



# Concept IRIs in FHIR

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Jul 18, 2022

Slides: <https://bit.ly/fhir-rdf-concept-iris-july-2022-slides>

Full details: <https://bit.ly/fhir-rdf-concept-iris-july-2022>




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# OLS ONTOLOGY SEARCH

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OLS / Experimental Factor Ontology EFO / EFO:0003035 Copy 

## cellulitis

Search EFO  Search

[http://www.ebi.ac.uk/efo/EFO\\_0003035](http://www.ebi.ac.uk/efo/EFO_0003035) Copy

Inflammation of the dermis and subcutaneous tissues caused by a bacterial infection. Symptoms include erythema, edema, and pain to the affected area. [ NCIT : C26715 ]

**Synonyms:** cellulitis cellulitis (disease) Other cellulitis and abscess

Tree view **Term mappings**

- experimental factor
  - material property
    - disposition
      - disease
        - infectious disease or post-infectious disorder
          - infectious disease
            - bacterial disease
              - skin disease caused by bacterial infection
                - cellulitis**
              - skin disorder caused by infection
                - skin disease caused by bacterial infection
                  - cellulitis**
- injury
  - toxicity
    - infectious disease

### Term information

**database cross reference**

- SNOMEDCT:385627004
- HP:0100658 (MONDO:otherHierarchy)
- MeSH:D002481
- MESH:D002481 (MONDO:equivalentTo)
- MedDRA:10007882
- MONDO:0005230
- ICD9:682.8 (MONDO:relatedTo)
- ICD10:L03
- SNOMEDCT:128045006
- Wikipedia:Cellulitis (EFO:0003035)
- SCTID:128045006 (MONDO:equivalentTo)
- NCIt:C26715

# The Linked Data world: cellulitis

The image displays four browser windows illustrating the linked data world for cellulitis:

- OLS (Ontology Search):** Shows a search for "cellulitis" with a highlighted URL: [http://www.ebi.ac.uk/efo/EFO\\_0003035](http://www.ebi.ac.uk/efo/EFO_0003035). The search results show "cellulitis" as a disease, with a tree view showing its classification under "infectious disease or parasitic disease" and "bacterial disease".
- SNOMED CT Browser:** Shows the definition of "cellulitis" (Q876887) as "Bacterial infection of the skin". It also lists "All entered languages" and "Statements" (instance of).
- Wikidata:** Shows the Wikidata page for "cellulitis" (Q876887), which is an instance of the SNOMED CT identifier (128045006).
- Wikidata Query Service:** Shows a SPARQL query: 

```
SELECT * WHERE {
  ?article wdt:n:P5806 <http://snomed.info/id/128045006>
}
```

 The query results show "1 result in 46 ms" and the article "wd:Q876887".

<http://snomed.info/id/128045006>

# Concept IRIs are widely used in RDF

## Form

URIs for components, based on the corresponding SCTID, take the following form:

`http://snomed.info/id/{sctid}`

URIs for members of a Reference Set, based on the corresponding UUID, take the following form:

`http://snomed.info/id/{uuid}`

For simplicity this document refers to either of the above forms as a *component URI*.

## Examples

The following table shows some examples of URIs for components and reference set members.

Table 2.2-1: Examples

| Resource   | URI  |
|--|--|
| The concept 74400008   Appendicitis              | <code>http://snomed.info/id/74400008</code>  |
| The description "Appendicitis" with id=123558018 | <code>http://snomed.info/id/123558018</code> |

IRI Stem

`http://snomed.info/id/128045006`

Code

# Coding.system/code pairs → Concept IRIs

| Codesystem/NamingSystem  | Coding.system   | Coding.code | Coding.display        |
|--|---|-------------|-----------------------|
| SNOMED CT<br><a href="https://terminology.hl7.org/2.0.0/CodeSystem-v3-snomed-CT.html">https://terminology.hl7.org/2.0.0/CodeSystem-v3-snomed-CT.html</a> | <a href="http://snomed.info/sct">http://snomed.info/sct</a> | 128045006   | Cellulitis (disorder) |



???

# Examples

Proposal: Add to HL7 Terminology website



| Coding.system  | Coding.code | IRI Stem  | Concept IRI   |
|--|-------------|---|---|
| ICD 10:<br><a href="http://hl7.org/fhir/sid/icd-10">http://hl7.org/fhir/sid/icd-10</a>   | G44.1       | <a href="http://purl.bioontology.org/ontology/ICD10/">http://purl.bioontology.org/ontology/ICD10/</a> | <a href="http://purl.bioontology.org/ontology/ICD10/G44.1">http://purl.bioontology.org/ontology/ICD10/G44.1</a> |
| SNOMED CT:<br><a href="http://snomed.info/sct">http://snomed.info/sct</a>  | 128045006   | <a href="http://snomed.info/id/">http://snomed.info/id/</a>   | <a href="http://snomed.info/id/128045006">http://snomed.info/id/128045006</a>                                   |
| MeSH:<br><a href="https://www.nlm.nih.gov/mesh">https://www.nlm.nih.gov/mesh</a>   | D000305     | <a href="https://id.nlm.nih.gov/mesh/">https://id.nlm.nih.gov/mesh/</a>                               | <a href="https://id.nlm.nih.gov/mesh/D000305">https://id.nlm.nih.gov/mesh/D000305</a>                           |
| LOINC: <a href="http://loinc.org">http://loinc.org</a>   | 35217-9     | <a href="https://loinc.org/rdf/">https://loinc.org/rdf/</a>   | <a href="https://loinc.org/rdf/35217-9">https://loinc.org/rdf/35217-9</a>                                       |
|  |             | Regional example  |   |
| Example of a code containing non-ASCII characters<br><a href="http://नारायणहृदयालय.example/">http://नारायणहृदयालय.example/</a> | हृदय        | <a href="http://नारायणहृदयालय.example/code/">http://नारायणहृदयालय.example/code/</a>                   | <a href="http://नारायणहृदयालय.example/code/हृदय">http://नारायणहृदयालय.example/code/हृदय</a>                     |

# IRIs vs URIs vs URLs

|     |   |   |                          |
|-----|---|---|--------------------------|
| IRI | <code>http://नारायणहृदयालय.example/code/हृदय</code>   | <b>Does not allow</b> characters that are significant in IRIs (such as spaces, '#', '/') but <b>allows</b> Unicode characters (including non-Latin characters). | <a href="#">RFC 3987</a> |
| URI | <code>http://xn--g2bge2acacu4d4bbf6d.example/code/%E0%A4%B9%E0%A5%83%E0%A4%A6%E0%A4%AF</code>   | Only allows ASCII characters.   | <a href="#">RFC 3986</a> |
| URL | <a href="http://xn--g2bge2acacu4d4bbf6d.example/code/%E0%A4%B9%E0%A5%83%E0%A4%A6%E0%A4%AF">http://xn--g2bge2acacu4d4bbf6d.example/code/%E0%A4%B9%E0%A5%83%E0%A4%A6%E0%A4%AF</a> | Only allows ASCII characters.   | <a href="#">RFC 3986</a> |
| URN | <code>urn:ietf:rfc:3986</code>  | Only allows ASCII characters.   | <a href="#">RFC 8141</a> |

# Who would this benefit?

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- RDF developers
- Any other applications that prefer to use a single identifier per concept, instead of a System + Code pair
- Anyone wanting to follow [Web Architecture](#):

***Good practice: Identify with URIs***

*To benefit from and increase the value of the World Wide Web, agents should provide URIs as identifiers for resources.*



# Additions needed

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1. Designate an *Identifier.system* value for IRI Stems in CodeSystems (e.g. “<https://terminology.hl7.org/IdentifierSystem/IRIstem>”).
2. Designate “`urn:ietf:rfc:3987`” as an `Coding.system` value for IRIs in <https://build.fhir.org/identifier-registry.html> to be used where the `Coding.code` is already an IRI.
3. Add an “IRIstem” value to the `NamingSystemIdentifierType`, allowing it to be used as a value in the `NamingSystem.uniqueId.type` field in NamingSystems.

(Full details in <https://bit.ly/fhir-rdf-concept-iris-july-2022>)

35 lines (34 sloc) | 1.8 KB

Raw Blame

```
1 <?xml version="1.0" encoding="UTF-8"?>
2
3 <CodeSystem xmlns="http://hl7.org/fhir">
4   <id value="v3-snomed-CT"/>
5   <language value="en"/>
6   <extension url="http://hl7.org/fhir/StructureDefinition/codesystem-properties-mode">
7     <valueCode value="not-present"/>
8   </extension>
9   <url value="http://snomed.info/sct"/>
10  <identifier>
11    <system value="urn:ietf:rfc:3986"/>
12    <value value="urn:oid:2.16.840.1.113883.6.96"/>
13  </identifier>
14  <identifier>
15    <use value="usual"/>
16    <system value="https://terminology.hl7.org/temporary/CodeSystem/IRIstem"/>
17    <value value="http://snomed.info/id"/>
18  </identifier>
19  <version value="3.2.0"/>
20  <name value="SNOMED_CT_INT"/>
21  <title value="SNOMED CT International Edition"/>
22  <status value="active"/>
23  <date value="2020-11-03"/>
24  <publisher value="International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International"/>
25  <contact>
26    <name value="International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International"/>
27    <telecom>
28      <system value="email"/>
29      <value value="info@snomed.org"/>
30    </telecom>
31  </contact>
```

```
11 <extension url="http://terminology.hl7.org/StructureDefinition/ext-namingsystem-version">
12   <valueString value="3.1.0"/>
13 </extension>
14 <name value="SNOMED_CT_INT"/>
15 <status value="active"/>
16 <kind value="codesystem"/>
17 <date value="2020-11-03"/>
18 <publisher value="International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International"/>
19 <contact>
20   <name value="International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International"/>
21   <telecom>
22     <system value="email"/>
23     <value value="info@snomed.org"/>
24   </telecom>
25 </contact>
26 <responsible value="International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International"/>
27 <description value="SNOMED CT is a core clinical healthcare terminology that contains concepts with unique identifiers."/>
28 <uniqueId>
29   <type value="oid"/>
30   <value value="2.16.840.1.113883.6.96"/>
31   <preferred value="true"/>
32 </uniqueId>
33 <uniqueId>
34   <type value="uri"/>
35   <value value="http://snomed.info/sct"/>
36   <preferred value="true"/>
37 </uniqueId>
38 <uniqueId>
39   <type value="other"/>
40   <comment value="IRIstem"/>
41   <value value="http://snomed.info/id"/>
42 </uniqueId>
43 </NamingSystem>
```

## NamingSystem (SNOMED)

# Also accessible through the NPM package!

```
CodeSystem-v3-snomed-CT.json + (~/Downloads/package) - VIM
{
  "resourceType": "CodeSystem",
  "id": "v3-snomed-CT",
  "language": "en",
  "text": {
    "status": "generated",
    "div": "<div xmlns='http://www.w3.org/1999/xhtml' xml:lang='en' lang='en'><p>This code system http://snomed.info/sct defines m
any codes, but they are not represented here</p></div>"
  },
  "extension": [
    {
      "url": "http://hl7.org/fhir/StructureDefinition/codesystem-properties-mode",
      "valueCode": "not-present"
    }
  ],
  "url": "http://snomed.info/sct",
  "identifier": [
    {
      "system": "urn:ietf:rfc:3986",
      "value": "urn:oid:2.16.840.1.113883.6.96"
    }
  ],
  "use": "usual",
  "system": "https://terminology.hl7.org/temporary/CodeSystem/IRIStem",
  "value": "http://snomed.info/id/"
},
{
  "version": "3.2.0",
  "name": "SNOMED_CT_INT",
  "title": "SNOMED\U0000CT International Edition",
  "status": "active",
  "date": "2020-11-03",
  "publisher": "International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International",
  "contact": [
    {
      "name": "International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International",
      "telecom": [
        {
          "system": "email",
          "value": "info@snomed.org"
        }
      ]
    }
  ],
  "description": "SNOMED CT is a core clinical healthcare terminology that contains concepts with unique meanings and formal logic based d
efinitions organized into hierarchies.",
  "copyright": "This artefact includes content from SNOMED Clinical Terms (SNOMED CT) which is copyrighted material of the International H
ealth Terminology Standards Development Organisation (IHTSDO). Where an implementation of this artefact makes use of SNOMED CT content, the
implementer must have the appropriate SNOMED CT Affiliate license - for more information contact http://www.snomed.org/snomed-ct/get-snomed-
ct or info@snomed.org",
  "content": "not-present"
}
-- VISUAL --
5 21,1 All
```

```
NamingSystem-v3-snomed-CT.json + (~/Downloads/package) - VIM
},
"extension": [
  {
    "url": "https://hl7.org/fhir/tools/StructureDefinition/extension-title",
    "valueString": "SNOMED\U0000CT International Edition"
  },
  {
    "url": "https://hl7.org/fhir/5.0/StructureDefinition/extension-NamingSystem.url",
    "valueUri": "http://terminology.hl7.org/NamingSystem/v3-snomed-CT"
  },
  {
    "url": "https://terminology.hl7.org/StructureDefinition/ext-namingsystem-version",
    "valueString": "3.1.0"
  }
],
"name": "SNOMED_CT_INT",
"status": "active",
"kind": "codesystem",
"date": "2020-11-03",
"publisher": "International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International",
"contact": [
  {
    "name": "International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International",
    "telecom": [
      {
        "system": "email",
        "value": "info@snomed.org"
      }
    ]
  }
],
"responsible": "International Health Terminology Standards Development Organisation (IHTSDO) trading as SNOMED International",
"description": "SNOMED CT is a core clinical healthcare terminology that contains concepts with unique meanings and formal logic based d
efinitions organized into hierarchies.",
"uniqueId": [
  {
    "type": "oid",
    "value": "2.16.840.1.113883.6.96",
    "preferred": true
  },
  {
    "type": "uri",
    "value": "http://snomed.info/sct",
    "preferred": true
  },
  {
    "type": "other",
    "value": "http://snomed.info/id/",
    "comment": "IRIStem"
  }
]
}
-- VISUAL --
5 51,1 Bot
```

# The NPM package can be used in JavaScript

```
88  /**
89  * Ideally, we'll eventually have some kind of prefix index within hl7.terminology.
90  * Until we have that, we have to index that package ourselves. We do that when this
91  * class is constructed so that further calls to this method should be fast.
92  */
93  constructor() {
94    let package_json_path = require.resolve('hl7.terminology/package.json');
95    if (!package_json_path) {
96      throw new Error("ConceptIRI requires 'hl7.terminology' to be installed.");
97    }
98    let hl7terminology_path = path.dirname(package_json_path);
99
100   // Initialize prefix indexes.
101
102   // The prefixIndex will be in the form this.prefixIndex[prefix][uri] = 1
103   this.prefixIndex = {};
104
105   // The uriIndex will be in the form this.uriIndex[uril][prefix] = 1
106   this.uriIndex = {};
107
108   // Load all CodeSystem and Naming files from the hl7terminology path and look for prefix information.
109   let files = fs.readdirSync(hl7terminology_path);
110   files
111     .filter(filename => filename.endsWith('.json') && (
112       filename.startsWith('CodeSystem-') ||
113       filename.startsWith('NamingSystem-')
114     ))
115     .forEach(filename => {
116       let raw = fs.readFileSync(path.join(hl7terminology_path, filename), "utf-8");
117       let content = JSON.parse(raw);
118
119       if (filename.startsWith('CodeSystem-')) {
120         let url = content.url;
```

<https://github.com/fhircat/fhir-rdf-playground/pull/12>

# Tested our approach with FHIR examples

The screenshot shows a Google Docs spreadsheet with the following data:

|     | A   | B       | C   | D          | E                                       | F                                 | G   | H | I |
|-----|---|---------|---|------------|---|-----------------------------------|---|---|---|
| 1   | system  | code    | iri   | resolvable | display                                 | path_ends                         | filenames   |   |   |
| 84  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 884375  | <a href="http://purl.bioontology.org/ontology/RXNORM/884375">http://purl.bioontology.org/ontology/RXNORM/884375</a>   |            | 500 Nystex 100,000 UNT/GM Topical C     | concept.coding                    | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 85  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 901813  | <a href="http://purl.bioontology.org/ontology/RXNORM/901813">http://purl.bioontology.org/ontology/RXNORM/901813</a>   |            | 200 Diphenhydramine Hydrochloride 25    | concept.coding                    | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 86  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1049623 | <a href="http://purl.bioontology.org/ontology/RXNORM/1049623">http://purl.bioontology.org/ontology/RXNORM/1049623</a> |            | 200 Oxycodone Hydrochloride 5mg ora     | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 87  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1114879 | <a href="http://purl.bioontology.org/ontology/RXNORM/1114879">http://purl.bioontology.org/ontology/RXNORM/1114879</a> |            | 200 Dopamine                            | concept.coding                    | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 88  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1155608 | <a href="http://purl.bioontology.org/ontology/RXNORM/1155608">http://purl.bioontology.org/ontology/RXNORM/1155608</a> |            | 200 alleplase injectable product        | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 89  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1160593 | <a href="http://purl.bioontology.org/ontology/RXNORM/1160593">http://purl.bioontology.org/ontology/RXNORM/1160593</a> |            | 200 cashew nut allergenic extract Injec | substance.coding                  | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 90  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1313112 | <a href="http://purl.bioontology.org/ontology/RXNORM/1313112">http://purl.bioontology.org/ontology/RXNORM/1313112</a> |            | 200 Phenytoin 25mg/ml oral suspensio    | concept.coding                    | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 91  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1594660 | <a href="http://purl.bioontology.org/ontology/RXNORM/1594660">http://purl.bioontology.org/ontology/RXNORM/1594660</a> |            | 200 Alemtuzumab 10mg/ml (Lemtrada)      | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 92  | <a href="http://www.nlm.nih.gov/research/umls/rxnorm">http://www.nlm.nih.gov/research/umls/rxnorm</a> | 1797870 | <a href="http://purl.bioontology.org/ontology/RXNORM/1797870">http://purl.bioontology.org/ontology/RXNORM/1797870</a> |            | 200 Nasonex 0.05mg/ACTUAT Nasal It      | concept.coding                    | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 93  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 306005  | <a href="http://snomed.info/id/306005">http://snomed.info/id/306005</a>   |            | 200 Echography of kidney                | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 94  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 339008  | <a href="http://snomed.info/id/339008">http://snomed.info/id/339008</a>   |            | 200                                     |                                   | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 95  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 357009  | <a href="http://snomed.info/id/357009">http://snomed.info/id/357009</a>   |            | 200 Closed fracture of trapezoidal bone | concept.coding                    | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 96  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 368009  | <a href="http://snomed.info/id/368009">http://snomed.info/id/368009</a>   |            | 200 Heart valve disorder                | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 97  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 1250004 | <a href="http://snomed.info/id/1250004">http://snomed.info/id/1250004</a>   |            | 200 Decreased (qualifier value)         | valueCodeableConcept.coding       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 98  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 1386000 | <a href="http://snomed.info/id/1386000">http://snomed.info/id/1386000</a>   |            | 200 Intracranial hemorrhage (disorder)  | definitionCodeableConcept.coding  | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 99  | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 1857005 | <a href="http://snomed.info/id/1857005">http://snomed.info/id/1857005</a>   |            | 200                                     | targetDisease.coding              | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 100 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 2095001 | <a href="http://snomed.info/id/2095001">http://snomed.info/id/2095001</a>   |            | 200                                     |                                   | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 101 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 2331003 | <a href="http://snomed.info/id/2331003">http://snomed.info/id/2331003</a>   |            | 200 Carbohydrate                        | modifier.coding                   | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 102 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 2667000 | <a href="http://snomed.info/id/2667000">http://snomed.info/id/2667000</a>   |            | 200 Absent (qualifier value)            | valueCodeableConcept.coding       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 103 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 3092008 | <a href="http://snomed.info/id/3092008">http://snomed.info/id/3092008</a>   |            | 200 Staphylococcus aureus Staphylococ   | valueCodeableConcept.coding conce | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 104 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 3127006 | <a href="http://snomed.info/id/3127006">http://snomed.info/id/3127006</a>   |            | 200 Fluorouracil                        | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 105 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 3457005 | <a href="http://snomed.info/id/3457005">http://snomed.info/id/3457005</a>   |            | 200 Referral                            | activity.coding                   | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 106 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 4147007 | <a href="http://snomed.info/id/4147007">http://snomed.info/id/4147007</a>   |            | 200 Mass (morphologic abnormality )     | morphology.coding                 | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 107 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 4335006 | <a href="http://snomed.info/id/4335006">http://snomed.info/id/4335006</a>   |            | 200                                     |                                   | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 108 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 5713008 | <a href="http://snomed.info/id/5713008">http://snomed.info/id/5713008</a>   |            | 200                                     |                                   | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |
| 109 | <a href="http://snomed.info/sct">http://snomed.info/sct</a>   | 6824005 | <a href="http://snomed.info/id/6824005">http://snomed.info/id/6824005</a>   |            | 200 Topical Bact                        | code.coding                       | /Users/gaurav/Development/thirca/json-ld.org/thirib |   |   |

<https://docs.google.com/spreadsheets/d/1g-TKGzKA2YdV4gELLkjlL0Ku5cZN0rz-VPNXgMLaJGhk/edit#gid=1303917068>

# Summary

---

- Adding IRI stems to HL7 Terminology would be a simple change that would make interconversion between FHIR and the Linked Data world much, much easier.
- HL7 Terminology's NPM package is a powerful mechanism for extracting and using data from the HL7 Terminology records.

# Feedback from Vocab WG

---

1. Who gets to pick IRI stems and with what criteria?
  - a. Vocab/TSMG will pick IRI stems for HL7 terminologies.
  - b. RDF subgroup can help find and maintain IRI stems for external terminologies.
    - i. Gaurav will be in charge of figuring out how to make changes through the UTG.
2. How do we deal with versioning?
  - a. Not necessary at the moment, but we will plan for this going forward.
3. How do we deal with characters that aren't ASCII?
  - a. We believe we can fully support translating back and forth from FHIR strings and codes.
4. Should FHIR ValueSets be changed to better support concept IRIs?
  - a. We don't anticipate needing to change this (apart from supporting concept IRIs via the "urn:ietf:rfc:3987" as an Coding.system value for IRIs)



# Credits

The RDF subgroup of the  
HL7 Implementable  
Technology Standards (ITS)  
working group

FHIRCat NIH grant  
#5-R01-EB030529-02

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# Additional slides



# Would be accessible on terminology.hl7.org

```

{
  "resourceType": "CodeSystem",
  "id": "v3-snomed-CT",
  "language": "en",
  "text": {
    "status": "generated",
    "div": "<div xmlns=\\"http://www.w3.org/1999/xhtml\\" xml:lang=\\"en\\" lang=\\"en\\">
  },
  "extension": [
    {
      "url": "http://hl7.org/fhir/StructureDefinition/codesystem-properties-mode",
      "valueCode": "not-present"
    }
  ],
  "url": "http://snomed.info/sct",
  "identifier": [
    {
      "system": "urn:ietf:rfc:3986",
      "value": "urn:oid:2.16.840.1.113883.6.96"
    },
    {
      "use": "usual",
      "system": "https://terminology.hl7.org/temporary/CodeSystem/IRIStem",
      "value": "http://snomed.info/id/"
    }
  ],
  "version": "3.2.0",
  "name": "SNOMED_CT_INT",
  "title": "SNOMED CT International Edition",
  "status": "active",
  "date": "2020-11-03",
  "publisher": "International Health Terminology Standards Development Organisation",
  "contact": [
    {
      "name": "International Health Terminology Standards Development Organisation",
      "telecom": [
        {
          "system": "email",
          "value": "info@snomed.org"
        }
      ]
    }
  ]
}

```

CodeSystem (SNOMED)

```

{
  "url": "http://terminology.hl7.org/StructureDefinition/ext-namingsystem-ve",
  "valueString": "3.1.0"
},
{
  "name": "SNOMED_CT_INT",
  "status": "active",
  "kind": "codesystem",
  "date": "2020-11-03",
  "publisher": "International Health Terminology Standards Development Organisation",
  "contact": [
    {
      "name": "International Health Terminology Standards Development Organisation",
      "telecom": [
        {
          "system": "email",
          "value": "info@snomed.org"
        }
      ]
    }
  ],
  "responsible": "International Health Terminology Standards Development Organisation",
  "description": "SNOMED CT is a core clinical healthcare terminology that contains",
  "uniqueId": [
    {
      "type": "oid",
      "value": "2.16.840.1.113883.6.96",
      "preferred": true
    },
    {
      "type": "uri",
      "value": "http://snomed.info/sct",
      "preferred": true
    }
  ],
  {
    "type": "other",
    "value": "http://snomed.info/id/",
    "comment": "IRIStem"
  }
]
}

```

NamingSystem (SNOMED)

# IRIs vs URIs vs URLs

---

- RDF systems generally use *IRIs*, which allow you to include Unicode characters (allowing non-Latin characters). Defined by [RFC 3987](#).
  - E.g. `http://नारायणहृदयालय.example/code/हृदय`
- All *IRIs* can be converted to *URIs*, which don't allow Unicode characters, but use percent-encoding to encode them. Defined by [RFC 3986](#).
  - E.g. `http://xn--g2bge2acacu4d4bbf6d.example/code/%E0%A4%B9%E0%A5%83%E0%A4%A6%E0%A4%AF`
- URIs may be *URLs* (which are *resolvable*, like the link above) or *URNs* (which are “persistent, location-independent resource identifier”). Defined by [RFC 8141](#).
  - URNs are in the format `urn:[namespace]:[identifier]`

# IRIs vs URIs vs URLs

---

- We propose using IRIs, since they are what RDF systems are generally designed to use, and since FHIR already has good support for Unicode in its string type.
- These already work well with Coding.code values, which are defined as codes, which are strings restricted to having no leading or trailing whitespace and no internal whitespace apart from single spaces.
- If needed, concept IRIs could be converted into URIs and stored as uris or urls, but we don't think there is a need for concept IRIs to replace Codings in FHIR.

# An algorithm for conversion

---

Given:

- a FHIR Coding.system, *s*, that identifies a terminology *t*, and
- a Coding.code, *c*, that is defined within *t*;

a Concept IRI, *conceptIRI*, corresponding to *s* and *c* is computed as follows:

1. If no IRI Stem is defined for *s* in the HL7 Terminology website, then *conceptIRI* is undefined. Halt.
2. Let *iStem* be an IRI Stem that is defined for *s* in the HL7 Terminology website.
3. As a special case, if *iStem* equals `urn:iETF:rFC:3987`, then *conceptIRI* is *c*, and *c* MUST be a syntactically valid absolute-IRI as defined by [RFC 3987](#). Halt.

*(Non-normative comments: The purpose of this special case is to permit System.codes that are already IRIs to be used directly as Concept IRIs, without any transformation.*

*Note that an absolute-IRI may also be a URL or a URN.)*

# An algorithm for conversion (2)

---

2. Let *cSafe* be the IRI-safe version of *c*, as defined by the algorithm in section 7.3 of R2RML: RDB to RDF Mapping Language (W3C Recommendation 27 September 2012), non-normatively quoted here for convenience:

*"The **IRI-safe version** of a string is obtained by applying the following transformation to any character that is not in the unreserved production in [RFC3987]:*

- 1. Convert the character to a sequence of one or more octets using UTF-8 [RFC3629]*
- 2. Percent-encode each octet [RFC3986]"*

# An algorithm for conversion (3)

The `iunreserved` production defined in [RFC 3987, section 2.2](#) using [ABNF](#) is also non-normatively quoted here for convenience:

```
iunreserved = ALPHA / DIGIT / "-" / "." / "_" / "~" / uchar
```

The `uchar` production defined in [RFC 3987, section 2.2](#) is also non-normatively quoted here for convenience. *(Non-normative comment: The `uchar` production defines international character ranges that are valid unicode characters within the intersection of path components (`ipath`), query strings (`iquery`) and fragment identifiers (`ifragment`). They do not include any reserved characters involved in parsing apart the various components of an IRI.)*

```
uchar = %xA0-D7FF / %xF900-FDCF / %xFDF0-FFEF  
       / %x10000-1FFFFD / %x20000-2FFFFD / %x30000-3FFFFD  
       / %x40000-4FFFFD / %x50000-5FFFFD / %x60000-6FFFFD  
       / %x70000-7FFFFD / %x80000-8FFFFD / %x90000-9FFFFD  
       / %xA0000-AFFFFD / %xB0000-BFFFFD / %xC0000-CFFFFD  
       / %xD0000-DFFFFD / %xE1000-EFFFFD
```

2. `conceptIRI` is the result of concatenating `iStem` and `cSafe`.



# Security issues (1)

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Hostile agents may try to introduce incorrect stem IRIs into the HL7 Terminology records, e.g. trying to set “<http://malicious.actor.org/>” as the stem IRI for SNOMED, so that cellulitis (128045006) would result in the concept IRI <http://malicious.actor.org/128045006>.

- 1. A healthcare application trying to dereference this URL could download malicious data to the application.

# Security issues (2)

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- 2. A healthcare application trying to dereference this URL could leak information to the malicious actor.
  - E.g. the malicious actor tricks a patient into accessing their healthcare records from a healthcare application at a particular time.
    - The application dereferences the concept IRI for all concepts related to their health information.
    - The malicious actor records can now deduce information about the patient.
  - Even if the previous attack does not work, the malicious actor could still perform a frequency analysis of the concepts being looked up within the healthcare application.
- 3. If some systems use the malicious IRI Stem and others use the correct IRI Stem, interoperability between those systems would be impaired, potentially resulting in denial of service.

# What would this cost?

---

- Additional identifiers in HL7 Terminology records
  - Should be very stable in the long term.
  - Unlikely that users will confuse IRI stems with Coding.system values.
- *Possible security issues*

# Who gets to pick IRI stems?

---

- Many vocabularies (SNOMED CT, LOINC) publish their own guidelines on how to create concept IRIs for their concepts.
  - All the vocabularies we've looked at use IRI stems, but someone might want to use more complex concept IRIs in the future.
- Extra property to indicate whether it's "official" from the organization or not?
- However, if concept IRIs are needed, several online databases of concept IRI patterns are available:
  - <https://bioregistry.io/> (e.g. <https://bioregistry.io/registry/loinc>)
  - <https://registry.identifiers.org> (e.g. <https://registry.identifiers.org/registry/uberon>)
  - Wikidata (e.g. <https://www.wikidata.org/wiki/Property:P5806>)

# Choosing IRI stems for HL7 Terminologies

---

- FHIR CodeSystems (<https://terminology.hl7.org/codesystems.html>)
  - (Check working build, there are some new changes being made to this list)
- External terminologies ([https://terminology.hl7.org/external\\_terminologies.html](https://terminology.hl7.org/external_terminologies.html))
  - 1. Official IRI stem, if one exists.
  - 2. Look through repositories to find any in community use:
    - <https://bioregistry.io/> (e.g. <https://bioregistry.io/registry/loinc>)
    - <https://registry.identifiers.org> (e.g. <https://registry.identifiers.org/registry/uberon>)
    - Wikidata (e.g. <https://www.wikidata.org/wiki/Property:P5806>)
  - 3. Assign an HL7 IRI stem in the hl7.org domain/namespace
    - If the organization comes up with one in the future, we can change the FHIR IRI stem to that.
- FHIR RDF group can be responsible for coming up with IRI stems for all FHIR CodeSystems and external terminologies.
- What if branding changes in the future and an organization wants to change their concept IRIs in the future?

# Concept IRIs and versioning?

---

- Each FHIR Coding can specify the version of the terminology from which the term was taken in the [Coding.version field](#).
- Concept IRIs generally don't require versions, since obsolete terms are supposed to be marked as deprecated while a new term is created for the updated concept (see e.g. [OBO Foundry's URI automated check](#)).
  - E.g. [UBERON:0006852](#) ("obsolete glomerular visceral epithelium") has been deprecated and replaced with [UBERON:0005751](#) ("glomerular visceral epithelium").
- If a use-case for versions becomes necessary, we would want to add an "IRI stem template" that allows both Coding.code and Coding.version to be inserted separately.

# Examples

| Coding.system  | Coding.code | IRI Stem  | Concept IRI   |
|--|-------------|---|---|
| ICD 10:<br><a href="http://hl7.org/fhir/sid/icd-10">http://hl7.org/fhir/sid/icd-10</a>   | G44.1       | <a href="http://purl.bioontology.org/ontology/ICD10/">http://purl.bioontology.org/ontology/ICD10/</a> | <a href="http://purl.bioontology.org/ontology/ICD10/G44.1">http://purl.bioontology.org/ontology/ICD10/G44.1</a> |
| SNOMED CT:<br><a href="http://snomed.info/sct">http://snomed.info/sct</a>  | 128045006   | <a href="http://snomed.info/id/">http://snomed.info/id/</a>   | <a href="http://snomed.info/id/128045006">http://snomed.info/id/128045006</a>                                   |
| MeSH:<br><a href="https://www.nlm.nih.gov/mesh">https://www.nlm.nih.gov/mesh</a>   | D000305     | <a href="https://id.nlm.nih.gov/mesh/">https://id.nlm.nih.gov/mesh/</a>                               | <a href="https://id.nlm.nih.gov/mesh/D000305">https://id.nlm.nih.gov/mesh/D000305</a>                           |
| LOINC: <a href="http://loinc.org">http://loinc.org</a>   | 35217-9     | <a href="https://loinc.org/rdf/">https://loinc.org/rdf/</a>   | <a href="https://loinc.org/rdf/35217-9">https://loinc.org/rdf/35217-9</a>                                       |
| Regional example   |             |   |   |
| Example of a code containing non-ASCII characters<br><a href="http://नारायणहृदयालय.example/">http://नारायणहृदयालय.example/</a> | हृदय        | <a href="http://नारायणहृदयालय.example/code/">http://नारायणहृदयालय.example/code/</a>                   | <a href="http://नारायणहृदयालय.example/code/हृदय">http://नारायणहृदयालय.example/code/हृदय</a>                     |