UNIVERSITÀ DEGLI STUDI DI TRENTO

Facoltà di Scienze Matematiche, Fisiche e Naturali

Manifesto del

Corso di Laurea Magistrale in Informatica

a.a. 2010-11

Approvato nel Consiglio di Facoltà del 28/04/2010

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 has been activated starting from the a.y. 2008//2009.

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 *Bio-informatics* provides students with the ability to interact with prefessionals 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* 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, automative and avionic systems, to domotics and ambient intelligence.
- 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 curriculum includes 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.

***All* students are required to present a personalized study plan.**

It is not required that students define at the start of their studies of their all courses of their choice. However, students that have no significant background knowledge of core foundational topics as defined in Annex I will be requested to include them in their personalized study plan as obligatory courses.

Such plan can be updated and refined every year at the request of the student. The plan will be evaluated by a committee appointed by the Consiglio d'Area Didattica in Informatica.

Students with the following degrees are automatically admitted to the Laurea Magistrale in Informatica subject to the presentation of the personalized study plan mentioned above.

- *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.
- *"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 sat isfies specific requirements identified by the National Association for Computer Science "Bollino GRIN". They are defined in Annex II of this Manifesto.
- *Bachelor degrees issued from the University of Trento "affine" to the Bachelor in Computer Science,* where the student's individual study plan contain at least 60 credits in Computer Science and Engineering (INF/01, ING-INF/05). They are defined in Annex III of this Manifesto.

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.

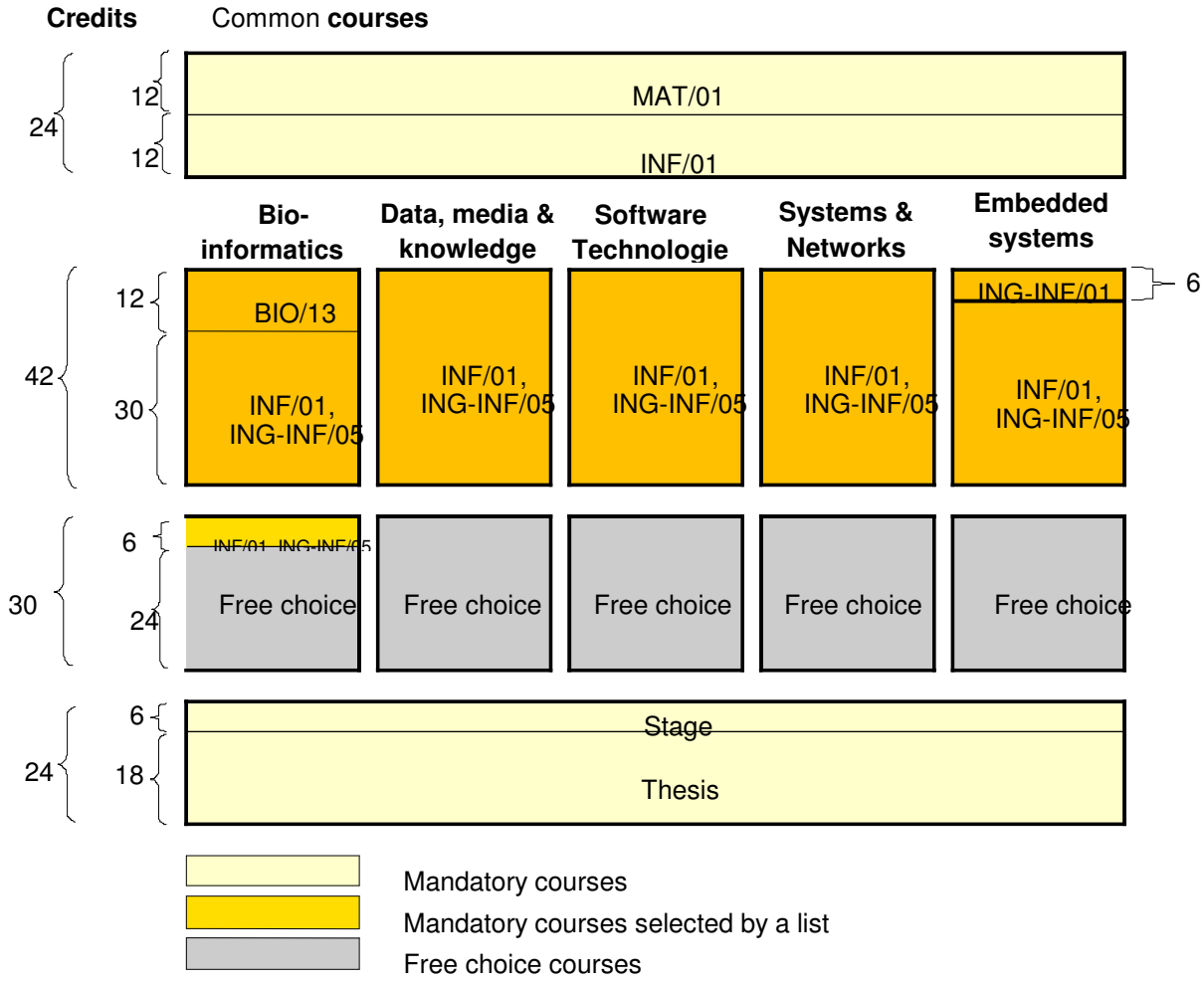
Application forms will be evaluated by a commission elected by the Consiglio d'Area Didattica in informatica. The commission can require a personal interview (possibly on-line) with the applicants, to better evaluated their knowledge.

4. Transient Norms

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.

5. 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.



Each course of 6 credits can include

- Lectures, with maximum 48 hours of lectures or blackboard exercises.
- Active exercises (AE) with up to 12 hours (possibly in turns for large classes) in which the students themselves prepare and discuss projects, exercises or have activities in the Laboratories etc. Course with active exercises can have at most 54 hours total between lectures and exercises.

- Laboratory courses (LAB) in which there are at most 24hours of Lectures and at least 24hours in which the students must develop a software project directly in the Laboratory under the supervision of the professor or an instructor.

The exam of a course of 6 credits might include (usually in alternative)

- A standard written/oral exam on the topics of the course, during or at the end of course
- A software project or project report to be submitted in installments during the course or as whole at the end of the course followed by a discussion on the project
- A laboratory work submitted during lab hours followed by discussion of a report of the work at the end of the course

All efforts should be doubled or combined for courses of 12 credits.

The 24 credits common to all specializations presents the core foundations of Computer Science.

Obligatory Courses	**Credits**	**Sector**	**Suggested year**	**Semester**	**Note**
Mathematical Logic	6	MAT/01	1	2	
Computability	6	MAT/01	1	1	
Concurrency theory	6	INF/01	1	2	
Computational Complexity	6	INF/01	1	1	AE

Foreign students must include the following course in their plan with an approved mark.

Title	**Credits**	**Sector**
Italian language (level A1)	6	

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
- Additional eligible courses listed in the final section of this Manifesto
- Research Project Courses listed in the final section of this Manifesto
- Methodological courses listed in the final section of this Manifesto
- Course of the Bachelor Degree in Computer Science, not taken 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. See the web page of the Doctoral School for additional information.

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.

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.

Students must select 42 credits out from the following courses:

Obligatory Courses in Bio-Informatics	**Credits**	**Sector**	**Semester**	**Note**
Biology	12	BIO/13	1	
Data mining for biological data	6	ING-INF/05	1	LAB
Formal methods[1]	12	ING-INF/05	2	AE
Modelling of biological systems	6	INF/01	2	
Simulation of biological systems	6	INF/01	2	

Students must complete their studies by selecting 6 credits in the sector INF/01 or ING-INF/05 among other courses.

[1]It is equivalent to Machine Learning (6 credits) and Performance Evaluation (6 credits).

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.

Students must select 42 credits from the following courses:

Obligatory Courses for Data Media and Knowledge	**Credits**	**Sector**	**Semester**	**Note**
Business Process Management and integration[2]	6	INF/01	2	LAB
Data and Information Integration[3]	6	ING-INF/05	1	
Data mining for knowledge management	6	INF/01	2	LAB
Human Computer Interaction	6	ING-INF/05	1	AE
Logics for data and knowledge representation	6	ING-INF/05	1	AE
Machine learning	6	INF/01	1	
Organizational Information Systems	6	ING-INF/05	2	AE
Service Oriented Architectures and Applications[4]	6	INF/01	1	LAB
Spatial databases	6	INF/01	1	AE
Web mining	6	INF/01	2	

[2] Part of the course Web Languages that is not any more offered.

[3] Previously called Advanced Information Systems

[4] Part of the course Web Languages that is not any more offered.

Embedded Systems

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. 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. An engineer operating in this domain must be provided with a wide body of knowledge, spanning over diverse scientific and technological disciplines. 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 discipline will be offered in the Signal and Systems course.

Students must select 42 credits from the following courses:

Obligatory Courses for Embedded Systems	**Credits**	**Sector**	**Semester**	**Note**
Advanced systems and architectures[5]	6	ING-INF/01	1	ENG
Formal methods	12	INF/01	2	AE
Laboratory of Embedded Control Systems	6	ING-INF/05	2	LAB
Nomadic communications	6	ING-INF/05	2	LAB
Real time operating systems and middleware	6	ING-INF/05	1	AE
Signal and systems	6	ING-INF/05	1	AE

[5] Offered at the Faculty of Engineering. Laurea Magistrale in Telecomunnication Engineering.

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).

Students must select 42 credits out from the following courses:

Courses in Software Technologies	**Credits**	**Sector**	**Semester**	**Note**
Agent-oriented software engineering	6	ING-INF/05	1	AE
Computer security	6	ING-INF/05	1	AE
Formal methods	12	INF/01	2	AE
Human-Computer Interaction	6	ING-INF/05	1	AE
Network security	6	ING-INF/05	2	AE
Requirement engineering	6	ING-INF/05	2	AE
Software analysis and testing	6	ING-INF/05	1	

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?

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 must select 42 credits out from the following courses:

Courses in Systems and Networks	**Credits**	**Sector**	**Semester**	**Note**
Advanced networking	6	ING-INF/05	1	
Computer security	6	ING-INF/05	1	AE
Distributed systems	6	INF/01	TACE	
Machine learning	6	INF/01	1	
Network security	6	ING-INF/05	2	AE
Nomadic communications	6	ING-INF/05	2	LAB
Web architectures	6	INF/01	1	AE
Web mining	6	INF/01	2	

Other Courses

Other Eligible Courses	Credits	Sector	Semester	Note
Chemistry for bio-informatics	6	CHIM/06	1	
Principles of Computer Graphics	6	ING-INF/05	2	
Computer Supported Co-operative working	6	ING-INF/05	2	LAB
Spoken Interactive Systems[6]	6	ING-INF/05	2	ENG
Wireless Sensor networks	6	ING-INF/05	2	LAB

Research Project Courses	Credits	Sector	Semester
Research project in Data, media and knowledge	12	INF/01	2
Research project in Embedded systems	12	ING-INF/05	2
Research project in Systems and networks	12	INF/01	2
Research project in Software technologies	12	ING-INF/05	2

The research project courses allows the student to explore advanced topic research topic under the supervision of a professor in Computer Science. After an initial exploratory analysis lasting ***at maximum two weeks*** the professor should propose, in agreement with the student, a roadmap for the successful conclusion of the project including different thresholds for grades.

Methodological Courses	Credits	Sector	Semester
Comunicazione delle scienze (in Italian)	6	MAT/04	2
Science, technology, and business	6	SECS-P/10	2
Information technology and intellectual property	6	ING-INF/05	1-2
Research methodology[7]	6	INF/01	2
Technical Writing	6		2

[6] Offered at the Faculty of Engineering. Laurea Magistrale in Telecomunnication Engineering

[7] This is the combination of two corse of the PhD degree each of 3Credit.

6. 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.

ANNEX I

Linguaggi Formali e Compilatori

Nel corso verranno affrontati i seguenti argomenti.

- INTRODUZIONE: cosa sono gli interpreti e i compilatori; linguaggi di programmazione e macchine; le pasi di un interprete e di un compilatore.

- LINGUAGGI E AUTOMI: linguaggi formali e grammatiche; gerarchia di Chomsky; linguaggi regolari e liberi dal contesto; automi a stati finiti; automi a pila.

- ANALISI LESSICALE: il ruolo dell'analizzatore lessicale; espressioni regolari; da espressioni regolari a automi a stati finiti; il generatore LEX.

- ANALISI SINTATTICA: il ruolo del parser; parsing top-down (LL) e parsing bottom-up (LR); il generatore di parser YACC.

- TRADUZIONE GUIDATA DALLA SINTASSI: definizioni guidate dalla sintassi; valutazione top-down e bottom-up delle definizioni guidate dalla sintassi.

- GENERAZIONE DEL CODICE: generazione del codice intermedio e generazione del codice target; linguaggi intermedi; ottimizzazione del codice intermedio; emissione del codice target.

- CONTROLLO DI SEQUENZA: comandi condizionali e iterativi; controllo dei sottoprogrammi; controllo di sequenza in interpreti e compilatori.

- TIPI DI DATO: tipi di dato elementari e strutturati; sistemi di tipi e espressioni di tipi; type checking statico e dinamico; gestione dei tipi di dato negli interpreti e nei compilatori.

- GESTIONE DELLA MEMORIA: memoria statica e dinamica; allocazione e de-allocazione della memoria; de-allocazione automatica della memoria: contatori dei riferimenti e garbage collecting.

- LABORATORIO: front-end e back-end, organizzazione del compilatore per crème CAraMeL; Generazione del codice intermedio, controllo di sequenza nel compilatore; Implementazione di array e sottoprogrammi nel compilatore; Generazione del codice target, gestione della memoria nel compilatore; Estensioni per interprete e compilatore.

Il corso ha lo scopo di fornire i concetti fondamentali (linguaggi formali, automi e macchine...) e di illustrare le tecniche principali per la realizzazione di interpreti e compilatori per linguaggi di programmazione.

Linguaggi di Programmazione: Semantica

1. Syntax and semantics: introduction
2. Operational, denotational and axiomatic semantics: comparison
3. Static and dynamic semantics
4. Transition systems
5. Structural Operational Semantics
6. Imperative languages: expressions
7. Imperative languages: statements
8. Imperative languages: declarations
9. Imperative languages: procedure

10. Functional languages: expressions and functions

11. Types

Lo scopo e' introdurre l'uso di metodi formali per la definizione, progettazione e implementazione di linguaggi di programmazione.

ANNEX II - Lista dei corsi di Laurea TRIENNALE con Bollino “GRIN”

Laurea Triennale	**Informatica (DM 270) Percorso unico**	**SEDE**
Informatica e Comunicazione Digitale		BARI
Informatica e Tecnologie per la Produzione del Software		BARI
Informatica e Comunicazione Digitale, sede di Taranto		BARI
Informatica, sede di Brindisi		BARI
Scienze e Tecnologie Informatiche, Cesena	Scienze e Tecnologie Informatiche	BOLOGNA
Informatica		BOLOGNA
Informatica		CAGLIARI
Informatica	Informatica Industriale	CAMERINO
Informatica	Tecnologie Informatiche	CAMERINO
Informatica	Informatica : curriculum Tecnologico	CATANIA
Informatica	Informatica : curriculum Metodologico	CATANIA
Informatica		della CALABRIA
Informatica		FIRENZE
Informatica	Curriculum Progettazione Software e Sistemi di elaborazione	GENOVA
Informatica	Curriculum Grafica ed Immagini	GENOVA
Informatica, sede di Varese		INSUBRIA
Informatica		L AQUILA
Informatica Applicata		Libera Università di BOLZANO
Informatica	Classe L-31	MILANO
Sicurezza dei Sistemi e delle Reti Informatiche, sede di Crema		MILANO
Informatica		MILANO-BICOCCA
Informatica		MODENA e REGGIO EMILIA

Laurea Triennale	**Informatica (DM 270) Percorso unico**	**SEDE**
Informatica	Indirizzo Generale	NAPOLI "Parthenope"
Informatica		NAPOLI "Federico II"
Informatica	Indirizzo Geomatica	NAPOLI "Parthenope"
Informatica	Indirizzo Tecnologie Multimediali	NAPOLI "Parthenope"
Informatica		PADOVA
Informatica		PALERMO
Informatica		PARMA
Informatica	Curriculum Reti	PERUGIA
Informatica		PIEMONTE ORIENTALE
Informatica		PISA
Informatica		ROMA "La Sapienza"
Informatica		ROMA "Tor Vergata"
Informatica	Curriculum Generale	SALERNO
Informatica	Curriculum Reti Informatiche	SALERNO
Informatica	Curriculum Sistemi Informativi su Rete	SALERNO
Informatica	Curriculum Modelli	SALERNO
Informatica Applicata	Curriculum Commercio Elettronico e Società dell'Informazione	SALERNO
Informatica	Percorso Scienze e Tecnologie Informatiche per la Società dell'Informazione	TORINO
Informatica	Percorso Sistemi e Reti	TORINO
Informatica		**TRENTO**
Informatica	Percorso base per le lauree specialistiche	UDINE
Informatica	Gestione e pianificazione	UDINE
Informatica	Servizi informatici per le aziende e la Pubblica Amministrazione	UDINE
Informatica	Progettazione software	UDINE
Tecnologie Web e Multimediali		UDINE
Informatica	Curriculum Professionalizzante	VENEZIA "Ca Foscari"

Laurea Triennale	**Informatica (DM 270) Percorso unico**	**SEDE**
Informatica	Curriculum Metodologico	VENEZIA "Ca Foscari"
Informatica		VERONA
Informatica Multimediale		VERONA

ANNEX III

Corso di Laurea in Triennale in Matematica – Facoltà di Scienze Mat. Fis. Nat.

Corso di Laurea in Ingegneria dell' Informazione e dell'Organizzazione d'impresa – Facoltà di Ingegneria

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

Title	Teacher	Sector	Credits
Data mining for knowledge management	Themis Palpanas	INF/01	6
Business Process Management and Integration	Fabio Casati	INF/01	6
Logics for data and knowledge representation	Fausto Giunchiglia	ING-INF/05	6
Modeling of biological systems	Corrado Priami	INF/01	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