

Extraction of the Combination Rules of Colors and Derived Fashion Images Using Fashion Styling Data

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Abstract—With the development of the Internet, people purchase various products online, with items for purchase being proposed on the basis of recommending algorithms. Fashion items are one of them. However, difficulties in recommending fashion items arise from problems in detecting the item's characteristics such as color, detail, and silhouette, in many still images on online shopping sites. In particular, color is a simple characteristic, but different color combinations give different impressions. Some people obtain a lovely and cute impression from the color combination of white and pink. Thus, this type of information is needed to focus on recommendation of items to users via the Internet. Our main aim in this study is to extract the rules related to the information described above, i.e., to obtain the associated rules from color combinations to derive impressions. We accumulated fashion styling data from online shopping sites related to fashion items. Then, we attempted to acquire the associated rules. After this procedure, we extracted approximately 6,000 rules. Subsequently, we tested the validity of the rules using questionnaires. The results demonstrated that our extracted rules were highly significant when compared with a controlled condition. Thus, we have successfully acquired association rules for fashion item recommendation.

Index Terms—Color image scale, fashion item recommendation, color information, text mining

I. INTRODUCTION

FASHION, both what to wear and how to wear it, is an essential factor in our daily life. For example, before leaving the house, we consider clothes with respect to various factors: what we will do, the time of day, where we will go, and whom we will see. If we detect insufficient and unsatisfactory aspects to our clothing, e.g., the lack of an elegant dress for the wedding of a friend, we must obtain new information on dresses by going to fashion shops, watching online shopping sites, and reading fashion magazines. Then, we need to repeat these processes until we have purchased suitable clothes for the occasion.

However, performing these processes, i.e., obtaining necessary information on clothes, to check whether these items are suitable for the proposed occasions, and to purchase

them, requires a great deal of time because we have little knowledge of fashion to decide whether our choices are appropriate. As a result, we may waste our precious time.

There are two types of studies on fashion recommendations to reduce wasted time during shopping. The first type is a study to assist users with choosing and purchasing clothes, called a fashion styling recommendation system [1]-[4]. In these studies, for assistance with purchases, users search for the items they want by using appropriate queries related to the items. Then, according to these queries, the system recommends some items based on a collaborative filtering algorithm. This recommendation has been already implemented, and useful techniques to make finding appropriate items easy have been discussed; see online shopping sites, e.g., Rakuten¹ and Amazon².

This technique for recommendation of fashion items is simple but effective because people like items selected depending on their characteristics. However, the queries in many cases, i.e., by keyword search are the names of the item or character strings in the comment that the salesclerk has described. In particular, the comments greatly depend on the vocabulary of the clerks. Suppose we want to search for a “casual” item. In this case, the appearance query is “casual”. However, we do not know beforehand whether the word is in the comment. The clerks may not have thought of using the word to describe the item. Needless to say, we cannot search for items if they have not been described.

The other type of study focuses on visual aspects, which are the most important points for humans. Based on the aspect, the impression derived from a fashion item is important. According to Kobayashi [6], color is also very important in influencing human impressions. For example, white may look clean, and orange may be associated with summer.

Therefore, we pay attention to the colors seen in online shopping sites. These sites contain many still images in which the colorful clothes are displayed. Once we see the clothes, we can receive various impressions based on the combination of the colors. For example, we may recognize the combination white and pink as a cute, lovely girl. In contrast, white and black may elicit the impression of a mature woman.

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¹ <http://www.rakuten.com/>

² <http://www.amazon.com/>

In this study, we attempt to extract some associate rules relating still images to color in fashion and evaluate whether the rules acquired are valid. As this type of study has rarely been undertaken before, this study should obtain significant results. We attempt to extract associate rules from massive data and evaluate them.

II. RELATED WORK

In a study of fashion recommendations, the color information of clothes is useful information. Iwata et al. automatically extracted a domain of tops and bottoms and acquired information on the images of clothes from the domain and, showed the effectiveness of recommending bottoms for tops and vice versa [5].

In addition, Kobayashi et al. connected the image with colors [6]. They performed a psychological investigation of 130 colors classified as a hue in a tone and constructed the Color Image Scale (CIS), which associates a color and an image. We show an example of the CIS in Table 1. However, the CIS is not suitable for fashion because it connects a general image. In this study, we generate rules connecting fashion images with color for fashions based on the principle of the CIS.

III. GENERATION OF THE RULE IN CONSIDERATION OF THE COMBINATION OF COLORS AND FASHION IMAGE

In this study, we extracted two colors of combinations and fashion images from fashion styling data and generate the rule from the information that we extracted.

A. Fashion Styling Data

Using 71,921 fashion styling data from online shopping sites, we extracted the information and generated a rule from a combination and the fashion image of the color information for each fashion styling. When the rule was generated, the amount of fashion styling data was 71,921 cases, but the number of real data points was 5,233 because we chose the fashion styling data which met three following conditions.

- Fashion Image : more than 1
- Tops color : more than 1
- Bottoms color : more than 1

Various information is listed in fashion styling data, but perform information extraction from information and the fashion styling introduction sentence of an item used for fashion styling in this study.

TABLE 1
EXAMPLE OF THE COLOR IMAGE SCALE

Color			Image
Magenta	Orange	Viridian	Tropical
Orange	Sulfur	Peacock Green	Casual
Brown	Mustard	Olive Green	Country-like
Carmine	Yellow	Orange	Vibrant
Carmine	Yellow	Ultra Marin	Active
Orange	White	Yellow	Cheerful

B. Extraction of Color Combinations

The combinations of colors were extracted from color informations listed in the item information of each fashion styling. The combination of colors extracts it with ${}_x C_2$ when it is assumed that the number of color informations that each fashion styling is given is x . As an item registered with fashion styling this time, we used an item of "tops" and "bottoms" and "shoes" as a color information except the item that influence was low as "hat" and "bag", a color information of the whole fashion styling including "accessories". As a result, combinations of 1,134 kinds of colors were extracted.

C. Extraction of Fashion Images

The fashion image extracted a noun to collocate with specific clue words such as "style" and "coordinates" from the fashion styling introduction sentence. As a result, 100 types of fashion images were extracted.

D. Extraction of the Combination Rule

We combined fashion images with color combinations, resulting in generation of 5,995 types of rules. We show an example of a generated rule in Table 2.

E. Evaluation of the Rule

In this study, we performed impression evaluation using the SD method. We performed narrowing by the following indexes on this occasion because large amounts of processing time are necessary for evaluating all rules, as in (1).

$$N(r) \geq Avg(i_r) + 2 \times Stdev(i_r) \quad (1)$$

Where r is a rule, $N(r)$ is the number of times that rule appears, i_r is a fashion image with added correspondence in a rule, $Avg(i_r)$ is the average between fashion images, and $Stdev(i_r)$ is the standard deviation between fashion images.

We conducted a questionnaire on approximately 780 cases of 390 rules (random) that randomly put a fashion image together for 390 rules (proposed method) formed using the proposed method and the total combination of colors. In 26 cases, three people answered a questionnaire about one case. The subjects were 90 graduates (men: 73, women: 17). "Inappropriate," "slightly inappropriate," "neither appropriate nor inappropriate," "slightly appropriate," not identified as any of the five phases of "appropriate" established six topics for the evaluation of the questionnaire. We added up the ratings from the questionnaire results, and

TABLE 2
EXAMPLE OF THE GENERATED RULE

Combination of Colors		Fashion Image
White	Navy	Marin
Green	Sax Blue	Fresh
Black	Red	Lady
Yellow	Orange	Summer
Green	Orange	Summer

TABLE 3
SURVEY RESULTS

	Appropriate	Slightly appropriate	Neither appropriate nor inappropriate	Slightly inappropriate	Inappropriate	Unknown
Proposed Method	122	368	220	234	94	132
Random	88	305	204	283	135	155

TABLE 4
SURVEY RESULT

	[appropriate]	[inappropriateness]
Proposed Method	152	87
Random	102	122

TABLE 5
COMPARISON OF THE RULE

	Rule	The combination of colors	Image
Proposed Method	5,995	1,134	100
The CIS	1,170	1,092	226

TABLE 6
EXAMPLES OF SUGGESTION TECHNIQUE [INAPPROPRIATENESS]

Combination of Colors	Fashion Image
Black Blue	Summer
White Navy	Military
Navy Off-white	Tropical
White Blue	Spring
White Blue	Military
Black Gray	Girl
White Beige	Men
Black Yellow	Going on a date
Red Green	Sea
White Navy	Monotone
Black Blue	Spring
White Pink	Holiday
Black Light Blue	Pop
White Navy	Military
Navy Off-white	Trend
Black Yellow	Lady
Navy Gray	Summer

the result of the U test of Mann–Whitney was highly meaningful ($W = 608856$, $p = 1.12e-6$). Therefore, the rule generation of this study was effective.

IV. RESULT OF EXPERIMENT AND ANALYSIS

The questionnaire results are shown in Table 3. We considered the rule that two or more estimated as “appropriate” and “slightly appropriate” to be [appropriate]. And we considered the rule that two or more estimated as “inappropriate” and “slightly inappropriate” to be [inappropriate]. The results are shown in Table 4.

In addition, as for the rule formed in this study, rules other than those in the CIS of Kobayashi et al. [6] were generated. The number of images, a comparison between total number, and number of the combinatorial kinds of the color of the rule are shown in Table 5.

At first, for a rule of the suggestion technique, we checked 87 rules evaluated as inappropriate. Examples of these rules are given in Table 6. In these examples, an image is not thought to be obviously linked with a color. In this case it is thought that there are more examples of black, white, navy, and off-white than other colors. We show the appearance ratio of color in Fig. 1. They occupy 53.7% in four colors of high ranks. Regardless of the appearance number of times of

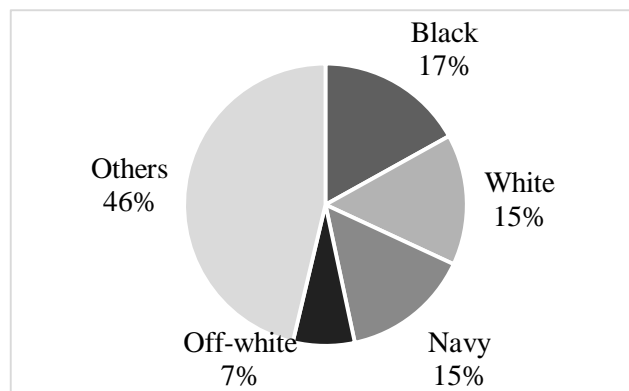


Fig. 1. Appearance ratio of color

TABLE 7
EXAMPLE OF RANDOM [APPROPRIATE]

Combination of Colors	Fashion Image
Black Gray	Boy
Black Gray	Formal
White Beige	Simple
Off-white Blue	Cool
Navy Off-white	Refined
Beige Pink	Elegant
White Beige	French
Off-white Blue	Work
White Blue	Work
Navy Beige	Autumn-Winter
Black Navy	Rock
Black Blue	Work
Navy Off-white	Sea
White Sax Blue	Sporty
White Green	Picnic
White Blue	Leisure
White Pink	Girl

the color, it is thought that it is good, and a fashion image to appear is more likely to be tied to four colors of high ranks that develop well because I generate a rule cyclopedically. I perform a heaviness charge account at the appearance number of times of the color to solve this problem and must adjust the appearance number of times of the color with much appearance number of times.

For randomly formed rules, we checked 102 rules estimated as adequate. We show examples of these rules in Table 7. Thirty-eight of 102 cases were included in 5,605 generated rules and were appropriate. This problem can be settled if the number of the coordinate data used for rule generation is increased. The coordinates that a color information cannot extract can supplement information in future if an RGB level from an image is extracted using the technique of Chang et al. [7] because there is the image of coordinates for all coordinates to effectively utilize the remaining 66,688 cases. In addition, by performing it from an image it is thought that we can commonize the judgment of a color listed by a salesclerk.

In addition, the extraction of the fashion image includes a problem. In this study, we extracted a noun to be associated

TABLE 8
EXAMPLES OF FASHION IMAGES

Good	Bab
Spring	Down
Summer	Denim
Autumn	Easy
Winter	Relaxation
Autumn-Winter	T-shirt
Work	Arrangement

with a specific word as a fashion image. We show an example of a fashion image in Table 8. A fashion image was able to perform the extraction of the image that I could associate with a color like "summer" and "autumn and winter", but the image that I could not associate with "relaxation" and a color "easy" existed. The image that there is much number of the appearances is a high image of the trust, and it is thought that the word that there is little appearance number of times is a low image of the trust to automatically remove such an image in combinatorial consideration of the clue word, paying its attention to the appearance number of times of the image again.

V. CONCLUSIONS

In this study, we attempted to extract the rules that related a fashion image to the combination of colors using accumulated styling data from online shopping sites. After the analysis of the data, we acquired approximately 6,000 rules. Using a questionnaire, we showed the effectiveness of our proposed technique with highly significant results.

In future studies, we would like to focus on analyzing all the data because all the data in this study were not dealt with, i.e., no tagged data existed. Inspection of the rule in the case of three colors is necessary like Kobayashi [6] in future.

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