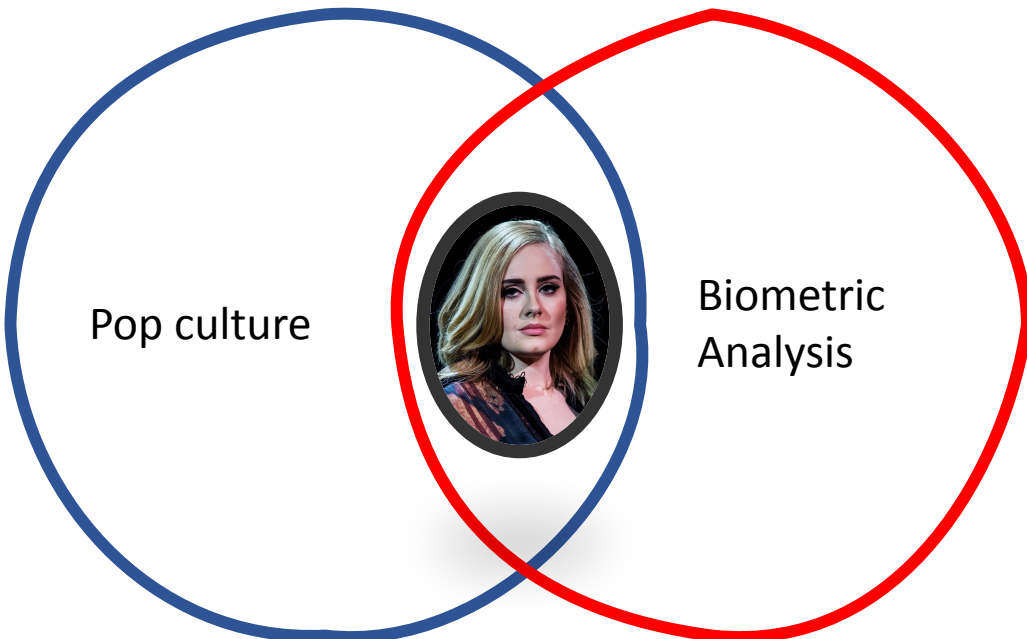


Introduction to ADELE

(Automated Documentation to Extract Learning from EEG)

and

Semester Plans



Agenda

- Overview of ADELE
 - data processing
 - current/future plans
- Entrance survey
- Expectations and Goals
- Deliverables

ADELE (Automated Documentation to Extract Learning from EEG)

- Automate interpretable report generation for any event with biometric data
- Use machine learning to segment large event to digestible, 'interesting' sub-events
- <https://github.com/mi3nts/ADELE>

Example ADELE Report

Event: Scrolling Twitter

Clustering: KMeans, n_clusters = 5

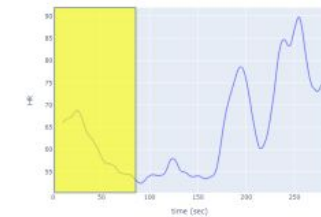
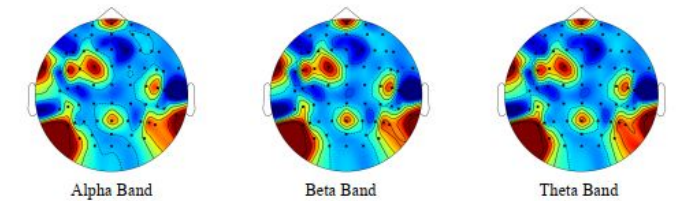
2020_06_04_T05_U00T

Cristian Garces, Bradley Krakar, Jesse Ladyman, Rami Jaber

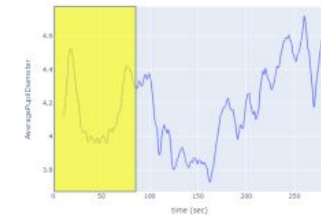
-- Table of Contents --

Cluster 0: from 1.288 to 161.46 seconds	2
Cluster 1: from 161.064 to 227.92 seconds	3
Cluster 2: from 227.818 to 246.98 seconds	4
Cluster 3: from 246.896 to 264.83 seconds	5
Cluster 4: from 264.514 to 283.068 seconds	6

Cluster 0: from 1.288 to 85.574 seconds



hey so you can start the timer click the button
and yeah
yeah
ah
mm
ah
it was like a
they like a the part of the avengers
where i'm
like everyone was coming back



Text Toxicity Analysis:
Toxicity: 0.828
Severe Toxicity: 0.012
Obscene: 0.073
Threat: 0.020
Insult: 0.042
Identity Hate: 0.017

Number of words: 47
Number of unique words: 32



P7: ba37L - Somatic Sensory Association Area - Involved in high level touch interpretation
C6: ba41R - Primary Sensory Cortex - Main receptive area for the senses, especially touch
FT9: ba20L - Auditory Association Area - Responsible for high level processing of sound, such as memory
P2: ba07R - Somatic Sensory Association Area - Involved in high level touch interpretation
FC1: ba06L - Primary Motor Cortex - Executes Movement
Fpz: ba10L - Prefrontal Cortex - Involved in decision making and abstract thought
FC5: BROCLA - Primary Motor Cortex - Executes Movement

Objective

Create an *interactive* ADELE

- Local webpage
- Python

Background: Big Picture

- ADELE seeks to automate the interpretability of EEG and other biometric data by using machine learning techniques
- Why?
 - Autonomic nervous system - study involuntary reaction
 - Use machine learning for *actionable insights*
- How?
 - Measure brain signals and other biometric quantities
 - Relate high activity regions to Brodmann areas
- What?
 - Automated Report that visualizes above biometrics, and provides audio to text analysis to gain insight and study reactions

Background: Autonomic Nervous System

- Requires no conscious effort

- Blood pressure
- Rate of breathing
- Pupil dilation

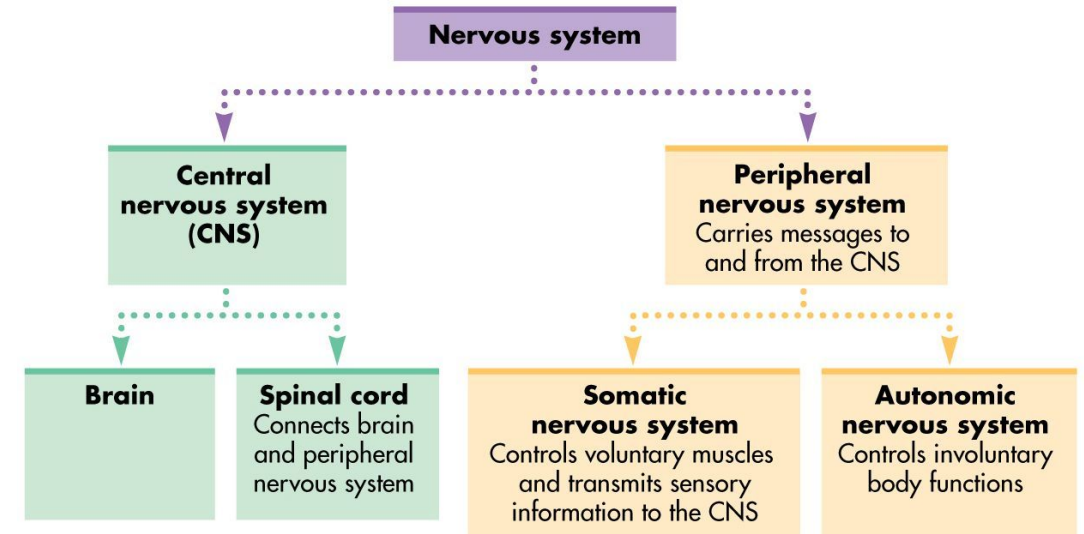
- Has two divisions

- Sympathetic

- Prepare body for stressful or emergency situations – **fight or flight**
- Increase heart rate and force of heart contractions
- Dilates airways and pupils

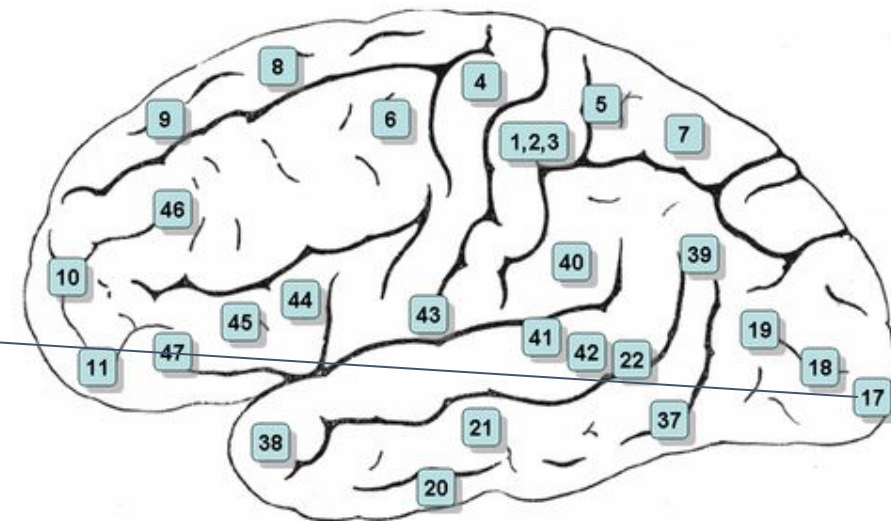
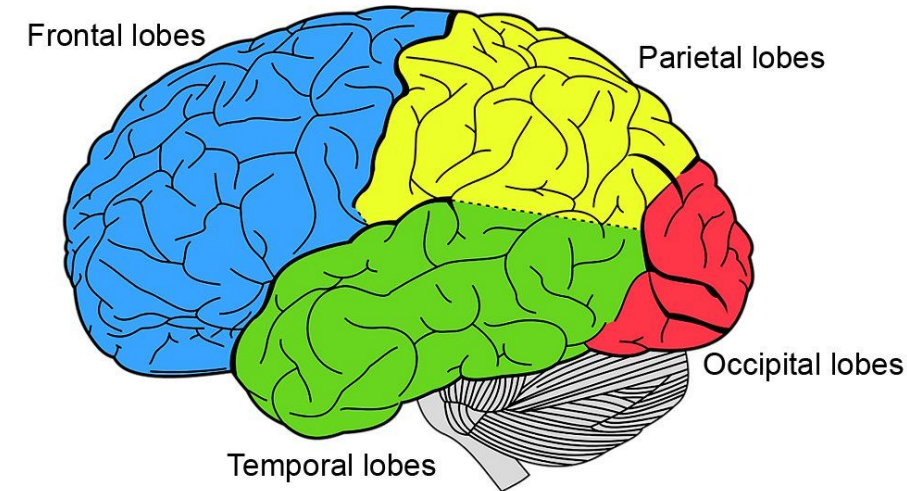
- Parasympathetic

- Maintain normal bodily functions during ordinary situations



Background: Brodmann Areas

- Cerebrum regions and processes:
 - frontal - personality, mood, social conduct
 - parietal - process language, spatial awareness
 - temporal - long-term memory, emotion
 - occipital - visual stimuli
 - cerebral cortex
- Cerebral Cortex consists of smaller regions labeled according to specialized functions
 - Brodmann areas
 - eg. BA17 - first stage of visual processing, lies in the occipital lobe
- We can relate Brodmann areas to electrode locations

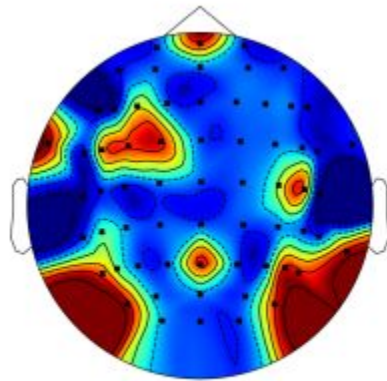


EEG Readings and Frequency space

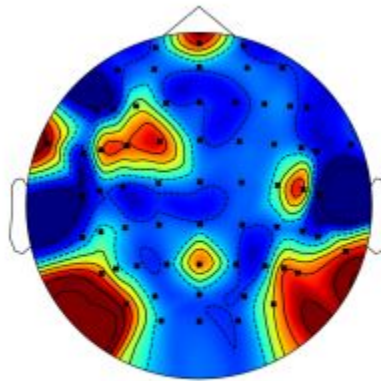
- Calculate power spectra using raw EEG readings (in microvolts) using Fourier transforms
- Frequency bands govern particular behavior
 - delta: 0.5-4 Hz
 - deep, non-REM sleep
 - theta: 4-8 Hz
 - focused, difficult cognitive tasks
 - alpha: 8-12 Hz
 - mental and physical relaxation, eyes closed
 - beta: 12-30 Hz
 - active concentration, anxiety

Brain Heatmaps from Frequency Spectra

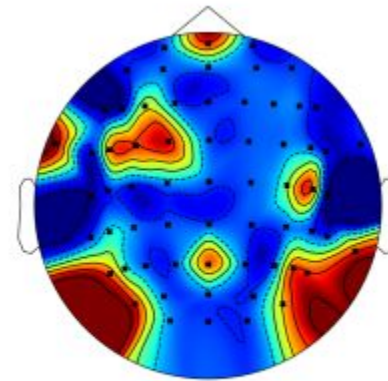
- Visualize brain activity
- Power spectra analysis:
 - For each electrode, find out which frequencies are most prevalent
 - Filter according to which frequency band to visualize
- Leads to Brodmann areas



Alpha Band



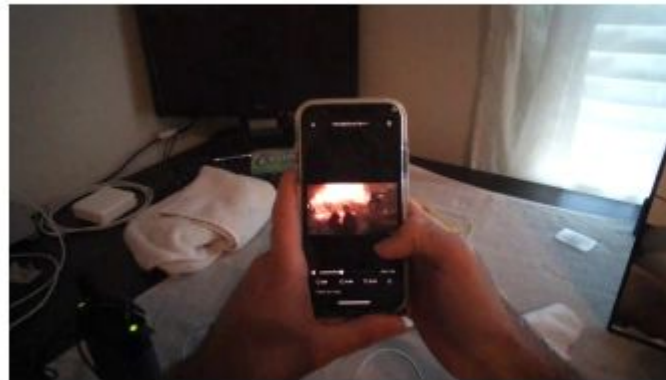
Beta Band



Theta Band

Brodmann Areas

- From brain heatmaps, we can recognize high-activity areas
- These are related to Brodmann areas and their known functions



```
'P03': 'ba19L',
'POz': 'ba17L',
'P04': 'ba19R',
'P08': 'ba19R',
'O1': 'ba19L',
'Oz': 'ba17R',
'O2': 'ba18R',
'REF': 'NAN',
'GND': 'NAN'

broadmanntoarea = {
    'ba01': 'Primary Sensory Cortex',
    'ba02': 'Primary Sensory Cortex',
    'ba03': 'Primary Sensory Cortex',
    'ba04': 'Primary Motor Cortex',
    'ba05': 'Somatic Sensory Association Area',
    'ba06': 'Premotor Cortex',
```

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PO8: ba19R - Visual Association Area - Involved in high level processing of visual stimuli
FC3: ba06L - Primary Motor Cortex - Executes Movement
F3: ba08L - Premotor Cortex - Involved in planning of movement
PO7: ba19L - Visual Association Area - Involved in high level processing of visual stimuli
Fpz: ba10L - Prefrontal Cortex - Involved in decision making and abstract thought
P8: ba37R - Somatic Sensory Association Area - Involved in high level touch interpretation

Audio To Text

- Analyze relationship between speech and biometrics
- Uses Vosk offline open-source speech recognition toolkit
- Pretrained model which takes in audio file as input and outputs the translated text
- Toxicity Analysis - Try to quantify how obscene, insults, threats, etc. from the translated text

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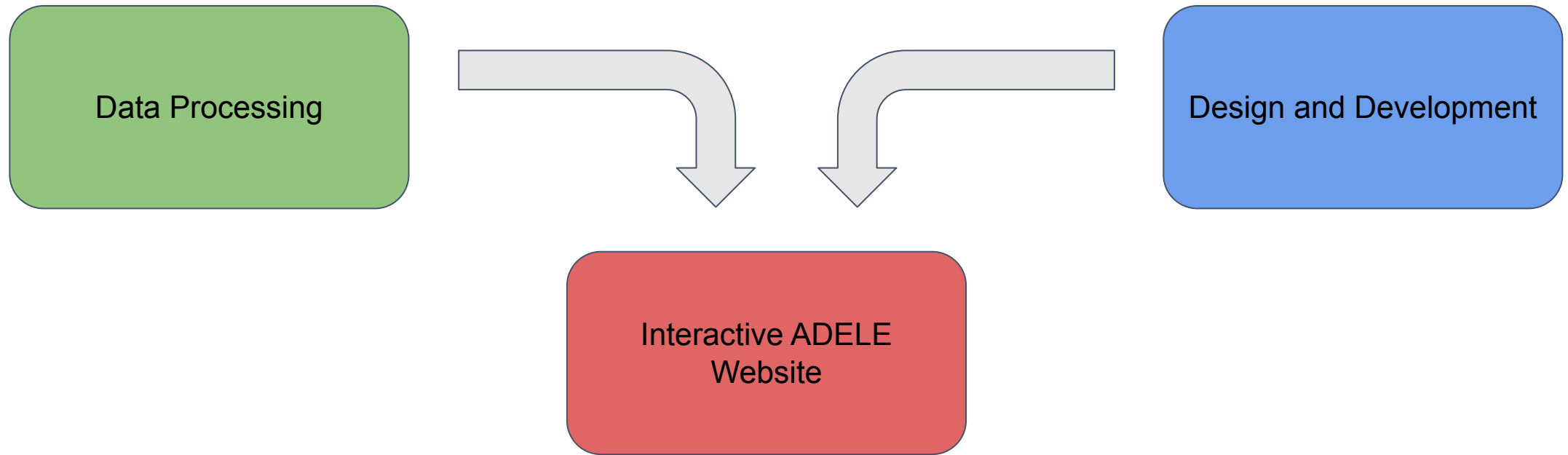
Identity Hate: 0.017

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Data processing

Teams



- At least two members per group

Entrance Survey

What attributes do you value most in a team?

5 responses

Communication and responsibility

Communication, hard work, and organized

Communication, Accountability, ability to take initiative, interested in the overall project development

Communication and planning

Cohesion, friendliness, punctuality, reliability, and helping each other grow.

What can we do to help you be successful?

5 responses

Offer guidance if the team is struggling

Be available to answer questions we might have and also have clear communication between everyone so we all understand each other and what needs to be accomplished.

be available

Help provide a general understanding of the expectations and efforts expected of our team working towards our goal.

Being given direction, some guidance, and clear goal.

Expectations

- Weekly meetings on Thursday 1pm
- ~7 hours/week
- Deliverables every week
 - use presentation template in repo
- When writing code:

```
% FUNCTION TO READ AIM2 DATA IN EEGLAB. DATA IS SAVED IN 3 FORMS: 1. EEGLAB  
% STRUCTURE 2. TABLE 3. TIMETABLE.  
  
% THE UNIVERSITY OF TEXAS AT DALLAS  
% MULTI-INTEGRATED REMOTE SENSING AND SIMULATION (MINTS)  
% CODE AUTHORED BY: SHAWHIN TALEBI  
  
% -----
```


Goals

- Sept. 24th
 - Acclimated, comfortable with project
- Oct. 22nd/29th
 - First draft of the app
- Nov. 18th
 - Final product, write report, make website

Deliverables

- Send github usernames
- Install python, set up IDEs
- Install dash-plotly python libraries
 - <https://dash.plotly.com/installation>
 - [Gallery of web apps](#)
- Pick an 'open-source' app and run it on your local machine