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

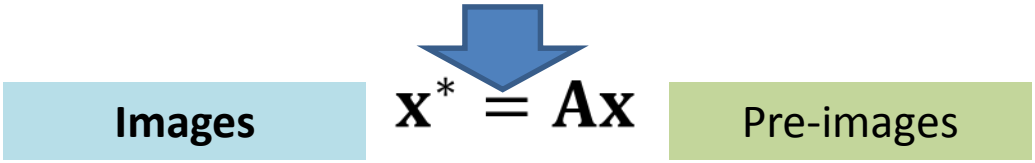
3.4 Orthogonal Transformation

3.5 Transformation Through Rotation

3.4 Orthogonal Transformation

Any linear transformation can be represented in matrix form => transforming vectors into vectors (solving simultaneous linear equations):

$$x1^* = a_{11}x1 + a_{21}x2 + \cdots + an_1xn$$
$$x2^* = a_{12}x1 + a_{22}x2 + \cdots + an_2xn$$
$$\vdots$$
$$xn^* = a_{1n}x1 + a_{2n}x2 + \cdots + annxn$$



3.4 Orthogonal Transformation

- Orthogonal transformation matrix:
  - $\mathbf{A}'\mathbf{A} = \mathbf{A}\mathbf{A}' = \mathbf{I}$
  - The rows and columns of **A** are mutually orthogonal and each of unit length
  - Geometrically, it forms a **rotation** (proper or improper) and expressed as sets of direction cosines.

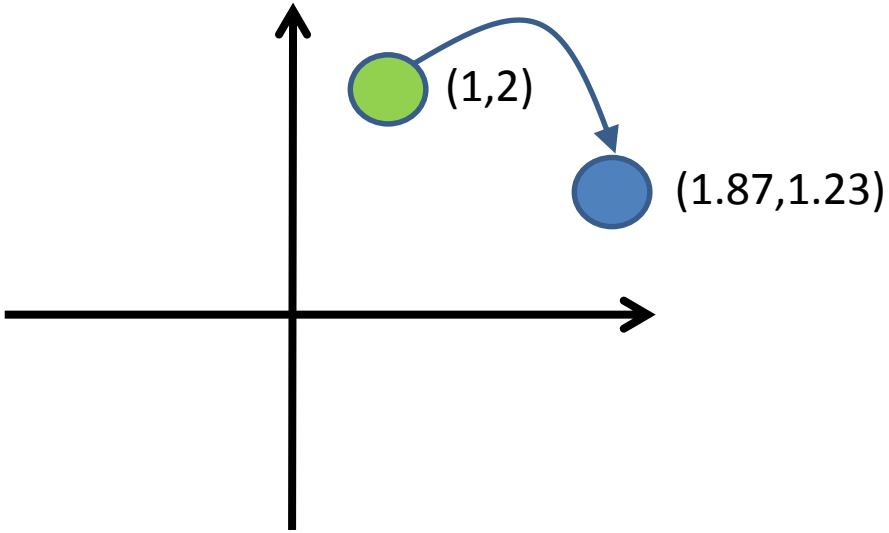
3.5 Transformation Through Rotation

- 2 types of rotation (around the origin):
  1. Point rotation: the points move clockwise or counterclockwise while the basis vectors remained fixed.
  2. Basis vector rotation: the original points remained fixed, while the basis vectors move clockwise or counterclockwise .

3.5 Transformation Through Rotation

Two types of rotation (around the origin):

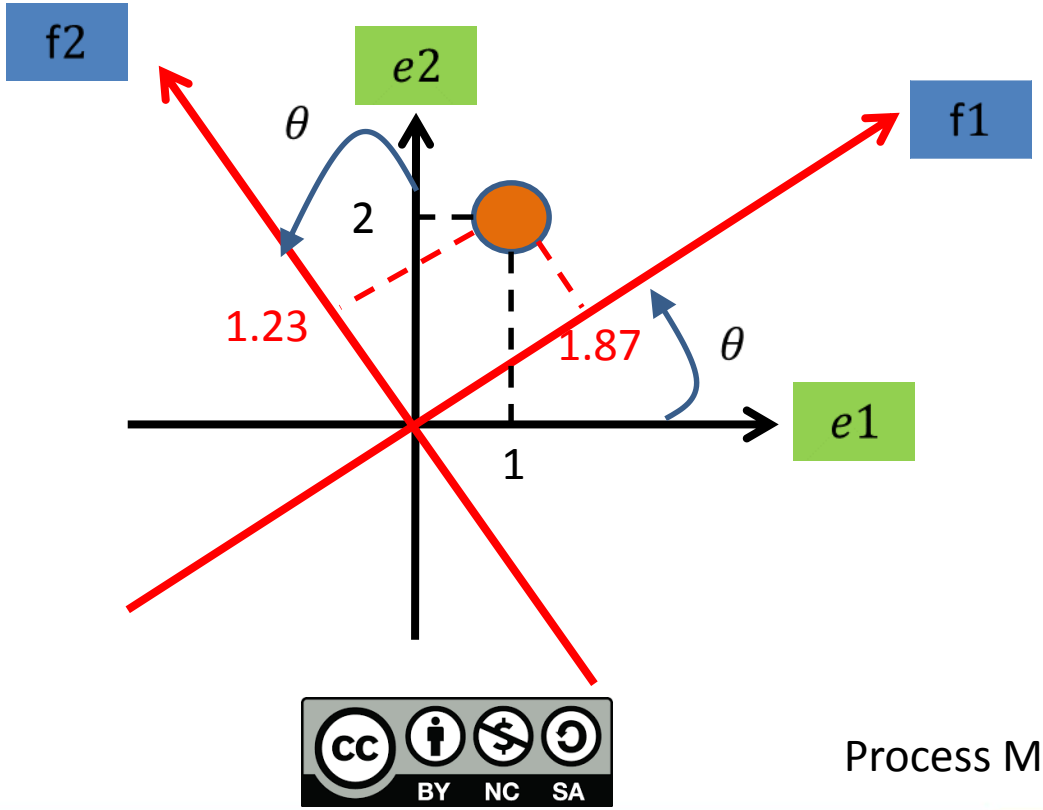
i. Point rotation: the points move clockwise or counterclockwise while the basis vectors remained fixed.



3.5 Transformation Through Rotation

Two types of rotation…cont.

ii. Basis vector rotation: the original points remained fixed, while the basis vectors move clockwise or counterclockwise



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: