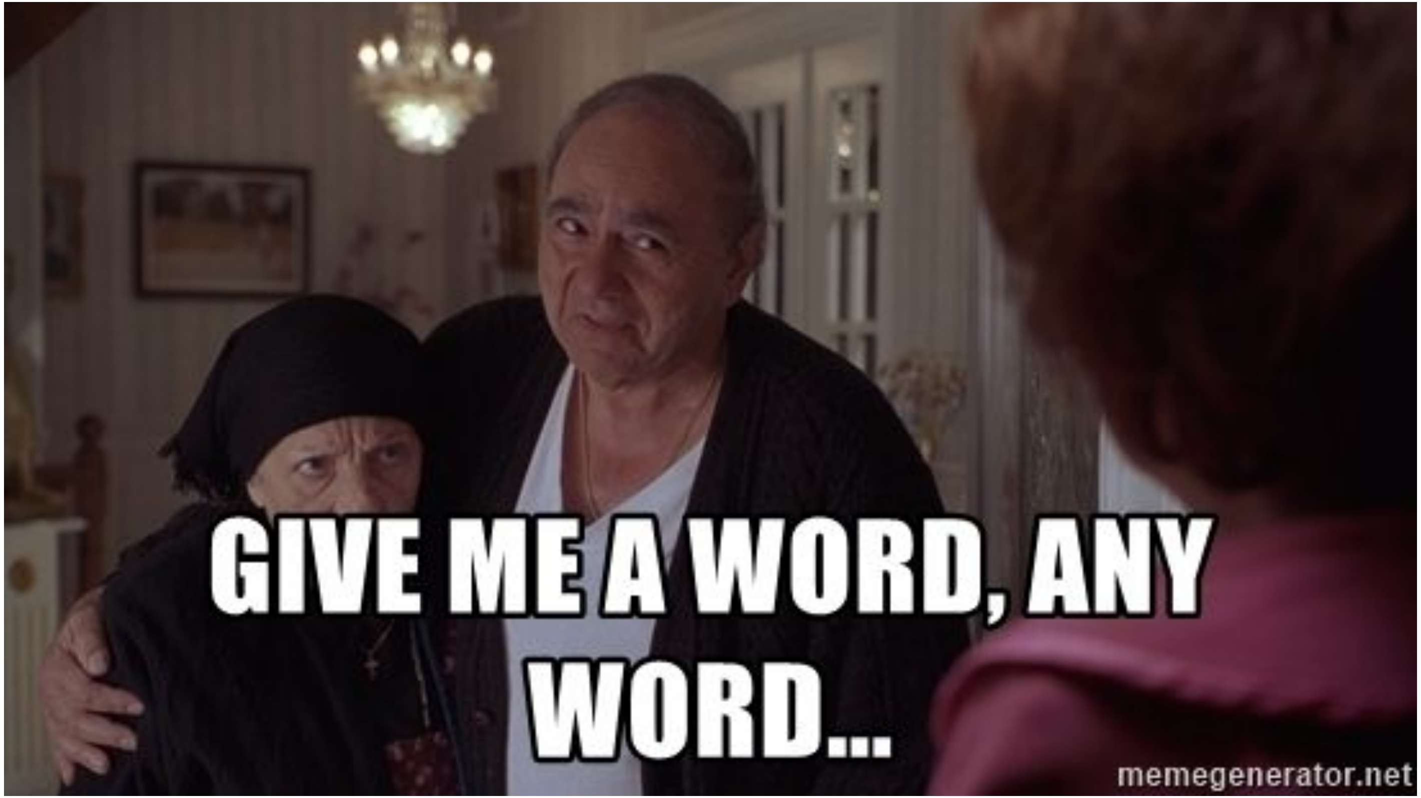
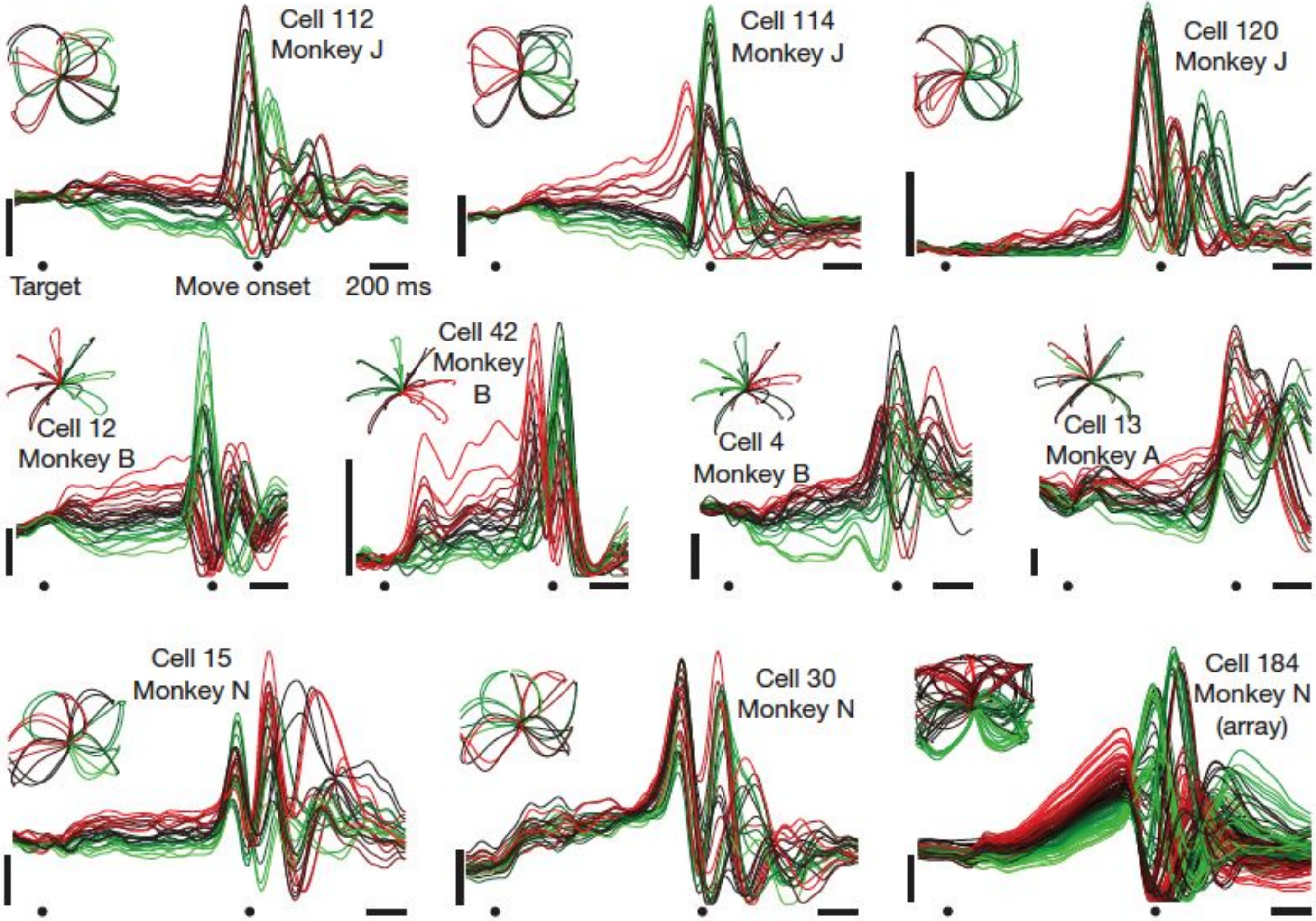
Principal component analysis

Principal component analysis (PCA)

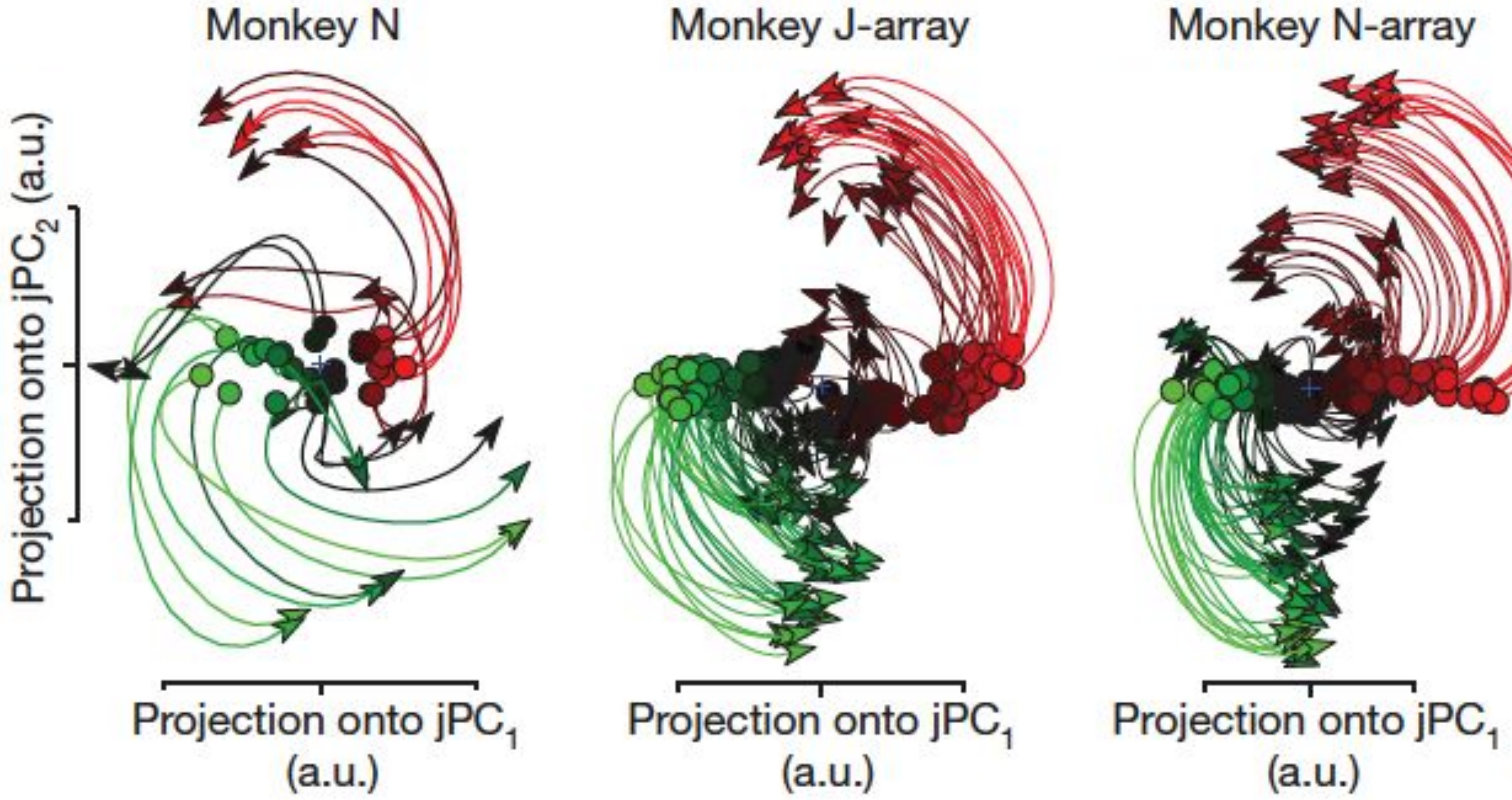
- workhorse of machine learning
- primarily used for dimensionality reduction
- unsupervised (does not predict)
- extension of “correlation” for multiple variables



Give me a machine learning algorithm,
and I can show you at the root of that algorithm is PCA!



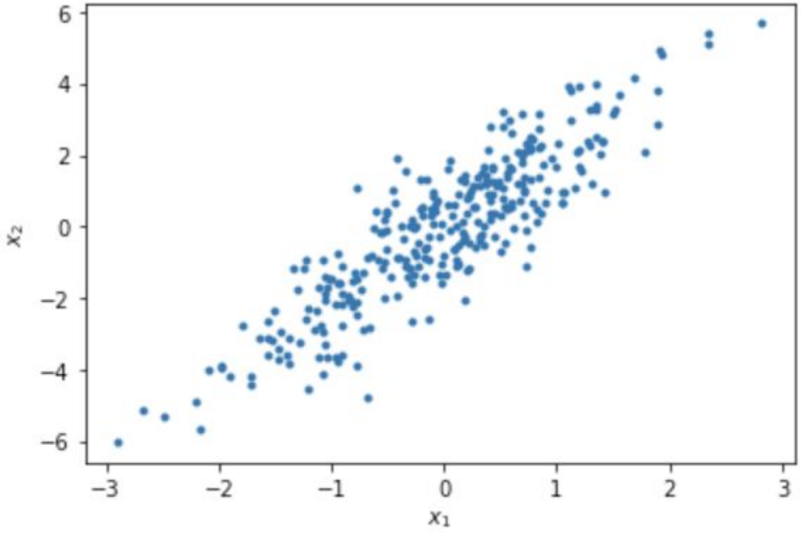
Churchland et al., 2012



Churchland et al., 2012

Consider two variables, x1 and x2.

How can we “compress” them?



Consider two variables, x1 and x2.

How can we “compress” them?

Idea 1: Only keep x1 or x2 that has the largest variance.

Consider two variables, x1 and x2.

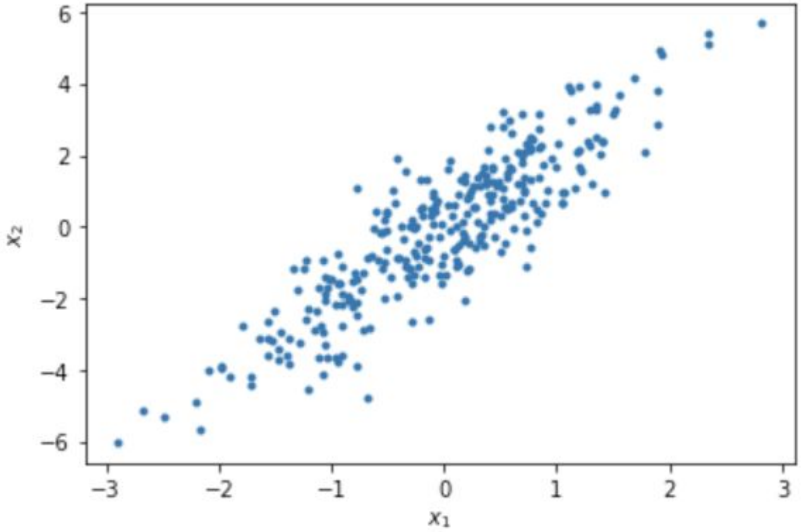
How can we “compress” them?

Idea 1: Only keep x1 or x2 that has the largest variance.

Idea 2: Search for a combination of x1 and x2 that has the largest variance.

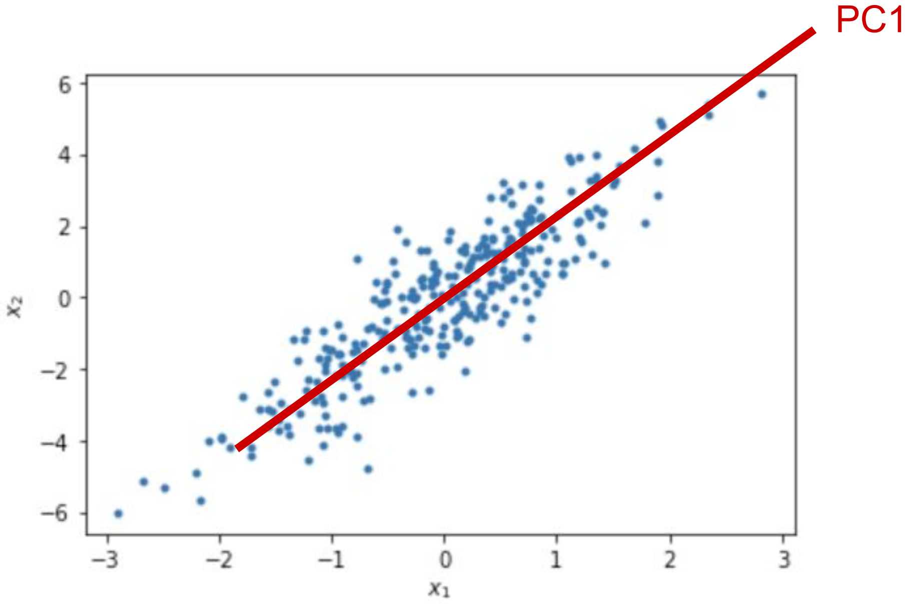
Consider two variables, x1 and x2.

How can we “compress” them?



Consider two variables, x1 and x2.

How can we “compress” them?



What happens for three variables: x1, x2, x3?

if data look like a pencil?

… a pancake?

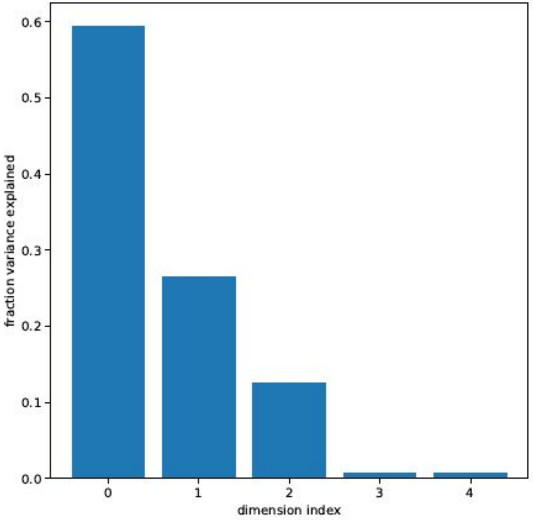
… a sphere?

Three useful outputs of PCA:

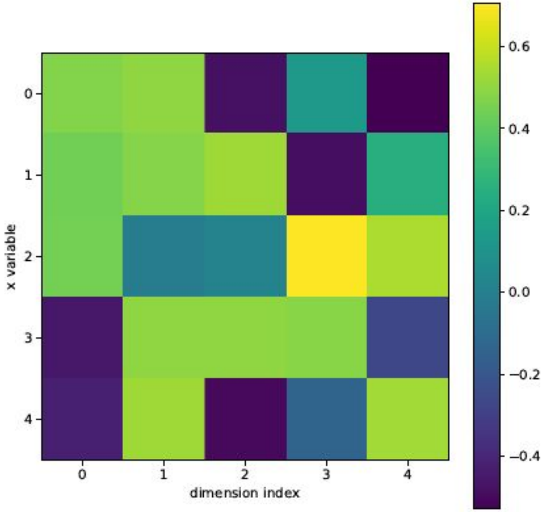
- fraction variance explained
- loadings
- principal components

Three useful outputs of PCA:

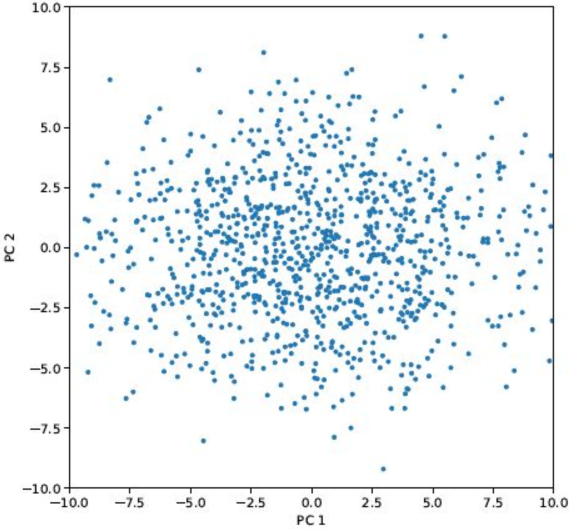
fraction explained variance



loadings



principal components



- Section 1 in Notebook

- Section 2 in Notebook