Combining semantic and lexical methods for mapping MedDRA to VCM icons

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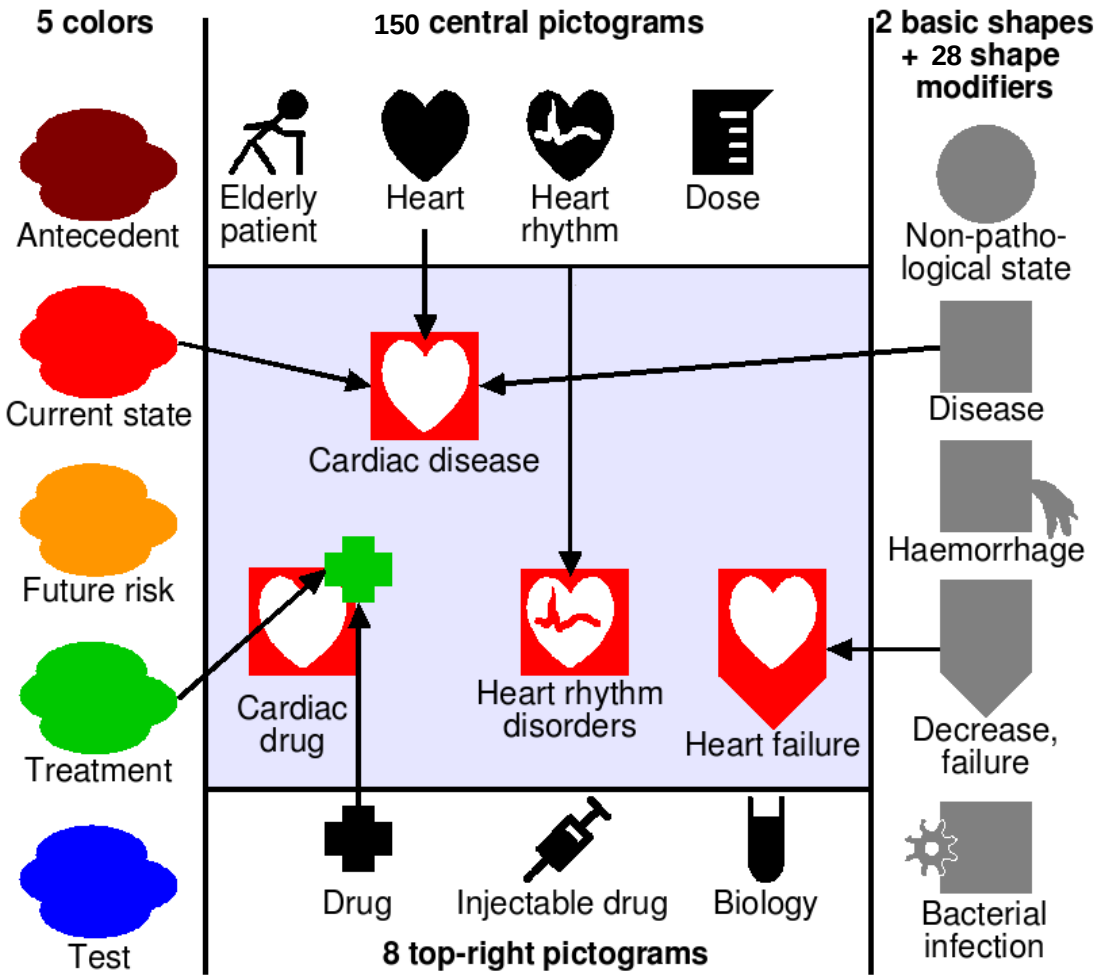
Introduction

- **Medical terminologies**
  - Essential for semantic interoperability
  - But difficult for Humans!
- **=> we developed since 10 years VCM, an iconic language for representing medical concepts**
  - Not as precise as terminologies, but can be used for enriching text or illustrating terms
- **Requires mapping between icons and terminologies**
  - Semantic methods for terminologies with a formal semantics (*e.g.* SNOMED CT [MEDINFO])
  - Other terminologies requires more complex methods
  - Here, we will focus on MedDRA :
    - Used for coding adverse effects
    - Multiaxial classification without formal semantics
  - => lexico-semantic method

VCM
(Visualization of Concept in Medicine)

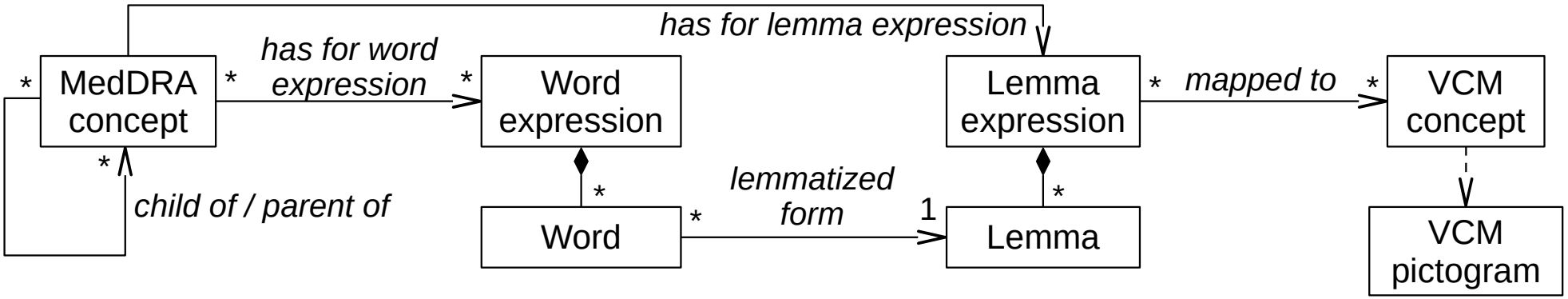
- **An iconic langage for medical concepts [BMC]**
  - Symptoms
  - Disorders
  - Treatments
  - Exams
  - Adverse effects
- **Combinatorial grammars**
  - 150 pictograms
  - 5 colors
  - 30 shapes
- **=> thousands of icons**

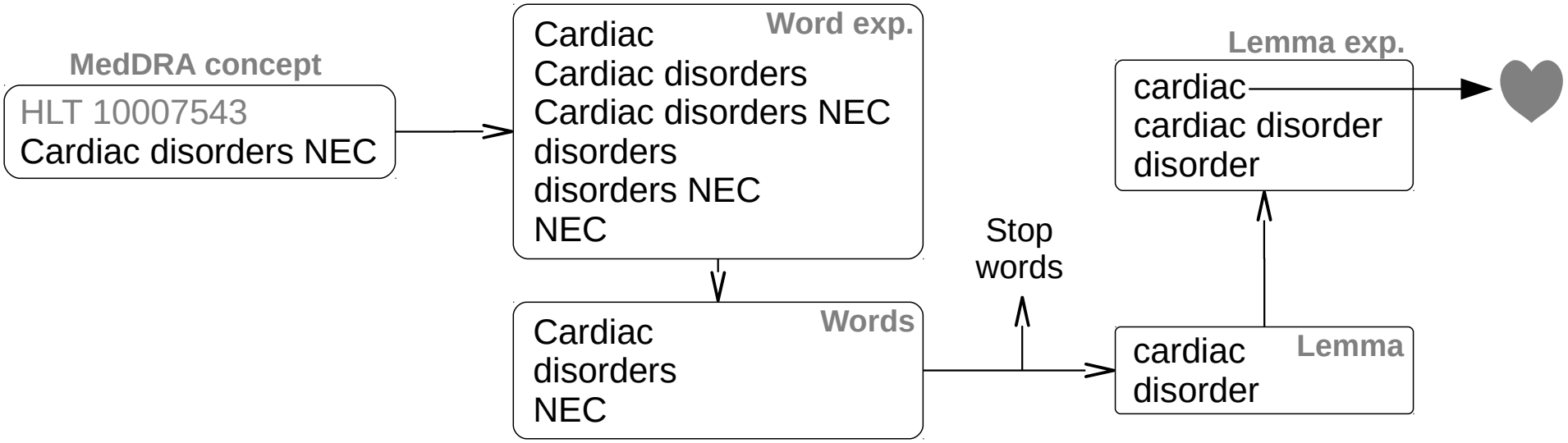


- **A formal semantics (based on an OWL 2.0 ontology) [KBS]**

Lexical methods

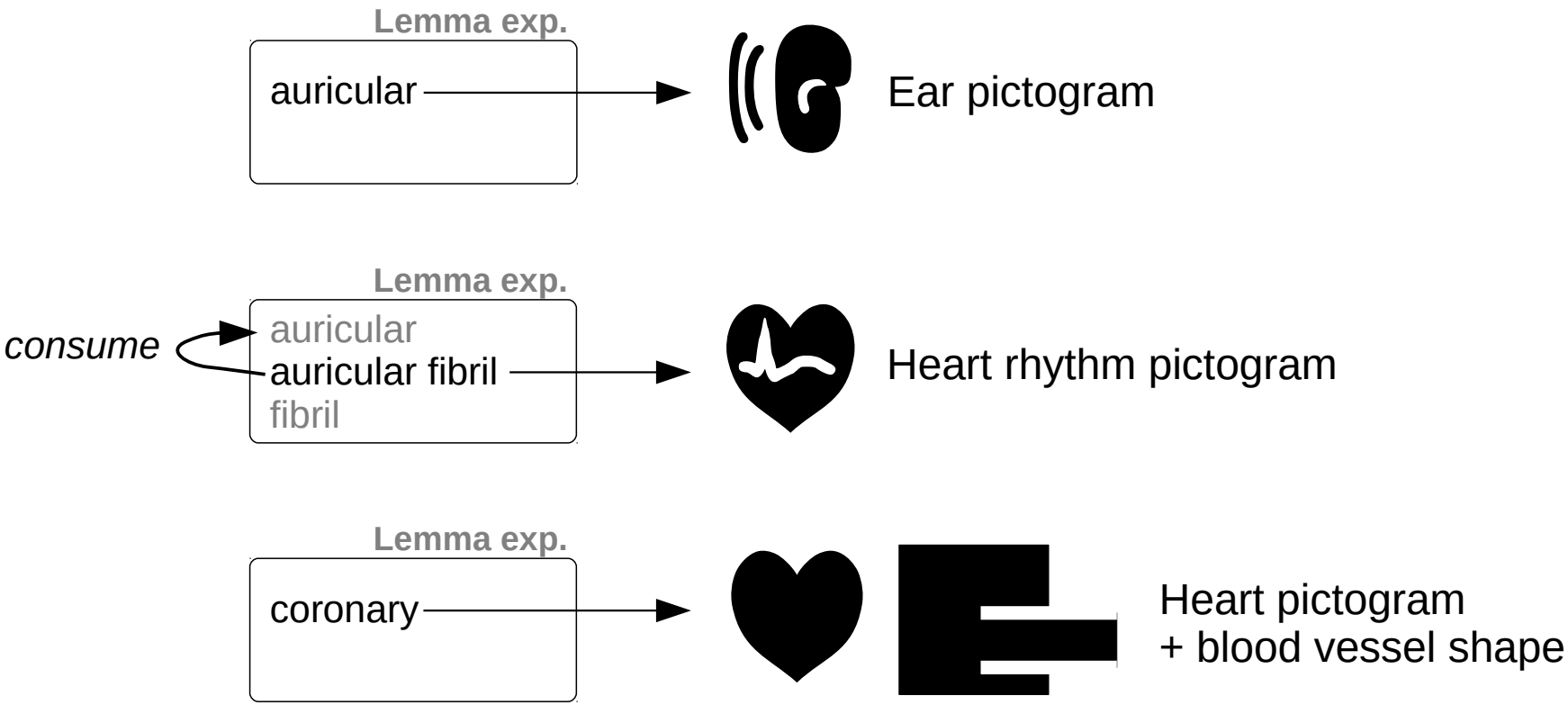
- **Design of an OWL ontology**
  - MedDRA terms with codes, labels, parent-child relations
  - Labels are decomposed in words and lemmas





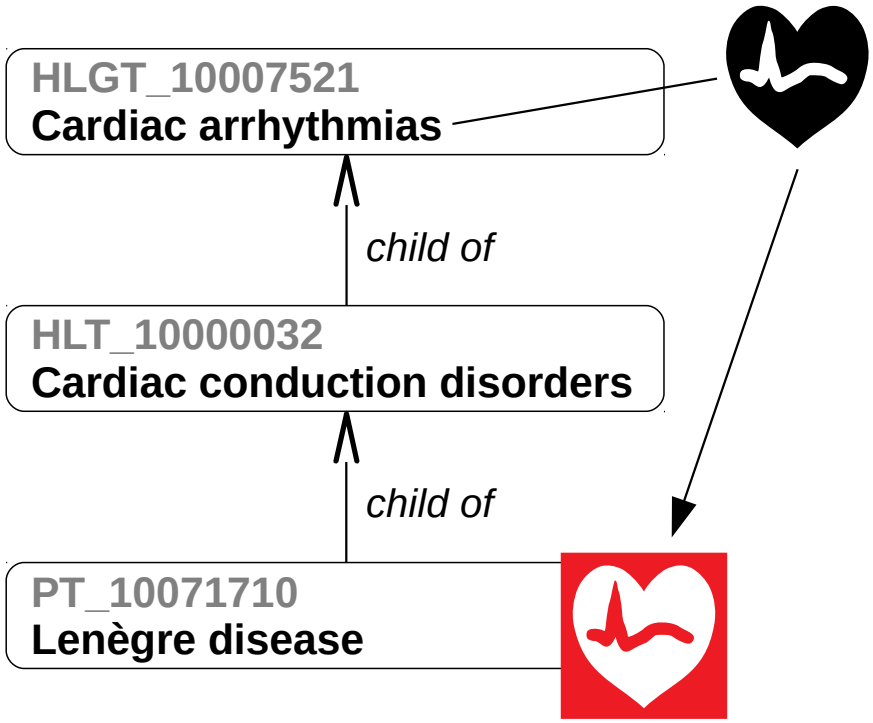
Lexical methods

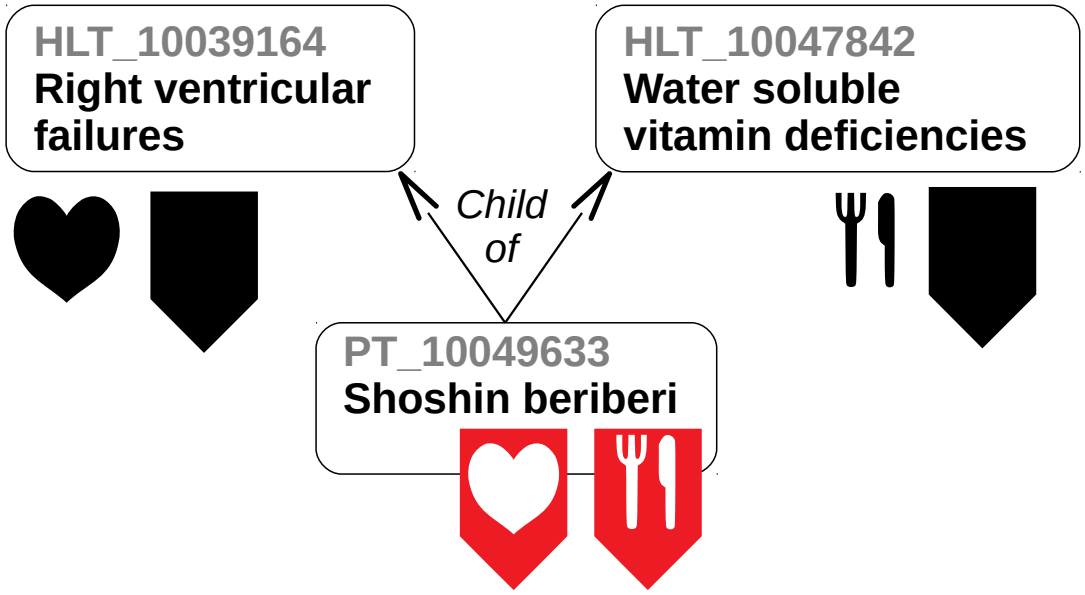
- **OWL ontology**
  - Association between lemma expressions and VCM concepts



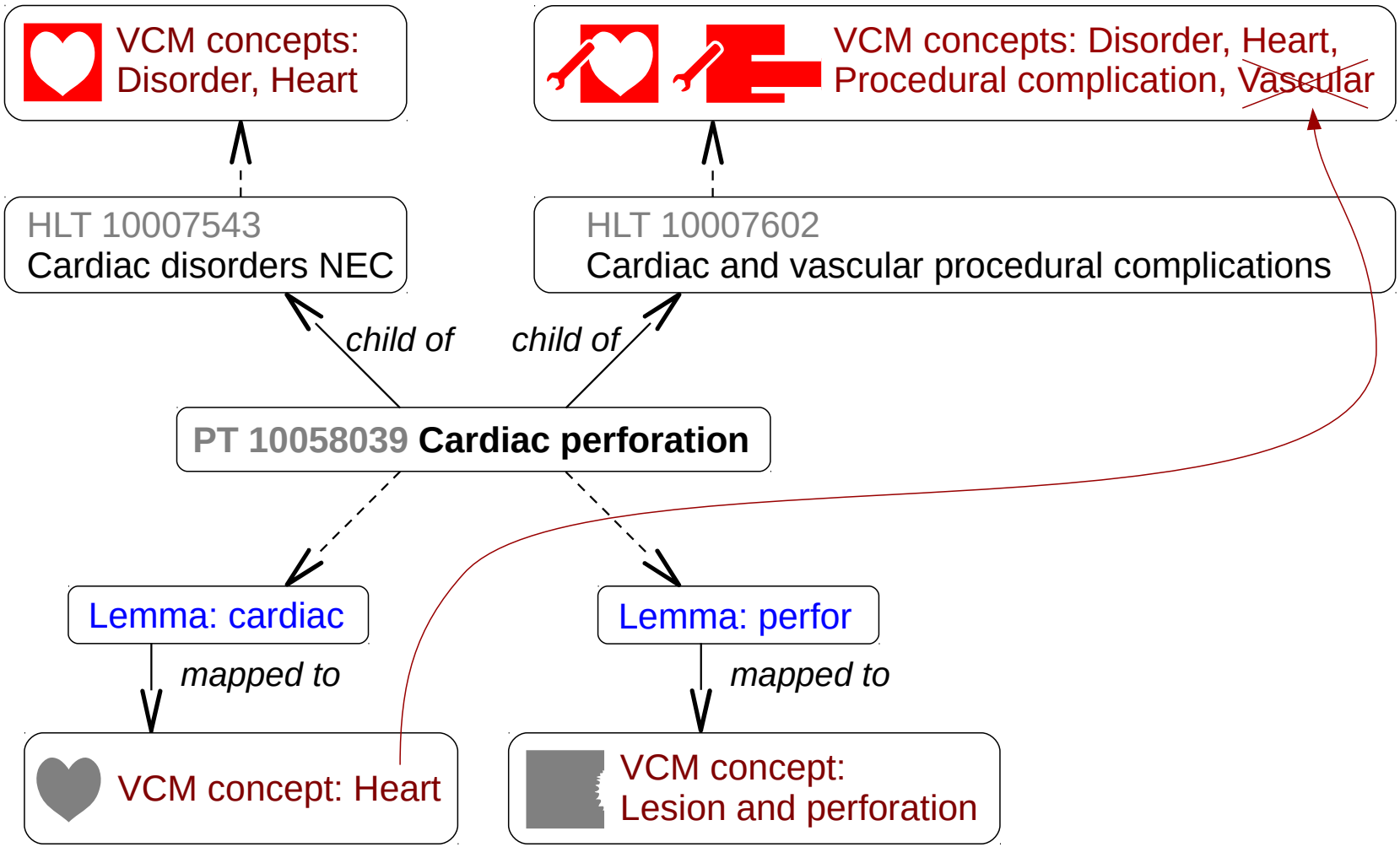
Semantic methods

- **Based on multiple inheritance through the MedDRA multiaxial classification**





Combining both methods

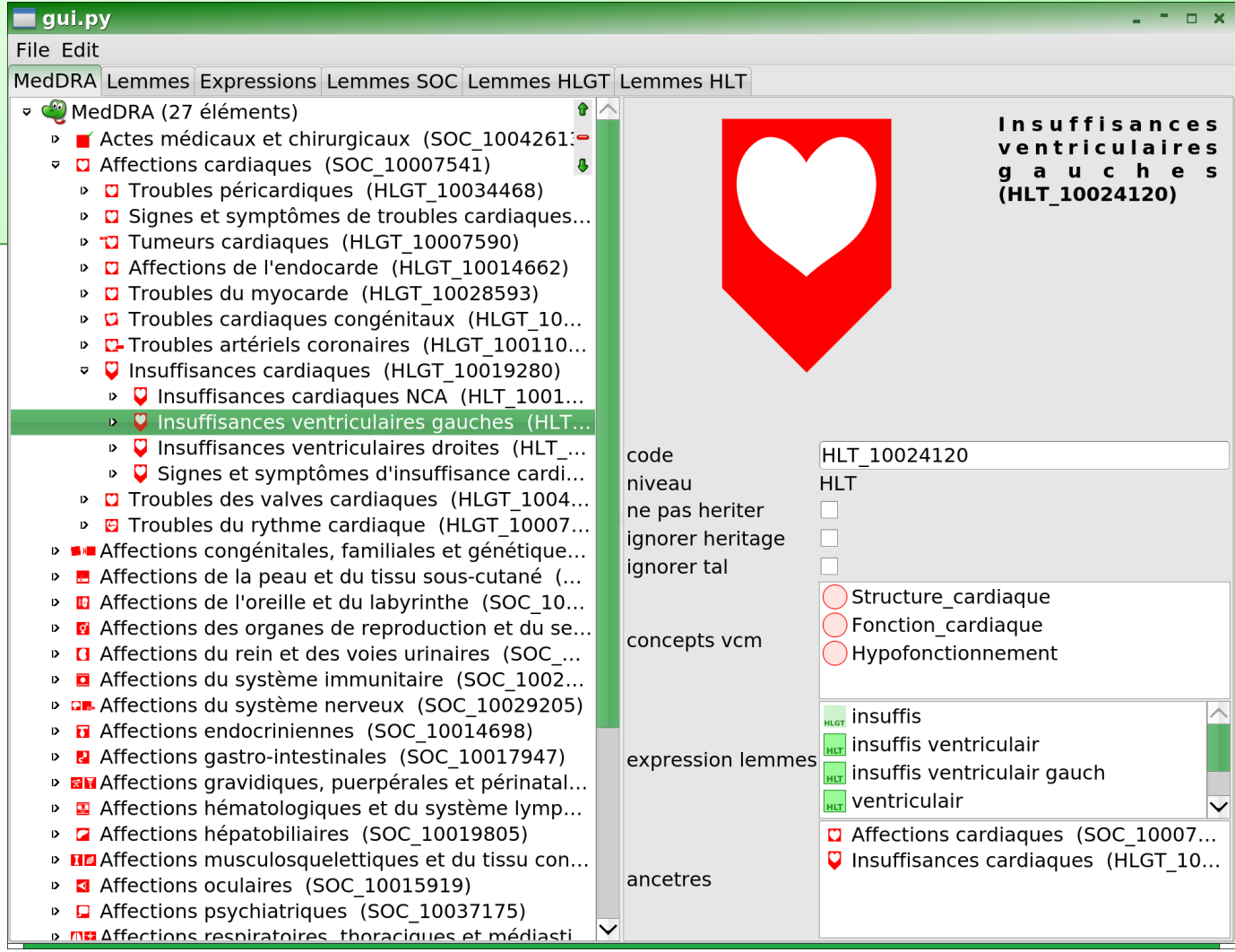


Combining both methods

PT 10058039 **Cardiac perforation**

VCM concepts: Disorder, Heart,
Procedural complication, Lesion and perforation

Results



- **User interface**
  - For mapping lemma expressions to VCM concepts
  - Python 3
  - Use OwlReady2 for accessing the OWL ontology [AIM]

OwlReady2

Ontology-oriented programming in Python [AIM]

```
from owlready2 import *

onto_termino    = get_ontology("http://test.org/meddra_vcm_tal.owl")
onto_alignement = get_ontology("http://test.org/meddra_vcm_alignement.owl")

with onto_termino:

  class ConceptTermino(Thing):
    def __repr__(self):
      c = MEDDRA[self.code]
      if c.meddra_type == "PT":
        return "%s  (%s %s)" % (c.term, c.code, c.primary_soc.term)
      return "%s  (%s)" % (c.term, c.code)

    def _get_concepts_vcm_her(self):
      vcms_her = set()
      for parent in self.parents:
        vcms_her.update(parent._get_concepts_vcm_a_heriter())
      return vcms_her

    def _get_concepts_vcm_tal(self):
      vcms_tal = set()
      expressions = [expression_mot.forme_lemmatise
                     for expression_mot in self.expression_mots
                     if  expression_mot.forme_lemmatise.aligne_avec_concepts_vcm or expression_mot.forme_

      expressions = expressions_prioritaires(expressions)
      for expression in expressions:
        vcms = expression.aligne_avec_concepts_vcm

        vcms_tal.update(vcms)
      return vcms_tal
```

Results

- **Application of the methods on the cardiac SOC of MedDRA**
  - 634 MedDRA terms (excluding LLT)
    - 212 lemma expressions
      - 123 with 1 lemma
      - 76 with 2 lemmas
      - 13 with more
    - **=> 212 lemma expressions mapped in lieu of 634 (longer) terms**
  - mapped to 114 different VCM icons
    - 541 to a single icon
    - 85 to 2 icons
    - 8 to 3 icons
- **Evaluation on 50 randomly-chosen terms**
  - A medical expert mapped the terms to VCM, blindly (*gold standard*)
    - For 40 terms, the expert chose exactly the same icons
    - For 6 terms, the generated icons were incomplete or more general
    - For 4 terms, the generated icons were discordant
      - E.g. mycoplasma infections classified as fungal infections

Discussion

- **Four main approaches for mapping medical terminologies :**
  - Manual mapping
    - Long, tedious, and often not reproducible
  - Chaining existent mapping:
    - MedDRA → SNOMED CT + SNOMED CT → VCM **=>** MedDRA → VCM
    - But cumules the errors and imprecisions of each mapping
  - Lexical approach
    - Difficult with icons
    - Bag of words *vs* expressions
  - Semantic approach
    - Ontology alignment methods
    - Requires terminologies having a formal semantics

Discussion

- **The proposed method is easier than a manual mapping**
  - Lemma expressions are shorter than terms, and less numerous
- **Perspectives**
  - Extending the methods with other approaches :
    - Learning method: try to learn new lexical mapping from the already asserted ones
    - Chaining method (using SNOMED CT as an intermediate terminology) : OntoADR
  - Application of the methods to the entire MedDRA terminology
  - Integration of VCM icons in pharmacovigilance software
  - Reuse of the lemma expressions - VCM concepts mapping
    - For mapping with other terminologies, *e.g.* ICD10
    - For producing icons from free text

References

[BMC] : Duclos C, Bar-Hen A, Ouvrard P, Venot A. An iconic language for the graphical representation of medical concepts. BMC Medical Informatics and Decision Making 2008;8:16

[MEDINFO] : Lamy JB, Tsopra R, Venot A, Duclos C. A Semi-automatic Semantic Method for Mapping SNOMED CT Concepts to VCM Icons. Stud Health Technol Inform 2013;192:42-6

[KBS] : Lamy JB, Soualmia LF. Formalization of the semantics of iconic languages: An ontology-based method and four semantic-powered applications. Knowledge-Based System 2017;135:159-179

[AIM] : Lamy JB. Owlready: Ontology-oriented programming in Python with automatic classification and high level constructs for biomedical ontologies. Artif Intell Med 2017;80:11-28