### Table

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| --- | --- | --- | --- | --- |
|  | key properties | learning | prediction | R code |
| hierarchical clustering | + grouping nearest cluster to build larger cluster  + max, min, avg distance to group | + grouping procedure (bottom-up)  + splitting procedure (top-down) | \*\*\* | tree <- hclust(data, method)  labels <- cutree(tree, k) |
| spectral clustering | + we look into spectrum of the laplacian matrix to see the clusters | + procedure: data >> similarity >> laplacien >> eigen >> clusters | \*\*\* | specc(data, k) |
| hmm | + to model the symbol sequence and state sequence  + align sequences (I love you) -> (noun, verb, noun) | + baum-welch procedure (EM procedure)  + E step: alpha, beta  + M step: pi, A, B | + Viterbi algorithm to find best state sequence from the sample/symbol sequence | h <- inithmm()  baumWetch(model, sequence)  s <- viterbi(model, sequence) |
| sampling | + to draw samples from distribution  + draw enough to reconstruct the original distribution | + box-muller to draw sample from N(m, s)  + rejection sampling to draw from complicated distribution  + importance sampling  + cholesky decomposition to draw from multivariate gaussian | \*\*\* | x <- runif(n, a, b) to draw n samples from uniform distribution U(a, b)  x <- rnorm(n, m, s) to draw n samples from gaussian distribution N(mu, sigma) |
| optimization for learning | + to find optimal points of given function  + if the function is convex/concave, we can find global optima  + sampling methods in general | + enumeration (uniform sampling)  + gaussian sampling to focus one certain point  + gibbs sampling  + simulated annealing | \*\*\* |  |