

早稲田大学審査学位論文
博士（人間科学）
概要書

Facilitating Reuse of Learning Objects: An Integrated
Approach Based on Social Network Mining and Analysis

ソーシャルネットワークモデルに基づいた統合アプロ
ーチによるラーニングオブジェクトの再利用

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Systems for learning support are categorized into three portions: the authoring system for courseware editing, the management system for activity performing and the storage system (or repository) for resources sharing and management. To ensure the reusability, standards, such as SCORM (Sharable Content Object Reference Model) and CORDRA (Content Object Repository Discovery and Registration/Resolution Architecture), are proposed to provide a general guideline and framework for the system development.

Owing to the popularity of Social Network and Web 2.0, a considerable number of resources are becoming applicable for education. These resources can be applied for different purposes to facilitate the learning process. For instance, resources are utilized to generate lectures for learners in different levels and, in addition, serve as extra materials for the reference. Although preliminary solutions regarding resources (i.e., the learning object) management were presented by SCORM and CORDRA, a few issues are still left unsolved. First, the tedious process of learning object creation, especially metadata annotation in SCORM, discourages the usability. Second, CORDRA presents a handler system to support learning object discovery in distributed repositories, but how learning objects are retrieved according to specific conditions from users has yet been addressed.

Concerning the challenges, this thesis goes further to investigate the inner attribute of learning object and its correlations with the main focus of human-centric support. Three primary issues are concentrated including (a) Vague Significance of Learning Object: The search has become a common service implemented in any web systems (i.e., the repository) that allow users to interact with the database. However, the common search service concentrates on accuracy (e.g., precision-recall) and efficiency (e.g., time cost) of the retrieval results and, in some ways, omits the significance that a data should have; (b) Uncertain Approach to Reuse: Though the search service provide a solution to learning object reuse, the approach to achieve above mention is still not clearly addressed. The common situation is that users have difficulty to obtain the expected information (or learning object in this study), and often leads to “cold start”. The approach to learning objects is not clearly defined; and (c) Time-Consuming Process of Learning Object Retrieval: One query, in general, is expected to

reach one result. That means a huge number of queries have to be sent once a lecture for specific purpose needs to be generated. Although built-in search service can serve the initial situation (but the above mentions still need to be concerned), the cost of time in selecting useful learning objects is still required.

As a solution, an integrated approach concerning interdisciplinary perspectives such as information retrieval, social network analysis and data mining is proposed. A set of algorithms, automated mechanisms and applications are developed to facilitate the ultimate task (i.e., the learning process in this research).

In the beginning, the concept LONET (Learning Object Network), a social-driven structure as systematic extension of the Reusability Tree, is firstly introduced to clarify the vague reuse scenario of learning object in the past, and to summarize usage experiences and behaviors which is graphed in accordance with corresponding relations (both implicit and explicit ones). Metrics based on social network analysis are proposed to quantify the interdependency and determine the correlation(s) among learning objects.

Based on the LONET, practical applications that facilitate the reuse process are then implemented from the perspective of information retrieval. The reference information, including citations and user feedbacks, are applied to develop a weighting/ranking algorithm with the focus of time-series information and highlight the significance. The search guidance algorithm is proposed to assist users in continuing the search process by providing progressive suggestions corresponding to the query. And, as a practical outcome, an interactive search algorithm is proposed to mine the collective intelligence in the LONET. It generates path (or lecture template) automatically based on the input and the usage experiences. As a self-enhancement, the adaption issue is considered. The ranking result is re-organized in accordance with the adaptive context. In addition, the adaptive route with the focus on first-level connection is generated according the combination of search guidance and lecture template.

To demonstrate the feasibility, an empirical study is conducted by two system performance evaluations and a usability testing experiment. The evaluation is performed based on TREC testing

with a general Precision-Recall test for retrieval accuracy and a nIAP (Non-Interpolated Average Precision) test for ranking accuracy. The usability experiment is conducted with around 50 users, including professors, lecturers and teacher assistants, and reaches an expected result.

The thesis is organized in six chapters and one appendix including:

- **Chapter I Introduction**

The challenging issues on learning object retrieval and reuse are introduced in the beginning of the chapter. We concentrate on the objective nature of the mentioned issues and assume that the solutions are imminently required with deep consideration of social factor including its technical aspects.

- **Chapter II Literature Review**

This chapter discusses the related issues regarding the systematic reuse of learning objects with the main focus human-centric support. The survey on web information retrieval, social network analysis and time-series mining technologies are summarized as the bases that develop this thesis.

- **Chapter III Learning Object Network**

The learning object network that is inspired by the concept of social network is proposed in attempt to clarify the reuse. The five-year usage experiences are applied to define the rules for investigating the correlations between learning objects. In addition, the metrics based on social network analysis are incorporated to quantify the relations and achieve the acquisition of collective experiences.

- **Chapter IV Applied Search in LONET**

This chapter addresses the potential search applications, including the weighting/ranking algorithm, the search guidance and the lecture template generation, that facilitate the discovery and systematic reuse of learning objects within the federated repository.

- **Chapter V Experiments and Evaluation**

The empirical study is conducted to demonstrate the feasibility of the proposed works. Two system evaluations and a usability experiment on around 50 users are involved.

- **Chapter VI Conclusion**

This chapter concludes the thesis with the brief summary of contributions, and presents the expected challenging issues and the future working directions.

- **Appendix Implementation**

The appendix demonstrates the concrete implementation of the proposed works mentioned in the Chapter III and Chapter IV. The system automated functions are walked through via a simple operation process of learning object searching.

The achievements are highly expected to enhance the capability of SCORM and CORDRA especially in learning object reuse and search, and prompted the reexamination of web search in general.

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This study is primarily featured by an integrated approach based on the social network analysis concerning the issues of the reusability and searchability of learning object. The quantitative results have presented a significant enhancement on standards (i.e., SCORM and CORDRA) for E-Learning. In addition, a set of algorithms, mechanisms and applications involved in the proposed approach is applicable to be applied in an interdisciplinary domain and prompted the reexamination of web search in general.