Imagerie et problèmes inverses

Lecturer
Ignace LORIS (Coordinator)

Course mnemonic
MATH-F502

ECTS credits
5 credits

Language(s) of instruction
French

Course period
Second term

Campus
Plaine

Course content

1) Direct and inverse problems in imaging (a direct problem in X-ray imaging and the structure of DNA, the phase problem as an example of an inverse problem, the alternating projections algorithm, ...).

2) Time and band-limited functions (Paley-Wiener theorem, the problem of time-frequency concentration, properties of Slepian functions, out of band extrapolation, ...)

3) Regularization of inverse problems (pseudo-inverse, regularization methods, deconvolution, ...)

4) Medical imaging and the Radon transform (the Radon transform, properties, the inverse Radon transform, ...)

5) Discrete wavelets (the cosine transform, Haar wavelets, orthogonal wavelets, filter banks, biorthogonal wavelets, applications, ...).

6) Wavelets in L2(R) (multiresolution analysis, wavelet decomposition, construction of a multiresolution analysis, properties and numerical computation of wavelet functions, biorthogoanl wavelets, ...).

Objectives (and/or specific learning outcomes)

This course offers an introduction to data inversion methods and their application to imaging and other problems.

At the end of this course a student will be capable of

1) giving some examples of ill-posed inverse problems

2) regularising ill-posed inverse problems

3) describing several ways of inverting the Radon transform

4) identifying the properties of discrete and continuous wavelet transforms

Pre-requisits and co-requisits

Required knowledge and skills

Some functional and harmonic analysis and some linear algebra

Teaching method and learning activities

Oral lectures and/or personal work

Contribution to the teaching profile

1- Create, develop and maintain knowledge in different domains of mathematics

1.1. Acquire fundamental concepts of certain recent branches of mathematics.

1.2. Acquire advanced notions of mathematics.

1.3. Analyze , synthesize and link knowledge of different areas of mathematics.

2- Solve problems as a scientist

2.1. Implement rigorous criteria, arguments and methods of proof.

2.2. Identify a concept based on observations or examples.

2.3. Elaborate the abstraction process or the study of data or examples with the aim of developping a theory or model.

4- Communicate in language adapted to the context and audience

4.1. Use a clear and rigorous language.

5- Self development, with respect of ethical questions linked to the domain

5.1. Exploit one's knowledge, imagination and creativity.

5.2. Develop a critical attitude towards the validity of a statement.

5.3. Give credit to original authors and refuse all forms of plagiarism.

References, bibliography and recommended reading

Charles L. Epstein. Introduction to the mathematics of medical imaging. SIAM, 2 edition, 2007.

G. Strang and T. Nguyen. Wavelets and filter banks. Cambridge, 1996.

S. Mallat. A Wavelet Tour of Signal Processing : The Sparse Way. Academic Press, third edition edition, 2009.

K. Bredies and D. Lorenz. Mathematical image processing, Springer, 2018.

Course notes

Syllabus and Université virtuelle

Other information

Place(s) of teaching

Plaine

Contact(s)

mail (Ignace.Loris@ulb.be), Teams or in person in my office (campus Plaine, building NO, office 2.O7.107)

Evaluation method(s)

Oral examination

Evaluation method(s) (additional information)

Oral exam. Typically 20-30 minutes per student. Date/time of exam to be discussed with students

Determination of the mark (including the weighting of partial marks)

Typically two questions (two chapters). 10 points par question.

Main language(s) of evaluation

French

Other language(s) of evaluation, if applicable

English

Programmes

Programmes proposing this course at the faculty of Sciences

MA-MATH | Master in Mathematics | finalité Research/unit 1 and finalité Research/unit 2 and MA-STAT | Master in Statistics : General | finalité Research General/unit 2

Programmes proposing this course at the Brussels School of Engineering

MA-IRCB | Master of science in Biomedical Engineering | finalité Professional/unit 2