6.2 Refinements

In this section, we illustrate how the set of matching concepts can be filtered using one or more simple attribute refinements. For more information on applying refinements to nested expression constraints, using nested attribute names and using nested attribute values, please refer to 6.7 Nested Expression Constraints.

Attributes

Adding an attribute refinement to an expression constraint restricts the set of valid clinical meanings to only those whose defining attributes satisfy the given refinement condition. Similarly to SNOMED CT Compositional Grammar, attribute refinements are placed after a 'colon' (i.e. ":") in the expression constraint.

The example below is satisfied only by the set of lung disorders, which have an associated morphology that is exactly equal to 79654002 |Edema|.

```
<  19829001 |Disorder of lung| :
    116676008 |Associated morphology|  =  79654002 |Edema|
```

Using the long syntax, the above expression is represented as:

```
descendantOf  19829001 |Disorder of lung|  :
    116676008 |Associated morphology|  =  79654002 |Edema|
```

In many cases, however, the value of the matching attribute is allowed to be either the concept itself, *or* a descendant of that concept. In these cases, the descendantOrSelfOf operator is used prior to the concept representing the attribute value. For example, the expression constraint below (in brief and long syntaxes respectively) is satisfied only by the set of lung disorders, which have an associated morphology of 79654002 |Edema| or any descendant of 79654002 |Edema|.

```
<  19829001 |Disorder of lung| :
    116676008 |Associated morphology|  = <<  79654002 |Edema|
```

```
descendantOf  19829001 |Disorder of lung|  :
    116676008 |Associated morphology|  = descendantOrSelfOf  79654002 |Edema|
```

When more than one attribute is defined in an expression constraint, the attributes are normally separated by a comma. A comma between two attributes indicates a conjunction and implies that both attribute conditions must be true. For example, the expression constraint below, written in brief syntax, is satisfied only by the set of clinical findings, which have both a finding site of 39057004 |Pulmonary valve structure| (or a subtype of 39057004 |Pulmonary valve structure|) and an associated morphology of 'stenosis' (or a subtype of 'stenosis').

```
<  404684003 |Clinical finding| :
    363698007 |Finding site|  = <<  39057004 |Pulmonary valve structure| ,
    116676008 |Associated morphology|  = <<  415582006 |Stenosis|
```

Please note that attribute refinements may also be used when the focus concept is '*' (or ANY). The following expression constraint represents any concept that has a 246075003 |Causative agent| attribute whose value is 387517004 |Paracetamol|.

```
*  :  246075003 |Causative agent|  =  387517004 |Paracetamol|
```

Using the long syntax, the above expression may also be represented as:

```
ANY  :  246075003 |Causative agent|  =  387517004 |Paracetamol|
```

Attribute Groups

Similarly to SNOMED CT compositional grammar, expression constraints use curly braces (i.e. "{..}") to indicate that a set of attributes should be grouped together in an attribute group. For example, the expression constraint below is satisfied only by the set of clinical findings with an associated morphology of 'stenosis' (or descendant) at the finding site 'pulmonary valve structure' (or descendant), and also with an associated morphology of 'hypertrophy' (or descendant) at the finding site 'right ventricular structure' (or descendant).

```
< 404684003 |Clinical finding| :
  { 363698007 |Finding site| = << 39057004 |Pulmonary valve structure| ,
    116676008 |Associated morphology| = << 415582006 |Stenosis| },
  { 363698007 |Finding site| = << 53085002 |Right ventricular structure| ,
    116676008 |Associated morphology| = << 56246009 |Hypertrophy| }
```

Using the 'long syntax', the above expression constraint is represented as:

```
descendantOf 404684003 |Clinical finding| :
  { 363698007 |Finding site| = descendantOrSelfOf 39057004 |Pulmonary valve structure| ,
    116676008 |Associated morphology| = descendantOrSelfOf 415582006 |Stenosis| },
  { 363698007 |Finding site| = descendantOrSelfOf 53085002 |Right ventricular structure| ,
    116676008 |Associated morphology| = descendantOrSelfOf 56246009 |Hypertrophy| }
```

Attribute Constraint Operators

In some cases, an attribute concept has subtypes or supertypes in the |Concept model attribute| hierarchy. Where this occurs, it is possible to indicate that an attribute condition may be satisfied by matching one of the subtypes or supertypes of the given attribute. This is done adding a constraint operator directly before the attribute name concept. For example, the expression constraint below will not only match clinical findings that are |Associated with| a type of |Edema|, but also those that are |Due to|, |After| or the |Causative agent| of a type of |Edema|. This result occurs because the 47429007 |Associated with| attribute concept has three subtypes: 255234002 |After|, 246075003 |Causative agent| and 42752001 |Due to|.

```
<< 404684003 |Clinical finding| :
  << 47429007 |Associated with| = << 267038008 |Edema|
```

This expression constraint is represented in the long syntax as:

```
descendantOrSelfOf 404684003 |Clinical finding| :
  descendantOrSelfOf 47429007 |Associated with| = descendantOrSelfOf 267038008 |Edema|
```

Similarly, the expression constraint below will not only match clinical findings that are |Due to| a type of |Edema|, but also those that have an |Associated with| relationship whose value is a type of |Edema|.

```
<< 404684003 |Clinical finding| :
  >> 246075003 |Causative agent| = << 267038008 |Edema|
```

This expression constraint is represented in the long syntax as:

```
descendantOrSelfOf 404684003 |Clinical finding| :
  ancestorOrSelfOf 246075003 |Causative agent| = descendantOrSelfOf 267038008 |Edema|
```

Concrete Values

The revised SNOMED CT Compositional Grammar allows attributes to be given concrete values (e.g. Strings, Integers, Decimal). The SNOMED CT Expression Constraint Language supports the ability to compare these attribute values with a given concrete value.

When numeric concrete values (i.e. Integers and Decimals) are compared, a set of standard mathematical operators may be used. These mathematical operators are:

Operator	Name
=	Equals
!=	Not equals
<	Less than
<=	Less than or equals
>	Greater than
>=	Greater than or equals

Please note that the 'not equals' operator may alternatively be represented as "<>" and "not =" (case insensitive) in the long syntax.

The following expression constraint is satisfied only by amoxicillin tablets, whose strength is greater than or equal to 200 mg[1] .

```
<  27658006 |Amoxicillin| :
    411116001 |Has dose form|  = <<  385055001 |Tablet dose form| ,
  {  179999999100 |Has basis of strength|  = (  219999999102 |Amoxicillin only| :
      189999999103 |Has strength magnitude|  >= #200,  199999999101 |Has strength unit|  =  258684004 |mg| )}
```

Please note that, as per SNOMED CT Compositional Grammar, integer and decimal values are preceded by a hash character (e.g. "#500"), while string values are surrounded by double quotes (e.g. "PANADOL").

To find those capsules that have a strength between 500 and 800 mg (inclusive), the following expression constraint may be used:

```
<  27658006 |Amoxicillin| :
    411116001 |Has dose form|  = <<  385055001 |Tablet dose form| ,
  {  179999999100 |Has basis of strength|  = (  219999999102 |Amoxicillin only| :
      189999999103 |Has strength magnitude|  >= #500,
      189999999103 |Has strength magnitude|  <= #800,
      199999999101 |Has strength unit|  =  258684004 |mg| )}
```

Concrete values of type string may also be included in an expression constraint, and compared using an 'equal to' (i.e. "=") or 'not equal to' (i.e. "!=") operator. The following expression constraint is satisfied only by products with a trade name equal to "PANADOL"[2] .

```
<  373873005 |Pharmaceutical / biologic product| :
    209999999104 |Has trade name|  = "PANADOL"
```

Reverse Attributes

In most cases, an attribute refinement is satisfied by those concepts, which are the source concept of a defining relationship whose destination concept matches the attribute value. In some cases, however, it may be necessary to select the destination concept of a relationship and constrain the source concept to a given attribute value. To achieve this, an expression constraint indicates that an attribute is to be constrained in the reverse order using a 'reverse flag'[3] . In the brief syntax, the reverse flag is represented by preceding the name of the attribute with a capital letter 'R'.

For example, the expression constraint below finds the set of anatomical structures, which are the finding site of a type of bone fracture (e.g. 85050009 |Humerus|, 71341001 |Femur|).

```
<  91723000 |Anatomical structure| :
  R  363698007 |Finding site|  = <  125605004 |Fracture of bone|
```

The above expression constraint is represented in the long syntax as:

```
descendantOf  91723000 |Anatomical structure| :
  reverseOf  363698007 |Finding site|  = descendantOf  125605004 |Fracture of bone|
```

Dotted Attributes

An alternative way of representing 'reversed attributes' is by applying the *dot notation* to represented them as *dotted attributes*. Using this alternative notation, " < 123456 |X| . 234567 |Y| " represents the set of attribute values (i.e. destination concepts) of the attribute "Y" for descendants or self of concept "X". This is therefore equivalent to " * : R 234567 |Y| = < 123456 |X| " using the reverse flag.

The previous expression constraint (which finds the set of body sites for any subtype of bone fracture) has an equivalent representation using the 'dot notation' of:

```
<  91723000 |Anatomical structure|  AND (<  125605004 |Fracture of bone| . 363698007 |Finding site| )
```

Because all values of 363698007 |Finding site| must be < 91723000 |Anatomical structure| (according to the SNOMED CT concept model), this expression constraint can be further simplified to:

```
    <   125605004 |Fracture of bone| . 363698007 |Finding site|
```

The next example below finds the set of substances, which are active ingredients of a 'TRIPHASIL tablet'.

```
    <   105590001 |Substance| :
        R  127489000 |Has active ingredient|  =  249999999101 |TRIPHASIL tablet|
```

This expression constraint is represented in the long syntax as:

```
    descendantOf  105590001 |Substance| :
        reverseOf  127489000 |Has active ingredient|  =  249999999101 |TRIPHASIL tablet|
```

An equivalent way of representing this constraint, using the 'dot notation' is:

```
    <   105590001 |Substance|  AND ( 249999999101 |TRIPHASIL tablet| . 127489000 |Has active ingredient| )
```

or (using the SNOMED CT concept model to simplify):

```
    249999999101 |TRIPHASIL tablet| . 127489000 |Has active ingredient|
```

When more than one dot attribute is used in sequence, the dot notation is evaluated sequentially from left to right. For example, the following expression constraint represents the set of |Finding sites| of any concept that is |Associated with| a subtype of |Disorder of lung|.

```
    <   19829001 |Disorder of lung|  . <  47429007 |Associated with|  .  363698007 |Finding site|
```

This expression constraint is evaluated by first finding the descendants of |Disorder of lung|, then finding the set of attribute values for these concepts (with an attribute type that is any subtype of |Associated with|), and then from these attribute value concepts, finding the value of any |Finding sites| attribute. Please note that the expression constraint above (with no brackets) is equivalent to the one below (with brackets added).

```
    ((< 19829001 |Disorder of lung| ) . <  47429007 |Associated with| ) .  363698007 |Finding site|
```

Any Attribute Name and Value

A single 'star' (i.e. "*") may be used in the place of an attribute name to represent any attribute in the substrate. The expression constraint below evaluates to the set of clinical findings which have any attribute with a value of 79654002 |Edema|.

```
    <   404684003 |Clinical finding| : * =  79654002 |Edema|
```

Using the long syntax, the above expression constraint may also be represented as:

```
    descendantOf  404684003 |Clinical finding| : ANY =  79654002 |Edema|
```

The 'star' symbol (i.e. "*") may also be used to represent any attribute value (either with or without refinement). The following expression constraint evaluates to the set of clinical findings which have an associated morphology (with any value).

```
    <   404684003 |Clinical finding| :  116676008 |Associated morphology|  = *
```

Using the long syntax, the above expression constraint may also be represented as:

```
descendantOf  404684003 |Clinical finding| :  116676008 |Associated morphology|  = ANY
```

---

[1] Please note that these example expressions are based on a hypothetical drug concept model, and are not intended to reflect any specific drug model. In these expressions, the SNOMED CT identifiers created with the '9999999' namespace are for example only, and should not be used in a production environment.

[2] Concrete values of type string are case sensitive and compared using the Unicode Collation Algorithm (http://www.unicode.org/reports/tr10/).

[3] It should be noted that using a reversed attribute joined by conjunction with a non-reversed attribute may lead to a nonsensical constraint (e.g. "<< a: {b=c, Rd=e}"). This is because the target concept of the reversed attribute must be matched with the source concept of the non-reversed attribute, which in turn must be the same as the source concept of the reversed attribute (being in the same attribute group). This would require the reversed attribute to be reflexive (i.e. the source and target concept to be the same).