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USING SIMULATION TO PREDICT MARKET BEHAVIOR FOR OUTBOUND CALL CENTERS

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ABSTRACT

In the last few years, the call center industry has considerably grown especially the outbound call center area, such as telemarketing. The productivity of the call centers has significantly increased, but they still require improvements especially because of the need to adapt their operations in some countries, like the UK and the USA, in which the silent calls are strictly regulated. For this reason, electronic dialer systems, termed predictive dialers, have been developed. Several of them have achieved good performance only under some special conditions. This paper intends to show how simulation models can be used as a predictive tool to forecast the outbound call center behavior aiming to build up a predictive dialer.

1 INTRODUCTION

In the global economy one remarkable aspect of the transition towards services has been the explosion of the call center industry (Gans, Koole, and Mandelbaum 2003). A call center is defined as a centralized office used for the purpose of receiving and transmitting a large volume of requests by telephone. Managing call center operations involves administrating incoming product support or information inquiries from consumers (inbound call centers), and/or outgoing calls mostly for telemarketing purposes (outbound call centers) (Merhotra V. and J. Fama 2003); Mandelbaum, Borst, and Reiman 2004). In this paper, our focus is on the latter, and our purpose is to exploit the use of simulation models to solve problems related to their operation. Particularly, we are considering the ability to obtain the best dialing rate allowing for the trade-off between the number of abandoned calls and the occupancy of the agents (productivity rate). Abandoned or mismatch calls are generated when the dialing system (automatic or predictive) gets more live parties on call attempts than there are agents available to take those calls. This is because a dialer cannot know which proportion of its calls will connect until it has made them, so it will change its dialing rate depending on how many connections it manages to achieve. Consequently, the dialer will disconnect calls that cannot be distributed to an agent. This is known as an abandoned call. The called party only hears silence until the disconnection. This is known as a silent call or a nuisance call. In some countries like the UK and the USA the silent calls are strictly regulated. There are rules limiting the number of silent calls that a company can make within a certain time frame, with the threat of large fines for companies that abuse these systems (Samuelson 1999).

2 STATEMENT OF THE PROBLEM

In computer-based outbound telephone dialing systems the dialing process is automatically made and connects those who answer with agents or representatives, while logging other results. Managing such systems involves controlling two main variables in the following way: improving agents' productivity and reducing abandoned calls, thereby keeping nuisance calls down to acceptable levels. The former is the one that some call center managers insist on 50 minutes per hour (83% occupation) and would prefer more than 55 per hour (92% occupation). The problem is to achieve high agent occupation rates without increasing the number of abandoned calls. Simply dialing every available line all the time enhances productivity at the cost of a high level of abandoned calls. Generally speaking, call center managers want to keep abandoned calls at below five percent of completed calls.

3 PREDICTIVE DIALING PROCESS

The quest for the automation of the dialing task is not a new subject, having started in the 80's. More recently, before the predictive dialer we had the autodialer. An autodialer is an electronic device that can automatically dial telephone numbers to communicate between any two points in the telephone and mobile phone networks. While the basic autodialer merely automatically dials telephone numbers to call center agents who are idle or waiting for a call, the predictive dialer uses a variety of algorithms to predict both the availability of agents and called party answers, adjusting the calling process to the number of agents that it anticipates (or predicts) will be available when the calls it places are expected to be answered.

The predictive dialer monitors the answers to the calls it places, detecting how the calls it makes are answered. It discards unanswered calls, engaged numbers, disconnected lines, answers from fax machines, answering machines and similar automated services, and only connects calls answered by people to waiting sales representatives. Thus, it frees agents from listening to unanswered or unsuccessful calls. This can dramatically increase the time that an agent spends on communication rather than waiting. Some studies report increasing talk time from 25 to 30 minutes in the hour in the late 90's to almost 50 in the last five years. Below we list some steps describing how the predictive dialer works (Samuelson 1999; Mandelbaum, Gans, and Koole 2003; Rufus 2005):

i) At the beginning of a campaign agents will be allocated and logged. A database with hundreds and possibly thousands of records of telephone numbers that are going to be called is available. Typically this information will be held on a network server, with links to all agents.

ii) The same network server has a link to a predictive dialing engine. This may be a physical one (hard dialer) connected directly into the public switched network (PSTN), or it may be a piece of software (soft dialer), mostly located on its own dedicated server, with links to a dialing platform (e.g. an ACD).

iii) When the campaign begins and agents become available, the server and/or the dialer decide on which order to dial the numbers, and calls are then initiated either directly through the dialing platform or managed directly by the dialer itself.

iv) In case of no answer after a programmed number of seconds, the dialer will cause a hang up. It will also disconnect if sometimes devices such as answering or fax machines are reached, allocating the remaining connects through to agents.

v) The results of all calls are monitored, such as the percentage of no answers, busies and so on. It will also be measuring agent performance in terms of average talk time and variances in it. It will use such information to calculate how many trunk lines the dialer should be dialing out on. At high no answer levels, this should mean at least several trunks being dialed for each agent who is either waiting or about to finish a call.

vi) This clearly keeps waiting times between calls for agents down. But, on the other hand, if not controlled, it will also lead to lots of abandoned calls. The role of the dialer's predictive algorithms is therefore to achieve low wait times, while keeping abandoned calls down to acceptable levels.

4 SIMULATION MODEL

The first question here is why a simulation model should be used to predict market behavior and to guide the dialer engine connected to the outbound call center. The circumstances in which predictive dialers operate are very dynamic, non-deterministic and with a high number of stochastic variables to deal with. In such a world the use of mathematical (analytical) models to define the best dialing rate will not work well. These models simply cannot capture the huge variety of conditions on outbound campaigns. There is no steady state, and there is little useful guidance available from similar previous experience, even in a given system, on consecutive days of the same campaign. On the other hand, simulation models can deal with as many details as we need to capture system behavior, including all kinds of stochastic variables (Anisimov, Kishinski, and Miloslavski 1999; Avramidis and L'Ecuyer 2005; Buist and L'Ecuyer 2005).

An outbound call center operation is an exceptionally lively environment with a variety of events mainly concerning the types of call request, types of obtained answer, and dynamics of agents' availability, all of this under external conditions of market behavior that fluctuates with time (Anisimov, Kishinski, and Miloslavski 1999; Brown, Gans, Mandelbaum, Sakov, Shen, Zeltyn, and Zhao 2005). The predictive dialer should capture all data from the events to simulate the behavior of the environment. Data are captured, analyzed and classified in classes or groups of variables allowing the model to simulate the agents' actions and all time activities, such as dialing times, ring times, talking times, etc. (Medeiros, Dum, and Robbins 2006). Figure 1 shows a block diagram of this process.

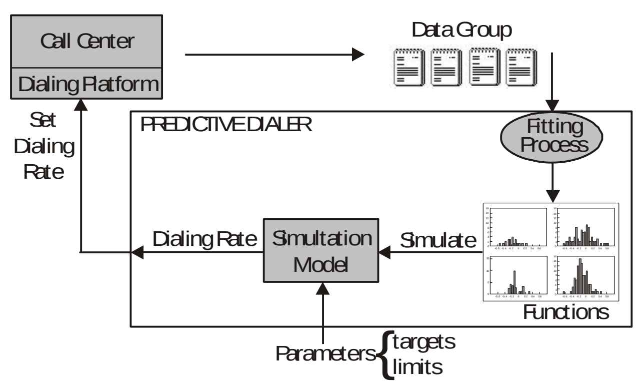

Figure 1: Block diagram of the fitting process of the predictive dialer.

The core of our scheme for solving this problem is a real-time simulation model that works in parallel with the computer-based dialer. Figure 2 shows a system time diagram indicating the process interaction between the simulation model (within the predictive dialer) and dialer system.

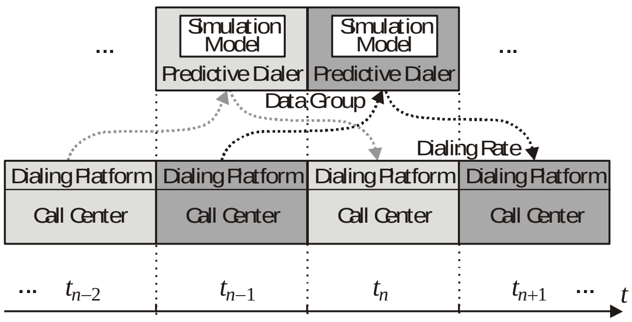

Figure 2: Time diagram of process interaction between the simulation model and dialer system.

At time t_n the simulation model receives data from the system (data group) related to time t_{n-1}. A fitting module, applying a chi-square method, fits the main stochastic variables and estimates the behavior of the market in the near future. Based on this preview, a dialing rate for the next time window t_{n+1} is determined and returned to the dialing system. The interval between each simulated estimate varies according to the external conditions. The simulation model reads and captures market behavior considering variables such as the number of active (logged) agents, percentage of abandoned calls, percentage of live calls (calls answered by a person), average talk time, number of rings until answer, among others.

Each data group of stochastic variables is sent to a fitting process before entering the simulation model itself. The best fitted function for the stochastic variables are used in each simulation. The fitting decision process aiming to choose the best function for a given data group is based on two criteria: first, the highest *p-value* is considered and, secondly, if necessary, the minimum square error of all fitted distributions is taken into account. Once the best fitted function for a variable is obtained it is addressed to the corresponding module in the simulation model for data creation purposes.

The optimization of the main variable (dialing rate) is performed after many scenarios are simulated in advance. At the end of this simulation process, an acceptable dialing rate is obtained considering the scenario whose abandoned call rate and the agents' occupancy rate are within pre-established limits.

The simulation model of Figure 1 is detailed in Figure 3.

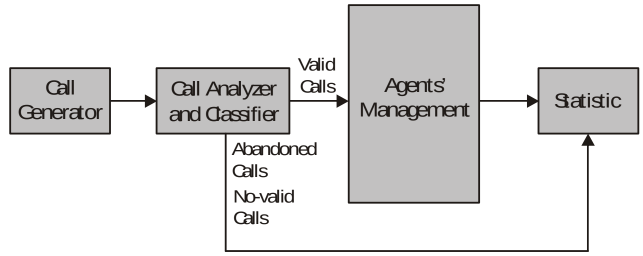

Figure 3: Block diagram of the simulation model of the predictive dialer.

5 EXPERIMENTAL DESIGN

In order to build, validate and calibrate the simulation model we have developed an experimental design to assess the model parameters considering their influence over the two main performance evaluation criteria of the system, i.e., the rate of abandoned calls and agents' occupancy rate.

To apply the design of experiment (DoE) technique we start listing a number of model parameters which we believe that could influence the performance of the simulation model to preview the market behavior. When working with real-time simulation models, not only the results should be correct but also the time to reach them is a very important characteristic. Our aim here is to understand which model parameters are dependent on the response variables (performance metrics) as well as to find the best values for them.

After a previous round of investigation we discard some of the less important parameters. At the end of such an analysis, we decide to assess the influence of five main parameters (factors) in two different DoE, one for each of the performance metrics. The selected factors are listed in Table 1.

Table 1: Selected parameters for the DoE

Parameter	**Description**
TIBS	Time interval between simulations
FTWSP	Future time window simulation period
DRSF	Dialing rate smoothing factor
Warm-up	Warming-up simulation period
DGFS	Data group size used in the fitting process

In the following, more details of the parameters included in Table 1 are considered:

a) TIBS is the time interval between simulations. If this value is too small, the simulation process is very recurrent and its performance could be poor. On the other hand, if the TIBS is too large, the dialing rate refreshing could not be adequate for fast changes in market behavior. Usual values of TIBS are between 15 and 30 seconds.
b) FTWSP is the future time window simulation period. It determines how many data from the

recent past are used to predict the model parameters. Its value is given in percentage. If FTWSP is 100% all data used are new. Values of FTWSP between 80% and 90% are usual. In this case, we use between 20% and 10% of data from the previous used data group.

c) DRSF is the dialing rate smoothing factor. It is applied to smooth the initial value of the dialing rate. Values of 0.8 or 0.9 are suggested.

d) Warm-up is the estimated simulation time in which the system model is considered in steady state. Usual values for this parameter are between 20 and 30 minutes of simulation.

e) DGFS is the data group size used in the fitting process. It is the minimum data quantity needed for the fitting process. Usual values are between 200 and 400 samples.

The obtained results in both DoE show that the parameters dialing rate smoothing factor (DRSF) and time interval between simulations (TIBS) have the major impact on the response variables. The first one is responsible for 55 % of observed variation in the simulation results in the abandon rate and 33 % of variation in the occupation rate. The second one is responsible for 36 % of variation in the occupation rate and 8 % of variation in the abandon rate. The remaining studied factors demonstrated a low influence over the simulation results. Table 2 shows a summary of the obtained results.

Table 2: Variation of the performance metrics

Parameters (factors)	Occupation Rate	Abandon Rate
TIBS	36%	8%
DRSF	33%	55%
Remaining factors	31%	37%

Since the most important parameters are found, it is possible to create a fine tuning investigation looking for their best values in order to achieve a better dialing rate. After this investigation we have the simulation model calibrated and ready to be used in a real scenario.

6 EXPERIMENTAL RESULTS

Aiming to test the potential of the predictive dialer and in particular the simulation model within it, we have two ways: the first one is to connect the model directly to the call center, receiving all needed data from it to perform the simulation, the second one is connect the model to a program that reads a log generated by the operation of the call center itself. These logs contains all chronological data associated with the events occurred during a real campaign. For system security reasons we choose the second alternative.

The performance of the predictive dialer has been tested in several different scenarios because each data log represents daily operations of the real call center in different outbound campaigns. Also for each test we have compared the performance of our predictive dialer against a commercial predictive dialer used by the call center in which the logs were acquired.

All obtained results show a compatible operation between our predictive dialer and the commercial one, considering the imposed limits and targets for the performance metrics. Table 3 presents the intervals where the achieved outcomes are positioned.

Table 3: Obtained results for the predictive dialer

Metrics	Outcome Intervals
Occupation Rate	85%–92%
Abandon Rate	3%–5%

7 CONCLUDING REMARKS

The great challenge of predictive dialers is to provide in advance a number of outgoing calls considering the imposed limits and targets for the performance metrics, i.e., occupation and abandon rates. Some systems reach such objectives but only under specific conditions. The use of a simulation model to overcome this problem type brings out several advantages as compared with other methods, such as analytical or statistical models. The most important benefit is its quick adjustment to the very volatile behavior of outbound call center conditions as well as the variations of the system operation itself. This sort of adaptation is not present in dialer systems supported by analytical or statistical models. When dealing with situations of a high variability, these dialers offer dialing rates that oscillate either above or bellow the ideal rate for long periods. During this time the performance metrics also vary, leading to a poor performance.

The simulation model captures the behavior of the call center by acquiring and fitting data for all stochastic variables. After optimizing how frequently and for how long the simulation model must run, the best adapted dialing rate is obtained and provided to the predictive dialer. This combination leads us to very acceptable results for the performance metrics during the entire campaign period as we could confirm with all experimental tests made.

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