

# **SNOMED CT as a tool to support interoperation of clinical and research data**

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Kent Spackman, MD PhD  
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# Outline of presentation

- About me & IHTSDO
- Structure of SNOMED CT
- Who uses it
- How can it be linked to anatomy?
- How can it be linked to other ontologies?
- Benefits of creating linkages
- Summary



# About me

- Current:
  - Chief Terminologist for IHTSDO
  - Clinical Professor of Pathology & Medical Informatics, Oregon Health & Science University, Portland, Oregon, USA
- Background primarily in academic medical informatics, and clinical pathology
  - MD – Canada. Primary care training.
  - PhD in CS, machine learning, U of Illinois
  - Specialty training and (former) practice in hematopathology, blood banking, transfusion medicine & coagulation
- 1997-2006 Scientific Director of SNOMED, for the College of American Pathologists



# IHTSDO

- International Health Terminology Standards Development Organization
  - Formed in Denmark in 2007, obtained ownership of SNOMED CT from College of American Pathologists
  - Governed by a General Assembly of Nations
    - Member Nations include U.S.A., U.K., Australia, Canada, New Zealand, Denmark, Sweden, Lithuania, Netherlands, Singapore, Cyprus, + others in process



# SNOMED CT

- Systematized Nomenclature of Medicine – Clinical Terms
  - Formed in 2002 from merger of SNOMED RT (Reference Terminology) with Clinical Terms (version 3) a.k.a. Read Codes
  - Deep roots in both primary care and specialty care, plus very large scale implementation efforts underway in UK (CfH), US (Kaiser, VA), Australia (NeHTA), with smaller scale efforts in other countries.



# IHTSDO Organizational Strengths

- Representative Governance by the Member Countries
  - Globally coordinated effort
  - Pooling of resources to share costs
  - Long-term sustainability
- Open forums and terminology development / review
  - Public web site: [www.ihtsdo.org](http://www.ihtsdo.org)
  - Collaboration site: [thecap.seework.com](http://thecap.seework.com)
  - Tools for international distributed development:
    - Workbench, CollabNet, SourceForge, Subversion,
- Involvement of clinicians
  - Medicine – primary and specialty, nursing, allied health, veterinary medicine
  - Selection as preferred terminology for clinical applications
  - Active and ongoing curation, review and QA



# SNOMED Content (1)

- Codes for
  - Diseases: most comprehensive disease nomenclature in the world (> 63,000 active)
  - Clinical findings, including test results, exam findings, imaging findings, pathology results, etc (> 32,000)
  - Procedures (> 45,000)
  - Observable entities - questions, tests (> 7,000)



## SNOMED Content (2)

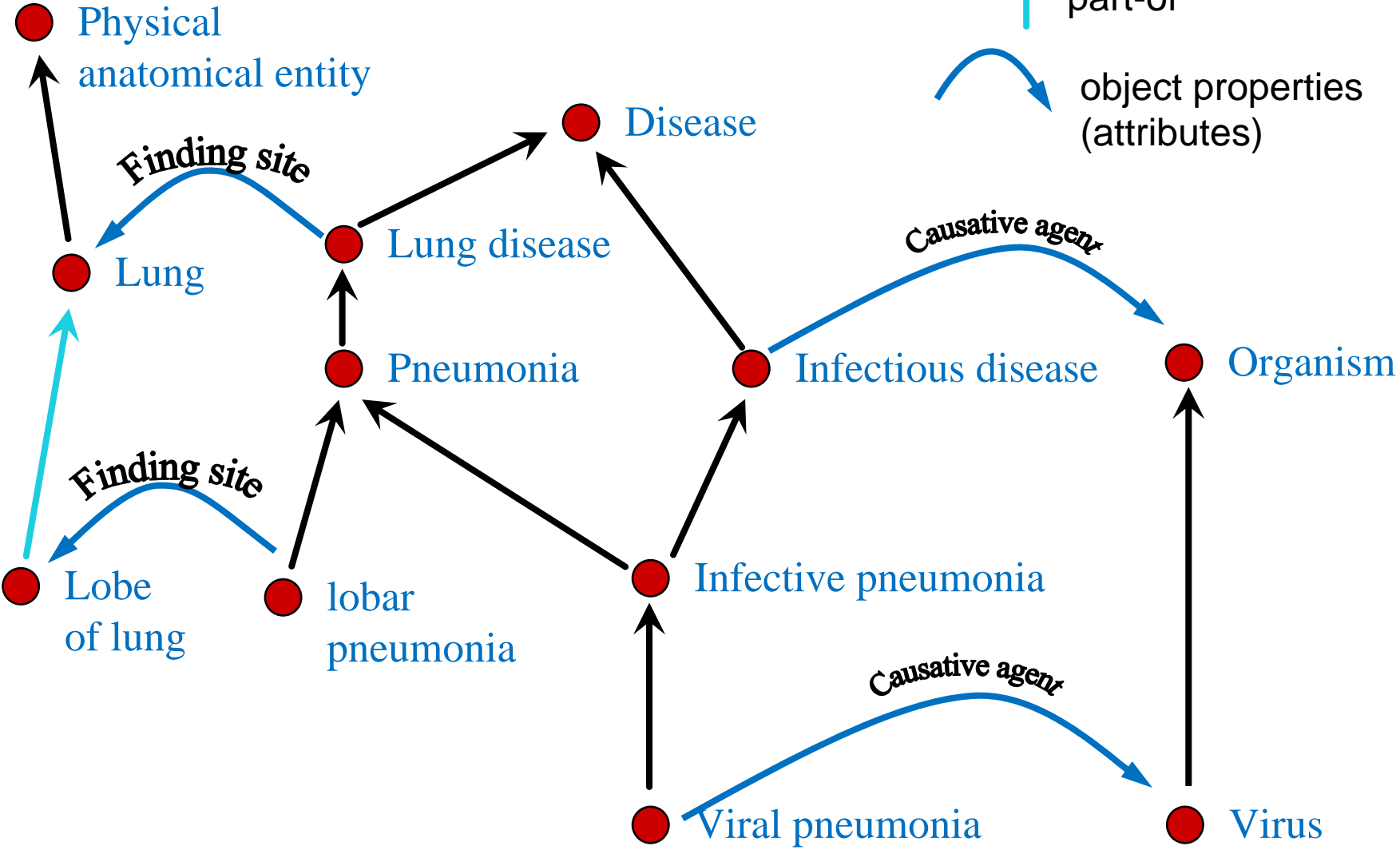
- Formal model for defining the meaning of diseases, findings, procedures, observables:
  - Anatomy (> 25,000 concepts)
  - Morphologic abnormalities (> 4,000)
  - Chemicals, proteins, drugs, other substances (> 23,000)
  - Organisms (> 27,000)
  - Causes of injury: events, physical objects, forces
  - Functions, activities

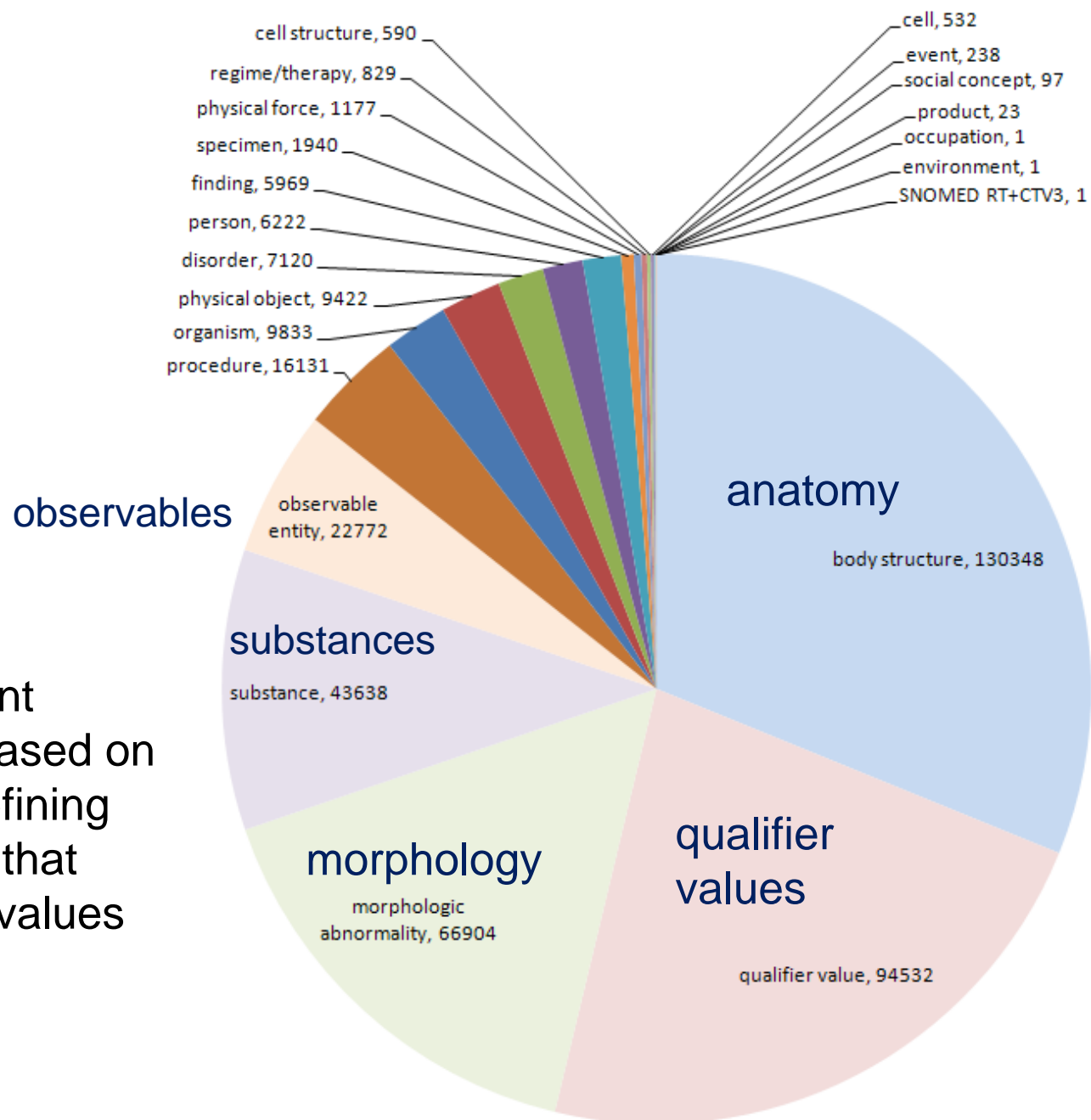
# Defining Relationships

↑ is-a

↑ part-of

↪ object properties (attributes)





Most important hierarchies based on number of defining relationships that use them as values



## SNOMED CT Content (3)

- Every one of the >280,000 active codes is located in a hierarchy, and all have a description logic definition. (DL ‘flavor’ currently is ELH).
- There is a compositional grammar that specifies a syntax for building new logic-based expressions for extending the terminology
- There is a machine-readable concept model that expresses further constraints, including domain and range restrictions for the object properties (called “attributes” in SNOMED)



# What exactly is it for?

- Electronic health records
  - Common meanings regardless of language, dialect, professional variation, etc.
- Interchange of clinical data
- Public health reporting
- Analysis and aggregation
- Support for choosing case classifications in ICD-10 and ICD-9-CM



# US FDA: SNOMED CT mandated for coded indexing of the Structured Product Label

- Medical Condition:
  - Indications
  - Contraindications
  - Warnings & Precautions
  - Drug interaction effects
  - Adverse events
  - Side effects



# Linking SNOMED to FMA

- Similar foundation (but not identical)
  - Some collaboration off and on since 1998
  - Closer alignment and more interaction recently
- Relative sizes
  - FMA 75 K, SNOMED anatomy 25 K
  - Closer look: perhaps up to 15 to 18 K in common
- Systematic differences
  - SNOMED SEP model
  - FMA pre-coordinates laterality



# Linking SNOMED to FMA

- Mapping can result in:
  - Match of both lexical string and semantics
    - ilioinguinal nerve
  - Semantic match but term difference
    - ninth thoracic vertebra
    - T9 vertebra
  - Term match but semantic difference
    - finger: in FMA thumb is-a finger
    - finger: in SNOMED, thumb is-a digit of hand

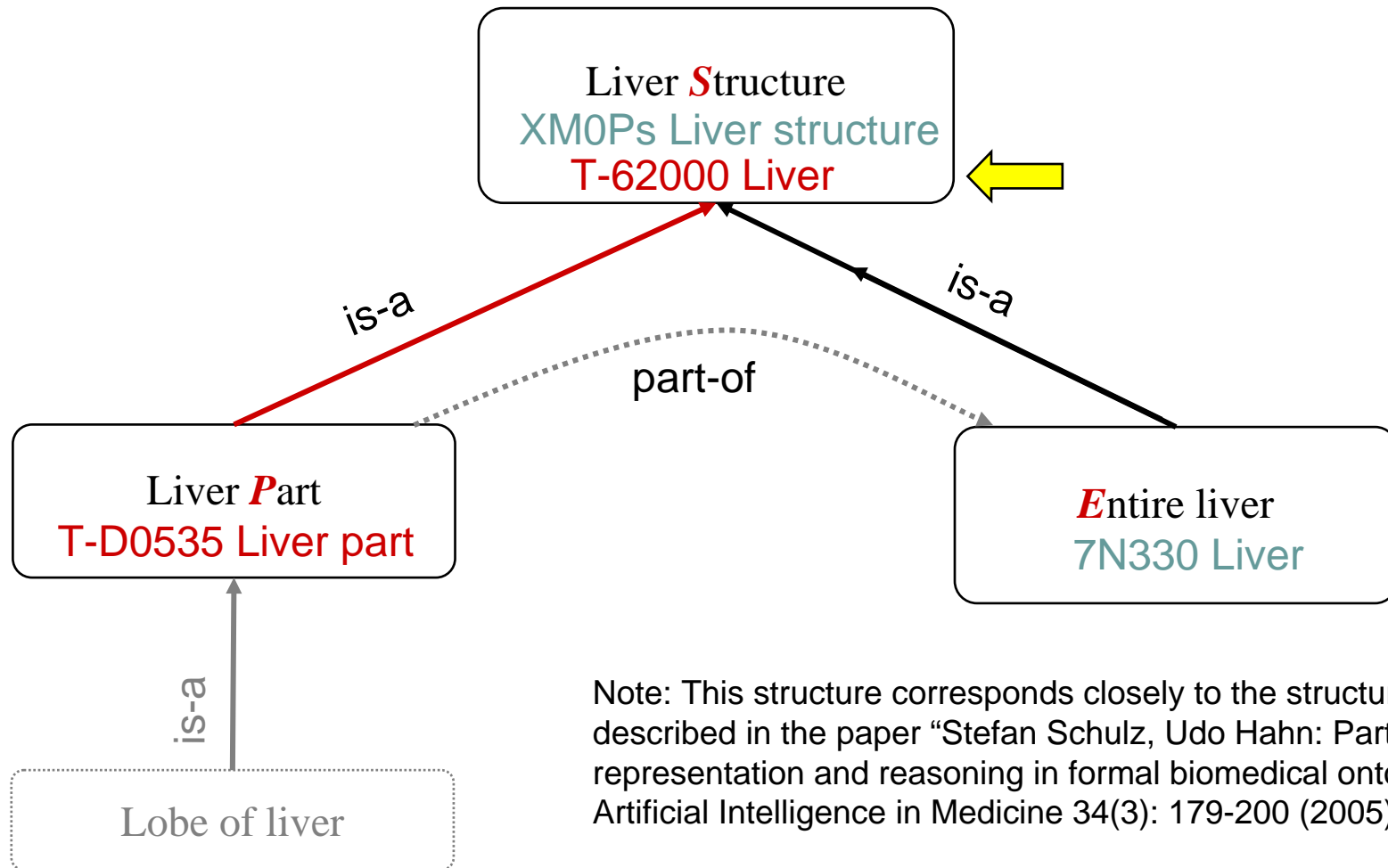


# Linking SNOMED to FMA

- Experience to date
  - 7,543 'concept' matches
  - Mutual benefit examples:
    - clarification of wrist, hand, hand proper, proximal and distal segments of wrist - in FMA
    - clarification of tree-structured organs (veins, arteries, nerves) in SNOMED CT
- Work to do:
  - Easy lexical matches have been found, so now requires manual review of hierarchies
  - Coordination of DL models

# S-E-P Model

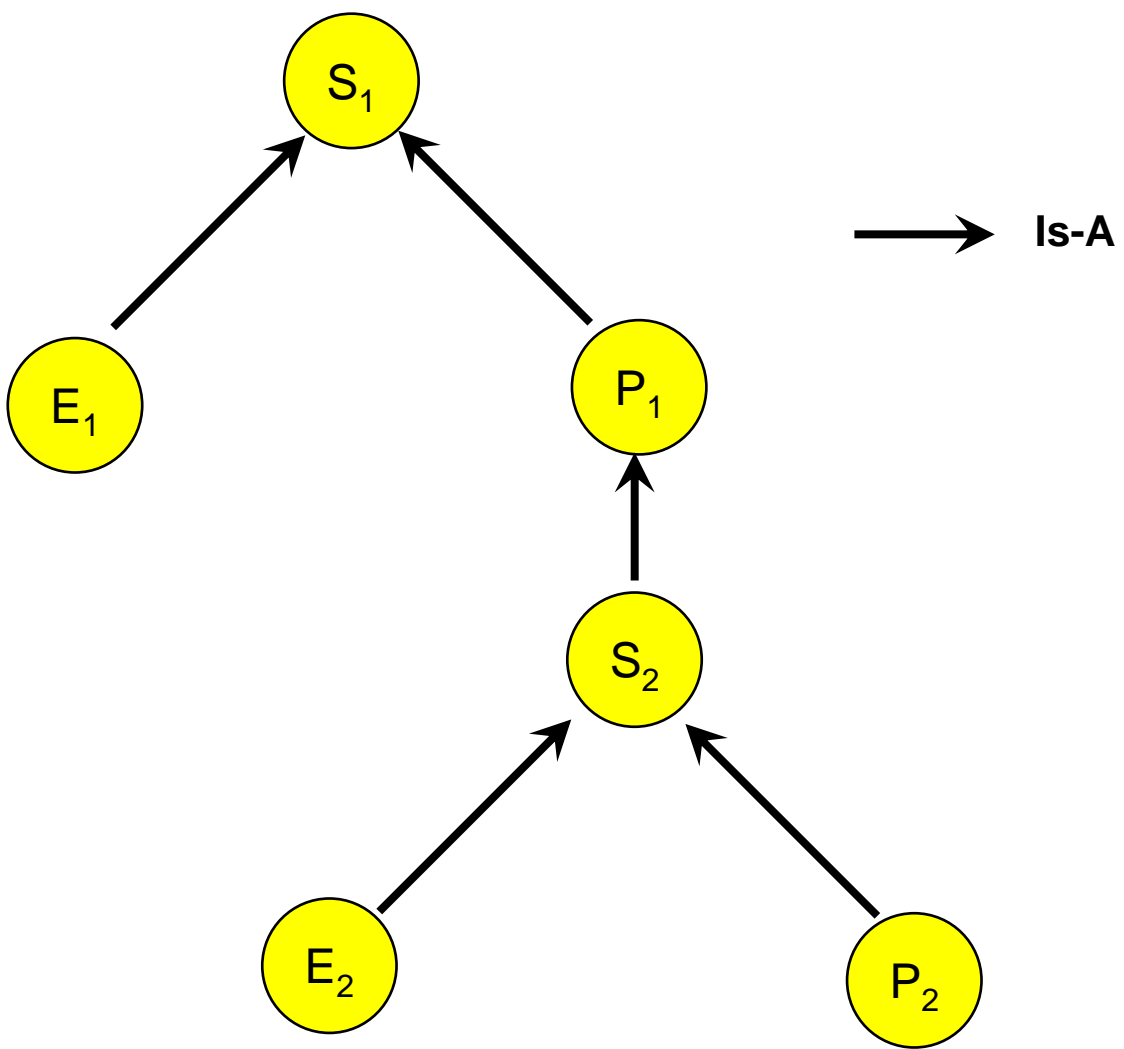
## Structure – Entire – Part



Note: This structure corresponds closely to the structure described in the paper “Stefan Schulz, Udo Hahn: Part-whole representation and reasoning in formal biomedical ontologies. Artificial Intelligence in Medicine 34(3): 179-200 (2005)



# SEP diagram: $E_2$ part of $E_1$

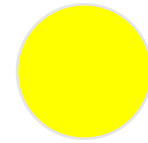


# What meanings in SNOMED get linked to FMA?



- SNOMED CT “E” nodes correspond in meaning to the FMA concepts
  - SCT “Entire liver” -> FMA “liver”

# Example:



Candidate to link to corresponding FMA code



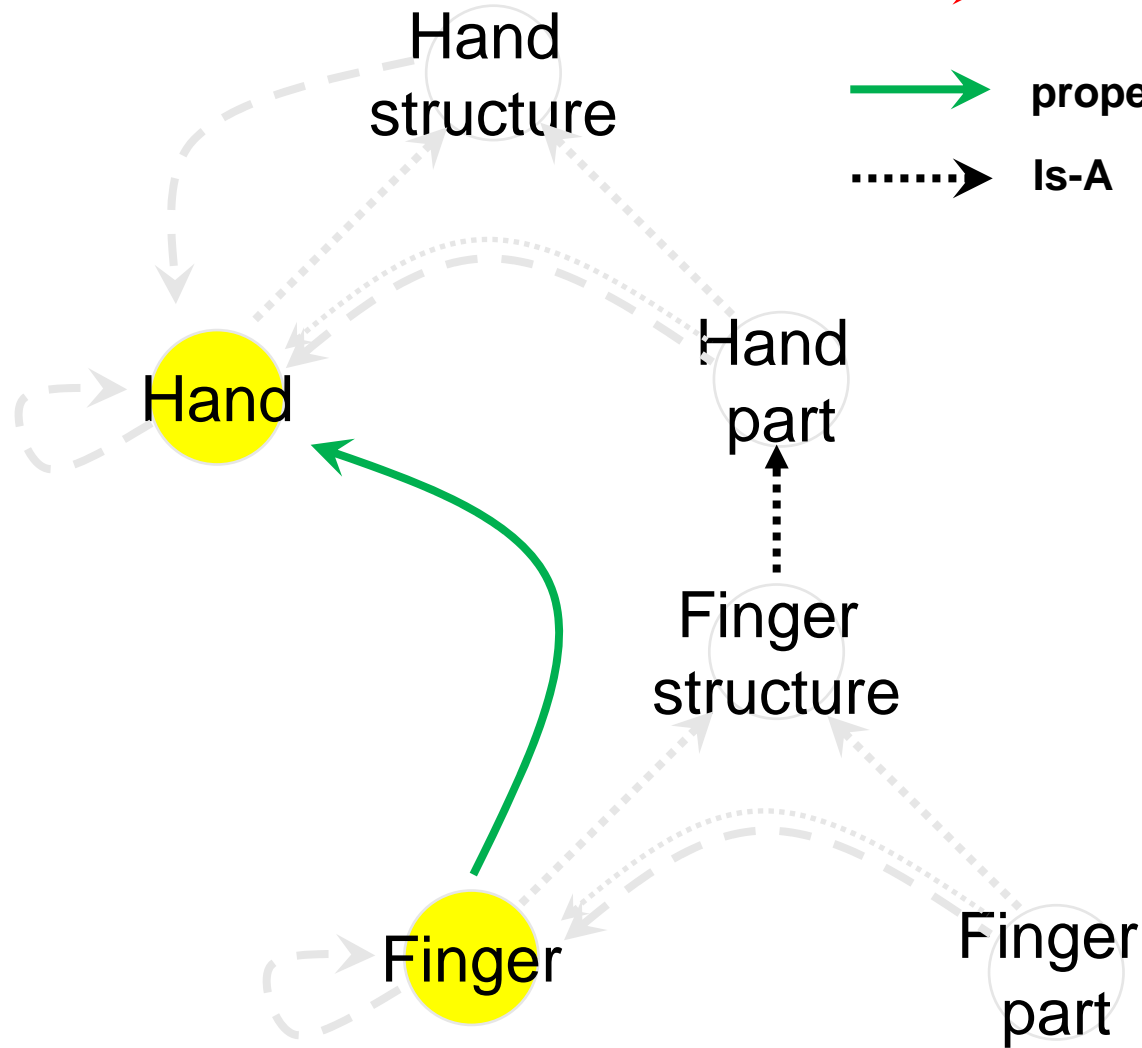
Part-of



proper-part-of

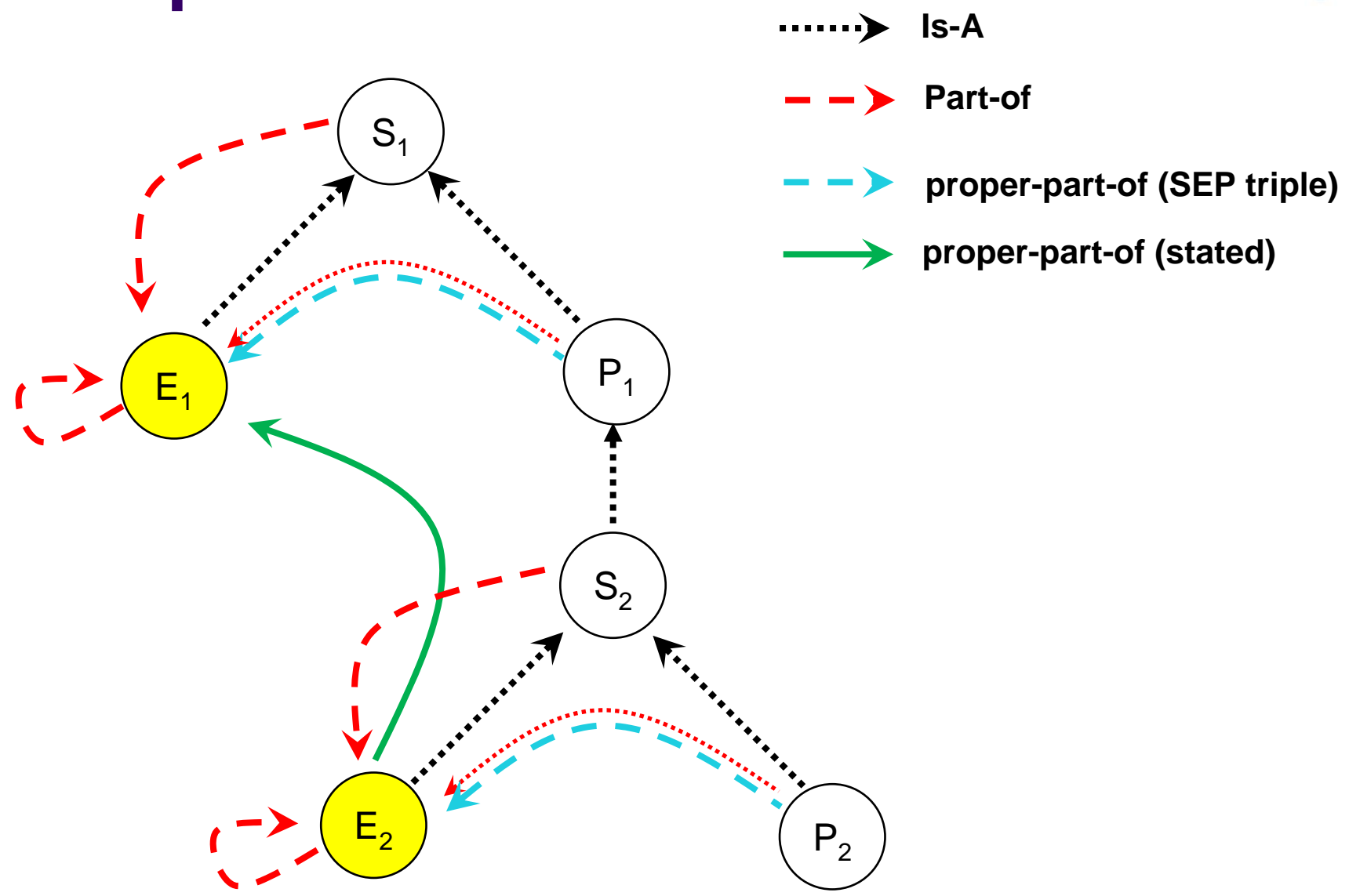


Is-A



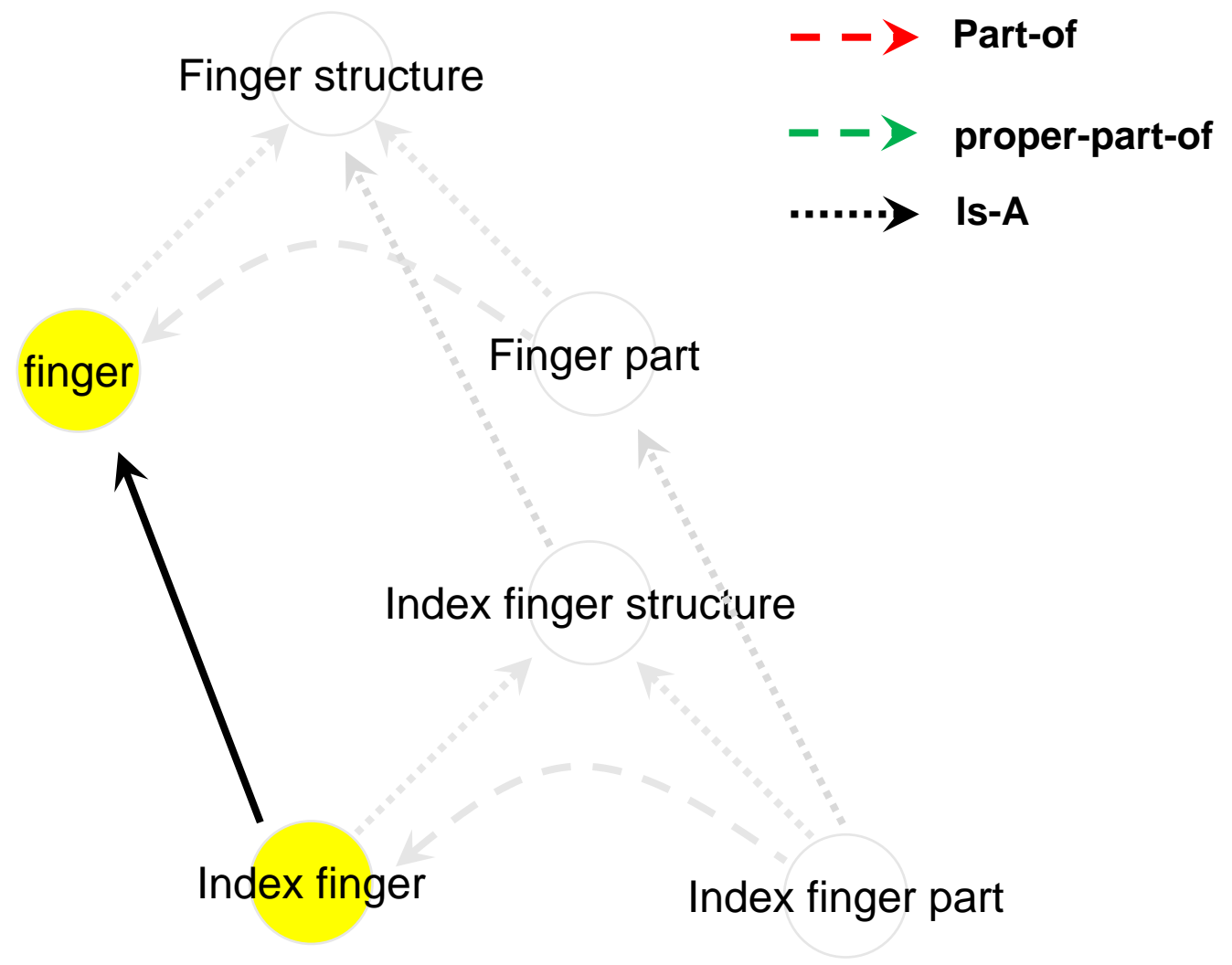


# E2 part-of E1



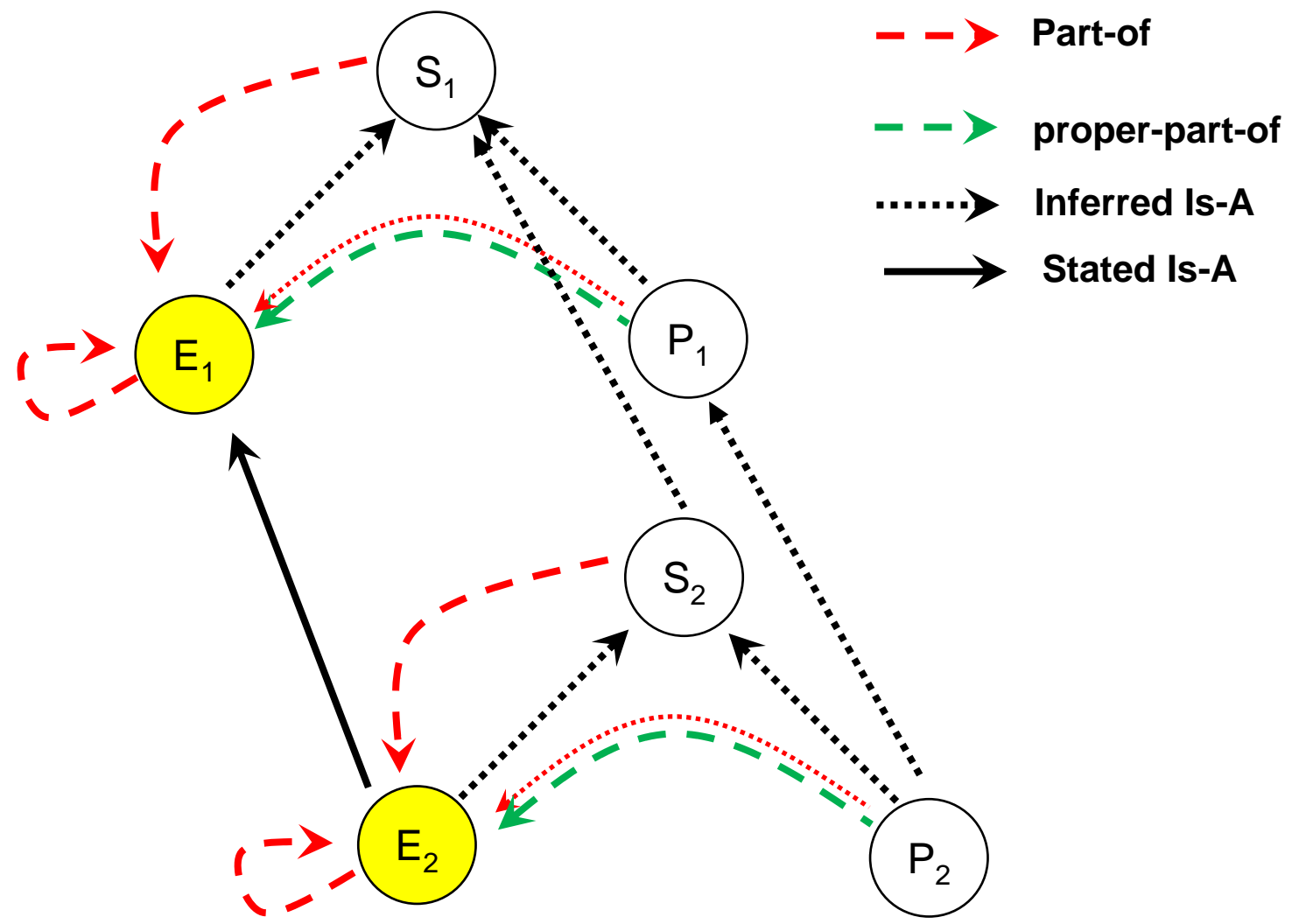


# Example 2





# E2 isa E1





# Benefits of a linkage

- Interoperation of clinical and research data
  - Supports increased translation of basic research to clinical application
  - Supports availability of clinical data for integration and analysis in research setting
- Mutual quality assurance
  - Highlights term usage variation
  - Refines logic-based definitions, hierarchies, and relationships to provide better aggregation & analysis



# Linking SNOMED to ontologies

- What about IP issues
  - Affiliate license for SNOMED CT does not invoke a cost unless you implement in data creation and analysis systems in non-member territories. There is also provision for exemption for qualifying research projects.
  - For implementation in data creation and analysis systems, SNOMED is freely used in all Member countries, and in the world's 50 low-income countries.
  - General principle of mapping: users who have license to use the two ends of the map can have the mapping also

# Linking to other terminologies, ontologies, and standards



- Existing maps to ICD-9-CM, ICD-10, CPT
- Integration work in progress with LOINC and with NPU (IFCC-IUPAC) for lab tests
- Close coordination with DICOM for imaging



# Summary

- Large volumes of clinical data have been / are being / will be coded with SNOMED CT in many countries
- Linkage to other terminologies and ontologies has many benefits