

Use of GELLO v.1.x, GLIF 3.5, SNOMED-CT and EN 13606 archetypes



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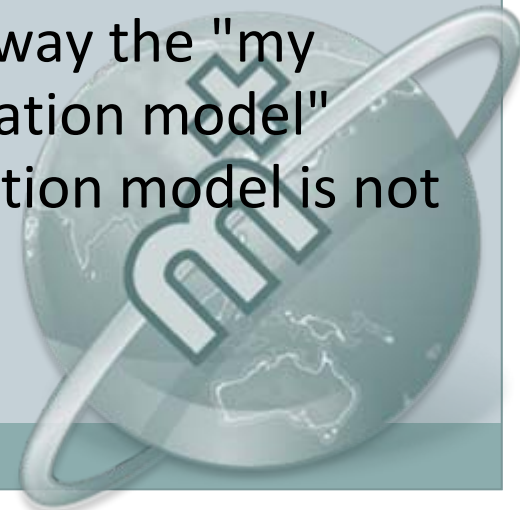
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Some main points



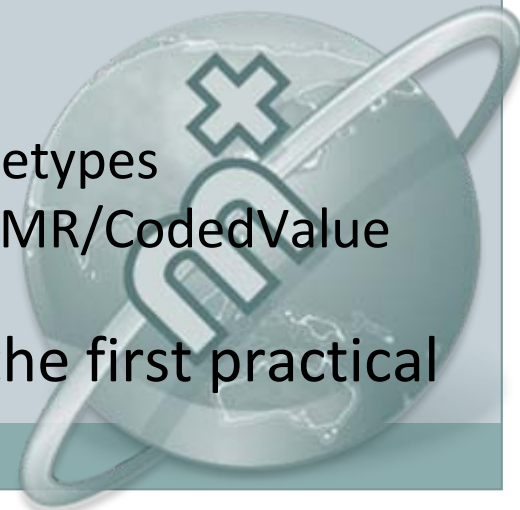
1. Standards integration achieves real implementations even in v.2 environments like Australia
2. A GELLO v.1.x parser/interpreter/engine can be used to:
 - a) enable decision criteria in GLIF
 - b) 'script' queries and processing on retrieved EHR data as well as SNOMED-CT knowledge and LOINC information space.
3. A virtual medical record (vMR) helps abstract away the "my information model is better than your information model" problem as well as the "my *reference* information model is not fully RIM compliant" problem.



Medical-Objects' HL7 GELLO v.1.0 projects



- Projects – 1. CDS for lymphoma 2. Setup of a small pathology laboratory
- GLIF was used for the former. Both used EN 13606 archetypes converted into a form accessible from the vMR.
- Decision was made to use GELLO encoded logic.
- GELLO v. 1 features
 - HL7/ANSI standard
 - OCL derived, but extended for health informatics functionality
 - Rich querying facilities.
 - Strongly typed, Object oriented, Declarative
 - vMR - Integrates well with HL7 and EN 13606 archetypes
 - Support for SNOMED-CT, LOINC, ICD-10 through vMR/CodedValue and more-so with CTS
- Implemented what we believe to be some of the first practical implementations of GELLO v.1 worldwide.



Rector's Model of models

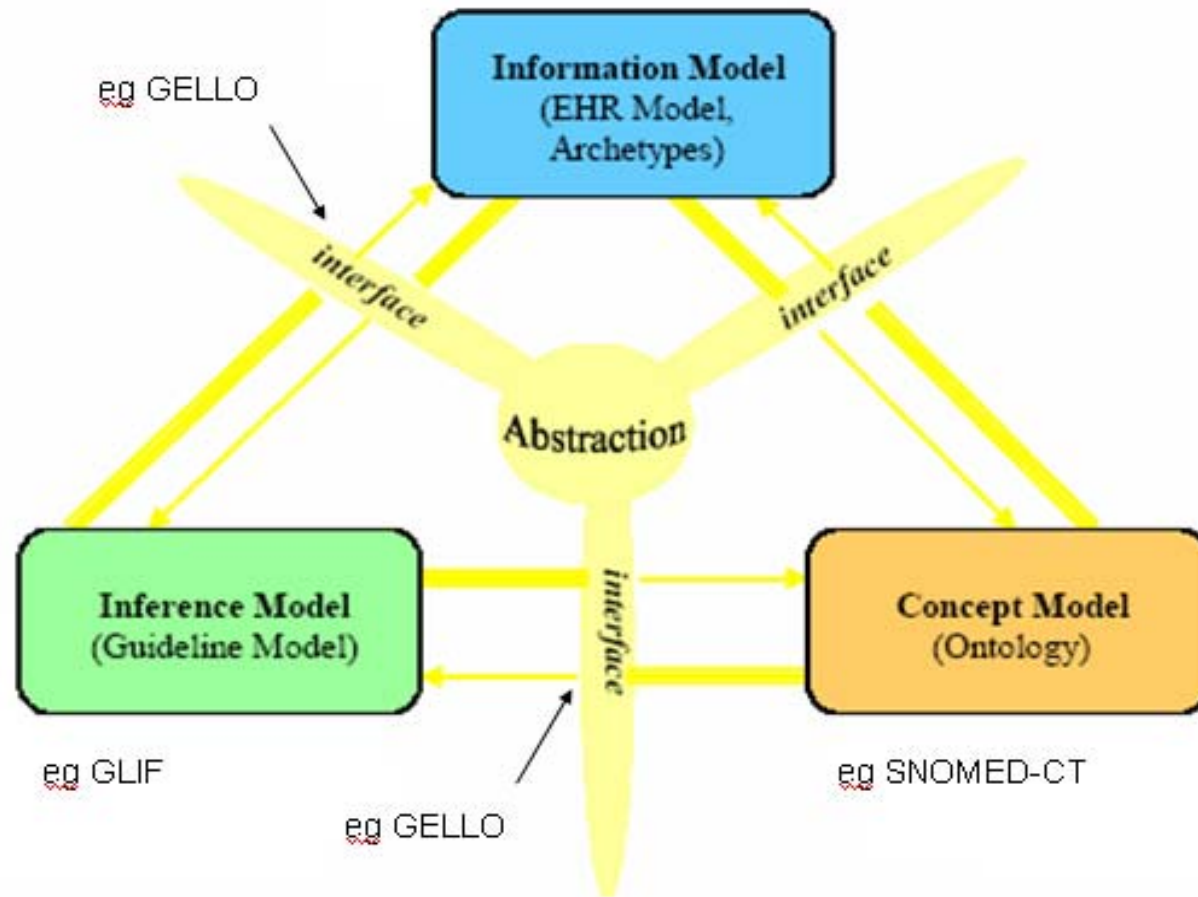


Diagram modified from Alan Rector's "Model of models" found at:

Rector A, Taweel A, Rogers J, (2004) Models and Inference methods for Clinical Systems: A Principled Approach, Proceedings of MedInfo 2004

Working with GELLO



- We completed the adaption of GLIF to the GELLO language
- We used EN 13606 archetypes as data structures within the GLIF and as the basis for templates. The templates are GELLO enabled.
- Peter Tattam and Andrew McIntyre improved GELLO spec's BNF, and built some tools (all available to informatics colleagues for playing and comments):
 - GELLO authoring tool and parser/interpreter
 - GLIF authoring tool and editor
 - SNOMED-CT server and
 - CEN 13606 Template editor



ISO/CEN13606 Part 2



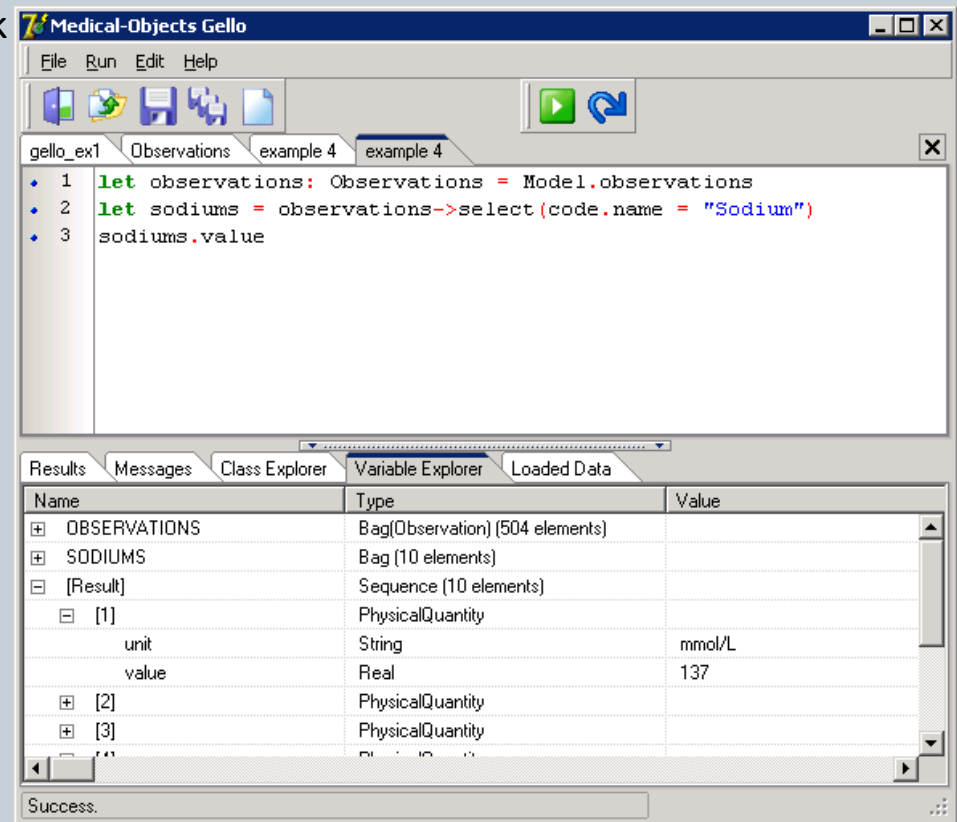
- About complex information to be communicated
- Extract -> Folder -> Composition ->(Section) -> Entry ->(Cluster) -> Element

Table 1 — Main hierarchy components of the EHR Extract Reference Model

EHR HIERARCHY COMPONENT	DESCRIPTION	EXAMPLES
EHR_EXTRACT	The top-level container of part or all of the EHR of a single subject of care, for communication between an EHR Provider system and an EHR Recipient.	(Not applicable)
FOLDER	The high level organisation within an EHR, dividing it into compartments relating to care provided for a single condition, by a clinical team or institution, or over a fixed time period such as an episode of care.	Diabetes care, Schizophrenia, Cholecystectomy, Paediatrics, St Mungo's Hospital, GP Folder, Episodes 2000-2001, Italy.
COMPOSITION	The set of information committed to one EHR by one agent, as a result of a single clinical encounter or record documentation session.	Progress note, Laboratory test result form, Radiology report, Referral letter, Clinic visit, Clinic letter, Discharge summary, Functional health assessment, Diabetes review.
SECTION	EHR data within a COMPOSITION that belongs under one clinical heading, usually reflecting the flow of information gathering during a clinical encounter, or structured for the benefit of future human readership.	Reason for encounter, Past history, Family history, Allergy information, Subjective symptoms, Objective findings, Analysis, Plan, Treatment, Diet, Posture, Abdominal examination, Retinal examination.
ENTRY	The information recorded in an EHR as a result of one clinical action, one observation, one clinical interpretation, or an intention. This is also known as a clinical statement.	A symptom, an observation, one test result, a prescribed drug, an allergy reaction, a diagnosis, a differential diagnosis, a differential white cell count, blood pressure measurement.
CLUSTER	The means of organising nested multi-part data structures such as time series, and to represent the columns of a table.	Audiogram results, electro-encephalogram interpretation, weighted differential diagnoses.
ELEMENT	The leaf node of the EHR hierarchy, containing a single data value.	Systolic blood pressure, heart rate, drug name, symptom, body weight.

Embedded GELLO v.1.x

- Embedded component within a GLIF and Archetypes framework.
- Developed using a LALR(1) parser framework in conjunction with a Delphi Object Pascal HL7 framework.
- It is interpretive in nature.
- Gello expressions are compiled at run time and stored as an internal object oriented expression tree.
- Execution speed is facilitated by the use of object oriented techniques.
- There is no “byte code” to execute, all calls are made natively to the HL7 framework.
- GELLO expressions can be implemented using an embedded IDE called “Mowgli”.
- Library facilities have been developed whereby frequently used GELLO expressions can be run indirectly from within another GELLO expression
- This library now has a syntax checker for whole library



a GELLO v.1.x example



```
let a:integer = 1  
let b:integer = 2  
  
a+b
```



a GELLO v.1.x example



```
let a:integer = 1  
let b:integer = 2
```

Let Statement
Let Statement

Outer Expression

(In)

```
a+b
```

Inner Expression



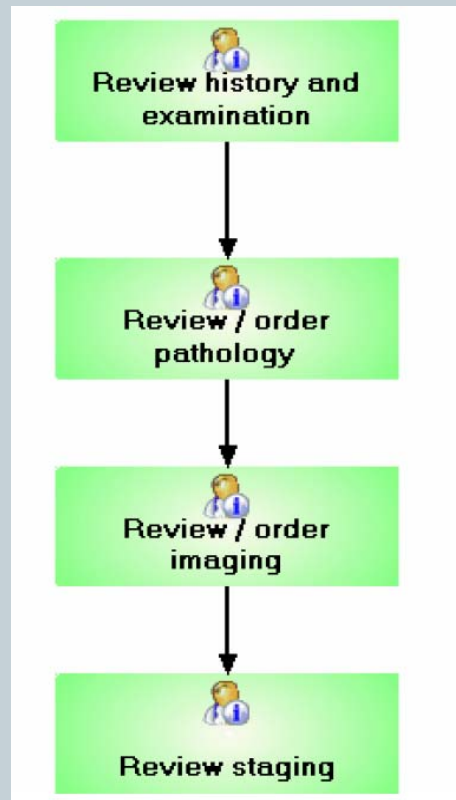
GLIF 3



➤ States



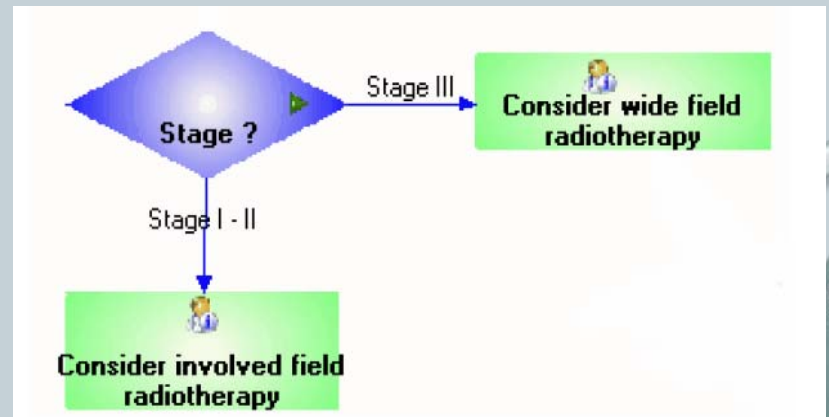
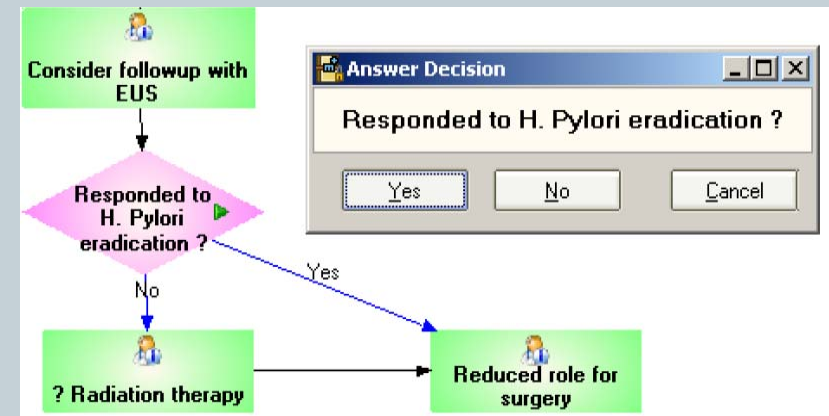
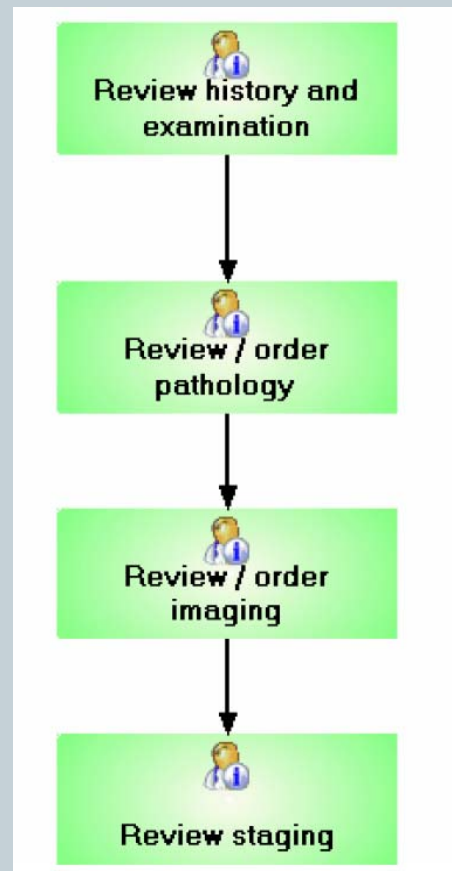
➤ Action steps



GLIF



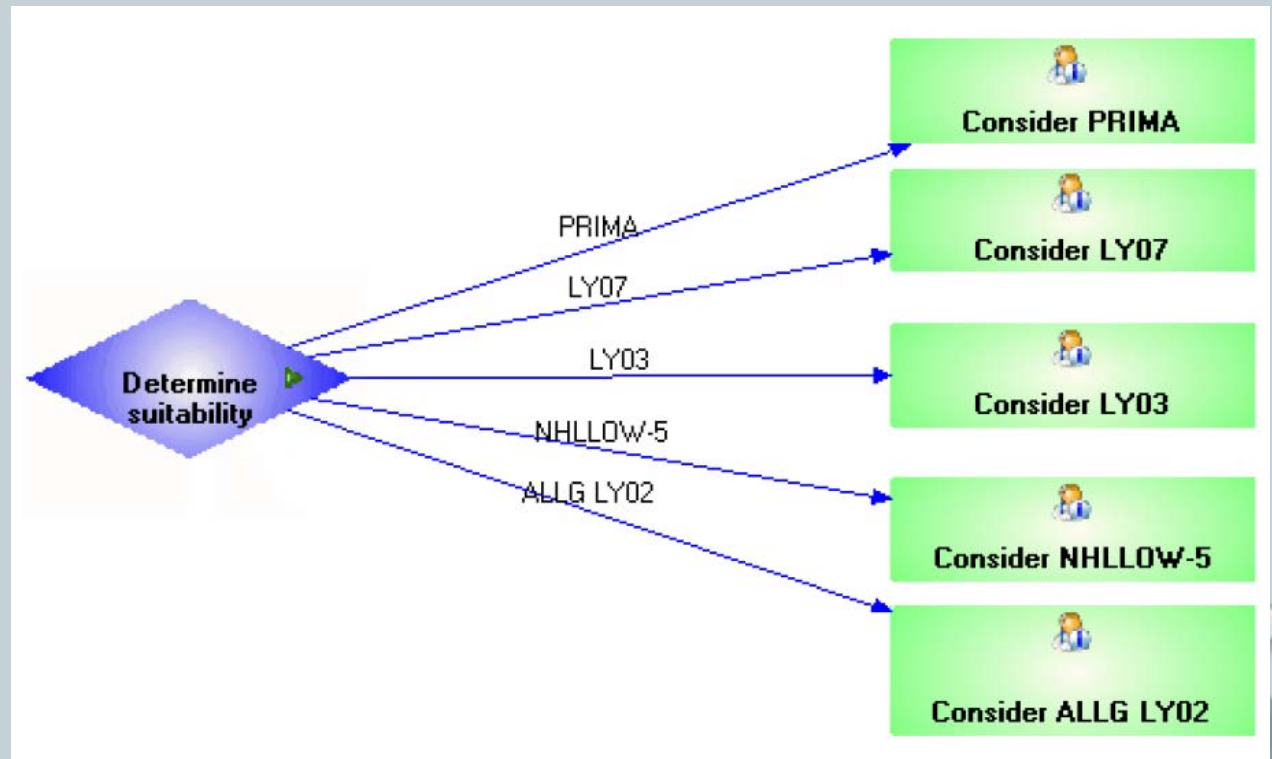
- States
- Action steps
- Decision steps
 - Conditional
 - User driven
 - automated



GLIF

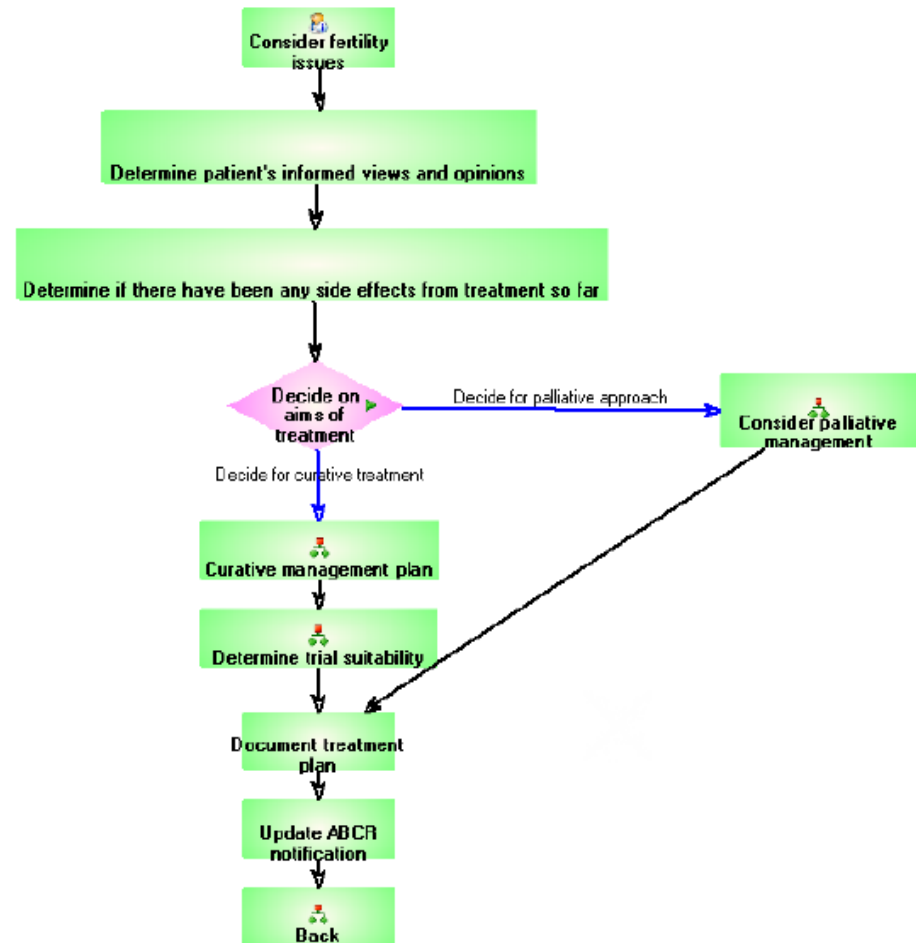


- States
- Action steps
- Decision steps
 - Conditional
 - User driven
 - automated
 - Branched



- Links
- Subguidelines
- Keywords
- Hints
- Sync nodes
- Didactics
 - Text
 - HTML

Treatment planning



Fertility

Treatment with chemotherapy or pelvic irradiation may lead to infertility and, given the long life expectancy following successful treatment and young age at which many patients present, it is crucial to address reproductive issues before treatment planning commences, except in cases where emergency treatment is required. Where relevant, that is, when treatment carries a significant risk of affecting reproductive function, referral for harvesting and storage of sperm should be made and appropriate specialist consultations arranged to discuss preservation of fertility in female patients. Ovarian transposition may be considered if pelvic radiotherapy is planned, but results of this procedure are variable.

Rector's Model of models

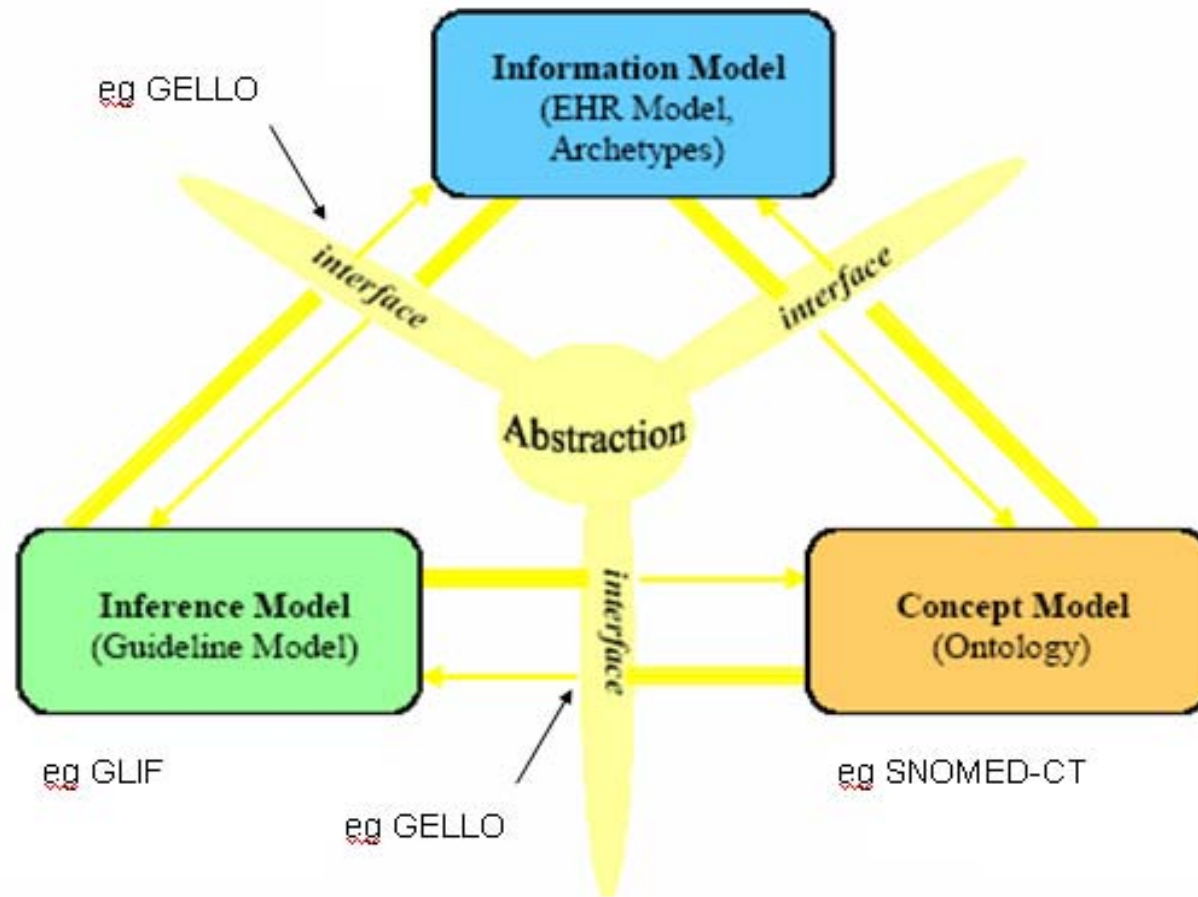


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Query on the Information Model



```
// most recent platelets observation as a physical  
quantity:
```

```
let plateletsCode: CodedValue =  
Factory.CodedValue('777-3', 'LN')  
let platelets_obs = observation->select(code =  
plateletsCode) ->sortBy(absolutetime) ->last()
```

```
platelets_obs.value
```



Rector's Model of models

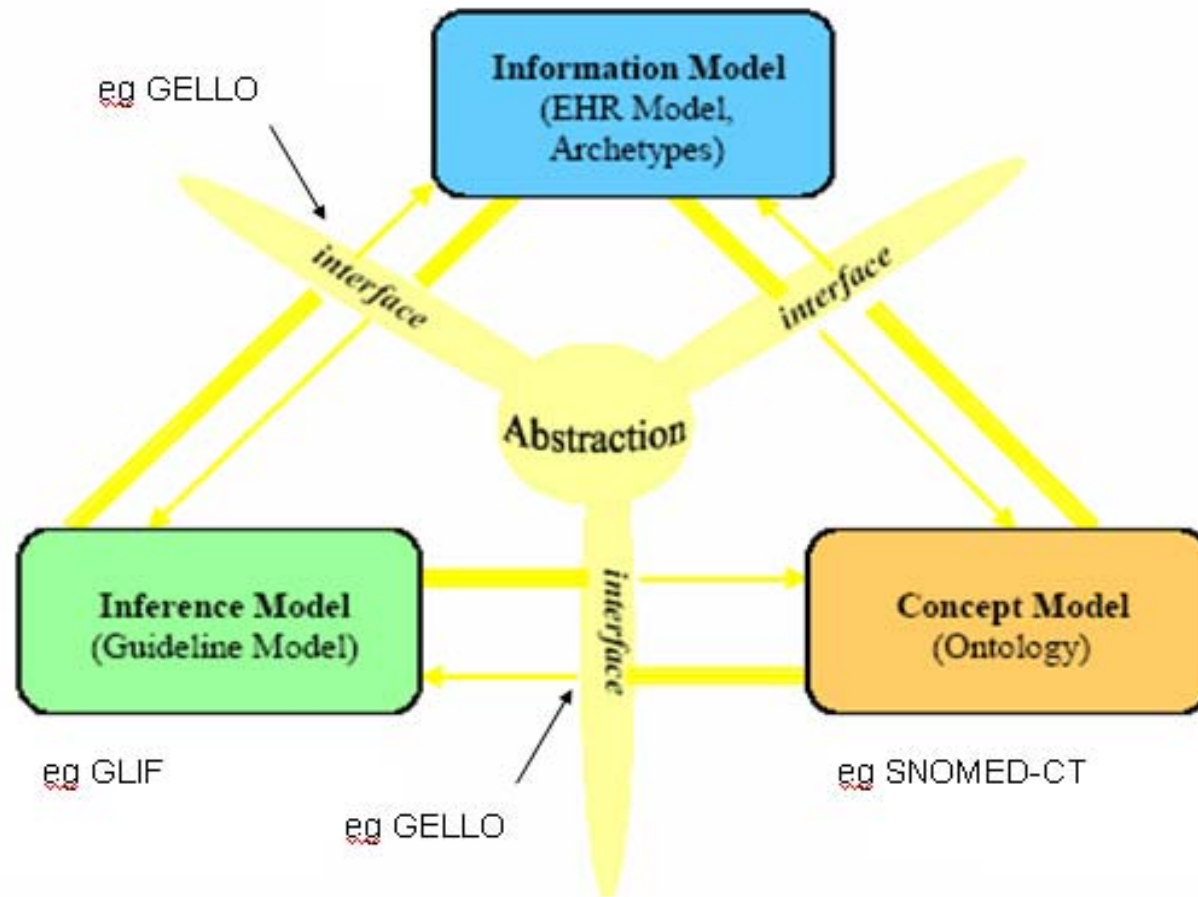


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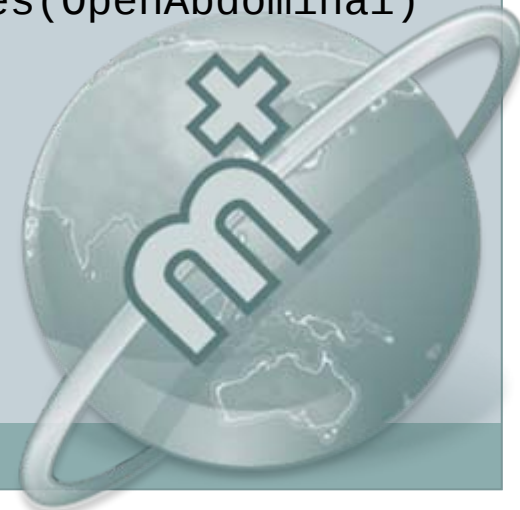
Rector A, Taweel A, Rogers J, (2004) Models and Inference methods for Clinical Systems: A Principled Approach, Proceedings of MedInfo 2004

Query on the Concept Model



```
Let o:observation = parameter[1]
Let OpenAbdominal:CodedValue = Factory.CodedValue('108189003', 'SNOMED-CT')
Let SnomedTerm:CodedValue =
  if o.isdefined() then
    o.find_observation('1.1.1').Value.asType(CodedValue)
  else
    Factory.CodedValue('64572001', 'SNOMED-CT')
  endif
Let CholeIsAbdoOperation: Boolean = SnomedTerm.implies(OpenAbdominal)

CholeIsAbdoOperation
```



CEN-ELFTS.v1

- ☐ Description
 - ☐ Uses 0 Archetype(s)
- ☐ Definition
 - ☒ ENTRY -- E/LFTs
 - ☒ items
 - ☒ ELEMENT -- Sodium
 - ☒ ELEMENT -- Potassium
 - ☒ ELEMENT -- Chloride
 - ☒ ELEMENT -- Bicarbonate
 - ☒ ELEMENT -- Anion gap
 - ☒ ELEMENT -- Glucose
 - ☒ ELEMENT -- Glucose - fasting
 - ☒ ELEMENT -- Urea
 - ☒ ELEMENT -- Creatinine
 - ☒ ELEMENT -- Osmolality
 - ☒ ELEMENT -- eGFR
 - ☒ ELEMENT -- Urate
 - ☒ ELEMENT -- Protein Total
 - ☒ ELEMENT -- Albumin
 - ☒ ELEMENT -- Globulins
 - ☒ ELEMENT -- Bilirubin Total
 - ☒ ELEMENT -- Bilirubin Direct
 - ☒ ELEMENT -- Alkaline Phosphatase
 - ☒ ELEMENT -- Gamma GT
 - ☒ ELEMENT -- ALT
 - ☒ ELEMENT -- AST
 - ☒ ELEMENT -- LD
 - ☒ ELEMENT -- Calcium
 - ☒ ELEMENT -- Corrected Calcium
 - ☒ ELEMENT -- Phosphate
 - ☒ ELEMENT -- Iron
 - ☒ ELEMENT -- Cholesterol
 - ☒ ELEMENT -- Triglycerides
 - ☒ ELEMENT -- Comments
 - ☒ CLUSTER -- Non reportable items
- ☐ Ontology
- ☐ Presentation

ADLMatchType	mtQuantity
AssumedValue	
CollapsedAtStart	False
HasDateField	False
HasReferenceRange	True
isCalculated	(No Gello)
isValid	(No Gello)
isVisible	(No Gello)
LevelOfDetail	0
LocalCode	at0003
MachineCode	
OccurrencesHigh	1
OccurrencesLow	0
OnCalcReferenceRange	(No Gello)
OnInitialize	(No Gello)
OpenEHRName	
ReferenceRange	135-145
SubscribeTo	(TStringList)
Term	Sodium
V3OutboundRelationship	
VisibleAtStart	True

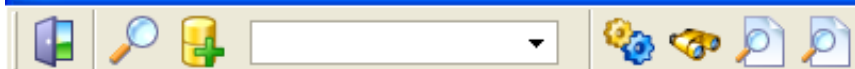
Sodium		Units	mmol/L ▼	Reference Range	135-145
Potassium		Units	mmol/L ▼	Reference Range	3.5-5.0
Chloride		Units	mmol/L ▼	Reference Range	95-110
Bicarbonate		Units	mmol/L ▼	Reference Range	22-32
Glucose		Units	mmol/L ▼	Reference Range	3.0-7.8
Glucose - fasting		Units	mmol/L ▼	Reference Range	3.0-5.5
Urea		Units	mmol/L ▼	Reference Range	1.0-3.0
Creatinine		Units	umol/L ▼	Reference Range	21-91
Urate		Units	mmol/L ▼	Reference Range	0.15-0.40
Protein Total		Units	g/L ▼	Reference Range	50-75
Albumin		Units	g/L ▼	Reference Range	28-44
Bilirubin Total		Units	umol/L ▼	Reference Range	<200
Bilirubin Direct		Units	umol/L ▼	Reference Range	0-7
Alkaline Phosphatase		Units	U/L ▼	Reference Range	50-300
Gamma GT		Units	U/L ▼	Reference Range	0-45
ALT		Units	U/L ▼	Reference Range	<80
AST		Units	U/L ▼	Reference Range	<80
LD		Units	U/L ▼	Reference Range	150-600
Calcium		Units	mmol/L ▼	Reference Range	2.10-2.60
Corrected Calcium		Units	mmol/L ▼	Reference Range	2.10-2.60
Phosphate		Units	mmol/L ▼	Reference Range	0.8-1.5
Iron		Units	umol/L ▼	Reference Range	10-30
Cholesterol		Units	mmol/L ▼	Reference Range	<5.5
Triglycerides		Units	mmol/L ▼	Reference Range	<2.0

Comments

Non reportable items

Working notes

Edit Term Definitions and Constraints



Term Definitions



Local Code	Lang.	Text	Description	Quality Control
at0017	en	AST	AST	
at0018	en	LD	LD	
▶ at0019	en	Calcium	Calcium	
at0020	en	Corrected Calcium	Corrected Calcium	
at0021	en	Phosphate	Phosphate	
at0022	en	Protein Total	Protein Total	
at0023	en	Albumin	Albumin	
at0024	en	Globulins	Globulins	
at0025	en	Iron	Iron	
at0026	en	Cholesterol	Cholesterol	
at0027	en	Triglycerides	Triglycerides	
at0028	en	eGFR	eGFR	
at0029	en	Comments	Comments	
at0030	en	Osmolality	Osmolality	
at0034	en	Non reportable items	Non reportable items	
at0035	en	Working notes	Working notes	
at0036	en	Glucose - fasting	Glucose - fasting	
at0037	en	Backup glucose	Backup glucose	

Term Binding


☒ Filter For Current Term Definition

Local Code	Terminology	Code	Text
▶ at0019	AUSPATH	CA	Calcium
at0019	Integra400Plus	0-012	Calcium
at0019	Integra400Plus	12	Calcium
at0019	LN	2000-8	Calcium
at0019	SNOMED-CT	271240001	Calcium

Medical-Objects Template Editor

File Archetypes

- Open
- Load from json
- Import V3 Template
- Load Archetype Collection
- Add Archetypes from File
- New Archetype
- Save as
- Save
- Visualize HL7
- Edit Config
- Load Gello Model Data
- Print Tree
- Exit



ArchetypeID	CEN-ELFTS.v1
Definition	(TDefinition)
☒ Description	(TDescription)
Authors	(TStringList)
ConfidentialityCode	U
DiagnosticServiceSection	CH
☒ EnglishDescription	(TArchetypeDescription)
Keywords	(TStringList)
LabNumberSuffix	ELFT
Revision	78
Rights	
Status	asProduction
☒ Submission	(TSubmission)
☒ UniversalServiceID	(TCEValue)
Version	1
xsVersion	0.9
NameOfCodingSystem	
☒ Ontology	(TOntology)
ConstraintDefinition	(TConstraintDefinitionManager)
DefaultOntology	SNOMED-CT
TerminologyDefinition	(TTermDefinitionManager)
☒ Presentation	(TPresentation)

☒ ELEMENT -- Protein Total
☒ ELEMENT -- Albumin



[Embedded GELLO]

```

1  let o:observation = parameter[1]
2
3  let Gender = Patient.gender
4  Let Age: Integer = patient.age_at(factory.absolutetime("0").now())
5
6  Let Cr: Real =
7
8      if o.isdefined() then
9          o.find_observation('1.1.9').value_asPQ().value
10         else
11             0.0
12         endif
13
14         Let x: real = Cr*0.0113
15         Let y: real = Age
16         Let MaleResult: Real =
17             If y > 17.0 then 186*x.power(-1.154)*y.power(-0.203)
18             else 0.0
19         endif
20
21         Let FemaleResult: real = MaleResult*0.742
22
23         Let MaleResultText: String =
24             if o.isdefined() then
25                 MaleResult.format(2,0)
26             else
27                 '0.0'
28             endif
29
30         Let FemaleResultText: String =
31             if o.isdefined() then
32                 FemaleResult.format(2,0)
33             else
34                 '0.0'
35             endif
    
```

Results Messages Class Explorer Variable Explorer Loaded Data

Name	Type	Value
O	Undefined	<undefined>
GENDER	String	
AGE	Integer	0
CR	Real	0
X	Real	0
Y	Real	0
MALERESULT	Real	0

Medical-Objects Gello

File Run Help Edit



SnomedDemo1a

```

1 //Try and determine if any open abdo surgery
2
3 //setup a dummy surgical history
4 let Chole:CodedValue = Factory.SnomedCV("60228007|Cholecystectomy, exploration of duct and cholangiogram|")
5 let Appendix:CodedValue = Factory.SnomedCV("6025007|Laparoscopic Appendectomy|")
6 let KneeArthroscopy:CodedValue = Factory.SnomedCV("38964008|Knee Arthroscopy and Meniscectomy|")
7
8 let PastSurgery: set(CodedValue) = set(Chole, Appendix, KneeArthroscopy)
9
10 //We use this as the test for a laparoscopic procedure
11 let Laparoscopic:CodedValue = Factory.SnomedCV("51316009|Laparoscopic Procedure|")
12 let AbdoSurgery:CodedValue = Factory.SnomedCV("386671008|Abdominal Cavity Surgery|")
13
14
15 //this is the test we are doing in the loop, done here as example only
16 let isLaparoscopic: Boolean = Appendix.implies(Laparoscopic)
17 let Kneeislaparoscopic: Boolean = KneeArthroscopy.implies(Laparoscopic)
18 let KneeisAbdo: Boolean = KneeArthroscopy.implies(AbdoSurgery)
19 let CholeIsAbdoOperation: Boolean = Chole.implies(AbdoSurgery)
20
21 //see if cholangiogram was done as example
22 let CholangiogramDone: Boolean = Chole.implies(Factory.SnomedCV("28367004|Cholangiogram|"))
23
24 //Iterate over past history, seeing if any laparoscopic surgery
25 let OpenSurgeryCount: Integer =
26     PastSurgery->iterate(SX, i:integer = 0 | if (SX.implies(AbdoSurgery) and (not SX.implies(Laparoscopic))) then i+1 else i endif)
27
28 //see if there has been any open abdo surgery
29 if OpenSurgeryCount > 0 then
30     true
31 else
32     false
33 endif
    
```

Medical-Objects Gello

File Run Edit Help



[Embedded GELLO]

```

1  Let o:observation = parameter[1]
2
3  Let Asthma: CodedValue = Factory.CodedValue('195967001', 'SNOMED-CT')
4
5  Let SnomedTerm1:CodedValue =
6      if o.isdefined() then
7          o.find_observation('1.1.2').Value.asType(CodedValue)
8      else
9          Factory.CodedValue('64572001', 'SNOMED-CT')
10     endif
11
12  let IsAsthma: Boolean = SnomedTerm1.implies(Asthma)
13
14  // return the result
15  IsAsthma
    
```

Results Messages Class Explorer Variable Explorer Loaded Data

Name	Type	Value
0	Undefined	<undefined>
ASTHMA	CodedValue	195967001^^SNOMED-CT
SNOMEDTERM1	CodedValue	64572001^^SNOMED-CT
ISASTHMA	Boolean	False
[Result]	Boolean	False