FaceReader: Best practices when creating custom expressions

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INTRODUCTION TO CUSTOM EXPRESSIONS

FaceReader™ allows the researcher to analyze 7 basic emotional expressions (happiness, scare, anger, surprise, sadness, disgust, and contempt) and a neutral state, but of course many more expressions exist. According to the interesting paper of Cowen and Keltner [1], there are 28 naturally occurring expressions that can be distinguished by humans. Because many emotional expressions are dependent on the context and population, it can be beneficial to create your own custom expression that suits your application perfectly .

With the custom expression editor, you can use Action Units (AUs) and other metrics for this exact purpose. Because you create your calculation beforehand, you can see the response right away and treat the custom expression as any other expression. This will also save you a lot of post-processing time. This white paper will provide some best practices and advice to help you along.

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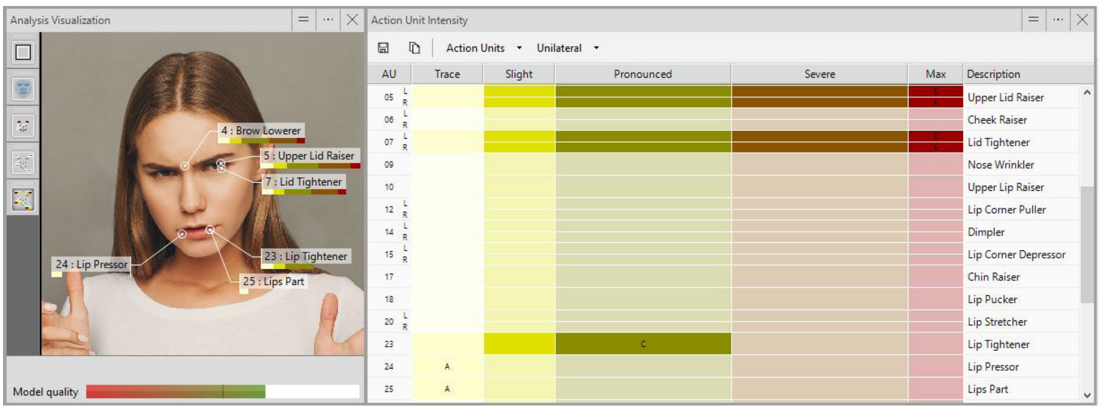
HOW TO GET STARTED

Custom expressions are available in the Action Unit module of FaceReader. It allows you to add different input blocks (e.g. Action Units, basic emotions, or head orientation), and processors (mathematical, logical, and temporal operators) to create a formula that is calculated in real-time during analysis. For practical information on how to create custom expressions, see the FaceReader user documentation.

To decide what your formula should look like, it is advised to consult relevant research or use your own dataset. That way you can find out what activations are relevant for the expressions you want to create.



THINGS TO CONSIDER

NOT ALL ACTION UNITS ARE ACTIVATED AS EASILY

This is due to natural variation in expressions. There are also individual differences. Some people show certain activations more clearly than others. There is also some variation in how accurate FaceReader is for each Action Unit [2,3]. Thus, it can be the case that for one person your calculation will be more sensitive than for another.

ACTION UNITS, VALENCE/AROUSAL, BASIC EXPRESSIONS, AND HEAD POSE ARE CREATED AND SCORED DIFFERENTLY

Think about the input you are combining (e.g. valence already includes basic expressions). If you choose to combine different types, you may also want to re-score them. Think about whether you want your output to be, for example, between 0 and 1 or -1 and 1, or not limited to a certain window.

ACTION UNITS HAVE DIFFERENT INTENSITIES (A, B, C, D, E)

You may not always be interested in the maximum output. If you are developing a custom expression, try to find a few prototypical forms and see what the intensities are. It may be that a B activation is typical for your expression, but D very untypical. Take this into account when developing your custom expression.

THINK ABOUT THE SETTING IN WHICH YOUR EXPRESSION OCCURS

Since expressions have overlapping Action Units, it may be that your custom expression score also reacts to a related expression. This is not necessarily a problem, especially if the related expression is very unlikely to occur in your setting.

PRACTICAL TIPS

- **You may want to turn smoothing off.** Smoothing spreads the activation of the Action Unit across time, this creates a less noisy signal. However, if you do this for each AU before you create a custom expression you risk losing relevant signals.
- Increase **certain values** to let them contribute more to the output. If the maximal prototypical expression only involves a C activation of an AU, let it contribute (e.g. 2x) more (than a D/E score). If a stronger activation does not fit the expression, change higher activations to 0 (zero).
- Do not use an action unit that **seldom activates** in the calculation of an average of action units, since it will always drive down the value of the output. You can set a threshold with the logical processor 'If ... else' to only include it if it reaches a certain threshold. Or you can scale it, so the value will be higher.
- If two AUs are very similar, **use OR** to let either activate the output or **use the MAX** value of the two AUs. This will increase the ease to pick up on the expression, but may also increase false alarms. The OR function can also help if the expression comes in two opposing forms (e.g. mouth open or closed).
- If your custom expression is getting **too complex**, consider creating a custom expression that you can use within your custom expressions (e.g. there are also custom expressions that are the AUs for the head movements).
- Check how activation of AUs affect the output to **check if your calculation is correct**. FaceReader includes an input simulator for simulating the calculation.
- **Test your custom expression** with several people, to see if you can get the desired effect.

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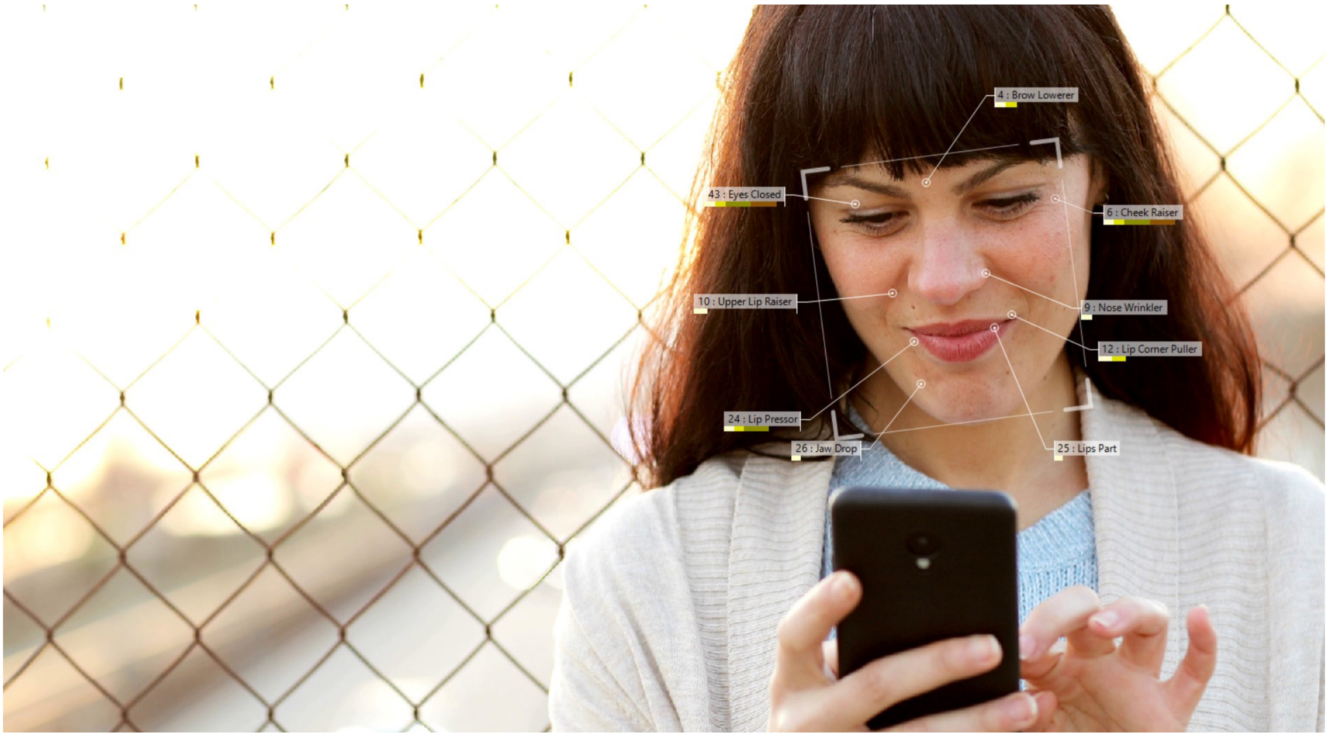
CONCLUSION

With these practical tips in mind, the custom expression tool opens a window of opportunities. You can create your own expressions, but there are also several custom expressions available as an example to experiment with. The examples given here, show how a useful custom expression can be created, and what considerations to keep in mind. You can also share your creations and let other researchers easily replicate your findings. If you need more help with creating custom expressions, you can always enlist the help of our consultants.



CUSTOM EXPRESSION EXAMPLES

Happiness is the only positive expression in the basic emotions, however, happiness comes in many different forms. A useful way to differentiate happiness is by smiling and laughter.

SMILING & LAUGHING

Description

Happiness is the only positive expression in the basic emotions, however, happiness comes in many different forms. A useful way to differentiate happiness is by smiling and laughter. Smiling can have several causes; however, laughter is usually seen when someone is really amused. In the example, we have operationalized smiling as lip corner pulling with mouth closed and laughter as lip corner pulling with mouth open.

Considerations

It is important to consider which AUs absolutely must be activated in order to activate the expression (see for example the paper by Drack *et al.* [4]). In addition, some AUs may be especially relevant for an expression or generally score lower and can therefore be scaled up to contribute more. Higher activations sometimes do not contribute more (AU12 D activation without mouth open is not likely), therefore you can let the calculation go over 1 and limit it. Since AU25 is more common in laughter, but sometimes AU26 is seen you can include whichever scores the highest. The thresholds are set in a way that smiling and laughter are (almost) mutually exclusive. You can set the threshold higher to reduce false alarms, or lower to find more small traces of smiles.

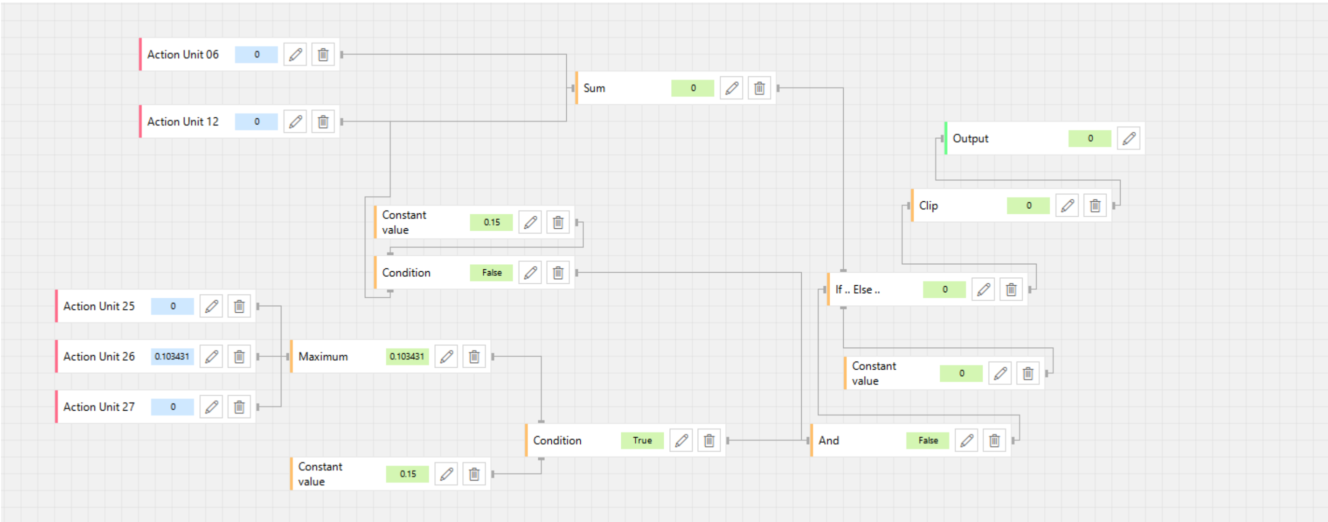
Limitations

When people are talking, it can sometimes appear like they are laughing.

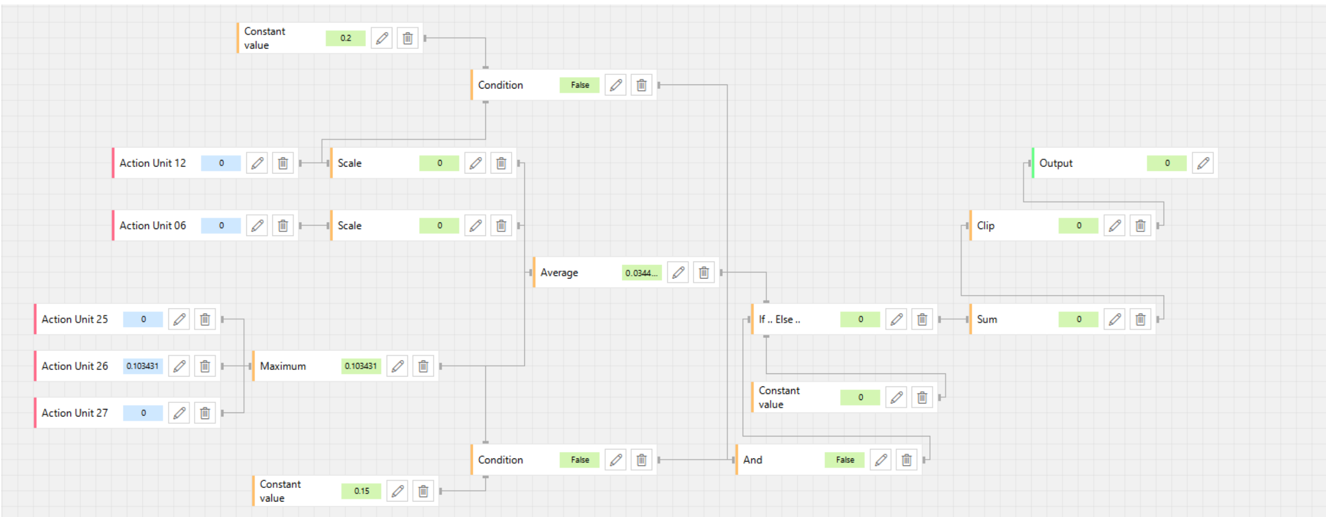
Basic calculation

- *Smiling:* Sum of AU12 & AU6, only if AU12 is higher than 0.15 and AU25/26 is lower than 0.15. Since the minimum value of smiling is then 0.15, it is rescaled to 0, the maximum is clipped to 1. The AU input is raw, but the output has a temporal average for smoothing (200 ms).
- *Laughter:* Average of (AU6 x 1.5) & AU12 & Max(AU25/AU26), only if AU12>0.15 & Max(AU25/26) > 0.217 (B). Then the same rescaling and smoothing steps as in smiling are followed.

Custom expression for smiling.



Custom expression for laughter.



ATTENTION

Description

It is relevant to know if someone is focusing their attention on the screen. A way to estimate this is by looking at the head orientation and position. When someone has their head close to the screen in a central orientation it is assumed they focus their attention on what is in front of them.

Considerations

Based on examples, you can estimate when a certain degree of pitch or yaw makes it unlikely someone is focusing attention. You can take the absolute value of pitch/yaw because it doesn't matter if the head moves left/right. You can create a dichotomous score simply illustrating attention by creating a threshold with 'if...else' statements. You can also create a continuous score (0-1), where moving away from the center reduces the value. In the example, we have also included the distance of the head to the screen. However, because people who are further away are likely less attentive, but not completely looking away, head position counts less strongly towards the total calculation.

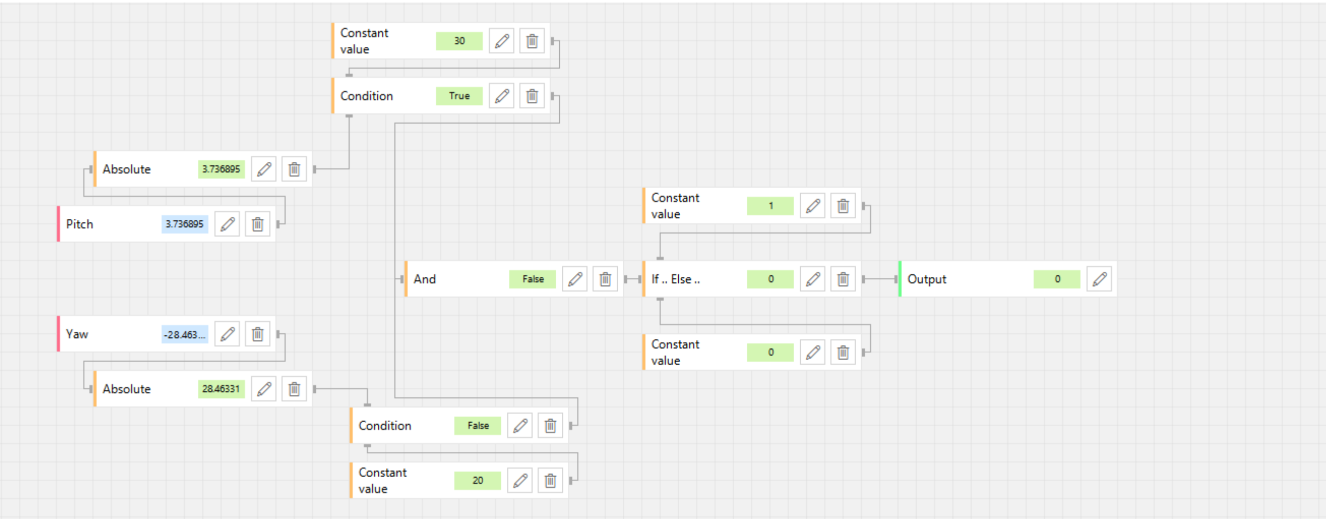
Limitations

Orientation of the head is determined in relation to the camera, so in cases where the camera placement is below or to the side of the face, it will appear as if attention is low. It does not include eye gaze, so if someone would focus their eyes on the screen but moves their head this is scored as no attention.

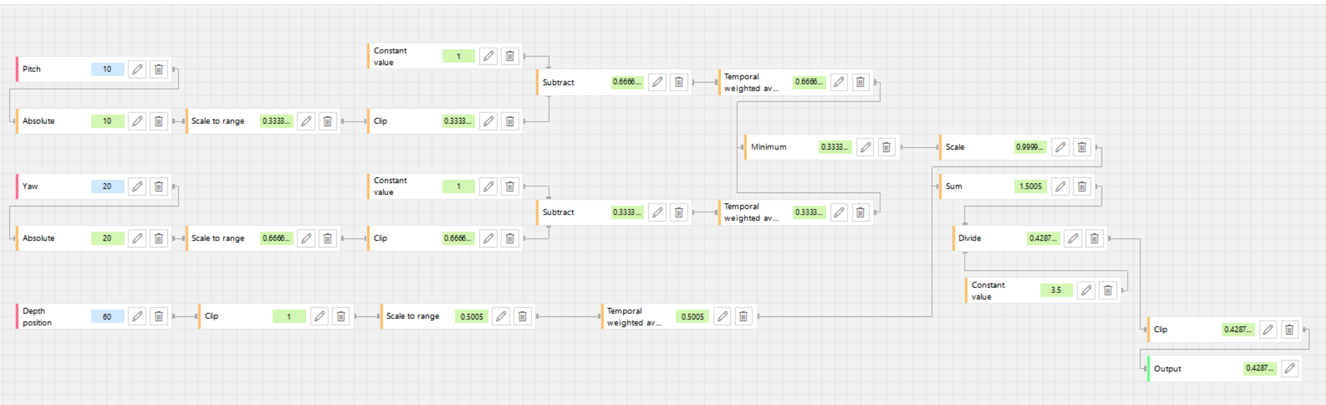
Basic calculation

- *Attention (binary):* IF absolute(pitch)<30 AND absolute(yaw)<20 = 1.
- *Attention:* Pitch/Yaw-rescaled = rescale the absolute(Pitch/Yaw) from 5-35 to 0-1 (ignore small/extreme movements) + (temp average for smoothing). Depth-rescaled = rescale Depth position from 500-1500 (mm to screen) to 0-1. Take the ((max of the Pitch/Yaw-rescaled x 3) + Depth-rescaled)/4. Then invert 0 and 1 (1 – ...) so that high scores mean high attention.

Custom expression for Attention with binary value as output.



Custom expression for Attention with continuous value as output.



BLINKING

Description

Blinking is a relevant psychophysiological metric that is scored in FACS as AU45. Blinking is quickly (within less than 0.5 second) closing and opening the eyes.

Considerations

Blinking uses the temporal elements of the custom expressions. You can determine the length of time for it to be a blink (100-150 ms) and how much the eyes need to be closed. It is important that smoothing of AU43 is turned off, otherwise it will be difficult to measure the fast change in AU43.

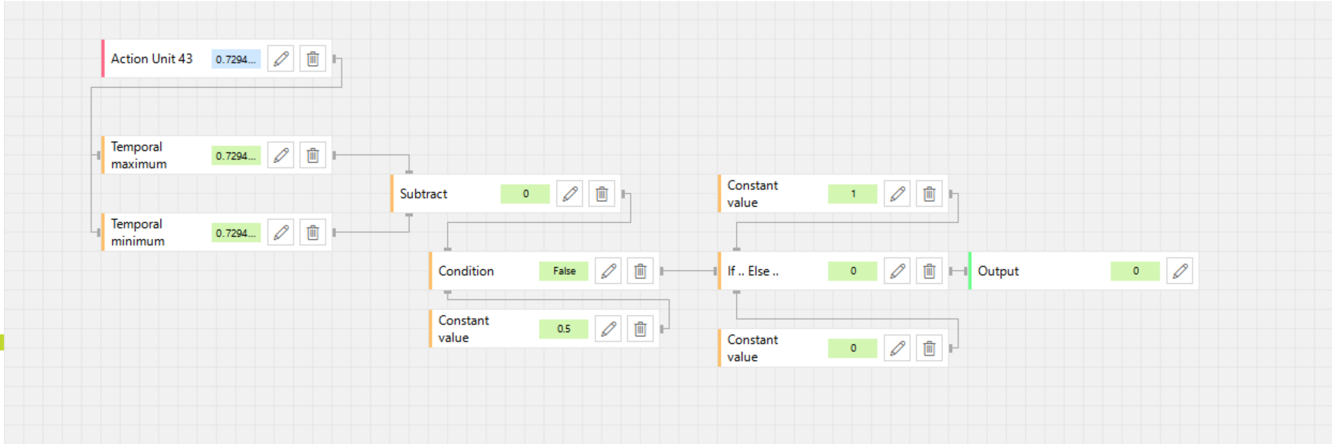
Limitations

High-quality videos are needed to capture the timing of a blink. If the lighting quality is low (e.g. producing shadows near the eyes) or the framerate is low (e.g. with 15 fps, a frame is only captured every 67 ms), blinks will not easily be detected.

Basic calculation

If (Max of AU43 – Min of AU43 during 200 ms) is bigger than 0.6 then = 1 (otherwise 0).

Custom expression for Blinking.



REFERENCES

1. Cowen, A. S., & Keltner, D. (2019). What the face displays: Mapping 28 emotions conveyed by naturalistic expression. *Am Psychol.*, **75(3)**, 349–364.
2. Noldus White Paper – Validation Action Unit Module. This white paper can be requested from your Noldus sales representative.
3. Lewinski, P., den Uyl, T. M., & Butler, C. (2014). Automated facial coding: Validation of basic emotions and FACS AUs in FaceReader. *Journal of Neuroscience, Psychology, and Economics*, **7(4)**, 227–236.
4. Drack, P., Huber, T., & Ruch, W. (2009). The apex of happy laughter: A FACS-study with actors. *Current and Future Perspectives in Facial Expression Research: Topics and Methodical Questions,* 32–37.

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