Procedia Computer Science
Volume 66, 2015, Pages 328–335
YSC 2015. 4th International Young Scientists Conference on Computational Science

Cognitive Television Viewer Rating

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Abstract
This paper is dedicated to methods and means of creating the forecasts of Television Viewers Rating (TVR) when it is influenced by as quantitative as qualitative factors. This study's objective is to review the existing methods of calculation the TVR and define shortcomings of the traditional methods. An alternative method of TVR calculation is proposed via integration of methods and means of traditional statistical analysis, cognitive modeling and networked electronic expertise (e-expertise).

Keywords: audience, cognitive modeling, networked expertise, forecasting, television viewer rating

1 Introduction

The main source of income for Russian on-air broadcasters is still the advertising time. Its price directly depends on day parts and a program during which an advertising block is displayed (Panova E.V., 2015). The economic crisis has exacerbated the struggle for the audience that brings profits by watching advertising. More accurate forecasting of each on-air event (broadcaster's schedule) admits avoid enormous losses of revenue. On the other hand, forecasting allows finding potential audience using better parameters of starting a program (day of week, airtime, etc.).

Forecasting methods are an important research in series of analysis. Wen-Tai Hsieh and Yu-Hsuan Cheng describe method based on analysis of social networks and used of the trained artificial neural network to perform a ratings forecast for upcoming television programs (Wen-Tai Hsieh et al, 2013). Zellner and Tobias have found that data aggregation reduces quality of forecast (Zellner et al, 1999). As Breitung and Swanson as Tiao have shown that at aggregation data is lost some qualitative information (Breitung at al, 2002; Tiao, 1999). According to Meyer and Hyndman, 'the most accurate forecasts are obtained by aggregating forecasts from segment rating models, with neural networks being used to fit these models' (Meyer et al, 2006).

[*] Television index forecasting
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[‡] Solution search model

 Selection and peer-review under responsibility of the Scientific Programme Committee of YSC 2015

doi:10.1016/j.procs.2015.11.038

It should be noted nearly complete lack of papers in Russia devoted to TV rating forecast. But it could be found the description of traditional method of forecast by analytics and computer's forecasting system that are exploited at Russian advertising agency, for example Video International. In fact, computer's forecast is the same as analytics work, but it gives the opportunity to use the potential of the methods of analysis Big Data. Video International used two different algorithms of computer's forecasts and there isn't substantial difference with analytics forecast. Average forecast that combines two automatic and one 'hand' forecast showed more accurate values (Vinogradov D.N., 2005). Unfortunately similar approaches do not take into account qualitative information completely, for instance, description of special guests at prime-time shows or celebrities at new comedy series. It is one of the main shortcomings of the traditional approaches.

This study's objective is to provide an alternative method of TVR calculation that is integrated of methods and means of traditional statistical analysis, cognitive modeling and networked electronic expertise (e-expertise) The considered method takes into consideration not only quantitative factors but qualitative totally.

The structure of the paper is as follows. Firstly, the traditional methods of the TVR calculations are discussed and their shortcomings defined. Then the new method of raising the quality of TVR calculations on the base of using cognitive modeling and networked expertise (e-expertise) is described, the example that demonstrates this new technique is presented. We called this method as Cognitive TVR (CTVR).

2 Existing Methods for TVR Calculation

Definition of television rating helps to find out the statistic idea: TVR is a broadcasting event audience (Audience), expressed in % of the target group (Head, Sydney W., 1994):

$$TVR = \frac{\text{"Audience" for taget group}}{\text{The size of taget audience}} * 100, \tag{1}$$

where "Audience" of an on-air event is the average number of its target audience viewers during the whole period of the event.

There exist different methods of TV audience analysis for defining program rating and its time period. Depending on data acquisition approaches, they can be divided into 2 groups, namely:

- polling-based ones (a respondent is polled via interview, diaries, questionnaires);
- automatic ones (an interviewer is totally eliminated from polling, a respondent interacts with a special device accumulating necessary data about its behavior (Rating Assessment Technique).

TNS Gallup Media Russia (www.tns-global.ru) is an official television viewing measurer in Russia. Electronic people meters register program preferences of the network television audiences through measuring of national samples of households (Jack Z. Sissors et al, 2002). Measuring of the viewing habits of every person in Russia is absolutely impossible, but it is possible to measure a small sample of audience. Anyway, this information is only an estimate of the size of the actual TV-watching viewing audience. Since January 2011 TNS Russia uses a new technology of television audience measurement known as Audio Matching System (AMS).

AMS performs on-air monitoring and creates a base of audio patterns corresponding to a certain broadcasting channel and time. Next, the system seeks for a correspondence between collected patterns and patterns from the base. This technology improves data accuracy, measures broadcasted content (not signal source), as well as provides the feasibility of delayed viewing measurements (nowadays, technically unavailable) (Panova, 2015). All received statistic information stores at TNS

Russian database named PaloMars and using as a statistic base for forecast. This base registered TV-watching of all federal, network, most of regional and a big numbers of thematic TV-channels.

Before any television programs have been aired different program departments carry out laborious work to choose programs (sport, talk-show, etc.) from long list, to make and forecast daily/weekly/monthly program schedules, as well as to sell advertising time and calculate potential profits. A program department defines input data for forecasting: program; display time-slot; days of week; display periods (months, quarters, etc.). If necessary to get extra ratings (e.g., high-cost content must be profitable) analysts would look for a better time-slots and etc. TVR is a universal tool for support marketing tasks, air content programming (broadcaster's scheduling), as well as efficient management.

Using input information from program department media analysts make their forecasts. They use the statistical data from PaloMars that can be divided into two groups (Panova, 2015):

1. Program data: Actual data of past on-air events if a program has been broadcasted and actual data for similar program if it has not yet been broadcasted. The ratio of the ratings of a target audience and a basic group (Affinity index) shows the interests of the target group (exceeds 100%).
2. Periods data: Statistical data for a similar horizon in 1-2 past years (period and time-slot specified by a program department), characterized by the following parameters:

Share as the percentage of television viewers from a target audience who watched a certain broadcasting channel (program, time-slot). 'But the sum of the audience shares represents only those homes tuned in at a particular time and theoretically equals 100 percent, because homes that had their sets turned off are never figured in the base' (Jack Z. Sissors et al, 2002).

Total TV TVR is the rating of all broadcasting channels during an analyzed on-air event. Total TV TVR can be classified as a potential size of audience because it includes a time consideration (Jack Z. Sissors et al, 2002). This index has daily (the highest level of television viewing falls on the interval between 7 p.m. and 11 p.m.), weekly (people prefer spend time in front of TV at Friday, Saturday and Sunday) or yearly trends (Russian climate has influence on TV-watching, thereby, the biggest rating takes place in winter, especially, in January when in Russia bank holiday is 10 days, whereas the lowest rating can be observed in summer, especially, in July). Moreover, television viewing appreciably differs among demographic groups: the highest rating corresponds to All 50+ group, whereas the lowest rating is in All 4-17 and All 18-24 (young generation prefers viewing on tablets and laptops). TVR repeats trends of Total TV TVR.

Historical values of Total TV TVR and share of program (or its analog) and time-slot data are the basis for the forecast. Note that Total TV TVR estimation employs a coefficient calculated by comparing the values of last five weeks (it is enough to estimate the change in trend) and those of the similar period in the previous year. Analyst gives an estimate of share based on statistic data. Then the rating is recalculated by the formula:

$$TVR = \frac{\text{Share} * \text{Total TV TVR}}{100} = \frac{3.5 * 16.7}{100} = 0.6. \qquad (2).$$

At the same time the described method has shortcomings, namely:

- inefficient consideration of qualitative situation parameters (social and political context);
- feasibility of unstable external context development;
- information may be inaccurate and distorted;
- lack measurement of group viewing;
- lack of minority representation etc.

Furthermore traditional TVR calculations doesn't show:

- the level of watching activity;
- the main reasons of the person's interest to the program;
- the quality of the program, etc.

For reducing the above disadvantages it is useful to strengthen the known methods by the method that take into account qualitative factors that affect the preferences of viewers. It can be done by integrating the method of cognitive modeling and networked expertise, as it is shown below.

3 Cognitive forecasting on the base of expert opinions

The CTVR method of creating TV rating forecast combines the results of rating assessment based on the above-mentioned analysis of the statistical forecasting, cognitive programming (Raikov A.N. et al, 2013; Abramova N. at al, 2009) and e-expertise (Gubanov D. et al, 2014).

Cognitive modeling consists of creating a graph of factors and certain connections between the factors that support the decision making. It involves such phenomenon as: concepts, analytic hierarchy, objects, denotations, association, synonyms, antonyms, connection, influences, impulses, etc. Cognitive model is created by using e-expertise method, when the group of networked experts formulates factors and connections between them. Cognitive modeling mechanism consists of the following sequence of procedures:

- gather information;
- formulate questionnaires based on Fuzzy Scales for the experts;
- send questions to the experts;
- collect answers, create factors and connections (interference);
- build the computer cognitive model, graph of factors;
- estimate different scenarios of actions;
- formulate the decision;
- create the TV-program distributions.

Graph of the factors is represented by the nodes that designate factors and the arrows that denote relations between them. Media analysts and representatives of program, financial and legal departments are invited into a networked expert community. They bring different changes into the description of the current situation thereby improving the accuracy of forecasting.

Implementation of e-expertise activities (Gubanov D. et al, 2014; Baranyuk V.V., 2013) for information analysis, ideas generation, planning, forecasting, situation assessment and optimal decision-making requires special organizational control which can be achieved via an analysis system of expert opinions and offers rating. Such system reduces decision-making risks (generates more substantiated, rational and stable solutions) by virtue of the following techniques:

- choosing most significant offers;
- constructing participant's rating based on its individual characteristics and current activity;
- performing strictly individual generation of ideas and their collective refinement;
- guaranteeing most reliable assessment of participants' offers, etc.

The generalized scheme of functioning of CTVR system, integrated the e-expertise and cognitive modeling procedures for forecasting TVR in the case where it is influenced by a lot of qualitative factors, is illustrated by Figs. 1.

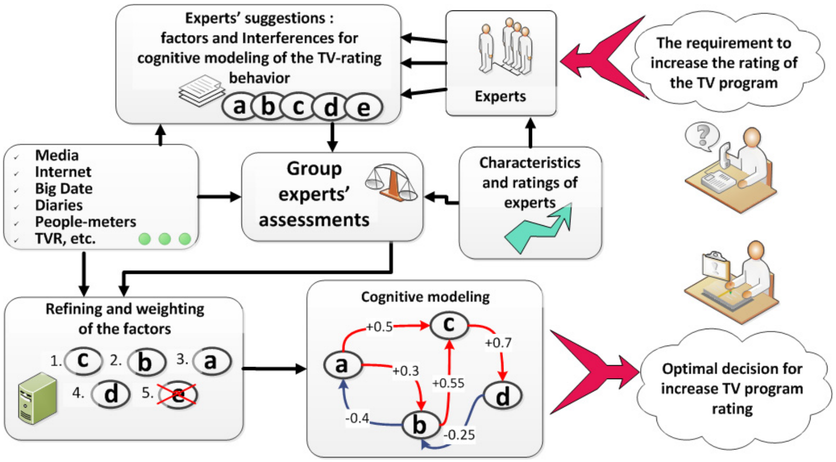

Figure 1: The conceptual scheme of the e-expertise and cognitive modeling procedure

In addition to the tools presented by Fig 1, the system admits different analytical tools for example electronic brainstorming and strategic conversations (Klimenko S. et al, 2013). The Analytic Hierarchy Process method (AHP) (Saaty T.L., 1988) can be used. AHP is the most simple and convenient method for problem structurization, alternative solutions design, associated factors identification, factor significance definition, alternatives assessment in terms of each factor, inaccuracy/contradiction revelation in judgments of decision-makers or experts, alternatives ranking, solution analysis and results substantiation. Such mixed tools could be taken into the base of the solution for a problem situation system during creating TV program schedules. Such mixed networked architecture traces all possible viewpoints and organizes their unbiased assessment ruling out the personal impact on the problem solving.

The combined usage of information analysis tools, cognitive modeling and the analysis system of expert opinions allows joint identification of all controlling factors (i.e., factors affecting the final result). CTVR method reduces the probability of incomplete picture consideration. Note that experts also enjoy access to dictionaries and dedicated databases and knowledge-bases, which facilitates information support during operation. Offers being made, experts can assess the results of solutions suggested by their colleagues. And so, the system based on analyze expert opinions and offers rating can be used to perform cognitive ranking of controlling factors, with subsequent integration or elimination of insignificant factors. Next, AHP implementation employs pairwise comparison: an expert intuitively assesses the quantitative significance of factors. For instance, a human holding two things in his hands easily defines which thing is heavier, but does not specify the exact difference in their weights. The analysis system of expert opinions and offers rating appreciably reduces the error of quantitative data assessment made by traditional statistical methods.

The e-expertise procedure conducted by CVTR implies initially individual generation of decisions, assessment of colleagues' decisions and, if necessary, further joint refinement of the results; these features serve for obtaining all necessary and high-accuracy data for subsequent forecasting of situation development.

Situation cognitive modeling within the activity of a networked expert community has to-be-conducted via conceptual knowledge structurization, opinions coordination and cognitive mapping of the situation. A cognitive map is a representation of experts knowledge about a situation, in the form of a matrix or graph. Based on the results of structural-goal analysis, scenario modeling (self-development, controlled development, control actions search) can be applied to a cognitive map.

In the case of creating TVR forecast, the cognitive model can include the following factors:

- important events (new season of series, the opening of the Olympic games, etc.);

- vacation period (for example, it’s important for audience – families with a children, etc.);
- planned changes in tariffs (for instance changes at Exchange rate);
- television viewing (day-part, week day, etc.);
- program genre and others.

Experts’ assessments are based on the statistical information from the above-mentioned database and parameter calculation by formulas (1, 2). However, a group of experts creates a cognitive model and check it with the data from Internet, media, Dig Data, etc. The technology of cognitive analysis and situation development modeling based on cognitive maps includes:

- structurization of experts' knowledge about situation in the form of primary cognitive maps;
- revelation of opportunities and threats in situation development;
- formalization of cognitive maps;
- revelation of goals and contradictions among them;
- analysis of control-goals consistency;
- analysis of interest conflicts among situation participants;
- revelation of problem situations and identification of their causes;
- choice and substantiation of goals vector;
- control vector choice for goals achievement;
- analysis of goals achievement from a current situation state;
- analysis of constraints on chosen control implementation;
- elaboration and comparison of goal achievement strategies;
- substantiation of possible situation development scenarios.

This approach involves the activity of an expert community based on semistructured information about a problem situation to design adaptive models. Owing to such models one can promptly correct problem solving strategies in TV program forecasting according to varying conditions. The resulting graph of cognitive analysis and situation development modeling could be represented as shown on the Fig. 2.

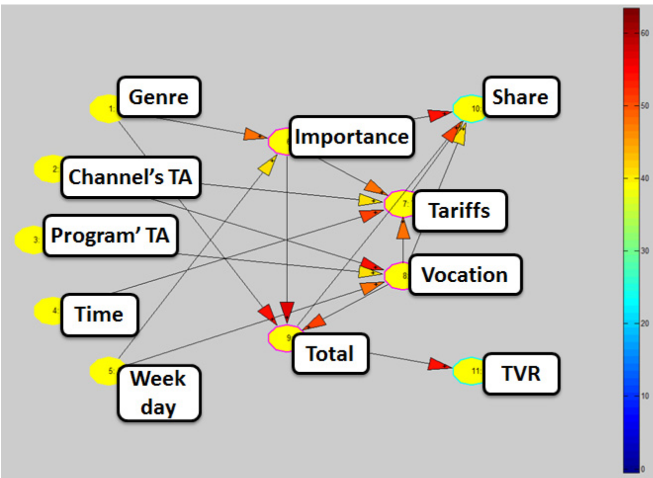

Figure 2: Cognitive model (graph) on the computer screen (TA – Television Audience)

The next step after cognitive modeling and creating cognitive graph serves for assessing the significance of factors and their mutual relations by experts for subsequent forecasting of television program rating. Next, information analysis tools (Raikov A.N. et al, 2013; Raikov A.N., 2013) are used to perform cognitive modeling which yields:

- the forecasted assessments of television program rating under the impact on "unhistorical" factors (the direct problem);
- the optimal preliminary actions for ensuring the highest rating of the program (the inverse problem).

Fig. 3 demonstrates the results of scenarios evaluation on the base of the inverse problem solving method with the genetic algorithm (Raikov A.N., at al 2013).

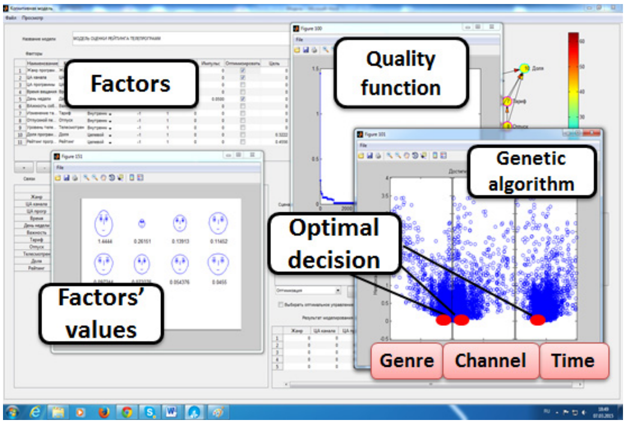

Figure 3: Scenarios evaluation on the base of the inverse problem solving method

The inverse problem solving method of CTVR allows obtaining an optimal decision for increase TV program rating.

4 Conclusion

The suggested approach with integration of existing statistical analysis, cognitive modeling and e-expertise allows verifying a forecasts obtained by traditional methods, as well as reaching a coordinated expert opinion regarding certain factors affecting forecast realizability and as a result increase TV program rating.

Nowadays, the proposed CTVR method is at the stage of checking in actual practice, complex integration and implementation of its separate components: cognitive modeling for television indices forecasting, designing an analysis system of expert opinions and offers rating calculation based on statistical data processing.

The future development of this approach authors are looking also into applying Big Data analytical methods to create and check the factors and the relationships between them for the cognitive modeling and as a result improve the quality of the TVR forecasts.

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