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INTRODUCING EGG – AN EXPERIMENTAL GAMES GENERATOR

1. INTRODUCTION: WHY EGG?

The Experimental Games Generator (EGG) is a software package for developing and running turn-based experimental games, created to support researchers in economics and other social sciences, who are interested in human decision making. It is completely web-based and open source—see 1c). The very first version of the software was developed by HR in 2009 for a study conducted by Ulrich Frey. It then underwent two major revisions, 2010, and 2011 when MP, OK, and CL joined the project, turning the software from a specific research tool for one study into a software package for a broad scope of possible uses.

This article briefly presents the basic architecture and features of the software package. More comprehensive documentation and help forums are available online (egg.tum.de).

a) EXPERIMENTS IN WEB 2.0

What sets EGG apart from other existing experimental software (e.g. Fischbacher, 2007) mainly is its complete web-integration. EGG is written as a web application and runs on any ordinary web server with support for PHP (> 5.3, see php.net). Once EGG is installed on a web server, experiments can be developed and run from basically every computer world-wide which has a working internet connection—stand-alone, offline use on a single computer or in a local area network is possible, too, of course. Making EGG a web application entirely, enables experimenters to make use of all the possibilities of Web 2.0, see sections 2e & 2f for details. Therefore, in addition to running classical lab experiments, EGG can be used to conduct experiments with participants joining in over the internet or on platforms like *Amazon's Mechanical Turk*, *facebook*, or *google+*—compliance of the experiments with the platforms' respective rules for add-in applications presumed.

b) LAB, FIELD, CLASSROOM, SOCIAL NETWORKS, OR AT HOME

EGG's HTTP-based client-server architecture allows for great flexibility with regard to experimental setups. Unlike with other experimental software, using EGG no additional software has to be installed on the client computers. Basically every computer with a standard web browser installed and a TCP/IP-connection to the server hosting EGG can be used to take part in an experiment. In addition to conducting studies in the laboratory, this renders new setups possible which could not be realized with traditional software. For example, professors can now ask their students to bring their laptops to class, conduct an experiment in the lecture hall and present the results of that same experiment right away; researchers can invite subjects via email or a website and let them take part in experiments over the internet; field workers

can bring a set of laptops, tablet computers or even smartphones to the field and conduct experiments there; or finally, experiments can be run which are adapted to the requirements of social networks like *facebook* and *google+* utilizing those networks' additional possibilities.

c) OPEN SOURCE SOFTWARE FRAMEWORK/API WITH EDITOR

EGG is open source software, free for non-commercial scientific use, distributed under [CC BY-NC-SA 3.0](). All we require from experimenters is a reference to this article and a link to the project's website at [egg.tum.de]() when they publish results obtained using EGG. Also, contributions to software development are highly appreciated! The developers' website can be found at: [tum-egg.sf.net]().

Technically speaking, EGG is a package of a software framework defining an application programming interface (API) and several tools, especially an easy-to-use editor[1], to create, run and manage experiments—which themselves are small programs. In short, EGG can be used for several purposes: 1) running and managing existing experiments, 2) creating new experiments, and 3) managing participants.

When installed on a web server, EGG consists of three mayor components: the *frontend*, the *backend* and, as a part of the backend, the *editor*. The *frontend* is all that participants will see when they connect to the server hosting EGG. All parts of the frontend can be configured through the *backend*, which is the part of the EGG installation that only experimenters have access to.
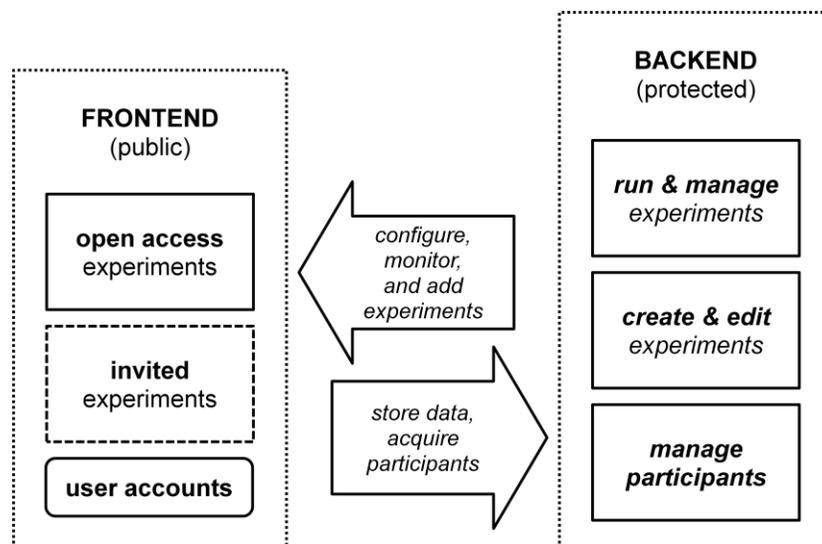

Figure 1: EGG's main structural components

Experiments run with EGG can be categorized into two main groups: open access and invited. Open access experiments are visible and accessible to everyone connecting to the server. Invited experiments

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[1] The editor – named "Bacon" – is not available, yet (July 2012).

can be accessed only by participants who possess a specific access code. Access codes for experiments, just like experiments themselves, can be created in the backend. All data gathered during the lifetime of an experiment is stored and accessible through the backend, too.

If experimenters enable this option, participants in the frontend have the possibility to register password protected user accounts[2]. These accounts have several purposes: 1) participants can be informed about new experiments and invited via email, 2) in longer running experiments participants can be notified when their next decision is required, 3) experimenters can easily keep track of the studies their subjects already took part in and sort them accordingly. To ensure anonymity, user accounts can be created with or without supplying an email address—see 2f) for further details.

The editor, finally, supplies experimenters with an easy-to-use tool for creating and modifying experiments. We included a set of example templates for experiments in the EGG installation package which can be freely used in any combination, but experiments can also be created completely from scratch, of course. The editor is one of the most intricate parts of EGG, since it is meant to provide experimenters without programming experience with an intuitive user interface to the logic of EGG-experiments. It will therefore remain work in progress for quite some time and will benefit from experimenters' criticism and ideas for improvement continuously. Nonetheless, experimenters with programming skills can also make use of the full power of the software framework and write their experiments directly in PHP using the simple extra commands and functions defined by the EGG API.

2. FEATURES OF THE SOFTWARE IN DETAIL

In the following we outline some of the features of EGG in more detail. We focus on features which, to our knowledge, could not be obtained with other software so far.

a) PLATFORM INDEPENDENCY

Like all web applications EGG is completely platform independent. Experiments hosted on a server running EGG can be accessed from all desktop computers, notebooks, tablets, smartphones or other devices, as long as they have a connection to the server and a standard web browser installed (like Firefox, Internet Explorer, Opera, Chrome, or Safari). To create experiments using EGG's editor nothing else is required, too. Experienced experimenters can use any source code editor of their liking (Netbeans, Notepad++, UltraEdit, or similar) and also need FTP client software to upload their experiments source files. For all additional software that you can use with EGG there are free open source options, allowing for completely cost-free use of EGG in research.

b) MULTI-LANGUAGE SUPPORT

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[2] User accounts are not available, yet (July 2012).

EGG's frontend and the experiments created with EGG can easily be made multilingual. The AGG API provides convenient ways of incorporating information in multiple languages at the same time. This enables experimenters to conduct experiments with people recruited world-wide in which all participants can be supplied with instructions and information in their native languages simultaneously.

c) Few Limitations on Time, Space, and Number of Participants

Just like EGG does not limit experimenters spatially much, see 1b), it also does not bring about many restrictions regarding time or the number of participants. Since participants can be notified via email when their next decision is required in a running experiment, experiments, technically, can run for years or longer. For one, this allows for experiments with many people in which it is not required that all participants wait for each other's decisions but can go about other activities, returning to the experiment only when they are needed. For another, this also allows for experiments which can be frozen in any state and 'revived' at a later point in time, for example forcing all participants to sleep on their decisions before they actually are put into practice.

Additionally, the number of participants is not limited much, technically. Although experimenters of course have to think about the complexities and delays arising from the interaction of large numbers of participants, the EGG API itself does not make severe restrictions concerning participant count. When EGG is run on a high-capacity web server, numbers up to 10,000 participants should not pose a problem to the software.

d) Web Content

Since EGG is developed as a web application in PHP, it is very easy to incorporate every sort of web content into experiments. Adding to standard web elements like images, sounds, tweets, feeds, or videos, this also includes interactive flash applications and Java applets, allowing for live audio and video chats or visually elaborated interactive user interfaces. In short: if it can be done on a website, it can be done in EGG-experiments, too.

e) Compatibility with Social Networks and other Websites

Apart from being used as a stand-alone web application, EGG experiments can also be developed to be apt for use in social networks like *facebook* or *google+*. Experimenters can use the EGG API to create experiments which can be distributed in the form of specialized apps on *facebook* and other platforms. These experiments can then make use of the opportunities social media offers to app programmers, which mainly means exploring users' friendship relations, biographic data, preferences and tastes, 'likings', etc. Additionally, experiments can recruit participants on web-based marketplaces for work like *Amazon's Mechanical Turk*. Here, people from all over the world receive micropayments for completing short tasks like image classification which cannot, or not as well, be solved by artificial intelligence. *Mechanical Turk* has received quite some attention by social scientists recently (e.g. Bohannon 2011) and might become

one standard online platform for conducting experiments and surveys in the future. EGG offers a set of tools to use this potential.

f) Integrated Management of Subject Pool

If experimenters decide to enable this option, EGG can also be used to manage subject pools conveniently. EGG will then offer participants an opportunity to register user accounts in the frontend. Once registered, EGG keeps track of all the activities of the registered participants, allowing experimenters for example to invite only a specific subset of their subjects back for a follow-up experiment. When participants register accounts in the EGG pool, anonymity is reduced of course, especially if they supply email addresses, for example for longer running experiments—see 2c). This issue always has to be considered in experimental design, though. Nonetheless, strictly anonymous experiments can still be created and run with EGG. This is done by not requiring participants to log in to their accounts before accessing an experiment. Like this, they cannot be distinguished from unregistered, unknown, anonymous participants during that experiment.

3. Outlook

The Experimental Games Generator is and remains work in progress. We intentionally chose to develop the project to a certain point and then distribute it as open source software in order to bring in more expertise and ideas for application and extensions we have not thought of. If you would like to join in and help with the development of EGG we heartily welcome you: tum-egg.sf.net. We have run several experiments using the software and tested it thoroughly. We cannot guarantee, though, that it is free of bugs. If you encounter one of them, please let us know! Whenever we can, our team will provide support for EGG and help you with creating more complex experiments.

We hope that EGG will facilitate your research; it does help us much with ours.

Acknowledgements

References

Bohannon, John (2011): Science 334, p. 307;

Fischbacher, Urs (2007): z-Tree: Zurich Toolbox for Ready-made Economic Experiments, Experimental Economics 10(2), pp. 171-178.