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博 士 学 位 论 文

网络推荐系统中基于时间信息的新颖性研究

Research on Novelty of Network Recommender System Based Time Information

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摘　要

随着信息技术和互联网计算的迅猛发展，Web 2.0 技术使得人们即是信息的消费者又是信息的生产者。推荐系统不需要用户提供明确的需求，而是通过分析用户的历史行为来建立用户偏好模型，主动为用户提供满足用户兴趣和需求的信息。几乎所有的大型电子商务系统都不同程度地使用了各种形式的推荐系统。

从推荐系统产生开始，相关的论文有 90%以上都在讨论准确度指标。实际上，除了准确性，影响用户满意的因素还包含有效性、新颖性和可用性。新颖性推荐成为最近几年推荐系统领域热门的话题。

从用户感知角度对新颖项目进行了定义，并依据项目新颖性对用户的时间相关性设计了离线实验方法和评价指标。采取过程融合和结果融合策略将未知性和差异性度量与传统算法进行融合，实验结果表明结果融合策略更有效。

基于产品生命周期理论的新颖性推荐算法对项目流行度的时间变化进行分析，建立了项目流行度预测模型，并以项目流行度预测值来判断用户对该项目的接受程度。分别以喜欢程度和接受程度两个标准选择备选集设计了ER和PP两种算法，实验结果显示ER算法的新颖度、准确度和覆盖率三个评价指标均较好。根据创新扩散理论对用户创新采纳积极度进行建模，使推荐系统能够识别用户在当前时刻对某类项目采纳的可能性，提高了推荐系统的准确度和新颖度。

项目新颖性还包含差异性，即待推荐项目与用户偏好的距离。采用全局聚类和用户已采纳项目集聚类两种方法来对用户偏好建模，再使用加权距离计算待推荐项目对于用户的差异度，能够减少新颖性推荐对准确度的下降幅度，并提高了覆盖率。

对于用户而言，项目的新颖度是和时间有密切关系的。首先时间感知的传统算法能够提高推荐结果的准确度；其次设计了时间感知创新扩散算法，更加准确的计算用户对各类项目的创新采纳积极度；最后根据用户已采纳项目每一类的数量和采纳时间设计了时间感知差异性算法。实验结果显示本文采用的时间感知传统算法不能有效提高推荐结果的新颖度，而时间感知创新扩散算法能够有效的提高推荐结果的准确度和新颖度，时间感知差异性算法在保证新颖度不降低的同时改善了推荐结果的覆盖率和流行度，从而进一步提升了推荐系统的性能。

关键词：新颖性推荐；时间感知；创新扩散理论

Abstract

With the rapid development of information technology and internet computing, Web 2.0 technologies make people act as both consumers and producers of information. Humans enter the age of information overload from information poverty for explosive development of internet information. Recommender systems no longer require users to provide definite requirements. Instead, user preference model is established to provide information satisfying users' interests and needs by analyzing their behavior history. Variety recommender systems are more widely used and applied by almost all large-scale e-commerce systems.

Accuracy indicator has been discussed in above 90% of theses concerning recommender systems since they came into existence. Actually, recommendations with high accuracy are useless. Users will be satisfied if results generated by recommender systems are not only beyond users' expectations but also liked by them. Novel recommendation becomes the hot topic in the field in recent years.

Novel item is defined from the perspective of user perception, and offline experimental methods and evaluation metrics is designed for user temporal correlation according to the novelty of item. process integration strategy and result integration strategy are adopted for the fusion of unknown n and dissimilarity metrics with traditional algorithms. The experiment result indicated that the result integration strategy is more effective.

The novelty recommendation algorithm based on the product life cycle theory is used for the analysis of the temporal variations of the popularity of the item, and a model of item popularity prediction is established, then users' acceptance of the item is determined with the predicted value of the item popularity. How users prefer and accept the item are used as two standards for the selection of alternative sets and two algorithms are designed, which were ER and PP. The experiment result showed that the novelty, accuracy and coverage of ER algorithm are relatively good. Users' initiative to adopt innovation is modeled with the diffusion of innovation theory, making the recommendation system capable of recognizing the possibility of whether

users may accept certain kinds of items at a given moment, and the accuracy and novelty of the recommendation system are improved.

The novel item also includes differentiation, namely the distance between the recommended items and user preferences. Global clustering and the clustering of the items accepted by users are adopted for the modelling of user preferences, and weighted distance is used to calculate the differentiation of recommended items towards users, reducing the influences on the recommendation system and improving coverage.

For users, the novelty and time of items are closely related. First, time-aware traditional algorithms may improve the accuracy of recommended results; secondly, time-aware innovation diffusion algorithm is designed for more accurate calculation of users' initiative to accept the innovations of various items; lastly, the quantity of each type of items accepted by users and the time took to accept were used for the design of the time perceptive differentiation algorithm. The experiment result shows that the time-aware traditional algorithm in this paper may not effectively improve the novelty of recommended results, while time-aware innovation diffusion algorithm may effectively improve the accuracy and novelty of recommended results. While ensuring that the novelty remains unchanged, the time-aware differentiation algorithm simultaneously the coverage and popularity of recommended results, further improving the comprehensive performance of the recommendation system.

Keywords: Novel recommendation; Time-aware; Diffusion of innovation

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