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Image and Neural Classifier Co-Training for Improved Classification in Rapid Serial Visual Presentation

Steven Gutstein[1,2], Vernon Lawhern[1], Brent Lance[1]

[1]Human Research and Engineering Directorate and [2]Computational and Information Sciences Directorate, U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, USA

459 Mulberry Point Rd, Aberdeen Proving Ground, MD 21005, USA. E-mail: steven.m.gutstein.ctr@mail.mil

Introduction: One of the major difficulties in machine learning is the acquisition of sufficiently large sets of labeled data. Semi-supervised techniques allow a classifier to take data that it has confidently labeled and add them to its training set. Yet, sometimes a classifier can gain more informative training samples from another classifier. Co-training exploits the situation when two learners have fundamentally different views of the training data in order to get these more informative data samples [1]. Some prior work has used co-training to help train image classifiers using audio and visual data as the two different feature sets [2] or linguistic and visual data [3]. In this work we investigate the co-training of computer vision and neural classifiers for discriminating target images in a rapid serial visual presentation (RSVP) brain-computer interface (BCI) system.

Material, Methods and Results: 18 subjects participated in an RSVP experiment with an image database of common office objects and environments. Images belonged to one of five target classes: stairs, doors, containers, posters and chairs. A sixth class of non-target background images not containing any of the five target classes was used as the baseline (Figure 1). Subjects performed five RSVP sessions, where in each session subjects were instructed to identify one of the five target classes against the non-target images. 256-channel EEG was recorded using a Biosemi ActiveTwo system, the RSVP presentation rate was 5Hz and the target/non-target ratio was approximately 5/95. We used the xDAWN spatial filter together with a Bayesian LDA as the neural classifier [5]. The computer vision (CV) classifier is the AlexNet Deep Learning system [6], as implemented in the BVLC Reference Caffenet. Co-training consists of training both classifiers, next re-training the CV classifier with the most confident target images as labeled by the neural classifier, and then retraining the neural classifier with the CV classifier's most confident target images.

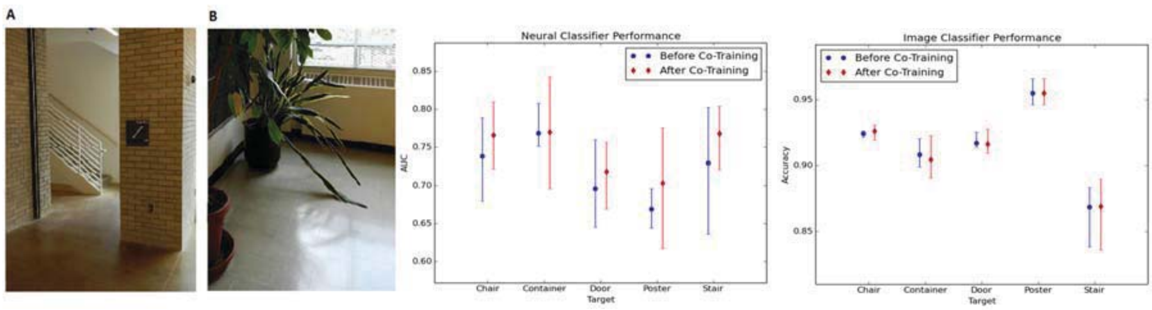

Figure 1. *(Left) Sample images of the target class Stair (A) and the background nontarget class (B). (Center and Right) Co-Training Performance of the Neural and CV Classifiers for detecting target classes versus the background images. Datapoints are average results over 5 trials, with error bars indicating maximum & minimum results.*

Discussion: We show that co-training the CV and neural classifier can markedly improve the performance of the neural classifier.

Significance: Our results suggest that co-training neural and computer vision classifiers can significantly improve the performance of future RSVP-based BCI systems.

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