

Post-coordinated expressions in forms and FHIR objects

Keith E Campbell
Informatics Architect
VHA Knowledge-Based Systems

Why post-coordinated expressions?

- We could only encode ~25% of concepts necessary for a nursing pressure ulcer form without using post-coordination of SNOMED concepts
- There are many other experiences published and unpublished indicating that post-coordination is necessary to represent a wide range of clinical content

FHIR supports post-coordination

Lloyd McKenzie says:

October 28, 2013 at 3:05 am



You can already use the post-coordination syntax as defined by SNOMED. The syntax of the code is defined by the code system. For post-coordinating code systems like SNOMED and UCUM, any valid expression is a legal string for code.

That said, when sending SNOMED codes, the display names should be excluded from the string. They make computation a lot more difficult, given that many systems will process SNOMED codes as strings with no parsing. If you have some need to send the SNOMED code with embedded human readable display names, that should be done using an extension.

Project Goals

- Current goals - Static Forms
 - Use integrated native standards for data encoding - SNOMED, LOINC, RxNorm (SOLOR)
 - Enable encoding of form output using SOLOR
 - **Enable class-based retrieval of captured data (pre- or post-coordinated using a shared logical model)**
- Future Goals - Dynamic Forms
- **Operability** first, then **interoperability** where the value is the greatest

SOLO

- SNOMED
 - Ownership changed to international consortium of countries, now acceptable license terms and availability. Part of Meaningful Use standards
- LOINC
 - By joint agreement, being made interoperable with SNOMED through use of Description Logic definitions of LOINC codes against SNOMED primitives
- RxNorm
 - Freely available from NLM, part of meaningful use standards

Local extension ability is mandatory

- We must be able to meet operations requirements without being forced to wait for potentially years for turnaround on operational requirements, hence:
- The VA Extension (and the XYZ extensions)



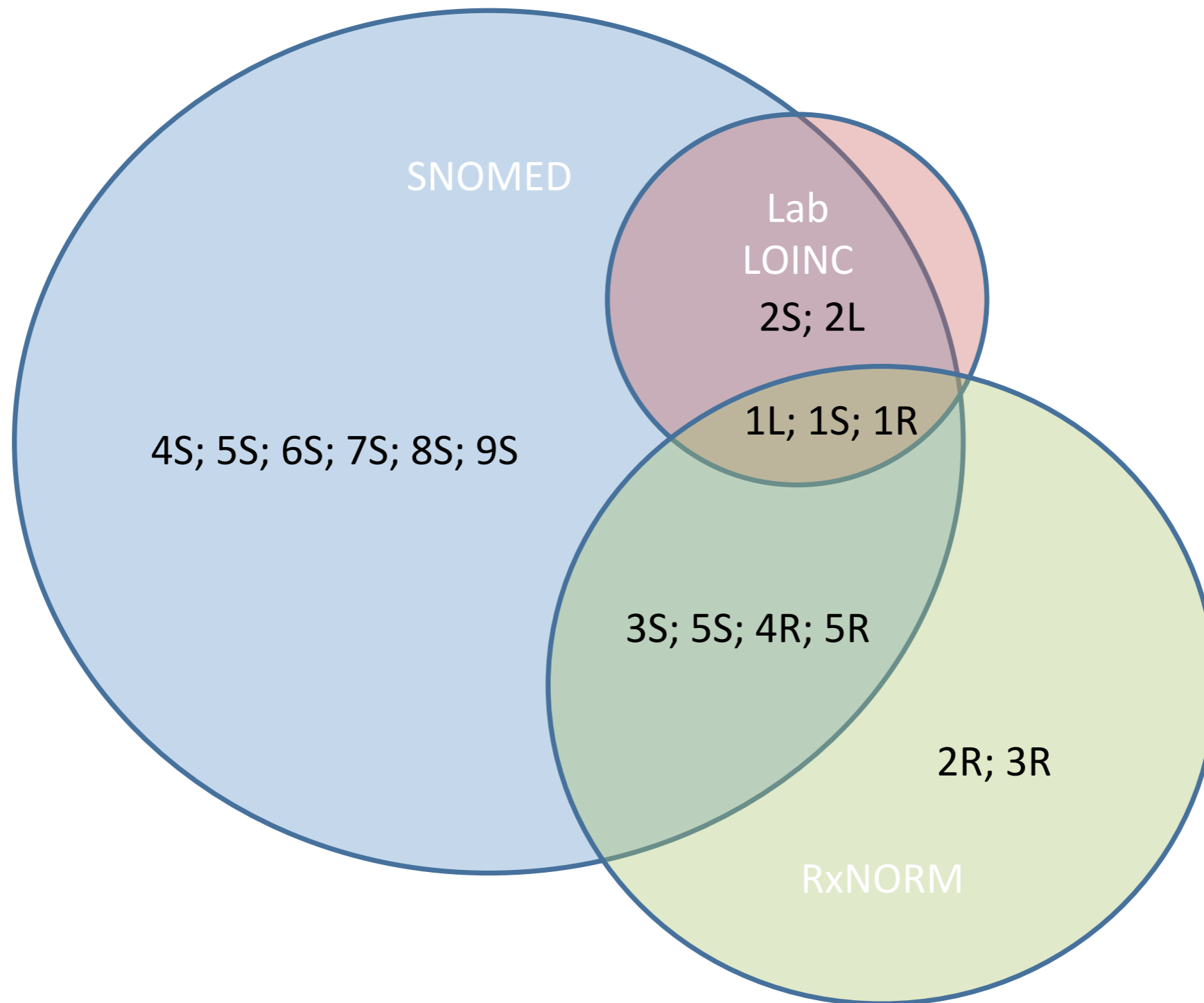
SOLOR

An Logical Foundation



SOLOR Benefits

- Normalize structure and form of clinical terminology
 - Improve software reuse
 - Shared tooling
 - Reduce learning curve
 - Shared post-coordination model
 - Simplified data analysis



SNOMED, LOINC, and RxNORM

Overlap Details

LOINC:

1L: Gentamicin is a component loinc (GENTAMICIN)

2L: Gentamicin is a component of a laboratory tests in loinc (Gentamicin^peak)

SNOMED:

1S: Gentamicin is a substance in SNOMED CT (a component in LOINC)

2S: Gentamicin is a component of a laboratory test in SNOMED (gentamicin peak)

3S: Gentamicin is a PRODUCT in SNOMED CT (a substance manufactured and sold)

4S: Gentamicin is an ALLERGEN in SNOMED CT

5S: Gentamicin is a presented in Prescribeable/Dispensable forms in SNOMED
(Gentamicin bone cement; Gentamicin 0.3% preservative-free eye drops)

6S: Gentamicin is specified in SNOMED administration and removal procedures
(Insertion of Gentamicin beads into bone; Removal of Gentamicin beads from bone)

7S: Gentamicin is specified in poisonings/overdoses

8S: Gentamicin allergic reactions are defined clinical situations

9S: Acute drug-induced renal failure is a disorder in SNOMED

RxNorm:

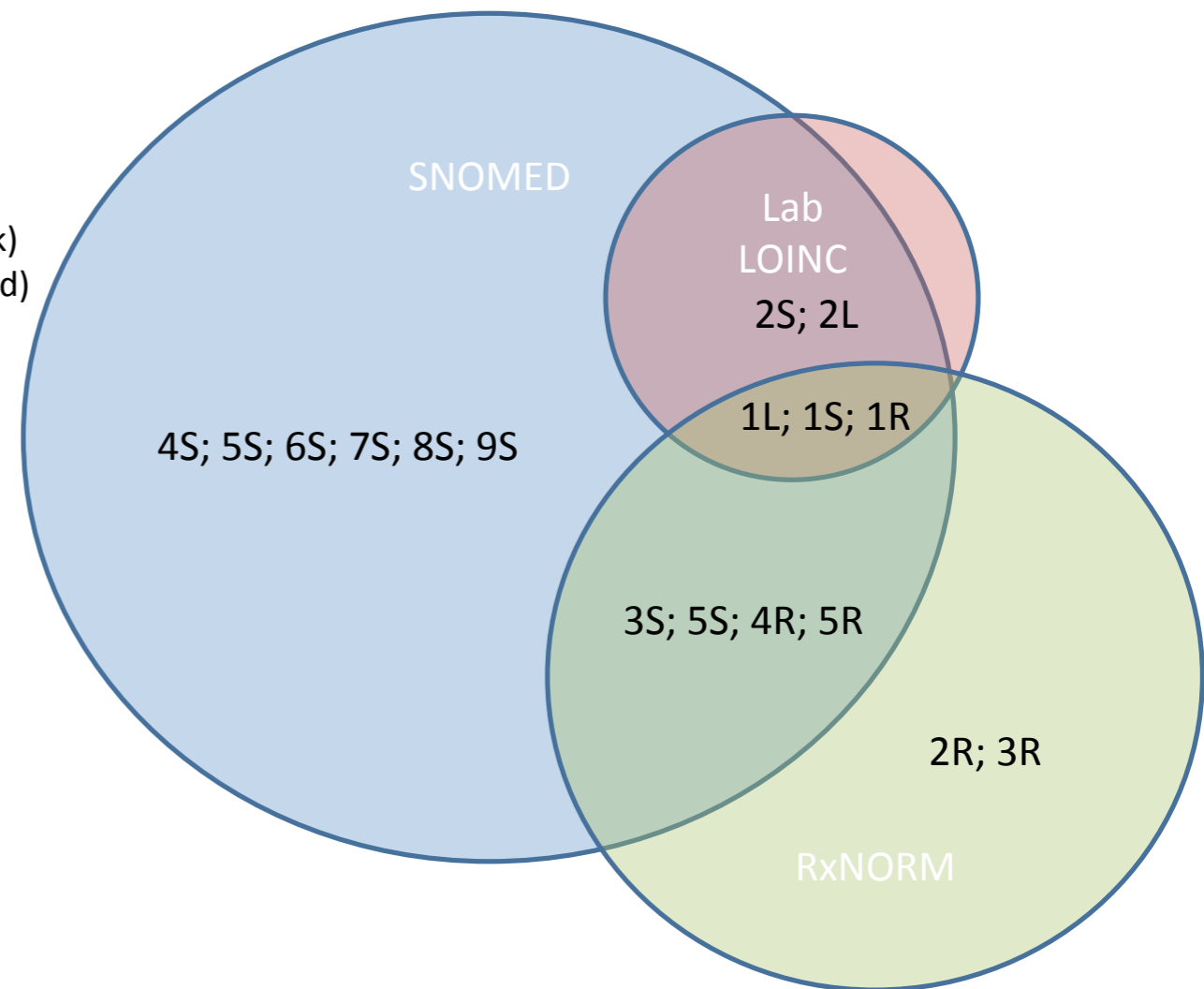
1R: Gentamicin is an ingredient in RxNorm (GENTAMICIN SULFATE)

2R: Gentamicin is a basis of strength in RxNorm (GENTAMICIN)

3R: Gentamicin is linked to Human Prescription Drug Labels

4R: Gentamicin is a presented in Prescribeable/Dispensable forms in RxNorm
(gentamicin sulfate 0.3 % Ophthalmic Solution)

5R: Gentamicin is a PRODUCT in RxNorm (a substance manufactured and sold)



Encounter Documentation

A derivative model

First Steps

- Existing structured forms for Compensation & Pension evaluations
- No encoding of these forms using native SOLOR standards
- FHIR was not on fire...
- We developed LEGOs to represent question/answer pairs for these forms

Documentation

- A collection of Acts
 - Assertions
 - Requests
- Related to a
 - Subject of record
 - Subject of Act

Assertions

- Observable
- Provenance
- Timing
- Value

Clinical Example

- Systolic blood pressure of 130 measured via automated blood pressure cuff from the right brachial artery
- Systolic Blood Pressure
 - some (measurement-location
 - some (brachial-artery (some laterality right)
 - some (measurement-device automated-bp-cuff)

A LEGO: In XML using Postcoordination

```
<assertion>  
  <observation> Systolic Blood Pressure  
    some (measurement-location  
      some (brachial-artery (some laterality right)  
        some (measurement-device automated-bp-cuff)  
    </observation>  
  <provenance>obtained during examination</  
provenance>  
  <timing>May 27, 2014 08:32:04</timing>  
  <value>130</value>  
</assertion>
```

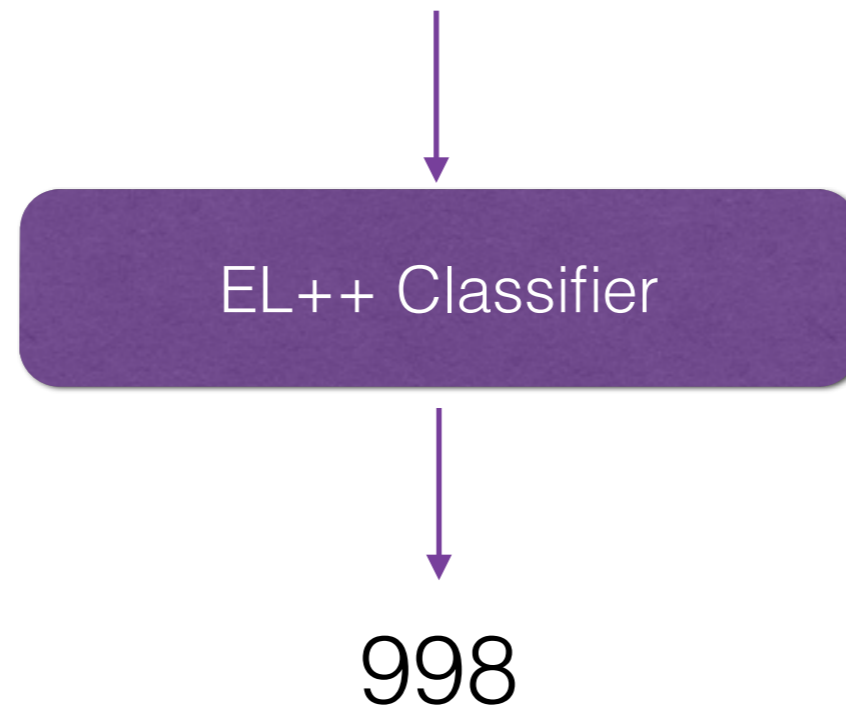

Expressions Normalized to Single Codes

Systolic Blood Pressure

some (measurement-location

some (brachial-artery (some laterality right)

some (measurement-device automated-bp-cuff)



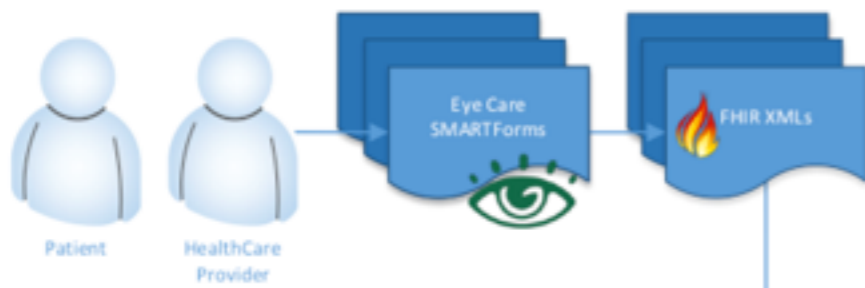
Normalized LEGO In XML

```
<assertion>  
  <observation> 998 </observation>  
  <provenance> 124 </provenance>  
  <timing>May 27, 2014 08:32:04</timing>  
  <value>130</value>  
</assertion>
```

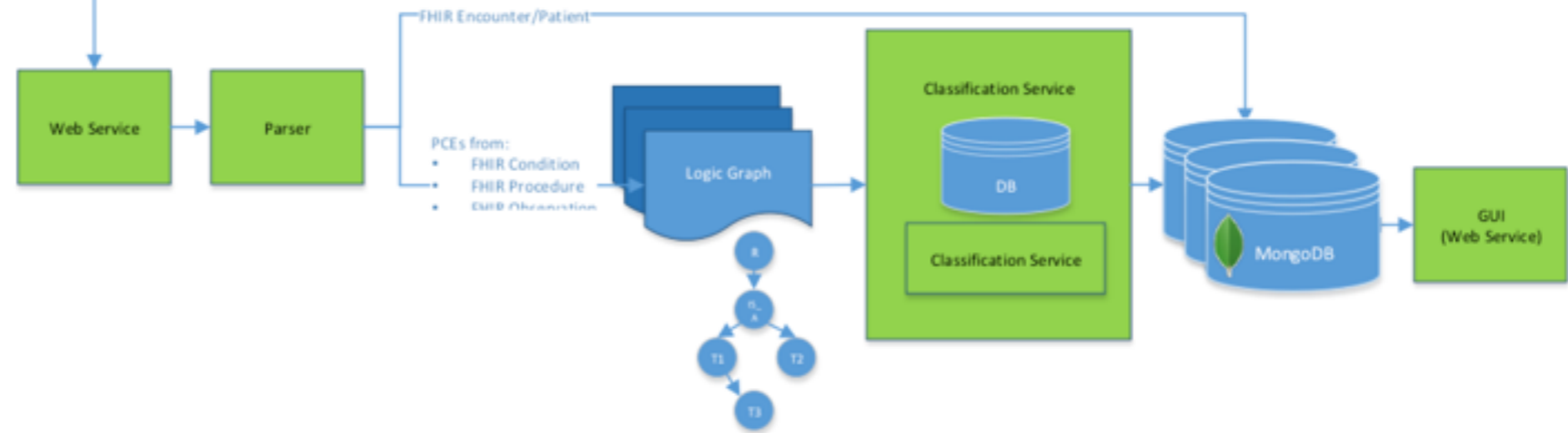
Can be persisted in relational or nosql databases

Where are we now?

SMARTForms



Semantic Normalization Prototype (SNP)



Participants

- Veterans Health Administration
 - Apelon
 - LEGO authoring
 - Tooling
 - Technatomy
 - Smartforms development
 - FHIR object output
- VHA (continued)
 - Deloitte
 - LEGO quality assurance
 - Mongo DB for class-based retrieval of forms-provided data
 - Round-trip integration
 - Dave Carlson & Galen Mulrooney
 - FHIR Profiles
 - FHIR Forms

Project Challenges

- We need a single shared logical model
 - Many silos need to be integrated
 - Boundaries between semantics of terminology encoding and fields of FHIR objects must be cleanly defined

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RxNorm:

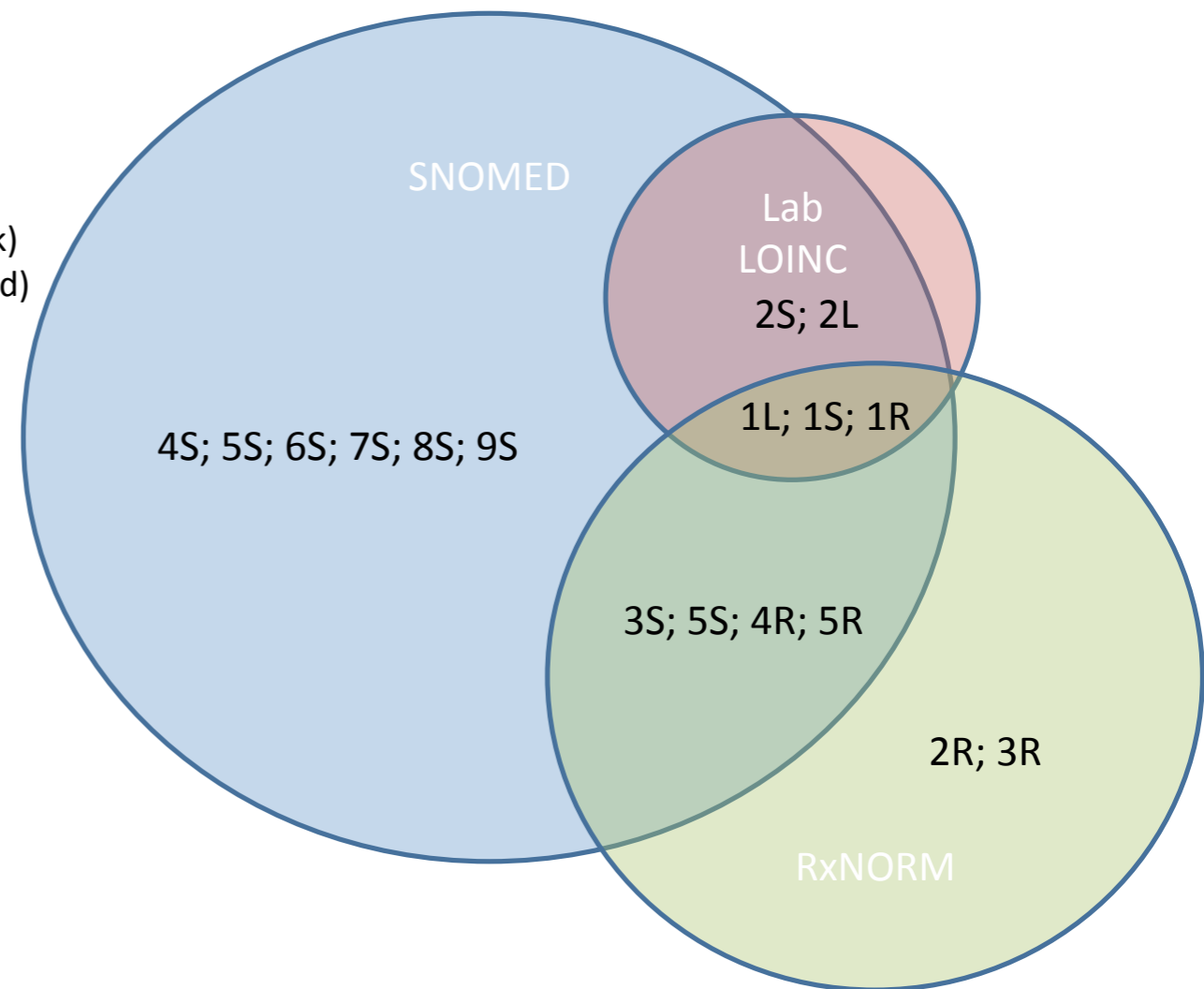
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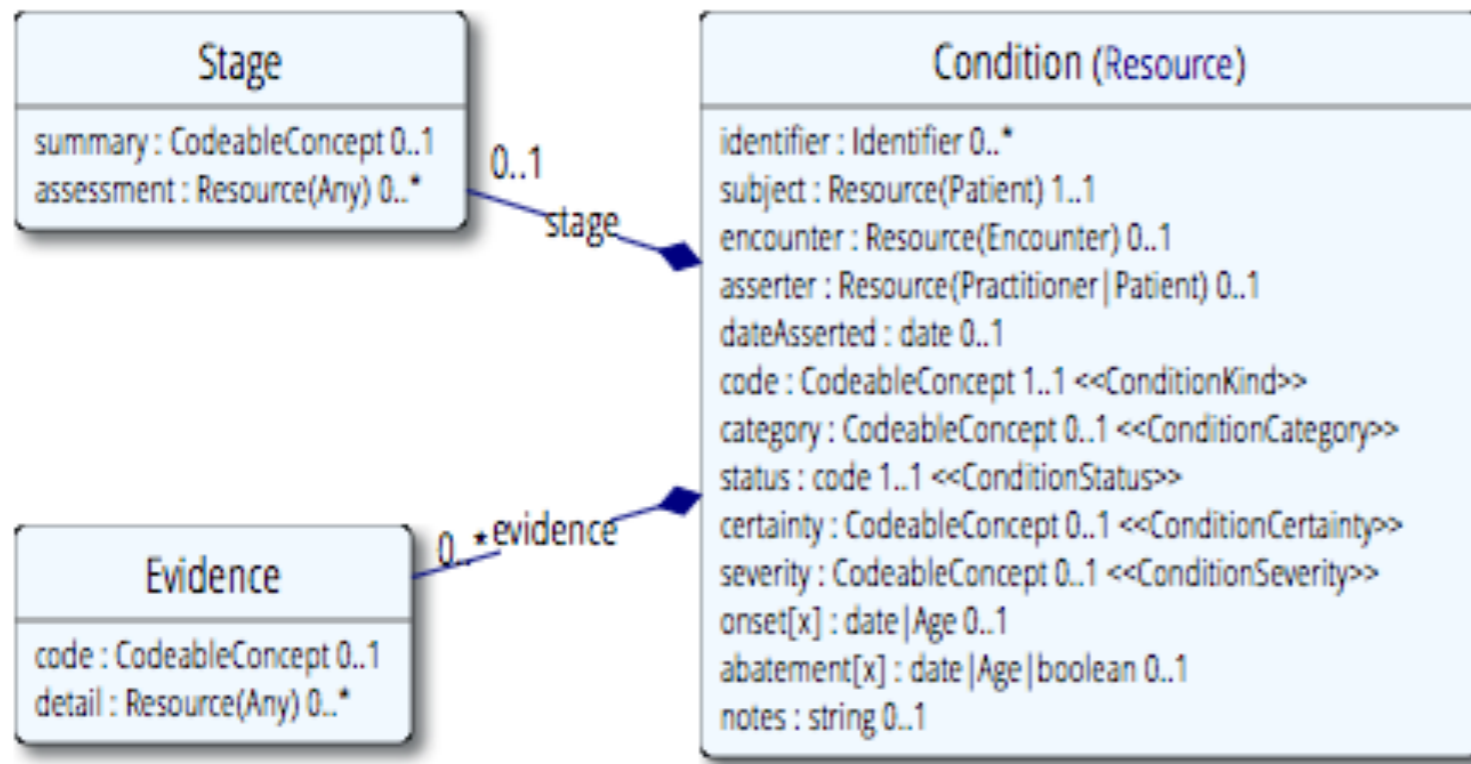
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FHIR Condition



- ▶ Late onset asthma (disorder)
- ▶ Mild asthma (disorder)
 - ▶ Intermittent asthma (disorder)
 - ▶ Mild intermittent asthma (disorder)
 - ▶ Mild persistent asthma (disorder)
- ▶ Mixed asthma (disorder)
- ▶ Moderate asthma (disorder)
- ▶ Non-allergic asthma (disorder)
- ▶ Occasional asthma (disorder)
- ▶ Occupational asthma (disorder)
- ▶ Seasonal asthma (disorder)
- ▶ Severe asthma (disorder)
 - ▶ Severe persistent asthma (disorder)
- ▶ Substance induced asthma (disorder)

FHIR Observation

Observation (Resource)
name : CodeableConcept 1..1 <<ObservationType>>
value[x] : Quantity CodeableConcept Attachment Ratio Period SampledData string 0..1
interpretation : CodeableConcept 0..1 <<ObservationInterpretation>>
comments : string 0..1
applies[x] : dateTime Period 0..1
issued : instant 0..1
status : code 1..1 <<ObservationStatus>>
reliability : code 1..1 <<ObservationReliability>>
bodySite : CodeableConcept 0..1 <<BodySite>>
method : CodeableConcept 0..1 <<ObservationMethod>>
identifier : Identifier 0..1
subject : Resource(Patient Group Device Location) 0..1
specimen : Resource(Specimen) 0..1
performer : Resource(Practitioner Device Organization) 0..*

- Diastolic blood pressure (observable entity)
 - ▶ ■ Average diastolic blood pressure (observable entity)
 - ▶ ■ Diastolic blood pressure on admission (observable entity)
 - ▶ ■ Lying diastolic blood pressure (observable entity)
 - ▶ ■ Maximum diastolic blood pressure (observable entity)
 - ▶ ■ Minimum diastolic blood pressure (observable entity)
 - **Sitting diastolic blood pressure (observable entity)**
 - ▶ ■ Standing diastolic blood pressure (observable entity)
 - ▶ ■ Target diastolic blood pressure (observable entity)
- Dorsalis pedis arterial pressure (observable entity)

A shared logical model

- A shared logical model needs to be collaboratively developed
 - The model developed by IHTSDO and Regenstrief to integrate SNOMED and LOINC is an example we should build on
- New capabilities may need to be added to the FHIR standard to support logical consistency in the use of
 - pre-coordinated expressions,
 - post-coordinated expressions, and
 - FHIR fields (or other structures)