Master *Informatique* – M2 *Computer Science for Networks (CSN)*

OVERVIEW

Title of the M2: Computer Science for Networks (CSN)
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https://www.ip-paris.fr/education/masters/mention-informatique/master-year-2-computer-science-networks

Program overview: (1000 signes)
CSN – What for?
Want to understand, analyze and improve your communication network? Want to develop and define software on top of next-generation networks? CSN provides techniques and tools that tackle these questions with deep studies of computer science and complex networks. Furthermore, and in order to deal with these objectives, graduate students complementary wish to master the recent approaches based on advanced software engineering.
The CSN program proposes core courses in computer science and networks and optional modules in specific domains. These courses are taught from September to mid February. A number of labs and projects are scheduled for students to practice and assimilate concepts more easily. High quality lectures and project supervision are provided by expert professors and industrials. Most of the professors are scientifically recognized in their research community and members of CNRS labs. Furthermore, courses and labs provided by industrials illustrates the relationships between the taught methods and their applications in the industry. Apart from the acquired technical background, the objective of the Master CSN is to give a first research experience so students are next able to apply for a PhD thesis, research engineers in academic or industrial organizations.

Language of instruction: English
ECTS: 60
Oriented: oriented both Industry and Research depending on the chosen core courses
Duration: 1 year
Courses Location: Palaiseau

Educational objectives of the M2:
The M2 CSN program proposes to be initiated to research and to acquire strong practical and theoretical knowledge in the network and computer science area. The broad range of proposed modules gives students the opportunity to deepen their technical knowledge through computer science methodologies applied to networks as well as to discover new emerging research topics. Two main objectives can be tackled:

(i) to master formal techniques for network and system analysis,
(ii) to study and apply advanced software engineering techniques (e.g., software defined networks, containerization, etc.) to compute, improve and master the keys of the development of distributed networks.

Program structure:
The M2 CSN program is divided in two semesters. The first one gets deeply into specialization with technical and research topics. This semester is mainly dedicated to the study of techniques, methods and tools provided by computer science to model, analyze and improve networks and distributed systems. Based on the choices of the courses made by the students, set of topics may define a CSN

specialization such as Formal Methods for Networks Analysis, Algorithmic in Communication Networks, SW development for the Networks, Dynamic systems, or Security and Testing. The courses (UE) mentioned below define these topics. They are taught by teachers and researchers from Telecom SudParis, Telecom Paris and Ecole Polytechnique as well as industrials.
The semester is built on 30 credits ECTS. Four UE are mandatory (with a total of 15 ECTS) and others have to be chosen by students among a broad choice allowing to target a specialization. Based on the students' choices, objectives above mentioned can be reached.
In parallel to the followed courses, a research project aims at initiating students to research. This project runs all along the semester whose 12 hours are dedicated to the areas of management and effective communications.
The second semester is dedicated to the master thesis (30 ECTS) which is commonly realized in an industrial or academic organization (always remunerated). The master thesis might be research oriented in case it is organized in an industrial context.

List of the CSN courses:

Simulation and Metrology (M. Marot, TSP, 2.5 ects)
Virtualization: Concept and implementation (A. Gopalasingham, Nokia Bell-Labs, 2.5 ects)
Dynamic Systems, autonomous and self-adaptative (A. Diaconescu, TP, 2 ects)
Network Security and Privacy (N. Kaaniche, TSP, 5 ects)
Network Science and Graph Learning (V. Gauthier, TSP, 3 ects)
Wireless network and IoT (B. Jouaber, TSP, 5 ects)

Middleware for distributed Applications (G. Bouloukakis, TSP, 5 ects)
Formal System Testing (S. Maag, TSP, 2.5 ects)
Software Model based Testing (N. Kushik, TSP, 2.5 ects)
Global Laboratory for Industry-Driven Software Development (P. Gibson, TSP, 6 ects)
Computational logic (S. Mimran, Ecole Polytechnique, 4 ects)
Algorithm analysis and Computational Complexity (N. Kushik, TSP, 2.5 ects)
Machine Learning for Networks (A. Araldo, TSP, 4 ects)
Formal Verification (R. Ameur-Boulifa, TP, 2.5 ects)
Algorithms for dynamic and reconfigurable distributed systems (P. Kuznetsov, TP, 2 ects)

Research Project (N. Kushik, TSP, 5 ects)
French (I. Lallemand, TP, 2.5 ects)

Details are provided in the following.

Simulation and Metrology

2.5 ECTS
21 hours

Objectives:

The objective of this course is to familiarize the Master students with event-driven simulation concepts. Performance studies can be driven either analytically, by simulations or by measurements. Simulation is a flexible methodology that can be used to analyse and to model the behaviour of systems and networks. Nowadays, simulations and modelling are being widely used in different fields: industries, research Institutes and Universities. Simulation results are also often used to compare those analytically. During this course, students will be introduced to simulation theory by practising with Network Simulator. Then, the main simulation concepts will be presented: different types of simulations, notion of scheduler, random number generation and confidence interval estimation. The course will be validated with a small project.

Lecturers: Pr Michel Marot

Evaluation: Students are evaluated by a project.

Middleware for distributed Applications

5 ECTS
42 hours

Objectives:

The aim of this module is to develop skills for designing and implementing distributed applications using middleware technologies. At the end of this course, students should be able to choose the appropriate architectural style: appropriate broadcast algorithms, synchronous methods, Representational State Transfer (REST), component oriented middleware, distributed event-based system (DEBS) and to produce enterprise distributed applications.

Lecturers:

Sophie Chabridon (TSP), Denis Conan (TSP), Michel Simatic (TSP), Chantal Taconet (TSP), Georgios Bouloukakis (TSP)

Program:

All the subjects of the module will be illustrated by research articles as well as practical labs. Through a micro-project, students will design and implement a distributed application.

- - Middleware for distributed applications definitions, patterns and overview, (lectures, 3h)
- - Component-based middleware with Java EE (lectures and labs, 9h)
- - Synchronous methods with Web Services (lectures and labs, 6h)
- - Representational State Transfer (REST) (lectures and labs, 6h)
- - Distributed Event Based systems (DEBS) (lectures and labs, 6h)
- - Distributed broadcast algorithms (lectures and labs, 9h)
- - Micro project (labs, 3h)

Evaluation:

- Presentation of a research article
- Results of labs and intermediary deliverables
- Final examination: microproject final deliverable and defense

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Virtualization: Concept and implementation

2,5 ECTS
21 h

Objectives:

The goal of this module is to present the different possibilities to virtualize system from both user-level and system-level point of views.

Lecturers:

Éric Renault (TSP), Aravinthan Gopalasingham (NOKIA)

Program:

Introduction
- What is virtualization
- History of virtualization
- The different kinds of virtualization
- Some elements on operating systems and compilation

Virtualization tools
- KVM, Virtualbox, etc.
- Linux containers, Dockers, etc.

Virtualization and implementation
- Diversion of function calls
- Diversion of system calls

Evaluation:
Evaluated lab or mini-project

Research Project

5 ECTS
42 hours

Objectives:
The main objective of the course is the presentation of the most important aspects of research. The student needs to be aware of the related difficulties, issues, as well as the possibilities to overcome them. During the class, the students should learn how to identify a research-oriented problem, how to investigate the current state of the art in the area, as well as how to present original approaches for its solution.

Lecturers:
Dr. Natalia Kushik; Invited researchers from and external to Télécom SudParis

Program:
Defining the research. Applied and fundamental research. Creativity and Curiosity in Research. PhD or no PhD?
Fundamental research: problems of analysis and synthesis; modelling and decision making; recalling 'classical' models in networks and approaches to their analysis and synthesis.
Applied research: languages and platforms used in the current and future networks; related technologies and existing solutions.
Research paper preparation: tips and hints on putting the background, motivation, related work, and contributions; checking related best practices.
Preparing a paper as a joint work: repositories, content-oriented editors, etc.
Research presentations: 5-min briefing, conference talk, seminar, (invited) lecture; checking related best practices.
Poster preparation: tips and hints.
Thinking of a traineeship / PhD at Télécom SudParis? Research directions and possibilities.

This course is supported by the execution of Applied / Fundamental projects proposed by the researchers from Télécom SudParis, including (Assistant) Professors, PhD students, research engineers, etc.

The class also includes attending research seminars of different kinds, including tutorials, graduate students' presentations, invited talks, etc. Seminars where the students are going to present their progress on individual / group projects, are also foreseen, as well as the practical work on the paper preparation.

Evaluation:
The evaluation is performed based on the quality of the individual / group project implementation, as well as defined control points, namely: i) project progress presentations at the seminar and homework, including preparation of a part of research paper, presentation, state of the art, etc. (25 %), ii) final presentation – project defense (25 %), and iii) supervisor's grade on the research project (50 %).

Network Security and Privacy

5 ECTS

42 hours

Objectives:
This course addresses both security and privacy in networks, under practical and theoretical dimensions. After positioning security vs privacy, some fundamental mechanisms are presented for securing networks (IPsec, SSL, VPN, PKI, filtering), and for preserving privacy in networks and digital identity management (TOR, blind and group signature). Useful basis as well as research aspects (RFID, blockchain) are given through labs, exercises and lectures.

At the end of the lectures, students are supposed to know:

- the fundamentals of security and privacy in networking area, and digital identity management
- security and privacy challenges in few hot research topics (RFID, blockchain)
- how to practically configure an IPsec VPN, and a traffic filter

Useful basis as well as research aspects (RFID, blockchain) are given through labs, exercises and lectures. Optional labs are also proposed for students to practice on their own in the security and privacy domains.

Lecturers:

Nesrine Kaaniche (TSP), Maryline Laurent (TSP), Olivier Paul (TSP), Joaquin Garcia-Alfaro (TSP)

Program:

- Introduction to security and privacy (course)
- Privacy and security models, digital identity, and anonymity of the IP traffic (course)
- Introduction to cryptography (course, exercises)
- Security protocols and VPN (course, lab, exercises)
- Traffic filtering (course, lab)
- Security, privacy and lightweight cryptography on RFID (course)
- Security protocol verification (course, exercises)
- Public Key Infrastructure (course, exercises)
- Security in cloud computing (course)

Evaluation:

The evaluation includes a 2 hour written exam and a lab.

The final grade is computed based on the following ratio: ¾ (exam) and ¼ (lab).

No extra exam is scheduled.

Network science and Graph Learning

4 ECTS

30 h

Objectives:

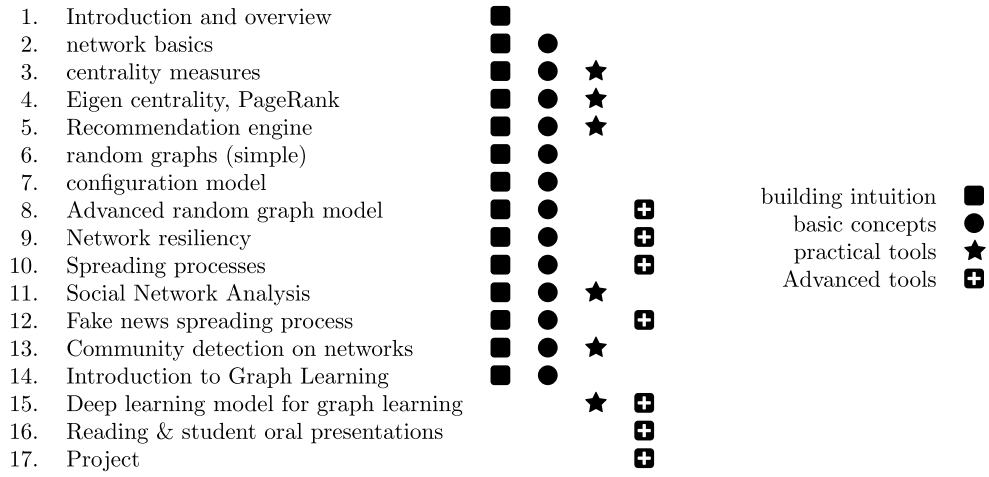
Over the past decade, there has been a growing interest for the complex "connectedness" of modern society. This connectedness is found in many incarnations: in the rapid growth of the Internet and the Web, in the ease with which global communication now takes place. Beyond this classical example, the Network science is a now thriving and increasingly important cross-disciplinary domain that focuses on the representation, analysis, and modeling of various connected systems such as social network, mobility, and transport networks. Motivated by these developments in the world, there has been a coming-together of multiple scientific disciplines to understand how highly connected systems operate. Network science aims to capture, modeling and understanding networks and rich data requires understanding the computational tools for identifying and explaining the patterns they contain. This graduate-level course will examine modern techniques for analyzing and modeling the structure and dynamics of complex networks. The focus will be on statistical algorithms and methods, and both lectures and assignments will emphasize model interpretability and understanding the processes that generate real data. Applications will be drawn from computational social science and Engineering.

Prerequisites: python/matlab, basic knowledge in algorithmic, probability

Lecturers:

Dr Vincent Gauthier

Program:



Evaluation:

The final grades will be weighted as follows:

1. Student project: 100%

References:

[1] D. Easley and J. Kleinberg, Reasoning about a Highly Connected World. Cambridge University Press, 2010.

[2] M. E. J. Newman, Networks : an introduction. Oxford University Press, 2010.

[3] J. Leskovec, A. Rajaraman & J. D. Ullman. Mining of massive datasets, Cambridge University Press, 2020.

[4] William L. Hamilton, Graph Representation Learning, Cambridge University Press, 2020.

Formal System Testing

2.5 ECTS

21 h

Objectives:

The main objective of this course is to provide students with some knowledge in Modelling, Verification and Validation aspects. Testing techniques applied to functional or non-functional aspects (e.g. security) on new generation networks (e.g., ad hoc routing protocols) are emphasized.

A first step is to present what a protocol's formal model is and how to obtain it. Therefore, languages and modelling industrial tools are introduced. The second step is to verify this model in order to finally, in a third phase, derive some tests to validate the real systems.

Lecturers: Pr Stephane Maag

Program:

Specification techniques for communicating protocols and services

A) model-based testing

B) ITU-T SDL and SySML

Techniques for automated generation of test scripts

A) from the models

B) field experience

Standardized test execution scores.

A) ETSI TDL and TTCN3

Network monitoring techniques applied to tests

A) passive test

B) DPI - Deep Packet Inspection

Industrial tools for testing

A) active / passive test tools

B) Monitoring tools for testing.

Evaluation: Project

Software Model based Testing

2,5 ECTS

21 h

Objectives:

The main objective of this course is the study of existing testing techniques for different types of software used in telecommunications. The students should learn how to estimate the software quality from a tester point of view and which formal models can be used to derive high quality tests or to verify the correctness of certain properties of software components of discrete event systems.

At the end of the course, the successful students should know and be able to effectually apply:

- Most popular test derivation strategies and their fault coverage;
- Existing active and passive testing techniques allowing to conclude about the software quality.

Classes are supported by research and development projects, implemented in groups or individually.

Lecturers:

Drs. Natalia Kushik and Jorge López (TSP)

Program:

- Introduction to software quality (lecture);
- Introduction to software testing problem; testing assumptions and methodologies; classification of various testing techniques (lecture and exercises / laboratory);
- Motivation to Model Based Testing; introducing formal models for discrete event systems (lecture);
- State model based test generation strategies (lecture and exercises / laboratory);
- Introduction to non-intrusive testing techniques (lecture and exercises);

- Static Analysis / Code Verification and Passive testing (lecture and exercises / laboratory);
- (Semi-) random test generation VS Model based (laboratory);
- Examples of existing tools implementing the test generation strategies of interest (laboratory);
- Individual / group project on software testing.

Evaluation:
The evaluation includes a 3 hour written exam and a project.
The final grade is computed based on the following ratio: 3/4 (exam) and 1/4 (project).

Global Laboratory for Industry-Driven Software Development
6 ECTS
42 h

Objectives:
The emphasis is on development of a prototype system in which software has a significant role. The software must be developed following a continuous integration approach based on agile development methods. The teams (made up of students located around the world) will be expected to deliver working software (to a real client) in a sequence of weekly sprints.

Prerequisites:
Each team member must be able to program competently in a high-level programming language. They must also know the fundamentals of software engineering, including all aspects of the software life-cycle.

Lecturers:
Dr J Paul Gibson

Program:
This module proposal is part of the European project HUBLINKED (http://www.hublinked.eu). **Global Labs** are online modules where teams of international students work on software development/other prototypes, which are specified by industry or community partners, with the aim of 'turning real-world ideas into experience-appropriate prototypes'. Student teams are mentored by both academic and industry staff.

This is not an industrial placement – the students continue to work in the academic environment.

The project will be developed over a time period of 12 weeks. Each team is expected to plan/schedule the work on a weekly basis. Every week the team must deliver a progress report, and an updated plan for the weeks ahead. The team must hold a meeting between team members at least twice a week; and a meeting with the academic advisor and/or industrial supervisor at least once a week.

The learning laboratories

Every week, the students will be expected to complete an on-line lab. explaining a useful technique/tool specific to the module in question. These can be completed individually and/or in teams.

References:
http://agilemethodology.org
https://www.martinfowler.com/books/duvall.html
https://theagileadmin.com/what-is-devops/

Evaluation:
The following **learning objectives** will form the basis of the evaluation –
1) Team work in a global context (using appropriate planning, communication and management tools)
2) Use of an industrial-strength version control system
3) Use of an industrial-strength continuous integration platform-service for agile development
4) Quality-assurance on delivered work
5) Interaction with an industrial client

The final mark will be calculated from:
Continual delivery of work (50%)
Engineering log journal (20%)
Participation in global learning labs (20%)
Presentation/Defense (10%)

Algorithm analysis and Computational Complexity
2,5 ECTS
21 h

Objectives:

Computer Science does not live without algorithms, and furthermore, 'good' algorithms, and thus, their analysis is crucial. The successful students after this class should understand why big industrial players now put a lot of efforts into the algorithm analysis and should be able to perform such analysis by themselves.
In the context of the CSN program we will tackle the network related classical and non-classical problems in computer communications and will study how to perform their analysis.
The main objective of the course is therefore the study of the design and analysis of algorithms, including the proofs of their correctness and their complexity estimation.

Lecturers:

Drs. Natalia Kushik and Jorge López (TSP)

Program:

Turing Machines. Computability. Decision problems. Decidable and undecidable problems. The Halting Problem (Lecture and exercises).
Algorithm and Problem Complexity. Complexity classes. Time and Space Complexity. Hardness and completeness of (decision) problems (Lecture and exercises).
SAT-problem (Lecture and exercises).
Algorithm analysis for *"very known"* problems (e.g., sorting) – where to start and how to proceed.
Hamiltonian path, Hamiltonian cycle problems, Clique problem (Lecture and exercises).
Data structures as a complexity reduction strategy.
Greedy algorithms as tempting ideas: how often do they lies and what is the price?
Algorithms and their analysis in related fields of Communication Networks:
- Complexity issues in information security (Lecture, discussion and students' presentations) – background for the guaranteed secrecy.
- Complexity issues in software testing (Lecture, discussion and students' presentations) – background for software certification.

Discussions and debates on open (Millennium) problems:
i) P =? NP.
ii) Alternative complexity definitions?
iii) Improving the performance of an implementation? 'Classical' compiler optimizations and beyond that; from high to low level programming languages?

Individual laboratories on the listed subjects will be performed. The algorithm analysis will be supported by the experimental evaluation of software quality parameters, such as performance, disc load, energy consumption, etc.

Evaluation:

The evaluation includes a 3 hour written exam (1/2 of the final grade).
The class also contains the continuous evaluation represented as homework, laboratories and students' presentations (1/2 of the final grade).

French as a Foreign Language
2,5 ECTS
42 h

Objectives:

French courses aim to develop language skills, intercultural skills and learner autonomy. They are organized by level. Each course aims to reach one of the CEFR levels:
Level A0 = complete beginner
Level A1 = introductory or discovery level
Level A2 = intermediate or survival level
Level B1 = basic operational level
Level B2 = advanced level or independent user
Level C1 = advanced or experienced, autonomous user
For more information see the Common European Framework Reference for Languages (CEFR): http://www.coe.int/t/dg4/linguistic/cadre1_en.asp

Lecturers:

Isabelle Lallemand

Program:

Courses are based on the communicative approach and action-oriented approach recommended in the CEFR. Students will carry out projects, tasks activities and exercises linked to the objectives of their language level. The intercultural approach is an integral part of courses. In addition learners are accompanied in developing learner autonomy.
Classes use ICT, authentic documents and multimedia. Besides class, significant engagement and personal work are required to make efficient progress.

References:

CEFR : http://www.coe.int/t/dg4/linguistic/cadre1_en.asp

Evaluation:

Assessment aims to determine what has been acquired, what is in the process of being acquired and what has not been acquired. It also takes into account class participation and personal work (continuous assessment). The final grade out of 20 is based on continuous assessment (60%) and the final exam (40%).

Machine Learning for Networks

4 ECTS

35h

Objectives:

- Understanding the main machine learning methods and algorithms
- Being able to apply them to computer networks and applications to solve practical use-cases
- Being able to define and follow a correct protocol (data pre-processing, training, test, validation) and to adapt it to the different use-cases
- Being able to use the main Python libraries for Machine Learning

Lecturers:

Andrea Araldo (TSP)

Program:

1. Introduction (supervised / unsupervised Machine Learning, protocol, data preparation in python)
2. Data exploration, Linear Regression, evaluation of regression models
3. Polynomial Regression, Logistic Regression, evaluation of classification models
4. Neural Networks (application to network intrusion classification)
5. Tree-based learning and Ensemble Learning
6. Non-supervised Learning
7. Anomaly detection (application to intrusion detection)
8. Recommender systems (application to recommendation of web content)
9. Time series, Long Short-Term Memory networks (application to IoT or data centers).
10. Preventive Maintenance
11. Project presentation and exam

All courses will be “cours intégrés”

Evaluation:

50% project, 25% exam, 25% participation in class.

Wireless network and IoT

5 ECTS

42h

Objectives:

- To learn and understand the challenges in the design of wireless networks.
- To learn about wireless networks’ architectures, protocols, technologies and QoS
- To learn about IoT ecosystem, uses cases, requirements and challenges, technologies and solutions
- To understand various security issues and challenges for IoT networks and learn about existing solutions.

Lecturers:

Badii Jouaber (TSP)

Program:

Part I (Theory)

1. Introduction to Wireless communications and Internet of Things
2. Example of connected things and IoT Use cases
3. Physical networks: WPAN, WLAN, WMAN and WRAN
4. Short Range Networks: WiFi, Bluetooth, Zegbee, RFID, 6LowPAN
5. Device2Device Networks, Ad Hoc and multihop networks
6. Cellular Networks (From GSM to 5G)
7. Networking solutions for IoT (LTE-M, NB-IoT, Lora, SigFox, …)
8. Cloud and Fog Networking for IoT
9. Platforms for IoT
10. Security and Green aspects of the IoT

Part II (reading articles and presentation)

It consists of selecting articles related to the Wireless technologies and IoT, working on the articles and then providing presentation to audience.

Evaluation:
Presentation research article, Final Examination

Formal Verification
2,5 ECTS
21h
Objectives:
Upon completion of the Formal method course, learners may :
- be able to write unambiguous specifications, and to express properties of systems.
- be able to reason about systems, and to realize demonstration of properties.
- be able to use tools which integrate and automate the formal analysis.

Lecturers:
Rabea Ameur-Boulifa (Telecom Paris)
Program:
In this course, part of the Computer science for Communication Networks, you will learn how to perform formal methods. We have chosen these methods because they are essential in building of highly reliable systems.
The concepts from this course can be applied for verifying any system from various domains.
The course focuses on theory for specification, validation and verification of Network and network services specified by communicating state machines. The theory covers modelling distributed and concurrent systems with process algebras. The notion and properties of bisimilarity relation. Temporal logics LTL and CTL for specification of behavioural properties of systems. And Model checking algorithm for verification of CTL formulae. With a focus on UPPAAL model-checker, hands-on practice will be carried for analysis and verification of systems.

Evaluation:
Lab sessions.

Dynamic Systems, autonomic and self-adaptive
2 ECTS
Objectives:
This course offers an introduction to autonomic systems. An autonomic system is capable of self-management, in order to achieve high level objectives (e.g., optimal performance, safety), while minimizing the need for low level human intervention (e.g., configuration of system variables) This is essential for the management of modern, increasingly complex cyber physical systems (CPS). The areas of application concerned include smart homes, smart electric grids, autonomous vehicular networks, robot coalitions, mobile sensor networks, Data Centers and Industry 4.0.
Lecturers: Ada Diaconescu (Telecom Paris)
Program:
The topics covered include component and service oriented technologies, allowing the adaptation of systems during their execution; an introduction to autonomic systems and their applications; and a presentation of common architectures of complex autonomic systems.
Practical work and an IT project will be developed via a service-oriented platform simulating a smart home (iCASA).
Prerequisites: Good knowledge of OO / Java programming

Algorithms for dynamic and reconfigurable distributed systems
2 ECTS
Objectives:
The class is devoted to algorithms designed for distributed systems with scalable members.
In particular, we plan to discuss techniques of reconfiguration, information gathering and election of leaders in dynamic systems.
Lecturers: Petr Kuznetzov (Telecom Paris)

Computational Logic
4 ECTS
33 hours
Objectives:
Computational logic has been used in a wide range of application in computer science, ranging from the deductive approach to Artificial Intelligence advocated by AI's founder John McCarthy, to proving the

absence of bugs in large industrial software such as the 14th metro line in Paris, or checking difficult theorems the as the one of Feit-Thompson in the classification of finite simple groups. The goal of this course is to explain how logic can be used in order for modeling problems of computational or mathematical nature, and how computers can be used to achieve this.
Lecturers: Samuel Mimran (Ecole Polytechnique)
Program: In particular, we will present proof assistants, which allow to formalize human reasoning by interactively constructing proofs, and explain their use to certify the absence of bugs in programs. This is based on the so-called Curry-Howard correspondence: a program is the same as a proof (or, more precisely, a typed functional program corresponds to a derivation of its type). We will gradually introduce the required notions: - propositional logic and the constructive variants, - functional programming, formalized by lambda-calculus, - typing systems and the Curry-Howard correspondence. Then in order to reach realistic applications, we will present the proof assistant Agda and dependent logic which underlies it. Time permitting, we will also present various important related notions and techniques such as set theory and proof search. This course is also about logic in practice: all the TDs will be on computer, using OCaml and then Agda. Pre-requisites: some basic knowledge of logic, the course INF412 being of course perfect for this, otherwise reading some introductory book on logic over the summer is recommended (see the references on the website). The website for the course is http://inf551.mimram.fr/

Decision Procedures for Artificial Intelligence
2.5 ECTS
21 hours
Objectives:
A student following the course will:
- learn to model complex problems from the AI and verification domain using logic, and solve them using sat and SMT solvers
- understand and apply the concepts of modern satisfiability algorithms (learning, non-chronological backtracking) also for first-order theories (lazy approach, theory solvers)
- learn how to use modern SAT and SMT solvers.

Lecturers:
Alexandre Chapoutot (ENSTA Paris)
Sergio Mover (Ecole Polytechnique)
Program: Reasoning automatically about logical formulas is crucial in solving problems in Artificial Intelligence (e.g., path and task planning) and Formal Methods (e.g., software verification). This course will present the modern, efficient algorithms (decision procedures) used to check the satisfiability (SAT) of formulas in propositional logics (e.g., Conflict Driven Clause Learning, CDCL) and the extensions of these algorithms to check more expressive first-order-logic formulas (Satisfiability Modulo Theory, SMT). The course will also present how logical modeling and satisfiability can solve problems in AI (Logical Knowledge-based agent) and formal methods (software verification). In detail, the tutorial will cover problems such as path planning, task planning, and bounded model checking to illustrate theoretical notions and practical implementation of algorithms.

The course cover
- Propositional logic and modeling: This lecture aims at introducing (recalling) basic elements on propositional logic and showing some examples on how to encode decision problems with Boolean formula.
- SAT solving algorithms: This lecture aims at presenting the main algorithms (namely DPLL and CDCL) to solve satisfiability problems of Boolean formula.
- Applications in AI: This lecture aims at presenting several AI applications of Boolean formula models for decision problems.
- Satisfiability Modulo Theory: This lecture recalls first order logic, introduces theories and the Satisfiability Modulo Theory problem, and then describe the lazy approach to SMT solving (DPLL(T)).
- Theory of Equality and Uninterpreted functions (EUF): the lecture covers the decision procedure for the EUF theory.
- Theory of Linear Arithmetic: decision procedures for the linear rational arithmetic theory (LRA) and linear integer arithmetic (LIA)
- Verification using SMT: introduce the application of SMT to verifying safety properties for software.

Each lecture will be followed by a 2 hours tutorial where the student will practice modeling and solving problems using SAT and SMT (using state of the art solvers) and will implement some of the algorithms covered during the lectures.

References:
Daniel Kroening and Ofer Strichman, Decision procedures: an algorithmic point of view, 2nd edition, 2016.
Aaron R. Bradley and Zohar Manna, The Calculus of Computation: Decision Procedures with Applications to Verification, 2007.

Evaluation:
The course will be evaluated via weekly multiple choice questions (20%) and an individual project.

IP Paris labs involved:
SAMOVAR
LTCI
LIX

Career prospects:
The Master CSN leads to research (in research institutes or universities) and engineering positions (e.g., industry) in the diverse fields of computer science dedicated to networks and communication systems. More specifically, the domains the students will be able to use their learned skills, knowledge and expertise on are the modeling and analysis of complex networks, distributed computing for new-generation communicating systems, their qualitative and quantitative studies.
Several research labs and companies hire students from CSN such as Nokia (Bell Labs), Orange (R&D), CEA, Thales, Huawei, etc. Students also have opportunities to continue with a PhD thesis in a CNRS Lab from Institut Polytechnique de Paris as well as in the industry (e.g., CIFRE).

Institutional partners:
Télécom SudParis
Télécom Paris
Ecole Polytechnique
ENSTA

The M2 CSN has also signed agreements with other universities as mentioned in the following:
Beijing JIAOTONG University, China, Dual Master Degree agreement
Galileo University, Guatemala, Dual Master Degree agreement
Mälardalen University (MDU), Sweden
Technological University Dublin (TUD), Ireland

Industrial partners: (1200 signes)
NOKIA
ANSSI
IBM

Chairs and Partnerships:
Chaire Cybersécurité des infrastructures critiques (Télécom SudParis et al.)
Chaire Valeurs et politiques des informations personnelles (Télécom SudParis et al.)
Chaire Inventivités Digitales (Télécom SudParis et al.)
Chaire Réseaux du futur pour les Services de demain (Télécom SudParis et al.)
Chaire Good In Tech (Télécom SudParis et al.)

Master Double Degree with JiaoTong University of Beijing, China (BJTU)
Master Double Degree with Galileo University, Guatemala (UGAL)
Label from European project and joint courses with universities through the ERASMUS+ HubLinked project.

Tuition fees: https://www.ip-paris.fr/education/masters/mention-informatique/master-year-2-computer-science-networks (dependent on agreements with universities/institutes)

Social networks
WhatsApp group
Twitter

ADMISSIONS

Academic Prerequisites
Basic knowledge on network protocols.
Basic knowledge in Object programming languages.
Basic knowledge in Mathematics and Probability.

Language prerequisites
English levels CEFR B2
IELTS: 5.5/9
TOEFL paper based: 550/677
TOEFL computer based: 213/300
TOEFL internet based: 79/120
TOEIC: 750/990
Cambridge: CAE (Certificate of Advanced English)
CET-6 600

Procedure https://www.ip-paris.fr/education/masters/mention-informatique/master-year-2-computer-science-networks

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M2 CSN URL: https://www.ip-paris.fr/education/masters/mention-informatique/master-year-2-computer-science-networks