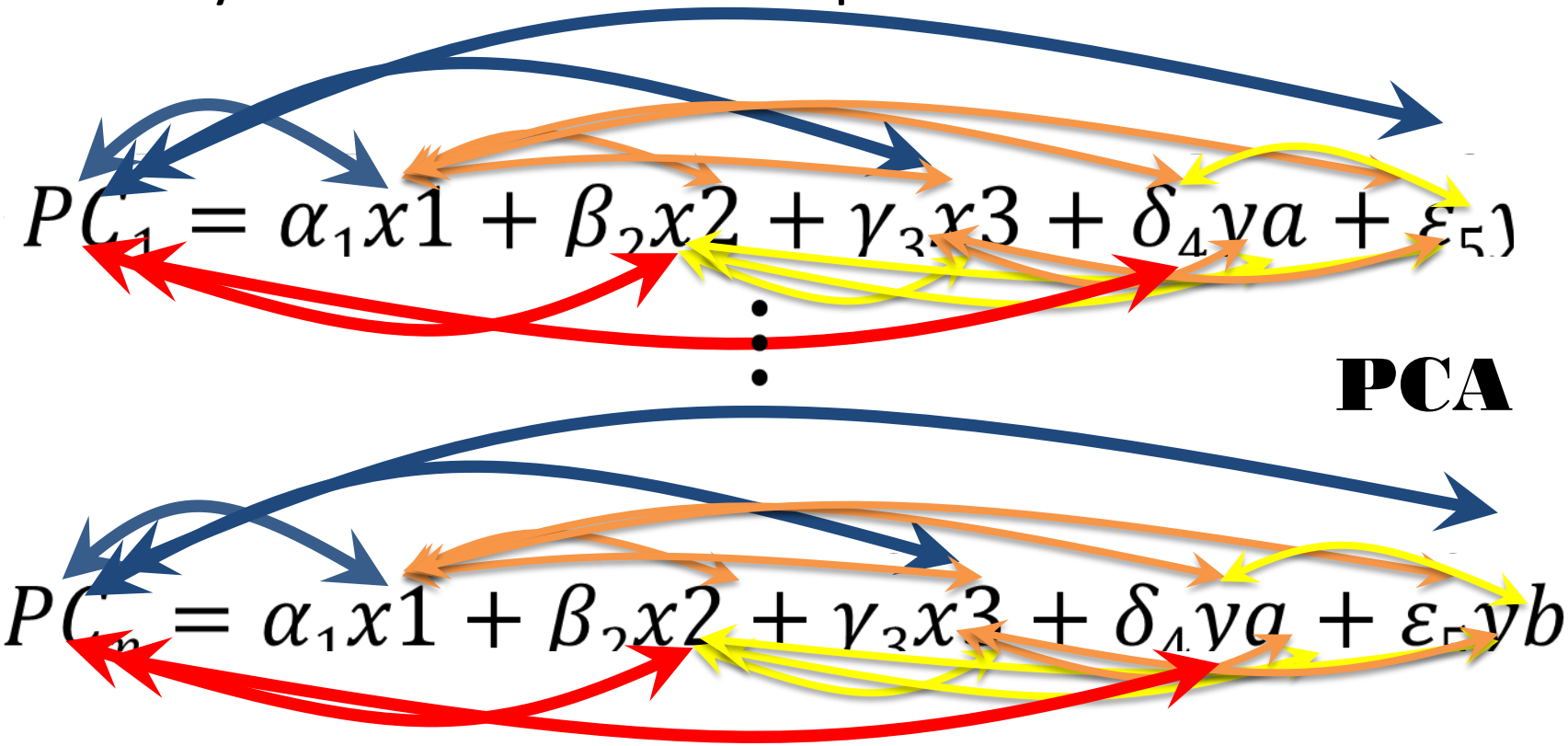
2. Multiple criterion, multiple predictor association



Multiple Linear Regression

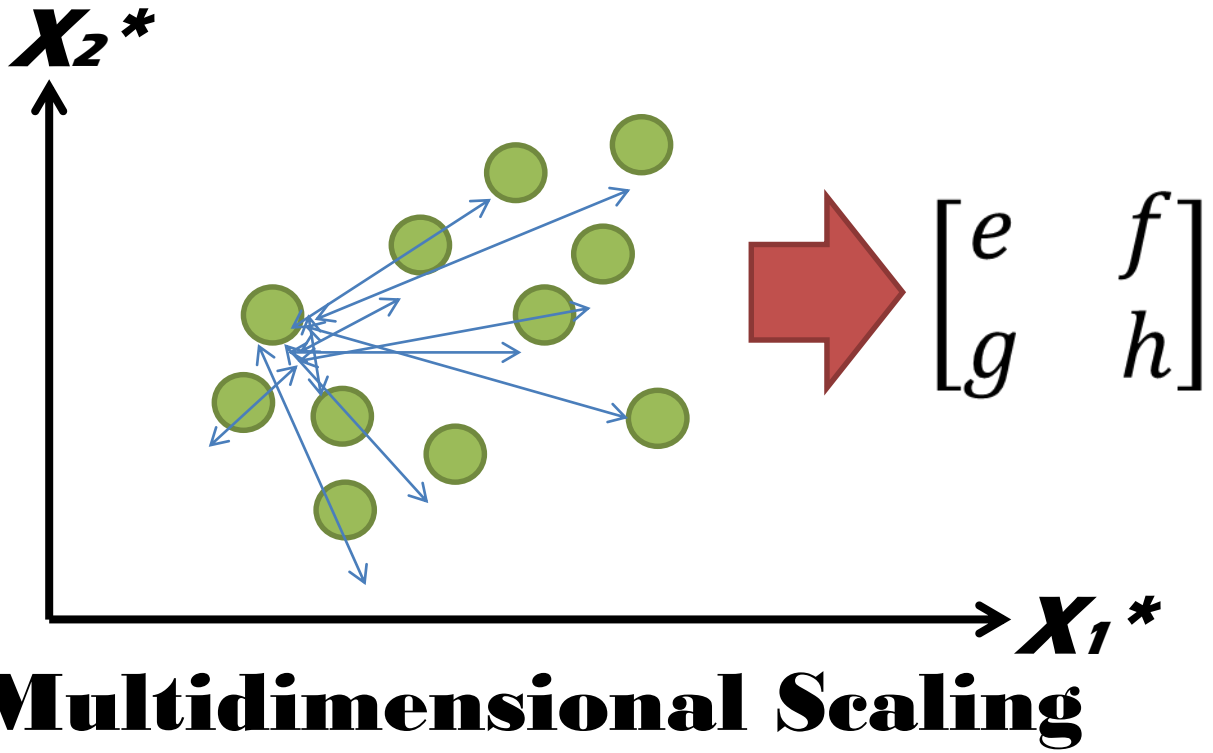
3.2 Classification of Multivariate Techniques

3. Analysis of variable interdependence



3.2 Classification of Multivariate Techniques

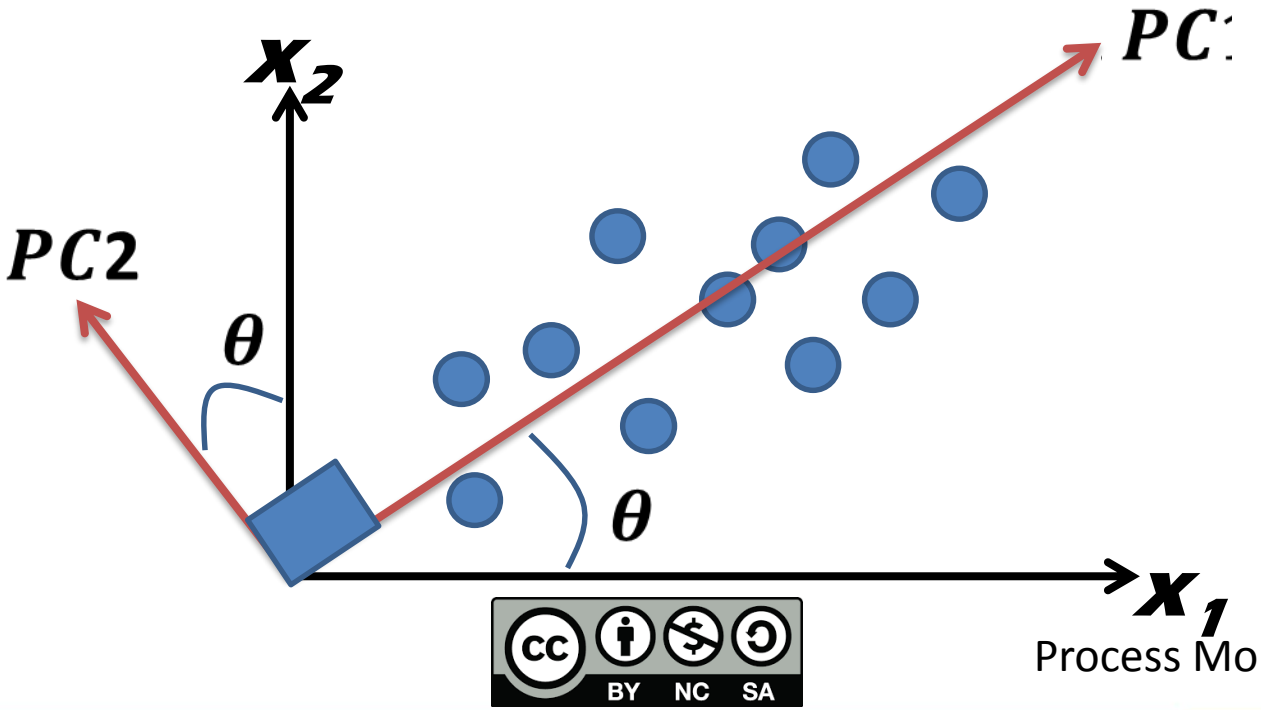
4. Analysis of inter-object similarity



3.3 Multivariate Dimensional Reduction Approach

MSPM framework depends on '**Dimension Reduction Technique**' (variable interdependence analysis):

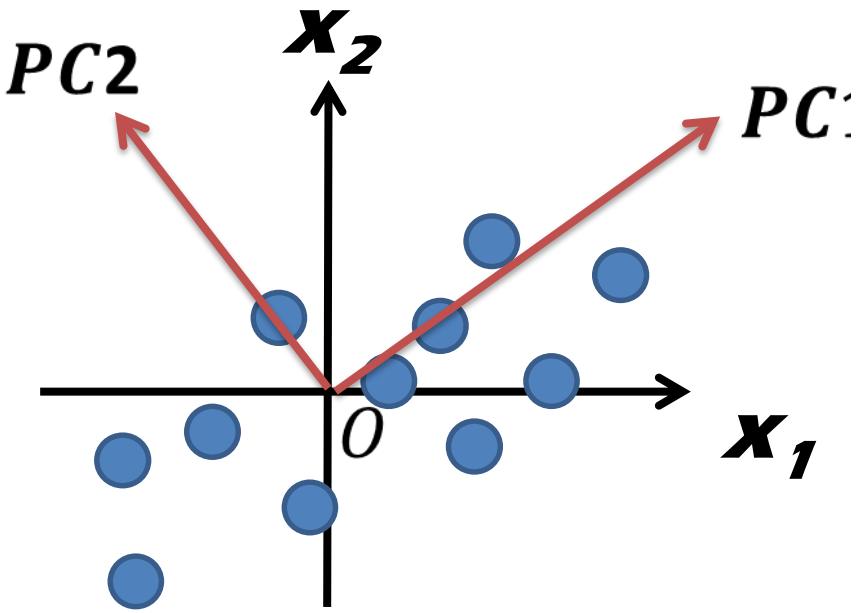
- Representing the objects of the investigation in terms of fewer dimensions than originally expressed.



3.3 Multivariate Dimensional Reduction Approach

Data modification:

- Mean corrected data
- Standardized data



3.3 Multivariate Dimensional Reduction Approach

- Types of matrices that useful for multivariate analysis:
  1. Minor product moment:
     - **$Bn=A'A$**
  2. Major product moment:
     - **$Bj=AA'$**
  3. The mean corrected sums of squares and cross products (SSCP) matrix:
     - **$S=A_d'A_d$**
  4. The covariance matrix:
     - **$C=1/(n-1)(A_d'A_d)$**
  5. The correlation matrix:
     - **$K=1/(n-1)(A_s'A_s)$**

1. What is the main different between covariance & correlation matrix in terms of value?
2. How can both be represented graphically?
3. What sort of information do they convey individually?

References

- Green, P.E., and Carroll, J.D., (1976). *Mathematical Tools for Applied Multivariate Analysis.* New York, USA: Academic Press.

- Jackson, J.E., (1991). *A User's Guide To Principal Components.* John Wiley and Sons. USA.

Authors Information

Credit to the authors: