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A neuro-advertising property video recommendation system

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ABSTRACT

Many factors influence the identification of the best real estate alternatives, such as supply and demand and the social, cultural, psychological and personal factors affecting buyer behavior and the emotional state of a buyer. What are the most effective ways of choosing a property, when the selection is so vast and complex? An aid is developed here to accomplish this, based on a new advertising format, an iterative method and the *NE*uro-*A*dvertising Property Video *R*ecommendation System (NEAR). A known methodology involves behavioral operational research and the emotions involved in decision-making. Three advanced research contributions are unique to the proposed method and NEAR, in contrast to innovative behavioral operational research. Firstly, data are compiled for a neuro decision matrix, based on housing attributes and the valence, arousal, emotional state and physiological parameters of a potential real estate buyer. Secondly, the performance of a multiple criteria neuroanalysis occurs as well as the selection of the most personalized and effective video clip ad variants drawn from many alternatives. Finally, NEAR is found to present the most effective video clips ads for real estate buyers for as long a period as possible, according to Multiple Resource Theory.

1. Introduction

A founder of behavioral economics, Nobel Prize laureate Kahneman (2011) asserts that two categories describe our thinking: fast thinking (first system) and slow thinking (second system). The foundation of the first system consists of emotions, impulses and exaggerated optimism. This system does not require any great effort; it operates almost automatically. In contrast, the second thinking system is slow and analytical, and has the ability to control behavior and thoughts.

Hämäläinen et al. (2013) draw attention to the need for behavioral operational research (BOR) to support human problem-solving by modeling the practice of OR in advance. These authors show that completely opposite results can be derived depending on the way the phenomenon is described, how the questions are phrased and which graphs are used; their results suggest that OR processes are highly sensitive to various behavioral effects. A growing stream of research has examined *emotions* and decision-making based on the appraisal tendencies associated with *emotions* (So et al., 2015). Initial theories described decision making as a psychophysical process; modern approaches, however, take into account factors such as *emotion* and intuition (Chick et al., 2017).

Nobel Laureate Simon (1997) analyzes the role of *emotions* in decision-making and concludes that there is no intrinsic conflict between rationality and emotion, and that emotion can be conducive to making good decisions. Mikels et al. (2015) provide an overview of theoretical perspectives that emphasize the role of *emotion* in decision-making. Koshkaki and Solhi (2016) provide empirical evidence that negative *emotions* (fear, *anger* and shame) significantly facilitate decision making. Treur and Umair (2015) analyze *emotions* as a vehicle for rationality. They investigate rational decision-making models based on *emotion*-related valuing. People often shop when feeling sad (Rick et al., 2014). Garg and Lerner (2013) have conducted research showing that sadness influences consumption, leading individuals to pay more to acquire new goods and to eat more unhealthy food than they would otherwise.

Some researchers (Bastiaansen et al., 2016; Cash et al., 2017; Challcharoenwattana and Pharino, 2016; Gohary and Hanzaee, 2014; Qin et al., 2017; Wang et al., 2013) have also applied behavioral multiple criteria decision making in their studies.

Globally, there are developments of multimodal (Lee and Norman, 2016; Esposito et al., 2015; Poria et al., 2017; Poria et al., 2016; Dai et al., 2015; Gauba et al., 2017; Chen et al., 2016; Mehmood et al., 2016; Ringeval et al., 2015) video biometric and affective computing systems, which endeavor to analyze user emotions.

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On a daily basis, the Internet offers increasing amounts of ever more varied data and information regarding widely differing real estate objects for sale. Potential real estate buyers are highly heterogeneous, differing from one another in terms of age, sex, level of education, income, marital status, social standing, psychological state, lifestyle and emotional and cultural features, all of which influence their needs. Differences in feelings, motivations, personalities, temperaments and moods are often intertwined with the emotions of potential real estate buyers. All of these data and information frequently originate as diverse modalities with dissimilar statistical properties. The processing and analysis of all these multimodal data, along with interpretations of the emotional states of potential real estate buyers followed by the submission of information most pertinent to them, are extremely complicated; however, these are of utmost importance to the real estate and construction industries. A multiple criteria, multimodal, neuroanalysis framework must therefore be developed for this purpose. This paper aims to analyze the effectiveness of the real estate advertising process in terms of increasing interest by applying intelligent and multimodal biometric technologies. These technologies serve as the basis for developing the Neuro-Advertising Property Video Recommendation System (hereafter, NEAR). NEAR is intended to analyze the real estate objects under deliberation, the needs and emotions of potential real estate buyers and their interest in pieces of advertising. It is also intended to rationalize the advertising process, based on the best worldwide practices and the current states of the audience.

The organization of this manuscript is as follows: Sections 2 and 3, which follow this introduction, describe the NEAR method and system. Section 4 presents case studies, and concluding remarks appear in Section 5.

2. The NEAR method

2.1. Establishing the most effective video clip ads

Studies of body language suggest that in face-to-face communication, silent signals account for 60%–80% of the speaker's impact on the person spoken to, voice accounts for 20%–30%, and words account for the remaining 7%–10%. Real estate brokers can observe and analyze a viewer's emotional state during commercials (by reading facial expressions and body movements, understanding voice inflections such as tone or intonations and the like) thereby becoming more efficient in communicating with a potential real estate buyer and selecting a more rational advertising style. When it comes to interaction (feedback) with potential buyers, real estate brokers beat current neuroadvertising systems (NAS) in terms of efficiency. One main reason for this is that a real estate agent can read a buyer's body language, which is a means of effective communication that helps to better understand buyers. Focusing attention on the buyer's words and scrutiny of the buyer's gestures or movements can disclose the inner states and emotions experienced while the person is exposed to real estate ads.

The *NE*uro-*A*dvertising Property Video *R*ecommendation System (NEAR) analyzes the requirements of potential buyers for real estate (with the aim of establishing the most appropriate video advertisement and performing a multiple criteria decision analysis on housing, with the goal of selecting the most effective variant). It also recognizes, interprets, processes and analyzes the buyer's emotions and interest in video clip ads, and proposes the most effective guidelines to make these video clip ads more interesting. This analysis of ad rationality takes into account the viewer's completed Personalized Questionnaire, video clip content (the opinion analytics of video texts), valence, arousal, emotional state (the Microsoft Emotion API (the integrated Microsoft Emotion API with FaceReader 5.0) Subsystem) and physiological parameters. This allows optimization of the various permutations of the set of video clips.

As a potential buyer watches a video ad, NEAR discovers further details of that person's emotions and responses. The viewer's facial expressions are monitored while a video ad is playing. This facilitates better control over alternative video clip ads, or even allows the process to be halted altogether, if no suitable video clip ads can be found in the property video clip ads database for the respective viewer. NEAR analyzes, in real time, the buyer's feelings: anger, surprise, happiness, disgust, sadness, fear and neutrality. This analysis of the viewer's emotions helps in presenting that viewer with those video clip ads which he or she would prefer at that point.

Following this, the model for evaluating a user's interest in a specific video clip makes a real-time selection of the most effective property ad. It performs this using an integrated assessment of the viewer's completed personalized questionnaire, video clip content, valence, arousal, emotional expressions on the potential buyer's face (happy, sad, surprised, scared, disgusted or neutral) and his or her physiological parameters.

2.2. Compilation of the neuro decision matrix

One of the most important stages of a multiple criteria decision analysis involves the establishment of a system of criteria describing the alternatives, measurement units, weights and values. The video clip ads to be shown (from the Property Video Clip Ads Database) relate directly to the quantitative and qualitative data of these alternatives (Real Estate Database) comprehensively describing the alternatives under consideration. The compilation of data for the neuro decision matrix is based on the Real Estate Database and the emotional state determined for each potential buyer while reviewing alternatives. This data comprehensively describe the real estate alternatives for that buyer. NEAR captures criteria together with the information which describes them (measuring units of the criteria, values $[x_{11} - x_{tn}]$ and weights $[q_1 - q_t]$) from the Real Estate Database. It also captures criteria $X_{t+1} - X_{t+7}$ from the Microsoft Emotion API Affective Database (measuring units of the criteria $[m_{t+1} - m_{t+7}]$, values $[x_{t+1\,1} - x_{t+7\,n}]$ and weights $[q_{t+1} - q_{t+7}]$) and criterion X_{t+8} from the QA5 SDK Emotions Database (measuring unit of the criterion $[m_{t+8}]$, values $[x_{t+8\,1} - x_{t+8\,n}]$ and weight $[q_{t+8}]$). This completes the compilation of a neuro decision matrix for a specific viewing buyer (see Table 1).

The elements of a neuro decision matrix indicate solutions based on specific behavioral operational research and emotions in decision making. The neuro decision matrix is valuable in assessing a system of decision-making aspects and evaluating the comparative importance of each aspect. A multiple criteria real estate analysis problem can be characterized by a neuro decision matrix. The methods used to establish the degree of utility and priorities of the variants under comparison are calculations of criteria values and weights and the application of multiple criteria analysis for projects.

2.3. The NEAR method

The integration involved in construction of the NEAR method includes self-analysis, Maslow's hierarchy of needs theory, four multiple criteria decision analysis methods developed by the applicants, and biometric, statistical (LOGIT, KNN, MBP, Rprop), recommender, big data and text analytics methods. The purpose of this research is to develop a new method for the property video neuroadvertising field. The proposed method matches the needs of potential property buyers with the existing housing market, based on multi-variant design and multiple criteria decision analysis procedures, a criteria system and a weighted tree structure applied to the selection of the most appropriate video clip content. Even if potential buyers have only a vague idea of the kind of property they are looking for, NEAR can offer valuable assistance in finding the most fitting property by analyzing a completed Personalized Questionnaire, video clip contents, valence, and a user's arousal, emotional state and physiological parameters. Reasoning and electronic negotiations form the basis of the NEAR model for