EE 486E: FINAL PROJECT

Spring 2015

100 points

Due: FRI 1 MAY @ 1930

Instructions

All components of your final project are to be completed by you alone. The final project is not a team project. You may use your notes, textbooks, discussions with your peers, and the Internet as resources in arriving at your final solution. However, you may not use any Internet resources that specifically address the problem assigned here, nor may you directly copy (either verbatim or with only trivial modifications) any code you find on the Internet. You are free to reuse any Matlab code you have written yourself for past assignments in EE486E, but you may not use code written by other EE486E students, past or present. If you are unsure whether a particular resource is on- or off-limits, consult with the instructor via email before engaging that resource.

Directions for Submission

Your final project submission will consist of three parts: 1) A written report following IEEE conference paper format; 2) A Google Drive upload of your Matlab code; and 3) A 10-minute slide presentation to be delivered during the final examination time slot listed in the "Due" line above. All data files for the final project as well as the IEEE report template can be found on Google Drive in `EE486E_CLASS\EE486E_DATA_FILES\FINAL_PROJECT`. Directions for each of the three submission components are elaborated below.

Written Report (50 pts)

Your report should not exceed 4 pages including text, figures, tables, and references. Include your Matlab code as an appendix. (The appendix need not adhere to the IEEE format and may extend the submission beyond 4 pages.) The report should contain the following four major parts: 1) An "Introduction" that goes beyond reiterating the assignment details and provides the neuroscience and engineering background required to contextualize the problem; 2) A "Methods" section detailing the algorithm you designed to address the problem; 3) A "Results" section containing figures, text, and/or tables that summarize your algorithm's performance and other experimental findings; and 4) A "Discussion" section describing your conclusions. You may turn in your written report any time between the "Due" date listed above and 2359 on the last day of the final exam period without penalty.

Google Drive Upload (30 pts)

You will upload two main Matlab files to Google Drive (`EE486E_CLASS\EE486E_DROPBOX\<YOURNAME>_EE486E_DROPBOX`), as well as any supporting files called by those two main files. The first main file to upload is analogous to the homework uploads you have been doing all semester. It should be called `RunFinalProject_<YOURNAME>.m` and when executed should reproduce the figures and analyses described in your written report. The second main file should be called `FinalClassifier_<YOURNAME>.m`. This should be a Matlab function that takes a single input argument, `testData`, with exactly the same format as the training data described in Section 3, below. The function should produce one output, an $n \times 1$ vector, `predictedClass`, that gives your algorithm's predicted class label (1 or -1; see Section 3 for more detail) for each of the n observations in `testData`. You may upload these two main files any time between the "Due" date listed above and 2359 on the last day of the final exam period without penalty.

Slide Presentation (20 pts)

Your final presentation should be in PowerPoint or PDF format and be uploaded to `EE486E_CLASS\EE486E_DROPBOX\<YOURNAME>_EE486E_DROPBOX` so that it can be easily accessed when it comes time to deliver your talk. It should follow the same general outline as your written report with the exception that any introductory slides should be confined to only the background necessary to understand your methodology. (Since all students are working on the same problem, you need not rehash the problem statement.) Presentations will be 10 minutes followed by a 2-minute question-and-answer period. Your final slide presentation must be complete by the "Due" date listed above.

1 Introduction

The data set for your final project was provided by Prof. Wolfgang Rosenstiel[1], Prof. Niels Birbaumer[2], Prof. Bernhard Schölkopf[3], and Prof. Christian Elger[4]. The problem description that appears below was originally provided by these authors, and is modified only slightly in places for clarity and to add instructions specific to EE486E.

2 Problem and Experiment Description

Designing a BMI classifier that can be trained on one day and remain effective on future days without retraining is a challenge. A given patient might be in a different state of motivation, arousal, attention, etc. than on the training day, and his or her brain may therefore generate different patterns of electrical activity. In addition, the recording system may undergo changes over time, for example in electrode positions and/or impedances. The data set described here potentially reflects this situation: training and test data were recorded from the same subject performing the same experimental task, but on two different days roughly 1 week apart.

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[4] Department of Epileptology, Universität Bonn, Bonn, Germany

During the BMI experiment, a subject had to perform imagined movements of either the left small finger or the tongue. Neural activity was recorded during these trials using an 8×8 ECoG platinum electrode grid which was placed on the contralateral (right) motor cortex. The grid was assumed to cover the right motor cortex completely, but due to its size (approximately 8×8 cm) it also partly covered surrounding cortical areas. All recordings were performed using a sampling rate of 1kHz. The units of amplitude are microvolts. Every trial lasted 3 seconds and consisted of either an imagined tongue or an imagined finger movement. To avoid the presence of visually evoked potentials in the data, recording intervals began 0.5 seconds after visual cues prompting the imagined movements had disappeared.

3 Data Format

The labeled training data (i.e., the data from the first recording session) are stored in the file `trainDataTubingen.mat`. This file contains two variables:

X: A $278 \times 64 \times 3000$ array containing the raw ECoG data ($trials \times channels \times time$)

Y: A 278×1 vector containing the labels (1 or -1) corresponding to whether the subject was imagining moving the finger or tongue

4 Your Task

The challenge of this final project is to use the training data recorded from the first experimental session to learn a model that accurately predicts output labels and will generalize well to new data. Your submitted classifier, `FinalClassifier_<YOURNAME>.m`, will be tested by the instructor against data recorded in the second experimental session. Its accuracy on this test set will be one of the factors that determines your final project grade.

A classification error below 9% on the test set coupled with a strong written report and oral presentation will earn you an automatic A in EE486E.

Good luck!