VIRTUAL ENVIRONMENTS FOR TEACHING QUALITATIVE RESEARCH METHODS

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Qualitative methods are often underrepresented in introductory statistics courses at the undergraduate level, particularly in large classes where the logistics of providing authentic experiences in qualitative data collection are challenging. To address this gap, we have extended an existing virtual environment that enables quantitative studies with human subjects to include a prototype interview system. We will give an overview of this system and our current methodology for simulating qualitative data, and then present examples of student project work carried out using the environment. These examples show the limitations of this prototype in capturing the richness of qualitative research but also the potential of the approach as the underlying technology of conversational agents improves.

BACKGROUND

Introductory statistics courses at the undergraduate level tend to focus on quantitative data analysis, even though qualitative research is increasingly important in many disciplines. There is an opportunity in these statistics courses to better expose students to different types of research data and to include mixed-method approaches in the curriculum (Ograjenšek & Gal, 2011). However, implementing qualitative research projects is impractical in large classes since the data collection typically requires a substantial investment of time and can involve difficult ethical questions (Hay, 2010). To help manage these issues, we propose extending an existing virtual environment to enable students to more efficiently engage with qualitative data collection and analysis.

The *Island* provides an online population of virtual human subjects for use in student research projects to help motivate the need for statistical analysis and provide a context for learning the associated skills (Bulmer & Haladyn, 2011). The focus of the original Island has mostly been on experimental trials, particularly around measuring the physiological effects of treatments, though there is some scope for observational studies. In 2015 we developed a new version of the software, the *Islands*, which builds in a stronger focus on social characteristics. This includes additional models for education, employment and wealth, as well as explicit social networks among the inhabitants, and expands the population to around 40,000 individuals. It also includes a more detailed framework for the surrounding environment, such as habitat and climate zones, with substantial differences between the three islands in the simulation.

This richer framework has enabled the development of a prototype system for students to conduct interviews with the population of virtual research subjects in the Islands. In this paper we will give an overview of how we approached simulating the responses for these interviews and how they were implemented within the virtual environment. We then illustrate this prototype with a case study based around environmental attitudes, including an example of a student research project carried out using the system.

SIMULATING QUALITATIVE DATA

For working with qualitative data, a content analysis would often use a coding scheme to classify a variety of responses by a single code, capturing a common theme. For simulating qualitative data, we essentially want to reverse this process by generating a variety of responses for a given code. By analogy, a common approach to simulating quantitative data is to generate values from a distribution where the mean is a parameter based on the factor of interest, and possibly on other variables, while the variance adds some individual uncertainty to the observations. For simulating qualitative data, the respondent's code will similarly reflect the assigned factor in the topic of interest, along with other latent variables. We add uncertainty by randomly choosing from a range of possible responses for the same code, while also modifying for other factors such as how the interview is proceeding (see Doyle & Bulmer, 2017) and recent events (such as the respondent consuming alcohol). This approach is summarized in Figure 1.

In M. A. Sorto, A. White, & L. Guyot (Eds.), *Looking back, looking forward. Proceedings of the Tenth International Conference on Teaching Statistics (ICOTS10, July, 2018), Kyoto, Japan.* Voorburg, The Netherlands: International Statistical Institute. iase-web.org

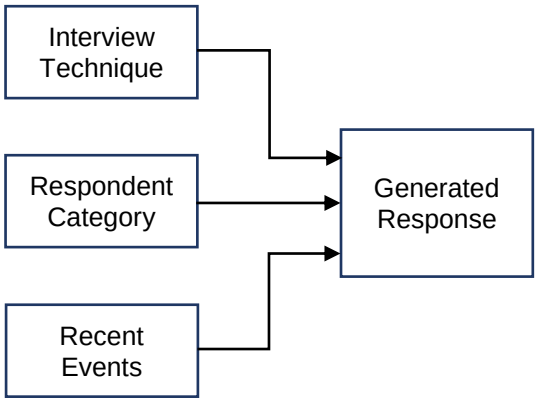


Figure 1. A model for simulating interview responses (adapted from Doyle & Bulmer, 2017)

To implement and test this simulation approach, we enabled interviews to be conducted on the Islands by adding a *chatbot* interface for each Islander. This tool was based on code for the popular *Program-O* chatbot (Perreau, 2013) and used the classic *Alicebot* set (Wallace, 2011) of AIML (Artificial Intelligence Markup Language) patterns and responses. The AIML content is processed recursively, allowing the Islanders to 'understand' a wide range of English expressions and hold simple conversations. For some of the patterns in the Alicebot set ('How old are you?', 'What is your favourite colour?', etc.) we already had data or models in the Islands that would provide these results and so we were able to directly replace existing AIML responses with dynamic code linked to each Islander. Finally, we added new patterns to the AIML set to match questions related to the qualitative research, generating responses using the method described above.

Note that the chatbot can record simple state information during a conversation and we used this to maintain a 'rapport' score for how the interview is going. Interviewers who greet their participants and use polite questions may increase the rapport score, often making the participants give more verbose answers. Interviewers who have a less polite tone may instead get less useful responses.

CASE STUDY

Our initial scenario was intended for statistics students in an environmental management program and was based on a 2009 study in the Australian state of New South Wales which investigated "how people … feel about the environment and how they are responding to environmental issues." A core component of this study was the segmentation of participants into three categories based on their responses to a questionnaire:

> *The behaviours used to identify the segments were household-based behaviours (e.g. reducing water and electricity use and household food waste, re-using things, avoiding heavily packaged products) and citizenship behaviours (e.g. participating in local development issues, or in Landcare or Bushcare). The behaviour segments are the Committeds (high on both household-based and citizenship behaviours), Privates (high on household, low on citizenship behaviours) and Reluctants (low on both types of behaviours). These segments also differed in terms of their environmental concern, knowledge and attitudes. (NSW Department of Environment, Climate Change and Water, 2009)*

The study went on to identify differences in demographics between the three categories. For example, 'Committeds' were more likely to be university graduates or live in rural areas, 'Privates' were more likely to be aged 65+, not have completed Year 12 schooling or have children, while 'Reluctants' were more likely to be male, be aged 15–24, not have children or live in Sydney.

Categories and Responses

To generate simulated responses, we started by developing a model which assigned each of the virtual Islanders to one of these three coded categories, based loosely on the demographic characterization provided in the study's report. The aim was then to develop a range of responses for each code so that students would then need to think about their own classification of the responses.

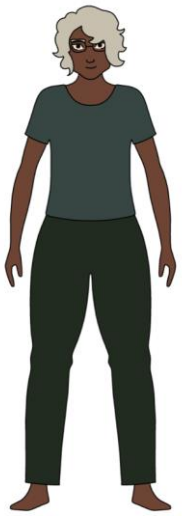
Table 1 shows the core questions that were added to the chatbot. For each of the three code there were generally different responses to these questions for each of the three islands. For example, residents of one island had to worry about a nearby active volcano and so tended to have different views about the environment than residents of another island with different geography. For each of these nine combinations of code and island, a range of different responses was created to add variability to what students would learn from the Islanders, resulting in between 40 and 52 available responses to each question. This one-to-many approach is important since if there was a one-to-one correspondence between codes and responses then students would discover the pattern easily and would not need to engage in their own segmentation of the sample. The disadvantage is the large amount of text that needs to be written for each scenario.

Table 1. Representative questions from the environmental attitudes example

Question	Responses
What does 'environment' mean to you?	48
What does 'biodiversity' mean to you?	48
What does 'sustainability' mean to you?	48
What worries you about the environment?	40
What is your greatest environmental concern?	40
How do you feel about the environment?	48
Do you do anything to help the environment?	40
Is the mayor doing enough to help the environment?	42
Is the climate changing?	52

Figure 2 shows an image of one of the Islanders, 66-year old Kari Jensen from Kiyobico on the eastern island, along with a sample interview using the above collection of questions. Based on her demographic profile, the model assigned her to the 'Committed' category for environmental attitudes. This conversation also illustrates an interviewer who is being polite. In contrast, Figure 3 shows a conversation with Kevin Wilson, a 14-year old from Eden on the southern island. This islander is a 'Reluctant' but additionally the interviewer has been much less polite in their questions.

Hello
Hello, I hope you're well.
Could you answer some questions for me?
I would be happy to answer some questions for you.
How do you feel about the environment?
Passionately! I think the environment is the most precious aspect of our world and we need to do everything we can to look after it, both for its sake and for the sake of us all. More people need to act now.
What is your greatest environmental concern?
There is obviously deforestation which is really hurting our biodiversity. I know we need farming land, we all need to eat, but if everyone did their bit and grew some of their own food there wouldn't be such a huge demand. And don't even get me started on water!
Tell me more
It is all connected. We are part of a much bigger web and if we cut out too many of the strands it will no longer be able to support us. We all need to come together as a community to solve these problems while we still have a chance.
What do you do to help the environment?
I attend rallies to promote water conservation. I also lobby the government to increase water restrictions and promote more water saving initiatives.
Ok, thank you.



Aha.. Don't mention it.

Figure 2. Example good interview with a 'Committed'

How do you feel about the environment?
The greenies! That's the first thing I always think of whenever anyone ever mentions environment, it's always the greenies. They make me so mad.
Can you tell me more?
It's like we've got to do everything to save the environment. That's ridiculous! We've got to save the whales too I suppose!
Do you do anything to help the environment?
The environment is getting along just fine. There is no need for me to go out of my way.
Really?
I guess there is probably more I could do but I'm not sure really. I mean I know I should but I struggle to make myself see why.
Tell me more
I don't have anything else to say.
You are so frustrating!
I don't have to answer your questions.

Figure 3. Example poor interview with a 'Reluctant'

Student Project

Students using this system for research projects were unaware of the underlying categories in the model of environmental attitudes. As an example of a research project, one student "investigated the factors which determine whether a person's belief or disbelief in climate change by interviewing 42 residents of three islands" (Walter, 2015), with samples taken from a single town (Carsten, Gido or Yakunai) on each of the three islands. This involved collecting data through the following interview questions:

1. How old are you?
2. Are you single, dating, engaged, married or widowed?
3. Do you have children?
4. What is your occupation?
5. How do you feel about the environment?
6. Do you believe climate change is real?

The student chose to code the last two qualitative questions using a Likert scale:

> *The participants' answers to Questions 5 and 6 were recorded and analysed for the use of similar key words, phrases and ideas. Each answer was ranked on a Likert scale from 1 to 5. For climate change belief a 1 represented a strong disbelief in climate change and 5 represented a strong belief in climate change. For example, the following was a '5' ranking answer: "Winter is coming. I can feel it getting colder every day. Climate change is the most serious threat to our society and I can't believe so few people believe in it". (Walter, 2015)*

Figure 4 shows how the resulting summary of these coded responses does suggest a difference in beliefs between the three towns. Although the underlying model for generating responses had three categories ('Committed', 'Privates' and 'Reluctants'), there was sufficient variety in the responses that the student had the flexibility to use a five-point scale and still find meaningful patterns in the qualitative data. Furthermore, although there were limited questions specifically related to the topic (Table 1), some open-endedness came from the wide range of background questions that could be asked.

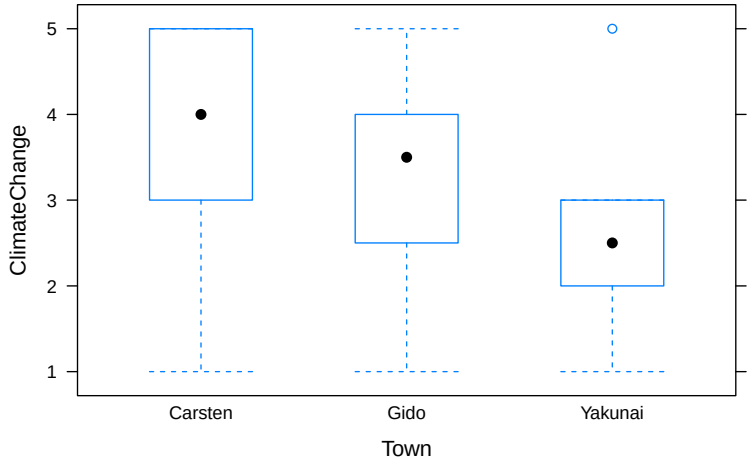


Figure 4. Comparison of responses on climate change between islands (based on Walter, 2015)

DISCUSSION

The broad background of the virtual population on the Islands provides an important context for adding simulated responses to interview questions. While the chatbot itself is an engaging interface for students, it is the rich background stories and existing data for the Islanders that allows novel research questions to be developed. For example, Questions 1 – 4 used in the student project above were not prescribed in any way by the environmental case study. The student researcher had the freedom to choose factors that they thought might be linked to environmental attitudes and explore them. They further had to manage the practical aspects of qualitative research, including the design of their sampling methodology, the collection of the data, and the coding of the interview responses.

Of course, the chatbot in this current prototype is very limited for the aims of exposing students to genuine research interviews. It does not capture any richness in the beliefs and attitudes of the individual, but it also does not attempt to build a model of the interviewer (beyond the simple 'rapport' state). New generations of chatbots based on neural networks, such as the recently open-sourced *CakeChat* (Khalman *et al.*, 2018), may enable more realistic interviews with genuine and diverse interactions between the user and the virtual participant. For example, despite knowing specific information about themselves (such as their age, where they were born, their favourite food, etc.), the Islanders all use the same collection of response templates from the underlying Alicebot. Persona-based conversation models (Li *et al.*, 2016) would make it feel more like you are speaking to different people, rather than a population of clones. Similarly, the current AIML implementation has a simple flag for 'topic', which can be used to crudely track what is being discussed in a conversation, but new methods for topic-awareness may help to "generate informative and interesting responses for chatbots" (Xing *et al.*, 2017) that will enable more natural interviews as a basis for simulating qualitative research.

Nevertheless, this prototype has demonstrated that it is possible to support an introduction to qualitative research methods within an introductory statistics course through student projects. Improvements in chatbot technology, combined with students who are regularly immersed in online chat, make this a natural medium for such engagement. As in a mixed-methods study, the qualitative component of student projects can also motivate the need for traditional quantitative data collection and analysis (Creswell, 2011), highlighting the value to students of their regular statistics course while also nurturing a broad view of research methodology.

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