SHAKE THE FUTURE.

CENTRALE NANTES

ENGINEERING PROGRAMME

SPECIALISATION

DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING

SPRING SEMESTER

Établissement public sous tutelle du
ministère de l'Enseignement supérieur, de la Recherche et de l'Innovation

GROUPE **CENTRALE**

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MULTIMODAL DATA ANALYSIS

DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Said MOUSSAOUI

Objectives

This course focuses on multi-sensor data analysis techniques using so-called source separation techniques. These recent methods - principal component analysis, independent component analysis and non-negative matrix factorization - make it possible to exploit sensor redundancy to analyse the content of data revealing mixtures.

The second part of the course addresses applications for signal and image processing and shows how to adapt the methods of analysis to the constraints of the applications.

Course contents

1. Source separation methods
a) Algebraic methods
b) Iterative methods
c) Statistical approaches (maximum likelihood and Bayesian estimation)

2. Applications for signal analysis
a) Spectrometry
b) Biomedical signals

3. Applications for hyperspectral imaging
a) Concepts of remote sensing
b) Geometrical approaches
c) Hyperspectral image analysis by source separation

Course material

[1] P. Comon and C. Jutten, Séparation de sources 1: concepts de base et analyse en composantes indépendantes, Traité IC2, série Signal et image, 03-2007
[2] P. Comon and C. Jutten, Séparation de sources 2: au-delà de l'aveugle et applications, Traité IC2, série Signal et image, 03-2007
[3] A. Hyvarinen, J. Karhunan, and E. Oja, Independent Component Analysis. Johns Willey & Sons., 2001.

Keywords

Principal component analysis, independent component analysis, source separation, non negative matrix factorisation, hyperspectral imaging

Links with other programmes

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	10 hrs	10 hrs	10 hrs	0 hrs

BIOMEDICAL IMAGING

DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING, ENGINEERING PROGRAMME SPECIALISATION
SPRING SEMESTER

Professor: Diana MATEUS

Objectives

This course in biomedical imaging comprises a series of lectures setting out:

- the functioning principles of different imaging techniques (e.g.: X-rays, ultrasound, computer tomography, magnetic resonance imaging etc.)
- some of the fundamental problems in medical image analysis, such as segmentation, registration and navigation, as well as a selection of established methods to resolve them.

Finally, a core part of the course will be practical hands-on experience on real biomedical images through Python programming.

The goal of this course is to prepare students for todays challenges and growing opportunities around assisted medical procedures through computer-aided solutions in imaging.

Course contents

This course will include three different teaching perspectives: Firstly, the methodological vision on the problems of acquisition and processing of medical images. Then, the participation of clinicians, physicians and industrialists will give another perspective related to the application of medical imaging. The course will close with implementation of methodologies on recognized problems.

Techniques:

- X-Ray,
- Ultrasound,
- Tomography,
- Magnetic resonance
- Nuclear medicine
- Microscopy

Issues and methods:

- Segmentation (implicit and graphical methods)
- Navigation and guidance
- Mapping (image-based, rigid or deformable methods)
- Reconstruction

Course material

[1] N. Paragios, N. Ayache & J. Duncan. Biomedical Image Analysis: Methodologies and Applications, Springer, 2010.
[2] Jerry l. Prince: Medical imaging signals and systems textbook second edition 2014

Keywords

Positron emission tomography (PET), magnetic resonance imaging (MRI), microscopy

Links with other programmes

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	10 hrs	12 hrs	8 hrs	0 hrs

R&D APPLICATIONS

DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Sébastien BOURGUIGNON

Objectives

This course is given by R&D engineers and researchers, whose work involves data analysis and processing in various fields of application. It aims to present, taking examples from current industrial and academic problems, how different information processing problems (signal, image, data analysis) are tackled through modern methodology, exploiting in particular the different courses that were taught during the first semester.

Course contents

Each lesson is one-day long. The morning session is dedicated to presenting the problem, the corresponding methodological obstacles and the solution(s) proposed in the research team. The afternoon lab session is dedicated to practical implementation of the related methods on real data.

Course material

Keywords

Signal and image processing, data analysis, industrial nondestructive control, remote sensing and satellite imaging, planetary science, astronomical imaging, underwater acoustics.

Links with other programmes

Applications may cover all fields composing the two first teaching periods: Scientific computing and numerical optimization - Statistical data modelling and analysis - Image processing and analysis - Signal representation and analysis - Machine learning theory and practice - Imaging and inverse methods - Systems identification and signal filtering - Biomedical signal analysis.

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	16 hrs	16 hrs	0 hrs	0 hrs

PROJECT IN SIGNAL AND IMAGE PROCESSING

DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Said MOUSSAOUI

Objectives

The aim of this course is to undertake a project related to the processing of real data: audio signals, biomedical images or signals, hyperspectral images. This project begins in the autumn semester and is pursued in the spring semester.

Course contents

The projects involve the processing of real data such as:

1. Spectral data and hyperspectral images: deconvolution, decomposition and separation
2. Physiological signals: EEG, EMG for BCI and Prosthesis control
3. Audio signals: segmentation, speech recognition, content analysis
4. Medical image analysis: image segmentation, pattern recognition, etc

Course material

1) Fundamentals of statistical signal processing - Vol I. Estimation theory. S. KAY. Prentice Hall, 1993.
System identification, theory for the user. L. LJUNG Prentice Hall, Englewood Cliffs, New Jersey, 1987 (1st ed.) - 1999 (2nd ed.).
2) Approche bayésienne pour les problèmes inverses. J. IDIER. Traité IC2, Série traitement du signal et de l'image, Hermès, 2001.
3) Pattern Classification. R.O. DUDA, P.E. HART, D.G.STORK, Willey 2001.
Analyse d'images, filtrage et segmentation. Sous la direction de J.P. COQUEREZ et S. PHILIPP, Masson 1995

Keywords

Separation, classification, optimization, signal processing, image restoration

Links with other programmes

All the courses of the specialisation.

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	2	0 hrs	0 hrs	0 hrs	48 hrs

AUDIO CONTENT ANALYSIS AND INFORMATION RETRIEVAL

DATA ANALYSIS AND APPLICATIONS IN SIGNAL AND IMAGE PROCESSING, ENGINEERING PROGRAMME SPECIALISATION

SPRING SEMESTER

Professor: Jean-François PETIOT

Objectives

This course aims to train students in:

- the principles of audio numerical representation (acoustic, encoding, processing)
- the principles of psycho acoustics (perception, cognition)
- modelling and learning of high level attributes (musical information retrieval)

Course contents

- Acoustics
- Representation
- Processing
- Auditory Scene Analysis
- Source separation

Course material

[1] Klapuri, A. and Davy, M. (Editors), Signal Processing Methods for Music Transcription, Springer-Verlag, New York, 2006

[2] Auditory Scene Analysis, The Perceptual Organization of Sound, By Albert S. Bregman, MIT Press

Keywords

Audio signal, perception, information retrieval

Links with other programmes

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	10 hrs	12 hrs	8 hrs	2 hrs