Terminology Binding and Expression Constraints
Audience and Objectives

Audience

▪ Designers and developers of EHR systems, health standards, information models and related tooling.

Objectives

To understand:

▪ Why, where and how SNOMED CT can be bound to information models
▪ How SNOMED CT expression constraints can be used
▪ The types of terminology binding approaches
Agenda

- What is terminology binding?
- Why is it important?
- When should it be done?
- Where should it be stored/bound?
- How should it be represented?
- Types of binding and approaches
- Metadata
- Examples
- Questions
Agenda

- What is terminology binding?
  - Why is it important?
  - When should it be done?
  - Where should it be stored/bound?
  - How should it be represented?
  - Types of binding and approaches
  - Metadata
  - Examples
  - Questions
What is Terminology Binding?

A link between an *information model* artefact and a *terminology artefact*

- Information model artefacts
  - Data model
  - Data groups
  - Data elements
  - Data type attributes
  - Data values

- Terminology artefacts
  - Codes
  - Sets of codes
  - Expressions
  - Sets of expressions
Types of Information Models

Information system core models

- Models of use
  - User interface models
  - Information storage models

- Models of meaning
  - Regional clinical models
  - National clinical models
  - International clinical models
  - Reference information models

Communication models

- Message models
- Service models

Interoperability based on shared definitions

Data entry, storage and retrieval

Discover knowledge from clinical data

Computerized support of evidence based care

Analytics models

- Data warehouse models

Knowledge models

- Guideline definition models
- Rule models

Local

Global
Types of Terminologies

- **Interface terminologies**
  - Local code systems
  - MEDCIN
  - Categorical Health Information Structured Lexicon
  - SNOMED CT

- **Statistical Classifications**
  - ICD 9, 10, 11
  - ICPC
  - ICF

- **Data entry and retrieval display**
  - Statistics and reimbursement

- **Consistent representation of clinical meaning**
  - Other terminological resources
    - UMLS
    - MeSH

- **Reference terminology**
  - SNOMED CT
  - LOINC
Types of Terminology Binding

▪ Value set binding
  ▪ To record the set of possible values which can populate a given coded data element or attribute in the information model

▪ Model meaning binding
  ▪ To define the meaning of an information model artefact using a concept or expression from the terminology
Example

Fracture

- Type (coded text)
- Location (coded text)
- Laterality (coded text)
Example – Value Set Binding

### Fracture Type Value Set

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>123735002</td>
<td>displaced</td>
</tr>
<tr>
<td>307184009</td>
<td>undisplaced</td>
</tr>
<tr>
<td>52329006</td>
<td>open</td>
</tr>
<tr>
<td>20946005</td>
<td>closed</td>
</tr>
</tbody>
</table>

### Fracture Location Value Set

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>71341001</td>
<td>femur</td>
</tr>
<tr>
<td>85050009</td>
<td>humerus</td>
</tr>
<tr>
<td>118645006</td>
<td>pelvis</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

### Laterality Value Set

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7771000</td>
<td>left</td>
</tr>
<tr>
<td>24028007</td>
<td>right</td>
</tr>
<tr>
<td>51440002</td>
<td>bilateral</td>
</tr>
</tbody>
</table>

Diagram:

- Fracture
  - Type (coded text)
  - Location (coded text)
  - Laterality (coded text)
Example – Model Meaning Binding

- Fracture
  - Type (coded text)
  - Location (coded text)
  - Laterality (coded text)

- Fracture of bone
  - Associated morphology
  - Finding site
  - Laterality
Agenda

▪ What is terminology binding?
▪ **Why** is it important?
▪ When should it be done?
▪ Where should it be stored/bound?
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▪ Types of binding and approaches
▪ Metadata
▪ Examples
▪ Questions
Why?

1. Why terminology binding matters?
2. Why terminology binding is useful?
3. Why is understanding SNOMED CT important?
Why Terminology Binding Matters

- To support information retrieval & decision support, EHR information must be computable in a meaningful way.

- Reliable interpretation of meaning depends on:
  - The way information is structured
  - The way clinical concepts are represented
  - The way the terminology is used within the structure

- A consistent approach to the interface between structural and terminological representations of information is required.
Alternative representations

The same idea can be expressed in different ways

- Information structures to match different user-interfaces
  a) A SNOMED CT coded check-lists (‘yes’ ‘no’ ‘unknown’)  
  b) A SNOMED CT value list (e.g. ‘asthma’, ‘diabetes’)

- Combining different information model structures with different terminology components
  a) Entering a disorder into a ‘Past history’ section  
  b) Using a concept with a “Past” temporal context attribute

- Populating the same information model structure with different amounts of precoordination
Semantically Equivalent Models

e.g. “Suspected Lung Cancer”
Semantically Equivalent Instances

e.g. “Suspected Lung Cancer”

Model Hierarchy

Problem Diagnosis

Problem Diagnosis Name

Location Details

Body Site

Laterality

Finding Context

Temporal Context

Subject Relationship Context

<table>
<thead>
<tr>
<th>General Practice</th>
<th>Polyclinic</th>
<th>Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>cancer</td>
<td>suspected cancer</td>
<td>suspected lung cancer</td>
</tr>
<tr>
<td>lung</td>
<td>lung</td>
<td></td>
</tr>
<tr>
<td>suspected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Alternative Representations

Different structure/terminology combinations may lead to similar information being missed when retrieving.

**Family history of asthma**
- Family history *check-list* with ‘asthma’ marked ‘yes’
- Family history *section* referring to the concept ‘asthma’
- *Record entry* referring to the concept ‘family history of asthma’
- *Record entry* containing an expression such as ‘family history : associated finding = asthma’
- *Record entry* containing the concept ‘asthma’ with an associated field to record the ‘family member’

*To avoid false negatives different representations must be transformed to a common model*
Alternative Representations

Risk of ambiguity from alternative interpretations

Absent Finding

- Information model attributes may indicate ‘absence’ or ‘negation’
- SNOMED CT finding context can represent ‘known absent’
- Does the combination of two representations of absence mean …
  - double-negative
  - redundant restatement of the negative
  - additional emphasis of the negative
- Logical interpretation (double-negative) may not be what was intended
- It may not be clear which concepts are ‘negative’
  - E.g. ‘conscious’ ‘not conscious’
  - ‘unconscious’ ‘no loss of consciousness’

To avoid misinterpretation there need to be clear rules about the way information model and terminology semantics combine
Balancing Structure and Terminology

- **Terminology model**
  - Preferred Terminology options (structural options deprecated)
  - Grey area (preference unclear or dependent on use case)
  - Preferred Structural options (terminology options deprecated)
- **Structural model**
<table>
<thead>
<tr>
<th>Terminology Model</th>
<th>What, how and why</th>
</tr>
</thead>
<tbody>
<tr>
<td>+++</td>
<td>Disease, Symptom, Sign, Procedure, Body structure, Morphology, Substance, Drug, Device, Organism</td>
</tr>
</tbody>
</table>
| ++| Semantic constraints  
    Refinement of concepts (e.g. laterality) |
| +| Clinical situations (context), Present/Absent/Uncertain, Family history, Past history, Requested/Planned/Done |
| ++| Relationships between record entries  
    Structural constraints on classes or attributes |
| +++| Dates, Times, Durations, Quantities, Text & markup, Instances of People, Organizations and Places |

| Structural Model | Who, when and where |
Why is Terminology Binding Useful?

Terminology binding is important whenever the link between information model and terminology is significant in achieving specific business or clinical objectives.

- Data capture
- Retrieval and querying
- Information model library management
- Semantic interoperability
Data Capture

- Data entry using value sets
- Data entry guided by decision support
- Data entry with exception handling
- Consistency of data entry
Retrieval and Querying

Analytics over valid values

Analytics over model meaning

Analytics over context-specific data

Analytics over data with different amounts of precoordination
Information Model Library Management

- Search information models based on meaning
- Identify semantic overlap between models
- Validation between model dependencies
Semantic Interoperability

- Message conformance testing
- Sharing data with similar models and value sets
- Sharing data with different models or value sets
Why is Understanding SNOMED Important?

▪ Understanding SNOMED CT’s content, structure and principles is required to create consistent terminology bindings.

▪ Consistent concept selection is a prerequisite for meaningful entry, querying and communication of patient information.
Inconsistent Terminology Binding

- **Patient position (enumeration)**
  - prone
  - right
  - back
  - left

  - 229824005 Positioning patient (Procedure)
  - 1240000 Prone body position (finding)
  - 24028007 Right (qualifier value)
  - 77568009 Back structure, excluding neck (body structure)
  - 7771000 Left (qualifier value)
Inconsistent Terminology Binding

Patient position (enumeration)

- prone
- right
- back
- left

SNOMED CT

- body structure
- procedure
- clinical finding
- qualifier value

Positioning patient

- prone body position
- left
- right

back structure, excluding neck
Consistent Terminology Binding

Patient position (enumeration)

- prone
- right
- back
- left

Positioning patient (Procedure)

Prone body position (finding)

Right (qualifier value)

Back structure, excluding neck (body structure)

Position of body and posture interprets:

- Lying on back
- Prone body position
- Left lateral tilt
- Right lateral tilt

Clinical finding

Observable entity
Consistent Terminology Binding

Patient position (enumeration)

- prone
- right
- back
- left

271605009 position of body and posture (observable entity)

1240000 prone body position (finding)

415346000 right lateral tilt (finding)

40199007 lying on back (finding)

414585002 left lateral tilt (finding)
Inconsistent Terminology Binding

Fracture
- Code (coded text)
  - Code: 72704001 fracture (morphologic abnormality)
- Type (coded text)
  - Type: 125605004 fracture of bone (finding)
- Location (coded text)
  - Location: 410656007 type (property) (qualifier value)
- Laterality (coded text)
  - Laterality: 246267002 location (attribute)
  - Laterality: 272741003 laterality (attribute)
Inconsistent Terminology Binding

- Fracture
  - Code (coded text)
  - Type (coded text)
  - Location (coded text)
  - Laterality (coded text)
Consistent Terminology Binding

- Fracture
  - Code (coded text)
  - Type (coded text)
  - Location (coded text)
  - Laterality (coded text)
Consistent Terminology Binding

Fracture

- Code (coded text)
  - 125605004 fracture of bone (finding)

- Type (coded text)
  - 116676008 associated morphology

- Location (coded text)
  - 363698007 finding site

- Laterality (coded text)
  - 272741003 laterality
Consistent Terminology Binding

Fracture

- Code (coded text)
  - 125605004 fracture of bone (finding)

- Type (coded text)
  - 125605004 fracture of bone (finding)

- Location (coded text)
  - 72704001 fracture (morphologic abnormality)

- Laterality (coded text)
  - 91723000 anatomical structure (body structure)

- Side (qualifier value)
  - 182353008 side (qualifier value)
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Historical misconceptions

Our EHR information model is terminology independent

Our clinical terminology can be used in any health record information model

- Component
  - Entry
  - Observation
  - Evaluation
  - Cluster
  - Blood pressure

- Concept
  - Finding
    - Flu
  - Otitis
  - Procedure
    - Appendectomy
A meaningful Electronic Health Record requires the SNOMED CT terminology model to be appropriately bound to a consistently designed structural information model.
Recognising interdependencies

- Practical consequences of interdependency between terminology and structural information models are often underestimated
  - Information models cannot be terminology neutral
  - Implementing SNOMED CT depends on a tight integration with standard information models
- Developers of clinical terminologies and clinical information models should adopt policies that facilitate ‘dependency aware evolution’

There must be collaborative development between the SNOMED CT Concept Model and an information model in order for effective implementation of SNOMED CT
Siloed Design Process

- Requirements
- Health care professionals
- Use cases
- Information models
- Value sets, Terminology
- Terminology bindings
- Modelling
- Information modellers
- Terminologists
Collaborative Design Process

Requirements

Terminologists

Health care professionals

Use cases

Information models ('terminology-aware' with example value set bindings)

Information models with complete terminology binding

Modelling

Information modellers

Terminology bindings

Terminologists
Agenda

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Where

- Where should bindings be stored?
- Where in a model do bindings go?
Where Should Bindings be Stored?

1. In the information model
2. In the terminology
3. Independent of both
4. Split between information model & terminology
Bindigns in the Information Model

Information Model

Terminology

Fracture

- Code (coded text)
  - 125605004 fracture of bone

Type (coded text)

- Fracture type value set
  - 123735002 displaced
  - 307184009 undisplaced
  - 52329006 open
  - 20946005 closed

Location (coded text)

- Fracture location value set
  - < 272673000 |bone structure|

Laterality (coded text)

- Laterality value set
  - < 272741003 |laterality|
Bindings in the Terminology

Information Model

Fracture
- Code (coded text)
- Type (coded text)
- Location (coded text)
- Laterality (coded text)

Terminology

Binding Reference Set

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>&lt;uuid&gt;</td>
</tr>
<tr>
<td>effectiveTime</td>
<td>20141031</td>
</tr>
<tr>
<td>active</td>
<td>1</td>
</tr>
<tr>
<td>moduleld</td>
<td>449080006</td>
</tr>
<tr>
<td>refsetld</td>
<td>2567891002</td>
</tr>
<tr>
<td>referenced Component</td>
<td>10013000</td>
</tr>
<tr>
<td>Model</td>
<td>ihtsdo.fracture.v1</td>
</tr>
<tr>
<td>Model Component</td>
<td>id3</td>
</tr>
</tbody>
</table>

Fracture type reference set

- 123735002 displaced
- 307184009 undisplaced
- 52329006 open
- 20946005 closed
### Bindings Stored Independently

**Information Model**

- **Fracture**
  - Code (coded text)
  - Type (coded text)
  - Location (coded text)
  - Laterality (coded text)

**Terminology**

<table>
<thead>
<tr>
<th>Fracture Type Reference Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>123735002</td>
</tr>
<tr>
<td>307184009</td>
</tr>
<tr>
<td>52329006</td>
</tr>
<tr>
<td>20946005</td>
</tr>
</tbody>
</table>

**Information Model Binding**

<table>
<thead>
<tr>
<th><strong>Id</strong></th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td>ihtsdofracture.v1</td>
</tr>
<tr>
<td><strong>Model Component</strong></td>
<td>id3</td>
</tr>
<tr>
<td><strong>Code System</strong></td>
<td><a href="http://snomed.info/sct">http://snomed.info/sct</a></td>
</tr>
<tr>
<td><strong>Binding Expression</strong></td>
<td>^10013000</td>
</tr>
<tr>
<td><strong>Binding Type</strong></td>
<td>value set</td>
</tr>
</tbody>
</table>
Split Between Information Model and Terminology

**Information Model**

- Fracture
  - Code (coded text)
  - Type (coded text)
  - Location (coded text)
  - Laterality (coded text)

**Terminology**

- Fracture code value set
  - 125605004 | fracture of bone |
- Fracture type value set
  - 123735002 | displaced |
  - 307184009 | undisplaced |
  - 52329006 | open |
  - 20946005 | closed |
- Fracture location value set
  - < 272673000 | bone structure |
- Laterality value set
  - < 272741003 | laterality |
  - 272741003 | laterality |
Where in a Model do Bindings go?

1. Model Meaning Bindings
   - Model, data group or data element

2. Value Set Bindings
   - Only coded text elements or data type attributes

<table>
<thead>
<tr>
<th>Coded Text Attribute</th>
<th>Example Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>code</td>
<td>78564009</td>
</tr>
<tr>
<td>term</td>
<td>“Pulse rate”</td>
</tr>
<tr>
<td>uri</td>
<td><a href="http://snomed.info/id/78564009">http://snomed.info/id/78564009</a></td>
</tr>
<tr>
<td>terminology (codeSystem)</td>
<td>FHIR/CIMI: <a href="http://snomed.info/sct">http://snomed.info/sct</a></td>
</tr>
<tr>
<td></td>
<td>HL7 v3: 2.16.840.1.113883.6.96</td>
</tr>
<tr>
<td>terminologyVersion (codeSystemVersion)</td>
<td><a href="http://snomed.info/sct/900000000000207008/version/20140731">http://snomed.info/sct/900000000000207008/version/20140731</a></td>
</tr>
</tbody>
</table>
Agenda

- What is terminology binding?
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SNOMED CT Languages

- Compositional Grammar
  - To define a SNOMED CT expression

- Expression Constraint Language
  - To constrain the set of possible concepts or expressions

- Query Language
  - To query over SNOMED CT content

- Template Language
  - To incorporate ‘slots’ to be filled at a later time
SNOMED CT Languages

- Compositional Grammar
  - To define a SNOMED CT expression

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  - To query over SNOMED CT content

- Template Language
  - To incorporate ‘slots’ to be filled at a later time
Expression Constraint Language*

To constrain the set of possible concepts or expressions

- **Expression Constraint**: A computable rule that can be used to define a set of concepts or expressions

- **Use cases**:
  - Constrain content of a particular data element in an EHR
  - Create a machine processable query over SNOMED CT concepts
  - Define an intensional reference set
  - Define a range constraint in the SNOMED CT concept model

* Draft language available for comment early 2015
## Expression Constraint Language

<table>
<thead>
<tr>
<th>Text</th>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>memberOf</td>
<td>^</td>
<td>Member of ref set</td>
</tr>
<tr>
<td>and</td>
<td>and</td>
<td>Intersection</td>
</tr>
<tr>
<td>or</td>
<td>or</td>
<td>Union</td>
</tr>
<tr>
<td>and not</td>
<td>and !</td>
<td>Exclusion</td>
</tr>
<tr>
<td>descendantOf</td>
<td>&lt;</td>
<td>Descendants</td>
</tr>
<tr>
<td>descendantOrSelfOf</td>
<td>&lt;&lt;</td>
<td>Descendants or self</td>
</tr>
<tr>
<td>ancestorOf</td>
<td>&gt;</td>
<td>Ancestors</td>
</tr>
<tr>
<td>ancestorOrSelfOf</td>
<td>&gt;&gt;</td>
<td>Ancestors or self</td>
</tr>
<tr>
<td>[X .. Y], [X .. Many]</td>
<td>[X .. Y], [X .. *]</td>
<td>Cardinality (e.g. [0..*])</td>
</tr>
<tr>
<td>reverseOf</td>
<td>R</td>
<td>Reverse relationship</td>
</tr>
<tr>
<td>“..”</td>
<td>“..”</td>
<td>Text string</td>
</tr>
<tr>
<td>#..</td>
<td>#..</td>
<td>Number</td>
</tr>
</tbody>
</table>
Expression Constraint Language

- **Examples:**
  - \(^{700043003} \text{problem list reference set}\)
  - <<= 71388002 \text{procedure}:
    - 363698007 \text{finding site} = <<= 80891009 \text{heart structure}
  - <19829001 \text{disorder of lung} \text{AND} !
    - \(^{152725851000154106} \text{cardiology reference set}\)
  - <<= 404684003 \text{clinical finding}:
    - 116676008 \text{associated morphology} = <<= 55641003 \text{infarct} \text{OR}
    - 42752001 \text{due to} = <<= 22298006 \text{myocardial infarction}
  - < 373873005 \text{pharmaceutical / biologic product}:
    - 
      - \([3..*]\) 127489000 \text{has active ingredient} = < 105590001 \text{substance}
    - < 105590001 \text{substance}:
      - R (127489000 \text{has active ingredient} = 111115 \text{TRIPHASIL tablet})
Template Language*

* Draft language available for comment 2015

To incorporate slots to be filled at a later time

- **Use cases:**
  - Defining reusable patterns for pre- or post-coordination
  - Defining information model constraints
  - Transforming between equivalent information models

- **Expression Template Examples:**
  - `[[ $diagnosis]]: 363698007 |finding site| = [[$bodySite]]`
  - `[[ << 64572001 |disease| ]]:: 363698007 |finding site| = [[ < 91723000 |anatomical structure | ]]`

- **Expression Constraint Template Example:**
  - `<< [[$procedure]]`
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Types of Terminology Binding

- **Value set binding**
  - To record the set of possible values which can populate a given coded data element or attribute in the information model

- **Model meaning binding**
  - To define the meaning of an information model artefact using a concept or expression from the terminology
Types of value set binding

▪ Simple
  ▪ The data element has a single value set
  ▪ Extensional or intensional

▪ Conditional
  ▪ Which value set is used depends on a condition

▪ Dependency
  ▪ The value of a data element depends on another value

▪ Compositional
  ▪ The value of a data element is composed from other values
Value Set Binding - Simple

Information model artefact

- Observation
  - Observation code (coded text)
  - Reason (coded text)
  - Priority (coded text)
  - Method (coded text)
  - Status (coded text)
  - Result (quantity)
    - value (number)
    - units (coded text)

Value Set Binding

- Metadata
  - xxx |observation reference set|
  - xxx |reason reference set|
  - xxx |priority reference set|
  - xxx |method reference set|
  - xxx |status reference set|

Terminology artefact

- xxx |observation units reference set|
Value Set Binding - Simple

Information model artefact | Value Set Binding | Terminology artefact
--- | --- | ---
Observation | Metadata | http://loinc.org
  | Observation code (coded text) | Metadata | xxx | reason reference set|
  | Reason (coded text) | Metadata | xxx | priority reference set|
  | Priority (coded text) | Metadata | xxx | method reference set|
  | Method (coded text) | Metadata | xxx | status reference set|
  | Status (coded text) | Metadata | xxx | observation units reference set|
  | Result (quantity) | Metadata | |
Value Set Binding - Simple

Information model artefact | Value Set Binding | Terminology artefact
---|---|---
Observation | Observation code (coded text) | Metadata | < 363787002 | observable entity |
Reason (coded text) | Metadata | < 404684003 | clinical finding |
Priority (coded text) | Metadata | OR < 71388002 | procedure |
Method (coded text) | Metadata | < 272125009 | priorities |
Status (coded text) | Metadata | < 129264002 | action |
Result (quantity) | value (number) | Metadata | < 288532009 | context values for actions |
| units (coded text) | Metadata | ^258666001 | units reference set |
Value Set Binding - Conditional

Patient’s sex determines which Procedure reference set to use.

Information model artefact
- Discharge Summary
  - Patient
    - Patient id (identifier)
    - Patient name (string)
    - Sex (coded text)
  - Past procedures
    - Procedure (coded text)
    - Date (date)

Conditional Value Set Binding
- If [$\text{Sex} = 248153007$ | male]
- If [$\text{Sex} = 248152002$ | female]
- If [$\text{Sex} \neq 248153007$ | male] and [$\text{Sex} \neq 248152002$ | female]

Terminology artefact
- xxx | male procedure reference set
- xxx | female procedure reference set
- xxx | all procedures reference set
Value Set Binding - Dependent

Procedure type must be a descendant of Procedure Category

Procedure Category (coded text)
Procedure Type (coded text)
Patient id (identifier)
Procedures
Discharge Summary

Terminology artefact
< [[ $ProcedureCategory ]]
Value Set Binding - Compositional

Transforming data from one model to another
Types of model meaning binding

▪ Simple with context
  ▪ The meaning (and context) of each model
▪ Concept Domains
  ▪ The SNOMED CT domain from which values are selected
▪ Attribute and Range
  ▪ The relationship type and (optionally) concept domain
▪ Expression Template
  ▪ The meaning of each data group instance
Model Meaning Binding – Simple

Information model artefact  |  Model Meaning Binding  |  Terminology artefact

- **Heart rate**
  - Observation code (coded text)
  - Reason (coded text)
  - Priority (coded text)
  - Method (coded text)
  - Status (coded text)
  - Result (quantity)

Metadata

- **364075005**
  - heart rate

Searching information model libraries
- e.g. Find all ‘Cardiovascular observation’ models
Analytics over meaning of model
- e.g. Find everything that has been requested
Model Meaning Binding – Context (2)

Information model artefact
- Observation
  - Observation code (coded text)
  - Reason (coded text)
  - Priority (coded text)
  - Method (coded text)
  - Status (coded text)
  - Result (quantity)

Model Meaning Binding
- Metadata
  - Metadata (context wrapper)

Terminology artefact
- 363787002 [observable entity]
- 243796009 [situation with explicit context]
- 408730004 [procedure context]

Analytics over meaning of model
- e.g. Find everything that has been requested
Analytics over meaning of model
- e.g. Find everything that has been requested
Query, semantic overlap and inconsistency between models
Helps to generate and validate value bindings
Model Meaning Binding – Attribute Range

Information model artefact | Model meaning Binding | Terminology artefact
--- | --- | ---
Observation | Metadata | 36378002 ['observable entity']
Observation code (coded text) | Metadata | 11668003 is a 36378002 ['observable entity']
Reason (coded text) | Metadata | 363702006 has focus 404684003 ['clinical finding']
Priority (coded text) | Metadata | 260870009 priority 272125009 ['priorities']
Method (coded text) | Metadata | 260686004 method 129264002 ['action']
Status (coded text) | Metadata (context) | 408730004 procedure context 288532009 ['context values for actions']
Result (quantity) | Metadata | 

Allows pre-coordinated concepts or expressions to be decomposed into structure

Note: ‘Close to user’ form may need transformation to be Concept Model valid
Individual concepts can be combined into a single expression

Note: ‘Close to user’ form may need transformation to be Concept Model valid
Agenda

- What is terminology binding?
- Why is it important?
- When should it be done?
- Where should it be stored/bound?
- How should it be represented?
- Types of binding and approaches

- Metadata
- Examples
- Questions
Value Set Binding - Metadata

- Regional scope
- Extensibility
  - Extensible by specialisation only
  - Extensible by extension only
  - Not extensible
  - Example only
- Coded Text value pattern
  - Specifies how each attribute in Coded Text datatype is populated
- Versioning
  - Information model, Terminology, Binding
- Substrate of expression constraints
  - Module, edition, extension, version
- Fixed, Default, Assumed value
- Literal or semantic (eg other equivalent codes acceptable)
- Only precoordinated concepts / Postcoordinated expressions allowed
Agenda

▪ What is terminology binding?
▪ Why is it important?
▪ When should it be done?
▪ Where should it be stored/bound?
▪ How should it be represented?
▪ Types of binding and approaches
▪ Metadata
▪ Examples
▪ Questions
Terminology Binding Examples

1. Health Level 7 (HL7)
   a) FHIR (Fast Healthcare Interoperability Resources)
   b) TermInfo

2. Archetype Definition Language (ADL)

3. Archetype Modelling Language (AML, UML)

4. Binding Terminology to User Interfaces
**Procedure (Resource)**
- identifier: Identifier 0..*
- subject: Resource(Patient) 1..1
- type: CodeableConcept 1..1
- bodySite: CodeableConcept 0..*
- indication: CodeableConcept 0..*
- date: Period 0..1
- encounter: Resource(Encounter) 0..1
- outcome: string 0..1
- report: Resource(DiagnosticReport) 0..*
- complication: CodeableConcept 0..*
- followUp: string 0..1
- notes: string 0..1

**Performer**
- person: Resource(Practitioner) 0..1
- role: CodeableConcept 0..1

**RelatedItem**
- type: code 0..1 <<ProcedureRelationshipType>>
- target: Resource(AdverseReaction)
- [AllergyIntolerance | CarePlan | Condition | DeviceObservationReport | DiagnosticReport | FamilyHistory | ImagingStudy | Immunization | ImmunizationRecommendation | MedicationAdministration | MedicationDispense | MedicationDispense | MedicationDispense | MedicationDispense | MedicationDispense | Procedure] 0..1

**Terminology Bindings**

<table>
<thead>
<tr>
<th>Path</th>
<th>Definition</th>
<th>Type</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure.relatedItem.type</td>
<td>The nature of the relationship with this procedure</td>
<td>Fixed</td>
<td><a href="http://hl7.org/fhir/procedure-relationship-type">http://hl7.org/fhir/procedure-relationship-type</a></td>
</tr>
</tbody>
</table>

**Value Set: Procedure Relationship Type**

<table>
<thead>
<tr>
<th>Code</th>
<th>Display</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>caused-by</td>
<td></td>
<td>This procedure had to be performed because of the related one.</td>
</tr>
<tr>
<td>because-of</td>
<td></td>
<td>This procedure caused the related one to be performed.</td>
</tr>
</tbody>
</table>
HL7 – TermInfo

- Provides guidance for the use of SNOMED CT in:
  - HL7 V3 Clinical Statement Pattern & CDA R2
  - How to deal with overlaps between RIM and SNOMED CT
  - Set of examples & patterns for common clinical statements
  - Constraints on SNOMED CT concepts applicable to relevant attributes in Clinical Statement Pattern

```xml
<observation classCode="OBS" moodCode="EVN">
  <code code="ASSERTION" codeSystem="2.16.840.1.113883.5.4"/>
  <text>Headache</text>
  <value xsi:type="CD" code="25064002" codeSystem="2.16.840.1.113883.6.96" displayName="Headache"/>
</observation>
```
Archetype Definition Language

- ADL 1.4 published as part of ISO13606 standard
- ADL 2.0 includes enhancements added by openEHR
- Value Set Bindings:
  terminology
  term_bindings = <
      [“snomedct”] = <
      [“at2”] = <http://snomed.info/id/78564009>
      [“ac3”] = <http://snomed.info/id/12394009>>
      ["id5.0.3"] = <http://snomed.info/id/363702006>>
### Classification of diabetic retinopathy during screening

**Structure:** Cluster  
Mandatory (1..1)  
Cardinality: Mandatory, repeating, unordered (1..*)

**DR screening**

<table>
<thead>
<tr>
<th>Coded Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional (0..1)</td>
</tr>
<tr>
<td>[SNOMED-CT::134395001] (Diabetic retinopathy screening (procedure))</td>
</tr>
</tbody>
</table>

Identification of presence or absence of diabetic retinopathy during screening. This classification has been grounded considering the characteristics of category 1 regarding the recommendations provided by the ATA.

- **No apparent DR** [ETDRS Levels of DR 10, 14, 15; DR absent]  
  [SNOMED-CT::2011410000000103]  
- **Diabetic retinopathy apparent**  
  [Level above 20 from the ETRDS classification]  
  [SNOMED-CT::4855003] (Diabetic retinopathy (disorder))  
- **DR not assessable** [The test is not assessable due to the low quality of acquisitions or uncertainty of the evaluator]

**Comments**

<table>
<thead>
<tr>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional (0..1)</td>
</tr>
</tbody>
</table>

Comments directed to reviewers specialized on DR screening. It may include test details or issues that provoke uncertainty while classifying the disease. It is useful as feedback channel to improve the quality of the DR screening service.
Archetype Modelling Language (AML)

**Goal:** To create a standard for modelling Archetype Models (AMs) using UML to support the representation of Clinical Information Modelling Initiative (CIMI) artefacts in UML.

**Process:** Being submitted for standardisation to OMG

**Profiles:**
- Reference Model Profile (RMP)
- Constraint Model Profile (CMP)
- Terminology Binding Profile (TMP)
AML Terminology Binding Profile

Pulse

attributes
+rate : Integer
+presence : PRESENCE
regularity : REGULARITY

«Constrains»

«ComplexObjectConstraint»
RestingPulse
{about = Pulse Rate,
id = ID3}

Pulse Rate : ConceptReference

describingCodeSystem = SNOMED_CT_INTL_20140731
description = 78564009_en
id = 78564009
uri = "http://snomed.info/id/78564009"

20140731 : CodeSystemVersionReference

uri = "http://snomed.info/sct/9000000000000000207008/version/20140731"

SNOMED_CT_INTL_20140731 : CodeSystemReference

uri = "http://snomed.info/sct/9000000000000000207008"
version = 20140731

78564009_en : ItemDescription

language = EN
sign = "Pulse Rate"
Binding Terminology to User Interfaces

- User interfaces should make it easy to enter data
  - Needs to be tailored to the way different clinicians work and think

- Data storage should enable effective retrieval and reuse
  - Retrieval must have answers that are:
    - Accurate – No false negatives
    - Precise – No false positives
    - Timely – Available when needed
    - Efficient – Without disproportionate time and effort
    - Consistent – Independent of how the data was entered
  - Storage design must represent similar types of information in the same way irrespective of the method of data entry
Binding Terminology to User Interfaces

- Balance interface design and information retrieval

  How easy is it to answer simple questions?

  *Does the patient have a family history of diabetes mellitus?*

```
<table>
<thead>
<tr>
<th>Family history</th>
<th>Patient: XXXX-YYYY</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Diabetes Mellitus</td>
<td></td>
</tr>
<tr>
<td>□ Hypertension</td>
<td></td>
</tr>
<tr>
<td>□ ...</td>
<td></td>
</tr>
</tbody>
</table>
```

- Code:
  - 150265008 |family history taken (situation)|
  - 73211009 |diabetes mellitus (disorder)|
Balance interface design and information retrieval

How easy is it to answer simple questions?

Does the patient have a family history of diabetes mellitus?

- Diabetes Mellitus
- Hypertension
- ...

150265008 |family history taken (situation)|

160303001 |family history: diabetes mellitus (situation)|
Binding Terminology to User Interfaces

- Balance interface design and information retrieval
  How easy is it to answer simple questions?

*Does the patient have normal blood pressure?*

**Clinical data entry template**

Blood Pressure Form

- Blood pressure:
  - Normal
  - Decreased
  - Increased

**Data storage**

- 75367002 |blood pressure (observable entity)|
- 17621005 |normal (qualifier)|
Binding Terminology to User Interfaces

- Balance interface design and concept selection
  How easy is it to answer simple questions?
  *Does the patient have normal blood pressure?*

Clinical data entry template

- Blood Pressure Form
  - Blood pressure:
    - Normal
    - Decreased
    - Increased

Data storage

- 75367002 |blood pressure (observable entity)|
- 2004005 |normal blood pressure (finding)|
SNOMED CT Use in Information Models

- For more information please refer to:
  - SNOMED CT Starter Guide: [www.snomed.org/sg.pdf](http://www.snomed.org/sg.pdf)