PÉRIODE D'ACCRÉDITATION : 2016 / 2021

UNIVERSITÉ PAUL SABATIER

SYLLABUS MASTER

Mention Informatique

M2 Computer Science for Aerospace

http://www.fsi.univ-tlse3.fr/
http://m1.deptinfo.fr/

2017 / 2018

23 FÉVRIER 2018

SUMMARY OF THE CONTENT

PRESENTATION

PRESENTATION OF THE DISCIPLINE

DISCIPLINE INFORMATIQUE

Computer science is nowaday at the core of many societal, industrial and scientific domains. The aim of the computer science master program at the university Paul Sabatier is to give student a in-depth expertise in several domain of computer science.
In the first year of this master, a set of common skills is delivered as the basis for a progressive specialization.
In the second year of this master, strong specialization year, theoretical and technological high-level training is offered to students, allowing them to access the many opportunities in the computer science industry but also to continue their doctoral studies.
The computer science master program is declined around the following thematic areas :
- Information processing and infrastructure
- Software engineering as a set of concepts, methods and development tools.
- Manipulation of content from different points of view : analysis / synthesis of information, structuring and retrievial of information, integrating the problem of massive data.
- Representation and processing of knowledge in artificial intelligence, with links toward robotic.
- Man machine interaction, with ergonomic and cognitive constraints relating thereto.

PRESENTATION OF THE YEAR OF M2 COMPUTER SCIENCE FOR AEROSPACE

CONTACTS SECTION

CONTACT INFORMATION CONCERNING THE SPECIALTY

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TABLE SUMMARIZING THE MODULES THAT MAKE UP THE TRAINING PROGRAM

page	Code	Title of the module	ECTS	Mandatory Optional	Cours-TD	TD	TP	Projet
First semester								
8	EIINE3AM	EUROPEAN AND INTERNATIONAL LAW	3	O		24		
9	EIINE3BM	MASTER THESIS	6	O				120
10	EIINE3CM	PROJECTS	2	O				40
11	EIINE3DM	THEORETICAL COMPUTER SCIENCE	3	O		24		
	EIINE3EM	ARCHITECTURE, SYSTEMS AND NETWORKS FOR AEROSPACE	8	O				
12	EIINE3E1	Platforms in Planes and Space				8		
13	EIINE3E2	Real Time				20	12	
14	EIINE3E3	Resource Management				14	10	
	EIINE3FM	ARTIFICIAL INTELLIGENCE FOR AEROSPACE	5	O				
15	EIINE3F1	Models and Tools for Decision				20		
16	EIINE3F2	Constraints and Planning				14	6	
17	EIINE3GM	IMAGES FOR AEROSPACE : ADVANCED IMAGE PROCESSING AND ANALYSIS FOR REMOTE SENSING	3	O		14	10	
Second semester								
19	EIINE4BM	MASTER THESIS	9	O				180
20	EIINE4CM	PROJECTS	3	O				60
	EIINE4DM	SOFTWARE, CERTIFICATION AND INTERACTIVE SYSTEMS FOR AEROSPACE	8	O				
21	EIINE4D1	Critical Embedded Software				12	8	
22	EIINE4D2	Validation and Certification			14		6	
23	EIINE4D3	Computer-Human Interaction for Critical Systems				16	8	
24	EIINE4EM	IMAGES FOR AEROSPACE : ADVANCED IMAGE PROCESSING FOR REMOTE SENSING	2	O		6	10	
	EIINE4FM	EMBEDDED INFORMATION SYSTEMS AND DATABASES	5	O				
25	EIINE4F1	Embedded Information Systems				20		
26	EIINE4F2	Embedded Databases				20		

page	Code	Title of the module	ECTS	Mandatory Optional	Cours-TD	TD	TP	Projet
18	EIINE4AM	SAFETY	3	O		16	8	

LIST OF THE MODULES

UE	EUROPEAN AND INTERNATIONAL LAW	3 ECTS	1st semester
EIINE3AM	TD : 24h		

LEARNING GOALS

This topic is on the European and International Law, specifically on IP Law (copyright on software, data bases, Patent Law), security, and Digital Law. The aim is to give fundamental knowledges to understand the main principles in Law, specifically IP and Digital Law, and judicial system.

SUMMARY OF THE CONTENT

Confidentiality and security of data Privacy and personal data protection IP Law : copyright on software, data bases, patent Contract Law

UE	MASTER THESIS	6 ECTS	1^{st} semester
EIINE3BM	Projet : 120h		

UE	PROJECTS	2 ECTS	1^{st} semester
EIINE3CM	Projet : 40h		

LEARNING GOALS

The goal is to apply skills developped during different courses of the first semester to long-term projects made in short teams.

UE	THEORETICAL COMPUTER SCIENCE	3 ECTS	1^{st} semester
EIINE3DM	TD : 24h		

LEARNING GOALS

Understand the performance issues in Systems and Networks. Mastering quantitative and qualitative modeling and associated tools (Petri Networks, Markov processes, queues). Applying simulation and experimentation techniques.

SUMMARY OF THE CONTENT

Introduction to the performance analysis
- Methodology
- Modeling
- Techniques, metrics, and common mistakes
- Data presentation techniques
- Qualitative evaluation (Petri nets)

Quantitative performance evaluation
- Stochastic process and Markov chains
- Single and multi-server queues
- Queuing networks

Simulation et Experimental design
- Experimental protocols
- Data sensitivity
- Results quality analysis
- Simulators

PREREQUISITES

Probability Theory, Algorithm complexity, C/C++ programming Language

REFERENCES

The Art of Computer Systems Performance Analysis : Techniques for Experimental Design, Measurement, Simulation, and Modeling, by Raj Jain.

KEYWORDS

Performance evaluation, stochastic processes, queuing theory, modeling, simulation

UE	ARCHITECTURE, SYSTEMS AND NETWORKS FOR AEROSPACE	8 ECTS	1^{st} semester
Sous UE	Platforms in Planes and Space		
EIINE3E1	TD : 8h		

LEARNING GOALS

Introducing avionics and satellite communication systems. Emphasis will be placed on aerospace platforms.

SUMMARY OF THE CONTENT

Avionics Communications (AFDX)
Satellite Communications
Avionics and aerospace platforms (e.g. OpenSand : Satellite telecommunication system emulation platforms)

PREREQUISITES

Network and communication architectures.

UE	ARCHITECTURE, SYSTEMS AND NETWORKS FOR AEROSPACE	8 ECTS	1^{st} semester
Sous UE	Real Time		
EIINE3E2	TD : 20h , TP : 12h		

LEARNING GOALS

This course focuses on real-time issues in embedded systems. It presents how to specify real-time constraints and enforce guarantees of these constraints on targeted software and hardware systems. Given the criticality of some real-time applications, it is crucial to meet timing constraints before running such applications and therefore to perform a priori validation. The aim of this course is to provide fundamentals in order to develop and validate real-time and embedded systems.

SUMMARY OF THE CONTENT

Worst-case execution time computation (flow analysis, hardware modeling and timing analysis, wcet tools), temporal predictability of soft and hardware.

PREREQUISITES

Fundamentals on architecture and systems.

REFERENCES

Cottet and al., Real-time scheduling, Wiley 2002.

KEYWORDS

Real-time, WCET (Worst-Case Execution Time), Scheduling, Modeling, Safety of critical systems

UE	ARCHITECTURE, SYSTEMS AND NETWORKS FOR AEROSPACE	8 ECTS	1^{st} semester
Sous UE	Resource Management		
EIINE3E3	TD : 14h , TP : 10h		

LEARNING GOALS

This course focuses on resource management issues in constrained environments.
In this course, resource must be understood as processors, memory, disk, network but also power or energy.
In embedded systems environment, the amount of these resources is clearly limited and must be controlled appropriety, in particular with global views and not only local ones (fair sharing, hungerless,)

SUMMARY OF THE CONTENT

Guaranteed resource management :
o monitoring networks, memories, processors
o load balancing, fair sharing, efficiency
o design methodologies
Energy management
o energetics, power management (including DVFS, P/C modes)
o management and reduction of energy consumption in a computing system

PREREQUISITES

- computer architecture : processor, bus, memory, assembly programming, architectures for embedded systems
- operating systems : distributed system

KEYWORDS

Resources management, load balancing, power consumption

UE	ARTIFICIAL INTELLIGENCE FOR AEROSPACE	5 ECTS	1st semester
Sous UE	Models and Tools for Decision		
EIINE3F1	TD : 20h		

LEARNING GOALS

This course introduces the models and frameworks proposed by artificial intelligence and decision theory (in the broad sense) for decision making : decision under uncertainty, decision in a multicriteria context, multi agent decision making (social choice, fair division, game theory). The course includes the handling of the associated algorithmic problems, case studies and exercises, and two miniprojets arising from real aerospace applications.

SUMMARY OF THE CONTENT

Multicriteria decision making
Agregation : additive utility ; ordinal approaches ; non independent criteria and Choquet integrals ; IntMeractive Approaches and pairwise comparison, outranking methods ;
Multicrittera Decision Making in Combinatorial Domains : multiobjective optimization, soft constraints, GAI nets and CP nets ; Application : experimentation of the Promethee-Gaia method on a problem of Satellite Configuration ; Decision making under uncertainty
Representation of uncertainty. Decision making under uncertainty. Algorithmic Decision Theory ; Markov Decision Processes Case study and Exercises Game Theory Formalisation : Normal Form ; Pure and Mixed Strategies ; Equilibrium (Nash, (iterated) Dominant Strategy Equilibrium) Algorithms : Decision trees, alpha-beta, double oracle
Collective decision making Social Choice : voting rules, Condorcet Winner, Arrow's Theorem, Collective decision making under uncertainty Fair division : proportionality, envy-freeness, competitive equilibrium,
Application : A case study (Sharing takeoff slots) and a mini project (Fair sharing of the ØPleaidesØ satellite)

PREREQUISITES

Basic mathematical background, iProbability theory, Knowledge of combinatorial optimization or linear programming

REFERENCES

H Moulin. Axioms of Cooperative Decision Making. Cambridge University Press, 1988.
H Moulin. Fair division and collective welfare. MIT Press, 2003.
Martin Osborne, Introduction to Game Theory, Oxford University Press,& #8206 ; 2009

KEYWORDS

planning graph, decision making under uncertainty, Markov decision processes, game theory, collective and multicriteria decision making,

UE	ARTIFICIAL INTELLIGENCE FOR AEROSPACE	5 ECTS	1st semester
Sous UE	Constraints and Planning		
EIINE3F2	TD : 14h , TP : 6h		

LEARNING GOALS

Introduction to the paradigms of constraint programming and automatic planning, two important generic combinatorial problems encountered in diverse applications. Emphasis will be placed on the modelling of real-world problems and the algorithms used to solve them, but certain theoretical notions related to computational complexity will also be mentioned.

SUMMARY OF THE CONTENT

I. CSP
1. Introduction and modelling
– Definitions and notation
– Constraint programming
– Modelling (classical examples including frequency assignment, stable marriage, production-line management)
2. Reduction operations - Arc consistency - Arc consistency for global constraints
3. Intelligent search
II. PLANNING
1. General Introduction - What is planning ? - Applications of planning.
2. Planning algorithms
– The classical framework : the STRIPS language and its extensions (ADL, PDDL...).
– Algorithmics for plan production : state-space search, plan-space search, GRAPHPLAN methods, SATPLAN and CSP-PLAN methods, heuristics

PREREQUISITES

The prerequisites are basic knowledge of propositional logic and algorithmics, together with some basic notions of complexity theory.

REFERENCES

R Dechter, Constraint Processing, Morgan Kaufmann, 2003.
C. Lecoutre, Constraint Networks : Techniques and Algorithms, ISTE/Wiley, 2009.
F Rossi, P Van Beek, Toby Walsh, Handbook of constraint programming, Elsevier, 2006.

KEYWORDS

constraint satisfaction, CSP, constraint programming, arc consistency, global constraints, search, automatic planning, STRIPS, PDDL, planning graph,

UE	IMAGES FOR AEROSPACE : ADVANCED IMAGE PROCESSING AND ANALYSIS FOR REMOTE SENSING	3 ECTS	1^{st} semester
EIINE3GM	TD : 14h , TP : 10h		

LEARNING GOALS

This course presents the principles of imaging techniques for spaceborne and airborne remote sensing and their main applications. Focus will be put on remote sensing data preprocessing, image visualization, interpretation techniques and digital image processing methods for information retrieval.

SUMMARY OF THE CONTENT

The course covers the following topics :
- Introduction to remote sensing
- Imaging techniques (active/passive)
- Principles of image processing
- Basics operations (noise reduction, filtering, edge detection)
- Mathematical morphology
- Information retrieval (textures, physical indices, objects)
- Image recognition (classification, segmentation, machine learning)

PREREQUISITES

Knowledge on computer programming, statistics and mathematics.

REFERENCES

González, R.C. ; Woods, R.E. Digital image processing. 3rd ed. Harlow : Pearson Prentice Hall, 2008. ISBN 9780131687288.
Tupin, F., Inglada, J. and Nicolas, J.-M. 2014. Remote Sensing Imagery. John Willey & Sons and ISTE. 368 p.

KEYWORDS

Remote sensing, image processing and analysis, active and passive cameras, machine learning.

UE	SAFETY	3 ECTS	2nd semester
EIINE4AM	TD : 16h , TP : 8h		

LEARNING GOALS

This course aims at acquiring theoretical and practical knowledge in dependability, in order to improve safety. Techniques from fault prevention, forecasting, removal and tolerance will be studied. Techniques of others courses (e.g., SCI) will be explained in this terminology. A more global approach, based on risk management coming from standards, is also necessary to link high level requirements (such as an integrity level) and dependability means, and to justify choices done for safety.

SUMMARY OF THE CONTENT

- Introduction : safety requirements, standards and research
- Dependability
  - Main concepts
  - Fault, error, failure
  - Fault prevention
  - Fault forecasting
  - Fault tolerance
  - Fault removal
- Risk Management
  - Main concepts
  - Process
  - Activities
  - Main risk analysis techniques (FTA, FMECA, HAZOP...)

PREREQUISITES

System designing, propositional logic and probability basic knowledge

REFERENCES

John Knight, Fundamentals of Dependable Computing for Software Engineers, January 12, 2012 by Chapman and Hall/CRC

KEYWORDS

Dependability, safety, risk management, risk analysis, integrity level, fault tolerance, fault removal, fault forecasting

UE	MASTER THESIS	9 ECTS	2^{nd} semester
EIINE4BM	Projet : 180h		

UE	PROJECTS	3 ECTS	2^{nd} semester
EIINE4CM	Projet : 60h		

LEARNING GOALS

The goal is to apply skills developped during different courses of the first semester to long-term projects made in short teams.

UE	SOFTWARE, CERTIFICATION AND INTERACTIVE SYSTEMS FOR AEROSPACE	8 ECTS	2^{nd} semester
Sous UE	Critical Embedded Software		
EIINE4D1	TD : 12h , TP : 8h		

LEARNING GOALS

This course deals with the safe modeling and programing of reactive systems. By definition, these systems have to permanently react to an environment while satisfying real-time constraints. This includes embedded systems (fly-by-wire command, braking systems, train tracking, on-board control, ...) which are critical as the occurrence of failure or malfunction may result in human loss, damage to equipment or environmental harm. Emphasis will be placed on requirement engineering and the refinement from specification models to concrete models or dedicated langagues for reactive systems (synchronous languages).

SUMMARY OF THE CONTENT

- data-flow modeling (Simulink) event-flow modeling (Stateflow)
- synchronous modeling with SysML
- synchronous programing
– the synchronous programing paradigm, a successful industrial transfer
– elements of Lustre and Esterel (syntax, semantics, compilation)
– Introduction to SCADE, an industrial standard for safety-critical systems development

PREREQUISITES

Basic knowledge in modeling, programing language and compilation

REFERENCES

Synchronous programming of reactive systems. N Halbwachs. Kluwer, 1993.
Principles of Cyber-Physical Systems. R Alur. MIT Press, 2015.
A Practical Guide to SysML S Friedenthal, A Moore, R Steiner. MK/OMG Press, 2009

KEYWORDS

synchronous paradigm, correctness-by-construction, reactive systems

UE	SOFTWARE, CERTIFICATION AND INTERACTIVE SYSTEMS FOR AEROSPACE	8 ECTS	2nd semester
Sous UE	Validation and Certification		
EIINE4D2	Cours-TD : 14h , TP : 6h		

LEARNING GOALS

This course deals with the safe development and certification of critical software. The first objective will be to understand the requirements imposed by the need for certification. Then, several formal techniques that are typically used for software verification and validation (V& V) will be presented, including abstract interpretation and static analysis, deductive verification, model checking, and domain-specific languages for automatic code generation. All the verification techniques that will be considered in this course will be positioned in the development process of critical software.

SUMMARY OF THE CONTENT

- Introduction to V& V for certifying aerospace software :
  - positioning of formal methods in the DO-178C standard
  - verification, validation and certification : overall view of a formal software development process
- Software model-checking (LTL, CTL)
- Abstract interpretation, static analysis and applications
- Deductive verification and (semi-)automated theorem provers (Frama-C, Alt-Ergo, Coq or Isabelle)
- Domain-specific languages and automatic code generation (DSML/METACASE)
- Certified code generation (CompCert)
- Analysis of real-time modelling, task models, real-time architecture (AADL)

PREREQUISITES

First-order logic, especially some basic notions of modelling in logic

REFERENCES

Understanding Formal Methods. Jean-François Monin. Springer, 2002

KEYWORDS

verification, validation, certification, model checking, abstract interpretation, deductive verification, static analysis, formal development, software testing

UE	SOFTWARE, CERTIFICATION AND INTERACTIVE SYSTEMS FOR AEROSPACE	8 ECTS	2nd semester
Sous UE	Computer-Human Interaction for Critical Systems		
EIINE4D3	TD : 16h , TP : 8h		

LEARNING GOALS

Master the issues related to the specification verficiation and validation of Interactive Systems

- Understand the issues related to hardware/software integration for interactive systems
- Know the standards related to the design and V& V of interactive critical systems (D0-178C, CS 25-1302)
- Understand the impact of human operator within system safety and reliability (human error types - human error descriptions - human as hero)
- Master description techniques of operators' tasks and knowledge required for operations
- Integrate the knowledge above to design and build reliable, fault-tolerant, usable interactive systems
- Understand the issues related to automation and migration of functions

SUMMARY OF THE CONTENT

- Short introduction to HCI-related standards (CS 25 - 1302)
- Short introduction to human errors and the ØstandardØ human malfunctions
- Modeling of operators' tasks, goals and activities task modeling techniques (HAMSTERS)
- Modelling and analysis of dependability as a whole starting from the underlying systems and including human error, organization and the interactive system (socio-technical system view)

PREREQUISITES

Knowledge on interactive systems programming, modeling and architectures ; knowledge in dependable computing (Lecture SAF)

REFERENCES

Human Error, James Reason, Cambridge University Press, 1990
Managing the Risks of Organizational Accidents. Reason, J., Ashgate, 1997.

KEYWORDS

Human error, operators' tasks analysis and modeling, automation, function allocation

UE	IMAGES FOR AEROSPACE : ADVANCED IMAGE PROCESSING FOR REMOTE SENSING	2 ECTS	2nd semester
EIINE4EM	TD : 6h , TP : 10h		

LEARNING GOALS

This course presents advanced techniques for analysis of remote sensing images. The main goal is to provide the students with a solid knowledge to develop their analytical and processing skills. This course focuses on processing of hyperspectral, multi-temporal, and LiDAR imagery.

SUMMARY OF THE CONTENT

- Introduction to advanced remote sensing image processing
- Analysis of hyperspectral images : Classification, spectral unmixing, target detection, spectral matching
- Processing of LiDAR acquisitions : Filtering, building Digital Surface Models, vegetation cover extraction
- Multi-temporal processing : Classification, agricultural monitoring
- Other imagery techniques : RADAR, very high-resolution imagery, etc.
- Image fusion

PREREQUISITES

Knowledge on image processing and remote sensing imaging techniques.

REFERENCES

González, R.C. ; Woods, R.E. Digital image processing. 3rd ed. Harlow : Pearson Prentice Hall, 2008. ISBN 9780131687288.
Tupin, F., Inglada, J. and Nicolas, J.-M. 2014. Remote Sensing Imagery. John Willey & Sons and ISTE. 368 p.

KEYWORDS

Advanced image processing in remote sensing, hyperspectral imagery, LiDAR, multi-temporal remote sensing.

UE	EMBEDDED INFORMATION SYSTEMS AND DATABASES	5 ECTS	2^{nd} semester
Sous UE	Embedded Information Systems		
EIINE4F1	TD : 20h		

LEARNING GOALS

Information systems are at the heart of all the embedded systems : collecting, managing, analysing, processing information, but also privacy, protection, safety, security and adaptiveness. Indeed, beyond the classical definition, The proper functioning of such systems depends on fundamental properties among which impact strength, liveliness and reactivity.

SUMMARY OF THE CONTENT

Skills aim at mastering modelling (requirements engineering), evolution of the configurations (repository, reverse engineering, etc.) and adaptive decision-making, including the legal, ethical and social dimensions.
A focus will be made on modelling data w.r.t. different use cases implemented in industrial contexts (Airbus, Thalès, etc.) : video surveillance, plane IS, hybrid modelling, indoor / outdoor location, spatiotemporal, etc.
A practical case concerning Information Systems within the framework of broadcasting alert will be detailed.

PREREQUISITES

An academic background in "classical" Information Science and Dababase

KEYWORDS

Information System - Database - Requirements - Design - Modelling - Querying -

UE	EMBEDDED INFORMATION SYSTEMS AND DATABASES	5 ECTS	2^{nd} semester
Sous UE	Embedded Databases		
EIINE4F2	TD : 20h		

LEARNING GOALS

The goal of this course is to present the fundamental constraints on the design and development of embedded database systems.

SUMMARY OF THE CONTENT

– Introduction : context and motivations
– Hardware constraints
– Embedded database system classification
– Functional architectures
– Overview of the main embedded database systems
– Performance evaluation and applications

PREREQUISITES

An academic background in "classical" Information Science and Dababase

KEYWORDS

Information System - Database - Requirements - Design - Modelling - Querying -

GLOSSARY

GENERAL TERMS

DEPARTMENT

The departments are teaching structures within components (or faculties). They group together teachers lecturing in one or more disciplines.

MODULE

A semester is structured into modules that may be mandatory, elective (when there is a choice) or optional (extra). A module corresponds to a coherent teaching unit whose sucessful completion leads to the award of ECTS credits.

ECTS: EUROPEAN CREDITS TRANSFER SYSTEM

The ECTS is a common unit of measure of undergraduate and postgraduate university courses within Europe, created in 1989. Each validated module is thus assigned a certain number of of ECTS (30 per teaching semester). The number of ECTS depends on the total workload (lectures, tutorials, practicals, etc.) including individual work. The ECTS system aims to facilitate student mobility as well as the recognition of degrees throughout Europe.

TERMS ASSOCIATED WITH DEGREES

Degrees have associated domains, disciplines and specialities.

DOMAIN

The domain corresponds to a set of degrees from the same scientific or professional field. Most of our degrees correspond to the domain Science, Technology and Health.

DISCIPLINE

The discipline corresponds to a branch of knowledge. Most of the time a discipline consists of several specialities.

SPECIALITY

The speciality constitutes a particular thematic orientation of a discipline chosen by a student and organised as a specific trajectory with specialised modules.

TERMS ASSOCIATED WITH TEACHING

LECTURES

Lectures given to a large group of students (for instance all students of the same year group) in lecture theatres. Apart from the presence of a large number of students, lectures are characterized by the fact they are given by a teacher who defines the structure and the teaching method. Although its content is the result of a collaboration between the teacher and the rest of the educational team, each lecture reflects the view of the teacher giving it.

TD : TUTORIALS

Tutorials are work sessions in smaller groups (from 25 to 40 students depending on the department) led by a teacher. They illustrate the lectures and allow students to explore the topics deeper.

TP : PRACTICALS

Teaching methods allowing the students to acquire hands-on experience concerning the knowledge learned during lectures and tutorials, achieved through experiments. Practical classes are composed of 16 to 20 students. Some practicals may be partially supervised or unsupervised. On the other hand, certain practicals, for safety reasons, need to be closely supervised (up to one teacher for four students).

PROJECT

A project involves putting into practice in an autonomous or semi-autonomous way knowledge acquired by the student at the university. It allows the verification of the acquisition of competences.

FIELD CLASS

Field classes are a supervised teaching method consisting of putting into practice knowledge acquired outside of the university.

INTERNSHIPS

Internships are opportunities enabling students to enrich their education with hands-on experience and to apply lessons learned in the classroom to professional settings, either in industry or in research laboratories. Internships are strongly regulated and the law requires, in particular, a formal internship convention established between the student, the hosting structure and the university.

UNIVERSITÉ TOULOUSE III PAUL SABATIER

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