An Approach to Decision Support in Heart Failure

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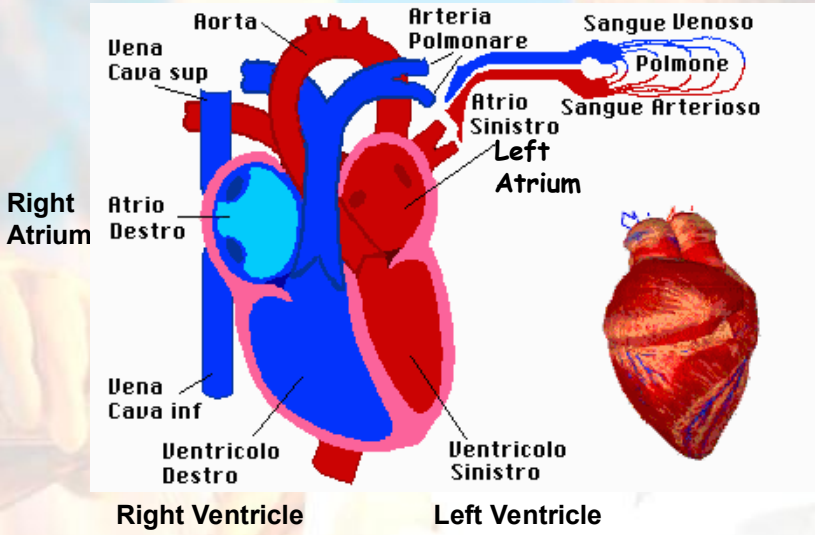
Information Society Technologies

Heart Failure (HF)

Have you an idea what does 1% of reduction of heart failure cases could be?



In Europe each year:

1.500.000 death

14.000.000 heart decompensation cases

One of main relevant causes of death & health problem in western civilized countries complex clinical syndrome:

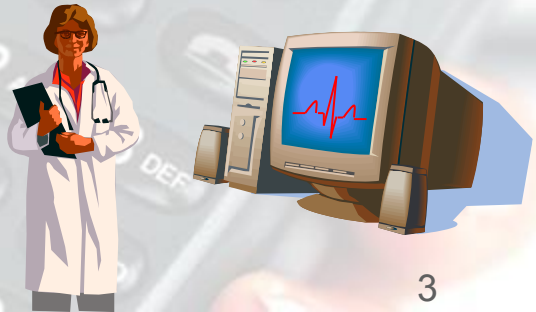
- **Heart no more able to** contract & to **pump blood** to circulatory system
- body accumulates water, **any action cause fatigue** …

Social & economic strong impact

- **hospital days to spend,** different life style **to conduct, time & money wasted**

HEARTFAID

- "***A knowledge based platform of services for supporting medical-clinical management of the heart failure within the elderly population***"
  aims
  - Improve life quality
  - reduce hospital admissions
  - allow to provide most of controls at home
- **also**
  - Improve clinical status
  - support difficult diagnosis, follow-up, and prognosis



Clinical Decision Support Systems (CDSS)

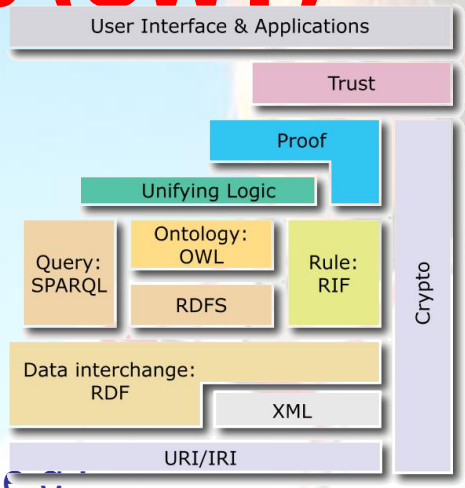
- **Early 1960s**: computerized applications development to support health care **started**

- **Most common realizations:**
  - electronic medical record (information retrieval)
  - computerized alerts & reminders
  - clinical guidelines formalizations
  - diagnostic support

- **CDSS development primary task: representing human knowledge**
  - formalize knowledge
  - solve problems
  - derive other knowledge
  - planning future activities

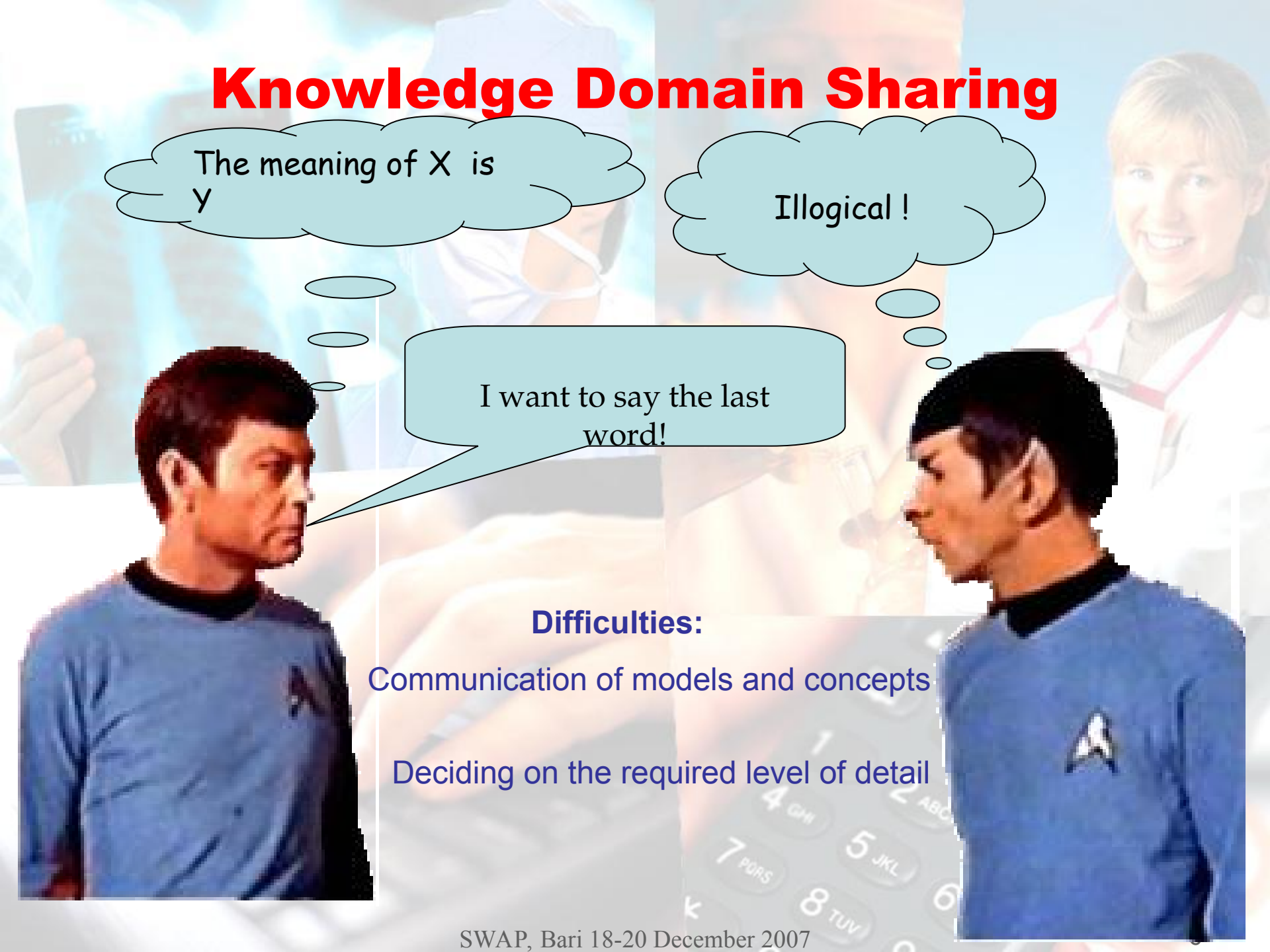
- Representing knowledge
  - KB is rule/frame/network/logic based
  - Workflow based representation also well-known (guidelines modelling)

Clinical Decision Support Systems & Semantic Web Technologies (SWT)



- Semantic Web Technologies gather attention within CDSS for
  - data integration
  - knowledge representation
  - reasoning
- SWT use evidence :
  - rise of several ontology (like) formalizations of medical domain, e.g.:
    - Systematized Nomenclature of Medicine (SNOMED)
    - Unified Medical Language System (UMLS)
    - Medical Subject Heading (MeSH)
    - GuideLine Interchange Format (GLIF)
  - systems developed using SWT, e.g.:
    - decision support in breast cancer management
    - clinical practice guidelines modelling
- W3C itself involved:
  - Health Care and Life Sciences group
  - RIF working group debated a medical use case
- SW recommendation insufficient to solve all problems
  ad hoc strategy usually developed

Knowledge Domain Sharing



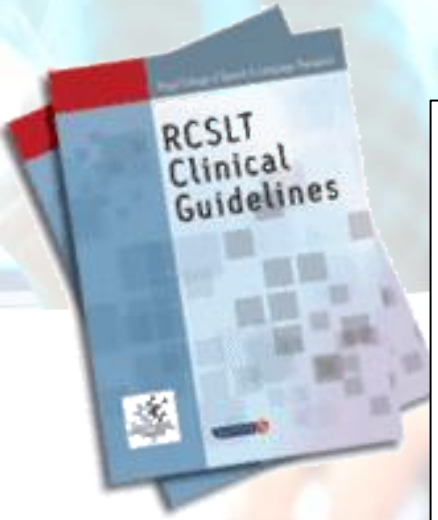
Difficulties:

Communication of models and concepts

Deciding on the required level of detail

Knowledge Domain Formalization

- European Guidelines: written by/for clinicians



…

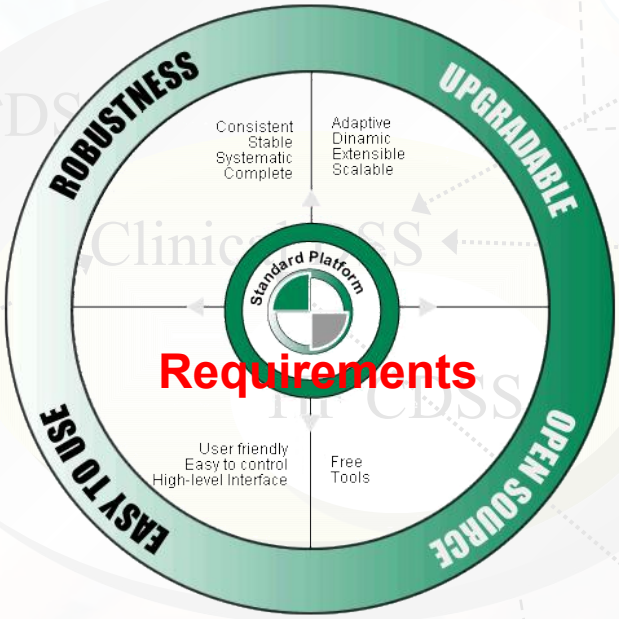
2 Aetiology of heart failure in Europe

Chronic heart failure may be due to myocardial dysfunction (in a vast majority of subjects caused by ischaemic heart disease or arterial hypertension, more rarely by other primary or secondary cardiomyopathies),

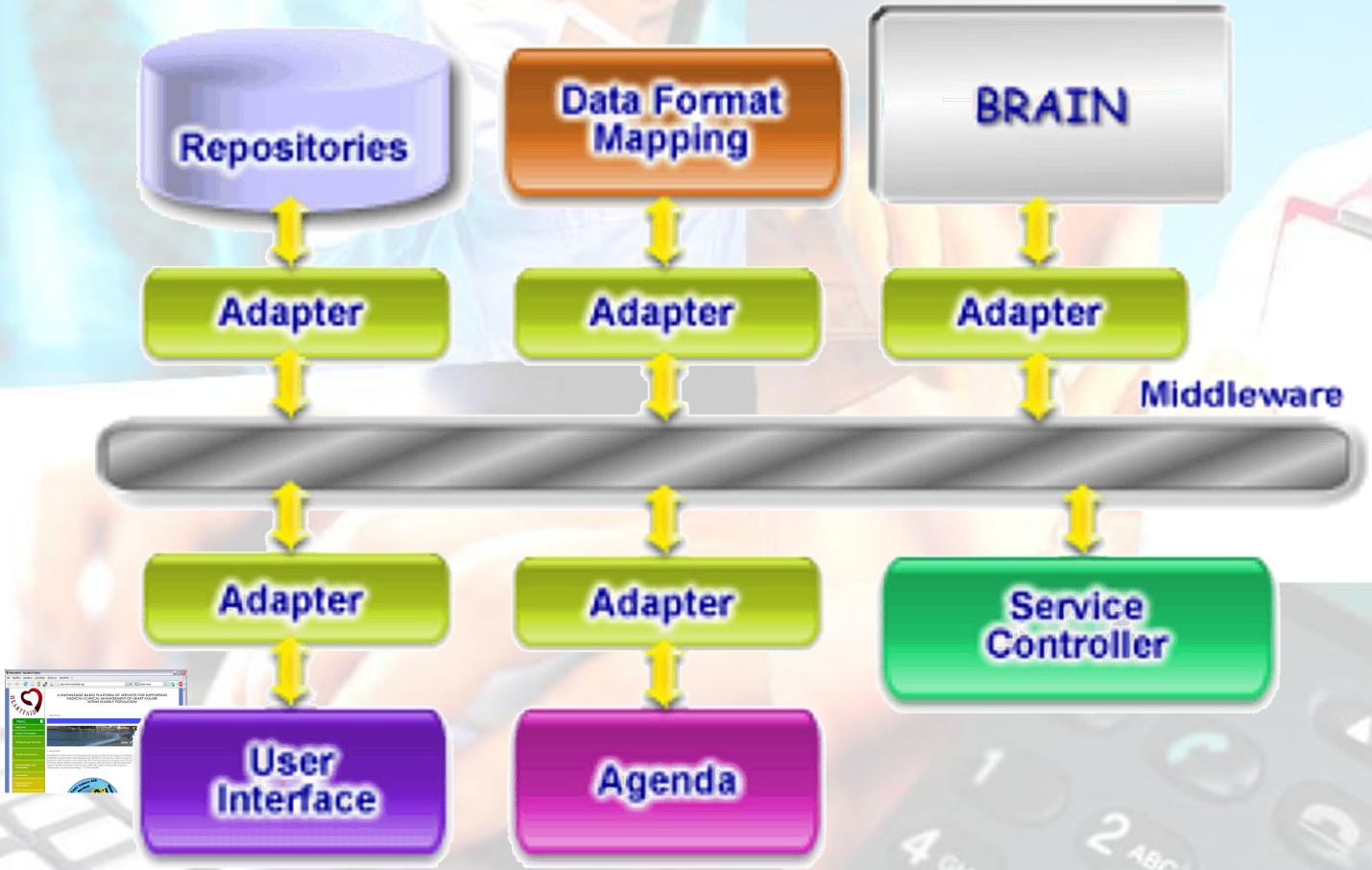
…

- Developing an ontology through
  - Discussion with experts
  - Extraction of terms from texts & articles & existing ontologies

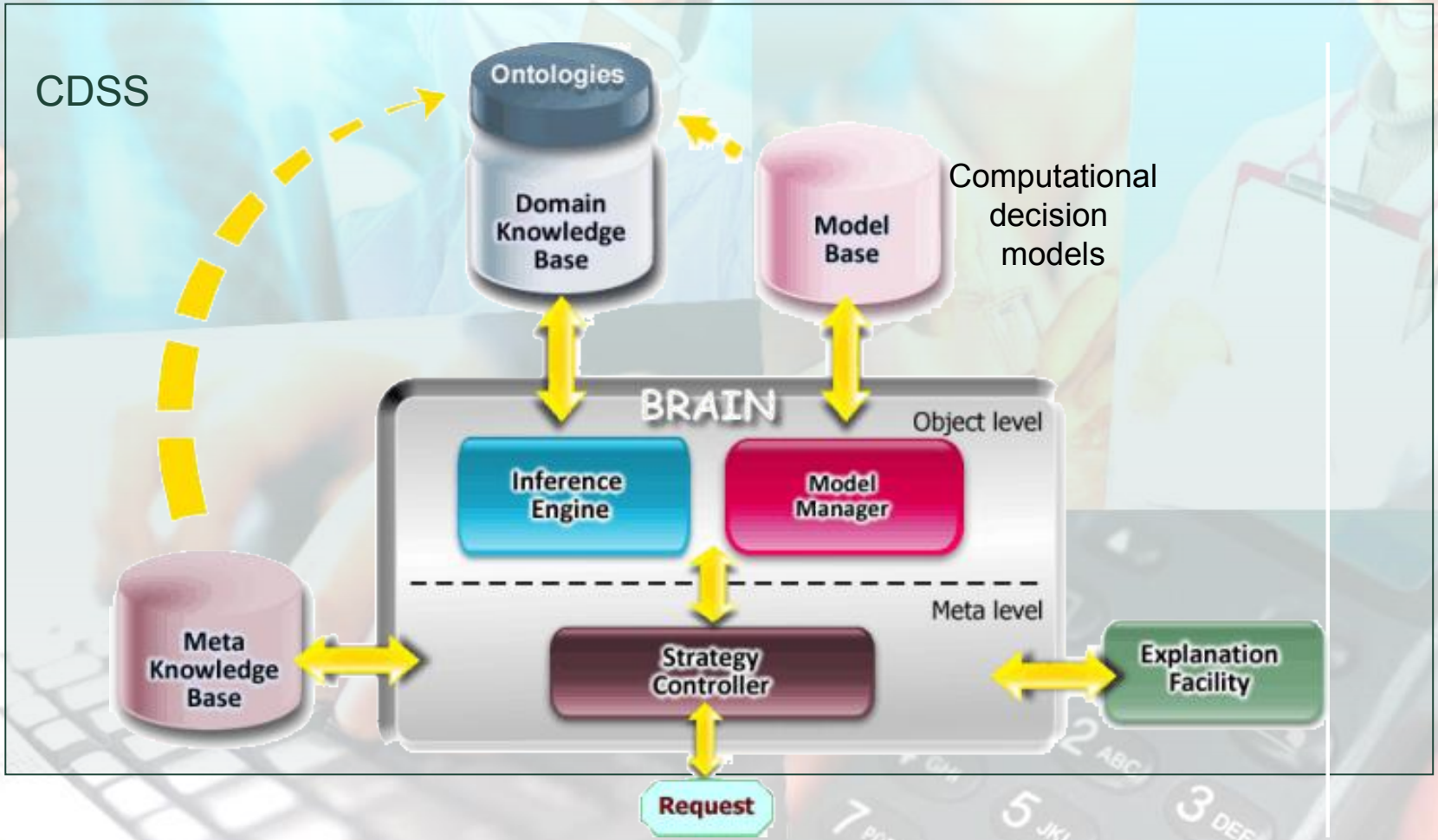
State of the Art Investigation
Main Platform Technologies



HEARTFAID Platform: General View



HEARTFAID Platform: The CDSS Brain Architecture

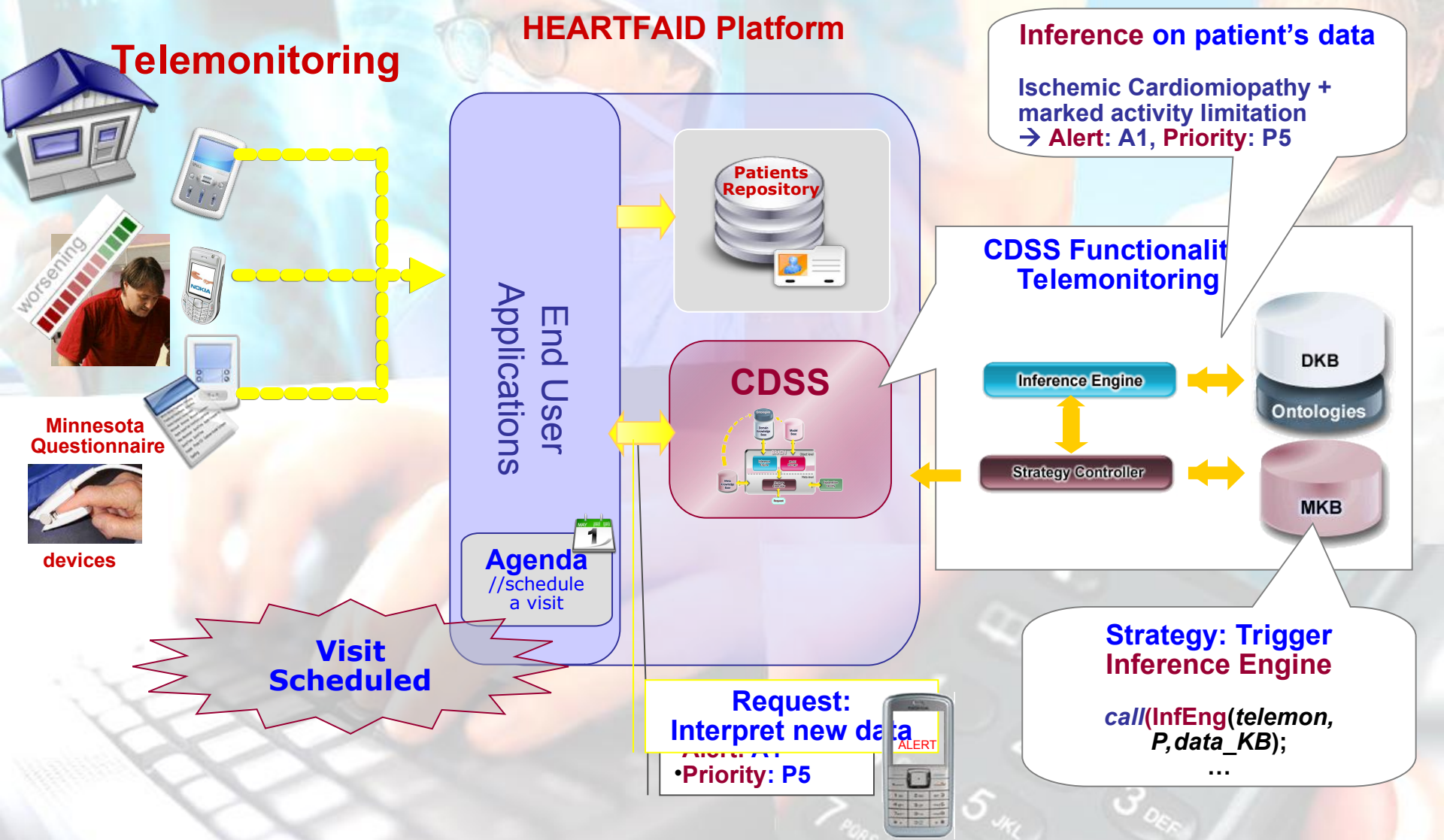


Brain: Implementation Tools

- **Inference Engine:**
  - Swoop+Protege
  - Jena + ARQ
  - Pellet

- **Other Models**
  - SVM, Bayesian Networks, Neural Networks

System Implementation: Real Use Case



Shortened

- Visit performed
- Signs & Symptoms collected
- CDSS suggested to perform EcoCardioGram
- ECO is performed
- CDSS analyze all infos & suggests therapy change

At Home (Telemonitoring)

HEARTFAID:: Patient Minnesota Questionnaire - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti ?

http://www.heartfaid.org:8080/Heartfaid/servlet/Controller

Google

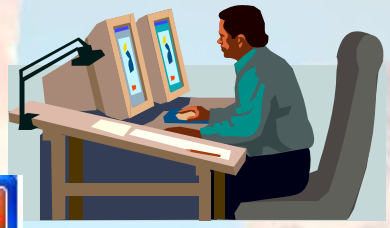
Minnesota Questionnaire

The following questions ask how much your heart failure (heart condition) affected your life during the past month (4 weeks). After each question, choose the 0, 1, 2, 3, 4 or 5 to show how much your life was affected. If a question does not apply to you, choose the 0 after that question.

Did your heart failure prevent you from living as you wanted during the past month (4 weeks) by		0=No 1=Very Little ---------- 5=Very Much
1	causing swelling in your ankles or legs?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
2	making you sit or lie down to rest during the day?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
3	making your walking about or climbing stairs difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
4	making your working around the house or yard difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
5	making your going places away from home difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
6	making your sleeping well at night difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
7	making your relating to or doing things with your friends or family difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
8	making your working to earn a living difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
9	making your recreational pastimes, sports or hobbies difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
10	making your sexual activities difficult?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
11	making you eat less of the foods you like?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
12	making you short of breath?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
13	making you tired, fatigued, or low on energy?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)
14	making you stay in a hospital?	(0 ◯) - (1 ◯) - (2 ◯) - (3 ◯) - (4 ◯) - (5 ◯)

devices

Clinician On Duty



HEARTFAID:: Patients Monitor - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti ?

http://www.heartfaid.org:8080/Heartfaid/servlet/Controller

Google

Patients Monitor

id	name	NYHA	status	date/time
1	Pietro Guarneri	IV	worse	8/11/2007 11:35:25
2	Vito Gattuso	IV	stable	8/11/2007 12:24:30
3	Maria Cecchi	III	worse	8/11/2007 12:15:11
4	Paolo Rossi	II	better	8/11/2007 11:44:14
5	Giovanni Sereni	I	better	8/11/2007 10:22:53

Proceed

Context links

- detail patient
- schedule visit
- assign therapy

WAI-AAA WCAG 1.0 XHTML 1.0

HEARTFAID:: Patient Situation - Mozilla Firefox

Patient Situation

Patient Anamnesis
Name: Pietro
Surname: Guarnieri
Age: 65
Sex: M
Other: former_smoker

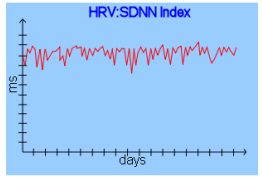
Patient Status
NYHA Class: IV

Diagnostic Procedures
Minnesota Questionnaire
Total Score: 33
Phisical Score: 17
Emotional Score: 16

Trans Thoracic Ecocardiography
Lvef: 40%
Esv: 114 ml
Edv: 190 ml
Sv: 76 ml
Lv: 6 cm

Pharmacological Therapy
ACE Inhibitors: Captopril, Dose (mg/die): 50 x 3
Sparring K Diuretics: Amiloride, Dose (mg): 12.5
Beta-blockers (mg): –, Dose (mg):
Aspirin Dose(mg/die):
Statin Dose (mg):

HRV:SDNN Index



Proceed

Context links
- schedule visit
- assign therapy
- assign diagnostic proc
- see agenda
- logout

Hospital Visit

HEARTFAID:: Clinical Visit :: NYHA Determination - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti ?

http://www.heartfaid.org:8080/Heartfaid/servlet/Controller

Clinical Visit: NYHA Determination

Patient name: **Pietro Guarneri** - id: **Patient_1**

Minnesota Questionnaire

Score	Base	Previous	Current
Total	33	33	97
Physical	13	13	38
Emotional	10	10	22

NYHA Classification

Base	Previous	Suggested (TotalScore)
II	II	IV

(Physical Score) IV

Context links

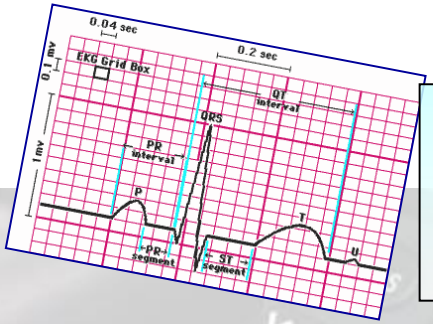
- schedule visit
- assign therapy
- assign diagnostic proc
- see agenda
- logout

Status: worsening - body water, physical activity, dyspnea, fatigue

Decide NYHA classification

set current NYHA to IV

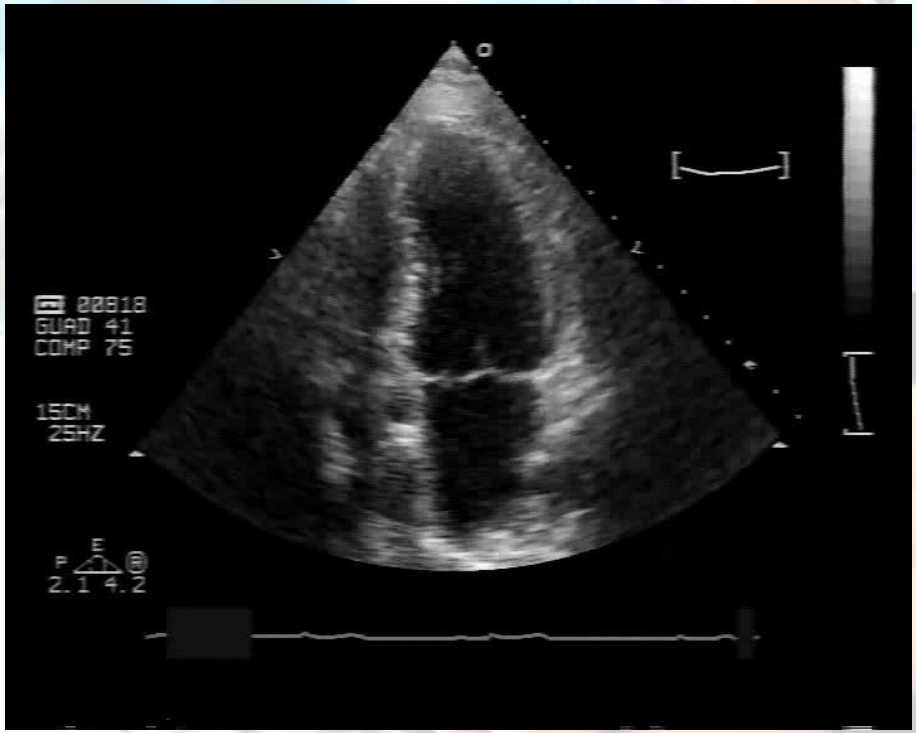
Submit Decision



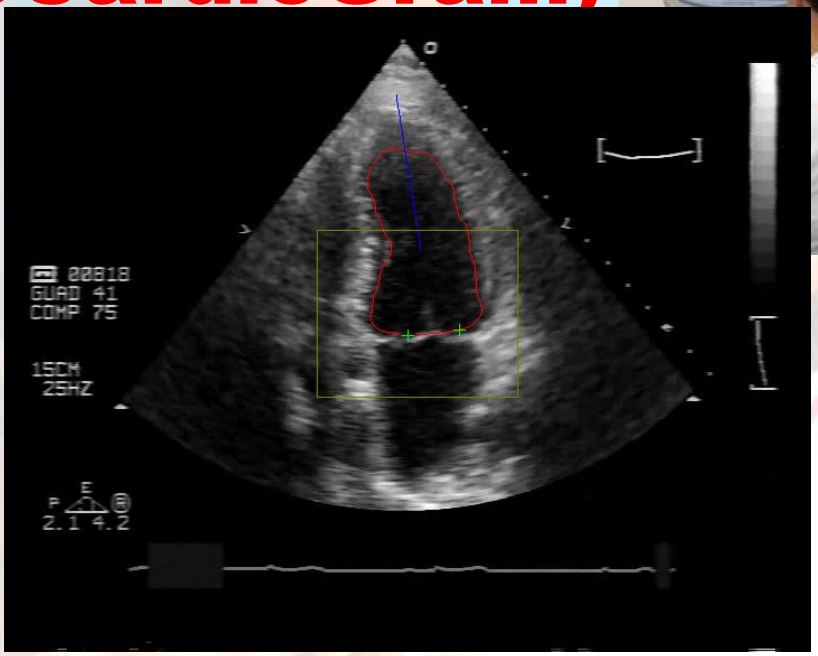
+HF Signs control
+ElectroCardioGram
+EcoCardioGram scheduling

Sonographer (EcoCardioGram)

original



preelaborazione



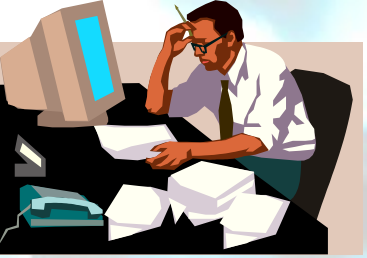
refinement

Image Processing Algorithms
Volumes extraction

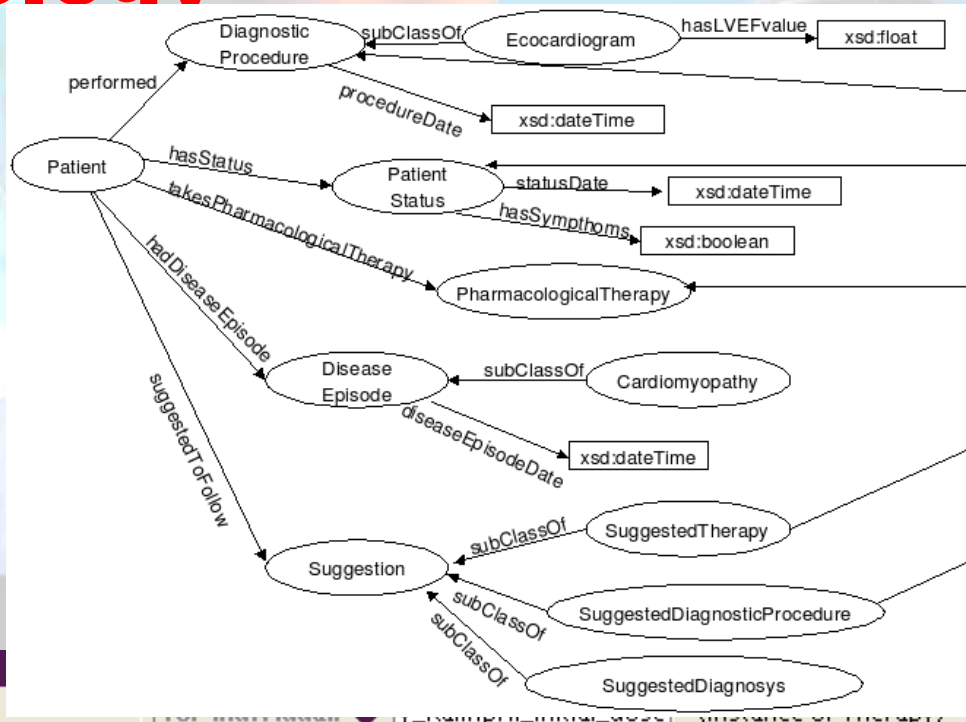
Hospital Visit

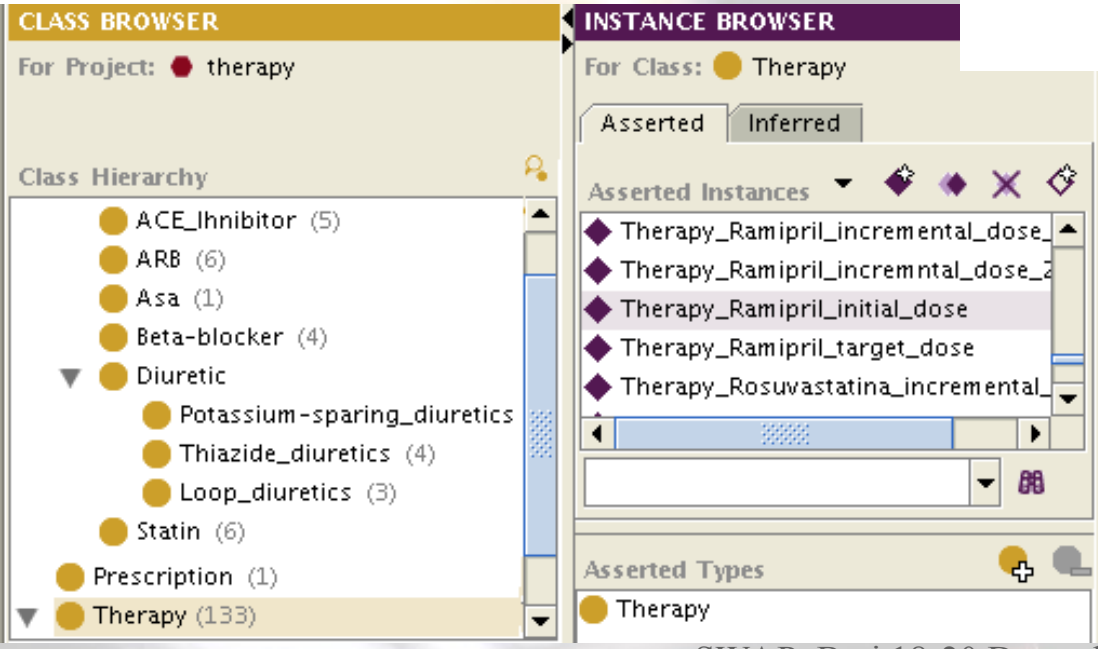
Change of therapeutic strategy decided by clinician supported by CDSS.

Ontology



Developing several core & upper level ontologies



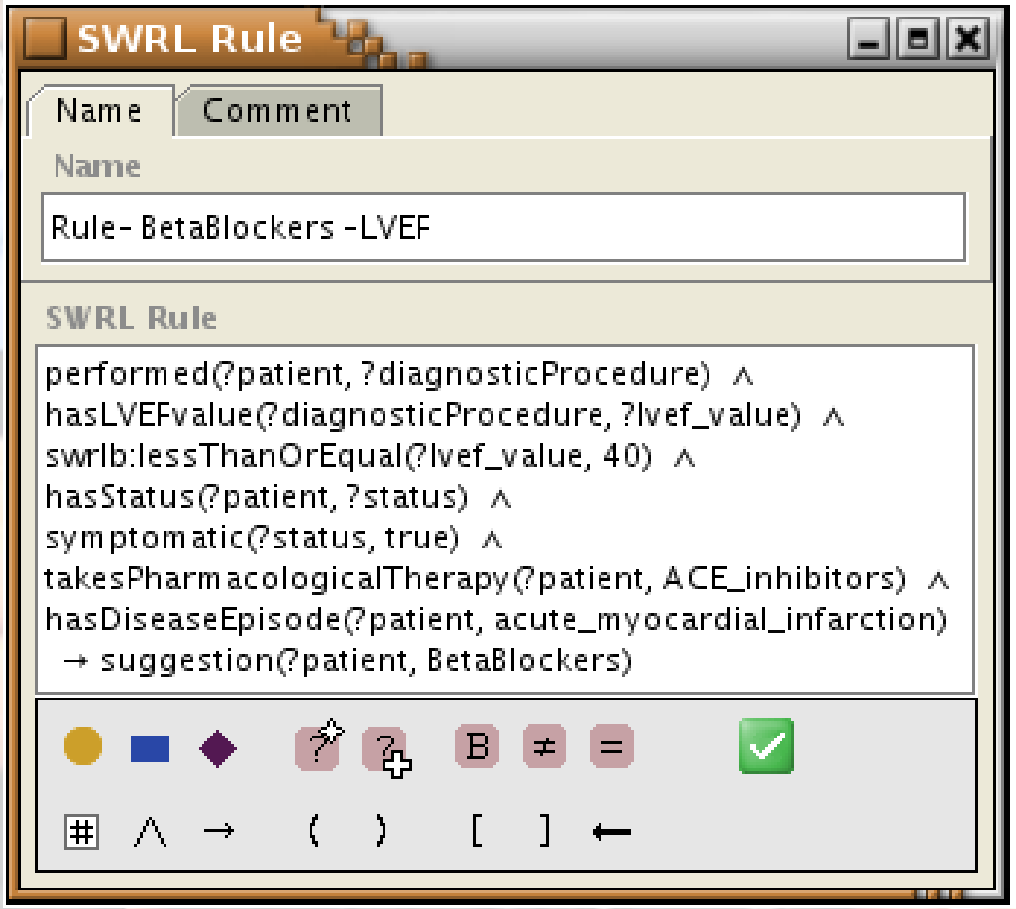


Rules

Elicited from **ESC** guidelines & **strong interaction** with clinicians

Example of natural language elicitation

"If a patient has Left Ventricle Ejection Fraction <= 40%
and he is asymptomatic
and is assuming ACE Inhibitors
and he had a myocardial infarction
then a suggestion for the doctor is to give the patient Betablockers"



Rules are a strong help to foster collaboration and improve to support decisions

Conclusions & Future Work

- Approach based on Semantic Web technologies shown
- Current implementation results (finalization in 2009)
- Terminological ontology is the most complete for this problem
- Clinicians collaborating with us glad of preliminary results

- **Future activities:**

finalize implementation of the CDSS

  - KB
  - Model Base algorithms
  - Meta level

other platform modules integration

Many thanks for your attention !