A call scheduling framework for telephone surveys

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# Introduction

Because of the decline in CATI response rates, development of efficient data collection strategies are critical for NSIs and other institutions, which utilize CATI for data collection. At Statistics Sweden, joint work between methodology, IT, and data collection departments have led to the recent development of several new features in the CATI data collection system WinDati. In the present work, we introduce the concept of process groups, which facilitates different contact strategies for groups of sample persons. We also introduce a call scheduling strategy aimed at increasing the contact rate by choosing the times to call a sample person in an informed way.

Previously, WinDati used the same overall contact strategy for all sample persons. Hence, sample persons with different prerequisites, e.g., from different rotational groups in panel surveys, were treated similarly. Process groups may differentiate between groups of sample persons. The partitioning into groups is based on the idea that individuals may require different processing or combination of efforts during field work to achieve a successful result, i.e. an interview. Individual characteristics from registers are used, and in panel surveys this may be combined with results from previous waves.

Call scheduling strategies commonly include the time to call respondents, where the best times to call come from some rules or guidelines, often derived with or assisted by statistical models. For a model to be useful in this context, it is important that it makes use of available information on sampled individuals. This includes background variables as well as paradata from the survey process. Currently, WinDati randomly selects sample persons for contact attempts during certain stages of the data collection. Thus, the times of contact for such sample persons are also chosen randomly. We present a call scheduling model aimed at increasing the contact rate in telephone surveys at Statistics Sweden, which will replace the random assignment of sample persons, i.e. call times, in WinDati.

# Process groups

As resources for field work are limited, Statistics Sweden generally base data collection strategies in telephone surveys on a “return-of-investment” principle. In practice, this means that we put more effort into cases with a higher probability of response. In panel surveys, such as the LFS, these strategies are mainly based on the sample persons’ response history, i.e. result in previous waves. This type of strategy has so far not been supported by WinDati. To remedy this, the concept of process groups has been introduced into case management to facilitate differential strategies for different groups. This allows for a more flexible approach, where strategy and length of field work phases are set up for each group separately. Explicit definition of groups in WinDati also makes it possible to prioritize cases prior to field work, thus increasing control of the use of interviewer resources. WinDati parameters, such as the total number of call attempts, are also set at group level.

# Call scheduling model

## Data

We use paradata from the LFS data collection at Statistics Sweden from May 2016 to January 2019. Data consist of times of contact attempts and the results of these contact attempts. The LFS is a rotating panel survey with eight panels and we use data from the first rotational group only, i.e. sample persons that participate in the survey for the first time. Hence, there is no previous information on preferred contact times for these sample persons. Only contact attempts with randomly chosen times of contact are considered. In the LFS, four time slots are available for contact attempts: 8:00-12:00, 12:00-17:00, 17:00-19:00, and 19:00-21:00. These are denoted time slots 1-4.

We want to use background variables from registers to explain the response propensity of sample persons. Register variables come from the total population register, the register of level of education, and the register of income and taxation. Variable values for sample persons come from the registry version dated nearest to an event. In case there is a missing value in the first considered version of the register, we use the next nearest dated registry version and so on.

## Predictive model

We use paradata from previous contact attempts and background variables for sample persons to train a model to predict contact probabilities in each of the four time slots for each sample person. Because we cannot expect that the available background variables can fully explain the variation in contact probabilities between sample persons, the effect of sample person will be included in the model. In most cases, there are several observations in paradata for each sample person. However, the number of observations may be small for some sample persons. Consequently, it is better to include the effect of sample person as a random effect in the model because it implies the use of pooled variance estimator. The effects of background variables are systematic to allow for comparisons.

We propose a mixed effects logistic regression model with a random sample person effect and systematic effects for background variables, which models the probability of successful contact in a contact attempt. The response variable indicates whether a contact attempt was successful or not. The model is inspired by [1]. An important difference compared to the model in [1] is that we consider individual level variables. We fit the model for each time slot separately and for each sample person derive an order of priority of the time slots from the predicted contact probabilities from the four models. The time slot with the highest predicted contact probability gets the highest priority.

## Markov model

WinDati assigns an order of priority of the four time slots to each sample person every day when data collection takes place. The order of priority decides when to call, i.e. the time slot with the highest priority is the primary choice, and the time slot with the second highest priority is the next choice and so on. The order of priority from the predictive model serves as a starting value in WinDati. It is however of interest to modify the initial order of priority according to the results of unsuccessful contact attempts in the survey round. To this end, we suggest a mechanistic Markov model with state space given by the set of possible orders of priority. Model parameters regulates the influence of the initial prediction and unsuccessful contact attempts on the selection of the current order of priority.

# Results

Because of the complex structure of the data collection system and of the proposed call scheduling model, evaluation by using paradata as test data only is difficult. Ideally, we would evaluate the model in an experiment in which we compare different ways of selecting times of contact. Because of the implementation of WinDati, it is however difficult to perform such an experiment. Rather, we have to rely on evaluation of results from the implemented system only and compare to previous results. The new case management paired with the new model for call scheduling has been implemented in several surveys for limited time periods. In parts of the LFS surveys for March and September 2020, several different setups were tested. Comparison of these will guide future implementations and further development of the model.

# discussion

The development of the call scheduling methodology is an ongoing process involving several parts of the organisation. The evaluation of model results is challenging and typically subject to bias from external factors influencing the data collection. However, the data-driven flexible framework introduced here provides a solid foundation for further development and repeated evaluation of the data collection process. We expect that coming extensions and adjustments to the call scheduling framework may further improve the data collection.

The proposed call scheduling model has several possibilities for future development, for example:

* Introduce additional flexibility with respect to the number of time slots and time intervals.
* Expand the usage of the model to different surveys. This includes more flexible time slots, but also using paradata from multiple surveys for training.
* Adapt the model for use in surveys with recurring sample persons. For example, we may include previous answers and call histories in both the logistic regression model and the Markov model.

There are a few options for general development of the model. We could extend the logistic regression model in the same way as in [1]. Another possibility is to develop the model in line with the call scheduling strategy presented in [2]. In a similar fashion, the framework of reinforcement learning (e.g., [3]), which is also governed by Markov decision processes, could be of interest.

# References

[1] Wagner, J. (2013). Adaptive Contact Strategies in Telephone and Face-to-Face Surveys. Survey Research Methods, Vol. 7, No. 1, pp. 45-55.

[2] Greenberg, B. S., & Stokes, S. L. (1990). Developing an Optimal Call Scheduling Strategy for a Telephone Survey. Journal of Official Statistics, Vol. 6, No. 4, pp. 421-435.

[3] Sutton, R. S. (2018). Reinforcement Learning: An Introduction. Cambridge, MA: MIT Press.