

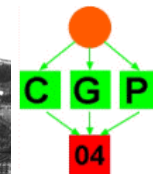
A Description Logics Approach to Clinical Guidelines and Protocols

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Formalization of CGP

- Up until now:
CGPs are treated as **plans**: actions, states, transition functions. Methodologies from the AI Planning & OR Scheduling community
- Why not:
Use Formal Ontology methodology to represent (at least, selected) aspects of CGPs in order to support consistency, fusion, and modularization of CGPs



Our Proposal

- **Ontological analysis of CGPs** (cf. Gangemi, Guarino et al.)
 - Introduce basic categories (e.g. event, state,...)
 - Axiomatize foundational relations (e.g. is-a, ...)
 - Classification of domain entities
 - Study interrelations between domain entities
- **Choose a logic framework for the formalization of the ontology**
 - Representation: Description Logics (subset of predicate calculus)
 - Reasoning: Taxonomic Classifiers (e.g., FaCT, RACER)



Basic Categories

Continuants	vs.	Occurrents (Events)
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*Physical Objects,
Substances, Organisms,
Body Parts*

*Processes, states,
Actions, Courses of
Diseases, Treatment
Episodes*

Individuals	vs.	Concept Classes
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*my left Hand, Paul's
Diabetes, Appendectomy
of Patient #230997*

*Hand, Diabetes,
Appendectomy*

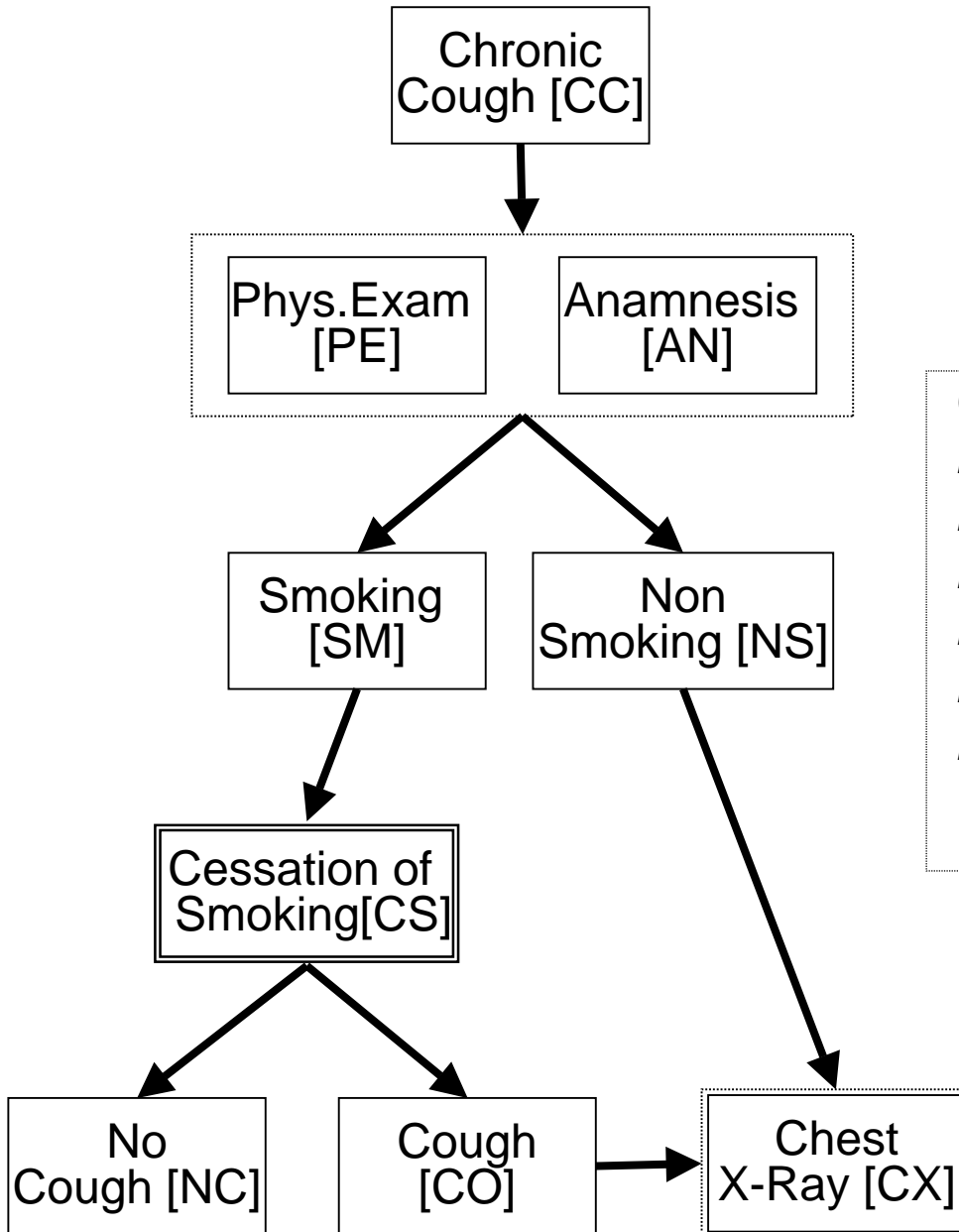
How do CGPs fit into this framework ?



Guidelines and Episodes

- Proposal: A Guideline G can be mapped to a set of classes of clinical episodes:
$$E = \{E_1, E_2, \dots, E_n\}$$
- The elements of E correspond to all allowed paths through a Guideline G
- Each element of E represents - as a conceptual abstraction - a class of individual clinical episodes

Simplified Chronic Cough Guideline



Clinical Episodes

$E1 = (CC, AN, PE, SM, CS, NC)$

$E2 = (CC, AN, PE, SM, CS, CO, CX)$

$E3 = (CC, AN, PE, NS, CX)$

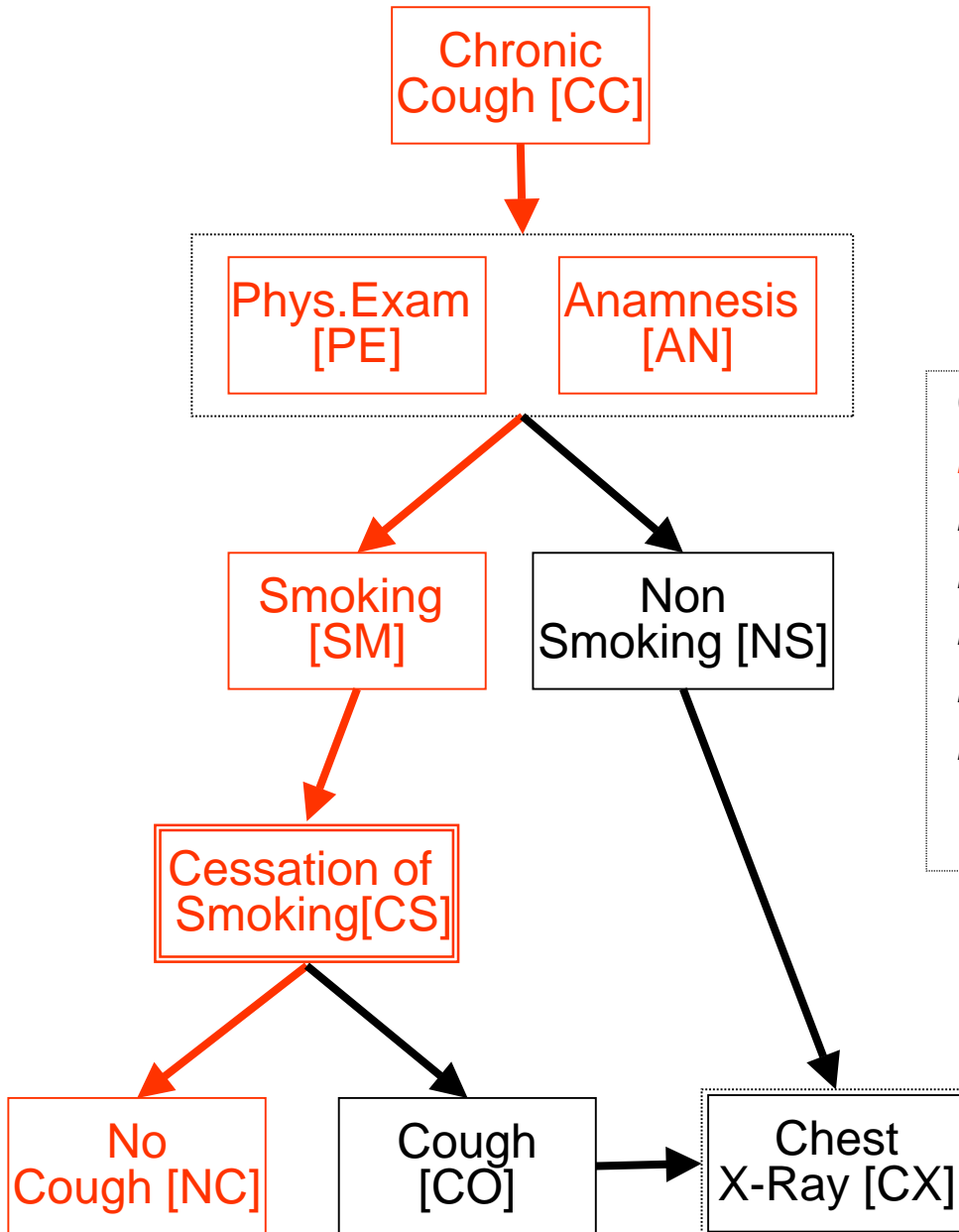
$E4 = (CC, PE, AN, SM, CS, NC)$

$E5 = (CC, PE, AN, SM, CS, CO, CX)$

$E6 = (CC, PE, AN, NS, CX)$

→
Temporal sequence
of events

Simplified Chronic Cough Guideline



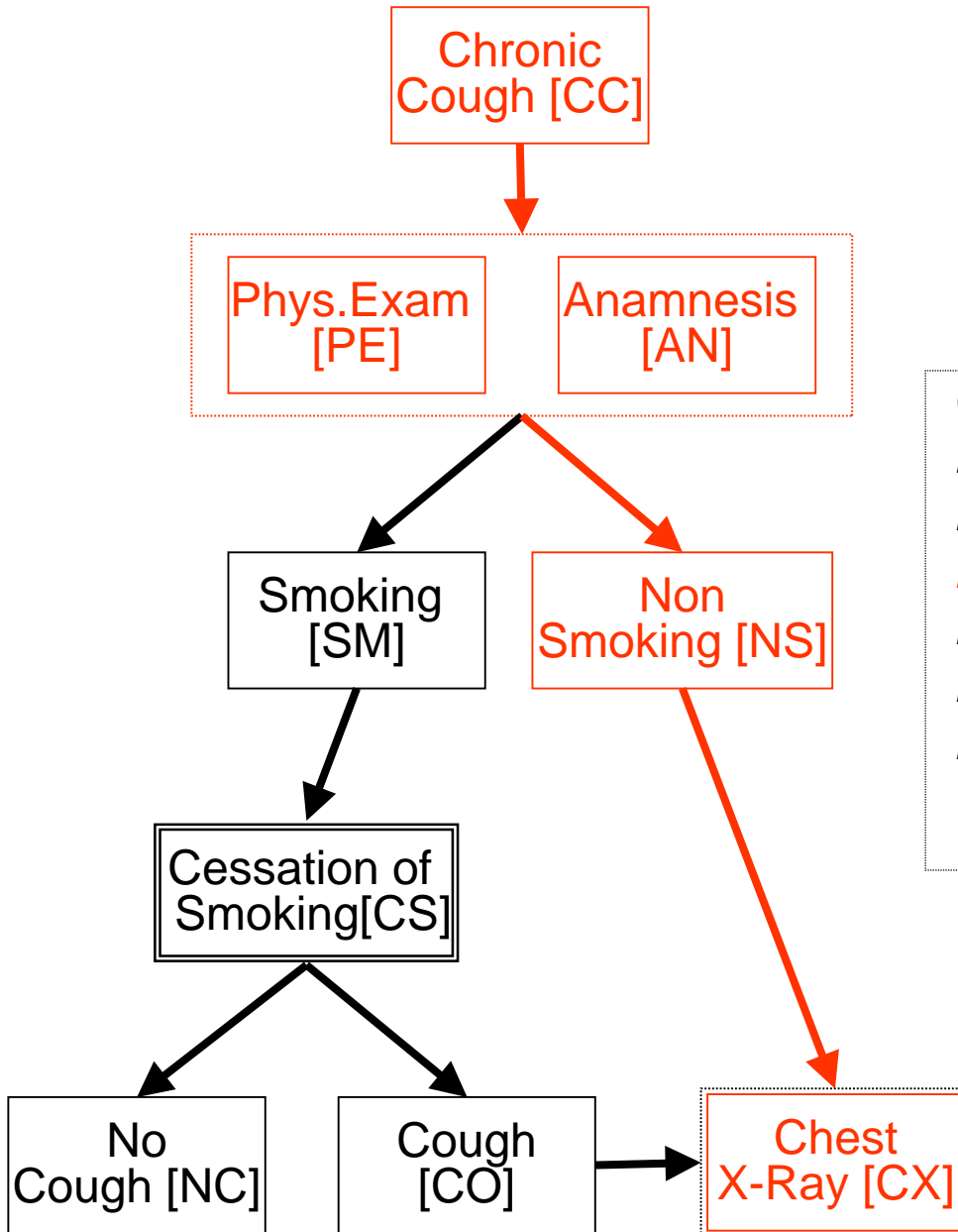
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Clinical event

Temporal sequence of clinical events

Simplified Chronic Cough Guideline



Clinical Episodes

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$E2 = (CC, AN, PE, SM, CS, CO, CX)$

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Temporal sequence
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Basic Relations



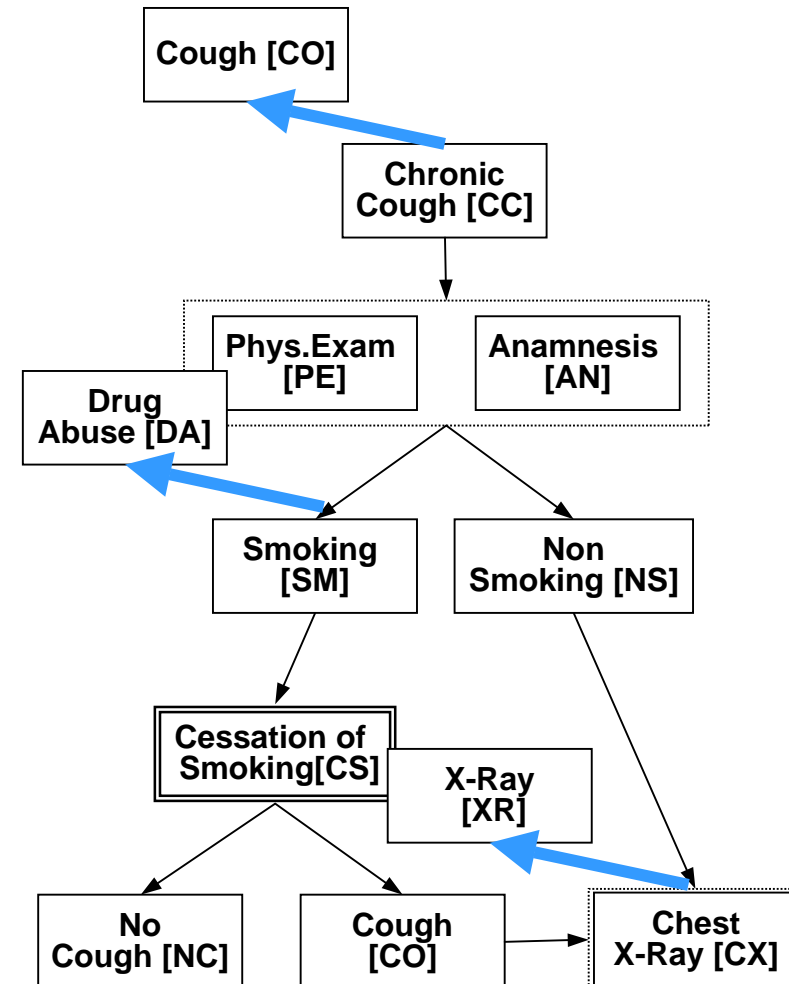


Basic Relations

Taxonomic Order (*is-a*)

relates classes of specific events to classes of general ones:

$$is-a(CX, XR) \rightarrow_{def} \forall x: CX(x) \rightarrow XR(x)$$





Basic Relations

Taxonomic Order (*is-a*)

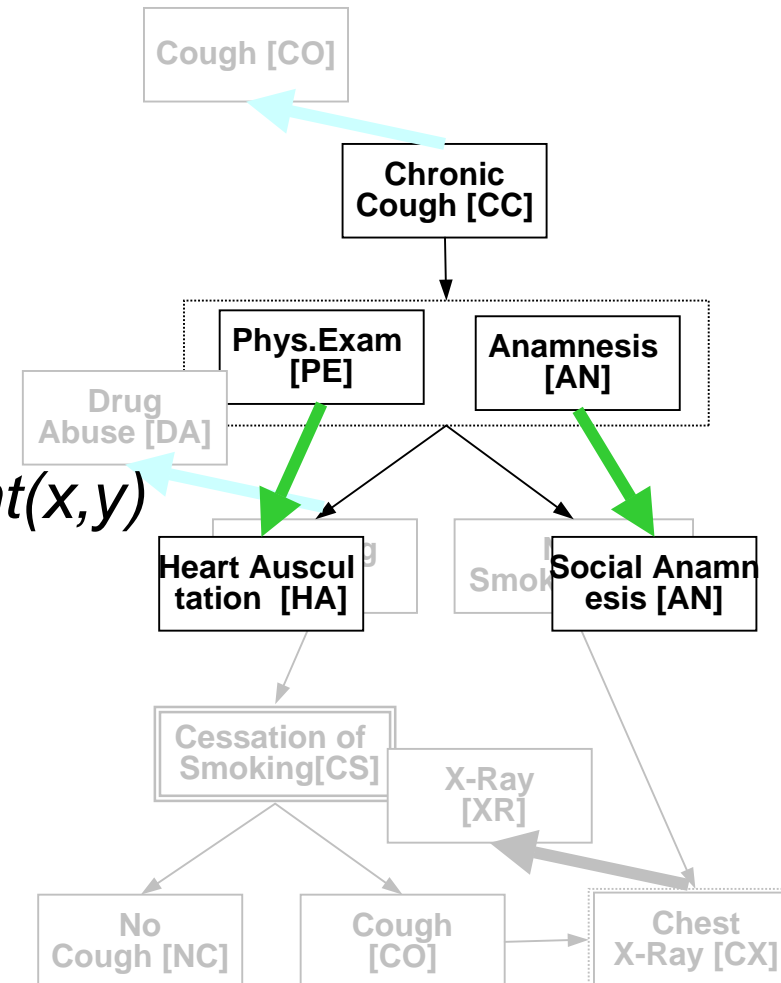
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Mereologic Order (*has-part*)

relates classes of events to classes of subevents

$$\forall x: PE(x) \rightarrow \exists y: HA(y) \wedge has-subevent(x,y)$$





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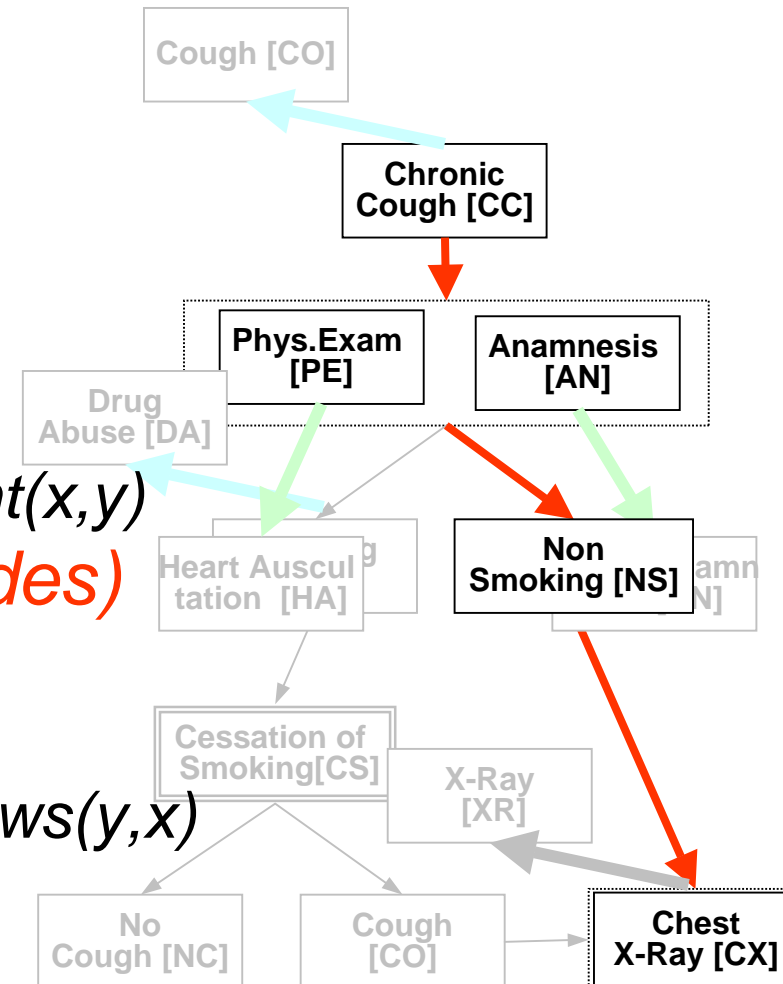
relates classes of events
classes of subevents

$$\forall x: PE(x) \rightarrow \exists y: HA(y) \wedge has-subevent(x,y)$$

Temporal Order (*follows / precedes*)

relates classes of events in terms of temporal succession

$$\forall x: NS_{CCGL}(x) \rightarrow \exists y: CX_{CCGL}(y) \wedge follows(y,x)$$



Modelling Pattern



(K) (L)

(T) (S)

event concepts

transitive relations

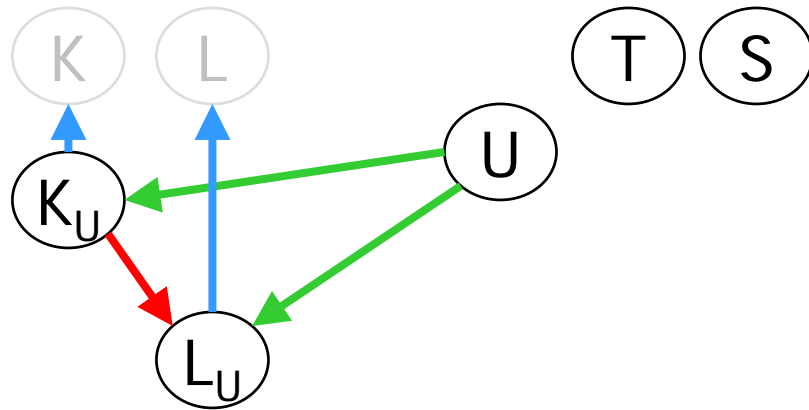
\exists *has-subevent* 

\exists *precedes* 

is-a 



Modelling Pattern



event concepts
definition of U

transitive relations

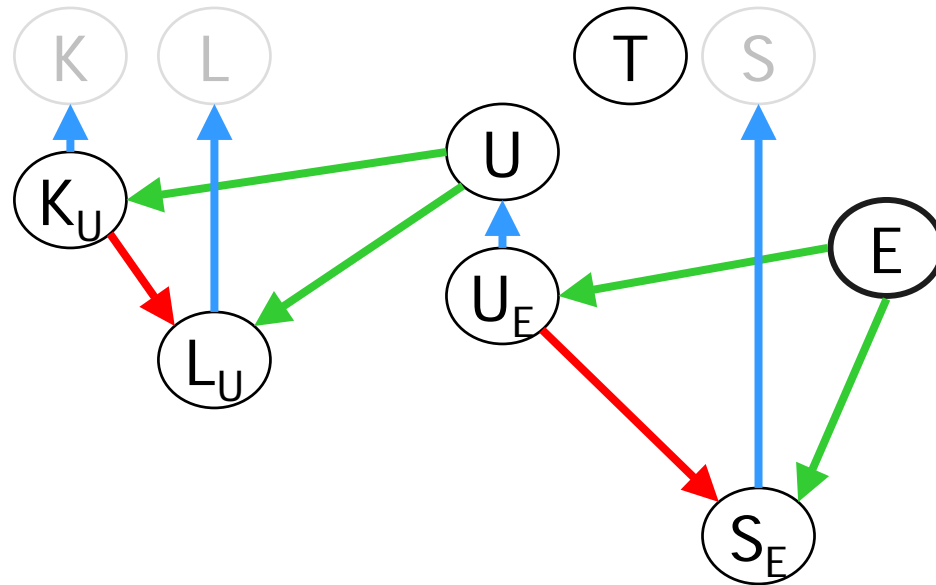
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Modelling Pattern



event concepts
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definition of E

transitive relations

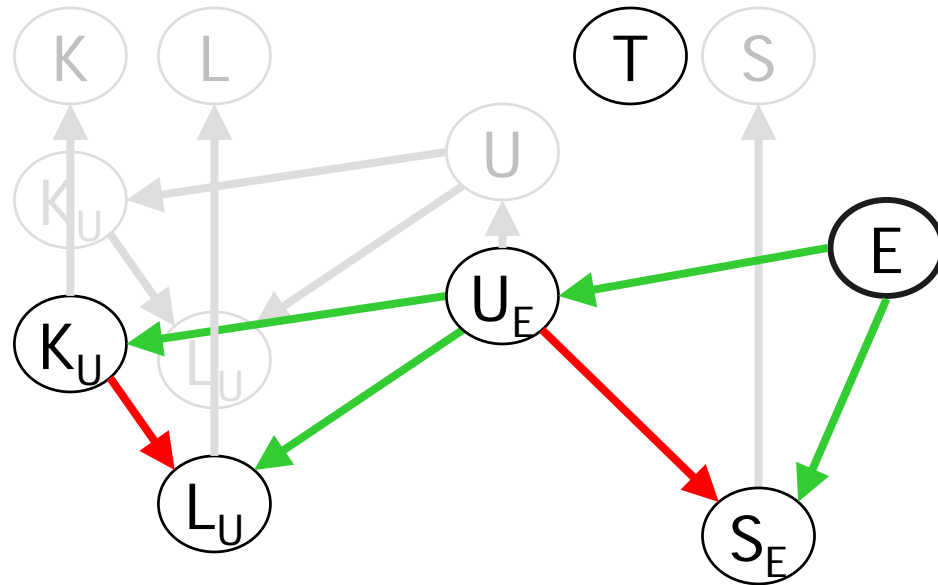
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Modelling Pattern

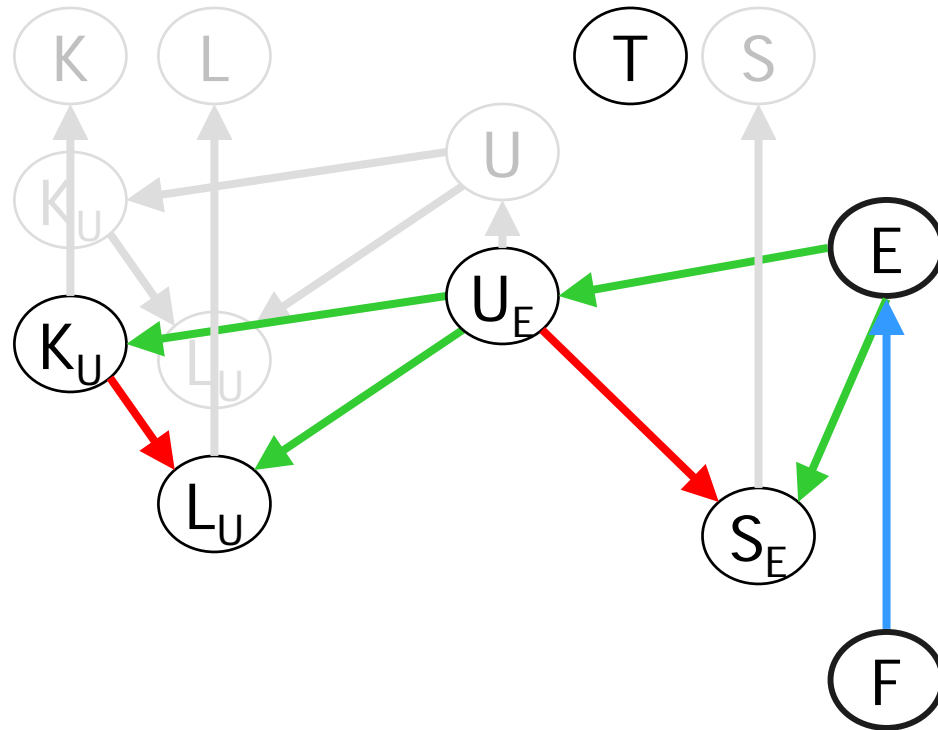


event concepts
definition of U
definition of E
 U_E inherits properties of U




transitive relations	
\exists <i>has-subevent</i>	
\exists <i>precedes</i>	
<i>is-a</i>	



Modelling Pattern

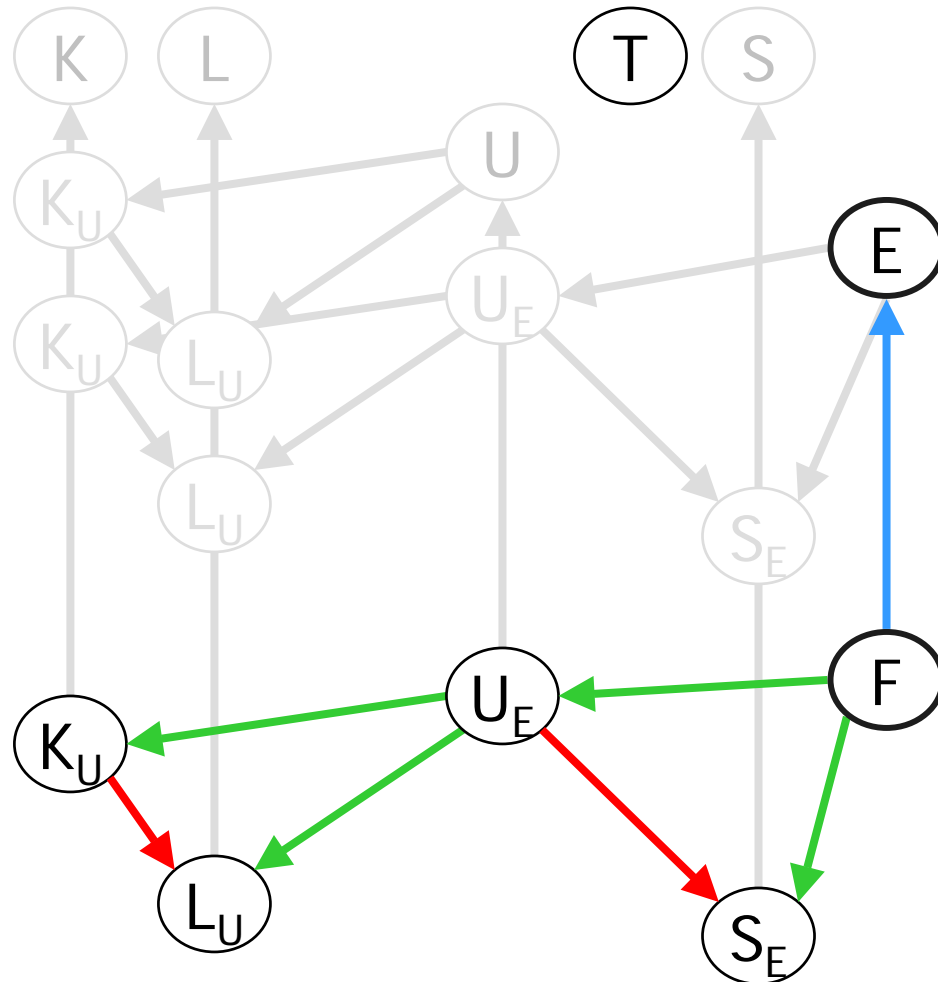


event concepts
definition of U
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 U_E inherits properties of U
definition of F as a subconcept
of E

transitive relations	
\exists <i>has-subevent</i>	
\exists <i>precedes</i>	
<i>is-a</i>	



Modelling Pattern

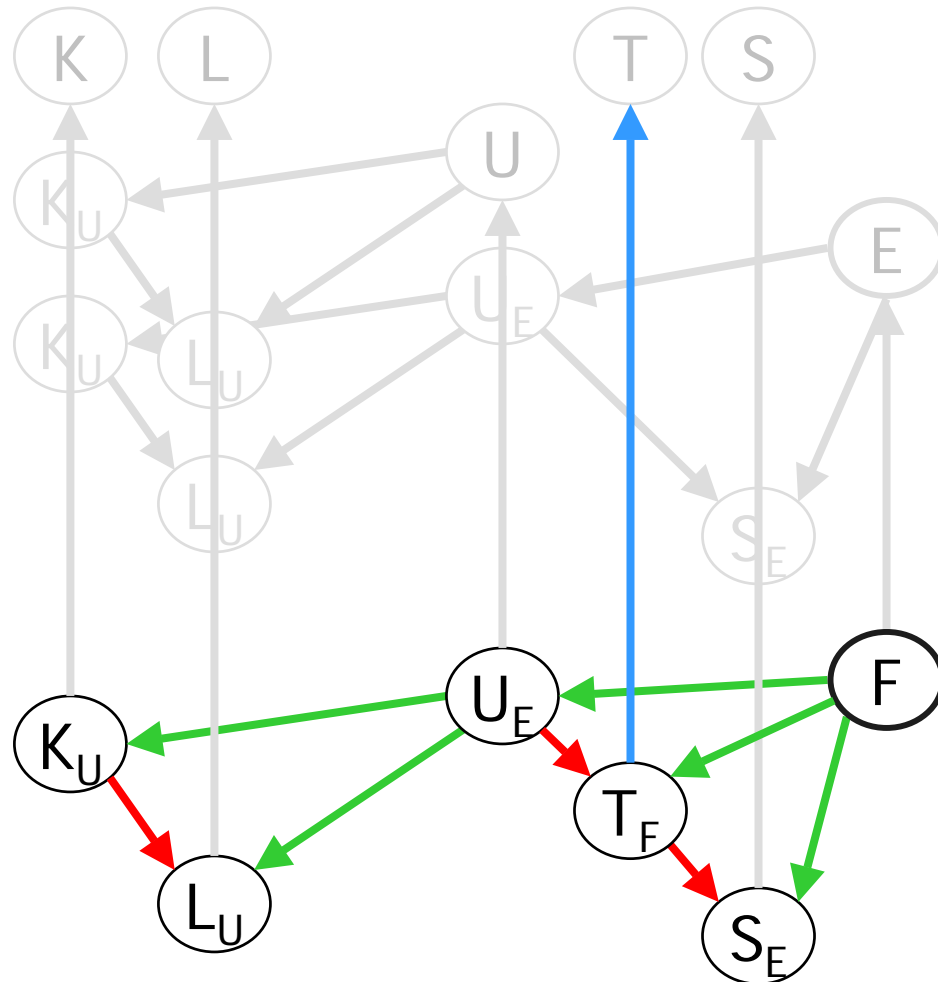


event concepts
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definition of E
U_E inherits properties of U
definition of F as a subconcept
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F inherits properties of E

transitive relations	
\exists has-subevent	
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is-a	



Modelling Pattern

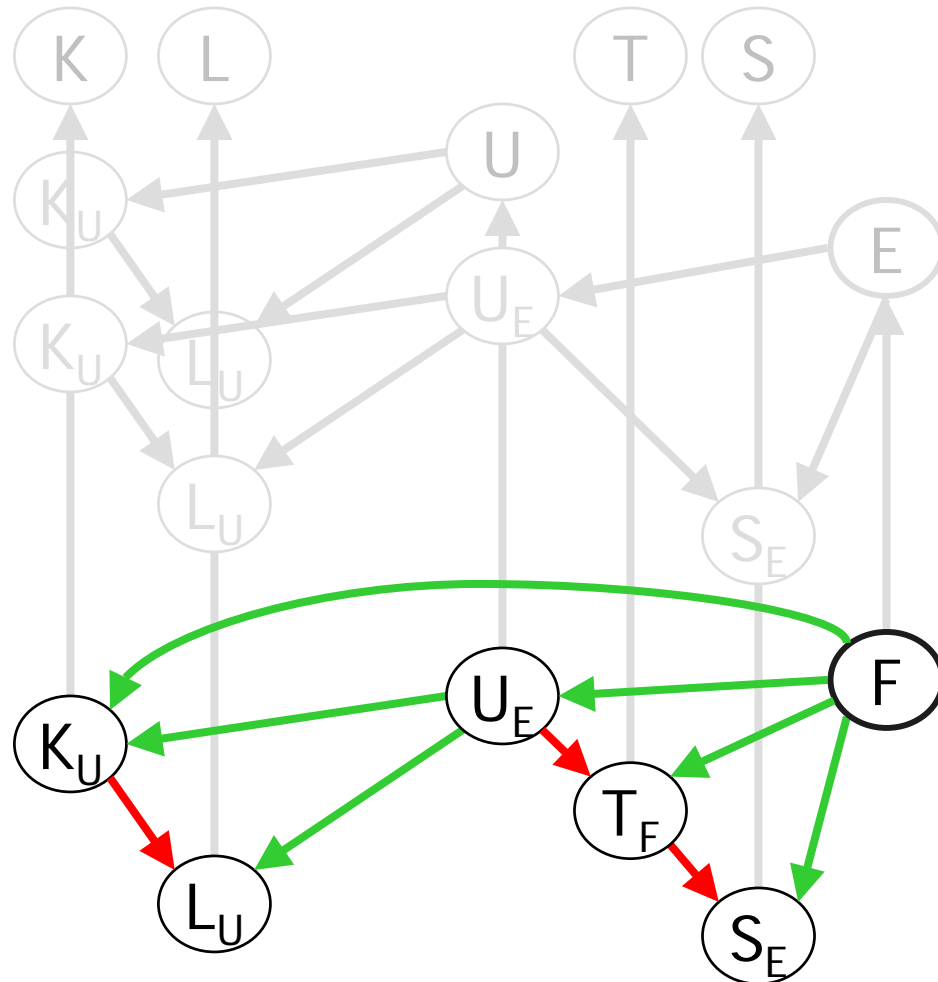


event concepts
 definition of U
 definition of E
 U_E inherits properties of U
 definition of F as a subconcept
 of E
 F inherits properties of E
 F, additionally, has a T which
 occurs between U and S

transitive relations	
\exists has-subevent	
\exists precedes	
is-a	



Modelling Pattern



event concepts
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 inferences / constraints
 (formalization see paper)

transitive relations

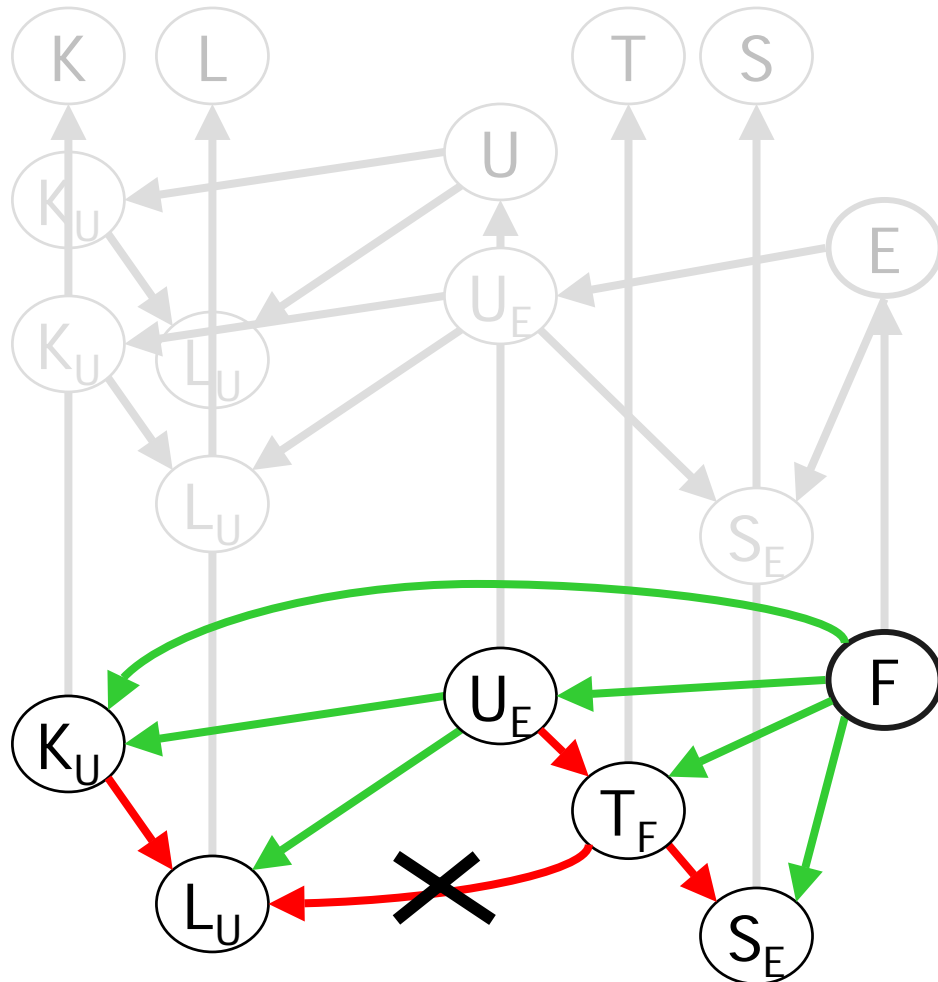
\exists has-subevent

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is-a



Modelling Pattern



event concepts
 definition of U
 definition of E
 U_E inherits properties of U
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 inferences / constraints
 (formalization in Description Logics - see paper)

transitive relations	
\exists has-subevent	
\exists precedes	
is-a	



Benefits

- Description Logics implementations allow taxonomic classification and instance recognition.
 - Checking of logical integrity in the management, cooperative development and fusion of CGPs
 - Detecting redundancies and inconsistencies, e.g., conflicting orders when applying several CGPs simultaneously to one clinical case (multimorbidity, proliferation of CGPs)
 - Auditing of concrete instances (cases) from the Electronic Patient Record for CGPs compliance



Discussion

- First sketch of a beginning research project
- Based on Description Logics (not necessarily)
- Up until now, not all (temporal) inferencing capabilities are supported
- Needs to be validated
- Recommended for further investigation
 - Tool: Oiled Knowledge editor (oiled.man.ac.uk) with built-in FaCT classifier
 - Theory: Baader et al (eds.) The Description Logics Handbook

Thank You !



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