The Educational Offer in Medical Informatics and Telemedicine at the Engineering Faculty of the Politecnico di Milano

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Abstract
Educational programs in Medical Informatics and Telemedicine offered at the Politecnico di Milano are described. At present they refer to the (5-years) Laurea Degree, the (3-years) Diploma Universitario Degree, the post-Laurea (3-years) Doctoral Degree, the (1-year) post-Laurea Master’s Degree and a Continuing Education program. The general aim of the educational efforts is that to enable the students to become information and communication technology experts, in whom the physician believes. The success in student attendance and in after-graduation company acceptance is remarkable. Nevertheless in Italy we are now starting with a deep reform of all educational engineering programs.

Keywords:
Education, medical informatics, telemedicine, biomedical engineering.

Introduction
On campus we have a population now consisting of more than 1100 students, enrolled for the different year courses in the several degrees in Biomedical Engineering at the Politecnico di Milano (http://www.polimi.it). This is more than a half of the total Italian educational reality in the field. The presence of a large Biomedical Engineering Department - whose effective academic manpower stays in the order of 35 full time positions, from post-graduate fellowships up to professors, and develops a corpus of worldwide known research activities - has been a powerful driving element for building the educational offer capable of attracting that large population of students. The maintenance of the educational offer open to Engineering degrees other than the Biomedical one - as this is the typical case of Medical Informatics and Telemedicine courses for the Informatics Engineering and Telecommunication Engineering programs - provides important educational cross-fertilizations. The attention to the hiring interests of hospitals and companies, the students will consider for their after-graduation job. The active presence of the Politecnico di Milano in some inter-university and company co-operated consortia, flexible and effective instruments for giving fast and tailored answers to the demand of training frequently focused on just-emerged knowledge subjects. All these cited elements compose the scenarios where the educational offer in Medical Informatics and Telemedicine is performed.

Framework
It is true that newly graduates in engineering do easier than graduates in other areas in finding their first job. Probably this comes from the synergic mixing of three major skills they learn along their educational pathways. All of them relate to the real world where all of us live. They can be labelled as related to the phases of knowing (know), modelling (model) and managing (manage). Knowing should be applied to the detailed and careful descriptions of what happens in the reality. Modelling refers to the need of reducing those descriptions to effective, synthetically expressed, powerful and faithful mathematical laws describing the reality, at least in essence. Managing is mastering an update and powerful basket of tools, such as hardware and software, signals and data processing, organizations, networking, etc. Apparently the “know & model & manage” paradigm applies to each of the engineering specialties without major objections.

To the “know & model & manage” paradigm, Biomedical Engineering adds the need of a second “patient-finalized and four-legs sustained” paradigm. While the first three legs come from evident areas, easy to be labelled with the historically established names of electrical, mechanical, and chemical, each of them being widely bio-oriented, the fourth leg consists of the mentioned managing skills.
The Educational Offer

As already said in [1], the inherent aim in each educational program offered in Medical Informatics and Telemedicine at the Politecnico di Milano is to enable students to acquire technical skills in order to become information and communication technology experts, in whom the physician believes. Many educators know how difficult it is to achieve such an aim.

The educational pathway to this aim is taken by making the students beginning with courses in basic computer sciences. The long lasting cooperation [2] with colleagues teaching these courses made it possible to insert exercises and examples taken from Medicine. To what extent the MS-Office software may be useful in helping the set-up segments of an electronic medical record has become the typical guiding-motif in the recent years for part of the exercises.

The IT-EDUC TRA project, funded by the European Commission Fourth Framework Program, is a significant experience we had years ago. Project final products came from the cooperation of some sixteen institutions of European countries interested in Information Technology Education and Training in Healthcare Informatics. Now stored in the easy usable IT-EDUCTRA CD-ROM, products mainly consist in collections - i.e. a grouping of products of similar format, type, level of detail and purpose rather than by subject or context. Within the IT-EDUCTRA project, different collection types have been developed: 1- Exercises and Examples; 2 - Background On ..; 3 - What is a...; 4 – Some Details About...; 5 – Healthcare professionals View on... We recommend such collections to the students for home-works, asking them to analyze how the views of the different users differ one another.

After the basics, the educational pathway is continued with the courses named Medical Informatics, institutionally described at the website http://www.polimi.it. For the 3-years based, “Diploma Universitario” Degree we did not implement major changes in respect to what described in [1]. For the 5-years based “Laurea” Degree we came to make compulsory that enlargement of the subject list, recommended over the recent years by the evolution of the information and communication technology areas and nevertheless offered for years on a voluntary basis only. So the offered courses, half-unit each, now are: Medical Informatics I, Medical Informatics II and Medical Informatics III (Laboratory), as it follows:

Course of Medical Informatics I (code: 001005)

Description

The course gathers qualifying subjects fundamental to every engineer who wants to candidate himself to work interactively with clinicians. The lecture subjects are: a) Healthcare and Clinical information taxonomy oriented to Information and Communication Technologies (I&CT); b) Medicine and Healthcare databases; c) Healthcare Information Systems; d) Security and privacy of Clinical data; e) Telemedicine and Medical Informatics standards. "Medical Informatics I" constitutes a compulsory exam for both the Medical Informatics II and Medical Informatics III (Laboratory) exams.

Contents

Part A: Digital Clinical Records

Languages and architectures:
Some either specifically born in the medical field (such as UMLS, CORBAmed), or of general use but well adaptable to the specific case (such as XML).

Databases: Base concepts and Fundamentals:
Conventional data models; The data relational model; Relational algebra; SQL language; A project methodology: the entity-relation model; Logic design; Object oriented data model; Tools for object oriented DBMS.

Clinical data:
Features: property rights and skill of use, temporal granularity and oblivion - Clinical records, DRG and other aggregations: taxonomies, dictionaries, use and storage. Multi services software for Medicine. Integration of clinical reports and images.

Part B: Healthcare Information Systems

Representation and sharing of databases:
Information, knowledge and merit system in healthcare organisations; Coding systems, supervised vocabularies and medical ontology.

Communication modalities:
Communication technologies; Multimedia interface technologies; Security and privacy in healthcare information systems.

Distributed services and user co-operation:

Part C: Standards for Medical Informatics and Telemedicine

Roles and activities of Institutes and Technical Committees at National and International levels in doing and updating of the body of standards.

Teaching methodology

Total number of 30 lecture hours and 10 practical sessions.

Exam Modality

Oral form only examination after the end of the course.

Recommended Readings

Suggested text books are those listed in references [2], [3], [4], [5], [6].
Course of Medical Informatics II (code: 001006)

Description
The course, which has the course of Medical Informatics I as prerequisite, is composed by Didactical Seminars that deepen and complete issues of Medical Informatics I. Internal and external professionals are involved in these lectures. The lecture subjects are presented in the following: a) Large repositories of bio-signals and bio-images; b) Aid systems to clinical decision; c) Aid systems to teaching; d) Telemedicine devices; e) Object language in distributed and concurrent applications.

During the course external technical guided tours are lead.

Contents
Part A: Teaching Seminars
Object language in distributed and concurrent applications: recalls of C++ and introduction to Java; Introduction to CORBAmed.

Bibliography bases: Structured electronic dictionary of medical terminology; Reference bibliographic bases and investigation tools.

Databases: Packages for the management of simple clinical records and their minimal requirements; Integration among image and data and sound control; Temporal databases, uncertain and active knowledge, user views; Human Genome databases.

Bio-signal archives and repositories, also on CD-ROM: cases, compression, modality and samples of use.

Large repositories of Bio-images: The Visible Human Dataset and the Milano Mirror Site: access modality, management problems, image compression techniques, use, and examples.

Intranet and Internet for Information, Clinical and Healthcare Systems: Departmental and territorial information system for clinics and health.

Teaching aid systems: Aid packages for teaching health care issues to clinicians and others healthcare professionals.

Decision aid systems: Shell of simple aid system and aid system to clinician decision; Guidelines distribution.

Security and reserve: Methods and devices for data security and privacy.

Telemedicine: Telemedicine systems for tele-consult and videoconference.

Part B: Technical Visits
In collaboration with the course of Medical Informatics III (Laboratory) several technical tours are held.

Exam modality
The exam consists of both the arrangement of a scientific review paper and an individual oral test devoted to the presentation of the paper. The issue to deepen and describe is agreed with the teacher between the set of arguments the course has dealt to.

Recommended Readings
Additionally to the suggested textbooks listed in references [7], [8], [9], [10], [11], a number of significant websites are recommended for update views on the seminar subjects. Some of them are in [12], [13], [14], [15], [16], [17], [18].

Course of Medical Informatics III (Laboratory) (code: 001007)

Description
The course, which has the course of Medical Informatics I as prerequisite, is held in the Informatics Room and is devoted to development of Medical Informatics and Telemedicine Projects. During the course External technical guided tours are held.

Contents
Part A: “Learning by doing” student projects
Educational purpose of the projects consists of allowing the students to acquire satisfactory professional levels - intended as the set of knowledge, friendliness competence, and ability of critical analysis - over some specific applications. Operative purpose of the projects, in support of educational aim and to practically demonstrate its results, focuses over the achievement of a WEB based CD-ROM master release on “Update in Medical Informatics and Telemedicine”.

For tuning purposes, in respect to knowledge and skills already owned by the students, at the course beginning application samples and tools are presented as it follows: products and services in 2D and 3D originated by the Visible Human Dataset; Search engine benchmarking: Medicine and Health; Cases of analysis of the Web sites offering biomedicine and health services to clinicians, patients and citizens; Construction tools of an updated Web-based CD-ROM on issues of Medical Informatics; Benchmarking of internet-based Telemedicine services; Implementation tools of Telemedicine services.

Part B: Technical Visits
The following technical visits are planned:

- V1 - Istituto Europeo di Oncologia - Divisione Sistemi Informativi (http://www.ieo.it).
- V2 - CILEA - Consorzio Interuniversitario Lombardo per l’I&CT (http://www.cilea.it).
- V3 - Istituto Clinico Humanitas - Divisione Sistemi Informativi (http://www.humanitas.it).
- V4 - Politecnico di Milano - Servizio Informatico di
Ateneo - Infrastrutture per la Teledidattica.

- V5 - Ospedale Multispecialistico MultiMedica - Divisione Sistemi Informativi (http://www.multimedica.it).

**Teaching methodology**

Total number of 45 lesson and exercise hours in the Informatics Laboratory Room and 15 hours devoted to external technical tours.

**Exam modality**

The exam consists of the following tests:

1. The implementation of a didactical project with high graphical and/or interactive content, if necessary carried out in collaboration with some of the sites of the external tours.
2. The individual discussion of the realized project.

**Recommended Readings**

Mainly suggested books are manuals, some of them appearing in [19], [20], [21], [22], [23].

**Thesis Subjects**

The thesis subjects are a relevant component of the educational offer. For the 1st semester of the Academic Year 2000/2001 subjects proposed for thesis in Medical Informatics and Telemedicine are as it follows:

   In cooperation with: National Library of Medicine – National Institute of Health - Bethesda, MD, USA and Istituto di Anatomia dell’Università di Milano, Italy
2. Medical Visual Knowledge: definitions, structures and implementations. To medical to knowledge, application of the emerging elements to detect and to structure the visual knowledge (MVK).
3. Databases for the Human Genome Project: multi-database queries by data-mining techniques applied to target instances, within environments accessible also via Internet (DB & HG).
   In cooperation with: Istituto Europeo di Oncologia, Milano, Italy.
4. Construction of repositories of bio-images from confocal laser microscopy: tools for the classification and quantitative analysis of bi-dimensional characteristics useful in designing, building and using repositories of bio-images (BiDB & Confoc).
   In cooperation with: Istituto Europeo di Oncologia, Milano, Italy.
5. E-Health sustainable.
   Internet services for Medicine and Health Care: from the definitions of user models to the project wishing performances, to the revenue models, to the implementation and to the service start-up (E-Health).

In cooperation with: CILEA – Consorzio Interuniversitario Lombardo per l’I&CT and Dipartimento di Economia e Produzione of the Politecnico di Milano.

6. Teaching Laboratory of Digital Medicine.
   In Internet, from evaluation of the available material to the construction of effective teaching aids dedicated to the illustration and evaluation phases (MedDD).
   In cooperation with: National Library of Medicine – National Institute of Health - Bethesda, MD, USA; Istituto di Anatomia dell’Università di Milano, Italy, and others.

   Benchmarking of specialized packages (Unified Booking Services, Departmental Electronic Medical Records, DICOM systems, etc.) (HIS).
   In cooperation with: specifically interested hospitals and clinics.

**Course on Advanced Health Information Systems**

At the post-graduate level we have a newly defined track where major component is a course on advanced health information management, from concepts to big systems.

**Description**

This course is going to be offered within the re-founded and now starting PhD Program in Biomedical Engineering of the Politecnico di Milano. Dedicated to post-graduate students, the course aims at transferring solid knowledge on the relevant problems widely still to be solved, as well as on the ongoing update of some hospital information system building blocks.

**Contents**


**Teaching methodology**

Lessons and seminars for a total of 30 hours of lessons and 20 laboratory sessions.

Credits: 7.5.
Exam modality

Development of a review paper as to submit to publication and the corresponding oral presentation.

Evaluation Modalities and Conclusions

At the Engineering Faculties of the Politecnico di Milano all the courses are yearly submitted to student evaluation. Within the persisting right requests of colleagues claiming for improved modalities, in the academic year 2000/2001 the Medical Informatics courses have been appreciated by the students in particular for their orientation to practice and for their Laboratory activities. Nevertheless both the high speed of changes present in I&CT and the start of a deep reform of the Italian Law related to all the Engineering curricula should be taken into proper account starting from the very near future. Dedicated to others than graduates in Biomedical Engineering [1], we still hope to offer again the (1-year) post-Laurea Master’s Degree of the Politecnico di Milano, cooperatively delivered by the Dipartimento di Bioingegneria and the CEFRIEL (http://www.cefriel.it) Consortium among universities, private companies and Government of the Regione Lombardia.

References


[18] www.w3.org for HTML and other mark-up languages.


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Email: pinciroli@biomed.polimi.it
GESTIONE AUTOMATICA DATI CLINICI

Gestione automatica delle varielle cliniche: l'esperienza del Policlinico "Campus Biomedico" di Roma
T. Petitti, M. Venditti, W. De Monte, P. Castrati, F. Agrò
(Univ. Campus Biomedico, Roma – Else Emme Data, Roma)
Sessione del carico di stress in pazienti con insufficienza cardiaca cronica
G.P. Carboni, R. Montesanti, C. Goffredo, B. Assogna, A. Antonelli, M. Crudele, M. Cortes, F. De Pascale e G. Di Sciascio
(Univ. Campus Biomedico di Roma)
Informatica in Nutrizione clinica e chirurgica
C. Rizzi (Azienda Policlinico – Univ. di Catania)
Misure del deficit funzionale e del carico di stress in pazienti con ipertensione arteriosa
G.P. Carboni, R. Montesanti, C. Goffredo, M. Crudele, A. Serio,
M. Cortes, F. De Pascale, P. Cammarata e G. Di Sciascio
(Univ. Campus Biomedico di Roma)
Identificazione di eventi in ECG
F. Sarteratto (Università di Venezia)
Proposta di un sistema di aiuto alla decisione con supporto informatico multimediale in radiologia diagnostica
C. Andreoli, M.L. De Ciccio, F. Giovagnorio, U. Cavallo
(Università "La Sapienza" – Roma)
Servizi di pronto soccorso e medici di medicina generale:
Integrazione e supporto alla decisione
F. Aguglia, L. Santì, F. Romeo (Politecnico politecnico Umbrico I –
Università "La Sapienza" e FIMMG – Roma)

LA RETE E LE RETI IN SANITA'

L'utilizzo e Classificazione dei siti sanitari in Italia
P. Di Giacomo (Univ. "La Sapienza", Roma – Telecom Italia
SpA)
Creazione, aggiornamento e gestione di siti internet di interesse
giocologico
G. Giraldo (Ospedale Cristo Re – Roma)
La tecnologia Internet come strumento per l'integrazione di sistemi informativi etereogeni in ambito ospedaliero
T. Petitti, P. Casorati, F. Agrò, S. Dessena, R. Diana, M.
Venditti, M. Crudele (Università Campus Biomedico, Roma)

Sabato 17 Marzo 2001
MATTINA

Sessioni su:

INFORMATICA E TERMALISMO
in collaborazione con FEDERTERME

INFORMATICA E PSICHIATRIA
in collaborazione con il Comitato Italiano per
l'Informatica in Psichiatria

L'INFORMATICA NEI SERVIZI INFERMIERISTICI
in collaborazione con il CEREF-Padova

Consensus Conference su:

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Le nuove tecnologie dell’informazione si sono ormai largamente diffuse così da interessare tutti i settori della vita sociale; anche il sistema sanitario non può ignorare le notevoli possibilità di sviluppo e miglioramento dell’assistenza che le moderne tecnologie consentono. Le applicazioni fin ad ora realizzate sono molto interessanti e si estendono alle diverse branche specialistiche e a molti servizi sanitari.

All’inizio del terzo millennio occorre chiedersi se le opportunità offerte dalla tecnologia dell’informazione siano sufficientemente conosciute e sviluppate all’interno del sistema sanitario; se gli ostacoli che ancora di frapporgono ad una più ampia utilizzazione di tali tecnologie possano essere finalmente superati e come ciò possa avvenire, se, infine, i problemi che si presentano a seguito della diffusione dei nuovi sistemi tecnologici (organizzativi, economici, formativi, etici, ecc.) siano stati adeguatamente affrontati per essere superati.

L’XI Congresso Nazionale di Informatica Medica vuole affrontare questi temi e darne oggetto di ampia discussione e serio approfondimento da parte di tutti coloro che operano nell’ambito della sanità. Il Congresso, inoltre, così come gli altri che lo hanno preceduto, ha la finalità di promuovere una più ampia e qualificata conoscenza ed impiego dell’informatica in tutti i settori della medicina e, più in generale, nell’ambito della tutela della salute.

SEDE DEL CONGRESSO

La cerimonia inaugurale e la sessione su “Informatica e formazione degli operatori sanitari” si svolgeranno presso l’Università di Padova. Tutte le altre sessioni si svolgeranno presso il Teatro Congresso “Pietro d’Abano” – Largo Marcon, 16 – Abano Terme (PD).

MOSTRA TECNICO-SCIENTIFICA

Contemporaneamente al Congresso si terrà una mostra tecnico-scientifica di prodotti hardware, software, strumentazione bio-medica e di altre tecnologie avanzate in sanità. Le Aziende che sono interessate a partecipare sono invitate a mettersi in contatto con la Segreteria Organizzativa.

PROGRAMMA SCIENTIFICO

GIOVEDÌ 15 MARZO 2001

ORE 11 CEREMONIA DI INAUGURAZIONE
University di Padova – Sede di Igiene del Dipartimento di Medicina Ambientale e Sanità Pubblica – Aula A
Via Loredan, 18 – Padova

ORE 14 INFORMATICA E FORMAZIONE DEGLI OPERATORI SANITARI

“Long Distance Learning and Teaching” nella Facoltà di Medicina e Chirurgia dell’Università di Padova
F. Novetta, A. Fassina, A. Zorzi, A. Gatta
(Dip.to Med. Clinica e Sperimentale, Presidenza Facoltà di Medicina, Centro di Calcolo, Univ. di Padova)
Formazione in Informatica nell’attuale ordinamento della Facoltà di Medicina: esperienze, proposte
A. Serio, M. Crudele (Università “La Sapienza” e Università Campus Biomedico, Roma)
The Educational Offer in Medical Informatics and Telemedicine at the Engineering Faculty of the Politecnico di Milano
F. Pinciroli, M. Masseroni, G. Tignola
(Dip.to di Biogenetica e Centro Ingegneria Biomedica CNR, Politecnico di Milano – Visible Human Dataset, Miliano Mirror Site – Med – san Service CILEA, Miliano)
Evidence Based Health Care and Best Evidence Based Education
P. Bincetti (Università Campus Biomedico, Roma)
La formazione informatica nel corso di laurea della Facoltà di Ingegneria Biomedica: una proposta
M. Crudele, G. Tanello, L. Marcelli (Università Campus Biomedico, Roma)

VENERDÌ 16 MARZO 2001

MATTINA

SISTEMI INFORMATIVI SANITARI

Informatica e sistema informativo ospedaliero
C. RizziVilillo (Azienda Policlinico – Univ. di Catania)
L'integrazione del sistema informativo ospedaliero dell’Ordine Mauriziano di Torino con la piattaforma middleware DHE
T. Torrengo, A. Bo, E. Nicolosi (Ordine Mauriziano. Torino)

TELEMEDICINA PER ASSISTENZA SANITARIA, EMERGENZA, AIUTI UMANITARI

Progetto emergenza: Proposta per una nuova organizzazione dell’emergenza sanitaria in Liguria
Impiego della Meditca satellitare per scopi umanitari
G. Roncini (Univ. “La Sapienza”, Roma)
Telemedicino – Medicina on Line
G. Refice, P. Petruini (Progesi Spa, Roma)
Reato e rapporto costo/efficacia della Telemedicina Cardiologica nella valutazione di pazienti con sospetto evento cardiaco
Telemedicina in neurodiagnotoscopia nelle zone montane
R. Mastrotolento (Ist.to Regina Elena, Roma)
Sistema di telediagnostica tecnica e medica per il veicolo a propulsione elettrica per la mobilità dei disabili in ambiente urbano
G. Arnulfo, M. Frasci, S. Dellepiane, M. Terrizzano, G.C. Bo, V. Sandrone
(Dip.to Ingegneria Biofisica ed Elettronica, Univ. di Genova – Ist.to Scient. Medicina Domani, Genova)