Neuroengineering

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What are we going to talk about today

- Meet each other
- Why neuroengineering
- Course topics
- Class schedule
- Course resources

(short break)

- Exams
- Questions

What is Neuroengineering

Definition that comes from the Institute of Electrical and Electronics Engineering.

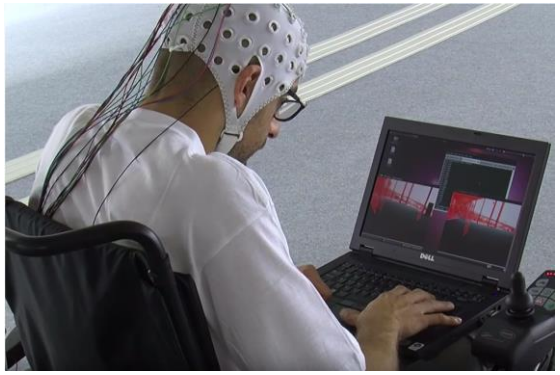
- Neuroengineering is a relatively recent field which is concerned with the **quantitative understanding of neural systems** (from single neurons to large-scale neural networks) in order to advance medical technology in applications related to the nervous system.
- It also relates to using **models of neural systems** in order to solve problems in other disciplines (e.g., pattern recognition, robotics).
- Neuroengineering involves a **convergence of knowledge and methodology from diverse disciplines**, such as neuroscience, mathematics, engineering, biophysics, computer science, and psychology

Source: https://tc-neuro.embs.org/resources/

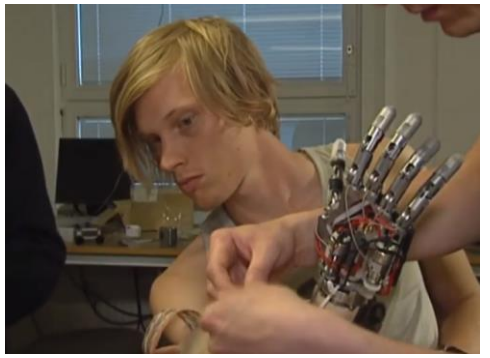
Talks / Demonstrations

Making the Paralyzed Move | Gernot Müller-Putz | TEDxTUWien

The Bionic Man - Explore the potential to interface the human nervous system with robotic limbs



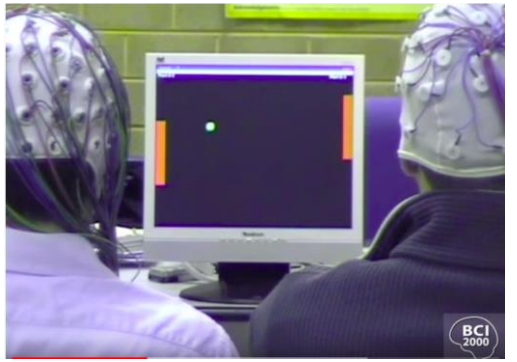
Brain-Machine Interface @ EPFL: Wheelchair



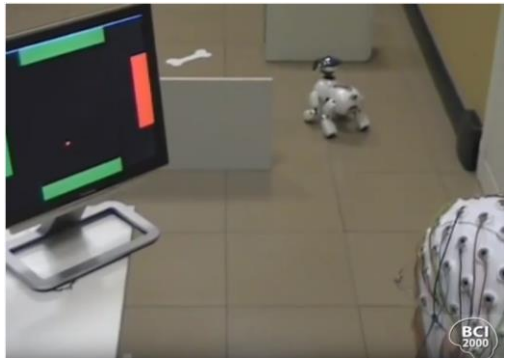
The bionic hand: how a crazy idea has become a medical breakthrough

BCI-controlled functional electrical stimulation – Graz University of Technology (more)

BCI control of a robotic hand



Playing the Game "Pong" with EEG



Robot Navigation Using a Brain-Computer Interface "Joystick"

TED Talk | How to control someone else's arm with your brain | Greg Gage

Course topics

- Electroencephalography
  - i.e. electrical signals from the brain
- Electromyography
  - i.e. electrical signals from muscles
- (Bio-)signal processing
  - Frequency domain analysis
  - Time-domain analysis
- Brain-Computer Interfaces
  - Non-invasive, direct interaction between brain and machines
- Functional Electrical Stimulation
  - Non-invasive, artificial drive of muscular contraction
- Seminars
  - BCIs in neurorehabilitation
  - Peripheral neuroprostheses

- Anatomy and physiology of the neural cell
- Generation of neural electrical and metabolic correlates
- Neural encoding and decoding
- Principles of the brain organization, natural neural networks, different levels of organization
- Network neuroscience - basic definitions (synchronicity, causality, influence)
- Model-free (data driven) vs model-based (biologically inspired) models of the brain as a complex system
- Analysis of brain networks at different scales (cellular and synaptic, cognitive neuroscience, behavioral neuroscience, multi-subject systems)
- Examples of application to clinical and physiological problems
- Seminars
  - …

Weekly schedule

lesson

break

Cincotti (mostly)

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:00-9:00	Robotics II De Luca Room B2 DIAG	Interactive Graphics Schaerf Room B2 DIAG	Neuroengineering 15’ Cincotti-Astolfi Room A2		Medical Robotics Vendittelli Room A2 DIAG
9:00-10:00	Robotics II De Luca Room B2 DIAG	Interactive Graphics Schaerf Room B2 DIAG	Neuroengineering Cincotti-Astolfi 15’ Room A2		Medical Robotics Vendittelli Room A2 DIAG
10:00-11:00	Vision and Perception Pirri Room B2 DIAG	Interactive Graphics Schaerf Room B2 DIAG	Neuroengineering Cincotti-Astolfi 15’	Elective in Artificial Intelligence De Giacomo-Iocchi Room A4 DIAG	Medical Robotics Vendittelli Room A2 DIAG
11:00-12:00	Vision and Perception Pirri Room B2 DIAG	Elective in Artificial Intelligence De Giacomo-Iocchi Room A2 DIAG	Vision and Perception Pirri Room B2 DIAG	Elective in Artificial Intelligence De Giacomo-Iocchi Room A4 DIAG	Interactive Graphics Schaerf Room B2 DIAG
12:00-13:00	Vision and Perception Pirri Room B2 DIAG	Elective in Artificial Intelligence De Giacomo-Iocchi Room A2 DIAG	Vision and Perception Pirri Room B2 DIAG	Elective in Artificial Intelligence De Giacomo-Iocchi Room A4 DIAG	Interactive Graphics Schaerf Room B2 DIAG
13:00-14:00					**Astolfi**
14:00-15:00		Elective in Robotics Vendittelli Room A2 DIAG	Robotics II De Luca Room B2 DIAG	Elective in Robotics Vendittelli Room A2 DIAG	Neuroengineering Cincotti-Astolfi Room A2
15:00-16:00	Medical Robotics Vendittelli Room A2 DIAG	Elective in Robotics Vendittelli Room A2 DIAG	Robotics II De Luca Room B2 DIAG	Elective in Robotics Vendittelli Room A2 DIAG	Neuroengineering 30’
16:00-17:00	Medical Robotics Vendittelli Room A2 DIAG	Seminars in Artificial Intelligence and Robotics Capobianco Room A5-A6 DIAG	Robotics II De Luca Room B2 DIAG	Elective in Robotics Vendittelli Room A2 DIAG	
17:00-18:00	Elective in Artificial Intelligence De Giacomo-Iocchi Room A2 DIAG	Seminars in Artificial Intelligence and Robotics Capobianco Room A5-A6 DIAG		Elective in Robotics Vendittelli Room A2 DIAG	
18:00-19:00	Elective in Artificial Intelligence De Giacomo-Iocchi Room A2 DIAG	Seminars in Artificial Intelligence and Robotics Capobianco Room A5-A6 DIAG			

Classrooms? Will depend on the number of students

Course resources

A. Bulletin board + forum
   - piazza.com

B. Cloud-based file sharing
   - Google Drive
   - Slides, exams, code …

C. Textbooks
   - Wolpaw J and Wolpaw E (eds.), Brain-Computer Interfaces, Oxford University Press, 2012. ISBN 9780195388855 / 9780199921485
   - Hari R, Puce A, MEG-EEG primer, Oxford Press, 2017, ISBN: 9780190497774

Course Material

- Slides of the lessons
  - New slides posted shortly after the lesson
- Example code
- Piazza posts
- Past exams (after June 2020)

How to access the course resources (3 steps)

1. Request to enroll in the course BB/forum (Piazza)
   - Self sign-up with `uniroma1` email:
   - http://bit.ly/neng-1920-piazza

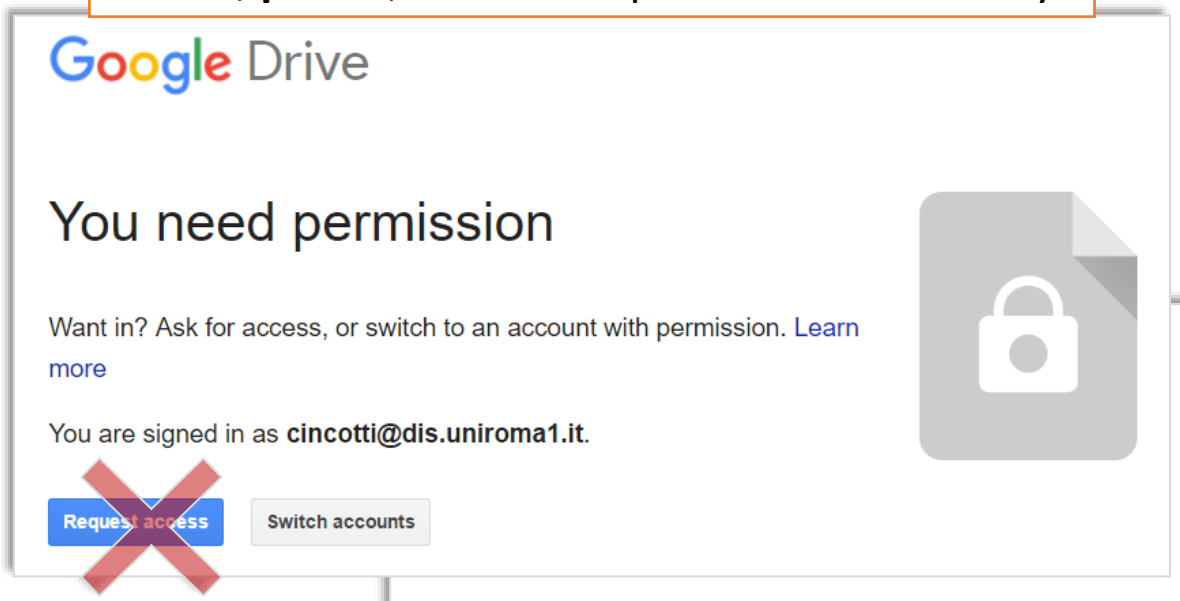
2. Request to access shared material
   - Instructions (and link) also available at the Piazza course home
   - Request sent through Google Form: http://bit.ly/neng-1920-req
   - Allows registering additional google profile (e.g. private email)

   … *wait for approval (usually within the day)* …

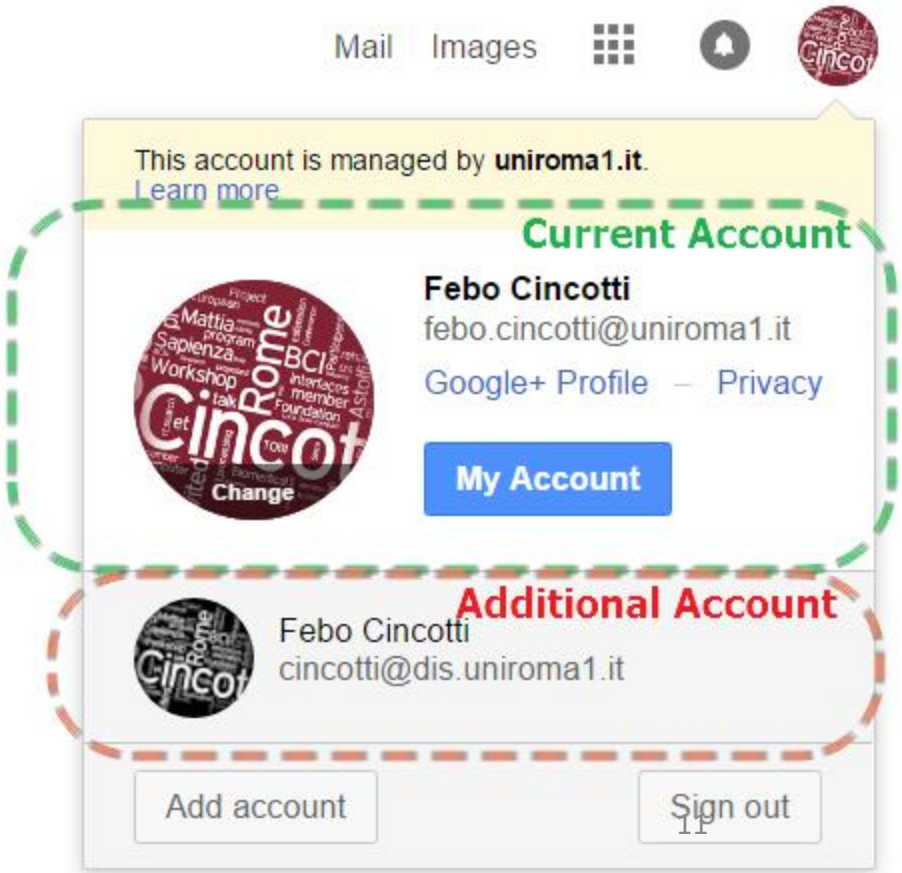
3. Access shared Google Drive Folder
   - Access granted when the previous form is reviewed (not automatic, be patient)
   - Links available in the *Resources* section of the Piazza course (and in the confirmation email when access is granted)
   - http://bit.ly/neng-1920-gd

(no) Access material on Google Drive

Please, **please**, do not «request access» this way!

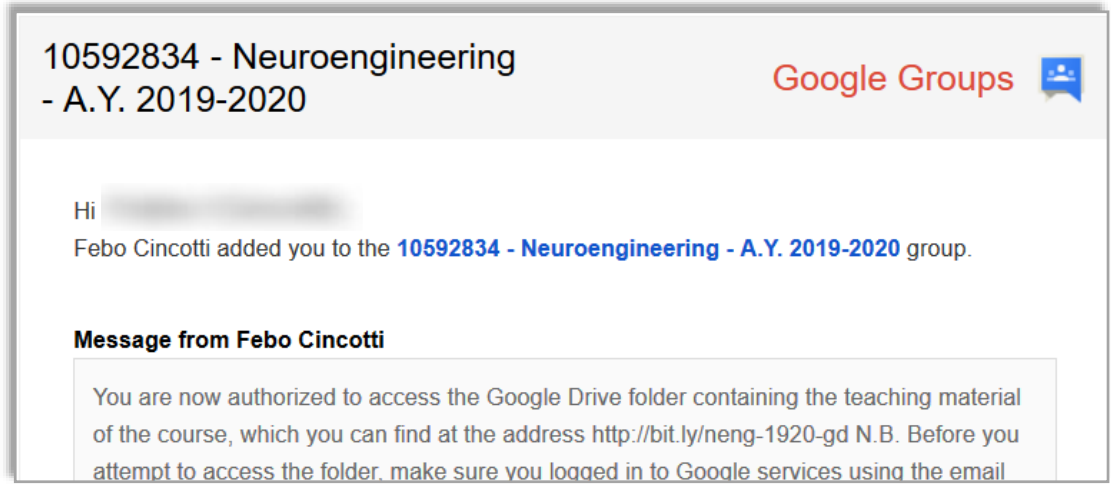


Double check which Google account you are signed in with



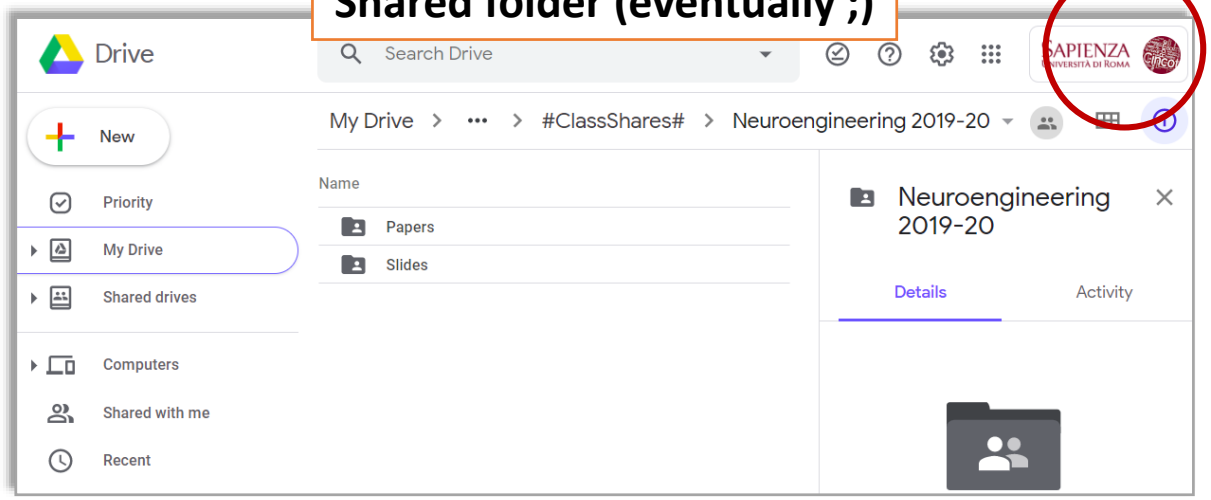
Access material on Google Drive

Confirmation email



Google Account

Shared folder (eventually ;)



– BREAK –
start accessing the course resources

1. Request to enroll in the Piazza class
   - Self sign-up with `uniroma1` email:
   - http://bit.ly/neng-1920-pz
     - i.e. https://piazza.com/uniroma1.it/spring2020/10592834

Piazza class

2. Request to access shared material
   - Request sent through Google Form: http://bit.ly/neng-1920-req
   - Allows registering additional google profile (e.g. private email)

… wait for approval (usually within the day) …

Google form

Exams

- Modality
  - Written test
    - Closed-ended questions
    - Short problems
  - Oral exam?
    - Oral test gives a marginal contribution to the mark
    - Dispensed if student delivers a project
- Mid-term exams
  - No, but it could be part of the selection to assign projects during the semester

- Written test
  - Assessment of learned concepts, and ability to apply them:
    - Examples of past tests with solutions will be posted to the Gdrive shared folder
- Oral test
  - Assessment of critical learning and ability to build on acquired knowledge
- Projects
  - On voluntary basis – more time consuming than preparing an oral exam
  - Opportunity given to the most motivated students
  - Small teams (2-3 students)
  - Some projects with predefined goals, others may be contributed by the team and discussed with the teacher
  - Multiple delivery dates – at the end of each semester, two weeks prior to final exam.

Exam dates

- All exam (opening) dates are published on Infostud
- Applications open about 1 month before, and close 1 week before the exam opening date
- The written test is scheduled on the opening day of the exam
- The oral exam will be scheduled in the following days, expectedly within one week
- Project delivery dates will be agreed with the teacher at the time of assignment

1. Tue 09/06/2020
2. Tue 07/07/2020
3. Thu 17/09/2020
4. xxx XX/01/2021 (*)
5. xxx XX/02/2021 (*)

Sat XX/10/2020 (*)
Sat XX/03/2021 (*)

(*) *Will be defined in September 2020*

Meet me

- During the breaks of each lesson, for quick questions
- By appointment:
  - Ask me in class
  - Post a private message on Piazza
  - Send mail to febo.cincotti@uniroma1.it or laura.astolfi@uniroma1.it