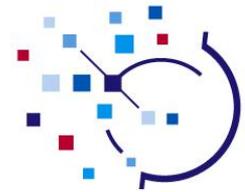


SNOMED Clinical Terms Fundamentals

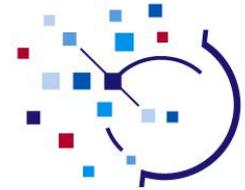
Penni Hernandez

Senior Terminologist, IHTSDO



Outline of presentation

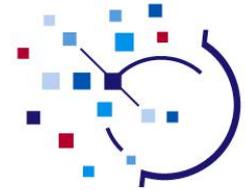
- What is SNOMED CT?
- What is it for?
 - EHR, statements and expressions
- What kinds of things are represented?
- How is it organized?
- How does it fit into/with the Electronic Health Record?
- What additional components & essential materials should I know about?
 - Mapping, subsets, extensions, definitions, documentation, etc
- How can I suggest changes or improvements?
 - working groups, communication, governance



What is SNOMED CT?

What is SNOMED Clinical Terms?

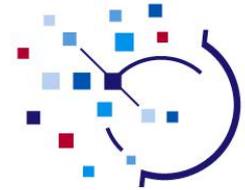
- What is it?
- What does it do?
- Where did it come from?
- What is it made up of?
- How big is it?



What is SNOMED CT?

What is SNOMED Clinical Terms?

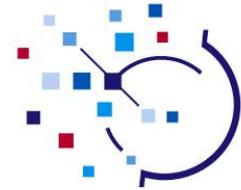
- **Name:**
 - Systematized Nomenclature of Medicine – Clinical Terms
- **Description:**
 - A work of clinical terminology
- **Main purpose:**
 - Coded representation of meanings used in health information



What is SNOMED CT?

What is a clinical terminology?

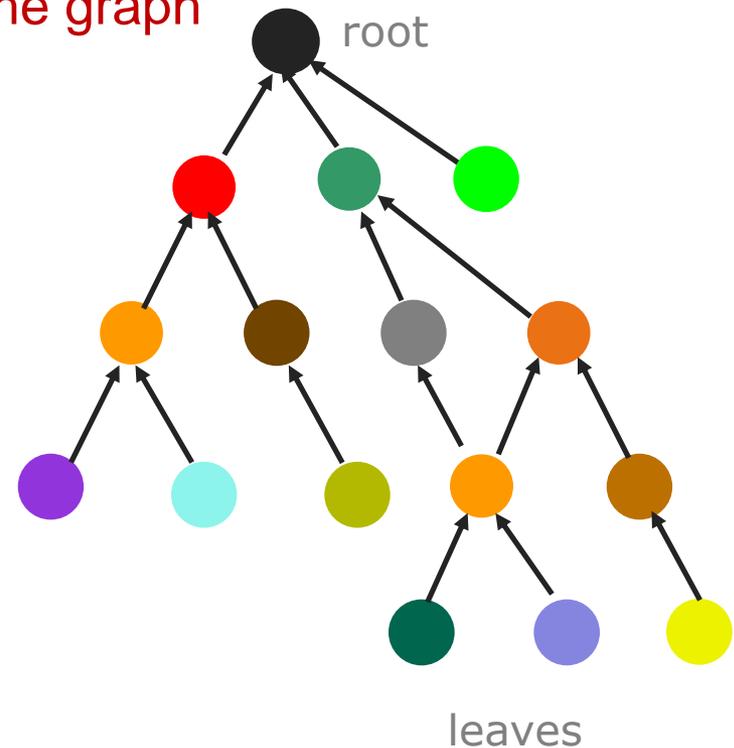
- **Terminology (ordinarily):**
 - A structured collection of terms
- **A clinical terminology**
 - SNOMED CT is a terminology
 - consisting of terms used in health & health care
 - attached to concept codes with multiple terms per code
 - structured according to logic-based representation of meanings

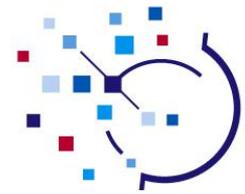


What is SNOMED CT?

Codes organized in a directed acyclic graph

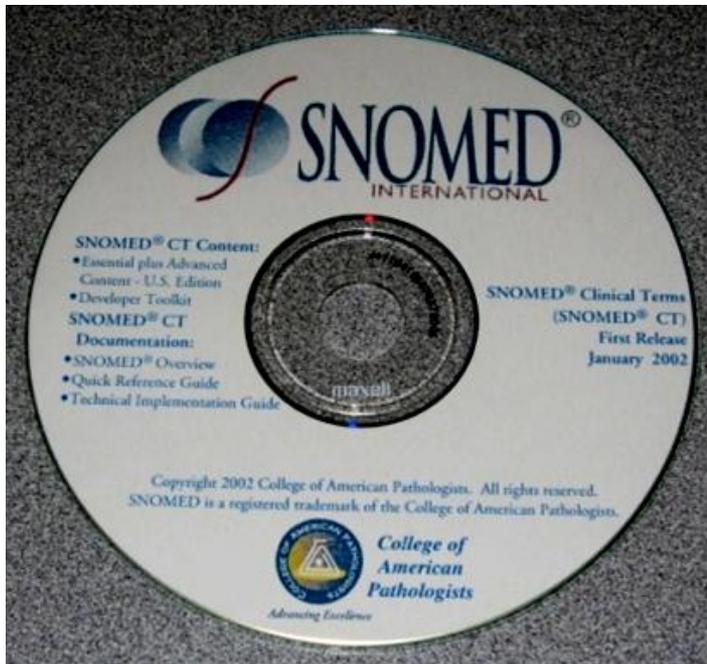
- Each code is represented by a node in the graph
- Each relationship is an arrow
- There are no cycles
- Codes may have >1 outgoing arrow
 - if only 1 outgoing, you have a tree
 - but C.S. trees are upside down





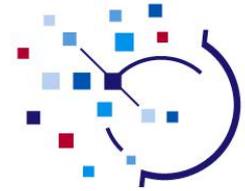
What is SNOMED CT?

A compact disc with data files



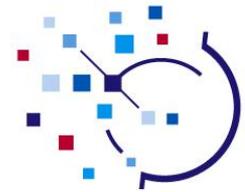
CONCEPTID	CONC EPT STATU S	FULLYSPECIFIEDNAME	CTV3ID	SNOMEDID	ISPRI MITIVE
210566005	0	Open wound of hand with tendon involvement (disorder)	S922.	DD-3317D	1
210567001	0	Complete division extensor tendon hand (disorder)	S9220	DF-008E6	1
210568006	0	Complete division flexor tendon hand (disorder)	S9221	DF-008E7	1
210569003	0	Partial division extensor tendon hand (disorder)	S9222	DF-008E8	1
210570002	0	Partial division flexor tendon hand (disorder)	S9223	DF-008E9	1
210571003	0	Degloving injury of hand (disorder)	S923.	DD-30125	0
210572005	0	Degloving injury hand, palmar (disorder)	S9230	DD-30126	0
210573000	0	Degloving injury hand, dorsum (disorder)	S9231	DD-30127	0
210574006	0	Severe multi tissue damage hand (disorder)	S924.	DD-00414	1
210575007	0	Massive multi tissue damage hand (disorder)	S925.	DD-00415	1
210576008	6	Open wound of hand, excluding fingers, NOS (disorder)	S92z.	DD-33163	1
210577004	4	Open wound: [finger(s) or of thumb] or [fingernail] or [nail] or [thumbnail]	S93..	R-F5944	1
210578009	6	Open wound of finger or thumb without mention of complication (disorder)	S930.	DD-3317E	1
125653000	0	Open wound of finger (disorder)	S9300	DD-33169	0
210579001	0	Open wound, finger, multiple (disorder)	S9301	DD-3317F	1
125654006	0	Open wound of thumb (disorder)	S9302	DD-3316A	0
210580003	0	Open wound of finger or thumb with complication (disorder)	S931.	DD-33189	1
210581004	4	Open wound: [finger or thumb with tendon involvement] or [finger with tendon injury]	S932.	R-F5945	1

What is SNOMED CT?



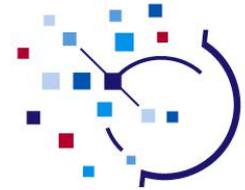
What does it do?

- **Facetiously: Nothing, it just sits there.**
 - Until incorporated into software systems



Organisational background and history

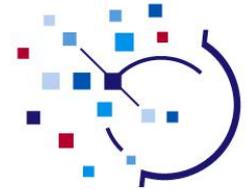
- **International Health Terminology Standards Development Organisation (IHTSDO)**
 - A not-for-profit organisation incorporated in Denmark
 - Member Nations provide the resources for coordinated development and release of terminology products
 - Owns and governs SNOMED CT and antecedent works



What is SNOMED CT?

Where did it come from?

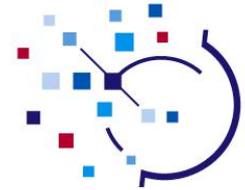
- **College of American Pathologists**
 - SNOMED 2 (1979)* Most widely adopted version in pathology systems worldwide
 - SNOMED 3 'International' (1993)
 - SNOMED RT 'Reference Terminology' (2000)
- **United Kingdom – National Health Service**
 - Read Codes '4-byte' (1984)
 - Read Codes 2 '5-byte' (1988)* Still the most widely used codes in GP systems in the UK
 - Clinical Terms version 3 'CTV3' ('Read Codes') (1999)
- **A true confluence**
 - All codes in SNOMED RT and CTV3 are included in SCT



What is SNOMED CT?

What is it made of?

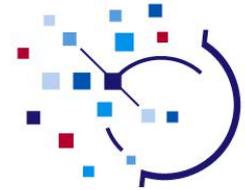
- **Components**
- **So-called “core” components:**
 - Concept codes
 - Descriptions (terms)
 - Relationships
- **Other components:**
 - Reference Sets (RefSets), RefSet Members
 - CrossMap Sets, Cross Maps, Cross Map Targets



What is SNOMED CT?

Concept Codes

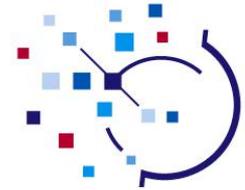
- **One code per meaning, one meaning per code**
 - Strings of digits, length 6 to 18 (most commonly 8 or 9 digits)
 - 22298006 means “myocardial infarction (MI)”
 - 399211009 means “past history of MI”
 - Meaningful, but without embedded meaning within the code
- **Codes vs Concepts vs Real things**
 - Concepts are in people’s heads
 - Codes are in the terminology
 - The codes *refer to* real things in the real world



What is SNOMED CT?

Terms & Descriptions

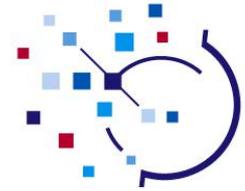
- A term string is a sequence of readable characters
 - E.g. “immunosuppression”
- A “description” is a term attached to a concept
- These are two different “descriptions” that have the same term string:
 - immunosuppression → immunosuppressive therapy (procedure)
 - Description ID = 507152014
 - Immunosuppression → immunosuppression (finding)
 - Description ID = 63394015



What is SNOMED CT?

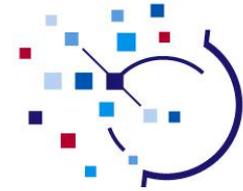
Relationships

- **Can be of several types:**
 - **Definitional:** necessarily true about the concept
 - **Qualifiers:** may be added to specialize the concept
 - **Historical:** provides a pointer to current concepts from retired
 - **Additional:** allows non-definitional information to be distributed

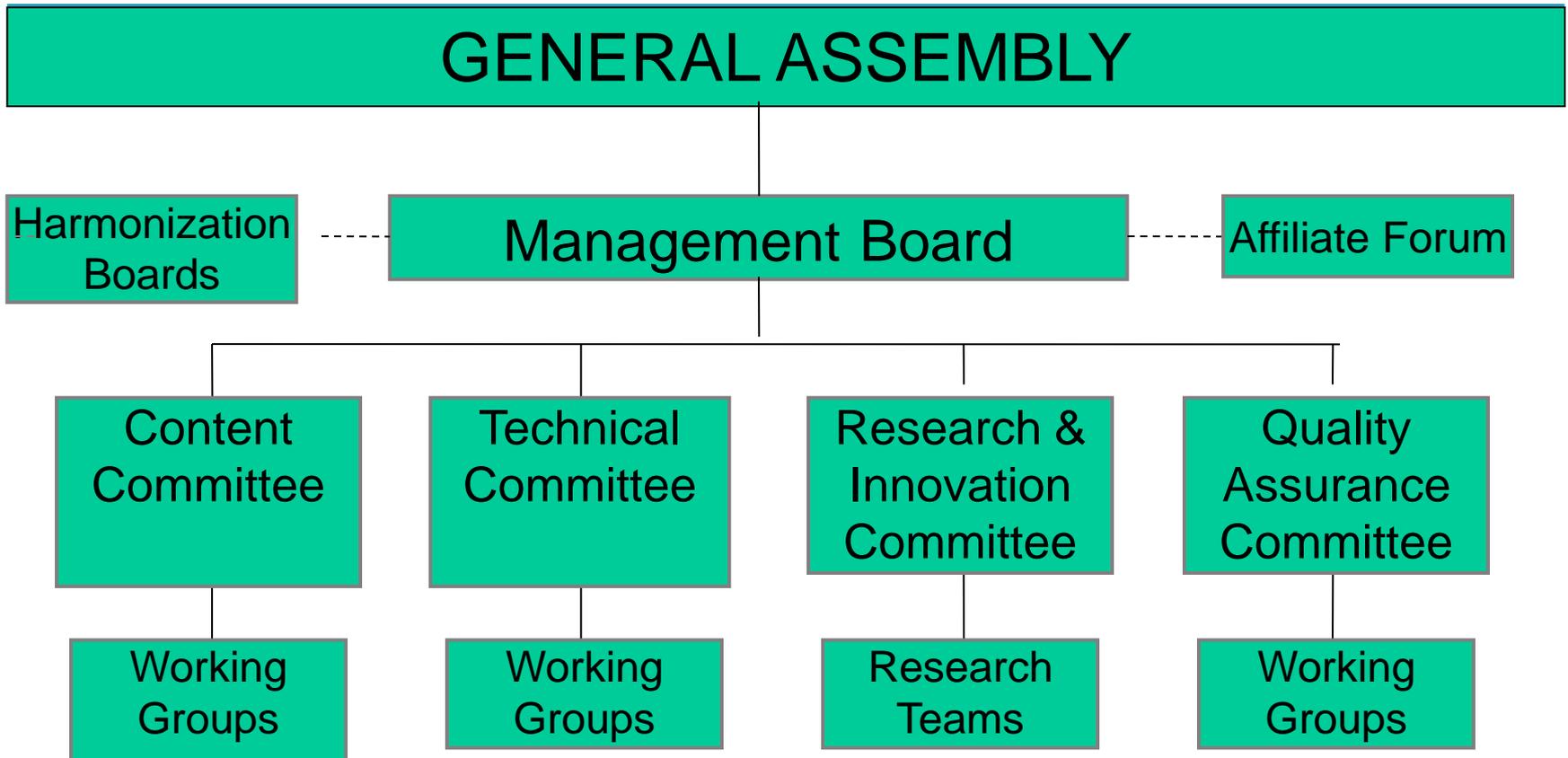


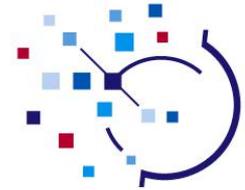
How big is it?

- 283,000 Active concept codes vs. 295,542 July 2011
- 732,000 Active terms (descriptions) vs. 769,428 July 2011
- 923,000 Active defining relationships vs.
 - If you spent 1 minute examining each description,
 - Working 40 hrs/week (2400 minutes/week), it would take
 - 305 weeks (~6 years) to examine all the active descriptions
- Scale is a major issue in developing, using and maintaining it



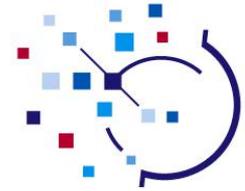
IHTSDO Structure and Governance





Requirements, benefits, users and uses

- **What does it do? facetiously: Nothing, it just sits there.**
 - Until incorporated into software systems
- **Really: It enables semantic interoperability, when implemented in an electronic health record**
 - Supports implementation of electronic health records
 - Decision support systems
 - makes them systematically maintainable, sharable

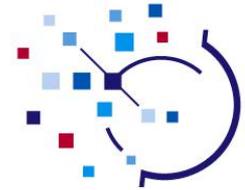


What is it for?

Terminology enables decision support

- **Influenza vaccination reminder**
- **decision support program criterion:**
 - chronic cardiorespiratory disorders
- **patient record:**
 - mild persistent asthma

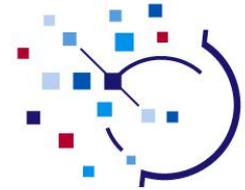




What is it for?

Purpose of the terminology

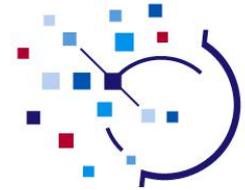
- To provide a consistent way of indexing, storing, retrieving and aggregating clinical data from structured, computerised clinical records
- In order to support clinical care
 - Recording statement about health and health care of an individual patient
 - Retrieving those statements according to their meaning
 - At various levels of abstraction
 - For clinicians, patient, researchers, organisations and other computer systems



What is it for?

Purpose of the terminology (2)

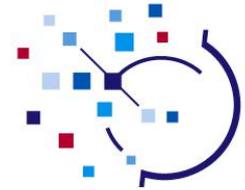
- **To represent health information**
 - Recorded by clinicians
 - At the level of detail they prefer
- **To retrieve and analyse health information**
 - Retrieving those statements according to their meaning
 - At various levels of abstraction
 - For clinicians, patient, researchers, organizations and other computer systems



What is it for?

Who uses it?

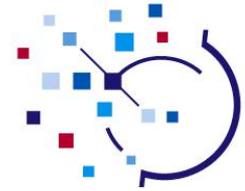
- **Users:**
 - Clinicians
 - The end users of EHRs
 - System developers & vendors / suppliers
 - System implementers
 - Hospitals, clinics, laboratories, etc
 - Policy makers (government, professions, etc)
 - Researchers



What is it for?

What are the uses?

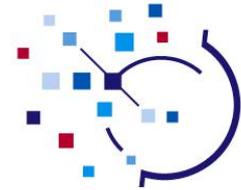
- **Representation of health information**
 - Indexing & retrieval of health information generally
 - Recording health & care of individuals
 - with fidelity to the clinical situation
 - Record retrieval & analysis based on meaning
 - Important for decision support applications
- **More specific examples**
 - Public health reporting – infectious diseases, cancer, biosurveillance
 - Reminders and alerts for preventive care



What is it for?

Expected benefits

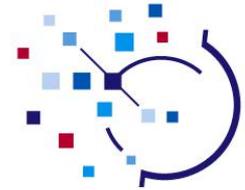
- **Reduction of errors**
 - Elimination of errors of omission via “reminders”
 - Elimination of errors of commission via “alerts”
- **Monitoring and responding to trends & problems in the health of populations**
- **Expanding knowledge of diseases, treatments and outcomes**



Building blocks

- **Concepts**
 - The anchors for meaning
- **Descriptions**
 - Terms (strings of readable characters) used to express the meanings of the concepts in human language
- **Relationships**
 - Concept-to-concept links used to express information in computer processable language
 - First purpose: formal logical meanings
 - Other purposes: tracking retired concepts, representing facts that may vary, and supporting post-coordination

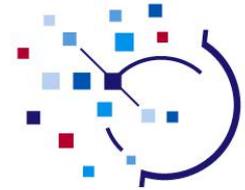
What kinds of things
are represented?



What kinds of things have codes?

- Organizing the world into types or classes is the work of “ontology”
- SNOMED focuses on classes that are useful in health & health care
 - Situations with explicit context
 - Procedures
 - Findings & disorders
 - Events
 - Body structures, anatomical or morphologically abnormal
 - Things that contribute to illness:
 - Organisms, substances, forces, objects, social context,
 - Other things important for health

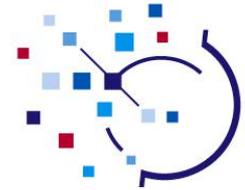
What kinds of things
are represented?



Situations with explicit context

- **Statements with “context”** are those that express something about:
who, whether, and/or when
- **Who:**
 - is it about the subject of the record, or someone else?
- **Whether:**
 - for findings, is the finding present, absent, or unknown?
 - for procedures, was it done, not done, or planned, ...
- **When:**
 - was the statement about the present, past, or perhaps future?

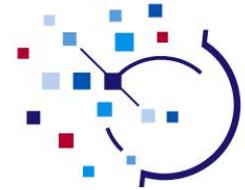
What kinds of things
are represented?



Situation examples

- **Family history of diabetes mellitus**
 - Who: a family member of the subject of record
- **Tetanus booster given**
 - Whether: yes, the procedure was done
- **Past history of pelvic fracture**
 - When: sometime in the past

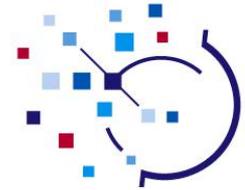
What kinds of things
are represented?



Findings & Disorders

- **Findings:**
 - fever
 - low platelet count
 - rash
 - normal blood pressure
 - knee jerk reflex 2+/4+
- **Disorders:**
 - sickle cell disease
 - Fanconi's anemia
 - heart disease

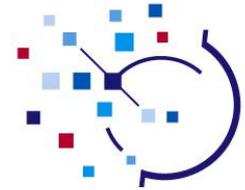
What kinds of things
are represented?



Procedures

- Any type of action done intentionally as part of the process of delivering health care
 - Patient education
 - Surgical procedure
 - Cholecystectomy
 - X-ray of left wrist
 - Discharge from nursing home
 - Family counseling

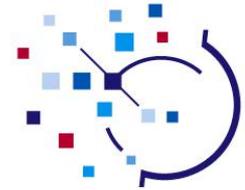
What kinds of things
are represented?



Events

- Occurrences, things that happen (not necessarily unintentional)
 - exposure to toxin
 - death
 - environmental event
 - homicide
 - travel

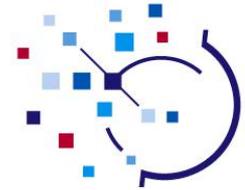
What kinds of things
are represented?



Observables

- Qualities, properties and other observable entities
- “Incomplete findings”, that is, findings without their values
 - blood pressure
 - age
 - respired oxygen concentration
 - ability to walk (“whether able to walk”, not “able to walk”)
 - histologic grade
 - lesion size

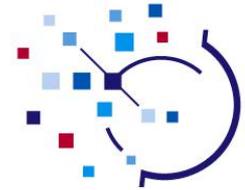
What kinds of things
are represented?



“Value hierarchies”

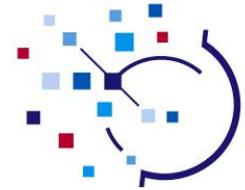
- Anatomy
- Morphology
- Drugs
- Substances
- Devices
- Organisms
- Physical objects
- Physical forces
- Social context

What kinds of things
are represented?



Miscellaneous

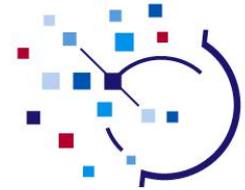
- Staging, scales, & other qualifier values
- Record artifacts
- “Special” concepts
 - Inactive
 - Navigational
- Linkage concepts
 - Attributes



How is it organized?

How are the codes organized?

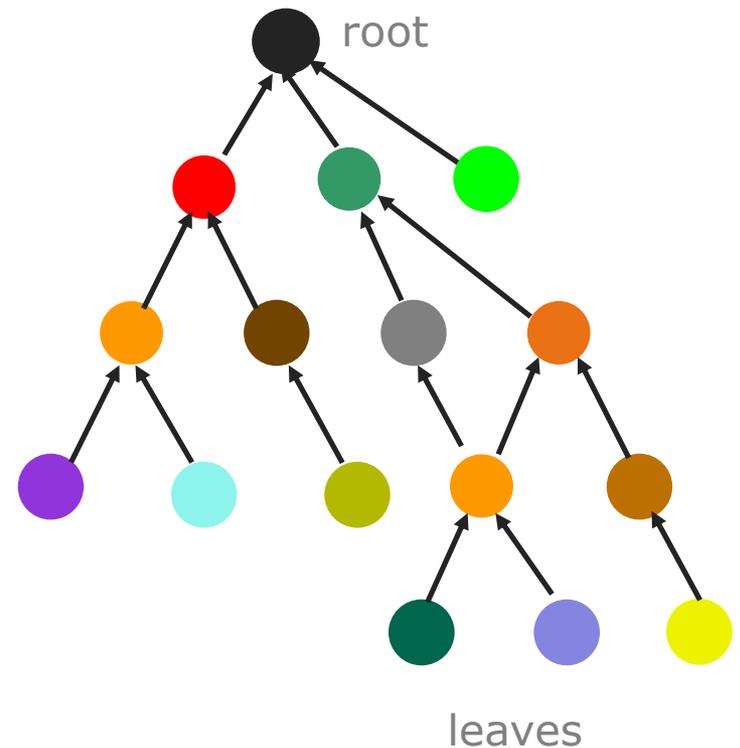
- 1) Directed acyclic graph
 - logical subsumption relationships, with a single root
- 2) Attributes with values
 - Necessarily true “existential restrictions”
- 3) Description logic definitions of each concept code
 - Structured combinations of isa’s and attribute-value relationships

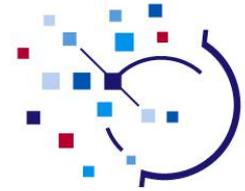


How is it organized?

DAG (Directed Acyclic Graph)

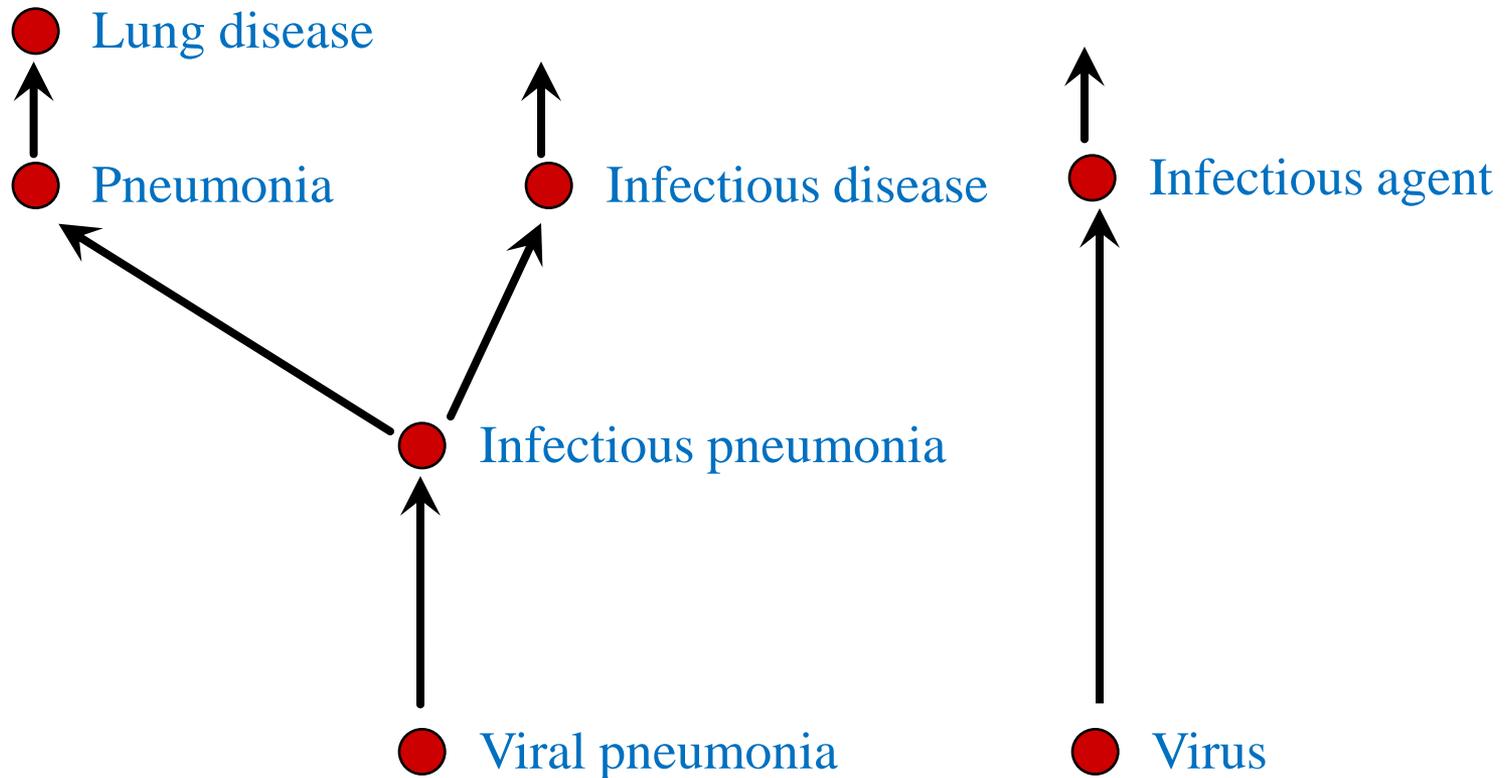
- Called the “is a hierarchy”
 - Represents logical subsumption
 - A isa B means all instances of A are also instances of B

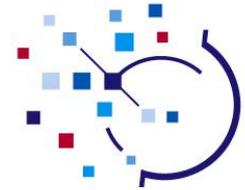




How is it organized?

Relationships: isa examples

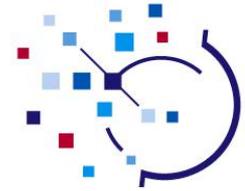




How is it organized?

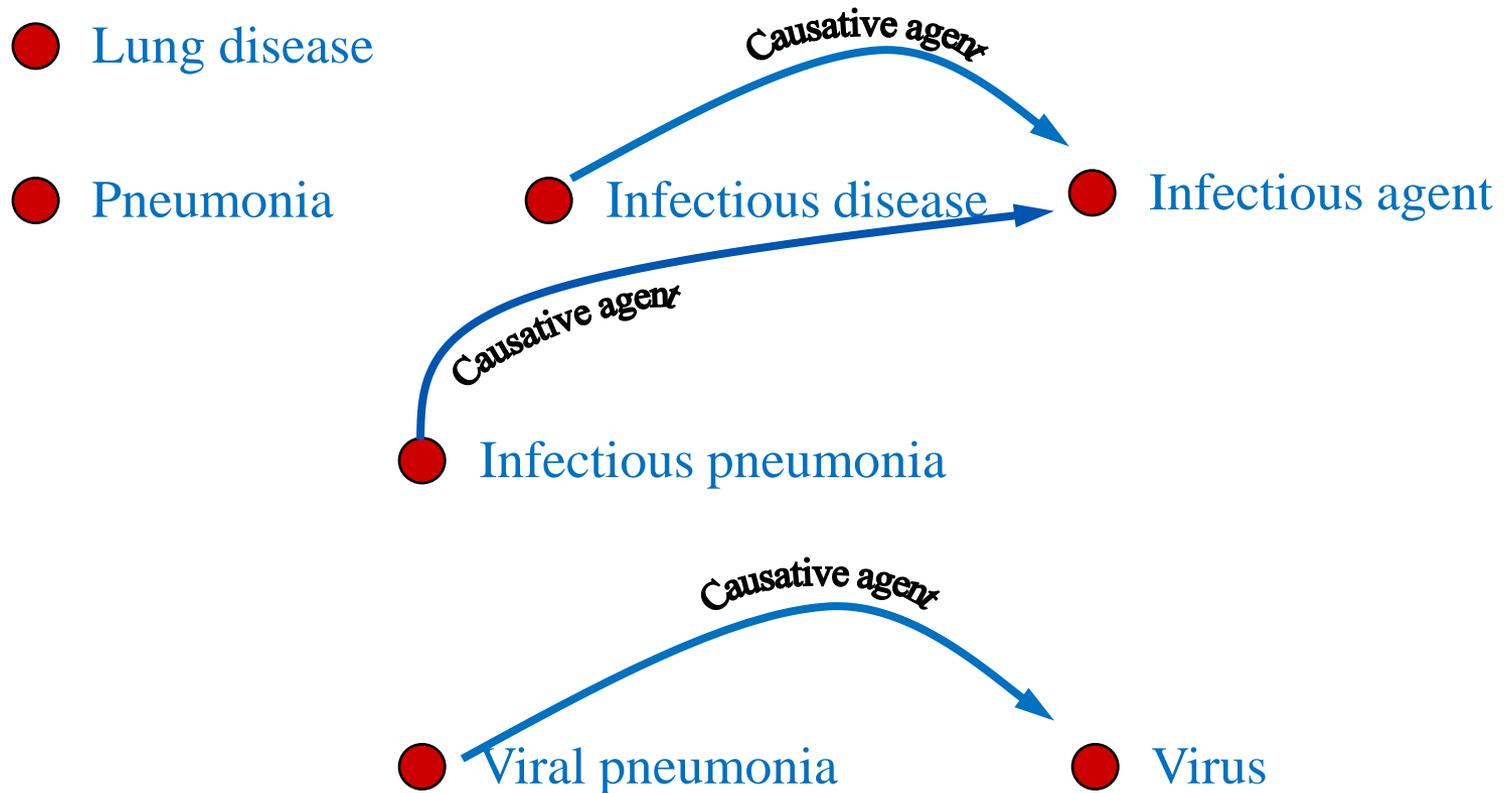
Attribute-value relationships

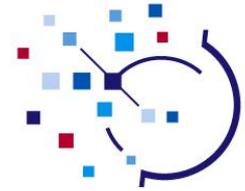
- **attribute – value**
 - Logical “existential restriction”
 - A rel B means that for every instance of A, there is at least one relationship “rel” with a value that is an instance of B



How is it organized?

Attribute example: causative agent

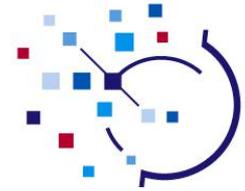




How is it organized?

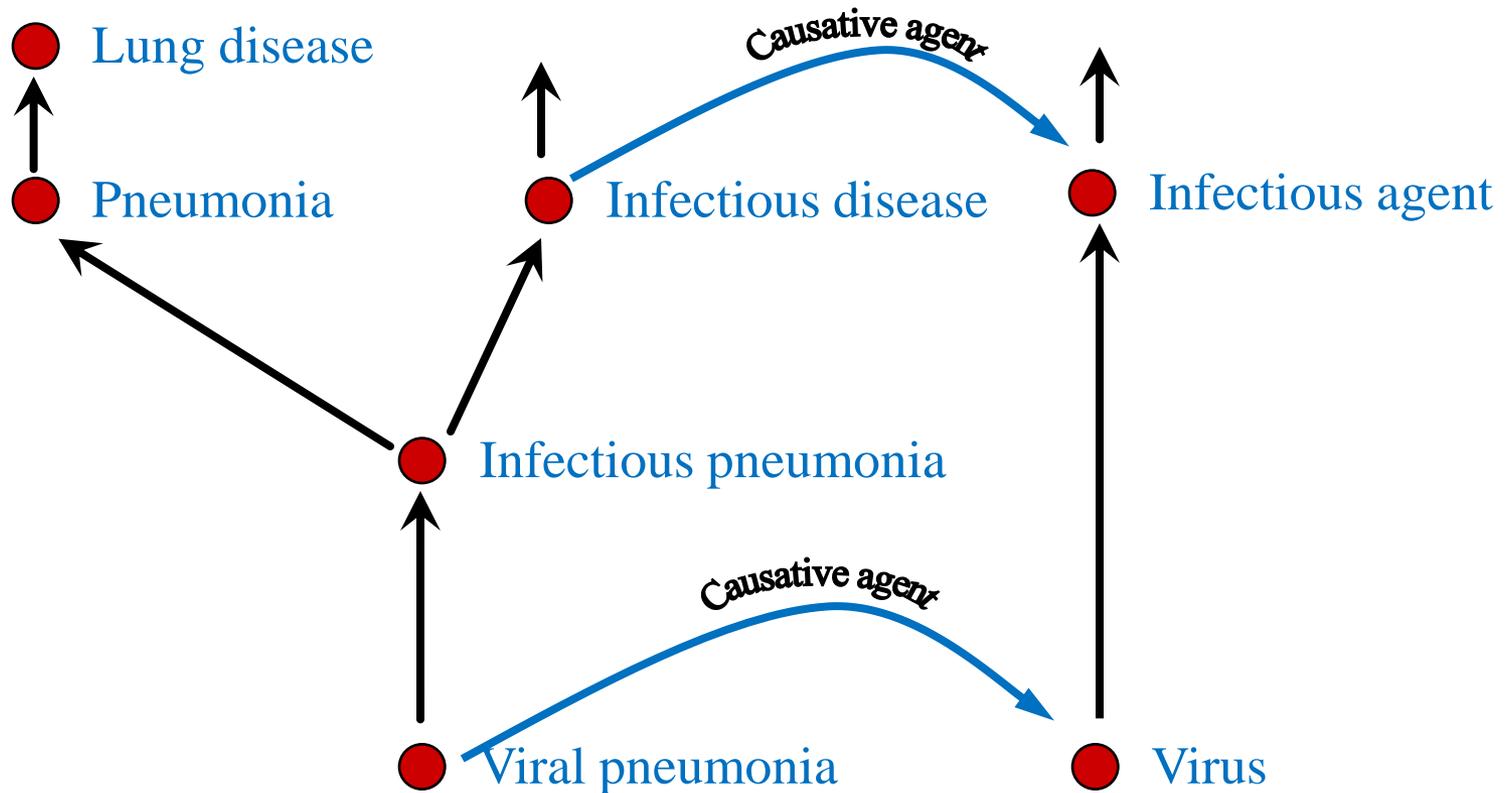
Description logic definitions

- **Viral pneumonia**
 - Is-a infectious pneumonia,
 - Causative agent = virus

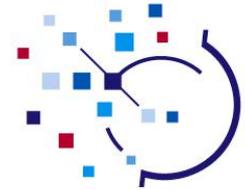


How is it organized?

Combining isa and attribute relationships

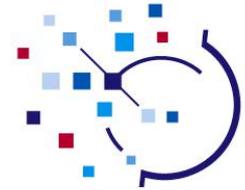


How does it fit
with the EHR?



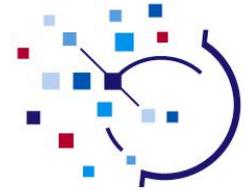
Where do the codes go in a record?

- **Statements in EHR's**
 - Electronic health record is made up of a series of statements
- **Codes are the values for fields/slots in the information model**
 - Codes from the terminology fill in some or all of the statement body
 - Information model determines the fields/slots available
- **Coordination required to avoid gaps & overlaps between**
 - terminology model
 - Information model



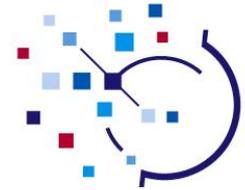
Additional components & features

- History tracking
- Cross Maps
- Subsets & Reference Sets
- Extensions



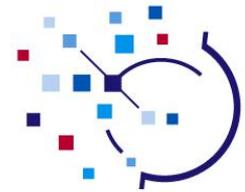
History Tracking

- **Each component is permanent**
 - But sometimes we correct errors. Then what?
- **Components may be marked inactive**
 - A component status field is included for each component
 - Additional two fields: release date, and change type
- **Historical references link inactive components to current (active) ones**
- **Application maintenance can use the history tracking mechanisms to:**
 - Update applications with new releases
 - Properly conduct retrievals on data containing inactive codes



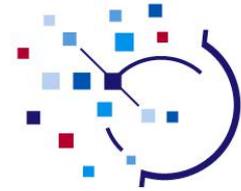
Cross Maps

- Cross mapping involves linking SNOMED CT to other terminologies
- Each cross map has a direction
 - Either from SNOMED to the other, or vice versa.
- Archetypal crossmap is from SNOMED to ICD (9 or 10 or variant)
- Usual use case for ICD:
 - I have a record. It needs to be assigned *the right code*.
 - NOS and NEC are meaningful and necessary
- Usual use case for SNOMED:
 - I have a patient. I can document all that is relevant, and my EHR will attach codes to much of it (not all).
 - NOS and NEC are meaningless



Reference Sets (RefSets)

- Formerly called “subsets”
- Define groups of SNOMED components to be used for a particular purpose
- Types of RefSets
 - Simple
 - Group
 - Tagged
 - Language
 - Navigation
 - Aggregation
 - Prioritized

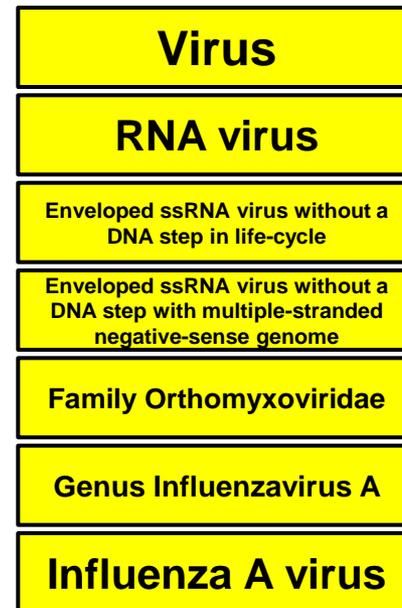


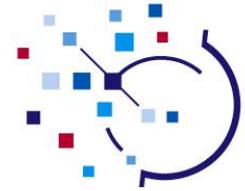
Navigational RefSet Example

How a GP might like to navigate to Influenza A virus from "virus":



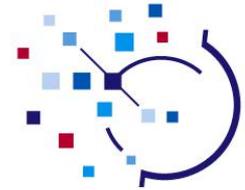
Six levels deep if you try to navigate the is-a hierarchy:





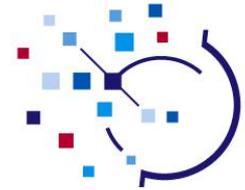
Making SNOMED Usable

- Requires design and selection of usable components
- Requires hiding some of the complexity from the users
- Requires software that enables the users to accomplish their goals



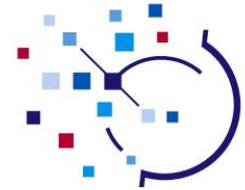
Extensions

- **SNOMED CT Identifiers**
 - Called “SCTIDs”
- **Allow for a part of the code to identify a Namespace**
 - A namespace is controlled by an organization other than IHTSDO
- **Extensions should add content that is not required in the international release**
 - **Realm-specific content:**
 - Otero County (Colorado) jail cell number
 - leave granted under the Mental Health Act 1983 (England and Wales)



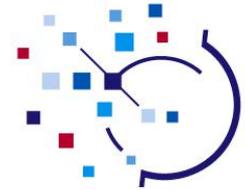
Documentation

- There is a wealth of documentation available, often overlooked:
 - SNOMED CT User Guide
 - SNOMED CT Technical Reference Guide
 - SNOMED CT Technical Implementation Guide
 - http://www.ihtsdo.org/fileadmin/user_upload/doc/
 - Abstract Logical Models & Representational Forms
 - Transforming Expressions to Normal Forms
 - Reference Sets – Technical Specification
 - SNOMED Interchange Format



Distribution files

- **SNOMED CT is distributed in three “core” distribution files**
 - Concepts (one row per conceptID)
 - Descriptions (one row per descriptionID)
 - Relationships (one row per relationshipID)
- **The international release consists of a common set of these core files**
- **Each national release centre may also provide extensions to each of these files**



Browsers

A browser generally

- Displays the components of the terminology

- Allows searching

- Allows navigation along the hierarchies

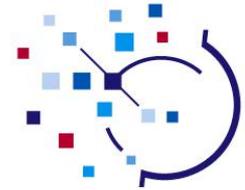
- Some may have more specialized functions

There are numerous freely available browsers

- Some examples include:

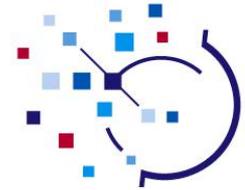
 - CliniClue (www.cliniclue.com)

 - SNOB (snob.eggbird.eu)



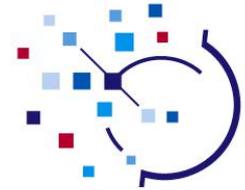
Classifiers

- **A description logic classifier can:**
 - Compare two expressions for subsumption or equivalence
 - Structure the is-a hierarchy
 - Identify expressions (including definitions) that match a query
- **A few well-known DL classifiers include:**
 - Apelon's Ontylog
 - FaCT++
 - CEL
 - Racer and RacerPro
 - Pellet



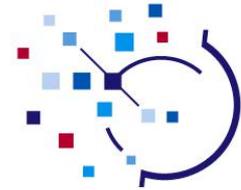
Influencing SNOMED & making improvements

- Governance & meetings
- www.ihtsdo.org
- Collaborative web site
- Working groups
 - Project groups
 - Special interest groups



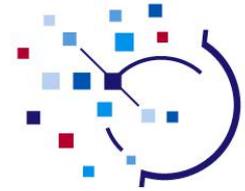
Meetings

- **In person**
 - General Assembly meets twice per year
 - Pattern has been for committees, working groups and Management Board to meet at same venue
- **Teleconferences**
 - Each committee & WG has its own schedule



Working groups

- **Two types: Project Groups & Special Interest Groups**
- **Project Groups:**
 - Focused on a particular task and project plan
 - Duration limited
 - Open to participation
 - Resourced according to the project needs
- **Special Interest Groups:**
 - Focused on a particular interest, community, or topic area
 - May be ongoing
 - Open to participation
 - Reliant largely on voluntary participation



Working Groups

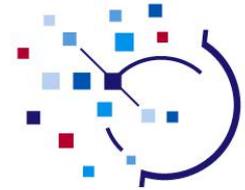
- For a complete list of current working groups, see:
 - www.ihtsdo.org/about-ihtsdo/governance-and-advisory/working-groups/

Current SIGs include:

Anesthesia
Concept Model
Education
IHTSDO Workbench Developer's
Implementation
International Family Practice/GP
International Pathology &
Laboratory Medicine
Mapping
Pharmacy
Translation

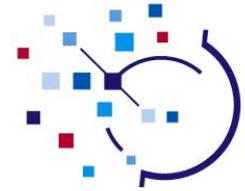
Current Project Groups include:

Anatomy Model
Collaborative Editing Roadmap
Event, Condition and Episode Model
Family/GP RefSet & ICPC Mapping
Machine & Human Readable Concept Model
Mapping SNOMED to ICD-10
Migration
Observable & Infectious Disease Model
Request Submission
Substance Hierarchy Redesign
Translation Quality Assessment



Web site & collaborative site

- www.ihtsdo.org
 - Calendar
 - Official announcements
 - Contact information
- Collaborative site (<https://csfe.aceworkspace.net/sf/sfmain/do/home>)
 - Working group discussions
 - Agendas & minutes of committee & WG meetings
 - Special interest group collaborative sites
 - Access freely available, registration required to join, email: collabnet@ihtsdo.org



Questions?