

## 5. Semantic Network

The Semantic Network consists of (1) a set of broad subject categories, or Semantic Types, that provide a consistent categorization of all concepts represented in the UMLS Metathesaurus, and (2) a set of useful and important relationships, or Semantic Relations, that exist between Semantic Types. This section of the documentation provides an overview of the Semantic Network, and describes the files of the Semantic Network. Sample records illustrate structure and content of these files.

The Semantic Network is distributed as one of the UMLS Knowledge Sources and as an open source resource available on the [Semantic Network Web site](#).

### 5.1. Overview

The purpose of the Semantic Network is to provide a consistent categorization of all concepts represented in the UMLS Metathesaurus and to provide a set of useful relationships between these concepts. All information about specific concepts is found in the Metathesaurus. The Network provides information about the set of basic semantic types, or categories, which may be assigned to these concepts, and it defines the set of relationships that may hold between the semantic types. The Semantic Network contains 127 semantic types and 54 relationships. The Semantic Network serves as an authority for the semantic types that are assigned to concepts in the Metathesaurus. The Network defines these types, both with textual descriptions and by means of the information inherent in its hierarchies.

The semantic types are the nodes in the Network, and the relationships between them are the links. There are major groupings of semantic types for organisms, anatomical structures, biologic function, chemicals, events, physical objects, and concepts or ideas. The current scope of the UMLS semantic types is quite broad, allowing for the semantic categorization of a wide range of terminology in multiple domains.

The Metathesaurus consists of terms from its source vocabularies. The meaning of each term is defined by its source, explicitly by definition or annotation; by context (its place in a hierarchy); by synonyms and other stated relationships between terms; and by its usage in description, classification, or indexing. Each Metathesaurus concept is assigned at least one semantic type. In all cases, the most specific semantic type available in the hierarchy is assigned to the concept. For example, the concept "Macaca" receives the semantic type "Mammal" because there is not a more specific type "Primate" available in the Network. The level of granularity varies across the Network. This has important implications for interpreting the meaning (i.e., semantic type) that has been assigned to a Metathesaurus concept. For example, a sub-tree under the node "Physical Object" is "Manufactured Object". It has only two child nodes, "Medical Device" and "Research Device". It is clear that there are manufactured objects other than medical devices and research devices. Rather than proliferate the number of semantic types to encompass multiple additional subcategories for these objects, concepts that are neither medical devices nor research devices are simply assigned the more general semantic type "Manufactured Object".

Figure 1 illustrates a portion of the Network. The semantic type "Biologic Function" has two children, "Physiologic Function" and "Pathologic Function", and each of these in turn has several children and grandchildren. Each child in the hierarchy is linked to its parent by the "isa" link.

The primary link in the Network is the "isa" link. This establishes the hierarchy of types within the Network and is used for deciding on the most specific semantic type available for assignment to a Metathesaurus concept. In addition, a set of non-hierarchical relations between the types has been identified. These are grouped into five major categories, which are themselves relations: "physically related to", "spatially related to", "temporally related to", "functionally related to", and "conceptually related to".

Figure 2 illustrates a portion of the hierarchy for Network relationships. The "affects" relationship, one of several functional relationships, has six children, including "manages", "treats", and "prevents".

The relations are stated between high level semantic types in the Network whenever possible and are generally inherited via the "isa" link by all the children of those types. Thus, for example, the relation "process of" is stated to hold between the semantic types "Biologic Function" and "Organism". Therefore, it also holds between "Organ or Tissue Function" (which is a "Physiologic Function", which is, in turn, a "Biologic Function") and "Animal" (which is an "Organism"). The relations are stated between semantic types and do not necessarily apply to all instances of concepts that have been assigned to those semantic types. That is, the relation may or may not hold between any particular pair of concepts. So, though the relation "evaluation of" holds between the semantic types "Sign" and "Organism Attribute", a particular sign or a particular attribute may not be linked by this relation. Thus, signs such as "overweight" and "fever" are evaluations of the organism attributes "body weight" and "body temperature", respectively. However, "overweight" is not an evaluation of "body temperature", and "fever" is not an evaluation of "body weight".

In some cases there will be a conflict between the placement of types in the Network and the link to be inherited. If so, the inheritance of the link is said to be blocked. For example, by inheritance, the type "Mental Process" would be "process of" "Plant". Since plants are not sentient beings, this link is explicitly blocked. In other cases the nature of the relation is such that it should not be inherited by the children of the types that it links. In that case, the relation is defined for the two semantic types it explicitly links, but blocked for all the children of those types. For example, "conceptual part of" links "Body System" and "Fully Formed Anatomical Structure", but it should not link "Body System" to all the children of "Fully Formed Anatomical Structure", such as "Cell" or "Tissue".

Several portions of the MeSH hierarchy have been labeled with child to parent semantic relationships. All of the anatomy, diseases, and psychiatry and psychology sections have been labeled, as well as a portion of the biological sciences section. The links that are expressed between MeSH terms are, with a few exceptions, reflected in the Semantic Network. That is, if two MeSH terms are linked by a certain relation, then that link is expressed in the Network as a link between the semantic types that have been assigned to those MeSH terms. For example, "Amniotic Fluid", which is a "Body Substance", is a child of "Embryo", which is an "Embryonic Structure". The labeled relationship between "Amniotic Fluid" and its parent "Embryo" is "surrounds". This is allowable, since the relation "Body Substance surrounds Embryonic Structure" is represented in the Network.

Figure 3 shows a portion of the Semantic Network, illustrating the relations, either hierarchical or associative, that exist between semantic types.

The UMLS Semantic Network is provided in two formats: a relational table format and a unit record format.

## 5.2. Semantic Network ASCII Relational Format

There are two basic tables, two ancillary tables, and two bookkeeping tables included in this format. The two basic tables contain exactly the same information as the unit record file, but the information is presented

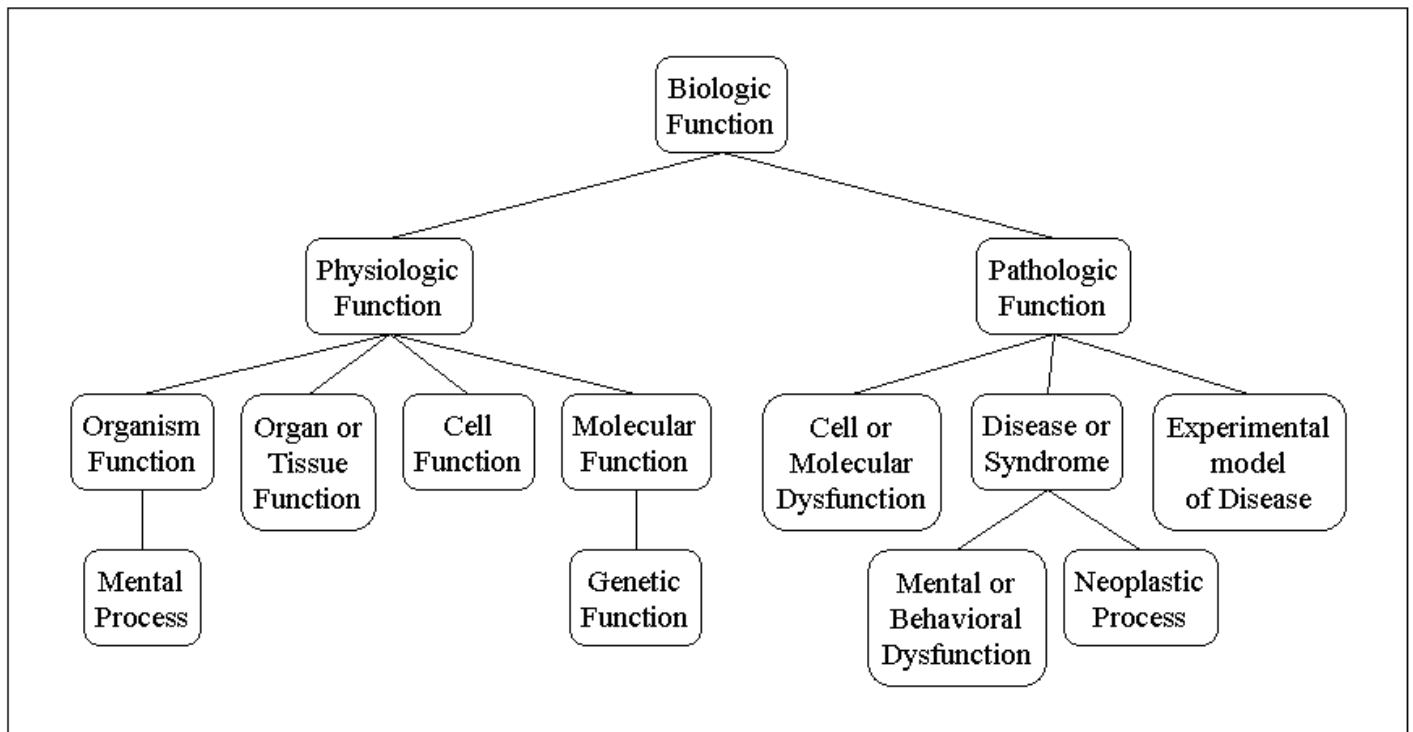


Figure 1. A Portion of the UMLS Semantic Network: “Biologic Function” Hierarchy

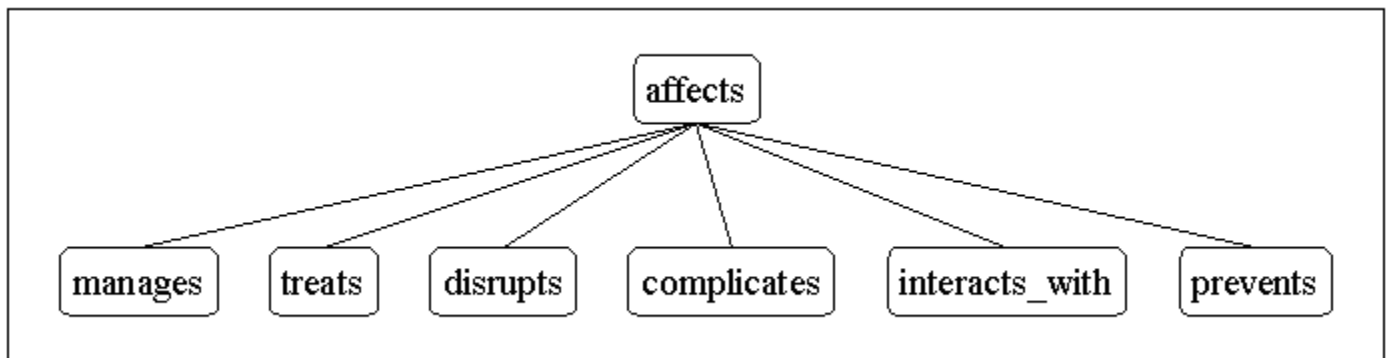


Figure 2. A Portion of the UMLS Semantic Network: “affects” Hierarchy

differently. One table contains definitional information about the semantic types and relations; the other contains information about the structure of the Network. Each semantic type and each relation has been assigned a four character unique identifier (UI). These are of the form "T001", "T002", etc. The ancillary tables are expansions of the table that contains the Network structure. They give the fully inherited set of links represented in the Network. The first table is expressed as triples of UI's. The second is expressed as triples of names. The two bookkeeping tables describe the relational files and their fields. Fields in all tables are separated by a "|". All tables are listed and described below:

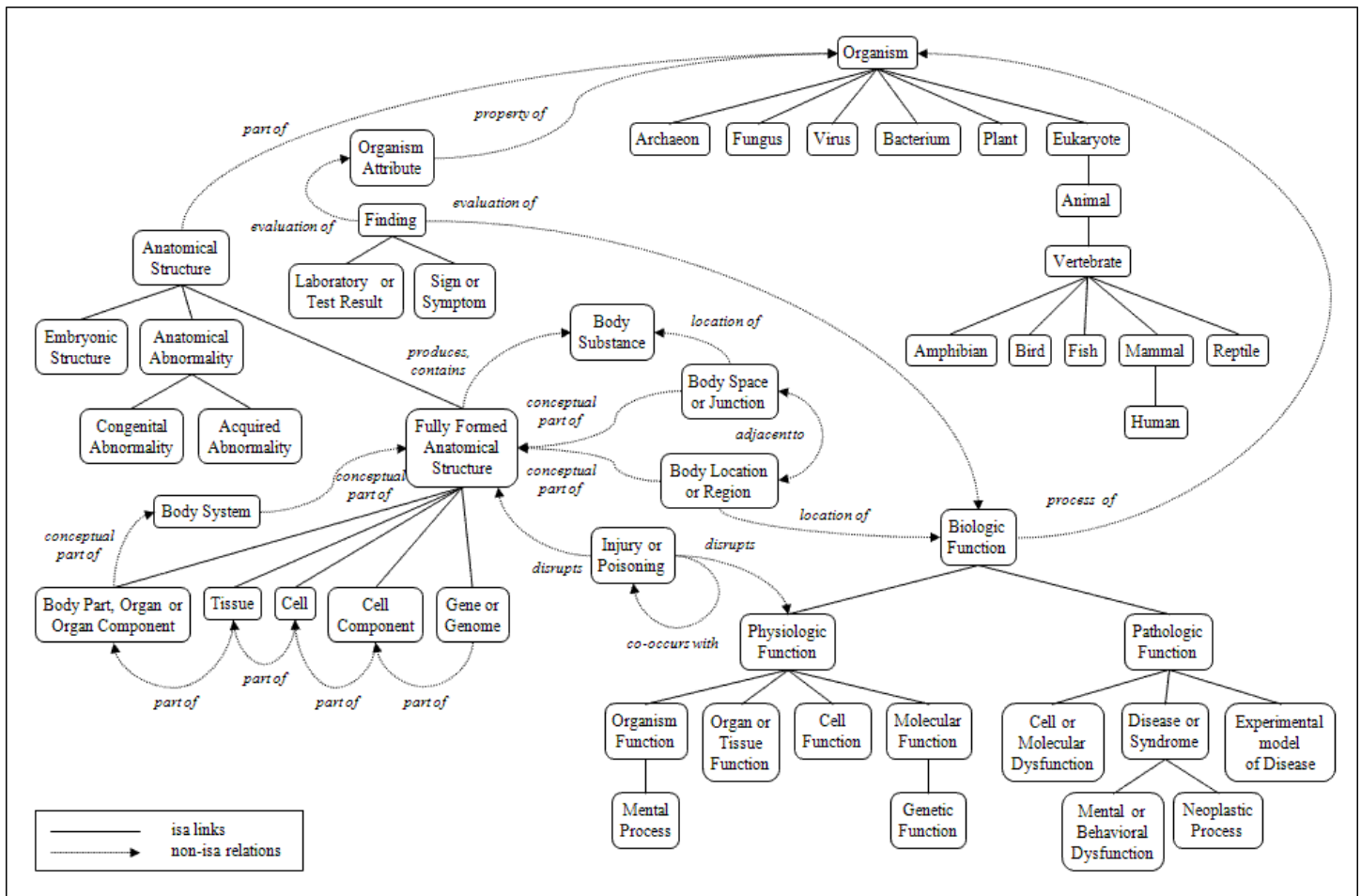


Figure 3. A Portion of the UMLS Semantic Network: Relations

Table	Description
SRDEF	Basic information about the Semantic Types and Relations.
SRSTR	Structure of the Network.
SRSTRE1	Fully inherited set of Relations (UI's).
SRSTRE2	Fully inherited set of Relations (names).
SRFIL	Description of each table.
SRFLD	Description of each field and the table(s) in which it is found.

**Specific Descriptions of each Table:**

Table: SRDEF

Field	Description
RT:	Record Type (STY = Semantic Type or RL = Relation).
UI:	Unique Identifier of the Semantic Type or Relation.
STY/RL:	Name of the Semantic Type or Relation.
STN/RTN:	Tree Number of the Semantic Type or Relation.
DEF:	Definition of the Semantic Type or Relation.

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Field	Description
EX:	Examples of Metathesaurus concepts with this Semantic Type (STY records only).
UN:	Usage note for Semantic Type assignment (STY records only).
NH:	The Semantic Type and its descendants allow the non-human flag (STY records only).
ABR:	Abbreviation of the Relation Name or Semantic Type.
RIN:	Inverse of the Relation (RL records only).

**Table:** SRSTR

Field	Description
STY/RL:	Argument 1 (Name of a Semantic Type or Relation).
RL:	Relation ("isa" or the name of a non-hierarchical Relation).
STY/RL:	Argument 2 (Name of a Semantic Type or Relation); if this field is blank this means that the Semantic Type or Relation is one of the top nodes of the Network.
LS:	Link Status (D = Defined for the Arguments and its children; B = Blocked; DNI = Defined but Not Inherited by the children of the Arguments). N.B.: The relations expressed in this table are binary relations and the arguments are ordered pairs. The relations are stated only for the top-most node of the "isa" hierarchy of the Semantic Types to which they may apply.

**Table:** SRSTRE1 or SRSTRE2

Field	Description
UI/STY:	Argument 1 (UI or name of a Semantic Type).
UI/RL:	Relation (UI or name of a nonhierarchical Relation).
UI/STY:	Argument 2 (UI or name of a Semantic Type). N.B.: The relations expressed in this table are binary relations and the arguments are ordered pairs. All relations have been fully inherited in this table.

**Table:** SRFIL

Field	Description
FIL:	File Name.
DES:	Description of the file.
FMT:	Format of the file (fields in a comma-separated list).
CLS:	Number of columns in the file.
RWS:	Number of rows in the file.
BTS:	Number of bytes in the file.

**Table:** SRFLD

Field	Description
COL:	Field name.
DES:	Description of the field.
REF:	Cross-reference to the documentation.
FIL:	File name(s) in which the field is found.

## Sample Relational Records

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SRDEF

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STY|T020|Acquired Abnormality|A1.2.2.2|An abnormal structure, or one that is abnormal in size or location, found in or deriving from a previously normal structure. Acquired abnormalities are distinguished from diseases even though they may result in pathological functioning (e.g., "hernias incarcerate").||NULL||acab||

STY|T047|Disease or Syndrome|B2.2.1.2.1|A condition which alters or interferes with a normal process, state, or activity of an organism. It is usually characterized by the abnormal functioning of one or more of the host's systems, parts, or organs. Included here is a complex of symptoms descriptive of a disorder.||Any specific disease or syndrome that is modified by such modifiers as "acute", "prolonged", etc. will also be assigned to this type. If an anatomic abnormality has a pathologic manifestation, then it will be given this type as well as a type from the 'Anatomical Abnormality' hierarchy, e.g., "Diabetic Cataract" will be double-typed for this reason.||dsyn||

STY|T052|Activity|B1|An operation or series of operations that an organism or machine carries out or participates in.||Few concepts will be assigned to this broad type. Wherever possible, one of the more specific types from this hierarchy will be chosen. For concepts assigned to this type, the focus of interest is on the activity. When the focus of interest is the individual or group that is carrying out the activity, then a type from the 'Behavior' hierarchy will be chosen. In general, concepts will not receive a type from both the 'Activity' and the 'Behavior' hierarchies.||acty||

STY|T059|Laboratory Procedure|B1.3.1.1|A procedure, method, or technique used to determine the composition, quantity, or concentration of a specimen, and which is carried out in a clinical laboratory. Included here are procedures which measure the times and rates of reactions.||NULL||lbpr||

RL|T173|adjacent\_to|R2.2|Close to, near or abutting another physical unit with no other structure of the same kind intervening. This includes adjoins, abuts, is contiguous to, is juxtaposed, and is close to.||||AD|adjacent\_to|

RL|T151|affects|R3.1|Produces a direct effect on. Implied is the altering or influencing of an existing condition, state, situation, or entity. This includes has a role in, alters, influences, predisposes, catalyzes, stimulates, regulates, depresses, impedes, enhances, contributes to, leads to, and modifies.||||AF|affected\_by|

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SRSTR

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Acquired Abnormality|co-occurs\_with|Injury or Poisoning|

Acquired Abnormality|isa|Anatomical Abnormality|

Acquired Abnormality|result\_of|Behavior|

Activity|isa|Event|

Age Group|isa|Group|

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SRSTRE1

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T020|T186|T190|

T020|T186|T017|

T020|T186|T072|

T052|T186|T051|

T052|T165|T090|  
 T052|T165|T091|  
 T100|T186|T096|  
 T100|T186|T077|  
 T100|T186|T071|

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SRSTRE2

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Acquired Abnormality|isa|Anatomical Abnormality|  
 Acquired Abnormality|isa|Anatomical Structure|  
 Acquired Abnormality|isa|Entity|  
 Acquired Abnormality|isa|Physical Object|  
 Acquired Abnormality|affects|Amphibian|  
 Acquired Abnormality|affects|Animal|  
 Acquired Abnormality|affects|Archaeon|  
 Acquired Abnormality|affects|Bacterium|  
 Acquired Abnormality|affects|Bird|  
 Acquired Abnormality|affects|Cell Function|  
 Acquired Abnormality|affects|Eukaryote|  
 Acquired Abnormality|affects|Fish|  
 Acquired Abnormality|affects|Fungus|  
 Acquired Abnormality|affects|Genetic Function|  
 Acquired Abnormality|affects|Human|  
 Acquired Abnormality|affects|Mammal|  
 Acquired Abnormality|affects|Mental Process|  
 Acquired Abnormality|affects|Molecular Function|  
 Acquired Abnormality|affects|Organ or Tissue Function|  
 Acquired Abnormality|affects|Organism Function|  
 Acquired Abnormality|affects|Organism|  
 Acquired Abnormality|affects|Physiologic Function|  
 Acquired Abnormality|affects|Plant|  
 Acquired Abnormality|affects|Reptile|  
 Acquired Abnormality|affects|Vertebrate|  
 Acquired Abnormality|affects|Virus|  
 Activity|isa|Event|  
 Age Group|isa|Conceptual Entity|  
 Age Group|isa|Entity|  
 Age Group|isa|Group|

### 5.3. Semantic Network ASCII Unit Record Format

The file "SU" contains individual records for both semantic types and relations.

Each record begins with a unique identifier field (UI) which contains the four character UI. These are of the form "T001", "T002", etc. Each field in a record begins on a new line and may continue over several lines. Some fields are optional.

Semantic Type records contain the following fields:

Field	Description
UI:	Unique Identifier of the Semantic Type.
STY:	Name of the Semantic Type.
STN:	Tree Number of the Semantic Type.
DEF:	Definition of the Semantic Type.
EX:	Examples of Metathesaurus concepts with this Semantic Type (optional field).
UN:	Usage note for Semantic Type assignment (optional field).
NH:	Semantic Type and its descendants allow the non-human flag (optional field).
HL:	Hierarchical links of the Semantic Type to its parent ({isa}) and its children ({inverse_isa}). If there are no hierarchical links, then the value <none> is assigned.

Relation records contain the following fields:

Field	Description
UI:	Unique Identifier of the Relation.
RL:	Name of the Relation.
ABR:	Abbreviation of the Relation.
RIN:	Name of the inverse of the Relation.
RTN:	Tree Number of the Relation.
DEF:	Definition of the Relation.
INH:	"N" if the relation is not inherited (optional field).
HL:	Hierarchical links of the Relation to its parent ({isa}) and its children ({inverse_isa}). If there are no hierarchical links, then the value <none> is assigned.
STL:	Semantic Types linked by this Relation. N.B.: These are binary relations and the arguments are ordered pairs. The relations are stated only for the top-most node of the "isa" hierarchy of the Semantic Types to which they may apply. This field does not appear in the "isa" relation record since its values can be computed from the "HL" field. If there are no semantic types linked by this Relation, then the value <none> is assigned.
STLB:	Semantic Types linked by this Relation are blocked (optional field).

## Sample Unit Records

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SU

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UI:	T020
STY:	Acquired Abnormality
ABR:	acab
STN:	A1.2.2.2
DEF:	An abnormal structure, or one that is abnormal in size or location, found in or deriving from a previously normal structure. Acquired abnormalities are distinguished from diseases even though they may result in pathological functioning (e.g., "hernias incarcerate").



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HL:	{isa} Anatomical Abnormality
UI:	T052
STY:	Activity
ABR:	acty
STN:	B1
DEF:	An operation or series of operations that an organism or machine carries out or participates in.
UN:	Few concepts will be assigned to this broad type. Wherever possible, one of the more specific types from this hierarchy will be chosen. For concepts assigned to this type, the focus of interest is on the activity. When the focus of interest is the individual or group that is carrying out the activity, then a type from the 'Behavior' hierarchy will be chosen. In general, concepts will not receive a type from both the 'Activity' and the 'Behavior' hierarchies.
HL:	{isa} Event; {inverse_isa} Behavior; {inverse_isa} Daily or Recreational Activity; {inverse_isa} Occupational Activity; {inverse_isa} Machine Activity

UI:	T100
STY:	Age Group
ABR:	aggp
STN:	A2.9.4
DEF:	An individual or individuals classified according to their age. EX: Adult; Infant, Premature; Adolescents; Aged, 80 and over
HL:	{isa} Group

UI:	T173
RL:	adjacent_to
ABR:	AD
RIN:	adjacent_to
RTN:	R2.2
DEF:	Close to, near or abutting another physical unit with no other structure of the same kind intervening. This includes adjoins, abuts, is contiguous to, is juxtaposed, and is close to.
HL:	{isa} spatially_related_to

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STL:	[Body Location or Region Body Location or Region]; [Body Location or Region Body Part, Organ, or Organ Component]; [Body Location or Region Body Space or Junction]; [Body Part, Organ, or Organ Component Body Part, Organ, or Organ Component]; [Body Part, Organ, or Organ Component Body Space or Junction]; [Body Part, Organ, or Organ Component Cell]; [Body Part, Organ, or Organ Component Tissue]; [Body Space or Junction Body Space or Junction]; [Cell Component Body Space or Junction]; [Cell Component Cell Component]; [Cell Cell]; [Tissue Body Space or Junction]; [Tissue Tissue]
UI:	T151
RL:	affects
ABR:	AF
RIN:	affected_by
RTN:	R3.1
DEF:	Produces a direct effect on. Implied here is the altering or influencing of an existing condition, state, situation, or entity. This includes has a role in, alters, influences, predisposes, catalyzes, stimulates, regulates, depresses, impedes, enhances, contributes to, leads to, and modifies.
HL:	{isa} functionally_related_to; {inverse_isa} manages; {inverse_isa} treats; {inverse_isa} disrupts; {inverse_isa} complicates; {inverse_isa} interacts_with; {inverse_isa} prevents
STL:	[Natural Phenomenon or Process Natural Phenomenon or Process]; [Anatomical Abnormality Physiologic Function]; [Biologic Function Organism]; [Anatomical Abnormality Organism]; [Health Care Activity Biologic Function]; [Diagnostic Procedure Patient or Disabled Group]; [Therapeutic or Preventive Procedure Patient or Disabled Group]; [Chemical Natural Phenomenon or Process]; [Gene or Genome Physiologic Function]; [Cell Component Physiologic Function]; [Physiologic Function Organism Attribute]; [Food Biologic Function]; [Behavior Behavior]; [Behavior Mental Process]; [Mental Process Behavior]; [Mental or Behavioral Dysfunction Behavior]; [Research Activity Mental Process]; [Regulation or Law Group]; [Regulation or Law Organization]