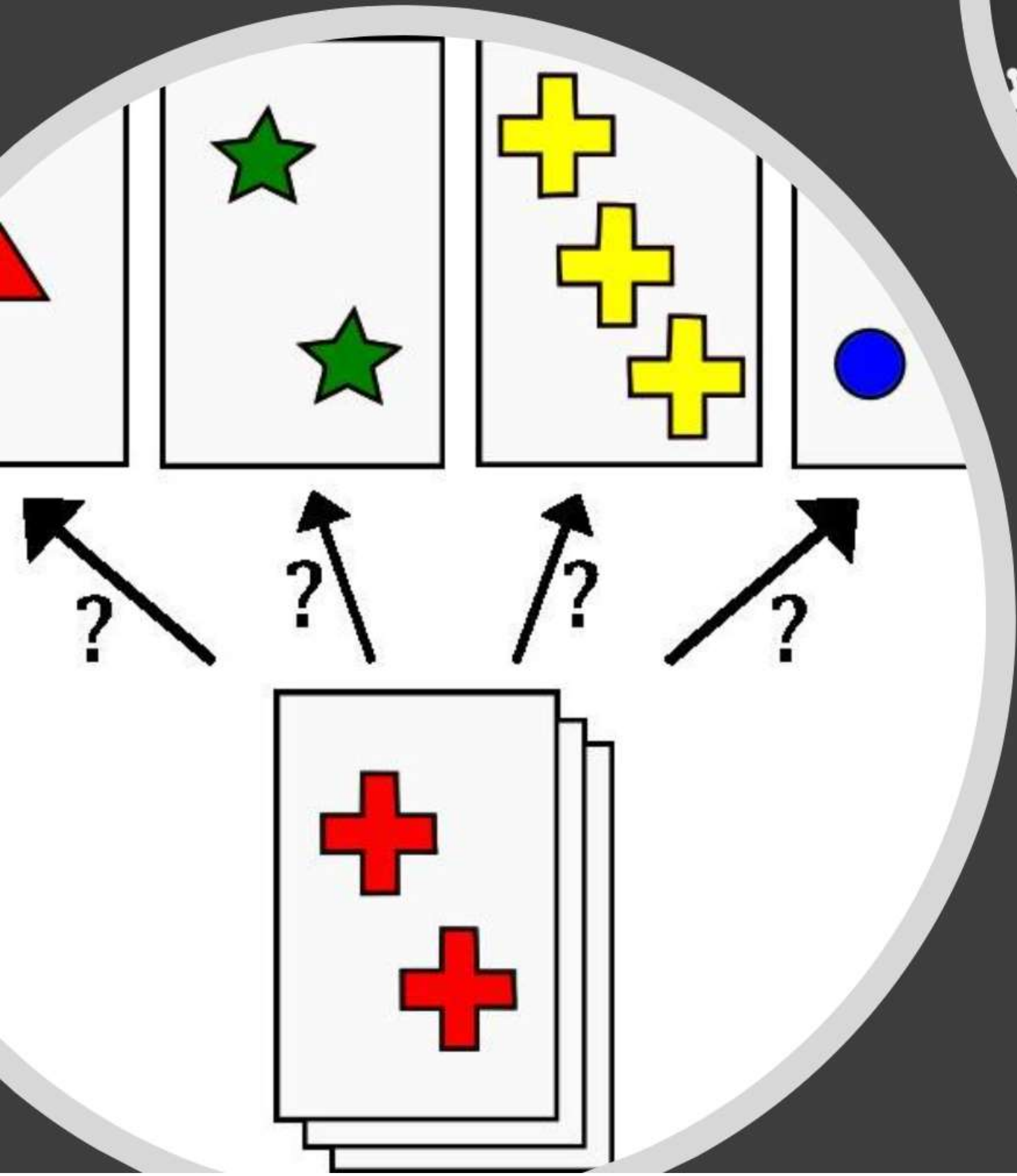


pod-011-nebulous-camel

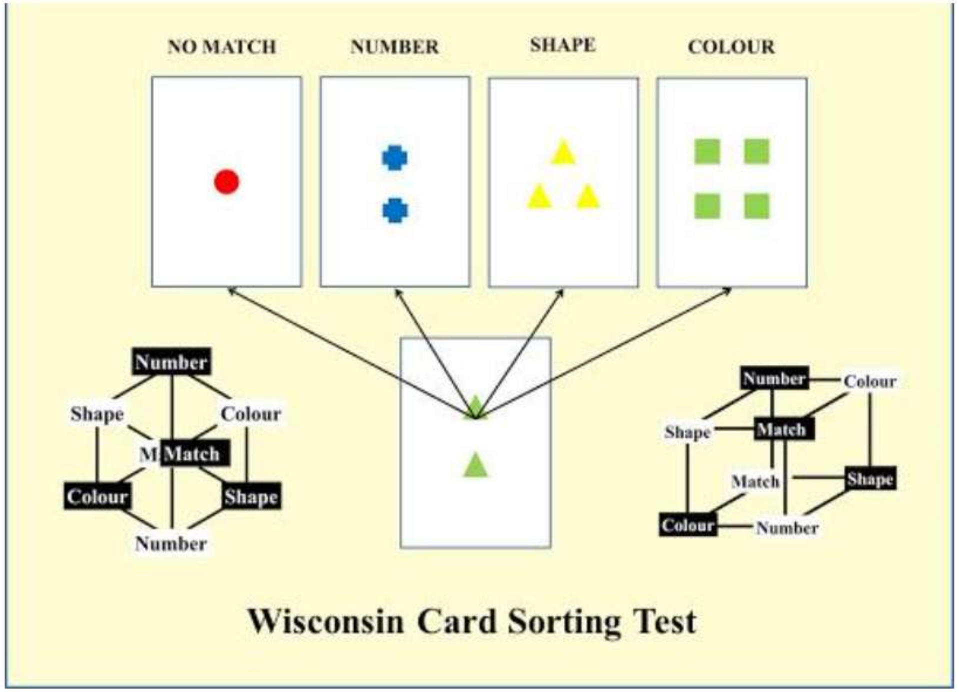
Beyza Akkoyunlu, Emel Gencer, Şerife Leman Runyun, Çağnur Tekeroğlu

Can reinforcement learning model imitate the underlying behavior patterns reflected in EEG signals during Wisconsin Card Sorting Task?

First Question: Can reinforcement learning model imitate the underlying behavior patterns reflected in EEG signals during Wisconsin Card Sorting Task?

Scientific Background:

- Wisconsin card sorting task (WCST) is used to assess executive functioning, especially set-shifting ability and cognitive flexibility. Several studies indicated that WCST performance is associated with prefrontal lobe function (Tranel et al, 1991).
- Reinforcement learning model offers a suitable framework explaining latent cognitive mechanisms during WCST (Steinke, Lange & Kopp, 2019). In this study, we suggest a reinforcement learning (RL) based model, which incorporates category and response learning in different levels of task complexity and to predict prefrontal EEG signalling.



First Question: Can reinforcement learning model imitate the underlying behavior patterns reflected in EEG signals during Wisconsin Card Sorting Task?

- <u>Proposed analyses:</u>

- Use reinforcement learning to figure out strategies for the different levels of task, and compare properties of these strategies to published behaviors and EEG data.
-

<u>Predictions:</u>

- Trained agents will model the task performance in the given dataset (both behavioral and EEG) which will be measured by policy specific statistical approaches.

First Question: Can reinforcement learning model imitate the underlying behavior patterns reflected in EEG signals during Wisconsin Card Sorting Task?

- **Dataset:**

- 76 sessions collected from 19 male and female users during three difficulty levels of Wisconsin Card Sorting Task
- EEG functionality, facial keypoints, real-time self-reports on cognitive fatigue and performance metrics achieved during the cognitive task (success rate, response time, number of errors, etc.)

CogBeacon: A Multi-Modal Dataset and Data-Collection Platform for Modeling Cognitive Fatigue

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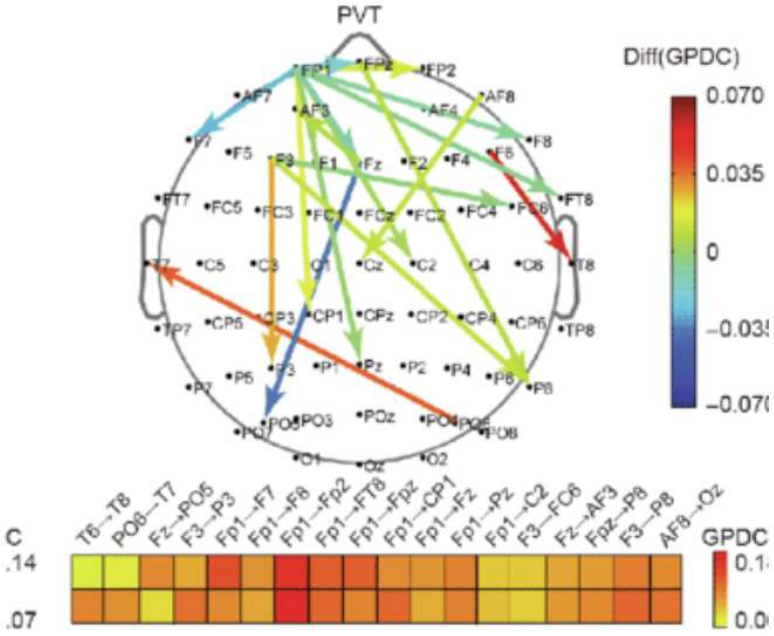
Problem!!!



(b)

- Because of the limited time to write the code for reinforcement learning model, our mentor suggested us to look for EEG connectivity analysis for different difficulty levels.

New Question: Is there any association between task difficulty levels and EEG connectivity of the brain?

Progress:

- Extracted time series from the data
- Utilized fieldtrip toolbox for connectivity analysis

Problems:

- The EEG system was based on dry EEG system which only had 4 electrodes.
- We could not find the right method of connectivity analysis for this data which has different structure than basic EEG systems.

References

- Anderson, S. W., Damasio, H., Jones, R. D., & Tranel, D. (1991). Wisconsin Card Sorting Test performance as a measure of frontal lobe damage. *Journal of clinical and experimental neuropsychology*, *13*(6), 909-922.
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EEG Decoding

Team

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Scientific Question and Model

Decoding lifting force intended to be exerted on an object of unknown weight using EEG signals

Logistic regression to discriminate between light and heavy objects. Followed by cross validation to asses overfitting.

Input: Average power spectrum of EEG data from a selected time period.

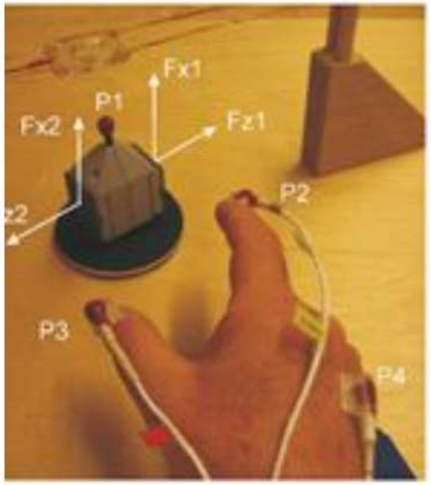
Output: The weight class of the previous object lifted.

WAY-EEG-GAL Dataset

EEG + event time codes

12 participants * 9 series * 30 trials/series

Process: participants were queued by an LED to reach out and lift an object to a certain position and then put the object back down at a certain time. Between trials, the researchers would change the surface material or mass of the object, unseen by the participant.



Discussion

EEG preprocessing is hard (not a lot of standard procedures)

Voltage vs time was too much data, even with PCA/regularization - had to switch to spectral analysis

Averaged spectral power across frequency bands

Highest prediction accuracy when including ~1s of data after the force has been applied

Future work?

Model Accuracy over Time Ranges

0: Onset of loading phase