Summer Internship Report
INTEGRATING RxNorm WITH MEDICINAL PRODUCTS IN SNOMED CT

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1 Introduction

RxNorm is a standardized nomenclature for medicinal products. It was started in 2002 to address the lack of standardization of drug names in US. It is based on a model that was presented and analyzed in several journal articles. SNOMED CT is the largest clinical terminology in the world and recently published a new model for the representation of medicinal products integrating requirements from the IDMP (Identification of Medicinal Products) standards. While RxNorm is a standard in US, its model must also take into account other standards, such as SNOMED CT and IDMP.

The objective of this work is to assess the extent to which RxNorm is consistent with the new SNOMED CT model for medicinal products. To perform this assessment, we integrated RxNorm with the subset of SNOMED CT that describes medicinal products. Integrating RxNorm with SNOMED CT enabled us to assess the compatibility of the RxNorm model with the new SNOMED CT model for medicinal products and to assess the consistency of the descriptions of medicinal products between RxNorm and SNOMED CT.

2 Background

In this section, we present and contrast the models of RxNorm and SNOMED CT for medicinal products.

2.1 SNOMED CT model for medicinal products

The model of SNOMED CT is restricted to generic drugs and does not represent packs. This model is constructed to support international interoperability of medication concepts. Based on IDMP requirements, medicinal products are fully described in SNOMED CT and clinical drugs are described in closed worldview. The model contains six (6) entities (two ***medicinal product*** entities (in open and closed worldview), two ***medicinal product form*** *entities* (in open and closed worldview), one ***medicinal product precisely*** entity (in closed worldview (optional)) and one ***clinical drug*** entity in closed worldview). The description of these entities is based on definitional roles and related types of values in SNOMED CT. ***Substances*** are types of values for *active ingredient*, *active moiety* and *basis of strength*, ***units of measure*** are types of values for *strength units*, ***numbers*** are types of values for

strength values and ***pharmaceutical dose forms*** and ***units of presentation*** are types of values for *dose forms* and *unit of presentation,* respectively. Because SNOMED CT, based on $\mathcal{EL}$++, does not support universal restrictions (i.e., the description logic constructor "Only"), SNOMED CT cannot represent the usual closure axiom to express that a clinical drug is restricted to a given set of active ingredients. Instead, SNOMED CT adds some axioms of "count of ingredients" to express closed worldview.

2.2 RxNorm model for medicinal products

RxNorm provides a model for generic drugs, branded drugs and packs. For the purpose of this work, we restricted this model to the part describing generic drugs. This sub-model includes four entities (Ingredient (IN, PIN), semantic clinical drugs component (SCDC), semantic clinical drugs forms (SCDF) and semantic clinical drugs (SCD)). Their definition relies on three mandatory features (ingredient, dose form, strength) and two optional features (quantity factor, qualitative distinction).

2.3 Comparison of RxNorm and SNOMED CT models

As shown in Figure 1, RxNorm entities can be aligned with SNOMED CT entities. Ingredients in RxNorm correspond to SNOMED CT's medicinal products (in open and closed worldview). RxNorm ingredients also correspond to SNOMED CT substances, which are active ingredients in SNOMED CT medicinal products. Dose forms in RxNorm correspond to pairs of pharmaceutical dose forms and units of presentation in SNOMED CT.

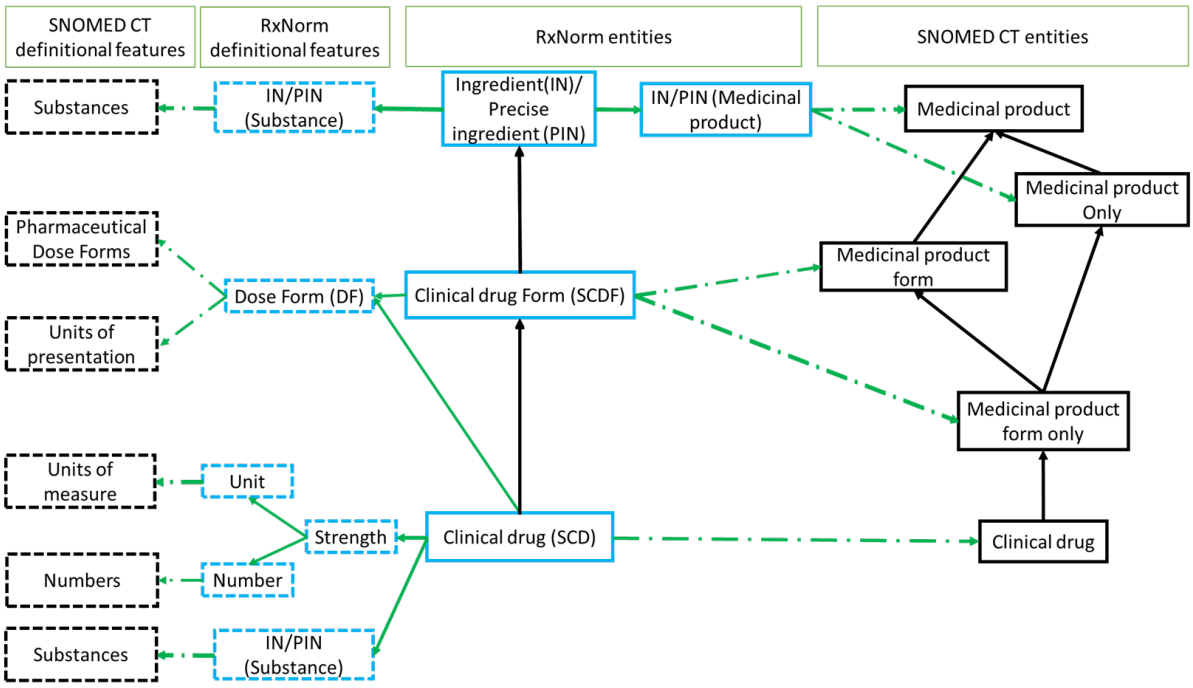

Figure 1: Comparison of RxNorm and SNOMED CT models

3 Materials

To integrate RxNorm with SNOMED CT medicinal products, we used SNOMED CT in OWL format (preview version as of 09/25/2018) and the current version of RxNorm (as of 09/04/2018). The mapping between RxNorm and the SNOMED CT was extracted from RxNorm (and reflects the US edition of SNOMED CT as of 03/2018).

4 Methods

We identified three steps to align medicinal products between RxNorm and SNOMED CT.

The first step is the **mapping of definitional features**. This step consists in mapping the definitional features used for the description of medicinal products in RxNorm and SNOMED CT (e.g., ingredients-substances, dose forms-dose forms/units of presentations). In this step, except for the mapping dose forms-units of presentations expressed by a specific mapping relation, the mapping between RxNorm and SNOMED CT concepts is materialized through equivalence axioms.

The second step is the **mapping of medicinal product entities**. This step consists in mapping the main entities for medicinal products in RxNorm and SNOMED CT (e.g., ingredient-medicinal product, semantic clinical dose form-medicinal product form, semantic clinical drug-clinical drug).

The third step is the **translation of medicinal products** described in RxNorm to SNOMED CT. For each type of medicinal product entity, we define a generic template (i.e., a generic logical definition in OWL), and then we instantiate these templates for all medicinal products in RxNorm. This step results in logical definitions (in OWL) for all entities in RxNorm, based on the SNOMED CT model for medicinal products. In this step we consider the mappings asserted between entities in RxNorm and SNOMED CT as the gold standard.

We evaluate the integration by comparing the inferred mappings obtained after classification (with the OWL classifier ELK) of the logical definitions for RxNorm and SNOMED CT medicinal products to the mappings asserted in RxNorm.

5 Results

5.1 Mapping of definitional features

This table describes the number of mappings between RxNorm and SNOMED CT for the definitional features of medicinal product entities.

Table 1 : Mappings for the definitional features

Mappings	RxNorm	Mapped	SNOMED CT
(IN/PIN)-Substances	**4,038**	**3,020**	**26,743**
Numbers-Numbers	**1,924**	**535**	**725**
Units-Units of measure	**18**	**10**	**1236**
Dose Forms-Pharmaceutical dose forms	**113**	**83**	**307**
Dose Forms- Units of presentation	**113**	***43**	**50**

*All mappings are 1-1, with the exception of the mappings between dose forms and units of presentation.

5.2 Mapping of medicinal product entities

We aligned RxNorm and SNOMED CT main entities for medicinal products:

- Medicinal product (from RxNorm Ingredient or Precise ingredient; in open worldview)
- Medicinal product “only” (from RxNorm Ingredient or Precise ingredient; in closed worldview)

- Medicinal product form (from RxNorm Semantic Clinical Dose Form; in open worldview)
- Medicinal product form "only" (from RxNorm Semantic Clinical Dose Form; in close worldview)
- Clinical drug (from RxNorm Semantic Clinical Drug; in closed worldview)

5.3 Translation of medicinal products

All RxNorm ingredients (including precise ingredients) and SCDFs were instantiated using the respective templates. 1877/18438 SCDs were not instantiated (because of unmapped units of presentation for some dose forms). Table 2 describes the mapping between RxNorm entities and SNOMED CT entities.

Table 2: Mappings between RxNorm and SNOMED CT entities

		SCD	IN/PIN		SCDF	
Corresponding classes in MP/MPF/CD model		CD	MP some	MP Only	MPF	MPF only
Cardinality	1-0	14,348	3,304	5,784	8,282	8,286
	1-1	3,915	2,462	0	4	0
	1-N	65	18	0	0	0
Total		18,438	5,784	5,784	8,286	8,286

Figure 2 gives an example of an instantiated semantic clinical drug based on the template defined for clinical drugs.

Figure 2:Instantiated semantic clinical drug according to its defined template

5.4 Evaluation

The evaluation was restricted to medicinal products in oral solid dose form, because other medicinal products had not been fully edited in SNOMED CT in the reference dataset used for this evaluation. Table 3 describes the comparison of inferred mappings (equivalence created after instantiation and classification) with those asserted by RxNorm. Interestingly, a small number of inferred mappings were not present in RxNorm. We will review these mappings with RxNorm experts to determine whether they represent false positive inferences or missing mappings in RxNorm. A significant number of mappings asserted in RxNorm failed to be inferred from our method. At first glance, these mappings correspond to limitations in our translation process (e.g., differences in units of measure between RxNorm and SNOMED CT) or data errors (difference in basis of strength or active ingredient between RxNorm and SNOMED CT).

Table 3: Comparison of mappings inferred after instantiation and classification with mappings asserted by RxNorm (limited to medicinal products in oral solid dose form)

		Asserted mappings through RxNorm		**Total**
		Present	Absent	
Inferred mappings	Present	1,892	85	1,977
	Absent	939	288	1,227
Total		2,831	373	3,204

6 Conclusion

Our project consisted in integrating RxNorm with SNOMED CT using the new SNOMED CT model for medicinal products. If the first results highlight the compliance of RxNorm with the SNOMED CT model, they also reveal some inconsistencies between RxNorm and SNOMED CT (e.g., differences in basis of strength substance or active ingredient). The translation process must be improved. For example, the mapping of dose forms and units of presentation needs to be validated by experts. Some alternative logical definitions with different units of measure could also be generated to eliminate some inconsistencies between RxNorm and SNOMED CT. Finally, this project also offers an opportunity for quality assurance in both RxNorm and SNOMED CT, especially in case of discrepancies in basis of strength substance or active ingredient.

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