



Health Decision Support Systems

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ESAT-SCD K.U.Leuven / IBBT

■ Outline

-Trends

-Context

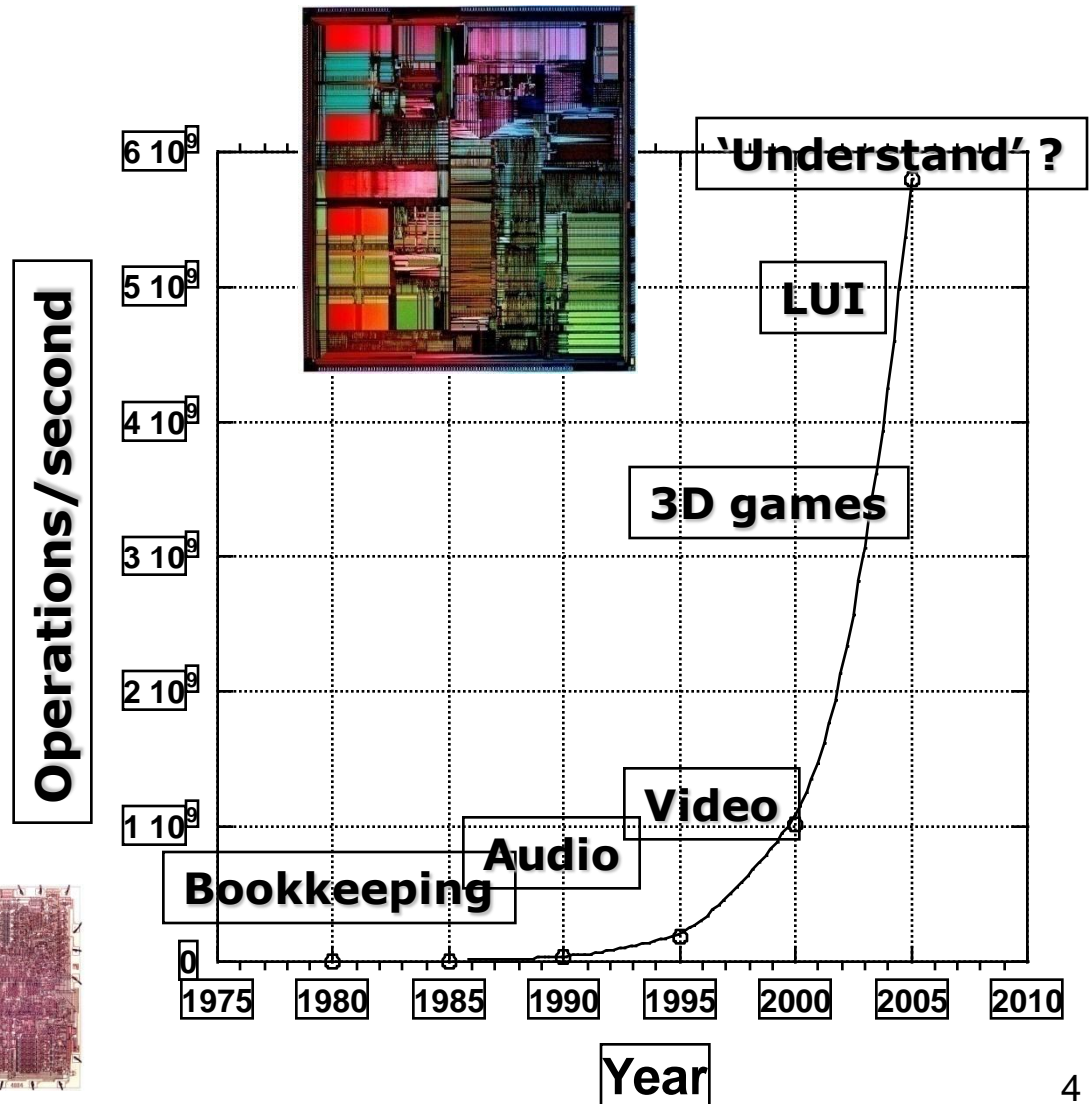
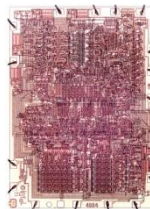
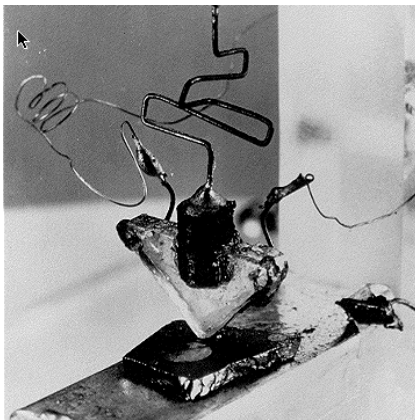
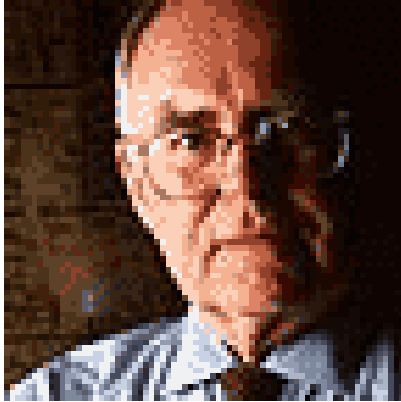
-Opportunities and challenges

-What to do ?

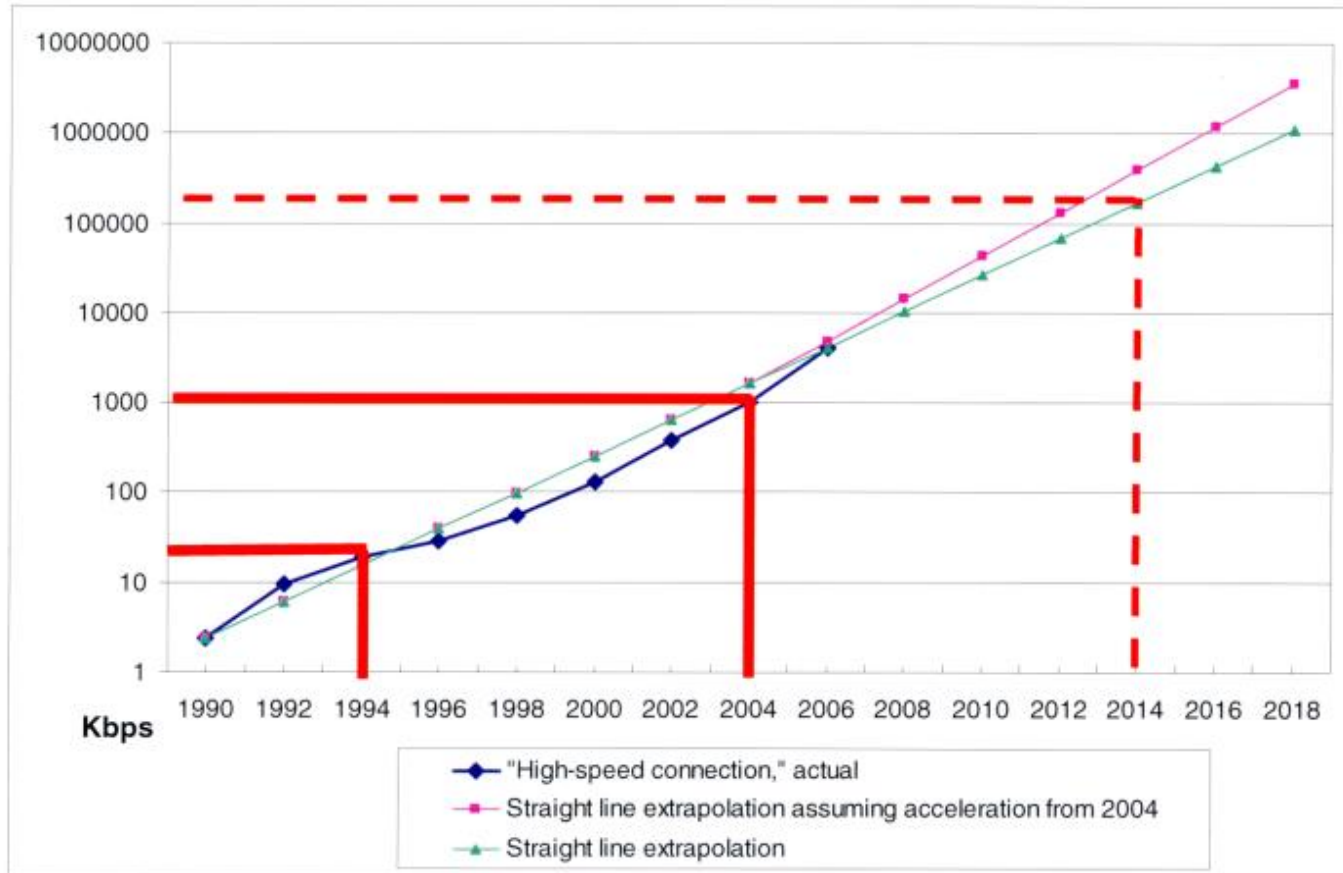
■ Trends

- I. Exponential evolution in ICT, medical and bio-technology
- II. Tsunami of data
- III. Inter-, cross-, and multi-disciplinarity
- IV. Societal demands
- V. Translational gap

Gordon Moore's law



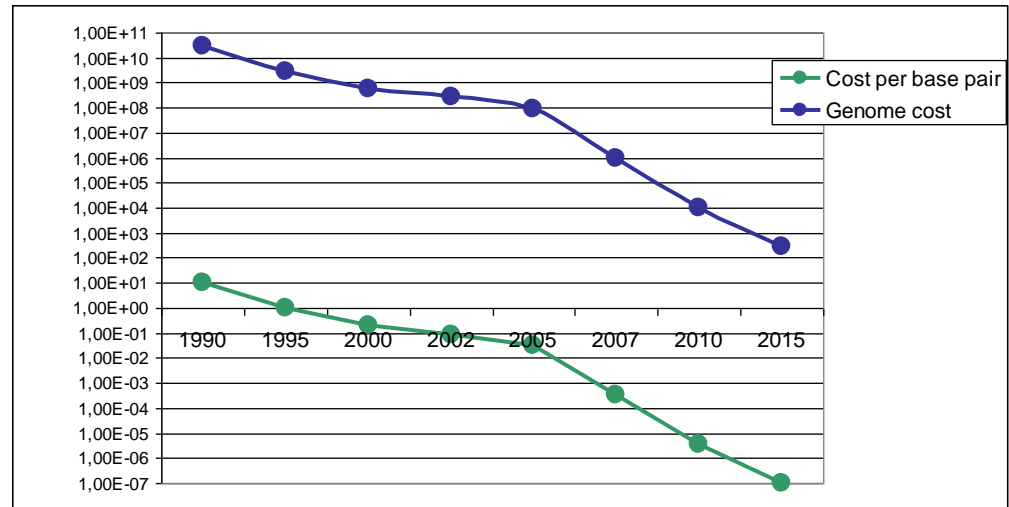
Broad band capacity



Source: Heavy Reading report "FTTH Worldwide Market & Technology Forecast, 2006-2011"

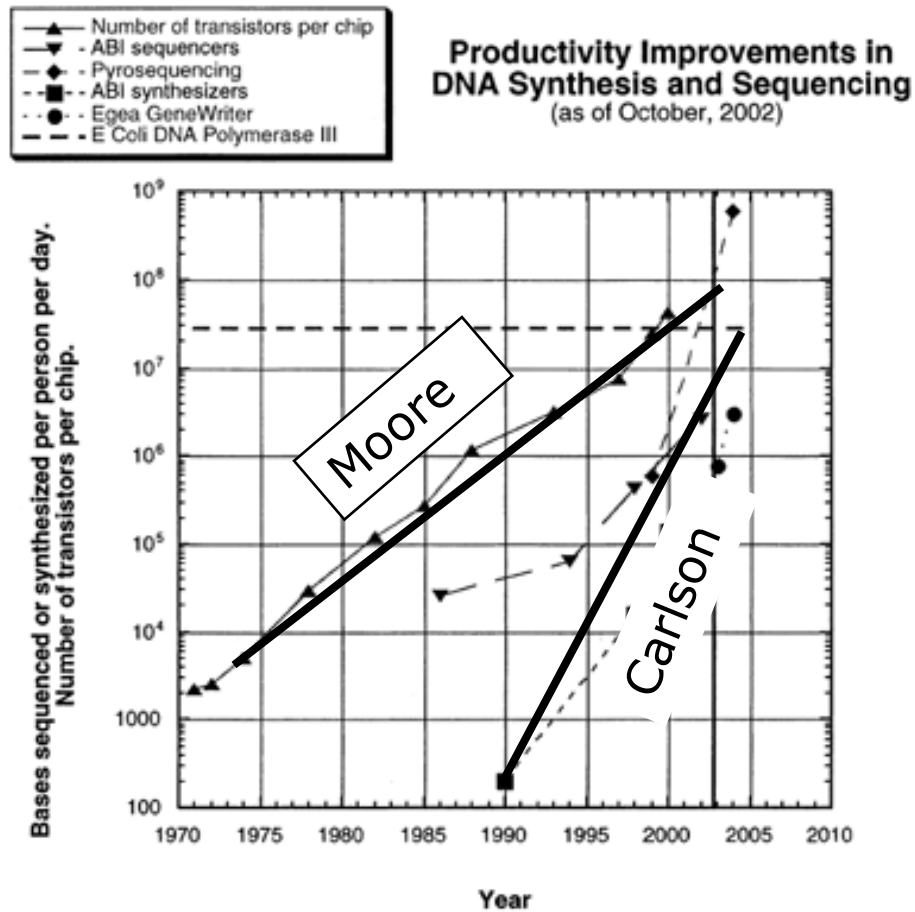
Making sense of the 1000 \$ genome ?

- Human genome project
 - Initial draft: June 2000
 - Final draft: April 2003
 - 13 year project
 - \$300 million value with 2002 technology
- Personal genome
 - June 1, 2007
 - Genome of James Watson, co-discoverer of DNA double helix, is sequenced
 - \$1.000.000
 - Two months
- €1000-genome
 - Expected 2012-2020



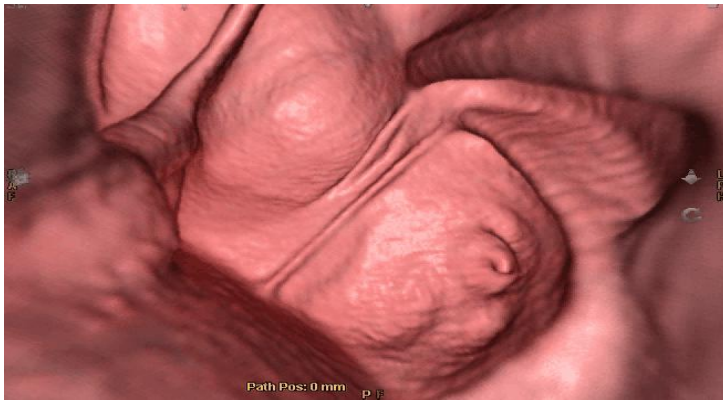
Year	Cost per base pair	Genome cost
1990	10	3E+10
1995	1	3.000.000.000
2000	0.2	600.000.000
2002	0.09	270.000.000
2005	0.03	90.000.000
2007	0.000333333	1.000.000
2010	3.33333E-06	10000
2015	0.0000001	300

Moore versus Carlson

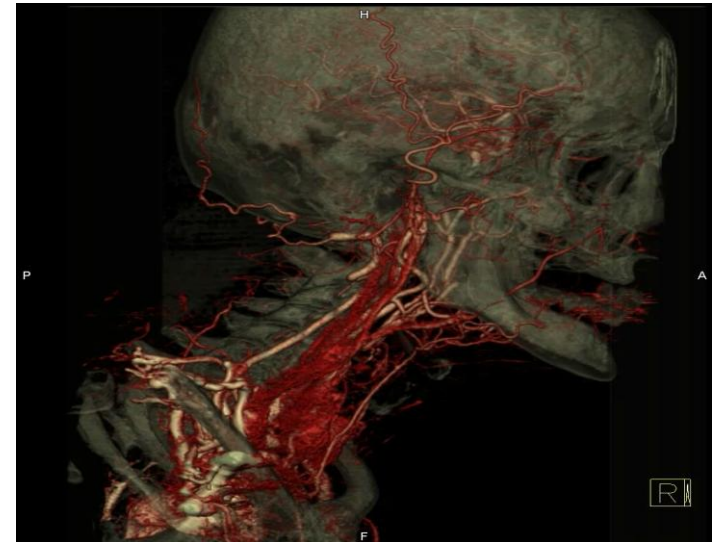


Tsunami of data

- New technologies generate more data
- Increased spatial and temporal resolution
- More studies per patient, more datasets per study

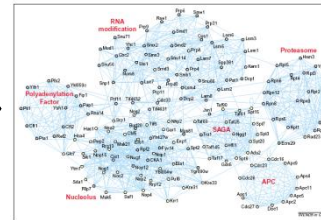
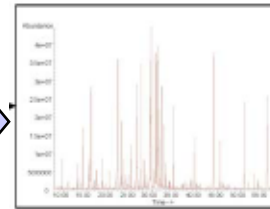
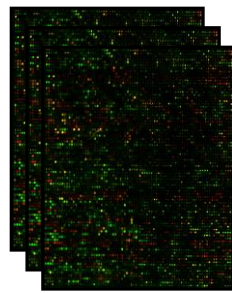
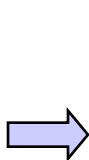
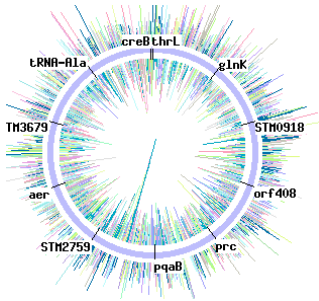
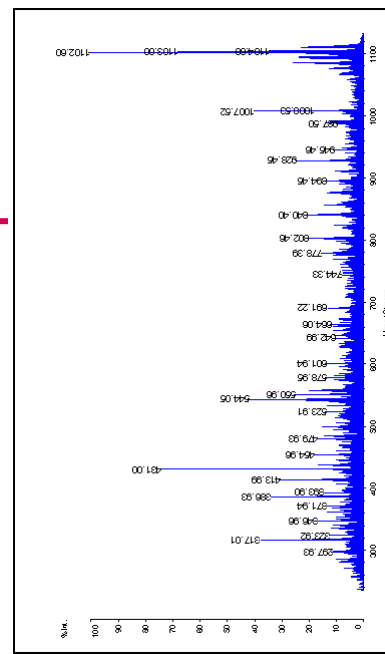
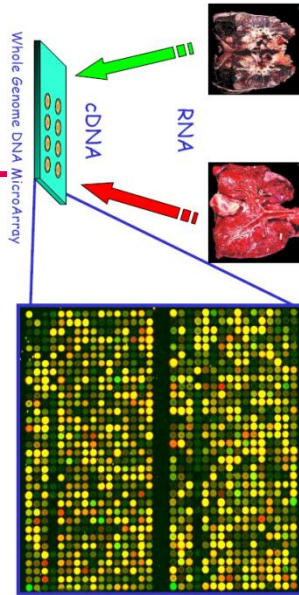


Virtual colonoscopy from CT
images
with automatically detected
polyps



subtraction CT angiography

ACACATTAATCTTATATGC
 TAAACTAGGTCTCGTTTTA
 GGGATGTTTATAACCATCTT
 TGAGATTATTGATGCATGGT
 TATTGGTTAGAAAAATATA
 CGCTTGTTTTCTTTCCTAG
 GTTGATTGACTCATAATGT
 GTTTCATTGAGGAAGGAAC
 TTAACAAAATGCACTTTTT
 TCAAGTTCACAGCTACTTTA
 AAAGTGATCAAAGTATATCA
 AGAAAAGCTTAATATAAAGAC
 ATTTGTTTCAAGGTTTCGTA
 AGTGCACAATATCAAGAAG
 ACAAAAATGACTAATTTTGT
 TTTCAGGAAGCATATATATT
 ACACGAACACAAATCTATTT
 TTGTAATCAACACCGACCAT
 GGTTTCGATTACACACATTA
 ATCTTATATGCTAAAACATG
 GTCTCGTTTTAGGGATGTTT
 ATAACCATCTTTGAGATTAT
 TGATGCATGGTTATTGGTTA
 GAAAAATATACGCTTGTTT
 TTCTTTCCTAGGTTGATTGA



genome

transcriptome

proteome

metabolome

interactome



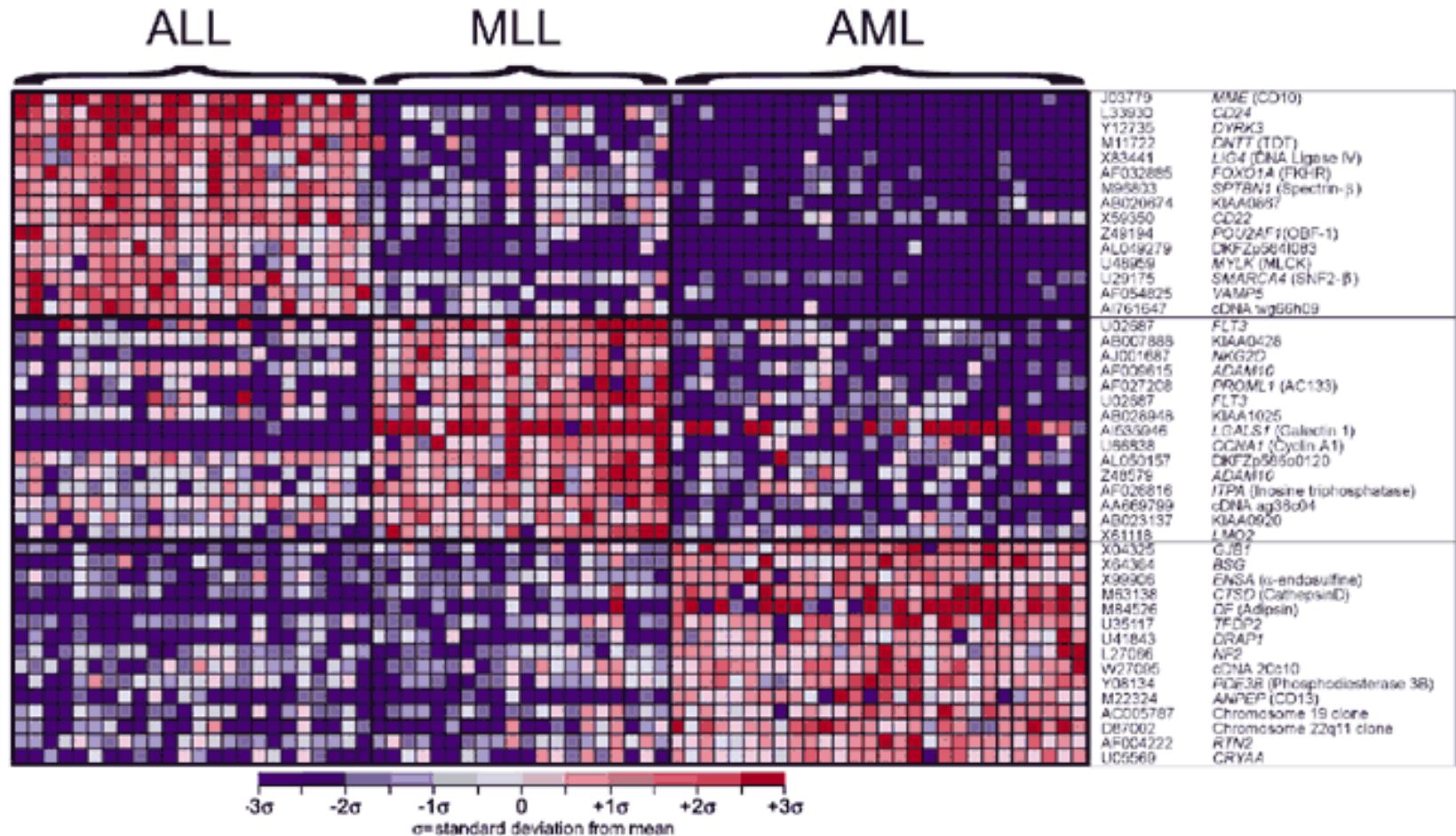
GS-FLX Roche
 Applied Science 454



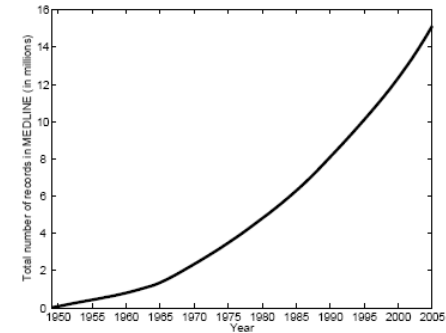
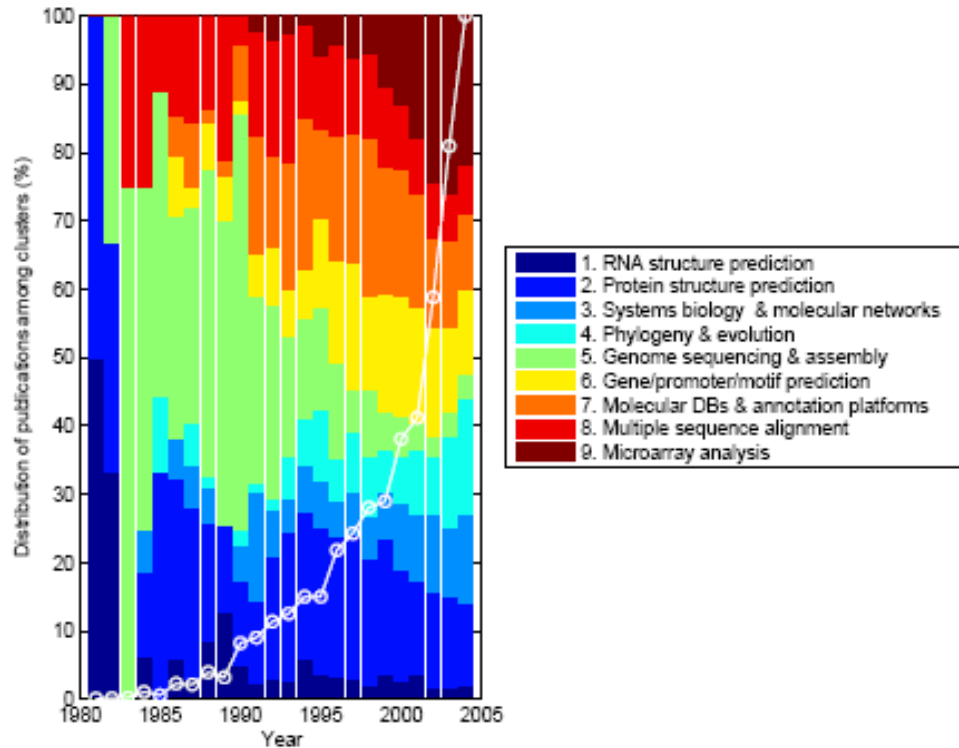
Prometa



Microarray data: genetic fingerprints



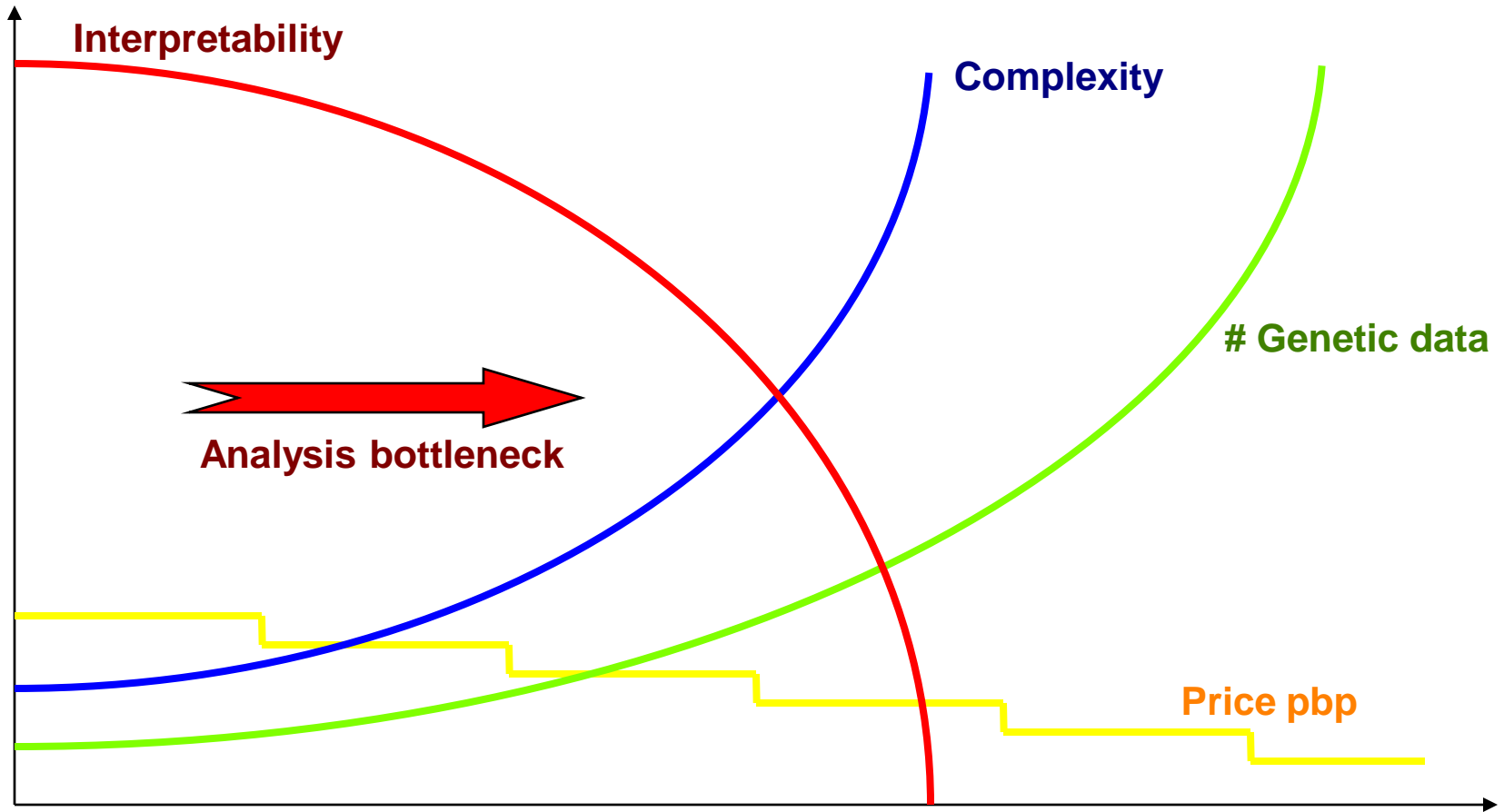
Text mining



1.2: Growth of MEDLINE, the U.S. National Library of Medicine (NLM) bibliographic database covering the fields of medicine, nursing, dentistry, veterinary medicine, the health care system and preclinical sciences. The number of scientific publications (in millions) is indicated for each year. MEDLINE contains approximately 15 million unique records about journals in life sciences. This figure was constructed using data published by [161].

By 2010, 1/3 of all world data bases will consist of biomedical data

■ Analysis bottlenecks



Transdisciplinary integration

Organic Displays

The next trend in Displays offer a wide variety of uses
Click here for more information>



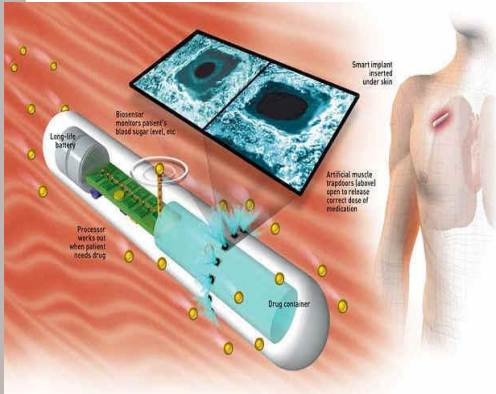
Materials, energy, IT



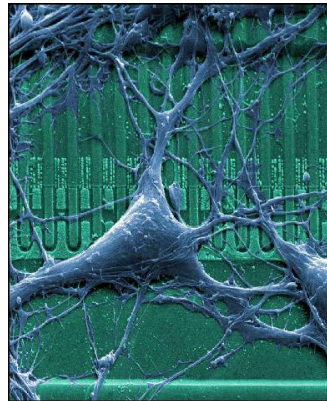
Ubiquitous computing



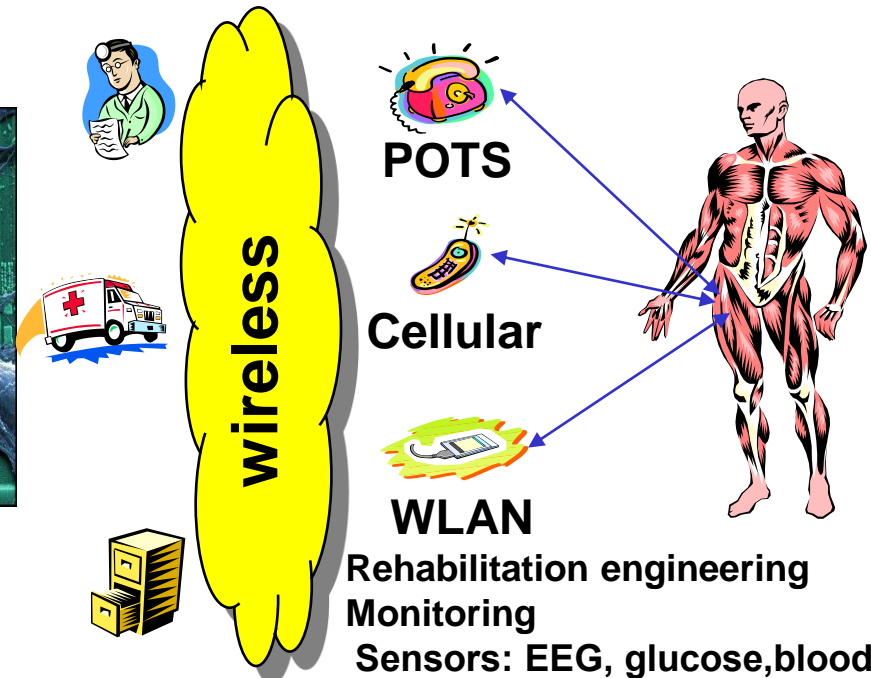
Ambient intelligence



Embedded intelligence
Smart pills



Neuron on chip

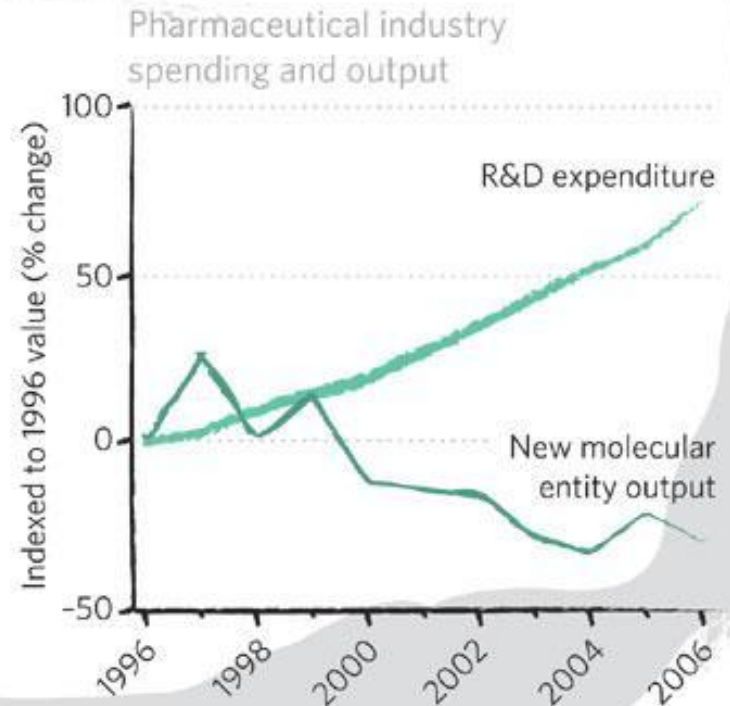
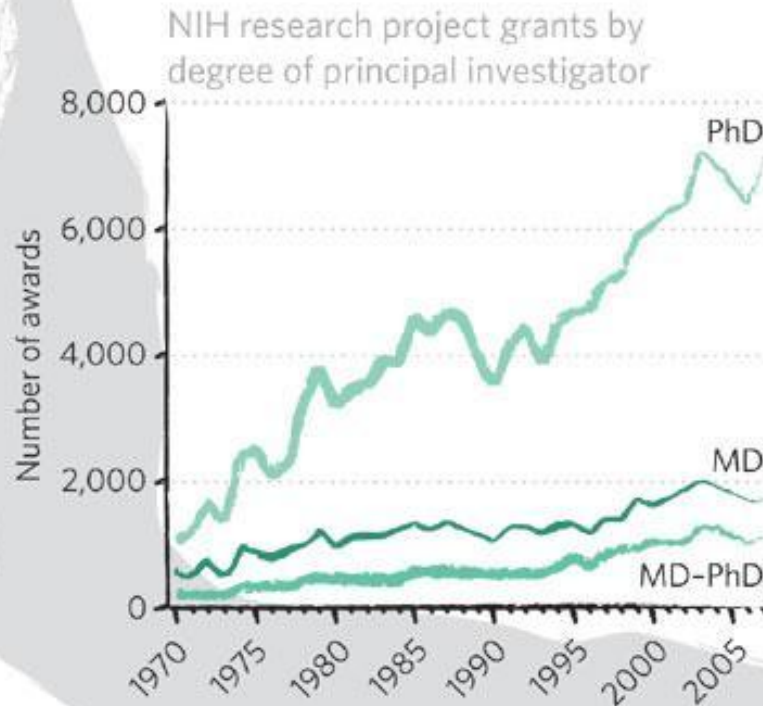


Rationales for eHealth

- Improve quality performance of health decision/diagnosis systems**
 - Support individual medical doctor
 - Avoid/decrease number of medical errors
 - Web portal for Evidence Based Medicine
 - Organised access to literature
 - Examples: UK, Norway, Sweden, Finland
 - Information sharing among doctors
 - avoid/monitor patient (s)hopping behavior
 - Global Medical File per patient
 - Interoperability
- Deal with 'empowerment of the patient': Patient-centric health care**
 - Medical care in 4P: personalized, preventive, predictive, participatory
 - Increasing trend for 'customized' personalized medicine
 - Improve transparency and consistency
 - Deal/cope with 'professional' (chronical) patients (heart, diabetes, cancer,...)
 - Improve patient mobility
- Cost effectiveness of the health care system**
 - Ageing population:
 - EU 2050: 65+ → +70%; 80+ → +180%
 - VI. 2012: 60+ → 25 % of VI.
 - Monitor overconsumption
 - Improve transparency
 - Detect abnormalities in diagnosis/therapy/...
- Cope with tsunami of available information and data (clinical, population,)**

Translational medicine: bed \leftrightarrow bench

THE TRANSLATION GAP

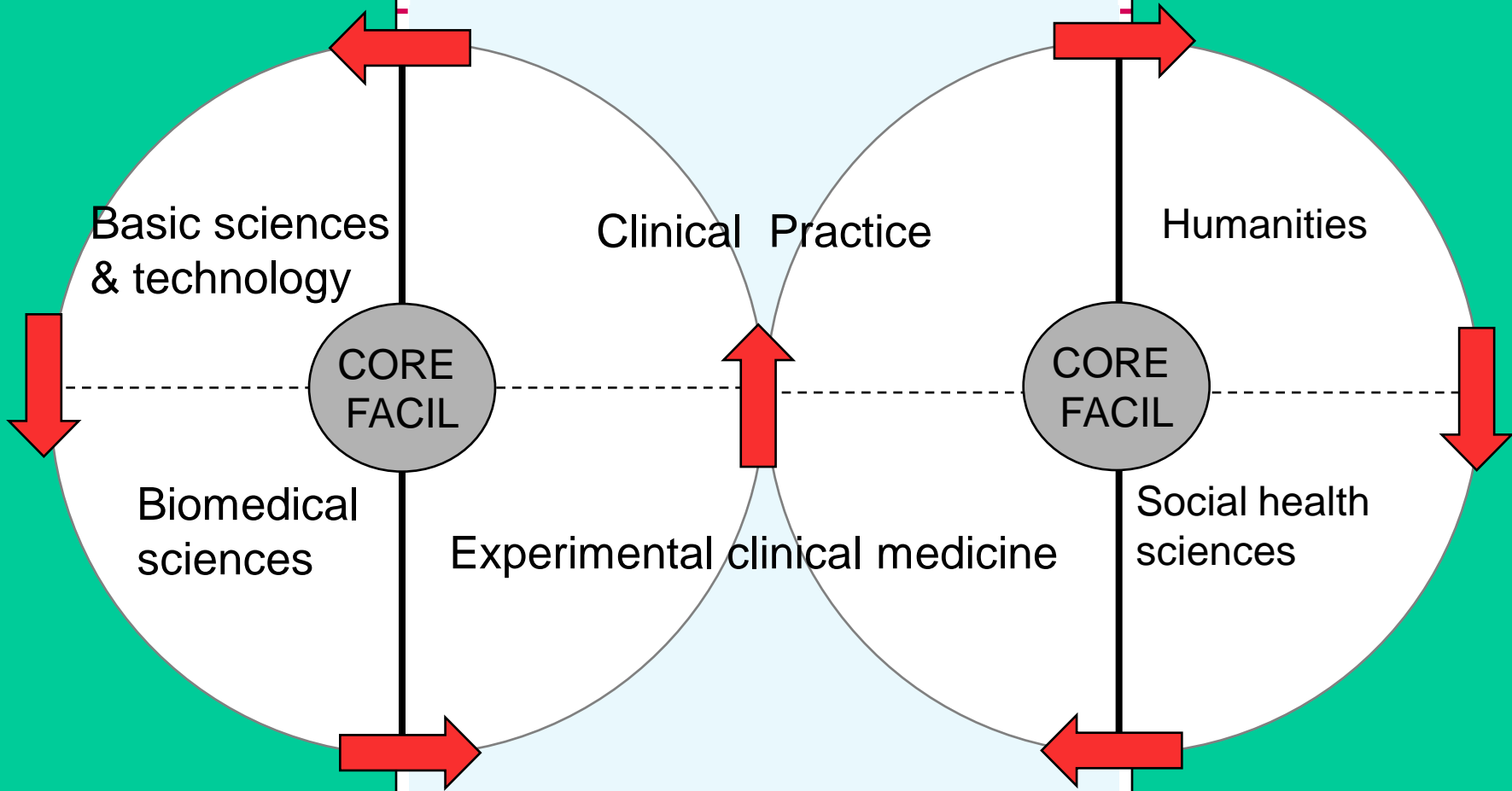


Source: NIH; CMR International & IMS Health

Academia

Health care system

Academia



Basic sciences & technology

Clinical Practice

Humanities

CORE FACIL

CORE FACIL

Biomedical sciences

Experimental clinical medicine

Social health sciences

BASIC / PRECLINICAL

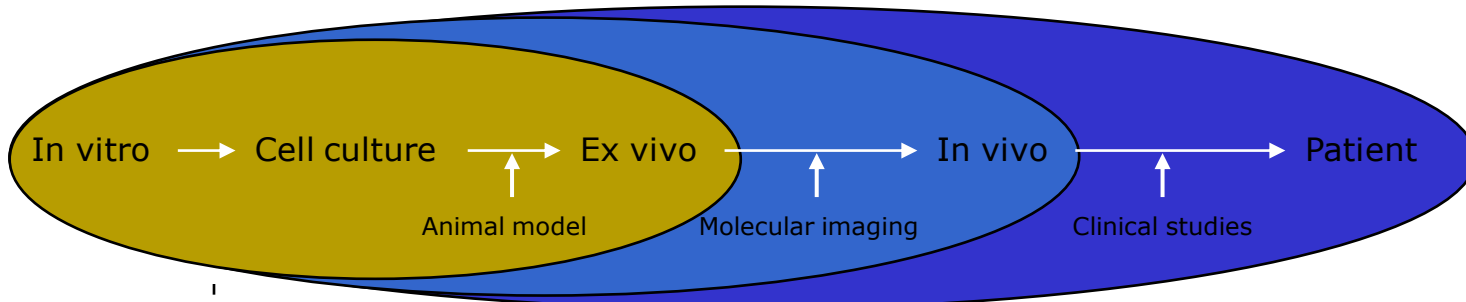
CLINICAL

BASIC / PRECLINICAL

Imaging in translational research

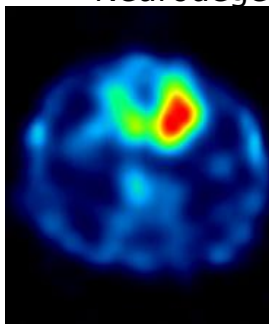
Molecular imaging:

translational research from animal models to clinical applications

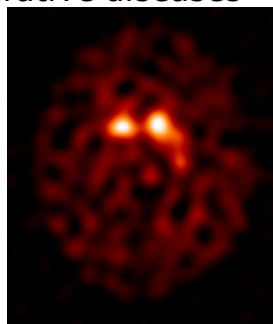


Animal model

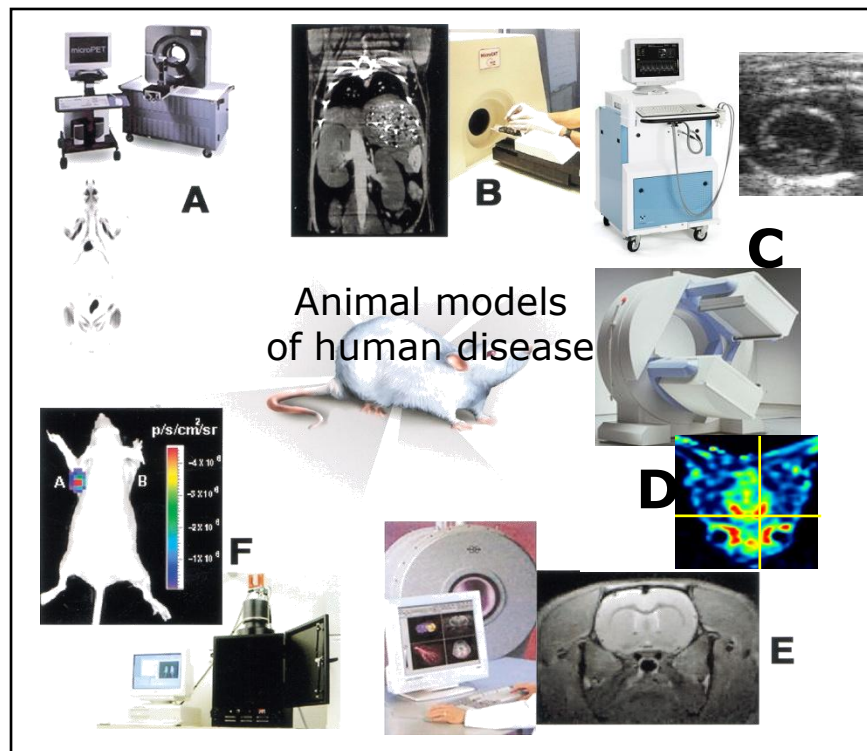
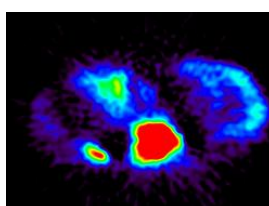
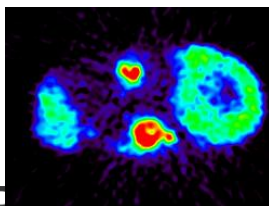
Neurodegenerative diseases



Patient



Chemotherapy



- A: PET
- B: CT
- C: US
- D: SPEC
- E: MR
- F: BLI

■ Outline

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-Opportunities and challenges

-What to do ?

Context



- VRWB cluster analysis
 - Cluster 2: ICT and Health Care
 - Cluster 5: New business models
- VRWB, 2008: De uitbouw van het translationeel onderzoek in Vlaanderen
- VR 30/04/2009: Oprichting van een Centrum voor Translationele Biomedische Innovatie / m.i.v. 8 mio euro voor biobank
- VIB, IBBT, Universities
- eHealth platform

Obama

But in order to lead in the global economy and to ensure that our businesses can grow and innovate, and our families can thrive, we're also going to have to address the shortcomings of our health care system.

The Recovery Act will support the long overdue step of **computerizing America's medical records**, to reduce the duplication, waste and errors that cost billions of dollars and thousands of lives. But it's important to note, **these records also hold the potential of offering patients the chance to be more active participants in the prevention and treatment of their diseases**. We must maintain patient control over these records and respect their privacy. At the same time, we have the opportunity to offer billions and **billions of anonymous data points to medical researchers who may find in this information evidence that can help us better understand disease**.

History also teaches us the greatest advances in medicine have come from scientific breakthroughs, whether the discovery of antibiotics, or improved public health practices, vaccines for smallpox and polio and many other infectious diseases, antiretroviral drugs that can return AIDS patients to productive lives, pills that can control certain types of blood cancers, so many others.

Because of recent progress -- **not just in biology, genetics and medicine, but also in physics, chemistry, computer science, and engineering -- we have the potential to make enormous progress against diseases in the coming decades**. And that's why my administration is committed to increasing funding for the National Institutes of Health, including \$6 billion to support cancer research -- part of a sustained, multi-year plan to double cancer research in our country. (Applause.)

<http://www.whitehouse.gov/blog/09/04/27/The-Necessity-of-Science/>

■ Need for investments

- RIZIV: 23 mia euro / year
- Cumulative R&D funding Flanders (FWO, IWT, IBBT, VIB, IMEC,...)
human health: 150 mio euro/year
- Need for new funding federal / communities / regions on
Innovation in Health Care
- FOD Volksgezondheid: 16 a 17 mio euro / year for IT Hospitals

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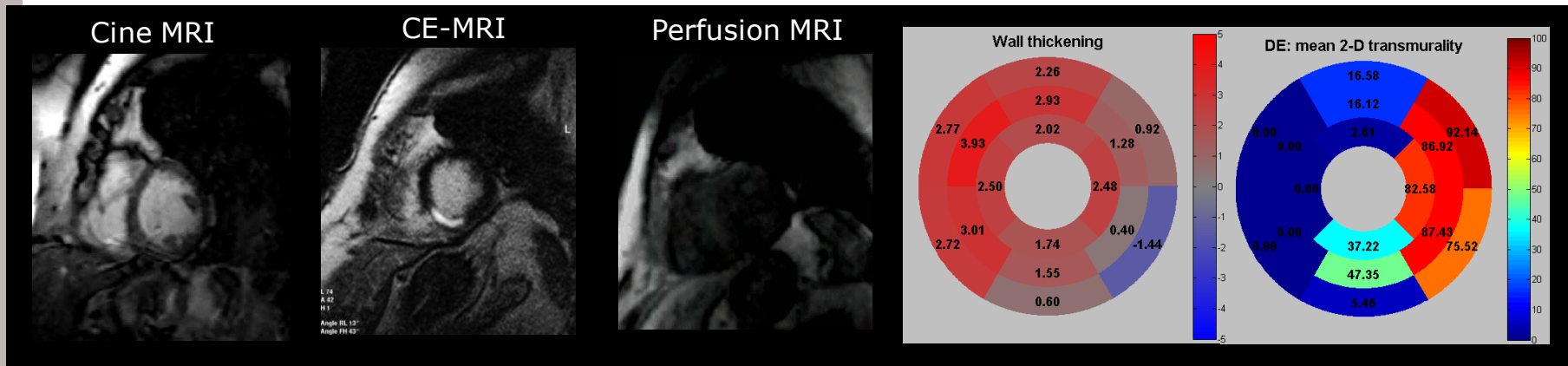
■ Opportunities: Decision support systems

- Advanced Health Decision Support Systems based on integration of heterogeneous data sources
- Policy Decision Support Systems
- Embedded Decision Support Systems

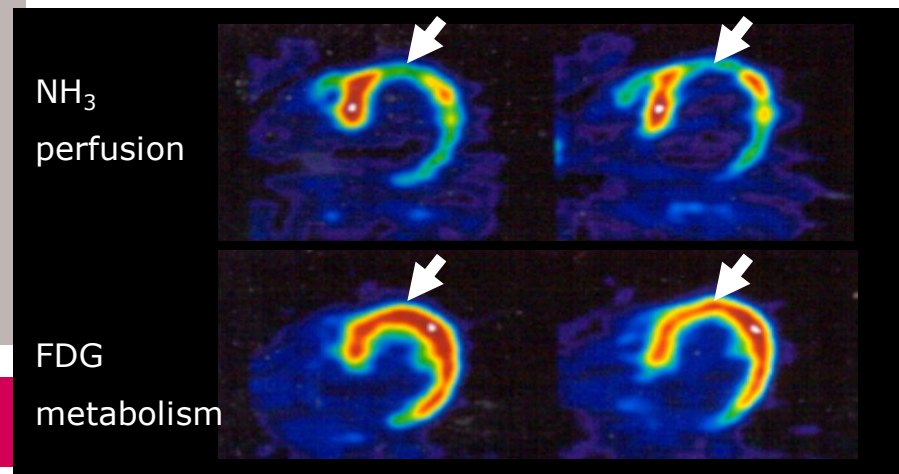
Multimodal image data integration

Assessment of myocardial infarction and residual viability:
multimodal characterization of function, perfusion and metabolism

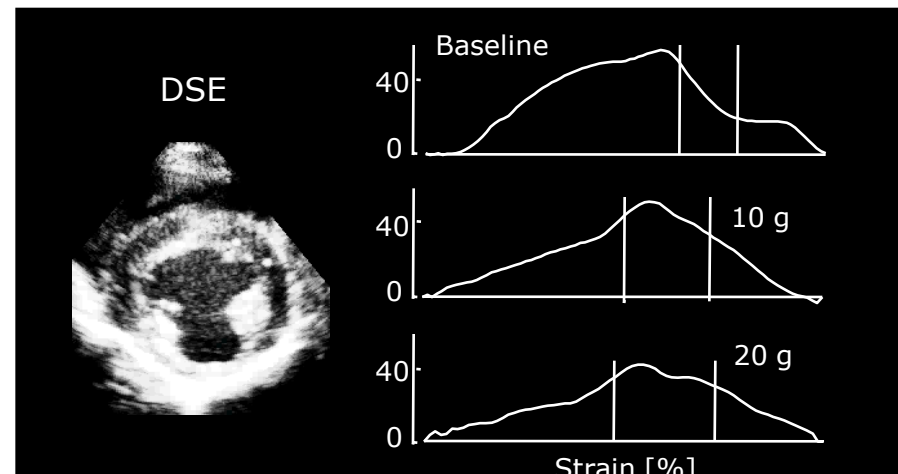
MR



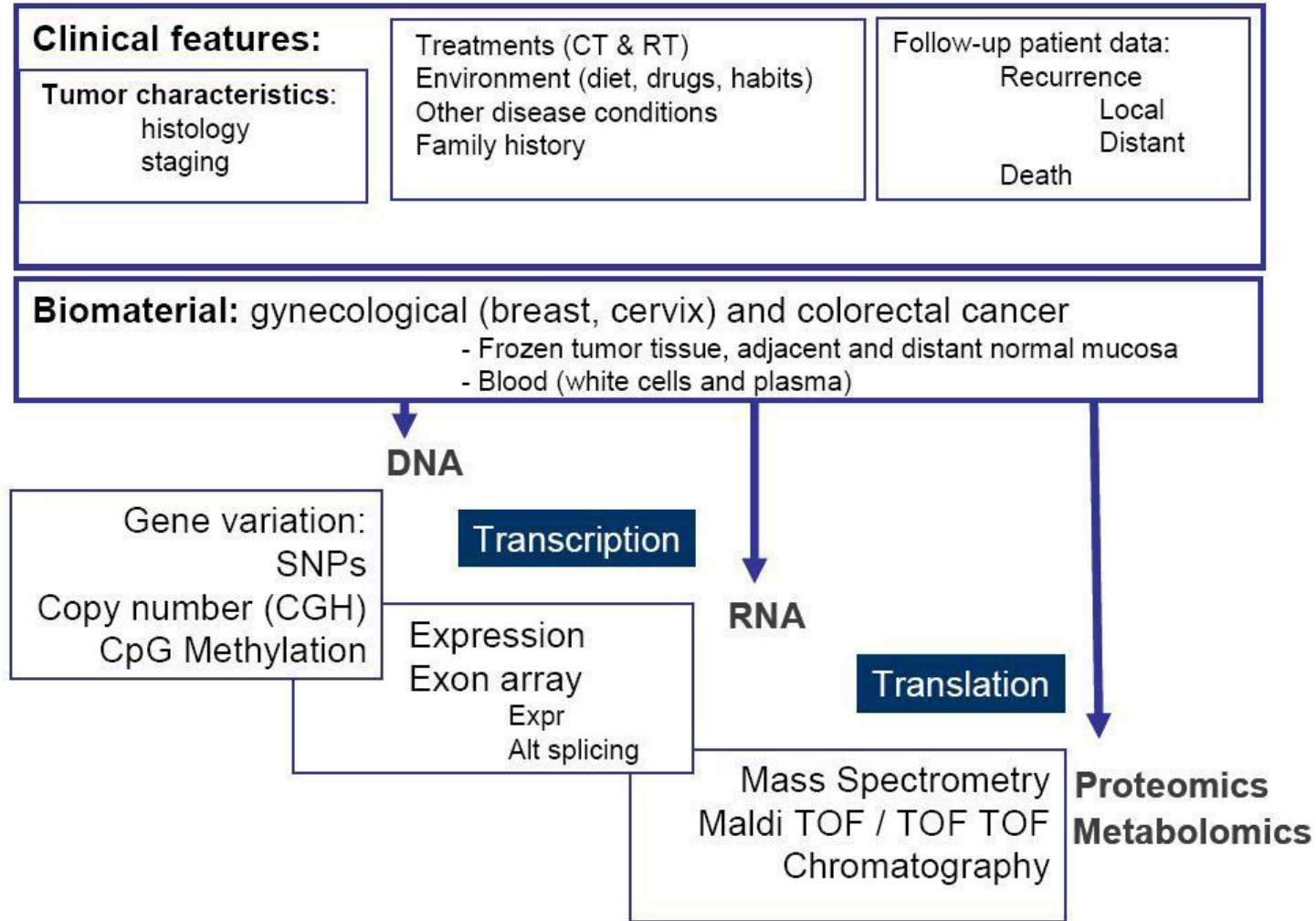
PET



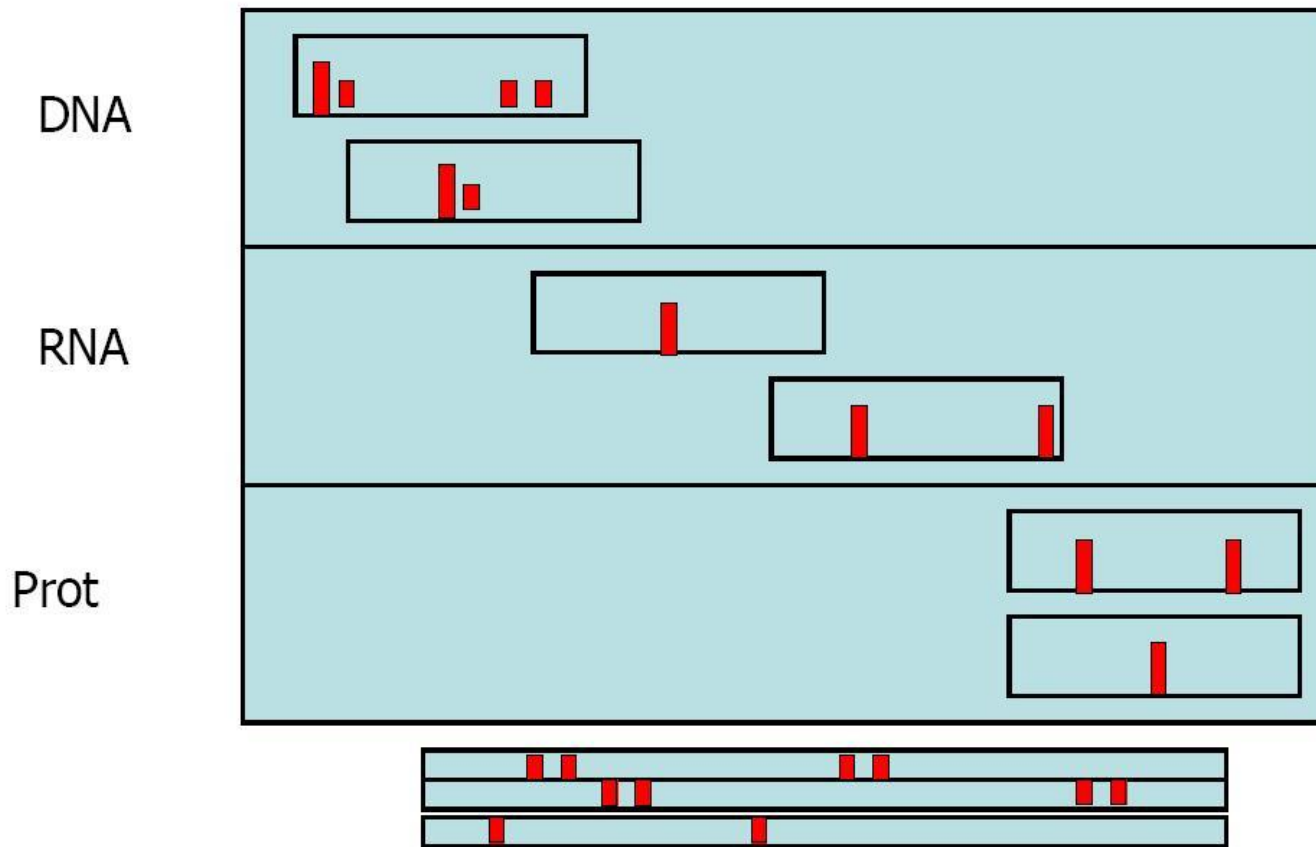
US



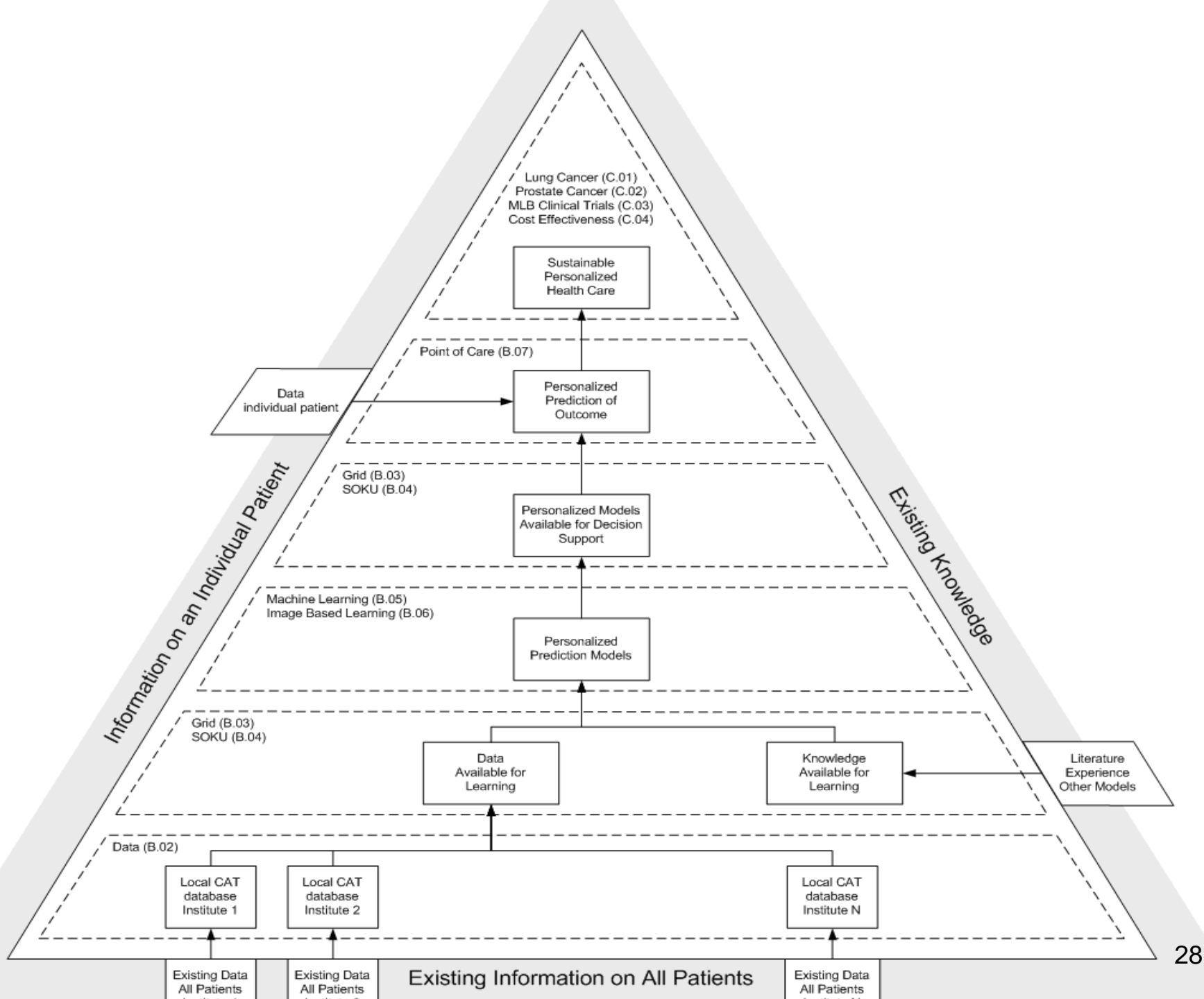
Clinical decision support



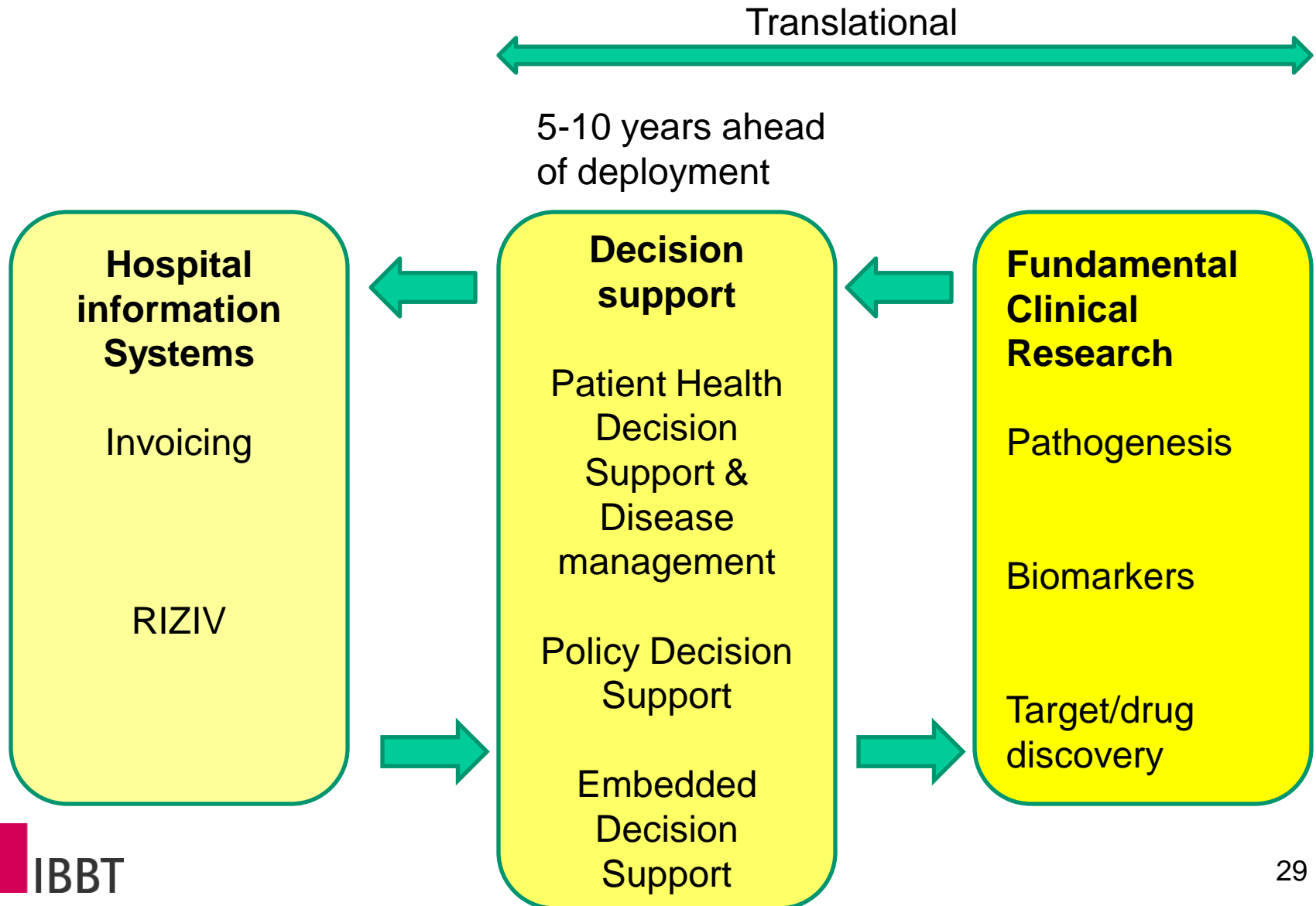
Clinical and integrated –omics data considered in this proposal



An integrated molecular profile derived from high-throughput genetic, transcriptional and proteomics data.



What to do ?



Information security aspects

- Multilateral security for community-centric healthcare IT platforms
- System and software security of critical community (e-health) infrastructures
- Enabling technologies for collaborative work in the e-health sector
- Policy negotiation, enforcement and compliance
- Privacy preserving data-mining and statistical databases
- Body Area Networks (implanted devices, wearable devices,...) and Personal Area Networks
- E-government : identity management, delegation, controlled data exchange

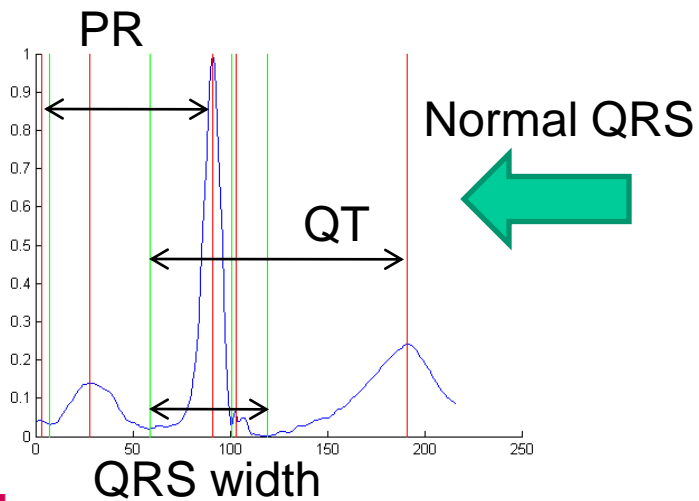
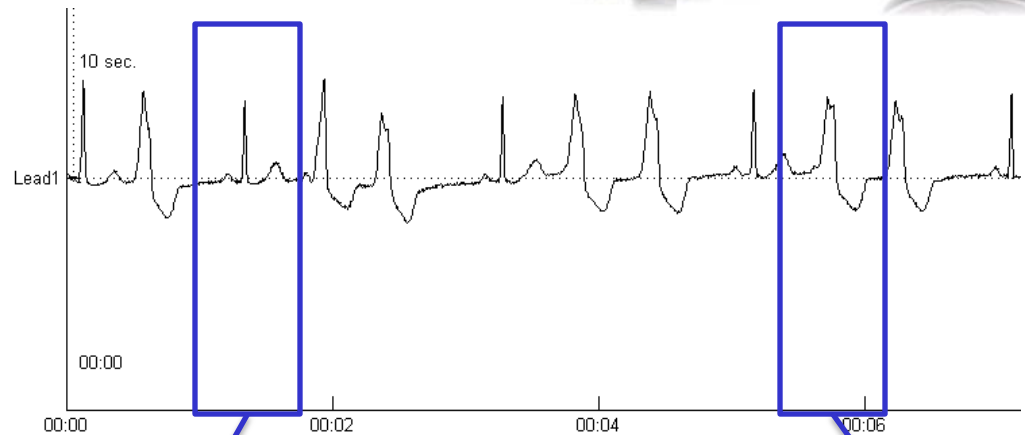
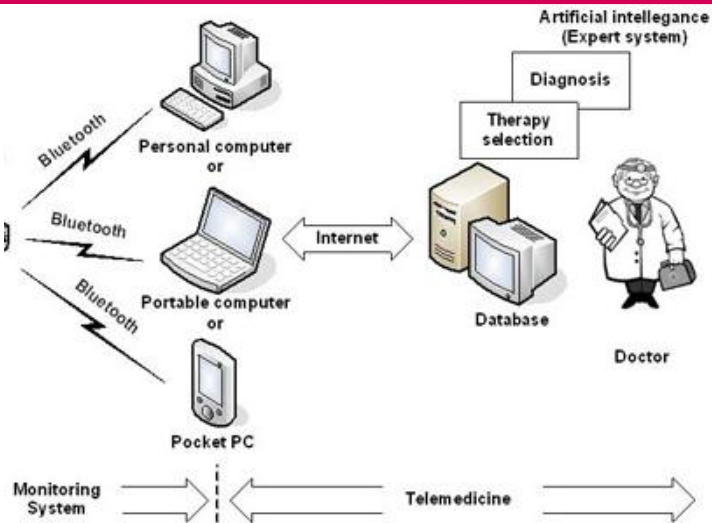
■ Policy decision support

- Population based mining
 - Spatial-temporal modelling
 - geography, age clusters, consumption profiles, longitudinal time series
- Clustering, classification, modelling, prediction, trends, seasonalities
- Outlier detection
- Federaal Kenniscentrum Gezondheidszorg

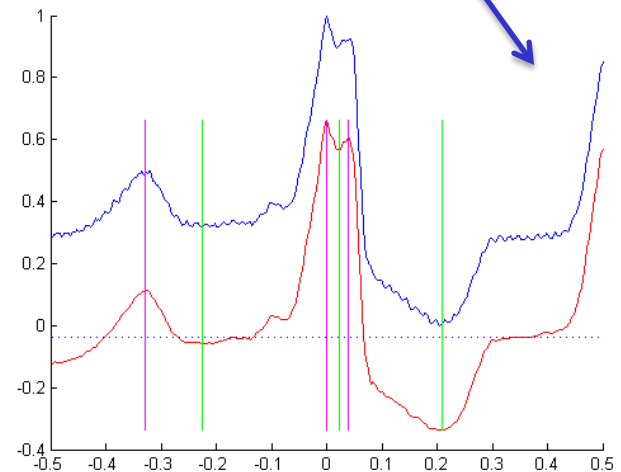
■ Embedded decision support systems

- Assistive health and wellness management systems
- Health telematics
- Intelligent environments, ambient intelligence, smart homes, home networks
- Home health monitoring and intervention
- Health vaults: personal medical data collection and processing
- Wearable sensor signal processing/wireless registration of physiological parameters

Advanced Signal Processing



Left Bundle Branch Block



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