

CDA Introduction

International HL7 Interoperability Conference IHIC
12 June 2016, Genoa, Italy

Dr Kai U. Heitmann, MD, FHL7
Heitmann Consulting and Services
ART-DECOR Expert Group
Template WG co-chair, HL7 International
Advisory Board, HL7 Foundation
CEO HL7 Germany
HL7 Germany / Netherlands / International



Agenda

CDA Introduction

- Interoperability
- Clinical Document Architecture
- Header
- Body: Section and Entry
- Entry Inspection: The Module Principle
- Templates

Interoperability and the Clinical Document Architecture



Interoperability

- Human
 - The “paper world” with documents, forms...
 - “Simple text”
- Application
 - Storage, management of clinical data
 - Context driven analysis
 - Reusability

not an evil,
inevitable!



Implementing Interoperability: Clinical Document Architecture



HL7's answer since 2005



Implementing Interoperability: Clinical Document Architecture

- Clinical Document Architecture (CDA)
- An approved standard way to exchange dictated, scanned, or electronic reports on a patient between various health information technology systems and platforms
- Release 2 since 2005



Structure of a CDA Document

- **Form**
 - A header providing the context:
 - To facilitate the exchanges and the management of the documents, their compilation in the patient record
 - A body
 - clinical information, ordered into sections, paragraphs, lists, tables, ...
- **Encoding in XML**
 - Comprehensive for the human...
 - ...and for the computers
 - can be validated by a schema

Header

structured and coded

Body

structured content with coded „sections“

- Salutation
- Problem/Subjective
- History

- Family History
- Past Medical History

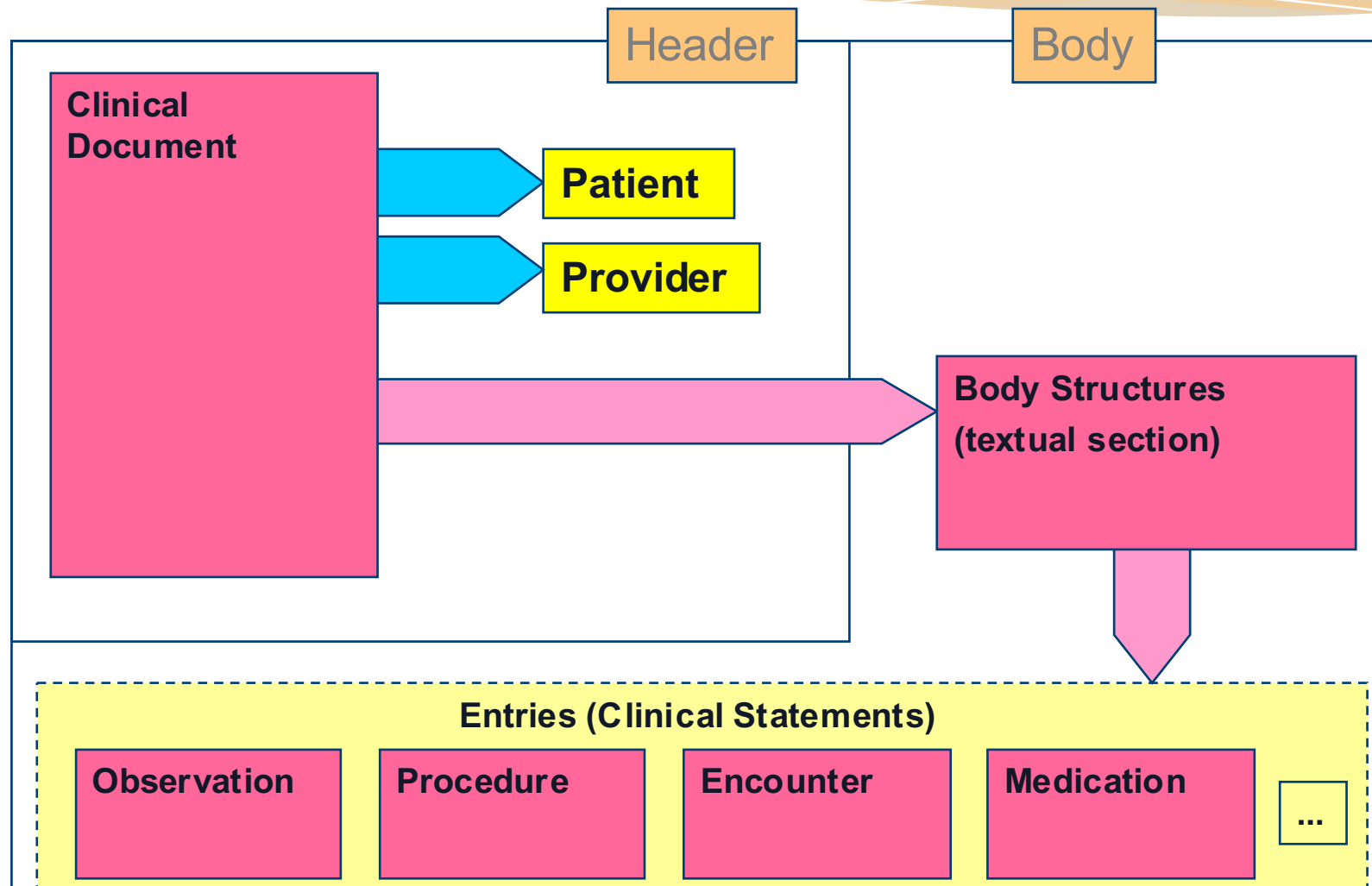
- Physical/Objective
- Diagnoses

- Admit diagnoses
- Intermediate diagnoses
- Discharge diagnoses

coded (e.g. ICD 10)

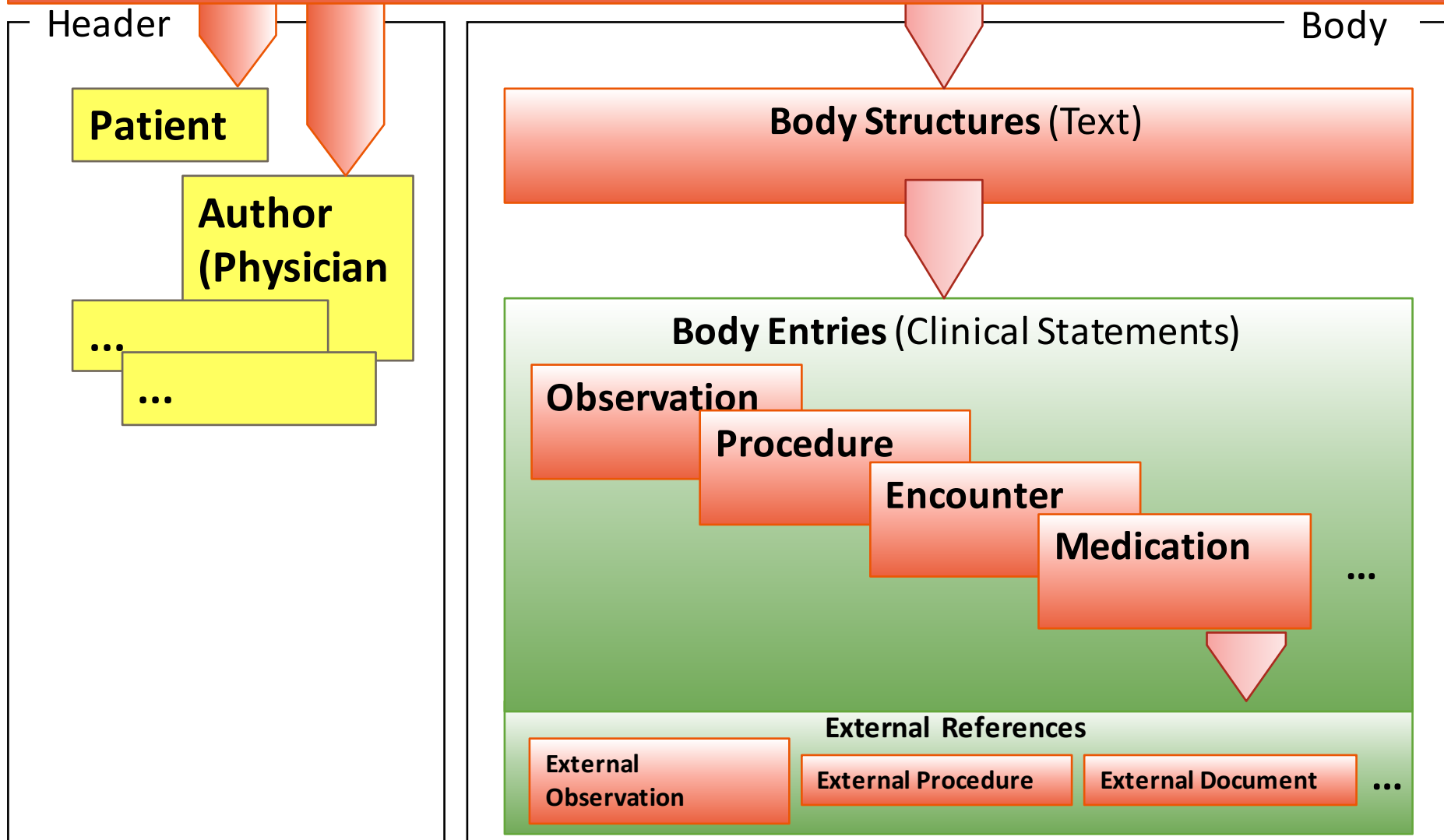
- Epicrisis
- Plan
-

Structure of a CDA Document



Structure of a CDA Document

Clinical Document (Document Information)



CDA Header + Body Text

- (e.g. when transformed to HTML)

“Human interoperability guaranteed”

Patient:	Paul Pappel	Patient-Nr:	6245
Kontakt:	Riedemannweg 59 13627 Berlin Tel: 030.456.345345 (zu Hause)		
geb.:	17. Dezember 1955	Geschlecht:	männlich
Behandelnder Arzt:	Dr. med. Theo Phyllin Krankenhausstraße 240 51371 Leverkusen Fax: 02473.238298.23 (Arbeitsplatz)	Erzeugt am:	29. August 2005

Arztbrief auf der Basis von CDA Release 2

!9.08.2005: Anamnese

Sei Jahren wiederholt **chronische Bronchitiden** besonders bei kalter Luft. Bei Anstrengung expiratorische Atemnot. Kontakt mit Haustieren.

!9.08.2005: Befund

- Pulmo: Basal diskrete RGs
- Cor: oB
- Abdomen: weich, Peristaltik: +++
- Muskulatur: atrophisch
- Mundhöhle: Soor, Haarleukoplakie
- Haut blass, seborrhoisches Ekzem, Schleimhäute blass, Hauttrugor herabgesetzt
- Neuro: herabgesetztes Vibrationsempfinden der Beine, distal betont, Parästhesien der Beine, PSR, AST oB und seitengleich.

!9.08.2005: Pricktest

- Birke +++
- Haselstrauch ++
- Erle ++
- Keine Reaktion auf weitere Pollen, Katzen-/Hundehaare, Schimmelpilze

!9.08.2005: Diagnosen mit ICD 10

Diagnose	ICD Code	Lokalisation	Zusatz
Allergisches Asthma	J45.0	--	G
Ausschluss Lungenemphysem	J43.9	--	A
V.a. Allergische Rhinopathie durch Pollen	J31.1	--	V

CDA Header



The Header: context of the document

- Identification of the document (ID, category/type, title, date, version)
- Confidentiality, language
- “Manager” of the document
- Patient
- Author
- Responsible Parties
- ...

ClinicalDocument

- Identification
- Classification
- Dates
- Language
- Versioning
- Relationships
- Participations

ClinicalDocument

classCode*: <= *DOCCLIN*

moodCode*: <= *EVN*

id*: II [1..1]

code*: CE CWE [1..1] <= *DocumentType*

title: ST [0..1]

effectiveTime*: TS [1..1]

confidentialityCode*: CE CWE [1..1]

<= *x_BasicConfidentialityKind*

languageCode: CS CNE [0..1] <= *HumanLanguage*

setId: II [0..1]

versionNumber: INT [0..1]

copyTime: TS [0..1] (Deprecated)

ClinicalDocument

- id
 - unique identification
 - OID concept
- code
 - Type of document
 - Specifies content
 - CE CWE [1..1]
 - Usually: LOINC codes

```
<code  
  code="34105-7"  
  codeSystem="2.16.840.1.113883.6.1"  
  displayName="Discharge Summarization Note"/>
```

ClinicalDocument.code

Code	Document-Type	Authoring Provider	Context
34133-9	Summarization of Episode Note	Practitioner	
18842-5	Discharge summarization note	Provider	
11490-0	Discharge summarization note	Physician	
34745-0	Discharge summarization note	Nurse	
34105-7	Discharge summarization note	Provider	Hospital
34106-5	Discharge summarization note	Physician	Hospital
18761-7	Transfer summarization note	Provider	
28616-1	Transfer summarization note	Physician	
28651-8	Transfer summarization note	Nurse	
18733-6	Ambulatory visit note		
18742-7	Arthroscopy report		
18743-5	Autopsy report		
18745-0	Cardiac catheterization report		
11488-4	Consultation note		
18747-6	CT report		
11520-4	Echocardiogram report		
15507-7	Emergency visit note		
11492-6	History and physical note		

ClinicalDocument

- title
 - additional information

```
<title>Patient Summary as of 24. October 2014</title>
```

- effectiveTime
 - creation of document (as printed on top)

```
<effectiveTime value="200601171415" />
```

- LanguageCode
 - ISO 639-1

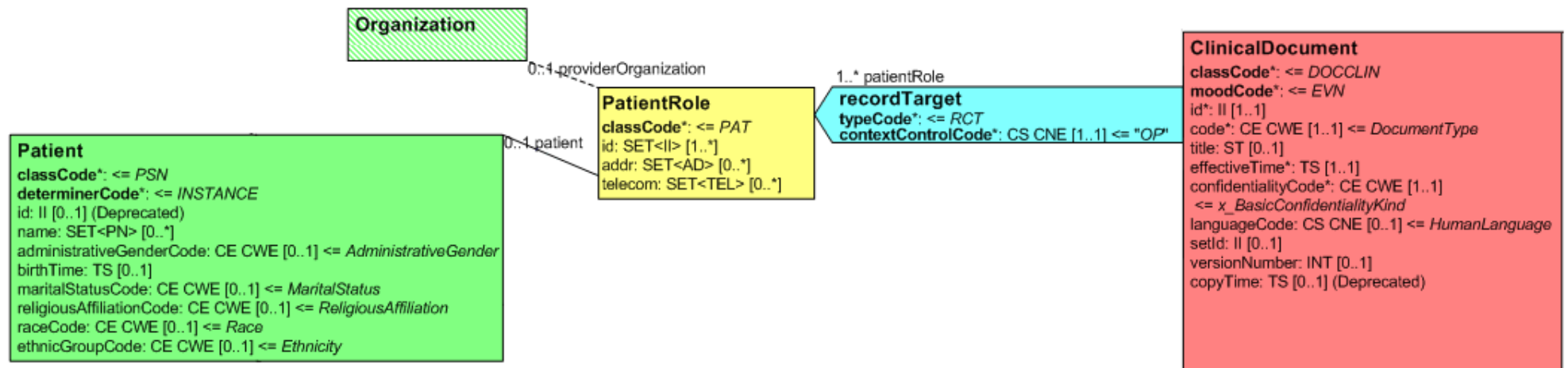
```
<languageCode code="de-DE" />
```

ClinicalDocuments: involved Parties

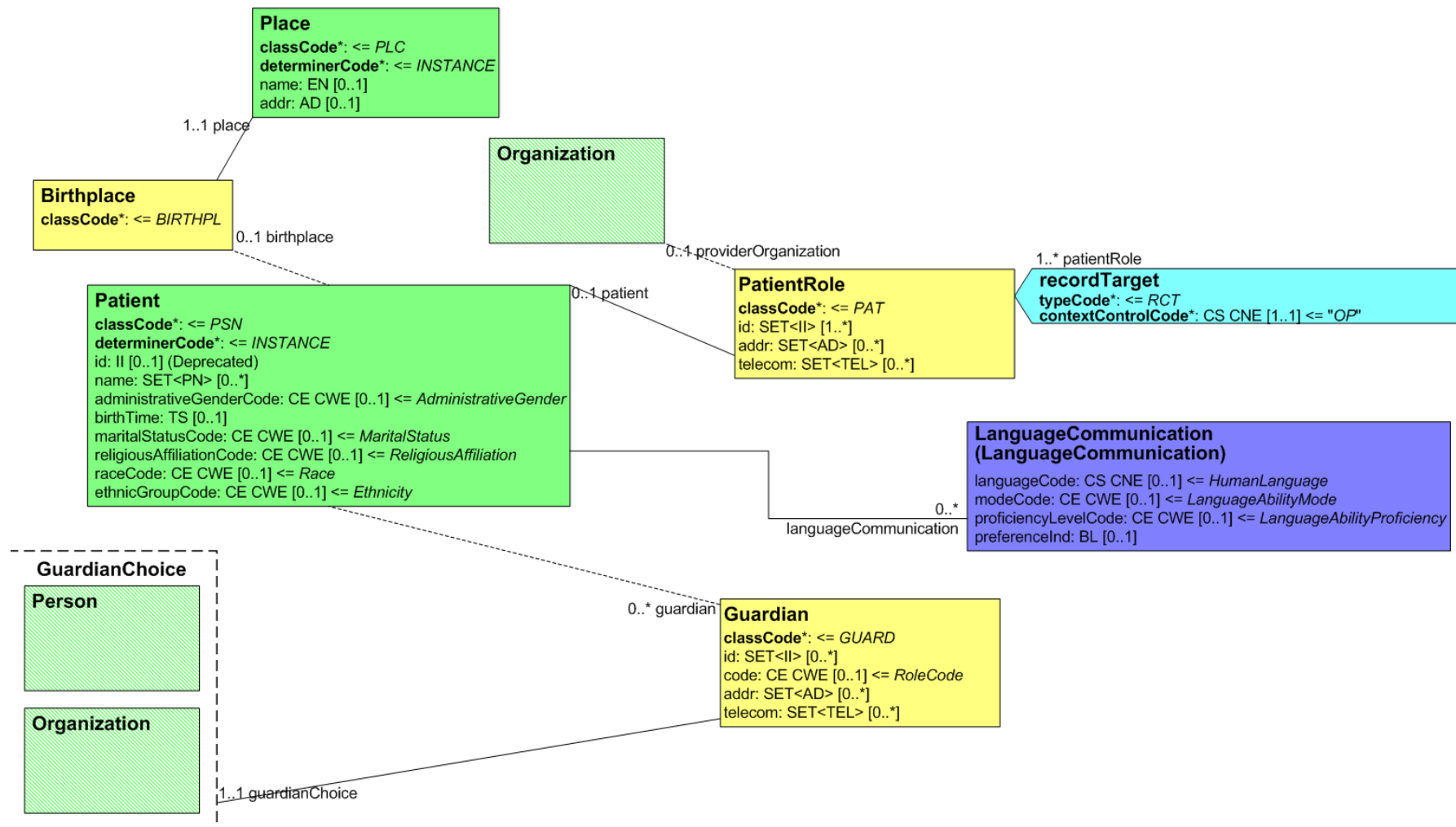
- **recordTarget:** Patient
- **author:** who has written the document
- **custodian:** organisation
- **informationRecipient:** intended receivers (as known at the time of creation of the document)
- **legalAuthenticator:** who has signed this document
- **authenticator:** other signing persons
- **dataEnterer:** transcriptionist
- **participant:** other assigned persons

recordTarget

- “Patient”



recordTarget (the real thing)

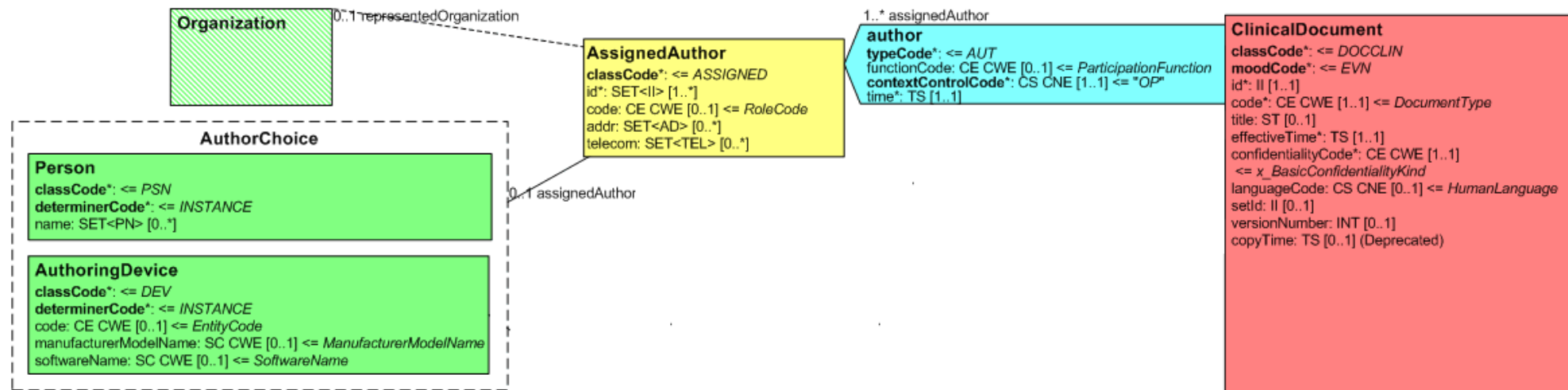


Patient Example XML

```
<recordTarget>
  <!-- Patient Data -->
  <patientRole>
    <id extension="6245" root="2.16.840.1.113883.19.3.933"/>
    <id extension="1543627549" root="1.2.276.0.76.4.1"/>
    <addr>
      <streetAddressLine>54 Main street</streetAddressLine>
      <postalCode>51371</postalCode>
      <city>Alphaville</city>
    </addr>
    <telecom value="tel:0221.444.5678"/>
    <patient>
      <name>
        <given>Paul</given>
        <family>Peterson</family>
      </name>
      <administrativeGenderCode code="M" codeSystem="2.16.840.1.113883.5.1"/>
      <birthTime value="19551217"/>
    </patient>
    <providerOrganization>
      <telecom use="WP" value="tel:02412127070"/>
      <telecom use="WP" value="fax:0241212707122"/>
      <addr>
        <streetAddressLine>12 Hospital street</streetAddressLine>
        <postalCode>51371</postalCode>
        <city>Alphaville</city>
      </addr>
    </providerOrganization>
  </patientRole>
</recordTarget>
```

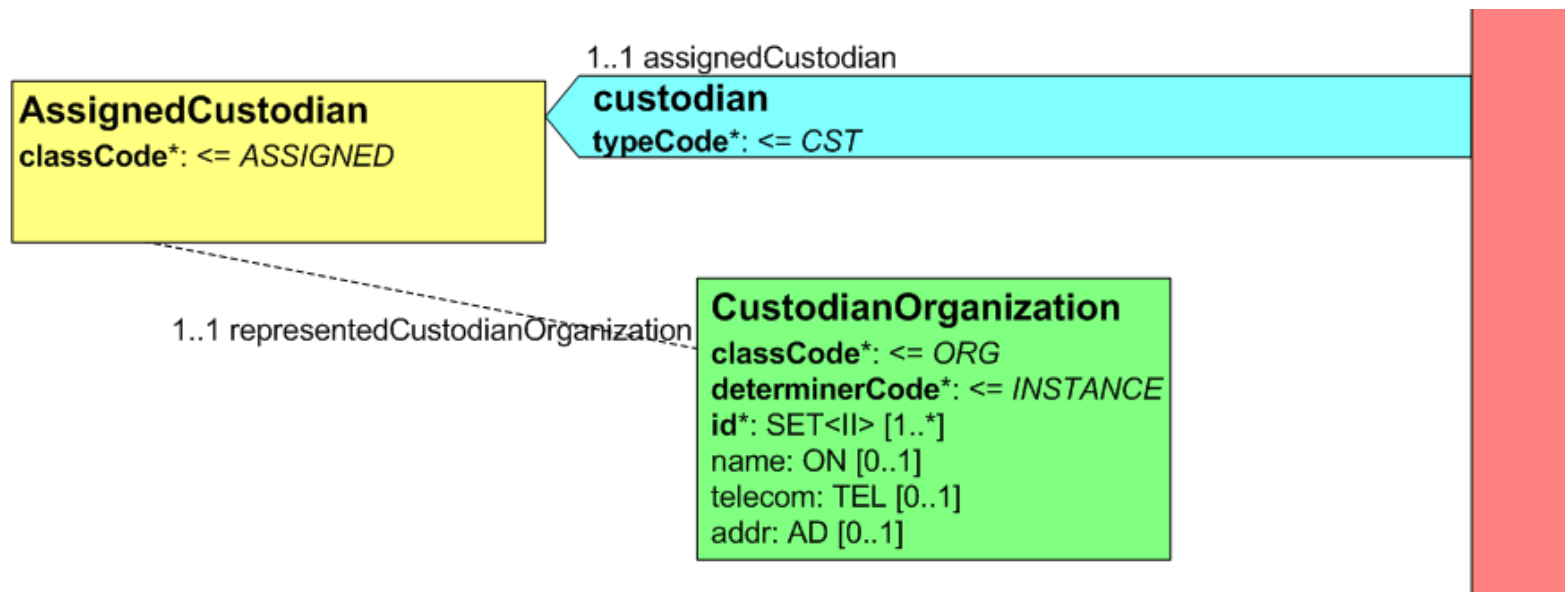
author

- Author: person or device



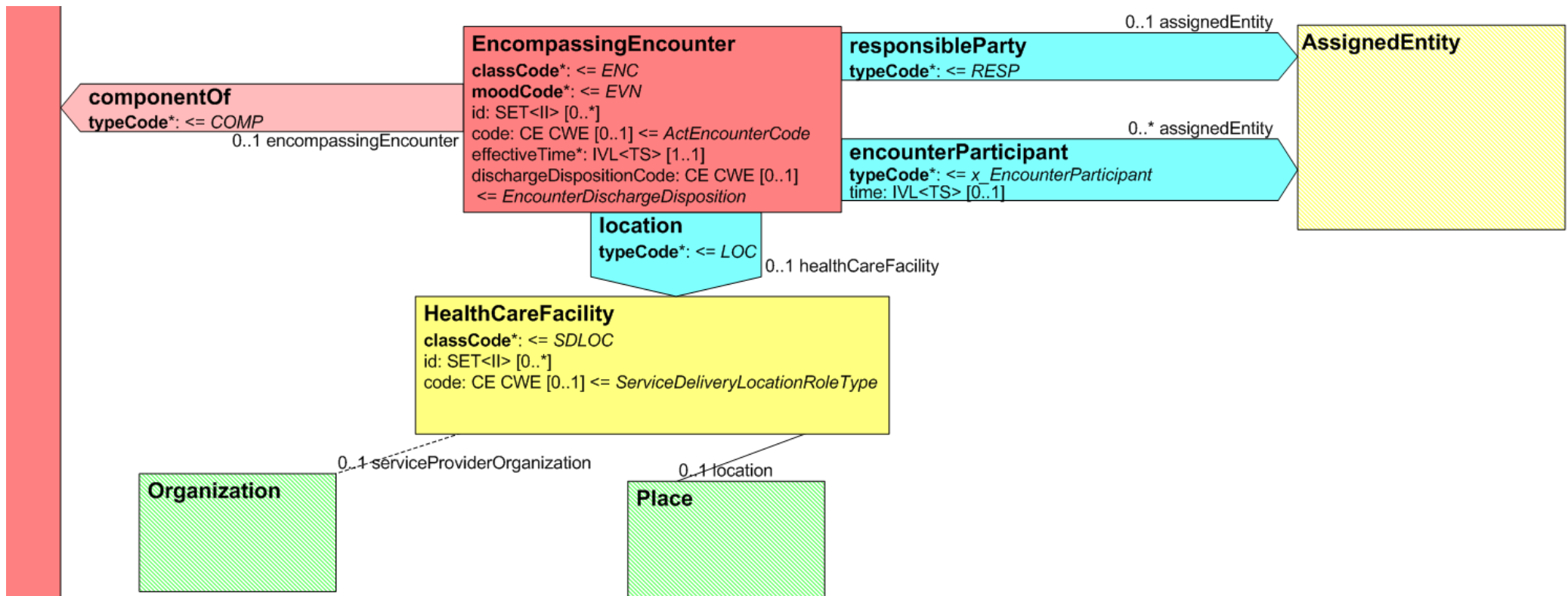
custodian

- Custodian



Visit Information

- Encompassing Encounter



CDA Body

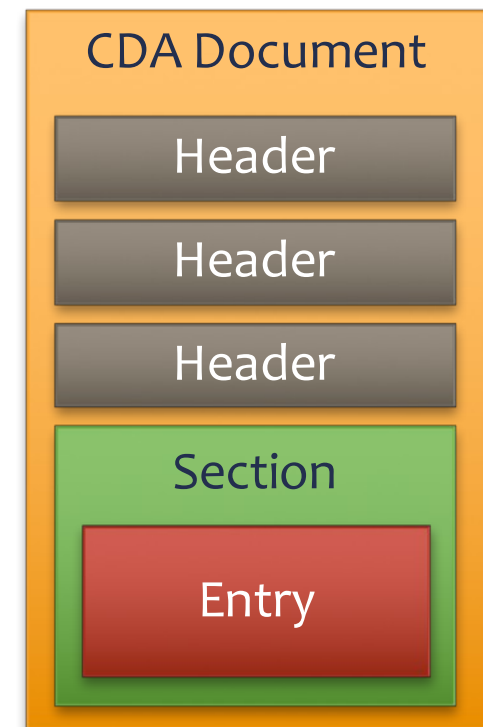


Body Overview

- Header ✓
- Body
 - Section
 - Entry
 - Entry
 - Section
 - Entry
 - Section

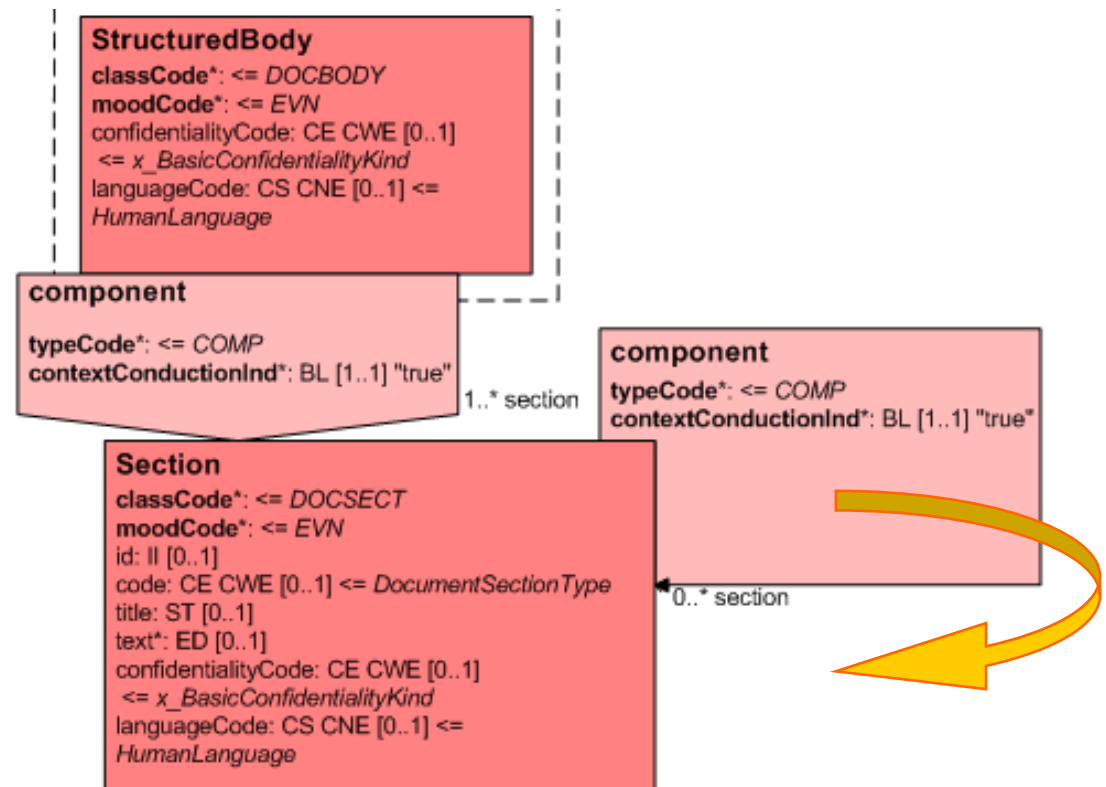
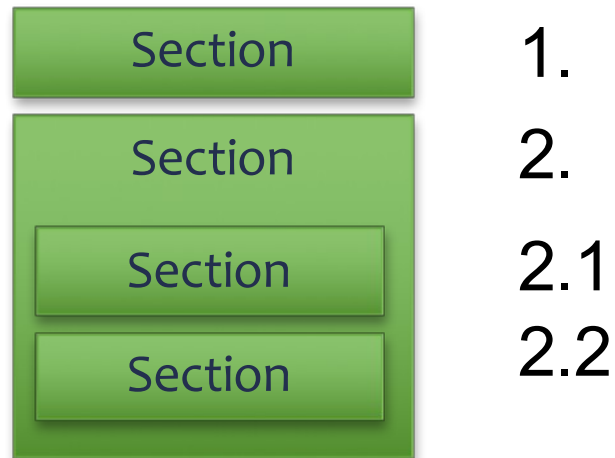
Human readable

Machine processable



The Body: Component Model

- iterative definition
 - .title = heading
 - .text = paragraph



Section, mandatory parts

- title
- text
 - section
 - paragraphs
 - headings
 - tables
 - lists
 - revision marks (insert, delete)
 - ...

narrative
block

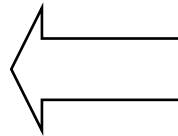
Formatting NarrativeBlock Content

- Section.text choice of
 - content
 - paragraph
 - linkHtml
 - sub / sup
 - br
 - footnote / footnoteRef
 - list
 - table
- table sequence of
 - caption
 - col / colgroup
 - thead
 - tr
 - th
 - tfoot
 - tr
 - td
 - ...
 - tbody
 - tr
 - td

Example Table

- rendered with XSLT

Col 1	Col 2
1	aa
2	bb



```
<text>
  <table>
    <thead>
      <tr>
        <th>Col 1</th>
        <th>Col 2</th>
      </tr>
    </thead>
    <tbody>
      <tr>
        <td>1</td>
        <td>aa</td>
      </tr>
      <tr>
        <td>2</td>
        <td>bb</td>
      </tr>
    </tbody>
  </table>
</text>
```

Sections: "Levels"

CDA Release 2	
CDA Level 1	The CDA specification.
CDA Level 2	The CDA specification with section-level templates applied. “My discharge letter has the following structure”
CDA Level 3	The CDA specification with section-level (and many entry-level) templates applied. “My discharge letter contains the following granular data”

Human Interoperability

Application Interoperability

CDA Sections: Level 2

- Level 1: Human readable text
- Level 2: a code to indicate the nature of the section

```
<component>
  <!-- History -->
  <section>
    <code code="10164-2"
          codeSystem="2.16.840.1.113883.6.1"
          codeSystemName="LOINC" />
    <title>29.08.2005: History</title>
    <text>
      Onset of asthma in his teens. He was hospitalized twice
      last year, and already twice this year.
    </text>
  </section>
</component>
```

Header + Level 1 (+2)

- e.g. when transformed to HTML:

Human
interoperability
guaranteed

Patient:	Paul Pappel	Patient-Nr:	6245
Kontakt:	Riedemannweg 59 13627 Berlin Tel: 030.456.345345 (zu Hause)		
geb.:	17. Dezember 1955	Geschlecht:	männlich
Behandelnder Arzt:	Dr. med. Theo Phyllin Krankenhausstraße 240 51371 Leverkusen Fax: 02473.238298.23 (Arbeitsplatz)	Erzeugt am:	29. August 2005

Arztbrief auf der Basis von CDA Release 2

29.08.2005: Anamnese

Sei Jahren wiederholt **chronische Bronchitiden** besonders bei kalter Luft. Bei Anstrengung expiratorische Atemnot. Kontakt mit Haustieren.

29.08.2005: Befund

- Pulmo: Basal diskrete RGs
- Cor: oB
- Abdomen: weich, Peristaltik: +++
- Muskulatur: atrophisch
- Mundhöhle: Soor, Haarleukoplakie
- Haut: blass, seborrhoisches Ekzem, Schleimhäute blass, Hauttrugor herabgesetzt
- Neuro: herabgesetztes Vibrationsempfinden der Beine, distal betont, Parästhesien der Beine, PSR, AST oB und seitengleich.

29.08.2005: Pricktest

- Birke +++
- Haselstrauch ++
- Erle ++
- Keine Reaktion auf weitere Pollen, Katzen-/Hundehaare, Schimmelpilze

29.08.2005: Diagnosen mit ICD 10

Diagnose	ICD Code	Lokalisation	Zusatz
Allergisches Asthma	J45.0	--	G
Ausschluss Lungenemphysem	J43.9	--	A
V.a. Allergische Rhinopathie durch Pollen	J31.1	--	V

Section.code

- LOINC
- coding strength: CWE

Category	Example Code	Description
Anamnesis	11348-0	History of past illness
Allergy	10155-0	History of Allergies
Diagnosis	29548-0	Diagnosis (Text; NAR)
Medication	10160-0	History of Medication Use
...		

Body Overview

- Header ✓

- Body

- Section

Human readable ✓

- Entry

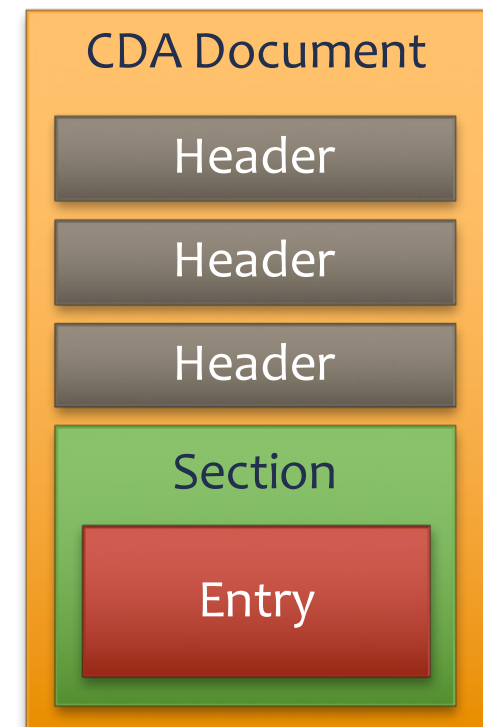
- Entry

Machine processable

- Section

- Entry

- Section



Entries: Computable Representations of Clinical Concepts

- Observation
- Procedure
- Substance Administration
- Supply
- Encounter
- Act
- Organizer

Observation

Region of Interest

Observation Media

Substance Administration

Supply

Procedure

Encounter

Organizer

Act

- Clinical context
- “Clinical Statement Pattern”

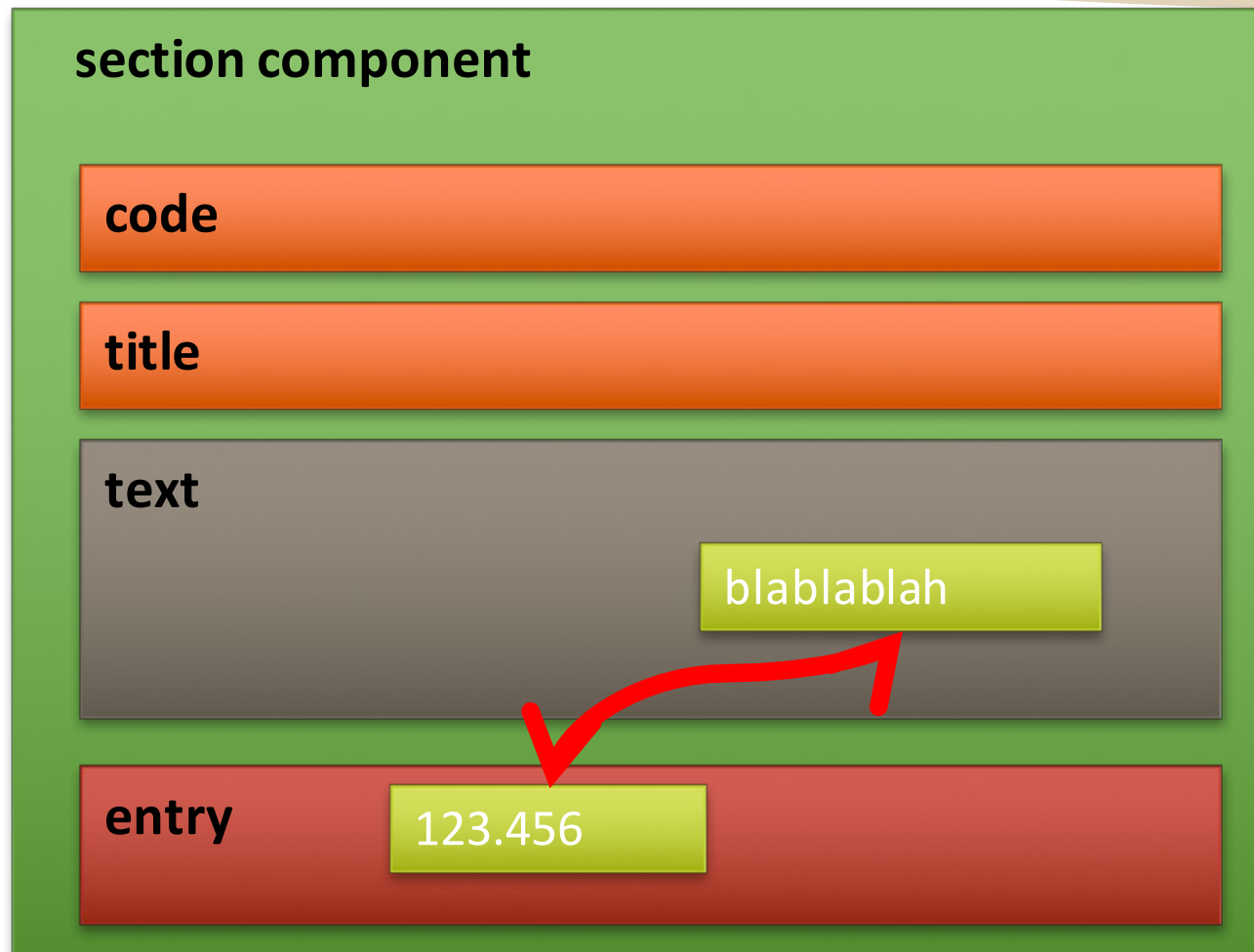


CDA sections: Level 3

- Level 3
- Classes from the HL7 model (clinical statements)

```
<component>
  <section>
    <code code="10164-2" codeSystemName="LOINC"
          codeSystem="2.16.840.1.113883.6.1" />
    <title>29.08.2005: History</title>
    <text>
      ...
    </text>
    <entry typeCode="COMP">
      <observation>
        <code code="195967001"
              codeSystem="2.16.840.1.113883.6.96"
              codeSystemName="SNOMED CT"
              displayName="Asthma">
        </code>
      </observation>
    </entry>
  </section>
</component>
```

Referencing Entries



Text/Entry relationship: COMP vs DRIV

- The entry relationship is defaulted to **COMP** (component)
 - The narrative is the original authenticated content
 - The CDA entries are created by various techniques (e.g., natural language processing, a human coder, a structured data entry tool that outputs both entries and a text report)
- The entry relationship **DRIV** (is derived from) can be used in the special case where the narrative is fully derived from CDA Entries

Derivation of text from a Level 3 entry (DRIV)

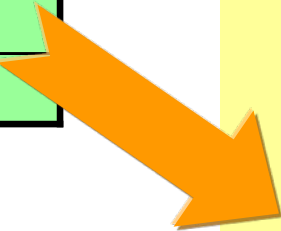
Blood Pressure

120

80



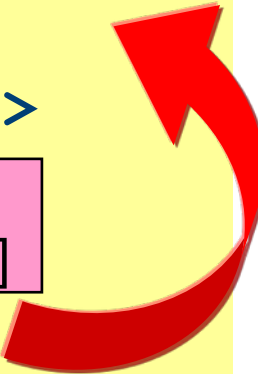
Database	
...	...
systolicBP	int
diastolicBP	int
...	...



DRIV (is derived from)

narrative is fully derived from the CDA entries

```
<section>
  <text>
    Blood pressure 120/80 mmHg
  </text>
  <entry typeCode="DRIV">
    Observation
    Systolic BP: 120 mm[Hg]
  </entry>
  <entry typeCode="DRIV">
    Observation
    Diastolic BP: 80 mm[Hg]
  </entry>
</section>
```



Derivation of text from a Level 3 entry (COMP)

Family History:

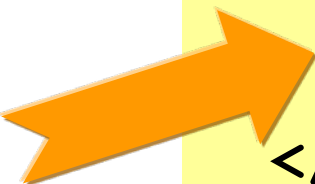
Patient with onset of asthma in his teens



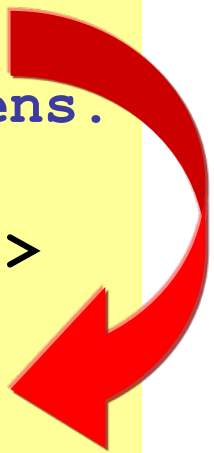
Database	
...	...
familyHistory	text
...	...

COMP (component)

narrative is the original authenticated content



```
<section>
  <text>
    Patient with onset
    of asthma in his teens.
  </text>
  <entry typeCode="COMP">
    Observation
    asthma
  </entry>
</section>
```



Observation
asthma

Entry Inspection: The Module Principle

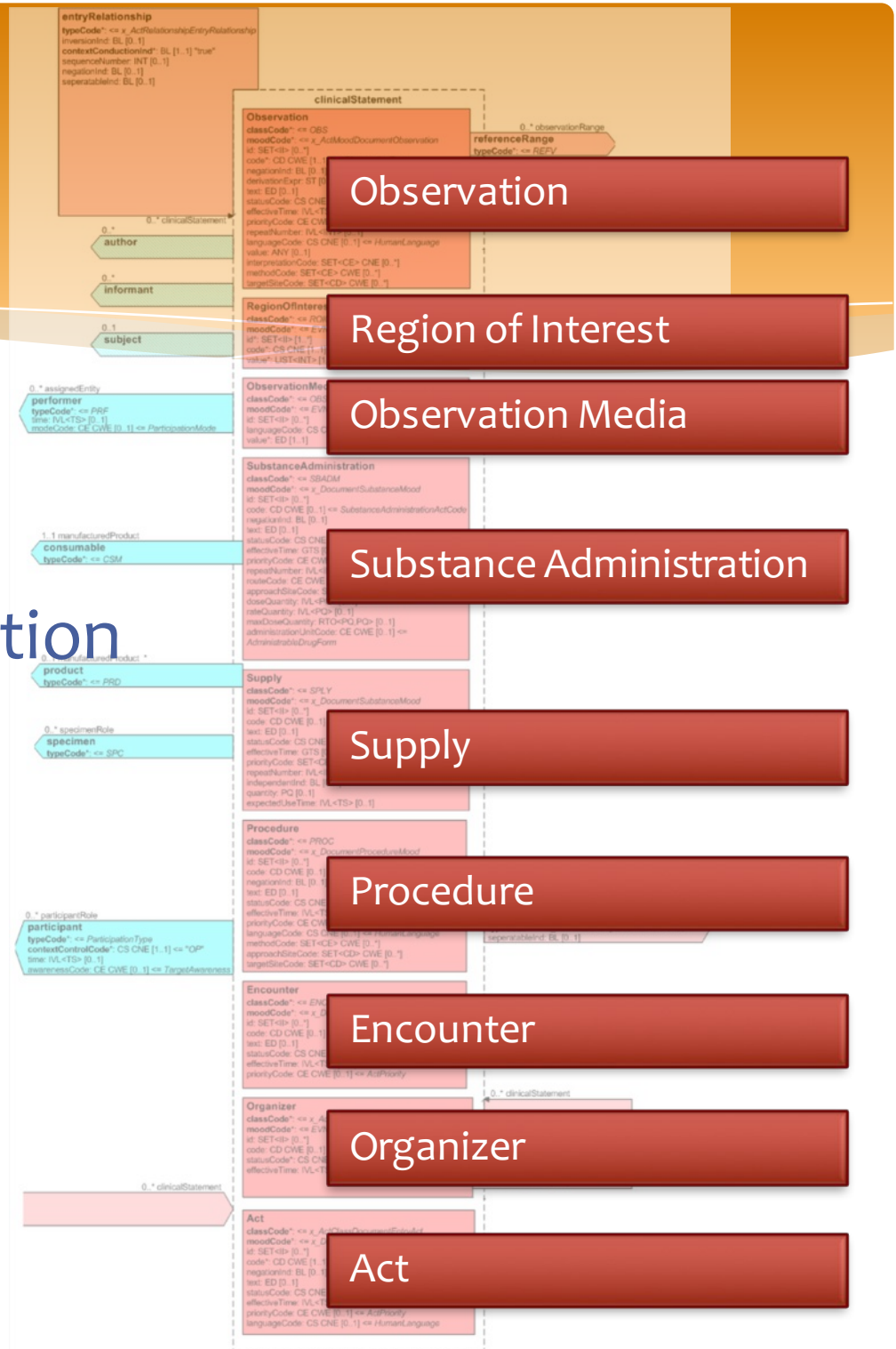


CDA Entries (Clinical Statements)

- Choice of Acts (from HL7's Reference Information Model)
- Relationships between Activities (Classes)
- Participations

Clinical Statement Pattern

- Observation
- Procedure
- Substance Administration
- Supply
- Encounter
- Act
- Organizer



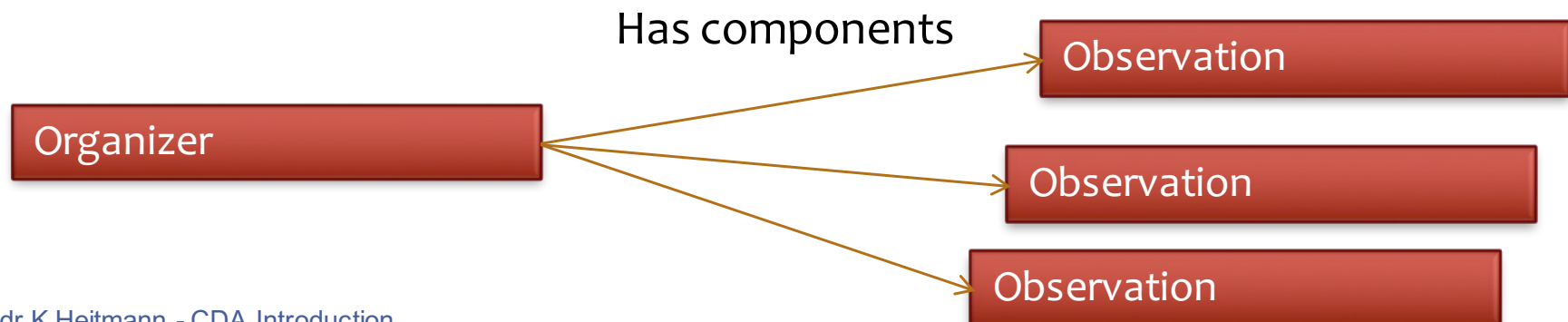
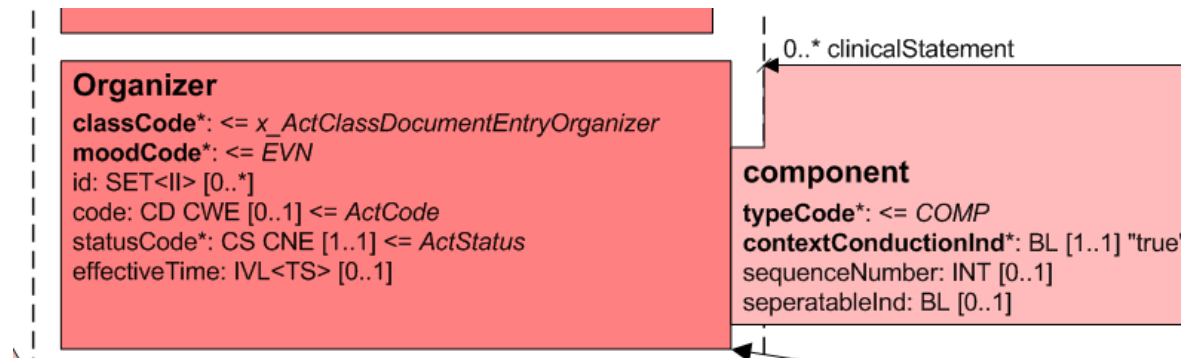
Clinical Statement Types

- Observation
 - A Finding, Result, Diagnosis etc.
 - Includes requesting, recommending, promising, refusing or setting a goal

```
Observation  
classCode*: <= OBS  
moodCode*: <= x_ActMoodDocumentObservation  
id: SET<II> [0..*]  
code*: CD CWE [1..1] <= ObservationType  
negationInd: BL [0..1]  
derivationExpr: ST [0..1]  
text: ED [0..1]  
statusCode: CS CNE [0..1] <= ActStatus  
effectiveTime: IVL<TS> [0..1]  
priorityCode: CE CWE [0..1] <= ActPriority  
repeatNumber: IVL<INT> [0..1]  
languageCode: CS CNE [0..1] <= HumanLanguage  
value: ANY [0..1]  
interpretationCode: SET<CE> CNE [0..*]  
methodCode: SET<CE> CWE [0..*]  
targetSiteCode: SET<CD> CWE [0..*]
```

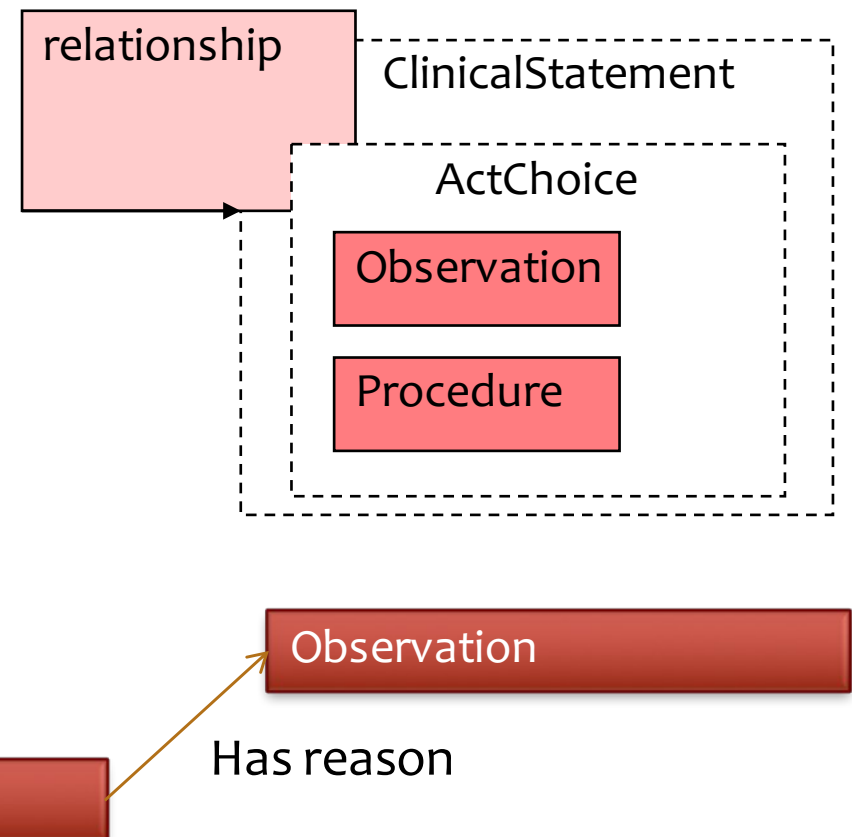
Clinical Statement Types

- Organizer relationships



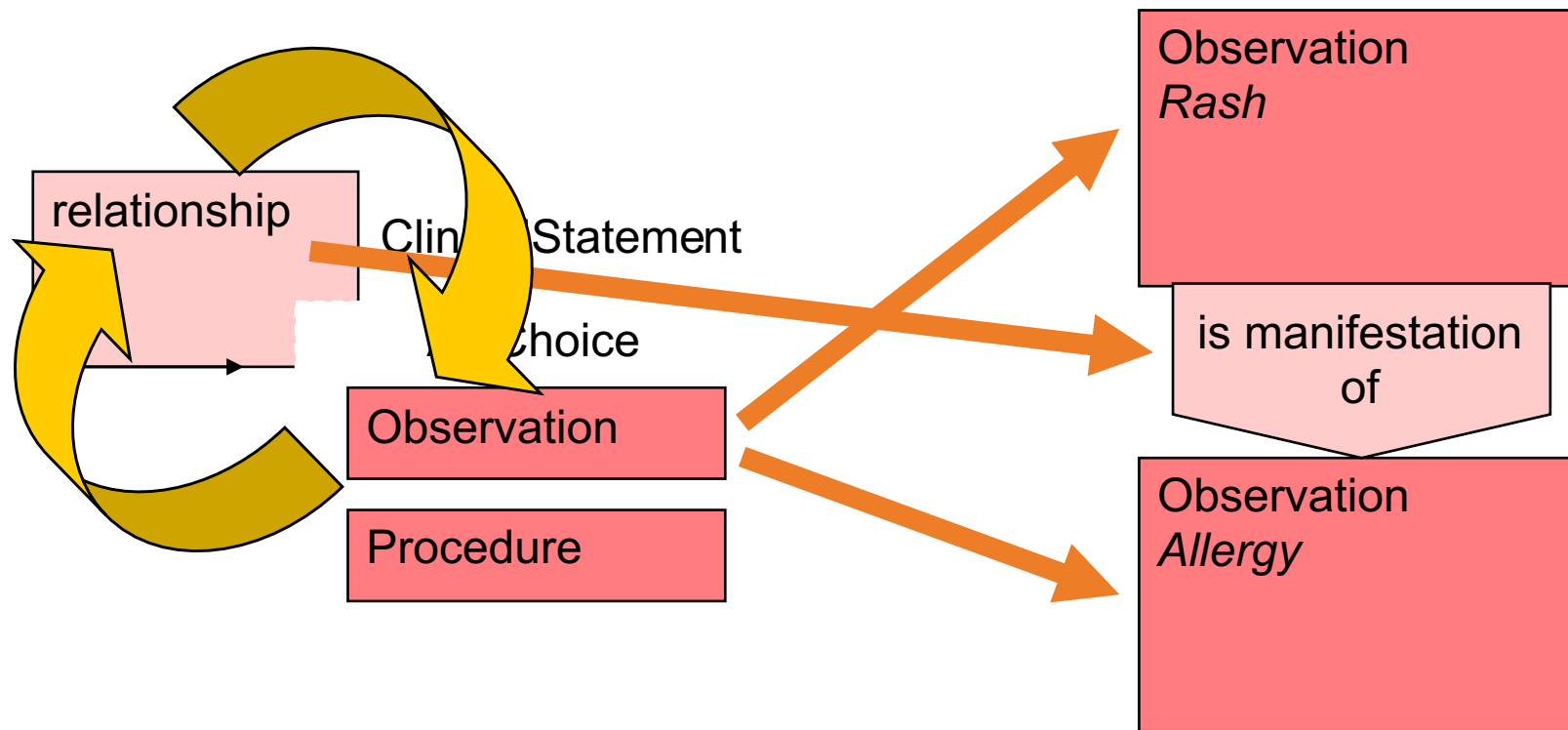
Clinical Statement Types

- Statement Relationship
 - A link between two or more Clinical Statements
 - Allows a relationship to be stated independently of the related Clinical Statements



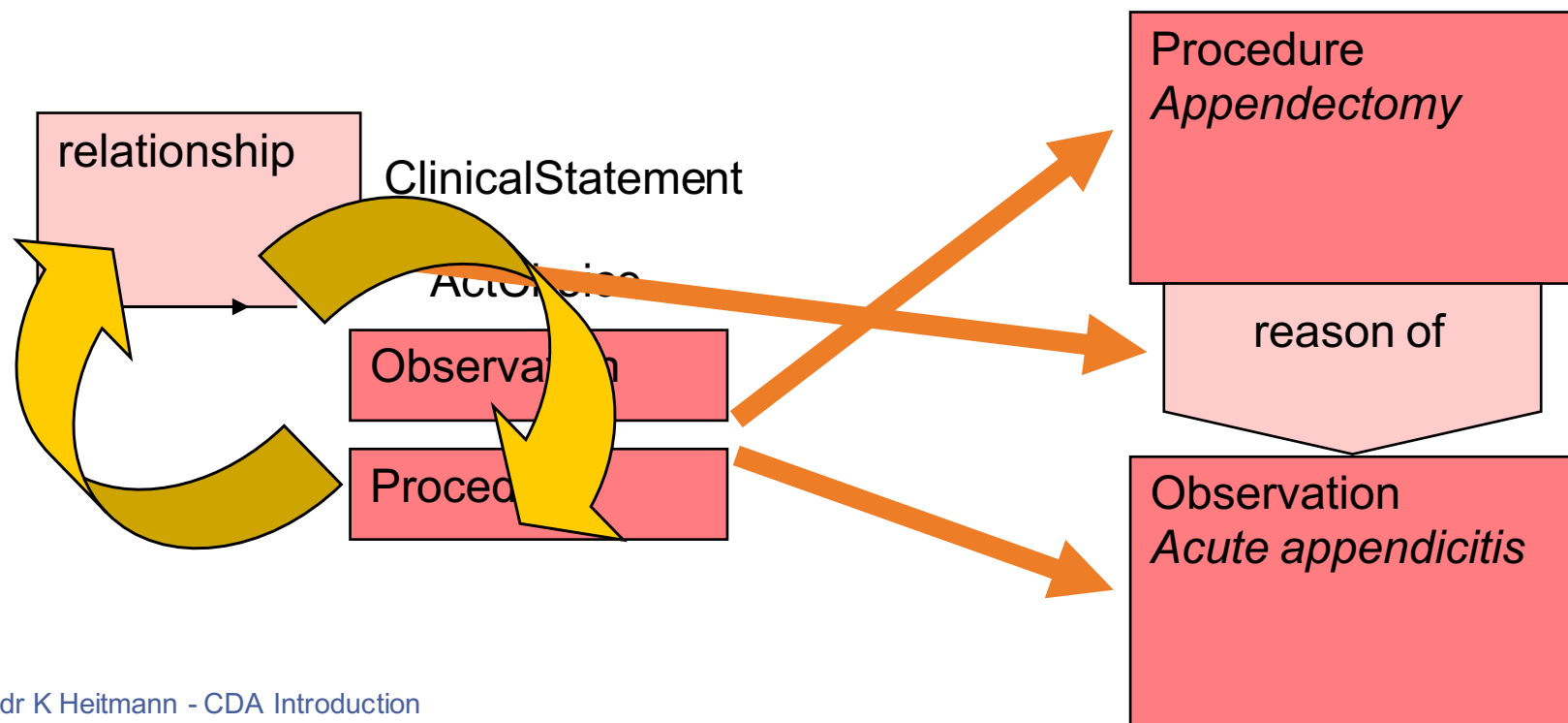
Composition example I

- Rash (skin) as a *manifestation* of an allergy



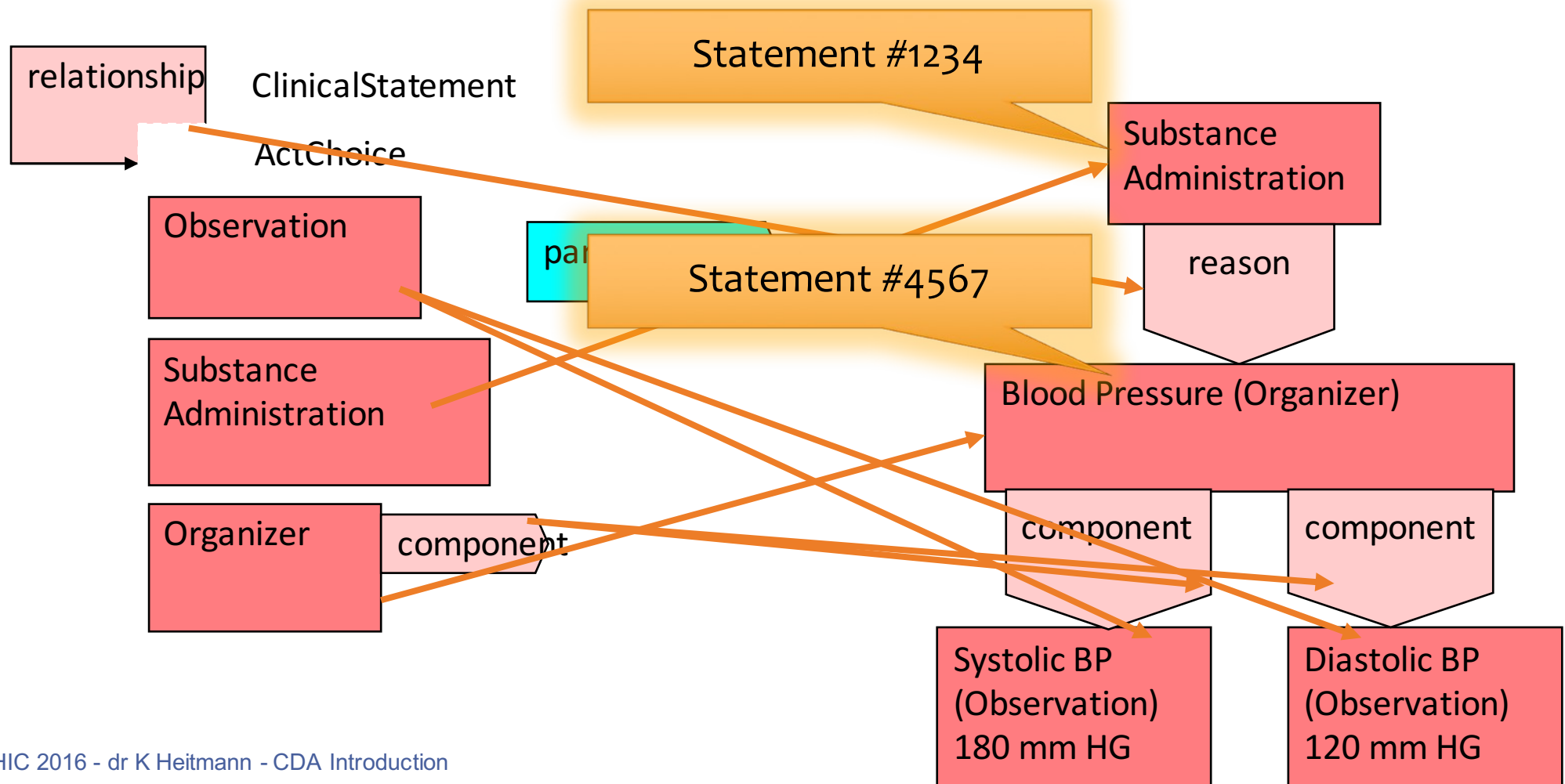
Composition example II

- An appendectomy (procedure) *because of the* (diagnosis) acute appendicitis



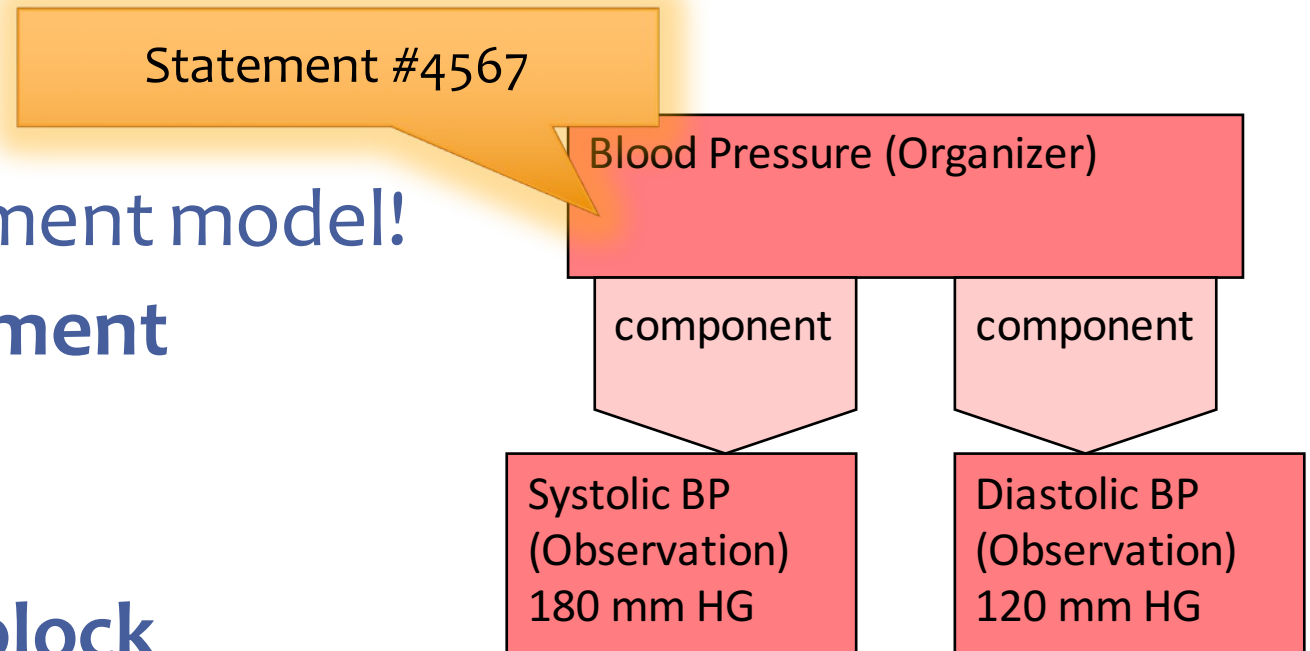
Composition example III

A Patient is given a medication because his blood pressure is found to be 180/120 mm[Hg].



Clinical Statement /recap

- Model deliberately broad and encompassing
- It would be possible to represent a particular statement in more than one way
- Therefore: constrain the Clinical Statement model!
- **Clinical Statement pattern**
- → Template
- → re-usable block

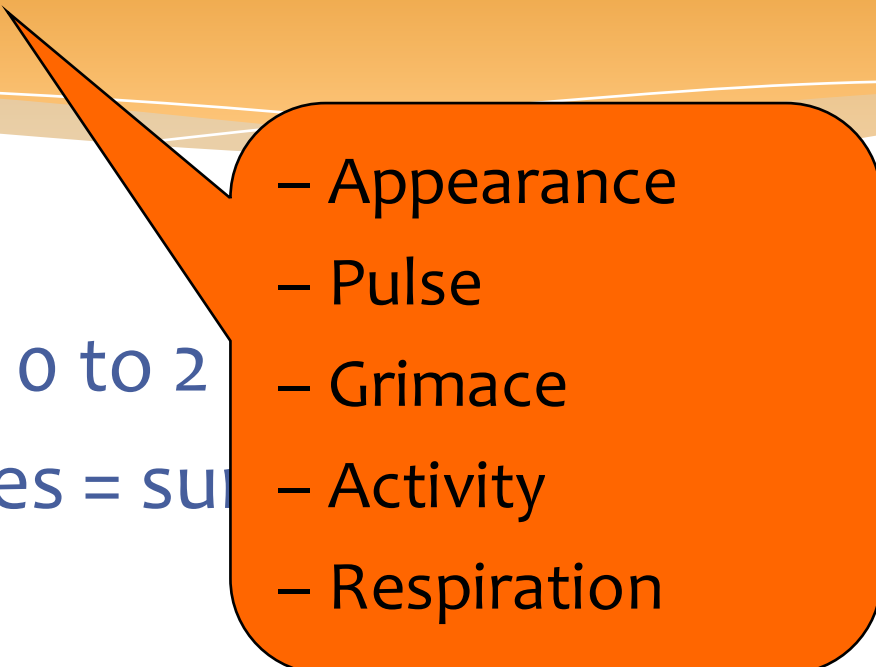


Example 1: APGAR score

- Apgar score
 - was devised in 1952 by **Dr. Virginia Apgar** as a simple and repeatable method to quickly and summarily assess the *health of newborn children* immediately after childbirth



Example 1: APGAR score

- Five criteria
 - ... Simple, on a scale from 0 to 2
 - summing up the five values = sum
- 
- Appearance
 - Pulse
 - Grimace
 - Activity
 - Respiration

	Score of 0	Score of 1	Score of 2	Component of Acronym
Skin color	blue all over	blue at extremities body pink (<i>acrocyanosis</i>)	no <i>cyanosis</i> body and extremities pink	Appearance
Pulse rate	absent	<100	>100	Pulse
Reflex irritability	no response to stimulation	grimace/feeble cry when stimulated	sneeze/cough/pulls away when stimulated	Grimace
Muscle tone	none	some <i>flexion</i>	active movement	Activity
Breathing	absent	weak or irregular	strong	Respiration

Example 1: APGAR score

- Method
 - The test is generally done at one and five minutes after birth
 - may be repeated later if the score is and remains low
- Interpretation
 - Scores 3 and below are generally regarded as critically low
 - 4 to 6 fairly low, and
 - 7 to 10 generally normal

Interspersed Exercise 1

- Prerequisites
 - Apgar score is scientifically validated
 - indicator of health condition of a newborn
- Exercise
 - Use the Clinical Statement model to represent Apgar score
 - Think about how to identify sum score and the five scales
 - Determine the properties of the class attributes

Interspersed Exercise 1

- Possible Solution

- Sum Score 0..10
 - Appearance 0..2
 - Pulse 0..2
 - Grimace 0..2
 - Activity 0..2
 - Respiration 0..2

Observation: *Agpar Sum Score*

code:

effectiveTime:

value:

component

component

component

component

component

Observation
Appearance

code:

value:

Observation
Pulse

code:

value:

Observation
Grimace

code:

value:

Observation
Activity

code:

value:

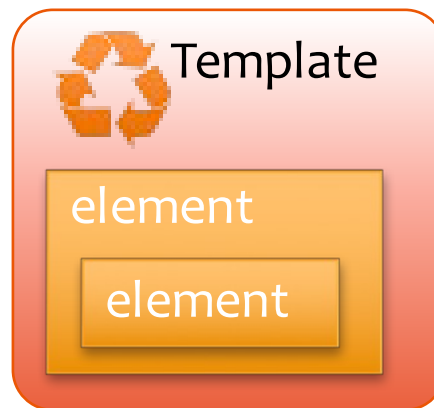
Observation
Respiration

code:

value:

Template Creation

- We just created a template...
- Is this really so easy?



Exercise

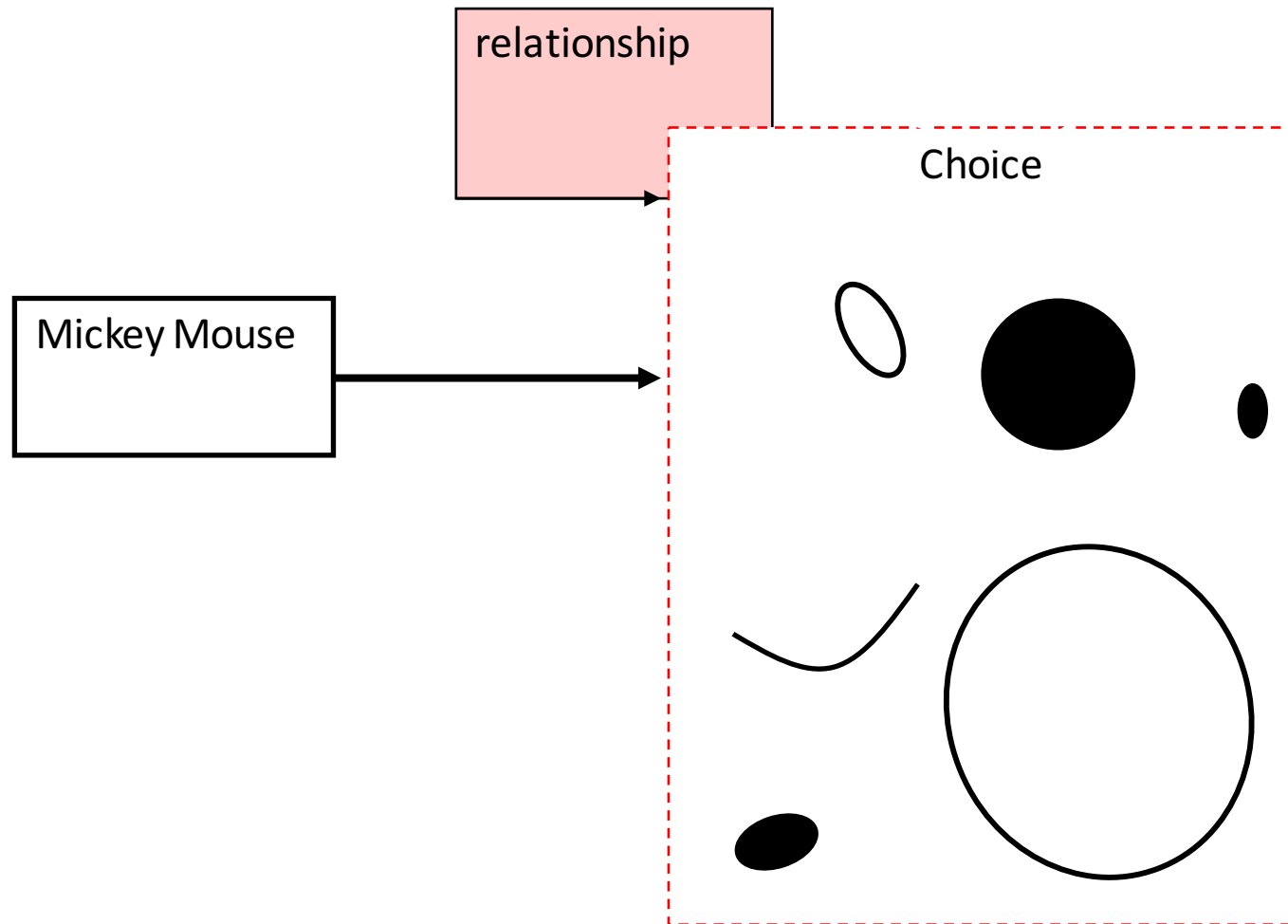
- Remember

Mickey Mouse

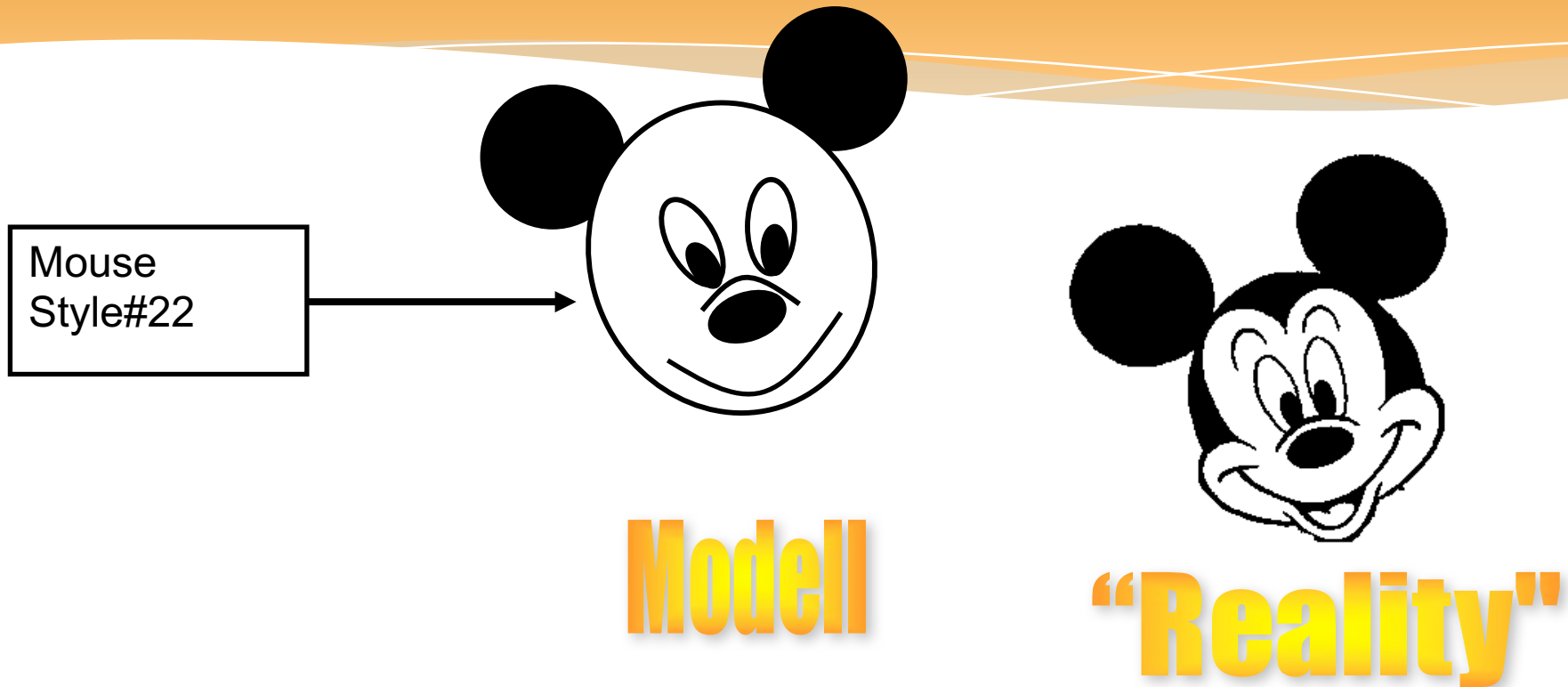
- Prerequisites
 - Pen and a piece of paper
 - Your memories and your drawing skills
- Exercise: draw the **face of Mickey Mouse**

Background Story

Mouse Statement



Template



Mini **Intro** and Outro

Templates



...with CDA you aren't there...



Generic models

...need something

...to fill the gap

...to semantic interoperability

Templates



Generic vs specific definitions

- CDA is not a *highly* specified/differentiated model
 - “any” document definition
- Rule: the more general a model is the more you have to bridge the gap towards semantic interoperability
 - “any” document definition → “my” document definition

CDA & Implementation

- Re-usable generic blocks
 - Once you implemented a RecordTarget, re-use it in all document types
 - Choice of RIM favorite acts in it's finest purity
- Incremental Interoperability
 - allows for a migration phase
 - 'lowest common denominator'
= human interoperability
 - Start with a simple CDA
 - Structured data elements are added over time

HL7 / CDA Templates

- A template is a set of further constraints on top of an underlying model
- Example: patient
 - **Model:** the patient shall have one or more identifications (id)
 - **Template:** our patients shall have exactly one Dutch national patient identifier
- Documentation of “rules” in HL7’s Templates Exchange Format Release 1 (STU)



Patient

id: II 1..1

addr: AD 0..*

telecom: TEL 0..*

Template (section level)

Allergies Section (entries optional)					
Version	2012-01-12			Status	Draft
Version Label				Id	2.16.840.1.113883.10.20.22.2.6
Name	AllergiesSectionentriesoptional			Display Name	Allergies Section (entries optional)
Classification	cdasectionlevel			Open/Closed	open
Description	This section lists and describes any medication allergies, adverse reactions, idiosyncratic reactions, anaphylaxis/anaphylactoid reactions to food items, and metabolic variations o latex, iodine, tape adhesives) used to assure the safety of health care delivery. At a minimum, it should list currently active and any relevant historical allergies and adverse reactio				
Reference	conf-671				
Context	**				

Item	DT	Card	Conf	Description
cda:section				
...cda:templateId	II	1..1	M	
...@root		1..1	F	2.16.840.1.113883.10.20.22.2.6
...cda:code	CD	1..1	M	
...@code		1..1	F	48765-2
...@codeSystem		1..1	F	2.16.840.1.113883.6.1
...@displayName		1..1	F	Allergies, adverse reactions, alerts
...cda:title	ST	1..1	M	
...cda:text	ED	1..1	M	
...cda:entry		0..*	R	contains : 2.16.840.1.113883.10.20.22.4.30 Allergy Problem Act

Consolidated CDA

Consolidated
CDA

Sample XML fragment

```
<observation classCode="OBS" moodCode="EVN">
  <templateId root="2.16.840.1.113883.10.20.22.4.4"/>
  <!-- Problem Observation template -->
  <id root="d11275e7-67ae-11db-bd13-0800200c9a66"/>
  <code code="409586006" codeSystem="2.16.840.1.113883.6.96"
    displayName="Complaint"/>
  <text>
    ...
  </text>
  <statusCode code="completed"/>
  <effectiveTime>
    <low value="1950"/>
  </effectiveTime>
  <value xsi:type="CD" code="195967001"
    codeSystem="2.16.840.1.113883.6.96"
    displayName="Asthma"/>
</observation>
```

Template (entry level)

Item	DT	Card	Conf	Description	Label
↳ cda:observation					conf-622
↳ @classCode		1..1	F	OBS	conf-7318
↳ @moodCode		1..1	F	EVN	conf-7319
↳ cda:templateId	II	1..1	M		conf-7317
↳ @root		1..1	F	2.16.840.1.113883.10.20.22.4.28	conf-10490
↳ cda:code	CE	1..1	M		conf-7320
↳ @code		1..1	F	33999-4	
↳ @codeSystem		1..1	F	2.16.840.1.113883.6.1	
↳ @displayName		1..1	F	Status	
↳ cda:statusCode	CS	1..1	M		conf-7321
↳ @code		1..1	F	completed	
↳ @codeSystem		1..1	F	2.16.840.1.113883.5.14	
↳ @displayName		1..1	F	Completed	
↳ cda:value	CE	1..1	M		conf-7322
			CONF	code from value set: 2.16.840.1.113883.3.88.12.80.68 dynamic	

Value Set

AdministrativeGender			
Version	07/24/2012	Status	
Version Label		Id	2.16.840.1.113883.1.11.1
Name	AdministrativeGender	Display Name	AdministrativeGender
Description	The gender of a person used for administrative purposes (as opposed to clinical gender)		
Source Codesystems	2.16.840.1.113883.5.1	2.16.840.1.113883.5.1	
Values			
Level/Type	Code	Display Name	Codesystem
0-L	M	Male	2.16.840.1.113883.5.1
0-L	F	Female	2.16.840.1.113883.5.1
0-L	UN	Undifferentiated	2.16.840.1.113883.5.1

Template Types

- Document Level Template
- Header Constraints (Templates)
- Section Level Templates
- Entry Level Templates
- ...

Templates: all together now

- Document Level Template
- Header Level Templates
- Section Level Template
- Entry Level Templates

Vaccination Doc

Client

Author

Custodian

Vaccinations

Vaccines
+
Reasons

Dr Kai U. Heitmann, MD, FHL7
Heitmann Consulting and Services
ART-DECOR Expert Group
Template WG co-chair, HL7 International
Advisory Board, HL7 Foundation
CEO HL7 Germany
HL7 Germany / Netherlands / International



Thank you!
Questions?

