

**Scalable Content-Aware Collaborative Filtering for Location Recommendation**

**Abstract:**

Location recommendation plays an essential role in helping people find attractive places. Though recent research has studied how to recommend locations with social and geographical information, few of them addressed the cold-start problem of new users. Because mobility records are often shared on social networks, semantic information can be leveraged to tackle this challenge. A typical method is to feed them into explicit-feedback-based content-aware collaborative filtering, but they require drawing negative samples for better learning performance, as users’ negative preference is not observable in human mobility. However, prior studies have empirically shown sampling-based methods do not perform well. To this end, we propose a scalable Implicit-feedback-based Content-aware Collaborative Filtering (ICCF) framework to incorporate semantic content and to steer clear of negative sampling. We then develop an efficient optimization algorithm, scaling linearly with data size and feature size, and quadratically with the dimension of latent space. We further establish its relationship with graph Laplacian regularized matrix factorization. Finally, we evaluate ICCF with a large-scale LBSN dataset in which users have profiles and textual content. The results show that ICCF outperforms several competing baselines, and that user information is not only effective for improving recommendations but also coping with cold-start scenarios.

**Existing System:**

Through analysis of ICCF, we establish its close relationship with graph Laplacian regularized matrix factorization, and offer a good explanation of the proposed algorithm, such that user (location) features refine the similarity between users (locations) on implicit feedback.

Therefore, ICCF not only becomes an alternative solution for similarity constrained matrix factorization algorithms, but also can be incorporated with domain-specific knowledge, such as document similarity between user tweets (e.g., vector space model), and age proximity between users.

**Proposed System:**

We extend implicit feedback based collaborative filtering through a sparse and rank-one weighting scheme, thus it subsumes three existing weighting schemes for modeling negative preference and naturally introduces a novel mixed weighting method. The effectiveness of the proposed sparse and rank-one weighting schemes has been extensively evaluated, showing its significant benefit for improving recommendation, in particular for locations at long tails.

We propose an efficient coordinate descent optimization algorithm to learn parameters in the sparse and rank-one weighting schemes, which scales linearly with data size and feature size, and quadratically with the dimension of latent space. In addition to theoretical analysis of time complexity, we empirically study convergence and efficiency issues in the proposed optimization algorithm.

We investigate how to incorporate biases into contentaware matrix factorization without any adjustment to the optimization algorithm, achieved by how to augment latent factors of users and locations. We also empirically study the effects of biases, and observe their significant benefit to recommendation from sparse datasets.

We elaborate on the procedure for establishing close relationship of the proposed model with a graph Laplacian regularized matrix factorization.