Non-Invasive Brain-Computer Interfaces KU (709.028) | Summer term 2019

Jonas Ditz | Institute for Neurotechnology | TU-Graz

Unit #1 (14.03.2019)

Exercise 0: Introduction to MATLAB

If you are not familiar with Matlab and did not have the time to go through the tutorial, then please refresh your knowledge before starting with exercise 1!

Exercise 1: Spatial filters

Artifacts are a major issue in BCI. One way to reduce the impact of artifacts are spatial filters. In this exercise you will study the effects of different spatial filters on artifact-contaminated EEG.

The file artifacts.mat contains a segment of a 120 channel EEG recording that is contaminated with artifacts. Use the MATLAB function load to load the .mat file. The EEG is sampled at a rate of 500 Hz and band pass filtered between 1 Hz and 200 Hz. Electrode setup and channel information are shown on the next pages. Please compute the following spatial filters for positions Fz, Cz and Oz:

Exercise 1.1: Bipolar derivation $X_{bip} = X_{anterior} - X_{posterior}$

Exercise 1.2: Laplace derivation
$$X_{lap} = X - \frac{1}{4} (X_{anterior} + X_{dexter} + X_{posterior} + X_{sinister})$$

Exercise 1.3: Common average reference derivation (CAR) $X_{CAR} = X - average(all\ channels)$

Task:

• Describe the effects of the different spatial filters on the EEG signal, especially on artifacts.

Exercise 2: P300 Evoked Potentials

The file BI5_segments_HTS.mat contains data from an auditory P300 BCI experiment. Study participants were asked to concentrate on a target tone, which was higher than the non-target tone. The multidimensional matrix segments stores the following information:

- First dimension: Channels (Fz, Cz and Pz, you can look that up in "ch_selection").
- Second dimension: Time course (77 time points, Sample rate: 64 Hz).
- Third dimension: Trials (2200).

Use the classlabels vector to identify non-target trials (class 1) and target trials (class 2). Store them in separate matrices and calculate their means.

Tasks:

- Compute the EPs by averaging the trials for each channel and modality (non-target and target) separately.
- Plot a figure for each channel with the two modalities (hold on).
- Describe the differences between the two modalities (P300).
- Are the differences the same for all channels?

Pre-submission via TeachCenter at the end of the unit; final submission 25.03.2018

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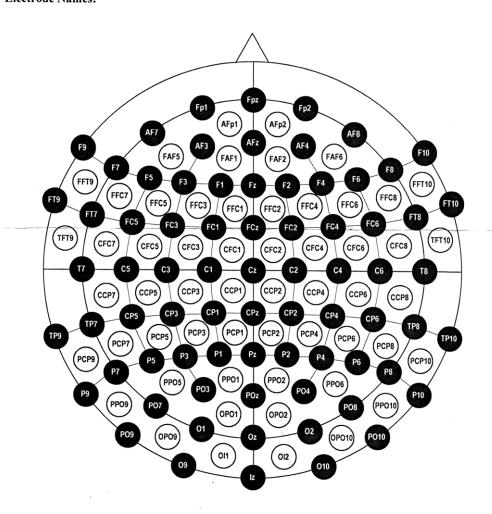
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Montage No. 15

See coordinates measured from a real head in "M15-ext-ThetaPhi.xls".

Electrode Names:



X:\AL-Arbeitsanleitungen\Montagen nummeriert\M15.doc

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Electrode positions:

1	Fp1	
2		
4	AFp1	
5 6	AFp2 AF3	
7	AFz	
8 9	AF4 FAF1	
10	FAF2	
11 12	F1 Fz	
13	F2	
14 15		
16	FC1	
17 18	FCz FC2	
	CFC1	
21	CFC2 C1	
22	Cz C2	
23 24	CCP1	
25 26	CCP2 CP1	
	CPz	
28 29	CP2 PCP1	
30	PCP2	
31 32	P1 Pz	
33	P2	
34 35	PPO1 PPO2	
36	PO3	
37 38	POz PO4	
39	OPO1	
40 41	OPO2 O1	
42 43	Oz O2	
44	OI1	
45 46	Ol2 I1	
47	lz	
48 49	I2 AF7	
50	F9	

F7

51 52 FT9 53 FAF5 54 F5 55 FFC7 56 FT7 57 F3 58 FFC5 59 FC5 60 CFC7 61 T7 62 FFC3 63 FC3 64 CFC5 65 C5 66 CCP7 67 TP7 68 P9 69 CFC3 70 C3 71 CCP5 72 CP5 73 PCP7 74 P7 75 P09 76 CCP3 77 CP3 78 PCP5 79 P5 80 PO7 81 OPO9 82 PCP3 83 P3 84 PPO5 85 AF8 86 F10 87 F8 88 FT10 89 FAF6 90 F6 91 FFC8 92 FT8 93 F4 94 FFC6 95 FC6 96 CFC8 97 T8 98 FFC4

101 102 CCP8 103 TP8 104 P10 105 CFC4 106 C4 107 CCP6 108 CP6 109 PCP8 110 P8 111 PO10 112 CCP4 113 CP4 114 PCP6 115 P6 116 PO8 117 OPO10 118 PCP4 119 P4 120 PPO6 121 EMG1SL 122 EMG1IL 123 EMG2SL 124 EMG2IL 125 EMG1SR

99 FC4 100 CFC6

C6