A visual aid on the ecological impact of products for online retail

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Abstract. We propose a browser plug-in for online retail that visualizes information regarding the ecological impact of a product to aide the user in making "greener" purchases. We document the design and implementation of such a tool, outlining also the design for a back-end recommendation engine, and report user experiments on the proposed plug-in, with favorable results.

Keywords: Eco-labels, shopping assistant, usability, ecology, browser plug-in, e-commerce

1 Introduction

The use of information technology already assists people in many of their everyday tasks, at home and at the office, helping human beings avoid errors and increase their efficiency. Shopping online is very common and more and more people prefer to shop for groceries online and have them delivered home instead of going to a supermarket themselves [9]. This opens a window of opportunity for *informing* the consumer of the products at the moment of (considering) purchase.

Interesting information could include details such as food calorie intake or the presence of allergenic agents (although the legal implications of failing such a warning make this a risky task for a service provider), and in this work we propose a prototype for providing the user of an online retail store with information regarding the *ecological impact* of the products viewed with the web browser. The goal is to guide the consumers towards environmentally friendly products and hence help them be "green" without the increased cognitive load implied in having to remember to check whether a detergent is non-toxic and if a packaging material is recyclable, for example.

The proposed browser plug-in could easily be adapted to provide dietary (calories, ingredients), financial (budget concerns, unit prices when not shown), or ethical (use of child labor) information about a product and/or its manufacturer, but we chose to begin with ecological information as the first case study due to the pressing need in developing countries to elevate the consciousness of the consumers to the importance of preserving the nature and the climate [4].

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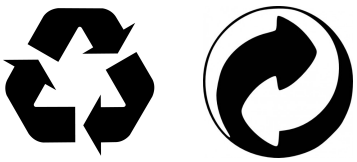


(a) Recycle. (b) Recollect.

Fig. 1: Eco-labels used to indicate characteristics of product packaging.

Whether or not a product is eco-friendly depends on its useful life (for how long will it be used before being discarded), the implied waste (packaging and remains of the product itself), the manufacturing (ingredients, energy usage, contaminants produced in the process), and also the transport of the product from the place of origin to the place of purchase (local products are likely to contaminate less during transport).

Our proposed system processes the web page displayed in a browser upon viewing a product in an online retail site, extracts information on the product to consult it with a recommendation back-end, and then visualizes the received ecological information in the browser for the user to view and consider. The rest of the paper is organized as follows: Section 2 briefly touches the background to establish terminology and context for the present work, and then Section 3 discusses related work, after which Section 4 describes the proposed solution in terms of the software involved and the functionality provided. Then in Section 5 we describe and report the experiments carried out with the implemented prototype, and finally in Section 6 we conclude the present work and discuss directions for future work.

2 Background

There are many ways to describing consumer behaviour as ecologically responsible, all implying that the purchase decisions are made considering the ecological impact of the product, its entire manufacturing process, the waste generated by the product itself, its packaging, the transport of materials, and the final product [13]. We refer to consumers with heightened awareness of these issues as *green consumers* and to the products they find appropriate as *green products* [6]. Among the main factors in determining the "greenness" of a product lies also the energy consumption and that of clean water [8].

In order to help green consumers identify green products, several organizations maintain and enforce normativity of ecological excellence of some sense, both to certify the manufacturing phase and to ensure eco-friendly characteristics of the final product. Contamination is to be avoided in obtaining and transporting the raw material, in the process of manufacturing the product, in the transport of the product to the consumer, and also in the process of consumption and the resulting waste.

The conformity to a certain ecological norm or (voluntary) regulation is often indicated by introducing an *ecological label* (eco-label for brevity) in the packaging of the product. These are commonly logotype-like figures, accompanied possibly by a brief text. A typical example is the symbol indicating that the packaging material can be recycled (c.f. Figure 1a), and also one indicating that the packaging is reusable (especially for plastic and glass bottles) is frequently used (c.f. Figure 1b). There are hundreds of eco-labels worldwide. Especially the paper industry has been active in the field; *FSC certified* by the Forest Stewardship Council, for example, indicates a proper use of the forests [11]. Another active field of eco-labels is that of the *carbon footprint*, promoted by the Carbon Trust (http://www.carbontrust.com/).

3 Related work

Published literature on consumer behavior as such is abundant in recent years. Wang [17] analyzes the relationship between consumer lifestyle and purchase decisions in order to identify green-consumer profiles among a sample of 433 persons (16 years or older), whereas Wang [16] explores the connection between lifestyle and green marketing strategies; both studies were carried out in Taiwan. Clare et al. [3] analyze factors affecting green consumption in Australia. A study of the effect of ecological beliefs on purchase decisions in Iran is presented by Hossein Khorshidi et al. [10].

The effect of consumer consciousness of ecological aspect on their purchases in practice is discussed by Pereira et al. [15], and also Juwaheer and Pudaruth [12] take a marketing approach to studying and exploiting consumption patterns to promote ecological lifestyle. The positive effect of marketing on green consumption is demonstrated by Kumar [14].

In their study, Bosch and Valor [2] found that consumers struggle to understand eco-labelling and are unable to assess the credibility of ecological information on products; only the consumers who express the most interest in ecology are unhindered in their comprehension. Also Grunert et al. [7] report a study on ecological labels, with emphasis on food products. The focus of the work proposed in the present work is making ecological information more readily available and easier to interpret for the general population of consumers, not only those that are motivated enough to inform themselves.

4 Proposed solution

The development of the software took place in four stages: planning, design, implementation, and testing [1]. The intended users were defined as adults between ages 18 and 40 with an interest in using information technology in their daily lives and who shop for groceries at least once a month. Due to the availability of an API for developing plug-ins for the Chrome browser by Google[1], we chose

[1] https://www.google.com/intl/en/chrome

to implement the prototype for that platform, and also expect the target users to be familiar with Chrome and with plug-ins in general.

The main functionality for the plug-in is the interactive visualization of ecological impact of the currently selected product. This needs to be done in a visible, but non-disruptive way that the user perceived as pleasant and informative. Technically this is achieved by *code injection*[2] to the websites of the stores to include the ecological information within the store website. Some stores block injection of code to their content, in which case we would have to access the store via a proxy, which in turn would have to be re-directed to the original site for the actual purchase. For the prototype we chose to work with sites that permitted code injection as such to avoid this issue.

Architecturally, the process is as follows:

1. Upon selecting a product, the plug-in identifies the information associated to it and creates a query from it.
2. The query is sent to a recommendation-engine back-end running on a separate web server.
3. The server processes the query to produce a response with the ecological information available, if any.
4. The plug-in adapts the styles and the sizes on the website to accommodate the response within the view of the browser.
5. The user may interact with the visualization of the plug-in to access further details.

The user is given the liberty to hide the plug-in at any time, as well as to customize the preferences regarding the type of information shown in the plug-in.

4.1 Product recognition

Upon activating a specific *division* (`<div>` in HTML5) on a web site, the plug-in processes the HTML content of that division to attempt to identify a product. The generalization of this to be automated over several websites is a machine-learning task, and we discuss here the particular case of the web store of the Soriana supermarket chain in Mexico. The divisions for showing products at the Soriana web store are all identified as `carR2`, and hence an event for the mouse-over on such a section is easily created. Within that element, the product name is placed within a `font`-directive and can be extracted with a simple HTML parser.

The design of the plug-in was done with *Bootstrap*[3] to obtain a responsive design. The back-end server is based on the *Google App Engine*[4]. The implementation with the API for Chrome plug-ins involves HTML5, JavaScript, and CSS3.

[2] A mechanism that inserts program code into a web page to modify its functionality or the way it looks.
[3] https://getbootstrap.com/
[4] https://developers.google.com/appengine/

Fig. 2: Principal elements of the plug-in.

A *content script* is used to detect when the user enters a compatible web store (such as the Soriana web site) and begins reacting to the mouse-over events while the user remains on that same site. Also the user location is retrieved[5] and the distance between the user and the place of origin of the product is computed to estimate the ecological impact of the transport involved. The plug-in is described in a file called `manifest.json`, determining its permissions and the scripts it is allowed to access whereas the libraries of Chrome are utilized in `background.js`; Figure 2 shows the principal elements of the plug-in.

On the server side in *Google App Engine*, a simple `GET` suffices to receive the query parameters. A web application written in *Python*[6] processes the resulting

[5] The geolocalization of HTML5 is used; user permission is requested explicitly.
[6] https://www.python.org/

ID	name
4644337115725824	Carranco Enchiladas Potosin...
4785074604081152	Hamburguesa Western Griller...
4925812092436480	Tyson Alitas Picantes 700 B...
5066549580791808	Soriana Hamburguesa De Res ...
5207287069147136	Older Grill Carne P/Hamburg...
5348024557502464	Soriana Pizza Indiv Queso 1...
5629499534213120	"aceite nutrioli"
5770237022568448	Older Grill Carne Para Hamb...

Fig. 3: An extract of the server-side database.

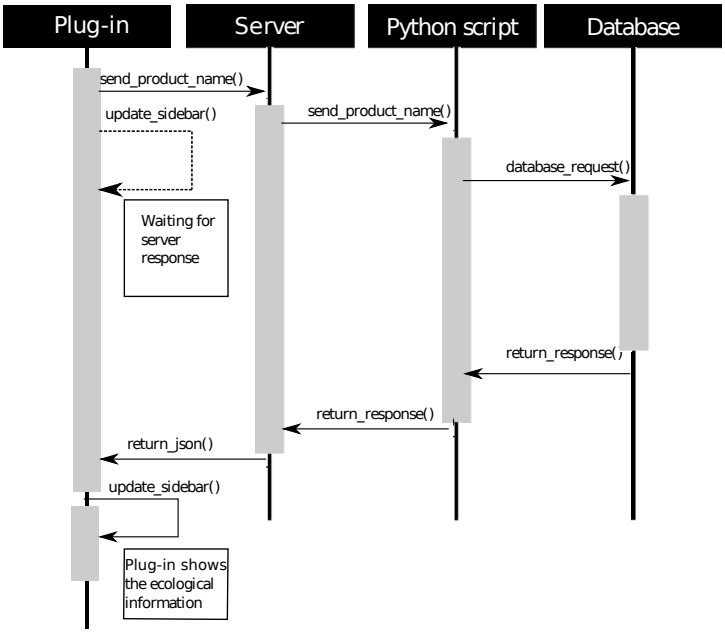


Fig. 4: Sequence diagram of the client-server communication.

HTTP request (produced in the plug-in with `AJAX`[7], checks if the product already exists in the recommendation engine (in our prototype implemented as a simple data base), inserts the product if it is not found, and uses the data stored in the database (if any) to produce a HTTP reply. Figure 3 illustrates the server-side storage, which is very simple in the present prototype, whereas Figure 4 shows the sequence with which the communication takes place. The ecological scores were artificially created on a scale to ten.

For the visual design, two alternatives were implemented: a summary view (shown in Figure 5a) and an extended view (shown in Figure 5b). The categories used for the aspects of eco-friendliness are very simple, this being a first prototype and the environmental information being locally stored. Our future work includes crawling on the web for ecological data, providing a social network for recommendation sharing, as well as information modules provided by government agencies or independent organizations.

5 Experiments

We carried out an experiment to assess whether the use of the plug-in affects the purchase decisions, i.e., whether there is some sign of an elevated ecological consciousness upon its usage. The sample consists in 24 persons between 18 and

[7] https://developer.mozilla.org/en/docs/AJAX

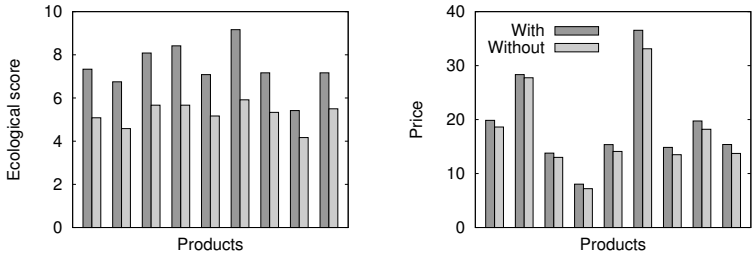
(a) Summary (pop-up). (b) Extended (sidebar).

Fig. 5: Screen shots of the plug-in used on a web store, cropped for detail.

40 years of age who have purchased something within the last month and are interested in trying out the proposed system. Each subject was provided with a list of basic products commonly acquired at a supermarket [5]. The sample was divided in two groups: one half used the Soriana website with the plug-in and the other half without it.

The task assigned to the subjects consists in purchasing products indicated on a shopping list with nine items, provided to the user. The control group uses the website only, whereas the other group employs the plug-in. The subjects are requested to select the products they would actually purchase, as honestly as possible. The plug-in stores automatically the information regarding the prices and the ecological profile of the selected products, allowing us to determine whether the users of the plug-in are in fact willing to pay more in order to select greener products. The results are shown in Figure 6.

After the website usage, those who had used the plug-in answered a questionnaire regarding their assessment of the environmental impact of their shopping habits and the usability of the plug-in on a scale from one (totally agree) to five (totally disagree). The results are shown in Table 1 and are quite favorable. The table indicates the questions posed to the users and the percentages



(a) Ecological score. (b) Price in Mexican pesos.

Fig. 6: Averages per product with and without the plug-in.

obtained for each answer option. The first set of questions were simple yes/no questions, whereas the second set was on a scale from one to five, one indicating the strongest agreement and five indicating the strongest disagreement.

Table 1: The percentage of responses per category in questionnaires.

(a) Ecological conscience.

Question	**Yes**	**No**
Do you prefer to purchase products that do not harm the environment?	75	25
When you shop, do you check if the products are reusable?	42	58
Do you feel that the plug-in helped you obtain information on the ecological impact?	83	17
Do you feel that the plug-in helped you make purchase decisions?	83	17
Do you think that the plug-in should be promoted among shoppers?	92	8

(b) Usability.

Question	**1**	**2**	**3**	**4**	**5**
The plug-in is easy to use.	75	17	0	8	0
I can easily find what I want in the plug-in.	75	17	8	0	0
I enjoy using the plug-in.	58	17	25	0	0
It is confortable to shop with the plug-in.	59	33	0	8	0
The information provided in the plug-in is relevant.	50	50	0	0	0
I would use the plug-in again in the future.	67	25	8	0	0
I would recommend the plug-in to a friend.	42	50	8	0	0
The plug-in is attractive.	59	33	0	8	0
The plug-in is simple and clear.	75	25	0	0	0

6 Conclusions

In this work we describe a prototype for providing ecological information on products while a consumer browsers an online retail store. The products are identified on the client side within a browser plug-in and then a server is consulted for information regarding the ecological impact of the product, after which the client side visualizes the received recommendation within the view of the browser. The design and implementation of the prototype is described, together with experiments that indicate a favorable effect on consumer behavior in a laboratory setting.

As future work, we leave the generalization of the present plug-in into a multi-platform tool that functions on different browsers and also on mobile devices. Also the automatization of the product recognition as well as the construction of a full-scale recommendation engine for the back-end are outside the scope of the present paper. Increasing the complexity of the system will also require more extensive usability evaluations as part of future work.

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