MBIC PhD Education Programme

Directors

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Course registration and information

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https://www.maastrichtuniversity.nl/research/institutes/m-bic/m-bic-education

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GRADUATE SCHOOL

Welcome and Introduction

Welcome to the MBIC Graduate School!

All new PhD students who join FPN-CN, will automatically be enrolled into the MBIC Graduate School.

The MBIC graduate school offers PhD students the opportunity to follow high-level courses on the different research areas and activities at the MBIC (and the CN department at FPN). A primary motivation is to offer education that will stimulate interest and provide a solid foundation in related research areas as well helping new PhD student to quickly get up to speed within their own field of research and facilitate their work.

The courses offered within the school are designed following a 2-year course cycle, which, participation in the school activities (e.g. courses, mentoring program, progress reports) will become the basis of a MBIC diploma. The course offering comprises of currently 14 courses that will be run in a two-year rotation. PhD students who inscribe to the courses offered by the Graduate School and participate in the Graduate School activities will, at the end of their PhD, receive an MBIC Graduate School Certificate that will reflect their high levels of background and expertise acquired through the Maastricht Brain Imaging Center's educational program.

For students of the department of Cognitive Neuroscience at FPN the graduate school is also an organization that aims at providing mentoring as well as help in managing progress during the PhD. All new PhD students who join FPN-CN, are automatically enrolled into the MBIC Graduate School. Next to following formal lecture courses and workshops, the participation in the Graduate School involves active engagement in the activities of the school and the MBIC.

Up-to-date information on the MBIC Graduate School course programme can be found for FPN students by accessing the intranet, for external students interested in more detailed information please consult this document or contact FPN-Mbic-school@maastrichtuniversity.nl

GRADUATE SCHOOL

Credit system and Attendance

In order to correctly report all activities TO OBTAIN the MBIC diploma, we ask all students to keep a complete log of all of their activities. We count on the student's honesty in correctly reporting them.

Activities in the MBIC graduate school will be discussed during the yearly evaluation meeting of each PhD student with their supervisors and an HR official. In preparation of this meeting, students will be asked to summarize all of their activities into the *Past-year overview in the Activity report form* and send it to the Graduate School.
The link to the Activity Report Form can be found *here*

At the end of the PhD, the MBIC diploma will be compiled based on all of the *Past-year overview forms.* A draft of the activity/courses record on the diploma will be sent to student and supervisors for inspection, at which moment any additional activities not included in the Past-year overview forms can be added. The MBIC diploma will be given together with the Maastricht University PhD diploma, upon successful completion of the thesis defense.

Applicable fees

MBIC Graduate School courses are accessible without any fee for **all FPN PhD students.**
For **external PhD students and UM PhD students** (non FPN PhD students) we ask an administration fee:

- 50 euro for 1day course
- 75 euro for 2day course (or longer)

Payment of the administration cost is done via Online Payment Platform (OBP). We will send the information with payment link after registration.

Course registration

- The courses for 2021 are **open for registration**. The data for 2022 courses are going to be announced as soon as possible.

- Students are required to register for courses **at least 1 week** before the start of each course, to send an email to Eva van Dort via email to FPN-Mbic-school@maastrichtuniversity.nl

- When you are unable to attend a course, please cancel your registration by sending an email to FPN-Mbic-school@maastrichtuniversity.nl at least 1 week before the start of each course.

- When we receive the cancellation on time (at least one week before the start of a course,) we can refund the administration fee. In case of cancellation later than a week before the start of a course or in case of a now show, the administration costs will not be refunded.

- It is possible to register for more courses in one go

Updated information on the MBIC Graduate School course program can be found under the following link: https://www.maastrichtuniversity.nl/research/institutes/m-bic/m-bic-education

GRADUATE SCHOOL

Overview courses 2021

MBIC01: Modeling Neuroimaging Data with Convolutional Deep Neural Networks
By Rainer Goebel and Mario Senden

MBIC02: Hemodynamic brain-computer interfacing
By Bettina Sorger

MBIC03: From basic to more advanced math and signal processing (or Bayesian statistics, optimization and information theory)
By Giancarlo Valente

MBIC04: Introduction to analysis of neuronal oscillation frequency, dynamics and coupling
By Mark Roberts

MBIC05: Combining TMS/TES with EEG and fMRI in Human Brain Research
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GRADUATE SCHOOL

Overview courses 2022

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MBIC09: Physiology of the BOLD response
By Dimo Ivanov

MBIC10: Brain Connectivity
By Alard Roebroeck

MBIC11: Hands-On Training on Population
By Mario Senden, Alexander Kroner & Salil Bhat

MBIC12: High resolution fMRI: An introductory course for data acquisition and analysis challenges
By Renzo Huber

MBIC13: Machine Learning
By Federico De Martino

MBIC14: Relating high-resolution fMRI brain responses to activity in biologically inspired deep neural network models
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GRADUATE SCHOOL

Course Descriptions

MBIC01: Modeling Neuroimaging Data with Convolutional Deep Neural Networks
Location: UM or Online
Structure: one theoretical (day 1) and one practical day (day 2)

Coordinators:
Rainer Goebel
Cognitive Neuroscience (FPN)
Phone: 043-38 84014
E-mail: r.goebel@maastrichtuniversity.nl

Mario Senden
Cognitive Neuroscience (FPN)
Phone: 043-38 82071
E-mail: mario.senden@maastrichtuniversity.nl

Objective(s)
This workshop will introduce participants to deep convolutional networks, discuss their role in neuroscience, and introduce methods for evaluating their predictions and parameters against neuroimaging data.

Key Words
Convolutional networks, deep learning, connectionism, neuroimaging, representational similarity analysis, common brain space.

Description of the Course
Understanding how the human brain achieves cognitive tasks is a question of fundamental importance in cognitive neuroscience. There has been impressive progress over the last years in creating neurobiologically inspired multi-layer (“deep”) models of visual tasks such as invariant object recognition. The object recognition performance of the most recent approaches, convolutional deep learning networks, even matches that of humans (LeCun et al. 2015; Szegedy, 2013). This course teaches principles of convolutional deep neural networks and how these networks learn to perform challenging visual and cognitive tasks. The course then focuses on approaches attempting to relate the operation of deep networks to measured brain imaging data, including representational similarity analysis and direct linking of columnar-level network nodes to vertices of cortex meshes allowing to test detailed spatiotemporal model predictions. Furthermore, limitations of deep networks are identified and discussed, including the role of feedback connections, more realistic learning rules and biologically better motivated cognitive architectures.

Instructional Approach
The course consists of morning and afternoon sessions over two days. On both days, the morning sessions consist of lecture series introducing deep learning architectures and learning algorithms [day 1] as well as techniques to evaluate their performance/parameters against neuroimaging data [day 2]. The afternoon session of both days consists of computer exercises with neural networks in Python. The course ends with a discussion on the aptitude of neural networks as a model of the brain.

Form of Assessment
Computer exercises and active participation in the discussion.

MBIC02: Hemodynamic brain-computer interfacing
Location: UM or Online
Structure: one theoretical (day 1) and one practical day (day 2)

Coordinator: Bettina Sorger, Cognitive Neuroscience (FPN)
Phone: 043-38 82177
E-mail: b.sorger@maastrichtuniversity.nl

Objective(s)
This workshop will introduce the participants to the methodology and application possibilities of brain-computer interfacing based on brain hemodynamics.

Key Words
Brain-computer interface (BCI), neurofeedback, functional magnetic resonance imaging (fMRI), functional near-infrared spectroscopy (fNIRS), real-time data analysis.

Description of the Course
Analyzing functional brain data *online* allows for brain-computer interfacing and therewith opens up novel possibilities in fundamental and clinical neuroscience. This course will focus on using hemodynamic functional neuroimaging methods (fNIRS and fMRI) for BCI purposes. Following an introduction of fNIRS and technical and methodological requirements and challenges of hemodynamic brain-computer interfacing, the course will review previously realized hemodynamic projects (neurofeedback training/therapy studies and brain-based communication experiments) as well as discuss further potential application possibilities. Finally, participants will be given a demonstration of an fNIRS-BCI experiment (performed by the course coordinator measuring herself and analyzing the data in real-time – that you can follow *online* ☺). In this way, the course participants can get some practical BCI experience.

Instructional Approach
As a preparation, students will read selected literature provided to students beforehand. The course will start with an overview lecture given by the coordinator. Then, seminal hemodynamic BCI projects (fundamental and clinical) will be presented and discussed by the course participants. Finally, an example hemodynamic BCI experiment will be performed online and the data will be analyzed in real-time and simulated real-time (thus, *post hoc*). Finally, novel ideas for useful applications of hemodynamic BCIs will be discussed (e.g., how you could implement BCI technology in your own PhD or follow-up project).

Form of Assessment
Writing assignment:
a) Report about performed BCI experiment *or*
b) Research proposal about novel reasonable hemodynamic BCI project

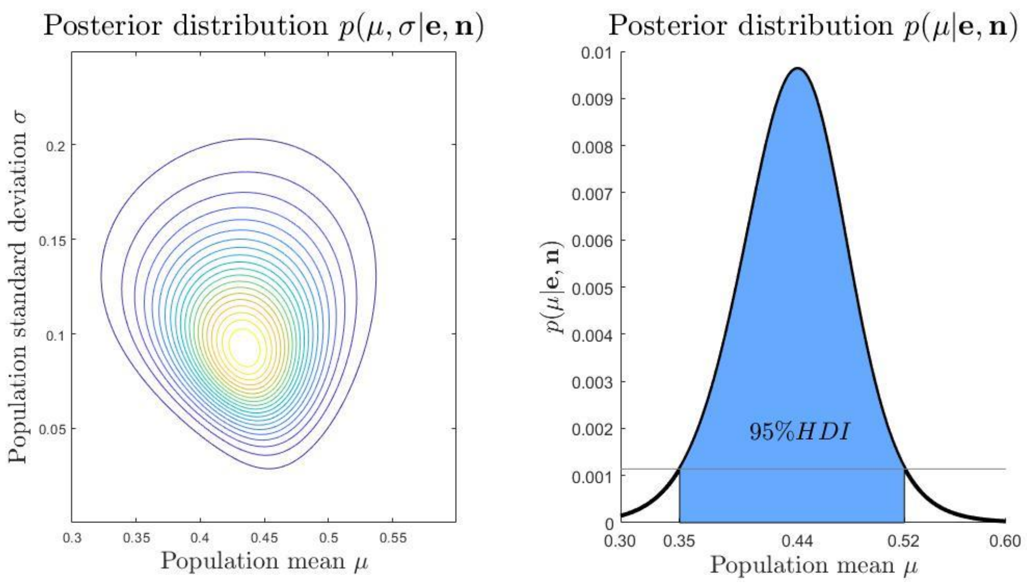
MBIC03: From basic to more advanced math and signal processing – Part II
Location: UM or Online
Structure: eight weeks, with one session (2hours) per week

Coordinator: Giancarlo Valente, Cognitive Neuroscience (FPN)
Phone: 043-38 82469
E-mail: giancarlo.valente@maastrichtuniversity.nl

Objective(s)
This course will teach the mathematical and statistical foundations for cognitive neuroscience research, taking participants form the basic to more advanced topics in math and signal processing.

Keywords
Probability theory, Frequentist Inference, Bayesian Inference, Information Theory, Optimization, Multivariate data representation.

Description of the Course
Mathematical methods are a fundamental tool for conducting research in Cognitive Neuroscience. This course aims at providing the basic concepts and instruments to deal with data analysis, with a two-year format: in Part 1 the focus is on pre-Calculus, Calculus and Algebra, whereas Part 2 deals with probability, multivariate techniques and optimization. A tentative list of topics that will be covered in Part 2 is: a) Probability, statistics and inference (frequentist and Bayesian) and information theory (Entropy, Mutual information) b) Optimization (Local and global) c) multivariate data representations (PCA, ICA). Large emphasis will be given to practical MATLAB/Python implementation of the concepts discussed in the course.



Instructional Approach
The course is a combination of lectures, and self-study exercises consisting of pen and paper as well as Matlab/Python tasks.

Form of Assessment
Attendance

MBIC04: Introduction to analysis of neuronal oscillation frequency, dynamics and coupling
Location: UM or Online
Structure: One day of mixed lectures and data analysis practical sessions

Coordinator: Mark Roberts, Cognitive Neuroscience (FPN)
Email: mark.roberts@maastrichtuniversity.nl

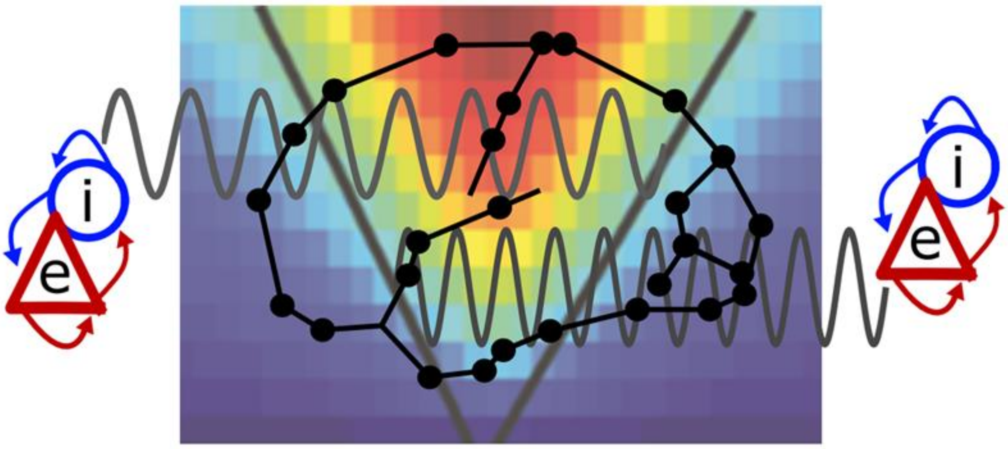
Objectives
This workshop will introduce the scientific importance of neuronal oscillations and a foundation in the signal-processing theorems and techniques that can be applied to the analysis of oscillations.

Key Words
Invasive Electrophysiology, Data analysis, Gamma, Neuronal action potentials

Description of the course
The day will start with a lecture giving an overview of the value of studying neuronal oscillations in the context of cognitive neuroscience, and the fundamental mathematical and signal-processing theorems that underlie this analysis. We will then start a hands-on session in which you will have the opportunity to implement in MATLAB the concepts discussed in the lecture. You will analysis model data and empirical data to answer specific questions about neuronal processes. At each step, there will be short lectures and discussions about the practical work.
The major topics will include Fourier transform, wavelets and time-frequency analysis, coherence and spike-field coherence analysis, the Hilbert transform, instantaneous frequency and phase analysis.

Instructional Approach
You will read basic papers as preparation to the course. The workshop includes lectures given by the coordinator and group discussion. The practical sessions will be based on working with provided data and matlab code which you will adapt to answer a worksheet of questions. The coordinator will instruct you and be on hand to provide support.

Form of assessment
Assessment will be based on completion of the worksheet which will include short written descriptions about your findings from the data



MBIC05: Combining TMS/TES with EEG and fMRI in Human Brain Research

Location: UM or online
Structure: two days; morning lectures (2 lectures separated by break), afternoon practical

Coordinator:
Inge Leunissen
Cognitive Neuroscience (FPN),
Oxfordlaan 55, Room 1.016,
E-mail: inge.leunissen@maastrichtuniversity.nl

Objective(s)
This workshop covers state-of-the-art multimodal applications of non-invasive brain stimulation with a particular focus on the experimental and simultaneous combination of transcranial magnetic and electric brain stimulation (TMS/TES) with neuroimaging tools such as functional magnetic resonance imaging (fMRI) and electroencephalography EEG). Participants will learn how to combine brain stimulation and brain imaging techniques in fundamental empirical brain research. Concrete applications, protocols, and experimental designs are discussed in the context of breakthrough literature from recent years.

Key Words
Non-invasive brain stimulation, neuromodulation, neuroimaging, multimodal, TMS, TDCS, tACS

Description of the Course
Cognitive neuroscience boasts various, complementary research tools. Most are neuroimaging methods, which reveal activity in the human brain as volunteers or patients perform different perceptual, cognitive, behavioral tasks. Non-invasive brain stimulation techniques (NIBS) add something unique to this field. Rather than measuring brain activity passively, while participants perform a task, NIBS approaches *manipulate* brain activity, to see what effect this has on that task. Or, in the case of multimodal approaches; what effect brain stimulation has on brain activity measured immediately afterwards or even simultaneously.
In recent years, the arsenal of brain stimulation approaches has grown rapidly. Today, we have transcranial magnetic stimulation (TMS), direct current stimulation (tDCS), alternating current stimulation (tACS), and random-noise stimulation (tRNS), to name a few. Just in the last few years, even more advanced implementations of NIBS have been developed. Some of those focus on the causal study of different brain oscillation parameters. While traditional NIBS asked whether a brain area was causally involved in a task, the latest applications ask whether a brain *mechanism within* such an area is causally involved in that task.
More and more NIBS is being combined with neuroimaging to either improve the power and efficacy of NIBS, or to visualize the effects of NIBS on the brain.

Instructional Approach
The course consists of two days, with morning and afternoon sessions. On both days, the morning sessions consist of lectures. Day 1 focuses on providing an overview of all the NIBS techniques out there, from basics to advanced applications. Day 2 focuses on explaining the very latest applications and approaches, with a particular focus on the multi-modal approaches of NIBS. In the afternoons, you get hands-on experience with brain stimulation equipment in lab sessions and demonstrations of combined TMS/TES and fMRI/EEG applications.

Form of Assessment
Active participation

MBIC06: Tracking Brain Rhythms and Timing: Common and advanced analysis of EEG time-series

Location: UM or online
Structure: two days; morning lectures (2 lectures separated by break), afternoon practical

Coordinators: Lars Hausfeld & Sanne ten Oever, Cognitive Neuroscience (FPN)
Email: lars.hausfeld@maastrichtuniversity.nl

Objective(s)

This course focusses on common and advanced analysis of EEG data. Our aim is that at the end of the course students gained valuable knowledge about different possibilities on how to analyze EEG data. Specifically, students should be able to correctly interpret results acquired from the various methods as well as apply these techniques to their own data.

Key words

EEG, time-frequency analysis, phase, multivariate analysis, time-series

Description of the Course

Electroencephalography (EEG) is a tool commonly used in neuroscientific research. In this course we provide various tools to analyze your EEG data. The course will be divided into two days. During the first day, lectures will provide an overview on the properties of the EEG signal and choosing an experimental design as well as on time-frequency decompositions. On the second day, we will focus on using EEG to assess subcortical function and also as input to machine-learning techniques (decoding and encoding). Hands-on practicals after the lunch break on time-frequency analyses (day 1) as well as machine learning (day 2) will ensure a better comprehension.

Instructional Approach

The course is a combination of lectures and practical sessions. The lectures will cover theoretical background and examples. Two practical sessions provide the possibility to gain hands-on experience on some of the analyses covered during lectures.

MBIC07: Ultra-High-Field (f)MRI Physics and Techniques
Location: UM
Structure: two days with three lectures each (2hours per lecture)

Coordinator: Benedikt Poser, Cognitive Neuroscience (FPN)
Oxfordlaan 55, Auditorium
Phone: +31 43-38 82427
Mobiled: +49 178 1441078
E-mail: benedikt.poser@maastrichtuniversity.nl

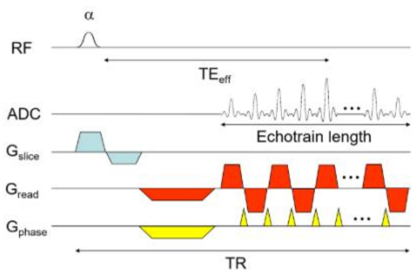
Objective(s):
This course will teach the basics of MR Physics including signal generation and image encoding for main neuro applications, and with particular emphasis on ultra-high field, will introduce the foundations of MR physics, as well as anatomical, diffusion-weighted, and BOLD functional imaging and physiology.

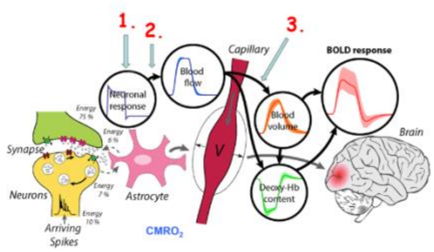
Key Words
MRI physics; MR pulse sequences and image reconstruction; MR contrast and anatomical imaging; diffusion-weighted imaging; physiological basis of BOLD fMRI; laminar and columnar fMR;

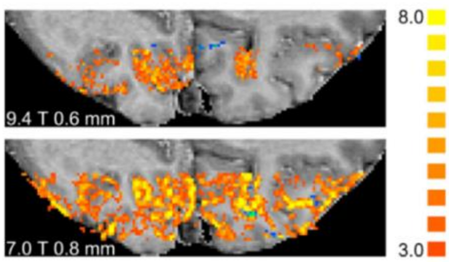
Description of the Course
The present course offers the foundations for high-field (f)MRI, and discusses the practical considerations that arise when moving from clinical field strengths to ultra-high field such as 7T or 9.4T. The course will introduce the MR physical consideration related to anatomical and functional image acquisition, and demonstrate the potential, the technical challenges, and their solutions by means of state of the art techniques and procedures. The course then focuses on the high end applications that are enabled by ultra-high field MRI, specifically anatomical imaging, diffusion imaging, high-resolution fMRI, perfusion imaging and BOLD physiology.
The course is primarily geared towards PhD students that use MRI for their projects, but will also be interesting for PhD students who do not use MRI and would just enjoy following lectures on MRI topics to increase their theoretical background on neuroscience imaging methods.

Instructional Approach
The course is a lecture based course, given on two consecutive days with three two-hour lectures each.

Form of Assessment
post-course study/reading







MBIC08: From basic to more advanced math and signal processing – Part I

By Giancarlo Valente
Location: UM or Online via Zoom
Structure: eight weeks, with one session (2hours) per week
Coordinator: Giancarlo Valente, Cognitive Neuroscience (FPN)
Phone: 043-38 82469
E-mail: giancarlo.valente@maastrichtuniversity.nl

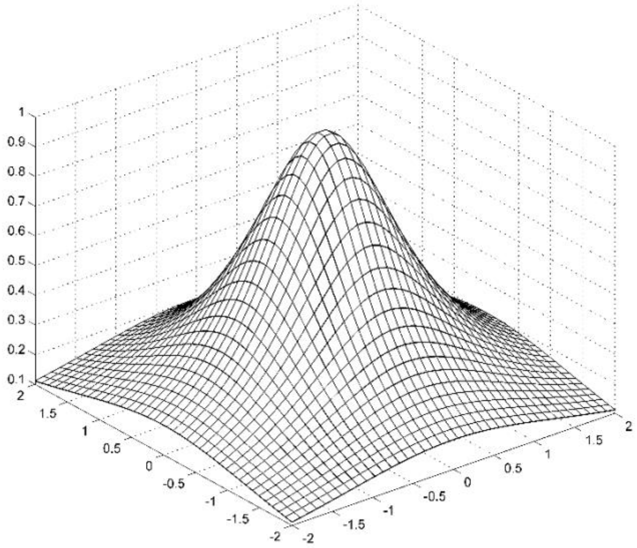
Course description:
Mathematical methods are a fundamental tool for conducting research in Cognitive Neuroscience. This course aims at providing the basic concepts and instruments to deal with data analysis, with a two-year format: in Part 1 the focus is on pre-Calculus, Calculus and Algebra, whereas Part 2 deals with probability, multivariate techniques and optimization. A tentative list of topics that will be covered in Part 1 is a) pre-calculus (if needed) b) calculus, c) linear algebra, d) signal processing. Large emphasis will be given to practical MATLAB/Python implementation of the concepts discussed in the course.

Course details:

- 1 session per week (1-1.5 hrs).
- Recorded lectures and notebooks will be made available before the session takes place, and will be discussed during the session.
- Eight sessions, February/March
- Pen and paper and Matlab/Python exercises

Topics (tentative):
The topics covered in the course may change based on students' background level.

- Pre-Calculus (if needed)
- Complex Numbers and Euler's Formula (if needed)
- Calculus
  - Limits
  - Derivatives
  - Series Expansion
  - Integrals
- Linear Algebra
  - Linear Systems
  - Vector Spaces
  - Eigenvalues and Eigenvectors
  - Singular Value Decomposition
- Signal Processing
  - Fourier transform and Sampling Theorem
  - Linear systems and Filters

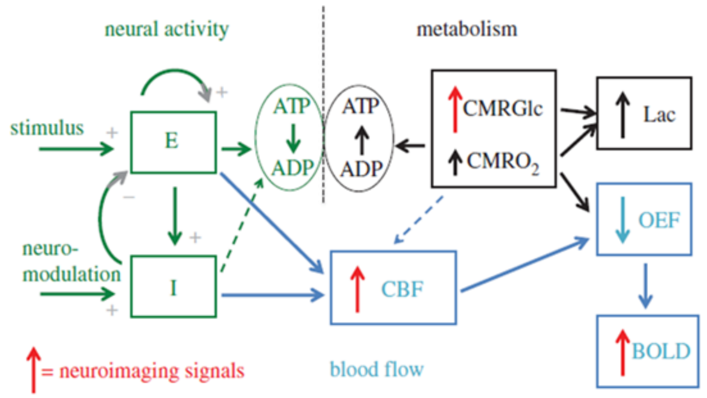


GRADUATE SCHOOL

MBIC09: Physiology of the BOLD response
By Dimo Ivanov
Structure: Two-day course containing lectures, discussion, and practical sessions
Coordinator: Dimo Ivanov
Additional speakers: Dr. Laurentius Huber
Location: Oxfordlaan 55
Date: 21st and 22nd April 2022
Email: dimo.ivanov@maastrichtuniversity.nl

Key Words

Neurovascular coupling, hemodynamic, excitatory-inhibitory balance, glucose and oxygen metabolism, vascular uncoupling, BOLD response, laminar response, modelling.



Objective(s)

This workshop will give an overview of the physiological mechanisms underlying the BOLD response and emphasize the importance of acquiring additional hemodynamic measurements and applying physiologically informed models to accurately explain observed fMRI data.

Description of the course

The BOLD response is an indirect reflection of neuronal activity, posing limits on the interpretation of fMRI data in terms of neurocognitive processing. However, over the last twenty years, our understanding of the physiological mechanisms underlying the BOLD response and its relationship to changes in neuronal activity has considerably improved. This course will provide a description of the most important physiological mechanisms using experimental examples and models that link the observed BOLD fMRI response to neuronal response at both macroscopic and laminar (mesoscopic) level. During this course, the lectures will focus on (a) neurovascular coupling, describing the modulation of blood flow by neuronal activity; (b) a dynamic interplay between blood flow, oxygen metabolism and blood volume; (c) their contribution to the BOLD response and its dependence on MR parameters, such as magnetic field strength; (d) the energetics of neuronal activity and how the large metabolic demand of the brain is met. In a practical session, students will learn how to employ dedicated MRI sequences to collect the relevant hemodynamic data and what additional physiological measurement devices can offer. The lectures will extend the acquired knowledge to high-resolution fMRI data and provide overview of our understanding of the physiological mechanisms at the laminar level. The accompanying practical session will discuss existing laminar hemodynamic models and how they can be used to understand the measured laminar responses.

Literature

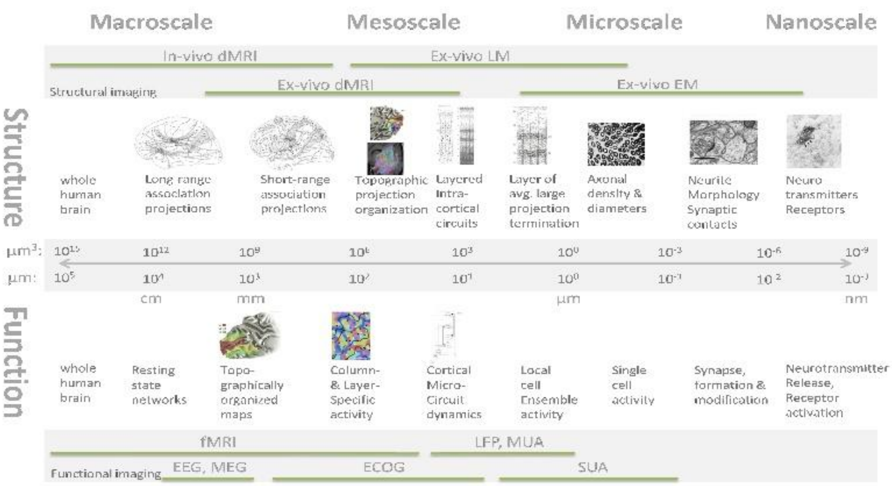
Journal articles and book chapters

MBIC10: Brain connectivity (course description will be adjusted)
Location: UM
Structure: one introductory and one advanced day

Coordinator: Dr. Alard Roebroeck, Cognitive Neuroscience (FPN),
50 Oxfordlaan, Room S1.009,
Phone 38 84309,
E-mail: a.roebroeck@maastrichtuniversity.nl

Objective

This workshop aims to give an overview of methods for modelling and measuring brain connectivity and their applications. After attending the workshop, the participant should be familiar with the different ways in which 'brain connectivity' can be defined, the different methods by which it can be measured or modeled and how each could be used in answering neuroscientific questions.



Key words

spatial scales of connectivity; connectomics; functional connectivity; effective connectivity; diffusion MRI; diffusion tensor imaging; tractography; independent component analysis; Granger causality; dynamic causal modelling; EEG/MEG coherence; Connectivity by TMS interference

Description of the Course:

This workshop will give an overview of commonly used methods for modelling and measuring brain connectivity. Both the structural aspect (i.e. white matter pathways) and the functional and processing aspects (i.e. communication or interaction between brain structures) will be discussed, with attention to the different spatial scales at which connectivity can manifest itself. The course will touch upon theoretical considerations of inferring causality, interference and information transfer. It will focus, in turn, on a few of the most used methods investigate connectivity and communication in the human brain: fMRI functional connectivity approaches; fMRI effective connectivity modelling; DTI, crossing fiber models and fiber tracking; EEG/MEG coherence measurement; and connectivity inference by TMS interference. For each of the methods the basic principles, strengths and shortcomings, and likely applications are discussed.

Instructional approach

Lectures and literature suggestions

MBIC11: Course Proposal: Hands-On Training on Population Receptive Field Mapping

Location: UM or online
Structure: one introductory and one advanced day

Coordinators: Mario Senden, Alexander Kroner & Salil Bhat
Cognitive Neuroscience (FPN)
Phone: 043-38 82071
E-mail: mario.senden@maastrichtuniversity.nl

Objective(s):
The objective of this course is to provide students with the knowledge and tools required to investigate the topographic organization of the human brain. The course starts with reviewing different approaches to retinotopic mapping as well as the population receptive field mapping technique for a range of applications. The majority of the course is then dedicated towards practical exercises covering the complete workflow from experimental design to analyses.

Key Words:
Population receptive field mapping; phase encoding; retinotopy; stimulus design; analyses tools

Description of the Course:
The topographic organization of neural populations is a fundamental principle of brain function and structure. As an example, visual and auditory cortices reflect properties like the locations of retinal stimulation (retinotopy) or the frequency of sounds (tonotopy) respectively. Topographic organization is not limited to sensory and motor cortices but has even been observed for more abstract properties like numerosity. Population receptive field (pRF) mapping is an important tool analyzing topographic organization of stimulus features.

The course will introduce students to both theoretical and practical aspects regarding the topographic organization of the brain in general, and pRF mapping procedures in particular. A hands-on experience will be provided that covers the entire workflow, starting from the design of an experiment, to the application and analysis of various mapping techniques. Lastly, advanced use cases, such as fast pRF mapping methods for real-time applications, will be discussed.

Instructional Approach: Lectures, computer exercises

Form of Assessment: Computer exercises and active participation during lectures

MBIC12: **High resolution fMRI: An introductory course for data acquisition and analysis challenges**

Location: UM or online
Dates: Bi-annually (even-numbered years)
Structure: 4 days with Lectures and practical sessions

Coordinators: Laurentius (Renzo) Huber & Omer Faruk Gulban, Cognitive Neuroscience (FPN)
Email: renzohuber@gmail.com or faruk.gulban@maastrichtuniversity.nl

Objective(s):
This course will be an introduction to acquiring and analyzing high resolution (<1mm) functional magnetic resonance imaging (fMRI) data. The course participants will acquire data and analyze with the guidance of the course coordinators.

In the first session, theoretical (introductory) background will be provided on the state-of-the-art high resolution fMRI methods.

The second session will involve data acquisition at 7T scanner.
These data will be used by the students to practice various image analysis techniques in the third session.

In the last session, all attendees will give a short 5-10 min presentation about a high-resolution fMRI topic of their choice.

After this course, participants will be able to:

- Give a rough overview of the seminal papers, challenges and prospects of laminar fMRI
- Discuss the most common artifacts at the scanner and how to address them.
- Make more informed decisions for their own high resolution fMRI acquisitions.
- Use image registration and segmentation methods to address some of the most challenging analysis steps.

Literature: There will be no textbook. Individual articles will be suggested for the sessions 3 and 4. A list of high-resolution fMRI paper suggestions for inspiration of the last session can be found here: https://layerfmri.com/papers/

Instructional approach: There will be 3 lecture sessions, 1 practical session for data acquisition at 7T MRI scanner. Session 3 will include “click-along” and “code-along” examples that can be followed by the participants with their personal laptops

Form of assessment: Attendance (all 4 sessions).
Lecture recordings of previous years: https://layerfmri.com/2020_summercourse/

GRADUATE SCHOOL

MBIC13: Machine Learning
Location: UM or online
Structure: Seven Lectures + Practical meetings
Coordinators: Federico De Martino, Giancarlo Valente, Agustin Lage-Castellanos and Elia Formisano – Cognitive Neuroscience (FPN). Oxfordlaan 55, Room 1.013,
Phone 043-38 84532,
E-mail: f.demartino@maastrichtuniversity.nl

Objective(s)

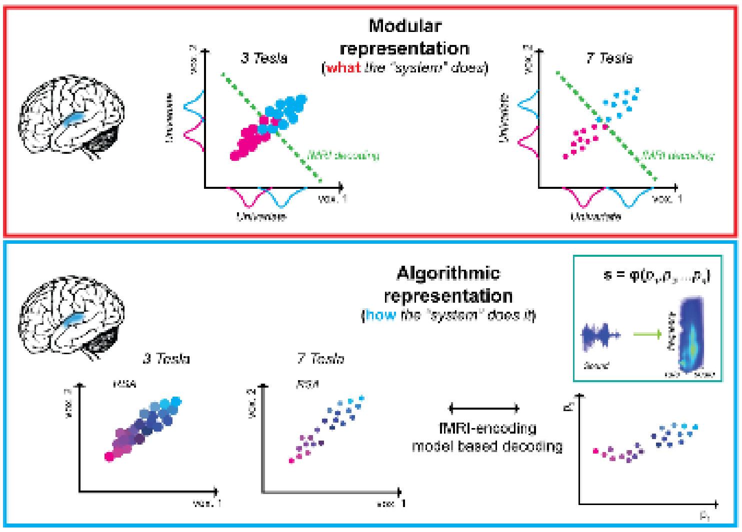
This workshop focuses on theoretical aspects underlying the use of machine learning techniques in neuroimaging (with a focus on fMRI – applications to EEG are covered in the MBIC20 course). We will discuss relevant topics using a series of lectures and practical sessions. The lectures will cover theoretical aspects and highlight key applications (e.g. multivoxel pattern analysis, model-based fMRI analysis, population receptive field modelling). Practical sessions (Matlab or Python) will be oriented towards analyzing some of the fundamental aspects in detail.

Key words

Machine Learning; pattern recognition; fMRI; distributed patterns; brain reading; decoding, encoding, pRF modelling, noise ceiling.

Description of the Course

Machine learning algorithms (classification and regression) are being increasingly used for the analysis of neuroimaging data. Such methods have been shown to be more sensitive than conventional statistical techniques for the detection of functionally specialized patterns of activity. Furthermore pattern recognition algorithms have received increasing interest for their ability to “predict” presented stimuli and/or subjects’ behaviour from the neuroimaging activity (“brain reading”). These techniques have also been used to link computational models of stimulus processing to neurophysiological measures (e.g. population receptive field modelling, encoding, model based decoding).



The course starts from applications (decoding, encoding, population receptive field modelling, representational similarity) and then introduces fundamental theoretical concepts (regularization, cross-validation and statistics and noise-level estimation) and ends with more advanced topics (canonical correlation analysis, partial least squares).

Literature

Journal articles, book(s) chapter(s).

Instructional Approach

Each topic is treated with a combination of a lecture and either a discussion session (journal-club) or practical session.

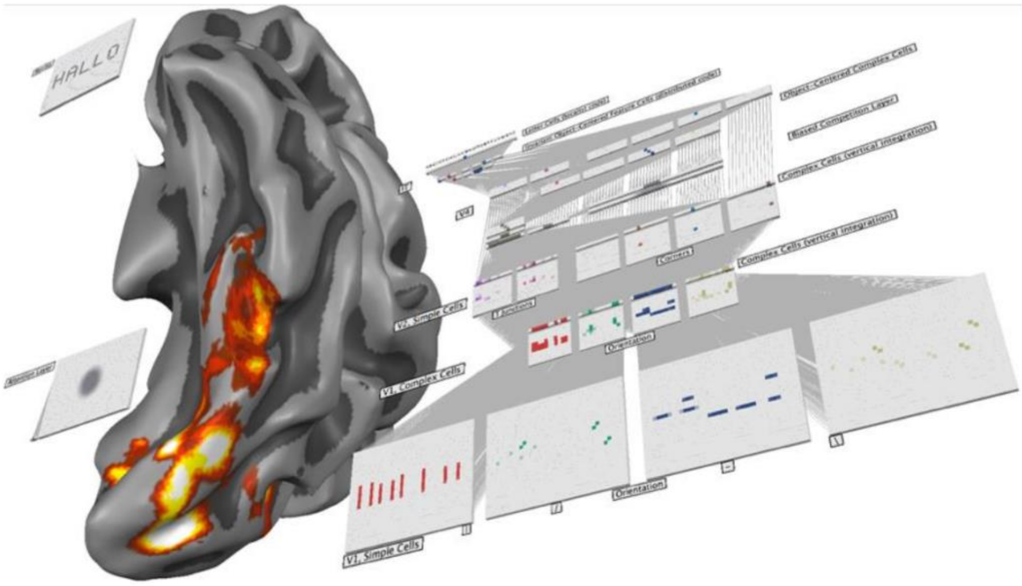
GRADUATE SCHOOL

MBIC14: Relating high-resolution fMRI brain responses to activity in biologically inspired deep neural network models

Coordinators: Rainer Goebel, Mario Senden

Key Words: deep learning, biological deep neural networks, fMRI

Objective(s):



Following up on MBIC15 *Modeling Neuroimaging Data with Convolutional Deep Neural Networks,* the objective of this course is to train students to utilize biologically plausible deep neural networks in conjunction with functional magnetic resonance imaging for generating and validating novel hypotheses of brain function.

Description of the Course:

Sensory systems enable perception and cognition through a cascade of hierarchical computations in cortical regions with distinct functionalities. In this course, we introduce and discuss approaches to relate biological deep neural network (DNN) models to functional brain responses as a means to discover putative functional representations in cortical areas, and to inspire empirical research to test new hypotheses of brain function derived from modeling. We will discuss how different approaches contribute to the understanding and improvement of the correspondence between representations in human brains and biologically inspired DNNs. The discussed (AI) computational approaches may, for example, provide novel functional mappings of human (sensory) cortices, and may lead to concrete testable hypotheses about representational contents in different brain regions as well as about the role of short and long-range connections.

One focus of this course is to teach students how to increase the biological realism of deep neural networks by, for instance, using spiking neurons rather than classic rate units. A second focus is to teach how to extract empirically testable predictions from these networks. A final focus is to teach advanced tools to link classic units in DNN layers as well as spiking neuron systems to voxels in fMRI brain measurements.

Instructional Approach: Lectures, computer exercises

Form of Assessment: Computer exercises and active participation during lectures.

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