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eVAS: A user-friendly electronic Visual Analogue Scale

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Summary

Data collection is ubiquitous in many areas of research. Recently, more and more data collection has been automated to facilitate subsequent computer analysis. The same applies to access to subjects' interpretations in the form of self-reports. These self-reports, usually collected in paper form as questionnaires, are standard in several applications in the field of psychology, and have been used in studies of e.g., pain, emotion, behaviour, anxiety and personality assessment. Ratings are often obtained using simple Visual Analogue Scales (VAS) or Numeric Rating Scales (NRS), where subjects are asked to rate a particular outcome on a straight line or by a number in a given range with specific anchors. For example, people are asked to rate their current perceived level of pain between the anchors 'no pain' and 'most pain imaginable'. While these self-reports are easy to do with pen and paper, open-source software that can easily digitise and quantify the results of self-reports on an ongoing basis is rare. This scarcity of software solutions is a particular problem for researchers who are not familiar with writing code and software themselves.

We therefore present the electronic Visual Analogue Scale (eVAS), an easy-to-use electronic visual analogue scale that continuously records subject feedback. Initially introduced to record pain levels for automated pain detection, but not limited to this use case, eVAS aims to provide a ready-to-use tool that is highly configurable, even for non-computer scientists, and can be used for various applications. eVAS is open source, hosted on GitHub, available from a download page and distributed under an MIT license. It employs automatic updates via GitHub when a new release is available, is working fail-safe, logs possible errors in a log file and saves results as text files.

Statement of need

Self-report measures are one of the most popular tools used to measure personality because of their practicality and extensive research support (Robins et al., 2009). In particular, VASs are used as simple tools to provide single index measures, with the majority of research using VASs focusing on obtaining health states (Åström et al., 2023). Examples include the measurement of pain (Heller et al., 2016), but also several other applications such as the estimation of hunger (Beaulieu & Blundell, 2021) or emotions such as fear (of childbirth) (Rouhe et al., 2009) or anxiety (Duinen et al., 2008). While paper-based solutions are easy to implement, they lack the continuity, scalability and automation that are of paramount importance in most areas of research. To overcome these problems, research could benefit from software that implements self-report scales. Electronic versions could help to automate data collection, allow continuous recording with accurate timestamps where reaction times are critical, and be used in large studies. For example, the inclusion of subjective perceived pain levels from a Computerised Visual Analogue Scale (CoVAS) in the construction of automated pain detection models has been shown to improve classification results (Gouverneur, Li, Szikszay, et al., 2021; Gouverneur, Li, Adamczyk, et al., 2021).

Although several papers have demonstrated that scores obtained from computer and mobile phone-based platforms and traditional paper-based VAS assessment are not interchangeable (Byrom et al., 2022), but yield comparable results (Byrom et al., 2022; Delgado et al., 2018; Kos et al., 2017; Whybrow et al., 2006), electronic implementations of VASs are not commonly used. More specifically, paper using electronic versions rarely share their software, such as Turnbull et al. (2020), and open source code to implement solutions is rare. In addition, research articles introducing electronic scales are outdated with broken download links, such as the Adaptive Visual Analog Scales (AVAS) (Marsh-Richard et al., 2009), or for specific use cases, such as the Visual Analog Scales Measuring State Anxiety (VAS-A) (Abend et al., 2014).

Therefore, we present eVAS, an open source Python software to easily implement an electronic VAS. It is available with built-in applications for all operating systems (Windows, Linux, MacOS), highly configurable and easy to use. A detailed description of the introduced scale can be found in the following sections.

Usage

The eVAS is designed to be as easy to use as possible, so that researchers without a background in computer science can use it. Standalone applications for Windows, Linux and MacOS are available from the following download page or the github release page. Simply download the appropriate software and double-click to run. The software runs without any additional files or requirements as such. The default use of the application allows the user to exit the software at any time by pressing Escape. On startup, the software checks for updates, then loads the full screen application, displays the scale and instruction message, and waits for user interaction. A recording can be started by pressing the space bar. The slider can then be moved left/right according to the user's feedback. The values are saved to a file throughout the session. As mentioned earlier, the user can stop the current recording by pressing the Escape key.

A screenshot of a possible appearance of the eVAS for pain assessment can be seen in Figure 1. Further examples are available at the following link, where the given configuration files can be copied to apply the specific scale.

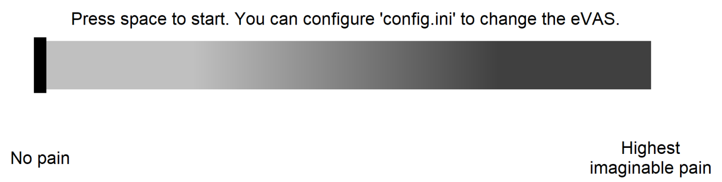

Figure 1: Default appearance of the eVAS.

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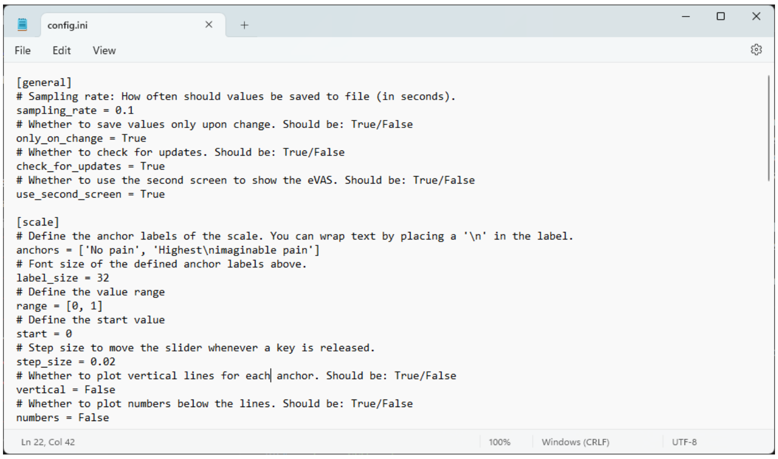
A text file ('config.ini') can be used to change the behaviour and appearance of the scale. Several parameters in the General, Scale, Devices, Keys, Appearance and CSV categories can be set directly in the text file. Each parameter has a short description that summarises its purpose and the changes that occur when it is modified. For example, keyboard or mouse control can be configured and even specific key mappings can be implemented. If no configuration file can be found, a default file is created at the start of the application, which implements a simple VAS for pain assessment. A screenshot of the beginning of the default configuration can be found in Figure 2. A list of all parameters can be found in Table 1.




```
[general]
# Sampling rate: How often should values be saved to file (in seconds).
sampling_rate = 0.1
# Whether to save values only upon change. Should be: True/False
only_on_change = True
# Whether to check for updates. Should be: True/False
check_for_updates = True
# Whether to use the second screen to show the eVAS. Should be: True/False
use_second_screen = True

[scale]
# Define the anchor labels of the scale. You can wrap text by placing a '\n' in the label.
anchors = ['No pain', 'Highest\nimaginable pain']
# Font size of the defined anchor labels above.
label_size = 32
# Define the value range
range = [0, 1]
# Define the start value
start = 0
# Step size to move the slider whenever a key is released.
step_size = 0.02
# Whether to plot vertical lines for each anchor. Should be: True/False
vertical = False
# Whether to plot numbers below the lines. Should be: True/False
numbers = False
```

Figure 2: Screenshot of the default configuration (config.ini).

Table 1: Parameters of the *config.ini* file.

Section	Name	Expected value	Default	Description
General	sampling_rate	float	0.1	How often should values be saved to file (in seconds).
	only_on_change	bool	True	Whether to save values only upon change.
	use_second_screen	bool	True	Whether to use the second screen to show the eVAS.
scale	anchors	list	`['No pain', 'High pain'\]`	Anchor labels of the scale.
	label_size	int	32	Font size of the defined anchor labels.
	range	list	`[0,1]`	List with two integers, defining the value range.
	start	int	0	Defining the start position/value of the slider.
	step_size	float	0.2	Step size to move the slider whenever a key is released.
	vertical	bool	False	Whether to plot vertical lines for each anchor.
	numbers	bool	False	Whether to plot numbers below the vertical lines.
devices	trigger_thermode	bool	False	Whether to trigger the thermode (QST.LAB TCS2).
	move_while_down	bool	False	Whether to move the slider while the button is held down.

Section	Name	Expected value	Default	Description
	use_mouse	bool	False	Whether to use the mouse (slider does not move with keys anymore).
	on_click	bool	False	Whether to update only on mouse click.
keys	keys_start	list	`[Key.space]`	Keys to start the recording.
	keys_end	list	`[Key.esc, Key.end]`	Keys to end the recording.
	keys_left	list	`[Key.left, Key.page_up]`	Keys to move the slider left.
	keys_right	list	`[Key.right, Key.page_down]`	Keys to move the slider right.
appear-ance	use_image	bool	False	Whether to load an external image as slider background.
	use_upper_im-age	bool	False	Whether to load an external image and place it above the slider.
	slider_width	int	31	Width of the slider.
	slider_height	int	138	Height of the slider.
	slider_color	list	(0,0,0)	Color of the slider.
	left_color	list	(192,192,192)	Background color left.
	right_color	list	(64,64,64)	Background color right.
	mid_color	list/None	None	Background color mid.
	use_triangle	bool	False	Use a triangle instead of a square for the background.
	use_two_tri-angle	bool	False	Use a decreasing & increasing triangle instead of a square for the background.
	welcome_mes-sage	string		Welcome message that is displayed at the beginning.
	hide_slider	bool	False	Whether to hide the slider until first user interaction.
csv	delimiter	string	;	Delimiter used in the CSV output file.
	decimal_point	string	,	Decimal point used in the CSV output file.
	deci-mal_places	int	4	Number of digits after the decimal point for the slider values saved.

Measured feedback from the eVAS is stored in a CSV file for ease of use. The resulting files consist of two columns, 'secs' and 'values', containing an entry with the measurement and an associated timestamp in seconds. The delimiter and floating point are set to the European standard, a semicolon and comma respectively, but can be changed in the configuration. In addition, the frequency and whether values should be saved only on change can also be set in the config.ini file. The timestamp in seconds is stored to two decimal places, while the values are freely configurable. The resulting file names contain the start time in the format "year|month|day_hour|minute|second_vas.csv", for example "20240206_093809_vas.csv". If the application is closed without recording any data, the empty CSV file is deleted on exit.

Although eVAS has been implemented to catch errors, unexpected errors are logged in a log.txt file. If no error is logged, the empty log file will be removed at the end of the eVAS instance.

Common errors, such as a corrupt config.ini file, are caught and useful information is provided to the end user via message boxes. A screenshot of an example warning displayed when the configuration file is incorrectly set up can be seen in Figure 3.

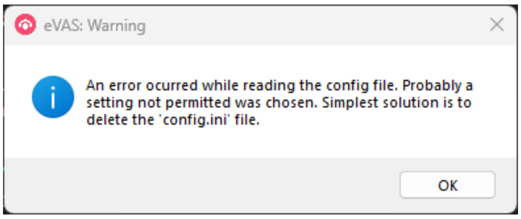


Figure 3: Warning if the config file is setup wrong.

To enable automatic deployment of new features and bug fixes, the software checks for new releases on GitHub at startup. If a new version is available, the user is notified and an automatic update can be performed (Windows only).

Researchers are welcome to contribute on GitHub, open pull requests, implement their own versions and deploy them using the provided scripts to build the executables using PyInstaller. The application and scripts have been implemented and tested using Python 3.12.

The idea and first implementations of eVAS were realised in the course of the BMBF project *PainMonit* ('Multimodale Plattform zum Schmerz-Monitoring in der Physiotherapie', 01DS19008A/B). Here, the task of building automated pain detection systems in the physiotherapy context showed a clear need for a digital yet easy-to-use tool. As we focused on providing a simple application that could be used by researchers of any background, we did not make the software available on the Python Package Index or related repositories. Knowledge of Python should not be a requirement for end users, so eVAS is available as standalone software running on Windows, MacOS and Ubuntu. Previous implementations of the software have been used to collect data for pain-related studies (Luebke et al., 2024; Szikszay et al., 2022, 2023). By creating easy-to-use Python software, we hope that eVAS can help researchers to easily conduct their experiments and collect subjective feedback from subjects.

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