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muCap: Connecting FaceReader™ to z-Tree*

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Abstract

μCap (muCap) is a software package (citeware) for economic experiments enabling experimenters to analyze emotional states of subjects using z-Tree and FaceReader™. μCap is able to create videos of subjects on client computers based on stimuli shown on screen and restrict recording material to relevant time frames. Another feature of μCap is the creation of time stamps in csv format at prespecified screens (or at prespecified points in time) during the experiment, measured on the client computer. The software makes it possible to import these markers into FaceReader™ easily. Until recently, connecting z-Tree and FaceReader™ was only possible using workarounds or by undertaking many successive actions manually. μCap is the first program that significantly simplifies this process with the additional benefit of extremely high precision. This paper describes the usage, underlying principles as well as advantages and limitations of μCap. Furthermore, we give a brief outlook of how μCap can be beneficial in other contexts.

JEL-Classification: C90, C91, C99.

Keywords: Experiment, Software, FaceReader™, z-Tree.

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1 Introduction

In economics, conducting laboratory experiments to determine causal relationships has become increasingly fashionable over the last few decades. A large number of laboratory experiments are nowadays conducted using computers as a result of the spread of computerized laboratories at major universities and research institutions. Urs Fischbacher's experimental software z-Tree (Fischbacher, 2007) is very popular around the globe and is among the most-used experimental softwares, having been cited more than 4,000 times as of late 2014.

z-Tree is versatile and yet easy to learn—version 3.5.0 even allows users to record the current time on the client machine. Part of z-Tree's popularity is presumably due to its simplicity and the convenience of creating even complex experiments with only very little programming effort. The analysis of video footage created during these experiments however was relatively inconvenient so far, since the capability of z-Tree to interact with other software packages was limited until recently. For example, consider an experimenter interested in facial expressions of subjects after they observe a certain screen. In order to perform their analysis, experimenters so far needed to employ a software to record videos, create and export the time stamps into z-Tree (using table dumpers)[1], and manually match time stamps and video footage in the program of their choice. It is apparent that this and similar methods might be very tedious to the experimenter since they rely on manually repeating a large number of tasks. This might be especially burdensome if experimenters deal with a large number of subjects and sessions. One of these situations for example concerns the analysis of emotions using FaceReader™.

FaceReader™ is a software package developed by the Dutch company Noldus (`http://www.noldus.com`), it analyzes facial expressions from photographs and videos with respect to six basic emotional states. The software lays a grid of more than 500 key points over images of each participant's face and identifies emotions by distinct muscle movement that are associated with a change in emotions. According to Noldus, the software performs equally well as trained annotators in describing emotional states of subjects. Researchers in economics have recently started to use FaceReader™ to investigate how emotional states correlate with economic decision making. For example, Noussair and Nguyen (2014) investigate the role of emotions in decision-making under risk and Breaban and Noussair (2013) look at emotions in the context of asset markets.

μCap is the first tool to allow experimenters to create a fully automated connection between z-Tree and FaceReader™ in a straightforward way. It is barely noticeable by subjects and imprecisions are kept very small with only a few milliseconds. As we will point out later, μCap can easily be

[1] As already said, this is only possible since version 3.5.0. If the experimenter were to use earlier versions, additional workarounds would have to be used (e.g. switching lights on and off to vary brightness).

implemented to improve experimenters' work flow and has possible applications beyond its original purpose.

2 μCap

μCap is a bundled software package and comes with two additional separate applications: μConfig and μProject. The governing principle of μCap is based on repeatedly reading a specific pixel from the top left corner of the participants' screen (for an example screen, see Figure 1). Whenever this pixel changes color, μCap will create a timestamp in a csv file.[2] By doing so, μCap handles each participant separately, such that the progress of participants in different stages of the experiment will still be recorded precisely. This procedure requires a minimum of additional programming effort by the experimenter. On the one hand, the tool μConfig renders the creation of hand-written configuration files unnecessary, as it offers experimenters a graphical interface to define colors μCap will react to and to attach labels to events. On the other hand, additional programming in z-Tree is limited to adding a small box of 20×20 pixels in the top left corner of the screen.[3]

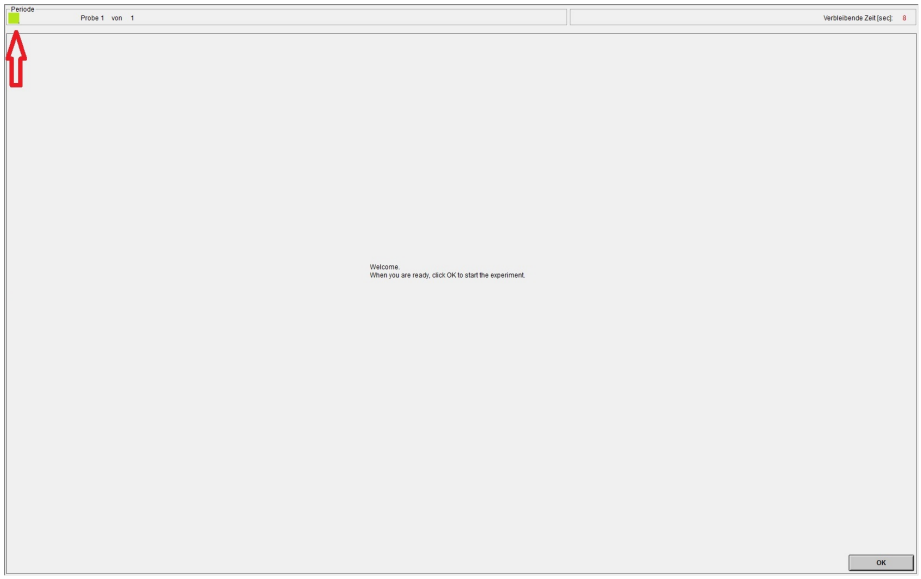

Figure 1: Participant's screen when using μCap, red arrow added to highlight the colored rectangle

In a typical experiment, experimenters will use μConfig when they program their experiment in z-Tree. A set of colors (using the RGB scheme) has to be defined in μConfig and rectangles with the corresponding colors have to be placed in the top left corner of the z-tree screen. Virtually unlimited

[2] CSV is short for comma-separated values, a simple file format to store tabular data.

[3] Although μCap only monitors one specific pixel, different screen types and resolutions might make it necessary to increase the monitored area to a rectangle of size 20×20 pixels. This takes up only a small part of the entire screen but still very likely includes the pixel of interest. We recommend every lab to pre-test the optimal rectangle size and position before first use.

numbers of markers can be defined to distinguish all parts of interest within the experiment. If the same part occurs more than once, markers can be re-used. Note that using the RGB scheme also enables users to only marginally vary the color of the rectangle (e.g. from 250,250,250 to 252,250,250) in a way such that μCap recognizes the difference, but the participant does not. This might be especially valuable in a setting where the experimenter does not want the participant to know (or guess) what the instances of interest are.

After μConfig has been set up correctly, μCap will not only create video files of participants (including starting and stopping the recording at prespecified color changes)[4], but also correctly create the necessary time stamps. For μCap to function properly, it simply needs to be executed on all clients (just like z-Leaf, the client program of z-Tree). After the start of the experiment, μCap will be executed in the background, not visible to subjects.

As soon as video files and time stamps have been collected from the client computers[5], μProject will help to automatically create a new project in FaceReader™. Not only will this project automatically create the total number of subjects, but also load the video files and time stamps. Especially in projects with a large number of subjects, the automated processing of data using μProject can substantially reduce experimenters' workload.

μCap can be used free of charge. We however kindly ask you to cite this paper in any academic publication or presentation when μCap has been used (citeware). The package and documentation can be downloaded at `http://mucap.david-schindler.de`.

3 Advantages, Limitations and Possible Extensions

The biggest advantage of using μCap for experimenters is the reduction of performing time-consuming manual tasks to link video footage and experimental data. This can prove extremely valuable in settings with a large number of subjects. While other options require repeating many small steps, μCap offers a worry-free solution that automatizes many of the necessary tasks and enhances work-flow. Another big advantage of μCap is the ability to only record parts of interest. Since FaceReader™ needs computational power to process the videos files, useless footage will drastically increase the time FaceReader™ will need for completing the analysis. In our experience, an average workstation needs about three minutes to process a one minute video file. Many experiments nowadays consist of more than 100 participants and last up to two hours. If a researcher

[4] An obvious prerequisite for the recording feature is of course that a video camera was installed on the respective computer. μCap was designed such that every standard webcam will do and no specific camera type or drivers will be required.

[5] At the University of Munich we created a tool (MELESSA Video Collector) for automating the process, it is however specifically tailored to our IT infrastructure. If you are interested in the tool, please get in touch.

were interested in only 15 minutes of the recordings, the use of μCap could reduce computation time drastically from 600 hours to only 75 hours.

An important issue for experimenters is probably the imprecision resulting from the use of μCap. Although we have not taken the effort to measure the exact latency μCap induces, we are very confident that the incongruence of timestamp and video frame are less than a frame (i.e. less than 40 milliseconds).[6] Apart from many important advantages, using μCap may have some downsides, which we would like users to be aware of. Although we tried to keep additional programming very limited, the use of μCap will always mean additional work to the experimenter. We think that our solution is very efficient in requiring as little effort as possible, but still, colored rectangles will have to be implemented in z-Tree and the system needs to run both, z-Tree and μCap, which might be more burdensome than using z-Tree alone. On the μCap website, we provide a template treatment that can help to reduce programming effort. Additionally, μCap is a program written for users of Microsoft Windows. We do not see ourselves able to offer the package for any other operating system, but we will continue to offer support for new Windows versions. Given that z-Tree requires Windows as an operating system as well, we deem this constraint not binding. μCap currently requires at least Windows XP and also supports any later version up to Windows 8.1. Support on other operating systems is probably possible using emulations.

While μCap was developed to work with FaceReader™, it is potentially interesting to use the tool in other environments or with different software packages, where timestamps in csv format are needed.[7] In addition to the presented application, one could think of linking experimental data to a variety of physiological measures, like eye-tracking, skin conductance and the like. Since most of those physiological measures are optimized to analyze individual behavior, μCap can offer a simple extension for the analysis of interactive behavior, especially in large groups. Also, the principle of placing colored rectangles on screen can be implemented in basically any experimental software that supports such a customization and therefore does not only limit μCap to be used with z-Tree.

Future versions of μCap will primarily deal with increasing user friendliness. Additionally, we will try to improve network functionalities to make a remote handling of the software easier.

4 Conclusion

In this paper we have introduced μCap, a software package for experimental economists to link FaceReader™ and z-Tree. We have explained the governing principle of μCap and discussed its

[6] The screen sensor monitors the pixel of interest with 50-100 frames per seconds which induces a latency of 7 to 20 milliseconds. One may add a few milliseconds for Microsoft Windows-specific latencies. We understand that there exist settings where this latency is unacceptable (and in those cases μCap should not be used), we however deem it small enough for almost all applications involving the use of z-Tree.

[7] We are very interested in potential applications, please let us know.

advantages and weaknesses. Furthermore, we have suggested possible extensions. We heavily rely on users' feedback to improve and enhance the program and therefore ask all users to contribute by sending in ideas.

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