MARCH 2023

TEXAS
The University of Texas at Austin

[HW-III]: Longitudinal MI Training and Plasticity

[ECE-379N/385J]: NEURAL ENGINEERING

The University of Texas at Austin

[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

Notes:

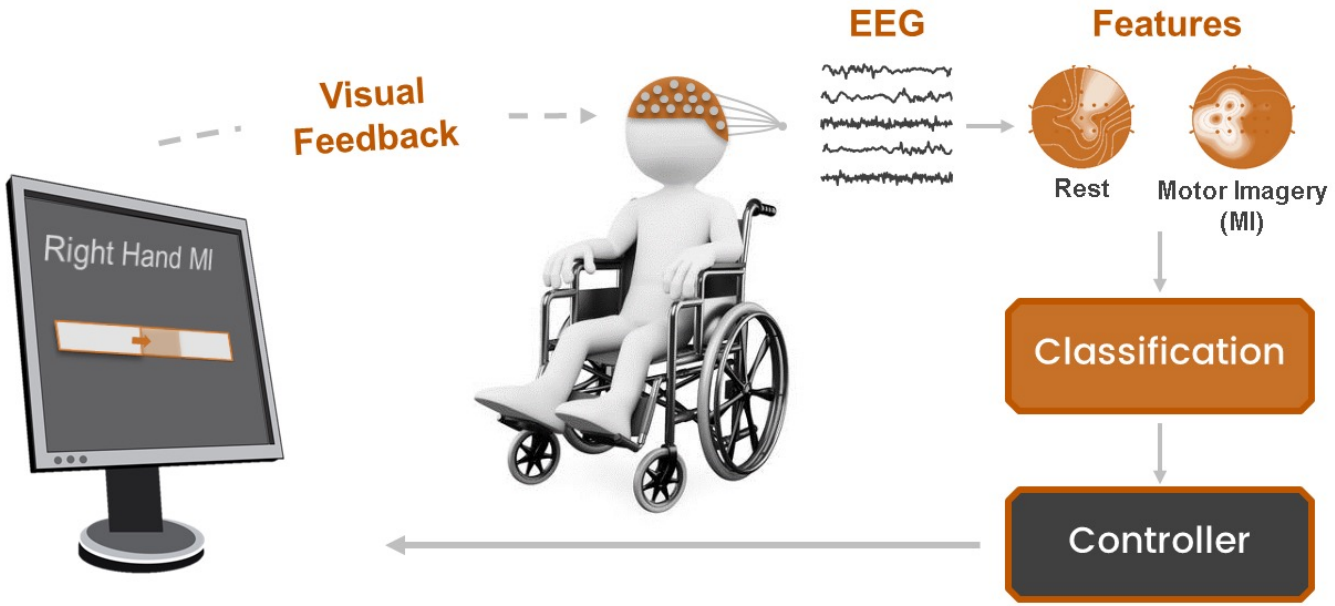
- HW-III is due on April 12th
- Please start early to make use of the QA session on Wednesday
- Read literature on EEG analysis – especially the paper on the Cybathlon race [1]
- Discuss with others but submit your own work!
- Analyze your results concisely and comprehensively!
- We want to know your thoughts and suggestions!

[1] Perdikis S, Tonin L, Saeedi S, Schneider C, Millán JdR (2018) The Cybathlon BCI race: Successful longitudinal mutual learning with two tetraplegic users. PLOS Biology 16(5): e2003787. https://doi.org/10.1371/journal.pbio.2003787

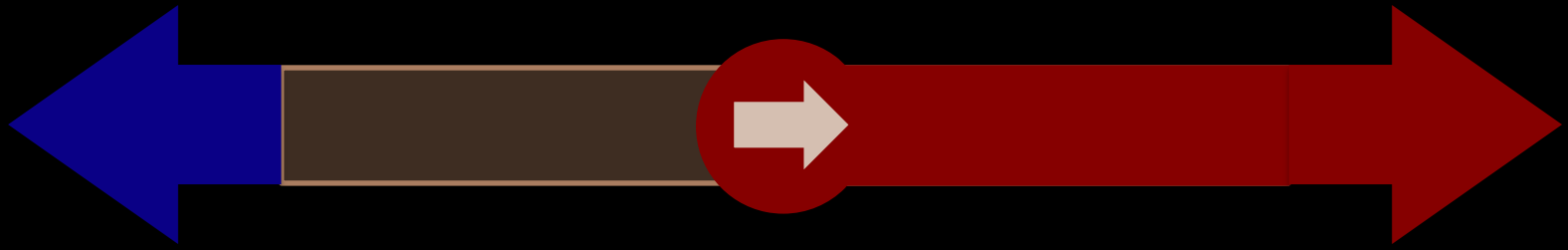
[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

Aim: ***- Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions***

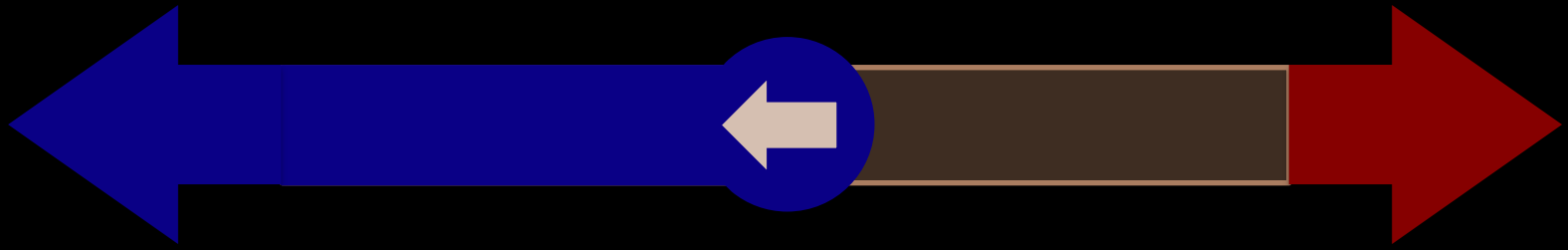
Experiment: ***Visual-feedback MI-based BCI training on several sessions***



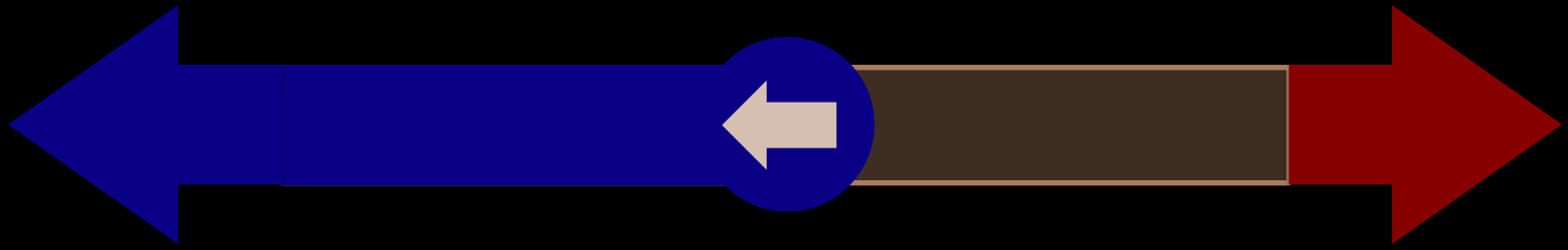
OFFLINE: Class-1 Trial



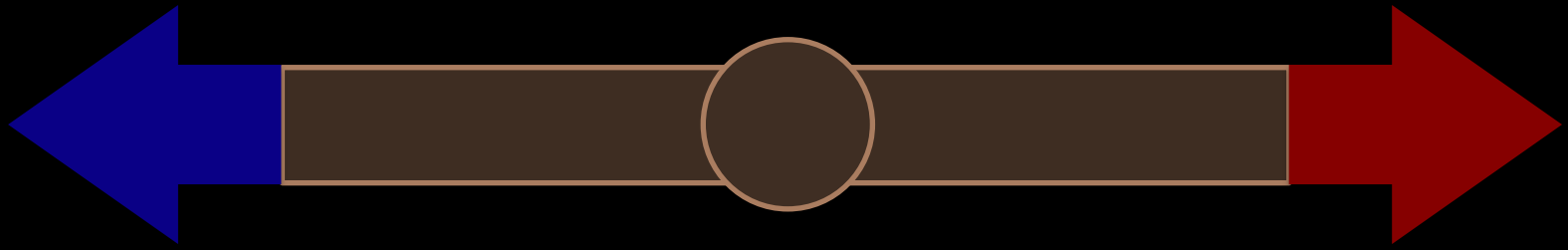
OFFLINE: Class-2 Trial



ONLINE: Class-2 Trial – delivered right command



ONLINE: Class-2 Trial – failed to deliver right command



[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

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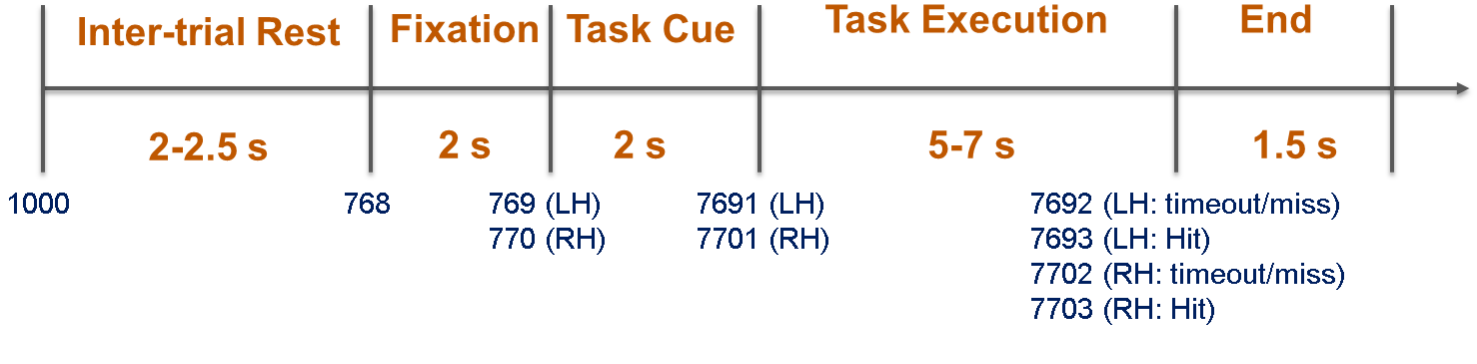

[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

***Aim:* - Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions**

***Experiment:* Visual-feedback MI-based BCI training on several sessions**

***Data:* subj1.mat file contains data of 7 sessions (1 offline, and 6 online)**

subj1.offline.run(r).eeg: (#samples x #sensors) contains eeg data of *run-r* in the offline session

subj1.offline.run(r).header: contains the header info of the *run-r* in the offline session

- ***.fs:*** sampling rate
- ***.chLabel:*** labels of the 32 EEG electrodes
- ***.EVENT.TYP:*** event triggers during the task
- ***.EVENT.POS:*** position in samples of each trigger

[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

Aim:* - *Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions

Experiment:* *Visual-feedback MI-based BCI training on several sessions

Data:* *subj1.mat file contains data of 7 sessions (1 offline, and 6 online)

subj1.online(s).run(r).eeg: (#samples x #sensors) contains eeg data of *run-r* **in online *session-s***

subj1.online(s).run(r).header: contains the header info of *run-r* in online session-s

- ***.fs:*** sampling rate
- ***.chLabel:*** labels of the 32 EEG electrodes
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[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

***Aim:* - Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions**

Tasks: 1) track the BCI-command delivery performance over sessions

	Class-1 Threshold	Class-2 Threshold	Timeout
Class-1	Hit	Miss	Timeout
Class-2	Miss	Hit	Timeout

$$\text{command delivery accuracy} = \frac{\#Hits}{\#Hits + \#Misses}$$

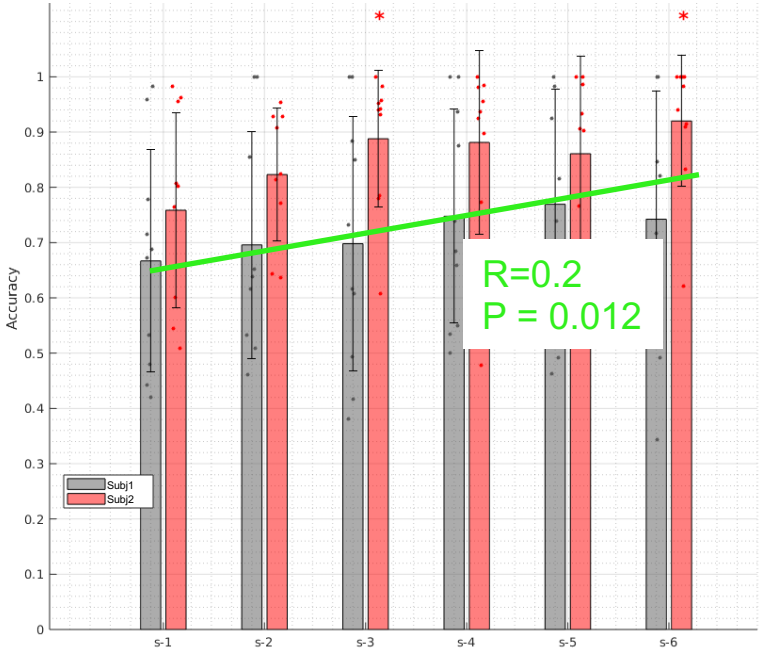
$$\%\text{timeout} = \frac{\#Timeout}{\#trials}$$

[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

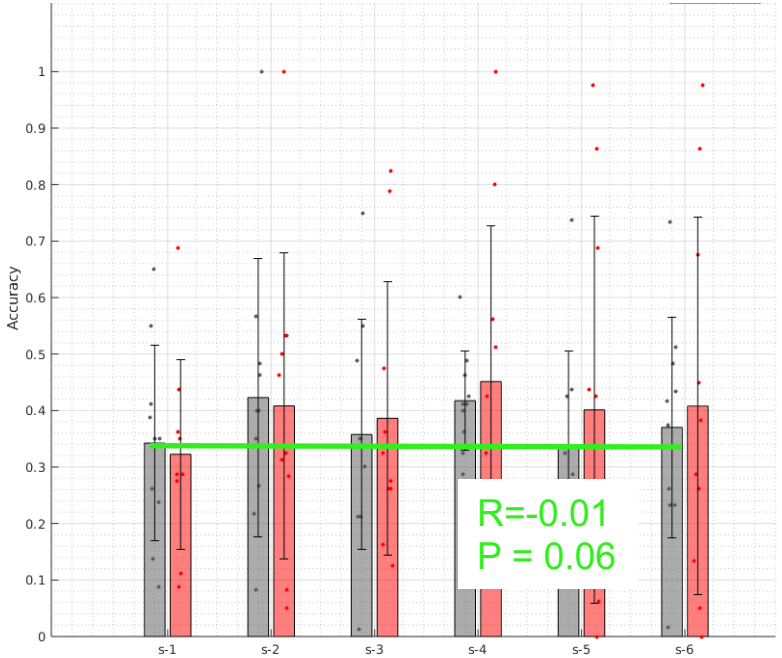
***Aim:** - Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions*

Tasks: 1) track the BCI-command delivery performance over sessions

Command delivery accuracy



Timeouts



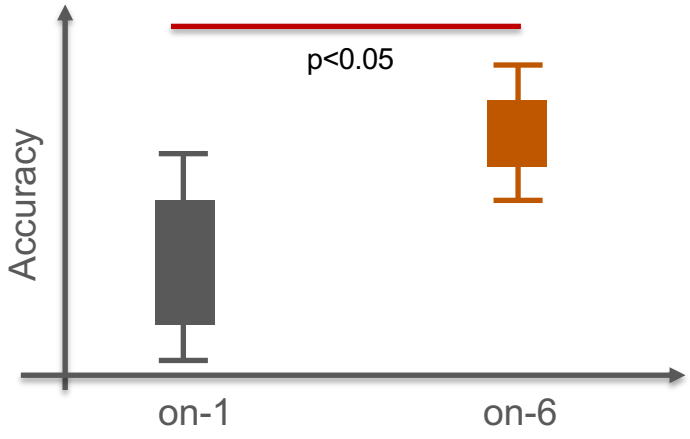
[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

Aim:* - *Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions

Tasks: 1) track the BCI-command delivery performance over sessions

Statistical Testing (runs of each session are treated as separate data points):

- Pre-post comparison at the group level (n=6 runs/session)
- Trend significance for each subject and at the group level



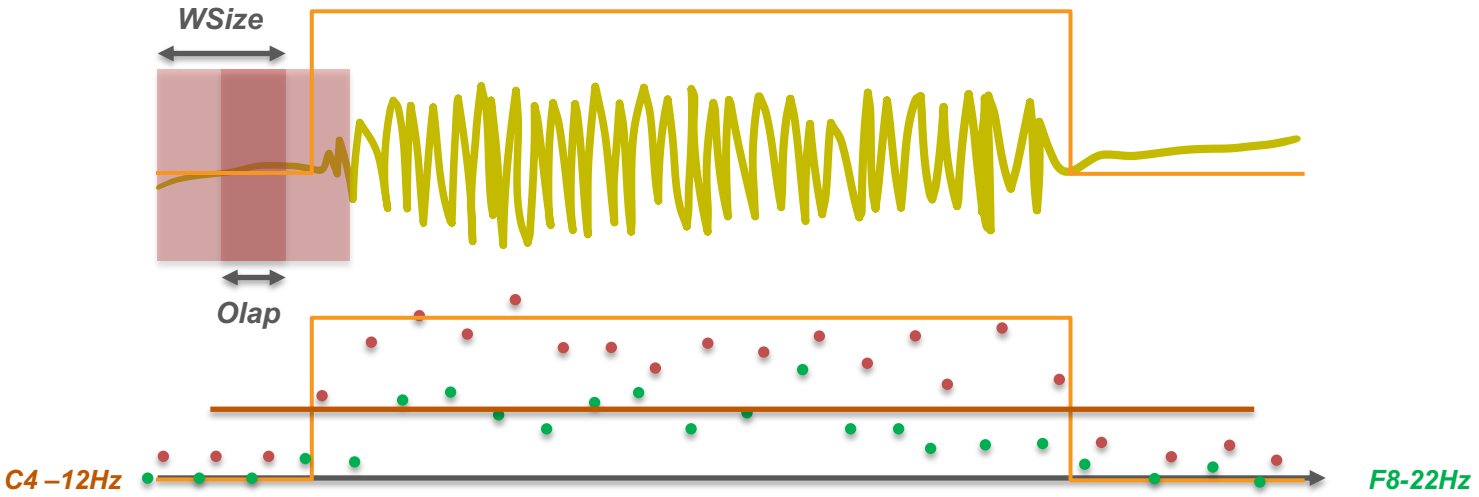
[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

***Aim:* - Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions**

Tasks: 2) track the Discriminability of the PSD features

- 32 channels
- 14 bands [4-30]Hz with a 2Hz resolution

=> 448 features in total



[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

***Aim:* - Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions**

Tasks: 2) track the Discriminability of the features

- Compute the fisher score as a measure of discriminability for each feature:

$$fisher\ score(i) = \frac{|\mu_{class-1} - \mu_{class-2}|}{\sqrt{\sigma^2_{class-1} + \sigma^2_{class-2}}}$$

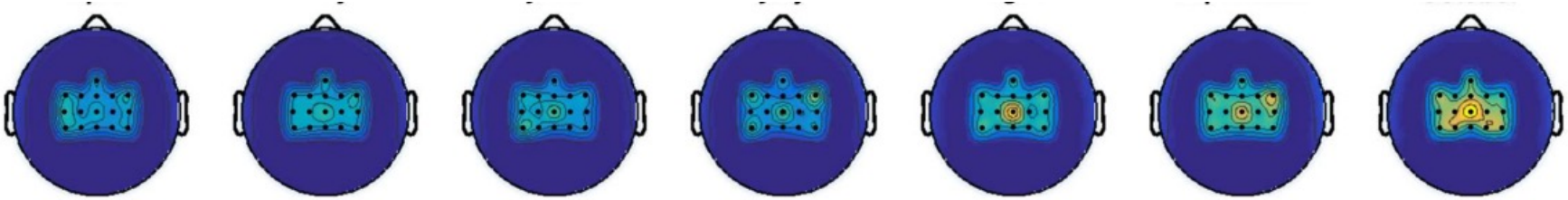
- Check the stability of the top 10 features across sessions

[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

Aim:* - *Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions

Tasks: 2) track the Discriminability of the features

- Show fisher score topoplots for features in:
  - For each of the 32 channels
  - Summed over all band features in [4-30]Hz



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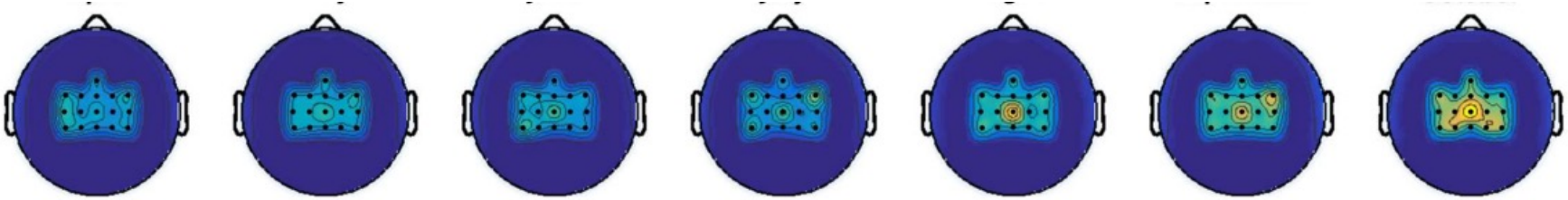
Aim:* - *Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions

Tasks: 2) track the Discriminability of the features

- Find the channel/band feature with highest fisher score for each subject:
  - Track the changes of the fisher score of that feature
  - Perform statistical analysis for trends (per subject) and pre/post difference (group-level)



[HW-III ECE374N/385J] Plasticity: Longitudinal MI Training and Plasticity

Aim:* - *Track BCI performance metrics and the evidence of plastic changes over multiple MI sessions

Tasks: 2) track the Discriminability of the features

- Correlate the trends of discriminability of the top 10 features in the last session to the trends of BCI performance for each subject