NEURAL DATA ANALYSIS

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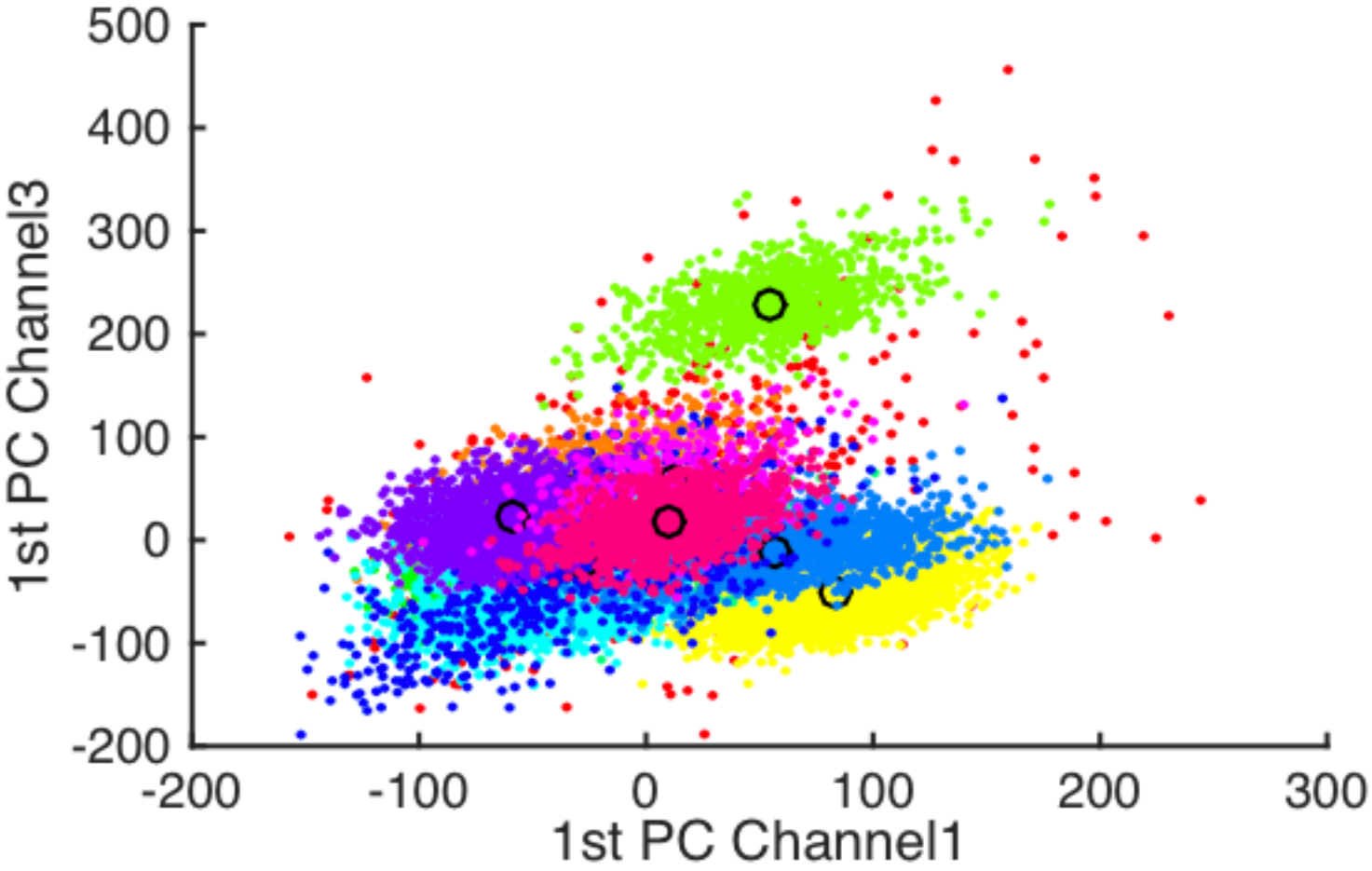
ASSESSING SPIKE SORTING RESULTS

TASK 3

OUTLIERS


500
400
300
200
100
0
-100
-200
1st PC Channel3
-200
-100
0
100
200
300
1st PC Channel1

MIXTURES OF T-DISTRIBUTIONS

- **Sometimes spike clusters have longer tails than Normal distribution**
- **More than one mixture component per cluster**

$$(1-\epsilon)N(\mu,\Sigma)+\epsilon N(\mu,c\Sigma)$$

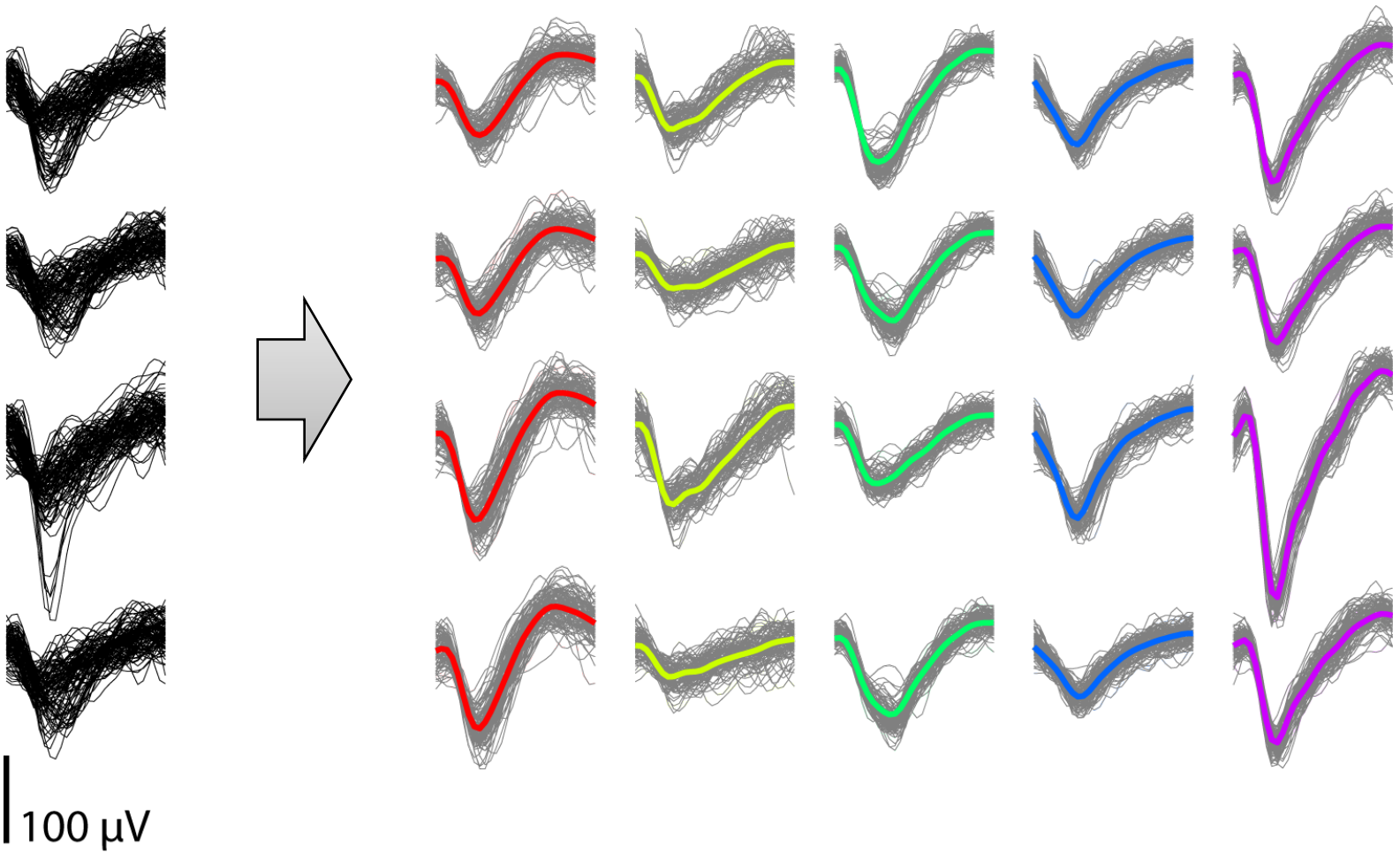
- **Generalisation: Multivariate T-distribution**

$$T(\mu,\Sigma,\nu)=\frac{\Gamma\left(\frac{\nu+p}{2}\right)|\Sigma|^{-\frac{1}{2}}}{\sqrt{\pi\nu}^{p}\Gamma\left(\frac{\nu}{2}\right)}\left(1+\frac{1}{\nu}(\mathbf{x}-\mu)^{\mathrm{T}}\Sigma^{-1}(\mathbf{x}-\mu)\right)^{-1/2(\nu+p)}$$

For $\nu \to \infty, T(\mu,\Sigma,\nu) \to N(\mu,\Sigma)$

Peel & McLachlan 2000

CURRENT STAGE: SORTED SPIKES



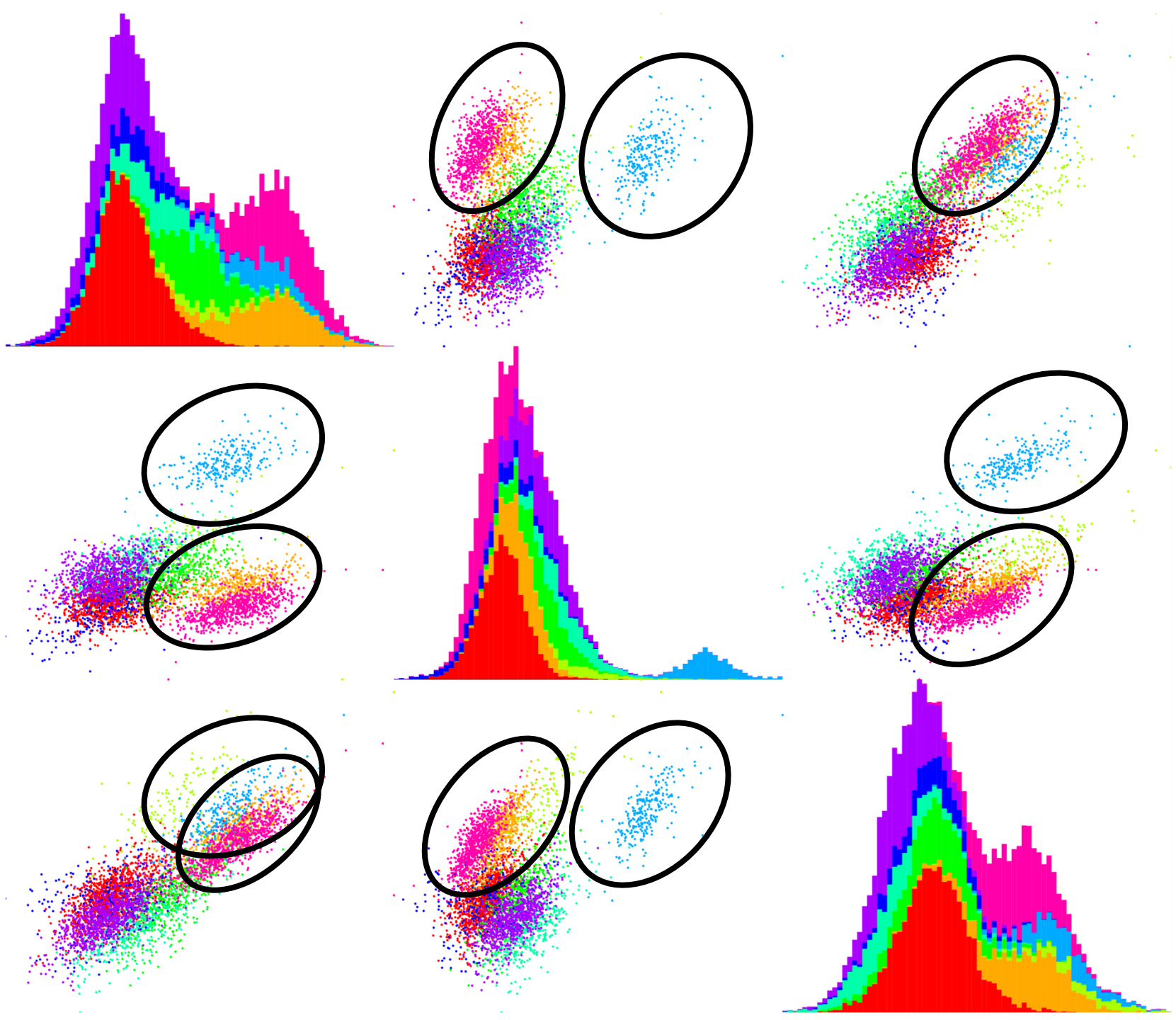
INTERPRETING CLUSTERING RESULTS

Not all clusters represent the spikes of a single neuron

- *Single unit:* a cluster with one neuron's spikes
- *Multi unit:* a cluster with multiple neurons' spikes

Tools for evaluating clustering:

- Scatter plot of the clusters
- Visual inspection of spike waveforms
- Temporal structure of the spike trains
  → refractory period
- Quantify cluster separation



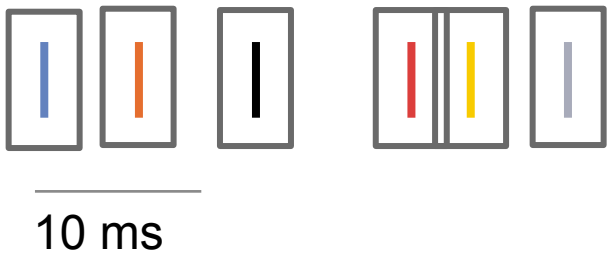
CROSS/AUTO-CORRELOGRAM

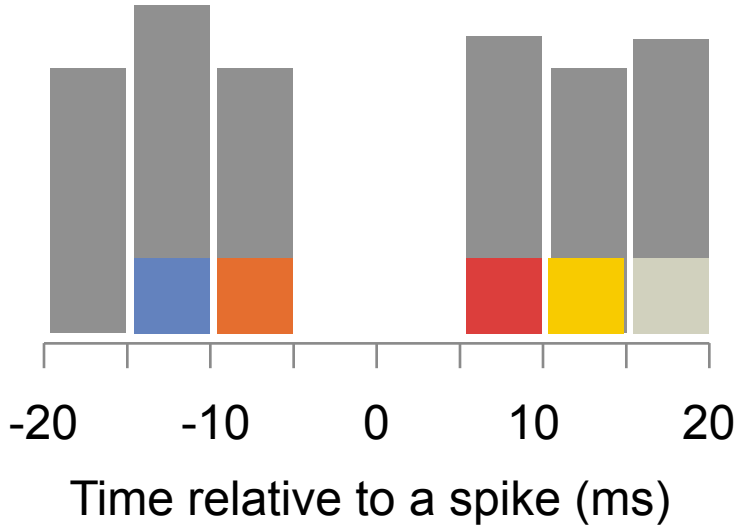
Cross correlation function

$$R_{ss}(\tau) = \int s(t)s(t-\tau)\,dt$$

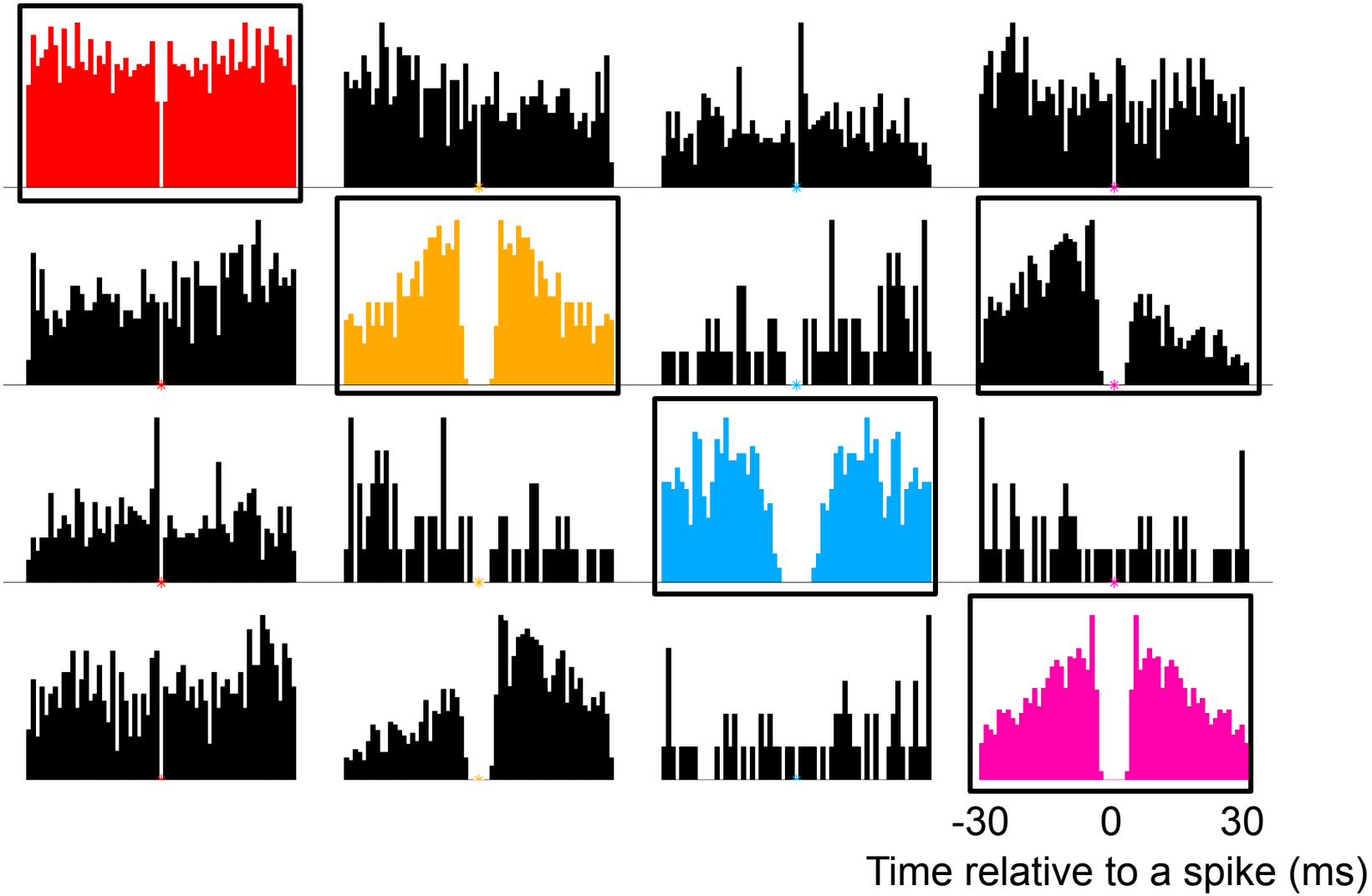
Cross-correlogram (or *Cross Correlation Histogram*)

- Discrete estimate
- Histogram of all $\Delta t = t_i - t_j$ for all spike times t_i and t_j.



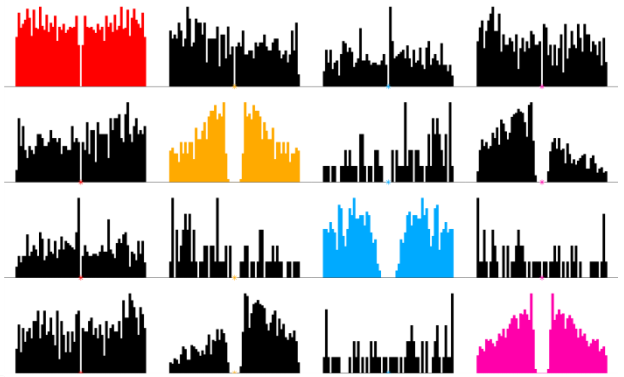


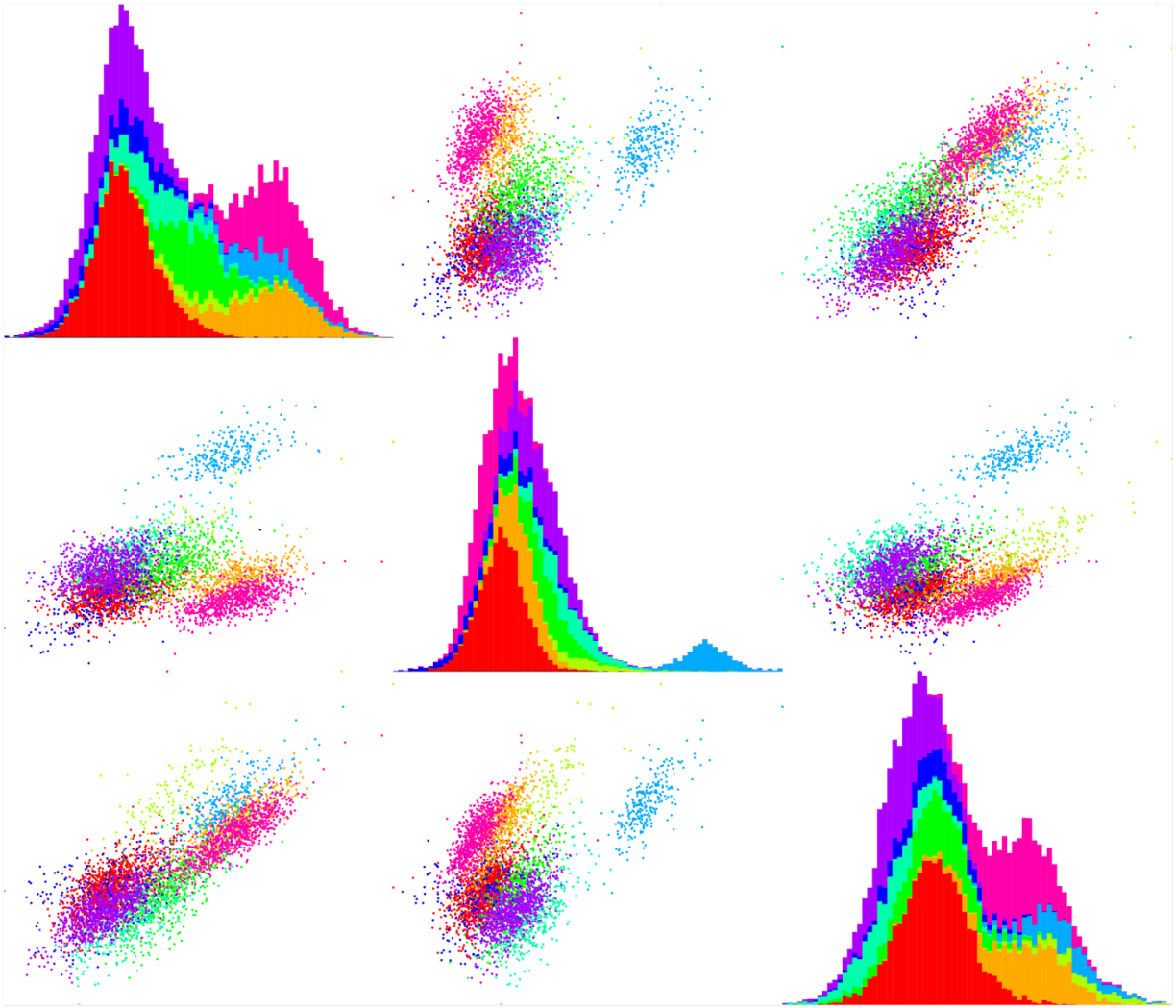
CROSS-CORRELOGRAMS



EXAMPLES

- Poisson process
- Oscillations
- Refractory period
- Coupled neurons

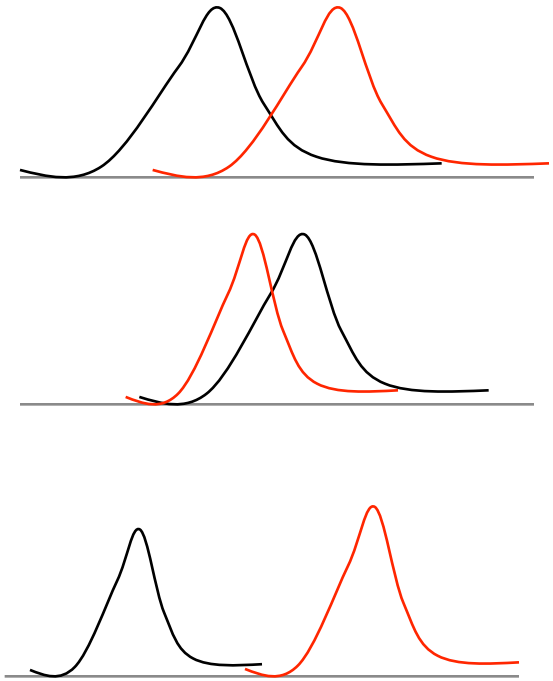


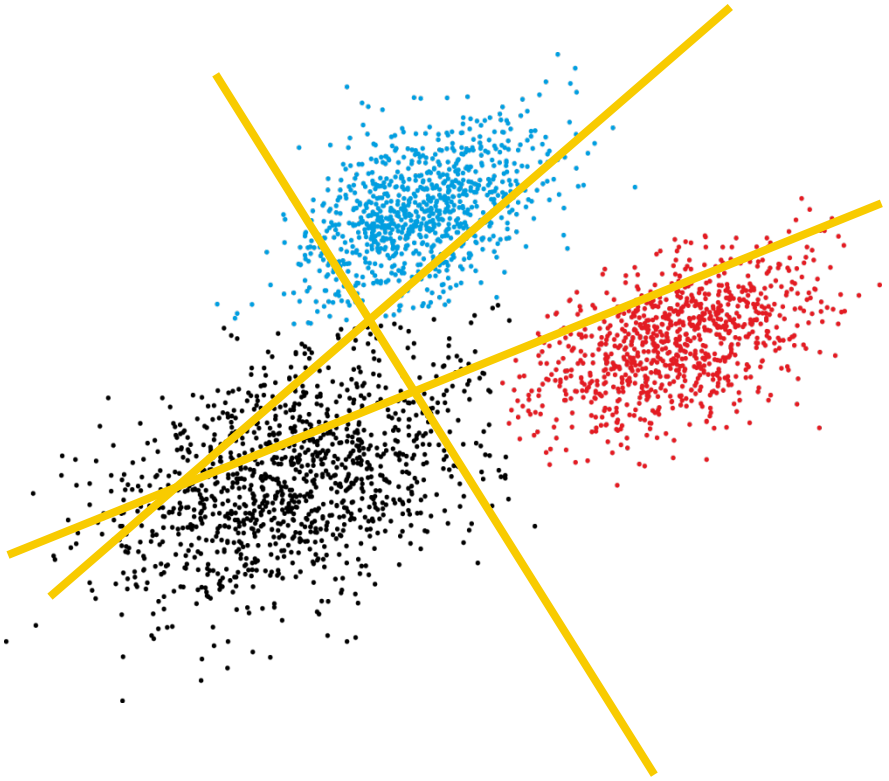


PAIRWISE CLUSTER SEPARATION

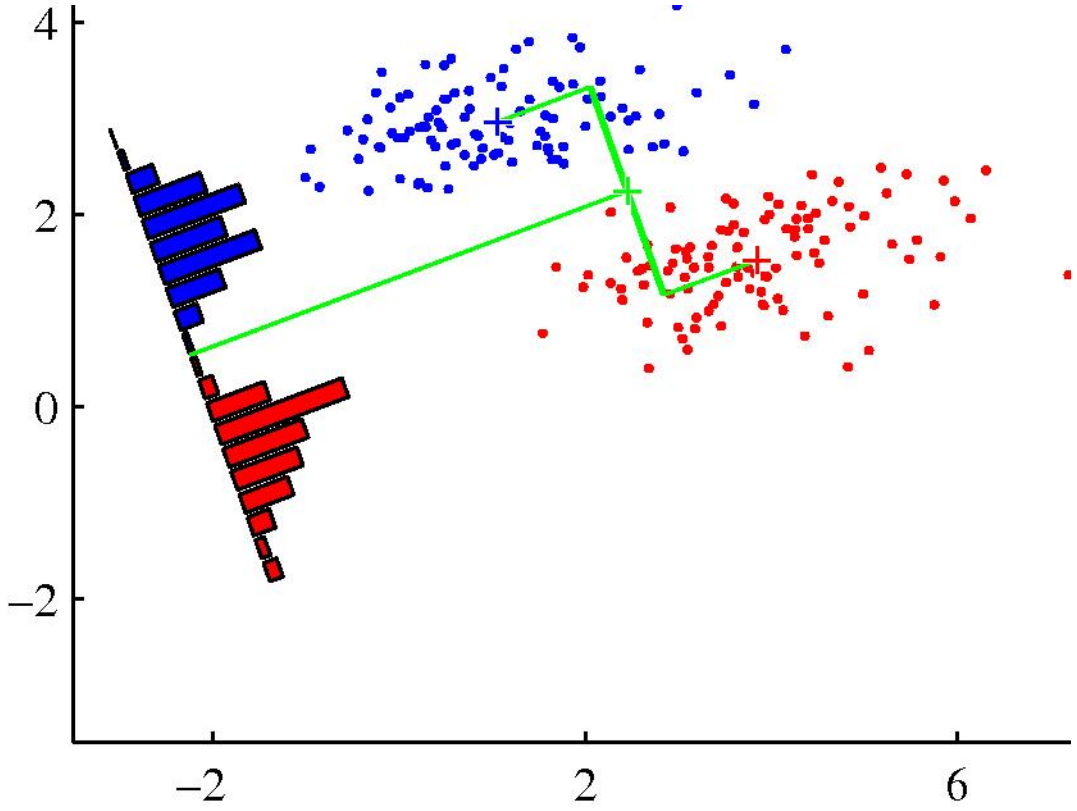
Tool for visual inspection

Project clusters onto one dimension





LINEAR DISCRIMINANT



$$w \propto S^{-1}(\mu_2 - \mu_1)$$

$$S = \Sigma_1 + \Sigma_2$$