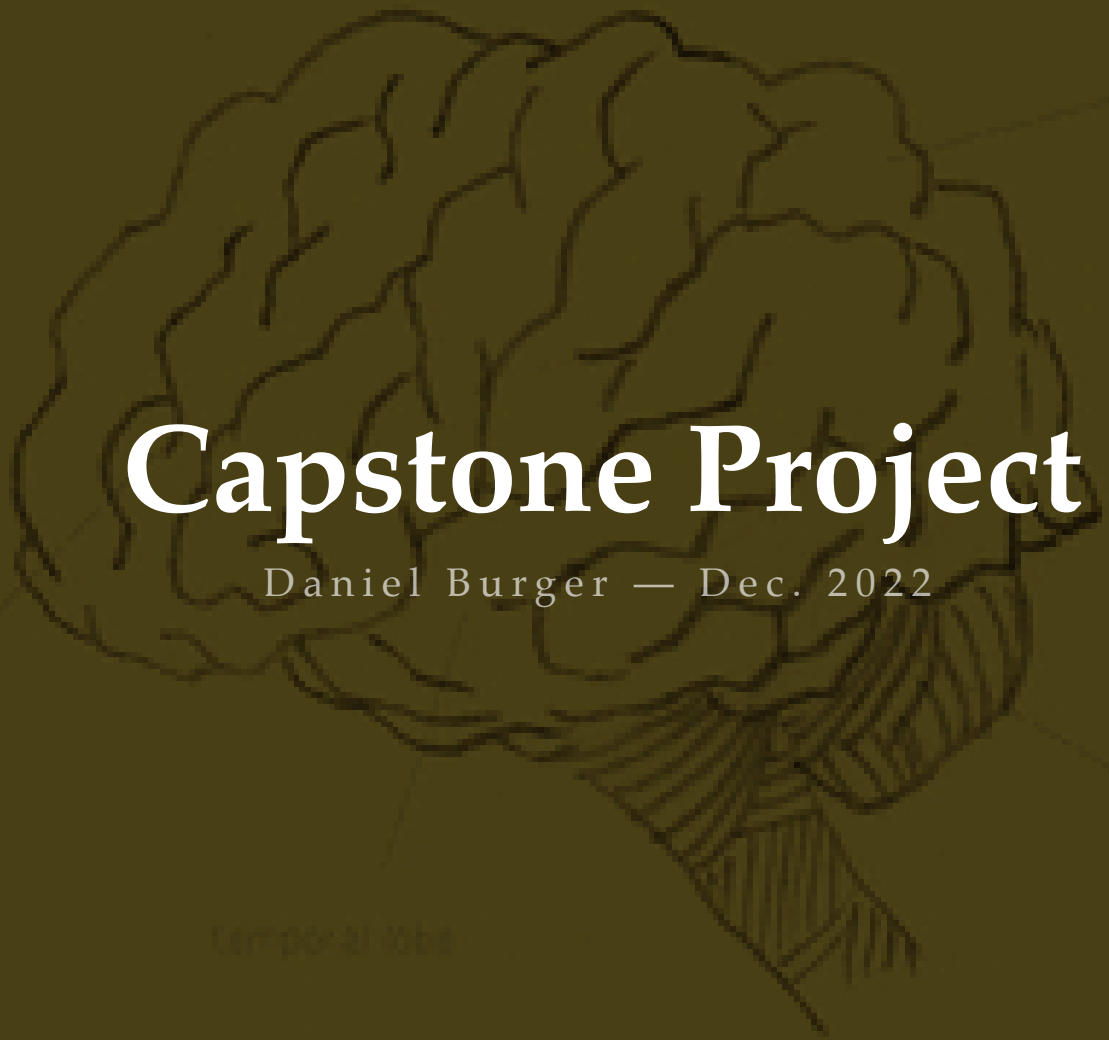
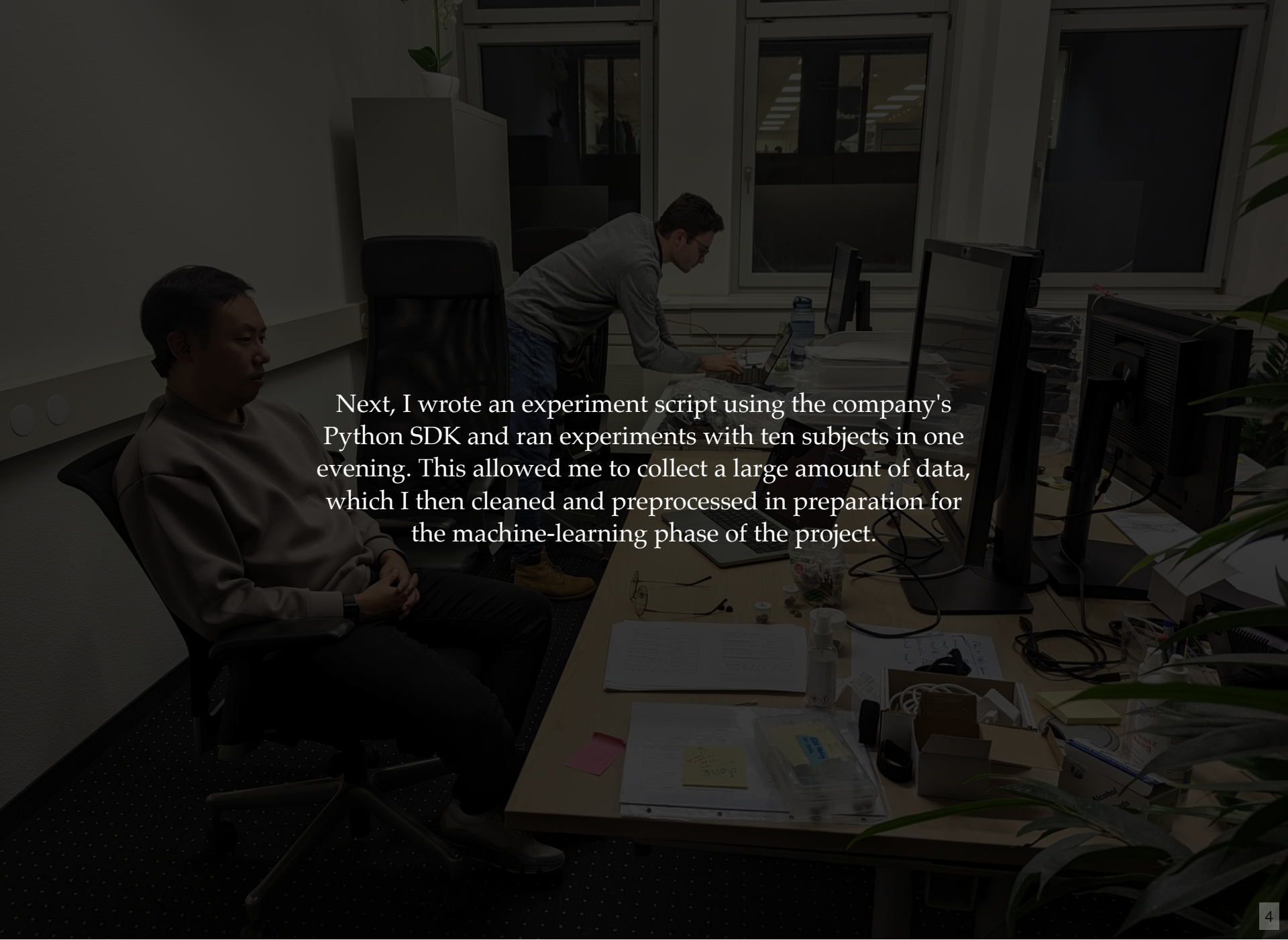


# Capstone Project

Daniel Burger — Dec. 2022

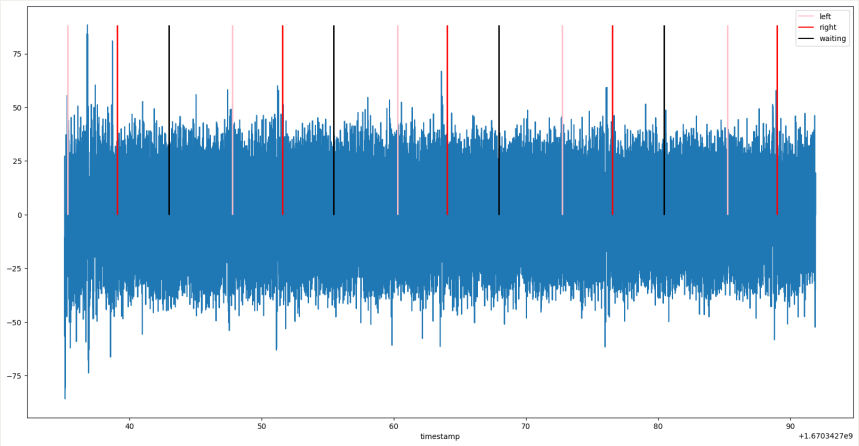

The project involved creating a classifier that can detect eye winks from EEG signals. To collect the necessary data, I used in-ear EEG earbuds from IDUN Technologies.


The first step in my project was to **conduct a feasibility study** to determine whether there were any discernible patterns in the neural signals after processing and transforming the data. I was pleased to find that there were indeed some patterns present, which indicated that it might be possible to develop a successful classifier.

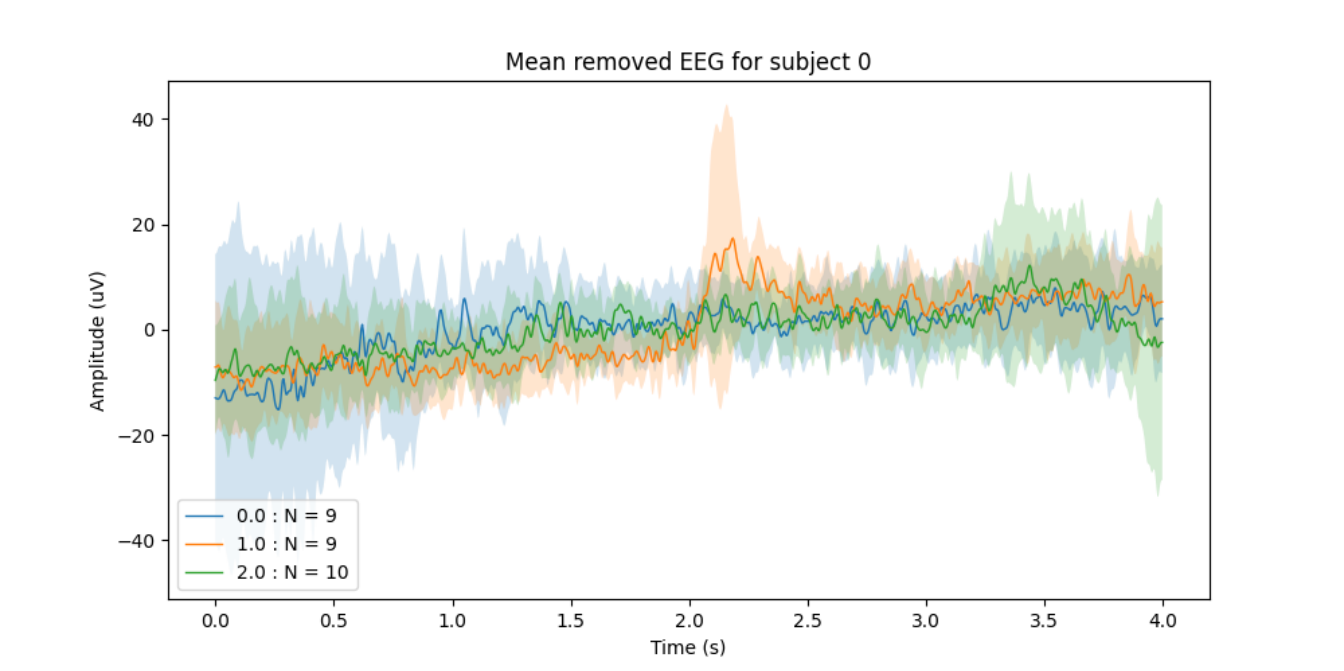


Next, I wrote an experiment script using the company's Python SDK and ran experiments with ten subjects in one evening. This allowed me to collect a large amount of data, which I then cleaned and preprocessed in preparation for the machine-learning phase of the project.

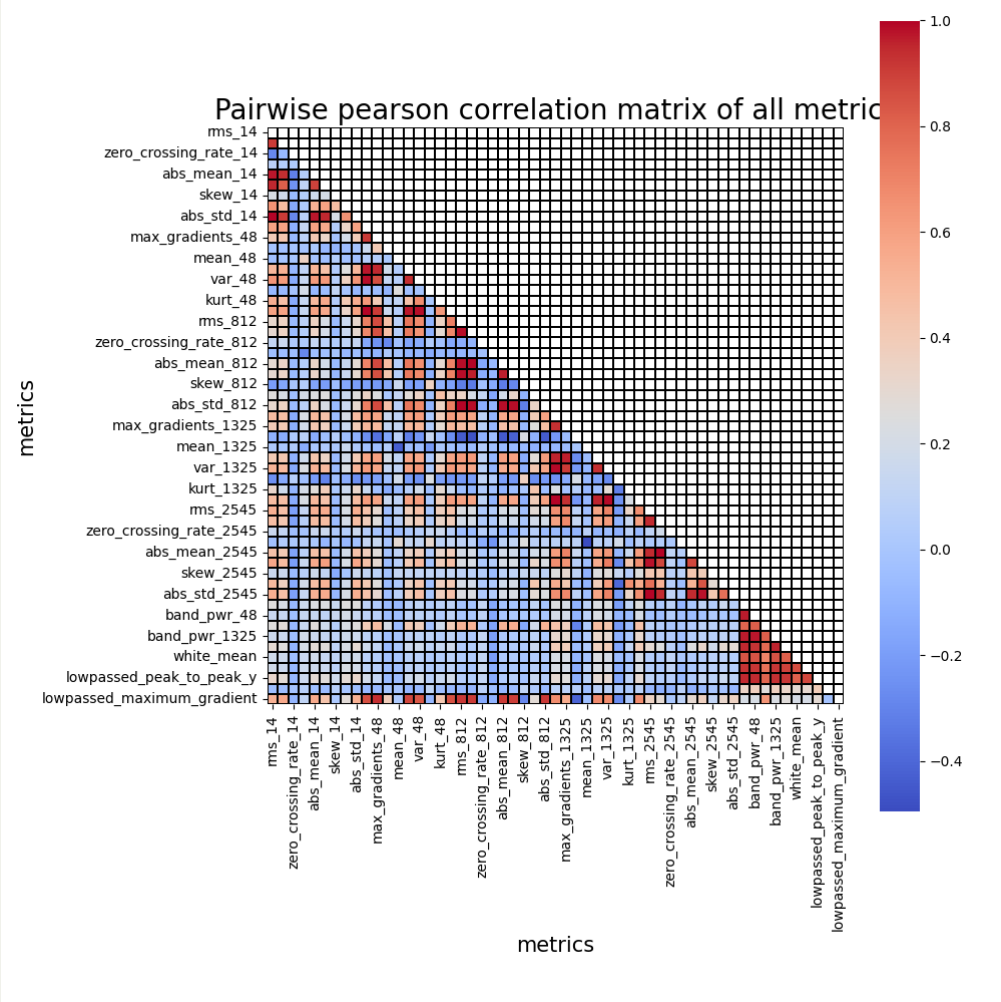
```
1626  1670354477.495994,1602.0389320896784
1627  1670354477.499994,1606.9563158698459
1628  1670354477.503994,1613.4159700174298
1629  1670354477.5079942,1611.247850805265
1630  1670354477.5119941,1608.632696703994,right
1631  1670354477.515994,1606.3975222584634
1632  1670354477.519994,1608.9009176374577
1633  1670354477.523994,1616.6122694745386
1634  1670354477.5279942,1614.8688334070246
1635  1670354477.531994,1607.1574815699437
1636  1670354477.535994,1601.7707111562147
1637  1670354477.539994,1603.245926290265
1638  1670354477.543994,1607.7162751813264
1639  1670354477.5479941,1609.638525204483
1640  1670354477.551994,1610.3537810270527
1641  1670354477.555994,1609.3703042710192
1642  1670354477.559994,1612.633658961494
1643  1670354477.563994,1614.9805921293012
1644  1670354477.5679939,1610.443188004874
1645  1670354477.571994,1605.2575832912426
```



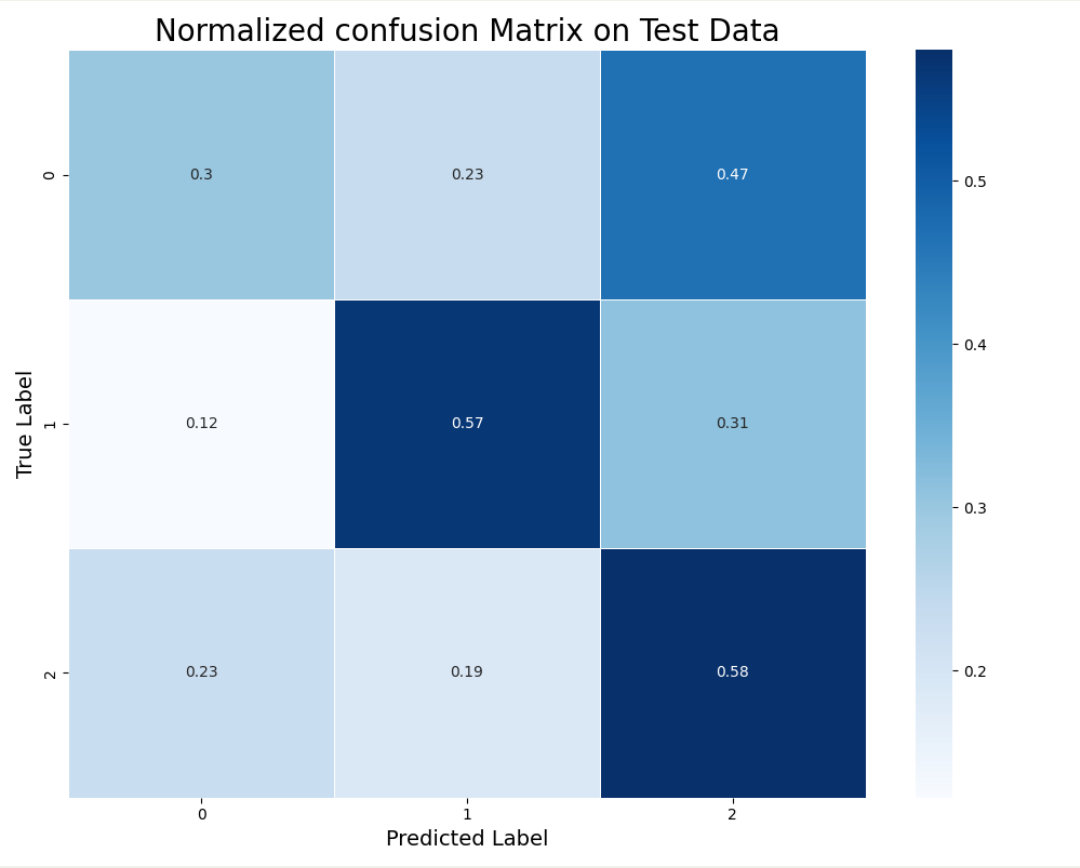

The result was multiple merged CSVs with the timestamps of the markers for the features and the actual EEG signal, as shown in the left figure above. The right figure above shows the bandpass-filtered EEG signal with the markers as an overlay, as defined in the experiment script.




I epoched the data around the three different types of markers and stored the epoched and filtered (bandpass filtering, denoising etc.) inside the repo. Above is an example of the mean EEG signal from all the subjects of the first epoch.




I used MLflow on an Azure compute cluster for AutoML to train and evaluate a variety of different machine learning models on the preprocessed data.




While I was pleased with the AutoML process results, I encountered some challenges along the way. For example, the collected data was quite noisy, which made it difficult to train accurate models. Additionally, the metrics from the AutoML process were not as good as I would have liked, indicating that there is still room for improvement.

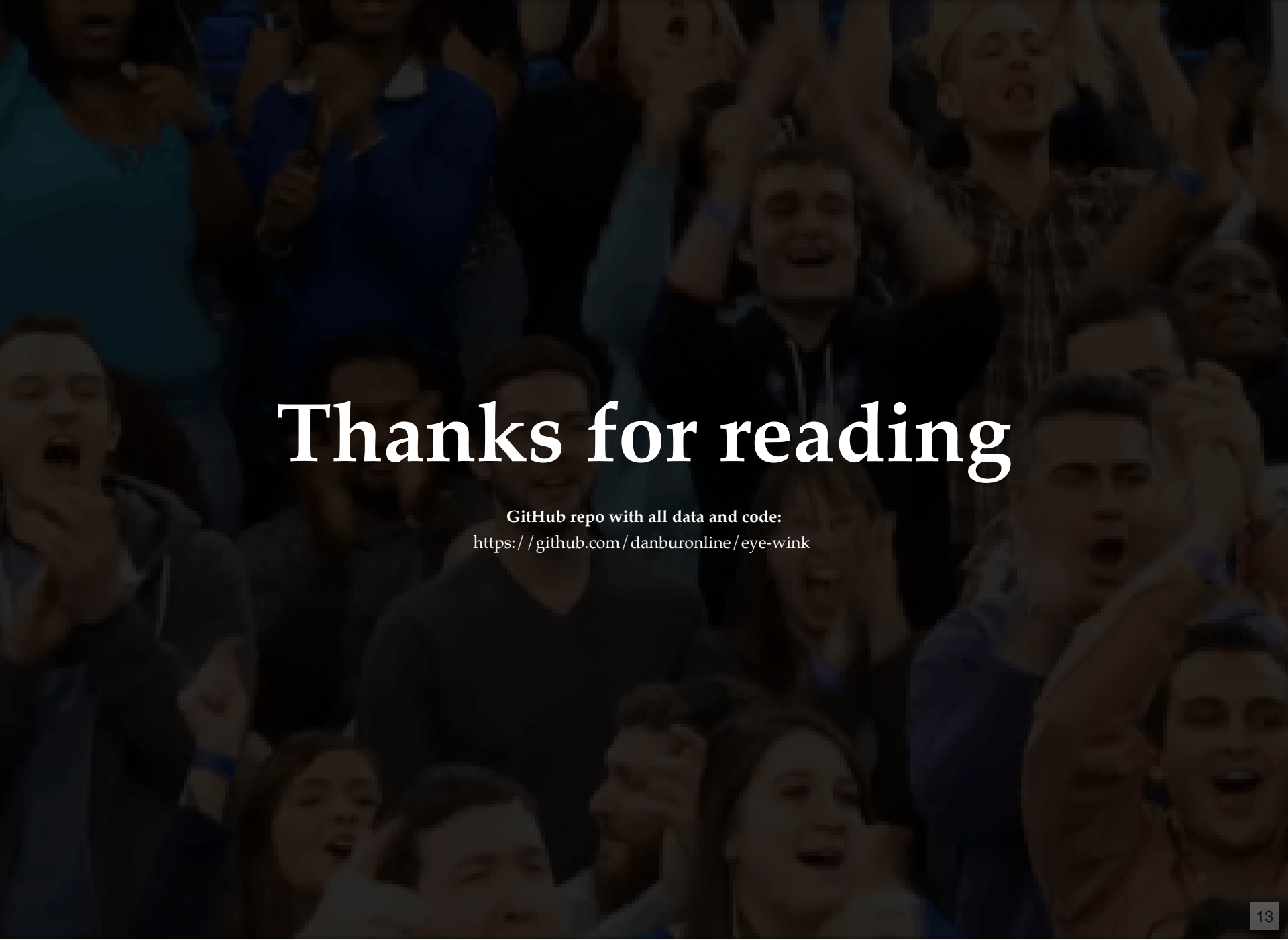
Despite these challenges, I am continuing to work on this project and am confident that I will be able to improve the classifier's performance. I am excited to see where this project takes me and am looking forward to continuing to learn and grow as a machine learning engineer.

> *One of the most important lessons I have learned is that it is very difficult to collect data from neural signals in a controlled way – so creating and collecting lots of data is not a trivial task in machine learning with BCI.*

Also, everyone's physiology is different in every way; see the videos above to see how different people wink their eyes. Some use more muscles in the face, others only the eyelids. This makes it even more difficult to detect patterns in the neural signals.

# *Next steps*

As next steps I would like to create more data and have more time for model selection, as I don't want to rely too much on AutoML in the future.



# Thanks for reading

**GitHub repo with all data and code:**
https://github.com/danburonline/eye-wink