



Advanced FHIR Terminology Services, incl. SNOMED CT

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16 November 2017

AUSTRALIAN E-HEALTH RESEARCH CENTRE, HEALTH & BIOSECURITY
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HL7 FHIR DevDays 2017



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Who am I?

- Australian eHealth Research Centre, CSIRO
- SNOMED involvement since late 2000s
 - Technical Committee 2010-2015
 - Modelling Advisory Group 2015-present
 - SNOMED Languages Project Group
 - SNOMED Logic Profile Working Group
- SNOMED CT URI specification
- Expression Constraint Language
- Ontoserver, Shrimp, Snapper, Snorocket
- Australia's National Clinical Terminology Service



Snapper

:Author
(also :Map)

work-in-
progress

The screenshot shows the Snapper Mapping Editor interface. On the left is a sidebar with a tree view of maps and resources. The main area is a table with columns: Src Code, Source, Tgt Code, Target, Map, and Comments. Below the table is a diagram showing a flow from 'Source' to 'Target' through various intermediate steps. On the right is a search bar and a property table.

Src Code	Source	Tgt Code	Target	Map	Comments
1000420100011...	metformin	100081008	Metformin	inexact	autopmap match 1 of 5: 372087039 [Metformin] 427520008 L...
1000840100011...	larvadine	100089001	Larvadine	inexact	autopmap match 1 of 5: 388897033 [Larvadine] 41208100...
1000660100011...	dimethylone	39021000	Dimethylone	inexact	autopmap match 1 of 5: 420874032 [Dimethylone] 420354032
1000677100011...	aripiprazole	400794005	Aripiprazole	inexact	autopmap match 1 of 5: 400794000 [Aripiprazole] 40000000...
1000717100011...	acacia	42154009	Acacia	inexact	autopmap match 1 of 5: 43987000 [Acacia] 23548004 [Acac...
1000730100011...	acetabutool	9008000	Acetabutool	inexact	autopmap match 1 of 5: 372015001 [Acetabutool] 290994000...
1000616100011...	diagnostic test L...			unmatch...	no match
2400479100011...	mefenide acetate	19114001	Mefenide acetate	inexact	autopmap match 1 of 5: 370440008 [Mefenide acetate 0% p...
1000844100011...	quinapril	100070004	Quinapril	inexact	autopmap match 1 of 5: 388874032 [Quinapril] 00044007 L...
1000680100011...	quinapril + hydro...	390870032	Quinapril hydroc...	inexact	autopmap match 1 of 5: 421852001 [hydrochlorothiazide + q...

Total Items: 2484

Property Value

Property	Value
Date	20160100
System	http://terminos.info/act
Version	http://terminos.info/act/325092100 00M1071version2016000
Display	Dimethylone
Designation	Dimethylone (substance)
Designation	Dimethylone

2016-10-18 08:08 | Serve | https://terminoserver.csiro.au/act | connected



ValueSet Explorer

- compare performance and behaviour

<http://ontoserver.csiro.au/vstool/>

FHIR ValueSet \$expand Comparison Tool

This tool sends the same expansion request to multiple FHIR endpoints and displays the results side-by-side. If your favourite endpoint isn't listed here, you can enter it in the text field below (JSON support required). It requests only the first 10 codes to minimise server load and the likelihood of a TooCostly response.

ValueSet:

Search text:

UHN HAPI Server Health Language
 NLM (VSAC) Termin
 Ontoserver (NCTS) Health Interactions (STU3) Hygeists
 Ontoserver (STU3) Apollo-27E HealthComx

	Ontoserver (NCTS) FHIR 1.4.0	Ontoserver (STU3) FHIR 1.6.0	UHN HAPI Server FHIR 1.8.0	Health Interactions (STU3) FHIR 1.9.0
	total: 24 time: 288 ms version: http://snomed.info/ct7/version=http://snomed.info/ct7/2016021009034107/version/20161011	total: 24 time: 360 ms version: http://snomed.info/ct7/2016081006036107/version/20161211	total: time: 272 ms version:	total: time: 1718 ms version: http://snomed.info/ct7/version=http://snomed.info/ct7/2016021009034107/version/20161011
1	Acute appendicitis 80189001	Acute appendicitis 80189001		Acute suppurative appendicitis 236709500
2	Acute focal appendicitis 236709500	Acute focal appendicitis 236709500		Acute appendicitis with localised peritonitis 698294004
3	Acute appendicitis NOS 156732000	Acute appendicitis NOS 196784009		Acute gangrenous appendicitis 50665009
4	Acute appendicitis NOS 196784009	Acute appendicitis NOS 156732000		Acute appendicitis 80189001
5	Acute suppurative appendicitis 236709500	Acute suppurative appendicitis 236709500		Acute gangrenous appendicitis with perforation AND peritonitis 64262005
6	Acute fulminating appendicitis 84634001	Acute fulminating appendicitis 84634001		Acute fulminating appendicitis with perforation AND peritonitis 84964000
7	Acute perforated appendicitis 156730008	Acute perforated appendicitis 156730008		Acute appendicitis with peritonitis 196781001
8	Acute perforated appendicitis 296967008	Acute perforated appendicitis 296967008		Acute focal appendicitis 236709500
9	Acute obstructive appendicitis 4998000	Acute obstructive appendicitis 4998000		Acute perforated appendicitis 296967000
10	Acute gangrenous appendicitis 50666000	Acute gangrenous appendicitis 50666000		Acute fulminating appendicitis (disorder) 84634001
	Status Code: 200	Status Code: 200	Status Code: 400 ValueSet clients include criteria with no system defined.	Status Code: 200

{base}/ValueSet/\$expand?_format=json&count=10&filter=app420acukidntif:iar=http://snomed.info/ct7/fhir/vs&url=ct7:236709500:snomed.info/ct7/fhir/vs

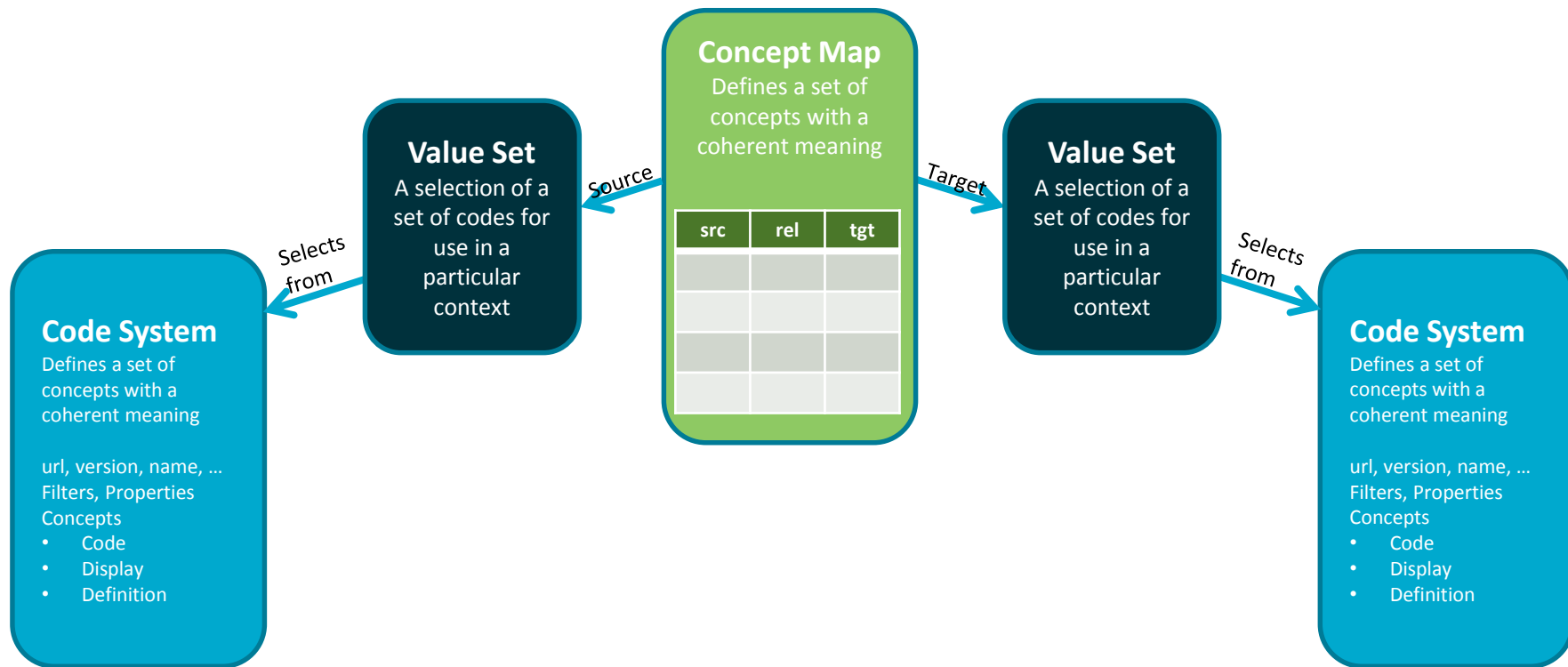


Getting to know each other

- Jim's Practical Terminology Services this morning?
- Used Terminology services?
- Implemented any part of the Terminology subsystem?
- SNOMED CT knowledge?
- Other code system knowledge?



FHIR Terminology - big picture



Terminology in FHIR Search

- A lot of search parameters in FHIR are of type 'token'
- These can leverage terminology services
- :above/:below
 - E.g.: /Condition?body-site:below=http://snomed.info/sct|272673000 (all Conditions where the finding site is a descendent of Bone Structure)
- :in/:not-in
 - E.g.:
/ProcedureRequest?code:in=http://snomed.info/sct?fhir_vs=refset/32570361000036108 (all ProcedureRequests in the Imagine Procedure refset)



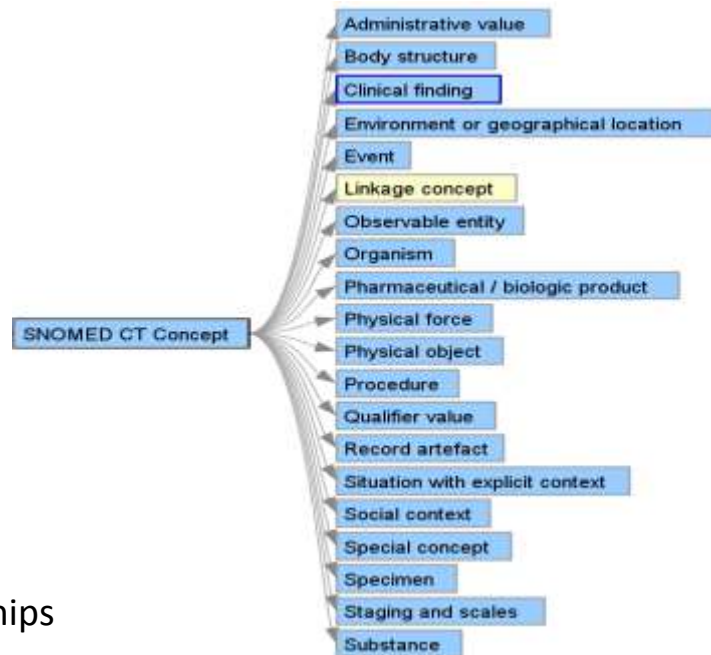
Externally defined code systems

External	Internal (FHIR)	HL7 V3	HL7 v2
URI	Source	Comment	
Externally Published code systems			
http://snomed.info/sct	SNOMED CT (IHTSDO)	See Using SNOMED CT with FHIR	
http://www.nlm.nih.gov/research/umls/rxnorm	RxNorm (US NLM)	See Using RxNorm with FHIR	
http://loinc.org	LOINC (LOINC.org)	See Using LOINC with FHIR	
http://unitsofmeasure.org	UCUM: (UnitsOfMeasure.org) Case Sensitive Codes	See Using UCUM with FHIR	



SNOMED CT

- 19 hierarchies
- ~ 400K Concepts
- ~ 1M Descriptions
 - 3 types
 - Fully Specified Name
 - Preferred term
 - Synonyms
- ~ 65 Attributes
 - Combined in triplets forming ~ 1.5M relationships
 - ~ 125 relationship patterns



Demo - Shrimp

The screenshot displays the 'Shrimp Terminology Browser: SNOMED Clinical Terms Australian extension'. The interface includes a navigation bar with 'Terminology', 'Helpdesk', and 'Outcomes' tabs. The main area shows a hierarchical diagram of clinical terms, with 'Acute appendicitis with perforation (disorder)' selected. A detailed view of this term is shown on the right, including its full name, active status, and various properties.

Acute appendicitis with perforation (disorder)

PROPERTY	VALUE
Class	113300E
Preferred	Acute appendicitis with perforation (disorder)
Full Name	Acute appendicitis with perforation (disorder)
Active	True
Effective Date	
Module ID	9400000000000000000
Concept ID	3004273
Set/Id	Class Finding
Foundation reference set	
Emergency	Emergency
Department/Division	Emergency
System/Source	Emergency
Version	1.0

Practical tips

1. Beware out-of-order responses
2. Minimise latency
 - Batch multiple operations for single round-trip
 - Also avoids need for client-side synchronisation
3. Minimise bandwidth
 - count for \$expand
 - includeDefinition, includeDesignations on \$expand
 - property for \$lookup
 - _count, _elements for search / read operations
 - Accept-Encoding: gzip
4. GET can be cached (HTTP level), POST cannot

Warning: A lot of these can be server-dependent. They're not proprietary, but you should check support for them by your terminology server.

Implicit ValueSets

Defined for specific code systems

SNOMED CT, LOINC, ...

```
http://snomed.info/sct?fhir_vs
```

```
http://snomed.info/sct?fhir_vs=isa/{sctid}
```

```
http://snomed.info/sct?fhir_vs=refset
```

```
http://snomed.info/sct?fhir_vs=refset/{sctid}
```

Typeahead controls

<https://plnkr.co/edit/wOjWbt>

```
<input
  uib-typeahead="suggestion for suggestion in concepts($viewValue,
  'http://snomed.info/sct?fhir_vs=isa/138875005')" />

$scope.concepts = function(term, valueSet) {
  return $http.get(
    'https://ontoserver.csiro.au/stu3-latest/ValueSet/$expand', {
    params: {
      identifier: valueSet,
      filter: term,
      count: 15,
      '_format': 'json'
    },
    responseType: 'json'
  }).then(function(response) {
    return response.data.expansion.contains || [{ display: term }];
  });
};
```

Typeahead controls

<https://plnkr.co/edit/wOjWbt>

```
<input
  uib-typeahead="suggestion for suggestion in concepts($viewValue,
  'http://snomed.info/sct?fhir_vs=isa/73211009')"/>

$scope.concepts = function(term, valueSet) {
  return $http.get(
    'https://ontoserver.csiro.au/stu3-latest/ValueSet/$expand', {
    params: {
      identifier: valueSet,
      filter: term,
      count: 5,
      '_format': 'json'
    },
    responseType: 'json'
  }).then(function(response) {
    return response.data.expansion.contains || [{ display: term }];
  });
};
```

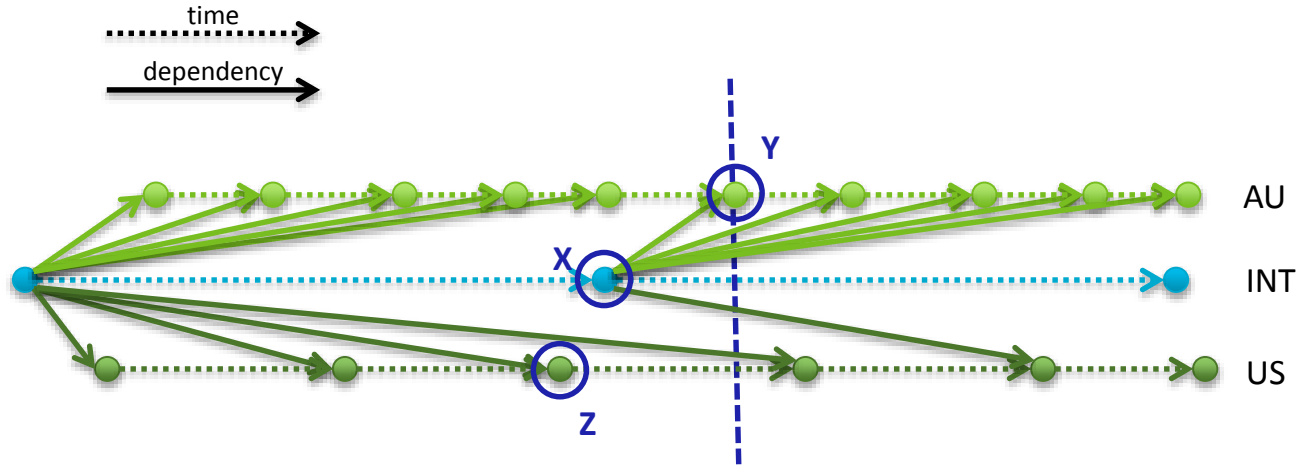
SNOMED CT Versioning

- International release (6 monthly)
- National releases (1-6 monthly)
- Other releases

Version is an Edition + Effective Time

<http://snomed.info/sct/{module}/version/{date}>

Branching version structure



No single “latest” version

Implicit ValueSets

Defined for specific code systems

SNOMED CT, LOINC, ...

```
http://snomed.info/sct?fhir_vs
```

```
http://snomed.info/sct?fhir_vs=isa/{sctid}
```

```
http://snomed.info/sct?fhir_vs=refset
```

```
http://snomed.info/sct?fhir_vs=refset/{sctid}
```

Implicit ValueSets

Defined for specific code systems

SNOMED CT, LOINC, ...

```
http://snomed.info/sct?fhir_vs
```

```
http://snomed.info/sct?fhir_vs=isa/{sctid}
```

```
http://snomed.info/sct?fhir_vs=refset
```

```
http://snomed.info/sct?fhir_vs=refset/{sctid}
```

```
http://snomed.info/sct/{module}
```

Implicit ValueSets

Defined for specific code systems

SNOMED CT, LOINC, ...

```
http://snomed.info/sct?fhir_vs
```

```
http://snomed.info/sct?fhir_vs=isa/{sctid}
```

```
http://snomed.info/sct?fhir_vs=refset
```

```
http://snomed.info/sct?fhir_vs=refset/{sctid}
```

```
http://snomed.info/sct/{module}/version/{date}
```

ValueSets and CodeSystem versions

compose	1	0..1	BackboneElement	Definition of the content of the value set (CLD)
lockedDate	Σ	0..1	date	Fixed date for version-less references (transitive)
inactive	Σ	0..1	boolean	Whether inactive codes are in the value set
include	Σ 1	1..*	BackboneElement	Include one or more codes from a code system or other value set(s) + A value set with concepts or filters SHALL include a system + Cannot have both concept and filter + A value set include/exclude SHALL have a value set or a system
system	Σ 1	0..1	uri	The system the codes come from
version	Σ	0..1	string	Specific version of the code system referred to
concept	1	0..*	BackboneElement	A concept defined in the system
code		1..1	code	Code or expression from system
display		0..1	string	Text to display for this code for this value set in this valueset
designation		0..*	BackboneElement	Additional representations for this concept
language		0..1	code	Human language of the designation Common Languages (Extensible but limited to All Languages)
use		0..1	Coding	Details how this designation would be used Designation Use (Extensible)
value		1..1	string	The text value for this designation
filter	?! Σ 1	0..*	BackboneElement	Select codes/concepts by their properties (including relationships)
property	Σ	1..1	code	A property defined by the code system
op	Σ	1..1	code	= is-a descendent-of is-not-a regex in not-in generalizes exists FilterOperator (Required)
value	Σ	1..1	code	Code from the system, or regex criteria, or boolean value for exists
valueSet	Σ 1	0..*	uri	Select only contents included in this value set
exclude	1	0..*	see include	Explicitly exclude codes from a code system or other value sets

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exclude	I	0..*	see include	Explicitly exclude codes from a code system or other value sets

“Complex” ValueSets

Cycles with ValueSet inclusion / exclusion

Mixing codes from multiple code systems (don't)

Multiple versions of the same code system

“Complex” ValueSets

```
“compose”: {  
  “include”: [{  
    “valueSet”:  
    “http://snomed.info/sct/32506021000036107/version/  
    20171031?fhir_vs=isa/138875005”  
  }],  
  “exclude”: [{  
    “valueSet”:  
    “http://snomed.info/sct/32506021000036107/version/  
    20170930?fhir_vs=isa/138875005”  
  }],  
}
```

Expression Constraint Language (ECL)

<http://snomed.org/ecl>

Based on post coordination syntax

Wildcard, descendants, ancestors, reference set members, cardinality constraints

http://ontoserver.csiro.au/shrimp/ecl_help.html

```
filter:[{property:'constraint', op:'=', value: '...' }]
```



ECL brief summary

Category	Syntax	Example
Basic	<i>sctId, *, ^ sctId</i>	<code>^ 723264001 lateralizable body structure </code>
Hierarchy	<code><< sctId, < sctId, <! sctId, >> sctId, > sctId, >! sctId</code>	<code><< 404684003 clinical finding </code>
Composition	<code>x AND y, x OR y, x MINUS y</code>	
Relationships	<code>a : b = c, a : { b = c, d = e}, a.b</code>	<code><< 404684003 : 363698007 finding site = ^ 723264001</code>
Cardinality	<code>a : [low..high] b = c</code>	<code><< 404684003 : [1..1] 363698007 = *</code>



SNOMED CT Post coordination

<http://snomed.org/scg>

```
71620000|Fracture of femur|:  
  272741003|Laterality| = 7771000|Left|
```

```
74400008|Appendicitis|:  
  116676008|Associated morphology|= 4532008|Acute inflammation|
```

```
64572001|Disease|:  
{  
  116676008|Associated morphology|= 4532008|Acute inflammation|,  
  363698007|Finding site| = 66754008|Appendix structure|  
}
```

CodeSystem operations

\$subsumes?codeA= &codeB=

- equivalent, subsumes, subsumed-by, and not-subsumed
- terminology server handles post coordination semantics

\$compose

- “Given a set of properties, return one or more possible matching codes”

ConceptMap\$closure

<http://hl7.org/fhir/terminology-service.html#closure>

Why? stateful??

Consider implementing search:

[base]/Condition?code:below=126851005

[base]/Condition?code:in=http://snomed.info/sct%3Ffhir_vs%3Disa/126851005



\$closure – usage flow




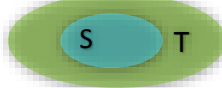




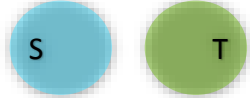
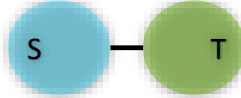
- init
 - add set of codes
 - ConceptMap of hierarchy & equivalence [transitively closed]
 - add more codes
 - ConceptMap of additional hierarchy & equivalence
 - ...
 - resynchronisation
- {}
 - 0: {}
 - {a, c}
 - 1: {a subsumes c}
 - {b, d}
 - 2: {a subsumes b, b subsumes c, a subsumes d}

code:below

- Use \$closure to maintain local edge-table of parent-child relationships
- code:below=123

```
SELECT C.*  
FROM Condition C, Edges E  
WHERE C.code = 123  
      OR (E.parent = 123 AND C.code = E.child);
```

ConceptMap - equivalence relationships

Code	Mnemonic	Code	Mnemonic
equivalent		wider	
equal		subsumes	
inexact		narrower	
unmatched		specializes	
disjoint		relatedto	

Tooling summary

- Shrimp
 - search & browse SNOMED CT, LOINC, ...
 - <http://ontoserver.csiro.au/shrimp>
- Ontoserver
 - powerful features, simple to deploy & use
 - [ECL queries](#)
 - <http://ontoserver.csiro.au/shrimp/ec1.html>
e.g., [concepts with finding site of appendix structure](#)
- Snapper:Author
 - Author (simple) FHIR Terminology Resources
- Snorocket
 - Description Logic reasoning engine