LIST OF THE MODULES

UE	Theory of Distributed Systems	4 ECTS	1^{st} semester
EIINP3AM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

Theory of distributed systems (TDS)This class aims at providing a state of the art about principles of distributed computing, standard limitations and impossibility results, and some examples of their application through distributed services : distributed file systems, dependable systems, distributed replicated memories, etc

SUMMARY OF THE CONTENT

Principles and concepts of distributed computing are described and their use in distributed systems. After a short introduction, the standard model of distributed computing based upon the causality relation is pointed out. Then, a survey of generic distributed algorithms is performed : logical time, causally ordered and atomic protocols, mutual exclusion, termination, global snapshots and checkpointing, consensus and failure detectors. Some distributed system examples are especially emphasized : ordered and atomic multicast protocols for fault-tolerance, distributed file systems (NFS, AFS), distributed memories and their various consistency semantics, large scale distributed systems, distributed simulation (HLA standard).

PREREQUISITES

A practical programming experience and fundamental knowledge about operating systems, concurrent programming, middlewares and networks are required

REFERENCES

AjayD.KshemkalyaniandMukeshSinghal Distributing computing : principles, algorithms and systems, Cambridge Univ. Press, 2008

KEYWORDS

Distributed systems, distributed file systems, fault-tolerance

UE	Cloud Computing and Big Data	4 ECTS	1st semester
EIINP3BM	Cours : 20h , TP : 16h , Projet : 5h		

LEARNING GOALS

Study advanced system services, especially those related to emerging fields that are Cloud Computing and Big Data. Study advanced network services

SUMMARY OF THE CONTENT

This teaching unit presents advanced system services in the field of Cloud Computing and Big Data. This domain is characterized by the need for elastic applications (covered in the autonomic systems part), and a need for optimal resource management (for Cloud and Big Data environments). - Autonomic systems - Software components (Fractal) - Autonomic systems (Tune, RoboConf) - Cloud computing - Cloud Platforms (OpenNebula, OpenStack, Eucalyptus) - Virtualization (Xen, KVM, Docker) Big Data - MapReduce (Hadoop) - filtering chains (TwitterStorm)

PREREQUISITES

Operating systems ; Concurrent programming ; Database systems ; Object-oriented programming ; Basic middleware and networks

REFERENCES

The Little Book of Cloud Computing, 2014 Edition : Including Coverage of Big Data Tools by Lars Nielsen

KEYWORDS

Cloud computing, BigData

UE	High Performance Parallel Programming	4 ECTS	1st semester
EIINP3CM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

Programming and algorithmic issues for large scale parallel computers (hundreds to hundred thousands of core) are addressed in this lecture

SUMMARY OF THE CONTENT

This module begins with a general introduction to high performance computing and programming where the general concepts used in the design of high performance computers (from multicore cache based memory computers to large clusters of nodes) are described along with the main issues related to efficient high performance programming (from sequential code optimization techniques up to shared memory parallel programming and distributed computing). Afterward, notions on architecture and execution modeling of a parallel program are provided aiming at accurate performance prediction. The notions of speed-up, isoefficiency, scalability are also introduced at this moment. The module is concluded with some brief concepts of Grid computing and the related issues.

PREREQUISITES

Computer architecture,operating system and synchonisation mechanisms, programming

REFERENCES

Peter Pacheco Parallel Programming with MPI
Barbara Chapman, Gabriele Jost, Ruud van van der Pas Using OpenMP : Portable Shared Memory Parallel Programming (Scientific and Engineering Computation)

KEYWORDS

high performance processors, parallel computers , design of parallel programs

UE	Information Systems	4 ECTS	1^{st} semester
EIINP3DM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

This class aims at introducing advanced concepts and techniques related to the management of information systems.

SUMMARY OF THE CONTENT

This class can be breakdown in 4 main elements. 1- Basic studies in information retrieval where the fundamentals will address the main components of search techniques and engines. 2- Deployment of information retrieval techniques from large social networks. 3- Semantic analysis and mining techniques of the web 2.0 : semantic access to information 4- Complex information systems management.

PREREQUISITES

Basic database systems, Programming, First order logic

REFERENCES

Turban, E., Aronson, J., & Liang, T. P. (2005). *Decision Support Systems and Intelligent Systems 7 Edition*Pearson Prentice Hall.

KEYWORDS

information retrieval, rules, ontologies, knowledge based reasoning, advanced database information systems

UE	Datamining : Theory and Practice	4 ECTS	1st semester
EIINP3EM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

The course will discuss the principles and ideas underlying the current practice of data mining at large scale, as well as introduce some useful tools of everyday life in datascience.

SUMMARY OF THE CONTENT

This module begins with a general introduction to datamining and associated bigdata issues. A strong mathematical background around predictive modeling is given through selected elements of statistical (machine) learning. This background helps to step-back and better understand presented tools (such as clustering, logistic regression, latent class analysis, association and event analysis, text mining,). Real use-cases in webmarketing (or other related areas) are discussed in depth : recommendation systems, retargeting applications, etc.

PREREQUISITES

Probability and statistics, Applied mathematics, Programming

REFERENCES

The Elements of. Statistical Learning : Data Mining, Inference, and Prediction. Second Edition. February 2009. Trevor Hastie · Robert Tibshirani.

KEYWORDS

Datamining, Machine Learning, Bigdata applications

UE	Safety Critical Systems	4 ECTS	1st semester
EIINP3FM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

Study of the main constraints and technologies for the development of safety efficient critical systems. Understand and implement static and dynamic analysis technologies : deductive verification, model checking, abstract interpretation, satisfiability modulo theory, constraint logic programming, test generation. Understand certification and qualification purposes and applications

SUMMARY OF THE CONTENT

Static Analysis - Deductive verification : Hoare logic, Weakest precondition calculus - Model checking : BDD, SAT - Abstract interpretation Certification and Qualification - Safety critical systems - Certification principles and standards - Qualification principles and standards

PREREQUISITES

Functional Programming ; Modular Imperative Programming ; Object and Event Driven Programming ; Mathematical tools for computer science ; Formal specification

REFERENCES

Jean-François Monin. Understanding formal methods Springer, 2003 Flemming Nielson, Hanne Riis Nielson, and Chris Hankin. Principles of program analysis Springer, 1999.

KEYWORDS

Formal methods Static analysis, Deductive verification, Model checking, Satisfiability

UE	Logic, Proofs and Tests	4 ECTS	1st semester
EIINP3GM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

Study of the main constraints and technologies for the development of safety efficient critical systems. Understand and implement static and dynamic analysis technologies : deductive verification, model checking, abstract interpretation, satisfiability modulo theory, constraint logic programming, test generation. Understand certification and qualification purposes and applications

SUMMARY OF THE CONTENT

The content of the Tests, Logic programming and Automated proof class is decomposed as follows : - Logic Programming - Constraint Logic Programming - Satisfiability based proofs - Satisfiability Modulo Theory based proofs - Stochastic tests - Test generation

PREREQUISITES

Functional and Modular Imperative Prog. ; Object and Event Driven Prog. ; Mathematical tools for computer science ; Formal specification

REFERENCES

Francesca Rossi, Peter van Beek, and Toby Walsh. Handbook of Constraint Programming) Elsevier A, 2006. Armin Biere, Marijn Heule, Hans van Maaren, and Toby Walsh, editors. Handbook of Satisfiability 2009.

KEYWORDS

Formal methods Automated Proof, Constraint Logic Program- ming, Stochastic testing, Test generation

UE	Rigorous Modeling and Complex Systems	4 ECTS	1st semester
EIINP3HM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

Increasing demand for new technology by the complex safety critical applications requires rapid adoption of commercial hardware and software to meet industrial standards, including high performance, reliability and safety. Refinement and proof-based formal methods are proven to be effective approaches to deal with growing system complexities during the development of complex systems. The principal objective of this course is to provide our students an opportunity to acquire comprehensive knowledge and to understand sound methodologies in the development of safety critical systems, including theory and practices, and practical skills of applying rigorous techniques on challenging problems.

SUMMARY OF THE CONTENT

This course covers rigorous modelling techniques from requirements analysis to system implementation using refinement approach. In particular, it covers semi-formal modelling, formal modelling, refinement, proof, verification, validation, simulation and code generation :
- Requirements Engineering
- Semi-formal and Formal Modelling
- Refinement and Proof
- Model Checking,
- Simulation and Animation
- Verification and Validation
- Introduction to Event-B method
- Presentation of Rodin toolset
- Industrial Case Studies from medical and transportation domains

PREREQUISITES

Logic, programming language, formal specification, formal proofs, software engineering, basic knowledge of UML.

REFERENCES

Abrial J. R., Modelling in Event-B : System and Software Engineering, Cambridge University Press, 2010.

KEYWORDS

Formal methods, refinement, proof, animation, simulation, verification, validation, Event-B.

UE	Multimedia Content Analysis	4 ECTS	1st semester
EIINP3IM	Cours : 20h , TP : 16h , Projet : 5h		

LEARNING GOALS

This course deals with automatic inference of information in various media content (audio, image and video). It also addresses challenges related to big media data and efficient techniques for browsing, indexing and analysing multimedia content.

SUMMARY OF THE CONTENT

Multimedia Analysis :
- Role of machine learning
- Annotation techniques and tools

Image analysis :
- Object detection and recognition
- Feature points detection
- Saliency detection
- Large-scale image analysis

Video analysis :
-Visual tracking
-Event detection

Speech and music analysis
- Speech description, parametrization and modeling
- Transcription systems
- Audio and visual joint analysis

PREREQUISITES

Applied mathematics, Basic Signal Processing, Programming

REFERENCES

Encyclopedia of Multimedia, Second Edition B. Furht Multimedia Content Analysis : Theory and Applications Divakaran, Ajay (Ed.) Springer

KEYWORDS

Image and video analysis, audio analysis

UE	High Performance Media Delivery	4 ECTS	1st semester
EIINP3JM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

In this course we present state of the art and challenges ahead in multimedia content delivery. We provide an overview of adaptive media delivery, specifically in the context of adaptive streaming including the recent MPEG-DASH standard.We jointly address video-on-demand and 3D content streaming.Take home messages will be given for client design,QoS and QoE optimizations,hybrid delivery scenarios, and synchronization issues.

SUMMARY OF THE CONTENT

- Multimedia content
3D representations
Modeling within openGL Online
3D models
- Multimedia Delivery
Multimedia networking
Streaming Technologies
Synchronisation
Multimedia User Interfaces
- Video delivery
theoretical foundations of video compression and real-time streaming
advanced topics : adaptation and DASH technologies, joint performance in QoE and QoS dimensions
- 3D content delivery
theoretical foundations of 3D compression and adaptive 3D streaming joint performance in QoE and QoS dimensions
advanced topics : Networked Virtual Environment design and deployment

PREREQUISITES

Programming ; Basic networks, Basic distributed systems ; Signal Processing

REFERENCES

Multimedia Systems : Delivering, Generating and Interacting with Multimedia, Tim Morris
Computer Graphics with OpenGL, 4th edition, Hearn, Baker, Carithers

KEYWORDS

Multimedia Streaming

UE	High Performance in Visual Processing	4 ECTS	1st semester
EIINP3KM	Cours : 20h , TP : 16h , Projet : 5h		

LEARNING GOALS

This course addresses simultaneously augmented reality (AR) techniques and resource utilization and performance challenges to support interactive/real-time AR services. Technical challenges in computer vision and computer graphics are first detailed before showing how to speed-up applications and optimize the perceived service quality.

SUMMARY OF THE CONTENT

Computer vision and computer graphics for AR
- Camera tracking and matchmoving (marker-based and markerless approaches)
- Simultaneous Localization And Mapping and real-time Structure From Motion
- VFX use-cases in real-time or quasi real-time

Performance issues
- Real-time AR implementations on several platforms
- Detailed examples (through conferences) e.g. GPU implementation for SIFT
- Large scale/incremental Sfm
- Image-based localization in large scale environments

PREREQUISITES

Image processing, Basic computer vision, Basic computer graphics, Programming

REFERENCES

Augmented Reality : A Practical Guide by Stephen Cawood and Mark Fiala Computer vision for visual effects, Richard Radke Learning OpenCV : Computer Vision in C++ with the OpenCV Library

KEYWORDS

Augmented reality, Real-time Matchmoving, VFX

UE	Numerical Methods for Large Linear Systems	4 ECTS	1^{st} semester
EIINP3LM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

The aim of this course is to describe up-to-date techniques for the solution of large linear systems on parallel computers. It also introduce duality theory that is a key ingredient in many linear programming solution methods.

SUMMARY OF THE CONTENT

This course begins with lectures that present parallel algorithms to solve linear systems arising from partial differential equations on parallel computers. The solution methods depend on the discretization technique that is used : the finite difference and finite element approaches are considered. A special emphasis will be put on the solution of time dependent problems by implicit technique, where scalability for massively parallel computations is reached using suitable mesh partitioning techniques. The course continues with lectures of direct solution methods for sparse linear systems. The objective of these lectures is to provide students with the basic theory behind the factorization of sparse matrices as well as the issues related to the implementation of a sparse, direct solver on modern, parallel computing architectures. Specifically the message will focus on the cost and efficiency of the involved basic linear algebra operations, the issues related to memory consumption, the exploitation of parallelism and concurrency as well as some aspects of numerical stability.

PREREQUISITES

Applied mathematics ; Basic optimization ; Programming,

REFERENCES

D. Bader, ed., *Petascale Computing : Algorithms and Applications*, Chapman & Hall/CRC, 2007.
J. M. Bahi, S. Contassot-Vivier, and R. Couturier, *Parallel Iterative Algorithms*, Chapman & Hall/CRC, 2007.

KEYWORDS

Parallel computing, sparse direct solver, sparse iterative solver, duality theory

UE	Data Assimilation and Optimization	4 ECTS	1^{st} semester
EIINP3MM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

This course provides theoretical background and algorithms for solving inverse problems.

SUMMARY OF THE CONTENT

The course begins with introductory lectures describing the mathematical foundation of inverse problem theory and parameter estimation in the case where the model and observation errors are supposed to be Gaussian. In practice, the problem often takes the form of a differentiable optimization problem with constraints that are both nonconvex and nonlinear. Effective solution methods rely on globalized optimization schemes that will be presented. Having insisted on the importance of having access to the derivatives of the functions and constraints, we will teach a survey on techniques to differentiating functions. These techniques range from sophisticated finite differences approaches, using more or less compact schemes, to automatic differentiation techniques. However there are still situations where either the function to optimize is mathematically complex, or its solution involves a large software. In this case evaluating derivatives may be unaffordable in terms of computational cost or software development, and practitioners fall back on derivative free optimization algorithms that will be briefly outlined.

PREREQUISITES

Applied mathematics ; Basic optimization ; Programming,

REFERENCES

A. Trantola Inverse Problem Theory and Model Parameter Estimation, 2005.
A. Conn, N. Gould, Ph. L. Toint Trust-Region Methods, 2000

KEYWORDS

Inverse problems, well-posedness, 4D-Var, Kalman filters, inexact and truncated iterative solvers for unconstrained optimization, maximum likelihood estimation

UE	Bayesian Analysis	4 ECTS	1st semester
EIINP3NM	Cours : 20h , TD : 6h , TP : 10h , Projet : 5h		

LEARNING GOALS

This course aims at developing competences in optimized risk managing and uncertainty by mastering the predictive tools and Bayesian analysis and decision theory.

SUMMARY OF THE CONTENT

Bayesian analysis and decision theory
• Decision considering information
• Modeling of a priori knowledge
• Risk and decision in uncertain future
• A posteriori computation
• Risk and decision Applications
- Conferences on examples of applications (forest fires ...)
- Optimized risk managing

PREREQUISITES

Elementary knowledge in statistics, Programming,

REFERENCES

James O. Berger, Statistical Decision Theory and Bayesian Analysis, Springer

KEYWORDS

Bayesian theory, decision

UE	Scientific English	2 ECTS	1st semester
EIINP3OM	Cours : 24h		

LEARNING GOALS

Improve an already good level in english while focusing on specific needs in the academia.

SUMMARY OF THE CONTENT

Use English to communicate effectively both in industry and research areas.
Know how to present a scientific problem and/or a technical project in oral and written English.
Acquire and master advanced tools and resources for operating and reporting daily research in spoken English.

PREREQUISITES

Good knowledge of English (B2/C1)

REFERENCES

Beer D. & McMurrey D. A Guide to Writing As an Engineer. J. Wiley & Sons, 2013
Markel M. Technical Communication. Bedford/St Martin's, 2014

KEYWORDS

Advanced scientific english

UE	Research Methodology	10 ECTS	2nd semester
EIINP4AM	Projet : 100h		

LEARNING GOALS

The teaching unit will outline the fundamentals of doing research along with a small introductory research project (six-weeks project when students work in groups of 4/5 on a modest yet realistic research topic).

SUMMARY OF THE CONTENT

Responses to key questions will be given : What is applied research ? What is a research problem ? How to identify and test a topic ? What is a literature review and why do we need to do one ? How to plan and manage a research project ? How to evaluate and compare candidate solutions to a problem ? How to build data sets ? How to report advances ? How to write and submit papers ?

PREREQUISITES

BSc level in computer science

REFERENCES

Many selected webpages including (https ://www.cics.umass.edu/~emery/misc/how-to.pdf or http ://www.lib.berkeley.edu will be exploited during this practical teaching unit.

KEYWORDS

Research methodology

UE	Long Internship	20 ECTS	2nd semester
EIINP4BM	Stage : 4 mois minimum		

LEARNING GOALS

This teaching unit is associated with a long internship period (either in a company or in a research laboratory). Students are expected to put what they learnt into practice by tackling a scientific problem, finding a solution, evaluating it and eventually reporting their work.

SUMMARY OF THE CONTENT

Internship within a company or a research laboratory for a (4-6) months period.The internship must be found by the student and the subject must be validated by the professor in charge of the PSMSC track. A state-of-the-art review is expected as a part of the final internship report.
An oral defense is scheduled at the end of the period for assessment.

KEYWORDS

Training period, professional experience