Item Matching Based on Collection and Processing Customer Perception of Images

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Abstract. The number of sellers and goods being sold on the e-marketplaces is growing, so the volume of data stored and processed by e-commerce information systems is increasing drastically. That is why the development of performance solutions is quite relevant. The given paper provides the approach of item matching based on the human perception of item images. The main goal of the study is to build a model for assessing the similarity of items. This paper provides a description of a software product for comparing product images collected on online trading platforms. The user evaluates the product visually. The developed software implements the crowdsourcing data collecting based on the comparator identification method. The use of this method involves an experiment in which the user is offered two images, by comparing which the determined binary reaction is obtained. The results show the perspective of the mobile client application as part of an item matching system that aims to optimize the search for products on the Internet.

Keywords: Product Matching, Crowdsourcing, Mobile Application, Customer Perception, Comparator Identification

1 Introduction

Digital transformation in all over our life is expeditiously growing nowadays. The amount of sellers and buyers via the Internet has increased for the latest years drastically. The current situation caused by Covid-19 makes new challenges for the community. Ukrainians like a lot of people in the world need to live in the circumstances of quarantine. It forces individuals to use online applications more often for purchasing goods. For some categories it is the first trial, for others, it can be commonplace. But in both cases, a problem of the huge amount of commodity propositions rises. In order to simplify the process of choosing the product for the buyer the amount of offered goods should be reduced by grouping them on similar features. In order to solve such a problem, online trading platforms provide different tools like filtering, recommendation, and so on. The issue of item matching has been already treated in our previous papers [1, 2]. In our experiments, we collected descriptions of commodities from different

trading platforms and grouped them according to similar characteristics. Those experiments showed good results partly because of the type of product. We made experiments with mobile phones and bicycles. Such commodities have a lot of clear quantitative characteristics. Concerning items that are described not so good set of attributes the images could be taken into consideration. The human perceives visual information naturally and makes decisions based on there. In this paper, we suggest using the human ability to perceive and divide visual images to collect data about item similarity.

There are a lot of researchers try to solve the item matching problem. In the paper [3] for product matching, the similarity function was proposed to compare products based on their attributes. Before applying this approach, each attribute has been categorized into a class that defines a specific similarity function that processes this attribute [3]. The process of classification is built on regular expressions. Also, a match function relied on the semantics is used for matching unstructured product offers [4]. A match function considers matches along with mismatches in attribute values between proposed commodities and distinguishes whether the attribute value is missed or mismatched. The study [5] provides an analysis of existing frameworks for entity matching and concludes all frameworks concentrate on offline matching. Analyzing existing approaches it is found out, that all of them have drawbacks and don't provide the general scheme to solve the studied task.

The image processing is also engaged for item matching [6]. Natural language text generation from commodity images is one of the issues examined by the research community. Corpus from the online market was processed by the generation model and described by humans [6]. The results of the experiment showed, that the generation model learns effectively from noisy online data. But there is a big difference in results if the type of task is the attribute-centric language generation and generic product description.

This paper represents the empirical study towards the creation of the tagged collection of item images creation in order to investigate their similarity and perception by the end-users of the e-market.

2 Our approach

The usage of the Internet and social media helps researches to collaborate and create value together. We suggest using a crowdsourcing approach in order to collect estimations of item matches. The term crowdsourcing was first used by Jeff Huff in 2006 in Wired magazine [7]. Crowdsourcing means engaging the general public, through the Internet, in research and solving public problems. Crowdsourcing presumes a process of combining individuals, paid or unpaid who are joined together with a shared interest and are able to increase results thanks to their aggregated actions. This approach can offer researchers access to new opportunities for co-creation, task optimization, and costs reduction. Concerning the study of items matching the crowdsourcing approach is the only way to obtain the data required. Due to creating the similarity model of items proposed on web sites and trading platforms the huge amount of tagged data is needed.

Analyzing a lot of up-today evaluation approaches we found out the pairwise comparison is the best way for human. Following the Theory of intelligence [8], we propose to take into consideration the feature of human intelligence and their ability to perceive images. So, according to [8], the person is called examinee in case his intelligence is being studied. In the process of examining the behaviour of human intelligence, it is important to research internal subjective state and information processing, which cause a particular way of behaviour. In order to research examinee internal state, the method of comparator identification is used [8]. The method of comparator identification is a type of indirect identification which is a mathematical description of some processes from real life. The examples of internal state are images and representations of real goods. We present the image of the product and get the perception as an assessment of the internal state.

Comparator identifies whether its input signals are in proper relation. And then the comparator reacts with a binary signal equals 1 if the relation is confirmed. The example of comparator work in human consciousness is comparing the images of goods. The method of zero instrument is a widely used approach for research the internal state of the intelligence system [8]. The key idea of the method is quite simple. Let us consider x_1 and x_2 are two images, which comparator percepts as objects y_1 and y_2. If the objects are the same, then examinee should answer "yes". It means that the perception of images of similar products is the same.

According to [8] the internal relations can be represented with a special function like predicate. The predicate of equivalence is every two-place predicate, which is reflective, symmetrical, and transitive. By analogy with the predicate of equivalence, we propose to consider the predicate of item similarity. The reflexiveness of the predicate of item similarity means that the same items correspond to the same image. The symmetry of the predicate of item similarity means that in the case of shifting the place of images the equality of items is the same. The transitiveness of the predicate of item similarity means that if the first and the second items are the same and the second and the third items are the same, then the first and the third items are also the same.

Thus, just observing the examinee we can obtain data about item similarity based on pairwise comparison of item images. That is why we need a tool to implement the method of zero instrument. Therefore, in the given work we suggest developing a special tool like a mobile application for observing the examinee and implementing a crowdsourcing approach for collecting data.

3 Image Matcher Application Design

The developed software component is and Android-mobile client, which provides end-user with the mechanism of comparing the products represented in the images. The user has the ability to compare images in pairs and indicate the similarity or difference of products offered for comparison. Before starting to compare the goods, the user should pass a questionnaire where they indicate gender and age. Proposed questionnaires are anonymous; their data are used only for the determination of correlation between the results of user data and the result of the comparison. The data provided by end-user is

collected in cloud storage and further will be used for structuring and analysis to provide an efficient search of goods through Internet trading platforms.

The main goal of the study is to build a model for assessing the similarity of items. To achieve this goal developed system should contain the client-side and server-side, where the questionnaire result would be stored. In the proposed solution, the Android application serves as a client-side, and the Firebase Cloud platform serves as a database and files storage. The examinee interacts with a user interface, passes an anonymous questionnaire and sends data about the comparison of item images. The component diagram of the proposed software presented in fig. 1.

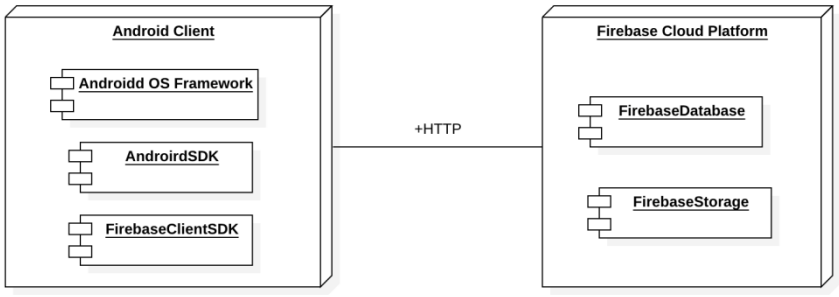

Fig. 1. Component diagram of developed software

The software emits new image files from remote file storage (Firebase Storage) each time it asks whether represented items are similar or not. The result of the comparison provided by the examinee is sent directly to Firebase Cloud node via HTTP-protocol where it would be validated and stored. Each user session has its unique ID to make data analysis more efficient by grouping data provided in the questionnaire.

The described user flow depicted in fig. 2. Each flow of the developed system is presented as independent components. Each component has its own package with a set of classes to provide the required functionality. Accordingly to MVP (Model–View–Presenter) pattern each package contains view interface, presenter class and dependencies which are necessary to implement set objectives. The system constructed as a serverless application without implementing any logic for sending, validation and storing data to storage. Instead of this, the decision was made to use a PaaS approach and integrate the Firebase platform which provided such functionalities.

The benefits of the serverless approach follow. Reduced time to market and quicker software release are present. Lower operational and development costs is needed. A smaller cost to scale – there is no need for developers to implement code to scale and administrators do not need to upgrade existing servers or add additional ones. Works with agile development allows developers to focus on code and to deliver faster. Serverless approach fits with microservices, which can be implemented as functions. It reduces the complexity of software. It simplifies packaging and deployment and requires no system administration.

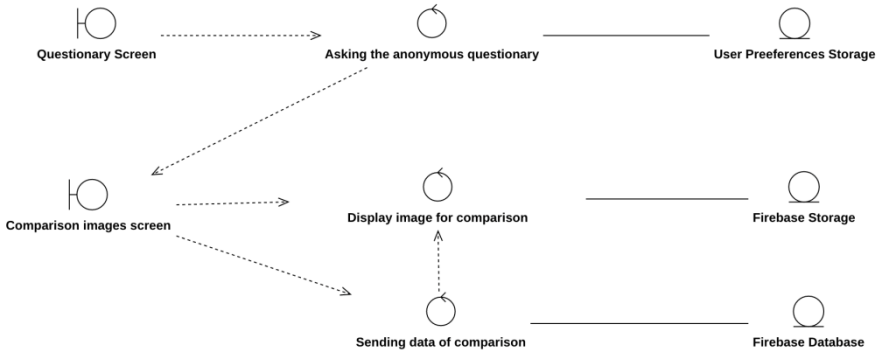

Fig. 2. User flow diagram

At the same time, “serverless” has the following drawbacks. Serverless is not efficient for long-running applications. In certain cases, using long tasks can be much more expensive than, for example, running a workload on a dedicated server or virtual machine. Also, you are depended on platform availability, and the platform’s API and costs can change. Serverless (and microservice) architectures introduce additional overhead for a function or microservice calls. There are no “local” operations; you cannot assume that two communicating functions are located on the same server. To utilize its resources more efficiently, a service provider may run the software for several different customers on the same physical server (this is also known as “multitenancy”).

Let us give a short data description. Before the user starts the comparison image of the product they should pass the questionnaire where they provide information about gender and age. To make it more efficient these fields were composed in two fields named “info”. This field is bit-mask of three bits where first bit represented user gender (“0” – Male, “1” – Female) and two bits of user age (“01” – younger 20 years, “10” – between 20 and 40 years, “11” – older 40 years). The division of respondents on such age groups is caused by the difference in their perception of information. People till 20 years mostly behave like pupils and carefully compare pictures, they try to find totally the same goods. Respondents aged 20 to 40 are often intelligent, have a job, use the internet actively. They are less careful and count similar things as the same. People aged after 40 use the internet less. The can have perception different than the active younger generation. So, the result of the questionnaire would be an integer value that contains information provided by the user. Because of using a NoSQL database, the result of the comparison is stored as a tree of nodes, where the parent node is user-session information and result of comparison represented as child-nodes. The example of stored data presented in fig. 3. The stored data can be exported as JSON file and analyzed using tools that can read and parse data in such extension.

Because of serverless architecture, it is required to create a thick mobile client that communicates with the Firebase platform using the appropriate protocol. The android application contains package modularization according to the CLEAN-architecture approach. It consists of such classes as CoroutinesUtils; Storage; MatchingModel; Domain; UserUtils and etc.

User interface is constructed accordingly to Material Design Approach. When the user starts the app they could see an introduction screen where describes the scope and aim of the current evaluation. This screen serves as a guide through the application. After reading this guide users navigate to the questionnaire. After passing the questionnaire user navigate to image comparing flow where depicted two images of items and the user determine similarity. If goods represented by the image are the same according to the user's perception they could press the button with text “Yes” and “No” otherwise.

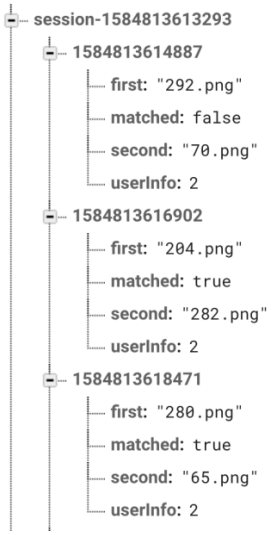

Fig. 3. Example of dataset stored in database

If the user wants to finish the comparing he could press the “Finish” button and the application would be closed. After reopening application flow of interaction begins from the guide screen. The questionnaire screen and the image comparison screen are given in fig. 4.

Therefore, the application has a user-friendly and intuitive interface. The user actions and navigation is clear and might not produce misconceptions while using the application.

4 Case Study

The case study of the given work is based on images collected from eBay trading platform (https://www.ebay.com/). The web crawler component launched on the website has gathered web pages that contain jackets being sold. Then we separate images and text descriptions. In the given study we use only images. The number of images used in the experiment is 311. All images are collected in the same format. In the given experiment we use *.png format.

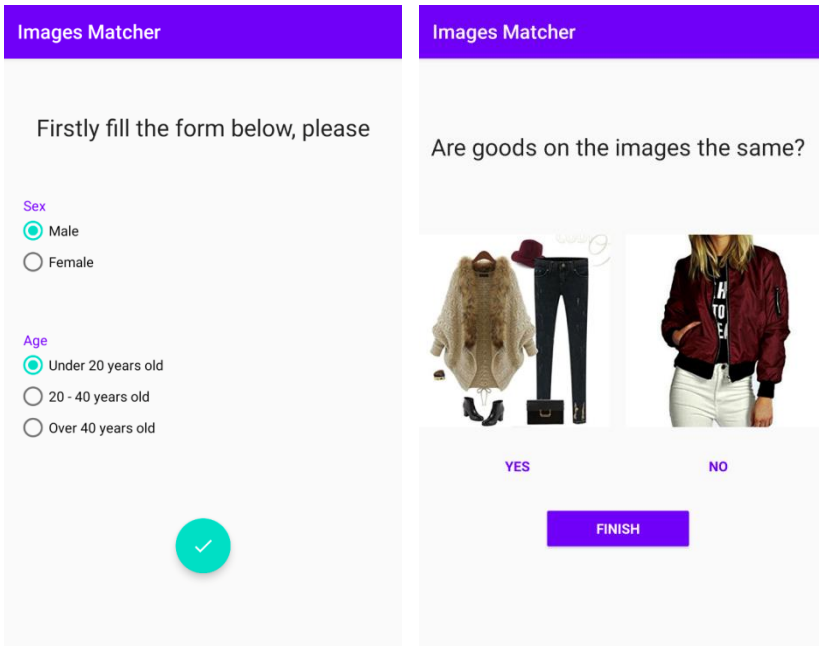

Fig. 4. Questionnaire screen and Image comparison screen

The overall description of the image data set is presented in Table 1.

Table 1. Image data representation.

Text Genre	Number of items	Number of similar items
Men jackets	174	37
Women jackets	137	29
Total	311	66

In order to test our approach and the mobile application, we ask 9 people to make the comparison based on the given data set. The figure 5 shows the distribution of the number of images that compared different categories of users as well as number of similar items they recognized.

The main purpose of the future work with the Image Matcher application is an analysis of item similarity based on its images. Caused by our plans we take values of an average number of items evaluated by each type of user and an average number of items recognized by each type of user (fig. 5) and try to analyze these values. Figure 5 shows that the “female, between 20 and 40 years” category has the highest number of evaluated items on average but “male, younger 20 years” has the most number of similar items. It can help us to future research for item matching estimation.

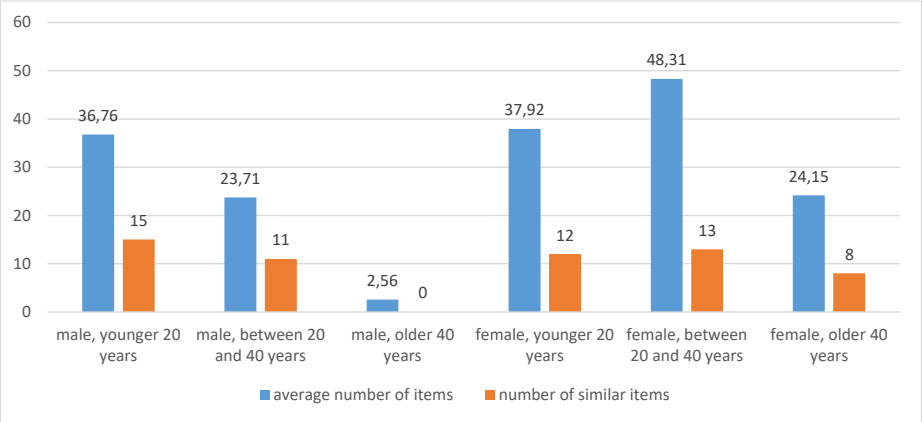

Fig. 5. Data distribution according user type

In this paper for our first time hosting we presented the results of conducted a trial run. It is too early to make any conclusions about the similarity of goods, which photos have been compared. We just proved that a proposed approach is suitable for solving such type of issue. In order to decide how many buyers should take part in the questionnaire and how to gather a representative sample, the marketing specialists should contribute. In future work, it is supposed to solve the problem of gathering and tagging a data set. After that, a link for access to this app could be distributed.

5 Discussion and Conclusion

A huge amount of electronic marketplaces are used for commercial exchange. In order to represent their products sellers usually give commodity image and textual description. Buyers in their turn look at the picture and read short descriptions. Moreover, because there is an enormous quantity of goods it is exhausting for a purchaser to look through all propositions. Using recommendation systems e-commerce platforms attempt to solve this problem. They try to single out product attributes and ask sellers to fill in. However, here arises the problem of item description normalization.

Onlooking for human behavior states that people more often firstly pay attention to pictures and then look through textual descriptions. Thus, we have worked on a data set, which could be tagged according to customer estimations. We suggest using crowdsourcing for tagging item images. The mobile application is developed for multiplying sampling. The simplicity of mobile application allows using it by a diverse people population. The application can be used just for fun and bring social benefits. An increasing amount of tagged pictures permits to investigate customer perception, which also depends on age and sex.

We intend to show the way of gathering data for estimating product offerings. As far as customers have no opportunity to touch products, the perception of a commodity depends only on image and text description. Clustering product offers into similar

groups can significantly reduce the search space and alleviate the process of choosing a commodity.

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