



UNIVERSITÀ DEGLI STUDI DI TRENTO

Facoltà di Scienze Matematiche,  
Fisiche e Naturali

**Manifesto del**  
**Corso di Laurea Magistrale in Informatica**  
**a.a. 2009-10**

Approvato nel Consiglio di Facoltà del 20 maggio 2009

**1. “Istituzione e attivazione”**

The Faculty of Science promotes the Corso di Laurea Magistrale in Informatica (Master of Science in Computer Science”, belonging to the class “LM-18 - Scienze e Tecnologie Informatiche”. The degree is activated starting from the a.y. 2008/2009 through the insertion in the Database of the Offerta Formativa.

**2. Objectives**

The Master of Science in Computer Science (“Laurea Magistrale in Informatica”) is aimed at training professionals provided with both an in-depth understanding of the theoretical principles of computer science, and a specific collection of knowledge related to one of the following areas:

- The area *Software technologies* provided students with the knowledge required to deal with the analysis, the design and the development of large-scale software systems, with a particular emphasis on properties such as quality, correctness and security.
- The area *Systems and networks* provides students with the ability of designing and understanding large systems composed of a distributed collection of interacting entities. Examples include both technological systems such as distributed systems and networks, as well as complex relational systems such as social networks.
- The area *Bio-informatics* provides students with the ability to interact with professionals and scientist in the field of life sciences, with the aim of proposing computer science solutions to scientific problems..
- The area *Data media and knowledge* provides students with the knowledge required to extract, manage and present information, with courses related to machine learning, advanced information systems and the web.
- The area *Embedded systems and ambient intelligence* is focused on the methodologies for the development of software applications for embedded systems, one of the fastest growing areas

in ICT. Applications range from automatic controls used in industrial, automotive and avionic systems, to recent infotainment systems (e.g. smart phones), to domotics and ambiente intelligence.

Each of this areas corresponds to a specialization. Each specialization consists of a small set of compulsory courses, common to all specializations; a collection of courses related to the selected specialization; and large set of free-choice courses.

The courses of the Laurea Magistrale in Informatica are taught in English.

### 3. Admission requirements

To apply to the Laurea Magistrale in Informatica, a Bachelor degree lasting for three years or longer is required; such degree *must* contain a minimum collection of courses related to programming, algorithms, data management, system architectures (hardware, operating systems, networks), mathematical notions related to calculus, discrete mathematic, probability and statistics. More in-depth notions related to architectures, operating systems, algorithms, networks, language theory, web must be required depending on the selected specialization.

In this section, the guidelines used to evaluate whether the bachelor degree satisfy these minimum requirements are discussed.

- *Laurea in Informatica (class “26 – Scienze e Tecnologie Informatiche”)* and *Laurea in Informatica (class “L-31 – Scienze e Tecnologie Informatiche”)*, issued by the University of Trento. Students with such degrees are automatically admitted to the Laurea Magistrale in Informatica. Students who have selected the professional specialization in their Bachelor degree are required to present a personalized study plan.
- “*Lauree passanti*”: Italian degrees belonging to the classes “L-31 – Scienze e Tecnologie Informatiche”, “26 – Scienze e Tecnologie Informatiche”, “L-8 – Ingegneria dell'Informazione”, “9 – Ingegneria dell'Informazione” whose syllabus satisfies specific requirements. Each year, the Consiglio d'Area Didattica in Informatica publishes a list of “lauree passanti”. The evaluation of which degrees belong to this list can be based on the correspondence between such degrees and syllabi defined at the national level. Students with such degrees are automatically admitted to the Laurea Magistrale in Informatica, but are required to present a personalized study plan.
- *Bachelor degrees issued from the University of Trento “similar” to the Bachelor in Computer Science*, which individual study plan contain a reasonable amount of credits in the the computer science area (sector INF/01 and ING-INF/05), previously agreed between the Consiglio d'Area Didattica that issues the Bachelor degree and the Consiglio D'Area Didattica in Informatica. Each year, the Consiglio d'Area Didattica in Informatica publishes a list of “similar” Bachelor degrees. Students with such degrees are automatically admitted to the Laurea Magistrale in Informatica, but are required to present a personalized study plan.
- In all the other cases, a formal application request is required, including the following information:
  - a detailed study plan of the Bachelor degree, including title and syllabus of all the courses;
  - a document issued from the University that issued the Bachelor degree reporting, in Italian or English, the list of courses, the score obtained in each of them and the final score associated to the degree.
  - work and professional experiences;

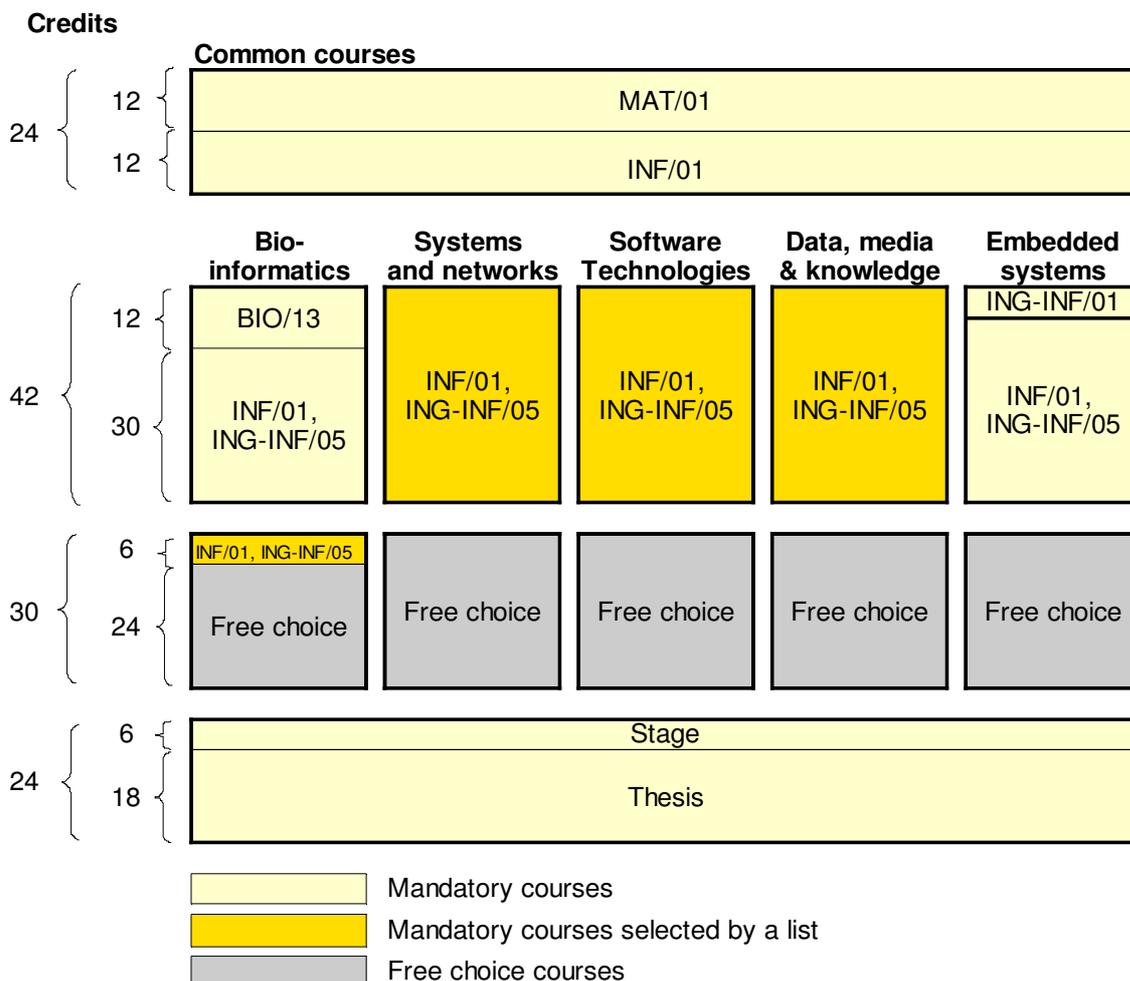
- level of knowledge of English Language, certified by internationally recognized organizations or by the University that issued the Bachelor degree;
- a motivation statement, explaining why the student is willing to apply to the Corso di Laurea Magistrale in Informatica, and what he/she expect from it.
- Students in this last condition must present a personalized study plan.

Application forms will be evaluated by a commission elected by the Consiglio d'Area Didattica in informatica. The commission can require a personal interview (possibly on-line) with the applicants, to better evaluated their knowledge.

Norma transitoria: gli studenti attualmente iscritti al Corso di Laurea Specialistica in Informatica (classe 23/S) dell'Università di Trento possono richiedere il passaggio al nuovo ordinamento, con riconoscimento totale dei crediti già acquisiti.

#### 4. Course and exams

The following figure shows the organization of the Master Degree. Out of a total number of 120 credits, 24 credits are in common and compulsory for all specializations; 42 credits are for courses linked to one of the five specializations; 30 credits are free choice. The degree is completed with 6 credits for the stage activity and 18 credits for the final thesis.



## 4.1 Common courses

The 24 credits common to all specializations are organized in four courses, in which the theoretical and mathematical principles of computer science are discussed.

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Suggested year</b>	<b>Semester</b>
Mathematical Logic	6	MAT/01	1	2
<a href="#">Computability</a>	6	MAT/01	1	1
<a href="#">Concurrency theory</a>	6	INF/01	1	1
<a href="#">Computational Complexity</a>	6	INF/01	1	1

Foreign students are also required to include the following two courses in their study plan. These activities are given an approved/not approved mark.

<b>Title</b>	<b>Credits</b>	<b>Sector</b>
Italian language (level A1)	3	
Italian culture	3	L-FIL-LET/10

## 4.2 Bio-informatics

Basic notions about genetics and molecular biology are provided; techniques to simulate biological behaviors are discussed; tools and techniques to model and analyze complex biological systems are introduced, together with fundamental notions about data mining. Potential spin-off on IT originated from the study of biological systems are discussed.

### Specialization courses:

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
<a href="#">Biology</a>	12	BIO/13	1
<a href="#">Data mining for biological data</a>	6	ING-INF/05	1
<a href="#">Formal</a> methods	12	ING-INF/05	1
<a href="#">Modelling</a> of biological systems	6	INF/01	2
<a href="#">Simulation of biological systems</a>	6	INF/01	2

Students complete their studies by selecting 6 credits in the sector INF/01 or ING-INF/05, and 24 credits are free-choice. An additional collection of suggested courses for the Bio-Informatics specialization is suggested here; other courses may be selected from the complete list of courses.

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
<a href="#">Chemistry for bio-informatics</a>	6	CHIM/06	1
Machine Learning	6	INF/01	1

### 4.3 Systems and networks

The last decades have witnessed an authentic revolution in the field of communications and distributed computing: technologies like Internet and cellular networks, although developed several years ago, have finally reached the general public and become a fundamental component of our lives. Future networks will be more pervasive than ever; possibly networking capabilities will be added to almost all human artifacts.

The sheer number of networked devices has already grown to billions of devices; in the future, further growth is to be expected. How to deal with such large scale and complexity? How to manage large-scale systems in a completely decentralized way? How to provide dependable services in spite of failures and malicious entities? These questions are just a few of those that haunt technicians and business men alike, in their seek for ever more performing and reliable computing and communication systems.

The System and networks specialization is aimed at educating professionals capable to dominate the inherent complexity of future networks, designing and managing the interconnected systems of the future society. The portfolio of offered courses covers all aspects of the distributed systems area, from low-level communication protocols to high-level applications and services, including also theoretical courses where the general problem of analyzing, managing and organizing large-scale, complex systems is discussed. Students are free to create their preferred mixture of courses by carefully preparing their study plan.

Possible suggestions for study plans are as follows:

- A study plan more oriented towards distributed systems, web, and complex systems: Machine Learning, Web Mining, Performance Evaluation, Distributed Systems, Complex Systems, Web architectures, Organizational Information Systems.
- A study plan more oriented towards networking: Advanced networking, Nomadic communications, Performance evaluation, System security, Network security, Distributed systems, Web architectures.

#### Specialization courses:

Students must select 42 credits out from the following courses:

Title	Credits	Sector	Semester
<a href="#">Advanced networking</a>	6	ING-INF/05	1
<a href="#">Computer security</a>	6	ING-INF/05	1
Complex systems	6	INF/01	TACE
<a href="#">Machine learning</a>	6	INF/01	1
<a href="#">Performance evaluation</a>	6	ING-INF/05	TACE
<a href="#">Web architectures</a>	6	INF/01	1
Distributed systems	6	INF/01	1
Network security	6	ING-INF/05	2
Nomadic communications	6	ING-INF/05	2
<a href="#">Web mining</a>	6	INF/01	2

Students complete their studies by 30 credits as free-choice. Free courses can be any course that is not counted in the 42 credits requirement. A list of free courses related to the area of Systems and Networks is provided for assisting students in their selections:

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
Service oriented Architectures and Applications	6	INF/01	1
Business process management and integration	6	INF/01	2
Optical networks*	6	ING-INF/05	2
<a href="#"><u>Organizational Information Systems</u></a>	6	ING-INF/05	2
Wireless sensor networks	6		2
Reserch project in Systms and Networks	12	INF/01	2

\* Offered by Telecommunication Engineering

## 4.4 Software technologies

This curriculum address the challenges of the analysis, design and software development of large scale socio-technical systems with proven quality of assurance, correctness, security and usability. The curriculum can be essentially designed in three main stream

- Design: the courses part of this stream complements the traditional part of Software Engineering in BSc courses with the analysis of organizational requirements behind the development of software systems (Requirements Engineering) and new development methodologies (Agent-Oriented Software Engineering) and usability (Human Computer Interaction).
- Assurance and Security: here the courses focus on the analysis of trust and security at organizational and business process level (Computer Security) and lower level (Network Security) that are . Also in this case usability considerations (Human-Computer Interaction) play a key role.
- Correctness: this stream faces the challenges of the design of a correct software systems through the technology of testing (Software Analysis and Testing, and Laboratory of Software Analysis) and the complementary techniques of formal verification and model checking (Formal Methods).

The curriculum can be complemented with a number of courses from other curricula among the suggested alternatives students can explore the issue behind the design of Organizational Systems where socio-technical issues are considered more thoroughly. Further we have envisaged the aspects of Software Management, for students that intends to continue their careers in Industry, and Research Projects in Software Technologies, for students interested in deepening their knowledge of applied research topics.

Students interested to pursue specialization in the areas of Design, Assurance and Correctness are also encouraged to take the advanced 3credits courses in each of the above area that are offered in the framework of the PhD programme (Conceptual Modeling and Ontological Analysis, Access Control and Information Theory, Advanced Software Verification,). The schedule of the courses, normally in the second semester, can be found at <http://ict.unitn.it/edu/ict/courselist.xml?year=2009>

Students are free to select their path in the curriculum by carefully preparing their study plan.

### Specialization courses:

Students must select 42 credits out from the following courses:

Title	Credits	Sector	Semester
<a href="#">Agent-oriented software engineering</a>	6	ING-INF/05	1
<a href="#">Computer security</a>	6	ING-INF/05	1
<a href="#">Software analysis and testing</a>	6	ING-INF/05	1
Human-Computer Interaction	6	ING-INF/05	1
<a href="#">Formal methods</a>	12	INF/01	2
<a href="#">Network security</a>	6	ING-INF/05	2
<a href="#">Requirement engineering</a>	6	ING-INF/05	2
<a href="#">Software project management</a>	6	ING-INF/05	2

Students complete their studies by 30 credits as free-choice. Free courses can be any course that is not counted in the 42 credits requirement. A list of free courses related to the area of Software Technologies is provided for assisting students in their selections:

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
Business Process Management and integration <sup>1</sup>	6	INF/01	2
<a href="#"><u>Organizational Information Systems</u></a>	6	ING-INF/05	2
Service Oriented Architectures and Applications <sup>2</sup>	6	INF/01	1
<a href="#"><u>Research project in Software technologies</u></a>	12	ING-INF/05	2

---

<sup>1</sup> Part of the course Web Languages that is not any more offered.

<sup>2</sup> Part of the course Web Languages that is not any more offered.

## 4.5 Data, media & knowledge

The aim of this specialization is to train the students in modern data management techniques for solving real world problems. Through the specialization, the students learn how to build large scale integration systems like those allowing heterogeneous medical data, i.e., MIR scans, X-Rays, text notes, statistical data, personal data, or sounds, to be shared across health institutions. They also learn how credit card companies can analyze transaction data of card owners in order to make predictions and discover anomalies that may indicate fraud. Students get expertise on building systems that successfully exchange information between data sources that have been developed independently, or merge them into one, as is the case of company acquisitions. They also learn how to efficiently and effectively query sensors like those measuring weather conditions, a challenging problem due to their small memory, limited power and restrictive computational capabilities. They find out how geographical information systems like those used by Google maps operate. The specializations has also a strong focus on web technologies. Students are taught how services can be used on the web to build successive e-commerce and e-business applications, and what is the logic theory and reasoning techniques that forms the foundation of all the successful modern web information systems. Furthermore, the specializations has a focus on Semantic-Web technologies. It communicates to students how web searches can be improved by adding semantics on the available web data and how systems can overcome the structural and syntactic limitations that naturally exist. Finally, it offers the opportunity to learn about Web 2.0 theories and its applications, i.e., blogs or Amazon-like customer reviews.

Graduates of this specialization through their training gain a large amount of technical experience that allows them to find high qualified jobs in the industrial and public sector. Furthermore, they obtain the required theoretical foundation that will allow them to pursue a PhD degree and excel in the academic sector or in high level managerial and technical positions within large industry organizations.

Students will have to earn 42 credits by selecting and succeeding in 7 courses from the list of high Data, Media and Knowledge related courses provided below. In addition, they have to complete their training by selecting 5 additional courses (30 credits) of free choice. These courses will allow them either to specialize further in an area of their choice, or to obtain strong interdisciplinary background.

**Specialization courses:**

Students must select 42 credits from the following courses:

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
Data and Information Integration <sup>3</sup>	6	ING-INF/05	1
Organizational Information Systems	6	ING-INF/05	2
Service Oriented Architectures and Applications <sup>4</sup>	6	INF/01	1
Business Process Management and integration <sup>5</sup>	6	INF/01	2
<a href="#">Machine learning</a>	6	INF/01	1
<a href="#">Data mining for knowledge management</a>	6	INF/01	2
Human Computer Interaction	6	ING-INF/05	1
Web mining	6	INF/01	2
<a href="#">Spatial databases</a>	6	INF/01	1
<a href="#">Logics for data and knowledge representation</a>	6	ING-INF/05	1

Free courses can be any course, including those in the list above, provided of course that they are not counted in the 42 credits requirement. A list of free courses related to the area of Data, Media and Knowledge is provided for assisting students in their selections:

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
<a href="#">Web architectures</a>	6	INF/01	1
<a href="#">Computer security</a>	6	ING-INF/05	1
Agent-oriented software engineering	6	ING-INF/05	1
Principles of computer graphics	6	INF/01	2
<a href="#">Requirement engineering</a>	6	ING-INF/05	2
<a href="#">Software project management</a>	6	ING-INF/05	2
<a href="#">Research project in Data, Media &amp; Knowledge</a>	12	ING-INF/05	2

---

<sup>3</sup> Previously called Advanced Information Systems

<sup>4</sup> Part of the course Web Languages that is not any more offered.

<sup>5</sup> Part of the course Web Languages that is not any more offered.

## 4.6 Embedded systems and ambient intelligence

Electronic technology has become the mainstay of any engineering system with complex functionality. Automobiles, air-planes, even everyday use objects such as pens and domestic appliances have an important electronic dimension, which is typically transparent to the users. For this reason, the electronic devices immersed in larger systems are called embedded systems. Among the most important functions embedded systems enable are control and monitoring of the operation of mechanical systems such as automotive engines or suspensions, chemical systems such as distillation towers, and communication systems such as cellular phones. Many embedded systems are safety critical, i.e., any malfunctioning may yield catastrophic outcomes for human health. The commercial importance of Embedded Controllers (EC) and of Embedded Systems in general has steadily grown in the past few years, opening unprecedented opportunities for improving the quality of the resulting products. The pervasiveness of these components is well illustrated by the following examples:

- the European automotive sector has a turnover of around 500 Billions Euro and it employs 2.7 million people in the EU. As of today, the 20% of the value of each car is due to embedded electronics. This ratio is expected to increase to 35-40% by 2015 creating more than 600.000 jobs in the automotive embedded systems alone (source ARTEMIS initiative)
- in the year 2005 the total amount of money spent in the EU for R&D activities in the Embedded systems areas is estimated in 20.000 millions Euro (19.750 from private investment and 250 from public investments). It is expected that in 2010 the total expenditure will overcome 28500 Millions Euro.

The development of EC is a very complex activity for a variety of reasons. The first problem is the presence of tight safety requirements. A failure of the system can even result in the loss of human lives. Moreover, fixing a problem in a system shipped in thousands of units can result in enormous additional costs for its manufacturer. Other issues such as time-to-market, cost of the deployed architecture, power consumption and memory footprint are also known to play a role of increasing importance. In short, designers and engineers are confronted with a challenge of overwhelming complexity: reliable (and often safety-critical) applications have to be developed in a short time using low-cost components. In order to cope with these challenging issues, an engineer operating in this domain must be provided with a wide body of knowledge, spanning over diverse scientific and technological disciplines. To build this knowledge, the faculty proposes a curriculum consisting of mandatory and optional courses. The mandatory courses cover the following cultural domains:

- Hardware/software platforms: the developer of embedded software has cost containment among his/her primary concerns. Hence, he/she needs foundational information on the main trade-offs present in hardware design and on how real-time computations can be performed even on low cost platforms. This information is conveyed by “advanced architectures” and “real-time operating systems”.
- Production of safety critical code: the correctness of the produced code is really the name of the game. Basic methodological skills on functional and temporal correctness will be offered in the “formal methods” and in the “real-time operating systems” courses.
- Networking: tomorrows embedded systems will be networked to an unprecedented extent. Particularly, wireless networking will take the lion share. Advanced information on wireless networking will be offered in the “nomadic communications” course:
- Signal and Systems: most embedded systems are used to process signals and implement control systems. A basic knowledge on this wide discipline will be offered in the Signal and Systems course.

**Specialization courses:**

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
<a href="#">Advanced systems and architectures</a> <sup>6</sup>	6	ING-INF/01	1
<a href="#">Real time operating systems and middleware</a>	6	ING-INF/05	1
<a href="#">Signal and systems</a> <sup>7</sup>	6	ING-INF/05	1
<a href="#">Formal methods</a>	12	INF/01	2
Laboratory of Embedded Control Systems <sup>8</sup>	6	ING-INF/05	2
<a href="#">Nomadic communications</a>	6	ING-INF/05	2

Students complete their studies by 30 credits as free-choice. Free courses can be any course that is not counted in the 42 credits requirement. A list of free courses related to the area of Embedded Systems and Ambient Intelligence is provided for assisting students in their selections:

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
<a href="#">Machine learning</a>	6	INF/01	1
<a href="#">Research project in Embedded Systems and Ambient Intelligence</a>	12	ING-INF/05	2
Wireless sensor networks	6		2

---

<sup>6</sup> Offered by Telecommunication Engineering

<sup>7</sup> Part of the course Signal and systems (12 credits) that is not any more offered.

<sup>8</sup> Part of the course Signal and systems (12 credits) that is not any more offered.

## 4.7 Free-choice courses

After selecting one of the five specializations, students can select free-choice courses from one the following possibilities:

- Courses listed in specializations different from the one chosen.
- “Horizontal” courses listed in Table 1 below.
- Course of the Bachelor Degree in Computer Science, not completed during the Bachelor Degree.
- Course offered by the Faculty of Science and the Faculty of Engineering of the University of Trento, in the sector MAT/\*, FIS/\*, BIO/\*, CHIM/\*, ING-INF/\*. For the complete list of courses, please refer to the Manifesto of the respective degree.
- Courses offered by the International Doctoral School in Information and Communication Technology of the Univ. of Trento. Each course is equivalent to 3 credits. Doctoral courses may be offered throughout the year. Additional information about course objectives, syllabus and scheduling can be found here: <http://ict.unitn.it/edu/ict/courselist.xml?year=2009>

For cases not included in the above list, including courses offered at any of Faculties of the University of Trento, can be selected as optional courses; in this case, however, the student must present a study plan containing a detailed motivation for such choice. If not satisfied by the motivation, the study plan commission can request modifications to the study plan itself.

**Table 1**

<b>Title</b>	<b>Credits</b>	<b>Sector</b>	<b>Semester</b>
<a href="#">Comunicazione delle scienze</a> (in Italian)	6	MAT/04	2
Research methodology <sup>9</sup>	6	INF/01	
<a href="#">Information technology and intellectual property</a>	6	ING-INF/05	1-2
<a href="#">Technical Writing</a>	6		2

---

<sup>9</sup> Offered by the International Doctoral School in Information and Communication Technology: Research methodology I and II

#### **4.8 Double and joint degrees**

Students participating in a double or joint degree with one or more partner universities can present a personal study plan satisfying the following rules:

- 24 credits must be related to topics related to the theory of computer science;
- 42 credits must be related to one of the five specializations listed in this document
- 18-30 credits can be free-choice
- 6 credits must be dedicated to “internato” (internship or stage)
- 18-30 credits must be dedicated to the final thesis

The detailed rules of the double and joint degrees are contained in the agreements between the University of Trento and the partner universities.

**Allegato A: Docenti di cui all'art. 1, comma 9 dei D.M. 16 marzo 2007**

<b>Title</b>	<b>Teacher</b>	<b>Sector</b>	<b>Credits</b>
Web architectures	Marco Ronchetti	INF/01	6
Biology	Alessandro Quattrone	BIO/13	12
Nomadic Communication	Renato Lo Cigno	ING-INF/05	6
Data mining for knowledge management	Themis Palpanas	INF/01	6
Data mining for biological data	Enrico Blanzieri	ING-INF/05	6
Agent-oriented software engineering	Paolo Giorgini	ING-INF/05	6
Business Process Management and Integration	Fabio Casati	INF/01	6
Service Oriented Architectures and Applications	Maurizio Marchese	INF/01	6
Logics for data and knowledge representation	Fausto Giunchiglia	ING-INF/05	6
Modeling of biological systems	Corrado Priami	INF/01	6
Performance evaluation	Renato Lo Cigno	ING-INF/05	6
Requirement Engineering	John Mylopoulos	ING-INF/05	6
Computer Security	Fabio Massacci	ING-INF/05	6
Network security	Bruno Crispo	ING-INF/05	6
Signal and systems	Luigi Palopoli	ING-INF/05	6
Distributed systems	Alberto Montresor	INF/01	6
Organizational information systems	John Mylopoulos	ING-INF/05	6
Real-time operating systems and middleware	Luca Abeni	ING-INF/05	6
Concurrency theory	Paola Quaglia	INF/01	6
Web Mining	Mauro Brunato	INF/01	6