



UNIVERSITÀ
DEGLI STUDI DI TRIESTE



Corso di Laurea in Ingegneria Clinica e Biomedica
Insegnamento di
Insegnamento "C.I. Informatica Medica" – 15CFU-365MI
Insegnamento "Fondamenti di Informatica Medica" - 9CFU-365MI-1 e 360MI

INFORMATICA MEDICA E eHEALTH

Prof. Sara Renata Francesca Marceglio

Chi sono

RECAPITI

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Tel – 040-558 3450

INTERESSI DI RICERCA

INFORMATICA SANITARIA

- Integrated care
- Mobile Apps for medicine and healthcare

NEUROMODULAZIONE

- Neurofisiologia dei gangli della base
- Dispositivi di neuromodulazione invasiva e non invasiva

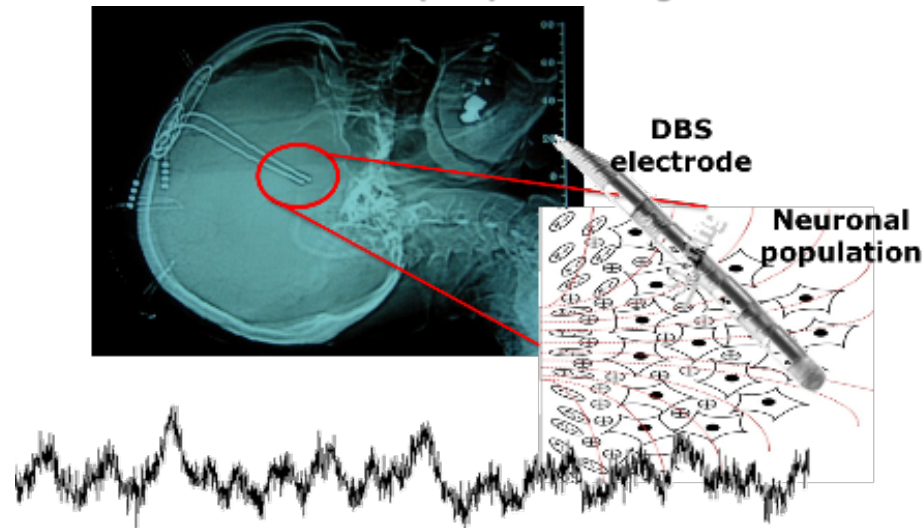


RESEARCH AREA 1: NEUROPHYSIOLOGY AND NEUROMODULATION DEVICES

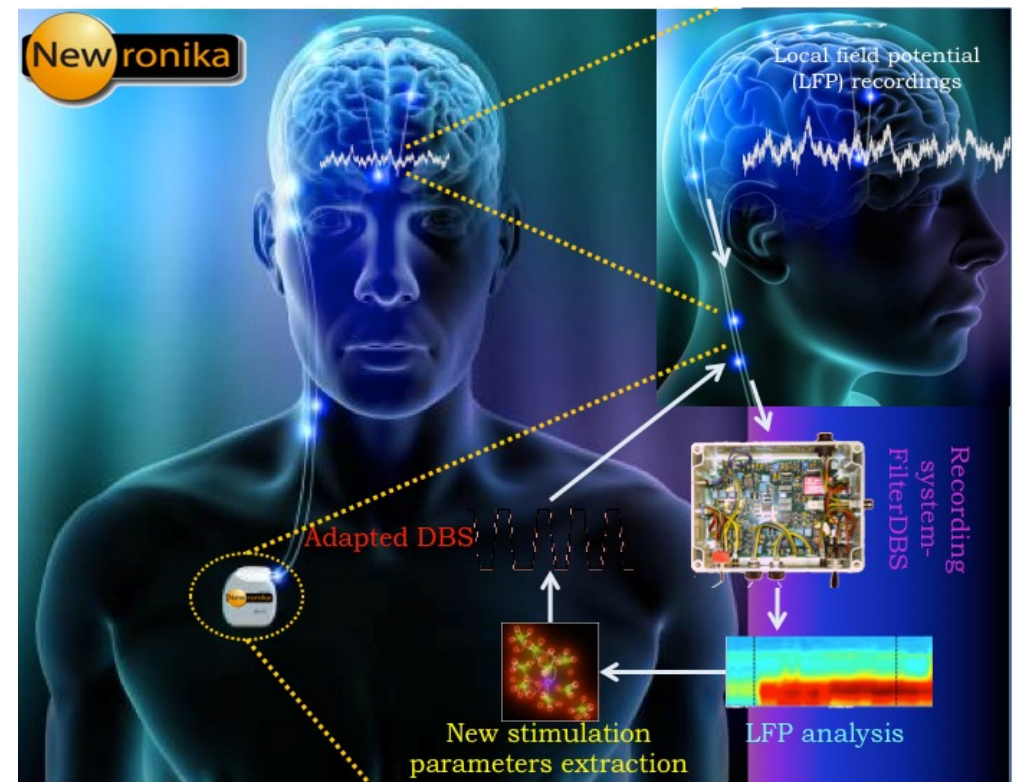
INVASIVE NEUROMODULATION:

- *Deep Brain Stimulation (DBS)* for Parkinson's Disease and other neurological and neuropsychiatric disorders
- Therapy optimization and mechanisms of action understanding through local field potential analysis

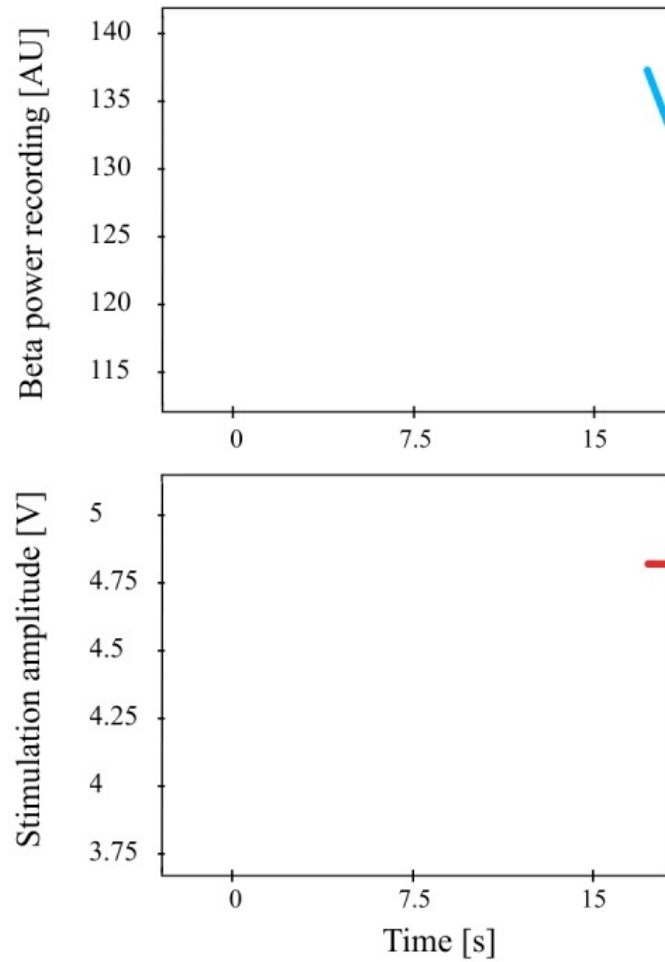
Local Field Potential (LFP) recordings



Adaptive Deep Brain Stimulation (aDBS)



RESEARCH AREA 1: NEUROPHYSIOLOGY AND NEUROMODULATION DEVICES



RESEARCH AREA 1: NEUROPHYSIOLOGY AND NEUROMODULATION DEVICES

Standard DBS
(2V, 130Hz, 60 μ s)

Adaptive DBS
(0-2V, 130Hz, 60 μ s)

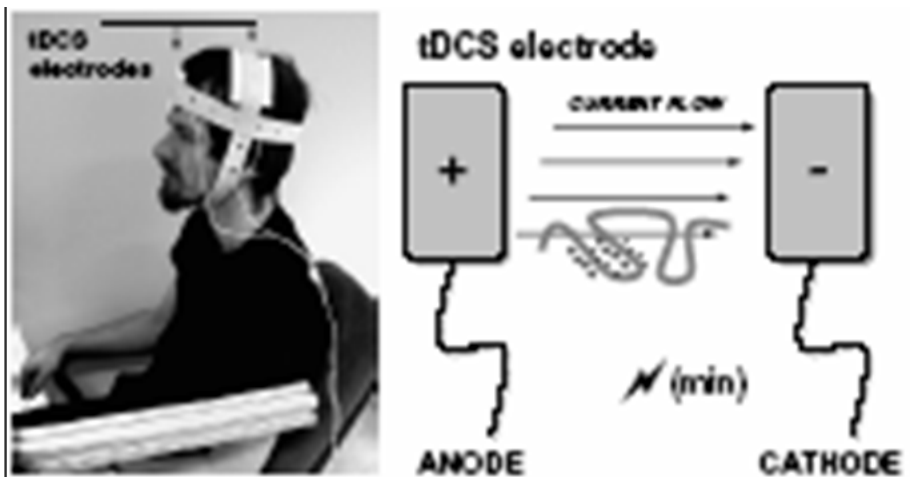
RESEARCH AREA 1: NEUROPHYSIOLOGY AND NEUROMODULATION DEVICES

NON-INVASIVE NEUROMODULATION

- *Transcranial Direct Current Stimulation (tDCS)* for depression, pain, and post-stroke rehabilitation.
- Development of portable devices that can be configured by the neurologist and used by the patients at home



Low-intensity (<2mA) DC current application on the scalp, on the area that has to be modulated.



RESEARCH AREA 2: mHEALTH AND INTEGRATED HEALTH

JAME – tremor control assistant

- Design innovativo
- Sensore di rilevazione del tremore
- AI per il riconoscimento del tremore
- Neuromodulazione non invasive
- App di telemonitoraggio



Integrated telemonitoring for neuromodulation



RESEARCH AREA 2: mHEALTH AND INTEGRATED HEALTH

- POINT OF CARE TELEMONTITORING FOR THERAPY OPTIMIZATION
- INTEGRATION BIOSIGNALS/BIODATA FROM PATIENTS

The application interface consists of several key components:

- GRAPH Screens:**
 - Right Side:** Displays two line graphs for 'Right Side' (top, purple) and 'Left Side' (bottom, green) showing beta band activity over a 24-hour period. The y-axis is scaled by 10^4 .
 - Left Side:** Similar to the right side, but with a different data series.
- ANALYSIS Screens:**
 - Daily Beta Band - Right Side:** Shows ON status (1.5) and OFF status (2.7) with associated bar charts.
 - Aggregate Beta Band - Right Side:** Shows ON status (1.7) and OFF status (2.8).
 - Daily Beta Band - Left Side:** Shows ON status (1.5) and OFF status (2.7).
 - Aggregate Beta Band - Left Side:** Shows ON status (1.7) and OFF status (2.8).
- Central GRAPH Screen (Patient Diary):**
 - Features a grid for 'ON status' and 'OFF status' with a 'SUMMARY' column.
 - Includes a 'From Patient Diary' indicator and a 'SUMMARY' button.
 - Allows users to 'Apply to current day' (02/01/2018) or 'Apply to all days'.
 - Has a 'SAVE' button at the bottom.
- Navigation and Controls:**
 - 'Change Day' and 'Set ON and OFF' buttons are present on the graph screens.
 - 'UPDATE' and 'SAVE' buttons are located on the analysis and central graph screens, respectively.

RESEARCH AREA 2: mHEALTH AND INTEGRATED HEALTH

PAIN RELIEF ECOSYSTEM SCENARIO APPLICATIVO



RESEARCH AREA 2: mHEALTH AND INTEGRATED HEALTH

Alimentazione dashboard e attori

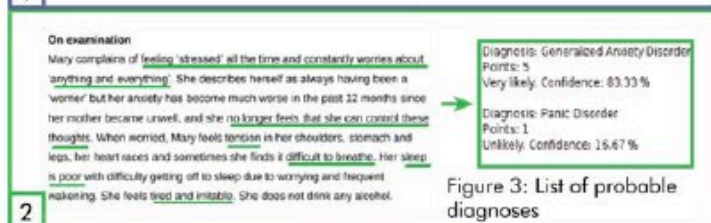


RESEARCH AREA 2: mHEALTH AND INTEGRATED HEALTH

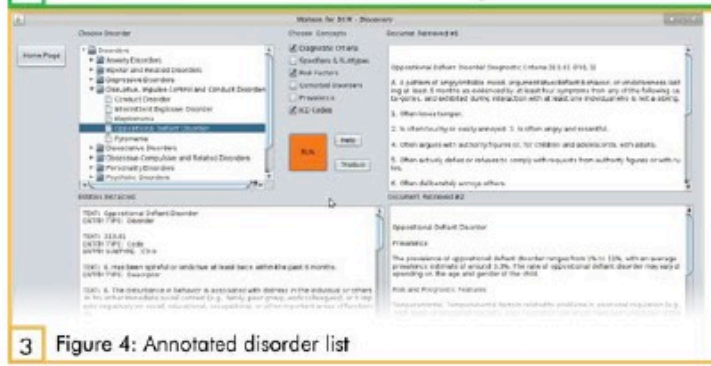
Sistemi di supporto alla decisione basati sull'analisi del linguaggio naturale



1 Figure 2: DSM-5 query for clinical observations



2 Figure 3: List of probable diagnoses



3 Figure 4: Annotated disorder list

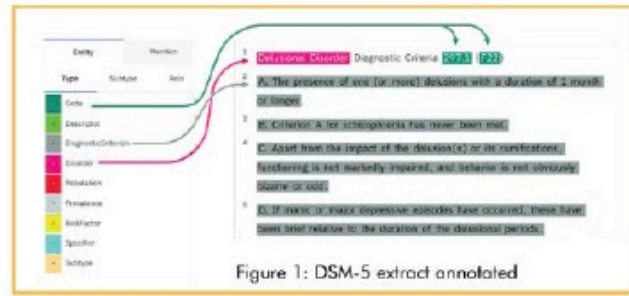


Figure 1: DSM-5 extract annotated

L'obiettivo è usare l'intelligenza artificiale per interpretare il linguaggio scritto e parlato per estrarre informazioni che fungano da supporto decisionale a medici

PROGETTI IN CORSO E POSSIBILI TESI

AREA DELLA NEUROMODULAZIONE

- EEG pediatrico: identificazione di indici quantitativi per la valutazione dello stato di crescita del neonato
- LFP nella Malattia di Parkinson e DBS adattativa: identificazione di algoritmi di retroazione e biomarker
- tDCS e sport: valutazione dell'effetto della stimolazione in atleti professionisti

AREA DEL eHEALTH

- JAME: Sistema indossabile per il controllo del tremore
- Telemonitoraggio dei pazienti con Malattia di Parkinson: sviluppo di un'applicazione mobile per la gestione ottimale dello stato clinico
- Nutrigenomica e sistemi di supporto alla decisione: definizione di algoritmi per la valutazione della dieta
- AI per la medicina: primi esperimenti di applicazione in ambito odontoiatrico
- Analisi del linguaggio naturale per il decision support system

PARLIAMO DI VOI...



https://docs.google.com/forms/d/e/1FAIpQLSeJ7fw3r1SVVK-w9DdYJYWnr--_j9-V5ghkiWnvXO3hh_78ww/viewform?usp=sf_link

MATERIALE DIDATTICO

- Le slide delle lezioni saranno caricate sulla piattaforma Moodle prima della lezione stessa
- Altro materiale didattico integrativo sarà inserito sulla piattaforma Moodle in corrispondenza dell'argomento trattato
- **NB: è NECESSARIO ISCRIVERSI all'insegnamento su Moodle** per poter accedere al materiale ad uso ristretto e per caricare gli esercizi.

SOFTWARE E SISTEMI UTILIZZATI DURANTE IL CORSO

- Durante il corso utilizzeremo alcuni applicativi/linguaggi di programmazione:
 - Basi di dati: SQLite (disponibili le istruzioni di installazione su Moodle)
 - Modellazione dei processi: STARUML – <https://staruml.io/download>
 - Linguaggio Python: ANACONDA e Spyder (disponibili le istruzioni di installazione su Moodle)
- Consulteremo anche alcuni dizionari medici che richiedono una registrazione:
 - UMLS – Unified Medical Language System - <https://uts.nlm.nih.gov/uts/>

ESAME – FONDAMENTI DI INFORMATICA MEDICA (9 CFU)

- L'esame relativo a Informatica Medica II consiste di due parti:
 - **Consegna di esercizi** che verranno proposti a lezione (4 esercizi = 15 punti).
Gli esercizi dovranno essere consegnati entro 24 ore prima dell'esame orale tramite la piattaforma Moodle.
 - **3 Domande orali, di cui una a scelta**, relativa agli argomenti trattati (6 punti massimo per ogni domanda - 18 punti)

ESAME – INFORMATICA MEDICA C.I.

- L'esame è relativo al Corso Integrato → registrazione dell'esame avviene per tutti i 15 CFU (annualità)
- Il voto del C.I. è così composto:
 - **Consegna di esercizi:**
 - 4 esercizi = 11 punti per la parte di Fondamenti di Informatica Medica (9CFU)
 - 3 esercizi = 9 punti per la parte di Complementi di Informatica Medica (6CFU)
 - **Esame orale:**
 - 3 domande di cui una a scelta sull'intero Corso Integrato (13 punti)

Appelli

- Gli appelli saranno nelle sessioni di :
 - Gennaio/Febbraio 2022 (per Fondamenti di Informatica Medica)
 - Giugno/Luglio 2022
 - Settembre 2022
 - Gennaio/Febbraio 2023 (per Informatica Medica C.I.)

LEZIONI

- Le lezioni si svolgono in PRESENZA:
 - Aula in presenza: ed C5, aula TECNOLOGIE
- Registrazione delle lezioni:
 - MS Teams, Team Informatica Medica 2021-22(365-MI e 360-MI)
 - **Iscriversi al Team tramite Codice: xwbvwft**
- Orario delle lezioni:
 - Martedì – 14:15 – 17:45
 - Giovedì – 08:30 – 12:00
- Le lezioni prevedono generalmente una pausa intermedia.

PROGRAMMA DELLE LEZIONI

- Il programma delle lezioni è disponibile su Moodle
- Eventuali variazioni verranno comunicate tempestivamente tramite:
 - Avviso su Moodle
 - Avviso sul Team del Corso
 - Mail → inserire la propria mail nel file condiviso “Lista Studenti 2021-22” (link disponibile su Moodle)

FAQ

- Posso seguire il corso da remoto?
 - In generale, il corso si svolge in presenza. La lezione viene comunque registrata tramite un meeting di Teams, a cui possono comunque collegarsi gli iscritti al Team stesso, in caso di necessità o in caso la capienza dell'aula non sia sufficiente.
- Quando devono essere presentati gli esercizi?
 - Gli esercizi devono essere presentati entro 24 ore prima dell'esame.
- Devono essere consegnati tutti gli esercizi?
 - Sì, per poter accedere all'esame orale, devono essere consegnati tutti gli esercizi
- Gli esercizi possono essere ripresentati se non sono soddisfacenti?
 - Gli esercizi vengono discussi all'orale, quindi è possibile anche migliorare il punteggio ottenuto
- UMLS una volta fatta la registrazione non mi fa entrare, perché?
 - La registrazione a UMLS non è immediata. Bisogna attendere l'approvazione della registrazione. Si consiglia comunque di effettuare la registrazione prima della lezione calendarizzata in cui verrà trattato UMLS.
- Seguo il corso integrato: posso dare l'esame nella prima sessione del 2022?
 - Gli esercizi possono sicuramente essere consegnati anche nella sessione di gennaio/febbraio 2022, l'orale deve essere fatto interamente al termine del corso



INFORMATICA MEDICA

Che cos'è?

Informatica Medica (Medical Informatics)

Morris F. Collen, 1977 (*Preliminary announcement for the Third World Conference on Medical Informatics, Medinfo 80, 1977*)

Medical informatics is the **application of computer technology to all fields of medicine** – medical care, medical teaching, and medical research.

Jan H. Van Bommel, 1984 (*Van Bommel, J.H. The structure of medical informatics. Medical Informatics, 9 (1984), p. 175*)

Medical informatics comprises the theoretical and practical aspects of **information processing and communication**, based on knowledge and experience derived from processes in medical and health care.

M.S. Blois and Edward H. Shortliffe, 1990

Medical informatics is the rapidly developing scientific field that **deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge for problem solving and decision making.**

British Medical Informatics Society

... the understanding, skills, and tools that enable the sharing and use of information to deliver healthcare and promote health.... the **place where health, information and computer sciences, psychology, epidemiology, and engineering intersect**

eHealth

World Health Organization (WHO)

eHealth is the use of **information and communication technologies (ICT) for health.**

Mitchell, 1999

A new term needed to describe the **combined use of electronic communication and information technology in the health sector.**

Medical Business News, 2000

E-Health is a convergence between the Internet and the health care industry **to provide consumers** with a wide variety of information relating to the health care field

Eysenbach, 2001

e-health is an emerging field in the **intersection of medical informatics, public health and business**, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

INFORMATICA MEDICA =

Insieme di conoscenze, metodi e teorie che si focalizzano sull'uso efficace delle INFORMAZIONI e della CONOSCENZA al fine di migliorare la qualità, la sicurezza e il rapporto costo-efficacia della cura dei pazienti e più in generale della salute degli individui e della popolazione

Milestones: Ledley and Lusted 1959

> [Science](#). 1959 Jul 3;130(3366):9-21. doi: 10.1126/science.130.3366.9.

Reasoning foundations of medical diagnosis; symbolic logic, probability, and value theory aid our understanding of how physicians reason

[R S LEDLEY, L B LUSTED](#)

PMID: 13668531 DOI: [10.1126/science.130.3366.9](#)

Considerato il primo lavoro che sancisce l'ingresso
dell'informatica in medicina

Milestones: decision support systems

- Early 60s → experimental prototypes
- Two advisory systems from the 1970s are the pioneers:
 - deDombal's system for diagnosis of abdominal pain (de Dombal et al., 1972)
 - Shortliffe's MYCIN system for selection of antibiotic therapy (Shortliffe, 1976)

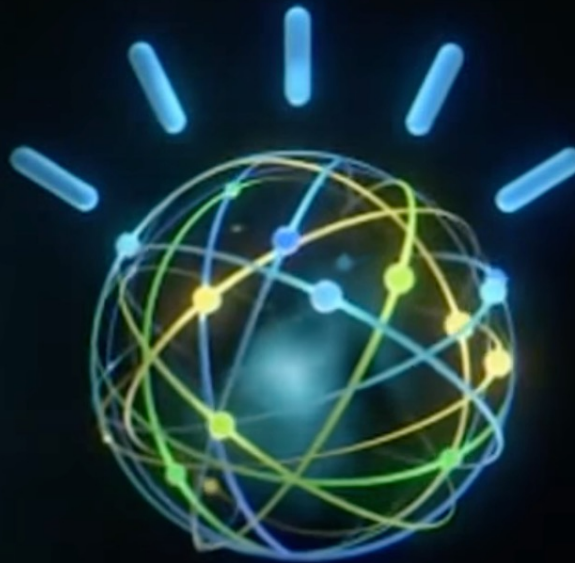
Rule507

IF:	1) The infection that requires therapy is meningitis, 2) Organisms were not seen on the stain of the culture, 3) The type of infection is bacterial, 4) The patient does not have a head injury defect, and 5) The age of the patient is between 15 years and 55 years
THEN:	The organisms that might be causing the infection are diplococcus-pneumoniae and neisseria-meningitidis

Figure 20.1. A typical rule from the MYCIN system. Rules are conditional statements that indicate what conclusions can be reached or actions taken if a specified set of conditions is found to be true. In this rule, MYCIN is able to conclude probable bacterial causes of infection if the five conditions in the premise are all found to be true for a specific patient. Not shown are the measures of uncertainty that are also associated with inference in the MYCIN system.

Today...

<https://www.youtube.com/watch?v=338CIHIVi7A>



▶ ⏪ 🔊 0:03 / 2:16



Milestones: Electronic Health Records

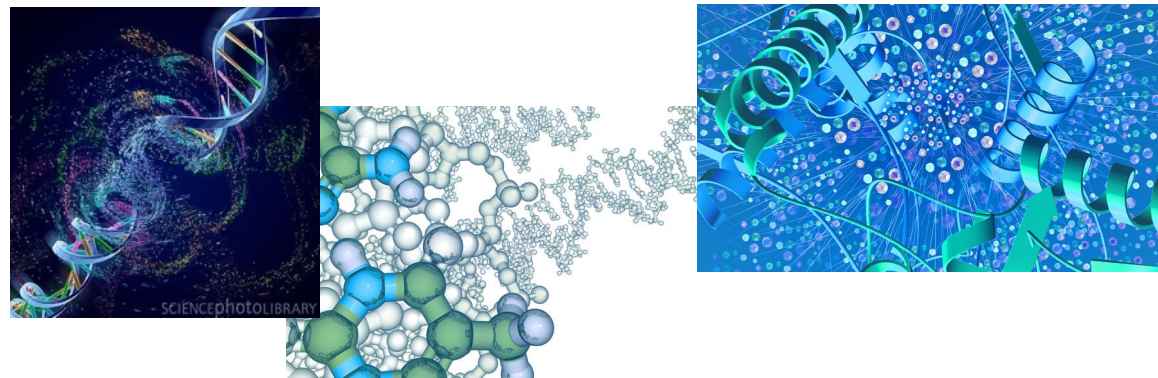
- Mid 60s → EHR systems were known as clinical information systems. First attempts by Academia and early vendors
- 1968 → COSTAR – Computer Stored Ambulatory Record (Massachusetts General Hospital)
- HELP – Health Evaluation through Logical Processing (University of Utah and 3M)
- 70s → VistA and CPRS (Computerized Patient Record System) – Veteran's Administration

Milestones: standards, terminologies and information retrieval

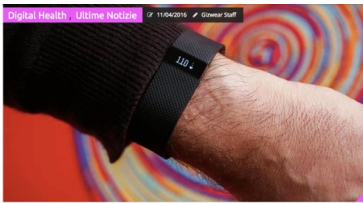
- 1988 → First version of HL7
- 1986 → NLM started UMLS project (harmonization of medical terminologies)
- 80s → NLM started projects on information retrieval from bibliographic databases

Milestones: the human genome project

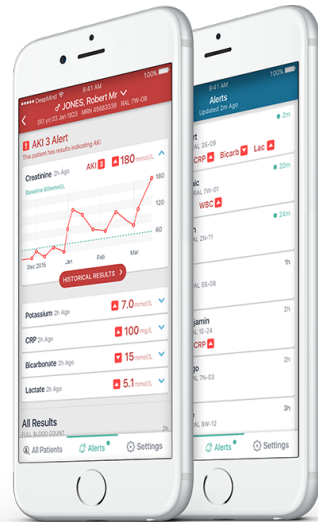
- Human Genome Project to sequence human genome began in 1988
- In 2001, NIH-based project published “first draft” simultaneously with private effort from Craig Venter of Celera Genomics
- Project “completed” in 2003
- Sequencing of more humans increased understanding of genomic variation and complexity



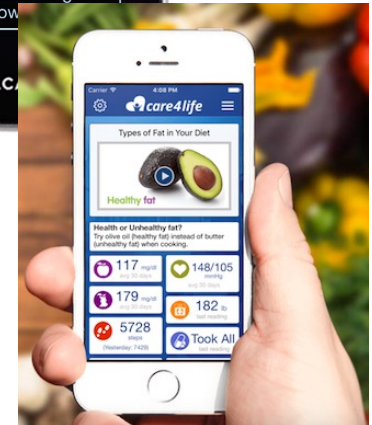
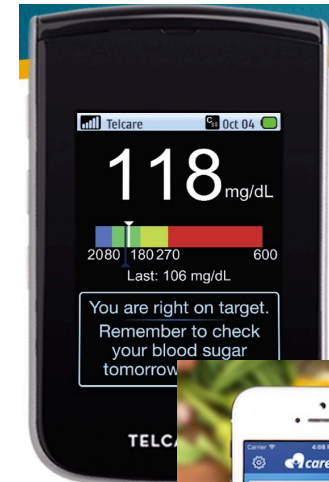
Milestones: big data, mHealth, health IoT in healthcare



Fitbit Charge HR salva la vita ad un malato di cuore!



- There are more mobile connections than people
- The number of devices connected to the Internet is more than 25 billions
- Data are collected continuously by apps and devices



Milestones: the COVID pandemic

New development: 'Healing at a distance'—telemedicine and COVID-19

Higor Leite, Ian R. Hodgkinson & Thorsten Gruber

To cite this article: Higor Leite, Ian R. Hodgkinson & Thorsten Gruber (2020): New development: 'Healing at a distance'—telemedicine and COVID-19, *Public Money & Management*, DOI: [10.1080/09540962.2020.1748855](https://doi.org/10.1080/09540962.2020.1748855)

To link to this article: <https://doi.org/10.1080/09540962.2020.1748855>

SHARE April 03, 2020 SPECIAL EDITORIAL

COVID-19 is catalyzing the adoption of teleneurology

Brad C. Klein, Neil A. Busis

First published April 1, 2020, DOI: <https://doi.org/10.1212/WNL.00000000000009494>

168-m998 doi: 10.1136/bmj.m998 (Published 12 March 2020) Page 1 of 2

Check for updates

Downloads

Check for updates

EDITORIALS

Video consultations for covid-19

An opportunity in a crisis?

Trisha Greenhalgh *professor*¹, Joe Wherton *researcher*¹, Sara Shaw *associate professor*¹, Clare

Vol. ■ No. ■ 2020 *Journal of Pain and Symptom Management* 1

COVID-19 for Fast Track Publication

Telemedicine in the Time of Coronavirus

Brook Calton, MD, MHS, Nuzley Abedini, MD, MSc, and Michael Fratkin, MD
Division of Palliative Medicine (B.C., N.A.), Department of Medicine, University of California, San Francisco (UCSF), San Francisco, California; and ResolutionCare (M.F.), Eureka, California, USA

Telemedicine services became crucial during COVID-19 pandemic, and their adoption was boosted

medRxiv
THE PREPRINT SERVER FOR HEALTH SCIENCES



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From Isolation to Coordination: How Can Telemedicine Help Combat the COVID-19 Outbreak?

Yunkai Zhai, Yichuan Wang, Minhao Zhang, Jody Hoffer Gittel, Shuai Jiang, Baozhan Chen, Fangfang Cui, Xianying He, Jie Zhao, Xiaojun Wang

doi: <https://doi.org/10.1101/2020.02.20.20025957>

This article is a preprint and has not been peer-reviewed [what does this mean?]. It reports new medical research that has yet to be evaluated and so should not be used to guide clinical practice.



The NEW ENGLAND JOURNAL of MEDICINE

Virtually Perfect? Telemedicine for Covid-19

Judd E. Hollander, M.D., and Brendan G. Carr, M.D.

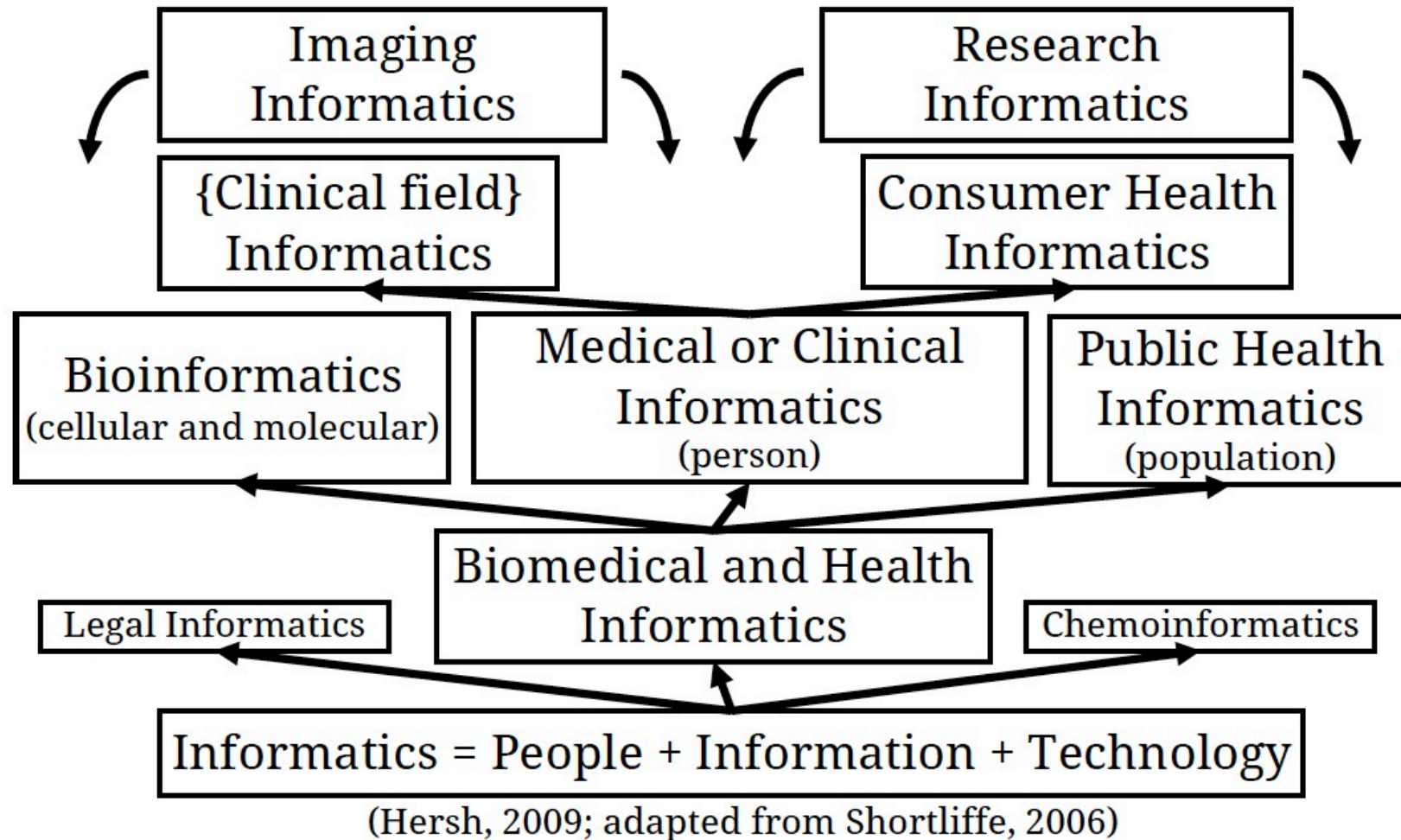
PERSPECTIVES IN HOSPITAL MEDICINE

Keep Calm and Log On: Telemedicine for COVID-19 Pandemic Response

Ameet Doshi, MD, MBA*, Yonatan Platt, MD, John R Dressen, MHA, Benji K Mathews, MD, FACP, SFHM, Jerome C Siy, MD, MHA, SFHM

Department of Hospital Medicine, HealthPartners, Bloomington, Minnesota.

Un po' di terminologia



Un po' di terminologia

- Health information management (HIM) – discipline historically focused on management of medical records
- Telemedicine – provision of healthcare when participants separated by time and/or distance
- Telehealth – pursuit of health when separated by time and/or distance
- mHealth – use of mobile devices for health
- Digital health – broad term for IT-related aspects of health and healthcare

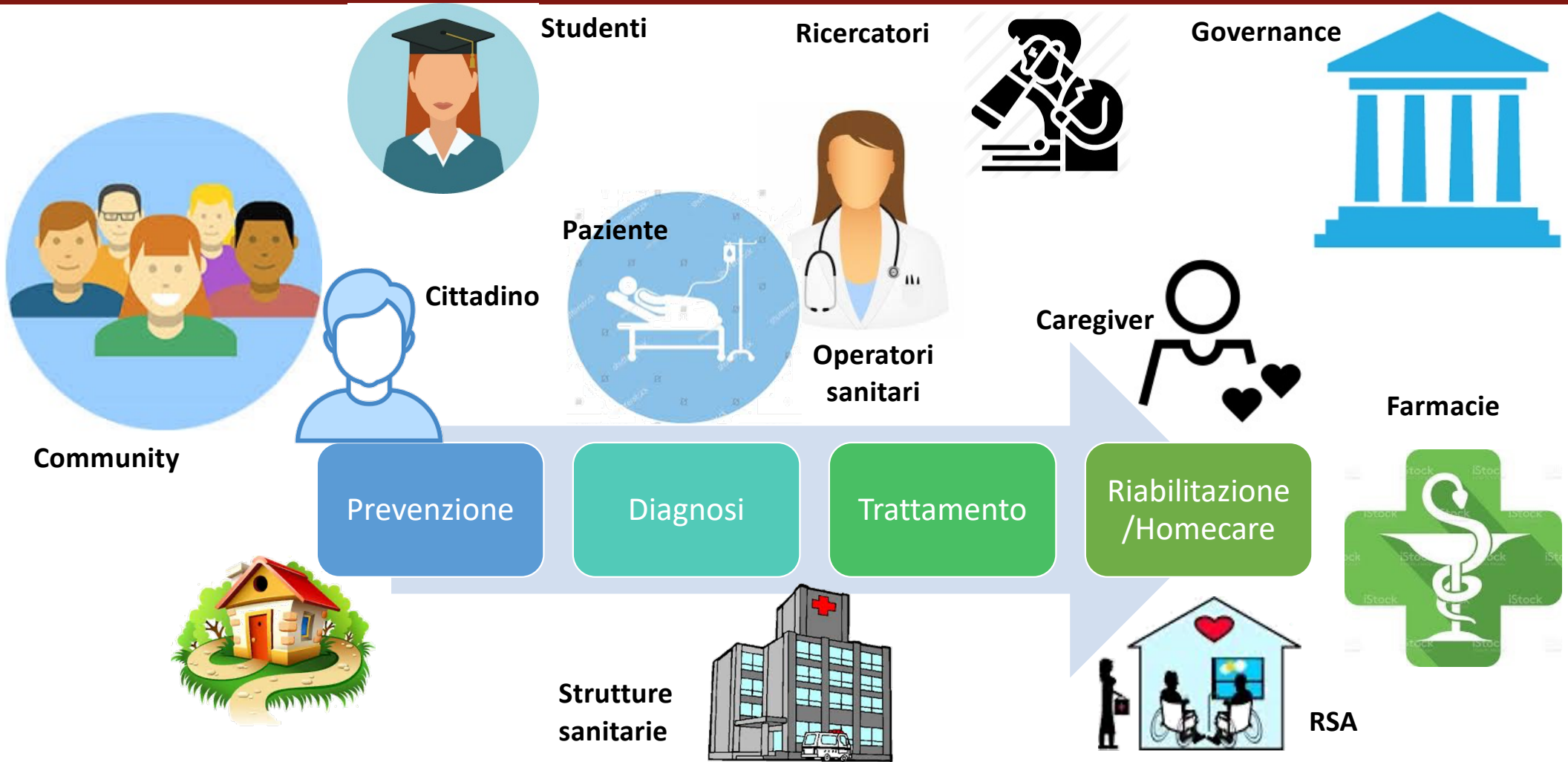
Un po' di terminologia

- Evidence-based medicine (EBM) – the application of the best scientific evidence in medical decision-making
- Evidence-based practice (EBP) – the application of EBM in clinical practice
- Comparative effectiveness research (CER) – research that compares one or more diagnostic or treatment options to evaluate effectiveness, safety or outcomes (also called patient-centered outcomes research)
- Information retrieval (also known as search, part of larger knowledge management) – the field devoted to searching (mostly text, mostly knowledge-based information)

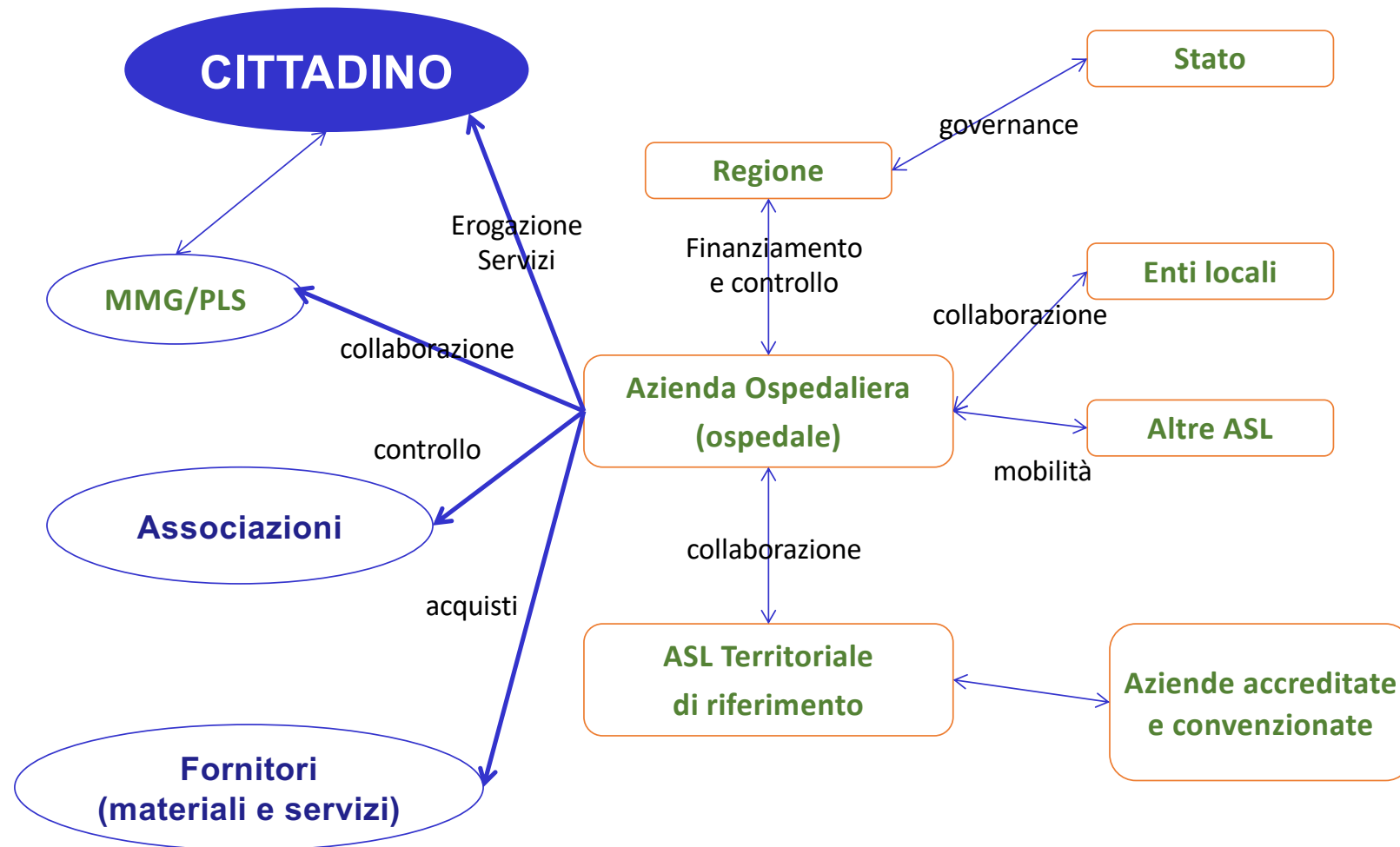
Un po' di terminologia

- Health information exchange (HIE) – exchange of health information across traditional business and other boundaries (a verb)
- Translational research – classically, the translation of basic research into clinical applicability (“bench to bedside”), but also from controlled settings to community and population (Woolf, 2008)
- Precision medicine (IOM, 2011; Collins, 2015) – clinical care tailored to an individual’s characteristics, including their genome
- Clinical research informatics (CRI) is area of informatics applied to clinical research (Richesson, 2019)
- e-Patients – Internet-enabled patients

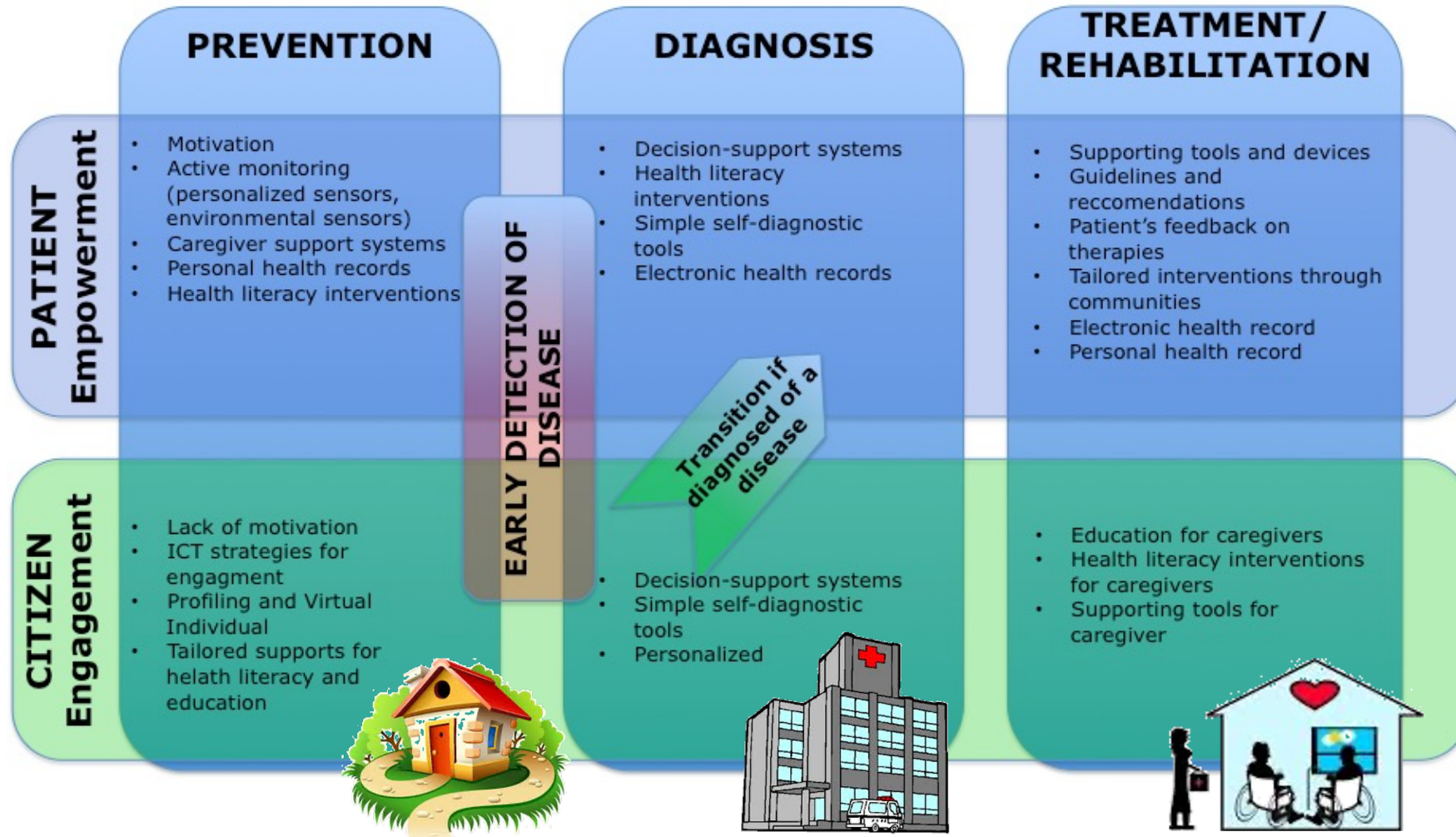
Scenario



Molteplicità degli attori nel Sistema sanitario



eHealth systems and tools



eHealth systems and tools

	Prevention	Diagnosis	Treatment and Rehabilitation
Citizens	Diet monitoring Exercise monitoring Educational tools Personal Health Record (PHR)	Communication with healthcare professionals Unsupervised symptom checkers e-services for checking symptoms Health information websites/apps	
Patients	Telemonitoring & Sensors Environmental monitoring Educational tools Personal Health Record (PHR)	e-services for checking symptoms Telediagnosis tools Portals for ranking/finding physicians	Drug tracking systems Telerehabilitation systems Patient portals
Family/Caregivers	Activity trackers Educational tools	Communication with healthcare professionals	Drug tracking systems Telerehabilitation systems Community support tools Family Health Records
Healthcare Professionals and hospitals/care centres	Risk assessment tools Screening and Telescreening Decision Support Systems Electronic Health Record (EHR)	Electronic Health Record (EHR) Supervised Symptom checkers Decision Support Systems Domain Ontologies and Knowledge representation systems Hospital Information System Reference databanks Biosignal/Bioimage Databanks	Telecare systems Computer Interpretable Guidelines (CIGs) and Recommendations Electronic Health Record (EHR) Social care records and supporting systems Reference databanks
Private/Public/insurance Payers	Insurance-provided PHRs Risk assessment	Health Information Systems	Telecare systems
Medical Students		Visual knowledge tools Bioimage databanks Online reference systems Virtual environments	
Researchers		Clinical report Forms (CRF) Shared Databanks Multicentre research platforms Reference databanks Crowdsourcing tools	

eHealth systems tools

**Electronic
Case Report
Forms**

**Electronic
Health
Record**

**Integrated
care
pathways**

mHealth

**Wearable
Devices
(IoT)**

**Hospital
Information
Systems**

**Decision
Support
Systems**

**Personal
Health Record**

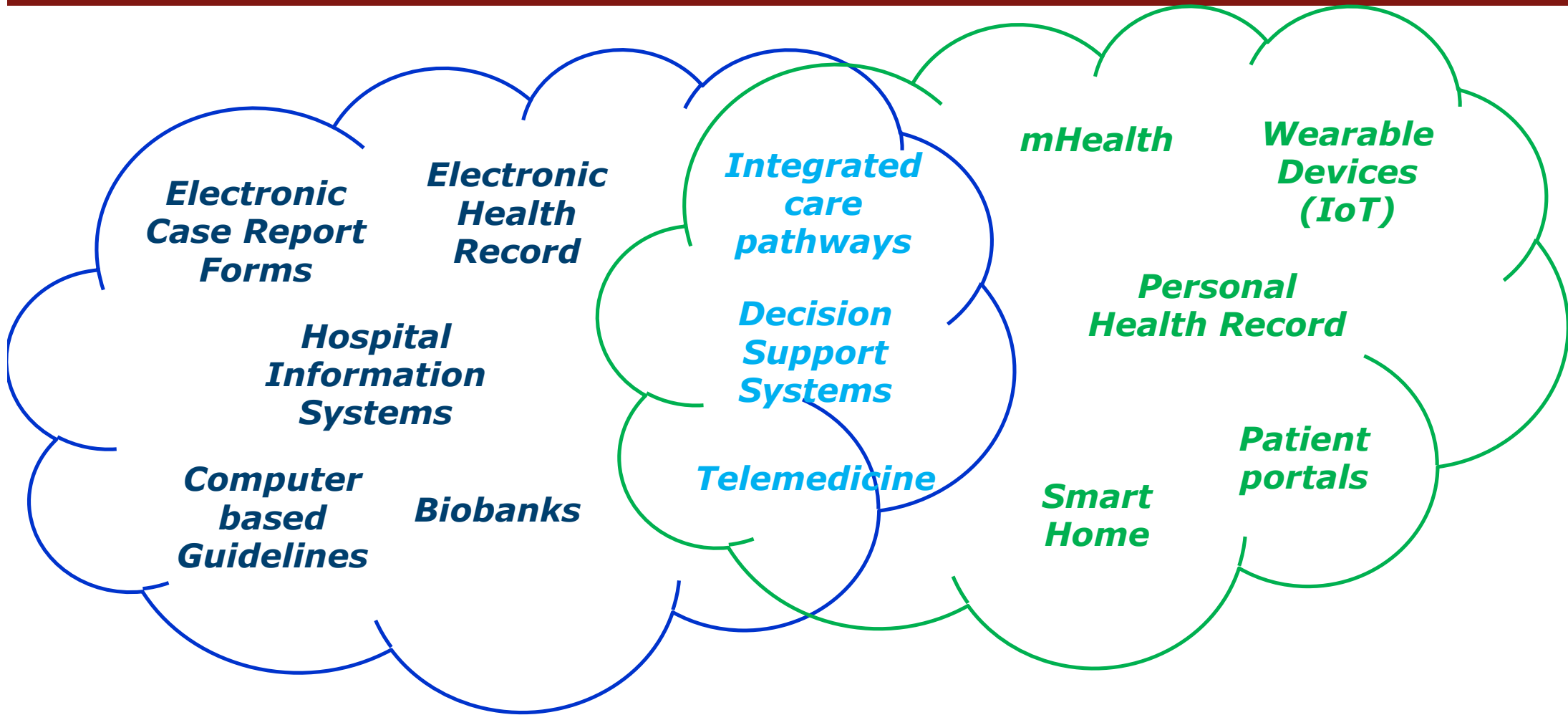
**Computer
based
Guidelines**

Biobanks

Telemedicine

**Smart
Home**

**Patient
portals**



Digitalizzazione in Italia

- L'informatica medica fa parte della strategia digitale nazionale
- 2012 → nascita AgID (Agenzia per l'Italia Digitale)
- **Piano Nazionale Ripresa e Resilienza (PNRR) Missione 6: Salute**



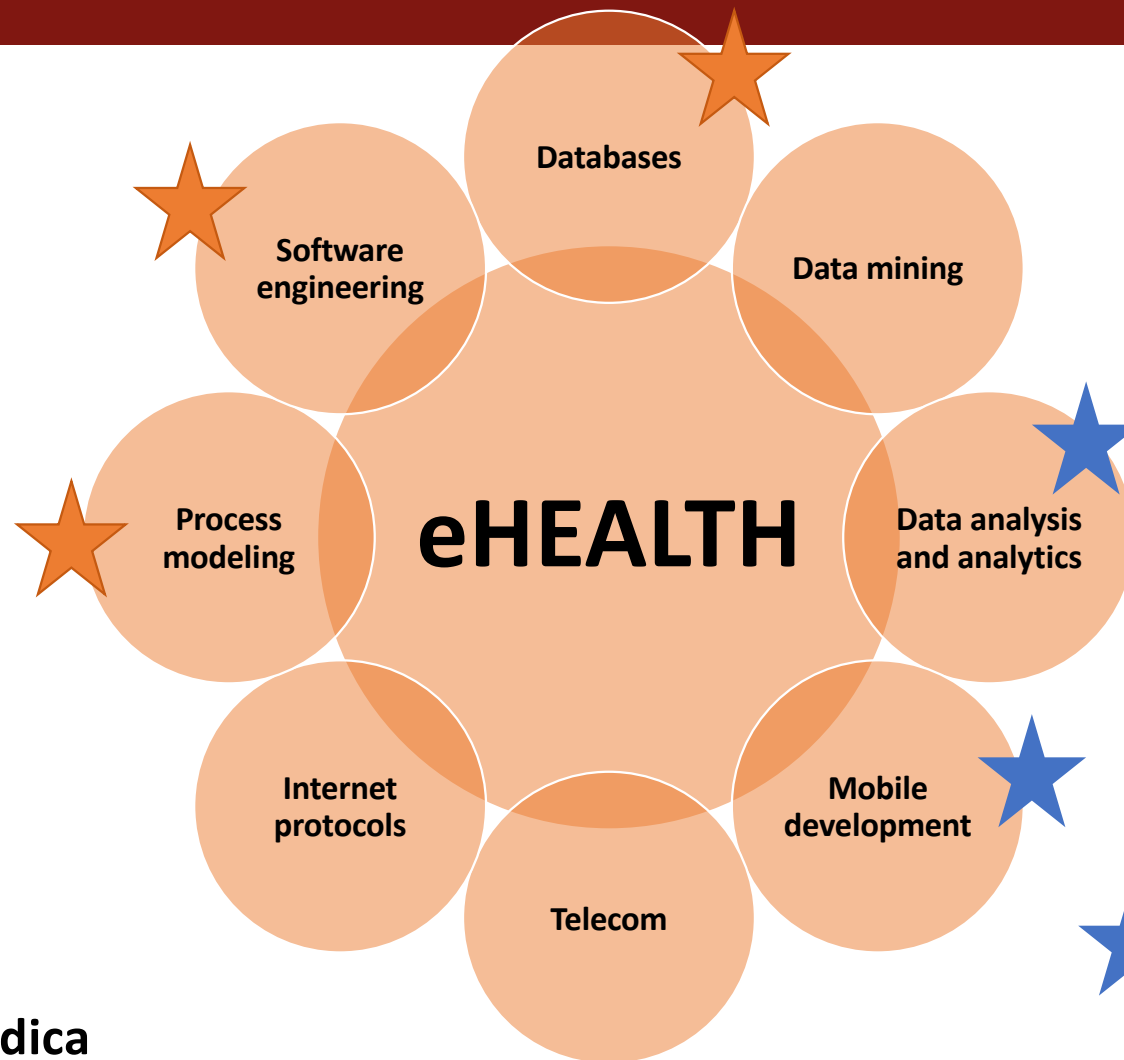
Investire nella digitalizzazione dell'assistenza medica ai cittadini, promuovendo la **diffusione del Fascicolo Sanitario Elettronico e la Telemedicina**, ma anche nell'adozione di **tecnologie digitali** nel settore dell'assistenza medica e dei servizi di prevenzione.



L'ecosistema sanità



Strumenti informatici per le soluzioni eHealth

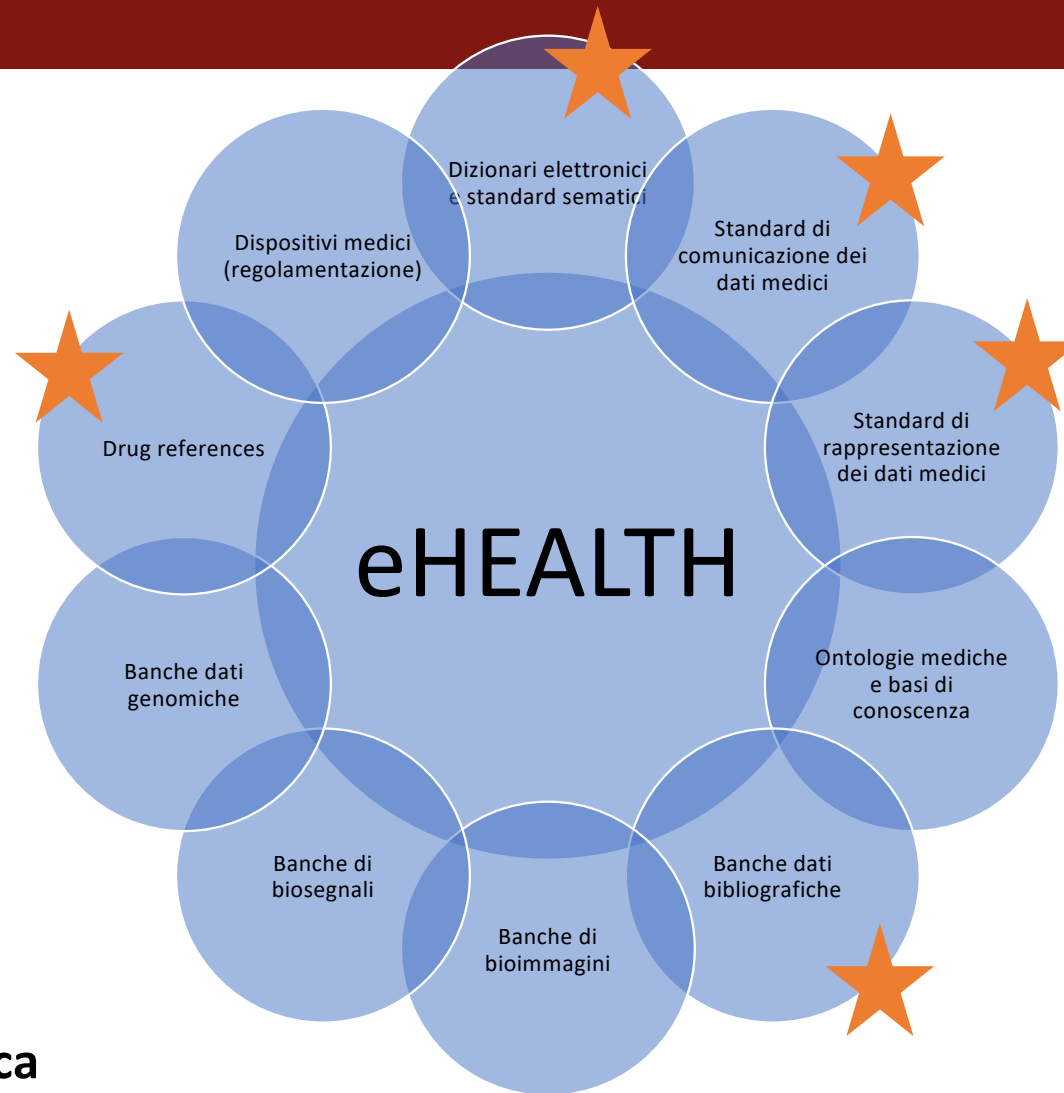


**Fondamenti di
Informatica Medica**



**Complementi di
Informatica Medica**

Strumenti dell'Informatica Medica a supporto del eHealth



**Fondamenti di
Informatica Medica**