

7th  
Edition

# ILCB SUMMER SCHOOL PROGRAM

FROM AUGUST 26TH TO AUGUST 30TH 2024

Centre International de Rencontres Mathématiques  
163 avenue de Luminy - Marseille, France



LANGUAGE, COMMUNICATION AND THE BRAIN



**ILCB**  
Summer school

Institute of  
language, communication  
and the brain

CIRM



**Inserm**

La science pour la santé  
From science to health

**amU**  
Aix Marseille Université



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# INTRODUCTION

The ILCB summer school will be held from Monday August 26th to Friday August 30th, 2024, at the Centre International de Rencontres Mathématiques in Luminy (CIRM). This interdisciplinary summer school brings knowledge on language and communication to international and local participants coming from very different backgrounds (linguistics, neurosciences, psychology, computer science, mathematics). The courses are given by ILCB researchers or by external colleagues of international renown.

For this 7th edition, participants will be able to choose between introductory and advanced courses. The morning introductory courses will be reserved for mathematics and computer science courses. Those in the afternoon will be reserved for general introductory courses (conceptual and methodological) on ILCB disciplinary fields: linguistics, psycholinguistics, neurolinguistics, and AI.

The advanced morning classes will develop a multidisciplinary theme over several days and will be based on the latest research (e.g., language and pathology, language development, from sound to cognition, mixed models).

In the afternoon, participants will be able to attend more focused “state-of-the-art» sessions addressing ILCB key themes.

Several social events (welcome party, social dinner, walks in the callanques) will allow participants to get to know each other in a friendly atmosphere. On Friday morning, Alejandrina Cristia and Arthur Jacobs will present two cross-cutting topics on “the Development of Speech Behavior” and «Neurocomputational Poetics» respectively.

Finally, two plenary keynotes constitute a high point of the summer school. It will be given this year by Antoni Rodriguez-Fornells and Susan Fuchs, the IMéRA/ILCB 2024/2025 chairs.

# INTRODUCTORY COURSE SCHEDULE

	MONDAY 26	TUESDAY 27	WEDNESDAY 28	THURSDAY 29	FRIDAY 30
8:45	Presentation Salle A1				
09:00-10:15	R programming and statistics T. T. Trang Salle S2				Cross-cutting topic A. Jacobs-Salle A1 9:00-10:30
10:15-10:45	Break				Break
10:45-12:00	Python programming and machine learning T. Schatz Salle S2				Keynote S. Fuchs-Salle A1 11:00-12:30
12:00-13:30	Lunch				Lunch 12:30
13:30-14:15	Conversations on language F-X. Alario				Trip in the calanques
14:30-15:45	Artificial Intelligence B. Favre-Salle A1	Brain for dummies B. Morillon-Salle A1	Animal behaviour A. Meguerditchian-Salle A2	Linguistic theory for the cognitive sciences J. German-F. Di Garbo-Salle S2	
15:45-16:15	Break				
16:15-17:30	Artificial Intelligence B. Favre-Salle A1	Imaging for dummies V. Lopez Madrona-Salle A1	Animal behaviour A. Meguerditchian-Salle A2	Linguistic theory for the cognitive sciences J. German-F. Di Garbo-Salle S2	
17:30-17:45	Break				
17:45-18:45	Social event 18:00	CREx workshop Salle A2	Cross-cutting topic A. Cristia-Salle A1	Keynote A. Rodriguez-Fornells-Salle A1	
19:00	Dinner				



# ADVANCED COURSE SCHEDULE

	MONDAY 26	TUESDAY 27	WEDNESDAY 28	THURSDAY 29	FRIDAY 30
8:45	Presentation Salle A1				
09:00-10:15	Language & pathology F-X. Alario, A. Trébuchon, S. Pinto, J. Ziegler Salle A1				Cross-cutting topic A. Jacobs-Salle A1 9:00-10:30
	Cognitive & communicative bases of language A. Fourtassi, C. François, I. Dautriche, T. Schatz Salle A2				
10:15-10:45	Break				Break
10:45-12:00	From sound to cognition E. Thoret, B. Morillon, P. Belin Salle A2				
	Mixed models R. Anders Salle A1				Keynote S. Fuchs-Salle A1 11:00-12:30
12:00-13:30	Lunch				Lunch 12:30
13:30-14:15	Conversations on language F-X. Alario				
14:30-15:45	Cognitive & neural mechanisms of reading acquisition C. Pattamadilok-Salle A2	Multimodal Language understanding B. Favre-Salle S2	Source localization in MEG & EEG V. Lopez Madrona-Salle A1	Bilingualism C. Frenck-Mestre-Salle A1	Trip in the calanques
	New paradigms to investigate social cognition T. Chaminade-Salle S2	Language in the brain & algorithms J-R King-Salle A2	Prosody & intonation C. Petrone-Salle S2	Models of IA & human language acquisition E. Dupoux-Salle A2	
15:45-16:15	Break				
16:15-17:30	Predictive coding in the human brain J. P. Lerousseau-Salle A2	Concept, word & association T. Chartier-Salle S2	Spatial maps of the sound to speech transformation B. Morillon-Salle A1	Language in the brain & algorithms J-R King-Salle A1	
	Interactions in the adolescent brain M-H. Grosbras-Salle S2	Language in the brain & algorithms J-R King-Salle A2	Deep learning for speech Y. Estève-Salle S2	Models of IA & human language acquisition E. Dupoux-Salle A2	
17:30-17:45	Break				
17:45-18:45	Social event 18:00	CREx workshop Salle A2	Cross-cutting topic A. Cristia-Salle A1	Keynote A. Rodriguez-Fornells-Salle A1	
19:00	Dinner				

# Keynote

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## Interdisciplinary approaches to respiratory rhythms

Breathing is a physiological rhythm that accompanies us from birth to death. Yet, beyond its primal function of oxygen exchange, respiration emerges as a linchpin, it plays an inherent role in spoken language, movement and cognitive processes in the brain. In this lecture, I will provide an overview of interdisciplinary approaches and empirical findings that cast new illumination on respiration as a research topic and make references to language acquisition and evolutionary trajectories of human communication.



**Susan Fuchs**  
CHAIRE IMÉRA-ILCB  
ZAS

# Keynote

## Intrinsic reward mechanisms in language learning

An important problem that language learners constantly face due to the highly undermined and uncertain learning environments (e.g., multiple new words, speakers, word-to-world mappings, etc.) is how to sample relevant information for their learning process. The present research seeks to shed light on how learners engage in optimal information sampling when acquiring the meaning of new words.

Our working hypothesis posits that this critical process is fueled by intrinsically triggered reward mechanisms, which serve to reinforce information-seeking and explorative behaviors. Recent investigations conducted by our group, focusing on adults learning new words, have unveiled an interesting cross-talk between subcortical dopamine reward-related mechanisms and cortical language networks. These findings suggest that such subcortical-cortical interplay play a pivotal role in triggering language curiosity and facilitating information seeking activities that are needed to optimal sampling during language learning.

A central tenet of our research is the idea that these mechanisms must be operative during the early stages of language acquisition to ensure curiosity, exploration as well as appropriately selecting which piece of information is crucial for future learning. By elucidating the dynamics of information sampling during language learning, our research aims to contribute to understanding the self-regulatory nature of language acquisition processes.



**Antoni  
Rodriguez-Fornells**  
CHAIRE IMÉRA-ILCB  
IDIBELL, UB & ICREA



# Cross-cutting topics

## Neurocomputational Poetics: Explaining why readers like verbal art

When you start reading a piece of fiction, a story or a novel, what makes you read on is whether you understand what the sentences try to tell you and whether you like what you read. If none of these conditions is met, most readers simply close the book and go on with their lives. But how can reading psychology explain how readers come to understand and like books? Well, so far it couldn't, because the last 150 years of reading psychology focused almost exclusively on the cognitive aspects of understanding texts, but left out the equally important part of liking them.

The Neurocognitive and Neurocomputational Poetics perspectives changed this by introducing new models and methods for predicting why readers like fiction (Jacobs, 2015; Jacobs, 2023; Willems & Jacobs, 2016). In this talk I discuss recent developments of these perspectives such as the explanatory predictive modeling –using a computational tool called SentiArt (<https://github.com/matinho13/SentiArt>)– of:

- readers' likeability ratings of entire books (e.g., Harry Potter and the Half-blood Prince)
- readers' ratings of the most beautiful lines of Bob Dylan's song lyrics (e.g., Lay Lady Lay)
- readers' ratings of the most beautiful lines of Shakespeare sonnets (e.g., Shall I compare thee to a summer's day)
- or the (perceived) beauty of great novels such Proust's 'In search of lost time', Camus' 'The Stranger' or Tolstoy's 'Anna Karenina'.

These developments lead to multiple revisions of standards in reading and media psychology, education, digital literary studies, or the publishing industry.



**Arthur Jacobs**  
CCNB, FREIE UNIV.  
BERLIN

# Cross-cutting topics

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## Voices Unbound: Long-Form Recordings to Study the Development of Speech Behavior in the Wild

Traditional laboratory experiments have significantly advanced our understanding of speech and language use, but a reliance on controlled environments limits our ability to ensure observations generalize to real-world communication. In this talk, I summarize some recent work on young children's speech development to introduce a novel approach that leverages long-form recordings from real-world interactions and machine learning to uncover the dynamics of speech behavior as it naturally occurs. For instance, in a 13-author collaborative study, we analyzed over 40,000 hours of audio from 1,001 children across 12 countries, revealing maturation and speech exposure as more important predictors of infants' speech development than gender and socioeconomic status. Furthermore, we use state-of-the-art self-supervised learning models to argue that tailored biases are needed to face the rich variability of naturalistic audio. Finally, I'll discuss the promise of wearable technology to study language and communication, highlighting both the breakthroughs and the hurdles of venturing beyond the lab.



**Alejandrina  
Cristia**  
ENS PARIS, CNRS

## Conversations on language

Having a conversation should be a good way to learn about language. On each day, Xavier Alario will discuss with an expert on issues pertaining to language, communication, or the brain. The aim is to convey a few key ideas on each topic using a light format.

### Participants:



**François-Xavier Alario**  
CRPN, AMU & CNRS



**Magalie Ochs**  
LIS, AMU & CNRS



**Benjamin Morillon**  
INS, AMU & INSERM



**Isabelle Dautriche**  
CRPN, AMU & CNRS



**Adrien Meguerditchian**  
CRPN, AMU & CNRS

# ILCB Center of Experimental Resources (CREx)

## Workshop

The ILCB Center of Experimental Resources (CREx) plays a central role within the ILCB Institute by providing support to all of its members and across all of its topics of research. This team is composed of four engineers specializing in scientific computing and data analysis as well as a team coordinator. During this session, CREx members will present some of the applications they are developing at ILCB.



**Thierry Legou**  
CREX, ILCB, AMU, CNRS



**Valérie Chanoine**  
CREX, ILCB, AMU & CNRS



**Deidre Bolger**  
CREX, ILCB, AMU & CNRS



**Franziska Geringswald**  
CREX, ILCB, AMU & CNRS

# TITLES AND ABSTRACTS

## Introductory courses

### R programming and statistics

This course introduces the basics of descriptive statistics, in particular, the concepts of population, variable, observation, as well as the representation of numerical data as tables and graphics, the measures of centrality and dispersion, and finally Exploratory Data Analysis. From real data examples, we will produce high quality graphics using the R software and the ggplot2 package. The last lecture focuses on the more advanced topic of describing the dynamics of functional connectivity from EEG traces.



**Thi Tuyet  
Trang**  
CHAU, LSCE, CEA,  
& IPSL



**Thomas  
Schatz**  
LIS, AMU & CNRS

### Python programming and machine learning

This class will introduce python programming, as well as data processing and machine learning libraries in python that are useful in the context of research into the cognitive (neuro)sciences of language (numpy/scipy/pandas/seaborn/scikit-learn/pytorch). **No prior knowledge of machine learning and computer programming is assumed.**

### Brain for dummies

This course will provide a general overview of the human brain, mainly through a historical, theoretical, and structural viewpoint.  
**No prerequisite.**



**Benjamin  
Morillon**  
INS, AMU & INSERM



# Introductory courses

## Imaging for dummies

In this course, we will see the basis of functional brain imaging from three different perspectives: functional magnetic resonance imaging (fMRI), electro and magnetoencephalography (EEG/MEG), and intracerebral EEG. Each modality provides a specific and unique way to measure the activity of our brain and all of them are complementary. We will briefly review their mechanisms and recording systems and provide an overview of the possible analysis that can be done. After the course, you will have the competences to decide the best modality to answer our scientific questions.



**Victor José  
Lopez Madrona**  
INS, AMU & INSERM



**Adrien  
Meguerditchian**  
CRPN, AMU & CNRS

## Animal behaviour

This course will explore the history of the study of behaviours mostly from the animal research field. We will travel across diverse – and sometimes divergent – approaches including behaviorism, objectivist ethology, behavioral biology, sociobiology... We will finish by the specific contribution of the emergence of cognitive science in the field which clearly addressed the question of the mind in the understanding of the behavior.

# Introductory courses

## Linguistic theory for the cognitive sciences

This course presents an overview of the essential components of and empirical motivations for the major branches of modern linguistic theory, with a special emphasis on phonetics, phonology, morphosyntax, semantics, as well as usage-based approaches to the study of language structures. The primary aim is to situate linguistic theory, and the cognitive representations of linguistic structure it proposes, within the cognitive sciences more generally, as well as to provide researchers in the cognitive sciences with fundamental analytical skills for addressing issues in language production, perception, and processing from a variety of methodological perspectives, including psychological, neurological, and computational ones.



**James German**  
LPL, AMU & CNRS



**Francesca Di Garbo**  
LPL, AMU



**Benoit Favre**  
LIS, AMU & CNRS

## Artificial intelligence

Through the lens of Natural Language Processing, this class will introduce the main concepts and methods of Artificial Intelligence, placing them in a historical perspective from the converging viewpoints of computer science, linguistics and signal processing.

# Advanced courses

## Language and pathology

### **Connecting healthy and pathological language processing – François-Xavier Alario**

How different are healthy and pathological language processing? Can the study of patients inform our understanding of the general population? Can theories describing “canonical” unimpaired language processing reliably inform clinical decisions? At what level of description should the pathological aspect of processing be described? How should remediations be conceived and implemented for these impairments? This segment of the “Language & Pathology” course will present some broad concepts and invite an interactive discussion of the links between healthy and pathological language processing. It will take examples from the three following sessions thus providing a general introduction to the course. You will be expected to speak out, not only listen and write.

### **Studying speech motor control from its impairment: a general introduction to dysarthrias – Serge Pinto**

Motor Speech Disorders refer to a set of signs affecting the control and production of speech consequent to neurological impairment. They are characterized by an approach which dichotomizes motor speech disorders in two modalities: apraxia of speech and dysarthria, which can be distinguished on at least two fundamental points: (1) dysarthria is the consequence of motor dysfunctions also involving the limbs (rigidity, akinesia, ataxia, dystonia, etc.) and of which a specific pathophysiology is determined; dysarthric disorders are constant, predictable, whereas this is not the case for patients suffering from apraxia of speech; (2) verbal dysfluency, marked in apraxic patients, is not characteristic of dysarthric speech. After presenting the classification and pathophysiology of dysarthrias associated with specific movement disorders, I will briefly introduce the relevance of targeting research on dysarthria, and mainly hypokinetic dysarthria in Parkinson’s disease, as a model for a better understanding of the involvement of cortico-basal ganglia-cortical pathways in speech motor control.



**François-Xavier Alario**  
CRPN, AMU & CNRS



**Serge Pinto**  
LPL, AMU & CNRS

# Advanced courses

## Language and pathology

### **Language pathology and epilepsy–Agnès Trébuchon**

In case of drug-résistant epilepsy the surgery procedure consisting in the resection of the “seizure generator” is considered as the treatment of choice. However, this procedure may induce Language deficits, particularly after left temporal surgery. In this context, counseling at the individual level patients about the risks and benefits of surgery can be challenging. The functional exploration of the language network is by consequent crucial.

### **Learning to read and dyslexia: from theory to intervention– Johannes Ziegler**

How do children learn to read? How do deficits in various components of the reading network affect learning outcomes? How does remediating one or several components change reading performance? In this talk, I will quickly summarize what we know about how children learn to read. I will then present developmentally plausible model of reading acquisition. The model will be used to understand normal and impaired reading development (dyslexia). In particular, I will show that it is possible to simulate individual learning trajectories and intervention outcomes on the basis of three component skills: orthography, phonology, and vocabulary. The work advocates a multi-factorial approach of understanding reading that has practical implications for dyslexia and intervention.



**Agnès Trébuchon**  
AP-HM, INS, AMU & INSERM



**Johannes Ziegler**  
ILCB, CRPN, AMU & CNRS



## Advanced courses



**Clément  
François**  
LPL, AMU & CNRS



**Thomas  
Schatz**  
LIS, AMU & CNRS

### Cognitive and communicative bases of language: a developmental viewpoint

Language development does not occur independently from the development of other cognitive abilities. This class will focus on how studying the development of perception, mental representations and social cognition informs our understanding of language acquisition. The class will also emphasize how a trend toward more methodological diversity—behavioral measures, brain imaging and computational simulations; comparative and developmental approaches; controlled experiments and large-scale observational studies—is enabling new advances on classical questions in developmental science.

#### **Session 1: An overview of the mechanisms of early language acquisition—Clément François**

From a biological perspective, the study of early development may provide an ideal level of analysis to understand the emergence of complex cognitive functions such as language. Early language acquisition requires infants to master a complex hierarchy of learning mechanisms, allowing them (i) to build robust phonological representations, (ii) to identify possible word candidates, and (iii) to map them onto conceptual representations. In this class, I will provide an overview of the learning mechanisms that explain the emergence of efficient language skills during infancy, with a particular interest in behavioural and neuroimaging approaches.

#### **Session 2: The development of speech perception and its computational modeling—Thomas Schatz**

From an ethological point of view, speech is the most important signal perceived by humans. Despite this importance, our knowledge of the mechanisms of speech perception and its development remains limited in many respects. Recent developments in computational modeling methodology offer new avenues of investigation that have begun to be explored, with sometimes surprising results. This course will (i) review the extent and limitations of our knowledge of the early development of speech perception, (ii) discuss the role(s) that computational modeling approaches have played so far and may play in the future in this area, and (iii) consider the implications for theories of early language acquisition.



# Advanced courses



**Isabelle Dautriche**  
CRPN, AMU & CNRS



**Abdellah Fourtassi**  
LIS, AMU & CNRS

## Cognitive and communicative bases of language: a developmental viewpoint

### **Session 3: Development and evolution of the language of thought –Isabelle Dautriche**

Fodor famously framed the idea that human minds operate in a language-like format, a “language of thought” (LoT), where mental representations compose in the manner of formal language symbols, allowing us to build arbitrarily complex mental structures out of a small set of initial primitive operations. Through all areas of cognitive science, there has been rich evidence supporting the idea that a LoT could explain many facets of human cognition. Do infants and animals also have a LoT? The overarching goal of this class/talk is to delve into the latest research studying the developmental and evolutionary origins of the LoT and its relationship with language development.

### **Session 4: Leveraging machine learning to study the development of language use in social interactions–Abdellah Fourtassi**

This presentation will delve into children’s language use development in social interactions, with a special focus on the role of machine learning. I will show how machine learning enables large-scale studies in this field through automated annotation, overcoming traditional barriers of scale and resource intensity. Additionally, I will highlight the groundbreaking potential of machine learning in making quantitative predictions about children’s language development within the complex, dynamic context of natural social interactions. This innovative approach offers a new lens for understanding the intricate processes of language acquisition in young children.

# Advanced courses

## Transverse approach from Sound to Cognition

This course will provide an overview of how sounds are processed by the human brain. The auditory system is the main sense to communicate between one another. Sounds are temporal in essence, and can be as diverse as voice, music, or environmental sounds. All of those carry selective cues that can be analyzed by the human brain, to share linguistic, semantic or emotional information. This course will lead you from the sound dimensions themselves to how cognitively relevant information is extracted and mapped in the cortex.

### Prerequisites:

Basic notions of neurophysiology: local field potential, functional neuroanatomy

Basic notions of signal processing: dimensions of a temporal signal (amplitude, time), an oscillatory signal (phase, frequency...). Spectral decompositions: Fourier or time-frequency.

**Computational audition: from psychoacoustics to deep-neural networks**–Etienne Thoret

**Neural dynamics of auditory and speech perception**–Benjamin Morillon

**Categorical processing of voice-specific information in the associative auditory cortex**–Pascal Belin



**Etienne Thoret**  
INT, AMU & CNRS



**Benjamin Morillon**  
INS, AMU & INSERM



**Pascal Belin**  
INT, AMU & CNRS

# Advanced courses

## Mixed models

This course will provide both the theoretical background and skills to apply linear and logistic mixed models in R/ RStudio. Mixed models are some of the most popular analytical approaches in the human sciences, and the R programming language is widely used in academia. Topics include (but are not limited to) loading and assessing the integrity of your data set (missing values, outliers, etc.), distributional analysis and visualization, mathematical understanding and requirements for an appropriate mixed model, data transformations and handling categorical variables, the specification of fixed and random effects, hierarchical implementations, model application, model checks and optimization, model selection, stepwise approaches/feature elimination, and if time permits, Bayesian implementations of the approach.



**Royce Anders**  
UNIV. PAUL VALÉRY  
MONTPELLIER



**Chotiga Pattamadilok**  
LPL, AMU & CNRS

## Neuro-Cognitive mechanism of reading and its impact on cognitive functions

Literacy acquisition induces several changes in cognitive functions, brain organization and brain structure, both within and outside the language system. One important change that has aroused strong interest in literature (nearly 10000 articles on the topic) is the emergence of a functional area within the ventral visual pathway, which plays a central role in reading. The lecture will cover some current debates around the origin of this specific brain area as well as its functional specificity (e.g., what is the function of the neurons in the area before reading acquisition? Why this area but not any other areas in the brain? Is the area specialized in orthographic processing?) We will also discuss how this culturally acquired activity modifies the way literates process speech and non-linguistic information.

# Advanced courses

## New paradigms to investigate social cognition: Second person neuroscience and human-robot interactions

Social Cognitive Neuroscience is a recent discipline that investigates the biological bases of social behaviours. It was revolutionized by the proposal of a new experimental approach, «second-person neuroscience», by Leonhard Schilbach and colleagues. This new experimental approach will be described, and specific examples from research in the neural bases of natural conversations using human-robot interactions will be presented.



**Thierry  
Chaminade**  
INT, AMU, & CNRS



**Jacques  
P. Lerousseau**  
INS, AMU & INSERM

## Predictive coding in the human brain

Predictive coding is a highly influential theory in neuroscience, providing a unifying framework for many neural phenomena. In this lecture, I will present the foundations of predictive coding, show the recent evidence for predictive processing in the human brain and discuss the limits of this theory.

## Interactions in the adolescent brain

Adolescence marks a critical juncture characterized by profound transformations in social dynamics, in the context of ongoing, specific, brain maturation. This presentation will highlight recent research advances in understanding the intricate interplay within the adolescent brain's functional architecture, particularly emphasizing systems crucial for social interactions. We will then discuss theoretical and clinical implications.



**Marie-Hélène  
Grosbras**  
CRPN, AMU & CNRS

# Advanced courses

## Prosody and intonation

In this lecture, we will cover different approaches to prosody and basic elements of current phonological theories.

Topics will include:

- Definitions of prosody
- Components of prosody (including phenomena like stress, intonation, phrasing) and their phonological representation
- How can we examine elements of prosody in the acoustic signal and what are their formal (phonological) relations and representations
- Some perception and cognitive influences on intonation processing.



**Caterina Petrone**  
LPL, AMU & CNRS

## Models of IA & human language acquisition



**Emmanuel Dupoux**  
LSCP



# Advanced courses

## Concept, word and association

Words are efficient tools for evoking similar mental representations in different individuals, hence for communicating. They can relate to a whole spectrum of conceptual abstraction, from unique material objects (very concrete) to historical or sociological constructs (very abstract). The involvement of associations in words and concepts, or in cognition in general, has been a matter of debate for over 70 years, with scientists fundamentally divided between “it explains a lot” and “it explains very little”. This presentation will provide a broad, interdisciplinary perspective on this divide. I will touch upon topics such word learning, large language models (LLMs), memory models, brain imaging or conditioning, to ask the question of what features might be missing in an associative account of concept formation: generalizability? bodily experience? social content? Finally, I will argue that giving the notion of “association” a clear, proper, unified definition – which we are currently far from – may help build bridges between levels of explanation, and eventually resolve that scientific quarrel.



**Thomas  
Chartier**

CRPN, AMU & CNRS

# Advanced courses

## Spatial map of the sound to speech transformation



**Benjamin Morillon**  
INS, AMU & INSERM

## Deep learning for speech



**Yannick Esteve**  
LIA, AVIGNON UNIV.

In the rapidly evolving domain of speech processing, deep neural networks have brought about remarkable advancements, significantly enhancing performance across various tasks. This lecture offers an exploration of prevalent neural architectures employed in speech recognition, translation, and synthesis. From convolutional neural networks to bi-directional long-short memory cells and Transformers, we delve into their implementations in neural models pretrained through self-supervision, or Whisper-like models trained by light supervision, as well as architectures like VITS and Tacotron for speech synthesis. Moreover, we examine the complex challenge of continuous speech representation, delving into the multifaceted aspects of information capture, including linguistic content, prosody, speaker characteristics, expressivity, and intelligibility. We also address the efficiency of these neural architectures and their accessibility, particularly for academic and small to medium-sized enterprises.

# Advanced courses

## Source localization in MEG and EEG

The inverse problem of MEG and EEG consists in estimating neuronal currents within the brain from measures performed at the surface. It allows in particular constructing 'virtual electrodes' that track within each brain region the neuronal activations, with a precision of the millisecond. Many methods have been proposed to solved this difficult inverse problem. In this lecture, I will review the general principles as well as the different families of methods, with an opening on recent advances in use of sparsity. I will also present the links with multivariate decomposition such as Independent component analysis.



**Victor José  
Lopez Madrona**  
INS, AMU & INSERM



**Benoit  
Favre**  
LIS, AMU & CNRS

## Multimodal language understanding, latest developments

Natural language processing has seen two consecutive revolutions in the past years, with the emergence of pretrained deep learning models such as BERT that can be finetuned on any NLP task, and large language models like ChatGPT, that are general enough to perform a range of tasks without additional training. Those models are limited to text and have no sensibility for other modalities, so can we expect the same developments on other modalities? In this talk, I'll survey the latest developments in deep learning models that account for text in the context of other modalities. In particular, I'll review self-training for speech, image, and video-based models, what to expect from them and what are the associated limitations. I'll also review how the community is trying to bridge the gap between large language models and other modalities through grounding.

# Advanced courses

## Bilingualism

The present series of lectures will examine online processing in a late-learned language, at various levels or representation (from phonology to syntax). Current theories of L2 processing will be confronted with data obtained via the recording of electrophysiology (ERPs), eye movements and fMRI in the aim of elucidating common versus distinct mechanisms that underlie L1 and L2 processing in adults.



**Cheryl French-Mestre**  
LPL, AMU & CNRS



**Jean-Rémi King**  
ENS-PSL & CNRS

## Language in the brain and algorithms

Deep learning has recently made remarkable progress in natural language processing. Yet, the resulting algorithms fall short of the efficiency of the human brain. To bridge this gap, we here explore the similarities and differences between these two systems using large-scale datasets of magneto/electro-encephalography (M/EEG), functional Magnetic Resonance Imaging (fMRI), and intracranial recordings. After investigating where and when deep language algorithms map onto the brain, we show that enhancing these algorithms with long-range forecasts makes them more similar to the brain. Our results further reveal that, unlike current deep language models, the human brain is tuned to generate a hierarchy of long-range predictions, whereby the fronto-parietal cortices forecast more abstract and more distant representations than the temporal cortices. Overall, our studies show how the interface between AI and neuroscience clarifies the computational bases of natural language processing.

# APPLICATION PROCEDURE (NON-ILCB MEMBERS)

The summer school courses are free of charge, courtesy of funding from ILCB. However, participants will be responsible for covering their trip expenses, including transportation, accommodation, and meals.



ILCB members are not concerned with this procedure.

## STEP 1

Apply before Friday, May 24 (anywhere on Earth)

[Apply to our ILCB summer school 2024](#)

The link will direct you to a form where you will be able to submit your application.

## STEP 2

Before the end of May, the summer school organizing committee will review your application. In June, you will be notified whether it has been accepted, waitlisted, or declined.

Once your application has been accepted, you will be able to confirm your participation and register for classes via the CIRM website. You may also reserve meals and housing at the CIRM.

## STEP 3

\* Further details will be provided in the acceptance email to facilitate your registration via the CIRM website.

\* Staying and having meals at the CIRM is not mandatory and it is only available for a limited number of participants. You will be notified whether you qualify for housing at the CIRM and how to reserve a room once your application is accepted. Consult CIRM's rates [here](#). There are many other [lodging options](#) in Marseille.





# THE LOCATION

## The Centre International de Rencontres Mathématiques (CIRM)

Situated on an estate with a thousand-year history, on the doorstep of the calanques, [CIRM](#) is in a unique location in the south of France. It is a quiet place, linking the charms of traditional Provence with all the facilities that researchers need for a successful event.



The main building called the 'Bastide' has kept the traditional look of Provençal houses with its pink walls. It contains a large number of bedrooms as well as offices. Other bedrooms and studios, recently updated, are situated in nearby buildings all a few minutes from each other. The restaurant is one of the main features of CIRM and offers a varied cuisine based on traditional French cooking and local products.



## Calanques National Park

The cultural heritage of the [Calanques National Park](#) is rich and diverse: you'll find castles, bastides, artists' villas, a lighthouse, a cave, wrecks of ships and airplanes, religious, agricultural, industrial, military, health buildings, as well as a few surprises, such as a «téléscaphe» (underwater cable car) and mysterious inscriptions.

# ARRIVING AT CIRM



## Coming from the airport

1. Take a taxi: about 50 minutes for a cost of 80€ to 100€.
2. Take the Airport shuttle bus which will take you to Gare Saint-Charles – Marseille's main train station – from where you can access public transport. Then take the metro 2 to the « Rond-Point du Prado » station and continue with the B1 or 21J bus to the terminus, the Luminy Campus.



## Coming from the train station

1. Take a taxi: average cost of 40€.
2. Take public transport. first the metro 2 to the « Rond-Point du Prado » station, then the B1 or 21J bus to the terminus, the Luminy Campus.

## Coming from the train station after 21:45

At night (after 9pm) you can catch Bus 521 outside the Gare St Charles. It will take you directly to the « Luminy PN des Calanques » stop, 6 minutes walk from the CIRM (signs will show you the way). You will not need to take the metro.

# ORGANIZING COMMITTEE



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