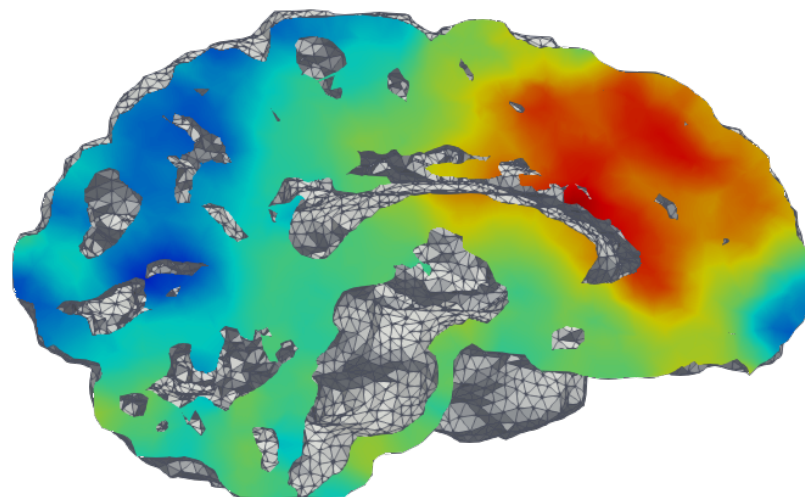




**POLITECNICO**  
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## 3 different projects on Understanding Human Brain Connectivity

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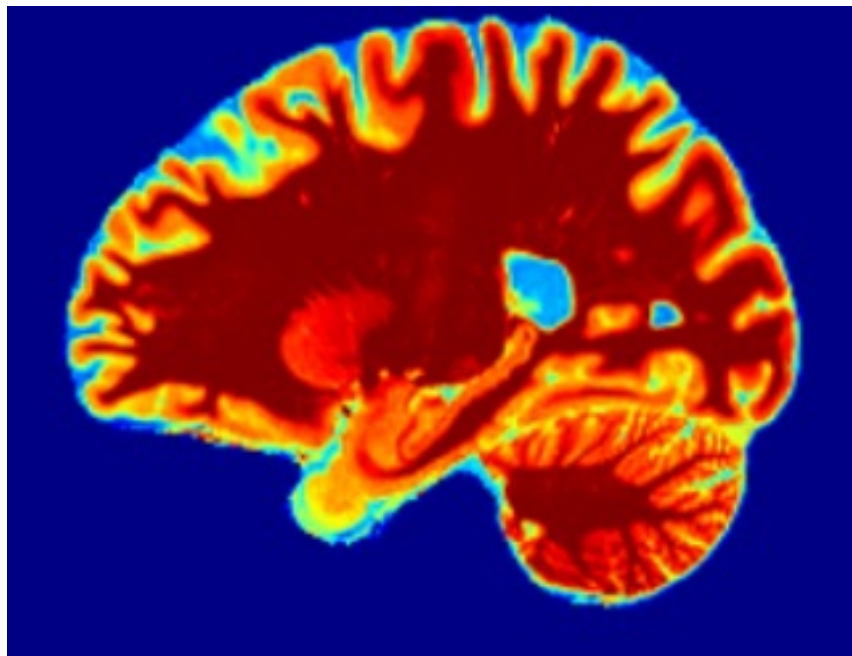
Laura Sangalli - [laura.sangalli@polimi.it](mailto:laura.sangalli@polimi.it)

MOX – Dipartimento di Matematica, Politecnico di Milano

# 3 different projects on Understanding Human Brain Connectivity

## Functional Magnetic Resonance Imaging (fMRI)

- ▶ Blood Oxygen Level Dependent (BOLD) signal
- ▶ proxy measure of neuronal activity (based on changes in deoxy-hemoglobin concentration related to energy use by brain cells)
- ▶ resting state fMRIs and task based fMRIs



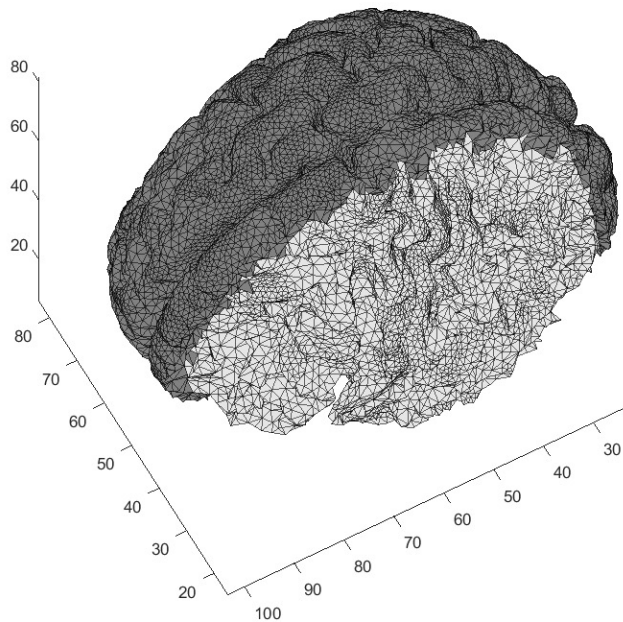
There currently is a strong momentum in the international community for the development of methods able to analyze the complex data structures emerging from neuroimaging modalities. This is fundamental for the advancement of the knowledge of how the brain works and for understanding the basic mechanisms underlying brain diseases and mental disorders.

The data are high-dimensional. They can be analyzed as simple multivariate data, and/or as functional data, and/or as spatial data.

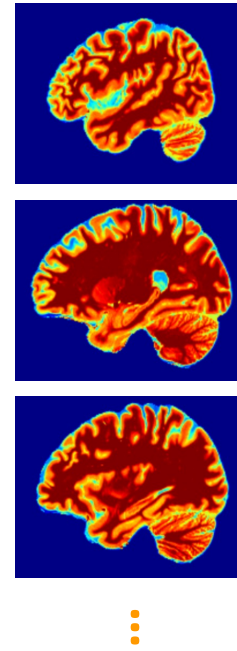
# 3 different projects on Understanding Human Brain Connectivity

- ▶ fMRI: 4D signals, referred to patient-specific morphologies
- ▶ All subjects' data are mapped to a *brain atlas* to enable comparison across different subjects

Brain Atlas

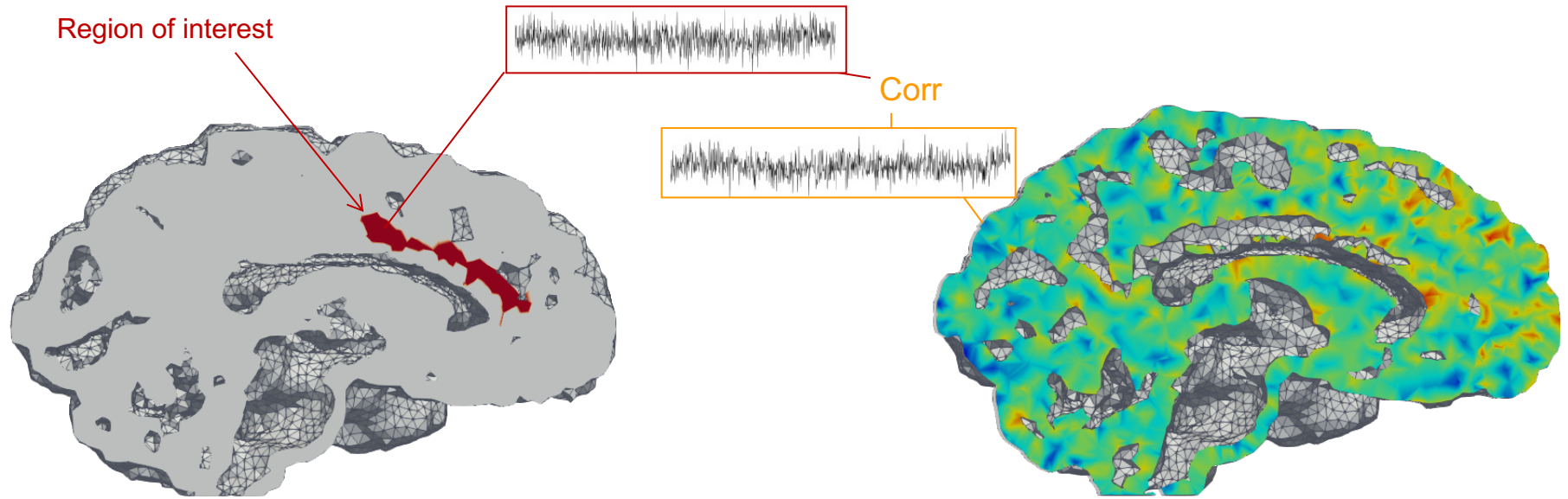


Subject's data



# 3 different projects on Understanding Human Brain Connectivity

- ▶ fMRI: 4D signals, referred to patient-specific morphologies
  - ▶ All subjects' data are mapped to a *brain atlas* to enable comparison across different subjects
  - ▶ For each subject the *functional connectivity map* w.r.t. a *region of interest* is computed
- The region of interest depends on the goals of the analysis and is selected on the brain atlas



# 3 different projects on Understanding Human Brain Connectivity



**Semel Institute for  
Neuroscience and Human Behavior**

The Consortium for Neuropsychiatric Phenomics at Semel Institute aims to facilitate discovery of the genetic and environmental bases of variation in psychological and neural system phenotypes, to elucidate the mechanisms that link the human genome to complex psychological syndromes, and to foster breakthroughs in the development of novel treatments for neuropsychiatric disorders.

Resting state and task-based fMRI for subjects having

- ▶ Attention-Deficit/Hyperactivity Disorder (ADHD)
- ▶ BIPOLAR DISORDER
- ▶ SCHIZOPHRENIA
- ▶ CONTROL

Project 1: Schizophrenic vs healthy subjects, Balloon Analog Risk Task

Project 2: Schizophrenic vs healthy subjects, Stop Signal Task

Project 3: ADHD vs healthy subjects, Paired Associate Memory Task

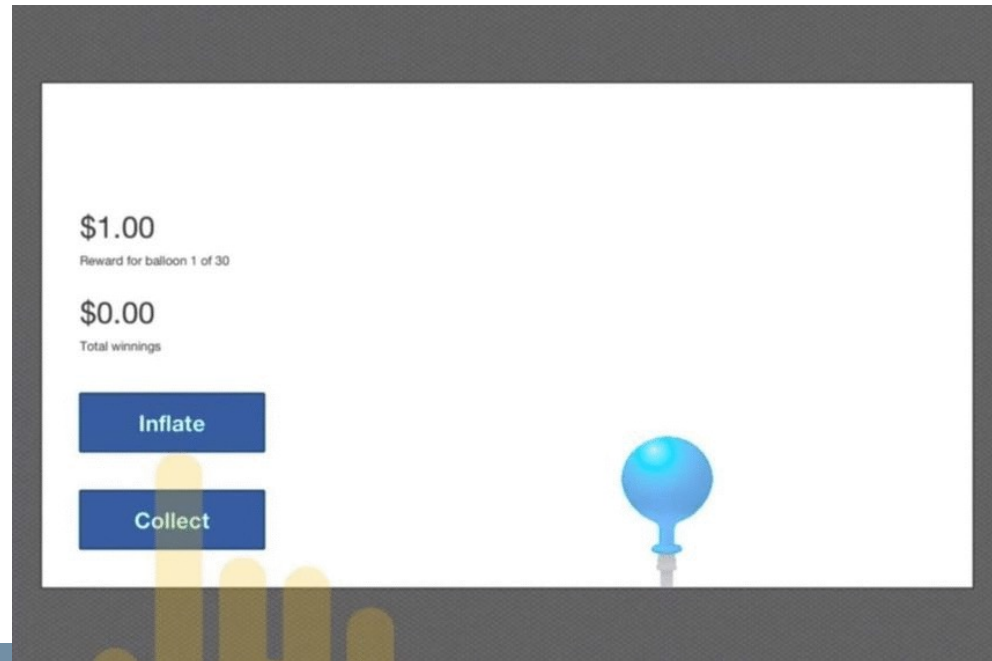
# Project 1

## Schizophrenic vs healthy subjects – BART test

Functional Magnetic Resonance Imaging (fMRI)

- ▶ 49 **schizophrenic patients** and 122 **healthy subjects**
- ▶ *Task-based* fMRI: Balloon Analog Risk Task (BART)
- ▶ schizophrenic patients have been reported to be more risk adverse than healthy subjects
- ▶ Region of interest: *left anterior cingulate gyrus*, key region involved in risk appraisal during decision making and in loss-aversion (Fukunaga, 2012, Cogn. Affect. Behav. Neurosci.)

**Overall aim:** exploring neuronal activity/connectivity of the various subjects while they perform the task and evaluating possible differences between schizophrenic and healthy subjects

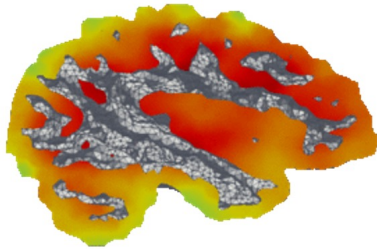




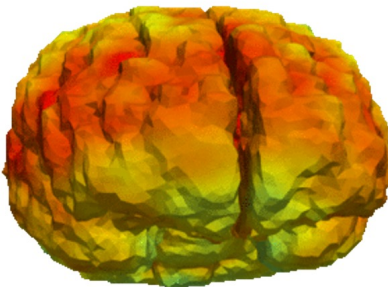
# Project 1

## Schizophrenic vs healthy subjects – BART test

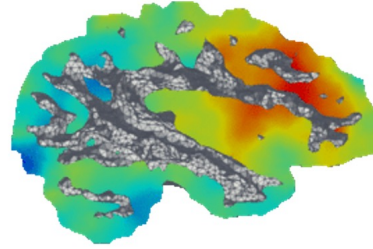
1st PC



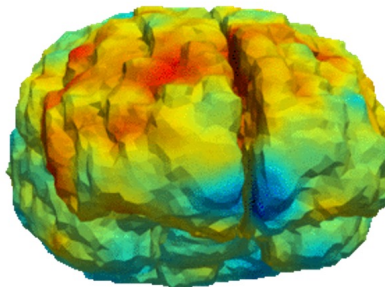
The 1st PC displays greater variation in the inferior frontal gyrus (region implicated in go/no go tasks and in risk aversion)



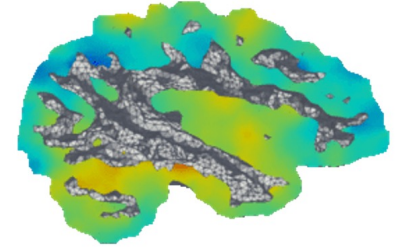
2nd PC



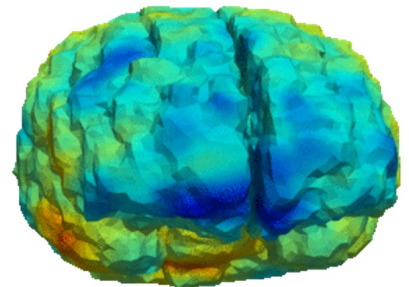
The 2nd PC contrasts Lingual gyrus & cunes (visual preprocessing) / insular cortex (emotional awareness)



3rd PC



The 3rd PC contrasts the rear and the frontal part of the cerebellum



Fondazione I.R.C.C.S.  
Istituto Neurologico Carlo Besta

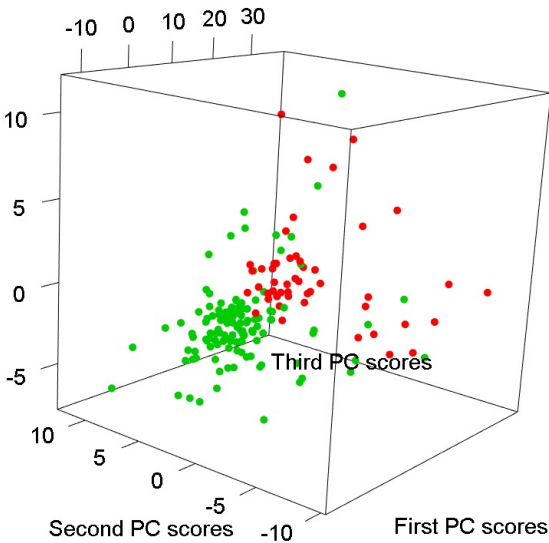
Sistema Socio Sanitario



Regione  
Lombardia

# Project 1

## Schizophrenic vs healthy subjects – BART test



PC scores with fPCA



## Linear Discriminant analysis

accuracy: 93%; precision: 89%

Predicted	True	
	Healthy	SCHZ
Healthy	117	7
SCHZ	5	42



# Schizophrenic vs healthy subjects

Laura Sangalli, MOX – Dipartimento di Matematica, Politecnico di Milano

Other goals:

- Perform dimensional reduction of these massive data
- Understand the main modes of variability in brain activation and connectivity, through the analysis of fMRI data
- Link fMRI signal to other available covariates

*Preprocessed data (with R code to upload and manage the data) will be provided*

All potentially interested students are invited to contact Laura Sangalli by  
Tuesday 1st March, early afternoon