ILCB

Institute of
language, communication
and the brain

Summer school

3ᵈ Edition

2020

31st August
4th September

CIRM
Centre International de Rencontres Mathématiques
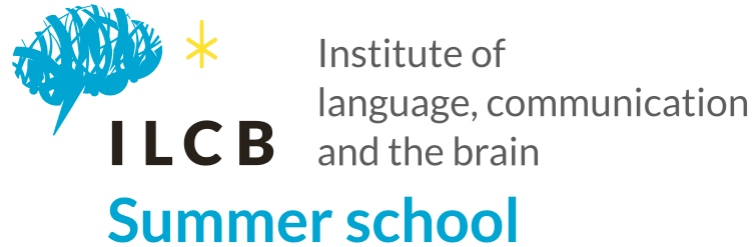
Marseille, France

Institute of language, communication and the brain

ILCB

Summer school

The 3d Edition of the ILCB Summer School offers Introductory, Intermerdiate and Advanced Classes in four core fields of Cognitive Science, reflecting the expertise of the Institute:

- Applied mathematics, statistics and networks;
- Neuroscience and behavior;
- Language and cognition;
- Computer science and machine learning.

Keynotes and social events complete this week of immersion.

KEYNOTE: Prof. Jonathan GRAINGER

Contact: contact@ilcb.fr

Registration until July 27th, 2020, at: https://conferences.cirm-math.fr/2158.html

Fees: - ILCB Members: Free (please, contact the administration for detail of accomodation)

- Non-ILCB Members: 105€ /day/per for Full Board (including accomodation, meals and participation to social events)

Basic Courses

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	
9h	Welcome	Speech for Dummies *Thierry Legou*	Language & Cognition *Ph. Blache & J. German*	Language & Cognition *James German*	Language & Cognition *Philippe Blache*	9h
	Language & the Brain *Kristof Strijkers*					
10h		*Break*	*Break*	*Break*	*Break*	10h
	Break					
11h	Brain for Dummies *Benjamin Morillon*	Behavior: From Aristotle to Cognitive Science *A. Meguerditchian & M. Montant*	Behavior: From Aristotle to Cognitive Science *A. Meguerditchian & M. Montant*	Behavior: From Aristotle to Cognitive Science *A. Meguerditchian & M. Montant*	The Predictive Brain *Daniele Schön*	11h
12h						12h
			Lunch			
14h	Imaging for Dummies *Christian Bénar*	Statistics *Frédéric Richard*	Statistics *Frédéric Richard*	Statistics *Frédéric Richard*	Statistics *Frédéric Richard*	14h
15h						15h
	Break	*Break*			*Break*	
16h	Machine Learning *H. Kadri & S. Takerkart*	Machine Learning *Hachem Kadri*	*Break*	*Break*	Machine Learning *H. Kadri & S. Takerkart*	16h
			Hiking in the Calanques	Machine Learning *H. Kadri & S. Takerkart*		
17h	*Break*					17h
	Social Event			*Break*		
18h				Keynote *Jonathan Grainger*		18h

Intermediate Courses

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	
9h	Welcome	Language & Emotion *Catherine Pélachaud*	Language & Emotion *Pascal Belin*	Language & Emotion *Aileen McGonigal*	Language & Emotion *Galina Iakimova*	9h
	Language & Emotion *Caterina Petrone*					
10h						10h
		Break	*Break*	*Break*	*Break*	
	Break					
11h	Early Development of Communication *Clément François*	Early Development of Communication *Isabelle Dautriche*	Early Development of Communication *Marianne Jover*	Roles of neural oscillations in cognitive processes *Benjamin Morillon*	Roles of neural oscillations in cognitive processes *Benjamin Morillon*	11h
12h						12h
	Lunch					
14h	Linear Regression *Royce Anders*	Mixed Models *Royce Anders*	Mixed Models *Royce Anders*	Mixed Models *Royce Anders*	Mixed Models *Royce Anders*	14h
15h						15h
	Break	*Break*			*Break*	
16h	Engineering Technics *Thierry Legou*	Engineering Technics *Valérie Chanoine*	*Break*	*Break*	Engineering Technics *Valérie Chanoine*	16h
			Hiking in the Calanques	Engineering Technics *Deirdre Bolger*		
17h	*Break*					17h
	Social Event			*Break*		
18h				Keynote *Jonathan Grainger*		18h

Advanced Courses

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	
9h	Welcome	Beyond Chomskynner *Arnaud Rey*	Beyond Chomskynner *Arnaud Rey*	Beyond Chomskynner *Arnaud Rey*	Beyond Chomskynner *Arnaud Rey*	9h
	Beyond Chomskynner *Arnaud Rey*					
10h		*Break*	*Break*	*Break*	*Break*	10h
	Break					
11h	Signal processing : spectral analysis, time-frequency and sparsity *Bruno Torresani*	Signal processing : spectral analysis, time-frequency and sparsity *Bruno Torresani*	Signal processing : spectral analysis, time-frequency and sparsity *Bruno Torresani*	Functional Connectivity and Information Theory *Andrea Brovelli*	Functional Connectivity and Information Theory *Andrea Brovelli*	11h
12h						12h
	Lunch					
14h	Bayesian Statistics *Pierre Pudlo*	BCI & Predictive Coding *Jérémie Mattout*	Bayesian Statistics *Pierre Pudlo*	Bayesian Statistics *Pierre Pudlo*	BCI (softwares & algorithms) *Theo Papadopoulo*	14h
15h	*Break*	*Break*			*Break*	15h
16h	Machine Learning: Deep Learning / NLP *Benoit Favre & Frédéric Béchet*	Machine Learning: Decoding *Sylvain Takerkart*	*Break*	*Break*	Machine Learning: Deep Learning / NLP *Benoit Favre & Frédéric Béchet*	16h
			Hiking in the Calanques	Machine Learning: Deep Learning / NLP *Benoit Favre & Frédéric Béchet*		
17h	*Break*					17h
	Social Event			*Break*		
18h				Keynote *Jonathan Grainger*		18h

SYLLABUSES

BASIC COURSES

Language & the Brain, *K. Strijkers*

Speech for Dummies: *Th. Legou*

Language & Cognition, *J. German & Ph. Blache*
Language is made of different components at different levels: sounds (or letters), words, groups, sentences, utterances (or texts). It is usually considered that human language relies on this ability to combine low-level units into larger ones in order to build meaning. Understanding how language works consists then in describing these different levels through their corresponding linguistic domains (phonetics, prosody, phonology, morphology, syntax, semantics) and to explain how do they interact. We propose in this course an overview of these domains and present the different theories explaining how meaning can be built from them.

Brain for Dummies, *B. Morillon*
This course will provide a general overview of the human brain, mainly through a historical, theoretical, and structural viewpoint.

Behavior: From Aristotle to Cognitive Science, *A. Meguerditchian & M. Montant*
This course proposes an introduction to human and non-human animal behavior in relation to language studies and the question of the phylogenetic origins of the language faculty. The course is organized in two parts. In the first part, Adrien Meguerditchian will make a brief historical overview of how behavior is assessed over times, from Aristotle to Darwin, then he will describe the concepts and methods proposed by the behaviorist paradigm, the biology of behavior and the contemporary cognitive ethology. During the second part, Marie Montant will address several questions raised by the comparison between human and non-human animals. Then she will describe the relationship between the complexity of behaviors and brain evolution, and how human behaviors are measured in cognitive paradigms.

The Predictive Brain, *D. Schön*
D. Schön will give a lecture about the predictive brain : How do we perceive the world surrounding us? What is the role of memory? How many real worlds exist? To what extent our knowledge limits how we study brain functions? I will try to address these and other questions by adopting a musical view of brain functions.

Imaging for Dummies, C.-G. Benar
In this course, I will provide an overview of functional brain imaging in humans. Specifically, I will present three modalities: functional MRI, electroencephalography (EEG), magnetoencephalography (MEG), and intracerebral EEG (this latter being performed in patients during presurgical evaluation of epilepsy). For each modality, I will review briefly the underlying mechanisms, the recording technique and the mathematical tools for data analysis.

Statistics:
This course is an introduction to statistical inference aimed at familiarizing participants with estimation and testing issues. After having presented some useful notions on random variables, we will first see how to estimate and test the mean value (expectation) of samples of random variables of unknown distribution. During two practical sessions carried out in Python, we will then study in details the case of samples of Bernoulli's law. Finally, in a last part, we will approach the inference problems in the framework of Gaussian samples.

Machine Learning, *H. Kadri*
This course aims to provide an overview of problem solving and data modeling from a machine learning perspective. The concepts of data representation, distribution, statistics as well as training, validation and testing will be reviewed, as well as the details of some learning algorithms. Practical work will be performed on a concrete problem with standard tools, which will allow to see the basic concepts of programming in Python.

INTERMEDIATE COURSES

Language & Emotion, *P. Belin, G. Iakimova, A. McGonigal, C. Petrone, C. Pélachaud*
- The lecture of P. Belin will be dedicated to investigating how the brain processes information in voice, including emotions.
- With C. Pélachaud class, we will present computational methods to model socio-emotional behaviors for virtual agent, focusing on communicative acts, emotions, and social attitudes. We will cover the relation between mental states and nonverbal behaviors as well as their realization in an embodied conversational agent.

- After reviewing basic notions concerning prosody (ie., the rhythmical and melodic organization of speech), Caterina Petrone will provide an overview of major findings on emotional prosody and their theoretical implications from a linguistic perspective. Issues for future research will be also discussed.
- A. McGonigal will give a lecture about Emotions and frontal lobe seizures.

Early Development of Communication, *I. Dautriche, C. François, M. Jover*
- Clément François se focalisera sur le développement neuroanatomique des réseaux de langage ainsi que sur les phénomènes de neuroplasticité sous-tendant le développement précoce de la perception de la parole avec un focus sur le raffinement phonologique. Pour se faire, il présentera les résultats d'études comportementales et de neuroimagerie menées chez le nourrisson et le tout petit.
- Isabelle Dautriche's lecture will concern word learning. Word learning is often considered the simplest and least controversial aspect of language development. Although theorists fiercely debate the ontogenetic and phylogenetic origins of grammar, everyone agrees that words must be learned by observing the contexts in which they are used. No other theory can explain how English-speaking children come to use 'shoe' to label footwear, whereas young French speakers use the same sequence of sounds to label cabbage. However, this self-evident truth masks a host of questions about how learning occurs and the knowledge that children bring to the problem. In this class, I will provide an overview of what we know about word learning in the very first years of life.
- From a developmental point of view, it is unlikely that intentional communication appears from scratch at the end of the first year (Ramenzoni & Liszkowski, 2016). Presenting her current researches, Marianne Jover will focus on the early development of communicative gesture and adults' understanding of the infants' movements (Jover & Scola, 2018, Jover et al., 2019).

Roles of neural oscillations in cognitive processes, *B. Morillon*
These two courses will introduce the main mechanistic functions for which neural oscillations are believed to play a role in information processing: synchronisation of local and large-scale neural ensembles, inter-areal communication-through-coherence, and segmentation of continuous sensory information into discrete computational units. We will review different cognitive functions for which these mechanisms apply, such as spatial and temporal attention, and most importantly speech, language and communication.

Linear Regression & Mixed Models, *R. Anders*
This course will provide both the theoretical background and skills to apply regression/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 visualisation, mathematical understanding and requirements for an appropriate regression/mixed model, data transformations, model application, model checks and optimization, model selection, and if time permits, generalized linear mixed models such as with the logit family.

Engineering Technics: *Th. Legou, V. Chanoine, D. Bolger*
- Session "Physics and acoustic aspects of the speech production" (Th. Legou)

Speaking is a complex activity that implies numerous high level and low level controls. While speech permits to communicate, producing various identified class of sounds, voice convey information about certain characteristics of the locutor itself and about its inner state.

We will first look at the vocal tract, identifying the main actuators/contributors (as well as their physic, mechanic and acoustic properties) that lead to the production of various sounds which, when combined, permit the speech production.

We will talk about vowels and consonants specificities, presenting rapidly the main classical signal processing to study and characterize them.

Online demos will permit to better understand acoustic properties of sounds produced, as well as the signal processing used to study these sounds.

ADVANCED COURSES

Beyond Chomskynner, *A. Rey*

In 1957, the publication of Syntactic structures by N. Chomsky and Verbal Behavior by B. F. Skinner introduced two radically different approaches to the study of language. After a brief and critical presentation of these approaches, I will pave the way to current approaches based on language use and implicit statistical learning, showing that these approaches have slowly created a favorable climate for a paradigm shift in the study of language processes. I will also argue that the central notion of syntax should certainly be reconsidered or eventually, abandoned.

Signal processing : spectral analysis, time-frequency and sparsity, *B. Torresani*
- Lecture 1 : Spectral analysis and time-frequency

The focus in this first lecture will be on signal analysis. We will review reference methods for spectral analysis (Fourier transform, periodogram), and time-frequency analysis (short time Fourier transform and periodogram, Gabor transform,…). If possible we will also briefly discuss iterated filter banks (convolution networks and scattering transform)
- Lecture 2 : Time-frequency and wavelets, synthesis

In the second lecture we will revisit time-frequency methods from the point of view of synthesis rather than analysis. We will describe the basics of frame theory, discrete transforms and the construction of linear systems defined in the time-frequency domain.
- Lecture 3 : Sparse time-frequency representations

The last lecture will be devoted to the concept of sparsity, and will focus on standard algorithms for constructing sparse time-frequency and wavelet representations.

Functional Connectivity and Information Theory, *A. Brovelli*

I will present an overview of the mathematval and computational tools for the analysis of functional connectivity (FC) among neural signals. I will introduce notions such as non-directed versus directed (e.g., Granger causality) FC, time- versus frequency-domain FC measures. Finally, I will present recent advanced in Information Theory that allow the characterisation of task-related neural interactions.

Bayesian Statistics: TBA

BCI & Predictive Coding: TBA

BCI (softwares & algorithms) : TBA

Machine Learning: Deep Learning / NLP: TBA

Machine Learning: Decoding: TBA

KEYNOTE LECTURE
PARALLEL ORTHOGRAPHIC PROCESSING AND READING
Pr. Jonathan Grainger

In written languages that use an alphabetic script, orthographic processing lies at the heart of the reading process, enabling visual information to make contact with linguistic information. Indeed, reading can be viewed as a bi-directional interaction between the processing of visual and linguistic information, with orthographic processing serving as the crucial interface between the two. In the present talk, I will summarize the knowledge that has accrued concerning orthographic processing in single word reading before presenting more recent research on sentence reading and the processing of orthographic information spanning several words. In both lines of research, the key words are: parallel, cascaded, and interactive processing. For single word reading the interactivity involves position-coded letter identities and whole-word orthographic representations, and for sentence reading it extends to involve ordered word identities and higher-level sentence structures.

This talk will be followed by a Lunch and a Concert! Registration is free but mandatory. Please confirm attendance by sending an email to nadera.bureau@blri.fr

Organizing Committee

Christian-G. Bénar
Caroline Chaux-Moulin
Valentin Emiya
Adrien Meguerditchian
Caterina Petrone
Philippe Blache
Julie Abbou
Nadéra Bureau

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