

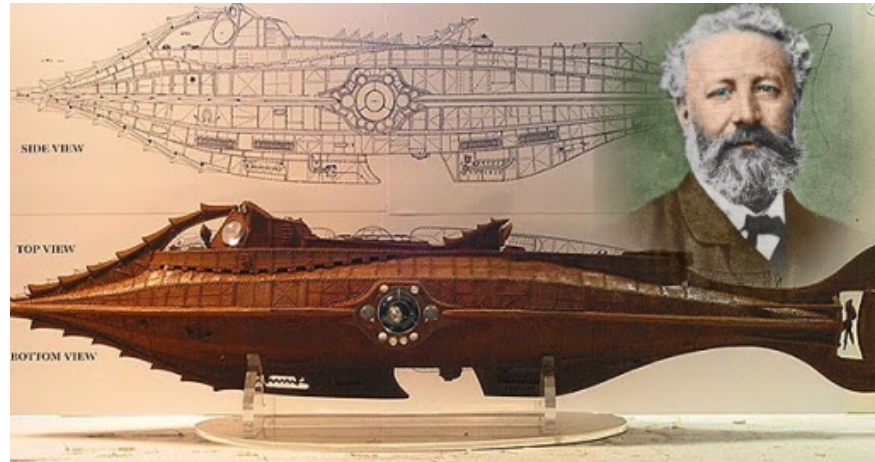


UNIVERSITÀ  
DEGLI STUDI DI TRIESTE



# Intelligenza Artificiale in Medicina

## I sogni, fin dall'antichità



Nautilus, Jule Verne, 1872

Iliade, tripode automatico  
VI sec aC

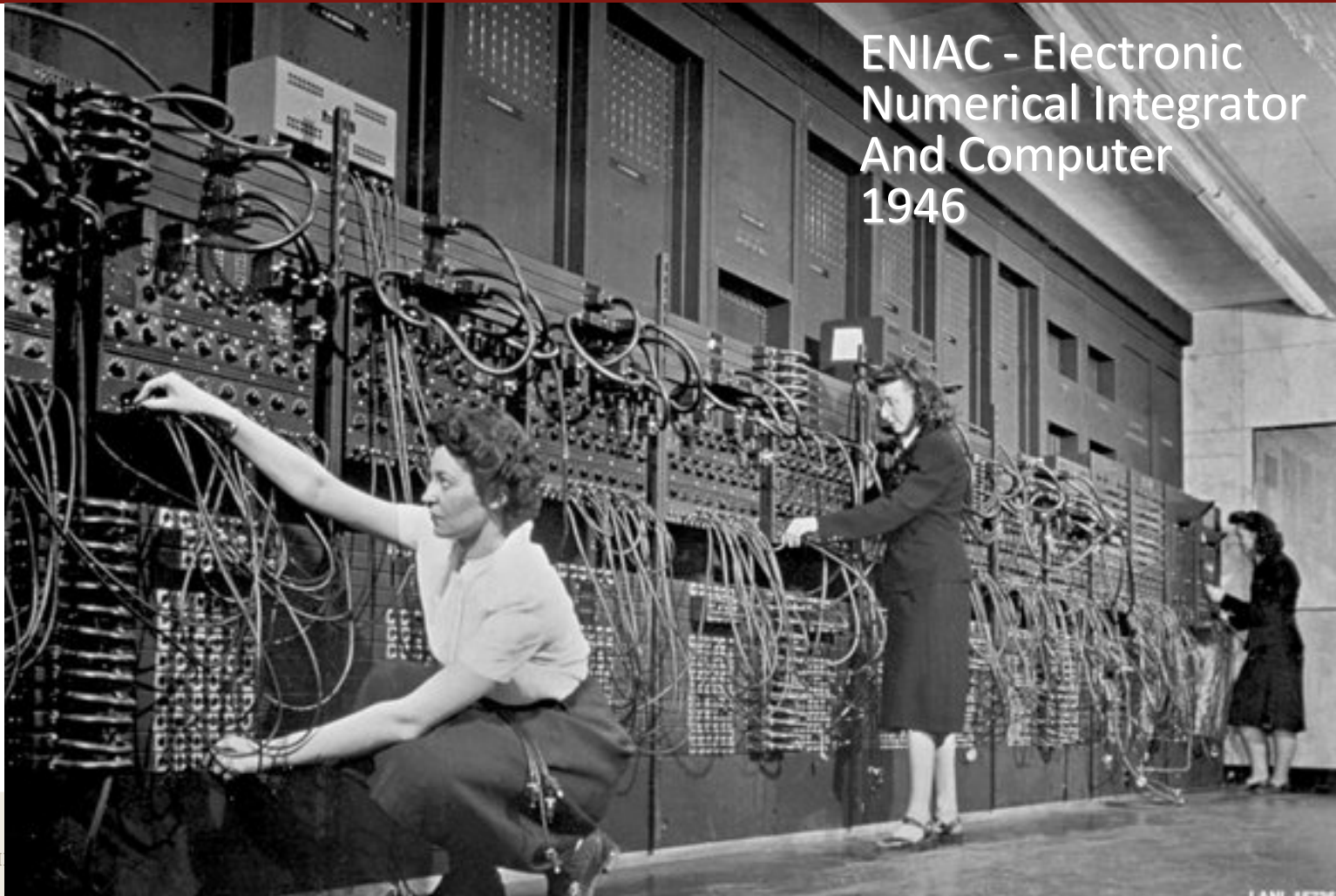


Il mago di Oz, Tik-Tok, 1907





## L'era dei computer



ENIAC - Electronic  
Numerical Integrator  
And Computer  
1946

## Pionieri – i programmi che imparano



**Arthur Samuel**  
**IBM 704**  
**1950s**

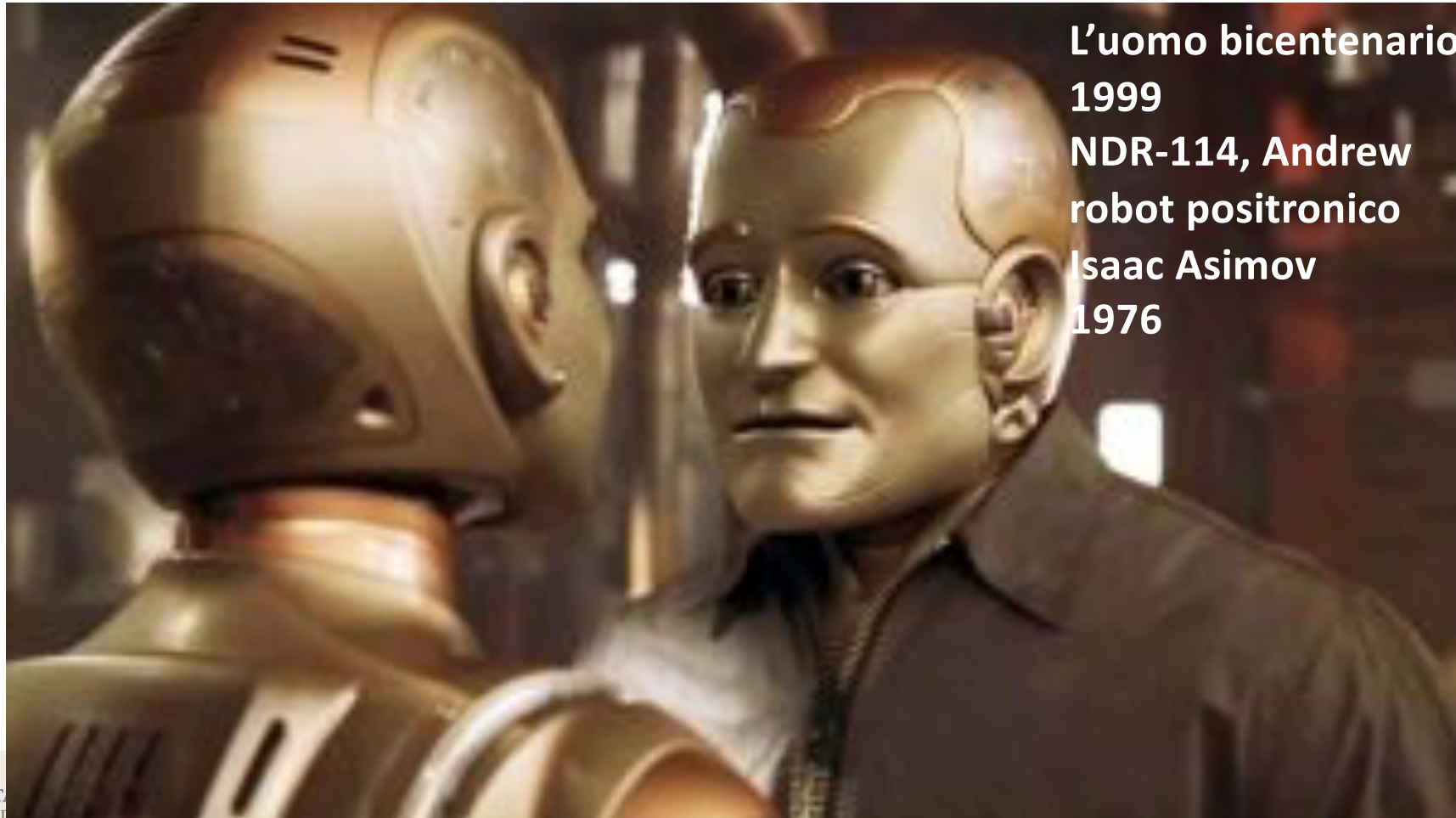


## La nascita del AI - 1956



Trenchard More,  
John McCarthy,  
Marvin Minsky,  
Oliver Selfridge, and  
Ray Solomonoff

# I sogni

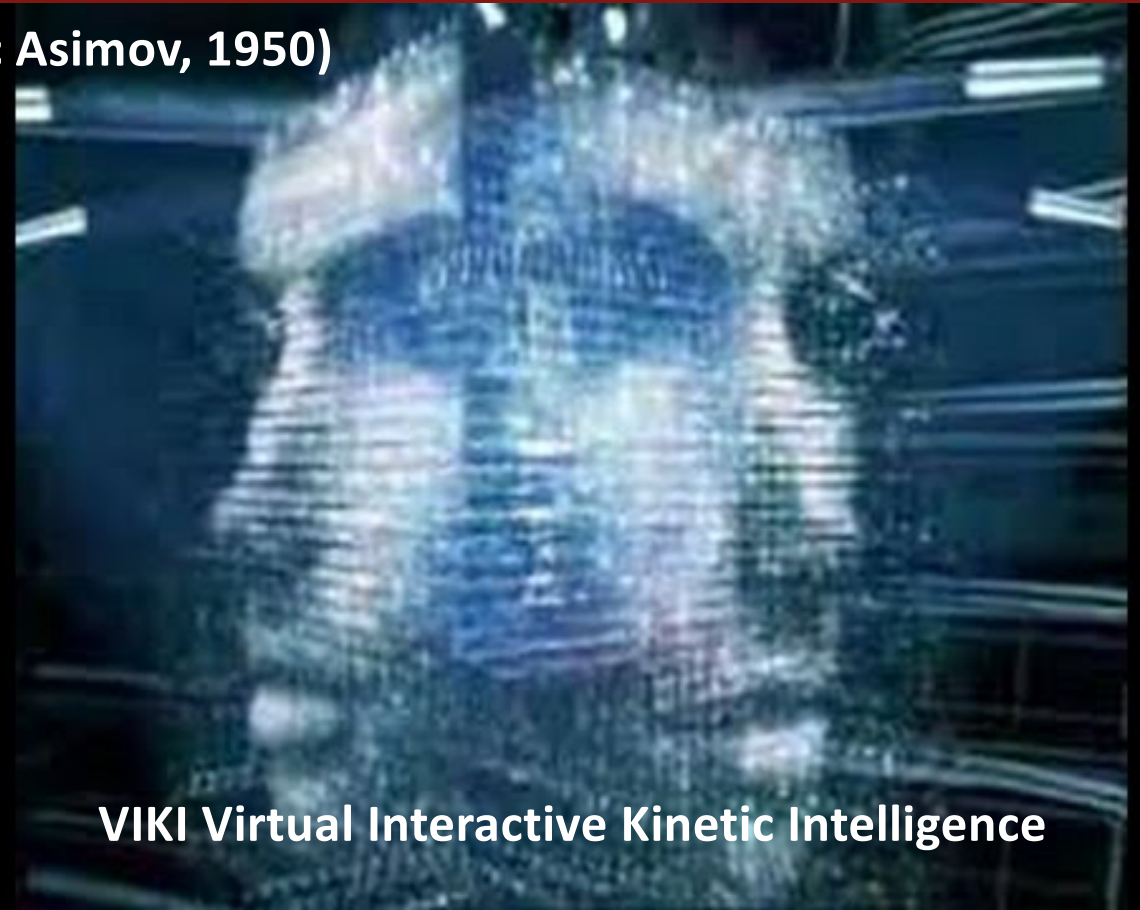


L'uomo bicentenario  
1999  
NDR-114, Andrew  
robot positronico  
Isaac Asimov  
1976

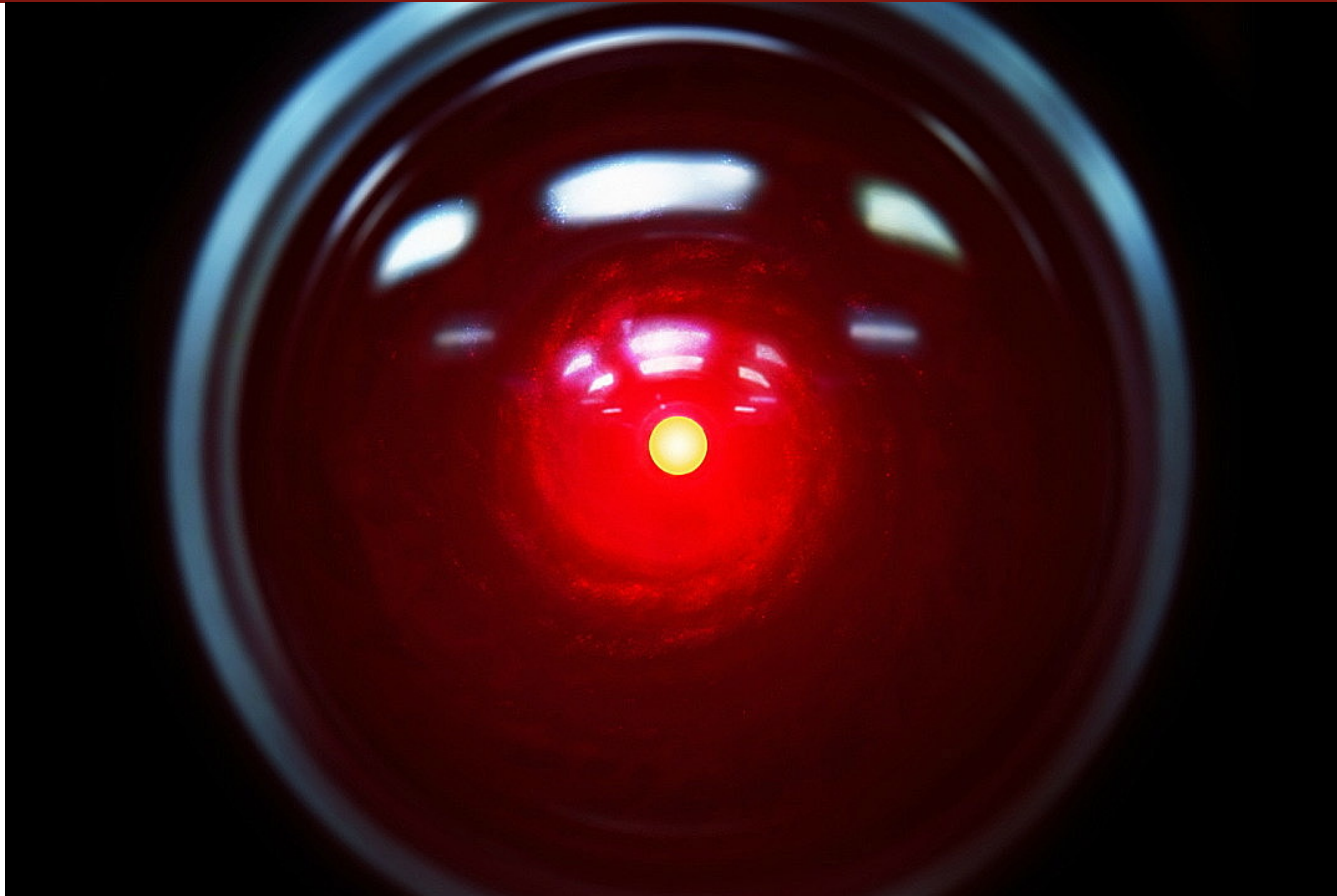


# I sogni

Io, robot 2004 (Isaac Asimov, 1950)  
NS-5 Sonny



# I sogni



**HAL 9000**  
**2001 Odissea**  
**nello spazio**  
**1968**

# I sogni



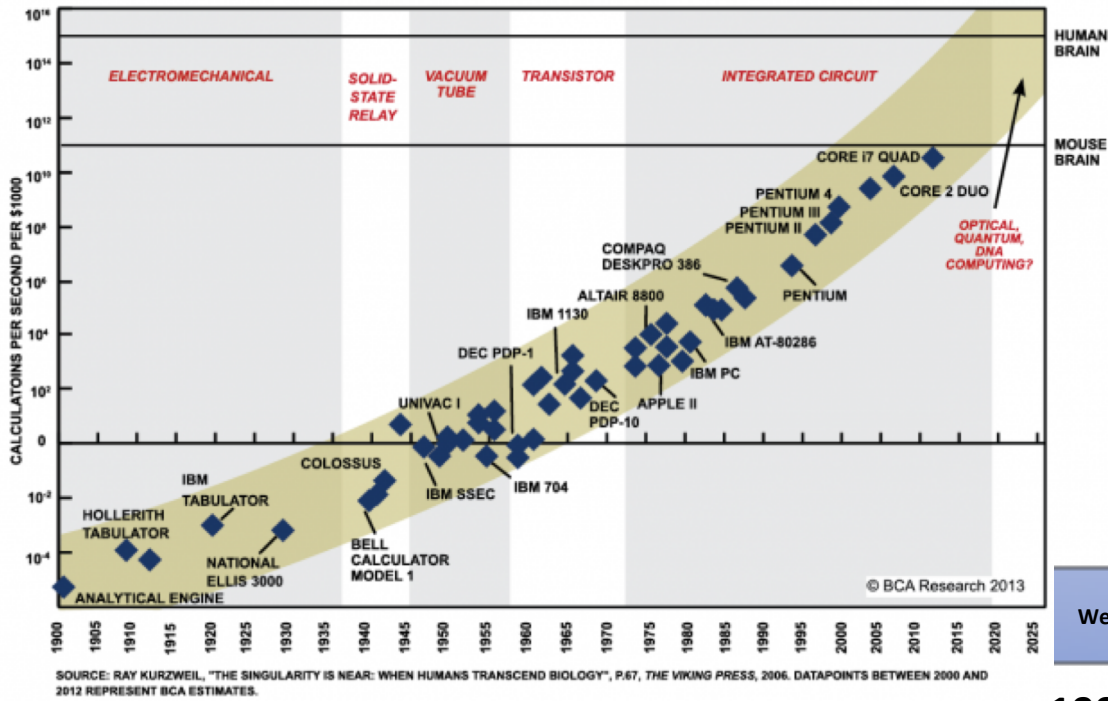
**Star wars**  
**1977**  
**1999**



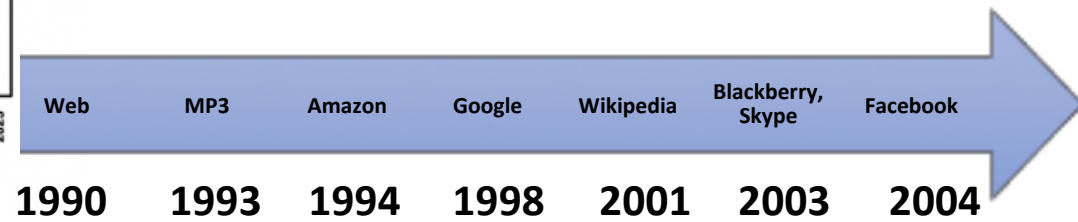
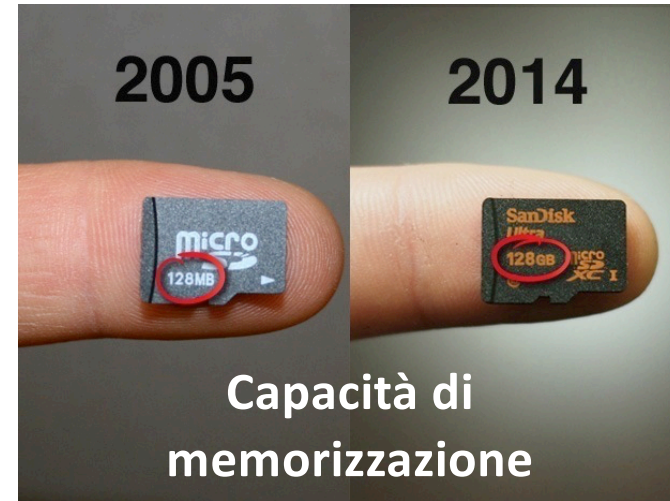
40 anni dopo...



# Tecnologia e ICT



Legge di Moore





# 2016: AlphaGO vs Lee Sedol



# Rivoluzione

# Rivoluzione



# L'era mobile





# Data disruption

compagnia di taxi senza auto



catena di alloggi senza hotel



Alibaba



Commerciante senza merci

Media company senza contenuti





## 2016: AlphaGO vs Lee Sedol



# Cognitive systems

## IBM Watson – Jeopardy!



**IBM Watson Health**  
**Welcome to the cognitive era of health**

A 36-year-old male with hypertension is admitted to the Emergency Department with heart murmur, acute chest pain, and acute abdominal pain. The patient underwent a CT which is shown here. Which is most likely?

**You answered**

- a. Aortic Dissection
- b. Esophagitis
- c. Penetrating Atherosclerotic Ulcer**
- d. Acute Myocardial Infarction

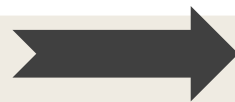
**Raw Data**  
3D Segmentation  
Segmented Aorta  
Dissected Slice

**Patient Case Analysis**  
Age: 36 years  
Gender: male  
Sign or Symptom: heart murmur  
Sign or Symptom: pain abdominal  
Sign or Symptom: acute chest pain  
Modality: CT scan  
Question Type: Differential Diagnosis

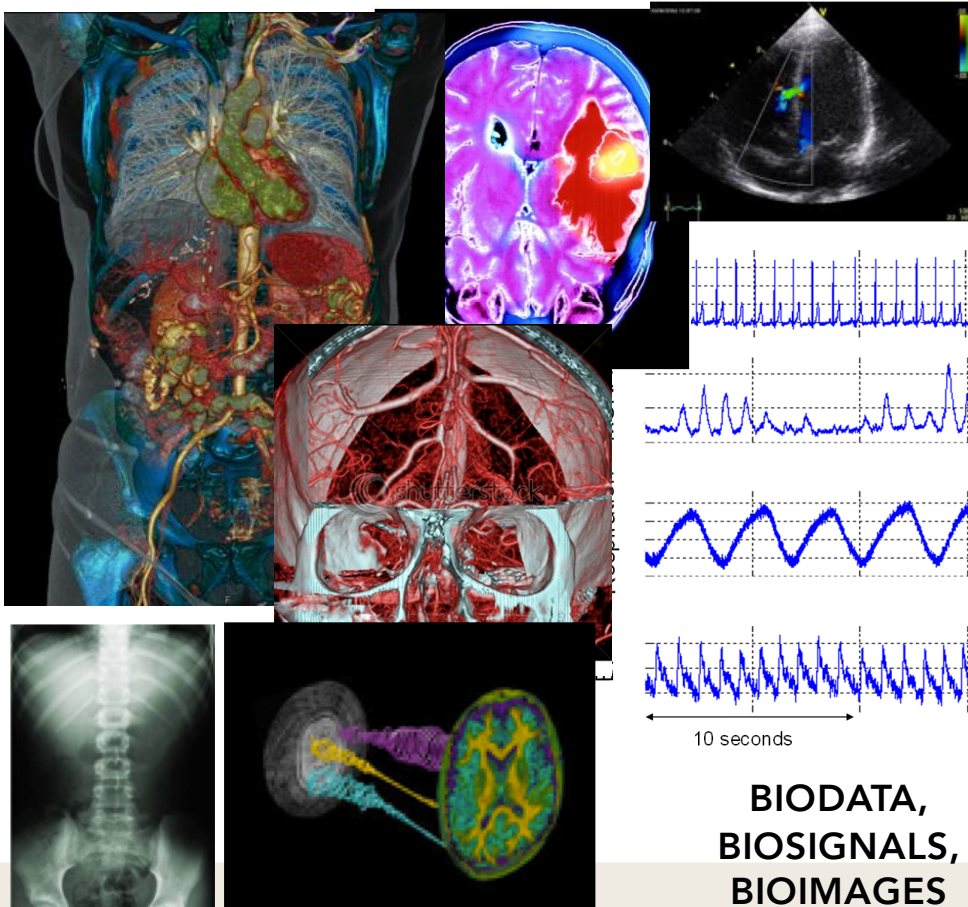
**Image Analysis**

**Watson Inference**  
Aortic Dissection [ ]  
Esophagitis [ ]  
Penetrating Atherosclerotic Ulcer [ ]  
Acute Myocardial Infarction [ ]

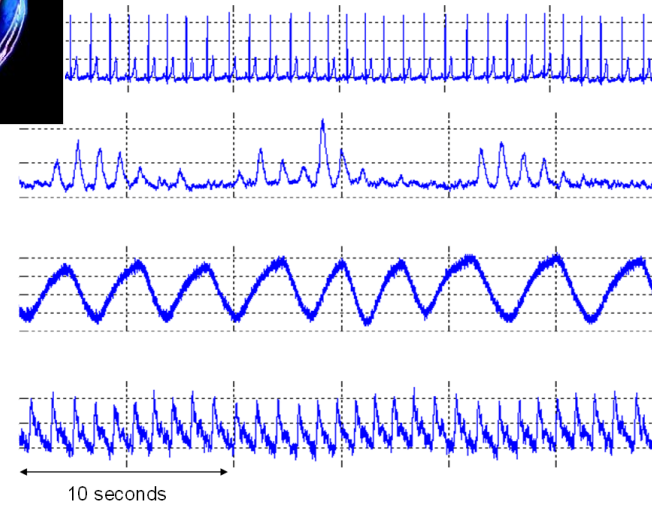
**Eyes of Watson**  
Analyzing Text → **Analyzing Images** → Reasoning → Selecting Answer



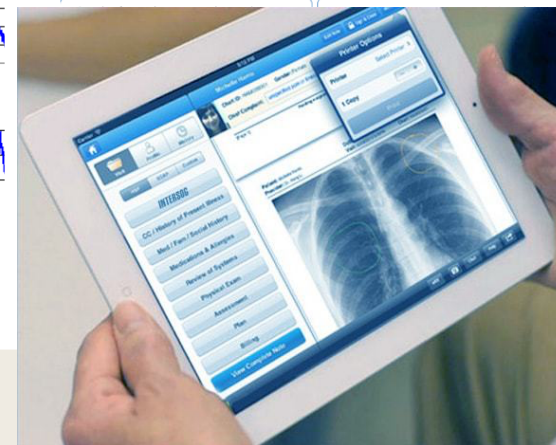
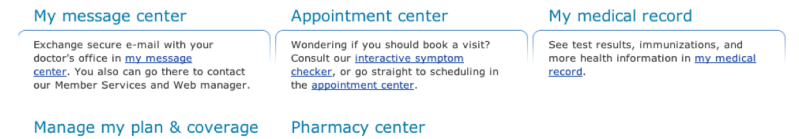
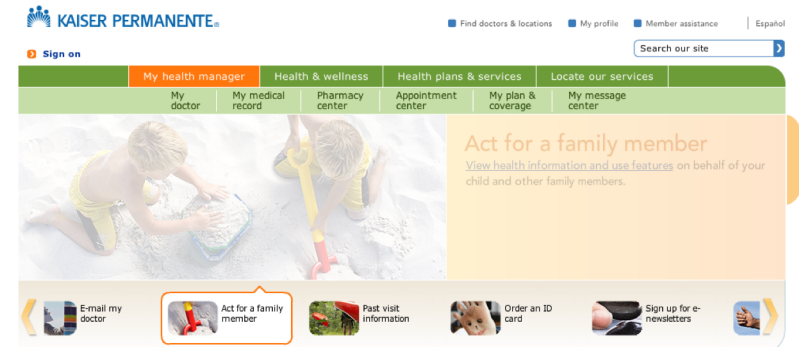
# Big data in healthcare: clinical data



## PERSONAL HEALTH RECORD



## BIODATA, BIOSIGNALS, BIOIMAGES



## ELECTRONIC HEALTH RECORD



# Big data in healthcare: evidence based medicine

NCBI Resources How To Sign in to NCBI

PubMed.gov  
US National Library of Medicine  
National Institutes of Health

PubMed

Advanced Help

**PubMed**  
PubMed comprises more than 28 million citations for biomedical literature from MEDLINE, life science journals, and books. Citations may include links to full-text content from PubMed Central and publisher web sites.

**Using PubMed**

- PubMed Quick Start Guide
- Full Text Articles
- PubMed FAQs
- PubMed Tutorials
- New and Noteworthy

**PubMed Tools**

- PubMed Mobile
- Single Citation Matcher
- Batch Citation Matcher
- Clinical Queries
- Topic-Specific Queries

**More Resources**

- MeSH Database
- Journals in NCBI Databases
- Clinical Trials
- E-Utilities (API)
- LinkOut

NIH U.S. National Library of Medicine  
**ClinicalTrials.gov**

Find Studies About Studies Submit Studies Resources About Site

ClinicalTrials.gov is a database of privately and publicly funded clinical studies conducted around the world.

Explore 271,017 research studies in all 50 states and in 203 countries.

ClinicalTrials.gov is a resource provided by the U.S. National Library of Medicine.

**IMPORTANT:** Listing a study does not mean it has been evaluated by the U.S. Federal Government. Read our [disclaimer](#) for details.

Before participating in a study, talk to your health care provider and learn about the [risks and potential benefits](#).

Find a study (all fields optional)

**Recruitment status**

Recruiting and not yet recruiting studies

All studies

**Condition or disease** (For example: breast cancer)

**Other terms** (For example: NCT number, drug name, investigator name)

**Country**

[Advanced Search](#)

National Guideline Clearinghouse

Help | Videos | RSS |  Subscribe to weekly e-mail | Search

Home

Guidelines

Browse

- By Topic
- By Organization
- Guidelines in Progress
- Guideline Index
- Guideline Archive
- Related NQMC Measures

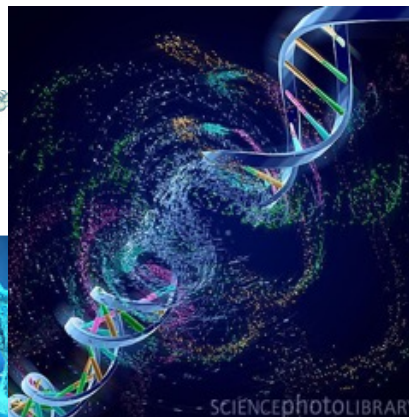
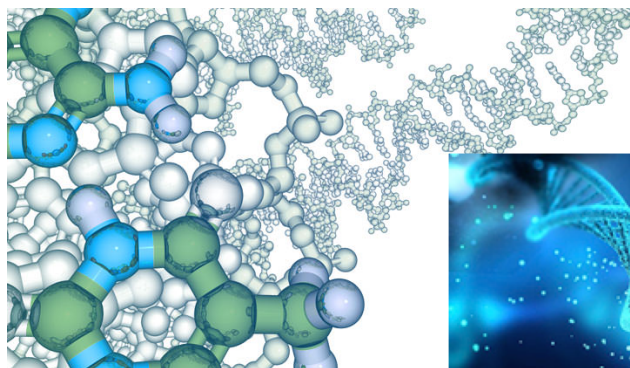
**Guidelines by Topic**

Browse topics to find guidelines represented in NGC that are linked to a particular term derived from the NLM [Medical Subject Headings \(MeSH\)](#), a controlled vocabulary for disease/condition/health services administration. MeSH is one of the controlled vocabularies included within the [Unified Medical Language System \(UMLS\)](#) ([what's this?](#))

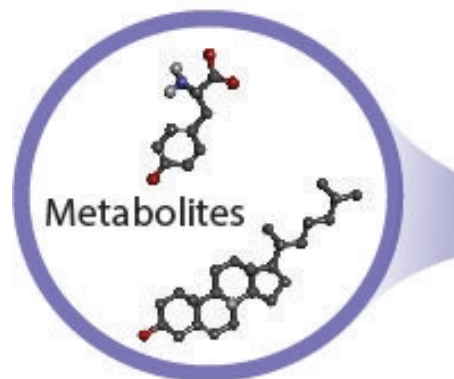
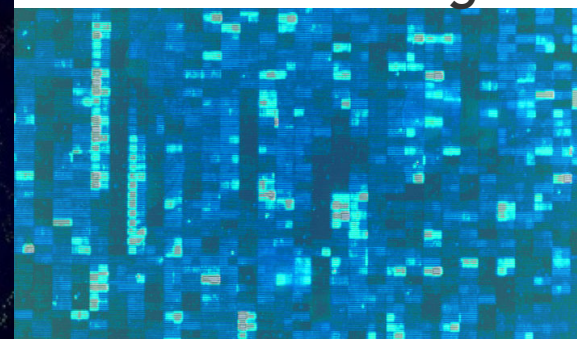
MeSH terms are arranged hierarchically ranging from broad headings to more narrow concepts. For example, the general concept "Nervous System Diseases" can be followed through the MeSH hierarchy down to the concept "Myasthenia Gravis, Neonatal;" the broad concept "Diagnostic Techniques, Digestive System" can be followed through "Endoscopy, Gastrointestinal" to the narrow concept "Sigmoidoscopy."

# Big data in healthcare: -omics

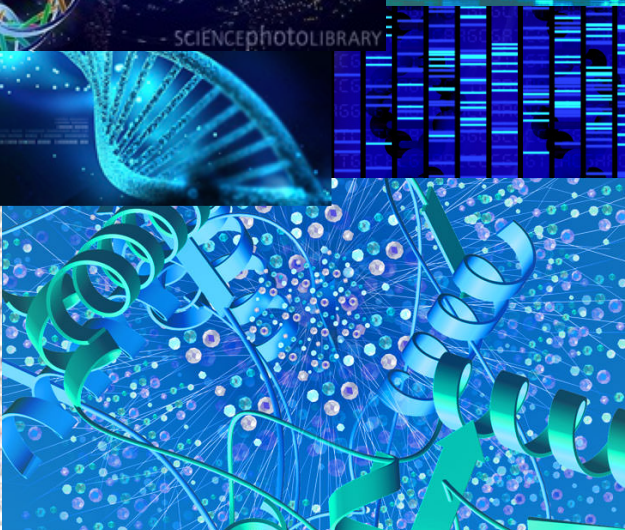
**Genomics**



**Toxicogenomics**

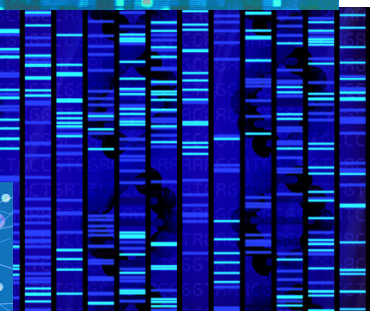


**Metabolomics**



**Proteomics**

**Transcriptomics**





# Big data in healthcare: wereable & implantable devices

The number of devices connected to the Internet was 12.5 billion in 2010, making the number of connected devices per person  $>1$  (1.84) for the first time in history. Now they are 25 billions



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

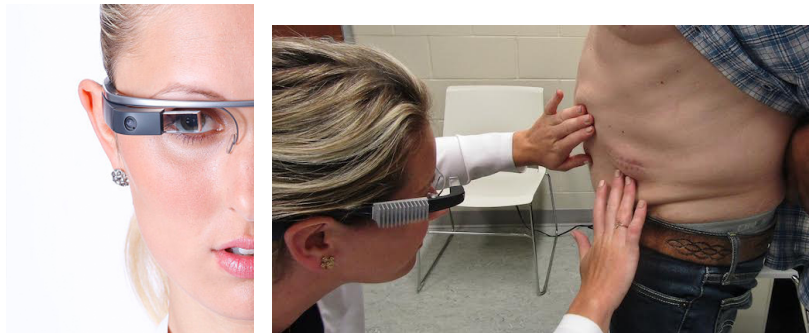


GIZWEAR.net

SOWATCH: lo smartwatch che previene l'ictus



THIM, il primo wearable al mondo "migliora-sonno" | Video



Hodei Technology helps hospitals use Google Glass for surgical collaboration; rural telemedicine



Medtronic implantable device for treating chronic pain by delivering neurostimulation at the spinal cord is connected to a Samsung Galaxy Tab S2, to allow data capturing and IPG controlling

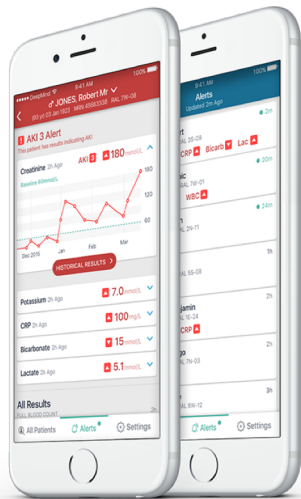
# Big data in healthcare: apps and social media

INTERACTIVE JOURNAL OF MEDICAL RESEARCH

Giordano et al

[Original Paper](#)

WhatsApp Messenger as an Adjunctive Tool for Telemedicine: An Overview



- There are more mobile connections than people
- Internet search engines like **Google** are the **3rd** source of information (51,4%), **Facebook** is the **fifth** (43,7%).
- Among younger people:
  - **First: Facebook (71,1%)**
  - **Second: Google (68,7%)**
  - **Fourth: YouTube (53,6%)**



# Big data in healthcare: scenario atteso



4/21/20

[www.ibm.com](http://www.ibm.com)



# Big data in healthcare: aspettative

## IMPROVING CLINICAL OUTCOMES

Comparative effectiveness research to identify the most cost-effective ways to diagnose/treat patients

## TELEMONITORING

Real-time monitoring at home and in-hospital to prevent acute episodes and adverse events

## PUBLIC HEALTH

Analyze disease patterns to improve public health surveillance, faster development of targeted vaccines, identify needs and provide targeted services

## DRUG DISCOVERY

Predictive modeling to identify candidate new drugs

## GENOMIC ANALYTICS

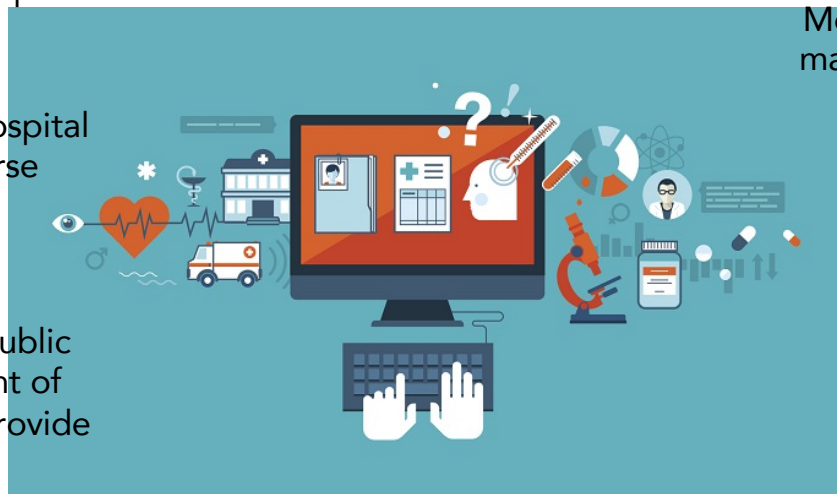
More efficient sequencing and analysis to make genomic analysis part of the regular medical decision making process

## CLINICAL RESEARCH

Improve clinical trial design, and improve data analysis to discover hidden information e.g., adverse effects

## FRAUD ANALYSIS

Automatic analysis of claim requests to reduce frauds, waste, and abuse



## PATIENT PROFILING

Segmentation, predictive modeling, to suggest lifestyle changes, and to evaluate risk profiles

## EVIDENCE-BASED MEDICINE

Extract valuable information from available heterogeneous clinical data

# Big data in the real world: le 4V

## VOLUME

- The size of data goes beyond the ability of common hardware/software
- Healthcare volume → z

## VELOCITY

- The rate of growth is very fast
- There is a constant flow of data often in real time

## THE BIG DATA 4Vs

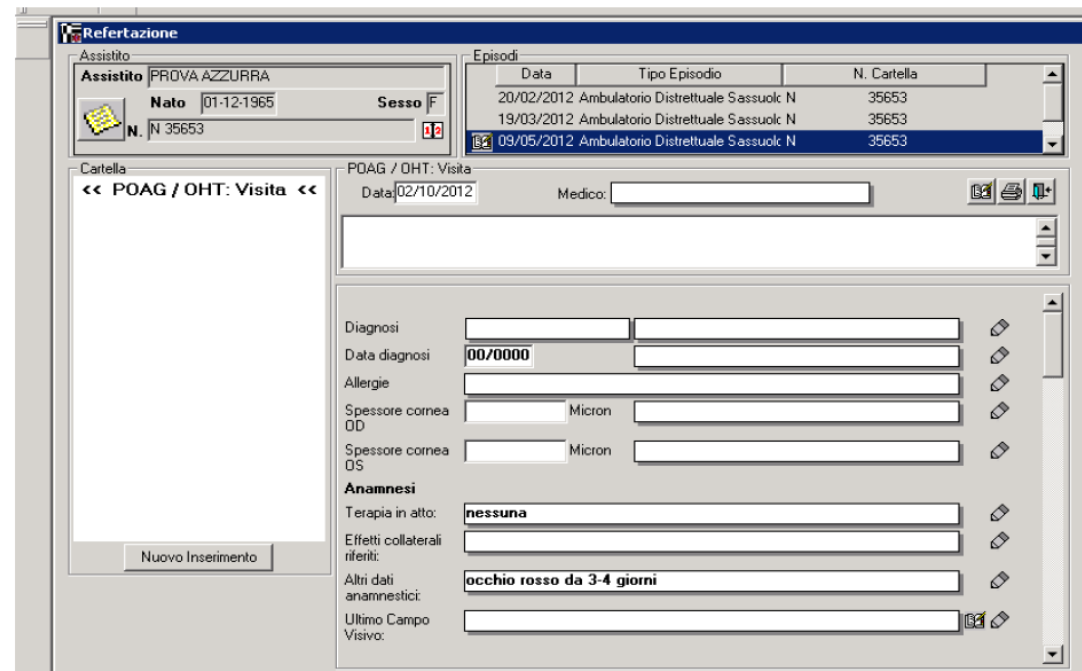
## VARIETY

- Heterogeneous data (structured, unstructured, semi-structured)
- Different data types

## VERACITY

- Errors and inaccuracies are possible
- Error free outcomes are the goal

# Big data in healthcare: heterogeneity



## STRUCTURED vs UNSTRUCTURED DOCUMENTS

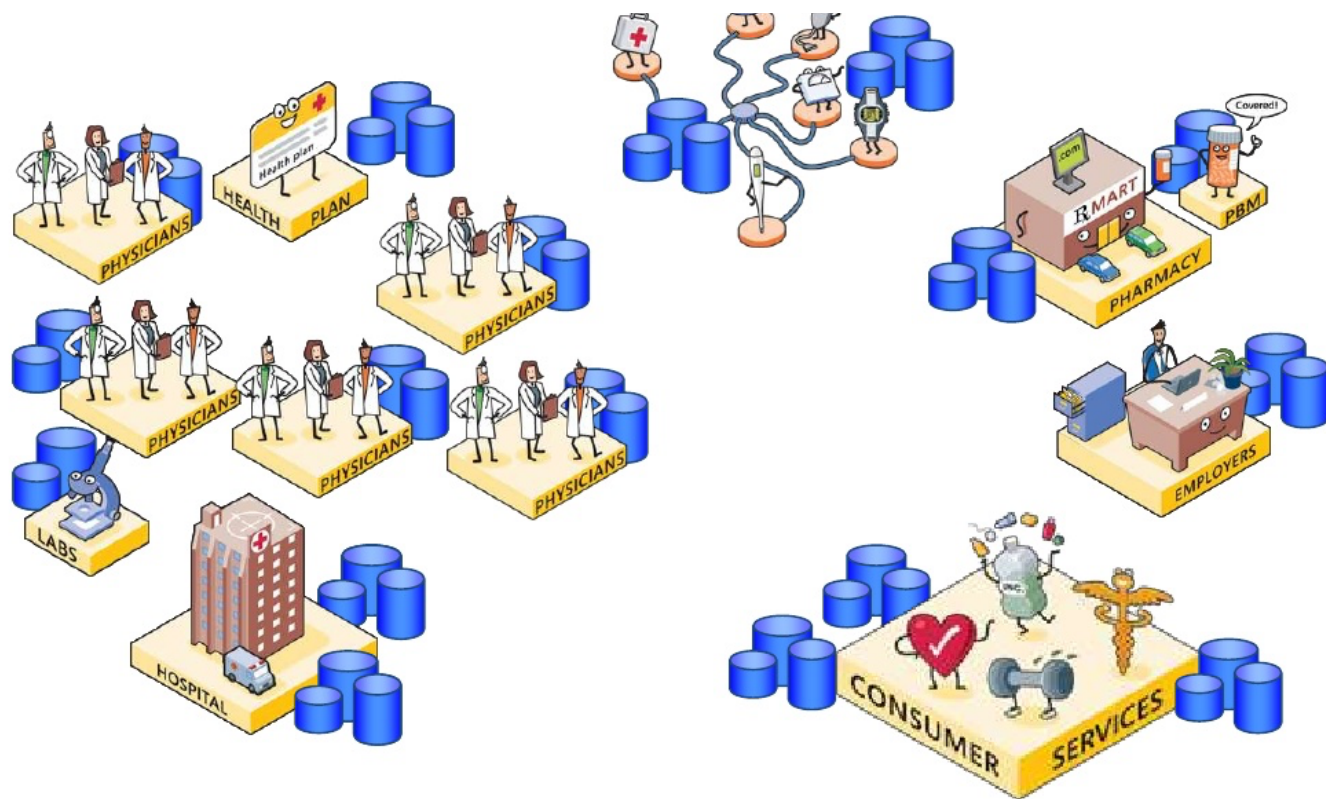


# Big data in healthcare: data silos

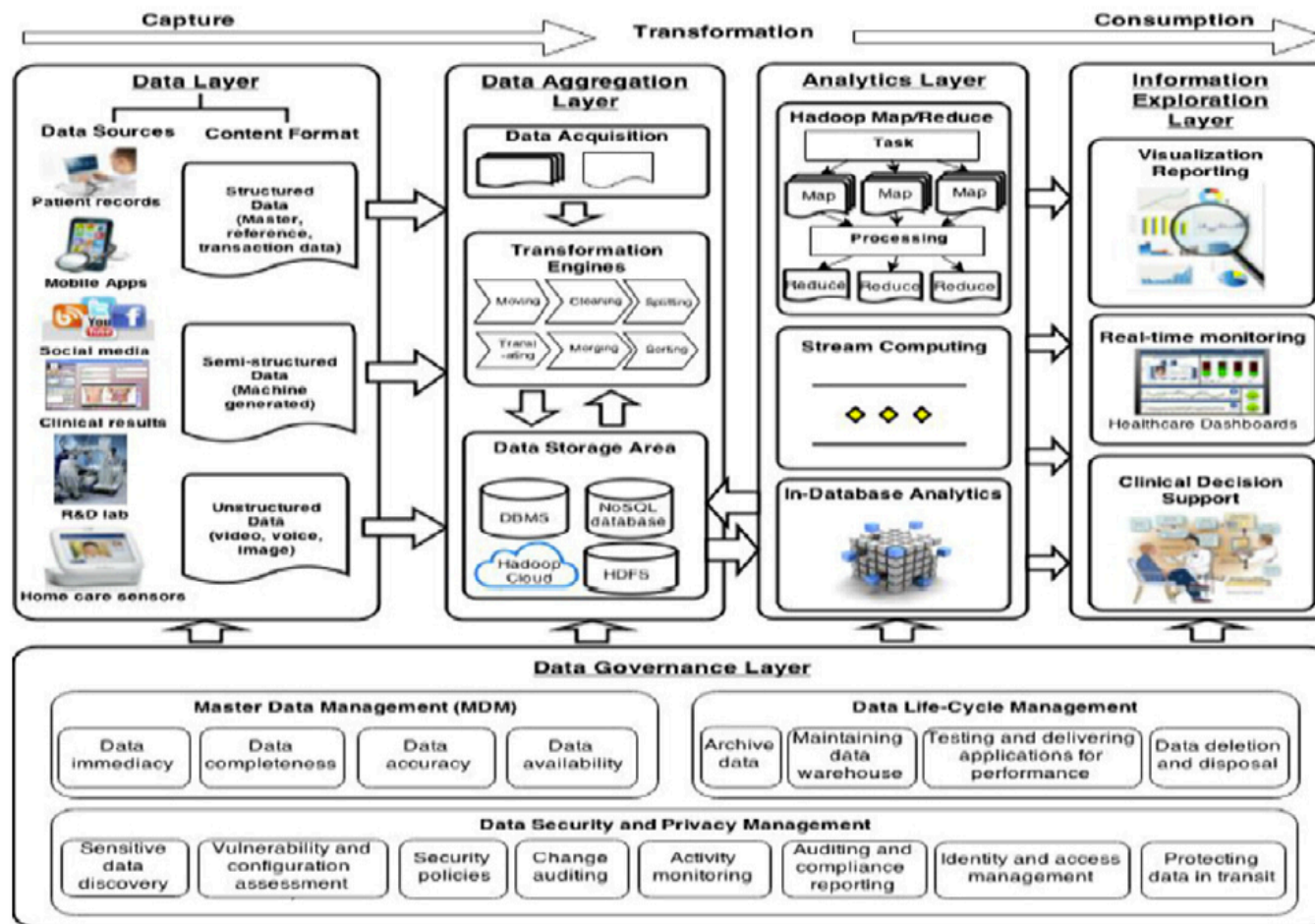
Healthcare data are stored in isolated "silos"



Interoperability is envisaged



# Big data in healthcare: analytics



- Four-step process:
- 1- Data collection
  - 2- Data aggregation
  - 3- Data analysis
  - 4- Information extraction

Technological Forecasting & Social Change 126 (2018) 3–13

Contents lists available at ScienceDirect



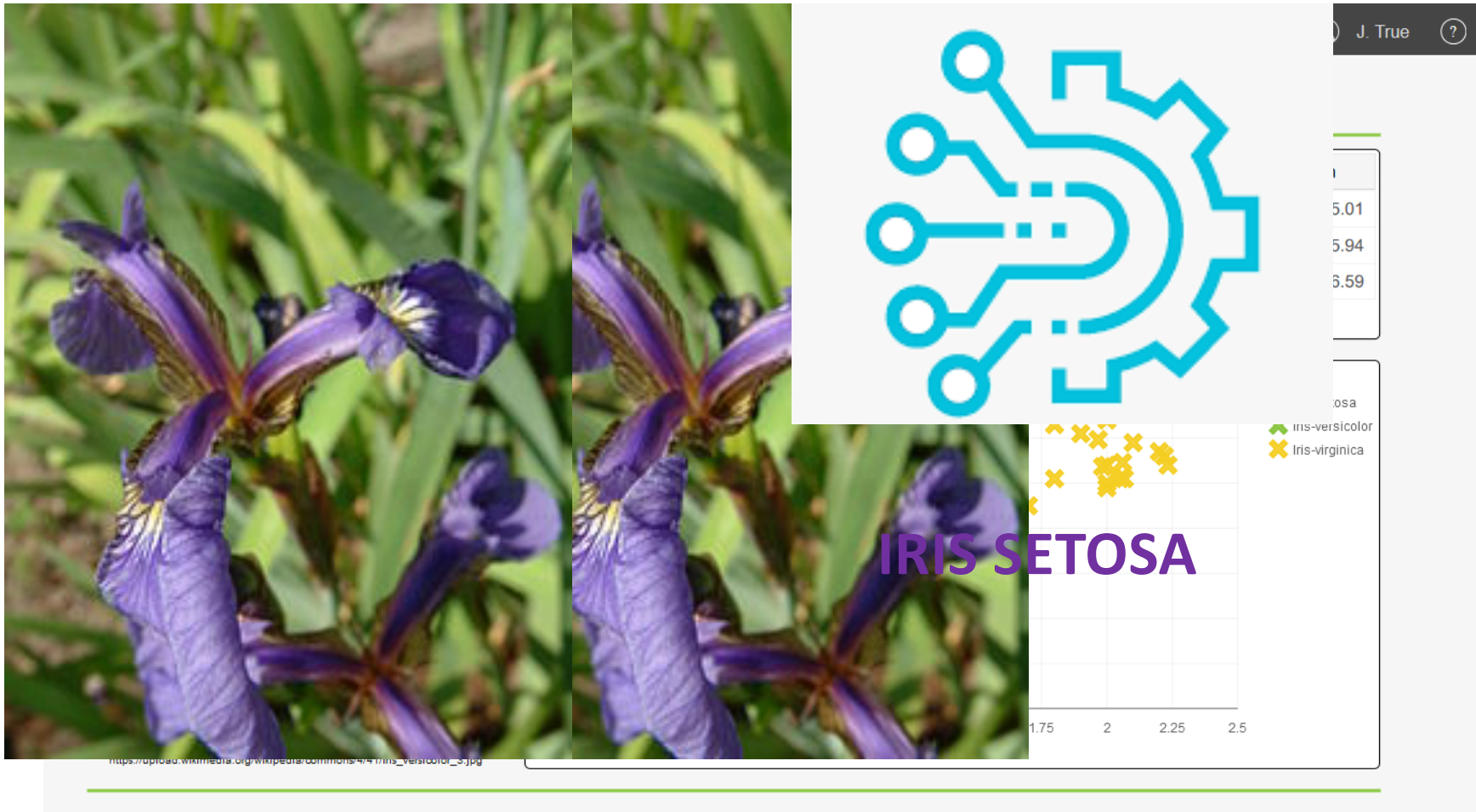
Technological Forecasting & Social Change

Big data analytics: Understanding its capabilities and potential benefits for healthcare organizations

Yichuan Wang <sup>a,\*</sup>, LeeAnn Kung <sup>b</sup>, Terry Anthony Byrd <sup>a</sup>

<sup>a</sup> Raymond J. Harbert College of Business, Auburn University, 405 W. Magnolia Ave., Auburn, AL 36849, USA  
<sup>b</sup> Rolver College of Business, Rowan University, 201 Mullica Hill Road, Glassboro, NJ 08028, USA

# Machine learning

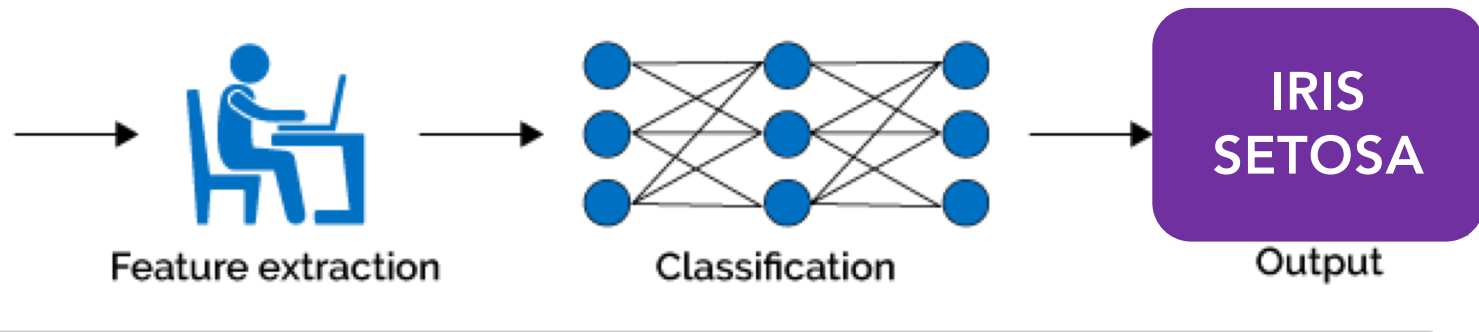




# Deep learning vs machine learning



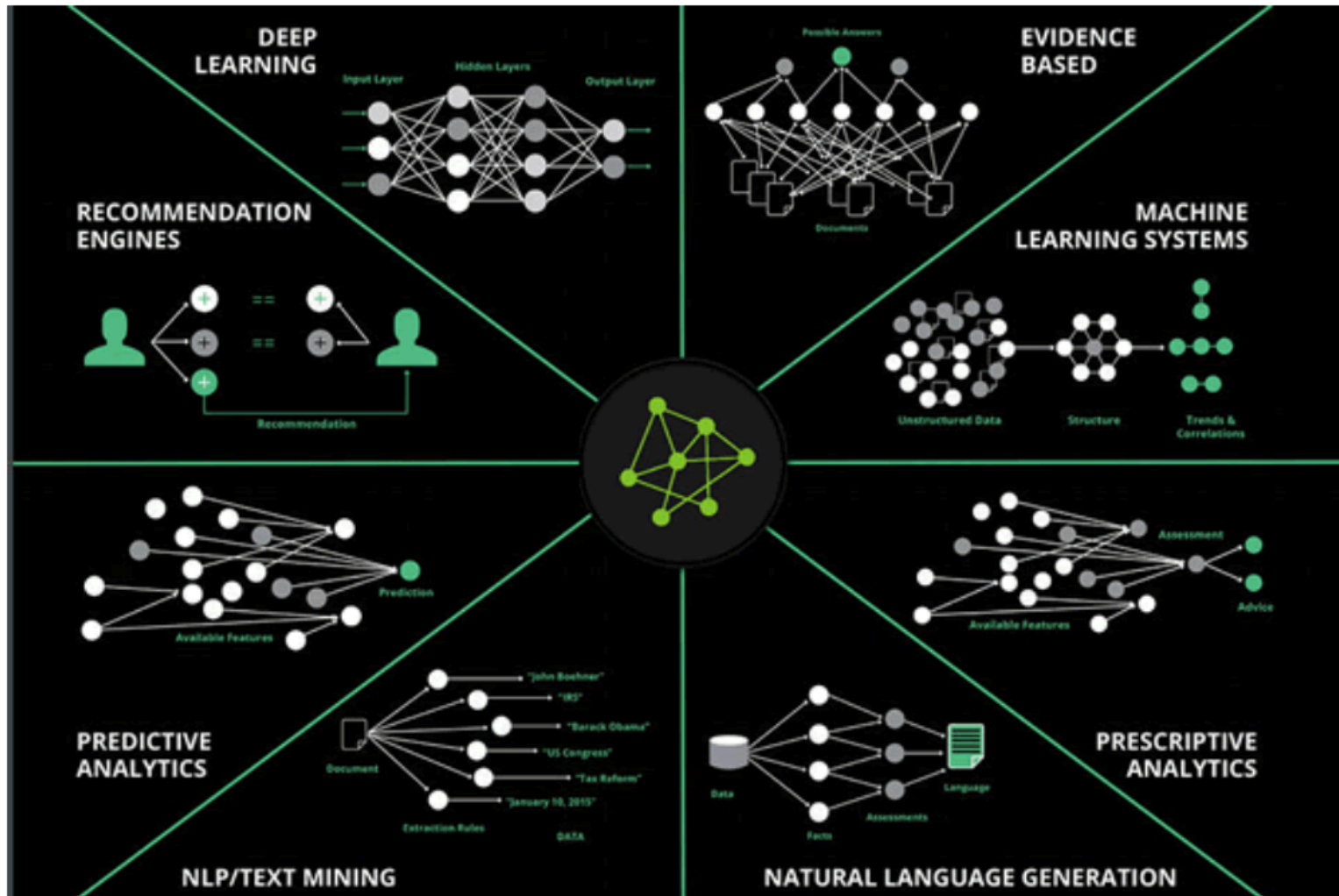
## Machine Learning



## Deep Learning



# Artificial intelligence

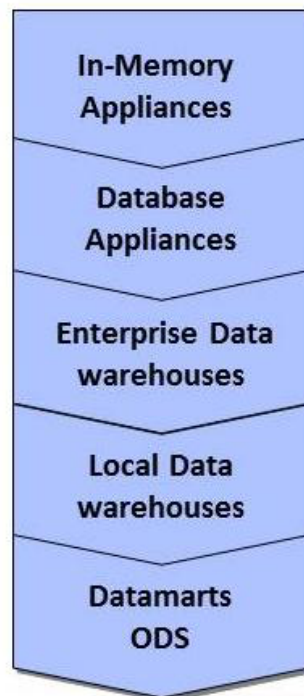


# Big data in healthcare: hardware infrastructures

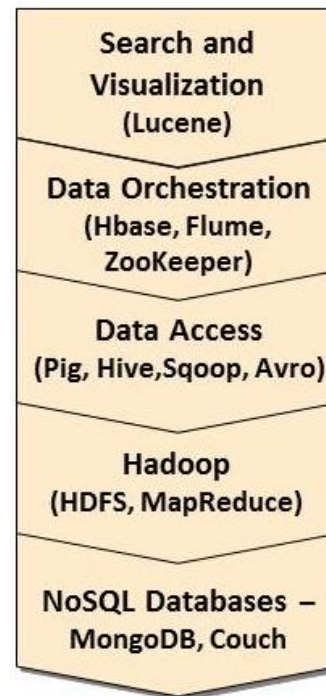


Big Data require a technological infrastructure that goes beyond the classical stand-alone system: nodes, distributed processing, high performance computing

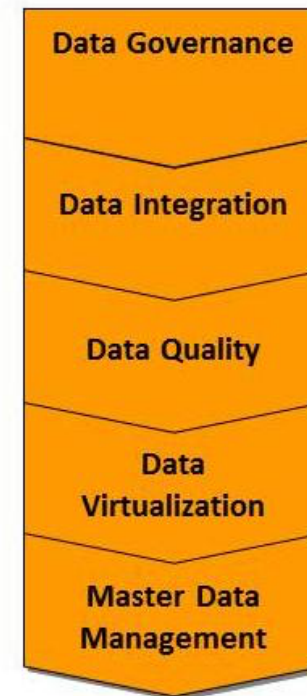
*Data Stack  
Structured & Unstructured*



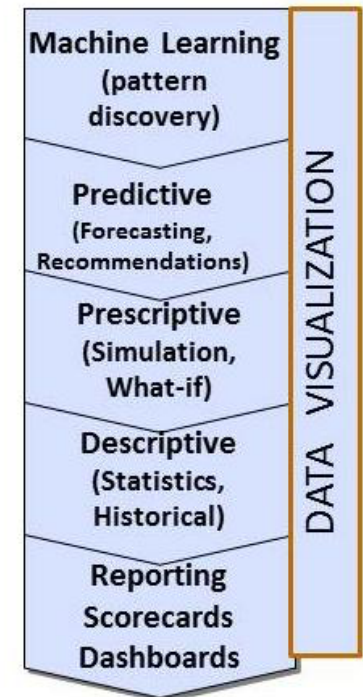
*Hadoop and Big Data  
Ecosystem*



*Enterprise Information  
Management Stack*



*BI Platforms, Analytics  
Tools and Insight Stack*

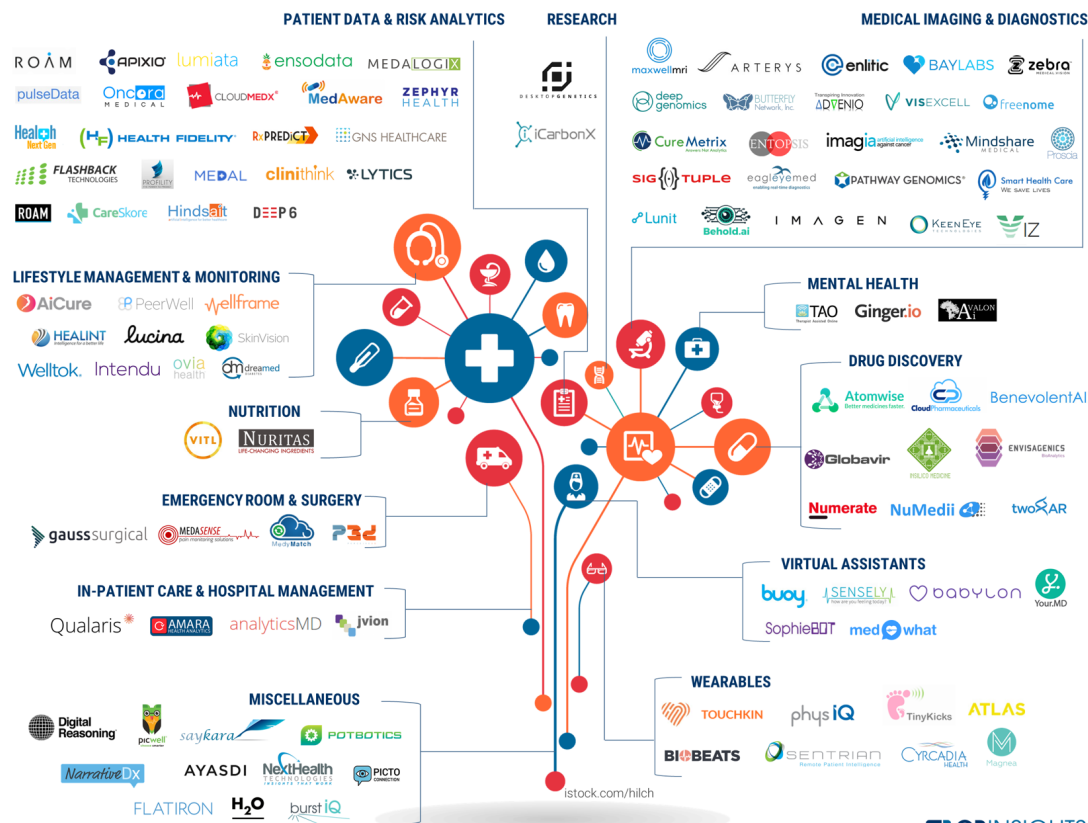


<http://www.rosebt.com/>



# Health innovation

## 106 STARTUPS TRANSFORMING HEALTHCARE WITH AI



CBINSIGHTS

# Sistemi di supporto alla decisione

MOSAIC - Sunnyvale Radiation Oncology

File Schedule eChart Tools Code Mgmt Claims Payments Ledgers Window Help

Home Chart Reports Chart Check QCL Multi-Code Notes Documents D and I Images RO Treat Quick Orders Alg/Alert Evaluate Help

Prostate, Test MR#: Prostate Select Patient

Plan Review

0.2 cm

Windows: 300 Level: 995 WJA Affects: CT 8/20/2017 2:18 PM

Visualization Tools Layout

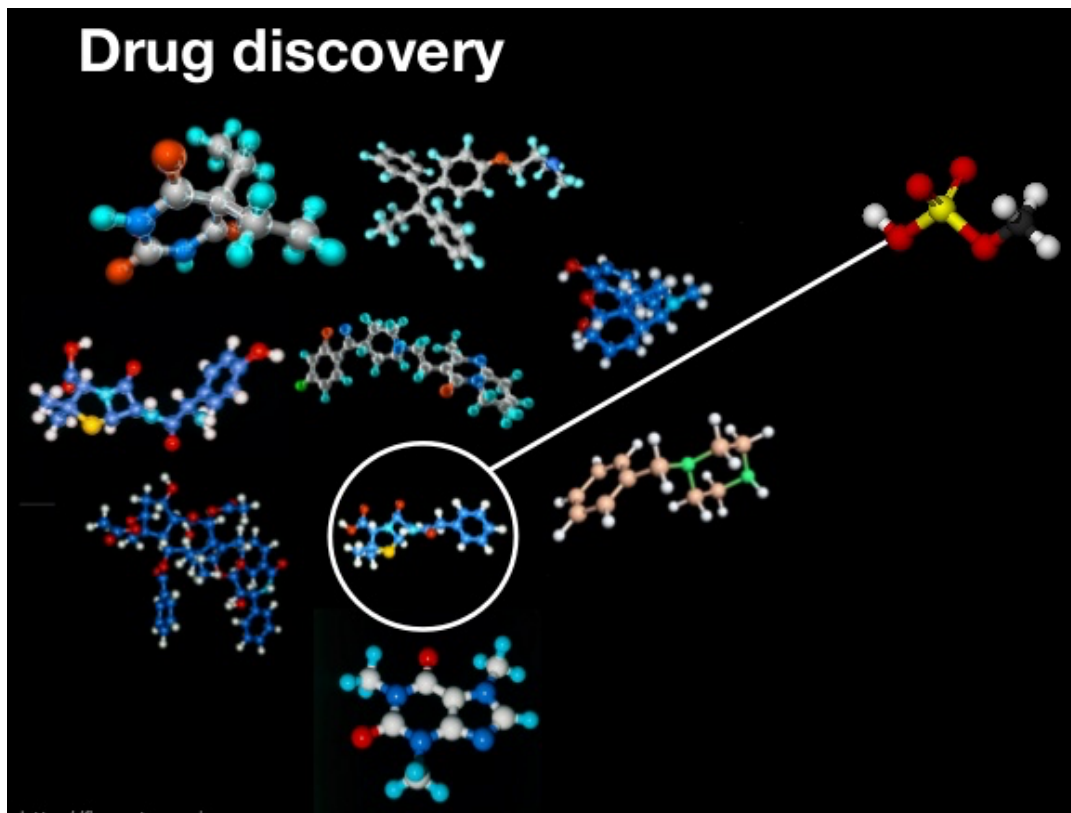
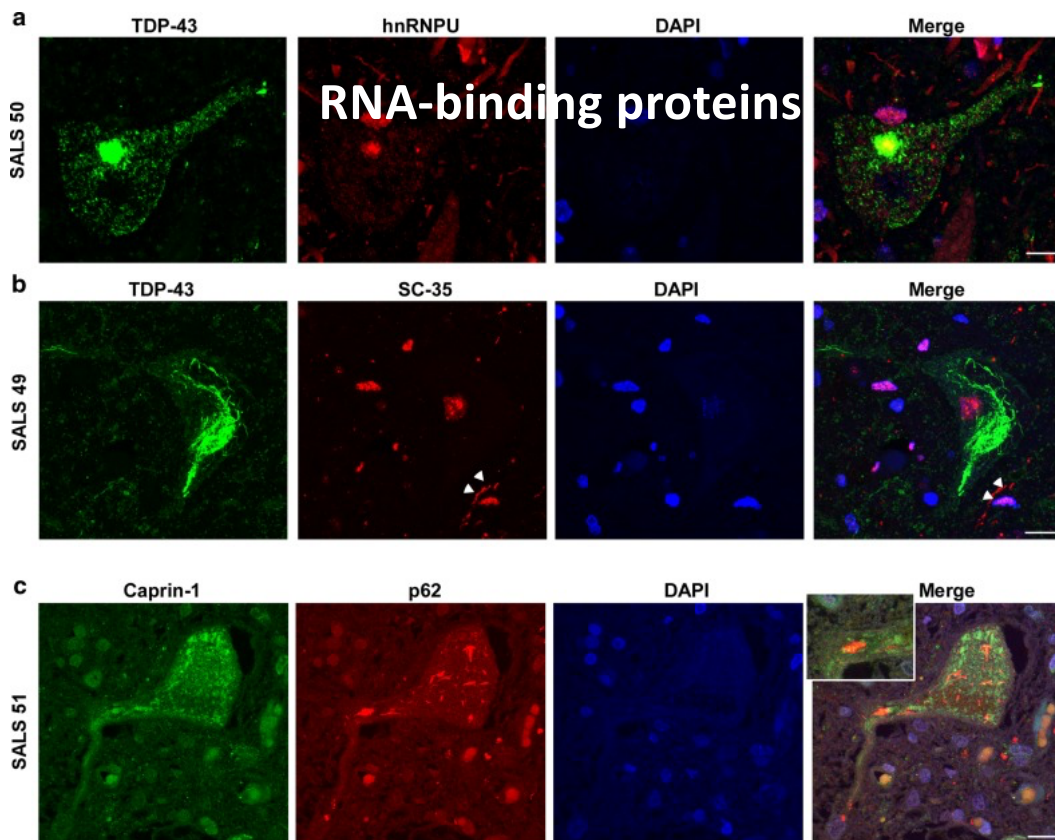
CT 8/20/2017 2:18 PM dMLC7560cGy STRCTRLABEL

Isodose		Color	Dose (Gy)	Dose (%)
<input checked="" type="checkbox"/>	<input type="checkbox"/>		8618.5	105.00
<input checked="" type="checkbox"/>	<input type="checkbox"/>		8208.1	100.00
<input checked="" type="checkbox"/>	<input type="checkbox"/>		8044.0	98.00
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<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		7387.3	90.00
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		5745.7	70.00
<input checked="" type="checkbox"/>	<input type="checkbox"/>		4104.1	50.00
<input checked="" type="checkbox"/>	<input type="checkbox"/>		2052.0	25.00
<input checked="" type="checkbox"/>	<input type="checkbox"/>		1231.2	15.00

Plan Spreadsheet

ia dipartimento di ingegneria e architettura

# Genomica e farmaci





# Cybersecurity



*“Threats will be dealt with in hours, not days or weeks”  
M. Taddeo, L.Foridi  
Nature 2018*

## Ambiente e sostenibilità

### Google uses AI to cut data centre energy use by 15%

Technology firm hailed success of machine-learning trial and said efficiencies will be applied to all its centres by end of year



AI-powered devices are helping consumers battle climate change





## AI a supporto della clinica

### **STUDY: NEW PEDIATRIC AI OUTPERFORMS JUNIOR DOCTORS**

Training a doctor takes years of grueling work in universities and hospitals. Building a doctor may be as easy as teaching an AI how to read.

How Big Data Helps To Tackle The No 1 Cause Of Accidental Death In the U.S.

Big Data In Healthcare: Paris Hospitals Predict Admission Rates Using Machine Learning



### **AL HOSPITAL TACKLES PATIENT SAFETY WITH NEW AI**

By identifying at-risk patients and informing care, Alabama's Southeast Health Medical Center is making the case for the potential impact of AI on reducing hospital-acquired infections like sepsis.



## Caveat



## Stephen Hawking



*"Humans, who are limited by slow biological evolution, couldn't compete, and would be superseded."*

*"The development of full artificial intelligence could spell the end of the human race."*

## Elon Musk

*‘What harm can a deep intelligence in the network do?’  
Well, it can start a war by doing fake news and spoofing  
email accounts and doing fake press releases and by  
manipulating information*



# Privacy



# Cosa deleghiamo alla AI?

## COMPAS



Cosa deleghiamo alla AI?

# FDA permits marketing of AI software that autonomously detects diabetic retinopathy

By **Dave Muoio** | April 12, 2018

## Viz.ai's stroke-detecting CDS app receives FDA nod

By **Dave Muoio** | February 14, 2018

SHARE < Share 339

[www.mobilehealthnews.com](http://www.mobilehealthnews.com)



## Regole

### **Clinical and Patient Decision Support Software**

Considera come punto cruciale il coinvolgimento dell'umano nella decisione

---

### **Draft Guidance for Industry and Food and Drug Administration Staff**

## **Voluntary Industry Guidelines for the Design of Medium Risk Clinical Decision Support Software to Assure the Central Role of Healthcare Professionals in Clinical Decision-Making**

Developed by the CDS Coalition



Clinical Decision Support Coalition

## Responsabilità condivisa



**Self-driving cars**




**Autonomous lethal weapons  
(LAW)**

# Autodeterminazione

## Targeted Social Advertising Examples




Suggested Post


 **Southwest Airlines**  
Sponsored · 48

Like Page

Lock this deal up! New service from Minneapolis/St. Paul to Atlanta as low as \$129 one-way. Service starts 6/6. Restrictions and exclusions apply. Book by 5/12 (<http://social.southwest.com/34c>)


**Ads You May Be Interested In**

-  **Earn an MBA or MA-Leader**  
For a better you, a better world. Info session May 7 at Lift Bridge Brewery
-  **Land Surveyor Jobs**  
The best way to find land surveyor work. Register to get work quickly.
-  **Education CMO Dashboard**  
Need A CMO Dashboard To Make Sense Of All Your Data? Domo's It. Get A Demo!


 **Toyota USA**  
Shared publicly · Nov 15, 2013

Follow

Shopping for a #Corolla made social with the Collaborator. <http://goo.gl/tham>

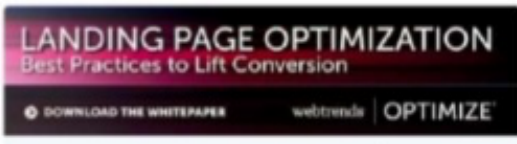


Followed by Charity Wainow, Candace Jensen and Lisa Sporek.

 **Webtrends** @Webtrends · 19h

Only 22% of brands are happy with their conversion rates. Make it better w/our new landing page optimization guide.

Promoted by Webtrends



**LANDING PAGE OPTIMIZATION**  
Best Practices to Lift Conversion

DOWNLOAD THE WHITEPAPER | webtrends | OPTIMIZE

Note: Guide will load immediately. [Get Your Guide](#)



May 29, 2014 | Copyright Collegis LLC. Proprietary and Confidential.

@GrantTilus

#Zenith2014



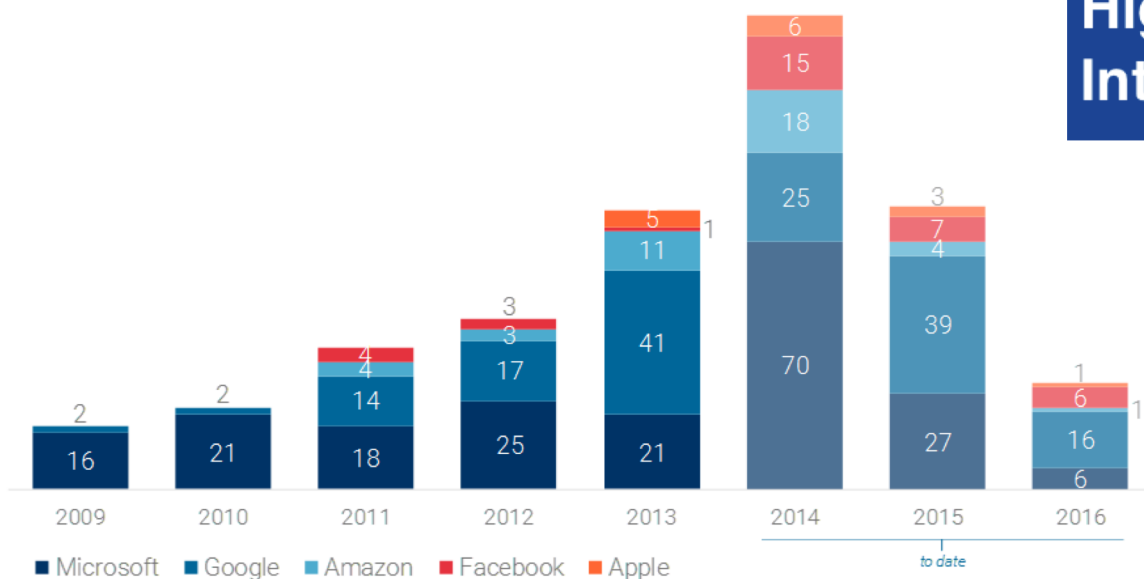


# Le nuove élite



## ARTIFICIAL INTELLIGENCE PATENT APPLICATION ACTIVITY

By date of application, 2009 - 2016 YTD (12/12/16)



## High-Level Expert Group on Artificial Intelligence

52 membri:  
17 accademici  
4 società civile  
**31 grande industria**

Analysis filters patent titles and abstracts for select relevant keywords, e.g. machine learning, deep learning, neural network, etc.  
Does not include pre-acquisition patent activity of purchased companies (e.g. DeepMind with Google)



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## Come affrontare le tematiche di etica



DEFENSE ADVANCED  
RESEARCH PROJECTS AGENCY

[Defense Advanced Research Projects Agency > Program Information](#)

## Explainable Artificial Intelligence (XAI)

# The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems