

CDS Workgroup  
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# Family History – Gello - vMR

# What is GELLO?

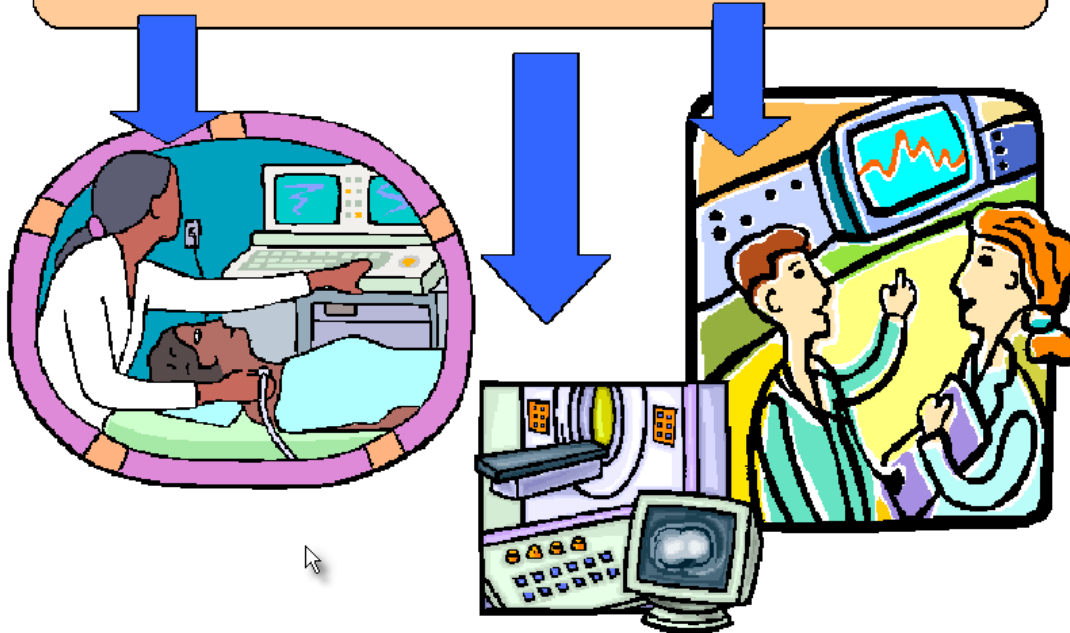
- Clinical Decision Support Language
- HL7/ANSI standard
- Revised April 2010
- Based on OCL 2.0
  - Optimised for Clinical Queries
  - Unneeded features removed
  - Features added eg. Factory, list operations
- Operates on a “Virtual Medical Record” (vMR)
  - vMR standard under development currently
  - ISO 21090 data types likely to be used

# GELLO Concepts

**GELLO expression:**

**Context Patient**

**ProblemList -> exists(Code.equals(Factory.CodedValue("Asthma")))**



Same GELLO expression in different settings

# GELLO examples

```
Let BreastCancer: CD = Factory.codedvalue('123456', 'SNOMED-CT', 'Breast Cancer')

Let EarlyBreastCancerCount: Integer =
  FamilyHistory relatives -> iterate(x; i:Integer = 0 |
    if (x.clinicalGenomicObservations ->
      select(code.implies(BreastCancer) and (dataEstimatedAge() < 50)).isEmpty()) then i + 1 else i endif)

EarlyBreastCancerCount > 0
```

Context SinglePatient

--We use this as the test for a laparoscopic procedure

```
let Laparoscopic: CD = Factory.SNOMEDCD("51316009|Laparoscopic Procedure|")
```

--This is used to determine abdominal surgery

```
let AbdoSurgery: CD = Factory.SNOMEDCD("386671008|Abdominal Cavity Surgery|")
```

--Iterate over past history, seeing if any laparoscopic surgery

```
let OpenSurgeryCount: Integer =
```

```
  Procedure -> iterate(SX; i:Integer = 0 |
    if (SX.code.implies(AbdoSurgery).value and
      (not SX.code.implies(Laparoscopic).value)) then
      i+1
    else
      i
    endif)
```

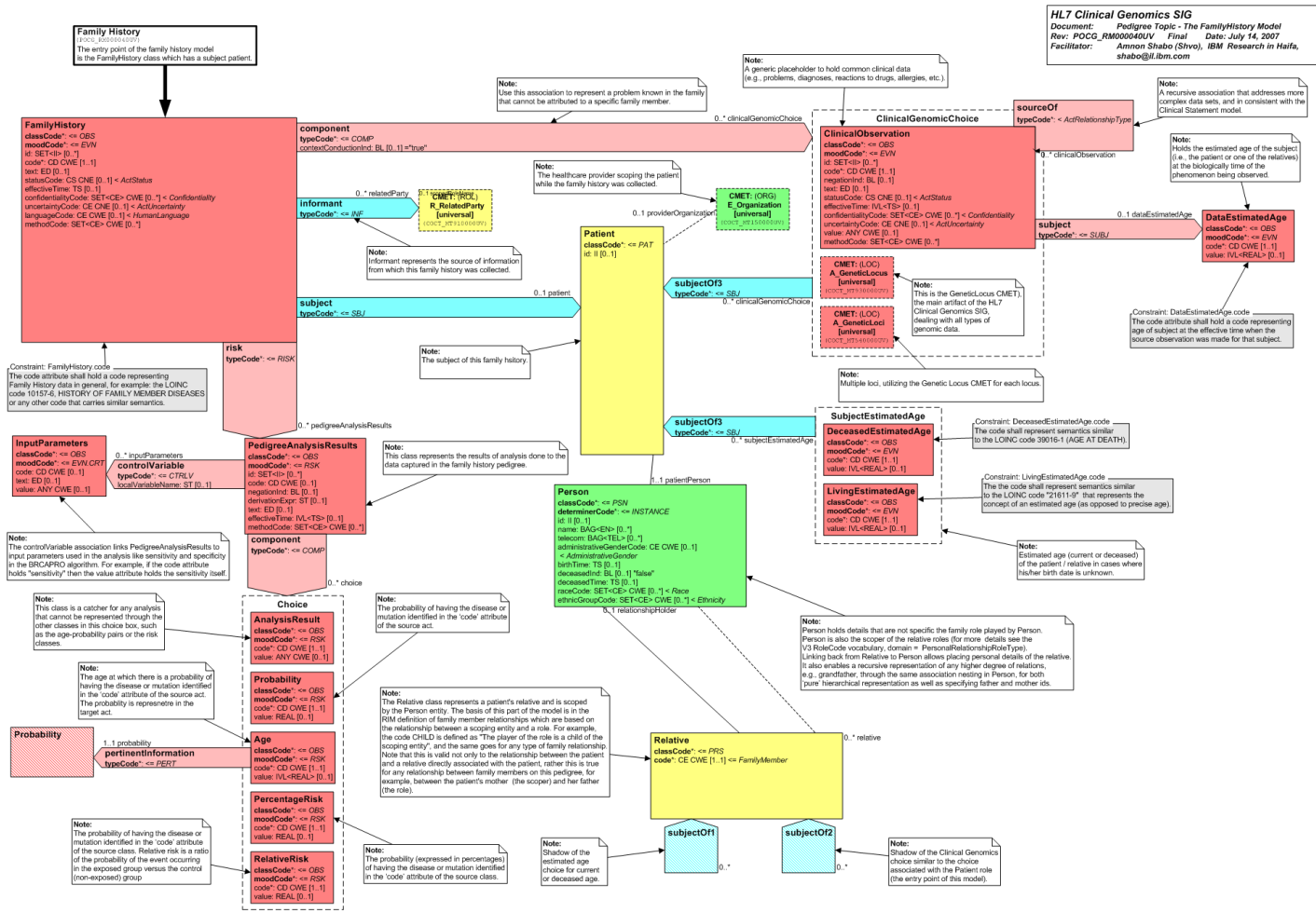
--see if there has been any open abdo surgery

```
OpenSurgeryCount > 0
```

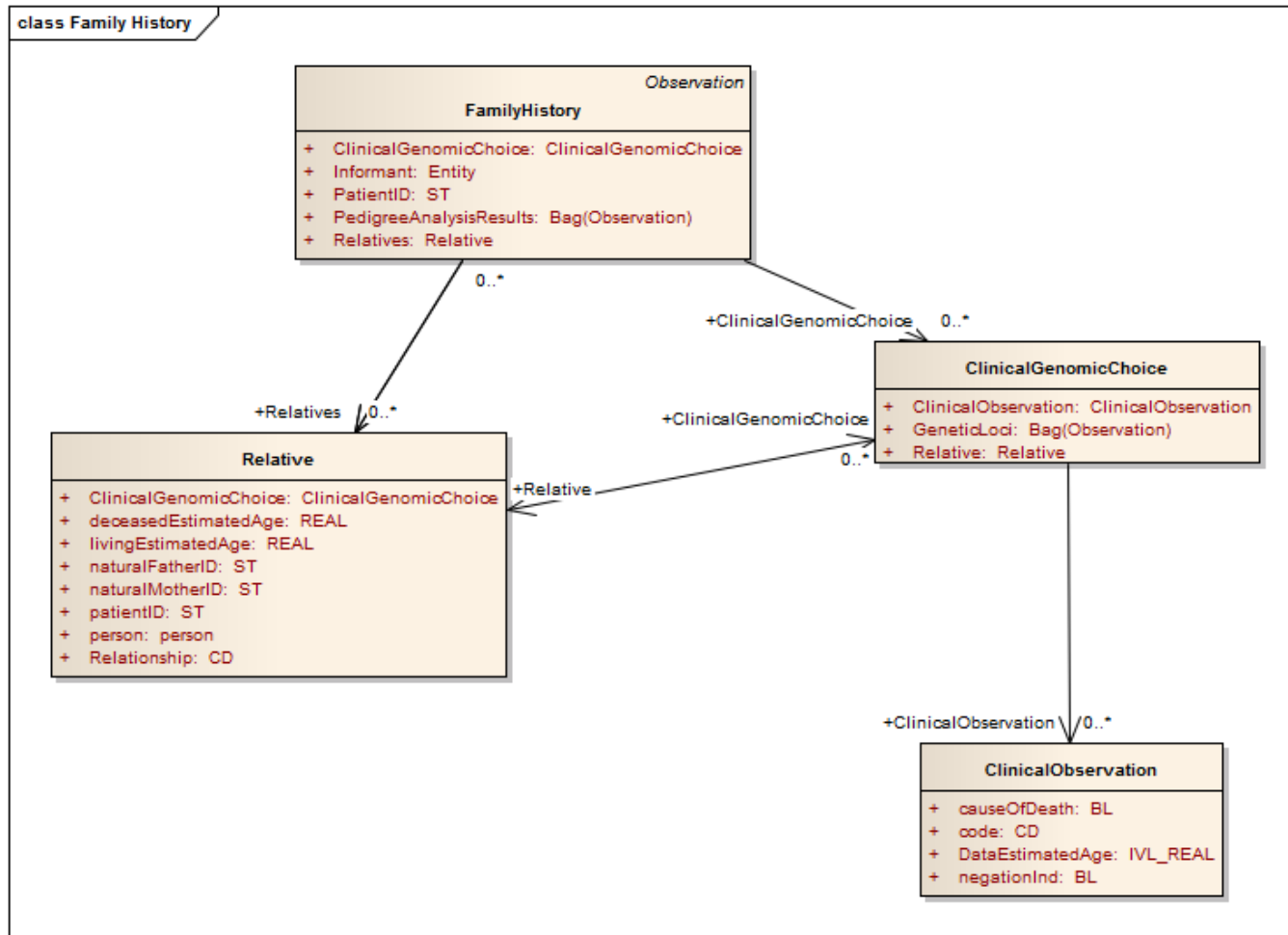
# DCM

- “Detailed Clinical Models”
- ISO Project
- Aims to be platform agnostic
- Activity in HL7 Patient care working group
  - UML models
  - Spread sheets
  - Word Documents
- Currently no formal model has been done
  - Interoperability unlikely without this

# Family History RMIM



# vMR Model for RMIM



# vMR Transform Principles

- The vMR model uses the RMIM to make the relationships explicit and easier to query without losing any data. The relationships in the RMIM are fixed and represented using the RIM whereas the VMR Model uses an explicit object model. The object model allows direct access to a collection of relatives as well as the collection of conditions that the relative suffers from.



# Example Family History GELLO

```
Context SinglePatient
```

```
Let IBD: CD = Factory.CodedValue('24526004', 'SNOMED-CT') --IBD
```

```
Let Colitis: CD = Factory.CodedValue('64226004', 'SNOMED-CT') --Colitis
```

```
FamilyHistory.ClinicalGenomicChoice -> select(  
  ClinicalObservation -> select(  
    (code.implies(IBD).value or code.implies(Colitis).value) and (not negationInd.value)  
  ).notEmpty()  
) .notEmpty()
```

```
Context SinglePatient
```

```
Let ColonCancer: CD = Factory.CodedValue('C2955', 'NCI') --Colon Cancer NCI Code
```

```
FamilyHistory.ClinicalGenomicChoice -> select(  
  (Relative.Relationship.code = 'NMTH' or Relative.Relationship.code = 'NFTH') and  
  ClinicalObservation -> select(  
    code.implies(ColonCancer).value and (not negationInd.value) and (DataEstimatedAge.low.value <= 50.0)  
  ).notEmpty()  
) .notEmpty()
```

# Core Model in GELLO Class format

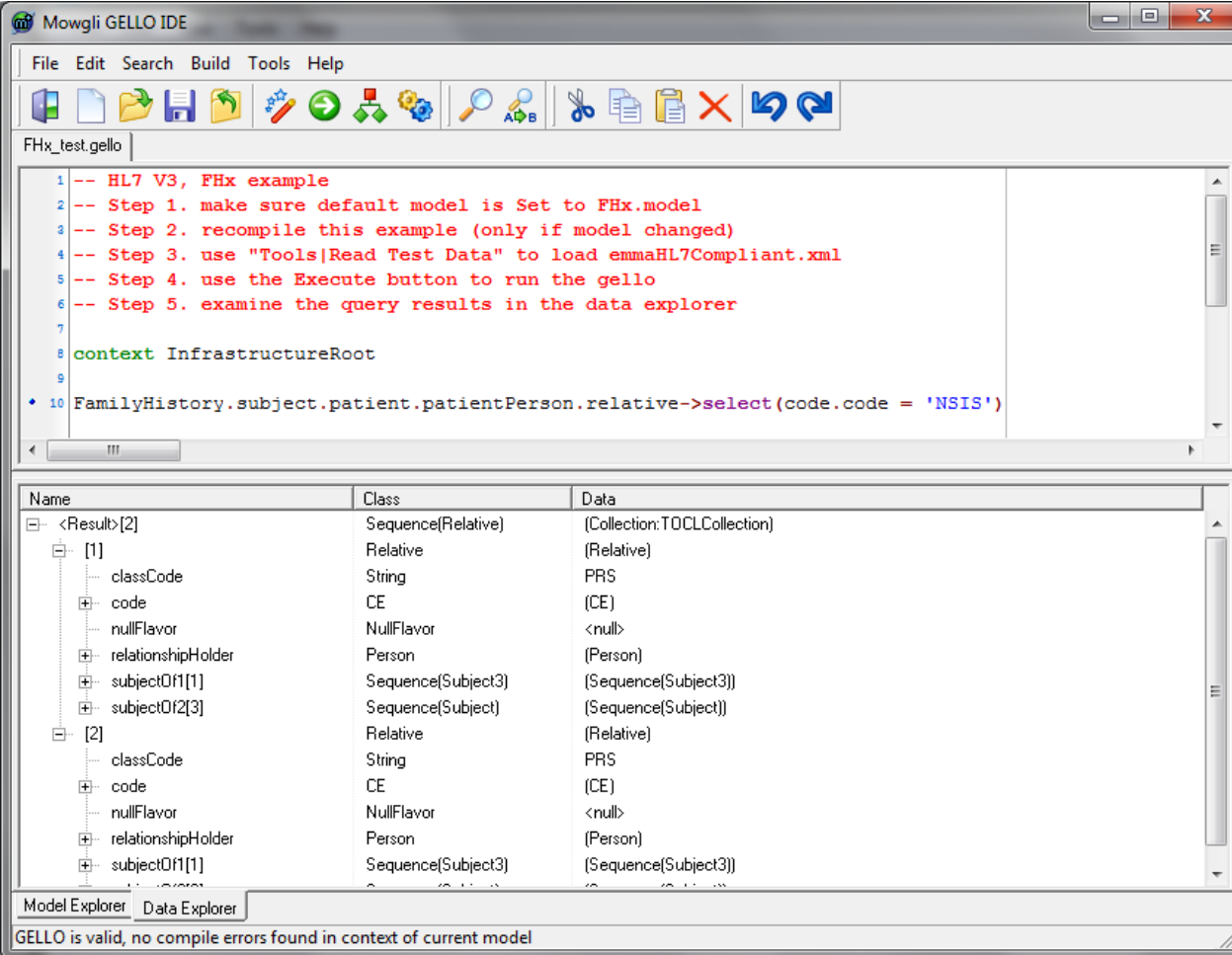
```
class FamilyHistory extends Observation
  ClinicalGenomicChoice: Sequence (ClinicalGenomicChoice)
  Informant: Entity
  PatientID: ST
  PedigreeAnalysisResults: Sequence (Observation)
  Relatives: Sequence (Relative)
```

```
class ClinicalGenomicChoice extends Any
  ClinicalObservation: Sequence (ClinicalObservation)
  GeneticLoci: Sequence (Observation)
  Relative: Relative
```

```
class ClinicalObservation extends Any
  causeOfDeath: BL
  code: CD
  DataEstimatedAge: IVL_REAL
  negationInd: BL
```

```
class Relative extends Any
  ClinicalGenomicChoice: Sequence (ClinicalGenomicChoice)
  deceasedEstimatedAge: REAL
  livingEstimatedAge: REAL
  naturalFatherID: ST
  naturalMotherID: ST
  patientID: ST
  person: Person
  Relationship: CD
```

# Full Family History Model



The screenshot shows the Mowgli GELLO IDE interface. The main editor displays a GELLO query with the following content:

```
1 -- HL7 V3, FHx example
2 -- Step 1. make sure default model is Set to FHx.model
3 -- Step 2. recompile this example (only if model changed)
4 -- Step 3. use "Tools|Read Test Data" to load emmaHL7Compliant.xml
5 -- Step 4. use the Execute button to run the gello
6 -- Step 5. examine the query results in the data explorer
7
8 context InfrastructureRoot
9
10 FamilyHistory.subject.patient.patientPerson.relative->select(code.code = 'NSIS')
```

Below the editor, the Data Explorer shows the results of the query in a table format:

Name	Class	Data
<Result>[2]	Sequence(Relative)	(Collection:TOCLCollection)
[1]	Relative	(Relative)
classCode	String	PRS
code	CE	(CE)
nullFlavor	NullFlavor	<null>
relationshipHolder	Person	(Person)
subjectOf1[1]	Sequence(Subject3)	(Sequence(Subject3))
subjectOf2[3]	Sequence(Subject)	(Sequence(Subject))
[2]	Relative	(Relative)
classCode	String	PRS
code	CE	(CE)
nullFlavor	NullFlavor	<null>
relationshipHolder	Person	(Person)
subjectOf1[1]	Sequence(Subject3)	(Sequence(Subject3))

At the bottom of the IDE, the status bar indicates: "GELLO is valid, no compile errors found in context of current model".

# HL7 V2 models

- HL7 V2
  - Has strong structural model
    - Not formally presented as such
    - No semantic attributes
    - Many class definitions eg Medication
    - Ability to create hierarchies not obvious
  - No formal Terminology binding
    - Also no conflict
  - DCM format for V2 is Word documents
  - Wide usage in many countries
    - Exclusive use of HL7V2 in Australia

# HL7v2 based VMR

```
OBX|10|CE|8262-8^^LN^CLUSTER^^EN 13606|1.3|^Family History^^at0004^^99A-7B3963A353FFB01C|||||F
OBX|11|CE|408732007^Subject Relationship Context^SNOMED-CT|1.3.1.1.1.1|66839005^Father^SNOMED-CT|||||F
  OBX|12|CE|246090004^^SNOMED-CT|1.3.1.1.1.4.1.1|38341003^Hypertensive disorder^SNOMED-CT|||||F
  OBX|13|CE|21984-0^Cause of Death^LN^at0064^^99A-7B3963A353FFB01C|1.3.1.1.1.4.1.3|64100000^False^SNOMED-CT|||||F
OBX|14|CE|408732007^Subject Relationship Context^SNOMED-CT|1.3.1.1.2.1|72705000^Mother^SNOMED-CT|||||F
  OBX|15|CE|246090004^^SNOMED-CT|1.3.1.1.2.4.1.1|64766004^Ulcerative colitis^SNOMED-CT|||||F
  OBX|16|NM|30972-4^Age of Onset^LN^at0063^^99A-7B3963A353FFB01C|1.3.1.1.2.4.1.2|20|yrs^^ISO+|||||F
  OBX|17|CE|21984-0^Cause of Death^LN^at0064^^99A-7B3963A353FFB01C|1.3.1.1.2.4.1.3|64100000^False^SNOMED-CT|||||F
  OBX|18|FT|^Notes^^at0006^^99A-7B3963A353FFB01C|1.3.1.1.2.4.2|Colectomy at 27\.br\|||||F
```

- Can represent Complex models in V2
  - Described by Template
  - Only data that differs needs to be in message
    - Allows default values
  - V3 Pedigree model could be duplicated

# Template (EN13606) Editor

The screenshot displays the Medical-Objects Archetype Editor interface. The main window is titled "Medical-Objects Archetype Editor" and contains a tree view on the left and a properties panel on the right. The tree view shows a hierarchy of archetypes, including "Radiology\_Findings", "Description", "Uses", "Definition", and "Ontology". The "Definition" section is expanded, showing a "Data Group (OBSERVATION) -- Radiology findings" which contains several "Data Element" and "Data Group" entries. The "Data Group -- Mediastinal mass details" is selected, and its properties are displayed in the right-hand panel.

The properties panel for the selected archetype includes the following fields:

- CardinalityHigh: 20
- CardinalityLow: 0
- ChoiceNode: False
- CollapsedAtStart: False
- isCalculated: (No Gello)
- isValid: (No Gello)
- isVisible: (Gello Code)
- LevelOfDetail: 0
- LocalCode: at0010
- OpenEHRName:
- Ordered: False
- Regions: (Snomed Regions)
- Systems: (Snomed Systems)
- Term: Mediastinal mass details
- Unique: True
- Visibility: nvVisible
- VisibleAtStart: False

At the bottom of the window, there is an "Ontology" section with tabs for "Term Definitions", "Term Binding", "Constraint Definition", and "Constraint Binding". The "Term Definitions" tab is active, showing a table of terms:

Local Code	Lang	Text	Description	Quality Control	Provenance
▶ at0002	en	Date of Radiology Procedure	Date of Radiology Procedure		
at0003	en	Abdominal Lymphadenopathy	Abdominal Lymphadenopathy		
at0004	en	Mediastinal Mass findings	Mediastinal Mass findings		
at0005	en	Mediastinal Mass Ratio	Mediastinal Mass Ratio		
at0006	en	Mediastinal width	Mediastinal width		
at0007	en	Retropitoneal Lymphadenopat	Retropitoneal Lymphadenopathy		
at0008	en	Radiology findings	Radiology findings		
at0009	en	Mediastinal mass present	Mediastinal mass present		
at0010	en	Mediastinal mass details	Mediastinal mass details		
at0011	en	error	error		

# Example vMR as EN13606

The screenshot displays a software interface for managing an ontology. On the left, a tree view shows the structure of 'CEN-PatientHistory.v1', including clusters for 'Past Medical History', 'Past Surgical History', 'Family History', 'Social History', and 'Smoking History'. On the right, a properties window is open, showing settings for 'AllowTextValue' (False), 'Choices' (Codes), 'DefaultIndex' (-1), and 'DisplayStyle' (dsList). A dialog box titled 'Selected codes or restraints' is also visible, listing various SNOMED-CT codes and their corresponding text values.

**Selected codes or restraints**

- Known present (at0013)
- Definitely present (at0014)
- Probably present (at0015)
- Confirmed present (at0026)
- Definitely not present (at0016)
- Probably not present (at0017)
- Probably not present (at0017)
- Probably present (at0015)
- Suspected (at0020)
- At risk (at0021)
- Likely outcome (at0022)
- Impending (at0023)
- Prognosis context (at0024)
- Goal (at0025)

**Ontology**

Term Definitions | Term Binding | Constraint Definition | Constraint Binding

Local Code	Terminology	Code	Text
at0017	SNOMED-CT	410593006	Probably not present
at0016	SNOMED-CT	410594000	Definitely not present
at0015	SNOMED-CT	410592001	Probably present
at0014	SNOMED-CT	410591008	Definitely present
at0013	SNOMED-CT	410515003	Known present
at0012	SNOMED-CT	246090004	Condition
at0011	SNOMED-CT	363589002	Procedure
at0010	SNOMED-CT	408730004	Procedure Context
at0009	SNOMED-CT	408729009	Finding Context
at0008	SNOMED-CT	408731000	Temporal Context
▶ at0007	SNOMED-CT	408732007	Relative

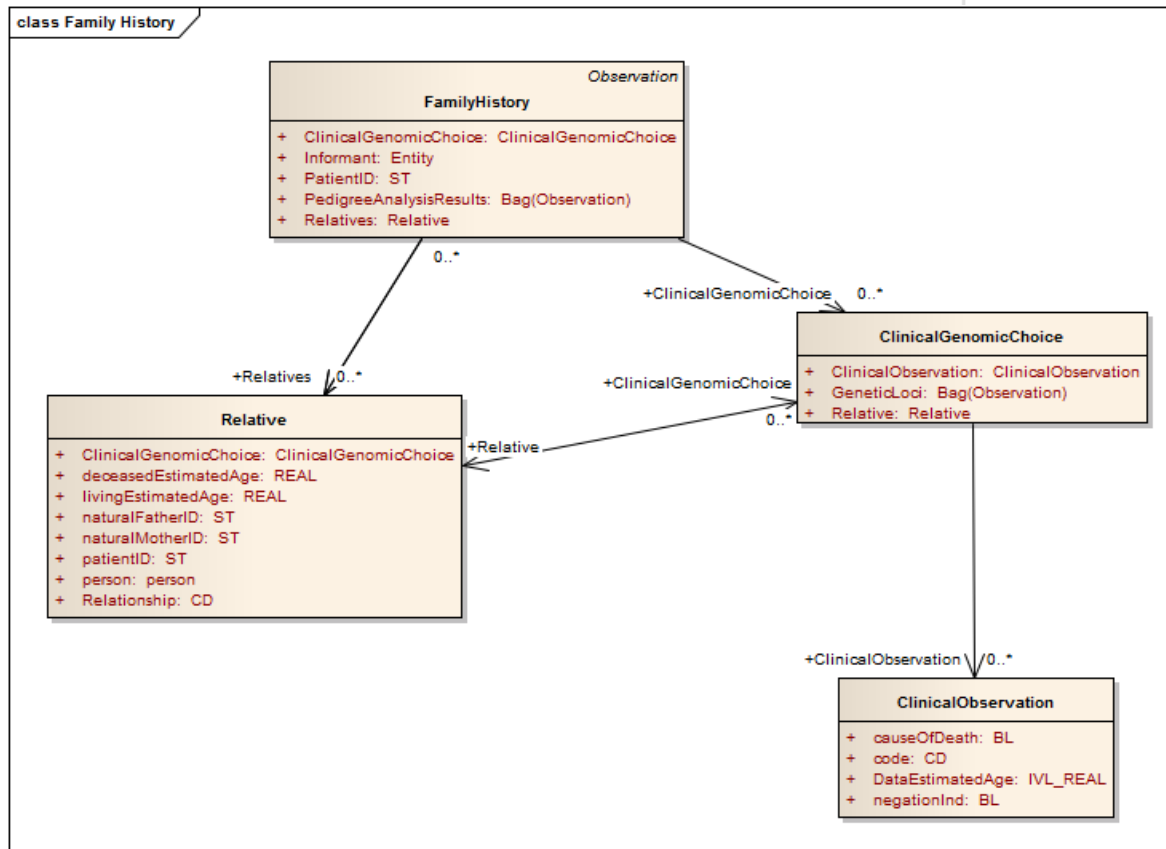
# Persistence in HL7V2

- Mechanism developed to persist archetyped data in HL7V2 messages
  - All OBX based, medication not modelled
  - Observation Sub-ID used to create hierarchy
    - Mapped to maximal Archetype data structure
  - Data type Mapping
  - OBR becomes COMPOSITION
  - Backward compatible with existing systems
  - Currently Standards Australia Technical Report



# Allows Gello based CDS in V2

```
1 Let IBD: CodedValue = Factory.CodedValue('24526004', 'SNOMED-CT') --IBD
2 Let Colitis: CodedValue = Factory.Codedvalue('64226004', 'SNOMED-CT') --Colitis
3
4 Let ColitisCount: Integer = FamilyHistory.Relative -> Select(x |
5     (x.ClinicalGenomicChoice.clinicalObservation ->Select (code.implies(Colitis) or code.implies(IBD)).cardinality() > 0)
6     and x.LivingEstimatedAge <= 20).cardinality()
7
8 ColitisCount > 0
```



# Mechanism is Generic

- Example of Urine Culture
  - EN13606 Archetype
    - Exports
      - GELLO Class
      - ADL file
      - Mindmap
      - UML (.xmi)
      - Spreadsheet (for V2 implementation)

# Microurine Template

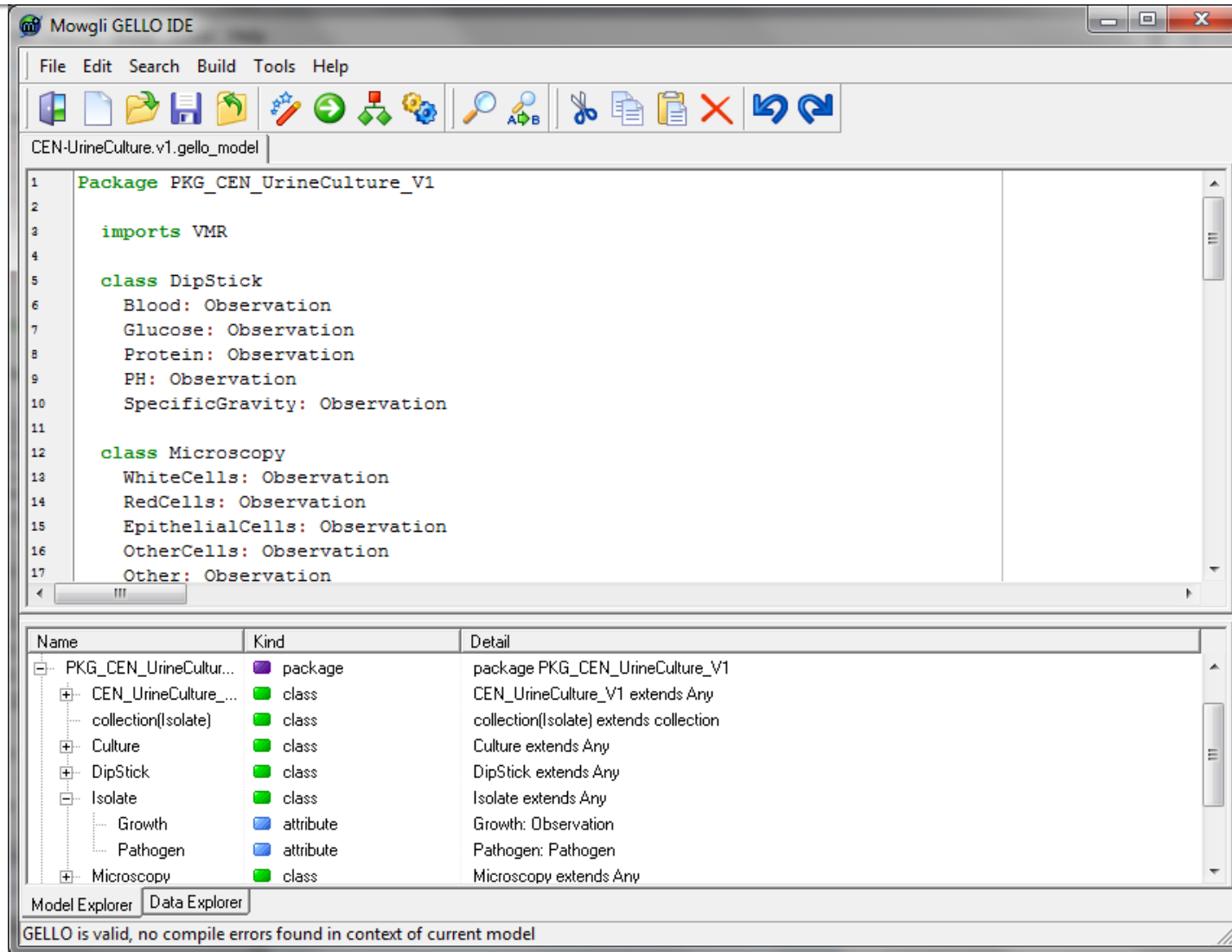
The screenshot displays the 'fmArchetypeEdit-1600x900' application window. The main area is divided into three sections:

- Tree View (Left):** Shows the hierarchy of the archetype. The selected element is 'ELEMENT -- Red cells' under the 'parts' sub-tree of the 'CLUSTER -- Microscopy' element.
- Properties Panel (Right):** Lists various configuration parameters for the selected element, such as 'ADLMatchType', 'AssumedValue', 'CollapsedAtStart', etc.
- Ontology (Bottom):** A table showing the mapping between local codes and terminology codes.

Local Code	Terminology	Code	Text
▶ at0039	SNOMED-CT	103764000	Non reportable items
at0000	SNOMED-CT	117010004	Urine microscopy and culture
at0040	LN	15431-0	Working notes
at0038	LN	8251-1	Comments
at0029	LN	18928-2	Gentamicin
at0028	LN	148-7	Cephalexin
at0027	LN	18956-3	Norfloxacin
at0026	LN	18955-5	Nitrofurantoin
at0025	LN	18998-5	Co-trimoxazole
at0024	LN	18997-7	Trimethoprim
at0023	LN	20-8	Augmentin

Path: <root>.1.4.1.2

# GELLO Class export for CDS



Mowgli GELLO IDE

File Edit Search Build Tools Help

CEN-UrineCulture.v1.gello\_model

```
1 Package PKG_CEN_UrineCulture_V1
2
3 imports VMR
4
5 class DipStick
6   Blood: Observation
7   Glucose: Observation
8   Protein: Observation
9   PH: Observation
10  SpecificGravity: Observation
11
12 class Microscopy
13   WhiteCells: Observation
14   RedCells: Observation
15   EpithelialCells: Observation
16   OtherCells: Observation
17   Other: Observation
```

Name	Kind	Detail
PKG_CEN_UrineCultur...	package	package PKG_CEN_UrineCulture_V1
CEN_UrineCulture_...	class	CEN_UrineCulture_V1 extends Any
collection(Isolate)	class	collection(Isolate) extends collection
Culture	class	Culture extends Any
DipStick	class	DipStick extends Any
Isolate	class	Isolate extends Any
Growth	attribute	Growth: Observation
Pathogen	attribute	Pathogen: Pathogen
Microscopy	class	Microscopy extends Any

Model Explorer Data Explorer

GELLO is valid, no compile errors found in context of current model

# XMI/UML

The screenshot displays the 'UrineCulture - EA' software interface. The main workspace shows a UML class diagram for the package 'PKG\_CEN\_UrineCulture\_V1'. The diagram includes several classes, each with a list of attributes:

- CEN\_UrineCulture\_V1** (Any):
  - + Comments: Observation
  - + Culture: Culture
  - + DipStick: DipStick
  - + Microscopy: Microscopy
  - + NonReportableItems: NonReportableItems
  - + OtherSpecimenType: Observation
  - + SpecimenType: Observation
- NonReportableItems** (Any):
  - + WorkingNotes: Observation
- DipStick** (Any):
  - + Blood: Observation
  - + Glucose: Observation
  - + PH: Observation
  - + Protein: Observation
  - + SpecificGravity: Observation
- Microscopy** (Any):
  - + EpithelialCells: Observation
  - + Other: Observation
  - + OtherCells: Observation
  - + RedCells: Observation
  - + WhiteCells: Observation
- Pathogen** (Any):
  - + Ampicillin: Observation
  - + Augmentin: Observation
  - + Cephalixin: Observation
  - + Co\_Trimoxazole: Observation
  - + Gentamicin: Observation
  - + Nitrofurantoin: Observation
  - + Norfloxacin: Observation
  - + Number: Observation
  - + Organism: Observation
  - + Trimethoprim: Observation
- Isolate** (Any):
  - + Growth: Observation
  - + Pathogen: Pathogen

The interface also features a Project Browser on the right showing a hierarchical tree of the model, and a Properties window at the bottom right showing settings for the selected class 'CEN\_UrineCulture\_V1'.

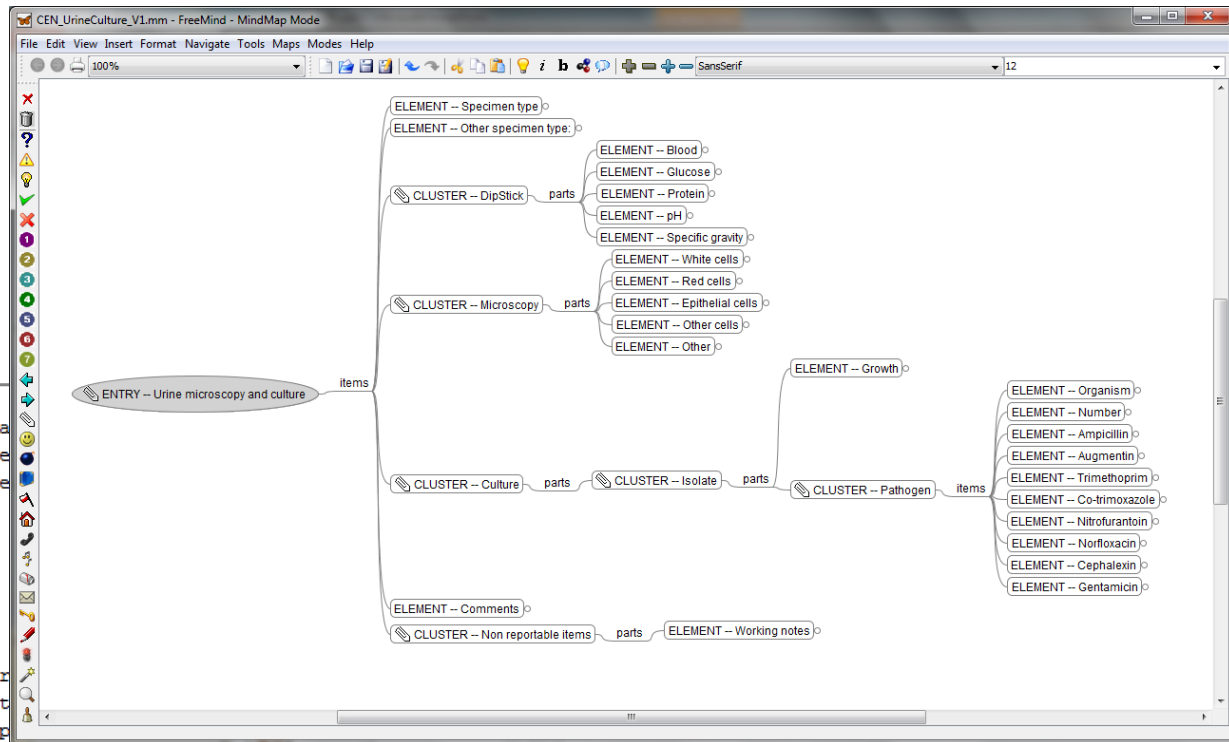
Class Settings	
Name	CEN_UrineCulture_V1
Scope	Public
Type	Class
Stereotype	
Alias	
Complexity	Easy
Version	1.0
Phase	1.0
Language	Java
Filename	
Project	
Advanced	

# ADL and Mindmap

```

26 definition
27   ENTRY[at0000] occurrences matches {0..1} matches {
28     items cardinality matches {0..*} matches {
29       ELEMENT[at0002] occurrences matches {
30         value matches {
31           CODED_TEXT matches {
32             code matches {
33               [local::
34                 at0061, -- Urine
35                 at0041, -- Clean
36                 at0057, -- Midstream
37                 at0042, -- Catheter
38                 at0043, -- Suprapubic
39                 at0044, -- First morning
40                 at0045, -- Paediatric bag
41                 at0058, -- Ureteric
42                 at0059, -- Bladder
43                 at0013; -- Other
44                 at0061] -- assumed value
45             }
46           }
47         }
48       }
49       ELEMENT[at0055] occurrences matches {0..1} matches {
50         value matches {
51           TEXT matches {*}

```



# Spreadsheet – For V2 Implementation

1	DISPLAYNAME	LOCALCODE	OCCURENCES	DATATYPE	V2VALUETYPE	SUBID	LOINC	SNOMED
2	Urine microscopy and culture	at0000	0..1	ENTRY	RP	<root>	630-4	117010004
3	Specimen type	at0002	0..1	CODEDVALUE	CE	<root>.1.1		
4	Other specimen type:	at0055	0..1	STRING	ST	<root>.1.2		
5	DipStick	at0003	0..1	SECTION	CE	<root>.1.3	50556-0	
6	Blood	at0004	0..1	STRING	ST	<root>.1.3.1.1	20409-9	
7	Glucose	at0005	0..1	STRING	ST	<root>.1.3.1.2	20406-5	
8	Protein	at0060	0..1	STRING	ST	<root>.1.3.1.3		
9	pH	at0006	0..1	REAL	ST	<root>.1.3.1.4		
10	Specific gravity	at0007	0..1	STRING	ST	<root>.1.3.1.5	2965-2	
11	Microscopy	at0008	0..1	SECTION	CE	<root>.1.4	12235-8	
12	White cells	at0009	0..1	PHYSICALQUANTITY	NM	<root>.1.4.1.1	45383-7	
13	Red cells	at0010	0..1	PHYSICALQUANTITY	NM	<root>.1.4.1.2	30391-7	
14	Epithelial cells	at0011	0..1	STRING	ST	<root>.1.4.1.3	30383-4	
15	Other cells	at0012	0..1	STRING	ST	<root>.1.4.1.4		
16	Other	at0013	0..1	STRING	ST	<root>.1.4.1.5		
17	Culture	at0014	0..1	SECTION	CE	<root>.1.5		
18	Isolate	at0094	0..10	STRUCTURAL	-	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate]		
19	Growth	at0015	0..1	CODEDVALUE	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.1		
20	Pathogen	at0016	0..1	SECTION	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.2		
21	Organism	at0018	0..1	CODEDVALUE	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.2.1.1		
22	Number	at0020	0..1	CODEDVALUE	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.2.1.2		
23	Ampicillin	at0022	0..1	CODEDVALUE	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.2.1.3	18864-9	
24	Augmentin	at0023	0..1	CODEDVALUE	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.2.1.4	20-8	
25	Trimethoorm	at0024	0..1	CODEDVALUE	CE	<root>.1.5.1.1.RepeatOf[CLUSTER -- Isolate].1.2.1.5	18997-7	

# Further Information

- Medical-Objects Clinical Decision Support wiki
  - [http://wiki.medical-objects.com.au/index.php/Clinical\\_Decision\\_Support](http://wiki.medical-objects.com.au/index.php/Clinical_Decision_Support)
- HL7 vMR Project
  - [http://wiki.hl7.org/index.php?title=Virtual\\_Medical\\_Record\\_\(vMR\)](http://wiki.hl7.org/index.php?title=Virtual_Medical_Record_(vMR))
- DCM
  - [http://wiki.hl7.org/index.php?title=Detailed\\_Clinical\\_Models](http://wiki.hl7.org/index.php?title=Detailed_Clinical_Models)
- GELLO
  - <http://www.hl7.org/v3ne2010/html/infrastructure/gello/gello.htm>