

Pôle Science des Données

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Data Science Dep. in a few words

Gathering

- several scientific communities
- common data science issues for/from observations

Strengthen skills and interactions

- signal and image processing
- machine learning, AI
- robotics
- cognition & physiological signals

Tackling scientific challenges and societal issues

- *topics*: environment, living, health, biomedical, robotics, perception, ...
- *methodological and theoretical*: physical and cognitive modeling, multimodal data, information extraction, statistical and non-statistical machine learning, algorithms and architecture, ...



Data Science Dep. in a few words

Methodology & Theory

physical & cognitive modeling
theoretical developments
performance analysis
specific/efficient algorithms

Societal issues

health, environment,
ecological transition,
intelligent mobility

Data Science From Acquisition to Interpretation and Decision

Experimental platforms

- environment (ISEE, HYDRO SIGNAL, MONT-BLANC,...)
- living (BIOMECA, LARYNX, AERO, KINOVIS, PERSEE,...)
- robotics (ATTENTIVE, ARCHI, ROBOTIQUE AERIENNE,...)



Robotics

Moving an "agent" in a complex environment efficiently and safely

- Determination of adapted and flexible **control laws** to make complex movements in a constrained and uncertain environment
- Embedded **multimodal perception system** to position the agent in his environment, analyze the situation, detect people, obstacles...
- Reactivity in **real time**: adapted hardware and software architectures

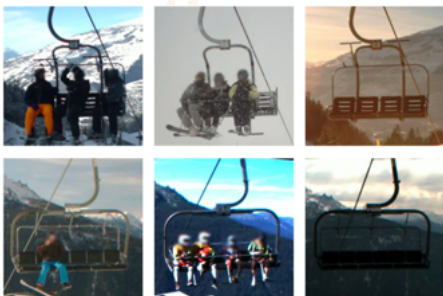




Image processing

Low-level analysis and high-level interpretation of image and video content

- **Study of human behavior:** detection, segmentation, tracking, modeling, classification of gestures and activity (individual, crowd), face analysis.
- **Scene modeling:** object model analysis, 3D analysis and perception of objects and scene.
- **Image integrity control:** detection of falsified images, identification of the origin and history of applied treatments.



Variabilité des images

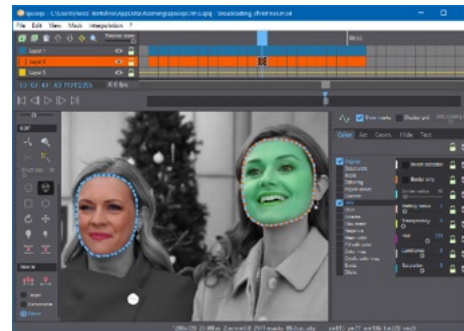
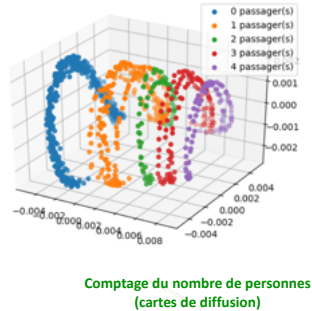
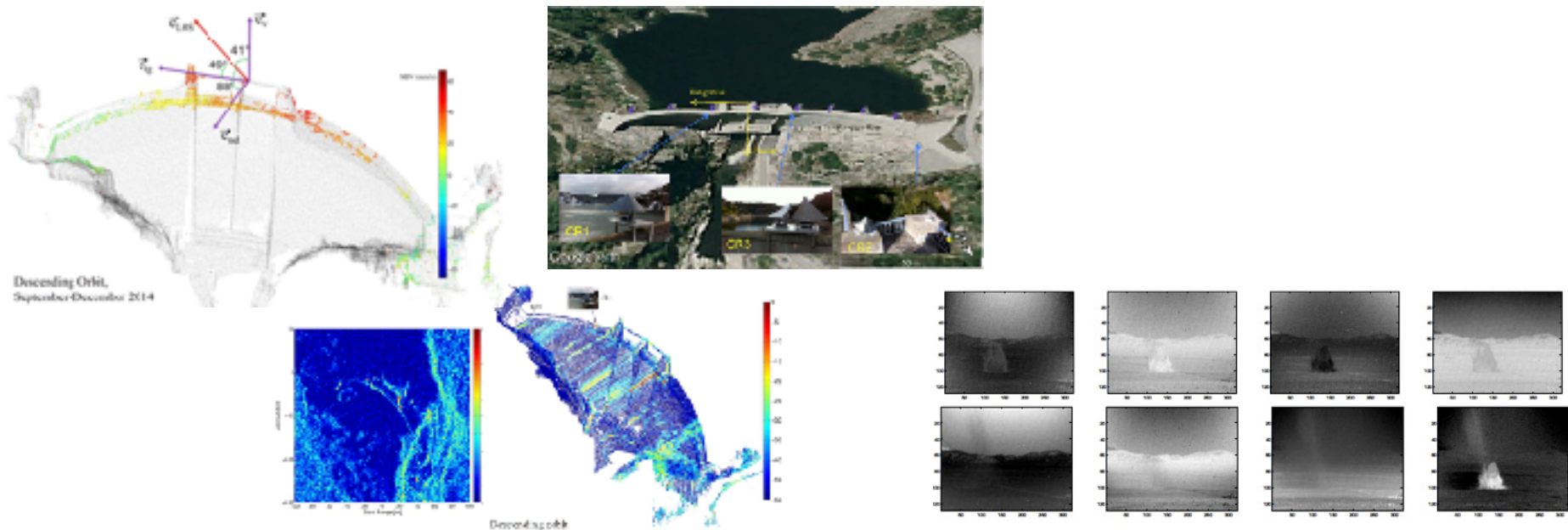




Image processing

Image processing and analysis for massive remote sensing data

- **Hyperspectral unmixing:** source separation, variability of endmembers and of model derived from a physical model
- **Multimodality, multi-scale and multi-temporal series:** fusion of heterogeneous data acquired by different sensors

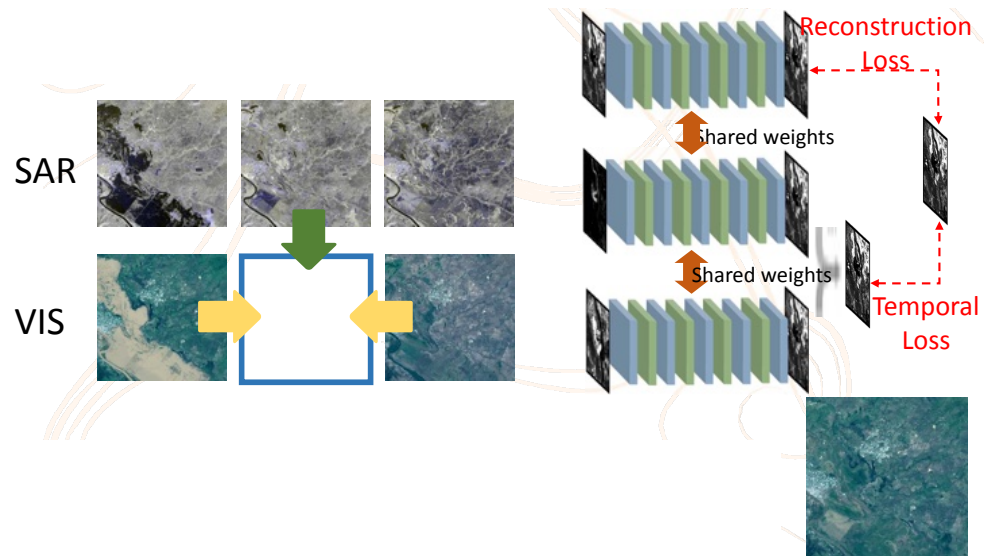
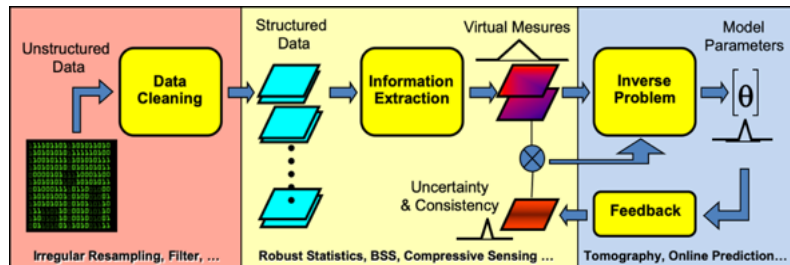
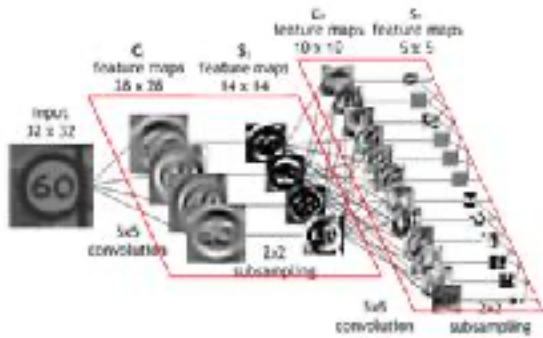




Machine learning

Extraction of relevant information

- **Reconstruction of missing data** by multimodal and multitemporal fusion: structured representation of the spatial information of images (hierarchical/graphical approaches)
- **Interpretation** of extracted features by CNN, RNN, ...

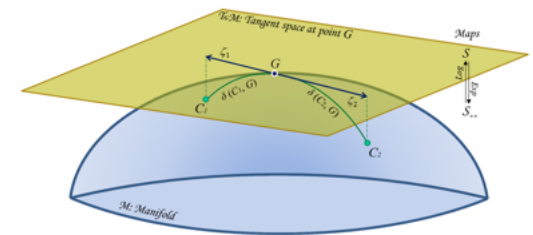
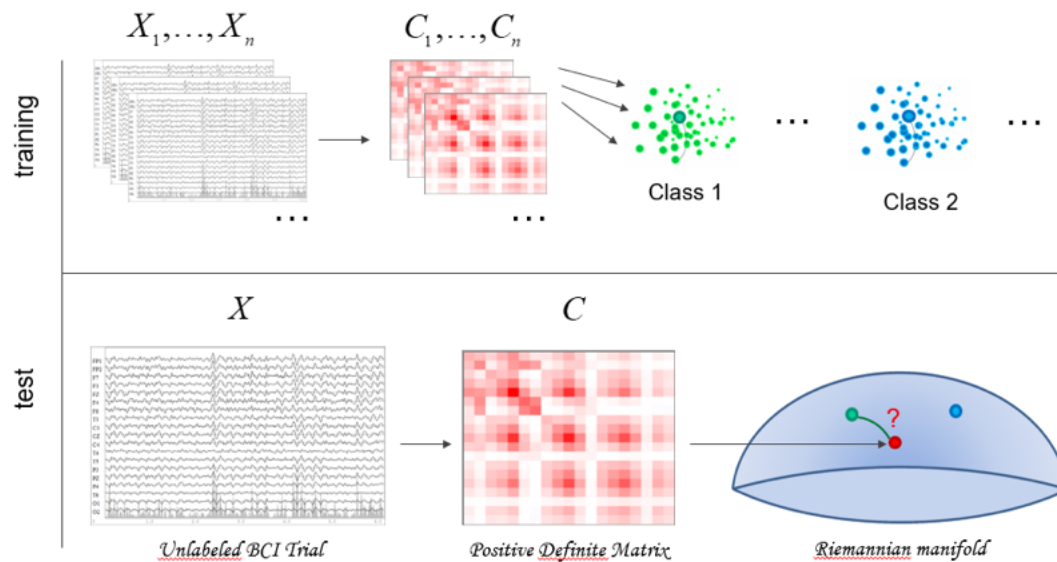




Machine learning

Riemannian geometry

- **Procrustes analysis:** alignment of independent databases
- **Transfer learning:** avoid calibration for BCI (brain-invaders, ...)

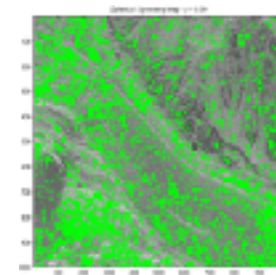
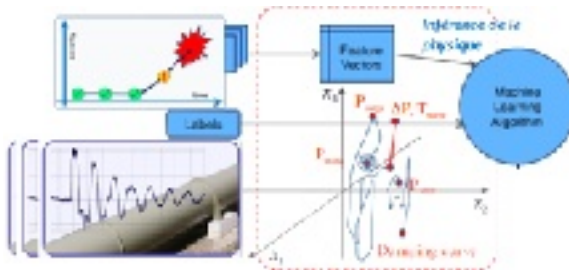




Signal processing

Physical models at the heart of signal processing algorithms

- **Fine characterization of deterministic and stochastic non-stationarity:** transient signal analysis (time-frequency, recurrence plot), multivariate statistical tests of conformity (gaussianity, sphericity, spherical symmetry, circularity), multivariate robust and adaptive filtering
- **Dynamical systems:** modeling the evolution of dynamic systems, follow continuous evolutions
- **Imaging by acoustics:** provide relevant images for the characterization of phenomena in complex and varying environments, solid structures in motion and immersed in fluids, monitoring of the underwater environment

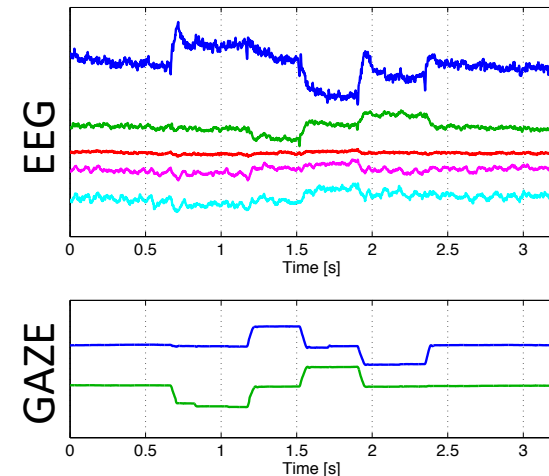
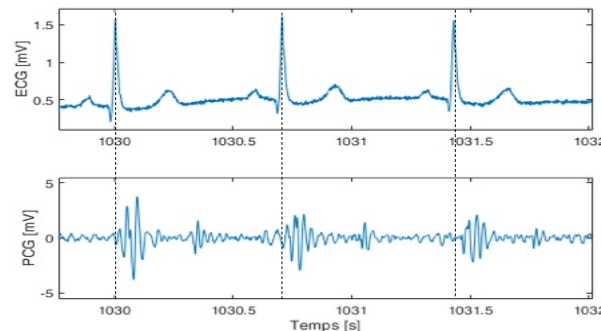
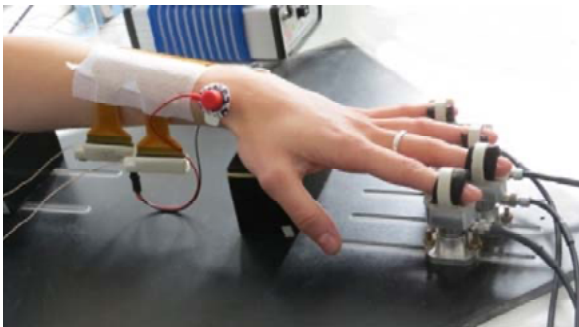




Signal processing

Sensor arrays and source separation

- **Multimodal source separation:** modeling multimodality, consideration of imperfections (jitters, missing/corrupted data, ...), localization/characterization of sources (volcanic, ...)
- **Dynamic sensor arrays:** prediction of best sensor locations, change-point detection
- **Repetitive signals:** evoked related-potentials, modeling quasi-periodicity/seasonality, reproducibility, ...

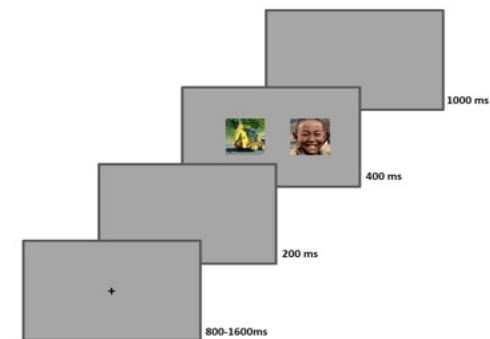
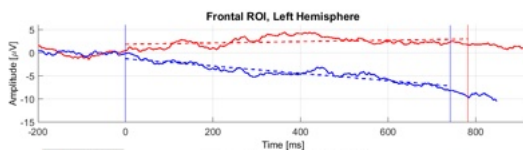
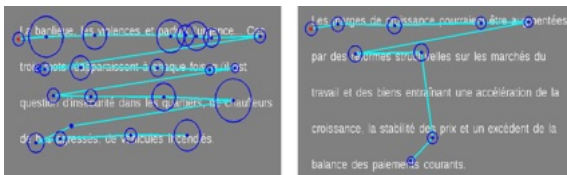




Cognition & living

Brain, vision and cognition

- **Eye movement analysis as markers of brain and cognitive functioning:** extract signatures, reflecting normal cognitive functioning, and to search for deviant signatures characteristic of different pathologies
- **Multistable perception:** analogies between optimal samplers (informed or uninformed) and ocular exploration of a micro-scale stimulus
- **Active process of visual perception by saccades analysis:** programming of the saccade (towards where and when to move the gaze) & perception during the saccade (intra-saccadic perception), EEG-IRM

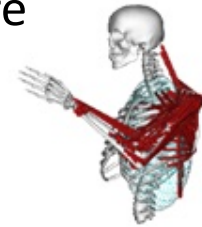




Cognition & living

Analysis, modeling and study of the cognitive control of gestures in the field of biomechanics and expressivity

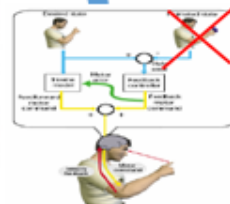
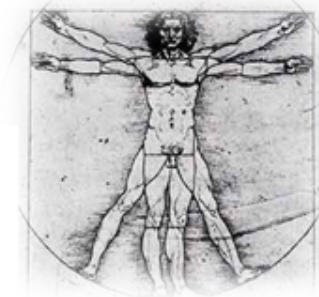
- **Kinematics:** from the capture to the analysis of the gesture
- **Kinetics:** modeling of muscle action
- **Control:** Neuromuscular control laws



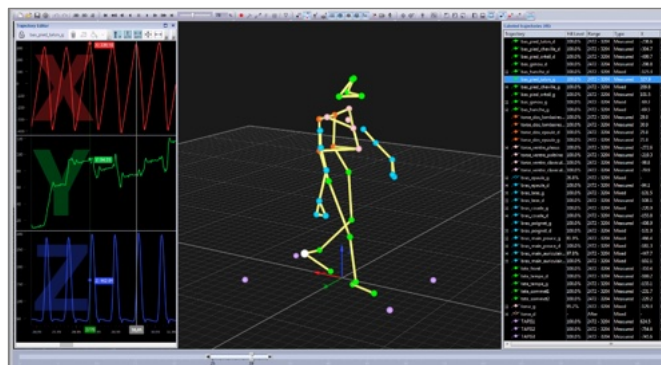
Défi 2 : Cinétique



Défi 1 :
Cinématique

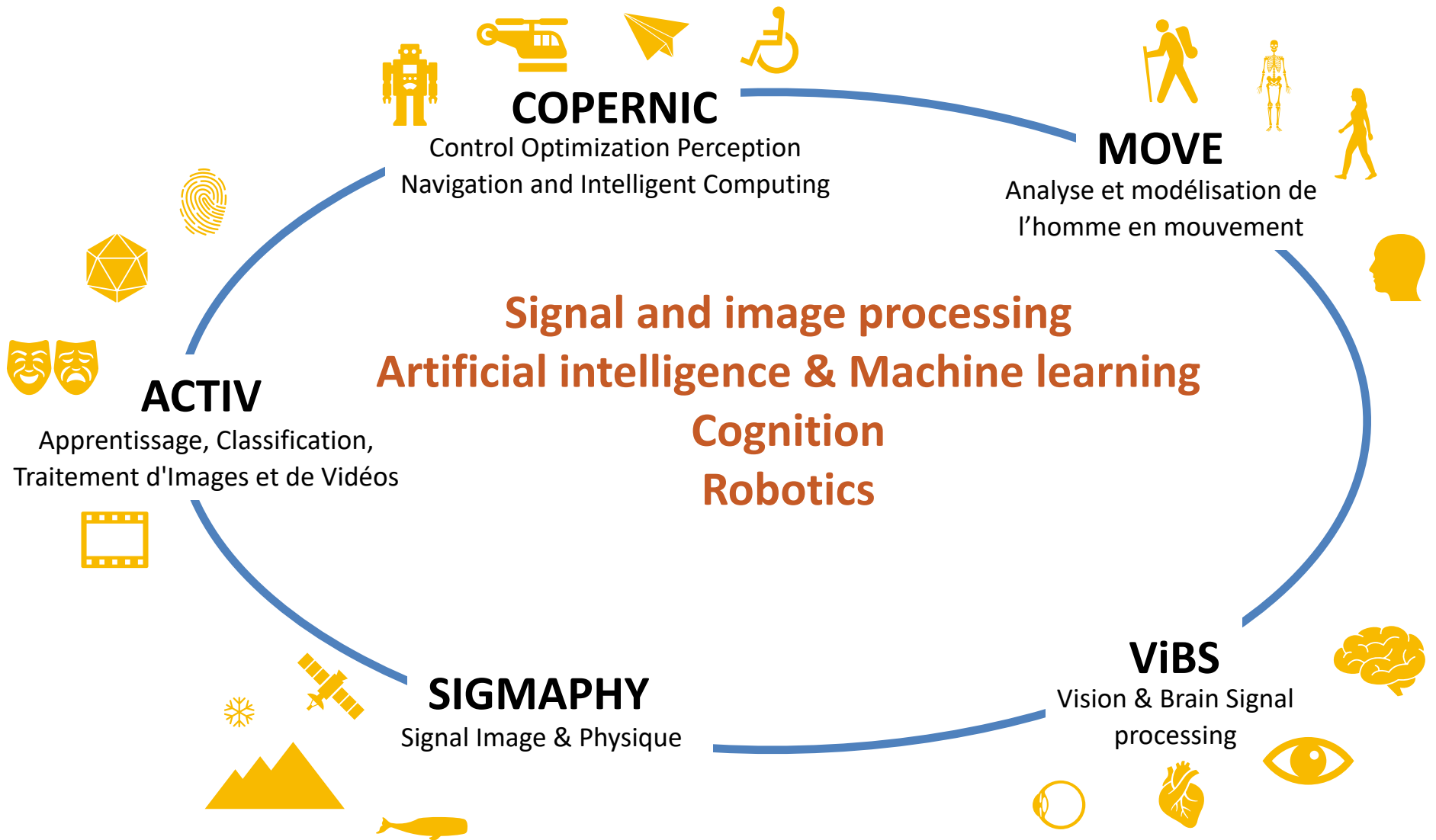


Défi 3 :
Contrôle



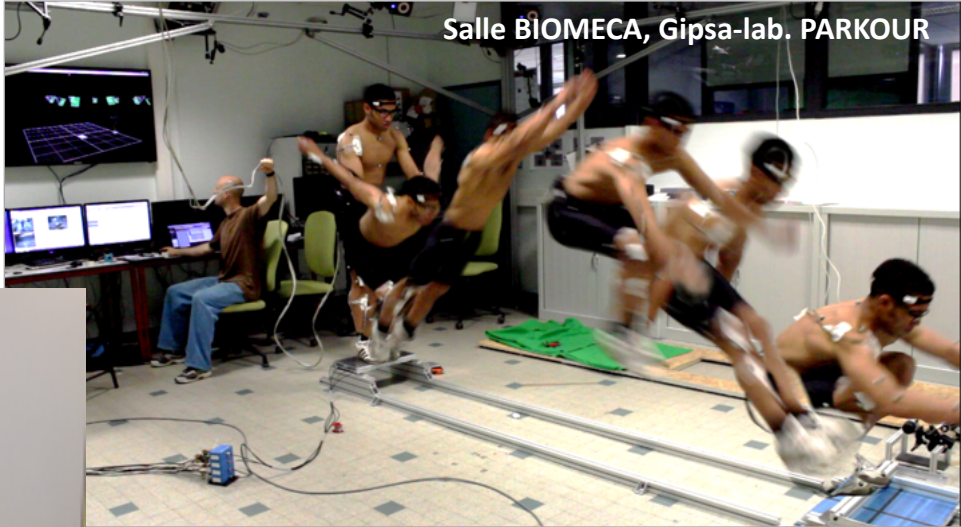


Teams

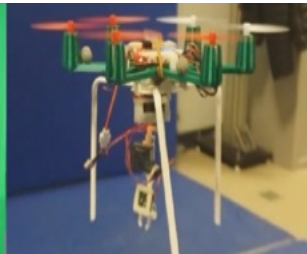
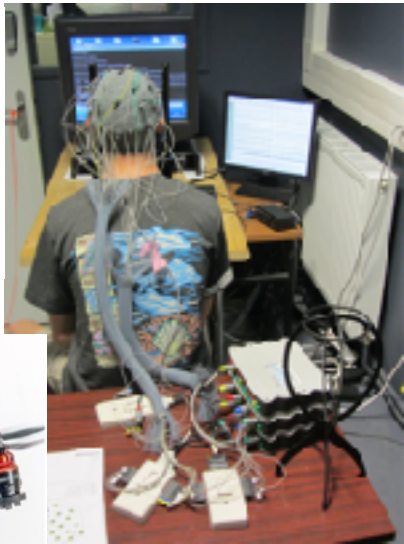
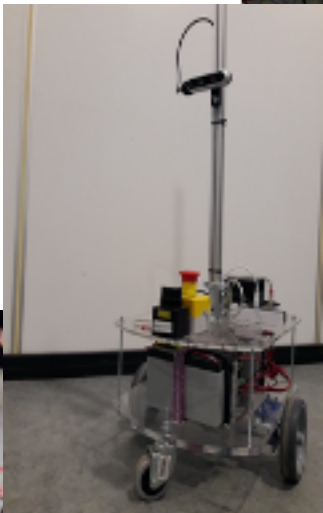
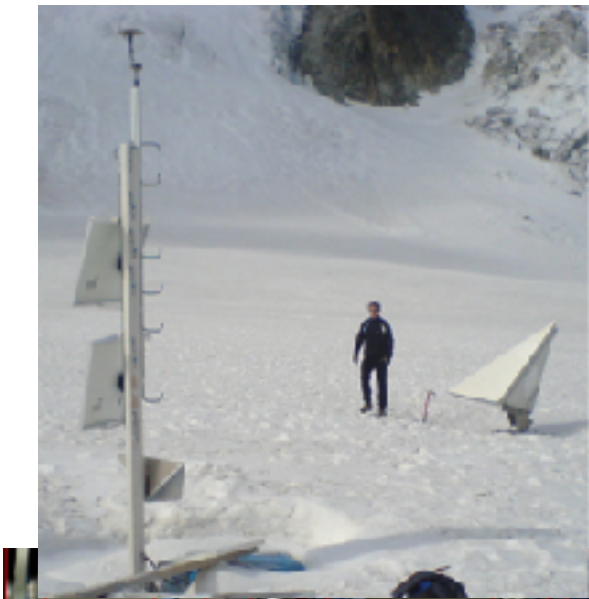




Experimental platforms



Salle BIOMECA, Gipsa-lab. PARKOUR



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