Decision Tree Based Targeting Model of Customer Interaction with Business Page

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Abstract: Company branding through social networks is most effective if it reaches the right customers. This study explores how to improve business page targeting on Facebook by customer behavior targeting, age and gender to form a more comprehensive contextual advertising strategy. Paper focuses on empirical modeling of targeting based on decision trees. The general practice of such models developing does not take into account business goals sufficiently. To correct this, we propose to create an algorithm for customer interaction simulating with a business page on Facebook based on decision trees within the control and optimization of a company's marketing strategy. The resulting algorithm combines statistical training principles and business goals in the form of campaign income maximizing. The basic approach to the marketing strategy formation is considered, the parameters of the algorithm and the algorithm of forming the client interaction targeting with the business page on the basis of decision tree are established. Based on the above algorithm, we build a model of customer interaction targeting with a business page based on the decision tree using the data of contextual advertising campaign on Facebook. Based on the simulation results, a re-formation of the advertising campaign and analysis with the input data were performed. The results of the study confirm the value of the proposed method, since the targeting model of customer interaction with a business page based on decision trees recommends significantly more profitable target groups than a few benchmarks.

Keywords: model, targeting, algorithm, method of decision tree, R language.

1 Introduction

One of the main tasks of modern business is to attract new customers and maintain relationships with existing customers. The importance of this problem is determined by the fact that social networks have become an integral part of modern life of most people whom the business views as potential customers. Social networks have become the landscape for business and attracting new customers. This space has its own features that set it apart from the traditional market.

All social networks are distinguished type. There are networks for people finding: classmates, colleagues and other people. There are business networks for searching of job, partners, professional communication and other business matters. Some networks are video-based, some are oriented on audio and specifically music and some are photo-based. There are also specialized networks that target a specific, well-defined group of people, such as the Habrahabr network that integrates everything related to IT. Advantages of social networks are the ability to use them to establish relationships with customers and monitor them [29].

All digital marketers must have the skills to build distributed computing systems, data warehouses, and electronic document management systems based on the client's network, as well as be able to register domain names, hosting and colocation traditionally targeted at large non-governmental enterprises and companies, government agencies, small businesses.

The global cost of online advertising has caught up newspaper advertising in 2013. The figures are huge: $ 82.09 billion spent on digital advertising in the US only in 2017, and it is expected to cost more than $ 113 billion in 2020 [1]. In March 2019, the most popular social network in Ukraine was Facebook, which was used by 50% of respondents. This is confirmed by the survey data from Research & Branding Group [2].

Facebook allows companies placing audience-targeted ads in the news feed, the right column of their account, show them on the mobile app, promote videos, etc. Properly setting and selecting the target group will save your campaign budget and time for setting your campaign up, so this is an issue for nowadays business community.

This work proposes Model of Customer Interaction Targeting with Business Page based on Decision Tree. The rest of the paper has the following structure: Section 2 examines existing methods and approaches to online advertising, including the use of targeting techniques to improve it. Section 3 describes the proposed algorithm for customer targeting interaction with a business page based on a decision tree. Section 4 discusses the findings of the study and Section 5 summarizes the findings.

2 Related Work

The study [3] investigates how to enhance geographical targeting by a suite of other targeting strategies, including behavioral targeting, temporal targeting, and use of discount in an online-to-offline commerce context, to form a more comprehensive contextual targeting strategy. However, there is no specification of the obtained results in this study, in particular the targeting group is not clearly defined.

Authors [4] stay that the level of focus on consumer advertising significantly affects the idea of ordering informativity, whereas specialized online remarketing advertising have a direct adverse effect on the customer, in addition, it increases the irritation caused by targeting behavior.

In general, work [5] can be considered as a first step in studying of large-scale, fine-grained digital traces of online human behavior and how they can be used to predict people's future marketing behavior.

Attention in articles [6, 7] focus on empirical targeting models. The papers argue that the general practice of such models developing does not sufficiently take into account business goals. The results of a comprehensive empirical study confirm that it recommends significantly more profitable target groups.

The authors of [8] use content analysis to study topics and formats of 5932 Facebook posts from leading US colleges and universities. The results show that there are content topics, such as athletics, that significantly increase engagement, and others tend to be less active. In addition, format, as well as user-generated content, is another contributing factor to engagement.

The study [9] outlines the risks of using Facebook for both users and marketers. The suggested scenarios will help marketers understand how Facebook marketing uses knowledge management tools like plan-do-check-act (PDCA) and root cause analysis (RCA).

A study [10] examines the effectiveness of advertising on Instagram and Facebook in terms of advertising attitude, advertising persistence and loyalty intentions. The results show that Instagram Stories not only improves consumer attitudes towards advertising, but also increases its responsiveness compared to Facebook Wall.

The results of a study [17] revealed that attitudes towards advertising on the social network, that is, any efforts to transmit product messages between network members, who are also consumers of different products, are formed and persuaded by hedonic motivation (HM), a source of derogation (SD), self-concept (SC), messages informality (MI), and experience messages (EM).

A study [18] examines Facebook advertising, namely social influence theory and regulatory focus theory. Structural equation modeling results show that in both developed countries (Australia) and developing countries (South Africa), there are significant relationships between the considered parameters in the model (privacy, trust, advertising, advertising, attitude to advertising, promotional values, Facebook advertising attitudes, and promotional behavior).

A study [19] proved that different advertising content in Facebook leads to different levels of recruitment and involvement of users in the advertisement. Different advertisements also change the choice of advertisement in terms of demographic and mental health characteristics.

Research findings [20] have shown that Facebook advertising has had a significant impact on brand image and price, both of which contribute to increased brand sales. The authors of a study [21] examined whether customer involvement in social media brands has a bearing on brand trust, brand loyalty, and brand creation, and the results indicated that motivation to participate in SNSs significantly influences customer engagement, which in turn, has a positive effect on brand credibility, brand loyalty.

The authors of [22] confirmed that Facebook, among users of social networks, is perceived as an effective means of advertising, and it is strongly associated with the benefits of "customer relationship management" and "promotion of new products".

Article [23] investigates the impact of two adverticement placements on Facebook, a sidebar ad, and a message bar to avoid advertising. The results indicate the crucial role of product engagement in Facebook ads targeting to the right audience and choosing the right ad placement.

Article [24] defines the influence of online advertising on students' decision-making and the choice of their universities. The results revealed that social media and websites have a positive effect on student decision making, which then has a significant impact on students' choices at a particular university.

The of the study result [25] revealed the two-sided nature of community size: universities with a strong reputation tend to have more Facebook fans, but the presence of numerous Facebook fans has a detrimental effect on attracting individual fans.

Article [26] analyzes the trends of video marketing. The algorithm of video content creation is defined and the ways of video marketing using in the activity of universities are suggested, namely: creation of high quality video, video format should demonstrate social proof of quality of educational services; universities' education video services to increase conversions.

We consider the work [11] as the most relevant one, where authors developed a two-step method based on the Gaussian filter and decision tree (M-GFDT). The Gaussian filter corrects the distribution of business data in the first phase, and classifies the decision tree to remove inefficient online advertising while achieving high accuracy in predicting effective advertising. The second step provides testing of the method experimentally with data from a cross-border e-commerce company. In our opinion such approach is too complicated.

Thus, the above mentioned works, on the one hand, mostly analyze user actions in response to online advertising, such as clicks and visits to brand sites, etc. On the other hand, a number of analogs require relatively sophisticated tools for their implementation, that is, the question remains the simplification of data flows intellectual processing, their interpretation, classification in the process of formation and, accordingly, the adoption of targeted management decisions in the formation of advertising strategy of customer interaction with the business side.

3 Algorithm for Customer Engagement Targeting with a Facebook Business Page

Facebook is suitable for finding customers among the most solvent customers in age 25–50. This segment of the audience responds well to ads that they find useful to both themselves and their friends. This is manifested in the "natural" user's activity: in likes, reposts, comments. Due to this activity, the ad can gain additional reach and, conditionally, "free" customers who have seen their friend's repost or comment and also are interested.

Currently, targeted Facebook ads have great business opportunities. Artificial Intelligence analyzes user reactions to promotional content and concentrates impressions only on those users who are more likely to become your customers. Advertising

works great even with small budgets. The algorithm is fast-paced and capable of delivering clients with limited budgets.

With a quality strategy, it is possible to achieve the desired result in social networks, because, quite often, marketers work with an audience that does not know the advertised brand. Based on the recommendations [12, 13, 27, 28] it is possible to form a strategy for advertising on social networks (Fig. 1).

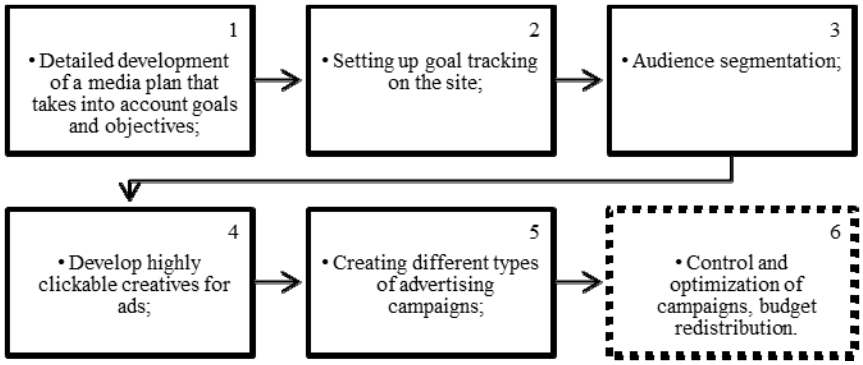

Figure 1. Step-by-step formation of advertising strategy on social networks

The last step (see Fig. 1) is worth considering in more details, as it takes a long time to process and is important for budget redistribution.

The objectives of controlling advertising include the following: analysis of the goals compliance and objectives of the advertising campaign with the goals and objectives of the company marketing strategy; Determining the difference between the planned and actual costs of the advertising campaign; determining specific results of advertising by certain time; development of measures for advertising activity improvement in future.

The control of advertising campaign results has seven stages [12, 14, 15]:

Stage 1. Conducting an audit, i.e. situational analysis.

Stage 2. Establishment of planned values and standards (goals and norms).

Stage 3. Measuring of actually achieved results for a certain period (day, week, month, quarter, year).

Stage 4. Comparison of actual values with planned and standard values.

Step 5. Analysis of the comparison results, which allows making changes in the planned values and standards or in the course of the advertising campaign.

Stage 6. Reflect on the effectiveness.

Stage 7. Ongoing project management.

The last two steps require the most time, so they will target the customer interaction with the business page based on the decision tree, and accordingly, it allows making changes in the advertising campaign.

The decision tree is a fairly common approach now to identify and visualize logical patterns in data. Dichotomous trees are used in this paper, here only two branches emerge from the top. Each node is mapped to a certain attribute, and branches to either specific values for qualitative features or a range of values for quantitative fea-

tures. The decision tree allows constructing a model of the dependence of many cases on many characteristic features.

The decision tree algorithm, first proposed by Quinlan, operates on the principle of recursively partitioning a dataset and incremental tree construction [16].

Table 1 lists the notations and descriptions used in the model tree targeting model. The table shows all the performance parameters that are displayed when targeting a Facebook ad campaign.

Table 1. Targeting options forming for customer interaction with a Facebook business page

Parameter	Value	Description
Age	**Age**	Age groups: 13-18, 18-25, 25-30, 30-35, 35-40, 40-45, 45-50, 50-55
Sex	**Sex**	female, male
r	**Results**	The number of times that an ad has reached a goal-specific result and setting.
W	**Interaction with page**	The total number of actions taken by people on a Facebook business page and posts on it as a result of viewing ads.

Let's build an algorithm for customer interaction targeting with a business page based on the decision tree (Fig. 2). The algorithm of customer interaction targeting with the business page on the basis of the decision tree will allow to reduce time-consuming and on the basis of it is possible to make changes in the advertising campaign.

For algorithm implementing the R programming language is used, which is free and has significant capabilities for statistical analysis, time series analysis, cluster analysis etc.

Initially, the data should be prepared for analysis (Block 1), with the R language requiring a database file (file with the extension "*.xlsx") (Block 2), where the model parameter values are located in the columns. Parameters are converted into data with factor values. In our case, there were parameters *Age*, *Sex* and *r*.

Next it is needed installation and running of the libraries (Unit 3) to build the model based on the decision tree.

The next step is to create control samples (Block 4). Splitting data from vector *r* into two sets in a predetermined ration, keeping the relative ratios of different labels in *r*. Also returned (Block 5) are subsets of vectors, matrices, or data frames that meet certain conditions.

In block 6, the model is constructed based on the recursive separation and regression tree. Due to the fact that the dependent parameter *r* is a factor, the construction of the model is determined by the class method. Next (Block 7) the targeting model of customer interaction with the business page is based on the decision tree, built on the breakdown of independent variables (*minbucket, minsplit, cp* (*Complexity parameter*).

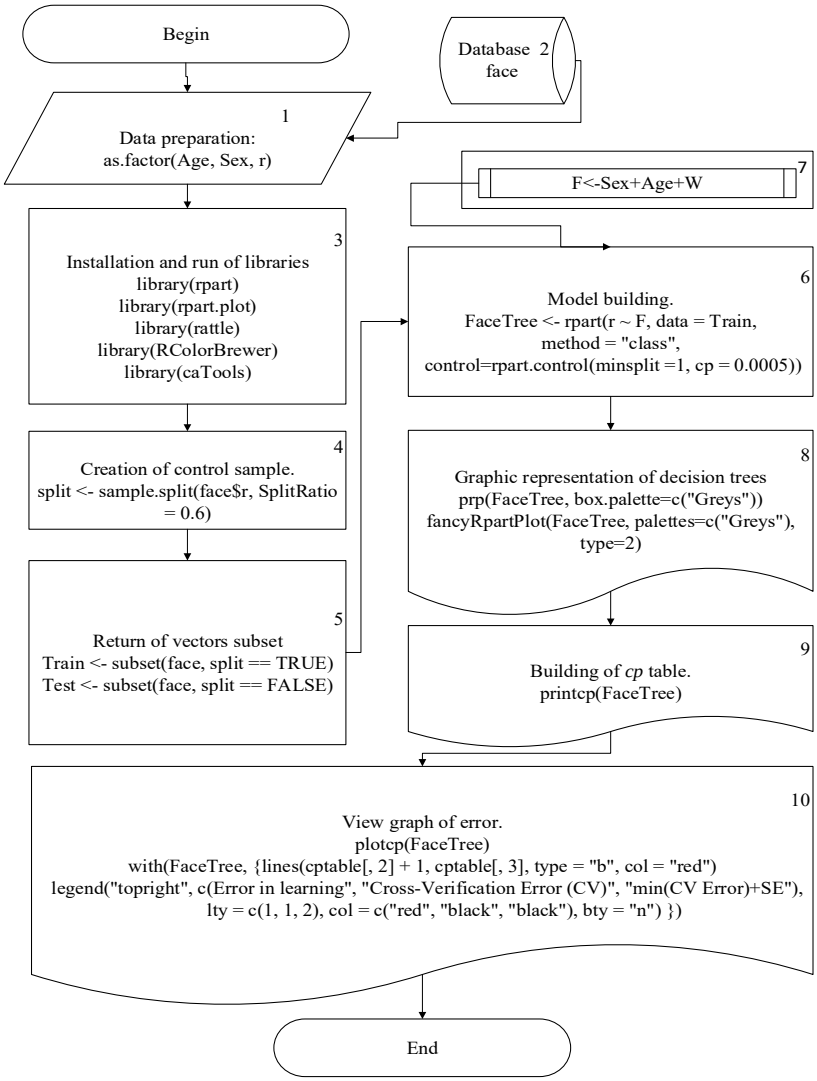

Figure 2. Algorithm for customer interaction targeting with business page based on decision tree

The graphs of the decision tree are then constructed, with the choice of the best representation (Block 8), the table of *cp* optimal segments based on the parameter of complexity (Block 9) and the graph of model error are presented.

4 Results and Discussion

Based on the above algorithm, we will build a model of targeting customer interaction with the business page based on the decision tree using data (more than 1 thousand indicators) of contextual advertising campaign on Facebook during the admission campaign, this is considered on the example of specialty “Computer Science” of Ternopil National Economic University (see Fig. 3).

Built model will reduce time spent, redistribute budget and make changes in the course of advertising campaign.

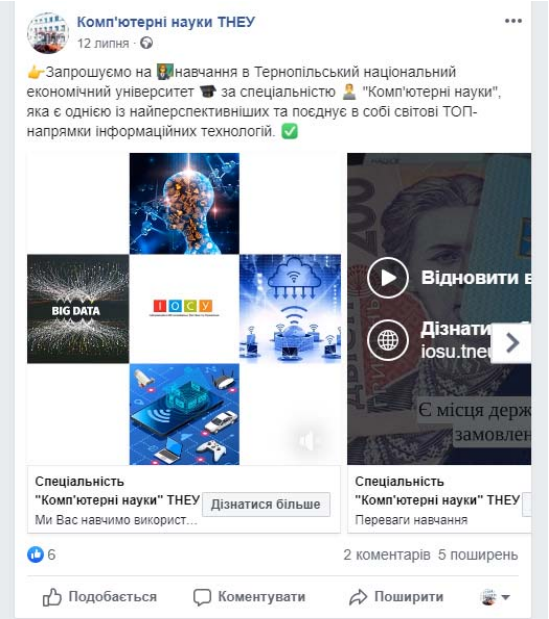

Figure 3. Advertising “Computer Science” of Ternopil National Economic University on Facebook

The targeting model of customer interaction with a business page based on a decision tree (see. Fig. 4) is usually the highest result (r) of a customer interaction with a Facebook business page “Computer Science TNEU” are for male and female in age group 40-55.

Fig. 5 shows the typical error behavior during ensemble training, the result is stabilized on the tree branch no. 5, the minimum relative error during cross-checking is $cp = 0.0021$.

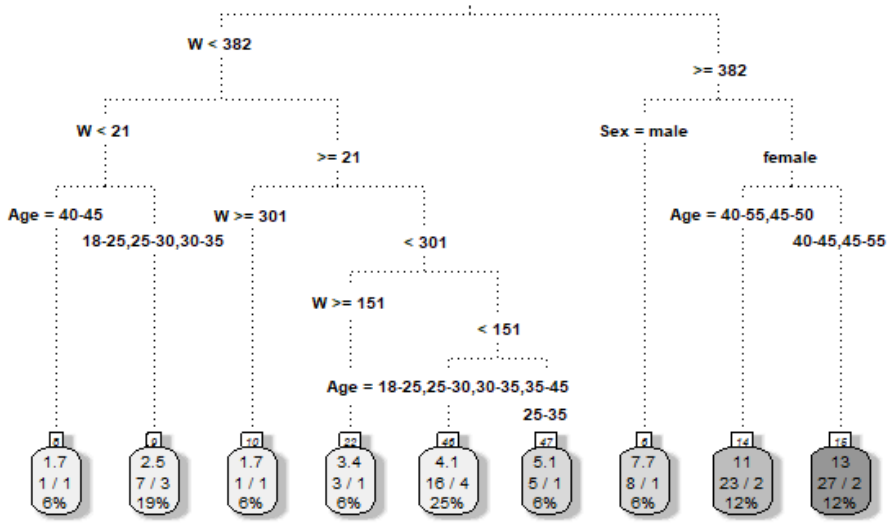

Figure 4. Targeting model of customer interaction with business page based on decision tree

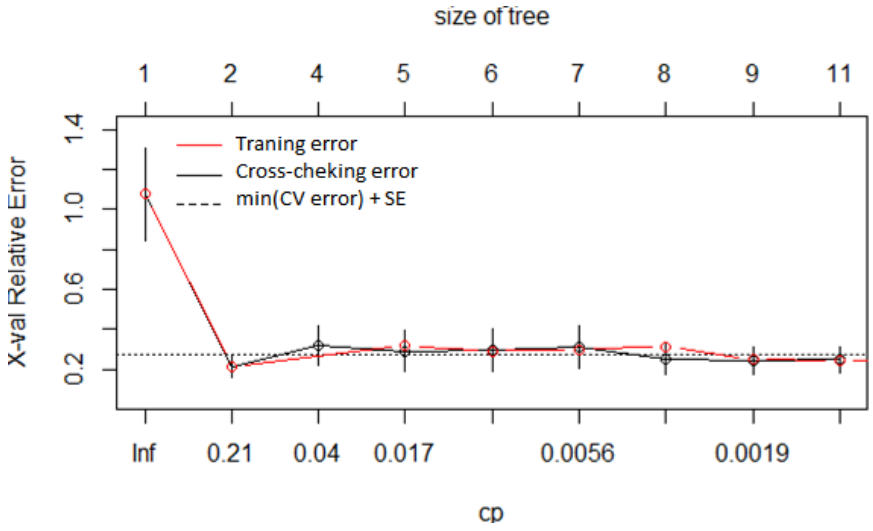

Figure 5. Errors in the targeting model for customer interaction with the business page based on the decision tree

Re-targeting results made it possible to improve advertising campaign results by 30% over first ad campaign option. The average *r* for all ad groups increased from 2.78 to 3.7. These results indicate the model adequacy.

The novelty of the work is following. In contrast to analogues [3, 11], a model of customer interaction targeting with a Facebook business page based on decision trees enables for the edges ("branches") of the tree to make changes to the advertising campaign strategy by the attributes on which the target function depends. Moreover, the

use of the rpart library in the R programming language makes it possible to clean and filter data quickly, which makes target groups forming easily comparing with [11].

The developed model of customer interaction targeting with a business page based on the decision tree has a practical importance for forming an advertising strategy of admission campaign in higher educational institutions.

5 Conclusions

The algorithm for forming the client interaction targeting with business page, based on the decision tree, is proposed. It enables to simplify the data flows intelligent processing, their interpretation, classification according to making the targeted management decisions.

Based on the algorithm, a model of customer interaction targeting with a business page based on the decision tree has built. It made it possible to evaluate the targeting of advertising campaign and form an advertising strategy of admission campaign.

According to the built model, the strategy of the advertising campaign for admission was formed as well as the basic rule was highlighted: the male and female clients in the age category 40-55 had the greatest interaction with the business page of Computer Science at Ternopil National Economic University. It enables to consider this rule to be taken into account during the advertising campaign for admission in higher educational institutions.

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