Report On

Cognitive Analysis of E-Commerce

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Introduction to Cognitive Neuroscience

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ABSTRACT

Neuromarketing is the application of neuroscientific techniques in the field of marketing to better understand the customers. It is being widely used by the e-commerce sites for gauging the interests of their customers and for building a better brand trust among them for increasing their sales.

In this project We propose a predictive modeling framework to understand consumer choice towards E-commerce products in terms of “likes” and “dislikes” by analyzing EEG signals.The EEG signals of volunteers with varying age and gender were recorded while they browsed through various consumer products. The stimulus comprises of various consumer products and the ground truth is made by user’s preference of the product in terms of two classes i.e. like or dislike.Further, we will pre-process this data and classify it using various methods to make suitable predictions.

1. INTRODUCTION

Neuromarketing is a commercial marketing communication field that applies neuropsychology to marketing research, studying consumers' sensorimotor, cognitive, and affective response to marketing stimuli. Neuromarketing seeks to understand the rationale behind how consumers make purchasing decisions and their responses to marketing stimuli in order to apply those learnings in the marketing realm. By using tools like functional magnetic resonance imaging scans (fMRI) and electroencephalograms (EEG), researchers can now directly see and analyze a consumer's neural activity while interacting with products or viewing ads. These tools can also capture the first impression a customer has when loading a website, and how easily they interface with a site's layout. Neuromarketing has made a big impact in the e-commerce industry. The major hurdle in the e-commerce industry is to increase their conversion rate (making more customers buy product from them). So e-commerce industries make use of neuromarketing techniques in 5 different areas to increase their customers.

1. **Branding** : Brand identity can let customers know what type of product or service to expect and can encourage engagement through positive associations. Neuromarketing techniques are applied to study the customer's responses towards a particular brand logo, and these brain wave responses are studied while designing the company logo.
2. **Product design and innovation:** Neuromarketing is also applied to developing and innovating new products or packaging designs. When it comes to design, brands need to strike a balance between novelty and familiarity. These two aspects of design are measured by focusing on two things: the type of attention a consumer gives to a

product for novelty, and the positive emotional reactions to familiarity.This fits into e-commerce by matching your product with your website's design. While your products can be novel to attract new customers or keep current customers interested, you should be able to present these in a way that maintains their trust and familiarity and won't scare them away.

3. **Advertising**: Advertising is very crucial for the e-commerce sites as the complete sales in the e-commerce depends on how well you advertise your products. Earlier, you could only measure the impact of an ad after launching the campaign and looking at the sales figures. Today, neuromarketing has made it possible to measure how well an ad campaign will perform via testing it among small groups as opposed to a public release.
4. **Customer Decision Making** : The online shopping experience is full of stimuli— colour, font weight, and typeface—all of which can be adjusted to influence customer decision making.
5. **Online Experience** : Our online experiences are greatly formed by appearance and usability. This is partly because our brains are hardwired to easily interpret visual cues; we can immediately tell if a website looks safe or easy to use.

Neuromarketing Techniques Used :

1. **Eye Tracking** : In eye tracking, you measure either the point of gaze/where your audience is looking or the motion of an eye relative to a person's head. Basically, it tracks how a person looks at something by how long they spend looking at a specific area, or the direction one looks over an item.This can be achieved through the use of wearable eye trackers that automatically collect and record relevant data.Eye tracking is used to see how customers scan the website and this helps in designing the website.
2. **Color Psychology :** Color psychology is the study of how colors affect and predict human behavior. Because sight is the most used sense in humans, color plays a significant role in influencing

purchasing decisions. For example, companies go to great lengths to test how colors can affect ads and call-to-action button.

2. LITERATURE SURVEY

As stated in the paper of “neuromarketing in e-commerce” [1], there exists a large number of differences between traditional marketing model and neuromarketing model. The traditional marketing focuses on convincing the customers with solid logical reasons. But on the other hand, neuromarketing model is based on people’s habits and their personal product experience and it does not do rational analysis of their choices. In addition, neuromarketing makes use of the fact that 90% of our buying decisions are unconscious and only 10% are conscious. The distinguishing factor between any product/service is not because of a change in the customer’s mind but because of a persuasive feeling that simulates the survival instinct the old brain to find alternative solutions. E-commerce sites use neuroscientific techniques to analyse and then design their ads in a way that easily attract consumer attention.

In another paper, “a new recommender system for 3D e-commerce: an EEG based approach” [4], the various types of recommender systems are discussed. This paper discusses a novel recommender system for e-commerce in virtual reality environments. Users’ positive emotions are captured in the form of electroencephalogram (EEG) signals while interacting with 3D virtual products prior to purchase. The prepurchase ratings are calculated from the averaged relative power of the collected EEG signals. By making proper use of both pre- and post purchase ratings, user preference can be modeled more accurately. This will improve the effectiveness of the current recommender systems.

2.1 Neuromarketing strategies - Case Studies

Furthermore, Neuromarketing makes use of familiar techniques like the EEG, fMRI and SST. Traditionally used to diagnose and treat disease, these tools are now helping tailor marketing campaigns to consumer

demand. These corporations share the same goal: “ to mine your brain so they can blow your mind with products you deeply desire”. We have analysed the applications of consumer neuroscience in the following five Fortune 500 companies:

2.1.1. Google : Uses consumer neuroscience to make Ads unskippable

In order to increase its revenue Google carried out a research test in Australia to find out if people are watching the ads on their television or not . The main aim of Google was to find out what makes an ad unskippable. So it partnered with Ipsos and its Eye-tracking partner, Objective Experience, to find out how Australian’s TV ad-viewing behaviour has evolved. They have conducted a research in which participants wore Tobii Pro eye-tracking glasses during their regular TV viewing sessions and they collected data.

Google’s Toolbar, Analytics, Adsense, Gmail, and search besides gathering petabytes of data, makes neuromarketing technology to peer inside our brains: Google and MediaVest used NeuroFocus findings to show that overlay ads appearing in YouTube videos grab consumers’ attention and boost brand awareness.

2.1.2 Apple : Uses consumer neuroscience based Ads to release dopamine

The psychology of iPhone explains the reason why the human brain can be easily convinced using Neuromarketing tactics. It makes you buy a specific product without thinking, by stimulating some parts of the brain. The ads increase production of dopamine, which leads to feelings of euphoria, self-satisfaction and well-being, and which can also lead to addiction.

Apple's neurological connectivity succeeds at satisfying all of the six major consumer value shifts - toward demand for experiences, customization, affordable luxury, continuous streams of new products/services, instantaneously and technology embedded in every aspect of our lives.

2.1.3. Ebay: Use of consumer neuroscience for personalised shopping experience

Using a strategy based on tests measuring brain activity and emotional responses, Neuromarketing industry leader NeuroFocus helped Ebay with its brand identity makeover. Further, Ebay is using EEG headsets to understand what is happening to shoppers at a neurological level during the shopping experience, by exposing them to art. Visitors wear electroencephalogram headsets to measure which artworks evoke particular neurological reactions in viewers. The EEG headset works by measuring electrical signals created by neurons in the brain. At the end of the tour of the art gallery, the results of the experience create a "personalised shopping cart based on their unique experience".

This idea stems from research that the company undertook by comparing the mindstates of people who follow others when selecting purchases against those who buy more uniquely.The result of the research suggests that people are most open to
inspiration when they remain present, focused, and calm.

Ebay even opened an emotionally powered shop in London for choosing the ideal gift options available on ebay. A person walks in a booth and put on noise cancelling earphones and then they are shown the list of ebay gift items and then their emotional response to each of the gift items is measured which help people select the best gift item.

3.MATERIALS AND METHODOLOGY

3.1 Dataset

For this dataset [3], an inexpensive setup was used to examine the brain activity using EEG signals that offers a high temporal resolution, easy handling, wireless connectivity and lower maintenance cost. The present dataset is obtained in an experiment with 25 subjects within the age group of 18-38 years, using 14 electrodes captured using Emotiv EPOC+ device. The aim is to estimate the Like/Dislike of each participant on commercial e-commerce products over 14 categories with 3 images, each displayed for 4 seconds. So, we have 42 (14×3) different product images. Thus, a total of 1050 (i.e. 42×25) EEG signals have been recorded for all participants.

3.2 Preprocessing

First of all, we iterated over text files in each directory using Python's standard utility module and parsed the EEG data into a comma separated values. Secondly, using the Pandas library, concatenated the csv files into a pandas DataFrame for data manipulation and analysis. After this, we extracted the labels from .lab files into an additional column and appended the transposed value of the column to the DataFrame for performing the supervised classification. Next, used the Scikit-learn package, an open-source Machine Learning library to split the data into training and testing data in the ratio of 80:20.

3.3 Feature Extraction

Once the data was preprocessed we implemented various feature extraction techniques. We converted the categorical variable to numerical variables using label encoder. We further scaled the dataset. Initially min max scaling technique was tried but it didn't increase the accuracy much so we implemented normalised scaling. Normalised scaling improved the accuracy of the classifier. Finally, we also implemented the standard scaler such that the data was transformed into mean 0 and standard deviation 1.

3.4 Classifiers

For performing the actual classification, we used different types of classifiers. First we started with a basic machine learning classifier like KNN, then we used a bagging classifier on top of the KNN to further improve its performance. We also tried some tree based classifiers like Decision Tree and Random Forest classifiers. Finally, we used a boosting

algorithm of Gradient Boosting classifier.

3.4.1 K-Nearest Neighbor

The k-nearest neighbors (KNN) algorithm is a simple, easy-to-implement supervised machine learning algorithm that can be used to solve both classification and regression problems. The KNN algorithm assumes that similar things exist in close proximity. In other words, similar things are near to each other.

3.4.2 Decision Tree Classifier

Decision Trees (DTs) are a non-parametric supervised learning method used for classifications and regressions. The goal is to create a model that predicts the value of a target variable by learning simple decision rules inferred from the data features.

3.4.3 Bagging Classifier

A Bagging classifier is an ensemble meta-estimator that fits base classifiers each on random subsets of the original dataset and then aggregate their individual predictions (either by voting or by averaging) to form a final prediction. Such a meta-estimator can typically be used as a way to reduce the variance of a black-box estimator (e.g., a decision tree), by introducing randomization into its construction procedure and then making an ensemble out of it.

3.4.4 Random Forest Classifier

A random forest is a meta estimator that fits a number of decision tree classifiers on various sub-samples of the dataset and uses averaging to improve the predictive accuracy and control over-fitting**.**

3.4.5 Gradient Boosting Classifier

GB builds an additive model in a forward stage-wise fashion; it allows for the optimization of arbitrary differentiable loss functions. In each stage n_classes_ regression trees are fit on the negative gradient of the binomial or multinomial deviance loss function. Binary classification is a special case where only a single regression tree is induced.

3.5 Evaluation metrics

For determining the performance of our model, we use the accuracy score from sklearn. In multilabel classification, this function computes subset accuracy: the set of labels predicted for a sample must exactly match the corresponding set of labels in y_true. In binary and multiclass classification, this function is equal to the jaccard_score function.

4. RESULTS AND DISCUSSIONS

After we performed the classification using the chosen optimal classifier, we have tabulated the accuracies obtained using the different classifiers as follows:

MODEL	ACCURACY
k-Nearest Neighbors	53.5%
Decision Tree classifier	55.9%
Bagging Classifier	62.1%
Random Forest classifier	59.8%
Gradient Boosting classifier	55.02%

Out of all the classifiers, the bagging classifier achieved the highest accuracy of 62.1% because we ran it one top of the KNN classifier which already had a high accuracy of 53.5%. Moreover, bagging classifiers are a type of ensemble classifiers which take a subset of the original dataset and then try to maximise the accuracy over each of these subsets. Hence, it ends up optimizing the performance of the base KNN classifier. Next, we have the random forest classifier which again achieves a high accuracy of 59.8% because it builds upon a number of individual decision tree

classifiers, approximately 150 separate decision tree classifiers. After this, we have the gradient boosting classifier which gives an accuracy of 55.02% mainly because it builds an additive model in a forward stage fashion.

5. FUTURE SCOPE AND CONCLUSION

The dataset contains the eeg-data as a response to various images, and based on the eeg responses we classify the customers based on whether they like the product or not. So the result can be used for analysing certain factors like the preferred colour and angle at which an image is clicked, also what products are liked by more customers. This analysis can help the e-commerce companies to decide what images of the product to depict on the site and also to design effective advertisement. There are certain limitations that we are currently facing one major limitation being the size of the dataset. For better analysis we can collect more eeg data which could provide better insights .

6. REFERENCES

[1] Yadava, M., Kumar, P., Saini, R., Roy, P. P., & Dogra, D. P. (2017). Analysis of EEG signals and its application to neuromarketing. *Multimedia Tools and Applications*, *76*(18), 19087-19111.

[2]htttps://github.com/meagmohit/EEG-Datasets

[3]https://blog.resellerclub.com/mind-games-successfully-using-neuromarketing-to-drive-sales-on-your-e-commerce-site/

[4] https://en.wikipedia.org/wiki/Neuromarketing

[5] Guo, Guibing, and Mohamed Elgendi. "A new recommender system for 3D e-commerce: An EEG based approach." *Journal of Advanced Management Science* 1.1 (2013): 61-65.

[6] https://www.neurosciencemarketing.com/blog/articles/google-neuromarketing.htm

[7]https://medium.com/@aminekh/the-psychology-of-iphone-a-neuromarketing-strategy-or-an-overdose-f76583ce6502

[8]https://www.thedrum.com/news/2017/10/06/how-ebay-has-been-reading-shoppers-brains-understand-consumer-cravings