ONLINE EXPLANATIONS FOR LEARNERS:
THE 'PLAY IT AGAIN SAM' FACILITY

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Beyond the printed worksheet, how can learners be provided with the guidance and explanation they need to make best use of a computer-based learning environment? In the context of StatPlay, our set of multimedia simulations and tools for statistics learners, we have developed Sam, a multimedia demonstration facility. Sam, as in 'Play it again...', allows the recording, storage and playback of any sequence of interactions with StatPlay, together with spoken commentary. Sam recordings, or 'demos', can be used to guide learner activities, provide teacher explanations, or present examples. Teachers can easily prepare demos for their own students, and students can prepare a demo to show their understanding. Demos prove in practice to be natural, appealing and effective, and have been enthusiastically received by teachers and students.

PROVIDING GUIDANCE IN A COMPUTER-BASED LEARNING ENVIRONMENT

Sam, as in 'Play it again…', is a facility for the recording and replay of multimedia demonstrations in the StatPlay learning environment for introductory statistics (Cumming and Thomason, 1998; Thomason, Cumming and Zangari, 1994). Our starting point was the simple observation in the computer lab that it is natural and appealing to grab the mouse and make a short interaction with StatPlay while speaking an explanation. Students as well as teachers do this constantly. Would it be useful to give teacher and student a tool to capture such brief demonstrations ('demos') for later use by others? We built Sam to provide this facility.

From a theoretical perspective, the problem is to provide guidance and explanation to a learner working in a learning environment designed to encourage free exploration. One approach to this problem is the Intelligent Tutoring System (ITS), which attempts to use artificial intelligence techniques to provide comments tailored for the individual learner. This approach raises problems of educational philosophy, and has not been very successful in practice. Even within the research field of Artificial Intelligence in Education, researchers are turning away from the ITS and are exploring a range of less onerous strategies to support the learner. One idea (Mayes and Neilson, 1996) is to make available to the learner a collection of excerpts from previous learner-teacher dialogues.

Other proposed systems are based on stored expert answers to sets of questions (Ackerman and Malone, 1990; Graesser, Langston, and Lang, 1992).

Sam can store fragments of learner-teacher dialogues, or expert answers to questions, and so can be used to study these approaches to augmenting a learning environment. However, the demo is such a general concept that Sam can be used in many other ways as well. In this paper we describe the current prototype Sam, then discuss some of the educational possibilities Sam offers.

SAM, THE MULTIMEDIA DEMO FACILITY

Sam allows the user to record and store as a demo any sequence of interactions with StatPlay, with a synchronised spoken commentary (Les, Cumming, Thomason and Finch, 1997; Les, Thomason, and Cumming, 1997). Menu selection allows playback of any demo.

To record, Sam stores the initial state of the whole StatPlay application—including the current screen—then stores microphone input of speech in real time, and mouse and keyboard inputs. To replay, Sam restores the initial state of the application, plays back the speech, and submits the stored sequence of mouse and keyboard signals to StatPlay at the correct times. During replay the user cannot use the keyboard or mouse, but simply sees and hears the same sequence of StatPlay behaviour, with synchronised spoken commentary, as was earlier recorded. Demos can be nested.

THE CONSTRUCTION OF SAM

The key idea of Sam is that, at playback, submission of a suitable stream of inputs to StatPlay can reproduce the exact sequence of interactions that occurred during recording. To achieve this, the state of StatPlay at the start of playback must be reset to match exactly the state at the start of recording. Sam must be able to store and reset the state of StatPlay, and therefore Sam is application-specific. The great advantage of Sam is that only small amounts of information need be stored, and so demo files are small, little larger than the compressed digitised speech. The software techniques of Sam are the subject of a provisional patent application.

By contrast, Lotus ScreenCam allows the recording of demos with any software application, but is based on recording sequences of whole screen images. It therefore gives extremely large files even when sophisticated compression techniques are used.

Sam is implemented in Visual C++ 5.0. The fact that the Windows interface is message driven allows Sam when recording to use Windows hook functions to intercept mouse and keyboard input before this passes to the Windows kernel and then the StatPlay application. A copy of the input is time-stamped and stored in the demo file. At playback, the recorded initial state of the application is set up—the user sees the screen as needed for the start of the demo—then mouse and keyboard are disabled and Sam passes stored mouse and keyboard information at the proper time to StatPlay via the kernel. Digitised speech is played back synchronously.

EDUCATIONAL POSSIBILITIES FOR SAM

A wide range of educational possibilities suggest themselves, including:

- Sam supports teacher-recorded explanations that are replayed at will by learners, for example when prompted by a printed worksheet. Sam demos can introduce topics, pose problems for learner solution, or give explanations on error.

- A set of demos can have a personality by being recorded in the language and style of a guide (Oren, Salomon, Kreitman and Don, 1990), for example the expert professor, an anxious and painstaking student, or the students' own well-known tutor. Alternatively a set could take a particular educational role, for example explaining the mathematical theory behind the concepts, or making the concepts relevant for economics, medicine, or some other particular discipline.

- It is easy to attach a demo to any icon or graphical feature on the screen to give a brief explanation and demonstration, perhaps only a few seconds long, of the meaning or usage of the feature. More generally, Sam can supply a part of the Help system.

- There are many puzzles, paradoxes and tricky examples that do not often arise in statistics textbooks yet can be revealing and educationally valuable. A set of demos of these could support a Lucky Dip, or offer the Strange Fact of the Day.

- Learners can make their own demos, and submit queries in demo form for tutor comment. Learners could be required, singly or in small groups, to make their own demo to explain a concept. As well as being a useful learning activity, such a demo, submitted for assessment, would be a sensitive indicator of learner understanding.

- A demo can be a record of a teaching-learning interaction involving more than one person. A particularly useful question and answer, or fragment of negotiation, could be restaged for recording as a demo.
- Extended Sam recordings could be used to store for research purposes a detailed record of learner and teacher interaction with StatPlay. The voice channel could record a learner's think-aloud protocol, rather than spoken instructional dialogue.

SAM IN EDUCATIONAL ACTION

We have used the Sam prototype with students in three psychology and environmental science statistics subjects. It has proved quick and easy for teachers to record demos of very acceptable quality. Students have worked in pairs or small groups, with printed worksheets to guide their activities, including suggestion of which Sam demos would be useful. Demos were presented via loudspeaker or multiple headphones. In every case there was an immediate positive response, with many teachers and students enthusiastic about the appeal, ease of use, and educational value of Sam demos.

Almost the only questioning comment was from one or two tutors who noted that sometimes their students were less available for talk with the tutor because they were absorbed with the spoken message from StatPlay!

FROM DEMO TO LEARNING SEQUENCE TO CURRICULUM

Our Sam prototype supports only a simple menu list of demo titles, which is unwieldy beyond one or two dozen items. We need to support many more demos, but keep strict limits on complexity and development time. There are two central challenges:

- We would like to offer a vast number and range of demos, yet make it very easy for the teacher or student to find the best one for any particular situation.
- The teacher or student should have freedom to explore, but we should also be able to construct curriculum sequences that are easy to use in various ways.

A DATABASE OF DEMOS

Some demos serve as part of the Help system, and should be linked to the icons or other display elements they explain. Other special purpose demos provide explanations of statistical terms, and are accessed via a glossary list.

Most demos are intended to contribute to statistics learning activities. Information can be stored automatically with each demo, including author, date of creation, StatPlay context, and duration. The author can add descriptors, including demo title, subject context and topic, and a brief free text summary of the demo. A relational database is then the natural structure for demo storage, so that a user can scan and select a demo for replay via any of the types of descriptors, or via a text search of demo summaries.

When a user is working in StatPlay and calls up Sam, presentation of the demo database should be as an easily-traversed tree. The presentation should be sensitive to the most recently used demo, and to the current location in StatPlay. In other words it should be easy to select demos close to the one most recently used, and most relevant to the current context in StatPlay. With the descriptive information should be a small preview picture showing the screen at the start of the demo: in many cases this picture would give a fast and natural indication of demo content.

BEYOND THE SINGLE DEMO: THE LEARNING SEQUENCE

We are convinced it is best to keep demos short, usually no more than a minute, to avoid 'video turn-off' and so that students spend most of their time carrying out their own activities. Therefore we need to be able to specify sequences of related demos. A teacher should, for example, be able to arrange for a student to play one demo, do some StatPlay work, play the next demo, maybe elect to step sideways to a demo giving further explanation, do some more StatPlay exploration, decide on the answer to a question, be directed to a demo appropriate to the answer given, and so on. We will therefore offer the teacher easy ways to set up links, and choice points so that a curriculum structure can be specified, drawing on a set of related demos.

A learner working through a sequence would at any time be able to see the current position in the sequence, to step back or forward, or to leave the sequence.

THE POTENTIAL OF THE MULTIMEDIA DEMO

The naturalness and appeal of our demos within StatPlay and the immediate positive response of users to Sam convinces us that the multimedia demo has enormous potential. The key technical issue in providing Sam facilities in other applications is the need to store the full state of the application at the start of a demo. There are software

library facilities now becoming available that make it easy for an application to be designed so that it can 'store its own state'. It therefore feasible to think of Sam being incorporated into a wide range of software. In most cases Sam demos could form the most user-friendly part of the Help system, and could also be arranged to give tutorial sequences to assist new users.

When the application has, like StatPlay, education as its primary purpose, demos can play an even more central role by offering a wide range of support to the learner. Many pedagogic and implementation issues need study before the full educational potential of the demo is realised.

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