

Introduction to the assignment

This week, we're continuing to learn about and contemplate an emerging technology that involves using EMG sensors to detect facial expressions (see the [description of the last assignment for more details](#)). While we're focusing on EMG (because the signals are fairly easy to see without complex analysis or lots of data), many of these techniques and questions can be applied to other technologies (facial expression recognition, EEG, and many other biometric sensors, or even things like environmental sensor).

Here's the suggested way to go through this week's assignment:

1. Read through this entire document.
2. Write yourself a note about what your learning goals and/or desired behaviors are for this week (in the context of this class)
3. [Sign up as working on Option A, Option B, or both. Note whether you prefer to work independently or collaboratively.](#) (Make sure to use the Week 11 tab!)
 - a. If you prefer to work collaboratively, please reach out to others interested in the same. We'll try to do sign-up at the end of class, so that people can coordinate quickly.
4. Check out at least one of the resources in Part 1. Everyone will look at at least one of these, then we'll discuss in class next week and share out.
5. Work on Option A or Option B (or both if you want in whatever ratio or configuration that makes sense with your other commitments and interests).
6. Write a reflection on your learning goals and/or intended behaviors (noted at the beginning of the week). Submit this on Canvas in this assignment. You are also welcome to submit other documentation if you like to use Canvas as a record or you want me to look at something.

In this assignment, it's not essential to do Part 1 before Part 2 (especially if you're doing the data analysis option), so feel free to do these in whatever order you want.

General commentary on assignment

You are welcome to collaborate on any parts of this assignment (might be more fun, but adds schedule complexity).

You should try to spend an appropriately scaled amount of time on this work to support your learning (recognizing that you may need to scale down your overall work time due to other obligations). You don't need to finish everything. Do what's right for your learning and your physical and mental health.

This is about learning, making connections, and having fun. While we're working on a specific example here, this type of contextual thinking and general analysis process are used for lots of areas. If you're having trouble connecting this to other things, talk to Sam.

If you're feeling stressed about this assignment or the flexibility, feel free to reach out to Sam (Zoom chat is probably the easiest).

Part 1: Learn about privacy from various perspectives (everybody)

Check out one of these resources that discuss privacy, security, and ethics in relation to online personal data. These resources are focused on different applications and also approach this topic through different lenses (policy, technical, and ethical). You are welcome to check out more than one of these, but don't feel obligated to do so.

In class, we will divide up into groups based on these resources and create a highlight reel (slides, clips, whatever works) for the rest of the class (so you'll get a taste of all of these). It might be helpful to have this in mind as engage with the resource (e.g., note important times or points). Please also think about how these topics specifically relate to biosensor data (such as facial EMG).

- Brookings Institute discussion on online privacy regulation from July, 2018. [~1 hour] <https://www.brookings.edu/blog/techtank/2018/07/30/how-should-the-us-legislate-data-privacy/> There is a video of an expert panel discussion between people who have worked in industry, research, and policy. There are some moments that are a little acronym heavy, so you may need to pause to look up a few of the terms (they usually policy or government acronyms).
- A blog post by BitBrain titled "Avoiding brain hacking - Challenges of cybersecurity and privacy in Brain Computer Interfaces" [30-60 minutes... I struggle to estimate reading time] (<https://www.bitbrain.com/blog/cybersecurity-brain-computer-interface>) This post talks more generally about brain-computer interfaces (especially using things like EEG), and discusses potential scenarios and impacts related to hacking.
- [Voices of VR Podcast titled "XR Ethics: An XR Ethics Manifesto"](#) by Kent Bye. [30 minutes]. Kent Bye hosts a podcast about mixed reality (XR), and lately he has been really digging into questions of privacy through a series of awesome interviews. This has culminated in his XR Ethics manifesto. While he's talking about these topics in the context of mixed reality, a big piece of this is the sensors that can be incorporated into this, including biosensors (it's pretty likely that these devices might have facial EMG sensors sometime in the future). You can either listen to this in podcast form (woo, no screens) or watch the video with the slides, which can be a nice supplement (but aren't necessary for understanding).

Throwback Sidebar: This new paper on lie detection with fMRI just came out. You don't need to read it, but you might enjoy just reading the abstract.

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230837>

Part 2 (Option A): Consider design decisions for a specific application of EMG expression recognition.

You're working on a team that will integrate a sensor like EMG into a wearable device. One reason to use EMG is to detect expression when a person's face is obstructed or it doesn't make sense to have a camera pointed at it (people wearing protective gear, VR headsets, winter clothes, etc). Chat Sam M. if you're having trouble thinking of a feasible application.

- 1) Choose your product/application. The application should involve the collection of sensor data (ideally EMG or EEG) from people and use of this data to estimate their state (e.g., smiling, happy, paying attention, grimacing) by implementing some kind of analysis and classification. You don't have to choose something that you know is feasible, but you should choose something that falls into this general framework.
- 2) Describe what your application of this technology is intended to do and who the audience is, plus who other stakeholders might be.
- 3) Take a first pass at describing the technology at a very high level (think a system diagram, and it's okay to have some ambiguous parts that are done via magic, just note this).
- 4) Determine what type of data would need to be collected.
- 5) Come up with other ways these data might be used beyond your intended purposes.
- 6) Brainstorm strategies to provide users with your application/service while best protecting their privacy.
- 7) Think again about your application and add some details about one specific user experience (e.g., I am using this application during Zoom meetings to alert me when I need a break). Determine how often your classifier should be making a decision about the person's state (e.g., every 5 minutes). For some applications, this is very frequent, for others the pace is slower. Determine how many decisions this is per hour of use (or some other time period if more appropriate).
- 8) Determine what the possible decisions your classifier could make (e.g., needs a break; doesn't need a break; uncertain).
 - a) Map out the effects of each decision when correct or incorrect (think confusion matrix, but now what are the effects of getting things right or wrong). For example, it might be more annoying to get told you need a break when you don't than getting told you don't need one when you do.

- b) Consider the implications of any differences here. Are there times where mistakes are more costly?
- 9) How well do you think your classifier needs to do (e.g. accuracy) to make a technology that's feasible for your users.

The output of this can take whatever form works best for you. I can imagine this being slides, a write up, some physical artifacts (pictures of these would be cool). I'd love to see what you worked on.

Part 2 (Option B): Smile/Frown Classification with Machine Learning

In this part of the assignment, you'll attempt to classify whether a hilarious person is smiling or frowning, based on essentially the same data that you saw last week. Now we're using machine learning to actually classify. This builds on some of what you learned for assignment 5, but now we are starting with data that is a bunch of values over time. In order to get interesting features for our classifier, we want to do some calculations to pull out what might be informative in this data, instead of plugging in all of the raw data. For example, we might want to look at the maximum value in our signal during the time period (epoch/trial) of interest.

This guided notebook has a lot of code and commentary, but doesn't actually require you to write very much code on your own. After we use some code to pull out the potentially interesting features, you can either use the Classification Learner app that we used in assignment 5 or a code version that I have provided. This code is a bit more generalized than some other code you may have seen in class, since it's actually built on a simplified version of code that my lab is actually using for some analysis. I've included a pdf link with some "answers" to help provide guidance if you get stuck. Please put comments and questions on this, or zoom chat me with questions.

The guided notebook is here:

https://drive.google.com/open?id=1JsN_UcPOflupkzrrOlwLhnAy1LdtQojl

The data are here:

https://drive.google.com/file/d/1XUEKdgr_DO7ynMsPI7Lv4AS-CutLxcRZ/view?usp=sharing

The pdf version of the notebook with some extra "answer" code is here (add comments/questions):

<https://drive.google.com/open?id=1ijAhcAsHPLyIVc-7H24CjYbjEq16DF0S>

A place to summarize your findings:

https://docs.google.com/spreadsheets/d/1F_whsg_i4gdsWVZlnwZTS1SmB0LT2RUFdVN-AfAxz1o/edit?usp=sharing

Part 3: Submit your reflection

It's really helpful for me to hear about your experiences so that I can get better at this. And I think it's valuable for you to reflect on your week and work.

For your reflection, please discuss (use these prompts as appropriate for you):

7. What were your initial goals (that you set at the beginning of the week)? How well did you progress toward them? How did they change (if applicable)?
8. What did you do for neurotech this week (what did you work on)? You don't need to break down each piece of the assignment into extreme detail, but it would be helpful to hear something like: "I read both of the suggested papers and took notes for class discussion. Then I worked on the data analysis part of the assignment because I want to build these skills. I made it through the book chapter with the example dataset. I started to work with the fEMG data set and was able to make the time series plots, but I ran out of time before I could do the statistical comparison part."
9. What is one thing that you learned this week?
10. What did you like about this assignment, and/or what suggestions do you have to improve the assignment?
11. What did you like about how you engaged this week and/or what would you like to change next week?

You can also submit other aspects of your work (code, slides, etc), but please be sure to at least submit your reflection in the Canvas assignment. Thanks!