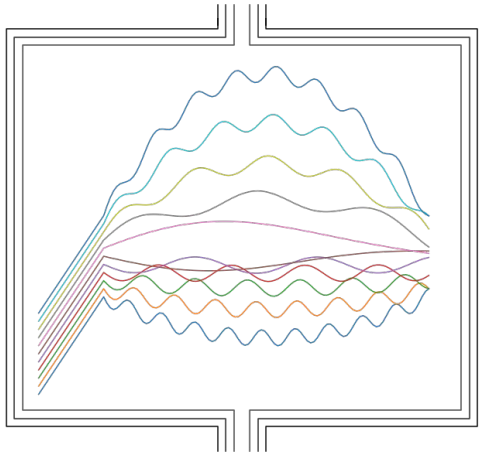
CortexType: Typing with your mind



Neureality Hackathon (March 2024)

Team Electric Sheep:

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Meet our team - Electric Sheep!

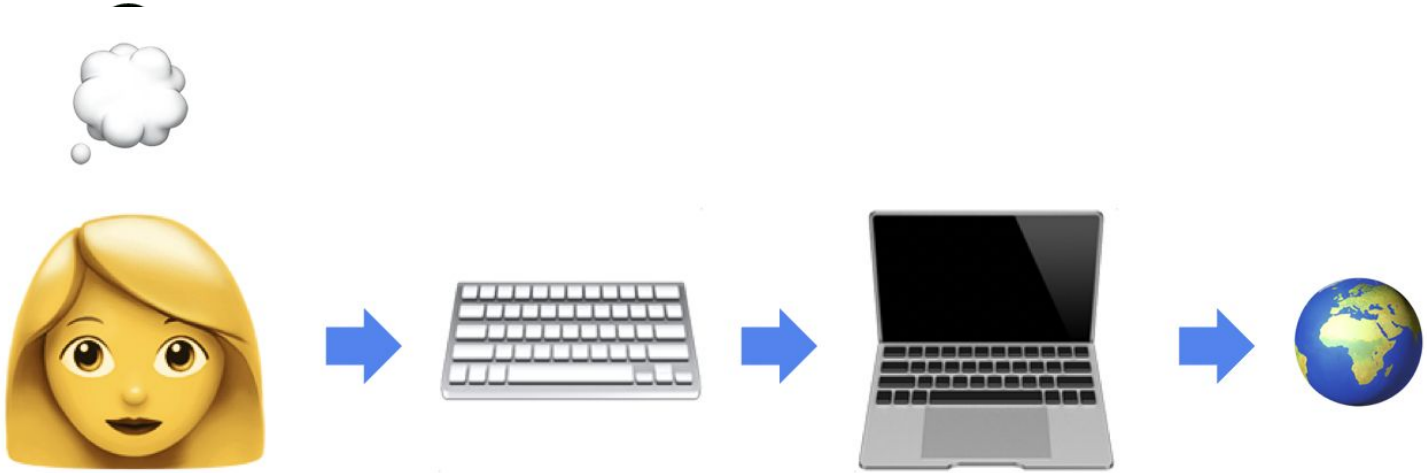
Our teammates (left to right):

@Joanna - biomedical engineering grad at Columbia → responsible for BCI hardware and software setup

@Kate - data science grad at Carnegie Mellon University → responsible for modelling and coding scripts, team lead

@Hussain - phd at University of Toronto → participated in the final testing of the algorithm

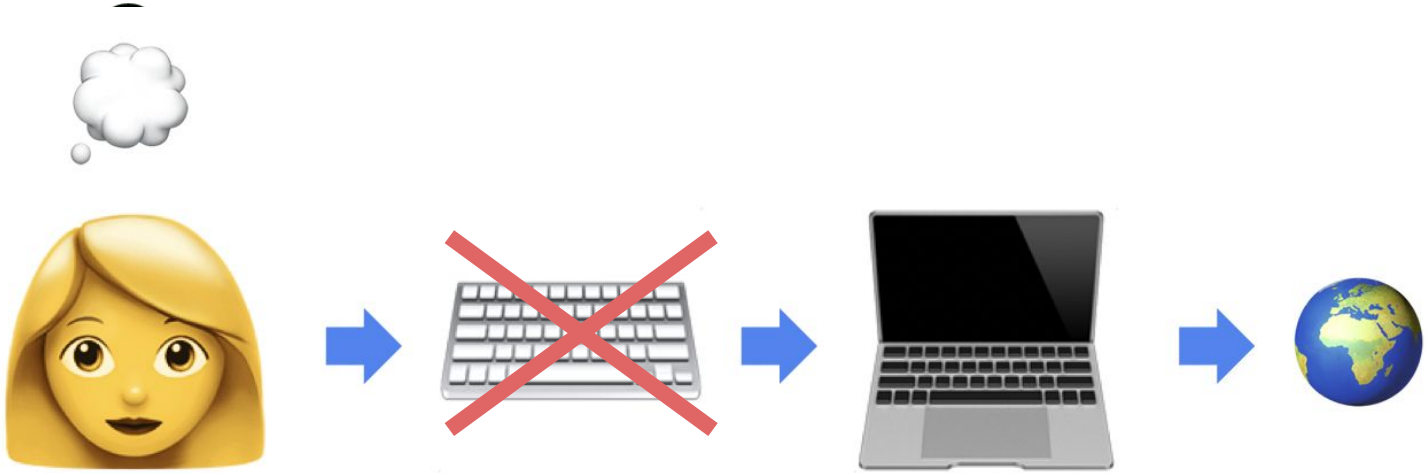
Present communication



Typing is hard, slow, and boring.

But more importantly, it’s not accessible for many people.

What if...



What if there is no physical barrier between your mind and digital interface?

What if you could type just with your mind?

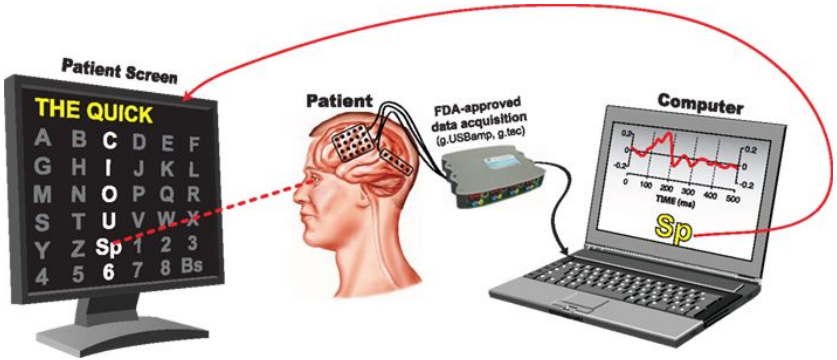
Current tools - P300 BCI Speller

Pros:

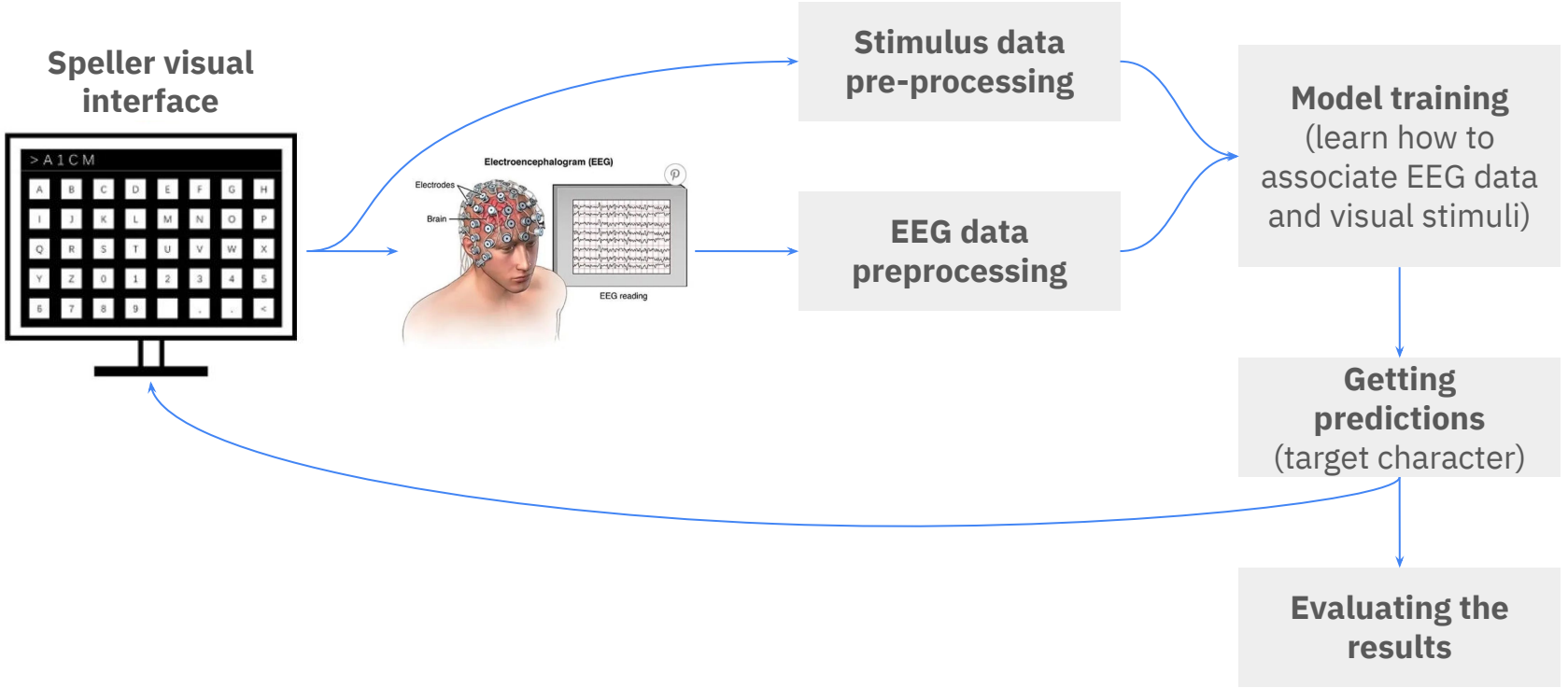
- Relatively high accuracy in detecting the focused character.

Cons:

- Require extensive training and calibration for each user.
- Slow typing speed.
- Sensitive to external disturbances.

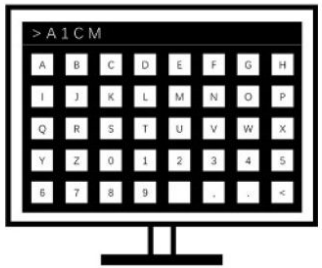


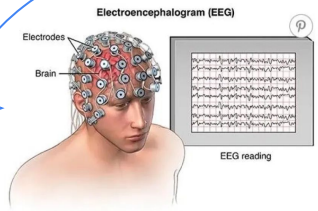
Our goal - Make the P300 BCI Speller more accurate and fast



Improving the model - classifier

Speller visual interface





Stimulus data pre-processing

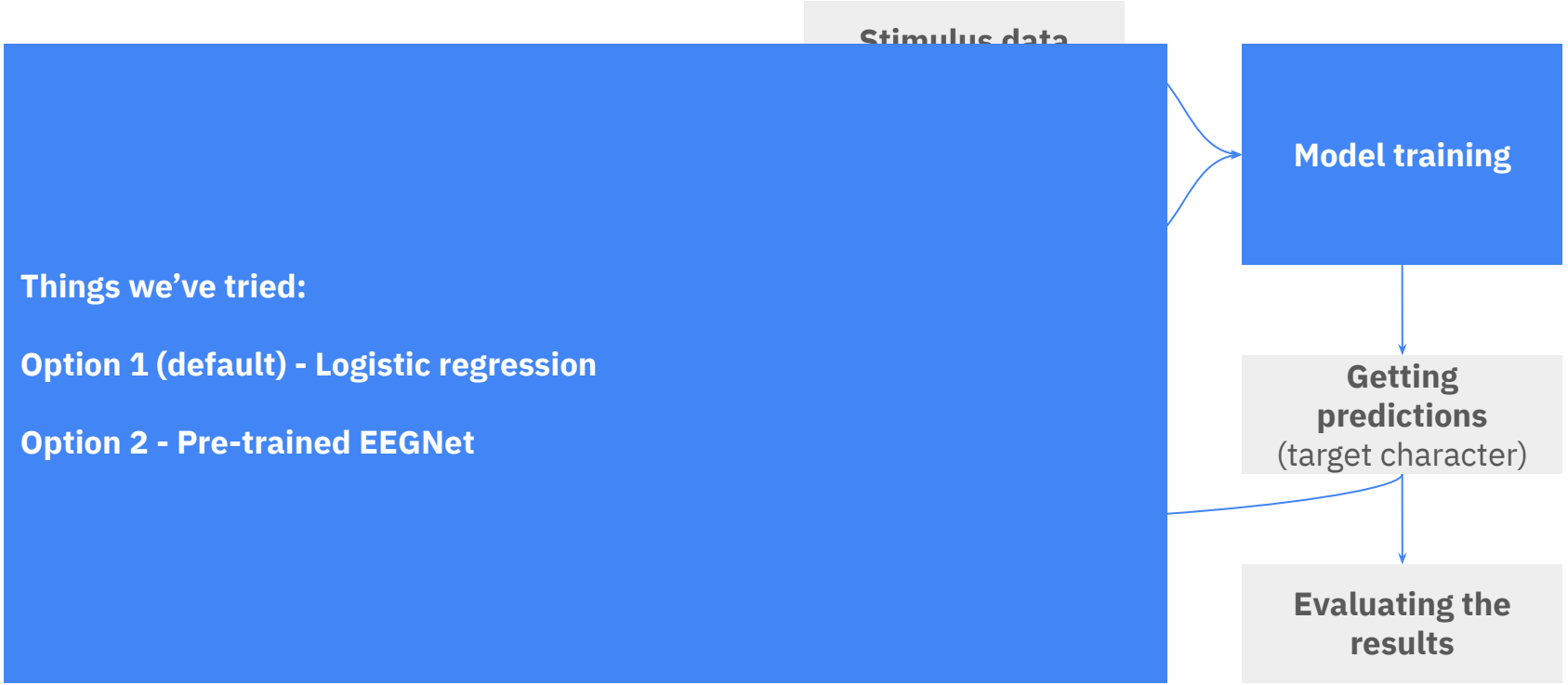
EEG data preprocessing

Model training

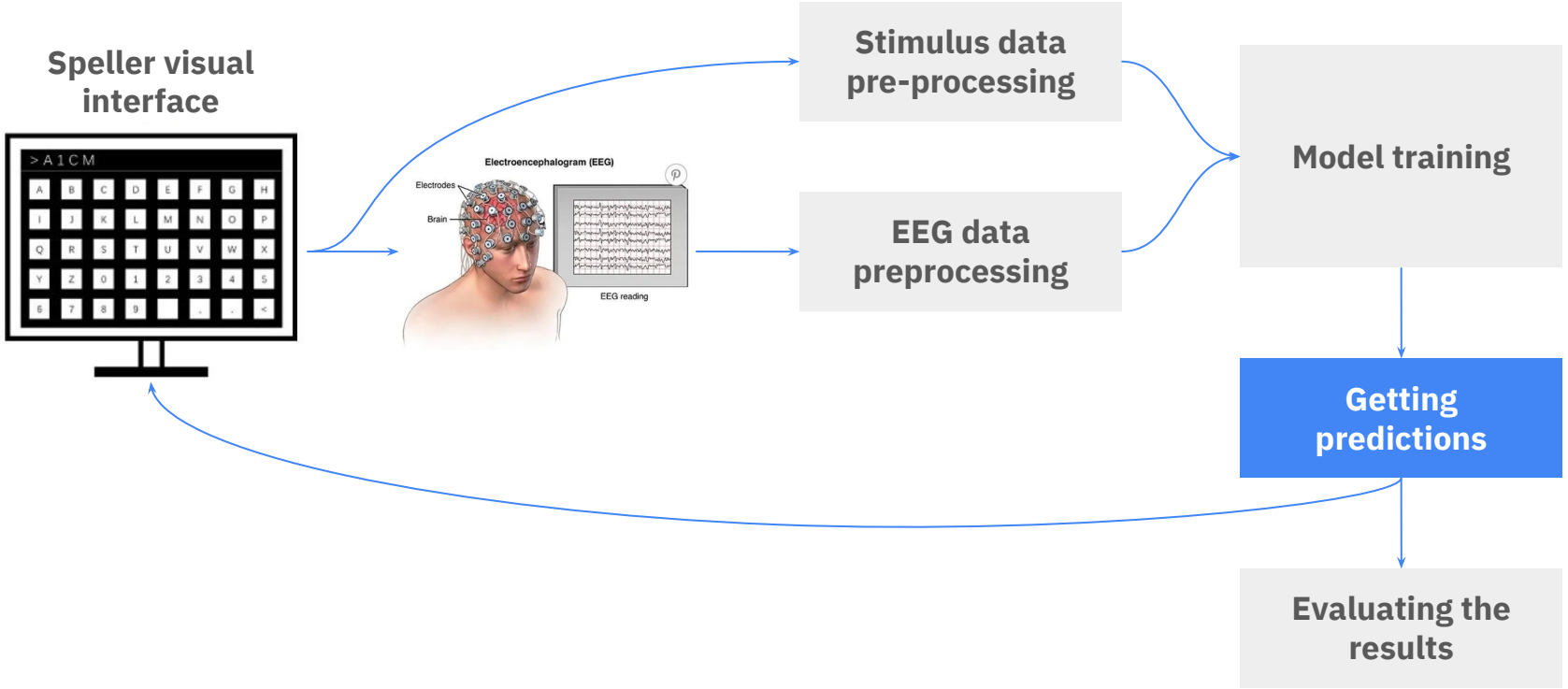
Getting predictions (target character)

Evaluating the results

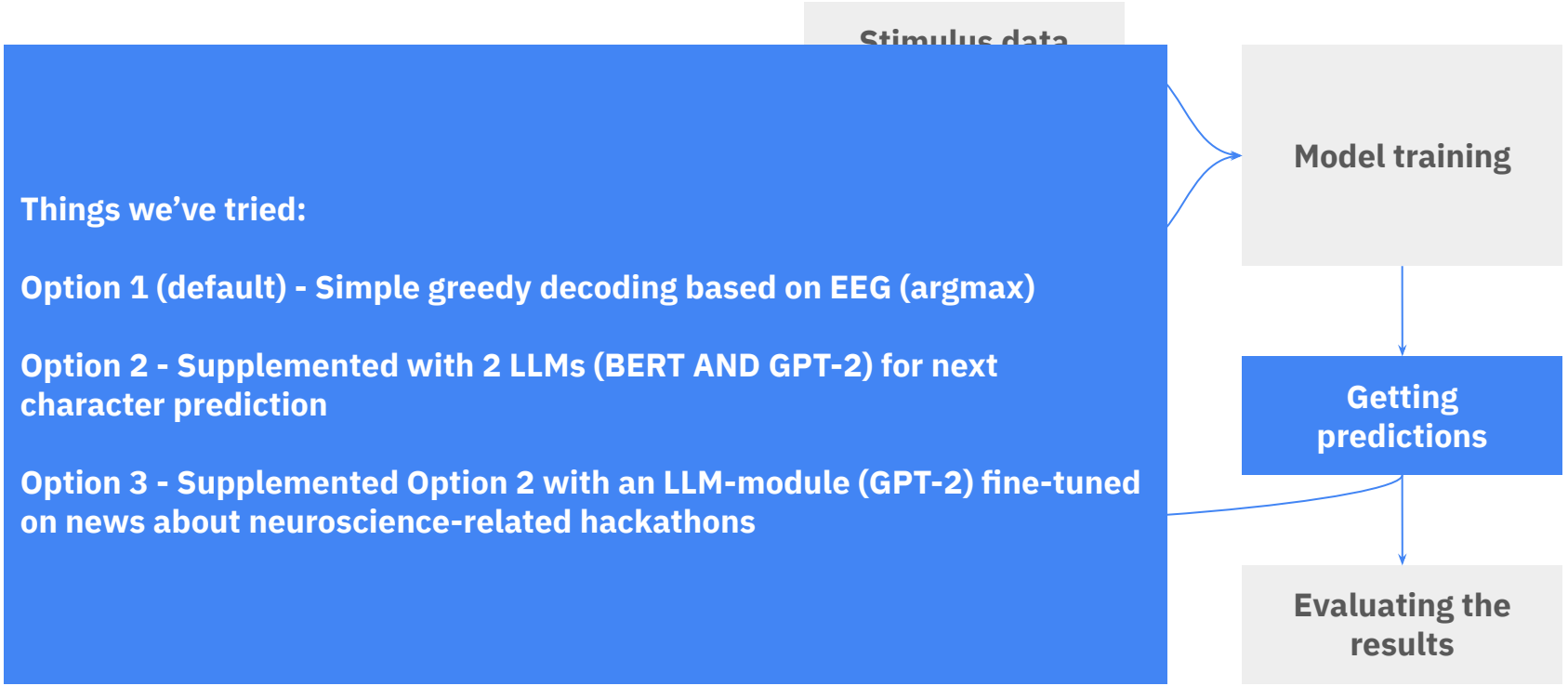
Improving the model - classifier



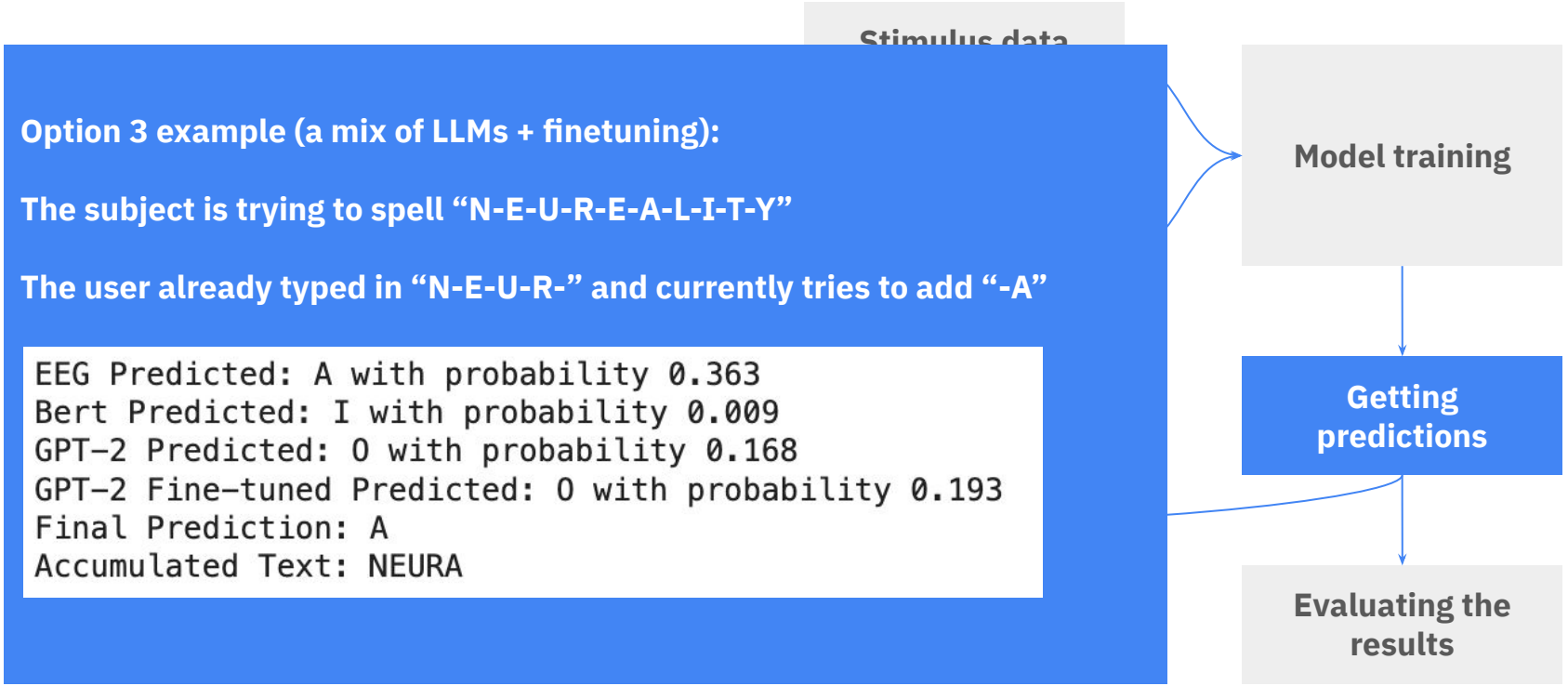
Improving the model - getting predictions



Improving the model - getting predictions



Improving the model - getting predictions



Training & testing - set up

- **EEG device**: g.tec Unicorn Hybrid Black Headset
- **Human subject**: our teammate Hussain (thanks, Hussain!)
- **Training**: multiple approaches (repeat trials of single or multiple letters)
- **Testing**: spell out the word N-E-U-R-E-A-L-I-T-Y

Training & testing - demo

LINK TO THE DEMO

Evaluation

- **Accuracy**: 53-60%*
- **Speed**: 4-5 minutes to spell out N-E-U-R-E-A-L-I-T-Y

* More comprehensive testing is required.

Next steps

- Experiment with other EEG signal preprocessing and feature extraction techniques.
- Complete testing and adaptation of models developed during the hackathon the using the EEG equipment.
- Check the correlation between EEG-based model and LLMs.
- Consider introducing additional subject-specific layer to account for variability between users.
- Probably rearrange the keyboard (find the best combo of characters, consider grouping, and viz)

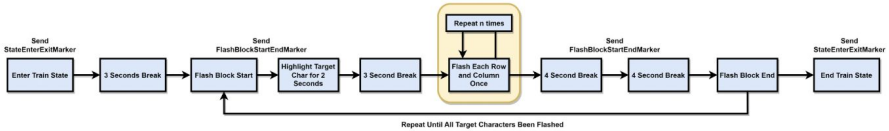
Thanks, organizers! We had fun and learned a lot!

References

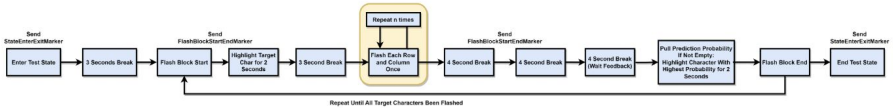
- PhysioLabXR-Community: https://github.com/PhysioLabXR/PhysioLabXR-Community/tree/master
- Neureality Hackathon: https://neureality-cu.github.io/Neureality/hackathon.html
- Pre-trained motor-imagery models: https://neurotechlab.socsci.ru.nl/resources/pretrained_imagery_models/

Annex

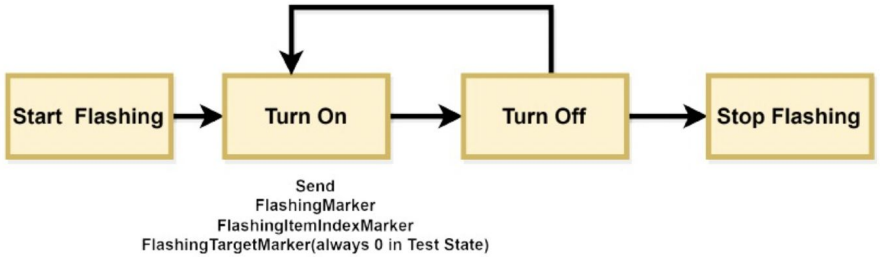
Train State



Test State



Flash Block



Source: https://physiolabxrdocs.readthedocs.io/en/latest/PhysioLabXRP300SpellerDemo.html