Graduate School of Creative Science and Engineering
Waseda University

博　士　論　文　概　要
Doctoral Dissertation Synopsis

論　文　題　目
Dissertation Title

Data Interpretation Based on Embedded Data Representation Models

Analytical Models for Effective Online Marketing in the Fashion Industry

Embedded Data Representation Model に基づくデータ解釈に関する研究

ファッション業界を事例とした
効果的なオンラインマーケティングのための分析モデル

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Online marketing has gained prevalence owing to digital devices that are used to serve customers and sell items worldwide. Consumers use these devices to browse e-commerce sites, social media, blogs, and video streaming applications, thereby acquiring information on items and making purchases via e-commerce sites. Following are the significant characteristics of online marketing: 1) ability to conduct worldwide marketing activities irrespective of the area or location of residence, and 2) impossibility of directly seeing the customers. Therefore, online sites possess an inordinate potential to approach users for marketing compared with brick-and-mortar stores; therefore, the accumulation and utilization of data are essential. Consequently, in the recent years, various companies have been working to improve their websites, app usability, and user satisfaction by utilizing their databases.

A limitation of online marketing includes users making purchasing decisions solely based on their knowledge, as online stores have no clerks. In particular, there is a considerable ambiguity in the fashion industry; the target of this study is to address this ambiguity. It is difficult for users to make their own purchasing decisions, particularly for the expensive items, or try emerging fashion trends during an online purchasing activity.

The recommender systems recommend several items to the users on e-commerce sites. The users are required to supplement the information as to “why this item is good (why it is recommended to them),” thereby making it difficult for non-experts to make purchasing decisions, particularly for the expensive items.

Additionally, the usage of ambiguous expressions, such as “casual,” “formal,” and “cute,” to describe fashion makes it difficult for users (especially non-experts) to understand and interpret fashion. Because the users cannot be supported by experts during online purchasing activities, they resort to interpreting these ambiguous expressions themselves for their decisions. This is a primary reason behind users finding the fashion domain complicated. For example, the queries such as “what would this outfit look like if it were more formal?,” “how office-casual is this outfit?,” and “what elements make this outfit casual?” are particularly challenging for non-experts (and not easy for experts either). Therefore, these ambiguities pertaining to the fashion domain may hinder user interest in the fashion industry by making it difficult for them to try new genres of clothing.

Despite the aforementioned intervening online marketing challenges,

users want to feel comfortable with online purchasing activities. However, the recognition and evaluation of fashion items by the consumers are ambiguous; therefore, employing an online user support to answer the questions from the users is essential. In this study, machine learning is used to develop a system that supports the user understanding and interpretation of items in the fashion industry, enhancing the online usability and user satisfaction. Additionally, the current study aims to facilitate reduction in the online marketing challenges and satisfy the user needs.

The proposals in this study are subdivided into the following two main approaches: 1) approaching the contact point between the company and users and 2) approaching the steps involved in evaluating and specifying the fashion item during the purchasing processes of the users.

Several studies have discussed the point of contact between a company and its customers, such as the recommender and retrieval systems. Chapter 3 describes the “explainable recommendation” technology, which empowers recommender systems with explanatory ability. The objective of this chapter is to develop this technique and propose a model (Model 1) that enables the efficient learning of massive quantities and various types of side information to be used for explanation. The proposed Model 1, based on the graph neural network model utilizing a knowledge graph, realizes the model-intrinsic explanation approach using the self-attention mechanism. It allows the user to understand the advantages of the recommended item (and why it is recommended) and aims to contribute to the realization of an effective recommender system.

Furthermore, in the item evaluation step during the user purchasing process, users evaluate items via e-commerce sites, social media, blogs, and video streaming applications. Nowadays, users can easily refer to other people's outfits via social media and other services. In chapters 4–7, we propose a novel technology called the “fashion intelligence system,” which aims at automatically interpreting ambiguous images related to fashion and supporting the users' understanding of fashion by assisting them with various fashion decisions (purchase of items and how to wear them) through diverse applications.

The fashion intelligence system is based on the visual-semantic embedding (VSE) model technology. The following three types of VSE models are proposed: 1) VSE that can map massive amounts of full-body outfit

images with abundant tags containing various ambiguous expressions into the same space, 2) partial VSE (PVSE) that enables sensitive learning of each part, and 3) dual Gaussian VSE (DGVSE) that enables the analysis of the meaning and diversity of mapped elements, such as outfits, items, and ambiguous expressions.

Chapter 4 proposes a “fashion intelligence system” based on VSE (Model 2). The mapping mechanism of VSE is realized by foreground-centered learning, background regularization, and other schemes. Various applications of the proposed VSE are presented; although the proposed Model 2 has a relatively simple structure, it includes various applications such as image retrieval, re-ordering, and attribute activation map creation. Additionally, we demonstrate the effectiveness of each application through various multifaceted evaluation experiments using multiple types of real-world service datasets.

In Chapter 5, we propose PVSE (Model 3) that obtains features for each part of a full-body outfit, such as hairstyle, face, jacket, T-shirt, pants, and shoes, in contrast to the proposed Model 2 that learns a full-body image instantly. Chapter 5 realizes an application focusing on the specified parts for fulfilling the intricate needs of the users, which is not possible using Model 2.

In Chapter 6, we propose the DGVSE model (Model 4), which maps each element onto the projective space as a distribution, rather than a point. Using Model 4, the meaning of the elements to be mapped and diversity of their uses can be explicitly analyzed, which is not attainable using Models 2 and 3. The objective of this chapter is to help users attain an enhanced understanding of the ambiguous images of fashion.

Multifaceted evaluation experiments using real-world service data have demonstrated that each proposed model contributes to the research objectives. The results of this study are expected to support the users' understanding and interpretation of fashion items and outfits leading to an improved usability and user satisfaction with online services. Particularly, this study paves way for the fashion intelligence system as a novel research field. Therefore, additional complex models for realizing a more powerful fashion intelligence system are expected to be proposed. Furthermore, in addition to the systems for the fashion industry, numerous models can be proposed and applied to various other domains.

List of research achievements for application of Doctor of Engineering, Waseda University

Full Name： 清水　良太郎　seal or signature

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種類別 (By Type)	題名、 発表・発行掲載誌名、 発表・発行年月、 連名者（申請者含む） (theme, journal name, date & year of publication, name of authors inc. yourself)
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