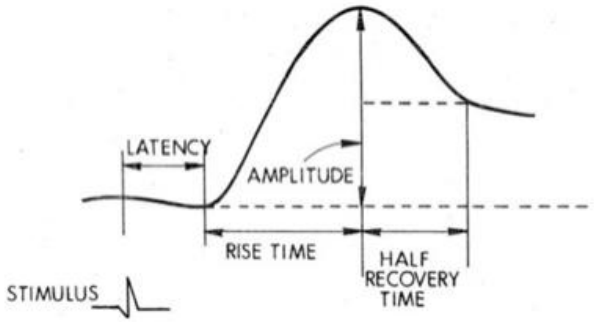
Electrodermal Activity Artifacts Labelling Instructions

Electrodermal activity definition

Electrodermal activity (EDA) is a direct measure of the sympathetic nervous system activation, which reflects the reactions of the human body to stress, emotions and engagement with an activity [1]. The main characteristic of EDA are skin conductance responses defined as follows.

Skin Conductance Responses (SCRs) definition

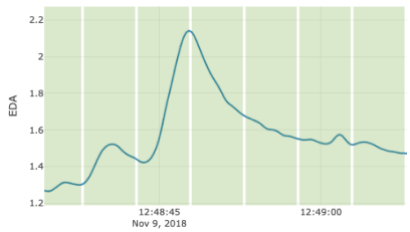
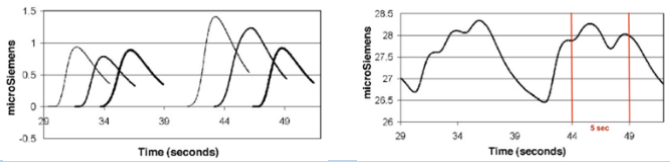
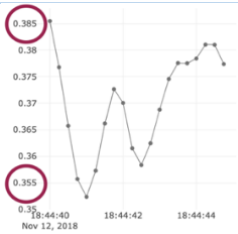
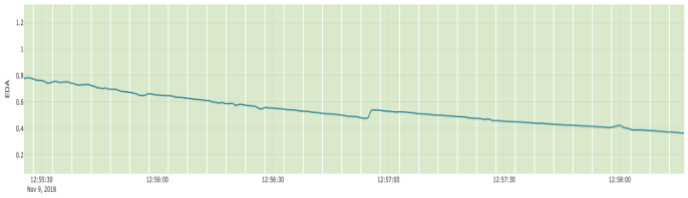
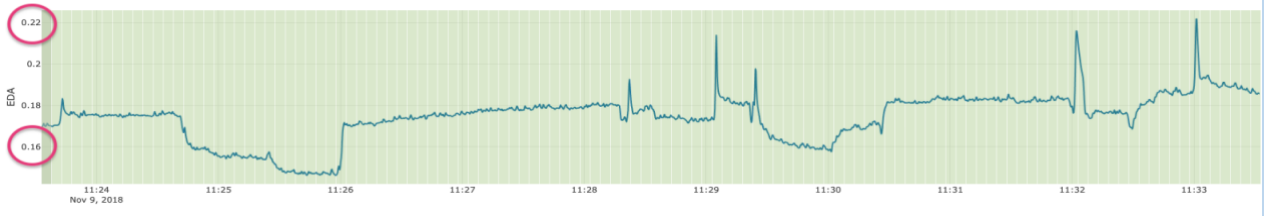
As of Boucsein [1], a SCR typically lasts between 1-5 seconds, has a steep onset and an exponential decay or recovery, and reaches an amplitude of at least 0.1 µS [2] similar to the figure as follows.



SCR specifications [3]:

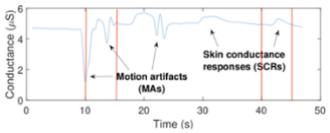
- SCR **amplitude**: **0.1 – 1.0** μS
- SCR **rise** time: **1-3** seconds
- SCR **half recovery** time: **2-10** seconds

Examples of clean EDA signal

Clean SCR peak	Overlapping SCR peaks [5]
	Overlapping SCRs are when two peaks are very close to each other in a short time period so that the decay of the first peak is interrupted by the second peak. 
Fluctuations (where EDAmax – EDAmin < 0.1 µS)	**No response**
	
Fluctuations (where EDAmax – EDAmin < 0.1 µS)	
	

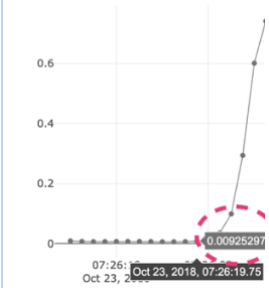
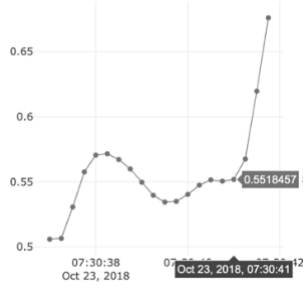
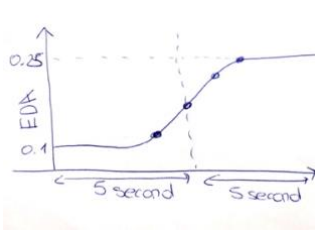
Artifacts definition

"Artifacts are defined as changes in the recorded bio-signal, which do not stem from the signal source in question. Instead, they may result from the recording procedure or from physiological responses in systems other than the electrodermal one." [1] The figure on the right shows as example of artifacts generated by movement of the sensor or the participant.



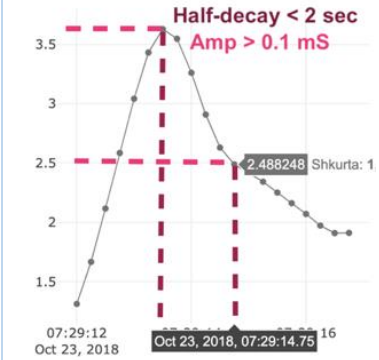
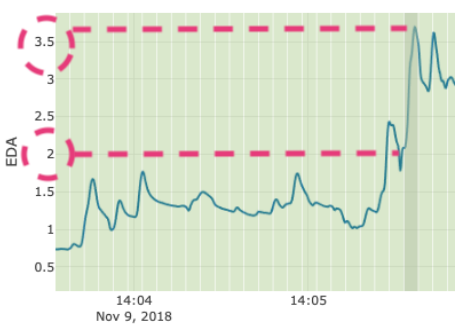
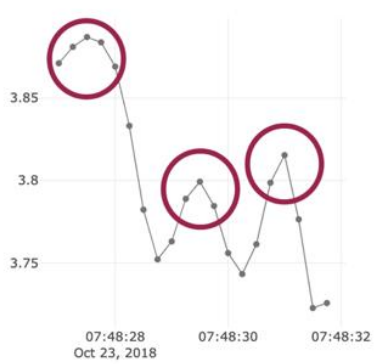
The following are the rules you should apply to identify artifacts. The general rules look at the EDA signal in general e.g., whether it is out of range. The specific rules are only related to the SCRs in EDA, so whenever there is a peak you should apply the specific rules.

General rules for labelling artifacts in EDA signal

1. **EDA** is out of range [4] not within 0.01-100 μS	2. **EDA** rises more than 0.1 μS in less than 1 second* (or 4 EDA points)	3. **EDA** drops more than 0.1 μS in less than 1 second	4. When an artifact is interrupted by the 5-second segmentation
Artifact type: **EDA is out of range**	Artifact type: **EDA rises quickly**	Artifact type: **EDA drops quickly**	Artifact type: **Invalid-left/right**
			

*Note that 1 second is equal to 4 points because the sampling frequency of the EDA sensor is 4Hz.

Specific rules for labelling artifacts in SCRs

1. **SCR** drops more than 0.1 μS [6] in less than 2 seconds	2. **SCR** has an increase of more than 1.0 μS	3. There are 3 or more **SCRs** within a 5-second segment (only when the EDA > 0.1 μS)
Artifact type: **Peak drops quickly**	Artifact type: **Peak rises quickly**	Artifact type: **Peaks too close**
		

References

[1] Boucsein, W., 2012. Electrodermal activity. Springer Science & Business Media.

[2] Taylor, S., Jaques, N., Chen, W., Fedor, S., Sano, A. and Picard, R., 2015, August. Automatic identification of artifacts in electrodermal activity data. In 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 1934-1937). IEEE.

[3] Dawson, M.E., Schell, A.M. and Filion, D.L., 2007. The electrodermal system. Handbook of psychophysiology, 2, pp.200-223.

[4] Kleckner, I.R., Jones, R.M., Wilder-Smith, O., Wormwood, J.B., Akcakaya, M., Quigley, K.S., Lord, C. and Goodwin, M.S., 2018. Simple, transparent, and flexible automated quality assessment procedures for ambulatory electrodermal activity data. IEEE Transactions on Biomedical Engineering, 65(7), pp.1460-1467.

[5] Alexander, D.M., Trengove, C., Johnston, P., Cooper, T., August, J.P. and Gordon, E., 2005. Separating individual skin conductance responses in a short interstimulus-interval paradigm. Journal of neuroscience methods, 146(1), pp.116-123.

[6] Zhang, Y., Haghdan, M. and Xu, K.S., 2017, September. Unsupervised motion artifact detection in wrist-measured electrodermal activity data. In Proceedings of the 2017 ACM International Symposium on Wearable Computers (pp. 54-57). ACM.

[7] Hernandez, J., Riobo, I., Rozga, A., Abowd, G.D. and Picard, R.W., 2014, September. Using electrodermal activity to recognize ease of engagement in children during social interactions. In Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing (pp. 307-317). ACM.