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Stream: A Toolkit for Rapidly Developing High Precision Experiments

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Introduction

With the increasing use of technology in the field of cognitive science there has been a need for software that can accomplish the tasks needed to further research. Many experiments require high levels of precision in spatial and temporal presentation of stimuli as well as the ability to collect data from participants. Many toolkits have been created for this purpose ranging different platforms and purposes. However, most psychologists lack the knowledge required to use these different toolkits, since they require substantial experience with programming languages like Python or MATLAB. Acquiring the necessary skills to use these toolkits is often practically impossible since the learning curve can be quite steep before one gets to the point of being able to use these tools effectively. The Stream Toolkit was created to bridge this gap. Stream simplifies the programming side of the experimental design process and allows people with a relatively basic level of programming knowledge to create complex experiments. Stream provides user-friendly scripts as well as many tutorials that will walk researchers through various aspects of experiment design, such as creating stimuli, displaying them, collecting responses, and analyzing data. It is still necessary to understand basic MATLAB functions and syntax in order to begin using Stream. The documentation provides a list of basic commands and topics that should be learned prior to beginning. Stream can be downloaded at: [https://bitbucket.org/streamtoolbox/stream_official_toolbox/downloads].

Psychtoolbox

Stream uses Psychtoolbox-3 (Brainard, 1997; Pelli, 1997; Kleiner et al, 2007) to interface with hardware, such as the graphics card, sound card, and mouse and keyboard drivers. This is essential to provide low-latency stimulus presentation and response collection. It is not necessary for the user to know Psychtoolbox, since Stream handles the interface. However, Psychtoolbox-3 must be installed and functional on the computer.

Summary of Features

Stream provides a skeletal framework of an experiment and a series of helper functions so that a user can add their own stimuli and data collection events. These helper functions include stimulus generation, event based presentation, collection of various data types, and simple analysis scripts. These features have been simplified for the user in order to streamline the experimental design process. The users only have to edit a few of the files in Stream while the brunt of the work happens behind the scenes in scripts that have already been written. All parts of Stream are open source, and users can access or modify Stream as needed.

Tutorials: A Good Place To Start

The Stream Toolkit provides users with a series of tutorials to teach the researchers how to use Stream. The main tutorials will walk users through the design of an experiment including data collection and analysis to become familiar with the format of Stream. Supplemental tutorials are provided for features not explained in the main tutorials. It is suggested that you read through the Main Stream Documentation before users begin the Stream Tutorials as the tutorials are meant to coincide with sections of the documentation.

Block Files

Block files are the main scripts that the user will edit in Stream. Block files represent the different experimental blocks in a task. When designing an experimental block, you will edit these files which will specify what stimuli are created, how they are to appear on the screen, and what response data are collected. If your experiment has multiple different blocks, you will create multiple block files that define each of them and run them in a specified order.

Stimulus Generation

At the top of your block file you will specify the stimuli that are used in the block. Stimuli are organized into 'sets'. You can create any number of stimulus sets that you choose, and each stimulus set can have as many stimuli as you choose. The only restriction on how you group stimuli into sets is that each set has to be comprised of the same kinds of stimuli (e.g. all of them are images). There are also a number of properties for each kind of stimulus that can be defined in order to customize your stimuli. By defining all of the stimulus properties in a structure you can bypass the need to understand Psychtoolbox functions, as Stream will do that work for you, although it will not hurt to become familiar with Psychtoolbox functions. Stream has many

different stimulus types including images, Psychtoolbox shapes, text, imagefonts, Gabor patches, and audio files.

Event-Based Presentation

All of the things that happen inside of a trial are called Events. Events are set up in block file and scheduled to happen at specific time points relative to the start of a trial. Once the events are scheduled, Stream takes over and executes them using a sophisticated timing loop that integrates stimulus presentation with data collection. All events are then time stamped with millisecond precision using the PsychToolbox GetSecs function. Screenshots can be collected at any point during the experiment, which is helpful for creating figures. Parallel port triggers can also be used in Stream.

Collecting response data

Responses are predefined using responsestructs, allowing you to give certain properties to a response event. These responsestructs are set up in the block files and then scheduled to occur at a particular time point. Any number of responsestructs can be used in an experiment. Stream allows for keyboard, mouse, and eye gaze responses (from Eyelink eye trackers).

Data Collection

When you run an experiment, Stream will create data files automatically. Stream is extensive in its data collection, such that every stimulus and event will automatically be saved along with timestamps. This extensive journaling allows for unanticipated exploratory analyses and also provides a safety net in case you forget to record condition labels. Because these files can be large and cumbersome to analyze, Stream also allows you to create compact data files containing only specific pieces of information that you choose. These compact files are a good way to filter only the information needed for analysis.

Analysis

You can use multiple methods to analyze your data, but if you choose, Stream has built in analysis scripts that will help you extract the data you have collected and allow you to perform analysis using custom code in MATLAB. Stream's analysis script is designed to pull information out of the compact data by looping through each subject, each block per subject, and each trial per block. Information from all of these trials is then copied into a structure. You can also opt to write these values to a text file that can be read into R, SPSS, or Excel if that is your preferred method of running statistical tests. Just like the block files, analysis scripts open-source and completely customizable.

Customer Support

For questions not covered in the documentation, customer support for the Stream Toolkit can be directed to Stream's main website [https://osf.io/tdvxm/]. Here you will find a Functions wiki as well as links to Google Group discussion forums where you can report bugs, suggest development projects, or as a general usage question.

References

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