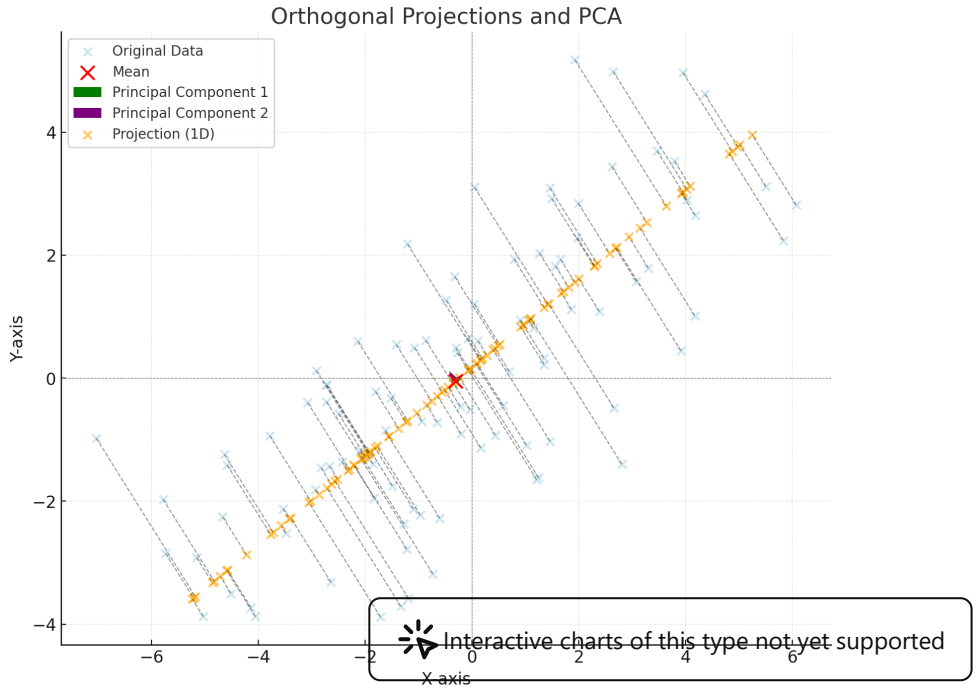
Orthogonal Projections And PCA



Orthogonal Projections with PCA Visualization

The plot above demonstrates **orthogonal projections** in the context of **Principal Component Analysis (PCA)**. Here's an explanation of the components in the visualization:

Step-by-Step Explanation

1. **Original Data**:

- The light blue points represent the original 2D dataset.
- This data has been generated with some correlation between the two axes, making it non-isotropic.

2. **Mean**:
   - The red dot marks the **mean** of the dataset, which serves as the center for computing principal components.
3. **Principal Components**:
   - The **green arrow** is the **first principal component (PC1)**, which explains the maximum variance in the data.
   - The **purple arrow** is the **second principal component (PC2)**, orthogonal to PC1 and explaining the remaining variance.
4. **Projections**:
   - The orange points show the projections of the original data onto PC1. These points lie on the line defined by PC1.
   - Each black dashed line represents the orthogonal projection of a blue point onto the PC1 axis.

Key Insights from the Visualization

- **Orthogonality**:

- The dashed lines are orthogonal to PC1, confirming the concept of orthogonal projections.

- **Dimensionality Reduction**:
  - PCA effectively reduces the 2D dataset to 1D by retaining only the projections onto PC1, which captures the majority of the variance.

Practical Applications of PCA and Projections

1. **Dimensionality Reduction**:
   - PCA reduces data dimensions while retaining maximum information.
2. **Noise Reduction**:
   - Orthogonal projections help filter noise by focusing on the most significant components.
3. **Data Visualization**:
   - High-dimensional data is projected onto 2D or 3D spaces for visualization.