

### formulas

standard units:  $z = (\text{original} - \text{mean}) / \text{standard deviation}$

$$\beta_1 = \text{cov}(x,y) / \text{var}(x)$$

$$\text{cov}(x,y) = (\sum (y_i - \bar{y})(x_i - \bar{x})) / n$$

$$\text{corr}(xy) = \text{cov}(x,y) / (s_x * s_y)$$

### hierarchical clustering

find successive clusters using previously established clusters  
- common approach is bottom-up: start with each element in a separate cluster

single linkage: use minimum distance

complete linkage: use maximum distance

average linkage: use average linkage

"minimum distance between group 1 points and group 2 points is larger than the minimum within-group distance for the same points"

### knn classification

### k-means

k-means algorithm: 1. construct clusters by associating each point with the closest centroid, 2. calculate new centroids for each set; repeat both till convergence

as k increases, average variance of clusters decreases

use features ( $x_n$ ) to partition data into K clusters (represented by its **centroid** -- center of points in the cluster)

goal is to minimize intra-class centroid points distances and find  $c_{nk}$  (0 - 1 cluster membership) and  $\mu_k$  (centroids) that minimize

### artificial neural networks

activation functions:

- sigmoid (0, 1)

$$\text{sigmoid}(z) = (\exp z) / (1 + \exp z)$$

- hyperbolic tangent (-1, 1)

$$\text{tanh}(z) = (\exp(z) - \exp(-z)) / (\exp(z) + \exp(-z))$$



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