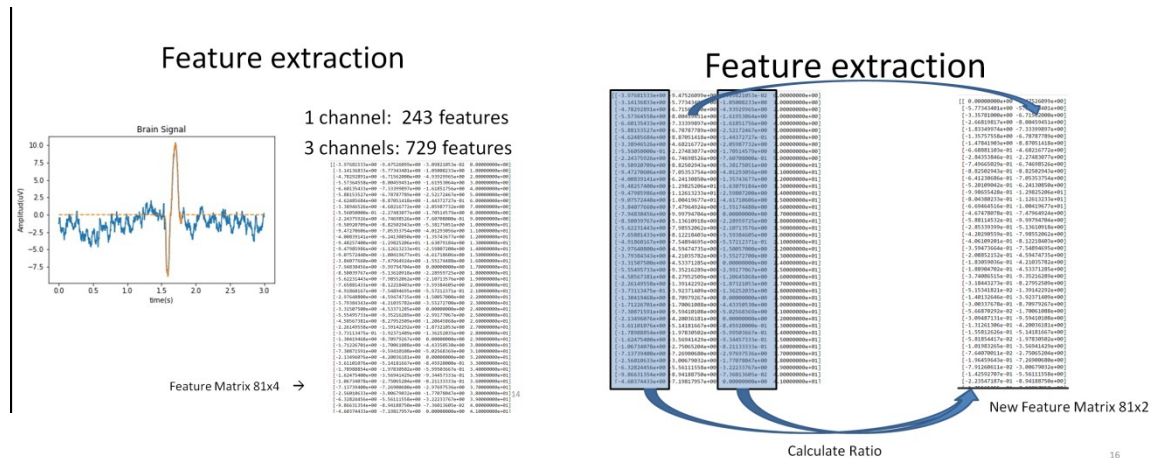


Classification basics of EEG signals of people with schizophrenia



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Candidato a Doctor en Sistemas Inteligentes
November 23th, 2022

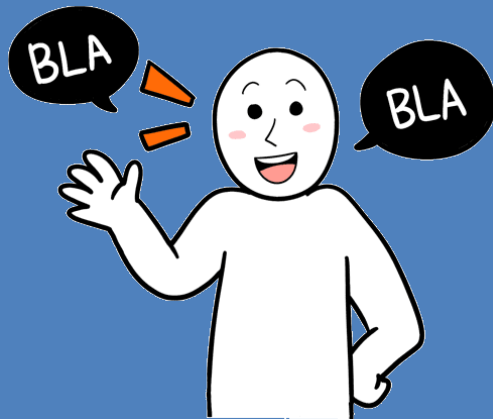
Motivation

Why?

- This disorder affects 1%
- Not completely understood
- New methods

What is Schizophrenia?

Internal Stimuli



External Stimuli



What is Schizophrenia?

- Schizophrenia is a chronic mental illness where **it is difficult to differentiate between internally and externally generated stimuli.**

Development

Classification system stages:

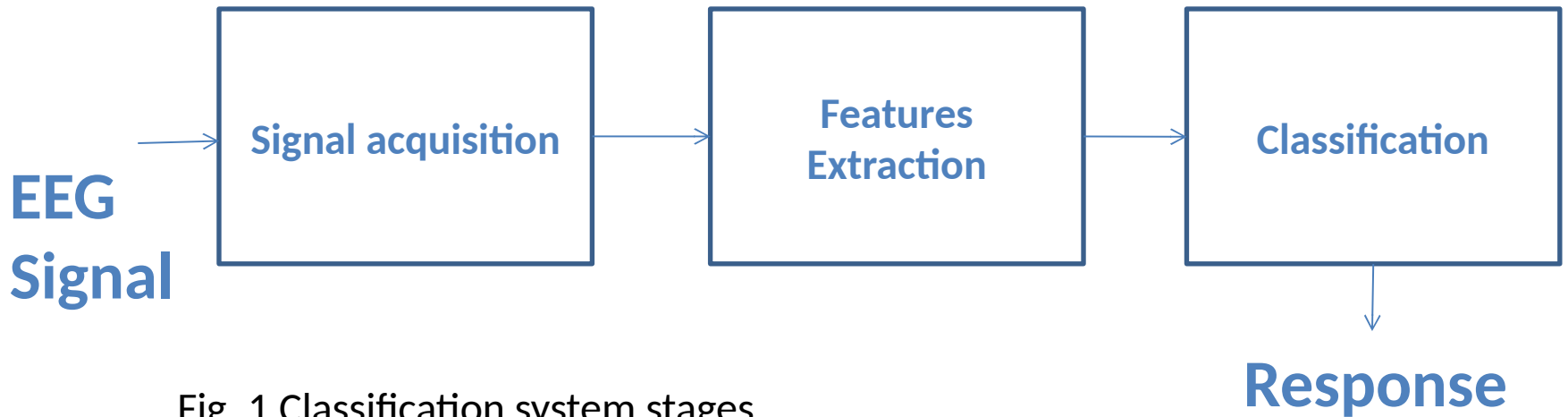


Fig. 1 Classification system stages

1. Signal Acquisition

<https://www.kaggle.com/broach/button-tone-sz>

 Dataset

^

91

EEG data from basic sensory task in Schizophrenia

Button press and auditory tone event related potentials from 81 human subjects



Brian Roach • updated 9 months ago (Version 6)

Data

Kernels (4)

Discussion (12)

Activity

Metadata


Download (19 GB)

New Notebook



 Usability 8.2

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 Tags natural and physical sciences, health, time series, neuroscience, mental health

Event-related potential (ERP)

- (1) pressed a button to immediately generated a tone,
- (2) passively listened to the same tone,
- (3) pressed a button without generating a tone

1. Signal Acquisition

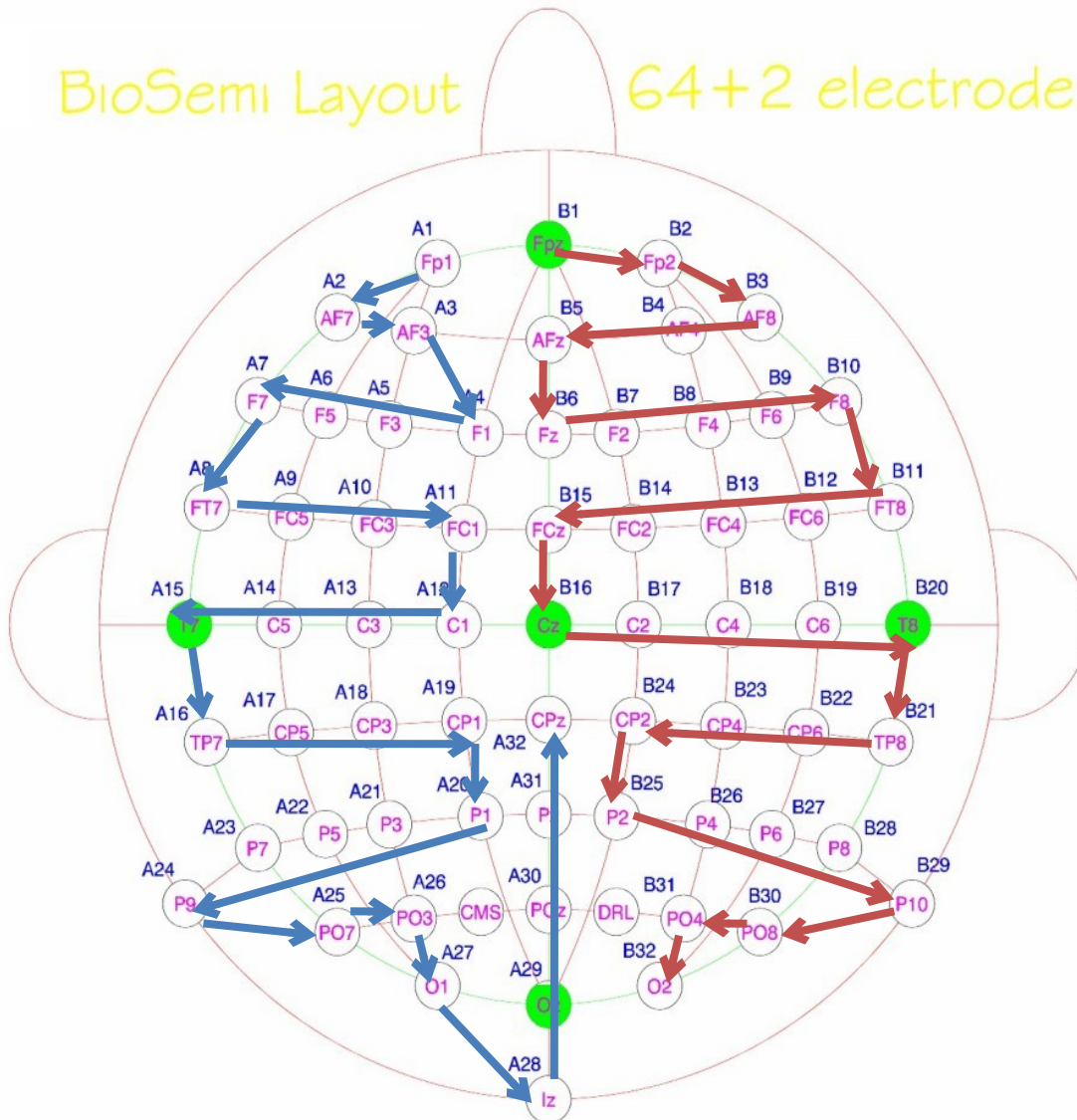
- 81 signals are processed:
 - 32 □ controls
 - 49 □ schizophrenia
- Sampling Frequency: 1024Hz
- Bandpass Filter: 0.5 Hz – 15 Hz
- Epoch separation: 3000ms

Key concepts

BioSemi Layout

64+2 electrodes

- 64 channels



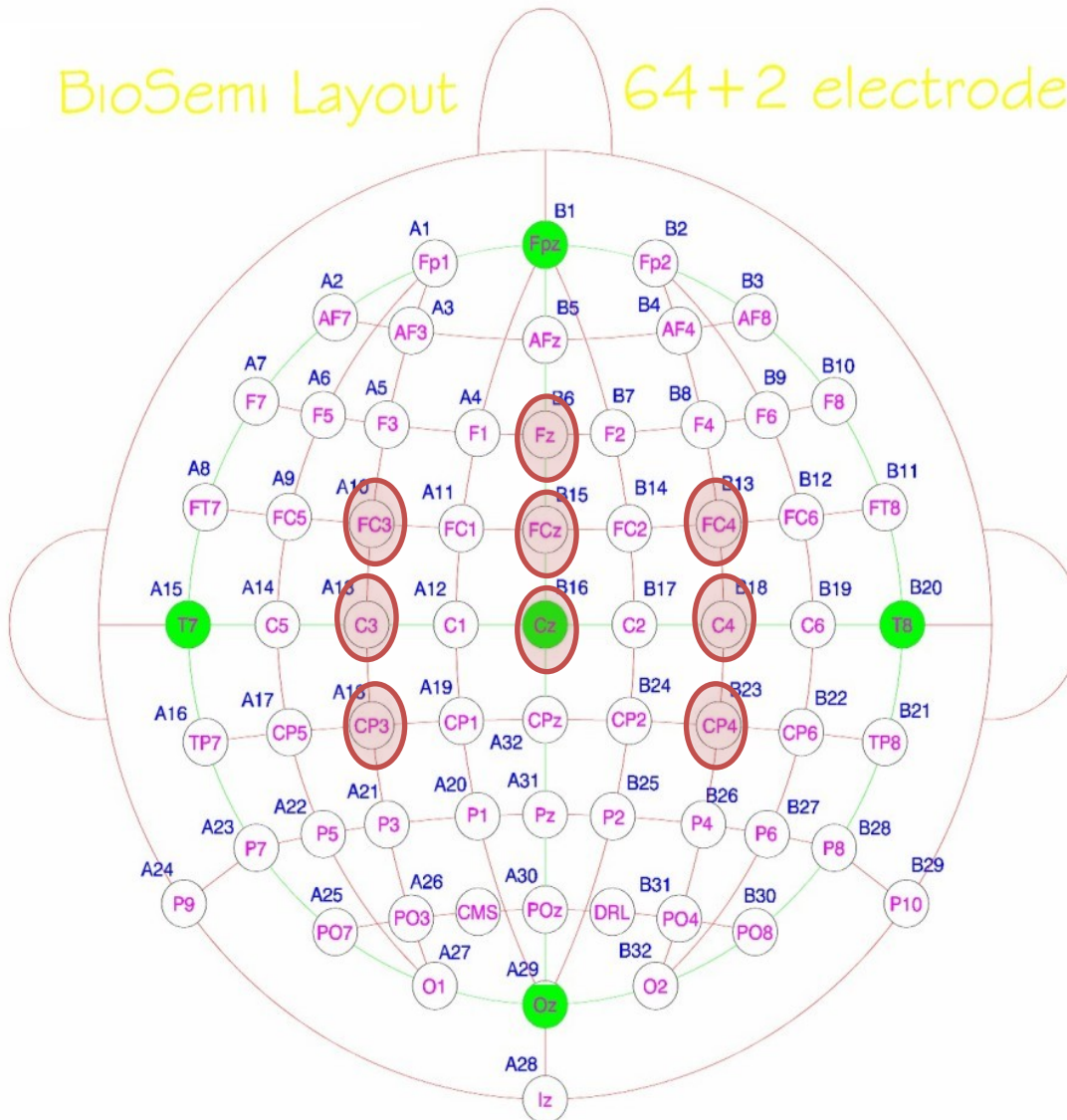
Key concepts

BioSemi Layout

64+2 electrodes

9 channels:

- Fz
- FCz
- Cz
- FC3
- C3
- CP3
- FC4
- C4
- CP4



Key concepts

BioSemi Layout

64+2 electrodes

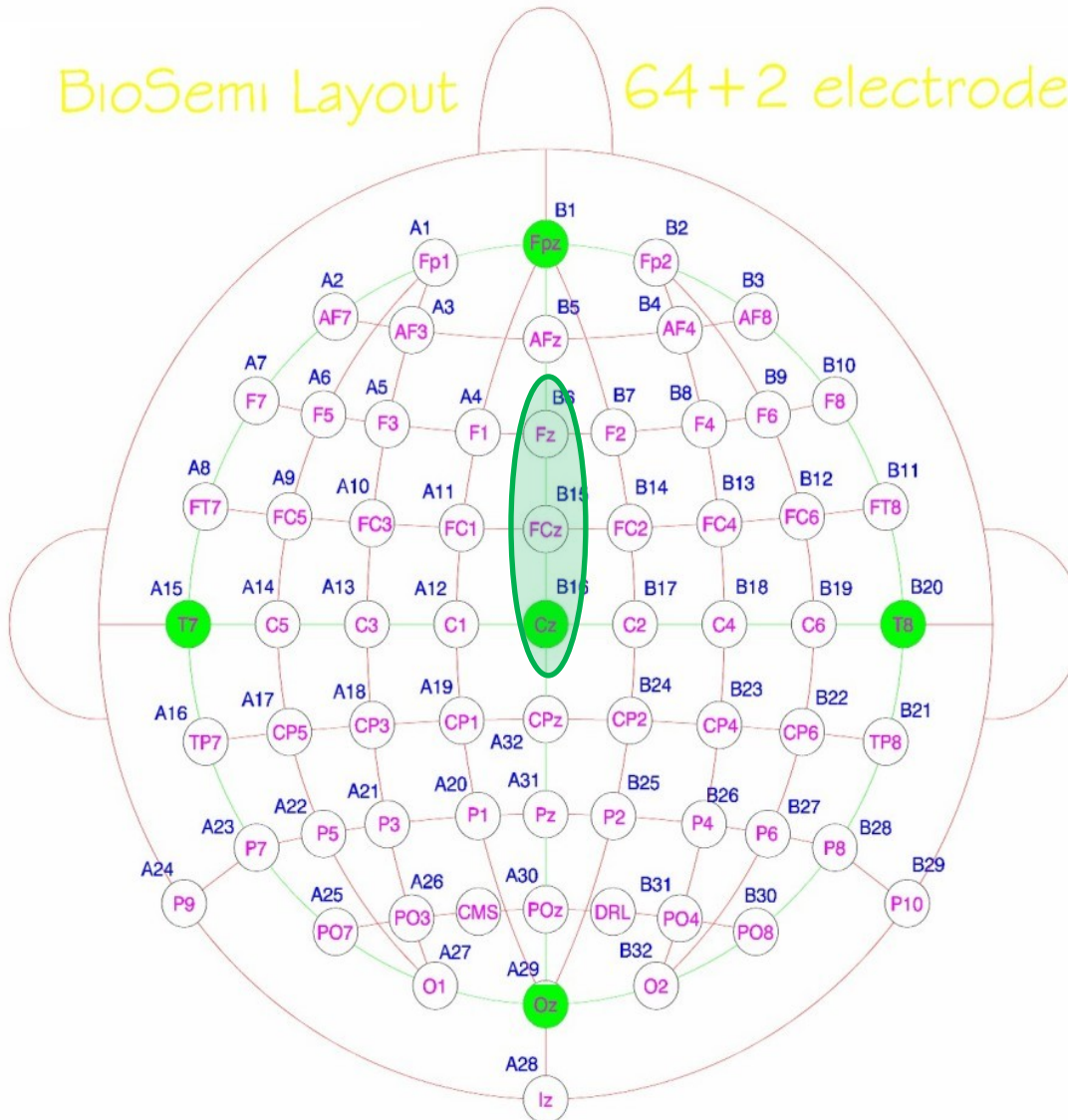
3

channels:

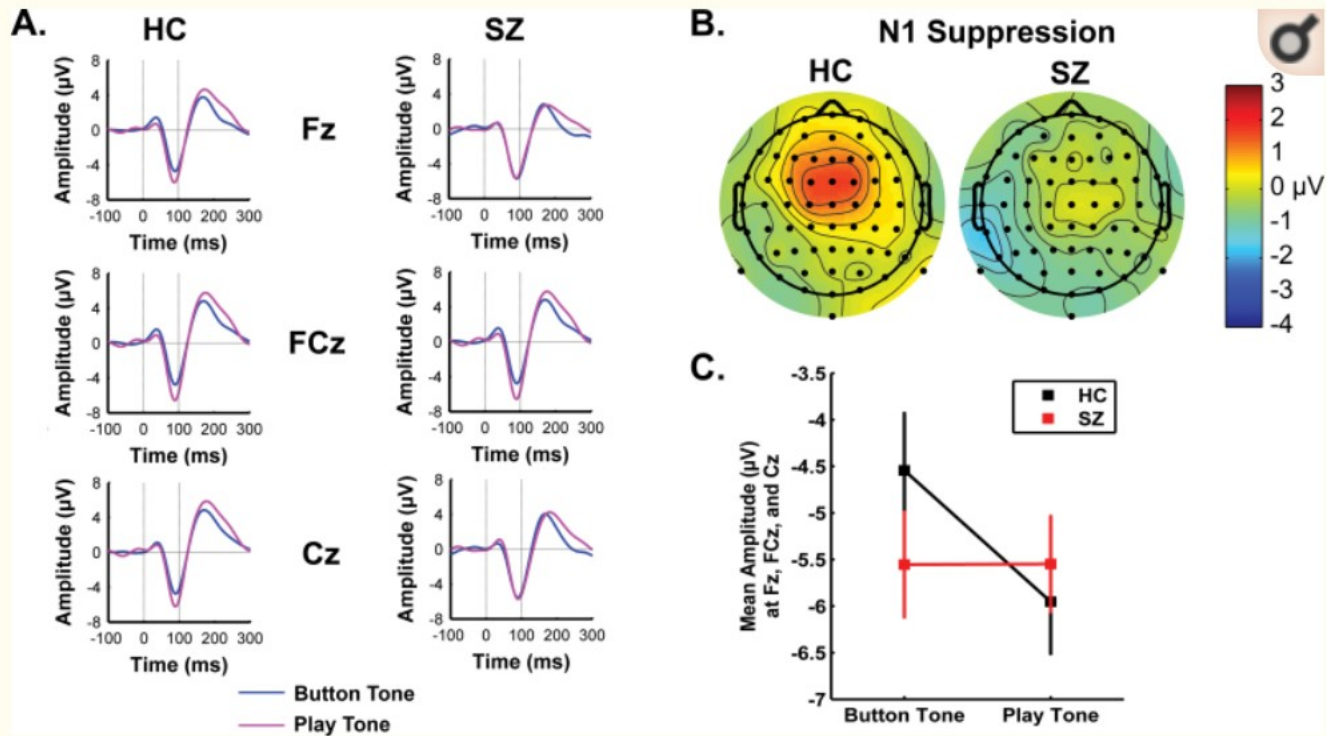
➤ Fz

➤ FCz

➤ Cz



Potential N100



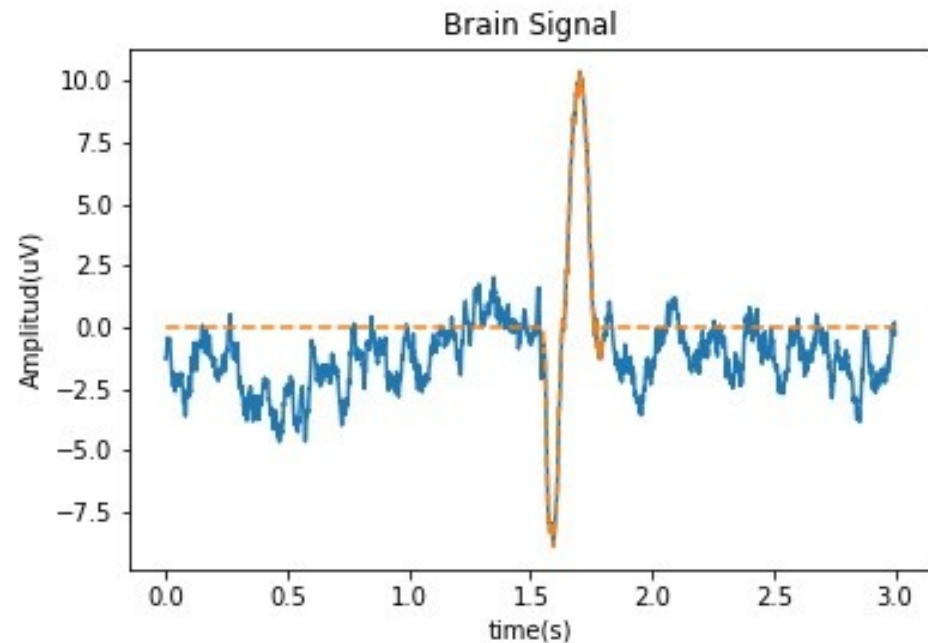
- Figure taken from:

Ford, Judith M and Palzes, Vanessa A and Roach, Brian J and Mathalon, Daniel H. *Did I do that? Abnormal predictive processes in schizophrenia when button pressing to deliver a tone*, Oxford University Press US. Schizophrenia bulletin, volume 40, number 4, pages 804--812, 2013.

Feature extraction

1 channel: 243 features

3 channels: 729 features



Feature Matrix 81x3



```
[[-3.97681533e+00 -9.47526099e+00 -3.09821053e-02
[-3.14136833e+00 -5.77343401e+00 -1.05008233e+00
[-4.78292891e+00 -6.71562000e+00 -4.93929965e+00
[-5.57364558e+00 -8.00459451e+00 -1.61953064e+00
[-6.60135433e+00 -7.33399897e+00 -1.61851756e+00
[-5.88153527e+00 -6.78787789e+00 -2.52172467e+00
[-4.62485684e+00 -8.87051418e+00 -1.44372727e-01
[-3.38946526e+00 -4.68216772e+00 -2.05987732e+00
[-5.56050000e-01 -2.27483077e+00 -1.70514579e+00
[-2.24375926e+00 -6.74698526e+00 -7.60708000e-01
[-9.50920709e+00 -8.82502943e+00 -5.38175051e+00
[-9.47270606e+00 -7.05353754e+00 -4.01293056e+00
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[-9.47985986e+00 -1.12613233e+01 -2.59807200e+00
[-9.07572440e+00 -1.00419677e+01 -4.61710606e+00
[-3.84077660e+00 -7.47964924e+00 -1.55174480e+00
[-7.94830456e+00 -9.99794704e+00 0.00000000e+00
[-8.50039767e+00 -5.13610918e+00 -2.28959725e+00
[-5.62231443e+00 -7.98552062e+00 -2.10713576e+00
[-7.65881433e+00 -8.12218403e+00 -3.59384605e+00
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[-2.26149558e+00 -1.39142292e+00 -1.87321053e+00
[-3.73113475e-01 -3.92371409e+00 -1.36252035e+00
[-1.30419468e+00 -8.70979267e+00 0.00000000e+00
[-1.71226701e+00 -1.70061088e+00 -4.43350530e+00
[-7.30871591e+00 -9.59410108e+00 -5.02568369e+00
[-2.13496076e+00 -4.20036181e+00 0.00000000e+00
[-3.61101076e+00 -5.14181667e+00 -8.45920000e-01
[-1.78988854e+00 -1.97830502e+00 -5.99503667e-01
[-1.62475400e+00 -3.56941429e+00 -9.34457333e-01
[-1.06734078e+00 -2.75065204e+00 -8.21133333e-01
[-7.13739400e+00 -7.26900680e+00 -2.97697536e+00
[-2.56010633e+00 -3.00679032e+00 -1.77078047e+00
[-6.32824456e+00 -5.56111558e+00 -3.22233767e+00
[-9.86631354e+00 -8.94188750e+00 -7.36013605e-02
[-4.60374433e+00 -7.19817957e+00 0.00000000e+00
```


Classification

```
[[-3.97681533e+00 -9.47526099e+00 -3.09821053e-02  
[-3.14136833e+00 -5.77343401e+00 -1.05008233e+00  
[-4.78292891e+00 -6.71562000e+00 -4.93929965e+00  
[-5.57364558e+00 -8.00459451e+00 -1.61953064e+00  
[-6.60135433e+00 -7.33399897e+00 -1.61851756e+00  
[-5.88153527e+00 -6.78787789e+00 -2.52172467e+00  
[-4.62485684e+00 -8.87051418e+00 -1.44372727e-01  
[-3.38946526e+00 -4.68216772e+00 -2.05987732e+00  
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[-2.24375926e+00 -6.74698526e+00 -7.60708000e-01  
[-9.50920709e+00 -8.82502943e+00 -5.38175051e+00  
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[-2.97640800e+00 -4.59474735e+00 -1.50057000e+00  
[-3.79384343e+00 -4.21035782e+00 -3.55272700e+00  
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[-5.55495733e+00 -9.35216289e+00 -2.99177067e+00  
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[-9.86631354e+00 -8.94188750e+00 -7.36013605e-02  
[-4.60374433e+00 -7.19817957e+00 0.00000000e+00
```

Logistic Regression
(LR)

Stochastic Gradient
Descent
(SGD)

Logistic Regression

$$\sigma(t) = \frac{1}{1 + \exp(-t)}$$

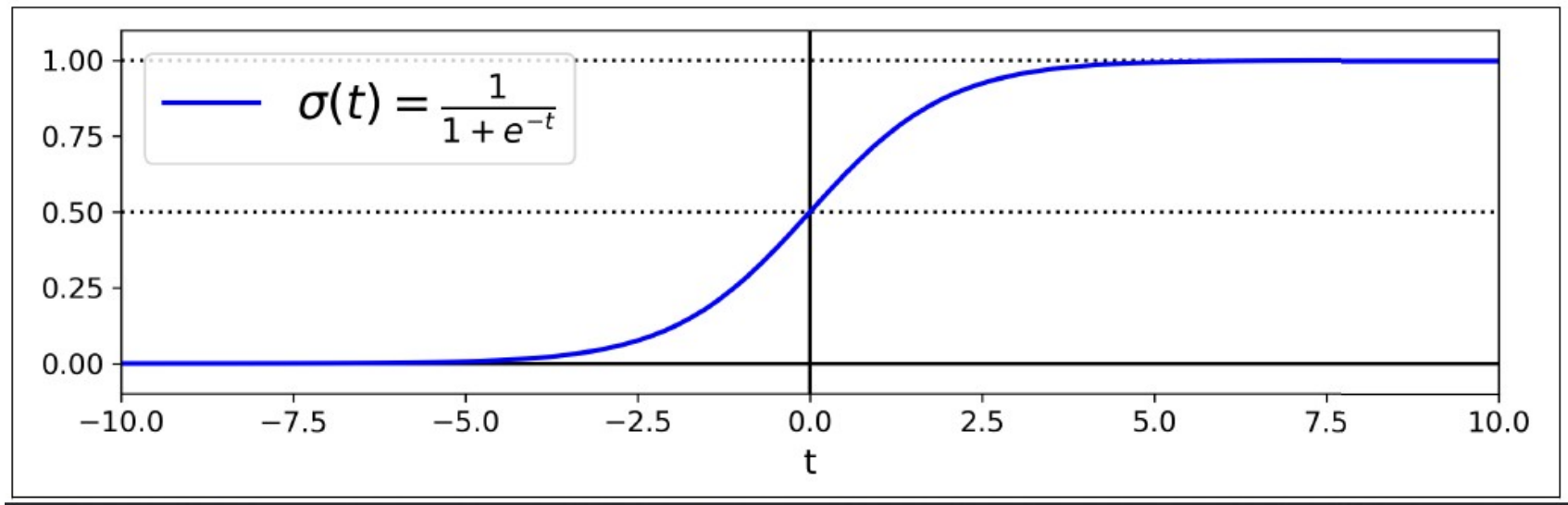


Figure taken from:

Géron, Aurélien, *Hands-on Machine Learning with Scikit-Learn, Keras and TensorFlow*. Publisher O'Reilly Media, 2019.

Stochastic Gradient Descent

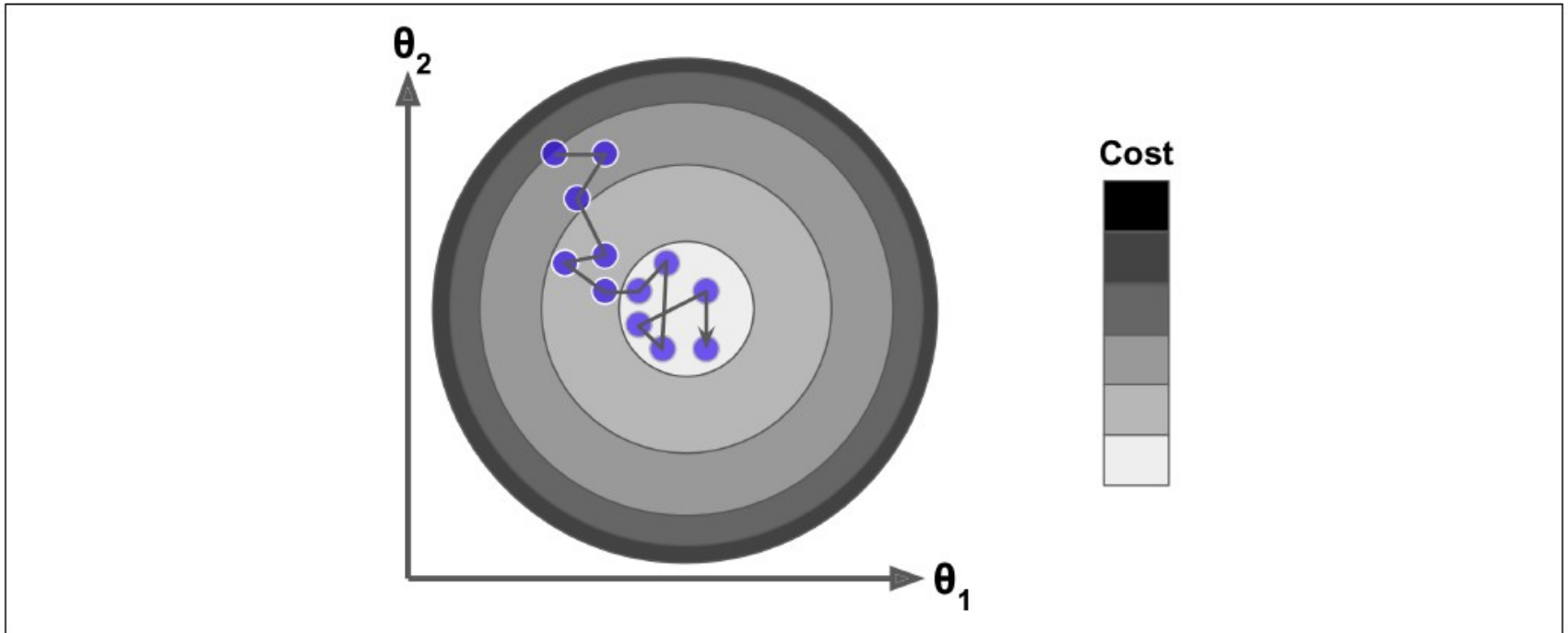


Figure taken from:

Géron, Aurélien, *Hands-on Machine Learning with Scikit-Learn, Keras and TensorFlow*. Publisher O'Reilly Media, 2019.

Results

16	7
06	31

TABLE 3

Confussion Matrix for LR

13	10
03	34

TABLE 4

Confussion Matrix for SGD

	<i>LR</i>	<i>SGD</i>
<i>Precision</i>	0.8157	0.7727
<i>Recall</i>	0.8378	0.9189

TABLE 1

Precision_Recall comparison for LR and SGD classifiers

Conclusion

Mean of 3 channels (Fz, FCz, Cz) was successful
SGD better than LP for sensitivity

Future work

- Generate an expert (Cepstrum)
- Analyse other channels (F1, F2)
- Use other classifiers (SVM)

REFERENCES

- [1] Ford, Judith M and Palzes, Vanessa A and Roach, Brian J and Mathalon, Daniel H. *Did I do that? Abnormal predictive processes in schizophrenia when button pressing to deliver a tone*, Oxford University Press US. Schizophrenia bulletin, volume 40, number 4, pages 804–812, 2013.
- [2] Paulraj et al. *Auditory evoked potential response and hearing loss: a review*, Bentham Science Publishers. The open biomedical engineering journal, volume 9, 2015.
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- [4] Géron, Aurélien, *Hands-on Machine Learning with Scikit-Learn, Keras and TensorFlow*. publisher O'Reilly Media, 2019.

Thanks