The Typological Database System
How to integrate databases without starting a typology war

Alexis Dimitriadis and Menzo Windhouwer

http://languagelink.let.uu.nl/tds/
Overview

- The Typological Database System (TDS) provides integrated access to multiple, independently created typological databases.

- Users can query the aggregated databases through the system’s web server:

  http://languagelink.let.uu.nl/tds/

- The TDS is an NWO-supported LOT project, with participants from UvA, UiL-OTS, Leiden University and Nijmegen University.
Who?

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Who?

- **Developers**
  - Tamas Biro (UvA), database integration
  - Alexis Dimitriadis (UU), project manager
  - Rob Goedemans (UL), database integration and phonology systems
  - Kees Hengeveld (UvA), database integration
  - Adam Saulwick (UvA), knowledge representation, ontology developer and typologist
  - Menzo Windhouwer (UvA), software system designer and developer

- **Steering Committee**
  - Martin Everaert (UU), Kees Hengeveld, chair (UvA), Roeland van Hout (RU), Pieter Muysken (RU), John Nerbonne (RUG), Peter Wittenburg (MPI)

- **Student assistants and interns**
  - Eugenie Stapert (UvA), Franca Wesseling (UvA), Ruth Lind (UU), Dirk van der Meulen (UvA)
Presentation outline

- Overview of the TDS
- Managing differences between databases
- The component databases
- The TDS server (demonstration/tutorial)
- *The TDS under the hood*
- *Guidelines for component databases*
Next:

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Superficial differences

- Different notational conventions
  - *e.g.* glossing labels, field and variable names, description language

- Different design choices
  - There are many ways to organize information into tables and attributes

- Different software platforms

- Different types of content
  - “Analytical” variables which characterize a language as a whole
  - Annotated sentences with glosses, translations, and descriptive parameters
  - Multiple constructions per language
Contentful differences

- Different theoretical commitments influence:
  - Selection of what is recorded as “data”, and decisions on what factors to control for
  - Criteria and categories to be described
  - Associated terminology

- These differences are deliberate choices; If researchers don’t agree on a single analysis, they cannot be resolved.
The TDS approach

- Resolve superficial differences.
- Respect and highlight the theoretical commitments of each database, taking care to preserve the integrity and validity of the data.
How databases are integrated

- A dump of the database is made available to the TDS.
- TDS developers define an import schema, which situates the contents of the database in the global hierarchy of the TDS.
- The data undergoes some transformations for uniformity; e.g., 1/0 and true/false become yes/no.
- Theoretically salient differences are preserved and documented (not removed!).
- The creators of the database are asked to clarify definitions and check the results.
How databases are integrated (II)

- The import schema is encoded as a combination of
  (a) modular, database-specific documentation and
  (b) pointers into a global ontology of linguistic concepts
- The information aids the system in data navigation and presentation, and the users in its interpretation
- Updated versions of the databases can be easily re-imported, using the existing schema
TDS system architecture

TDS Workbench

- Importing
- Transforming
- Merging
- Enriching
- Querying
- Reasoning

1060 & BB

1. Offline:
   - Importing
   - Transforming
   - Merging
   - Enriching

2. Online:
   - Navigating and searching
   - Querying
   - Reasoning

- Global domain ontology
- Local DTL specifications
- meta data
- component databases

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Metadata architecture

- Database schemata (any DDL)
- Local database ontologies (DTL)
- Global linguistic ontology (OWL)
- Topic taxonomies (SKOS)

- Database developer
- TDS Knowledge engineer
- Domain expert

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Overview of the TDS

Managing differences between databases

The component databases

The TDS server (demonstration/tutorial)

The TDS under the hood

Guidelines for component databases
The component databases (I)

- Person-Agreement database (A. Siewierska, D. Bakker)
  Person and agreement phenomena. Over 400 languages

- Typological Database Nijmegen (L. Stassen)
  Word order, predication, case marking, relative clauses, comparatives, possession, coordination, and more. Between 140 and 400 languages, depending on topic

- Typological Database Amsterdam (K. Hengeveld)
  Basic word order and constituent order systems; parts-of-speech systems
The component databases (II)

- StressTyp (R. Goedemans, H. van der Hulst) metrical systems (stress, foot types, extrametricality etc.) for 510 languages
- SylTyp (H. van der Hulst, R. Goedemans) syllable structures
- UCLA Phonological Segment Inventory (I. Maddieson) segment inventories with phonological features for 451 languages
- Smith’s Phoneme Inventories (N. Smith) Phoneme and lexical tone inventories for 111 languages
The component databases (III)

- Anaphora Typology database (A. Dimitriadis, M. Everaert, E. Reuland, T. Reinhart)
  examples of reflexives with analysis; only a few languages are in the database

- Berlin database of intensifiers and reflexives (V. Gast, D. Hole, E. König, P. Siemund, S. Töpper)
  properties and examples for over 100 languages

- Graz database on reduplication (B. Hurch, V. Mattes, O. Konovalova)
  phonology, morphology and semantics of reduplication, with information on productivity and diachrony
The component databases (IV)

- World color survey (P. Kay, B. Berlin, L. Maffi, W.R. Merrifield)
  Summary information on color term systems

- Topic-focus database (E. Aboh, K. Hengeveld)

- Free Personal Pronoun System (N. Smith)
Auxiliary resources

- ISO 639-3 language codes
  Three-letter codes (the former Ethnologue/SIL codes)

- Genetic affiliation according to the Ethnologue (SIL International)

- Geographic coordinates
  Geographic location of languages (M. Dryer/WALS, and G. Segerer)

- Universal Phoneme Positioning Chart
  Table of potential phonemes, derived from UPSID data with additional processing
In the process of being added

- Berlin-Utrecht reciprocals survey (M. Everaert, E. König, V. Gast, A. Dimitriadis, C. Emkow, T. Hanke)
  Inventory of reciprocal markers, with some morphosyntactic and semantic information

- African Anaphora Project (K. Safir, O. Adesola, C. Linares-Scarcerieau)
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http://languagelink.let.uu.nl/tds/

- The TDS interface relies heavily on JavaScript support in the browser

- Supported browsers
  - Firefox
  - Internet Explorer

- TDS is a bit heavy on the client side, depending on your computer occasionally timeouts may occur
  - on the TDS homepage you find some hints on how to avoid the timeouts

- The back button might not always do what you expect
  - use the mechanisms of the TDS interface
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TDS metadata architecture

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Incoming database schemata

- Any schema associated with the source data
- Preferably accompanied by metadata

Frequent problems for integration process:
- Metadata isn’t rich enough, or there is no metadata at all
- Even for well documented databases, metadata not precise enough for our purposes
- Semantics are often “hidden” in the UI (if exists) and not represented in the database schema
- Database schema often not fully normalized, e.g., single table
- A lot of the required information only exists in the developer’s head
Database examples

- Original schema snippet from TDN database:

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Metadata</th>
</tr>
</thead>
<tbody>
<tr>
<td>V105</td>
<td>0, 1, 9, 99</td>
<td>ATTRIBUTIVE ADJECTIVES ARE RELATIVE CLAUSES</td>
</tr>
<tr>
<td>V168</td>
<td>0, 1, 9, 99</td>
<td>PRED LOC = ZERO + LOC PP</td>
</tr>
<tr>
<td>V204</td>
<td>0, 1, 9, 99</td>
<td>PRED ADJ = COP VS. PRED LOC = VERB (NONCOP)</td>
</tr>
</tbody>
</table>

- Original schema snippet from SPIN database:

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Database examples

- Diagram of the table schema of the TDIR database
TDS metadata architecture

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Local database ontologies

- We have developed the special-purpose Data Transformation Language (DTL), which specifies a hierarchical overlay on component databases.

The nodes in the hierarchy play specific roles:
- Field and value notions are associated with database fields and/or values
- Concept notions have links to concepts in the domain ontology
- Grouping notions build the hierarchical structure and keep related notions together, and
- Root notions identify key data structures
An example from the DTL

1. TOP NOTION tdn:locationalPredicates
2. LABEL "Locational predicates"
3. DESCRIPTION "Information concerning locational predicates, including form of, and conditions on, construction, and form of the negation."
4. LINK TO CONCEPT locationalPredicate
5. GROUPS {
6. NOTION tdn:ZeroEncoding
7. LABEL "Locational predicate is zero"
8. LINK TO CONCEPT conditionsOnEncoding
9. GROUPS {
10. NOTION tdn:v168_Zero_plus_locative_prepositional_phrase
11. LABEL "Locational predicate is zero + locative prepositional phrase"
12. DESCRIPTION "The locational predicate is expressed without the use of an overt verb, but has a locative prepositional phrase."
13. IS FIELD v168
14. GROUPS WHEN "yes" {
15. NOTION tdn:v169_Zero_for_present_only IS FIELD v169;
16. NOTION tdn:v170_Zero_in_positive_sentences_only IS FIELD v170;
17. }
18. }
19. }
20. }
DTL notion hierarchy

- Notions live in a hierarchy
- The hierarchies are split into semantically coherent contexts
- A DTL specification can describe and relate multiple hierarchies

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Other DTL facilities

- **Preprocess data**
  - General cleanup of data before being processed by the rest of the DTL specification

- **Uncertainty handling**
  - Example: database value “"L?” is normalized to “left” marked as UNSURE
  - Will allow support for different levels of uncertainty handling during query time:
    - Certain: never selects and never projects marked values
    - Normal: ignores markers
    - Uncertain: marked values are always selected and are thus always projected (they can be any value)

- Some notions can be marked as (general) annotation notions, their data is accessible when data from the parent or root notion is projected.

- Allows the declaration of loosely reusable notion hierarchies.
TDS metadata architecture

Database schemata (any DDL)
Local database ontologies (DTL)
Global linguistic ontology (OWL)
Topic taxonomies (SKOS)

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Global linguistic ontology

- We have developed a custom, bottom-up ontology as required for our integration needs.

- Design principles:
  - *Bottom-up approach:* concepts are only established on the basis of generalization from information existing in component databases
  - *Inclusive perspective:* provides a common vocabulary that serves as a non-prescriptive basis for integration of database- and theory-specific categories

- Content:
  - Unifying concepts are established on the basis of local DTL notions

- Implementation:
  - The ontology is specified in the W3C recommendation Web Ontology Language (OWL)
Ontology: linguistic concepts

- *Linguistic objects* can be thought of as existing in themselves, *e.g.* Sentence and Morpheme;
- *Linguistic properties* are (linguistically salient) properties predicated of a linguistic object, *e.g.* Basic Word Order and Referential;
- *Linguistic relations* model a phenomenon involving two or more linguistic objects or properties, *e.g.* Agreement and Stress Assignment
Ontology: relationships

- **Subsumption**: super- and subordinate concepts;
- **Loose synonymy**: variant linguistic terminology used to refer to the same phenomenon;
- **Related phenomena**: variant linguistic terminology used to refer to similar or related phenomena;
- **Meronymy**: part/whole relations;
- **Determination**: a linguistic property is defined in terms of one or more other linguistic properties;
- **Form-function relationship**: the linguistic function served by some linguistic entity.
An example from the global ontology

[Diagram showing the relationships between predicate, non-verbal predicate, adjectival, ascriptive, existential, identity, nominal, possessive, locational, and their connections through is-a, disjoint-with, alias, spatial adverb, and adpositional predicate relationships.]

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An example from the global ontology

- core constituent word order
- subsumes
- equates with
- basic word order
- predicate-based word order
- OSV
- SOV
- SVO
- VSO
- predicate initial
- predicate medial
- predicate final

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TDS metadata architecture

TDS metadata architecture involves several components:

- **Database schemata**: (any DDL)
- **Local database ontologies**: (DTL)
- **Global linguistic ontology**: (OWL)
- **Topic taxonomies**: (SKOS)

The diagram illustrates the relationships between these components and the roles of:

- **Database developer**
- **TDS Knowledge engineer**
- **Domain expert**
Topic taxonomies

- Thematic groupings of topics
  *i.e.*, not strict subsumption relations

- Purpose is to provide alternative domain-specific entrance points to concepts and associated notions

- Current taxonomies:
  - Table of contents from *Describing Morphosyntax* (Payne, 1992)
  - The subsumption hierarchy of the global linguistic ontology
  - The BRILL classification hierarchy (under construction)

- Implementation:
  - Taxonomies are specified in the new W3C working draft
    Simple Knowledge Organisation System (SKOS)
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Good database design

- A properly designed database is easy to enter data into and extract information from; it is also easier to modify as one’s research design evolves.
Typological databases have a long lifespan. Assumptions and procedures are lost, which may lead to inconsistencies. Document the database to make it possible:
- to refresh the project’s collective memory
- to keep data clean and consistent
- to provide rich metadata if the database is eventually made public or reused
Citations to the sources of information

- Essential for error-checking or further research
- List at least the source(s) of information for each language
- Put these sources in a separate table so they can be easily referenced
- Ideally each group of information in the database would include a separate citation with relevant page numbers
Key values

- Look for standards to take your key values from:
  - Languages: ISO 639-3
  - Dialects: ISO 639-3 + dialect name (Ethnologue)
  - Phonemes: Unicode codepoints (IPA Console)
  - ...

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Comment fields

- Provide separate comment fields for separate fields or topics requiring comment. Be explicit about the field to which a comment applies.

- If you decide on new types of data to collect, don't store it in a general comment field. Make separate fields, even if they will be sparsely filled.
NULL values

- NULL values are controversial as they can mean many things:
  - Is the field irrelevant?
  - Should a default value be used?
  - Is there no value yet?
  - Did analyst search for a value but didn’t find it yet?

- Make all these circumstances explicit, and let NULL have no or one meaning
Uncertainty

- Encoding uncertainty in a value is a poor strategy:
  - ‘X’ and ‘X?’ are 2 different things for a DBMS
  - ‘1?’ has to be stored in a text field, while the proper value is a numeral
- Ideally, encode uncertainty in a separate field
- At least use a consistent notation and document it

- More generally, elaborate embedded notation for values is difficult and error prone. Use multiple fields as needed.
Future work

- Performance/stability improvements
- Import more databases
  - ODIN
  - ZAS
  - … yours?
- The TDS as a basis for the preservation of databases
  - Archiving typological databases (IDDF)
- The TDS as a web service
  - CLARIN
  - TypEx
- The TDS as a data integration framework
  - Other (scientific) domains?
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Any feedback is welcome 😊

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