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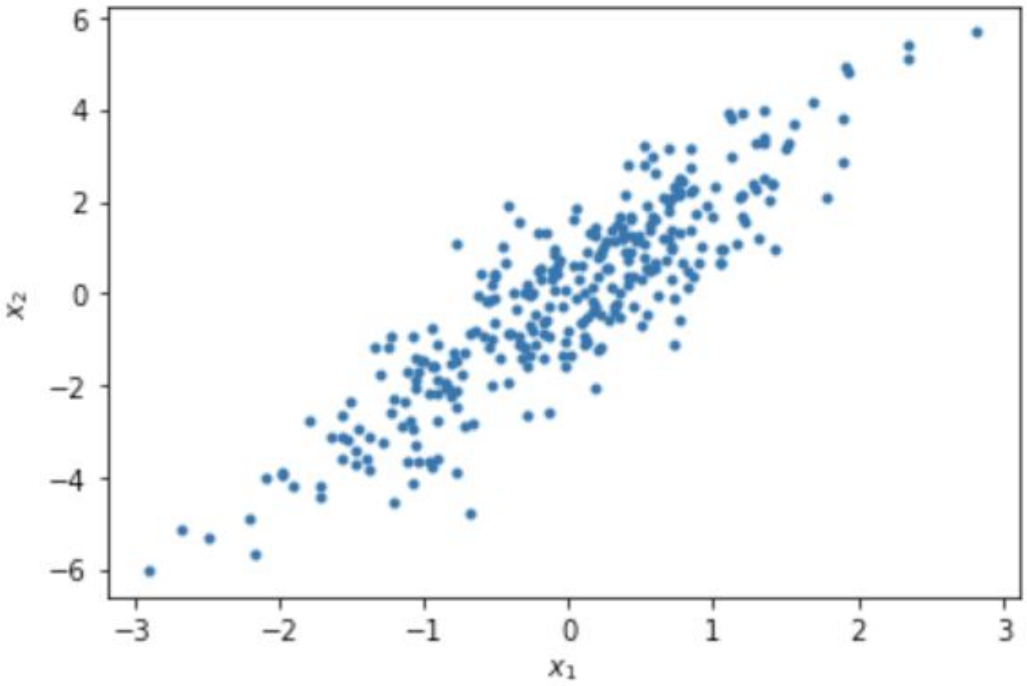
Principal component analysis (PCA)



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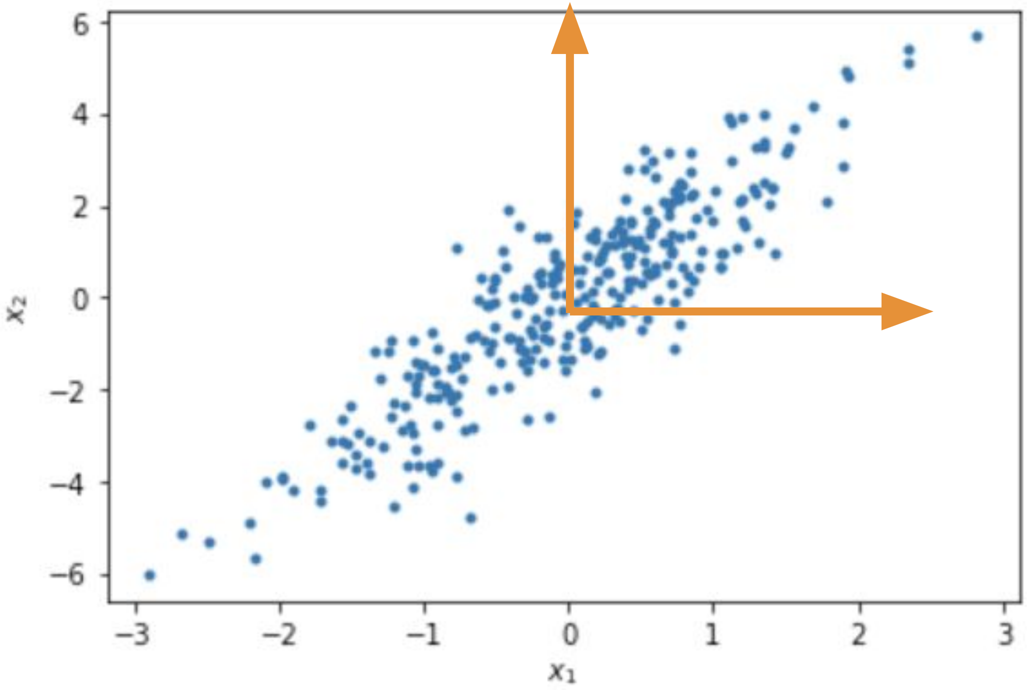

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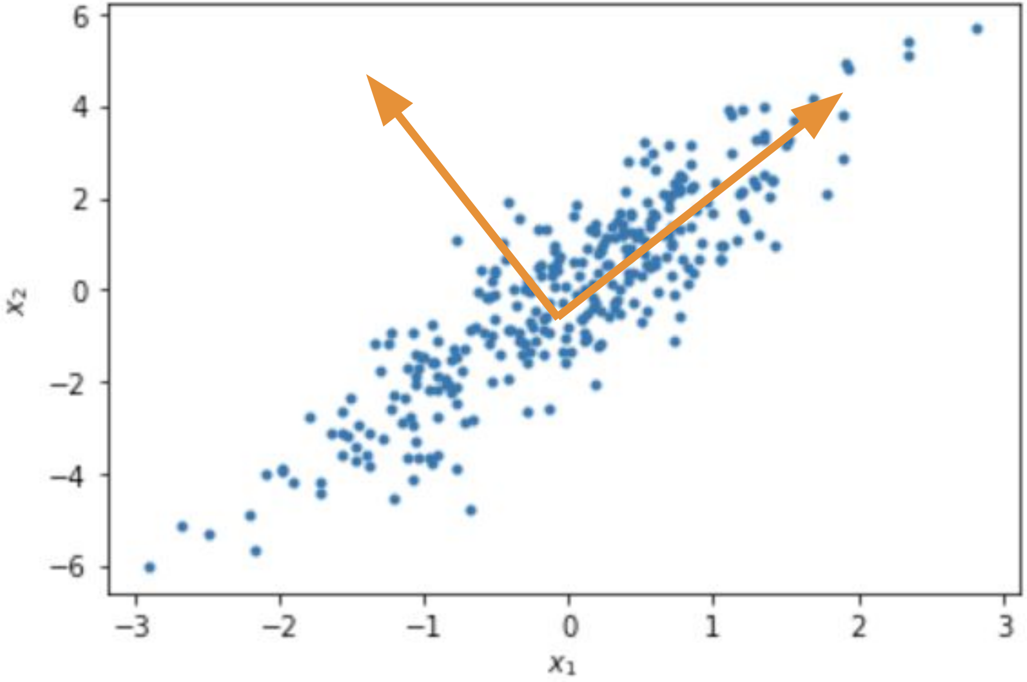

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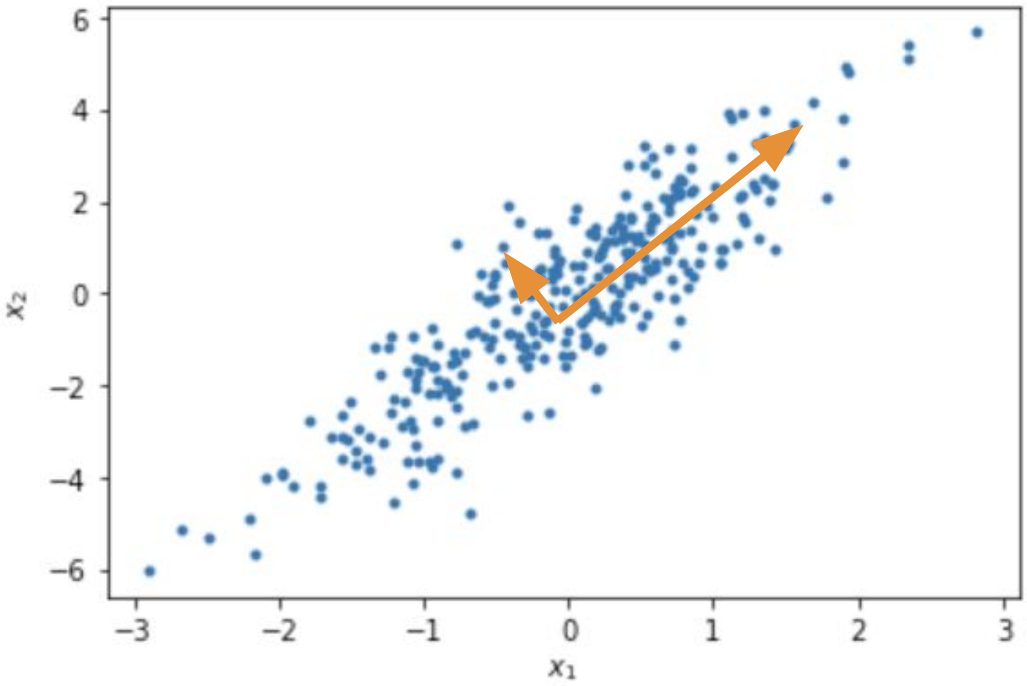
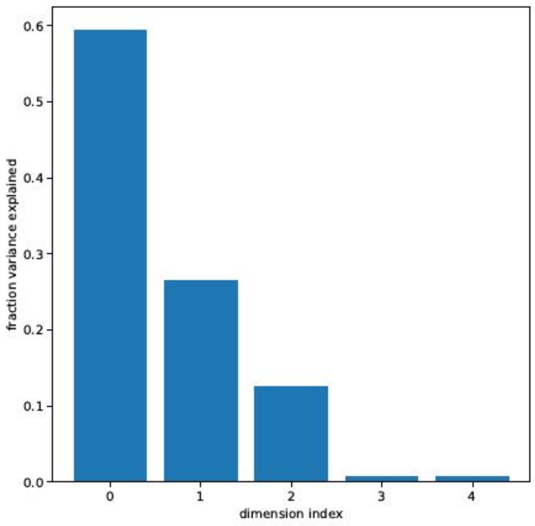
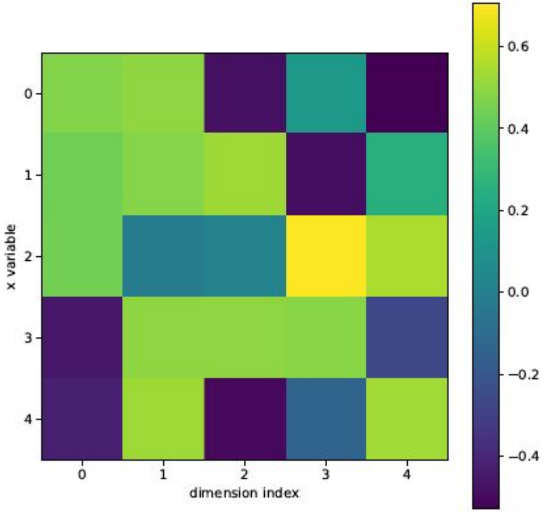


Last time:

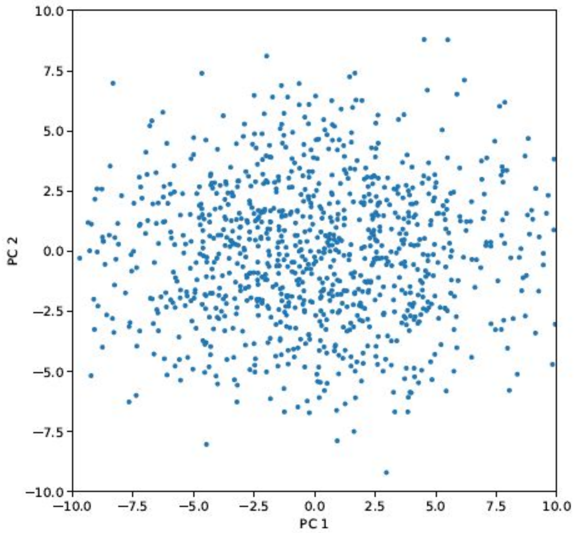
fraction explained variance



loadings



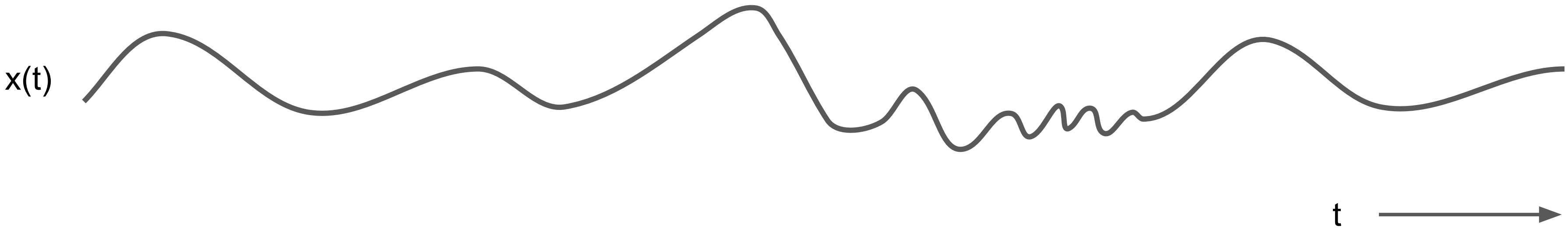
principal components



Today:

- PCA for time series
- tSNE (nonlinear dimensionality reduction)

A time series is the output of a variable over time.



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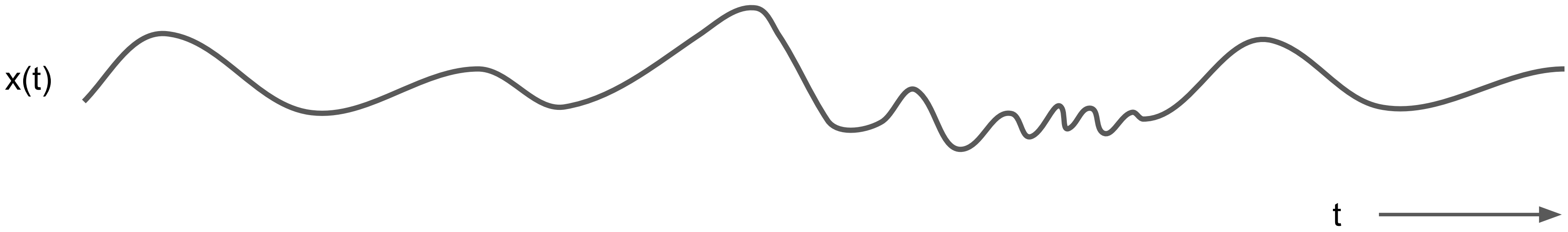

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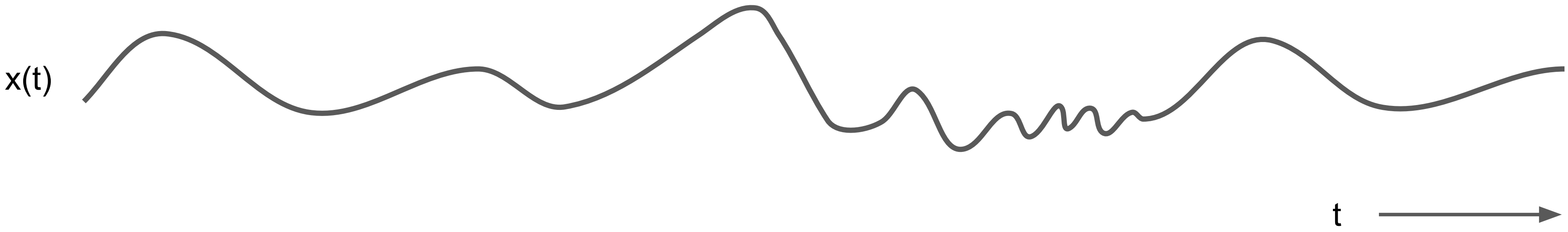

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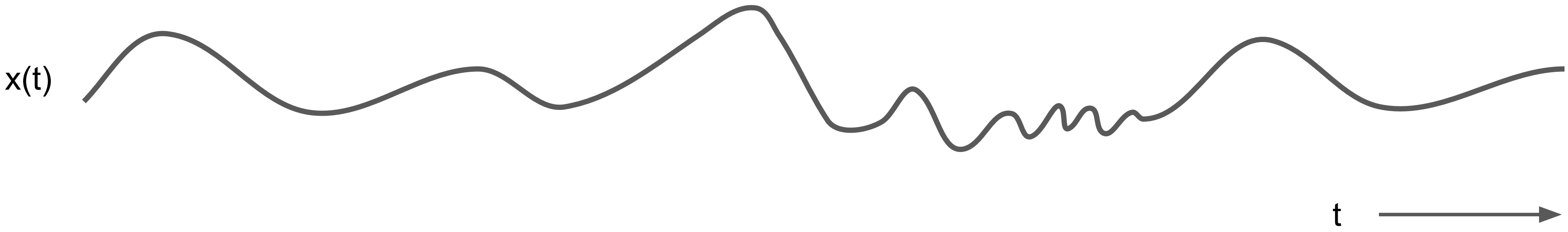

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However, time breaks this assumption.
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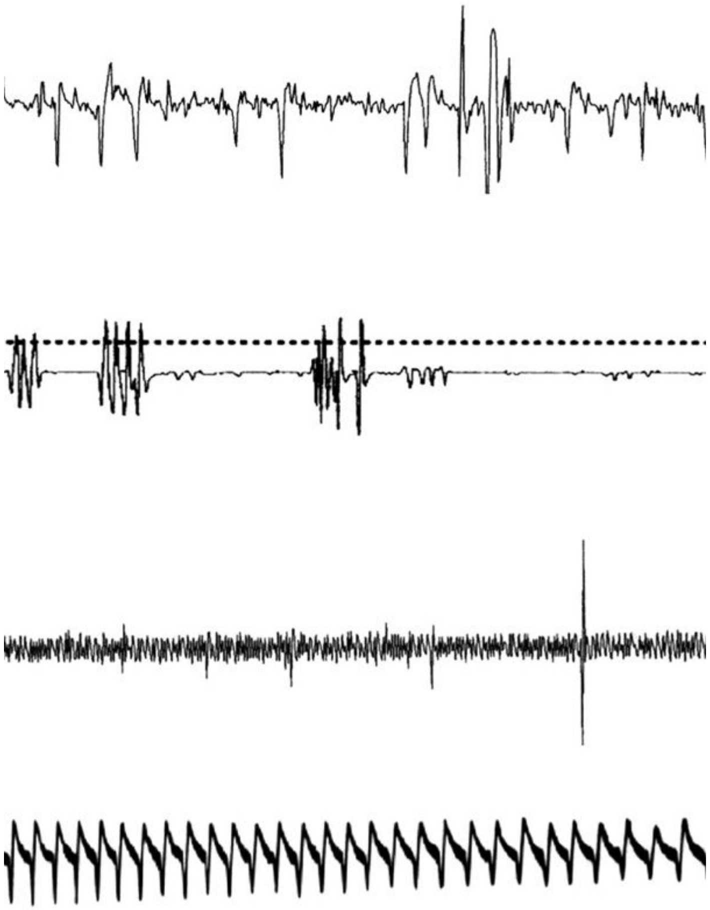
An important property:
The value of two nearby timepoints should be similar (smoothness).

Often in neuroscience, we work with time series.

Examples:



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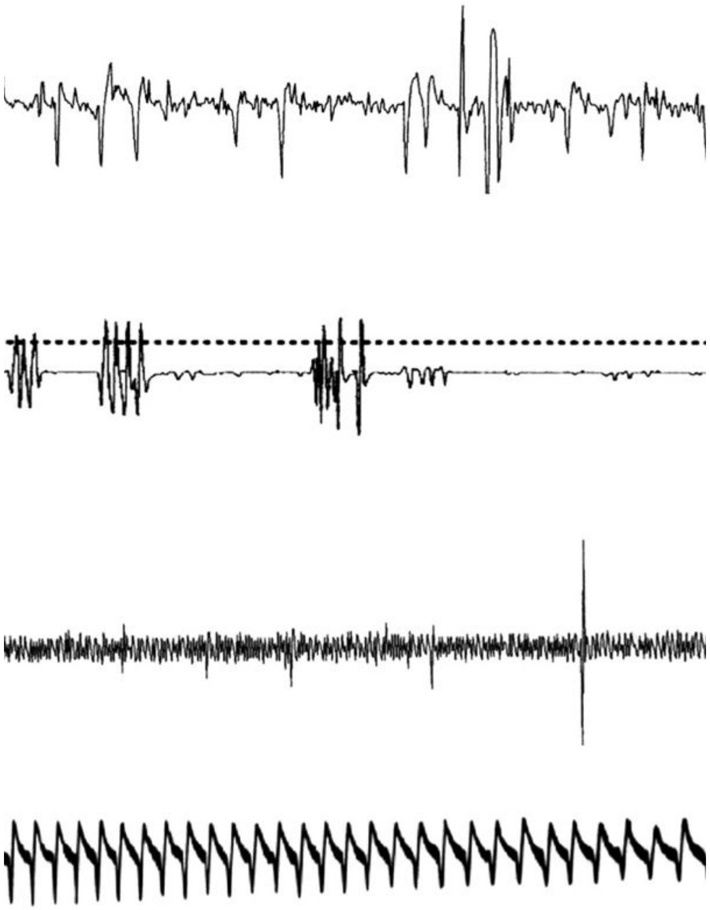
Examples:

- EMG activity of arm reaches
- EEG activity
- action potential/spike waveforms
- pupil diameter trace
- stimulus videos
- auditory signals
- any type of dynamics



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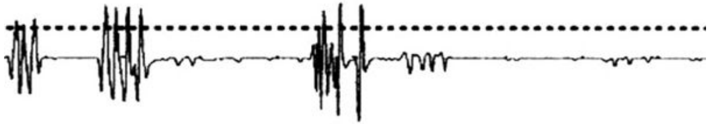

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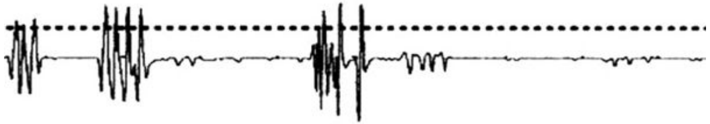

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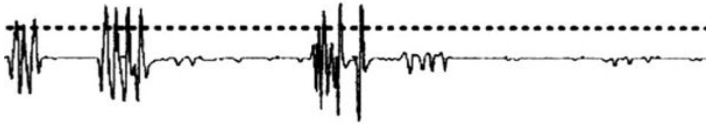

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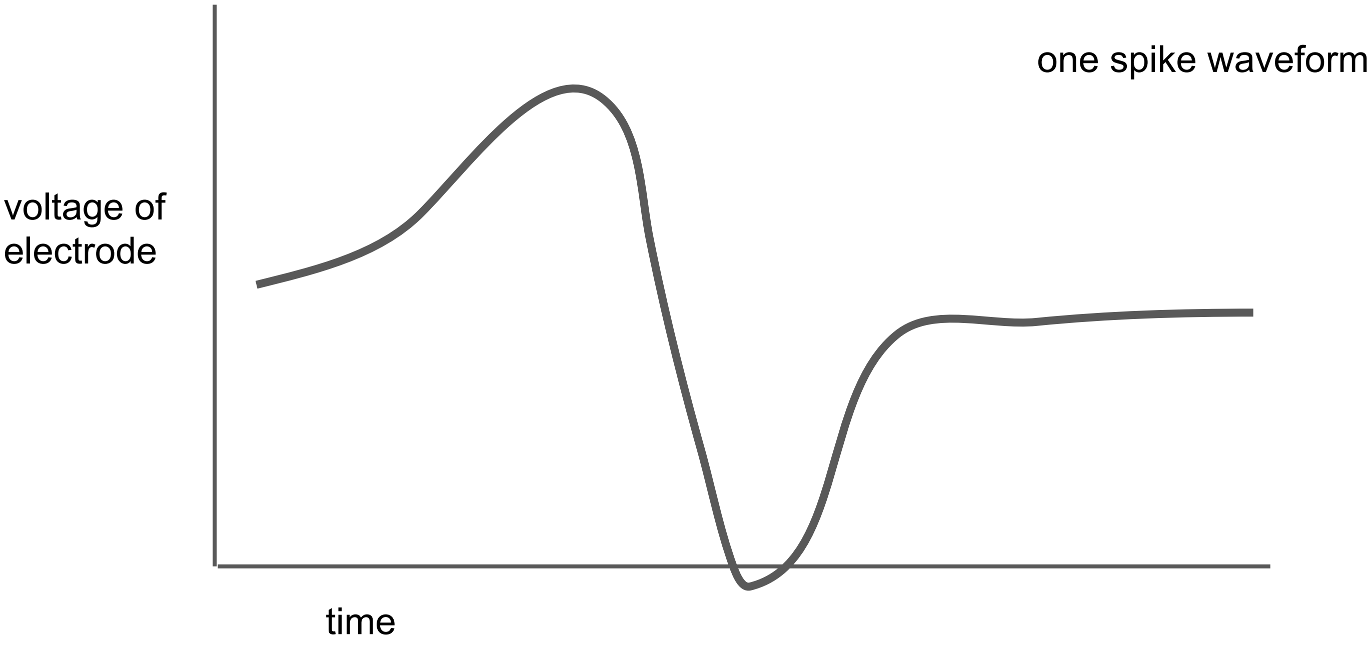
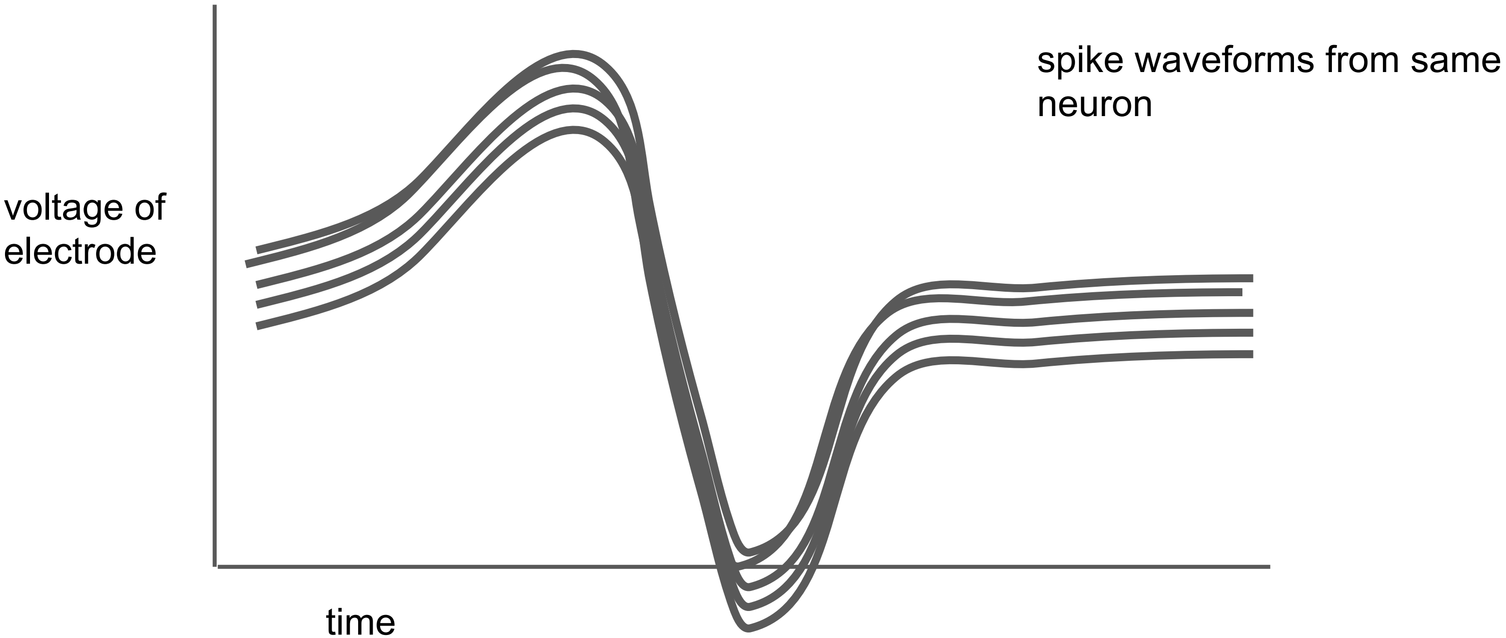
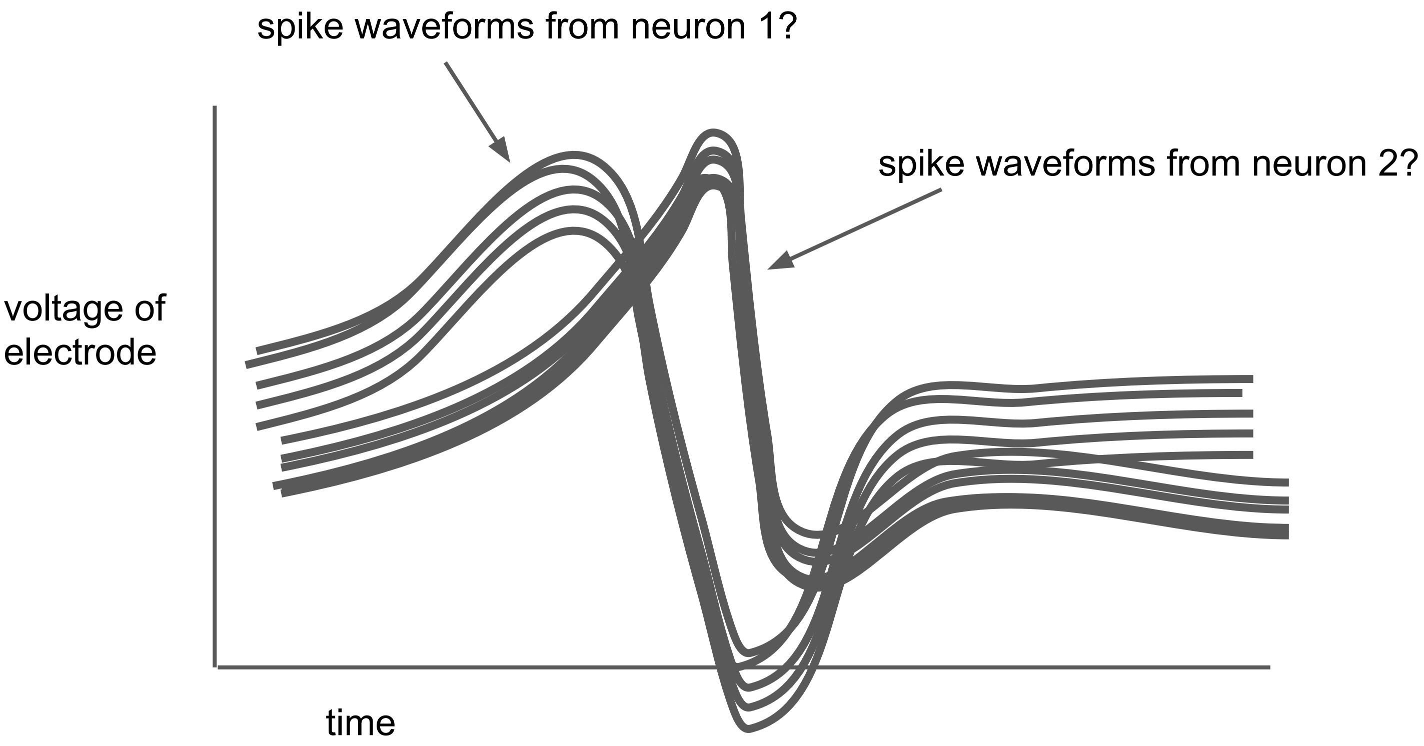
Solution: Identify “templates” of spike waveforms.
Each template corresponds to a different neuron!


one spike waveform
voltage of
electrode
time


spike waveforms from same neuron
voltage of electrode
time


spike waveforms from neuron 1?
spike waveforms from neuron 2?
voltage of electrode
time

PCA to the rescue!

Idea:

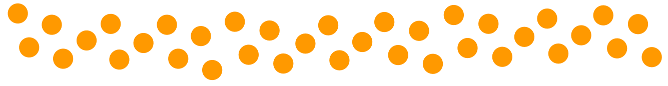
1. Treat each time point as a variable.
2. Treat each spike waveform as an observation.
3. Apply PCA (with time points as features)
4. Look at loadings of PCA

---> Colab Notebook

tSNE

high-d space (2-d):

tSNE reduced space (1-d):



tSNE

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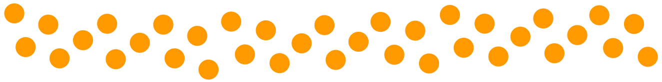

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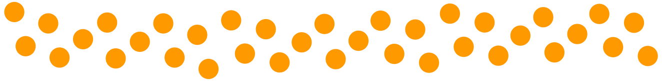

tSNE

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- nonlinear dimensionality reduction: takes K features and maps datapoints to 2 or 3 dimensions
- key idea: nearby distances between datapoints in reduced-space are similar to distances in high-d space

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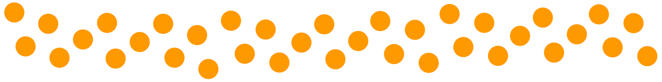

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Note: tSNE has some hyperparameters that we are ignoring for this class (knobs that may be important in defining clusters)

Colab notebook:

t-SNE on a simple problem (together)

t-SNE with increasing number of clusters (on your own)