# PSY9511: Seminar 5

## Unsupervised learning

Esten H. Leonardsen

24.10.24


UNIVERSITY
OF OSLO

# Outline

1. Overview of unsupervised learning
2. Clustering
    - K-means
    - Hierarchical
3. Dimensionality reduction
    - Principal component analysis (PCA)
    - Independent component analysis (ICA)
    - Partial least squares (PLS)

# Unsupervised learning


UNIVERSITY
OF OSLO

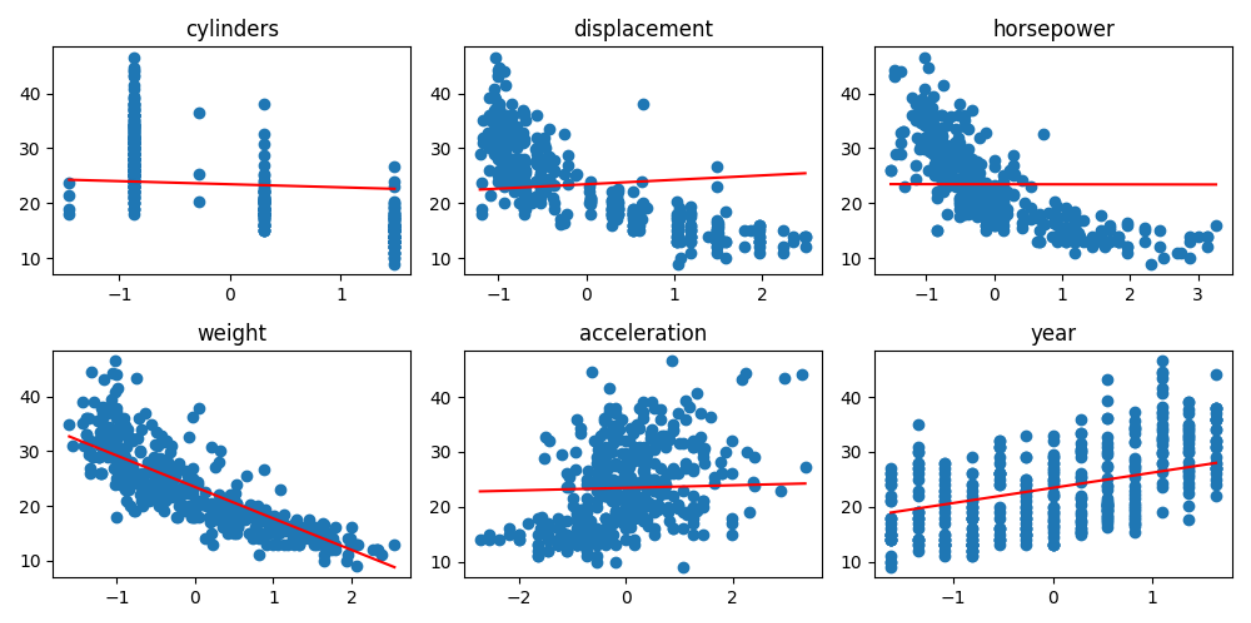
# Unsupervised learning: Motivation

Supervised learning: Find $\hat{y} = f(X)$

# Unsupervised learning: Motivation

Supervised learning: Find $\hat{y} = f(X)$

- Descriptive: Understand the relationship between $X$ and $y$



# Unsupervised learning: Motivation

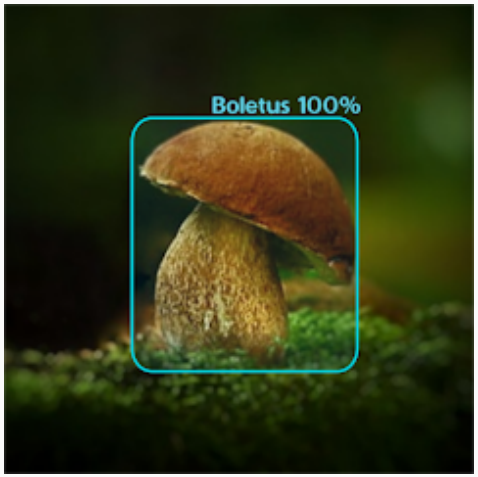
Supervised learning: Find $\hat{y} = f(X)$

- Descriptive: Understand the relationship between $X$ and $y$
- Predictive: Predict $y$ given new $X$.

# Unsupervised learning: Motivation

Supervised learning: Find $\hat{y} = f(X)$

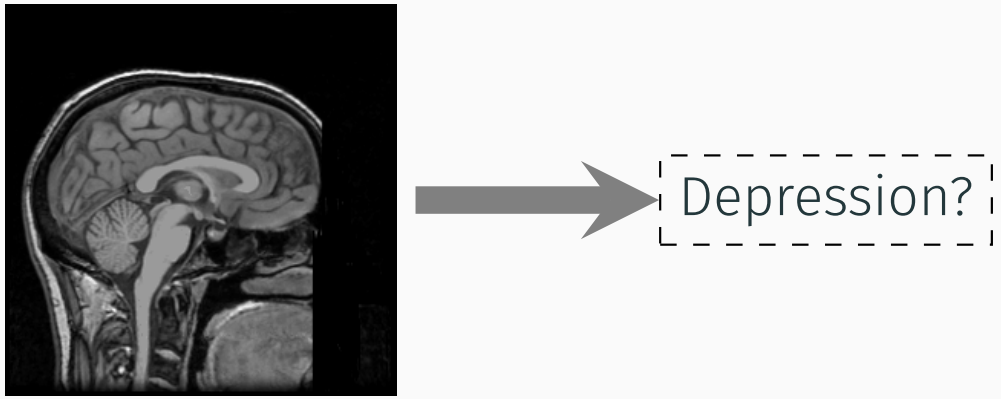
- Descriptive: Understand the relationship between $X$ and $y$
- Predictive: Predict $y$ given new $X$.
  - Because the predictions are useful



# Unsupervised learning: Motivation

**Supervised learning: Find $\hat{y} = f(X)$**

- Descriptive: Understand the relationship between $X$ and $y$
- Predictive: Predict $y$ given new $X$.
  - Because the predictions are useful
  - Because we want to know if it is possible



# Unsupervised learning: Motivation

Supervised learning: Find $\hat{y} = f(X)$

- Descriptive: Understand the relationship between $X$ and $y$
- Predictive: Predict $y$ given new $X$.
  - Because the predictions are useful
  - Because we want to know if it is possible

Unsupervised learning: Are there some interesting patterns in X?

# Unsupervised learning: Motivation

**Supervised learning: Find $\hat{y} = f(X)$**

- Descriptive: Understand the relationship between $X$ and $y$
- Predictive: Predict $y$ given new $X$.
  - Because the predictions are useful
  - Because we want to know if it is possible

**Unsupervised learning: Are there some interesting patterns in X?**

- Can we find subgroups or interesting axes of variability?

# Unsupervised learning: Motivation

**Supervised learning: Find $\hat{y} = f(X)$**

- Descriptive: Understand the relationship between $X$ and $y$
- Predictive: Predict $y$ given new $X$.
  - Because the predictions are useful
  - Because we want to know if it is possible

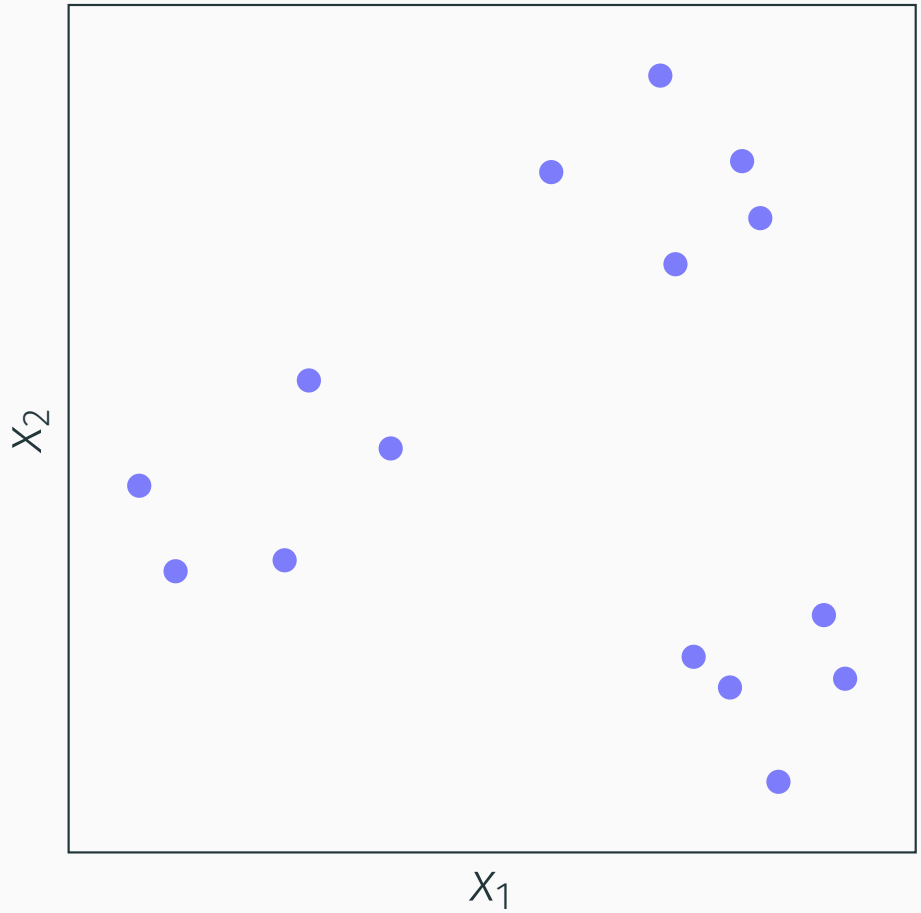
**Unsupervised learning: Are there some interesting patterns in X?**

- Can we find subgroups or interesting axes of variability?
- Visualization

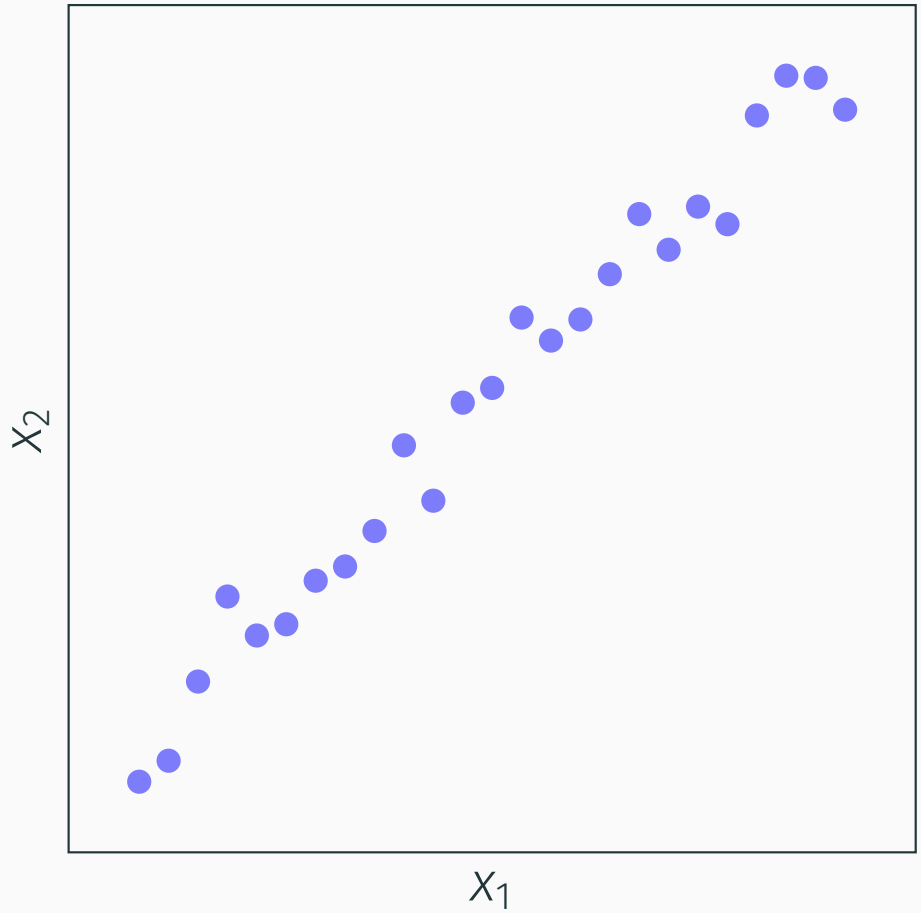
# Dimensionality reduction


UNIVERSITY
OF OSLO

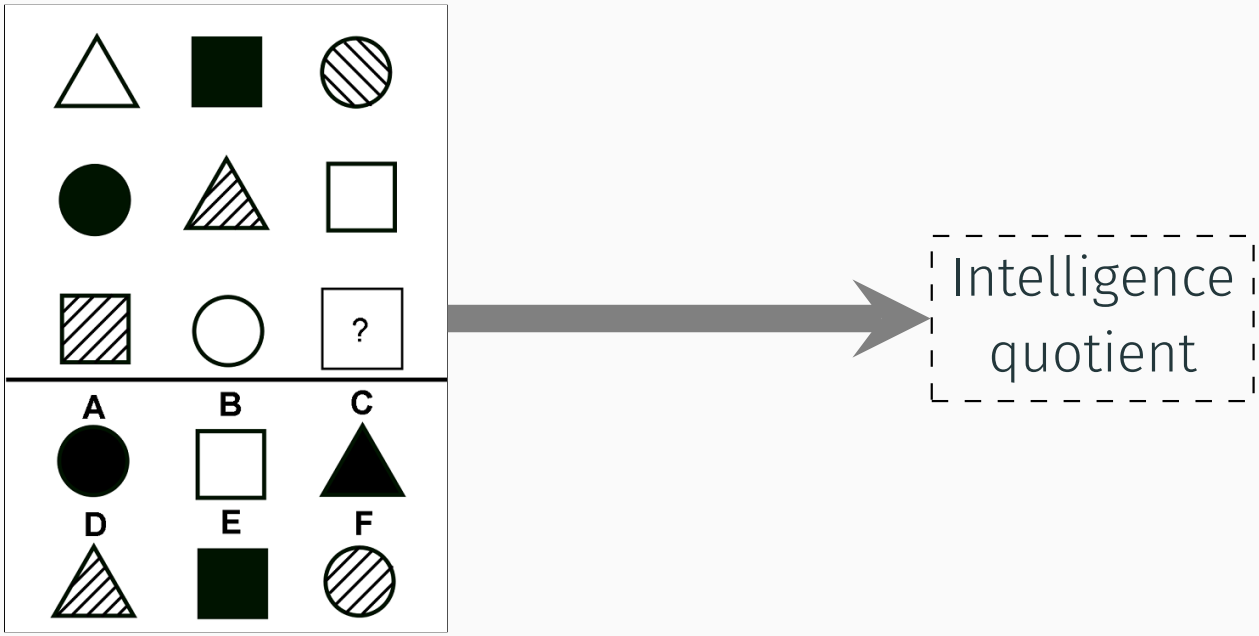
# Dimensionality reduction: Motivation



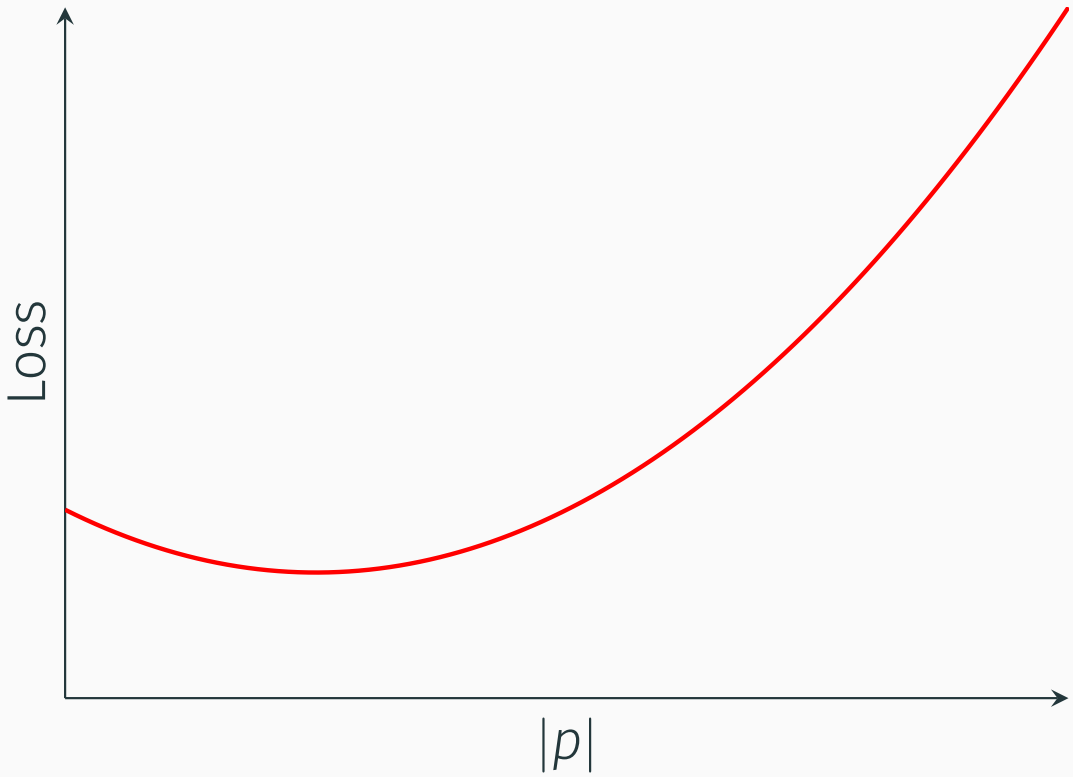
# Dimensionality reduction: Motivation



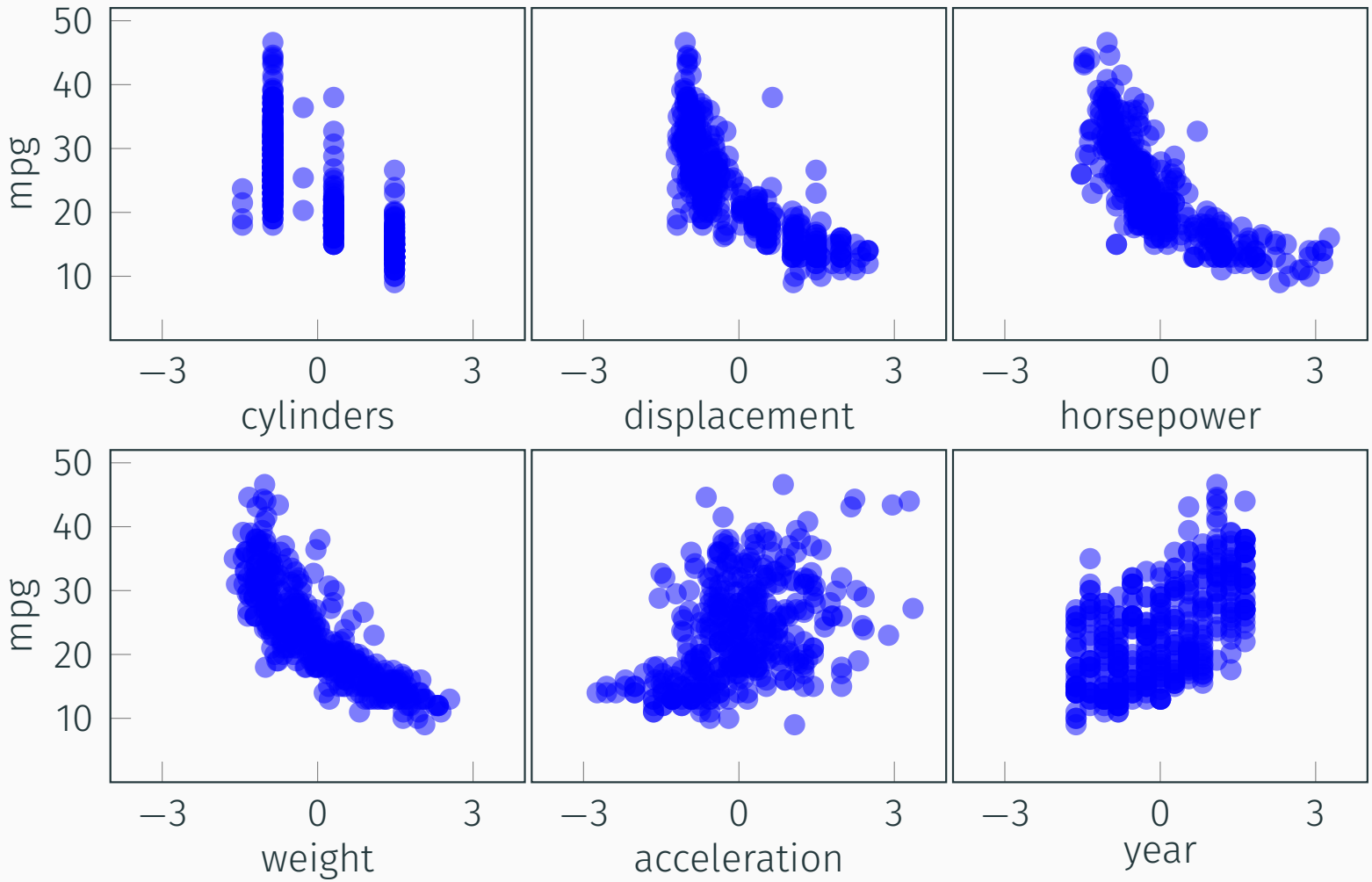
# Dimensionality reduction: Motivation



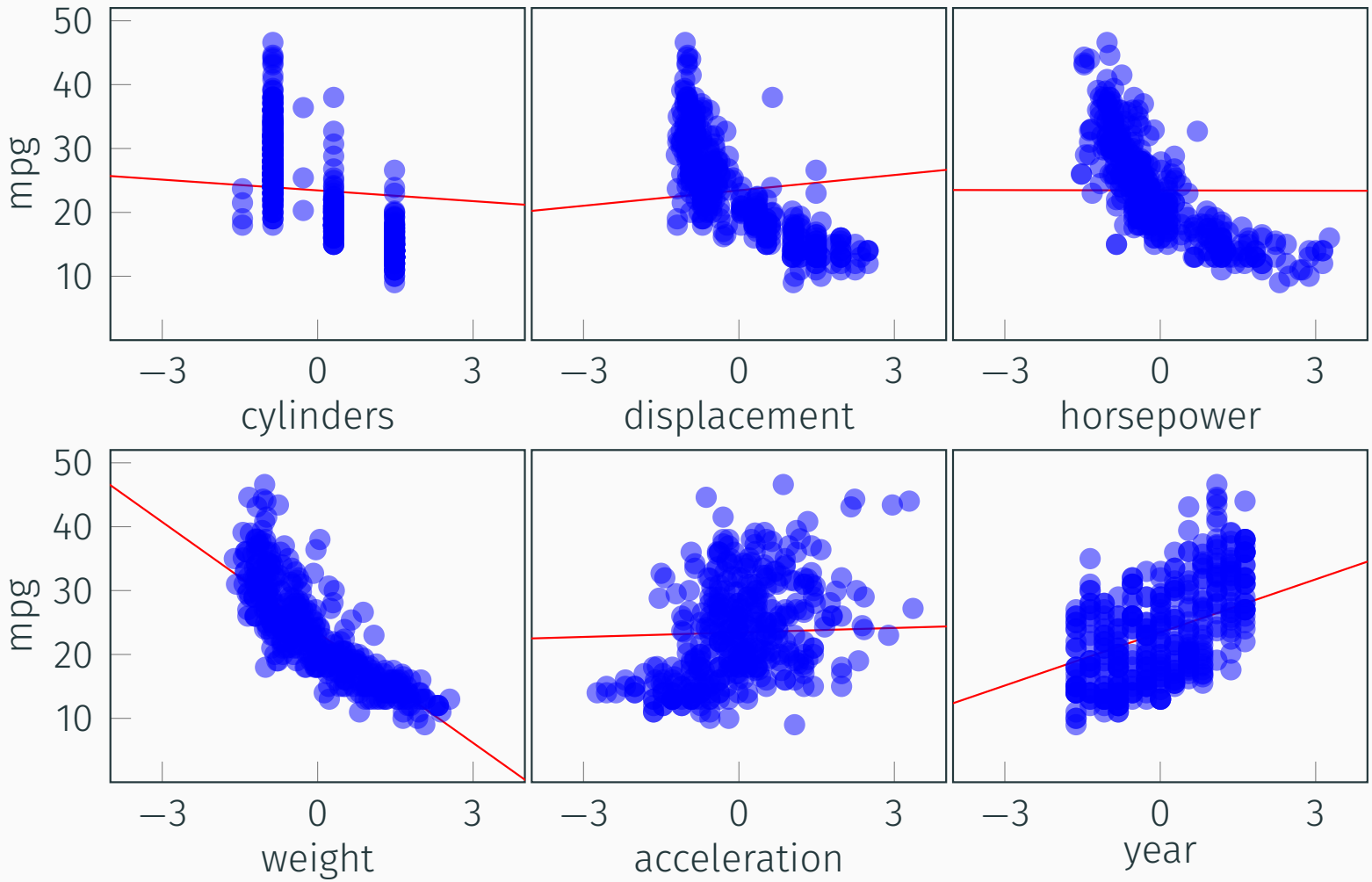
# Dimensionality reduction: Motivation



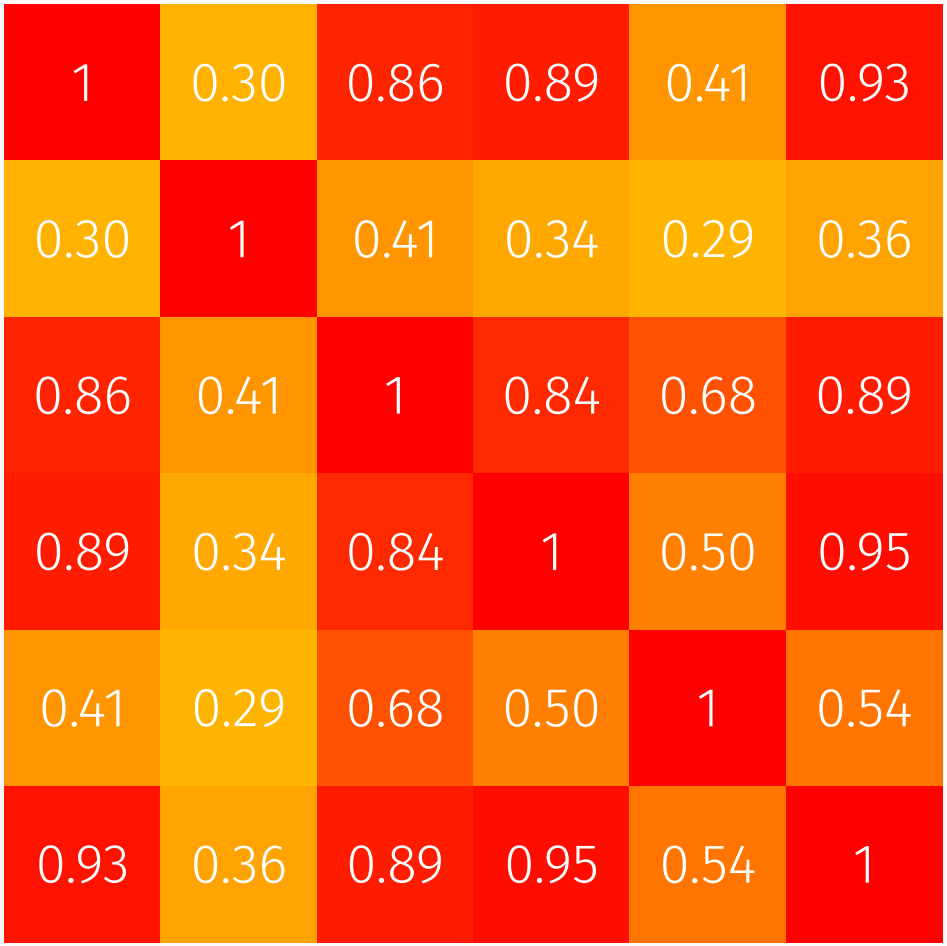
# Dimensionality reduction: Motivation



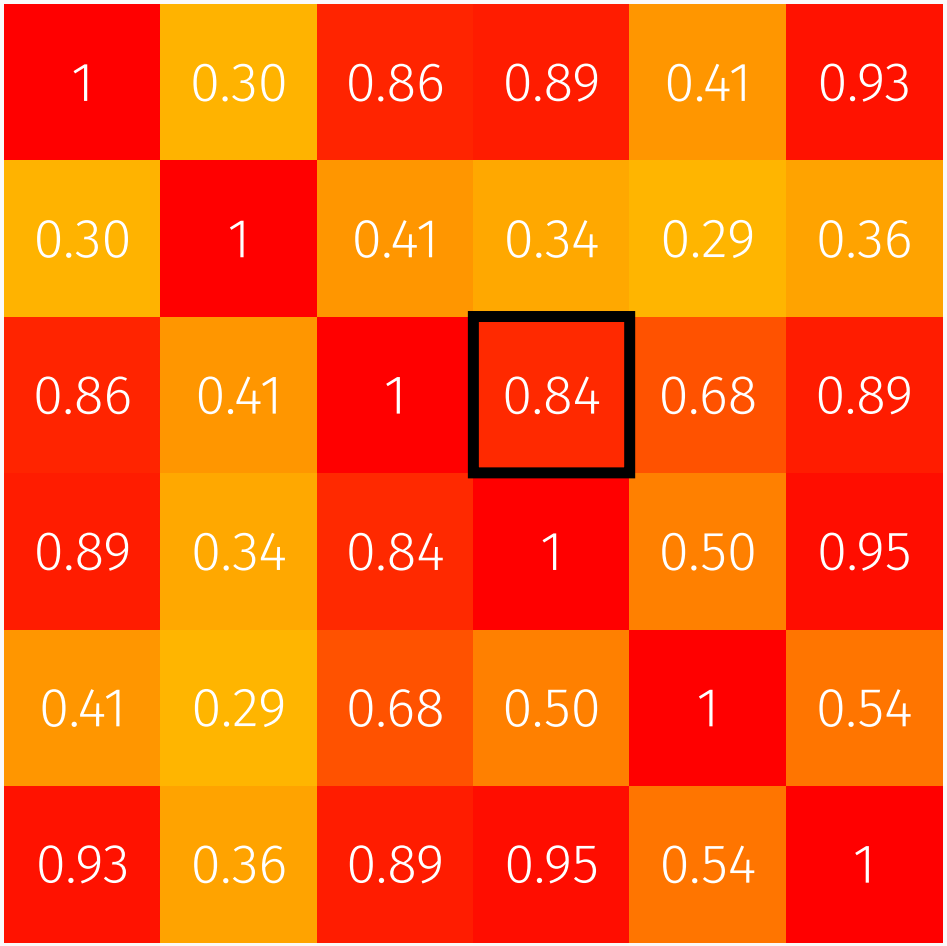
# Dimensionality reduction: Motivation



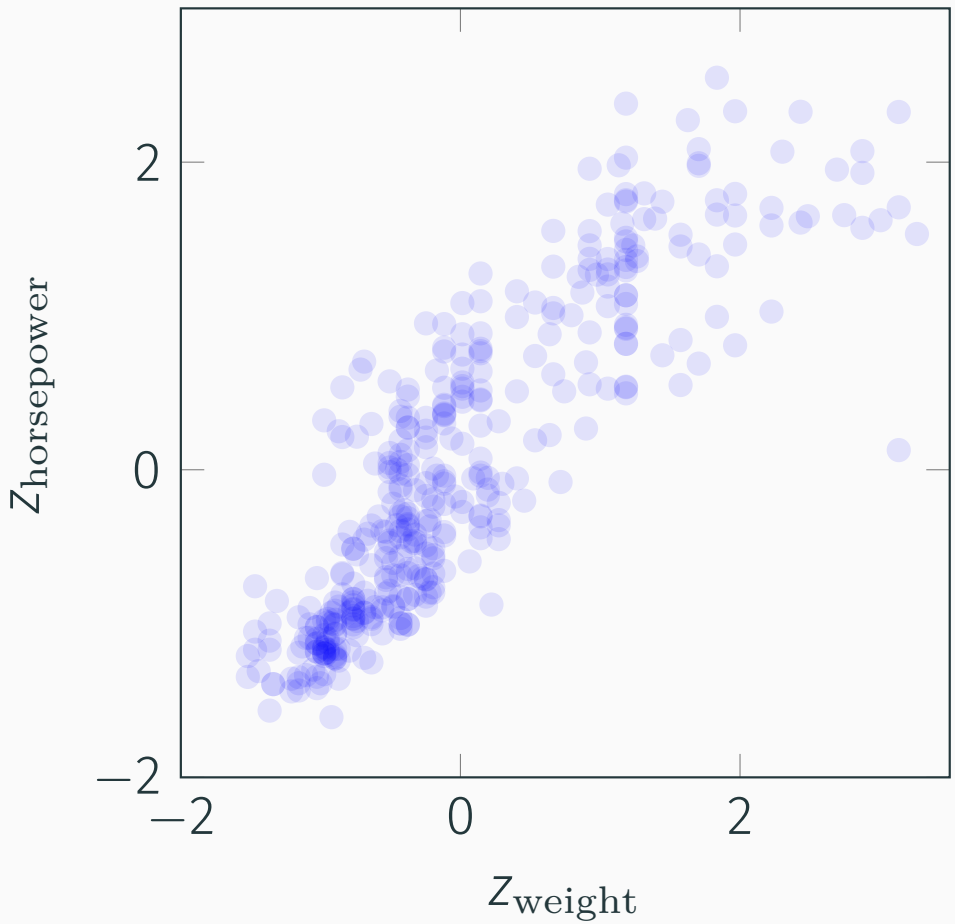
# Dimensionality reduction: Motivation



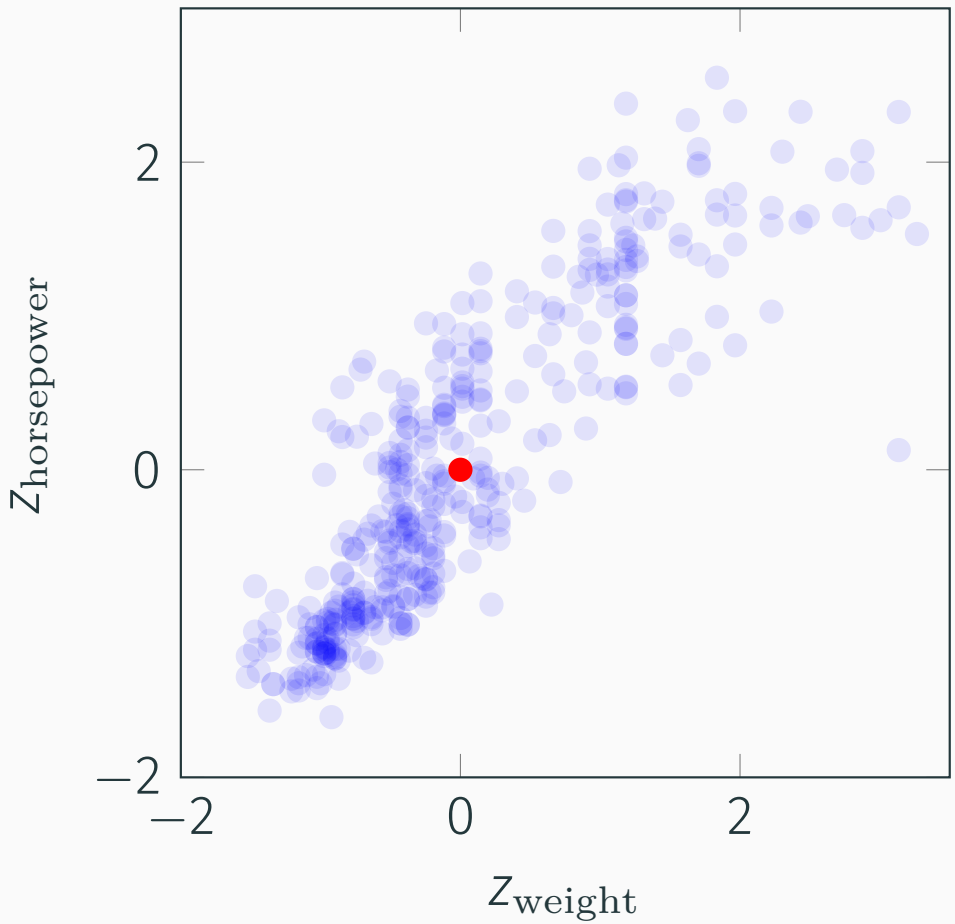
# Dimensionality reduction: Motivation



# Dimensionality reduction: Principal component analysis

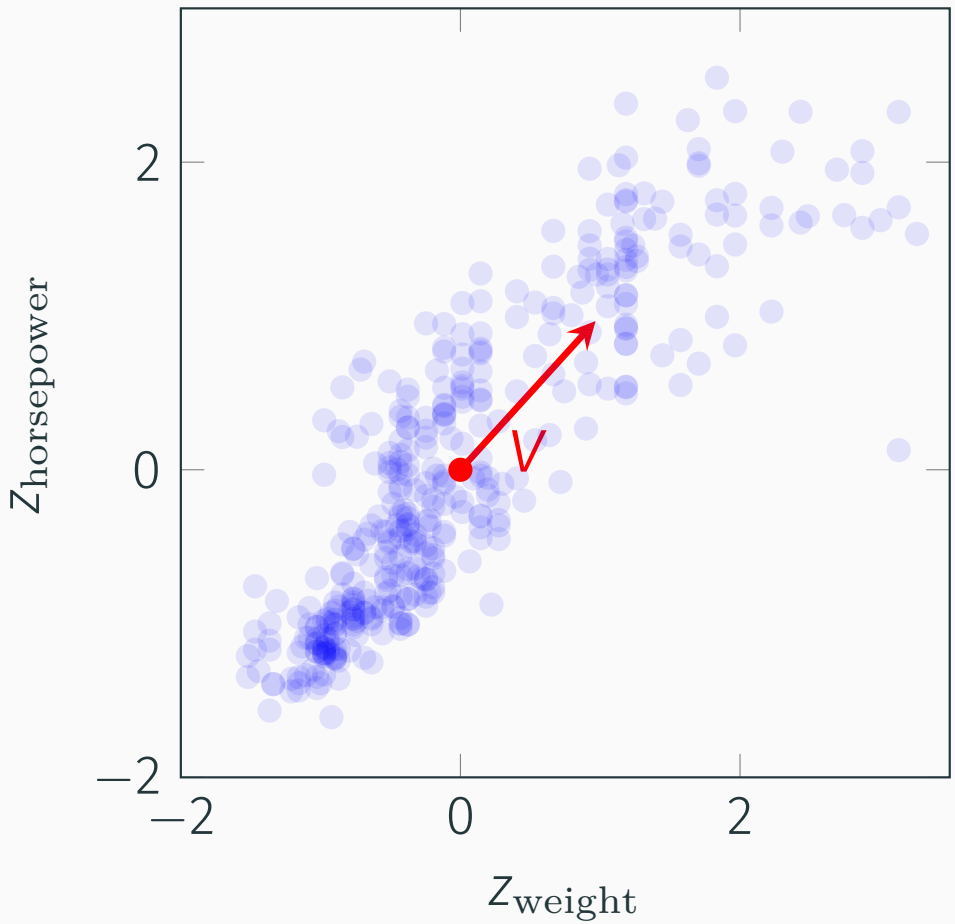


# Dimensionality reduction: Principal component analysis



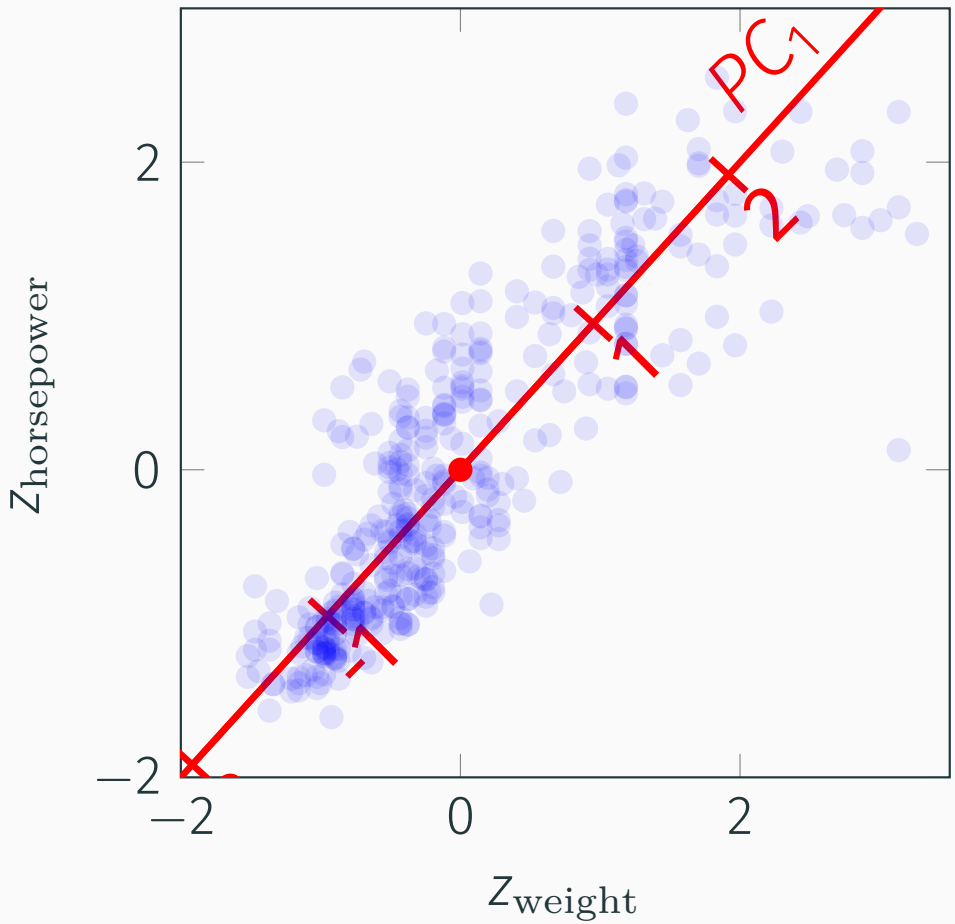

$c \rightarrow$ center of the data

# Dimensionality reduction: Principal component analysis



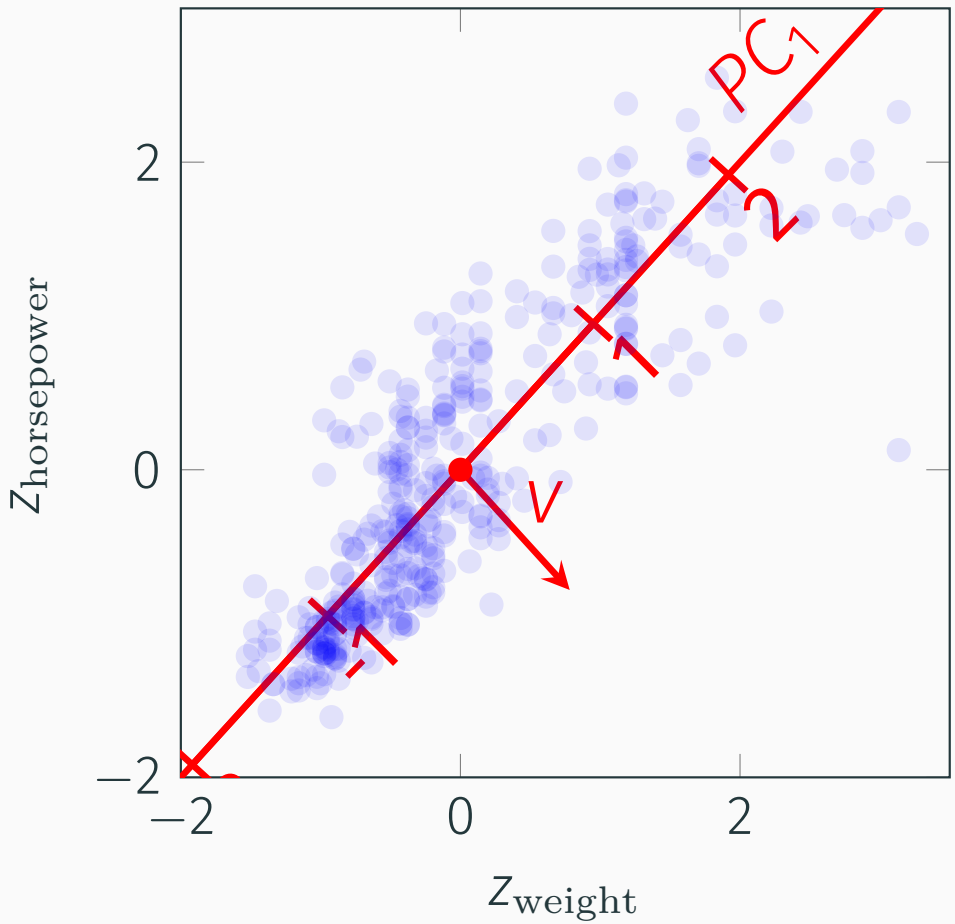

$v \rightarrow$ direction of maximum variance

# Dimensionality reduction: Principal component analysis




$$PC_1 \rightarrow 0.69 * z_{\text{horsepower}} + 0.71 * z_{\text{weight}}$$

# Dimensionality reduction: Principal component analysis




$v \rightarrow$ direction of maximum variance **orthogonal** to $PC_1$