Hierarchical Affinity Propagation

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Affinity Propagation (AP) [1] is a recently introduced algorithm for exemplar-based clustering. The goal of the algorithm is to find good partitions of data and associate each partition with its most prototypical data point ('exemplar') such that the similarity between points to their exemplar is maximized, and the overall cost associated with making a point an exemplar is minimized. The solution proposed to this NP-hard problem was to formulate it as inference in a factor-graph, and find approximate MAP assignment using the max-product algorithm.

In their paper [2], Xiao et al describe a greedy heuristic hierarchical clustering variant of the AP clustering algorithm. The objective function it optimizes does not correspond to a natural objective for an exemplar-based hierarchical structure, and viewed under such natural objectives, due to its greedy nature it may find suboptimal solutions. We describe two alternative graphical models for hierarchical exemplar-based clustering that correspond to what we believe to be possible natural objectives. While one variant we propose is directly motivated by [2], the other can also be seen as closely related to a hierarchical version of the facility location problem (hierarchical facility location) – a well studied problem in the operational research community [3].

Similarly to AP, we find approximate solutions to the objective functions we define by deriving the corresponding updates for the max-product algorithm on the underlying graphical models. As is the case in AP, the messages have an intuitive interpretation in terms of, *e.g.* points announcing their availability to become exemplars subject to the constraints imposed between the different levels of the hierarchy. Constraints between levels ensure that the exemplar choices are consistent, *i.e.* a point can be an exemplar at a high level of the hierarchy only if it is also an exemplar at the lower levels.

We demonstrate the algorithms perform favorably in comparison to [2], and we show their applicability to problems in hand-written digit recognition, image segmentation, and optimal web-proxy placement.

References

[1] B. J. Frey and D. Dueck, "Clustering by Passing Messages Between Data Points", Science, 305(5814): 972-976, (2007).

[2] J. Xiao et al., "Joint Affinity Propagation for Multiple View Segmentation", in ICCV (2007).

[3] G. Sahin and S. Haldun, "A Review of Hierarchical Facility Location Models", Computers and Operations Research, 34(2007):2310-2331, (2005).

Topic: graphical models, learning algorithms.

Preference: poster