Enriching Recommender Systems Results with Data about Sustainability and Ethical Standards of Brands

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Abstract—In recommender systems research, not only user preferences but also the sustainability and ethical standards of the services underlying item fruition should be considered to promote virtuous selection decisions. We analyze user interfaces that guide item comparison taking these evaluation criteria into account and we test a synchronized multi-list aimed at raising users' awareness about items by enabling them to (i) sort items according to different evaluation criteria, and (ii) simultaneously view the overall evaluation of an item and its ranking in each criterion. A user study in the fashion domain has shown that the presentation of data about environmental sustainability and ethical standards induces virtuous selection behavior and that participants are more confident in their selections when using our synchronized multi-list user interface than with single-lists.

Index Terms—multi-list user interfaces, sustainability, fashion, human-centric computing and services.

I. INTRODUCTION

The sustainability and ethical standards of the services underlying item fruition are important to promoting green consuming behavior [1]. In the recommender systems research [2], this suggests to present results based on multiple, possibly conflicting criteria that go further than satisfying individual user preferences. In [3], we introduced a *synchronized multi-list model* to raise the user's awareness of recommender systems results by enabling her/him to (i) sort items according to different evaluation criteria, and (ii) simultaneously view the overall evaluation of an item and its separate ranking in each criterion. However, we only carried out a preliminary test to identify the eye-gaze behavior while interacting with the multi-list. In the present paper, we compare our multi-list to different single-list user interfaces. As a test bed, we chose the fashion industry, which challenges item selection by raising severe sustainability [4] and ethical [5] issues in production practices. We investigate the following research questions:

- *RQ1: is the presentation of information about environmental sustainability and ethical standards of fashion brands useful to select items in a clothing catalog?*
- *RQ2: does the presentation of this information influence the selection of garments in a clothing catalog?*
- *RQ3: does the presentation of multi-criteria item evaluations support users' confidence in item selection considering environmental sustainability and ethical standards?*

To answer these questions, we developed a test application that manages three user interfaces: a synchronized multi-list, a standard single-list of items, and a single-list enriched with a summary of the sustainability and ethical standards of items' brands. In a user study involving 72 people, we investigated the user experience with them and their impact on user awareness and decision-making. We found that the presentation of data about sustainability and ethical standards is useful and positively influences users' selection decisions, inducing people to choose clothes that mediate between their own preferences and the other evaluation aspects. Moreover, our synchronized multi-list supports confidence in item selection.

II. RELATED WORK

We investigate the influence of visualizing item evaluations in recommendation lists [6]. Online platforms like Zalando [7], and Amazon [8] highlight products over a sustainability threshold. Differently, we help people compare items according to multiple criteria. This might help critical consumers, who are attentive to virtuous purchasing practices, to find products satisfying their ethical values [9]. Carousels are used to present thematic lists of products, based on different optimization criteria [10]–[12]. While this supports diverse relevance perspectives, it does not help combining criteria. [13] pursued multi-lists to increase the diversity of suggestions while reducing choice overload. Differently, our synchronized multi-lists support the simultaneous ranking and presentation of a set of items according to multiple evaluation criteria.

Users' navigation behavior with multi-lists differs from the one observed in single lists and [14] noticed that the user's attention in 2D user interfaces is mainly focused on the top-left triangle of the window. [15] proposes to analyze log data to reveal a propensity to positions in the user interface. Moreover, in a multi-list user interface, people tend to select the items from the upper lists [10], [16]. Furthermore, users are more satisfied with the items selected through grid-based/multi-list user interfaces than single-lists but the former cause higher choice difficulty than the latter [10]. We confirm the complexity of multi-list user interfaces. However, by synchronizing them on the item in the user's focus of attention, we support users' confidence in their choices by enabling the assessment of items' ranking in the various evaluation criteria.

III. Information about Clothes

We collected information about products from the Zalando website that we scraped from February to March 2022. For each item, we retrieved the category (e.g., skirt), the first available image, its material, price, and brand. The dataset includes 30,722 clothes produced by a total of 2,730 brands.

We analyzed the images of the clothes using the pre-trained model based on ResNet50, from the MMFashion library [17]. This resulted in a 1000-dimensional vector $\vec{v_i}$ for each item i, specifying binary features such as "striped", and "pocket". We inferred the color of clothes on a standard scale using a convolutional neural network trained for our dataset, using transfer learning on ResNet50 [18]. We retrieve the data about brands' sustainability and ethical standards from Good On You [19], which returns their "environment rating", "labour rating" and "animal rating" values.

IV. User Interfaces

The user interfaces we test show 30 clothes from a category C, i.e., jumpers and cardigans for men or women on desktop and mobile devices. Given C, we selected the sets of items to be displayed (a different set for each user interface) as follows. First, we evaluated the overall sustainability and ethical standards of the items of C. Then, we selected 25 items having a low value and 25 items having a high one. From the set I of 50 selected items, we chose the 30 that were most diverse from each other in color and style. To exclude the 20 most similar pairs of items from I, we computed the pairwise stylistic similarity σ of any two items $i, j \in I$ as $\sigma_{ij} = AVG(\sigma_{color_{ij}}, \sigma_{features_{ij}})$ and we iteratively removed the items occurring in a pair having the highest similarity in the remaining subset of pairs. In the above formula, $\sigma_{color_{ij}} = 1 - \delta_{color_{ij}}$, where δ is the color difference of the two items, based on ΔE CIEDE 2000 [20]. Moreover, we computed $\sigma_{features_{ij}}$ as the Jaccard similarity of the feature vectors of the two items ($\vec{v_i}$, and $\vec{v_j}$).

In the MULTI-LIST user interface [3] (see Figure 1), the top shows the item in the user's focus of attention and presents the overall sustainability and ethical standards of its brand. The photo includes a label showing the item's score in [1, 5], using color coding to graduate values from green (good values) to red (bad ones). This score is the arithmetic mean of the "environment rating", "labour rating" and "animal rating" values that Good On You attributes to the item's brand.

Below the item details, four ranked lists ("CLOTHES SORTED . . .") show the 30 items sorting them left to right from the best to the worst values. The upper list reports the aggregated data (overall evaluation). The photos of the clothes in the lists are enriched with labels representing their scores in the respective evaluation criteria. By clicking on a photo, the system highlights it and displays the item details at the top of the page. Moreover, all the carousels center themselves on it; see Figure 1. The lists are in synch to let the user vertically scan items and assess their evaluation in the respective criteria.

The SINGLE-LIST user interface is a projection of MULTI-LIST on brands' aggregated sustainability and ethical stan-
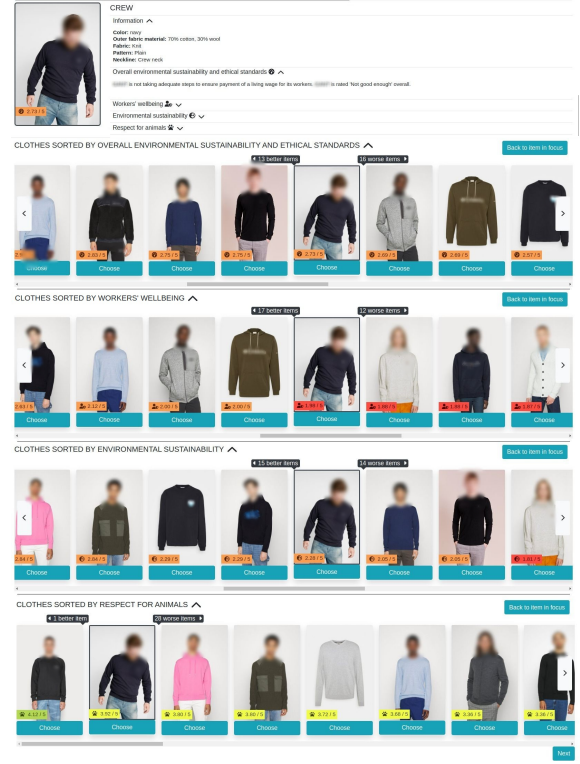

Fig. 1. MULTI-LIST user interface (blurred for publication purposes).

dards. It shows the details of the item in the user's focus of attention and only displays the first list of items of Figure 1.

BASELINE is a standard user interface that shows the details of the item, and the list of available clothes, without reporting any data about sustainability or ethical standards.

V. User Study

We applied a within-subjects approach, managing each treatment condition (BASELINE, SINGLE-LIST, MULTI-LIST) as an independent variable. Each participant received all the treatments in counterbalanced order. We aimed at a sample participants size = 55 which, according to power analysis, supports statistically significant results with $\alpha = 0.05$, *power* = 0.80, and *effect size* = 0.35. To evaluate the statistical significance, we used the Kruskal-Wallis test. We recruited adult people through public mailing lists and social networks, asking them to use a PC for the test. People joined the experiment voluntarily, without any compensation. The application guided them in all the steps of the study, logging their actions on the user interfaces, and administering attention tests. To guarantee users' privacy, it did not collect their names: it generated numerical identifiers to tag the anonymous data it acquired.

The application asked users to read the informed consent (https://bit.ly/3PnXhPi), declare that they were ≥ 18, and give their explicit agreement to participate in the study. Then, it asked them to fill in a first questionnaire to retrieve demographic data, cultural background, and familiarity with e-commerce platforms, and a second one about Trust in e-commerce systems and technology, from [21]. The statements

TABLE I
POST-TASK QUESTIONNAIRE RESULTS. THE BEST VALUES FOR EACH STATEMENT ARE IN BOLDFACE (MINIMUM FOR Q7, MAXIMUM FOR THE OTHER STATEMENTS). WE REPORT THE p-VALUES OF THE STATISTICALLY SIGNIFICANT RESULTS

Statement	p-value	BASELINE	SINGLE-LIST	MULTI-LIST
Q1: The user interface of the system was sufficiently informative.	0.03	3.57(1.00)	3.86(0.84)	**3.99(0.94)**
Q2: I found the user interface of the system very intuitive.	0.09	3.78(0.94)	**3.99(0.85)**	3.64(0.98)
Q3: I thought this system was easy to use.	0.08	**4.07(0.79)**	3.96(0.81)	3.74(0.92)
Q4: I found the labels that enrich the images of products with ratings about environmental sustainability and ethics useful.			**4.00(0.69)**	3.92(0.85)
Q5: The textual explanations about environmental sustainability and ethics were useful to me.			**3.79(0.92)**	3.72(1.01)
Q6: I understood the information concerning environmental sustainability and ethics.			**4.06(0.80)**	3.94(0.90)
Q7: I changed my mind several times before choosing the preferred product.		3.42(1.03)	**3.15(1.17)**	3.17(1.16)
Q8: I think I chose the product I liked the most.		**4.14(0.83)**	3.99(0.88)	3.99(0.88)
Q9: I think I chose a product that mediates between my preferences and environmental sustainability/ethics information.			3.75(0.96)	**4.00(0.84)**
Q10: It was easy to understand why some products were good and others were not.	0.001	3.54(0.98)	**4.01(0.93)**	3.97(0.82)
Q11: I felt very confident using this system to explore clothes.	0.05	3.75(0.93)	3.92(0.85)	**4.10(0.84)**
Q12: I think that I would like to frequently use this system to explore clothes.	0.06	3.49(0.92)	3.72(1.05)	**3.78(1.00)**

of these questionnaires are in the {Strongly disagree, …, Strongly agree} scale, mapped to [1, 5]. The application also asked participants to declare how important are environmental sustainability, workers' well-being, and respect for animals in choosing clothes ([1, 5]). Then, it asked users whether they wanted to inspect clothes for women or for men, and for each user interface, it presented 30 clothes, asked them to select the preferred one, and administered the post-task questionnaire of Table I. In the end, the application asked users two questions aimed at assessing the impact of data about brands' sustainability and ethical standards on their selection decisions, and awareness of these issues, in [1, 5].

Our experiment has been approved by the Ethics Committee of the University of Torino (Protocol Number: 0244699).

A. Participants' Data, Backgrounds and Opinions

77 people joined in the user study from November 15 to December 15, 2022, but we excluded 5 of them because they did not pass the attention checks. On average, the experiment lasted about 18 minutes.

The 72 participants we considered included 31 females, 39 males, 2 not-binary, and 0 not declared. Age: $\leq$ 20 (1), 21-30 (43), 31-40 (16), 41-50 (7), and 51-60 (5). Education level: middle school(3), high school (3), university (59), Ph.D. (7). Background: technical (25), scientific (16), humanities and languages (16), economics (9), and other backgrounds (6).

37 participants classified themselves as advanced computer users, 30 as average ones, and 5 as beginners. 15 people declared that they used those platforms daily or almost daily, 37 a few times in a week, 15 a few times in a month, and 5 just a few times overall. Participants moderately agreed with trusting the suggestions generated by e-commerce systems [Mean(SD): 3.50(1.01)] and moderately trusted the images of the products shown on web catalogs [3.90(0.97)]. They stated that they tend to trust a person/thing even though they have little knowledge

of it [3.53(1.20)]. They concurred that to buy clothes online, they needed to inspect item descriptions [4.00(0.93)]. They considered environmental sustainability [3.72(1.10)], workers' well-being [3.82(1.17)], and respect for animals [3.75(1.26)] as fairly important.

B. Post-task Questionnaire Results

Table I shows the results of the post-task questionnaires, for each user interface. MULTI-LIST is perceived as the most informative user interface (Q1); the second best is SINGLE-LIST. Concerning the ease to understand why some products are good and others not (Q10), SINGLE-LIST is the best one, followed by MULTI-LIST, and BASELINE is the worst one. Moreover, participants felt very confident in using MULTI-LIST (Q11) and they would like to frequently use it to explore clothes more than SINGLE-LIST and BASELINE (Q12).

SINGLE-LIST was considered the most intuitive user interface (Q2) and BASELINE the easiest to use (Q3). The other results are not statistically significant but suggest that people changed their minds more rarely when choosing a product with SINGLE-LIST (Q7). As confirmed by the log analysis described in Section V-C, this means that this user interface helps users focus their attention on the portion of the catalog that better suits their interests for sustainability and ethical standards.

We also grouped participants by their level of interest in environmental sustainability and brands' ethical standards: low interest $\leq$ 3, high interest > 3; see Table II, where we only show statistically significant results. The group with a high interest in these topics found MULTI-LIST as sufficiently informative (Q1) and would like to frequently use it to explore clothes (Q12). However, they found SINGLE-LIST as very intuitive (Q2) and the best one to distinguish good products from bad ones (Q10). Differently, the group having a low interest in sustainability and brands' ethical standards evaluated the BASELINE model as the easiest to use (Q3).

Statement	Low Interest (≤ 3)				High Interest (> 3)			
	p-value	BASELINE	SINGLE-LIST	MULTI-LIST	*p-value*	BASELINE	SINGLE-LIST	MULTI-LIST
Q1: The user interface of the system was sufficiently informative.		3.48(0.81)	**3.57(0.68)**	3.52(1.03)	0.02	3.61(1.08)	3.98(0.88)	**4.18(0.84)**
Q2: I found the user interface of the system very intuitive.		**3.67(0.73)**	**3.67(0.80)**	3.43(1.12)	0.07	3.82(1.01)	**4.12(0.84)**	3.73(0.92)
Q3: I thought this system was easy to use.	0.08	**3.81(0.81)**	3.62(0.92)	3.19(1.03)		**4.18(0.77)**	4.10(0.73)	3.96(0.77)
Q10: It was easy to understand why some products were good and others were not.		3.57(0.93)	3.52(0.93)	**3.76(0.77)**	0.0008	3.53(1.01)	**4.22(0.86)**	4.06(0.83)
Q12: I think that I would like to frequently use this system to explore clothes.		3.19(0.81)	3.19(1.17)	**3.33(1.11)**	0.06	3.61(0.94)	3.94(0.93)	**3.96(0.89)**

Indicator	BASELINE	SINGLE-LIST	MULTI-LIST	MULTI-LIST overall	MULTI-LIST workers	MULTI-LIST environment	MULTI-LIST animals
Mean number of clicks per user	**6.82(8.98)**	3.01(2.60)	3.68(4.07)	1.54(3.63)	0.74(1.10)	0.51(0.63)	0.89(1.87)
Mean rank of clicked items		**13.42(10.84)**	13.17(10.21)	13.34(10.64)	15.57(10.1)	12.73(10.26)	11.12(9.25)
Mean rank of chosen items ("choose" button)		**16.44(10.49)**	14.89(10.31)	15.59(11.63)	17.43(9.05)	16.58(9.05)	12.0(9.21)
Mean time spent on each user interface (seconds)	**236.69(20.12)**	41.94(1.93)	111.08(8.69)				
Total left scroll events	287(7.39)	475(9.12)	**711(14.20)**	259(7.99)	154(3.48)	113(2.56)	185(4.7)
Total right scroll events	**719(12.19)**	443(8.23)	616(11.92)	179(5.47)	151(3.3)	112(3.02)	174(4.04)

C. Post-test Results and Log Analysis

When answering the post-test questionnaire, participants declared that the information about environmental sustainability and ethics impacted their selection decisions [3.68(0.96)] and made them aware of these issues [3.92(0.92)].

Table III describes the most important logged events. On average, participants performed more clicks to visualize the details of clothes when using BASELINE (6.82) than with SINGLE-LIST (3.01) or MULTI-LIST (3.68). Moreover, the mean ranking of the clicked items (which describes the position of the items within the lists) is similar in SINGLE-LIST (13.42) and MULTI-LIST (13.17) and confirms that participants tended to focus on the products in the first half of the lists. We notice a similar behavior for the mean rank of chosen items: people tended to choose a product in the middle of the list both in SINGLE-LIST (16.44) and MULTI-LIST (14.89).

The mean time spent on each user interface is higher for BASELINE (236.69 seconds) than SINGLE-LIST (41.94) and MULTI-LIST (111.08). This is related to the fact that, when using BASELINE, users tended to browse the catalog more extensively and had to inspect each product to view its details. For what concerns the left and right scroll events on the product lists, when using BASELINE there was a higher number of events on the right (right: 719, left: 287). Differently, when using SINGLE-LIST and MULTI-LIST, people generated a higher number of left scroll events.

VI. Discussion

We can positively answer our research questions. *RQ1:* Participants appreciated the user interfaces that show data about the sustainability and ethical standards of the brands (Q1,

Q2). BASELINE was considered the easiest to use but the least informative user interface. *RQ2:* We learned through the log analysis that, in SINGLE-LIST and MULTI-LIST, participants tended to inspect the items in the first half of the lists and to choose a product in the middle-high of the list. This supports the hypothesis that they mediated between their preferences and the environmental sustainability and ethical standards of brands. Indeed, the results of Table I are consistent with the log and suggest that participants were mostly influenced in their choices by MULTI-LIST. *RQ3:* The post-task results show that participants felt confident using MULTI-LIST to explore clothes (Q11) and they would like to frequently use it for that purpose (Q12). However, the results concerning the support in distinguishing good products from bad ones are mixed, with a preference for SINGLE-LIST. That is, it is worth presenting multicriteria evaluations, and specifically data about environmental sustainability and ethical standards of brands, as done in SINGLE-LIST and MULTI-LIST, but the former can satisfy the largest number of users. Thus, it could be used as a default user interface in clothes catalogs, adding a widget for switching to MULTI-LIST to satisfy specific information needs.

VII. Conclusions

We found that presenting information about brands' sustainability and ethical standards in clothes catalogs supports responsible product selection. Specifically, people feel confident in the selection of items from a user interface showing different evaluation criteria (sustainability, etc.) in a synchronized multi-list that supports in-depth item comparison.

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