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. 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. Our 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,

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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.