

## **Samson's RIM**

Samson's RIM has 3 components:

1. **Canonical\_Terms\_Metaclasses** that defines classes for high-level medical concepts. These are:

- Body Systems
- Disease Categories
- Medical Conditions
- Diagnostic Term
- Diagnostic procedures
- Therapeutic procedures
- Measured Parameters
- Derived Parameters
- Toxicity

2. **EPR\_Entity** that defines the EPR data model:

- Patient (demographics)
- Note\_Entry (observation at a single point in time)
- Numeric\_Entry
- Problem\_List\_Entry (problems over a duration of time)
- Encounter
- Medication
- Adverse\_Reaction

3. **Medical\_Domain\_Class Ontology**

Classes in the medical domain hierarchy can be instances of the Canonical\_Terms\_Metaclass hierarchy. All the terms that are used by the guideline that is being modeled are included (added, if necessary) in the medical domain ontology. When a term is added, it is added as a subclass in the medical domain hierarchy and as an instant of the Canonical\_Term\_Metaclass hierarchy.

The medical domain class hierarchy is the only part in the domain ontology that has to be changed when encoding a guideline that introduces new domain terms

### **Criteria**

When you write a criterion you first choose the criterion type. Each criterion type has different attributes.

A *presence criterion* refers to a domain term, taken from the medical\_domain class. It also lets you specify what type of EPR\_Entity you are talking about, and the mood {actual, authorized, recommend\_add, recommend\_delete, recommend\_modify}.

A *general comparison criterion* include the attributes that were discussed for a presence criterion, but lets you compare the term to a value expression.

**Because 2 criteria can refer to the same medical domain term, but to two different kinds of EPR entities, you can have a criterion that refers to domain term A as a time stamp observation, or as an interval valid time of observation.**

### **Action\_Specifications**

There are several types of action specifications. Some of them are:

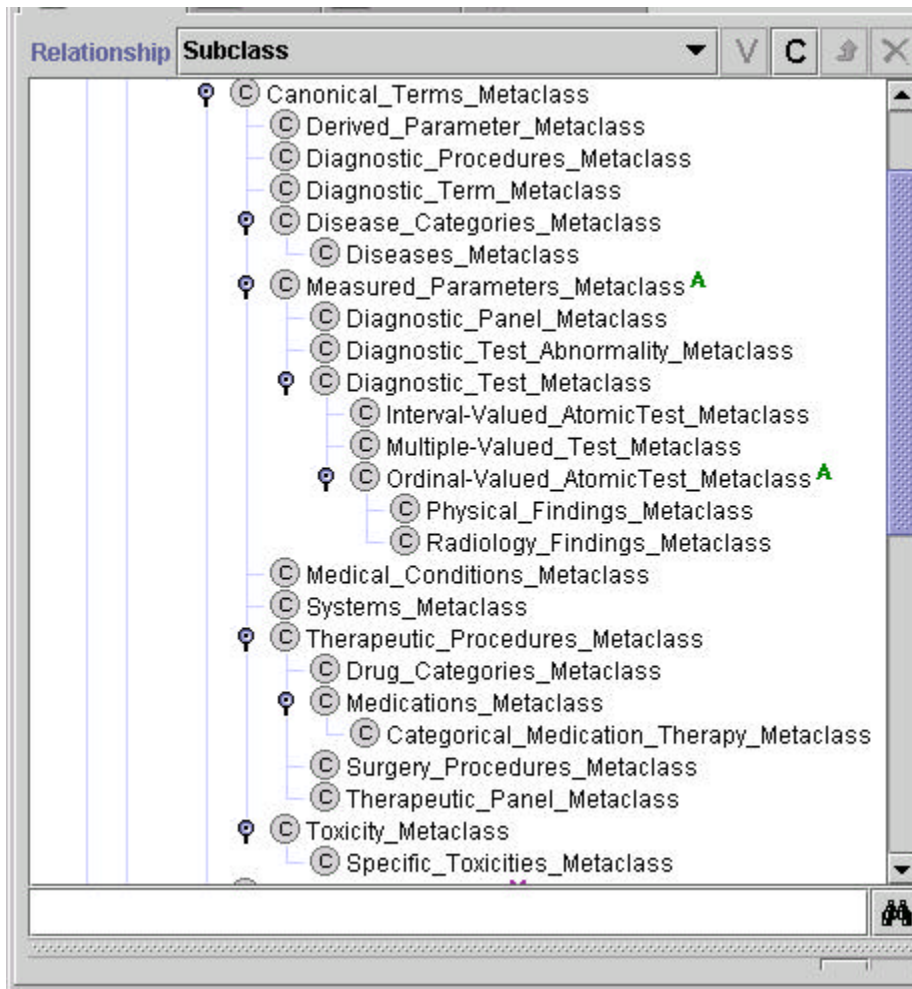
- Acute\_Prescription (refers to Medication\_Class)
- Collect\_Patient\_Data (refers to Diagnostic\_Class)
- Investigation (refers to Laboratory\_Result)
- Present\_Data (refers to EPR\_Entity)
- Procedure (refers to Therapeutic\_procedures and to Diagnostic\_Procedures\_Class)

### **Canonical Terms Metaclasses<sup>1</sup>**

The canonical terms meta-class is a subclass of a standard class. In addition, it has a slot (own slot) called “prettyname”, of type string, that lets you define a “pretty name” or “short name” for a class that is an instance of the “CANONICAL\_TERMS\_METAClass” meta-class. It also has a slot (own slot) called “synonyms”, that lets you define synonyms for a class that is an instance of the “CANONICAL\_TERMS\_METAClass” meta-class.

---

<sup>1</sup> Meta-class – a class that has instances that are themselves classes. For example the meta-class “STANDARD-CLASS” has a slot called “role” that lets you indicate whether a class that is an instance of the “STANDARD-CLASS” meta-class is abstract or concrete. It also has a slot called “DIRECT-TEMPLATE-SLOTS” that lets you define attributes (slots) of classes that are instances of the “STANDARD-CLASS” meta-class.



The Derived\_Parameter\_Metaclass has a slot called “definition”, of multiple cardinality, and of type Expression.

The Diagnostic\_Procedure\_Metaclass has a slot called “SystemsOfObservation”, of multiple cardinality, and of type Systems (e.g., respiratory system).

The Diagnostic\_Term\_Metaclass has the following slots.  
 A slot called “DiagnosticCriteria”, of single cardinality, and of type Criterion.  
 A slot called “ListOfConditions”, of multiple cardinality, and of type Medical\_Condition\_Class (see Figure 2).  
 A slot called “ListOfFindings”, of multiple cardinality, and of type Medical\_Findings\_Class (See Figure 2).

The Disease\_Categories\_Metaclass has a slot called “BodySystem”, of multiple cardinality, and of type Systems (e.g., respiratory system).

The Disease\_Metaclass, that is a subclass of Disease\_Categories\_Metaclass has the slot called “DiseaseCategory”, of multiple cardinality, and of type Disease\_Categories  
 A slot called “ICD-9-code”, of single cardinality, and of type String.

?

The `Measured_Parameters_Metaclass` has the following slots.  
A slot called “DefaultSource”, of single cardinality, and of type `Expression`.  
A slot called “PreferredSource”, of single cardinality, and of type `Expression`.

The `Diagnostic_Panel_Metaclass` that is a subclass of `Measured_Parameters_Metaclass` has the slot called “ConstituentDiagnosticTests”, of multiple cardinality, and of type `Diagnostic_Findings_Class`.

?

The `Diagnostic_Test_Abnormality` that is a subclass of `Measured_Parameters_Metaclass` has the slot called “LabTestAffected”, of multiple cardinality, and of type `Laboratory_tests`.

The `Diagnostic_Test_Metaclass` that is a subclass of `Measured_Parameters_Metaclass` does not define additional slots.

?

The `Interval-Valued_Atomic_Test_Metaclass` that is a subclass of `Diagnostic_Test_Metaclass` that has the following slots.  
A slot called “LowerLimitOfNormal”, of single cardinality, and of type `Expression`.  
A slot called “UpperLimitOfNormal”, of single cardinality, and of type `Expression`.  
A slot called “Precision”, of single cardinality, and of type `integer`.  
A slot called “Units”, of single cardinality, and of type `Units_Class`.

The `Multiple-Valued_Test_Metaclass` that is a subclass of `Diagnostic_Test_Metaclass` that has the following slots.  
A slot called “TestResultParameters”, of multiple cardinality, and of type `Diagnostic_Findings_Class`.

The `Ordinal-Valued_Atomic_Test_Metaclass` that is a subclass of `Diagnostic_Test_Metaclass` that has the slot called “FindingModifier”, of single cardinality, and of the enumerated type {mild, moderate, severe}.

The `Physical_Finding_Metaclass` that is a subclass of `Diagnostic_Test_Metaclass` does not define additional attributes.

The `Radiology_Finding_Metaclass` that is a subclass of `Diagnostic_Test_Metaclass` does not define additional attributes.

The `Medical_Conditions_Metaclass` that is a subclass of `Canonical_Terms_Metaclass` does not define additional attributes.

The `Systems_Metaclass` that is a subclass of `Canonical_Terms_Metaclass` has the slot called “DiseaseAffectingSystem”, of multiple cardinality, and of the type `Disease_Categories`.

The Therapeutic\_Procedures\_Metaclass that is a subclass of Canonical\_Terms\_Metaclass does not define new slots.

The Drug\_Categories\_Metaclass that is a subclass of the Therapeutic\_Procedures\_Metaclass does not define new slots.

The Medications\_Metaclass that is a subclass of the Therapeutic\_Procedures\_Metaclass defines the following slots.

A slot called “DoseSupplied”, of multiple cardinality, and of type Float.

A slot called “DrugClass”, of multiple cardinality, and of type Medication\_Class.

A slot called “DrugGenericName”, of single cardinality, and of type String.

A slot called “DrugInfo”, of single cardinality, and of type Drug\_Information.

A slot called “OnFormulary”, of single cardinality, and of type Boolean.

A slot called “TradeNames”, of multiple cardinality, and of type String.

A slot called “Units”, of single cardinality, and of type Units\_Class.

The Class Categorical\_Medication\_Therapy\_Metaclass that is a subclass of the Medications\_Metaclass defines the following slots.

“MedicationsOrDrugClassUsed”, of multiple cardinality, and of type Drug\_Categories.

The Surgery\_Procedures\_Metaclass that is a subclass of the Therapeutic\_Procedures\_Metaclass defines the following slots.

“SurgicalProcedure”, of single cardinality, and of type String.

The Therapeutic\_Panel\_Metaclass that is a subclass of the Therapeutic\_Procedures\_Metaclass defines the following slots.

“ConstituentTherapeuticProcedure”, of multiple cardinality, and of type Therapeutic\_Procedure.

The Toxicity\_Metaclass that is a subclass of Canonical\_Terms\_Metaclass does not define new slots.

?

The Specific\_Toxicities\_Metaclass that is a subclass of Canonical\_Terms\_Metaclass defines the following slots.

“AttributionToDrug”, of single cardinality, and of enumerated type { 1\_unrelated, 2\_unlikely, 3\_possible, 4\_probable, 5\_definite }

CriteriaForToxicity of multiple cardinality

RequiredMonitoringTests of multiple cardinality, and of type Genreic\_Monitoring

“Toxicity” of single cardinality, and of type Drug\_Toxicity\_Probability\_Table

## **Medical Domain Ontology**

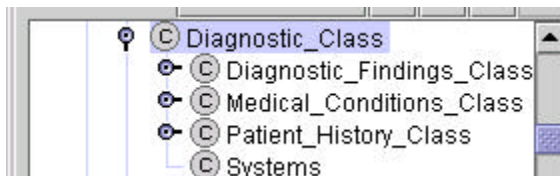
All of the classes have the attribute synonyms (multiple strings).

No attributes are defined for any of the following classes (Figures 1 through 9)



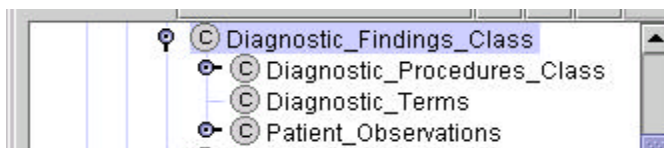
See Figures 2, 8, 9

Figure 1.



See Figures 3, 6, 7

Figure 2.



See Figures 4, 5

Figure 3.

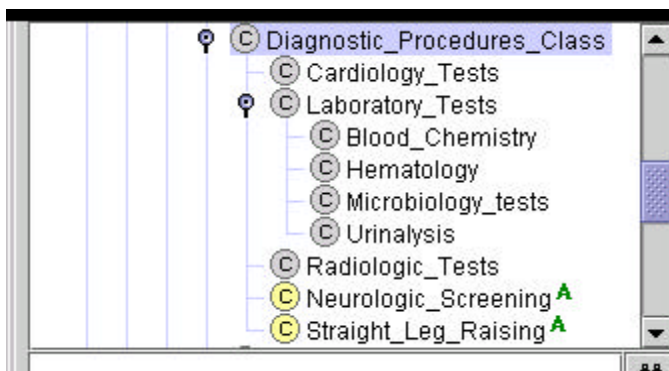


Figure 5.

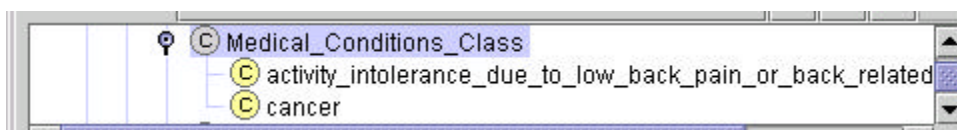


Figure 6.

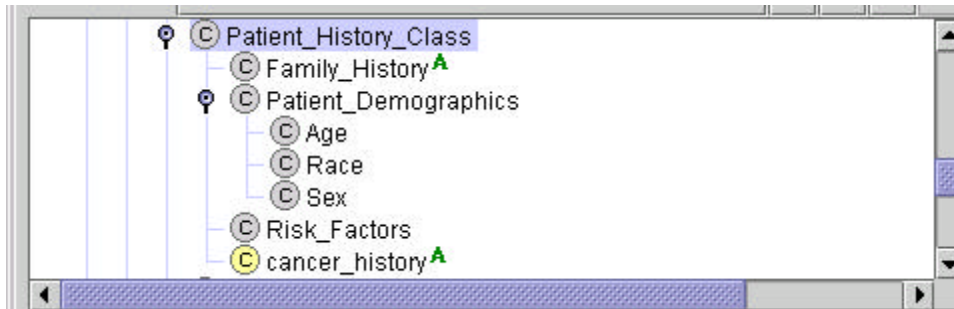


Figure 7.

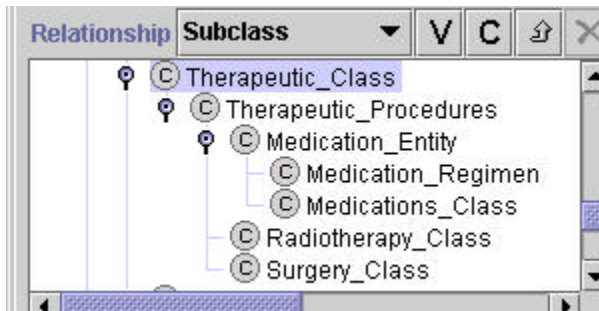


Figure 8.

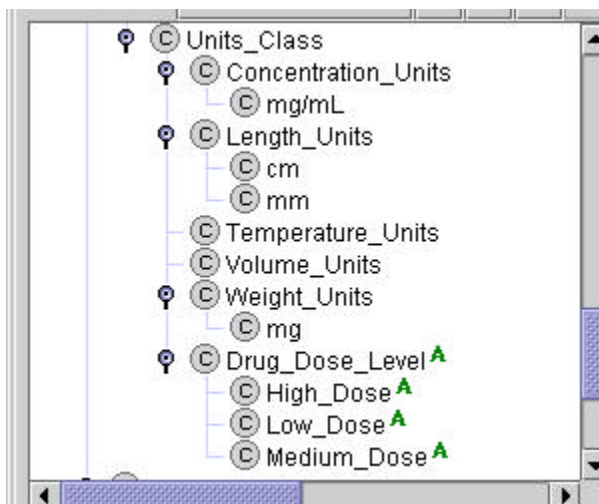


Figure 9.

## EPR\_Entity

```

EPR_Entity
    Patient_id: string
  
```

Adverse\_Reaction is-a EPR\_Entity  
domain\_term: string  
Substance: string  
valid\_time: Time\_Stamp

Encounter is-a EPR\_Entity  
when: Time\_Stamp  
with\_HCP: Health\_Care\_Provider

Medication is-a EPR\_Entity  
drug\_name: string  
daily\_dose: float  
daily\_dose\_unit: string  
frequency: integer  
frequency\_unit: string  
route: string  
prescription\_id: string  
valid\_time: Time\_Interval

Note\_Entry is-a EPR\_Entity  
domain\_term: string  
value:string  
valid\_time: Time\_Stamp

Numeric\_Entry is-a EPR\_Entity  
domain\_term: string  
value:string  
unit: string  
lower\_limit: float  
upper\_limit: float  
valid\_time: Time\_Stamp

Patient is-a EPR\_Entity  
age: integer  
dateOfBirth: string  
sex: enum {Female, Male}

Problem\_List\_Entry is-a EPR\_Entity  
domain\_term: Diagnostic\_Class      // see Figure 2  
valid\_time: Time\_Interval

## **Expressing criteria**

There are several criteria in Samson's model.

.....



Criterion

label :string  
description :string

Extended\_Boolean\_Criterion is-a Criterion

Comparison\_Criterion is-an Extended\_Boolean\_Criterion

valid\_window: Time\_Interval  
unit: string  
assume\_if\_no\_value: enum {no\_assumption, assume\_satisfied,  
.....  
..... assume\_unsatisfied, use\_default}  
.....

General\_Comparison\_Criterion is-a Comparison\_Criterion

domain\_term: Medical\_Domain\_Class // Figure 1  
entry\_type: EPR\_Entity  
operator: enum: {<, >, <=, >=, =, eq, neq, member\_of}  
value: Expression  
default\_value: string  
aggregation\_oprerator: enum {most\_recent}

Numeric\_Term\_Criterion is-a Comparison\_Criterion

numeric\_domain\_term: Medical\_Condition\_Class OR Medications\_Class OR  
Diagnostic\_Findings\_Class OR Patient\_History\_Class  
Operator: enum { =, !=, <, >, <=, >=}  
default\_value: float  
value: float  
unit: string  
aggregation\_operator: enum {most\_recent, average, max, min, count}

N\_ary\_Criterion is-an Extended\_Boolean\_Criterion

criteria: Criterion // multiplicity many  
operator: enum {AND, OR, NOT}

Presence\_Criterion is-an Extended\_Boolean\_Criterion

domain\_term: Medical\_Domain\_Class  
entry\_type: EPR\_Entity  
variable\_name: string  
presence: Boolean  
period: Time\_Interval  
filter: Filter // a class used to express the “where” part of a query (i.e., SQL  
.....  
..... query)  
.....

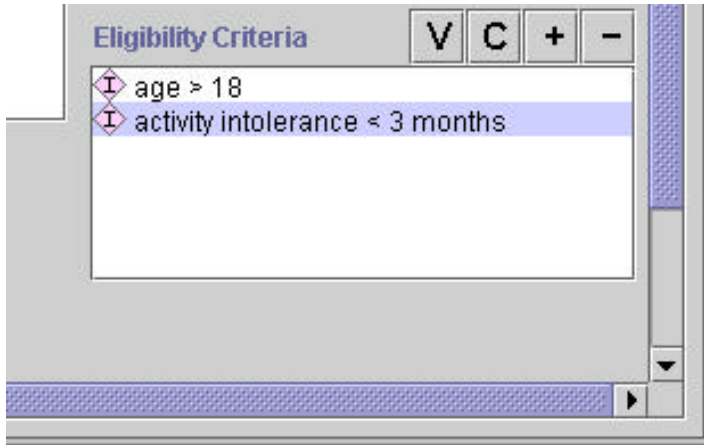
Temporal\_Criterion is-an Extended\_Boolean\_Criterion // to express a ChronusII

Query  
.....

Medication\_Contraindication\_Criterion is-an Extended\_Boolean\_Criterion

Goal\_Criterion is-a Criterion

## Eligibility Criteria for the guideline



See Figures 11, 12, 13, 14

Figure 10.

Age is a Numeric\_Term\_Criterion. It uses the numeric\_domain\_term "Age" (Figure 7).

A screenshot of a configuration window titled "KB\_00002 (instance of Numeric\_Term\_Criterion)". The window contains several fields and controls:

- Description:** An empty text field.
- Operator:** A dropdown menu showing ">".
- Label:** A text field containing "age > 18".
- Mood:** A text field that is empty, with "V", "+", and "-" buttons to its right.
- Unit:** A text field containing "year".
- Numeric Domain Term:** A text field containing "Age", with "V", "+", and "-" buttons to its right.
- Default Value:** An empty text field.
- Value:** A text field containing "18.0".
- Valid Window:** An empty text field, with "V", "C", "+", and "-" buttons to its right.
- Aggregation Operator:** A dropdown menu showing "most\_recent".
- Assume If No Value:** An empty dropdown menu.

Figure 11.

.....

**KB\_00009 (instance of N\_ary\_Criterion)**

**Description**

**Label**  
activity intolerance < 3 months

**Operator**  
OR

**Mood**

**Criteria**  
 chronus lower back pain activity intolerance < 3 months  
 lower back pain < 3 months

Figure 12. // see figures 13 and 14

**KB\_00008 (instance of Temporal\_Criterion)**

**Context**

**Description**

**From**  
problem\_list\_entries

**Label**  
chronus lower back pain activity intolerance < 3 months

**Select**

**When**  
duration < 3 months

**Where**  
domain\_term = "activity intolerance due to lower\_back\_pain"

☒ **Presence**

Figure 13. the domain term "activity\_intolerance\_due\_to\_lower\_back\_pain" is shown in Figure 6.

**KB\_00003 (instance of Presence\_Criterion)**

**Description**

**Label**  
lower back pain < 3 months

**Variable Name**

☒ **Presence**

**Domain Term**  
activity\_intolerance\_due\_to\_low\_back\_pair

**Entry Type**  
Problem\_List\_Entry

**Mood**

**Filter**  
duration < 90 days

**Period**

Figure 14.

.....

.....

The guideline:

The screenshot shows a software window titled "KB\_00016 (instance of Elementary\_Action\_Step)". The window contains a form with the following sections:

- Label:** A text field containing "history and physical".
- Start Constraint:** A section with buttons "V", "C", "+", and "-", followed by an empty text field.
- References:** A section with buttons "V", "C", "+", and "-", followed by an empty text field.
- Followed By:** A section with buttons "V", "C", "+", and "-", followed by a text field containing "red flags".
- Actions:** A section with buttons "V", "C", "+", and "-", followed by a list of actions:
  - neurological screening
  - SLR
  - age and cancer history

Figure 15.

**KB\_00021 (instance of Procedure)**

**Description**

neurological screening

**Domain Term** V + -

Neurologic\_Screening

**Label**

neurological screening

**References** V C + -

☐ **Deferred**

Figure 16. The term “Neurologic\_Screening” can be seen in Figure 4.

**lower\_back\_pain\_00001 (instance of Procedure)**

**Description**

**Domain Term** V + -

Straight\_Leg\_Raising

**Label**

SLR

**References** V C + -

☐ **Deferred**

Figure 17. The term “SLR” can be seen in Figure 4.

**lower\_back\_pain\_00002 (instance of Data\_Entry\_Template)**

**Description**

**Label**

age and cancer history

**References** V C + -

☐ **Deferred**

**Data To Collect** V C + -

- ask for age
- ask for cancer history

Figure 18.

**lower\_back\_pain\_00003 (instance of Quantitative\_Data)**

**Description**

**Domain Term** V + -

Age

**Label**

ask for age

**Prompt**

age

☐ **Deferred** ☐ **Sensitive**

**References** V C + -

Figure 19.

**lower\_back\_pain\_00004 (instance of Qualitative\_Data)**

**Description**

**Domain Term** V + -

cancer\_history

**Label**

ask for cancer history

**Prompt**

☐ **Deferred** ☐ **Sensitive**

**Choice Type**

one\_of ▼

**Allowed Terms** V C -

yes  
no

**References** V C + -

Figure 20. The domain term “Cancer\_history” can be seen in Figure 7.

Here we are OR-ing the red-flags for cancer:

**lower\_back\_pain\_00107 (instance of N\_ary\_Criterion)**

<b>Description</b>	<b>Mood</b>
<b>Label</b>	<b>Criteria</b>
cancer red flags	<ul style="list-style-type: none"><li>unexplained weight loss within 3 months</li><li>cancer occurrence or cancer history</li></ul>
<b>Operator</b>	
OR	

Figure 21. Note that we added “within 3 months” to be less vague.

**lower\_back\_pain\_00108 (instance of Presence\_Criterion)**

<b>Description</b>	<b>Entry Type</b>
	Note_Entry
<b>Label</b>	<b>Mood</b>
unexplained weight loss within 3 months	
<b>Variable Name</b>	<b>Filter</b>
<input checked="" type="checkbox"/> <b>Presence</b>	<b>Period</b>
	within 90 days
<b>Domain Term</b>	
unexplained weight loss	

Figure 22. Note that we added “within 3 months” to be less vague.

**lower\_back\_pain\_00115 (instance of N\_ary\_Criterion)**

<b>Description</b>	<b>Mood</b>
<b>Label</b>	<b>Criteria</b>
cancer occurrence or cancer history	<ul style="list-style-type: none"><li>cancer history</li><li>presence of cancer</li></ul>
<b>Operator</b>	
OR	

Figure 23.

**lower\_back\_pain\_00116 (instance of Presence\_Criterion)**

<b>Description</b>	<b>Entry Type</b> [V] [ + ] [ - ]
	Note_Entry
<b>Label</b>	<b>Mood</b> [V] [ + ] [ - ]
cancer history	
<b>Variable Name</b>	<b>Filter</b> [V] [C] [ + ] [ - ]
<input checked="" type="checkbox"/> <b>Presence</b>	<b>Period</b> [V] [C] [ + ] [ - ]
<b>Domain Term</b> [V] [ + ] [ - ]	
cancer_history	

Figure 24. The domain term “Cancer History” can be seen in Figure 7.

**lower\_back\_pain\_00117 (instance of Presence\_Criterion)**

<b>Description</b>	<b>Entry Type</b> [V] [ + ] [ - ]
	Problem_List_Entry
<b>Label</b>	<b>Mood</b> [V] [ + ] [ - ]
presence of cancer	
<b>Variable Name</b>	<b>Filter</b> [V] [C] [ + ] [ - ]
<input checked="" type="checkbox"/> <b>Presence</b>	<b>Period</b> [V] [C] [ + ] [ - ]
<b>Domain Term</b> [V] [ + ] [ - ]	
cancer	

Figure 25. The domain term “cancer” can be seen in Figure 6.

Notes:

- 1) In the criterion: “previous cancer history”, previous is vague.
- 2) In the criterion “unexplained weight-loss”, there should be defined within the past X months



- 3) In the criterion “failure to improve with 1 month of therapy”, therapy is vague. Therefore, we could not model this criterion.
- 4) Back pain relieved by bed rest. We would like this to be a vocabulary term. Does GALEN or SNOWMED have these terms?
- 5) In Samson’s model there is some structuring, and the rest is pushed into the vocabulary that should support compositionality as in (4). In USAM, this is done via a service relationship.
- 6) Samson modeled data stating that a patient had cancer in 2 places. One is “cancer” (Figure 6), which is a medical condition, that can be a Note\_Entry or a Problem\_List\_Entry in the EMR. The other is cancer\_history (Figure 7) which is a Patient\_History instance, which means that the cancer was not diagnosed and recorded by a clinician into the present EMR, but that the patient supplied this history and this has to be recorded differently than diagnosis data.