Algo-arias

Music and AI for Health

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Abstract

This project explores the exciting potential of merging music and technology to create a new frontier in personalized music therapy. Its focus is on harnessing the power of **Affective Algorithmic Composition (AAC)** to generate music tailored to an individual's emotional state in real-time.

Music has a profound impact on our emotional well-being and music therapy has proven effective in various healthcare settings. However, traditional methods of music therapy may lack real-time personalization to the degree of precision at which computers can generate it.

Imagine a system that "reads" your music taste through facial expression/mood as you listen to a variety of pre-selected music with various differing musical components. By listening to a curated selection of music with diverse elements like tempo, melody, and instrumentation, the system would analyze your facial expressions to understand which components resonate most with you. Then this same system would create personalized music that perfectly complements your unique taste in real-time, or to bring about some desired effect, e.g. calming down, uplifting mood, increase/decrease in neurotransmitters like serotonin, oxytocin, dopamine.

This is especially useful for patients diagnosed with Autism, Depression, Alzheimer's, Parkinson's, Dementia.

Research Goals

- How can AI technologies make highly effective and personalized music using computer vision techniques such as ***Facial Expression Recognition (FER)*** in conjunction with the knowledge of specific musical components such as rhythm, chord progressions, melodies, timbre, etc. in order to produce desired effects?

- How can we implement Facial-Expression Recognition (FER) algorithms as a tool to gather patient/user data?

- How can we implement automated music generation using ***Affective Algorithmic Composition (AAC)*** tailored to an individual?

- How can we assess the necessity and opportunities of this technology, with the goal of enhancing mental health therapy and patient care?

Introduction

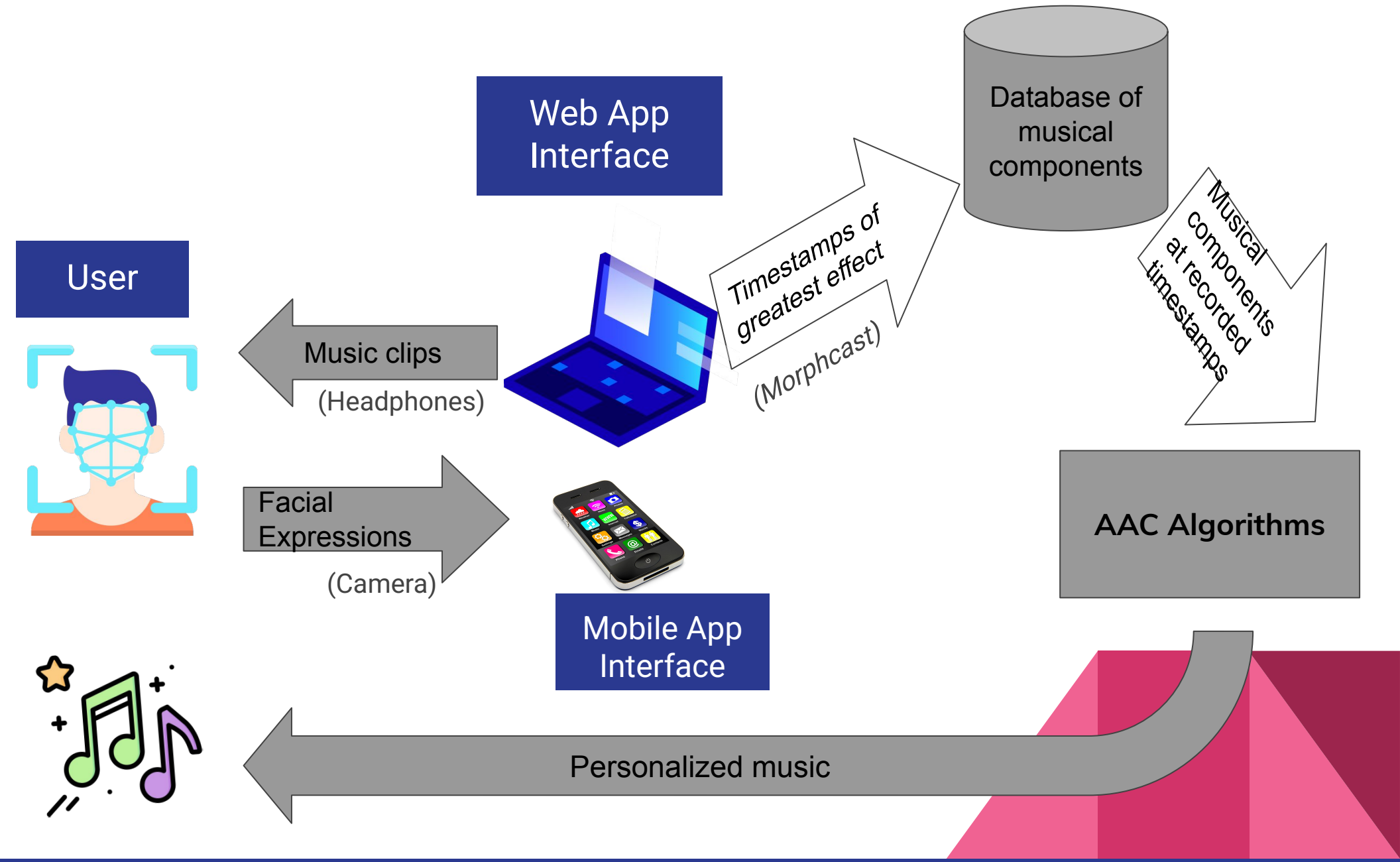
- Music's ability to evoke emotional responses is a well-established phenomenon that has been a subject of continuous investigation (Zaatar et al., 2024; Juslin et al., 2015; Conard et al., 2009; Panksepp et al., 2002). When we hear music, several brain regions work together to perceive the sound and determine the emotional feeling associated with the melody, allowing us to recognize the sound (Koelsch & Siebel, 2005; Moreno & Bidelman, 2014). This sophisticated process contributes to our ability to hear music and is also key to the mental well-being benefits that music can offer (Zaatar et al., 2024).

- With the advent of the study of music theory and more recent developments in sensory perception, research has found direct links between particular musical components and induced states of mind, such as loudness (Reybrouck et al., 2019), timbre (Quinto et al., 2013), tempo (Liu et al., 2018), and the major-minor dichotomy (Bharucha & Stoeckig, 1986; Carraturo et al., 2023). These characteristics are manipulated to fully harness the therapeutic power of music in diverse healthcare applications, ranging from pain alleviation in medical procedures (Nilsson, 2008) to aiding cognitive function in dementia patients (Särkämö et al., 2013; Edwards et al., 2023). Such non-invasive music-based interventions are globally being used more often, especially in surgery and the ICU (Lorek et al., 2023; Fu et al., 2020).

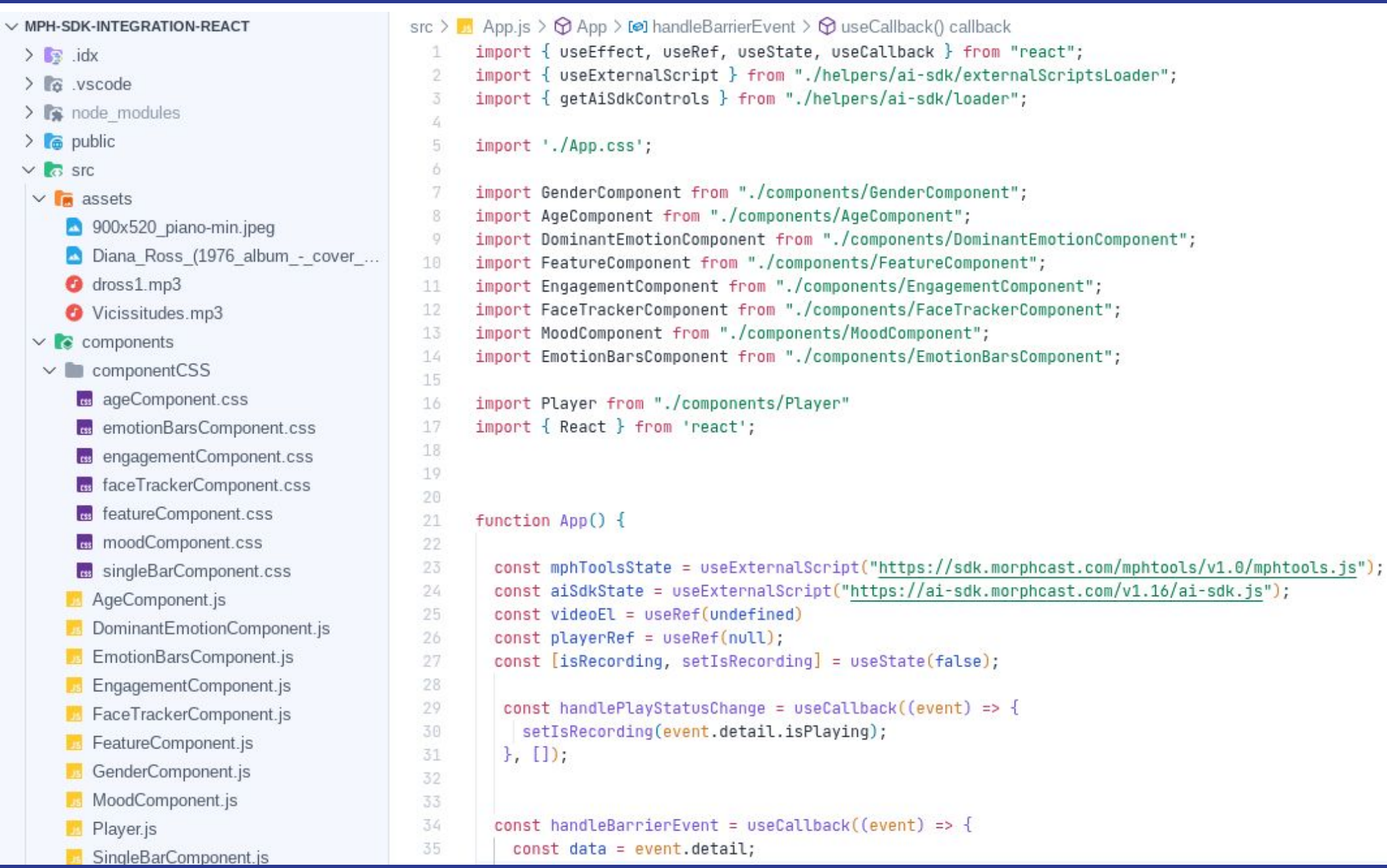
- In parallel, algorithmic composition is a growing field that offers a promising route for creating novel and engaging musical experiences tailored specifically to the individual brain (He, 2022). Affective Algorithmic Composition (AAC) exploits computer aid in order to generate new music with particular emotional qualities and affective intentions (Williams et al., 2017). Instead of relying on past listening history, which does not fully capture a person's evolving tastes or immediate emotional responses, using real-time metrics can lead to a more adaptable approach to gauging responses to music. There is growing importance placed on patient preferences in music-based intervention (MBI) research: "it is the act of making a choice that determines the greatest effectiveness of the [musical] procedure" (Guerrier et al., 2021).

- Music preferences differ across individuals on the basis of their experience and culture, which precludes a one-size-fits-all approach: "music deemed sublime by one person may be judged as cacophonic by another" (Devlin et al., 2023). Music has more pronounced effects on listeners when it is tailored to them, and the precision of algorithms can make its neurological effects even stronger (Huang & Lin, 2013; Woods et al., 2019).

Architecture



Code Sample


MPH-SDK-INTEGRATION-REACT
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src
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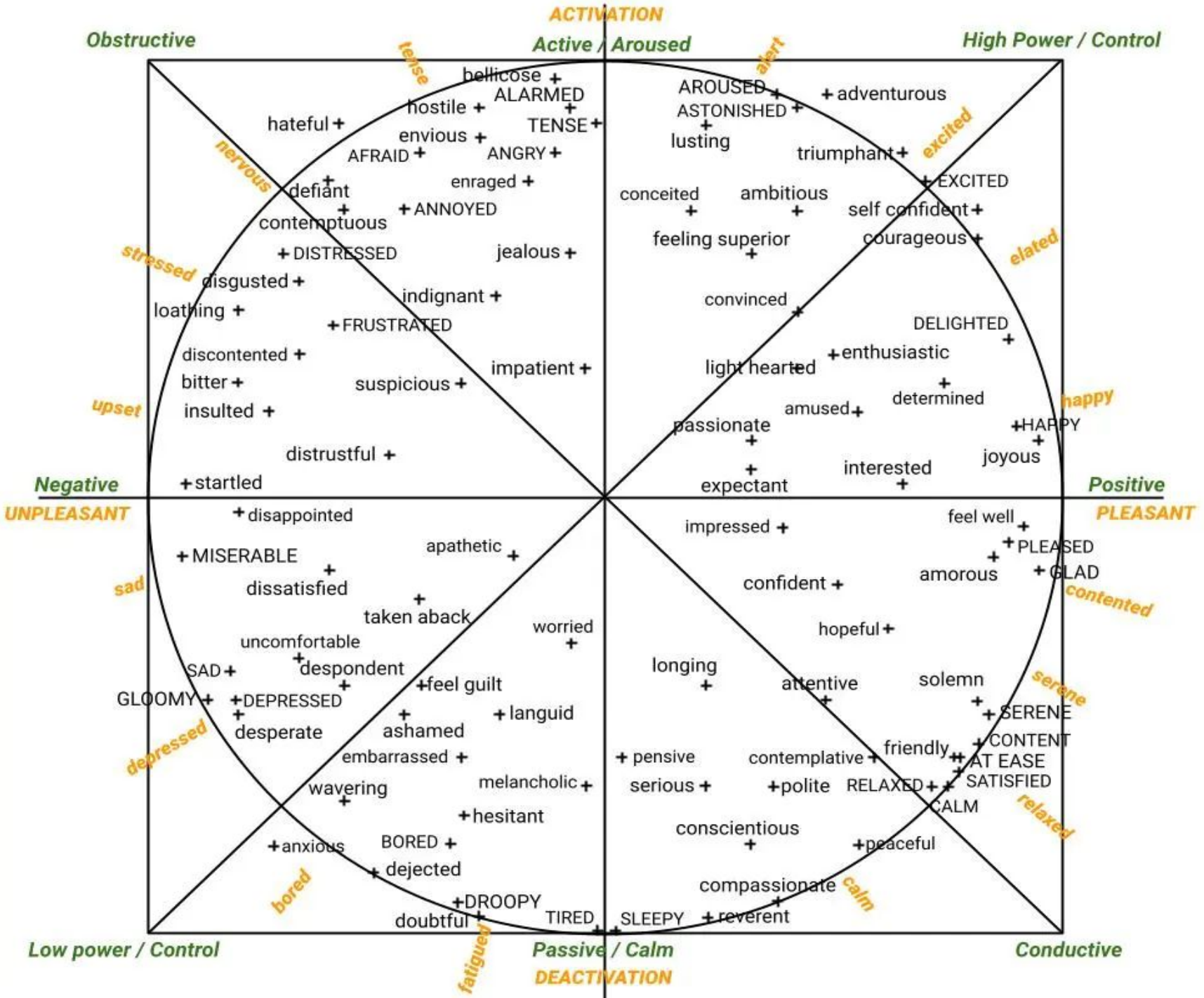
Diana_Ross_(1976_album_-_cover_...
dross1.mp3
Vicissitudes.mp3
components
componentCSS
ageComponent.css
emotionBarsComponent.css
engagementComponent.css
faceTrackerComponent.css
featureComponent.css
moodComponent.css
singleBarComponent.css
AgeComponent.js
DominantEmotionComponent.js
EmotionBarsComponent.js
EngagementComponent.js
FaceTrackerComponent.js
FeatureComponent.js
GenderComponent.js
MoodComponent.js
Player.js
SingleBarComponent.js
src > App.js > App > handleBarrierEvent > useCallback() callback
1 import { useEffect, useRef, useState, useCallback } from "react";
2 import { useExternalScript } from "./helpers/ai-sdk/externalScriptsLoader";
3 import { getAiSdkControls } from "./helpers/ai-sdk/loader";
4
5 import './App.css';
6
7 import GenderComponent from "./components/GenderComponent";
8 import AgeComponent from "./components/AgeComponent";
9 import DominantEmotionComponent from "./components/DominantEmotionComponent";
10 import FeatureComponent from "./components/FeatureComponent";
11 import EngagementComponent from "./components/EngagementComponent";
12 import FaceTrackerComponent from "./components/FaceTrackerComponent";
13 import MoodComponent from "./components/MoodComponent";
14 import EmotionBarsComponent from "./components/EmotionBarsComponent";
15
16 import Player from "./components/Player"
17 import { React } from 'react';
18
19
20
21 function App() {
22
23 const mphToolsState = useExternalScript("https://sdk.morphcast.com/mphtools/v1.0/mphtools.js");
24 const aiSdkState = useExternalScript("https://ai-sdk.morphcast.com/v1.16/ai-sdk.js");
25 const videoEl = useRef(undefined)
26 const playerRef = useRef(null);
27 const [isRecording, setIsRecording] = useState(false);
28
29 const handlePlayStatusChange = useCallback((event) => {
30 setIsRecording(event.detail.isPlaying);
31 }, []);
32
33
34 const handleBarrierEvent = useCallback((event) => {
35 const data = event.detail;

Valence-Arousal Circumplex Model



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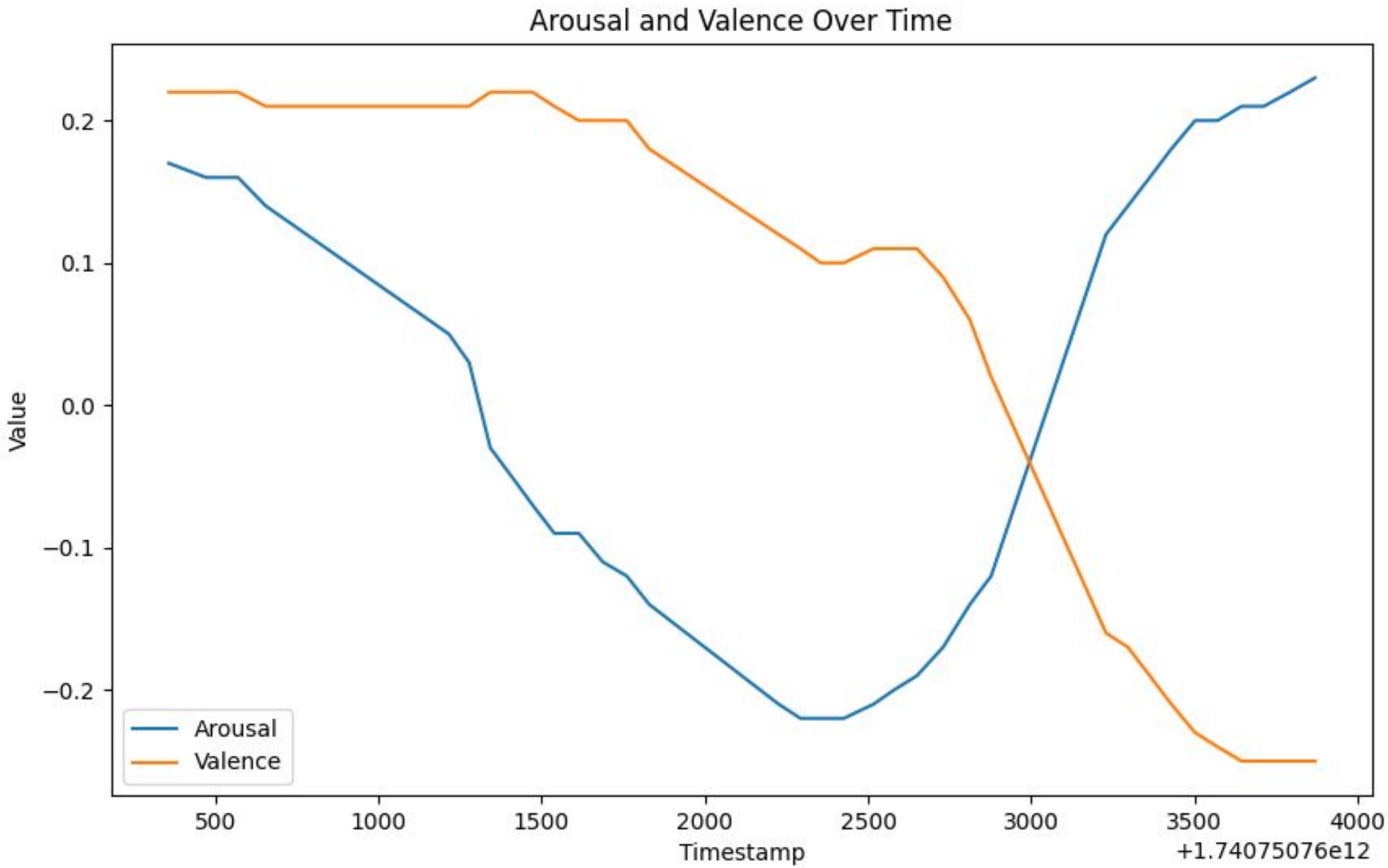
Data Charts


Arousal and Valence Over Time
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0.1
0.0
−0.1
−0.2
Arousal
Valence
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1500
2000
2500
3000
3500
4000
Timestamp
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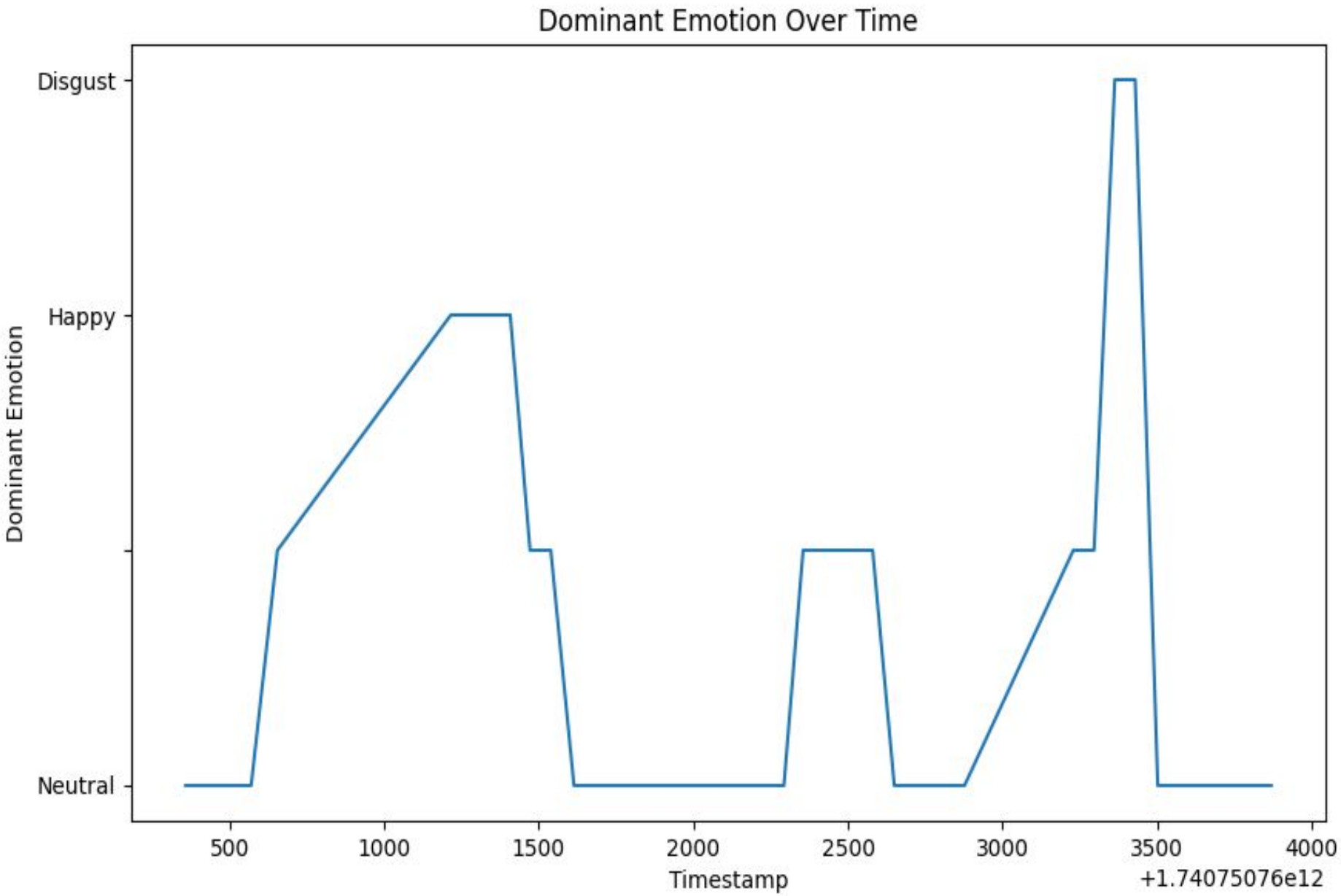
Data Charts


Dominant Emotion Over Time
Disgust
Happy
Neutral
Dominant Emotion
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1000
1500
2000
2500
3000
3500
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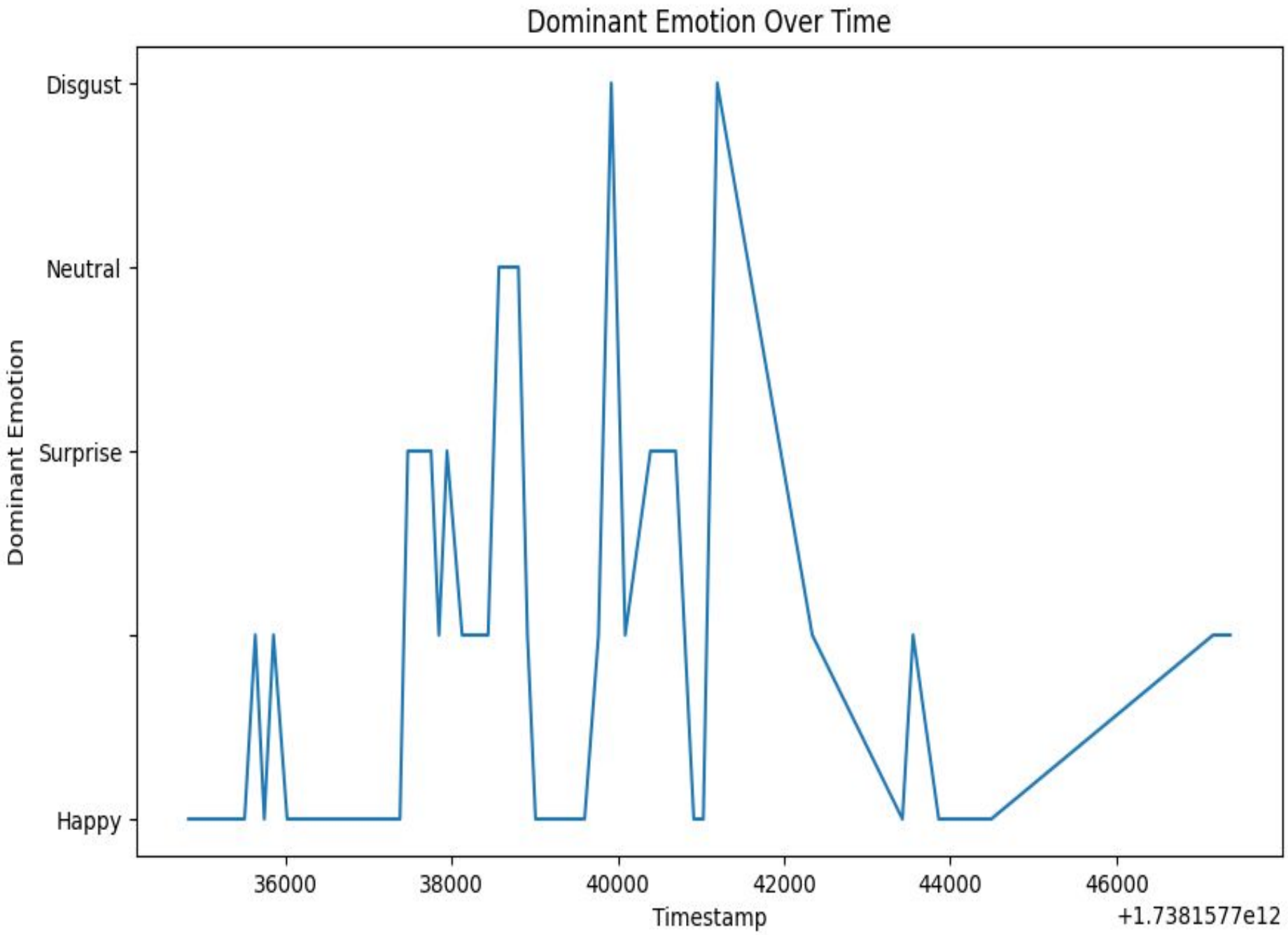
Data Charts


Dominant Emotion Over Time
Disgust
Neutral
Surprise
Happy
Dominant Emotion
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38000
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44000
46000
Timestamp
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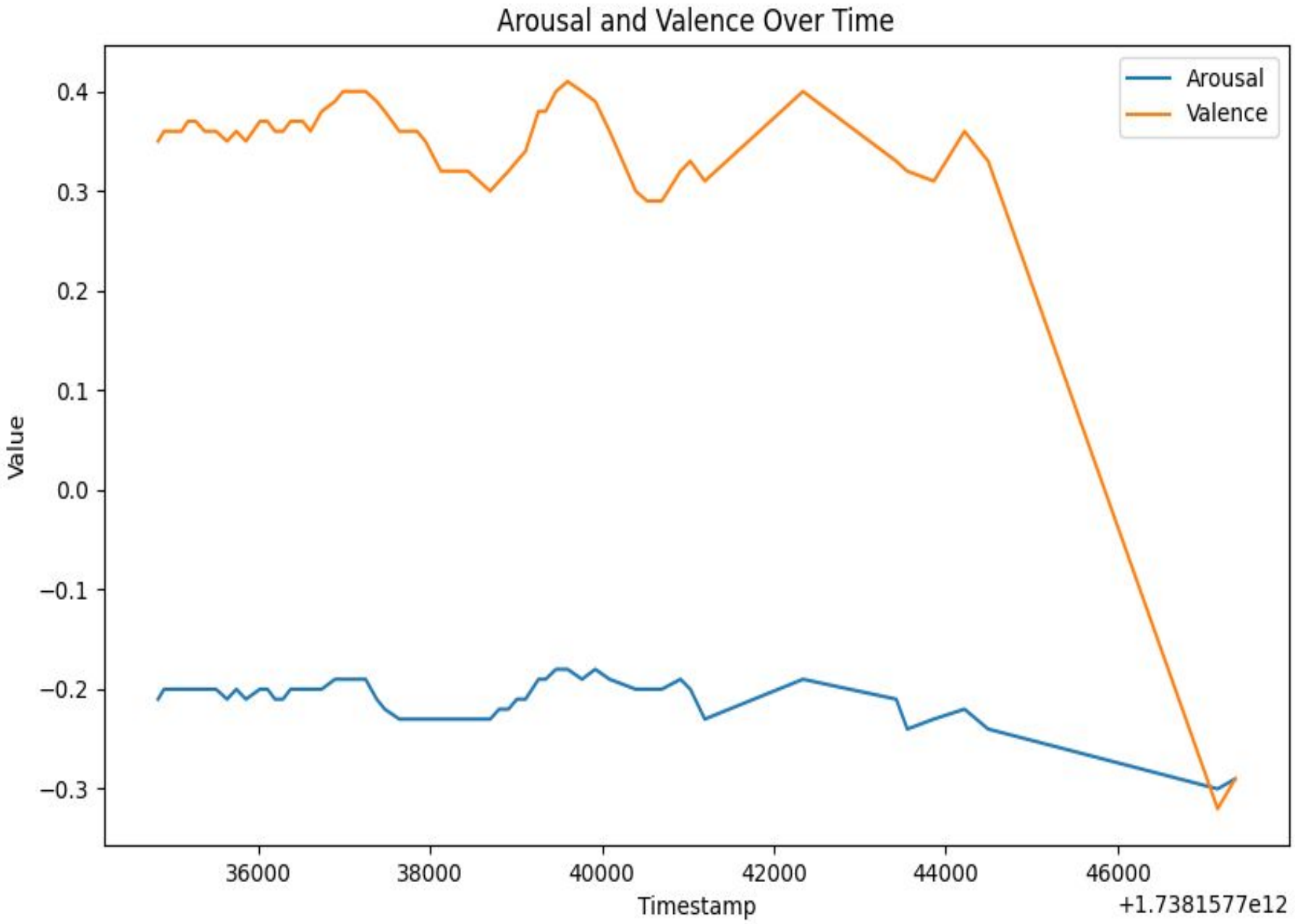
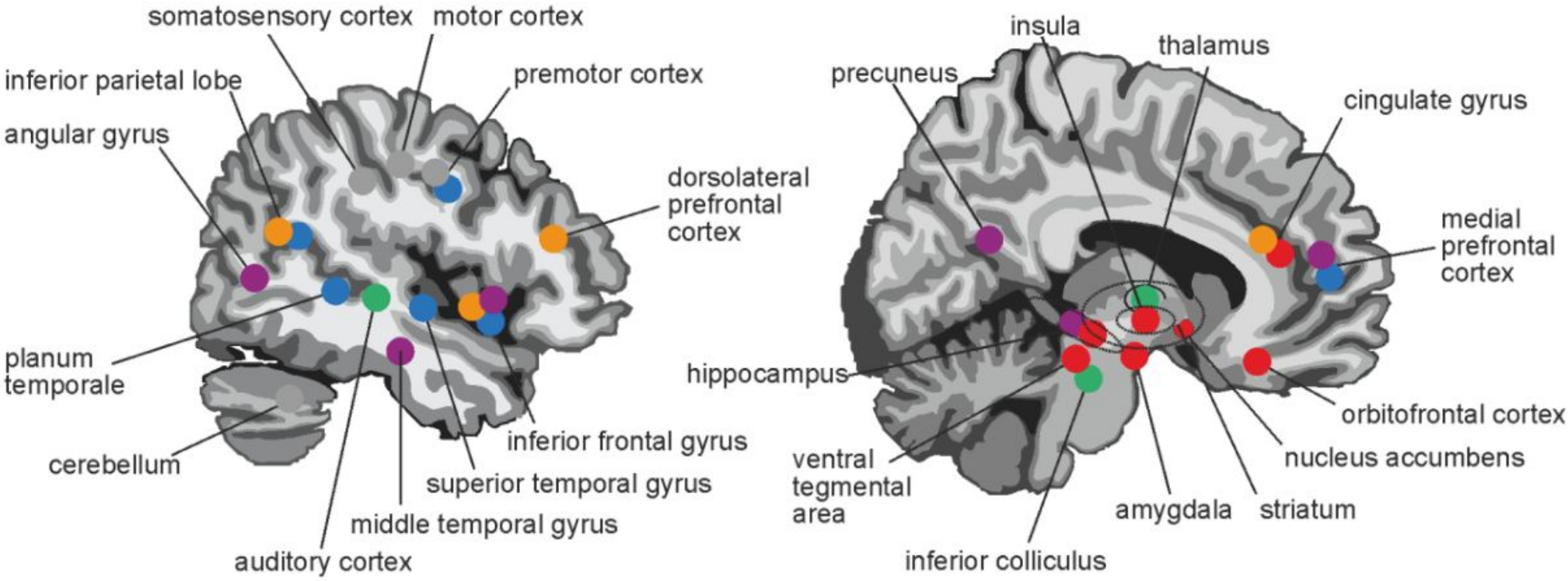
Data Charts


Arousal and Valence Over Time
Arousal
Valence
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
Value
36000
38000
40000
42000
44000
46000
Timestamp
+1.7381577e12

Key Brain Areas Associated with Music Processing



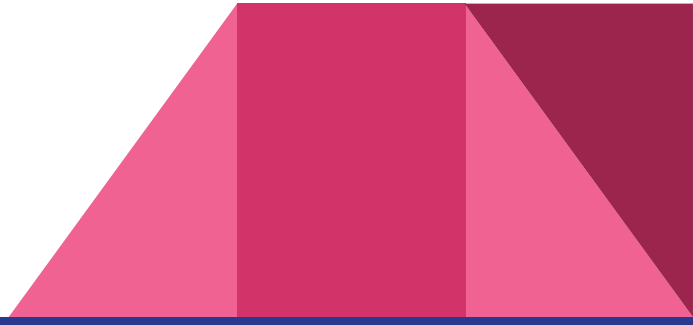
- Basic auditory pathway: perceiving the basic acoustic features of music
- Music-syntactic network: perceiving higher-order musical features
- Attention and working memory network: focusing and keeping track of music in time
- Episodic memory network: recognizing music and recalling associated memories
- Motor network: playing, singing and moving to the beat of music
- Reward and emotion network: music-evoked emotions and experiencing pleasure and reward

Conclusions and Outcomes

- Music has a powerful effect on our emotions, and this effect can be harnessed for therapeutic purposes.
- Music-based interventions can even surpass cultural boundaries and work for people of all backgrounds.
- Personalized music-based interventions have the potential to improve mental health, manage pain, aid in substance abuse recovery, etc.
- Technological advancements like Affective Algorithmic Composition (AAC) and facial recognition offer new possibilities for personalized music therapy.
- Facial recognition technology provides a cost-effective and versatile way to measure emotions in real-time for music therapy applications.

Applications and Future Work

- Cost-effective solutions to alleviating anxiety, stress
- Reducing duration of hospital stays
- Aiding in substance abuse recovery
- Reducing the need for opioid dosages for pain management
- Aiding those with neurological conditions
- Contributing to the burgeoning field of Precision Music Medicine
- Finding a sufficient blend of music that tests all musical components
- Generation of personalized music
- Feasibility of real-time music generation vs. batch/offline processing
- Have a streamlined user experience
- A Mobile app interface



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