Future Health at the Institute of BroadBand Technology

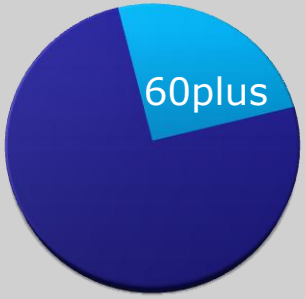
prof. Bart De Moor

E-Health: from promises to results
December 2nd 2011

Societal trends

Ageing

Flanders 2012



age related & chronic diseases rise

→ **challenge:** reconcile **quality** with **costs**

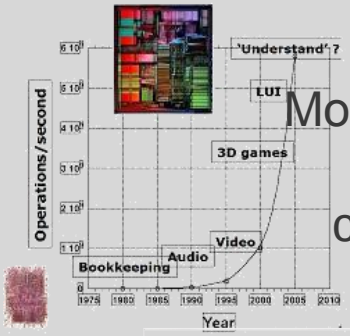
Patient empowerment → P4 Medicine

- Personalized
- Preventive
- Predictive
- Participatory

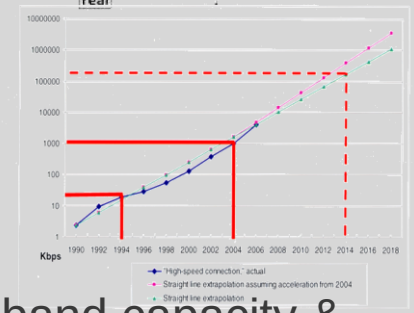
→ **challenge: patient-centric & personalized** health care

Technological trends

IT + internet performance & pervasiveness



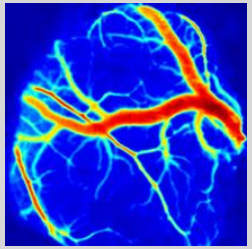
Moore's Law ↓ computing power

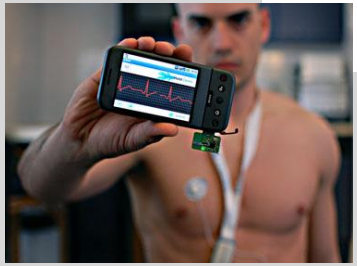


broadband capacity & pervasiveness
→ data access and sharing

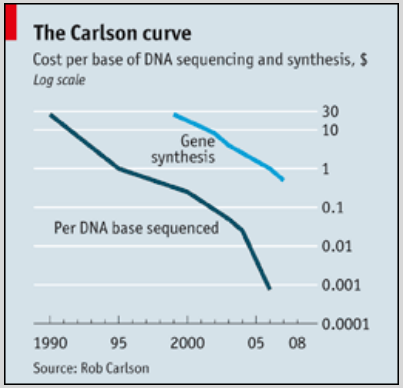
Monitoring & smart systems

- Variety of imaging modalities
- Multichannel, Wireless, Mobile & Real-Time



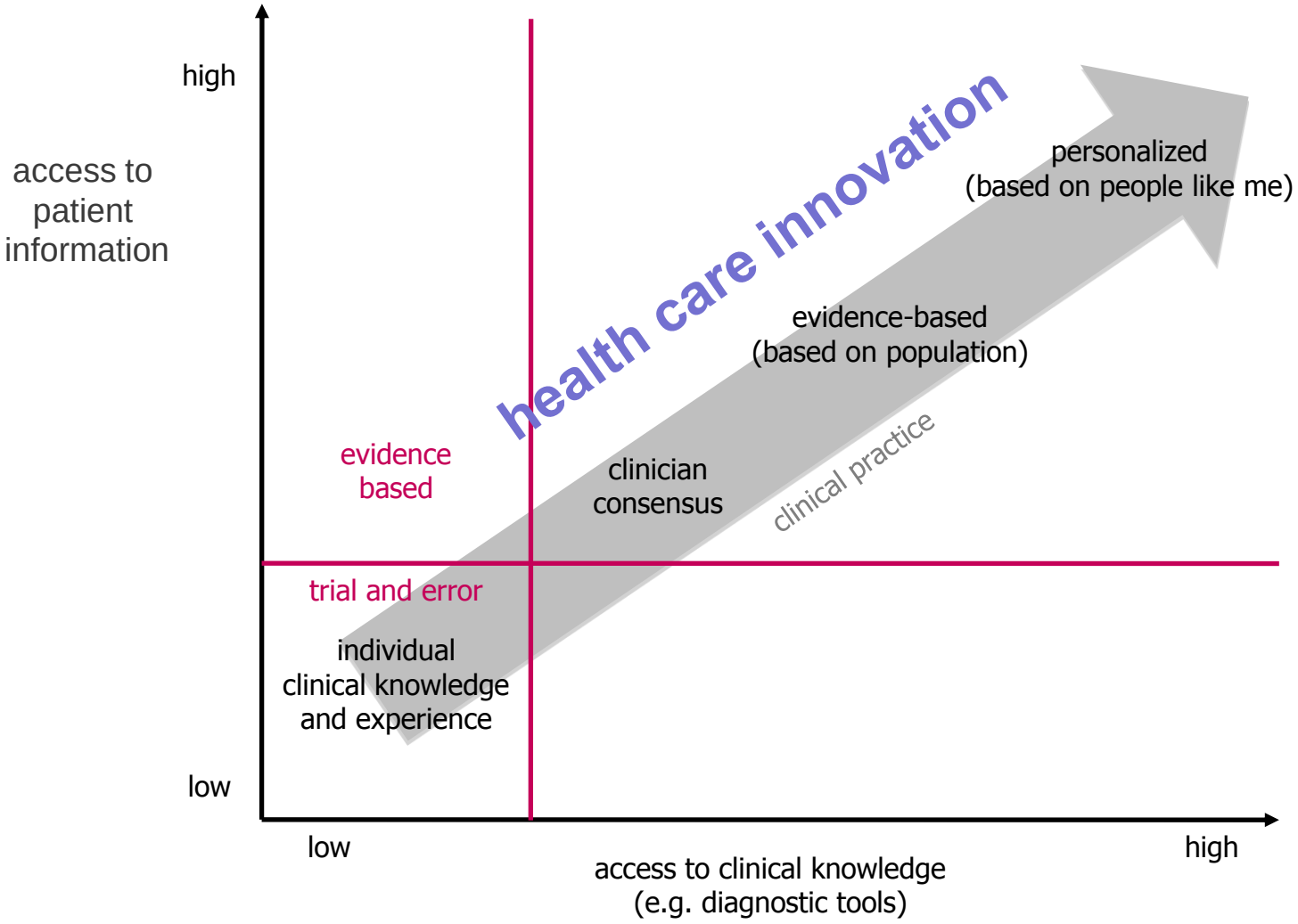


Biomedical technologies

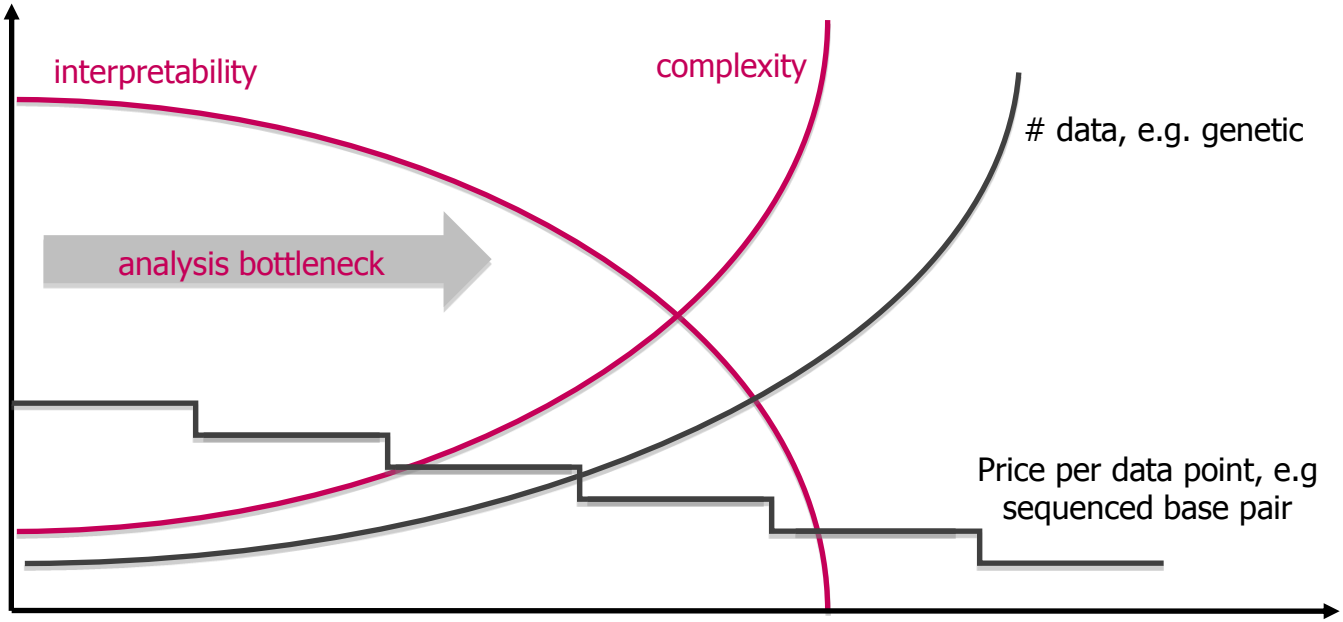


Carlson's law → $1000 personal genome

Towards evidence-based and personalized medicine



Challenge: data tsunami



IT to the rescue!

IT, mathematical engineering and software design

→ **fully exploit the opportunities** created by advancing technologies

IBBT Future Health Department: Health Decision Support

ibbt
connect.innovate.create

data: clinical, biomedical, imaging, omics, health insurance data, medical knowledge …

- **Clinical** → **exploit data for more effective medicine**
- **Patient** → **patient-centred care for empowered patients**
- **Policy** → **smart & data-driven health care system policies**

- IT & software design
- data processing & mining
- data integration & visualization
- user experience & e-learning

to **extract** **appropriate information**

to **transfer** **this information** to the user:
professional, patient and policy maker

decision support to enable better health care

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Positioning of IBBT

- IBBT = Interdisciplinary Institute for Broadband Technology
- 1 out of 4 strategic research centers (SOC) in Flanders

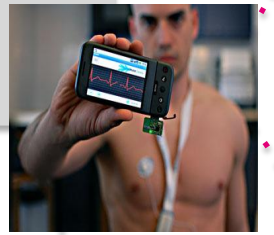
- Virtual: expertise of university research groups
- Link between research and industry
  - Supporting companies and organizations active in research and development
  - stimulate the development of innovative ICT services and applications in close collaboration with government and industry

Structure of IBBT: 5 research departments

Future Internet

Security

Future Health



Digital Society

Future Media

Future Health: Research Groups

- bioinformatics & machine learning
- biomedical data processing
- digital signal processing for audio & telecom

- Fac. Engineering
  Dept. ESAT - K.U.Leuven

- bioinformatics & computer science
- education
- linguistics
- statistics

- K.U.Leuven
  campus Kortrijk

- user experience research

- Fac. Social Sciences
  K.U.Leuven

- medical imaging

- Fac. Engineering
  Dept. ESAT
  K.U.Leuven

Future Health: Mission Statement

→ create lasting and positive impact on society through IT innovation

→ improve quality and cost effectiveness in health care through computational research and IT development

Health Decision Support for Professionals . Patients . Policy

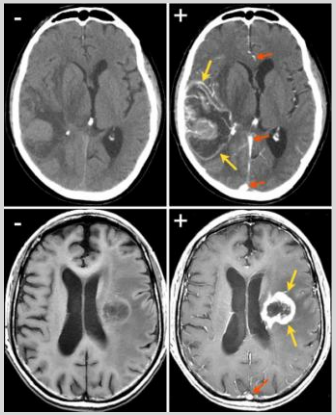
- Dialogue with health care stakeholders
- Demand-driven & interdisciplinary
- Economical & societal valorization

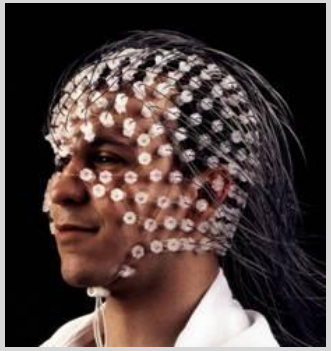
reference center for computational research in health care

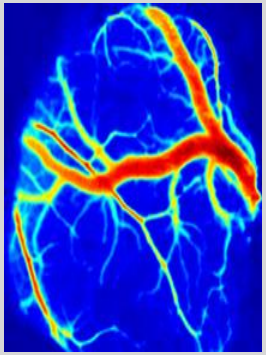
Research Focus

Clinical Decision Support

- interpretation of wide range of data
- demand-driven, user-centred, with future vision





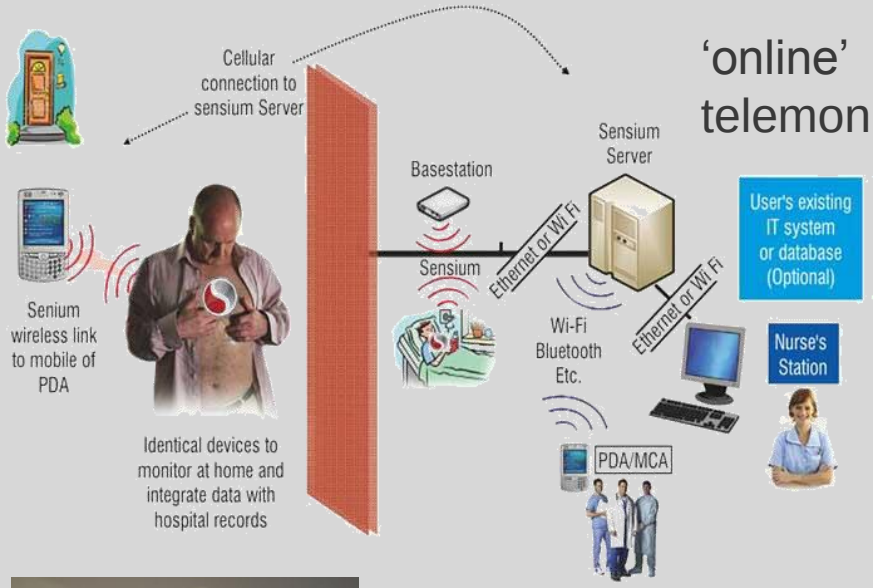

Patient DS

Policy DS

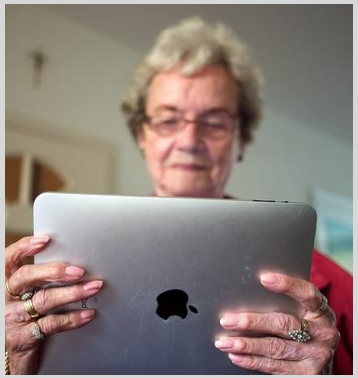
Research Focus

Clinical DS

Patient Decision Support



‘online’ telemonitoring



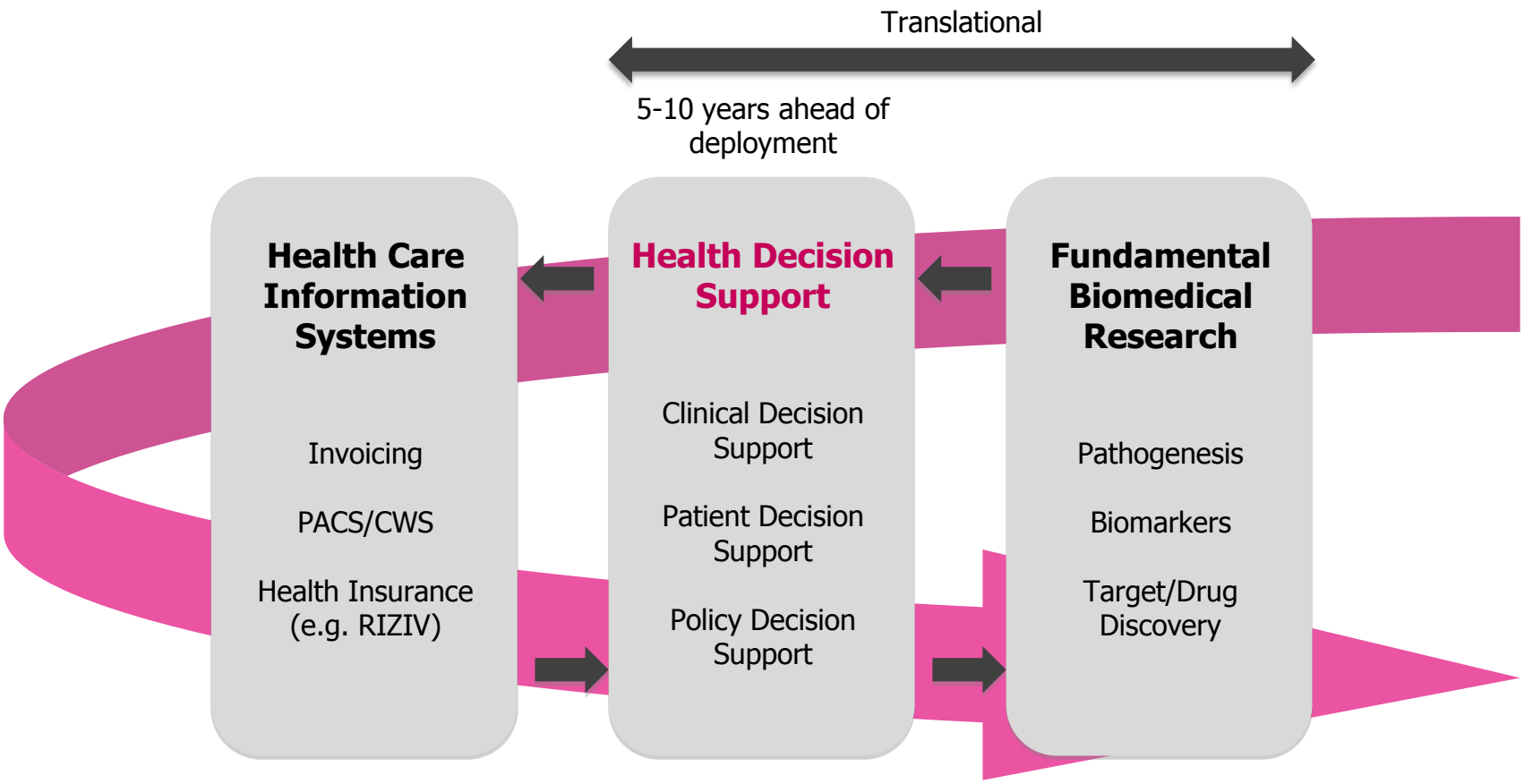
‘patient empowerment’: e.g. disease management for patients with chronic diseases using new media

Policy DS

- data mining to identify best practices, …

- hospital logistics

Future Health: Positioning



Through dialogue with stakeholders

key to accessible and efficient health care = dialogue
between research, technology and health care

research
universities & research centres
strategic research centers: IBBT, imec, VIB, VITO
…

health care stakeholders
patients
hospitals
doctors
health insurance
health care policy
…

technology providers
& core facilities
industry
supercomputing
medical imaging center
usability lab
sequencing (Genomics Core)
…

Cases

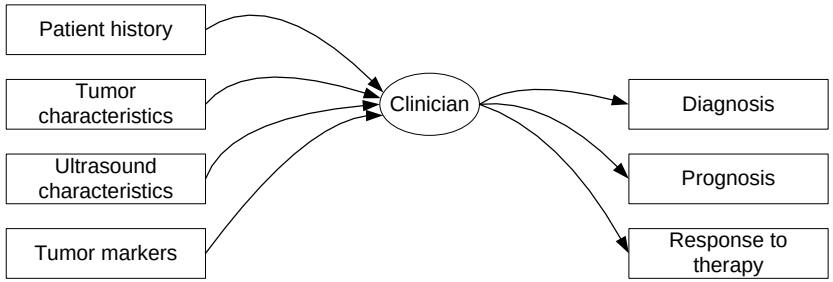
- IOTA: International Ovarian Tumour Analysis Group
- Endeavour: disease gene prioritization
- Epilepsy detection
- Tumor classification via MRS
- Semi-Automatic Blood Glucose Control in the ICU
- Cardiac function analysis
- Theraplay
- ACCIO: Ambient aware provisioning of Continuous Care for Intra-mural Organizations

Case: IOTA - International Ovarian Tumour Analysis Group

→ Making it easier to diagnose ovarian cancer

Clinicians have to make many decisions concerning the therapy of their patients e.g.:

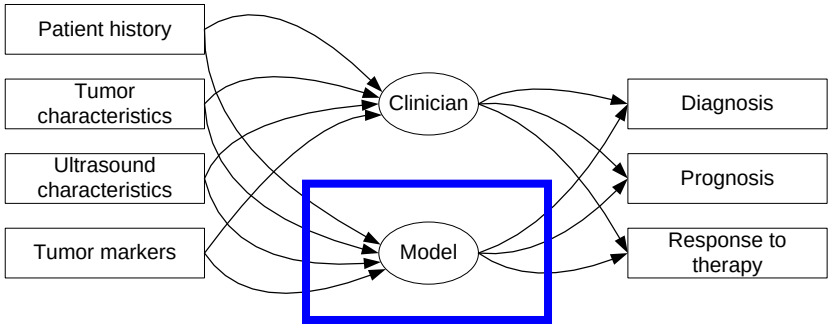
- Diagnosis
- Prognosis
- Therapy response



- Based on **expertise**
- But often the clinician has
  - Patient Data
    - Patient history
    - Tumor characteristics
    - Ultrasound characteristics
    - Tumor markers

Case: IOTA - International Ovarian Tumour Analysis Group

- Solution:
  - Clinical decision support modeling
  - Building a mathematical model on the data
  - Use this model to predict patient outcome
    - Diagnosis
    - Prognosis
    - Therapy response



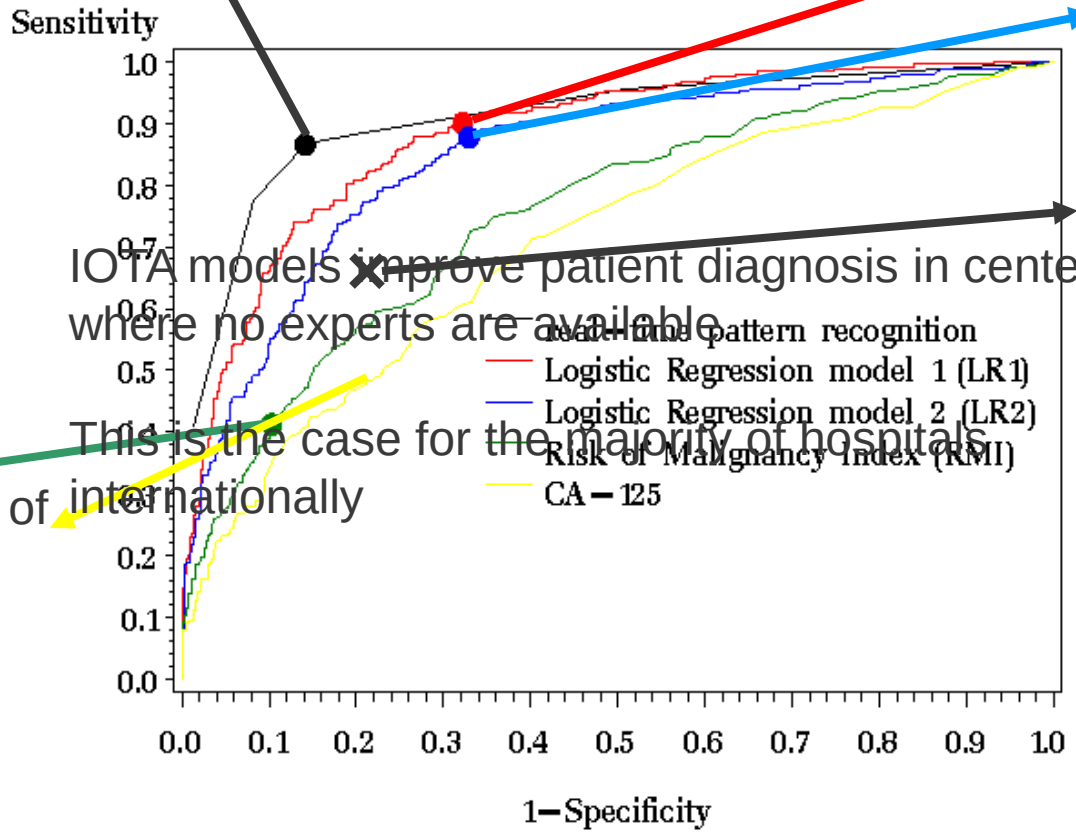
Case: IOTA - International Ovarian Tumour Analysis Group

Performance of an expert

Performance of IOTA models

Performance of non-experts

Performance of old models



IOTA models improve patient diagnosis in centers where no experts are available

This is the case for the majority of hospitals internationally

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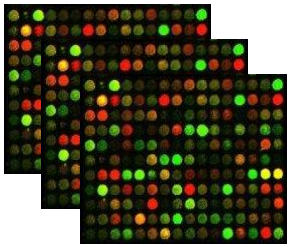
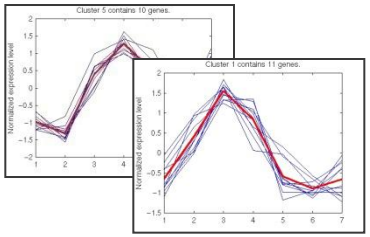
Case: Endeavour - disease gene prioritization

High-throughput genomics



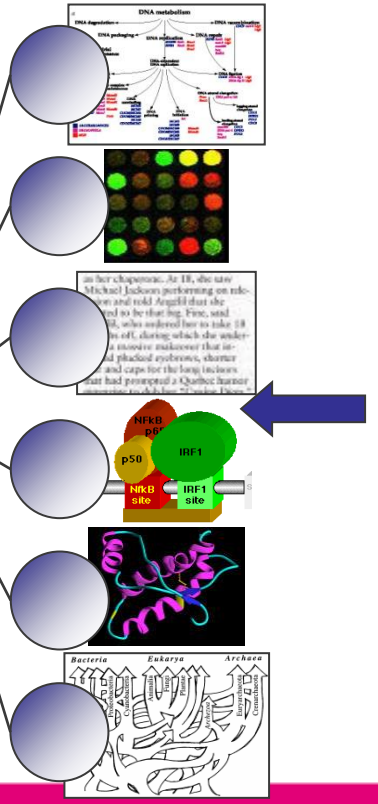
Data analysis



Candidate genes

Name	Ensembl
TTR	ENSG00000118271
PAH	ENSG00000171759
G6PC	ENSG00000131482
IGF1	ENSG00000017427
ALB	ENSG00000163631
CRP	ENSG00000132693
HABP2	ENSG00000148702
IF	ENSG00000138799
FST	ENSG00000134363
ARAF1	ENSG00000078061
HMGA2	ENSG00000149948
C9	ENSG00000113600
PCBP2	ENSG00000111406
HOXB6	ENSG00000108511
RERE	ENSG00000142599
HOXA11	ENSG00000005073
CLIC1	ENSG00000096238
ERCC3	ENSG00000163161
ERCC3	ENSG00000163161
TLL2	ENSG00000095587
SYT4	ENSG00000132872
SYT4	ENSG00000132872
PIK4CB	ENSG00000143393
PKD2	ENSG00000118762
	ENSG00000081026
ANKRD3	ENSG00000183421
F13A1	ENSG00000124491
BPAG1	ENSG00000151914
KCNN3	ENSG00000143603
GRIN2A|GRIN2B	ENSG00000150086
SIM1	ENSG00000112246
	ENSG00000174891
	ENSG00000089195
C14orf10	ENSG00000092020
STX8	ENSG00000170310
	ENSG00000107671
MSH5	ENSG00000096474
CRH	ENSG00000147571
MID1	ENSG00000101871
	ENSG00000184508
	ENSG00000113460
TGFB3	ENSG00000
C10R	ENS
	ENS
PDG	ENS
PD	
NR	
NFYA	
	ENS 06537
MMP3|MMP1	ENSG00000149968

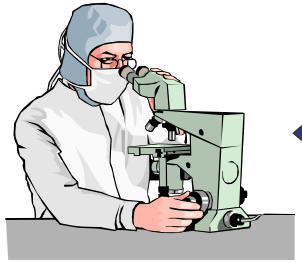
Information sources



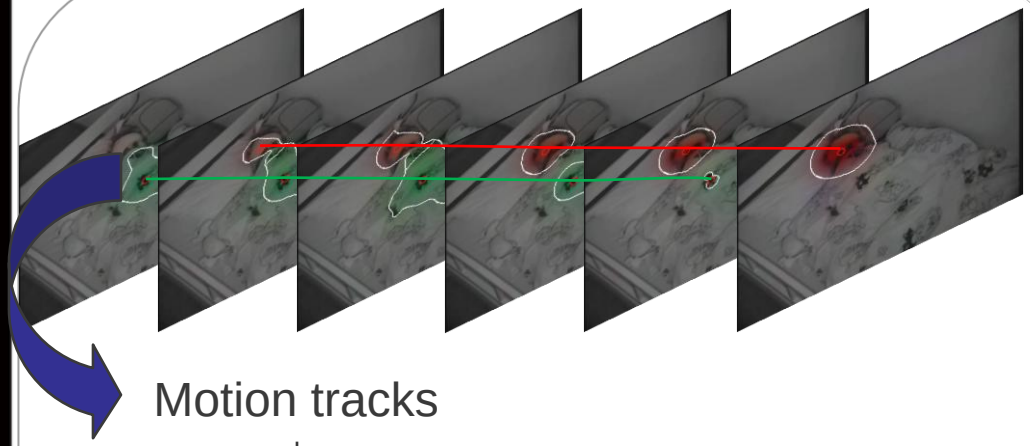
Candidate prioritization

Rank	En	Ex	Ip	Ke	GO	Te Avg	Pval
1	TTR	G6PC	PAH	G6PC	IGF1	TTR		TTR
2	IGF1	TTR	IGF1	PAH	PAH	IGF1		PAH
3	CRP	ALB	TTR	RERE	G6PC	CRP		G6PC
4	HOXB6	HABP2	ALB	ERCC3	TTR	HOXB6		IGF1
5	ALB	PAH	HDC	ERCC3		ALB		
6	NR4A2	IF	TLL2	ANKRD3		HMGA2		CRP
7	PAH		C1QR1	ARAF1	HDC	NR4A2		HABP2
8	HOXA11	IGF1	G6PC	PKD2	F13A1	PAH		IF
9	NFYA	CRP	HABP2	MTMR1	KCNN3	HOXA11	C13orf7	FST
10	C9	ARAF1	IF	HDC	CLIC1	NFYA	TTR	ARAF1

Validation

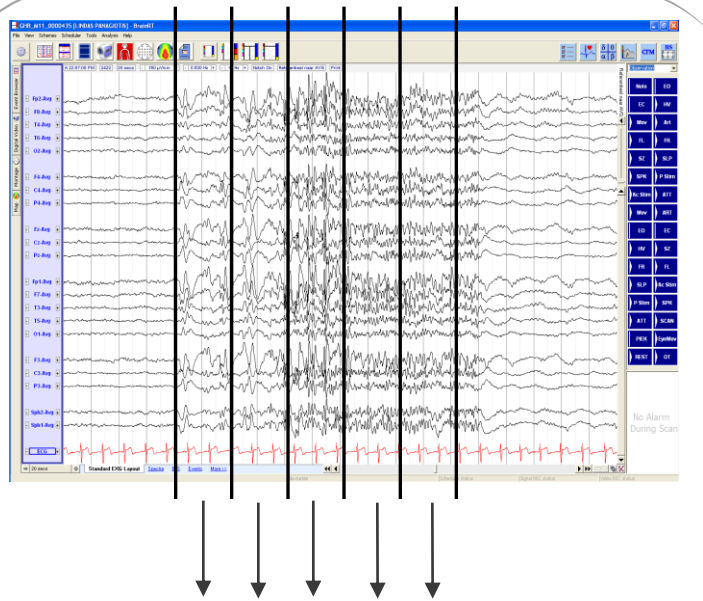


Case: Epilepsy detection



Motion tracks

Extract features based on the motion tracks



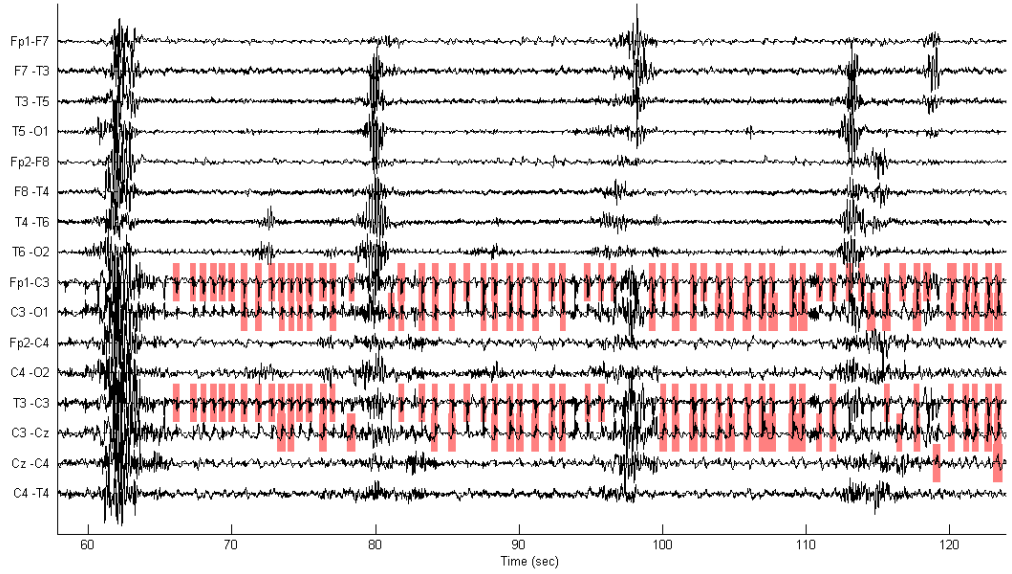
Extract time and frequency domain **features**

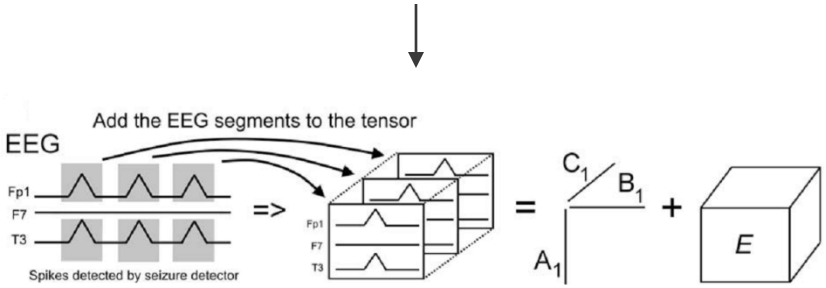
Video-EEG monitoring

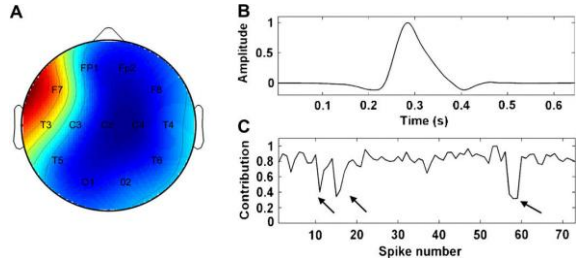
ESAT/SCD

Discriminate between **normal** and **epileptic** events

Seizure localization

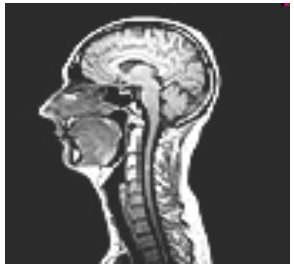






Parafac component corresponding to seizure

Case: Tumor classification via MRS

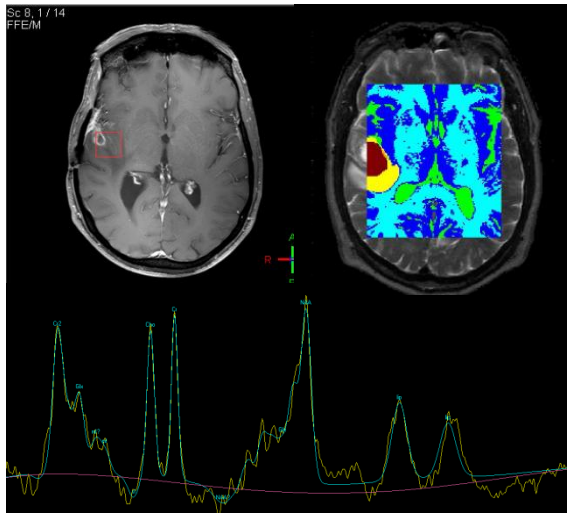


Nuclear magnetic resonance imaging (NMR):

- “water images”
- concentraion of protons → anatomical details

Magnetic resonance spectroscopic imaging:

- Quantitative metabolite maps

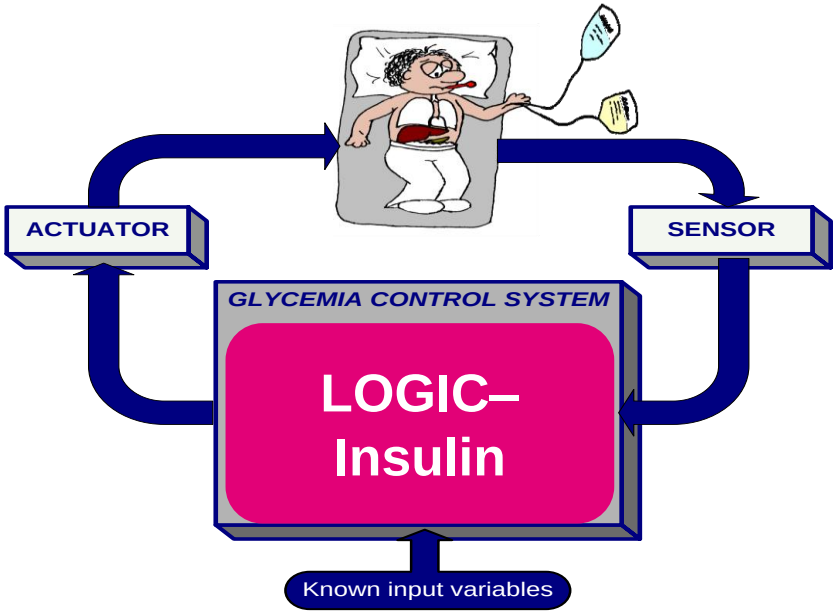


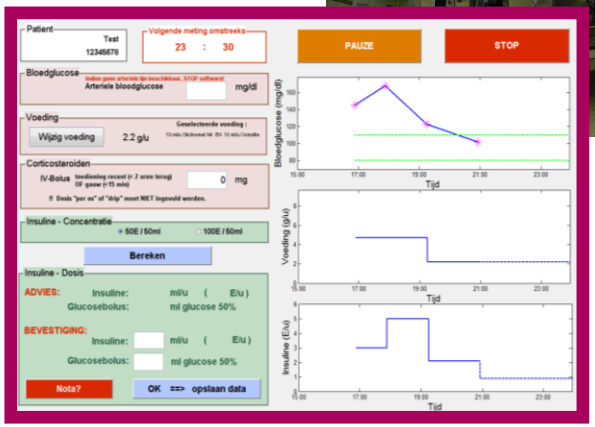
Key challenges:

- Accurate and fast quantitaion
- Artifact removal
- Automated classification

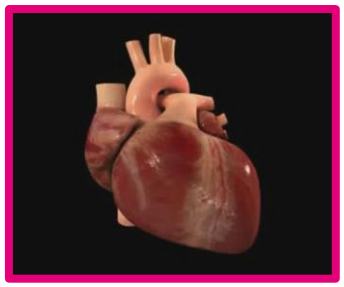
Case: Semi-Automatic Blood Glucose Control in the ICU

- Intensive Care Unit: critically ill patients - High insulin resistance leads to hyperglycemia in the ICU → need for Tight Glycaemic Control (TGC) = 80-110 mg/dl
- LOGIC-Insulin: algorithm and graphical user interface for normalizing blood glucose in critically ill patients in the ICU





Case: Cardiac function analysis



Heart = Four-chamber system

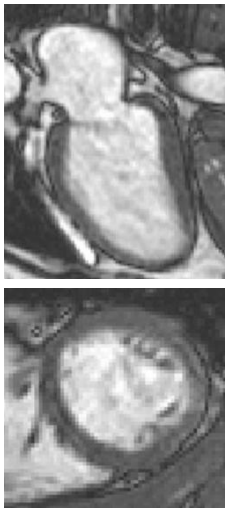
Supply body with oxygen and nutrients and remove metabolic waste products

Cardiovascular disease (CVD): Ischemia, arrhythmias, valvular heart disease, …

→ 17 million = 30% of all worldworldwide deaths in 2008 due to CVD*

→ 100 deaths per day in Belgium**

→ **Cardiac imaging** for non-invasive quantification of heart function

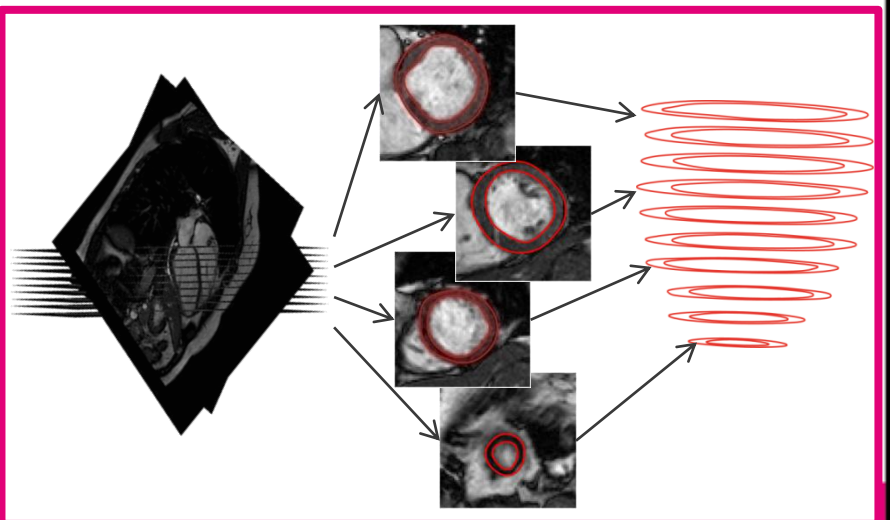


MR

Functional parameters:

- Myocardial thickening
- Stroke volume
- Ejection fraction
- Wall strain

→ Manual segmentation

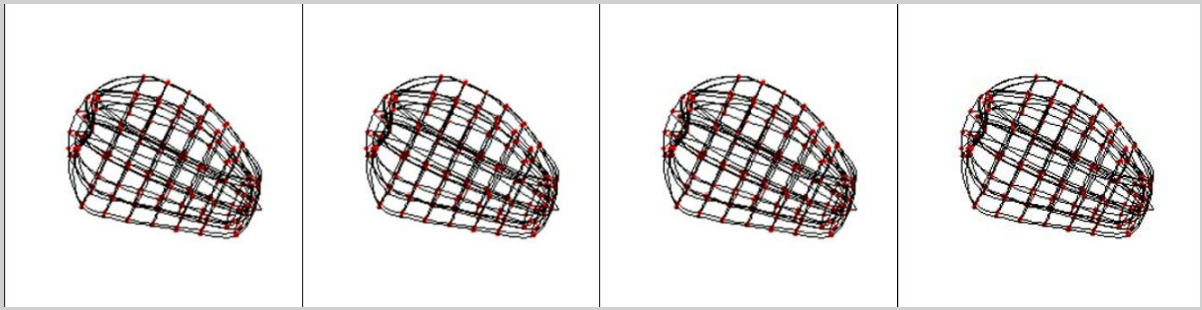


http://www.youtube.com/watch?v=P5fR2pCzm3k&feature=

*World health organization

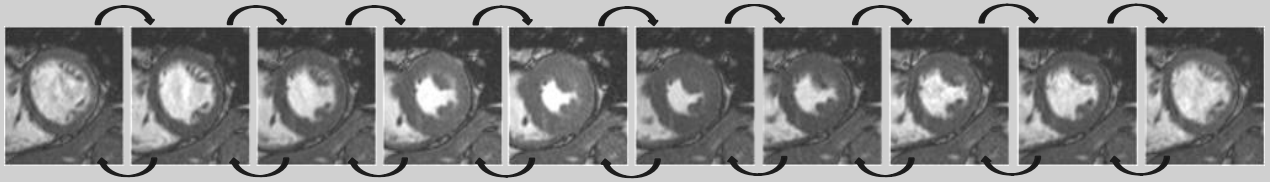
**Belgische cardiologische liga

Case: Automatic 3D+time segmentation

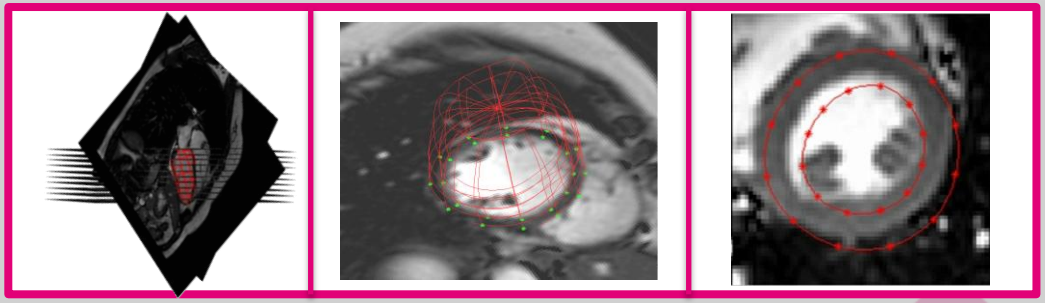


Statistical models of shape and intensity, learned from training data

Information of all timeframes and slices **linked together**



→ Results in **automatic, consistent, accurate** measurements of cardiac function



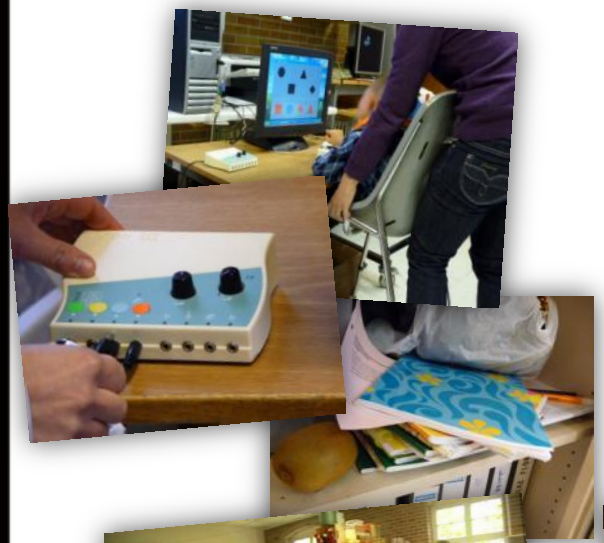
Case: Theraplay

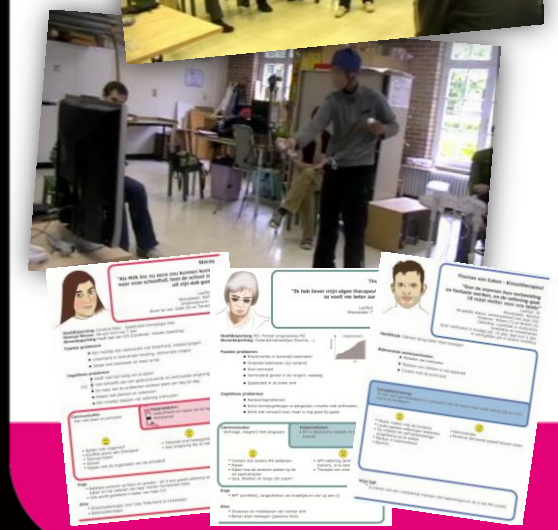
CUO – IWT-TETRA project

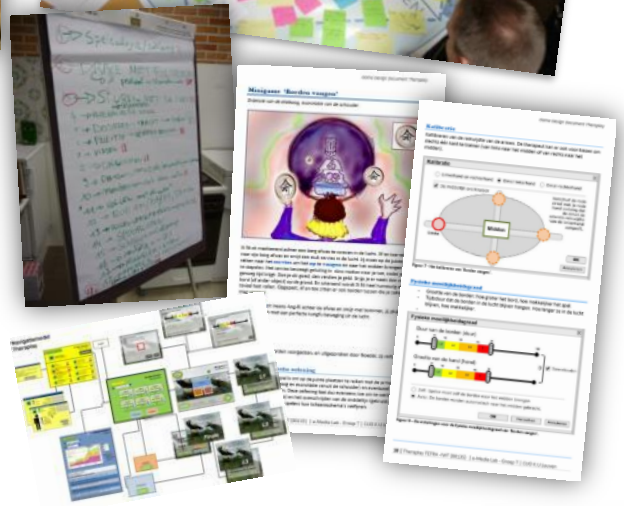
Analysis

Design

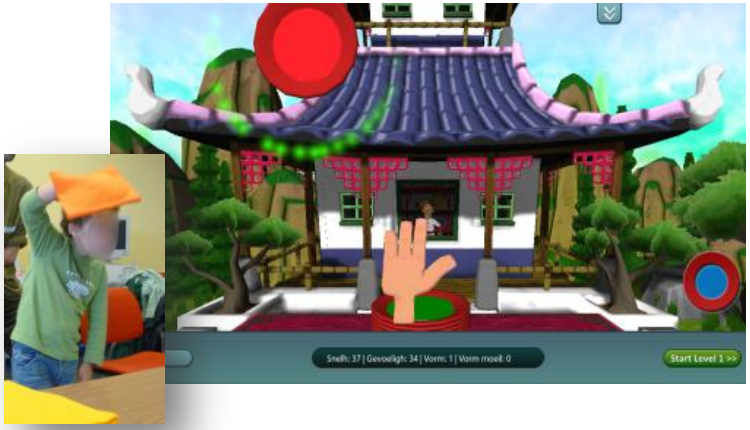
Evaluation







Kung Fu Kitchen



Case: ACCIO

Ambient aware provisioning of Continuous Care for Intra-mural Organizations

- Define scope, concepts & rules of a human-centred **ontology**
- Supports **continuous care** in multiple care settings
  - Residencies > Care
  - Hospitals > Cure
- **Modelling** relevant knowledge:
  - roles
  - processes
  - tasks

Role of CUO:

- Guide the **user-centered design** process
- Involve end-users and stakeholders in **every phase**:

observations

Extensive observations of care practices in two settings to cover two main forms of institutionalized care: residential and hospital care. Observations were systematically represented in mindmaps.

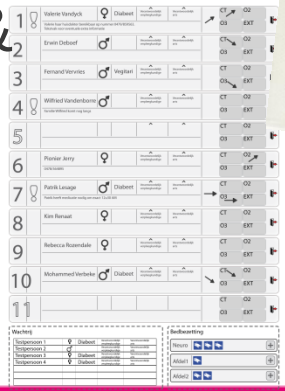
scenarios

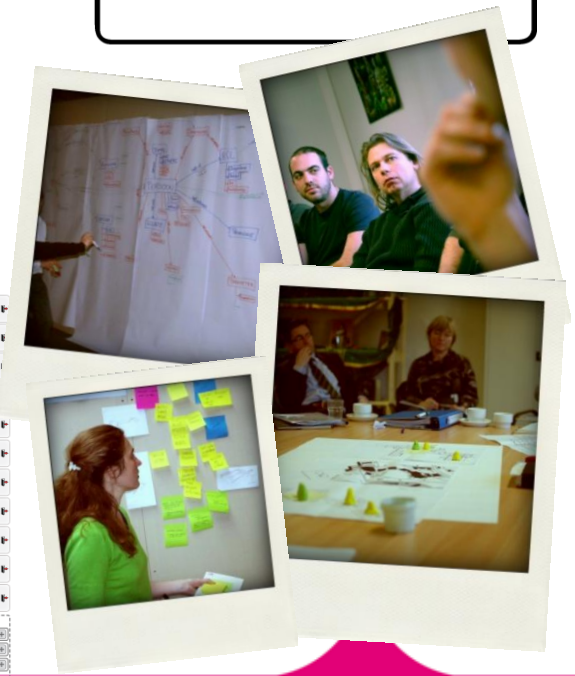
The scenarios serve as a communication tool among all stakeholders. It expresses the scope, requirements and general rules of the ontology under development in a way that generates empathy with the users.

co-creation

Our stakeholder group consists of potential end-users (e.g. care-takers, nurses, doctors, etc.), ontology engineers, social scientists and professionals work-ing for the healthcare industry.

- Develop **new concepts** for future ambient aware technologies
- **Expert** reviews of existing applications
- Iterative **evaluation** of insights & prototypes





Results:

- Recommendation report based on the analysis of Cure & Care contexts
- Product ecology (tools, practices and attitudes)
- ER observation concept
- Guidelines for involving end-users in medical ontology creation
- Proof of Concept demonstrator for an intelligent nurse call system

Track Record

Cartagenia

data handling & mining for clinical genetics

silicos

in silico drug discovery

icoMetrix

Quantifying Your Images

image quantification

PYXIMA

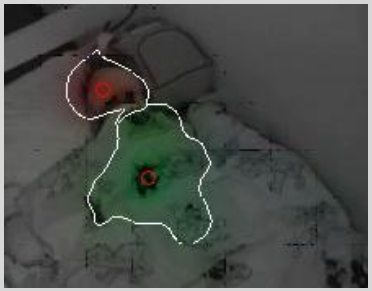
SOCIAL INTEREST SOFTWARE SERVICES

social interest software

medicim

MEDICAL IMAGE COMPUTING

medical image computing



televic education

(e-)learning solutions

home monitoring for epilepsy detection

VISION++

Experts in Computer Vision

http://www.visionplusplus.com

vision software & hardware

Theraplay: ergotherapeutic game

Track Record

- 17 PI, 25 postdocs, 88 PhD students
- ~ 270 publications /year
- ~ € 5 million external financing /year
- ~ 15 PhDs /year
- ~ 40 patents
- 5 spin-offs launched since 2005

Cartagenia

PYXIMA
SOCIAL INTEREST SOFTWARE SERVICES

user plus

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Experts in Computer Vision
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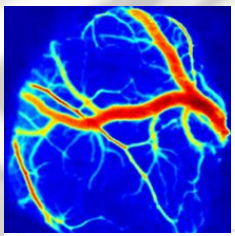
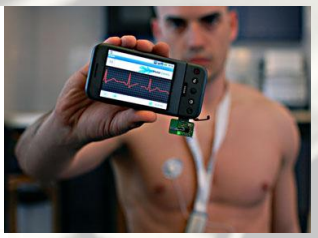
Conclusion

Trends

improve health care quality and cost effectiveness





Decision Support for Professionals, Patients & Policy

- **Clinical** — exploit data for more effective medicine
- **Patient** — patient-centred care for empowered patients
- **Policy** — smart & data-driven health care system policies

- Dialogue
- Demand-driven
- User-centred
- Future vision

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Future Health Department

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