Sharing Clinical Decision Support Rules Using *open*EHR Archetypes and SNOMED CT

IHTSDO Showcase 2012

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Outline

- **Background**
  - Who, why, how
- **Guide Definition Language (GDL)**
  - Scope, aims, design
- **Implementation of GDL**
  - GDL Editor, some examples
- **SNOMED CT related implementation issues**
- ***Live*** **Demo of GDL Editor**
- **Summary & Questions**

Cambio Healthcare Systems

- Founded in 1993
  - 330 staff across the globe
  - Private and Venture funded
- The leading provider of **Regional EHR solutions** in Scandinavia - presence in Sweden, Denmark, UK, others to follow
- COSMIC is an international standard product
- Close to 95 000 staff users when current projects are fully implemented
- Our solutions are open, scalable and flexible based on *industry standards*
- Cambio invests 150 000 hours annually in COSMIC
- ISO 9001 certification and CE Marked EHR

One Patient – One Record – Anytime – Anywhere

Cambio COSMIC:

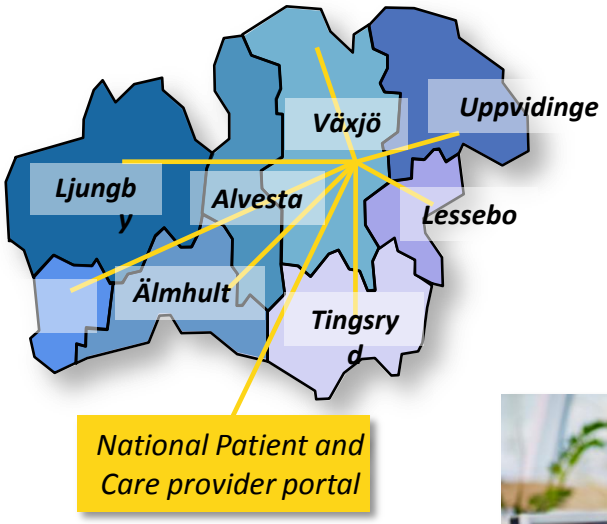
- Mainapplication and platform for process support
- Common repository for all healthcare information

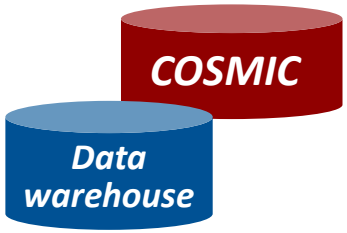
Integrated with:

- Clinical care support system
- Medical equipment
- Digital archives and PACS
- Decision support

County of Kronoberg

7% of the working people in Kronoberg are COSMIC users.





- Wireless Network in hospitals
- VPN over Mobile network
- VPN over Internet
- Network of Municipalities
- National Network for Healthcare in Sweden
- 95 % of the population in Kronoberg have an EHR in COSMIC

Background

- **Computerized Clinical Decision Support (CDS)**
  - Evidenced-based medicine, improved efficacy
  - Improved patient safety

- **Update-to-date CDS content is critical**
  - Fully computerized
  - Terminology bound
  - Based on common EHR models

- **Sharing of CDS Rules**
  - Sharing within our customer group
  - Sharing with external clinical groups
  - Medical knowledge is open, and should be shared !!

Stroke Prevention in Atrial Fibrillation

- **20% of strokes** caused by atrial fibrillation
- **European guideline on management of atrial fibrillation**, European Heart Journal (2010) 31, 2369–2429

Table 8 CHA_2DS_2VASc score and stroke rate

(a) Risk factors for stroke and thrombo-embolism in non-valvular AF	
'Major' risk factors	**'Clinically relevant non-major' risk factors**
Previous stroke, TIA, or systemic embolism Age ≥75 years	Heart failure or moderate to severe LV systolic dysfunction (e.g. LV EF ≤40%) Hypertension - Diabetes mellitus Female sex - Age 65–74 years Vascular disease[a]

(b) Risk factor-based approach expressed as a point based scoring system, with the acronym CHA_2DS_2-VASc (Note: maximum score is 9 since age may contribute 0, 1, or 2 points)	
Risk factor	**Score**
Congestive heart failure/LV dysfunction	1
Hypertension	1
Age ≥75	2
Diabetes mellitus	1
Stroke/TIA/thrombo-embolism	2
Vascular disease[a]	1
Age 65–74	1
Sex category (i.e. female sex)	1
Maximum score	**9**

Tromboembolirisk och behandlingsrekommendation vid förmaksflimmer enligt CHA_2DS_2VASc[1-2]

	Riskfaktor	Poäng
C	Hjärtsvikt (EF ≤40 %)	1
H	Hypertoni	1
A	Ålder ≥75 år	2
D	Diabetes	1
S	Tidigare stroke/emboli	2
V	Aterosklerotisk sjukdom	1
A	Ålder 65–74 år	1
S	Kvinnligt kön*	1

* kvinnor under 65 årsålder utan andra riskfaktorer har tveksam nytta av antitrombotisk behandling.

$CHAD_2DS_2$-VASc-poäng:	0 = ingen behandling (ev. ASA)
	1 = warfarin (ev. ASA)
	≥2 = warfarin

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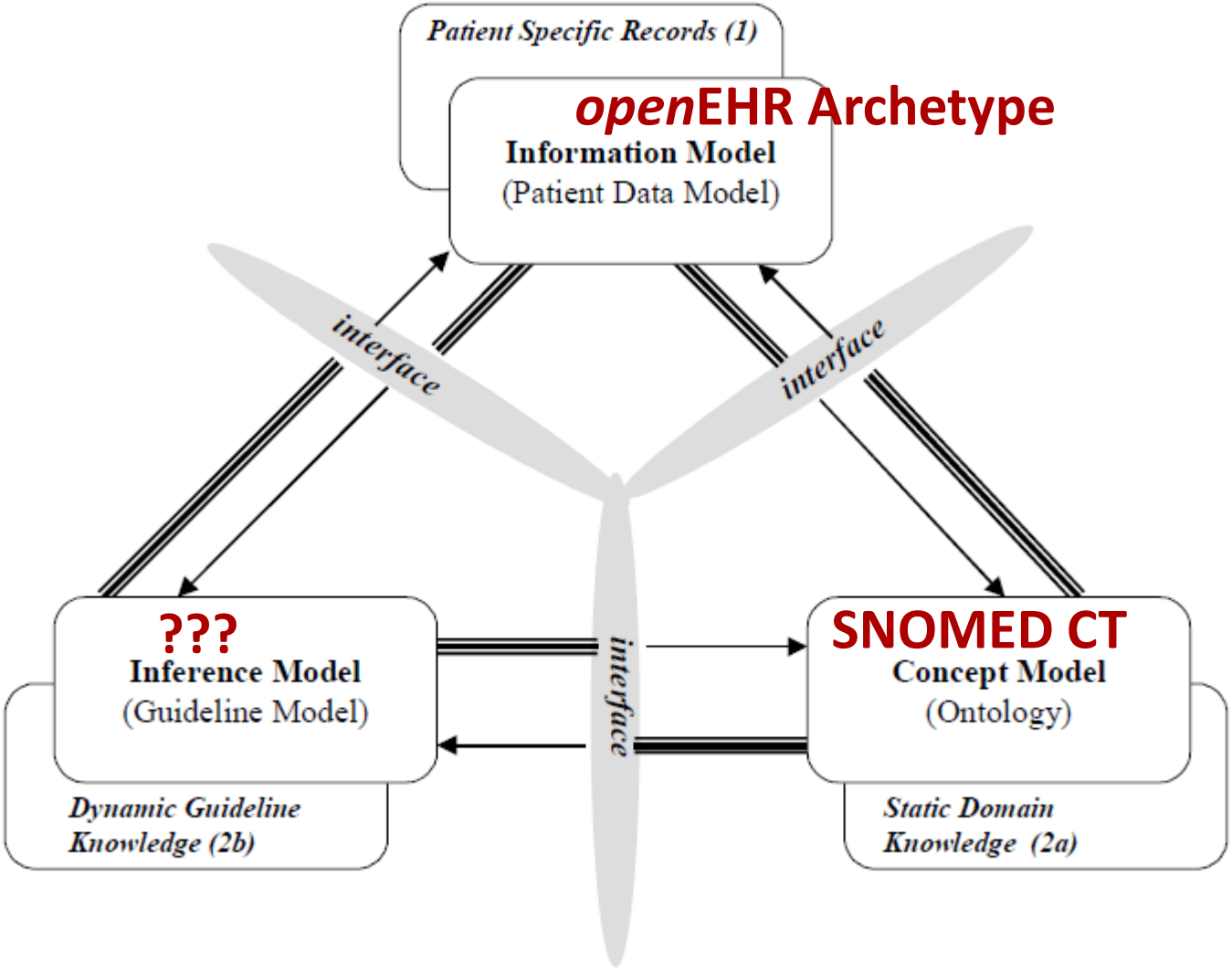
Scope & Aims

- **A formal language to express CDS rules**
- **Natural language independent**
  - Easy to add translations
- **Terminology independent**
  - Easy to add term bindings
- **EHR model independent**
  - Reuse of common EHR models both for input and output
- **Rules for single decision making**
  - Process handling not in scope
- **Coherent and reusable**
  - Encapsulated and possible to chain the rules
- **Technical platform independent**



A L Rector PD Johnson S Tu C Wroe and J Rogers (2001) Interface of inference models with concept and medical record models. in S Quaglini, P Barahona and S Andreassen (eds) *Proc Artificial Intelligence in Medicine Europe (AIME-2001)* Springer:314-323

Guide Definition Language (GDL) Design

A minimum language to glue together archetypes, terminologies and rules

Three Pillars

- Bindings between archetype elements and variables in the rules
- Rule expressions easily converted to industry rule engine languages
- Bindings between local concepts used in the rules and concepts from reference terminologies

1st Pillar: Bindings between archetype elements and rule variables

```
[2] = (ARCHETYPE_BINDING) <
    archetype_id = <"openEHR-EHR-OBSERVATION.body_weight.v1">
    domain = <"EHR">
    elements = <
        ["gt0005"] = (ELEMENT_BINDING) <
            path = <"/data[at0002]/events[at0003]/data[at0001]/items[at0004]">
        >
    >
    function = <"LAST">
>

["gt0012"] = (RULE) <
    when = <"$gt0002>=20.0 yr", "$gt0003==local::at0005|Male|">
    then = <"$gt0011.magnitude=(((1.23*(140-$gt0002.magnitude))*$gt0005.magnitude)
    priority = <2>
>

["gt0005"] = (TERM) <
    text = <"Weight">
    description = <"The weight of the individual.">
>
```

Each rule variable is unique identified by a gt code and mapped to a Archetype ID and a path to access an element

The same gt code is used to represent the variable in all rules in the same guide

Then the gt code is translated into terms in different natural languages (English, Swedish..)

2nd Pillar: Rule expressions easily converted to industry rule engine languages

```
["gt0012"] = (RULE) <
    when = <"$gt0002>=20.0 yr", "$gt0003==local::at0005|Male|">
    then = <"$gt0011.magnitude=(((1.23*(140-$gt0002.magnitude))*$gt0005.magnitude)
    priority = <2>
>
```

- **when** & **then** statements are commonly supported by rule languages
- **Expressions** used in these statements are based on common design (similar to assertions in openEHR Archetype Definition Language)

3rd Pillar: Bindings between local term used in the rules and concepts from reference terminologies

```
["gt0017"] = (RULE) <
    when = <"$gt0003|diagnosis| is_a local::gt0100|Heart failure|",...>
    then = <"$gt0012=1|local::at0028|Present|",...>
    priority = <10>
>

term_bindings = <
    ["SNOMEDCT"] = (TERM_BINDING) <
        bindings = <
            ["gt01000"] = (BINDING) <
                codes =<[SNOMEDCT::84114007],...>
            >
        >
    >
    ["ICD10"] = (TERM_BINDING) <
        bindings = <
            ["gt01000"] = (BINDING) <
                codes =<[ICD10::I50],...>
            >
        >
    >
    ["ICD9"] = (TERM_BINDING) <
        bindings = <
            ["ICD9"] = (BINDING) <
                codes =<[ICD9::428.0],...>
            >
        >
    >
>
```

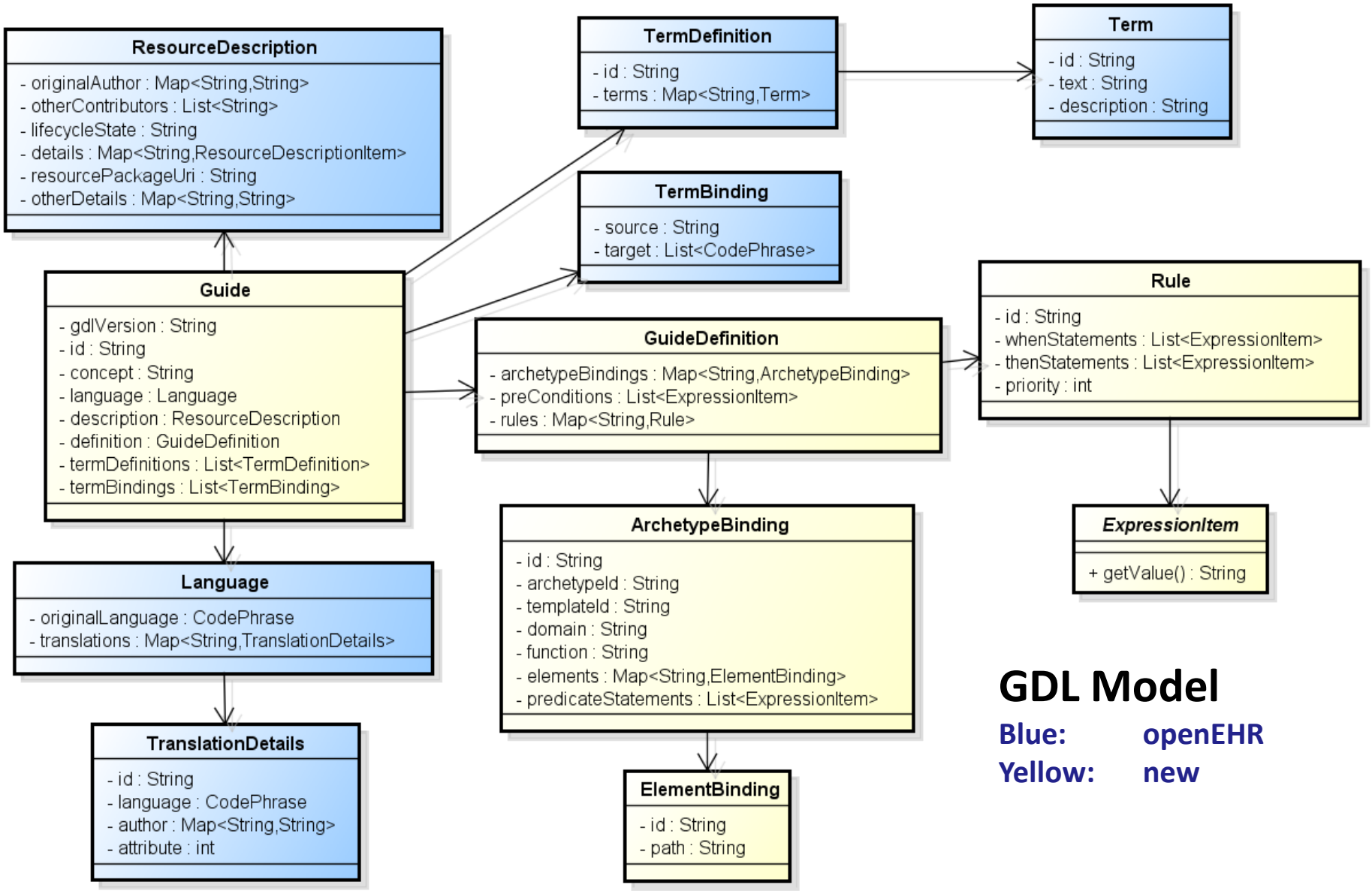
a local term is used as a proxy to externally defined concepts in reference terminologies

a local term can be bound to list of concepts or a refset in different target reference terminologies

Guide Definition Language (GDL) Design Cont.

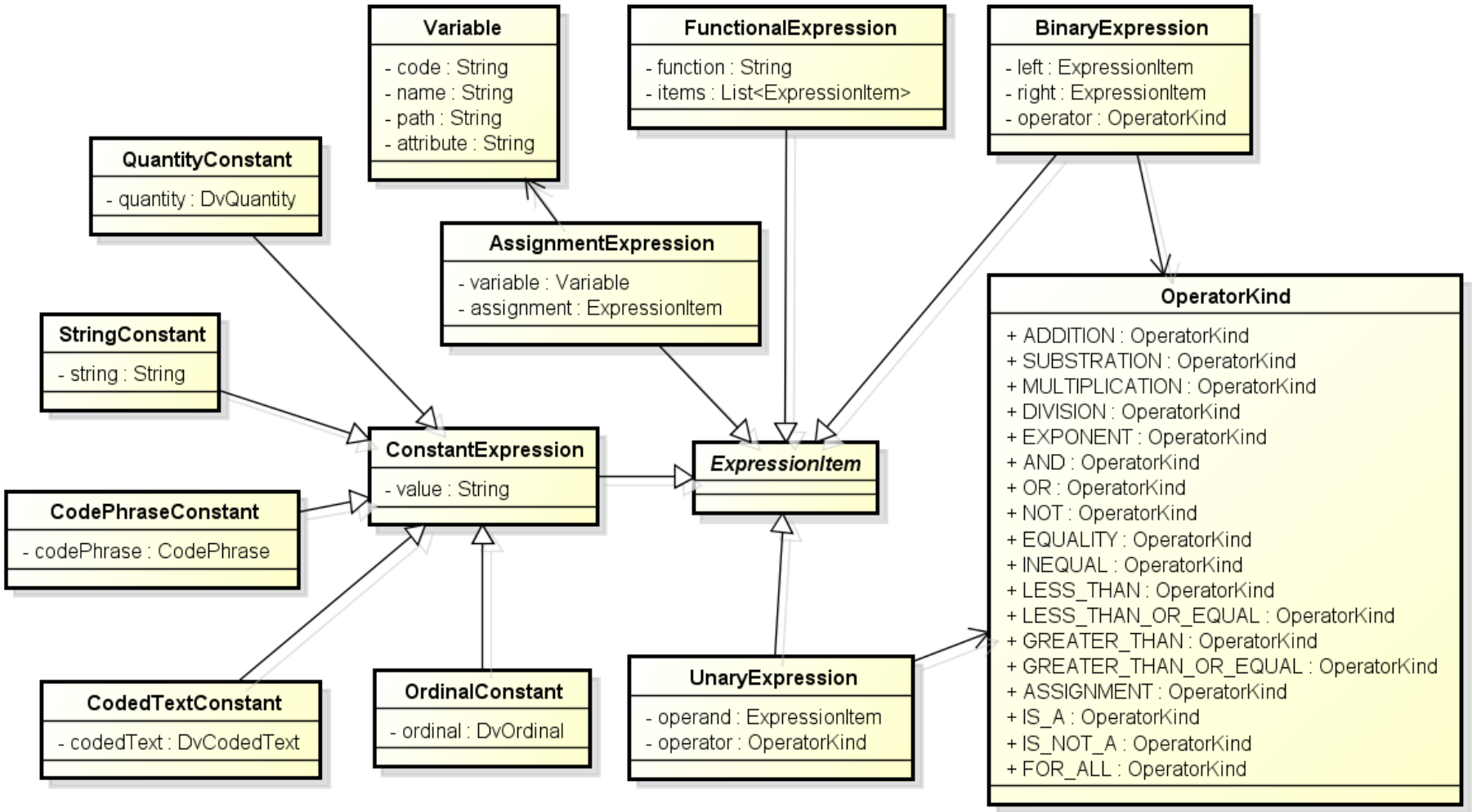
- **A formal language based on openEHR d-ADL**
  - Machine-readable format
- **The main object model consists of**
  - Header: Id, concept, language, description, translation
  - Archetype binding
  - Guide definition, pre-condition and list of rules
  - Each rule has when and then expressions
  - Term_definitions for language-dependent labels
  - Term_bindings for terminology bindings
- **Expressions model**

Extensive reuse of existing openEHR specifications



GDL Model

Blue: openEHR
Yellow: new



GDL - expressions

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CHA_2DS_2-VA

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(b) Risk factor-based approach expressed as a point based scoring system, with the acronym CHA_2DS_2-VASc
(Note: maximum score is 9 since age may contribute 0, 1, or 2 points)

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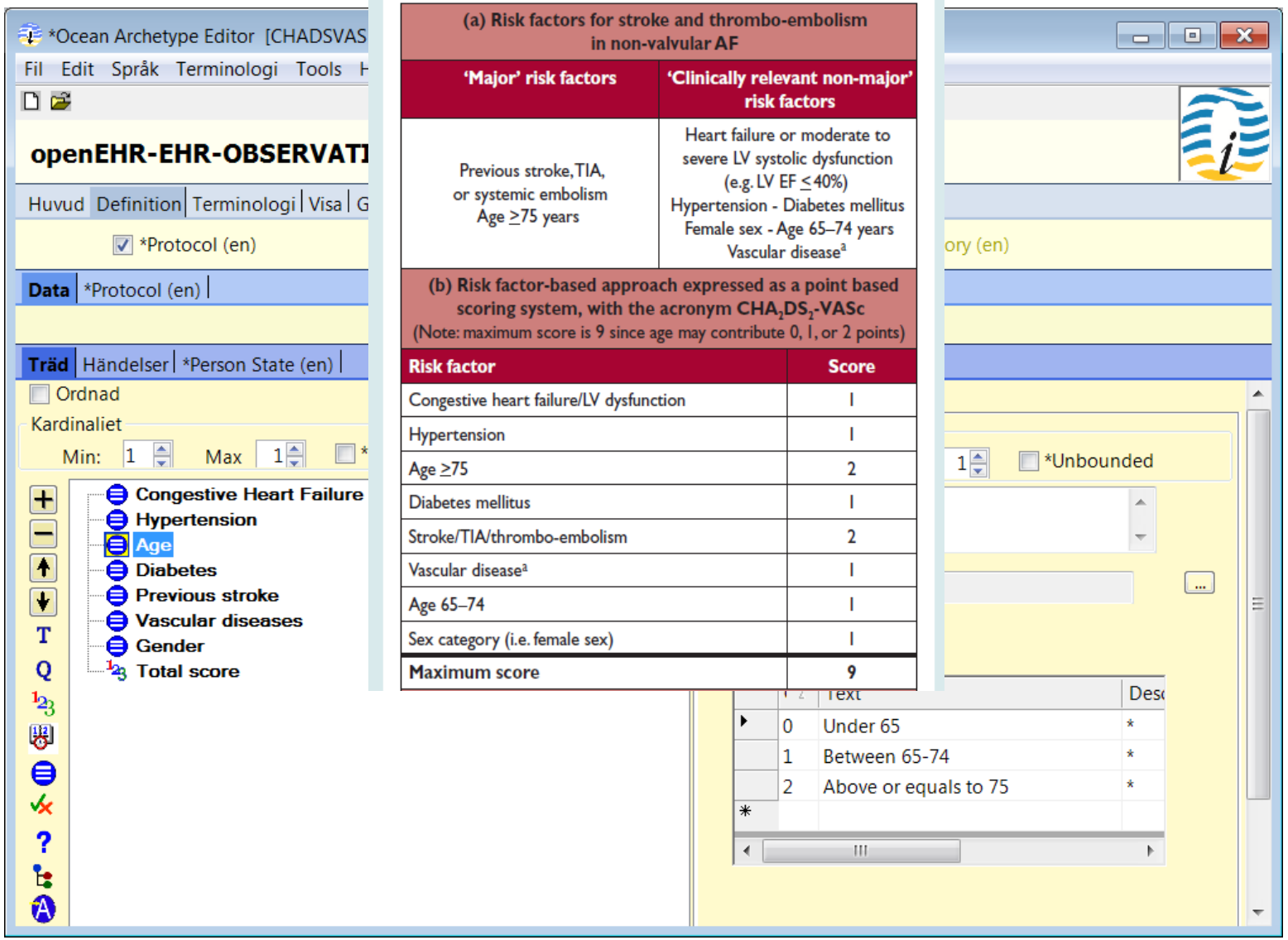
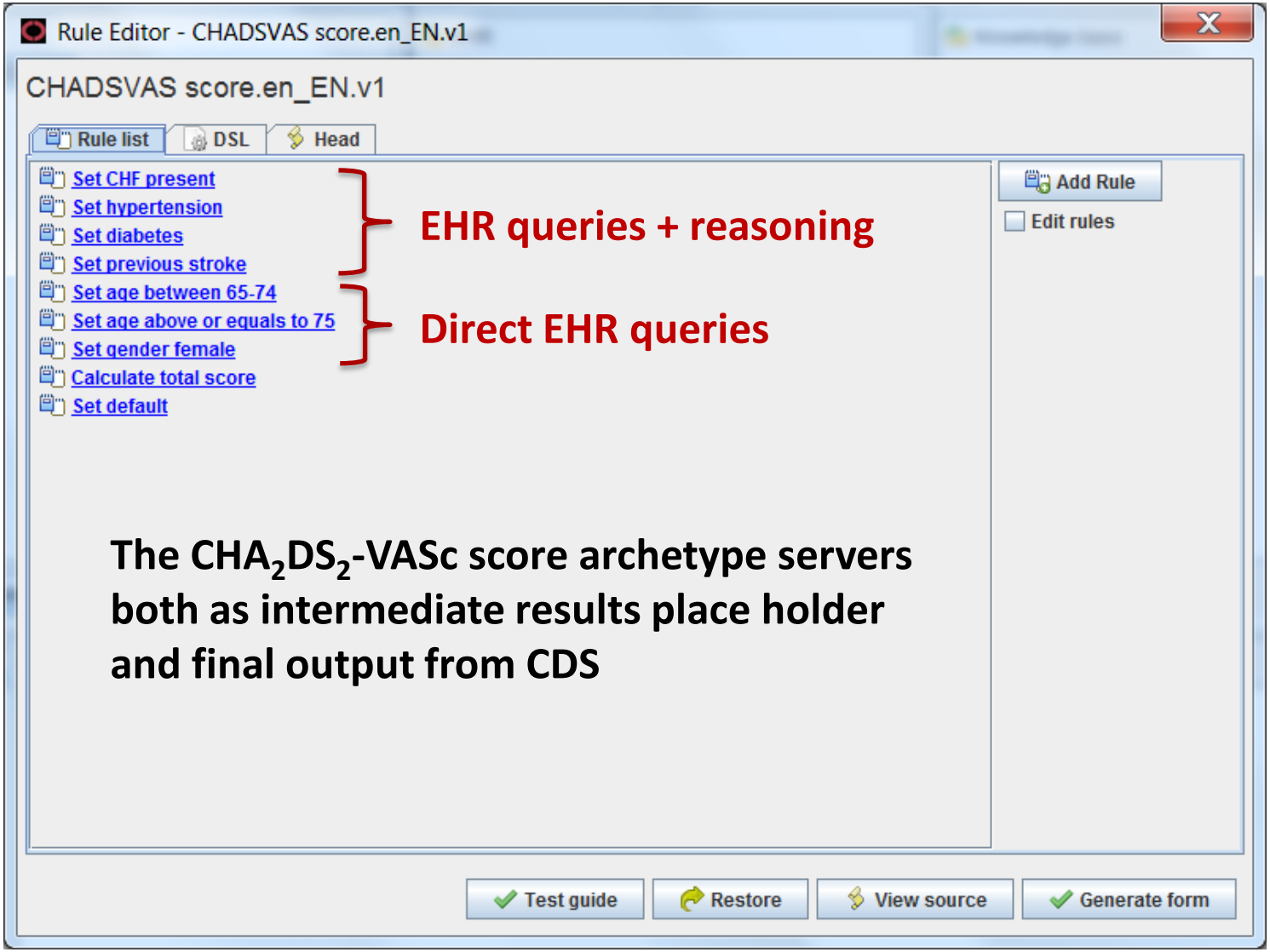
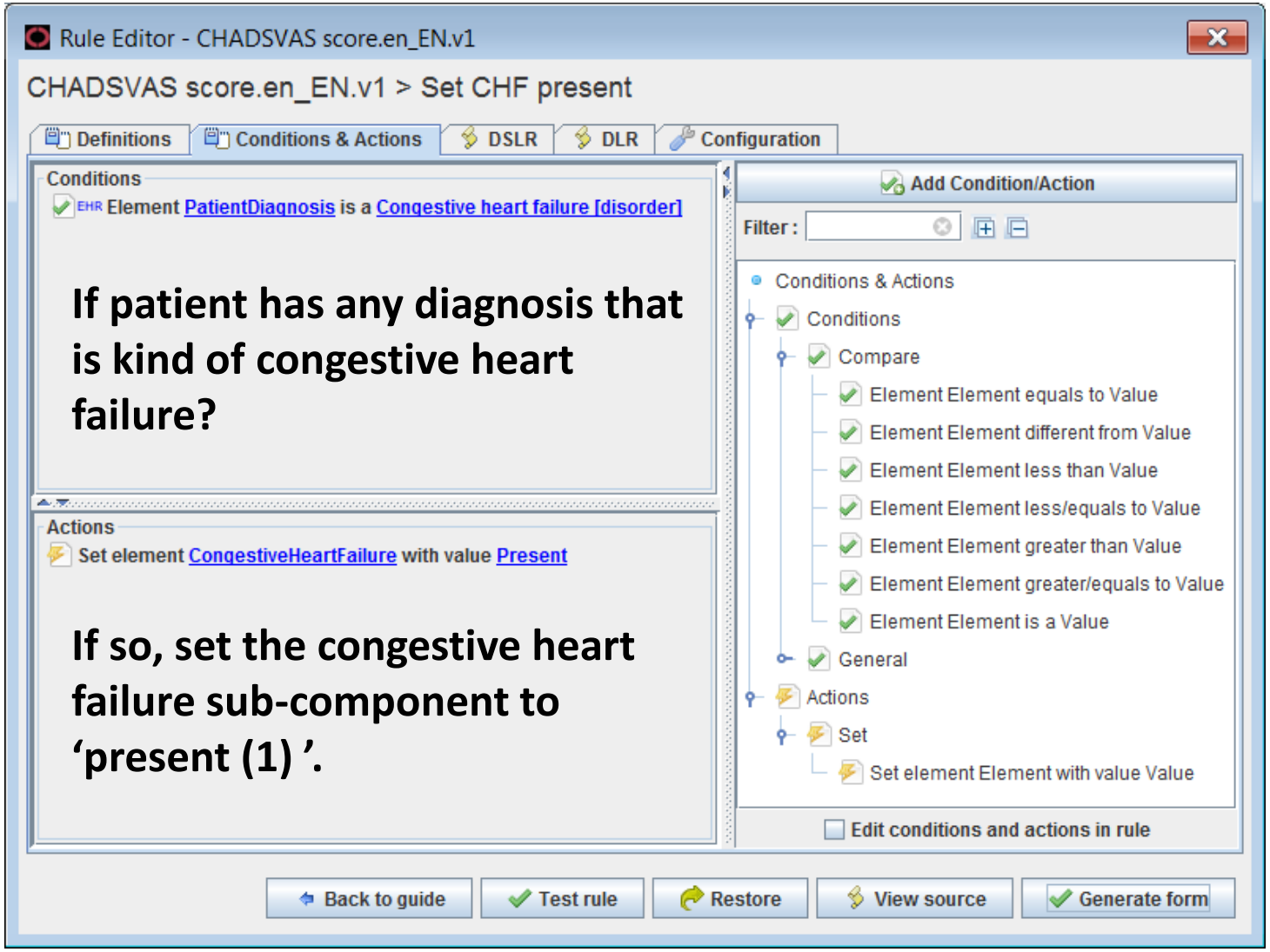


GDL Guide for calculating CHA_2DS_2-VASc score

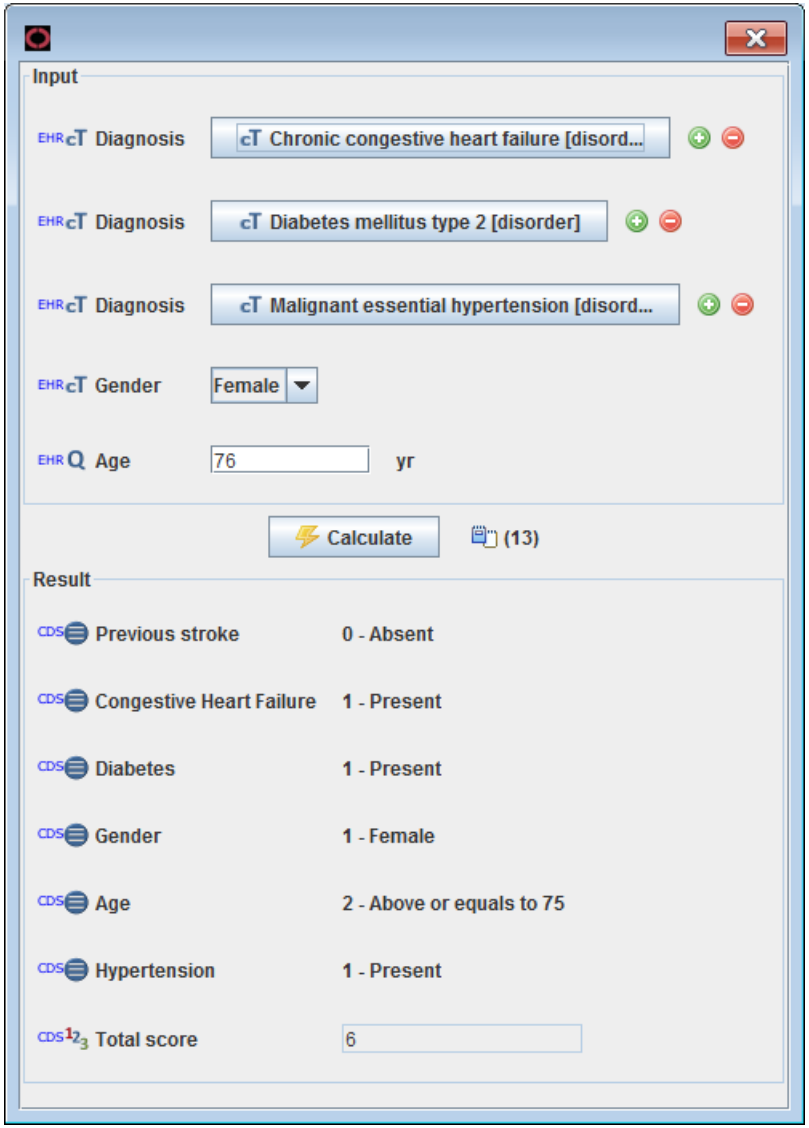


The CHA_2DS_2-VASc score archetype servers both as intermediate results place holder and final output from CDS

Rule for Checking Congestive Heart Failure



Simulation of CHA_2DS_2-VASc Guide



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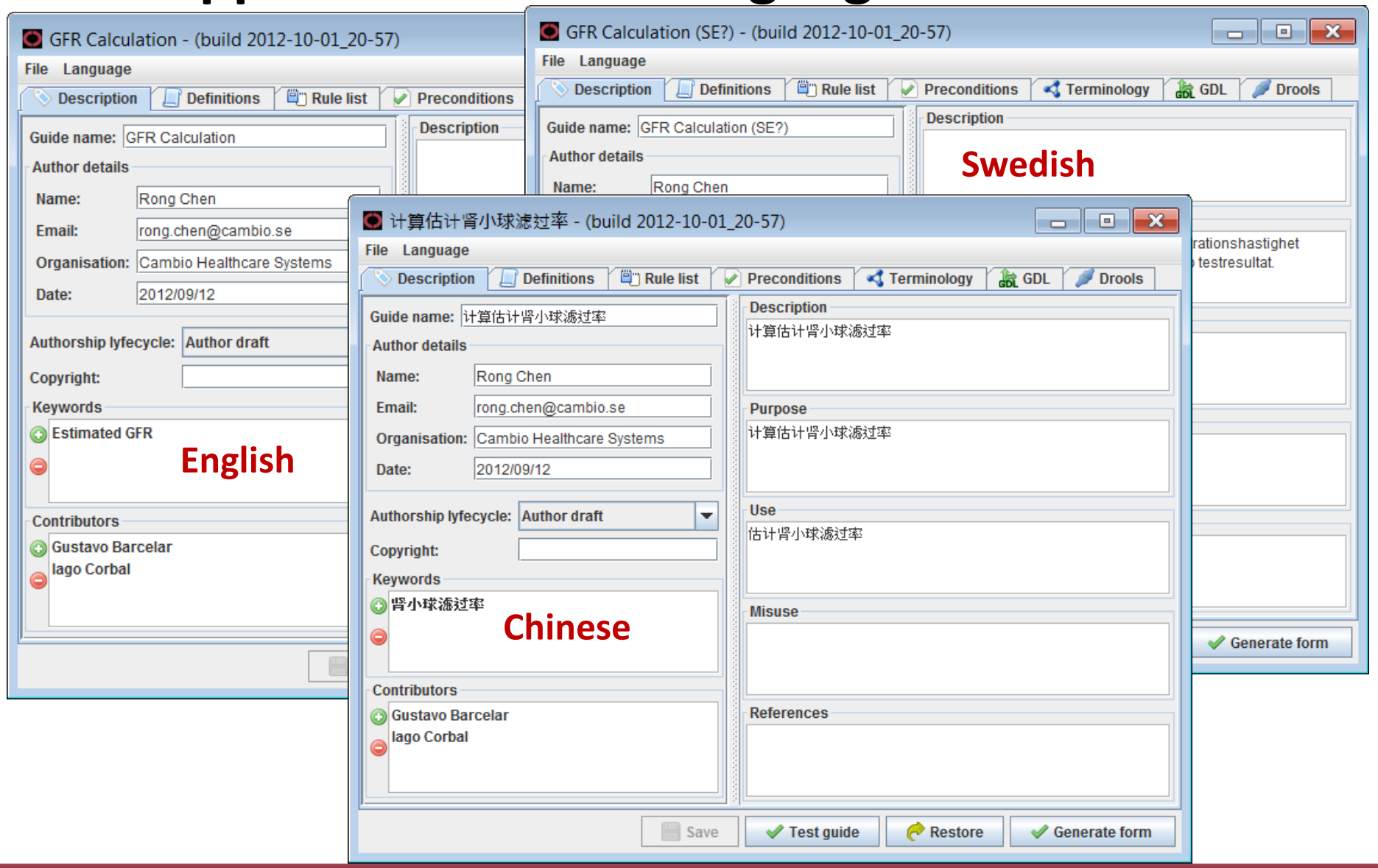
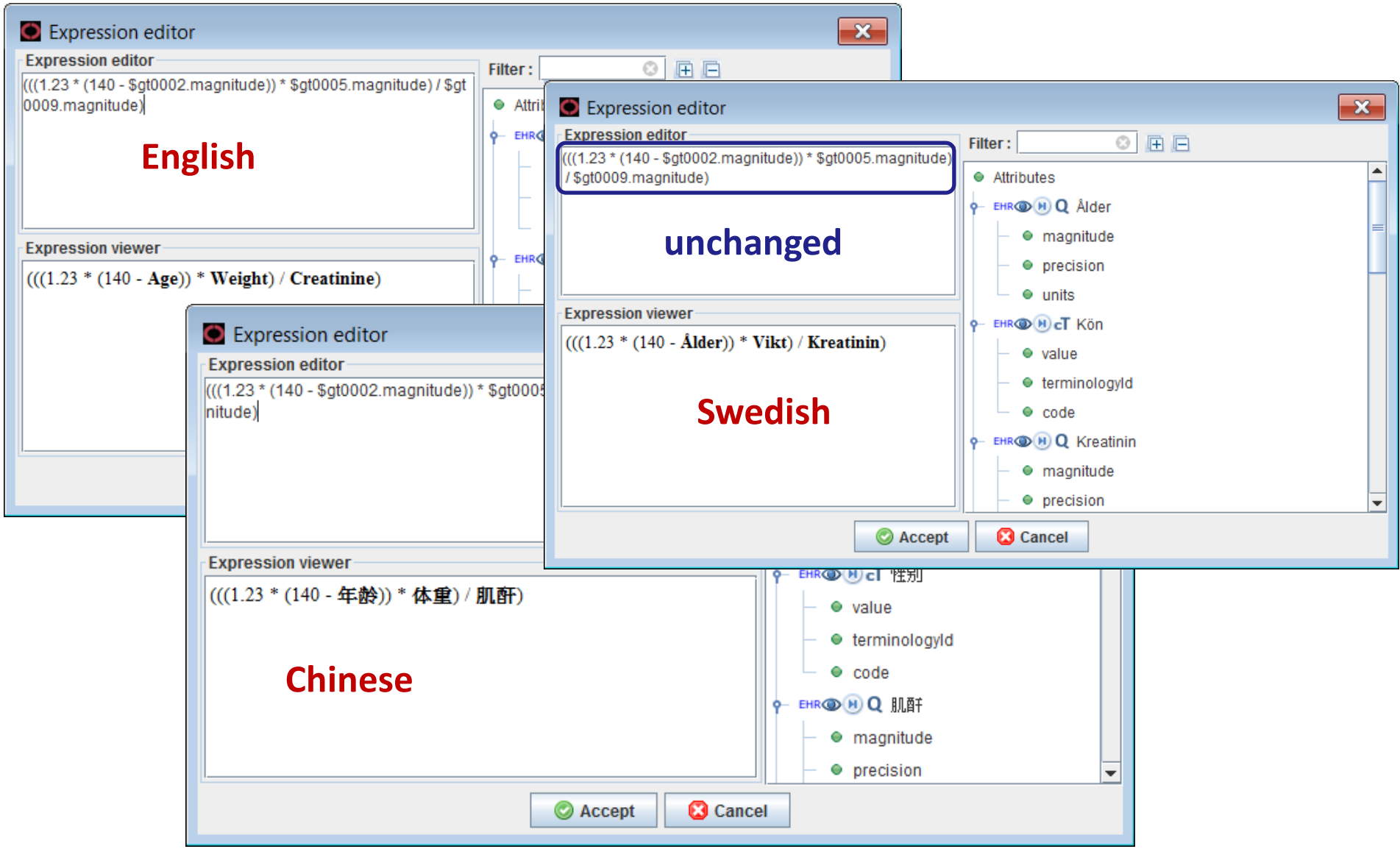
Support for Natural Languages - Header



Support for Natural Languages - Expressions



SCT Related Implementation

- **Use cases**
  - Subsumption relationship: IS_A
  - Semantic equivalence check: post-coordination expressions
- **OWL representation of SNOMED CT content**
  - Converted by Perl scripts included in the release
- **Protégé OWL editor v4.1**
  - OWL Module Extraction by DL Query Plugin
- **Runtime terminology service (experimental)**
  - SCT Concept ID => OWL identifier
  - OWL API v3.3, reasoner: Hermit 1.3.6

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Summary

- Guide Definition Language (GDL) is a way to **share** CDS rules using ***open*EHR archetypes** and reference terminologies, e.g. **SNOMED CT**
- GDL rules are natural language, terminology and technical platform independence
- **open specification, open source** reference implementation of tools will be available
- GDL design is still evolving, and will improve through more CDS rules modeling in different domains

Acknowledgements

Academic collaborators

- **Iago Corbal**, ATIS, A Coruña University Hospital, Spain
- **Nadim Anani**, HIC, Karolinska Institute, Sweden
- **Daniel Karlsson**, IMT, Linköping University, Sweden
- **Gustavo Barcelar**, Porto Univeristy Hosptial, Portugal

Questions, suggestions, comments? Please contact

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