Relevance- and Interface-driven Clustering for Visual Information Retrieval

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Highlights

In this paper, we propose:

1. To better satisfy end-user task needs for clustering in visual search interfaces, we present a novel *relevance-driven clustering objective* that extends standard information retrieval metrics to clustering. Specifically, in light of relevance uncertainty, we derive *expected metrics for precision and recall of clusters*, but ultimately argue that a good cluster must balance both and thus focus on a derivation of *expected F1-score (EF1)* of cluster relevance as our key objective. Two key features of EF1 are that (a) it automatically extracts coherent clusters in terms of space, time, and content for presentation in a visual search interface and that (b) optimizing it does not require the specification of complex ad-hoc distance metrics required by other unsupervised clustering algorithms such as K-means.
2. Through a series of transformations, we demonstrate that the globally optimal solution to EF1 maximization of clusters can be cast as a Mixed Integer Linear Program (MILP), which is unfortunately NP-hard and thus computationally expensive to solve. To improve the algorithmic efficiency of optimization, we present two algorithms: Greedy and Binary Partitioning Search (BPS). Referring to our Relevance-driven Clustering Algorithm as RadiCAl, this leads to three variants: RadiCAl-MILP, RadiCAl-Greedy, and RadiCAl-BPS. We quantitatively evaluate and compare all RadiCAl variants and K-means on a search-driven tweet clustering task and demonstrate that RadiCAl-BPS provides the best overall tradeoffs in terms of performance and efficiency.
3. Returning to our end-user visual search task motivation, we conclude the experimental evaluation of this work with a user study to evaluate whether this new relevance-driven clustering method improves human performance in comparison to K-means clustering and a multiple filter search baseline.[1] Our

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[1]While there are a large number of unsupervised clustering algorithms in the literature, we had limited user interaction time in our user study and thus could only choose one clustering algorithm for comparison in addition to the non-aggregation baseline. We chose K-means since it is arguably the most commonly used clustering algorithm – not only in general, but also

results show that clusters derived in our relevance- and interface-driven optimization framework result in faster search task completion with higher accuracy while requiring a minimum workload leading to high effectiveness, efficiency, and user satisfaction among alternatives. These results coincide with our offline evaluation that also demonstrate the superiority of our relevance-driven clustering approach over competing methods.

specifically in our coverage of related work on clustering in information retrieval and visual search.