

R & I

Assist. Prof. Nadica Miljković, PhD

University of Belgrade - School of Electrical Engineering ETF
Signals & Systems Department
e-mail: nadica.miljkovic@etf.rs



Hello world!

- My name is Nadica Miljković.
- I am Assist. Prof. of Biomed. Eng. at the ETF.
- I have 10 yrs. long experience in Academia and 6 yrs. in industry.
- For a long time (> decade) I used Matlab mainly.
- Prof. Predrag Pejović introduced me with:
 - free software and
 - R.
- I searched for R. No results. Tried “R programming” instead.



Dr. Predrag Pejović

Professor

[Faculty of Electrical Engineering](#)
[University of Belgrade](#)

E-mail: peja@etf.rs

[Google Scholar Profile](#)

ORCID ID: [0000-0003-4064-6204](#)

TEACHING

LIST OF PUBLICATIONS

PERSONAL

Undergraduate Courses

- Electrical Measurements ([13E042EM](#))
- Analog Electronics ([13E043AE](#))
- Power Electronics 1 ([13E043EE](#))
- Software Tools in Electronics ([13E042PSA](#))
- Electronics Lab 2 ([13E043LVE2](#))

Graduate Courses

+
...
🗑️

Hvala!

Why oh why?

- Two features caught my eye:
 - data cleaning tools (namely **dplyr** package)
 - data visualization tools (namely **ggplot** package)
- And I wasn't in the industry any more... more free time!
- I decided to learn R.



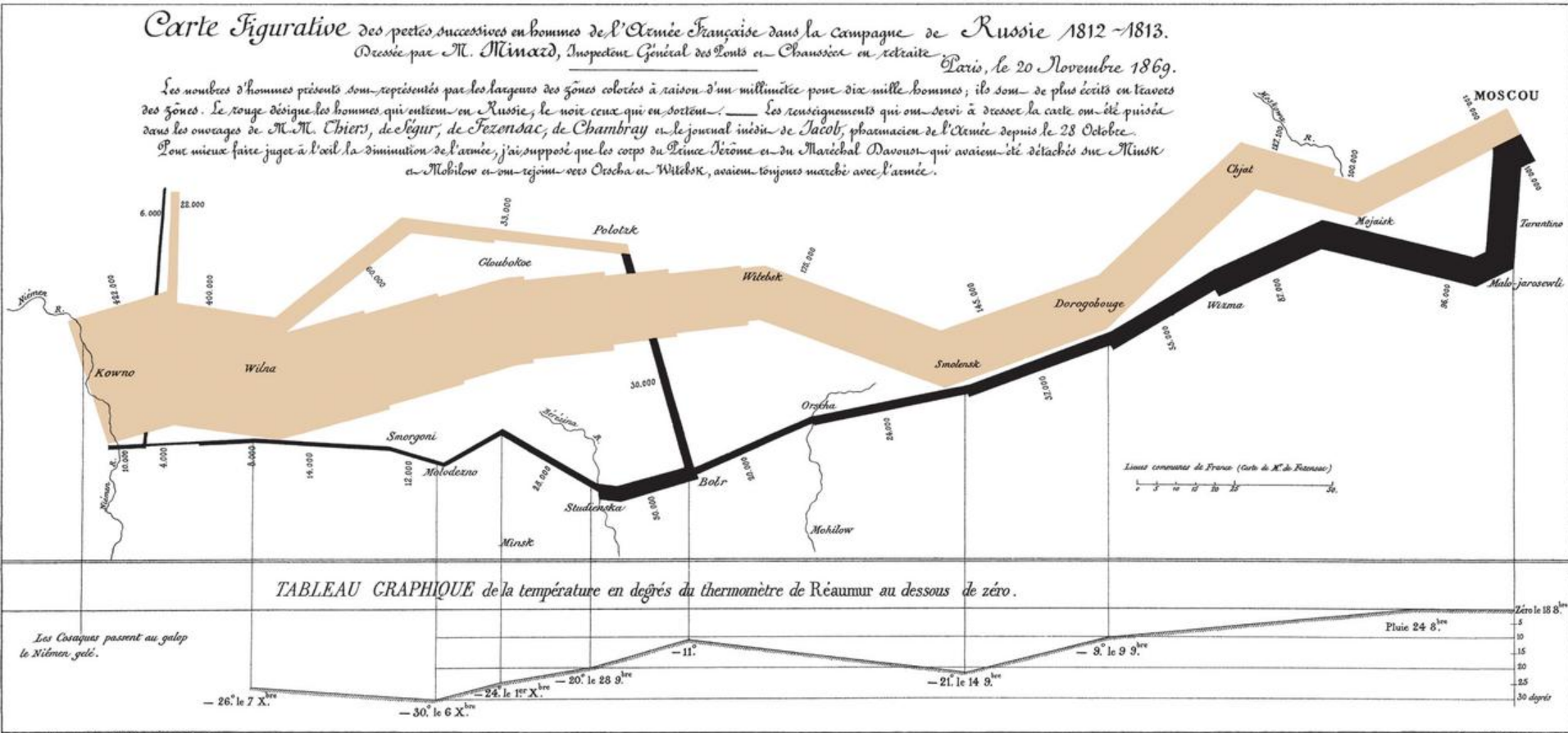
Minard's map

Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en traits de zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Legur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davout, qui avoient été détachés sur Minsk et Mohilow et qui s'étoient joints vers Orscha et Witebsk, avoient toujours marché avec l'armée.



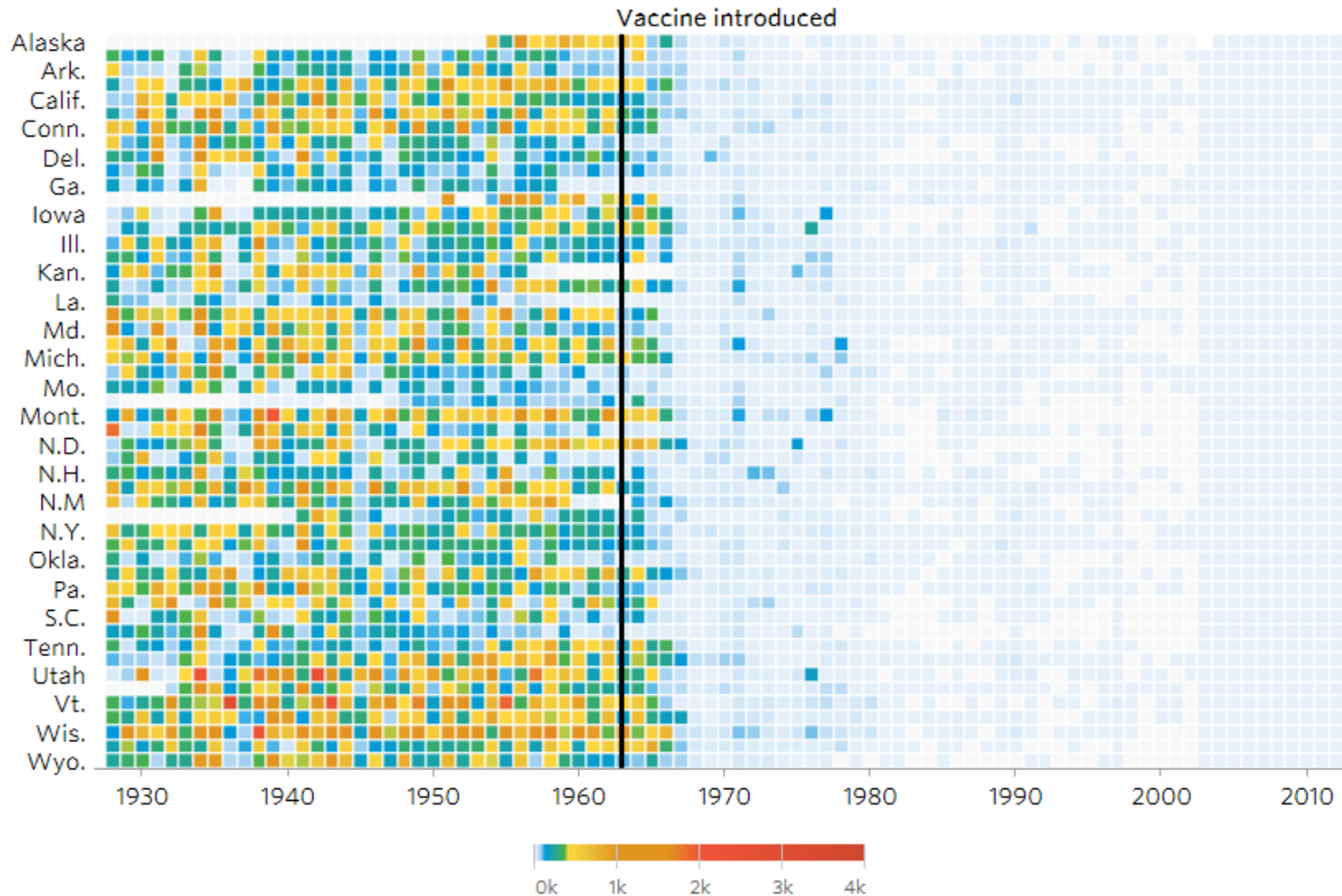
Autog. par Reignier, R. Par. 5^{me} Marie 3^{me} 0^{me} à Paris.

Imp. Lit. Reignier et Doucet.

By Charles Minard (1781-1870) - see upload log, Public Domain,
<https://commons.wikimedia.org/w/index.php?curid=297925>.

Other visualizations?

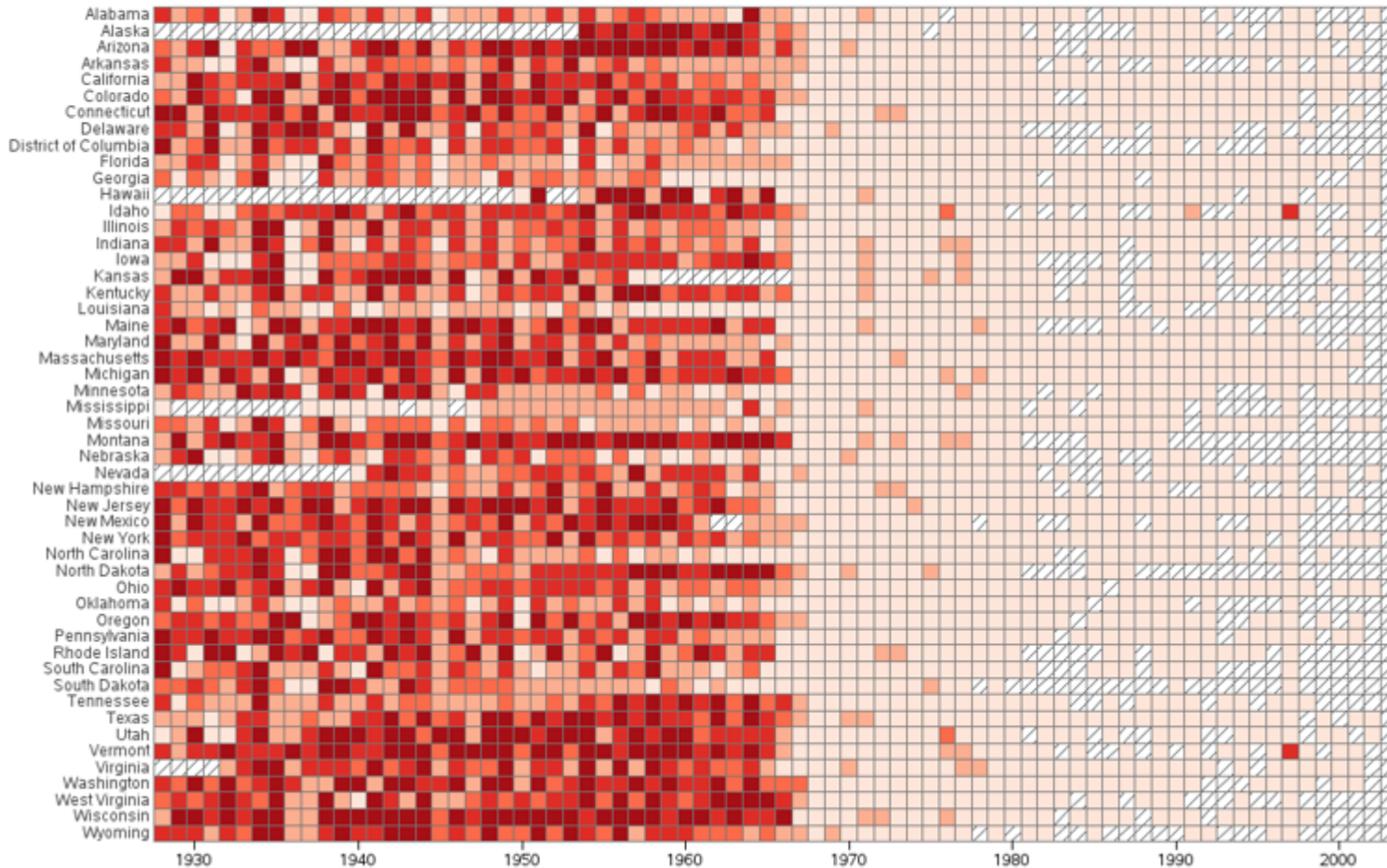
Measles



Improved visualizations?

Measles: Average Weekly Incidence per 100,000

■ ≥ 10 ■ < 10 ■ < 5 ■ < 3 ■ < 1 □ N/A



Hello R!

- I learnt a lot from :
 - edX (courses taught by prof. Rafael Irizarry, Harvard University) and
 - Coursera (courses taught by prof. Rodger Peng, John Hopkins University).
- Then, I searched for tutorials, books, blogs, forums, and various online resources.
- Last, but not least I coded.

R book (for learning R)

R Programming for Data Science



[Roger D. Peng](#)

This book brings the fundamentals of R programming to you, using the same material developed as part of the industry-leading Johns Hopkins Data Science Specialization. The skills taught in this book will lay the foundation for you to begin your journey learning data science. Printed copies of this book are [available through Lulu](#).

[Table Of Contents](#) ☰

R Programming for Data Science



Roger D. Peng

LAST UPDATED ON 2016-12-22

- Peng R. D. R programming for data science, Leanpub book, 2014-2016.
- <https://leanpub.com/rprogramming>.

R book (for understanding R)

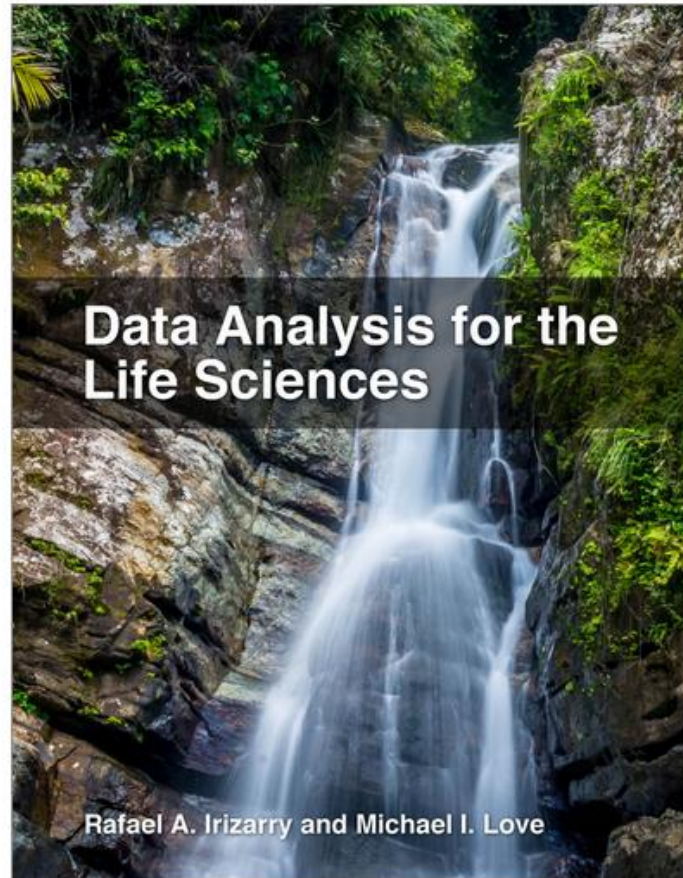
Data Analysis for the Life Sciences



Rafael A Irizarry and Michael I Love

Data analysis is now part of practically every research project in the life sciences. In this book we use data and computer code to teach the necessary statistical concepts and programming skills to become a data analyst. Instead of showing theory first and then applying it to toy examples, we start with actual applications and describe the...

Table Of Contents 



This book is 100% complete
COMPLETED ON 2015-09-23

- Irizarry R. and Love M. I. Data analysis for the life sciences, Leanpub book, 2015.
- <https://leanpub.com/dataanalysisforthelifesciences>.

Meanwhile...

- I hated R, I loved R, I was overwhelmed with R, I missed R, I missed Matlab, I wanted to do something else, ...
- In the end, I learnt it.
- Exhausted, but happy, I wanted to share my enthusiasm with students.
- And colleagues, cosins, neighbours, others.

Then, I decided to propose course on R!



R at the ETF

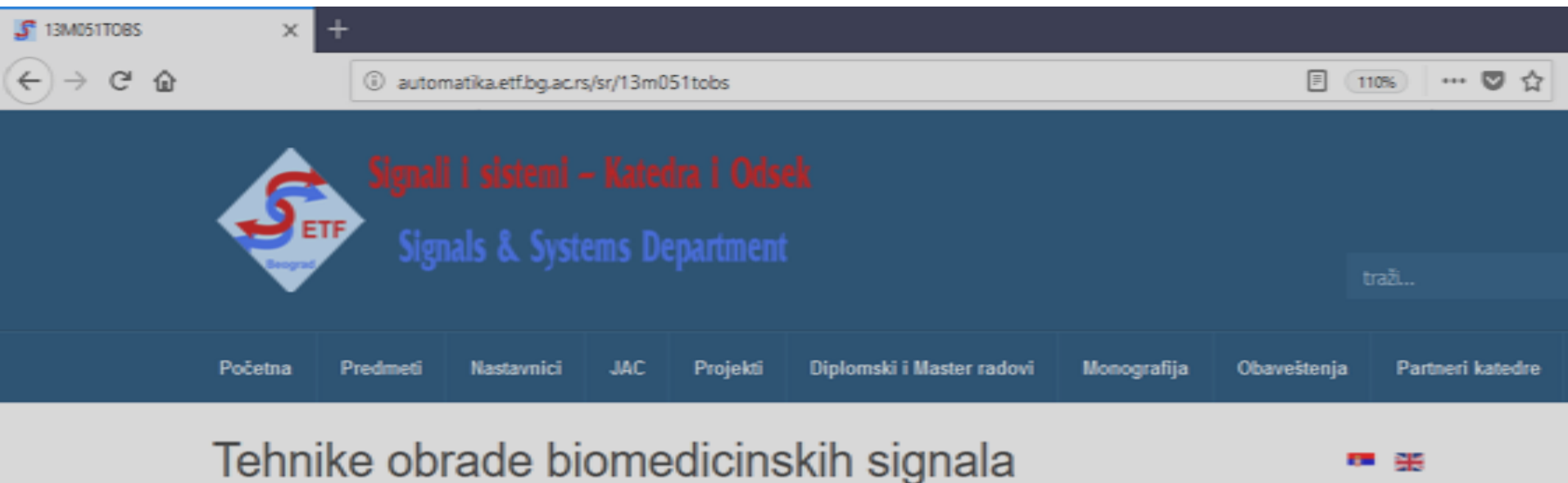
- I proposed new electoral master course with the aim to teach students to analyze biosignals in R.
- Had to change course title ... Politics ...
- Final title: “Biomedical signal processing techniques” or “Tehnike obrade biomedicinskih signala” in Serbian (yes!, it’s TOBS, but not the baseball one).
- And the course began.

<http://www.acme.com/heartmaker/heartmaker.cgi>



TOBS

- 4 h (2 h of lectures and 2 h of computer coding) a week for 14 weeks students learnt about R.
- Although I prepared all in advance, I had to change course materials, mostly to enhance:
 - automatic reporting (**R markdown** package) and
 - development of web based applications and interactive reporting (**Shiny** and **plotly** packages).



13M051TOBS

automatika.etf.bg.ac.rs/sr/13m051tobs

110%

traži...

Početna Predmeti Nastavnici JAC Projekti Diplomski i Master radovi Monografija Obaveštenja Partneri katedre

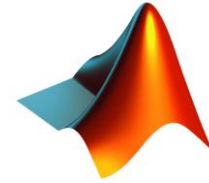
Tehnike obrade biomedicinskih signala

🇷🇺 🇬🇧

Hard R

- The first code was simple
- The second code was harder
- The third code looked like this sentence: “Meni tutto mixed up y ahora Я не могу mehr zu tun ...”
- ...
- The same for students!
- But, the 100th code, was different!

Why bother at all?



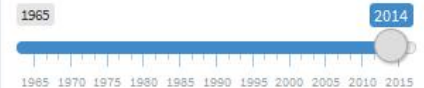
- Why not stick to Matlab?
 - There are methods for signal analysis and visualization that are not available in Matlab (*vice versa* applies too) or someone has to pay for them.
 - R is free software and there is a large user's community (<https://directory.fsf.org/wiki/R>)
 - R is relatively simple
 - R has over 12000 packages (14th June, 2018, <https://cran.r-project.org/web/packages/index.html>)
 - All projects are written in more than one programming language.
 - R is a must in the curriculum at the most prestigious Universities.
 - There is an ongoing debate which programming language to use!
- Who knows more languages knows more! If you ask me...
- For those who know Matlab and learn R (and *vice versa*), I recommend: [*R and MATLAB*, Chapman and Hall / CRC, 2015, ISBN 9781466568389.](#)
- Maybe true debate is Matlab vs. GNU Octave not R vs. Matlab. Right?

Selected TOBS2017 projects 1/3

World Atlas Statistics



Year



Primary feature:

Total Population

- Plot secondary feature
- Disable automatic plotting

The main feature is plotted on the map as circles with diameters proportional to amount. Hovering over a marker will show the concrete value of the primary feature along with country name. A histogram of these values is available as well as a table indicating the highest and lowest values. The secondary feature is plotted as a color from a palette chosen according to feature intensity, view legend for details.

Color

Jovan Rnjak, 2016/2017, Shiny + Leaflet + plotly + ggplot

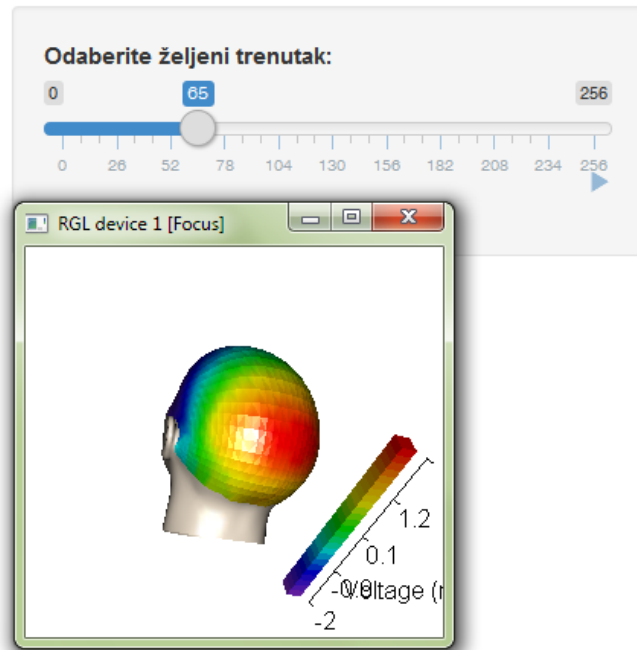
Selected TOBS2017 projects 2/3

eegkit paket Uvod eegcap eegica eegsmooth temporal eegsmooth spatial Literatura

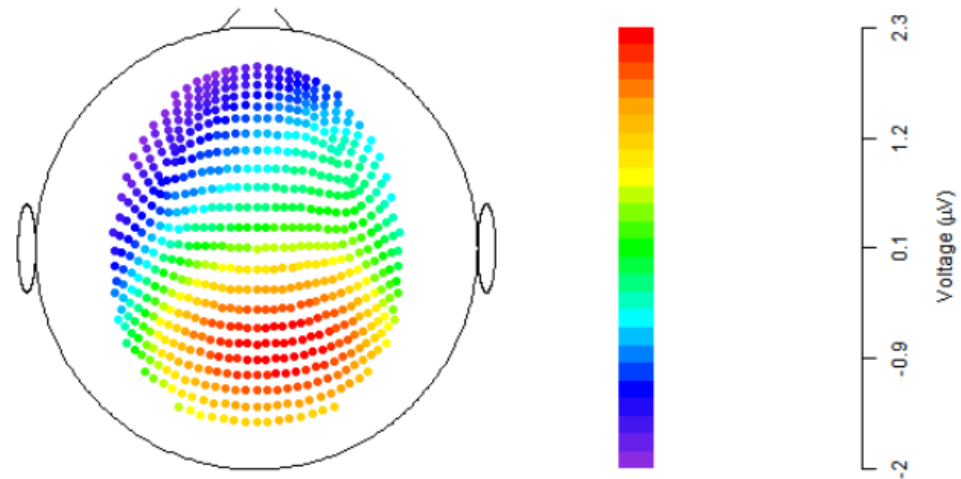
Spatial smoothing signal sa jednog kanala

Funkcija eegsmooth može da smooth-uje signale sa jednog ili više kanala u vremenu ili prostoru.

Ovde je prikazana raspodela potencijala u prostoru u određenom vremenskom trenutku. Ova funkcija je odlična za vizuelizaciju EEG podataka na 2D i 3D mapama.



2d mapa u određenom vremenskom trenutku (vreme je izraženo u ms):



Bojana Mihajlović, 2016/2017, Shiny + eegkit + eegkitdata

Selected TOBS2017 projects 3/3

The image shows a PDF viewer interface. At the top, there is a toolbar with various icons for file operations and navigation. Below the toolbar, a sidebar on the left contains a 'Bookmarks' section with a list of document sections: 1. Zadatak, 2. Uvod, 3. Metod rada, 4. Rezultati, 5. Diskusija, 6. Zaključak, and 7. Literatura. The main content area displays the title page of a document. The title is 'Automatska detekcija ritmova u EEG signalu primenom EMD i Hilbertove transformacije'. Below the title, the author's name 'Jovan Samouković 3112/2015' and affiliation 'Katedra za signale i sisteme, Elektrotehnički fakultet, Univerzitet u Beogradu' are listed, along with the date '4 jul 2017.'. A table of contents (Sadržaj) follows, listing the same sections as the sidebar with their corresponding page numbers. The first section, '1. Zadatak', is expanded to show its introductory text.

1 / 23 | 75%

Bookmarks

- 1. Zadatak
- 2. Uvod
- 3. Metod rada
- 4. Rezultati
- 5. Diskusija
- 6. Zaključak
- 7. Literatura

Automatska detekcija ritmova u EEG signalu primenom EMD i Hilbertove transformacije

Jovan Samouković 3112/2015
Katedra za signale i sisteme, Elektrotehnički fakultet, Univerzitet u Beogradu
4 jul 2017.

Sadržaj

1. Zadatak	1
2. Uvod	1
3. Metod rada	2
4. Rezultati	6
5. Diskusija	22
6. Zaključak	23
7. Literatura	23

1. Zadatak

Problem koji je analiziran u okviru ovog projekta je bio ispitivanje mogućnosti detekcije odnosno ekstrakcije različitih moždanih ritmova (talasa) iz elektroencefalografskog (EEG) signala primenom *Empirical Mode Decomposition* (EMD) algoritma za dekompoziciju signala i *Hilbert* - ove transformacije. S obzirom na to da EMD algoritam za dekompoziciju signala vrši razgradnju ulaznog signala, u vremenskom domenu, na osnovne funkcije, *Intrinsic Mode Functions* (IMF), čiji se frekvencijski sadržaji nalaze u različitim uskim frekvencijskim opsezima, pitanje na koje bi ovaj projektni zadatak trebao da odgovori je da li je moguće

Jovan Samouković, 2016/2017, signal + EMD + markdown

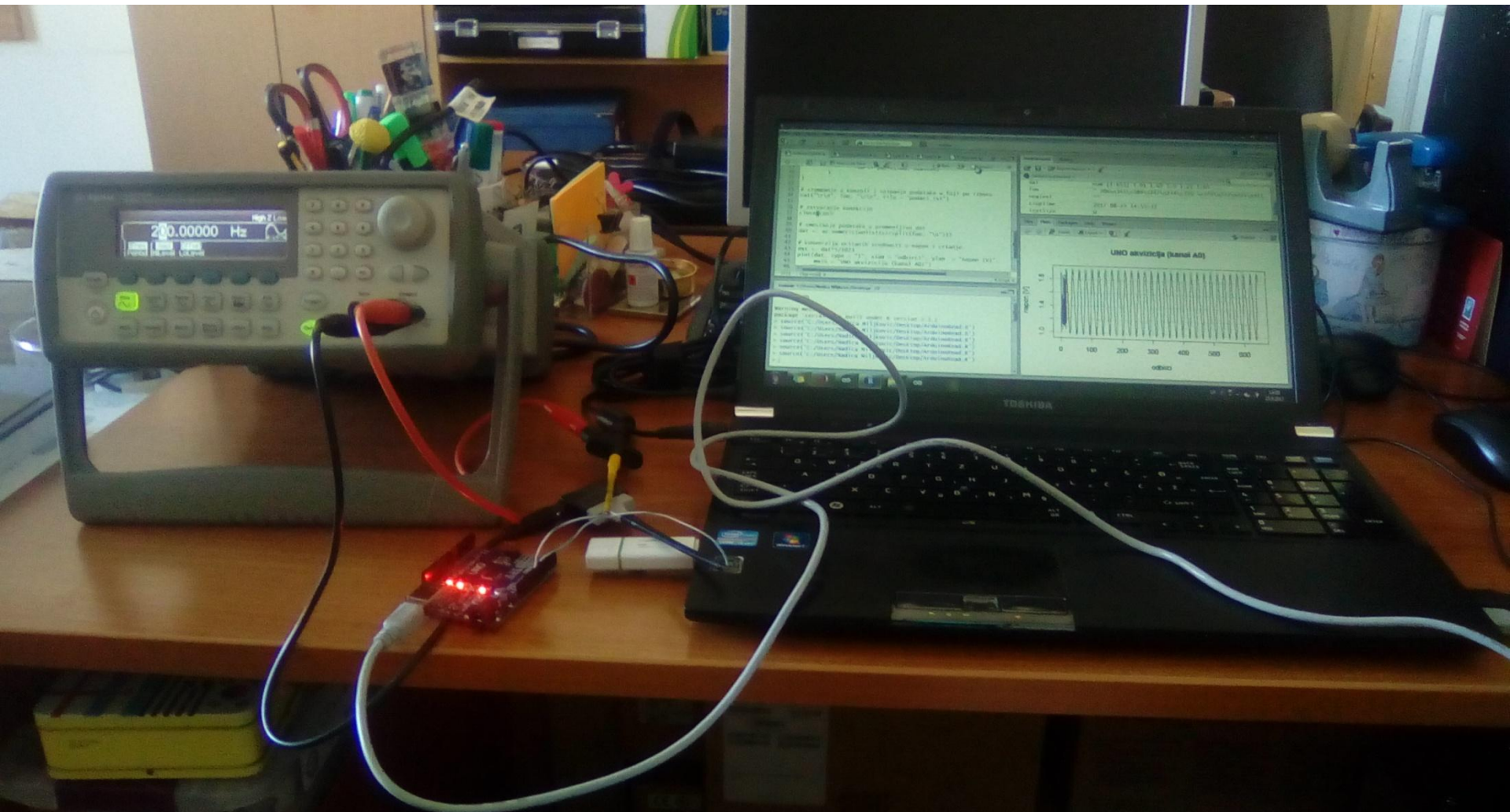
Students about R

- “More course promotion is needed.”
- “ggplot is interesting, but it is so different and hard to learn”
- “This is the most useful master course. Projects were so interesting, and we learnt a lot...”
- “Tell us in advance that the computer practices are obligatory, we have bad habits not to come.”
- “It is hard to choose the project during the semester, since we did not learn all we should.”

Me about students & R

- Very inspiring and motivated environment.
- Hard working students made any assignment (including advanced) easy. Setting limits even higher seems as a good idea.
- We had rich and joyfull discussions, with students heavily involved, about Bioethics and Data Ethics. I would like to spend more time on that.
- They liked examples of practical implementation.
- More ggplot definetely!

Scientific research and R



Under construction until 2018!

Until May 2018 (ZINC Conference)

Two simple capacitance sensing solutions: Microcontroller-based measurements

Nadica Miljković and Milan Bjelica
University of Belgrade – School of Electrical Engineering

Introduction

The main goals of the presented study are:

1. To design & test two systems for capacitance measurements that are: a) simple and low-cost and b) based on application of microcontrollers, open software, open hardware, and free software.
2. For undergraduate courses in electrical measurements and biomedical engineering.
3. To discuss application for healthcare solutions.



<http://www.ti.com/tool/MSP-EXP430G2#1>

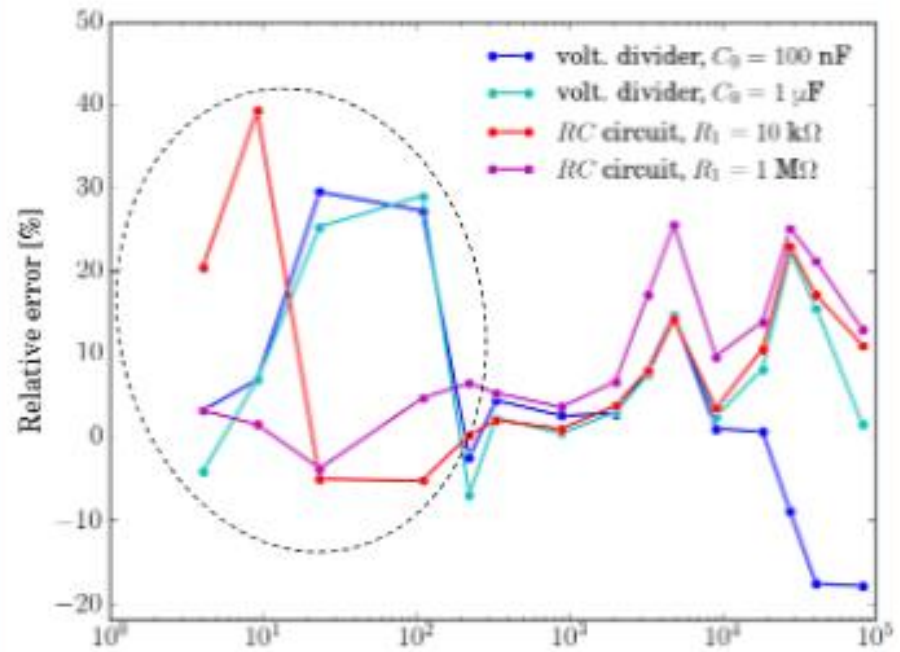


Electronics Co., <https://www.aliexpress.com/>



Results & Discussion

Relative errors from both methods (voltage divider and RC method) are presented in figure below (ceramic capacitors are presented within the dashed circle):



Or June 2018 (Belbi Conference)

Motor Imagery Classification using H2O Machine Learning Platform

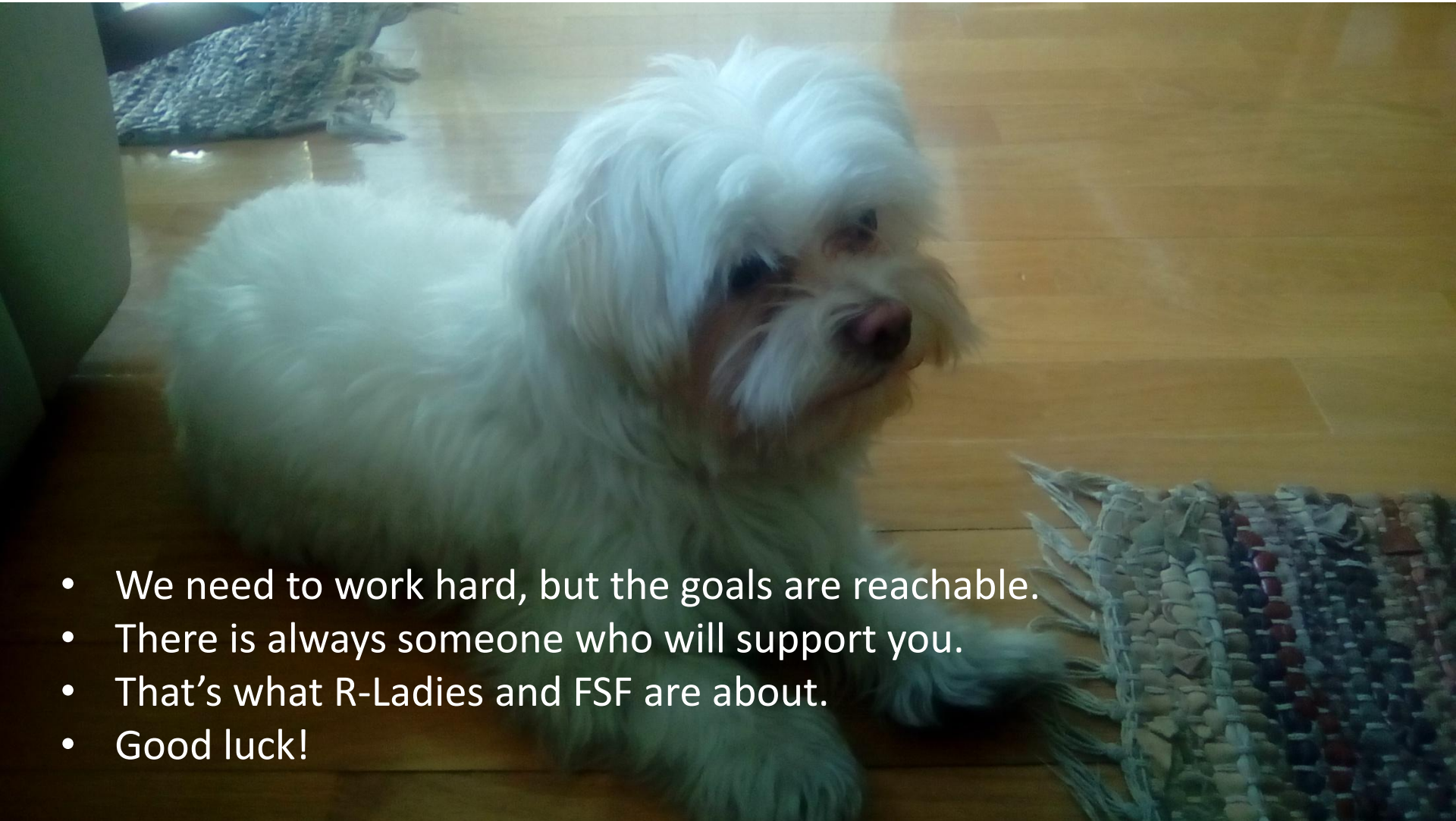


**NATALIJA KATIĆ, DR NADICA MILJKOVIĆ,
DR ALEKSANDRA MARJANOVIĆ**

**FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITY OF BELGRADE
BELGRADE, SERBIA**

Take-home messages

- We need to work hard, but the goals are reachable.
- There is always someone who will support you.
- That's what R-Ladies and FSF are about.
- Good luck!



PH.D. NADICA MILJKOVIĆ » R-LADIES COMPLETE LIST

- [Go back to directory.](#)
- [Add to Address Book.](#)

PH.D. NADICA MILJKOVIĆ

Assist. Prof.

University of Belgrade

Signals & Systems Department School of Electrical Engineering

Home

Belgrade

Serbia



BIOGRAPHICAL INFO

- **Interests:** biomedical engineering, biosignal analysis, data visualization, free software.



- RECENT POSTS -

Hello world!

- SOCIAL MEDIA -

SOCIAL ACCOUNTS BY CHAPTER

- @RLADIESGLOBAL -

Assist. Prof. Nadica Miljković



Slides will be available at: <https://bit.ly/2Mo6VR1>
Or shared via @NadicaSm

Nadica Miljković, PhD

Assist. Prof. of Biomedical Engineering

mail: nadica.miljkovic@etf.bg.ac.rs

office 68, Building of Technical Faculties

Nadica Miljković finished Bachelor, Master and PhD studies at the School of Electrical Engineering, University of Belgrade (ETF). Her main research focus is related to Biomedical Engineering. She published papers related to Biomedical Signal Processing and Electrophysiological Signal Acquisition. Her main scientific contribution is multi-array electrode application in both measurement and electrical stimulation, and application of novel assessment methods based on electrophysiological signals analysis. She started to work at ETF at 2008. as Research and Teaching Associate, and since 2015. she works as Assistant Professor.