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LabVanced: A Unified JavaScript Framework for Online Studies

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The huge potential of online-based research has gained great interest from researchers in many disciplines. Specifically, technological advances such as crowdsourcing (e.g. Amazon Mechanical Turk), open data repositories (e.g. Open Science Framework), and online analysis tools (e.g. Jupyter notebook) offer rich possibilities to improve, validate, and speed up research, data acquisition and analysis processes and publication processes (Buhrmester, Kwang, & Gosling, 2011; Fernando Pérez, 2007; Open Science Collaboration, 2015). However, until today there is no cross-platform integration of these subsystems. Furthermore, implementation of online studies still suffers from the complex implementation (server infrastructure, database programming, security considerations etc.). As a result, online studies have not yet lived up their promises. To improve this situation, we developed LabVanced, a JavaScript web application that offers an easy to use online editor by which professional behavioral research, social research, market research, or recruitment tests can be implemented. At the same time the framework provides rich functionalities for hosting the content of the study, data recordings and data export. In the following these functionalities will be explained and investigated in close detail.

The LabVanced editor offers web-based creation and manipulation of experimental content using a graphical user interface (see Figure 1). Here psychological terminology is used to create an intuitive understanding of available functions. The overall study design offers the possibility to define subject-groups, sessions, blocks, and tasks. Thereby we implemented a nested functionality, so that tasks can be grouped into blocks; blocks can be grouped into sessions, which again can be assigned into different subject-groups. Thus, the user has the option to balance the task order, specify at what time each session can be executed (recorded), who can participate in which subject-group and even has the possibility to create longitudinal studies (repeated measures). The experimental content (e.g. text, images, videos etc.) is then defined within each task. A task can be composed of several trials, which are used to repeatedly present and test the experimental content. Each trial has again one or more frames on which the content is placed. There are two types of frames, canvas frames and page frames. On a canvas frame images, videos, text, and other content can be added via a simple mouse click and then be positioned resized, and manipulated similarly as in other graphical editors (e.g. Adobe Illustrator). On a page frame one can also add any content element via a mouse click, but the elements are automatically stacked vertically as in typical online questionnaires. The combination of these two frame types in the trial system allows for a mixture of different use cases. Thereby, even complex questionnaires, behavioral tasks, instructions, or feedbacks, can easily be realized.

Importantly, different trials can be used to modify stimulus properties for each trial-repetition. To create additional trials, the user has to specify how many independent factors (with how many levels) are in the task. By automatically crossing the levels of the independent factors, the framework creates the conditions and for each condition a number of repetitions can be defined. Each repetition is one trial. To now change, for instance, the size of an image or the image content depending on the trial, the user graphically selects one trial and uploads one image and thereafter selects another trial and uploads another image. To speed up this process there are also several functionalities for changing multiple trials at once. Finally, the trials can be randomized either between subjects or within subjects, allowing for full experimental control.

Many tasks require complex participant interactions, such as interactive changes of stimulus properties, dynamic feedback based on the response of the participant, storing and changing states of variables, or recording participants' responses. In this regard, the framework offers an event system in which these dynamic interactions are defined. Each event is specified by a trigger, several actions and possibly some requirements. For example, a trigger could be a keyboard or mouse click of the participant on some stimulus, a change of a stimulus property or some state change of a variable. The action describes what should change or happen when the trigger fires, for instance, the start of the next frame or trial, a change of a stimulus property or the recording of some variable such as which button was pressed. The requirement is a logical operator, by which additional checks can be made. Only when these are fulfilled the action is executed. In essence, the event system offers very rich possibilities to create complex interactions by an easy to use graphical interface.

As the study implementation is completely conducted online in the browser, users have the possibility to share their study designs in the library. Other users can then import these studies, and consequently reuse and modify the existing tasks. Thereby each user can start building new studies and tasks on top of existing ones. By these possibilities, the LabVanced framework will increase transparency, reproducibility, and the validity of online research.

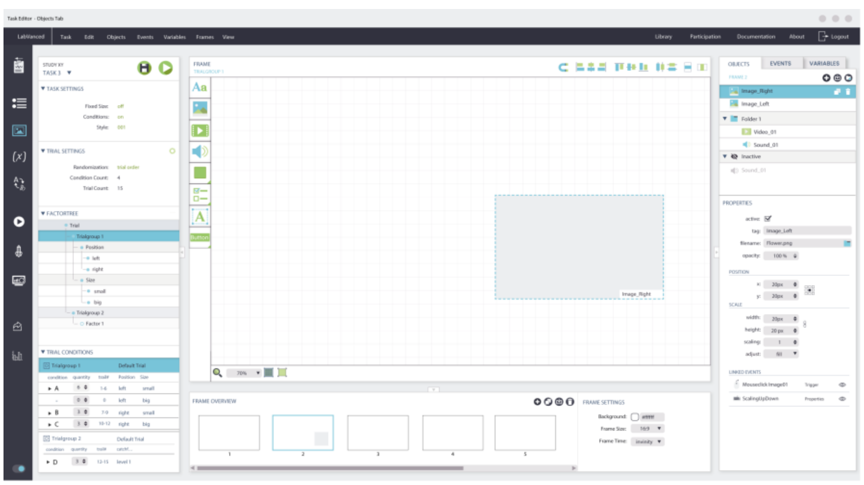

Figure 1: The LabVanced task editor. On the left is the trial menu, which is used to select the trial that is currently edited. On the bottom menu different frames can be added and selected for each trial. The center panel shows the content of the currently selected frame. New content can be added using the toolbar on the left and then be resized and positioned using drag & drop. Properties and events (dynamic changes of stimuli content) can be setup on the right panel.

Once the study creation is completed, the users can use the LabVanced framework to directly publish the study into a library. Every visitor of the website will thereby be able to participate in the study. Of course the link to the study can additionally be posted on external websites, and individualized invitations can be generated with a few clicks. Besides posting the study on the LabVanced website, the framework is linked to crowdsourcing platforms such as Amazon Mechanical Turk. Hence users can choose how many subjects they would like to recruit using crowdsourcing and how much each subject will be paid. Based on these settings the task will be automatically posted onto crowdsourcing platforms such that the speed of data collection can be significantly improved.

The presentation of the experimental content during the recording-session is implemented using a content-preloading-approach, which ensures that before a trial starts, all the content is already loaded into the framebuffer of the graphics card. This approach ensures that all experimental stimuli are presented with high precision. To further improve experimental control, the size of the visual stimuli can be adjusted to the screen size (resulting in fixed visual degree). Thereby the participant needs to calibrate his screen size using a standard-sized object (i.e. ruler or credit card). In fact the precision and control of the experimental stimuli in the LabVanced framework is as close to a lab-based situation as technically possible. Besides reaction time, mouse clicks, and keyboard presses, the LabVanced framework also offers build-in functionalities for webcam-based eye tracking and webcam-based detection of facial expression. This enables the researcher to get even more relevant data. Once the recordings are finished all the data can be inspected, cleaned, and finally downloaded into different formats to further perform statistical analysis using preferred additional software (e.g. SPSS, Python, R, Matlab).

Overall, we showed how the LabVanced framework facilitates a variety of features that are important for creating and conducting professional online research. Particularly, the framework offers the possibility to create and run complex experiments without the need to program a single line of code! Instead a browser-based intuitive graphical user interface can be used to create and modify the experimental content. The unique feature of sharing the studies between users will further increase the efficiency of study creation and strengthen the transparency and reproducibility of experimental findings. Furthermore, the framework also offers several options to host the created study on the web and takes care of the participant recruitment via build-in crowdsourcing capabilities. Preloading and spatial screen-calibration ensures that the experimental control during the measurements is comparable to a lab based scenario. Finally, the direct transformation of the recorded data into the preferred format will further speed up the process of online research. All in all, this paper introduces a new powerful Javascript framework for online studies, which has the potential to significantly improve the scientific methodology.

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