Stimulus-EEG testing for forecasting health outcomes of comatose patients

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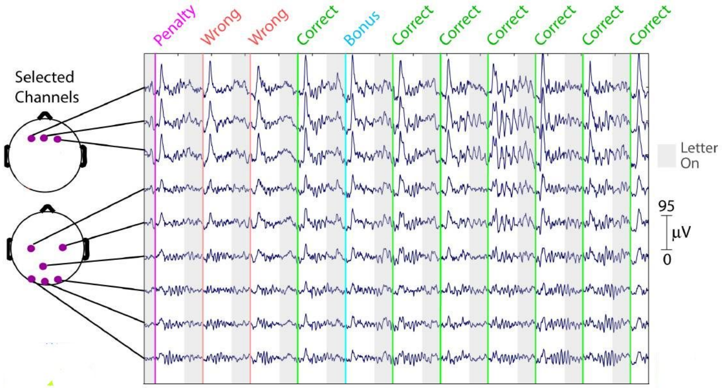
Background

- 250 new comatose patients per 100,000 people in the US each year
- Need: correlated electroencephalogram (EEG) data with outcomes
    - Measures brain activity of patients



- Implications for medical doctors and clinical researchers

https://sccn.ucsd.edu/~arno/fam2data/publicly_available_EEG_data.html

Project Goals

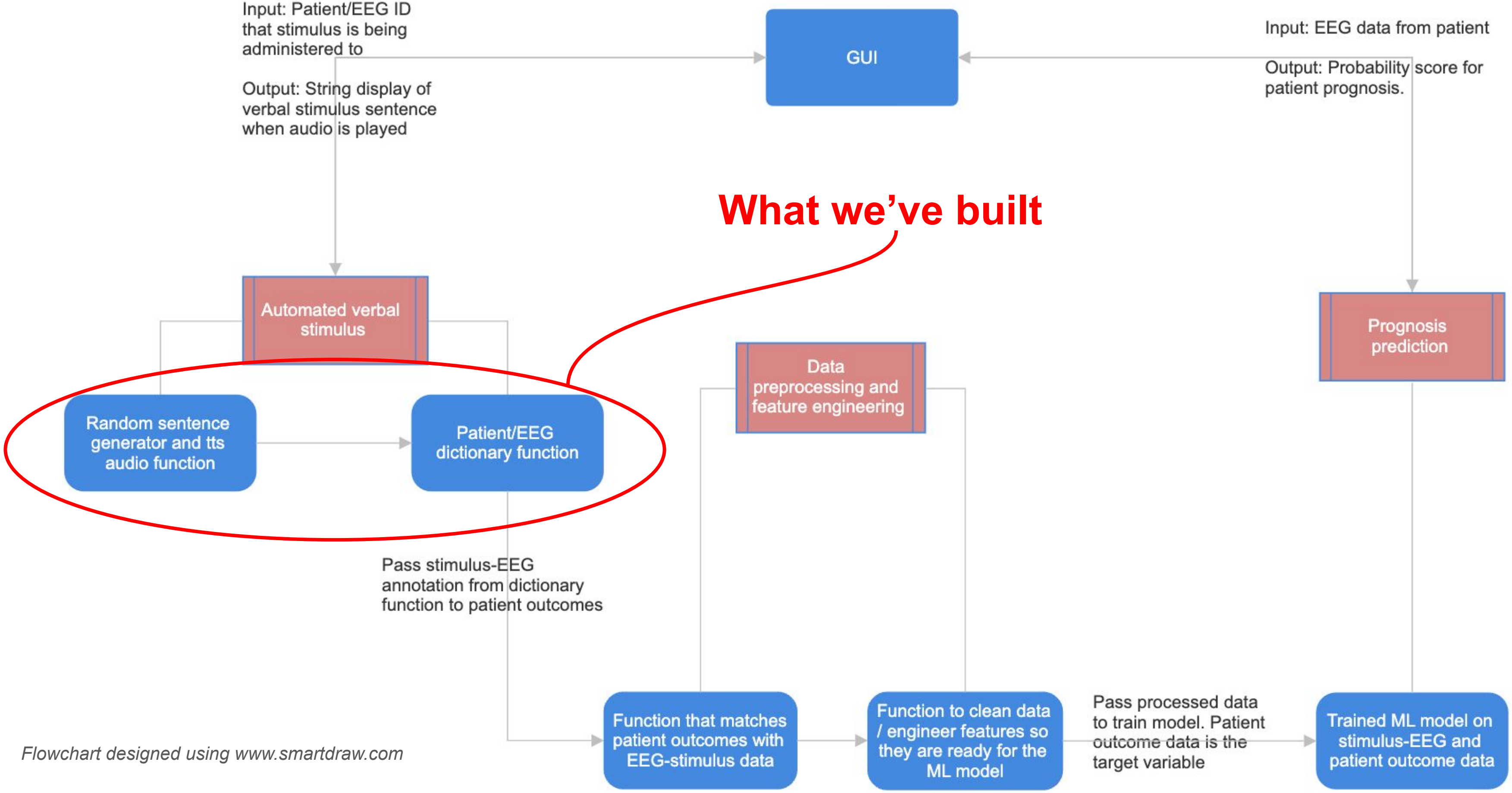
Winter Quarter:

- Develop standardized stimulus protocol to be implemented during data collection
  - Method to recognize when a stimulus was introduced to the patient in the EEG data (markers for stimuli)
  - IRB approved 03/07/2024

Spring Quarter:

- Develop an analysis pipeline software to analyze data
- Implement protocol with admitted patients (non-comatose, admitted for observation)

Use-cases and components


Input: Patient/EEG ID that stimulus is being administered to
Output: String display of verbal stimulus sentence when audio is played
GUI
Input: EEG data from patient
Output: Probability score for patient prognosis.
What we've built
Automated verbal stimulus
Random sentence generator and tts audio function
Patient/EEG dictionary function
Data preprocessing and feature engineering
Prognosis prediction
Pass stimulus-EEG annotation from dictionary function to patient outcomes
Function that matches patient outcomes with EEG-stimulus data
Function to clean data / engineer features so they are ready for the ML model
Pass processed data to train model. Patient outcome data is the target variable
Trained ML model on stimulus-EEG and patient outcome data

Flowchart designed using www.smartdraw.com

Design architecture

PsychoPy

- Used for creating automated stimuli for psychological tests

GTTS

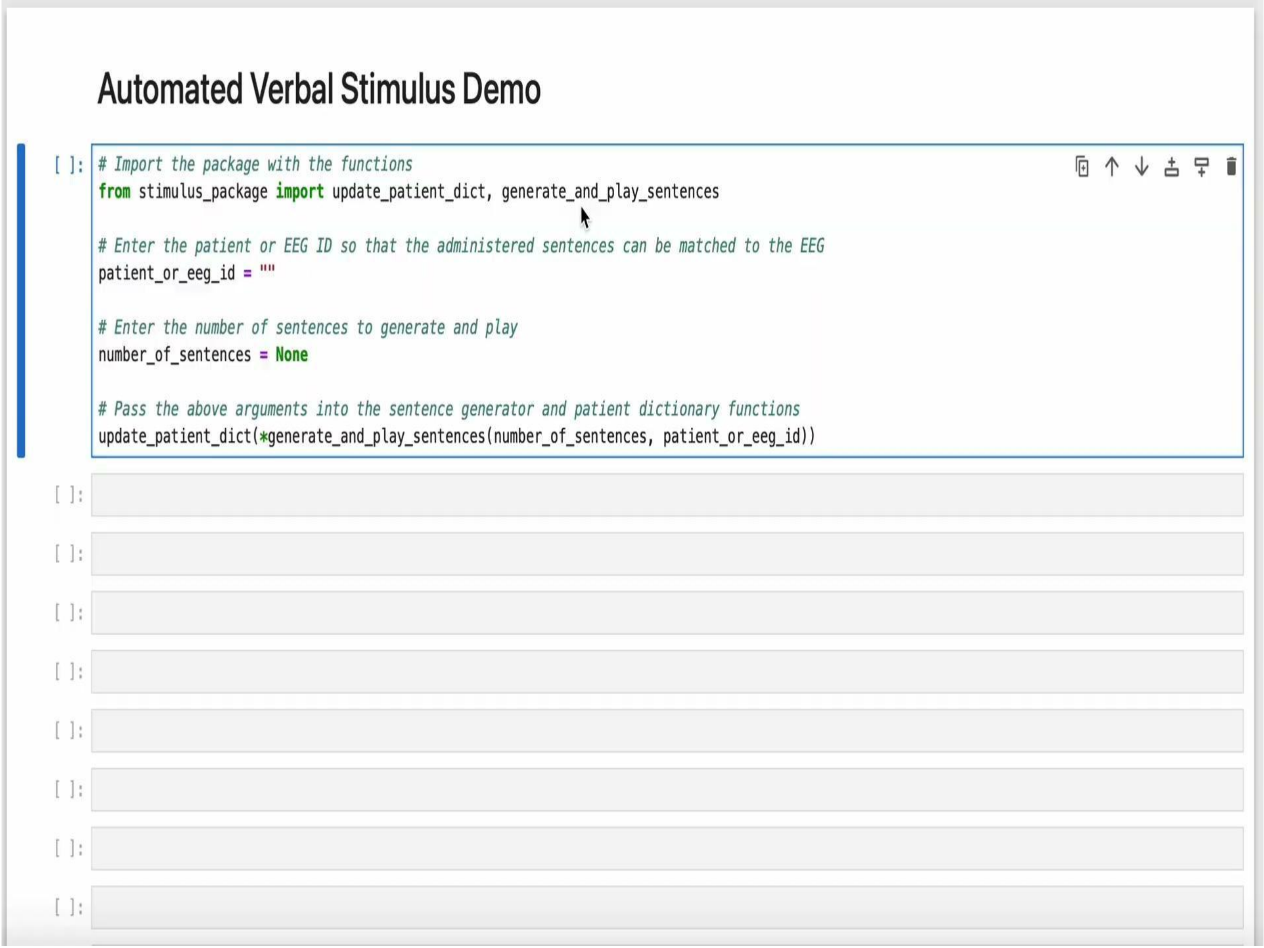
- Used to normalize audio stimulus for patients

All code written in Python

Structure:

- Generate sentence from predefined lists of nouns, verbs, adjectives
- Play sentence out loud for patient, recording timestamp
- Dictionary holding patient ID + timestamp + stimulus is updated

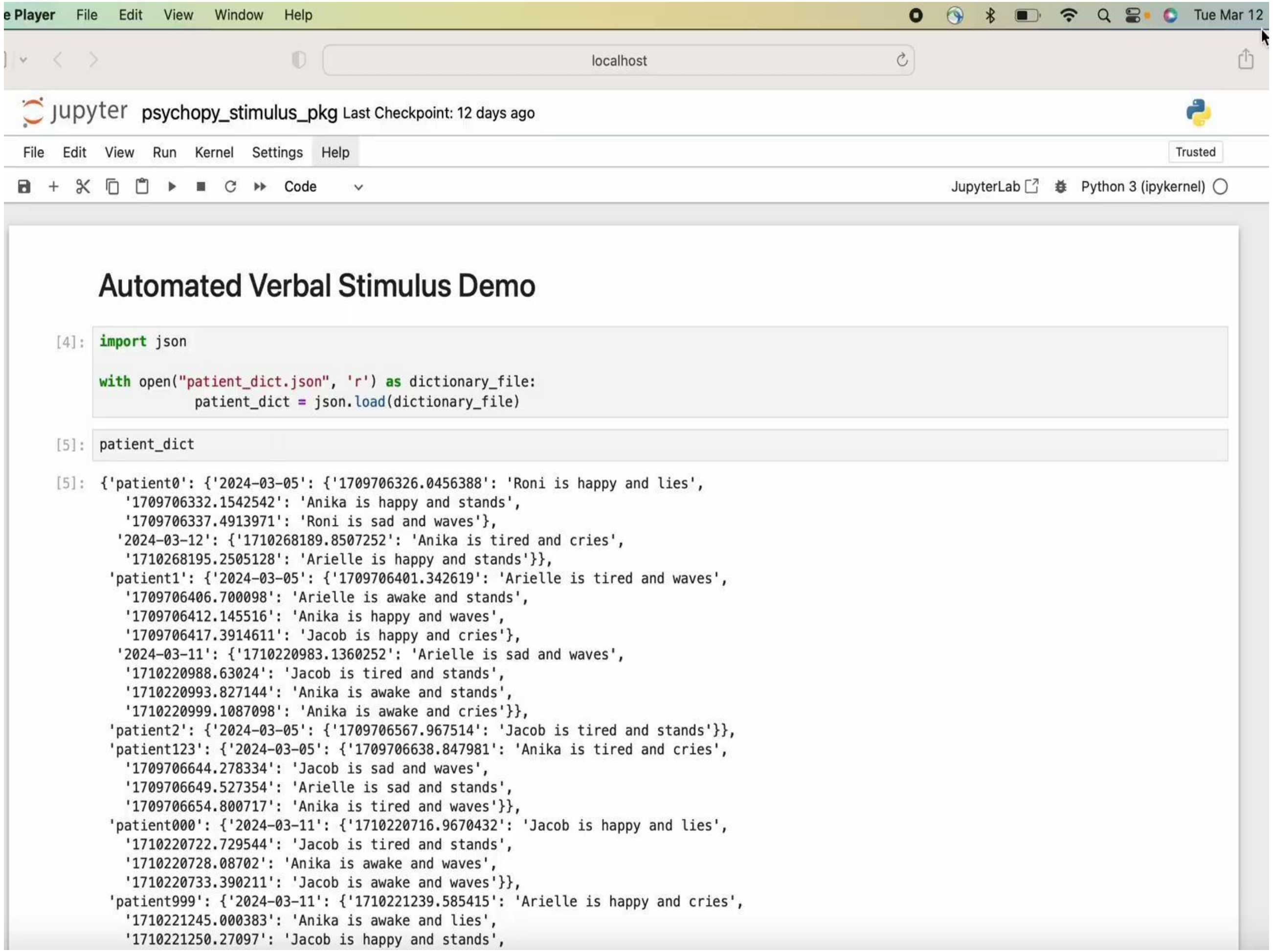
Project demo



Automated Verbal Stimulus Demo

```
[ ]: # Import the package with the functions
     from stimulus_package import update_patient_dict, generate_and_play_sentences

     # Enter the patient or EEG ID so that the administered sentences can be matched to the EEG
     patient_or_eeg_id = ""

     # Enter the number of sentences to generate and play
     number_of_sentences = None

     # Pass the above arguments into the sentence generator and patient dictionary functions
     update_patient_dict(*generate_and_play_sentences(number_of_sentences, patient_or_eeg_id))
```

Project demo


e Player File Edit View Window Help
Tue Mar 12
localhost
jupyter psychopy_stimulus_pkg Last Checkpoint: 12 days ago
File Edit View Run Kernel Settings Help
Trusted
Code
JupyterLab
Python 3 (ipykernel)

Automated Verbal Stimulus Demo

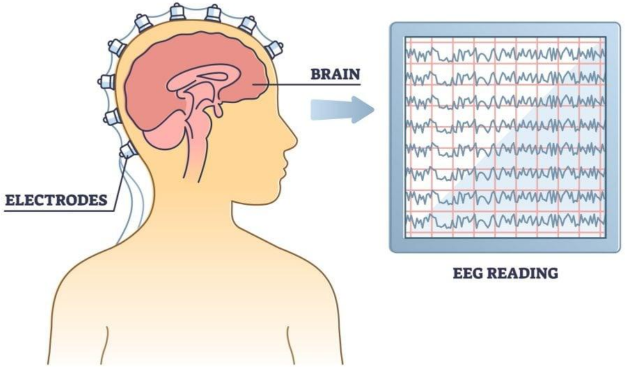
```
[4]: import json

     with open("patient_dict.json", 'r') as dictionary_file:
             patient_dict = json.load(dictionary_file)
```

```
[5]: patient_dict
```

```
[5]: {'patient0': {'2024-03-05': {'1709706326.0456388': 'Roni is happy and lies',
        '1709706332.1542542': 'Anika is happy and stands',
        '1709706337.4913971': 'Roni is sad and waves'},
       '2024-03-12': {'1710268189.8507252': 'Anika is tired and cries',
        '1710268195.2505128': 'Arielle is happy and stands'}},
      'patient1': {'2024-03-05': {'1709706401.342619': 'Arielle is tired and waves',
        '1709706406.700098': 'Arielle is awake and stands',
        '1709706412.145516': 'Anika is happy and waves',
        '1709706417.3914611': 'Jacob is happy and cries'},
       '2024-03-11': {'1710220983.1360252': 'Arielle is sad and waves',
        '1710220988.63024': 'Jacob is tired and stands',
        '1710220993.827144': 'Anika is awake and stands',
        '1710220999.1087098': 'Anika is awake and cries'}},
      'patient2': {'2024-03-05': {'1709706567.967514': 'Jacob is tired and stands'}},
      'patient123': {'2024-03-05': {'1709706638.847981': 'Anika is tired and cries',
        '1709706644.278334': 'Jacob is sad and waves',
        '1709706649.527354': 'Arielle is sad and stands',
        '1709706654.800717': 'Anika is tired and waves'}},
      'patient000': {'2024-03-11': {'1710220716.9670432': 'Jacob is happy and lies',
        '1710220722.729544': 'Jacob is tired and stands',
        '1710220728.08702': 'Anika is awake and waves',
        '1710220733.390211': 'Jacob is awake and waves'}},
      'patient999': {'2024-03-11': {'1710221239.585415': 'Arielle is happy and cries',
        '1710221245.000383': 'Anika is awake and lies',
        '1710221250.27097': 'Jacob is happy and stands',
```

Future directions

- Determine connection to EEG machines
  - This will inform future efforts to sync our software with hardware components
- **Timestamp synchronization**
  - How can we ensure that the data collected on the EEG is properly synchronized with the software stimulation time points?
- Train ML model for forecasting patient health outcomes
  - Based on stimulus EEG test
  - Using previously reported data from the literature
- In-person shadow of data collection process
- Individual patient considerations
  - Auditory perception
  - First language



Guy-Evans, O. (2023). EEG Procedure. Retrieved from https://www.simplypsychology.org/what-is-an-eeg.html

Thank you!

Questions?

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