TerminoDiff – Detecting Semantic Differences in HL7 FHIR CodeSystems

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Motivation

- Interoperability in healthcare informatics is on the rise
- Structural standards like HL7 FHIR, openEHR
- Use of standard terminology like SNOMED CT, ICD-x, LOINC, etc.
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• Use of standard terminology like SNOMED CT, ICD-x, LOINC, etc.
  – Maintained independent of other specification
  – Robust tooling for updating
  – Human- and Machine-readable change logs
  – Distribution in proprietary formats, not via HL7 FHIR CodeSystem resources
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Interpreting the Delta

• Very different levels of quality for difference lists and maintenance in terminologies
  – ICD-10-GM has highly-informative PDF reports, but only simple CSV delta files
  – SNOMED CT maintains historical associations forever and can generate Delta packages between releases

• What about non-standard terminological resources?
  – Specifically, FHIR Terminology resources
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HL7 FHIR Terminology

- **ConceptMap**: Mappings between code system concepts
- **ValueSet**: Selection of codes for use in particular context
- **Element Definition**: Data element, binding characteristics
- **CodeSystem**: Set of concepts with coherent meaning
- **Element (instance)**: Coded Data Type
- **Naming System**: Identifiers of a code or identifier system

HL7 FHIR Terminology

- **ConceptMap**: Mappings between code system concepts
- **ValueSet**: Selection of codes for use in particular context
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- **Element**: Definition, Data element, binding characteristics
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Related Work

- Scoping review
  - ("fhir" OR "ontology" OR "rdf" OR "terminology") AND ("diff" OR "change" OR "difference" OR "version")

- Few records found in general

- No related work for FHIR TS
  - Few publications regarding FHIR TS in general, currently

- Similar problems in domain of formal ontologies / semantic web
OncoTree

- Cancer classification System, maintained by MSKCC, NY, USA
- 2021-11-02: 884 tumor types, 32 tissues
- Not natively FHIR, but conversion easy
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Difference Graphs

Colour key: insertions are blue solid, deletions are orange dotted. Black dotted edges are resolved to parent properties.
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TerminoDiff

- GPLv3
- Kotlin + Jetpack Compose for cross-platform
- Support for local and remote CodeSystems
- Metadata and concept differences shown

https://itcr-uni-luebeck.github.com/TerminoDiff
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### Concept Diff

<table>
<thead>
<tr>
<th>Code</th>
<th>Graph</th>
<th>Display</th>
<th>Definition</th>
<th>Properties / Designations</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANEC</td>
<td>✗</td>
<td>Pancreatic Neuroendocrine</td>
<td>null</td>
<td>3 P / 0 D</td>
<td>Only right</td>
</tr>
<tr>
<td>CHOL</td>
<td>✗</td>
<td>CHOL carcinoma</td>
<td>Identical</td>
<td>null</td>
<td>Different</td>
</tr>
<tr>
<td>EHCH</td>
<td>✗</td>
<td>Extrahepatic CHOL carcinoma</td>
<td>Identical</td>
<td>null</td>
<td>Different</td>
</tr>
<tr>
<td>GBAD</td>
<td>✗</td>
<td>Gallbladder adenocarcinoma, NOS</td>
<td>Identical</td>
<td>null</td>
<td>Different</td>
</tr>
<tr>
<td>GBASC</td>
<td>✗</td>
<td>Adenocarcinoma of the Gallbladder</td>
<td>Identical</td>
<td>null</td>
<td>Different</td>
</tr>
<tr>
<td>GBC</td>
<td>✗</td>
<td>Gallbladder Cancer</td>
<td>Identical</td>
<td>null</td>
<td>Different</td>
</tr>
</tbody>
</table>

### Metadata Diff

<table>
<thead>
<tr>
<th>Property</th>
<th>Comparison</th>
<th>Left value</th>
<th>Right value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Different</td>
<td>Thu Oct 01 00:00:00 CEST 2020</td>
<td>Tue Nov 02 00:00:00 CET 2021</td>
</tr>
</tbody>
</table>
Graph View
Graph View
Graph View
Graph View

- Localized graph view
  - Zoom out for changes in context
  - Changes connected to shown concepts are followed transitively

- Global difference graph view
Discussion & Outlook

• Still interesting opportunities for further development
  – Support for HL7 FHIR ValueSets and ConceptMaps
  – SNOMED CT, LOINC support
  – Algorithmic release note generation

• Comparison to approaches from Semantic Web / Ontology research

• Tooling support for FHIR terminology subject of ongoing development
Contact

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- @jpwiedekopf
- www.linkedin.com/in/jpwiedekopf
Levels of Difference

<table>
<thead>
<tr>
<th>Level</th>
<th>Aspect</th>
<th>Example</th>
<th>Resolution strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Metadata-level</td>
<td></td>
<td>Presentation as a table in the GUI</td>
</tr>
<tr>
<td>1.1</td>
<td>Simple differences</td>
<td>title, name, version</td>
<td>String comparisons</td>
</tr>
<tr>
<td>1.2</td>
<td>Differences within lists</td>
<td>identifier, language</td>
<td>(keyed) difference lists, e.g., by language.code</td>
</tr>
<tr>
<td>2</td>
<td>Concept-level</td>
<td></td>
<td>Presentation as a table in the GUI</td>
</tr>
<tr>
<td>2.1</td>
<td>Simple differences</td>
<td>display, definition</td>
<td>String comparisons</td>
</tr>
<tr>
<td>2.2</td>
<td>Differences within lists</td>
<td>property, designation</td>
<td>(keyed) difference lists, e.g., by property.code</td>
</tr>
<tr>
<td>2.3</td>
<td>Unilaterality of concepts</td>
<td>Deletions and additions of codes /</td>
<td>Surfacing in the table with dedicated filter and highlighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>concepts across versions</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Edge differences</td>
<td>Changes to properties linking concepts,</td>
<td>Creation and visualization of a difference graph</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i.e., parent</td>
<td></td>
</tr>
</tbody>
</table>
ConceptMap creation support

- Algorithmic FHIR ConceptMap support
  - User must verify mappings
  - Only verified mappings included in output
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