NER 2015 BCI Challenge

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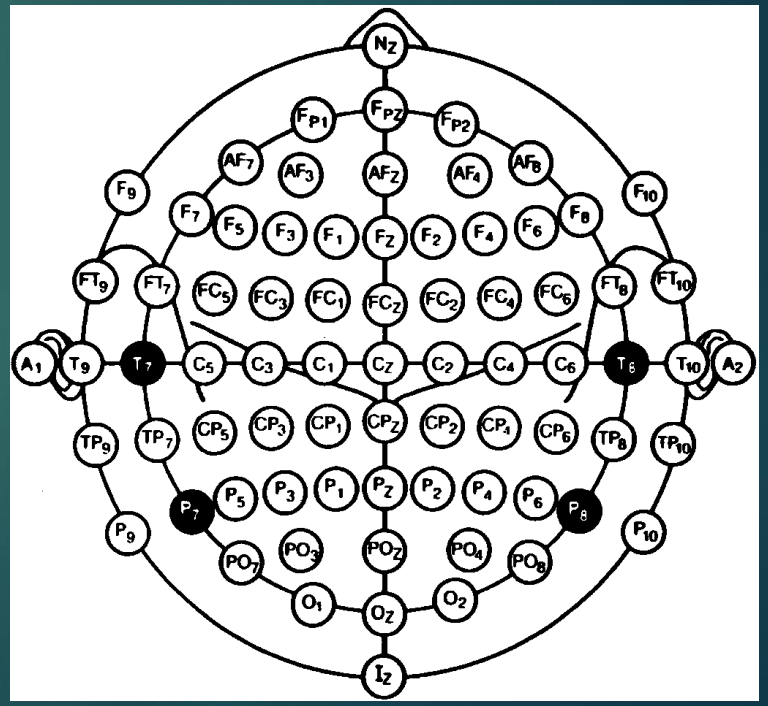
Outline

- The Challenge
- Course Relevance
- Data Format and Preprocessing
- Machine Learning Schemes
- Result Comparision
- Ranking and Outlook

The Challenge

- This particular Kaggle challenge has already been archived and was posed as part of the IEEE Neural Engineering Conference 2015 (NER2015) with the goal to flag errors in brain-computer interface responses through analysis of EEG data in the test subjects.

BCI



Course Relevance

- EEG Data mapping brain activity
- Due to data complexity machine learning algorithms are applied some of which are brain inspired such as certain neural networks
- The experiment is based on a BCI setup and is geared towards improvements in BCI setups in order to make a more general application of BCI possible

Data Format and Preprocessing

Data Format:

- EEG data of 16 test subjects with 5 sessions per person was provided (80 files = 8.7 GB)
- Full set of the 56 electrodes was measured at 200 Hz
- The timing of feedback events was labled

Preprocessing:

- Feedback related 1.3 second long chunks of EEG data cut out of complete data set
- Application of Butterworth filter with a passband of 1-40 Hz (alpha activity 8-13 Hz, beta activity 13-31 Hz)
- Amplitude Average over 1.3 seconds of the Butterworth filtered data
- Downsampling for SVM application

Machine Learning Schemes

sklearn based implementations

Random Forrests:

- Number of trees n = 500 or 1000
- best result 0.697, Channel 39, n = 500

Support Vector Machines:

- Precision requirement C = 5
- runtime issues with training (>15h)
- best result 0.636, Channel 39, downsampled 5x, n = 500

Gradient Boosting Machine:

- Number of estimators n = 500 or 1000
- a single regression try fit on the negative gradient of binomial deviance loss function
- Best result 0.644, Channel 39, n = 500

EEGlearn based implementations

Fully Connected Neural Network:

- Linear sequential stack, epochs = 3000
- Best result with cross referenced train data 0.84
- Corresponding test result 0.5 (random)

Convolutional Neural Network:

- Require images as input
- Alpha, Beta, Theta bands are being averaged for this
- Result 0.542, Epochs = 3000

Result Comparision

Feature	Classifier	Channel, Electrode	Parameter	Result acc
Raw Time Series	Gradient Boosting	channel 46, P1	n=500	0.573
		channel 46, P2	n=1000	0.58
		channel 40	n=500	0.582
		channel 39	n=500	0.609
	Random Forest	channel 46, P1	n=500	0.577
		channel 46, P2	n=1000	0.574
		channel 40	n=500	0.595
		channel 39	n=500	**0.647**
		channel 40	n=1000	0.639
Filtered Time Series				
	Gradient Boosting	channel 46	n=500	0.584
		channel 39	n=500	0.0.644
	Random Forest	channel 46	n=500	0.653
		channel 46	n=1000	0.678
		channel 39	n=500	**0.697**
		channel 39	n=1000	0.684
		channel 39	n=1500	0.682
	Support Vector Machine	channel 39	5xdown, n200	0.623
		channel 39	5xdown, n500	0.636
		channel 39	10xdown, n200	0.630
		channel 39	10xdown, alle	0.624
	Fully Connected Neural Network	channel 39, CP4	Epochs = 3000	0.5 (**0.84** cross reference)
Filtered Average	Gradient Boosting	channel 39	n=500	0.518
	Random Forest	channel 39	n=500	**0.533**
Averaged three channel image	Convolutional Neural Network	Averaged theta, alpha, beta	Epochs = 3000	**0.542**

- Random Forest Approach delivers best results in all categories
- Prior knowledge about EEG data motivated Butterworth Filter application
- Filtering showed positive impact
- Averaging showed negative impact

Ranking and Outlook

12	↑33	ThibaultV	0.70152	20	Mon, 26 Jan 2015 10:57:45 (-5.5d)	
13	↑136	A.M.	0.69865	11	Wed, 11 Feb 2015 23:39:57 (-13.5d)	
-		**Erzlearner**	**0.69659**	-	**Tue, 05 Jul 2016 22:36:18**	**Post-Deadline**

Post-Deadline Entry
If you would have submitted this entry during the competition, you would have been around here on the leaderboard.

14	↑29	os	0.69468	12	Sat, 21 Feb 2015 18:02:02 (-3.9d)
15	↑12	Black Swan (NER)	0.69364	39	Tue, 20 Jan 2015 01:02:22 (-6.9d)

- Challenge felt impactful
- Motivation to work on future challenges
- Future projects in this subject area