xsd2pgschema v3 User Guide

Author: Masashi Yokochi, Institute for Protein Research, Osaka University
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xsd2pgschema is an application suite for processing XML documents in reference to XML Schema. It primarily targets replication of relational database in local environment that (i) reduces network delay and computing resource of the original data publisher and (ii) enables to optimize response time, which depends on the available resources. Native XML database provides a one-stop solution for generic XML processing, but it often leads problems in reliability, performance, and data update, especially when processing large data set. The tool allows users to select middleware suitable for their own tasks, such as SQL search/update, full-text indexing, and XPath query evaluation. The freedom choice of optimal middleware for specific XML data processing is the next best solution though the following drawbacks are included.

It is noted that the **xsd2pgschema v3** supports XML Schema Definition Language 1.1 (XML Schema 1.1 or XSD 1.1, thereafter prefix "`xs`" stands for namespace URI of the XML Schema; http://www.w3.org/2001/XMLSchema) and XML Path Language 1.0 (XPath 1.0) standards, Unlike the native XML database, XPath 2.0/3.0/3.1, XQuery 2.0/3.0/3.1 standards, and schema-less XML documents are not supported. Instead, our solution enables full-text indexing on XML contents via established open-source search engines (Apache Lucene, or Sphinx Search) and supports wildcards of XSD 1.1 (a.k.a. `<xs:any>`, and `<xs:anyAttribute>`), which enable to extend document under the conformity.

This document describes how to install the tool and how to interact with external systems, such as PostgreSQL (https://www.postgresql.org), Apache Lucene (http://lucene.apache.org), and Sphinx Search (http://sphinxsearch.com).

License

Requirements

The **xsd2pgschema** is platform-independent and runs on Java 8 (or later) with PostgreSQL 9.5 (or later). Optionally, Apache Lucene (included in the package), or Sphinx Search can be used as search engine.

Installation

First of all, access https://sourceforge.net/projects/xsd2pgschema/ and download the latest package, `xsd2pgschema-4.0.x.tgz`. Then, uncompress the .tgz file.

```
tar xvzf xsd2pgschema-4.0.x.tgz
```

`xsd2pgschema.jar` file in the package is a JAR file contains main classes, core library and all required libraries. The following commands is typical case that invokes the main class of the package:

```
java -cp (class_search_path)/xsd2pgschema.jar (main_class_name) (arguments)
```

where `(class_search_path)` is the class search path for the JAR file and `(main_class_name)` is the main class name of the package. The default main class is set to `xsd2pgschema`, which converts specified XML Schema to PostgreSQL Data Definition Language (DDL) (see also section 1.1). The `(arguments)` depends on the selected main class, the terms are shared in the relevant main classes. See appendix paragraph of each main classes.

Footprint of core library, packaged as `xsd2pgschema-min.jar` file, is small. Users have to gather required libraries (JAR files) as described in `pom.xml`.

When importing the tool in own project, add the following dependency.

```
<dependency>
	<groupId>net.sf.xsd2pgschema</groupId>
	<artifactId>xsd2pgschema</artifactId>
	<version>4.0.0</version>
</dependency>
```

Selection of Main Class

The **xsd2pgschema** is originally designed to be backend tools for a web service of integrated databases which are updated periodically. Individual functions of the tool are available by the selection of main classes as shown. The functions are classified roughly into (1) Replication of PostgreSQL database, (2) Full-text indexing using Apache Lucene or Sphinx Search, (3) File conversion from XML to JSON, (4) XPath 1.0 query evaluation over PostgreSQL, (5) Utilities for pre-processing, and (6) Data model server for fast XML Schema analysis (Table. 1). Jump to the following interesting topics.

Table. 1 Main classes of xsd2pgschema and its functions

Main class	Function	Section
xsd2pgschema	Generate PostgreSQL DDL from XML Schema	1.1
xml2pgsql	PostgreSQL data migration or differential update	1.2
xml2pgcsv/xml2pgtsv	Convert XML to CSV/TSV and data migration (batch)	1.3
csv2pgsql/tsv2pgsql	Import CSV/TSV to PostgreSQL database	1.4
xml2luceneidx	Full-text indexing using Apache Lucene	2.1
luceneidx2dic/ftxt/infix	Generate dictionary from Lucene index	2.2
xml2sphinxds	Prepare Sphinx data source (xmlpipe2) for full-text indexing	2.3
dsmerge4sphinx	Merge Sphinx data sources	2.4
dicmerge4sphinx	Generate dictionary from Sphinx data source	2.5
xsd2jsonschema	Generate JSON Schema from XML Schema	3.1
xml2json	Convert XML documents to JSON documents	3.2
xpathparser	XPath 1.0 parser being aware of XML Schema	4.1
xpath2xml/json/pgsql	XPath 1.0 query evaluation over PostgreSQL	4.2
xmlsplitter	Split large XML file into smaller ones	5.1
xmlvalidator	Parallel XML Schema validation of multiple XML documents	5.2
chksumstat	Report check sum directory status	5.3
pgschemaserv	Data model server for fast XML Schema analysis	6

1. Replication of PostgreSQL database

1.1 Generation of PostgreSQL DDL from XML Schema

`Relevant main class: xsd2pgschema`

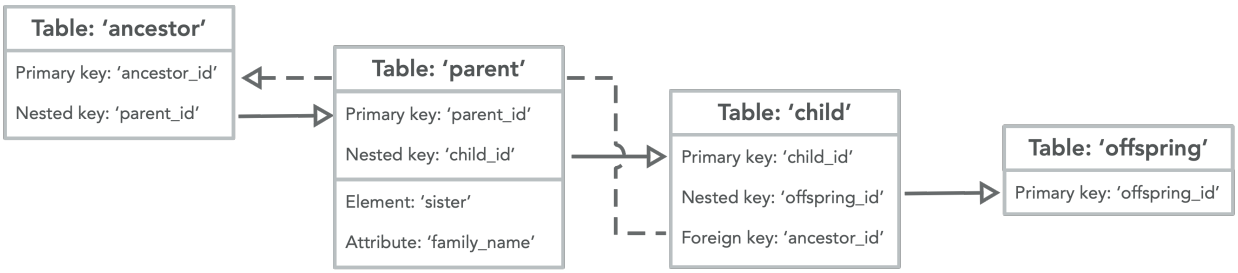
The **xsd2pgschema** main class analyzes XML Schama(ta), generates versatile relational data model internally, and writes PostgreSQL DDL file (Appendix. 1). All specifications of the XSD 1.1 (https://www.w3.org/TR/xmlschema11-1/) are supported. The conversion of hierarchal data model to relational data model is achieved by introduction of three **system keys**; **primary key**, **nested key**, and **foreign key** (Table. 2). First, all relations have a primary key having concatenated column name pattern, `(table_name)_id`, which serves as destination of the other reference keys. The nested key is like SQL foreign key without a foreign key constraint but implicitly points to the primary key of the child table and has concatenated name pattern, `(child_table_name)_id`. The primary key does not always have unique constraint that depends on whether parent table is list holder, where `@maxOccurrs` is greater than 1, because the single nested key of the list holder (parent) is shared by multiple primary keys of the list member (child), in other word, that violates the unique constraint. The foreign key has the same concept of SQL term including foreign key constraint, which has explicit direction pointing the primary key of parent node in ancestor table, and has concatenated name pattern, `(parent_node_name)_id`. The foreign keys are generated when identity-constraint definition exists, i.e. a pair of `<xs:key>` and `<xs:keyref>`, or implicit ancestor-child relationship which is generally occurred by complex type definition, `<xs:complexType>`. It turns to generate a virtual parent table in relational data model. The foreign key is useful to trace back to parent XML node. Typical hierarchal parent-child relationship is expressed using these system keys shown in Fig. 1 for a case that the virtual parent table exists. Thus, nested key and foreign key have a specific direction for the document tree, namely, the nested keys head for their leave table, and the foreign keys head for the parent XML node.

Table. 2 System keys to map hierarchal data model of XML Schema to relational data model

System key	Destination	Column name pattern	Constraint
Primary key		`(table_name)_id`	has a unique constraint except for list member
Nested key	child table's primary key	`(child_table_name)_id`	
Foreign key	parent XML node's primary key in ancestor table	`(parent_node_name)_id`	has a foreign key constraint

where `(table_name)`, `(child_table_name)`, and `(parent_node_name)` represent current table name, child table name, and parent node name, respectively.

Fig. 1 A typical database diagram modeling hierarchal parent-child relationships defined by XML Schema.



XML Schema:

```
<xs:element name="ancestor" type="parent"/>

<xs:complexType name="parent">
  <xs:sequence>
    <xs:element name="child" type="offspring"/>
    <xs:element name="sister" type="xs:string"/>
  </xs:sequence>
 <xs:attribute name="family_name" type="xs:string"/>
</xs:complexType>
```

XML Instance:

```
<ancestor family_name="…">
 <child>
  …
 </child>
 <sister>…</sister>
</ancestor>
```

Optionally, the relational data model can be extended by introduction of three **user keys** for facilitating SQL search/update, preserving document order, and enabling absolute XPath addressing. They are called **document key**, **serial key**, and **xpath key**, respectively (Table. 4). At first, the document key contains a name that quotes the source XML document file name, which represents unique ID for each unit of data corresponding entry ID, session ID, etc. The document key is appended to all relations by default because the document ID often becomes primary SQL query's condition or SQL search results. Second, the serial key holds ordinal numbers which reveal document order in a list. The serial key is required to execute document-order dependent XPath queries. Though, PostgreSQL does not guarantee document-order during data migration using C0PY command, the document-order will be substantially preserved by using the **xml2pgsql** main class that makes use of SQL transaction. The last xpath key provides a way to select rows from absolute XPath addressing. To reduce database size, the xpath key holds hash codes representing the absolute XPath of current node. Please refer to Fig. 2 for the encoding scheme in case of empty document ID.

User key	Role	Column name	Data type	Default
Document key	specify source XML document	document_id	text	yes
Serial key	document order preservation	serial_id	ordinal number	no
XPath key	absolute XPath addressing	xpath_id	hash code	no

Table. 3 User keys to facilitate SQL search or update

As shown in Table 2 and 3, there are the reserved column name patterns for system keys and user keys. In addition, the tool defines reserved column names for special data types corresponding to <xs:simpleContent>, <xs:any>, and <xs:anyAttribute> (see Table. 4). If schema component name of source XML Schema matches the reserved names, the tool edits the schema component name by inserting an under score character, "_", at a head of the name. When name collision occurs between two relations, the tool will merge columns of the both relations and rearrange value types and constraints as necessary. In general, the schema component names of the source XML Schema are kept with the best effort. However, it rarely occurs if XML namespace is supported (**--pg-public-schema** and **--pg-named-schema** arguments). If the **--pg-named-schema** arguments is on, prefix of XML namespace defined in the XML Schema is used for the named schema in PostgreSQL, otherwise "public" schema will be applied by default.

Table. 4 Reserved column name for special data types

Data type	Role	Column name	Value type
<xs:simpleContent>	Simple content	content	text
<xs:any>	wild card for any element	any_element	xml
<xs:anyAttribute>	wild card for any attribute	any_attribute	xml

In case the document key becomes redundant because entry ID is already included in XML data itself, it is possible to take over the document key's role to the existing element, attribute, or simple content that is called in-place document key (**--discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME**, **--inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME**, and **--doc-key-if-no-inplace** arguments). It is possible to turn off the relational data model extension that is good choice if you will manage database manually and do not plan to reconstruct XML document from database (**--no-rel** argument). Even in that case, simple XPath queries could be executed. It is noted that the document key is always required for data update described later, please select **--no-rel** and **--doc-key** arguments together for the case. Generally, the document key and the primary key are required to evaluate XPath query (see also section 5). To reduce physical database size, the tool automatically implements all simple bridge tables using PostgreSQL views that act as identity transformation from unique parent's nested key to unique descendant's primary key.

In order to facilitate SQL composition in your own applications, it is possible to choose case-insensitive names for all relations and columns (**--case-insensitive** argument). Name collision caused by the lowercase naming will be resolved with the best effort. There is an another useful option to enable inlining simple contents as either attributes

and elements, respectively (**--inline-simple-cont** argument). The inlineing seems to be more intuitive mapping and reduce system keys and relations, if shared simple contents are heavily utilized in the XML Schema.
All constraints defined in XML Schema (data type, enumeration, restriction, and so forth) are mapped into PostgreSQL DDL including primary, foreign, and unique constraints of system keys. The tool natively supports data migration while enabling these all constraints, but it is possible to turn off system key constraints by enabling **--no-key** argument.

Finally, the obtained PostgreSQL DDL file can be applied to database by the following `psql` command:

```
createdb -U (db_user) (db_name) # required only for the first time
psql -U (db_user) -d (db_name) -f (ddl_file)
```

where `(db_name)` is database name, and `(db_user)` is database user name. You must have permission to create database, of course. `(ddl_file)` represents the PostgreSQL DDL file.

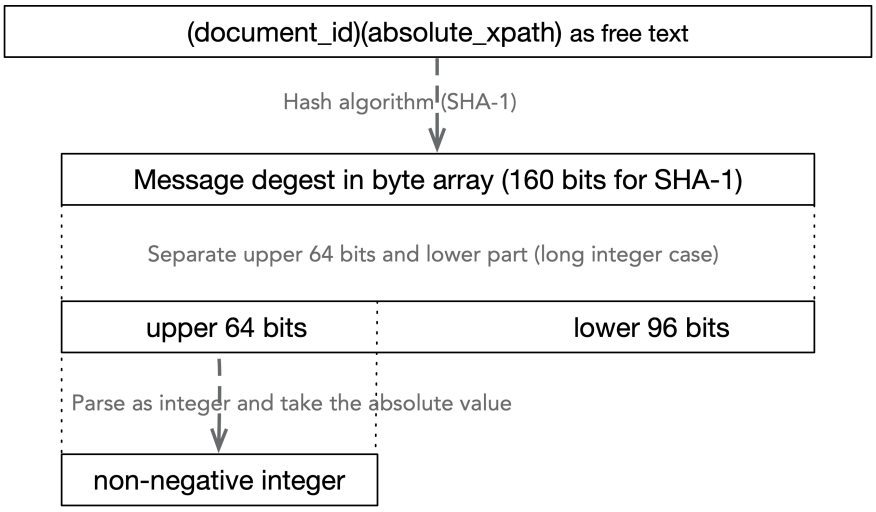
1.2 PostgreSQL data migration or differential update

```
Relevant main class: xml2pgsql
```

The **xml2pgsql** main class parses multiple XML documents using document object model (DOM), then imports to PostgreSQL database defined by the generated PostgreSQL DDL as described in the previous section. You must select the same XML Schema(ta) and set all relevant arguments used in the **xsd2pgschema** main class (Appendix. 2). The document IDs are set by quoting XML file names ignoring its file extension such as `.xml`, `.xml.gz`, and `.xml.zip`. Please specify the file extension using **--xml-file-ext FILE_EXTENSION** argument, there is no need to uncompress the XML files. The tool will find all XML files having the same file extension in directories specified by **--xml XML_FILE_OR_DIRECTORY** arguments, then uncompress as necessary. The document ID can be customized by a combination of the following arguments: **--xml-file-prerix-digest DIGESTIBLE_PREFIX**, **--xml-file-ext-digest DIGESTIBLE_EXTENSION**, **--lower-case-doc-key**, and **--upper-case-doc-key**.
Data type of the system keys are defined by both **--hash-by ALGORITHM** and **--hash-size BIT_SIZE** arguments. By default, non-negative 64 bits integer is selected.

Detailed encoding scheme of the system keys is shown in Fig. 2.

Fig. 2 A typical encoding scheme for generation of the system keys.



The value of system key obviously depends on the document ID and absolute location of XML node written in XPath expression. In principle, the predictable encoding of the system keys enables to access SQL rows without traveling document tree. Though, uniqueness of key is not guaranteed by the bit truncation after the message digest, hash collision rarely occurs because message digest will show drastic change with tiny changes and source key is limited on particular part of XML documents, namely a relation. Eventually, PostgreSQL detects violation of unique constraint during data migration. For the case, the tool also allows users to choose the native length of hash algorithm as the system keys. The 64 bits integer is usually enough and practical choice for both performance and storage size, because the standard cryptographic hash calculations such as SHA-1 tend to be accelerated by specific circuits implemented in currently available 64 bit CPUs.

1.3 Convert XML to CSV/TSV and data migration

```
Relevant main class: xml2pgcsv, xml2pgtsv
```

The **xml2pgcsv** and **xml2pgtsv** are sister main classes, which convert XML documents to CSV/TSV files for each relations, then execute PostgreSQL's `COPY` command if database is specified. This is the fastest data migration if the document-order is not problem. The **--sync CHECK_SUM_DIRECTORY** argument, see Appendix. 3, is implemented to enable differential update for the next time by the **xml2pgsql** main class. It is noted again that PostgreSQL does not guarantee the document-order in the batch data migration, you must select the same XML Schema(ta), and set all relevant arguments used in the **xsd2pgschema** main class. A null value in the TSV format is coded in PostgreSQL manner using "`\N`" (backslash-N).

1.4 Import CSV/TSV and data migration

```
Relevant main class: csv2pgsql, tsv2pgsql
```

The **csv2pgsql** and **tsv2pgsql** are sister main classes, which import CSV/TSV files in a working directory to PostgreSQL database. These main classes should be invoked for CSV/TSV files generated by either **xml2pgcsv** or **xml2pgtsv** main class, respectively. There is no substantial difference as data migration in separating into two steps, generates CSV/TSV files, then imports to PostgreSQL database.
These main classes is prepared for debugging on the system keys, users can confirm human-readable system key values, composed of document ID and absolute XPath expression of XML node, generated by the **xml2pgcsv** main class with **--hash-size debug** argument in Appendix. 3. Then, the PostgreSQL's `COPY` command can be followed.

Please find example scripts of the package for data migration; `clone_intact.sh`, and `clone_uniprotkb.sh`.

2. Full-text indexing using Apache Lucene or Sphinx Search

2.1 Full-text index using Apache Lucene

```
Relevant main class: xml2luceneidx
```

The **xml2luceneidx** main class parses multiple XML documents and generates full-text index using Apache Lucene. Apache Lucene is a full stack search engine including full-text indexing, query parser, auto-suggestion, highlighting, and so on. In order to build a web service from XML documents, both a search engine and a relational database are essential components. The main class supports full-text indexing, differential index update, field selection (**--field** argument) by means of SQL like designation, `(table_name).(column_name)`, attribute selection that defines retrievable value stored in the index (**--attr** argument), content type dependent attribute selection (**--attr-stinrg**, **--attr-integer**, **--attr-float**, **--attr-date**, and **--attr-time** arguments), setting minimum words required for indexing (**--min-word-len MIN_WORD_LENGTH** argument), and sharding (**--shard-size SHARD_SIZE** argument) (see also Appendix. 5). Under normal settings, the tool performs full-text indexing on an index field named "`content`" for all XML content. It is possible to append any index attributes to retrieve associated values from hit documents like simple database. For information on how to use the generated Lucene index, please refer to the official document.

2.2 Generate dictionary from Lucene index

```
Relevant main class: luceneidx2dic, luceneidx2ftxt,
luceneidx2infix
```

The **luceneidx2dic**, **luceneidx2ftxt**, and **luceneidx2infix** main classes are utility dedicated for providing auto-suggestion function on a web service. They open Lucene index and generate a dictionary for specified fields. For information on how to implement the dictionary to own service, please refer to the official document.

2.3 Prepare Sphinx data source (xmlpipe2) for full-text indexing

```
Relevant main class: xml2sphinxds
```

The **xml2pshinxds** main class parses multiple XML documents and generates Sphinx data source in *xmlpipe2* format. Sphinx is an alternative open-source search engine implemented by in-memory technologies so that it often excels in search performance if there is plenty of memory. It has own query language, *SphinxQL*, acting as a drop-in extension on MySQL query interface. The *xmlpipe2* format is one of data source for Sphinx. In actual, the full-text indexing is applied on the generated data source by executing Sphinx's command, `indexer`. As with the Lucune's full-text indexing, the main class supports differential update of the data source, field selection by means of SQL like designation, `(table_name).(column_name)`, attribute selection that defines retrievable value stored in index, content type dependent attribute selection,

setting minimum words required for indexing, and sharding (Appendix. 7). "content" is the field index for all XML content. It is noted that there is a little difference in attribute designation in *SphinxQL*, please use member operator "__" in *SphinxQL* to avoid confusion with SQL's ".". For example, the attribute in *SphinxQL* should be expressed by (table_name)__(column_name). The documents in the *xmlpipe2* format are expressed in a tag "<sphinx:document id='...'>" where the attribute "id" has a unique 64 bits integer, which is generated from the document key values by the same encoding scheme shown in Fig. 2. Please refer to the official document for Sphinx search engine and its query language, *SphinxQL*.

2.4 Merge Sphinx data sources

```
Relevant main class: dsmerge4sphinx
```

The **dsmerge4sphinx** main class merges multiple data sources into one for the case the sharding is unnecessary. It is noted that the sharding is required for large data because maximum memory allocation for a data source is limited. See also Appendix 7 and 8.

2.5 Generate dictionary from Sphinx data sources

```
Relevant main class: dicmerge4sphinx
```

The **dicmerge4sphinx** main class generates dictionary from Sphinx data source. It is counterpart of lucene2dic/ftxt/infix main classes. Generation of a dictionary from index is not implemented as a Sphinx function so far. For auto-suggestion function, the main class generates the dictionary by converting keywords in the source index to trigrams.

Please find example scripts of the package for full-text indexing; lucene_index_uniprotkb.sh, sphinx_shard_uniprotkb.sh, and lucene_ftxt_uniprotkb.sh.

3. File conversion from XML to JSON

3.1 Generate JSON Schema from XML Schema

`Relevant main class: xsd2jsonschema`

The **xsd2jsonschema** main class maps XML schema components to JSON schema components. JSON has advantages being light-weight as data container and having flexibility for schema-less document in comparison with XML. The flexibility often leads negative consequence as protocol of web service. JSON Schema (https://json-schema.org) provides one of solutions that define JSON document and web service. We focus on document definition using JSON Schema (core specification). There is no straight mapping scheme from XML Schema to JSON Schema that mainly depends on how to deal XML's simple content and JSON's array. The tool provides the following three ways of JSON Schema mapping: object-oriented, column-oriented, and relational-oriented schema mapping. First, the object-oriented schema mapping (**--obj-json** argument) is an intuitive translation that holds the same XML data structure in JSON avoiding the use of JSON array. Second, the column-oriented schema mapping (**--col-json** argument) utilizes JSON array for storage values of list members, which can reduce redundant XML tags in a list effectively. The tool selects the column-oriented schema mapping by default. Finally, the relational-oriented schema mapping (**--rel-json** argument) also utilizes JSON array for all values of any relations except for the root relation that resembles dumping data stored in relational database. The JSON object definitions in the relational-oriented schema mapping are minimal than the others. To obtain more intuitive JSON Schema mapping, the inlining simple contents as either attributes and elements (**--inline-simple-cont** argument) is highly recommended. The system keys and the user keys are ignored in the JSON Schema mapping and succeeding JSON document conversion (see the next section). In either case, the simple content of the XML document creates a JSON object named "`content`". Please see Appendix. 10 for arguments of the main class. It is possible to validate the generated JSON Schema against JSON Schema core specifications using online JSON Schema validation service provided by newtonsoft.com (https://www.jsonschemavalidator.net). The tool parses XML Schema and then create an instance of relational data model so that reusable schema component definitions in XML Schema using `<xs:complexType>` will not converted to counterparts on the JSON Schema. Therefore, the obtained JSON Schema may have redundant JSON object definitions. Instead of the redundancy, we can choose the different JSON Schema mapping strategies for arbitrary complex XML Schema(ta). For the reasons above, we do not provide reverse mapping solution from JSON Schema to XML Schema. Finally, the obtained JSON Schema inherits all annotations defined in the source XML Schema(ta).

3.2 Convert XML documents to JSON documents

`Relevant main class: xml2json`

The **xml2json** main class converts selected XML documents to JSON documents. Unlike other main classes, the main class does not support differential update because generated JSON document depends on not only source XML documents but also the selected arguments shown in Appendix. 11. It would be better to validate the obtained JSON documents against the JSON Schema converted from the XML Schema as well.

4. XPath 1.0 query evaluation over PostgreSQL

4.1 XPath 1.0 parser being aware of XML Schema

```
Relevant main class: xpathparser
```

The **xpathparser** main class parses XPath 1.0 query based on ANTLR v4 (https://www.antlr.org) and reports abstract syntax tree of the query and validity against the relational data model (Appendix. 12). The main class accepts XPath query for content in the wild cards defined by <xs:any>, and <xs:anyAttribute>. The main class automatically delegates a part of the query accessing the wild card content to native XPath implementation on PostgreSQL.

4.2 XPath 1.0 query evaluation over PostgreSQL

```
Relevant main class: xpath2xml, xpath2json, xpath2pgsql
```

The **xpath2xml**, **xpath2json**, and **xpath2pgsql** main classes parses XPath 1.0 query and evaluate the query on the PostgreSQL database generated by the data migration, then output results as XML, JSON, or CSV/TSV formats, respectively. (Appendix. 13, 14, 15) At first, the tool performs query translation from XPath to SQL, then, executes the SQL query. All child nodes in the results are traced until they reach terminal nodes. In most cases, the final results forms a fragmented document, which contains multiple root nodes that violates the specification of XML and JSON. For the case, the tool throws exceptions (to allow the violations, see **--xml-allow-frag** in Appendix 13 and **--json-allow-frag** in Appendix 14). There is no need to set target namespace URI and its prefix, they are defined by the source XML Schema. It is possible to include document ID under the root node of the result that is the easiest way to retrieve the source document information, corresponding entry ID or session ID. Some queries depending on the document-order require the serial key that must be prepared when the data migration (see also section 1.1). Users can run multiple XPath query evaluations and get results stored as different files for each XPath query. To get optimal performance as a web service, instance objects of the main class should be reused because Java process's startup time and XML Schema analysis time are not ignorable. Please utilize a data model server, called **PgSchema server** (**pgschemaserv** main class), which accelerates the XML Schema analysis (see also section 6). See example scripts to control the PgSchema server; start_pgschema_serv.sh, stop_pgschema_serv.sh, and status_pgschema_serv.sh. Of course, real performance primary depends on how much PostgreSQL's index was optimized. There are functions to create/delete PostgreSQL's indexes based on XML Schema and database size (**--min-rows-for-index MIN_ROWS_FOR_INDEX**, **--create-doc-key-index**, **--create-attr-index**, and so forth in Appendix 2 and 3), but further performance tunings are lefts to user's discretions.

Please find example scripts of the package for XPath 1.0 query evaluation over PostgreSQL; eval_xpath_uniprotkb.sh.

5. Utilities for pre-processing

5.1 Split large XML file to smaller ones

`Relevant main class: xmlsplitter`

The **xmlsplitter** main class splits a large XML file into smaller ones. The large XML file could not be parsed by the DOM since memory limitation. Users can arbitrary decide the location of document key using XPath expression (**--xpath-doc-key XPATH_EXPR_FOR_DOC_KEY** argument), then the values of the selected document key become split XML file names (Appendix. 16). This is not a simple chopper, but split XML documents are valid against the XML Schema. Please find an example script, `split_uniorotkb.sh`, for splitting a large XML file.

5.2 Parallel XML Schema validation on multiple XML documents

`Relevant main class: xmlvalidator`

The **xmlvalidator** main class is a helper tool for full-featured XML Schema validation based on Apache Xerces (http://xerces.apache.org). It is a heavy task to validate a large number of XML documents with complex XML Schema (Appendix. 17). The main class supports parallel XML Schema validation and differential update. It is possible to utilize available computer resources for acceleration of XML Schema validation and reduce the tasks for previously validated XML documents effectively (**--sync CHECK_SUM_DIRECTORY** argument). Optionally, it is possible to remove invalid XML documents (**--del-invalid-xml** argument). It is better to run the XML Schema validation whenever you notice problems.

5.3 Report check sum directory status

`Relevant main class: chksumstat`

The **chksumstat** main class compares the checksum of previously processed XML documents and current XML documents, then reports which XML documents will be created, updated, or deleted before actual processing begins, aka. dry-run. (Appendix. 18).

6. Data model server for fast XML Schema analysis

```
Relevant main class: pgschemaserv
```

The **pgschemaserv** main class is a server implementation that distributes a previously generated data model to the client main classes. Analysis of complex XML Schema(ta) and succeeding data modeling cost a lot. Because all main classes that process multiple XML documents are parallelized, the same data model is generated for each thread. Furthermore, XPath query evaluation is severe on performance that links to user experience. The **PgSchema server** is a dedicated server to improve XML Schema analysis performance of the client main classes. Please find the server control scripts in example directory (see the section 4), then you can test performance when the server is alive (Appendix. 19). The PgSchema server uses the **5430** port (**--port PG_SCHEMA_SERV_PORT_NUMBER** argument), and the client main classes are enabled to access the server by default (**--no-pgschema-serv**, **--pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME**, and **--pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER** arguments in Appendixes. 2, 3, 4, 5, 7, 8, 11, 12, 13, 14, 15, and 16).

Appendixes

The **xsd2pgschema** is an application suite application for processing XML documents based on XML Schema. Individual function of the tool can be accessed through the following main classes and their arguments.

Appendix. 1 Arguments of the **xsd2pgschema** main class

```
xsd2pgschema: XML Schema -> PostgreSQL DDL conversion
Usage:  --xsd SCHEMA_LOCATION --ddl DDL_FILE (default=stdout)
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --realize-simple-brdg (realize simple bridge tables, otherwise
implement them as PostgreSQL views by default)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
        --no-doc-key (remove document_id column from all relations,
effective only with relational model extension)
        --ser-key (append serial_id column in child relation of list
holder)
        --xpath-key (append xpath_id column in all relations)
        --no-key (turn off constraint of primary key/foreign key/
unique)
Option: --case-insensitive (all table and column names are lowercase)
        --pg-public-schema (utilize "public" schema, default)
        --pg-named-schema (enable explicit named schema)
        --pg-map-big-integer (map xs:integer to BigInteger according
to the W3C rules)
        --pg-map-long-integer (map xs:integer to signed long 64 bits)
        --pg-map-integer (map xs:integer to signed int 32 bits,
default)
        --pg-map-big-decimal (map xs:decimal to BigDecimal according
to the W3C rules, default)
        --pg-map-double-decimal (map xs:decimal to double precision 64
bits)
        --pg-map-float-decimal (map xs:decimal to single precision 32
bits)
        --field-annotation (retrieve field annotation)
        --no-field-annotation (do not retrieve field annotation,
default)
        --max-uniq-touple-size MAX_UNIQ_TUPLE_SIZE (maximum tuple size
of unique constraint derived from xs:key, ignore the limit if non-
positive value, default=1)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ASSUMED_ALGORITHM [MD2 | MD5 | SHA-1 (default) |
SHA-224 | SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int (32 bits) | long (64 bits, default)
| native (default bit of algorithm) | debug (string)]
        --ser-size BIT_SIZE [short (16 bits); | int (32 bits,
default)]
        --doc-key-name DOC_KEY_NAME (default="document_id")
        --ser-key-name SER_KEY_NAME (default="serial_id")
        --xpath-key-name XPATH_KEY_NAME (default="xpath_id")
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
```

--inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
--doc-key-if-no-inplace (append document key if no in-place document key, select --no-doc-key options by default)
--show-orphan-table (map orphan tables)

Appendix 2. Arguments of the **xml2pgsql** main class

```
xml2pgsql: XML -> PostgreSQL data migration
Usage:  --xsd SCHEMA_LOCATION --xml XML_FILE_OR_DIRECTORY --db-name
DATABASE --db-user USER --db-pass PASSWORD (default="")
        --db-host PG_HOST_NAME (default="localhost")
        --db-port PG_PORT_NUMBER (default=5432)
        --test-ddl (perform consistency test on PostgreSQL DDL)
        --min-rows-for-index MIN_ROWS_FOR_INDEX (default=2048)
        --create-non-uniq-pkey-index (create PostgreSQL index on non-
unique primary key if not exists, default)
        --no-create-non-uniq-pkey-index (do not create PostgreSQL
index on non-unique primary key)
        --drop-non-uniq-pkey-index (drop PostgreSQL index on non-
unique primary key if exists)
        --create-doc-key-index (create PostgreSQL index on document
key if not exists, enable if --sync option is selected)
        --no-create-doc-key-index (do not create PostgreSQL index on
document key, default if no --sync option)
        --drop-doc-key-index (drop PostgreSQL index on document key if
exists)
        --create-attr-index (create PostgreSQL index on attribute if
not exists, default)
        --no-create-attr-index (do not create PostgreSQL index on
attribute)
        --drop-attr-index (drop PostgreSQL index on attribute if
exists)
        --max-attr-cols-for-index MAX_ATTR_COLS_FOR_INDEX (default=1)
        --create-elem-index (create PostgreSQL index on element if not
exists)
        --no-create-elem-index (do not create PostgreSQL index on
element, default)
        --drop-elem-index (drop PostgreSQL index on element if exists)
        --max-elem-cols-for-index MAX_ELEM_COLS_FOR_INDEX (default=1)
        --create-simple-cont-index (create PostgreSQL index on simple
content if not exists, default)
        --no-create-simple-cont-index (do not create PostgreSQL index
on simple content)
        --drop-simple-cont-index (drop PostgreSQL index on simple
content if exists)
        --max-fks-for-simple-cont-index MAX_FKS_FOR_SIMPLE_CONT_INDEX
(default=0)
        --update (insert if not exists, and update if required,
default)
        --sync CHECK_SUM_DIRECTORY (insert if not exists, update if
required, and delete rows if XML not exists, select --create-doc-key-
index option by default)
        --sync-weak (insert if not exists, no update even if exists,
no deletion, select --create-doc-key-index option by default)
```

--sync-rescue (diagnostic synchronization, set all constraints deferred)
--no-rel (turn off relational model extension)
--inline-simple-cont (enable inlining simple content)
--realize-simple-brdg (realize simple bridge tables, otherwise implement them as PostgreSQL views by default)
--no-wild-card (turn off wild card extension)
--doc-key (append document_id column in all relations, default with relational model extension)
--no-doc-key (remove document_id column from all relations, effective only with relational model extension)
--ser-key (append serial_id column in child relation of list holder)
--xpath-key (append xpath_id column in all relations)
--no-key (turn off constraint of primary key/foreign key/ unique)
--validate (turn on XML Schema validation)
--no-validate (turn off XML Schema validation, default)
--well-formed (validate only whether document is well-formed)
--xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates xml.gz suffix) | zip (indicates xml.zip suffix)]
Option: **--case-insensitive** (all table and column names are lowercase)
--pg-public-schema (utilize "public" schema, default)
--pg-named-schema (enable explicit named schema)
--pg-map-big-integer (map xs:integer to BigInteger according to the W3C rules)
--pg-map-long-integer (map xs:integer to signed long 64 bits)
--pg-map-integer (map xs:integer to signed int 32 bits, default)
--pg-map-big-decimal (map xs:decimal to BigDecimal according to the W3C rules, default)
--pg-map-double-decimal (map xs:decimal to double precision 64 bits)
--pg-map-float-decimal (map xs:decimal to single precision 32 bits)
--no-cache-xsd (retrieve XML Schemata without caching)
--checksum-by ALGORITHM [MD2 | MD5 (default) | SHA-1 | SHA-224 | SHA-256 | SHA-384 | SHA-512]
--hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 | SHA-256 | SHA-384 | SHA-512]
--hash-size BIT_SIZE [int (32 bits) | long (64 bits, default) | native (default bit of algorithm) | debug (string)]
--ser-size BIT_SIZE [short (16 bits) | int (32 bits, default)]
--xml-file-prerix-digest DIGESTIBLE_PREFIX (default="")
--xml-file-ext-digest DIGESTIBLE_EXTENSION (default=".")
--lower-case-doc-key (lower case document key)
--upper-case-doc-key (upper case document key)
--fill-default-value (fill @default value in case of empty)
--filt-in table_name.column_name

```
        --filt-out  table_name.column_name:regex_pattern(|
regex_pattern...)
        --fill-this table_name.column_name:filling_text
        --doc-key-name DOC_KEY_NAME (default="document_id")
        --ser-key-name SER_KEY_NAME (default="serial_id")
        --xpath-key-name XPATH_KEY_NAME (default="xpath_id")
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
        --doc-key-if-no-inplace (append document key if no in-place
document key, select --no-doc-key options by default)
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --max-thrds MAX_THRDS (default is number of available
processors)
```

Appendix 3. Arguments of the **xml2pgcsv** (or **xml2pgtsv**) main class

```
xml2pgcsv: XML -> CSV conversion and PostgreSQL data migration
Usage:  --xsd SCHEMA_LOCATION --xml XML_FILE_OR_DIRECTORY --work-dir
DIRECTORY (default="pg_work")
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --realize-simple-brdg (realize simple bridge tables, otherwise
implement them as PostgreSQL views by default)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
        --no-doc-key (remove document_id column from all relations,
effective only with relational model extension)
        --ser-key (append serial_id column in child relation of list
holder)
        --xpath-key (append xpath_id column in all relations)
        --no-key (turn off constraint of primary key/foreign key/
unique)
        --validate (turn on XML Schema validation)
        --no-validate (turn off XML Schema validation, default)
        --well-formed (validate only whether document is well-formed)
        --xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates
xml.gz suffix) | zip (indicates xml.zip suffix)]
Option: --db-name DATABASE --db-user USER --db-pass PASSWORD
(default="")
        --db-host PG_HOST_NAME (default="localhost")
        --db-port PG_PORT_NUMBER (default=5432)
        --test-ddl (perform consistency test on PostgreSQL DDL)
        --min-rows-for-index MIN_ROWS_FOR_INDEX (default=2048)
        --create-non-uniq-pkey-index (create PostgreSQL index on non-
unique primary key if not exists, default)
        --no-create-non-uniq-pkey-index (do not create PostgreSQL
index on non-unique primary key)
        --drop-non-uniq-pkey-index (drop PostgreSQL index on non-
unique primary key if exists)
        --create-doc-key-index (create PostgreSQL index on document
key if not exists, enable if --sync option is selected)
        --no-create-doc-key-index (do not create PostgreSQL index on
document key, default if no --sync option)
        --drop-doc-key-index (drop PostgreSQL index on document key if
exists)
        --create-attr-index (create PostgreSQL index on attribute if
not exists, default)
        --no-create-attr-index (do not create PostgreSQL index on
attribute)
        --drop-attr-index (drop PostgreSQL index on attribute if
exists)
        --max-attr-cols-for-index MAX_ATTR_COLS_FOR_INDEX (default=1)
```

--create-elem-index (create PostgreSQL index on element if not exists)
--no-create-elem-index (do not create PostgreSQL index on element, default)
--drop-elem-index (drop PostgreSQL index on element if exists)
--max-elem-cols-for-index MAX_ELEM_COLS_FOR_INDEX (default=1)
--create-simple-cont-index (create PostgreSQL index on simple content if not exists, default)
--no-create-simple-cont-index (do not create PostgreSQL index on simple content)
--drop-simple-cont-index (drop PostgreSQL index on simple content if exists)
--max-fks-for-simple-cont-index MAX_FKS_FOR_SIMPLE_CONT_INDEX (default=0)
--case-insensitive (all table and column names are lowercase)
--pg-public-schema (utilize "public" schema, default)
--pg-named-schema (enable explicit named schema)
--pg-map-big-integer (map xs:integer to BigInteger according to the W3C rules)
--pg-map-long-integer (map xs:integer to signed long 64 bits)
--pg-map-integer (map xs:integer to signed int 32 bits, default)
--pg-map-big-decimal (map xs:decimal to BigDecimal according to the W3C rules, default)
--pg-map-double-decimal (map xs:decimal to double precision 64 bits)
--pg-map-float-decimal (map xs:decimal to single precision 32 bits)
--pg-map-timestamp (map xs:date to PostgreSQL timestamp type according to the W3C rules)
--pg-map-date (map xs:date to PostgreSQL date type, default)
--pg-tab-delimiter (use tab separated file)
--no-cache-xsd (retrieve XML Schemata without caching)
--sync CHECK_SUM_DIRECTORY (generate check sum files for differential update, select --create-doc-key-index option by default)
--checksum-by ALGORITHM [MD2 | MD5 (default) | SHA-1 | SHA-224 | SHA-256 | SHA-384 | SHA-512]
--hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 | SHA-256 | SHA-384 | SHA-512]
--hash-size BIT_SIZE [int (32 bits) | long (64 bits, default) | native (default bit of algorithm) | debug (string)]
--ser-size BIT_SIZE [short (16 bits) | int (32 bits, default)]
--xml-file-prerix-digest DIGESTIBLE_PREFIX (default="")
--xml-file-ext-digest DIGESTIBLE_EXTENSION (default=".")
--lower-case-doc-key (lower case document key)
--upper-case-doc-key (upper case document key)
--fill-default-value (fill @default value in case of empty)
--filt-in table_name.column_name

```
        --filt-out  table_name.column_name:regex_pattern(|
regex_pattern...)
        --fill-this table_name.column_name:filling_text
        --doc-key-name DOC_KEY_NAME (default="document_id")
        --ser-key-name SER_KEY_NAME (default="serial_id")
        --xpath-key-name XPATH_KEY_NAME (default="xpath_id")
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
        --doc-key-if-no-inplace (append document key if no in-place
document key, select --no-doc-key options by default)
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --max-thrds MAX_THRDS (default is number of available
processors)
```

Appendix 4. Arguments of the **csv2pgsql** (or **tsv2pgsql**) main class

```
csv2pgsql: CSV -> PostgreSQL data migration
Usage:  --xsd SCHEMA_LOCATION --work-dir DIRECTORY (default="pg_work")
--db-name DATABASE --db-user USER --db-pass PASSWORD (default="")
        --db-host PG_HOST_NAME (default="localhost")
        --db-port PG_PORT_NUMBER (default=5432)
        --test-ddl (perform consistency test on PostgreSQL DDL)
        --min-rows-for-index MIN_ROWS_FOR_INDEX (default=2048)
        --create-non-uniq-pkey-index (create PostgreSQL index on non-
unique primary key if not exists, default)
        --no-create-non-uniq-pkey-index (do not create PostgreSQL
index on non-unique primary key)
        --drop-non-uniq-pkey-index (drop PostgreSQL index on non-
unique primary key if exists)
        --create-doc-key-index (create PostgreSQL index on document
key if not exists, enable if --sync option is selected)
        --no-create-doc-key-index (do not create PostgreSQL index on
document key, default if no --sync option)
        --drop-doc-key-index (drop PostgreSQL index on document key if
exists)
        --create-attr-index (create PostgreSQL index on attribute if
not exists, default)
        --no-create-attr-index (do not create PostgreSQL index on
attribute)
        --drop-attr-index (drop PostgreSQL index on attribute if
exists)
        --max-attr-cols-for-index MAX_ATTR_COLS_FOR_INDEX (default=1)
        --create-elem-index (create PostgreSQL index on element if not
exists)
        --no-create-elem-index (do not create PostgreSQL index on
element, default)
        --drop-elem-index (drop PostgreSQL index on element if exists)
        --max-elem-cols-for-index MAX_ELEM_COLS_FOR_INDEX (default=1)
        --create-simple-cont-index (create PostgreSQL index on simple
content if not exists, default)
        --no-create-simple-cont-index (do not create PostgreSQL index
on simple content)
        --drop-simple-cont-index (drop PostgreSQL index on simple
content if exists)
        --max-fks-for-simple-cont-index MAX_FKS_FOR_SIMPLE_CONT_INDEX
(default=0)
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --realize-simple-brdg (realize simple bridge tables, otherwise
implement them as PostgreSQL views by default)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
```

--no-doc-key (remove document_id column from all relations, effective only with relational model extension)
--ser-key (append serial_id column in child relation of list holder)
--xpath-key (append xpath_id column in all relations)
Option: **--case-insensitive** (all table and column names are lowercase)
--pg-public-schema (utilize "public" schema, default)
--pg-named-schema (enable explicit named schema)
--pg-map-big-integer (map xs:integer to BigInteger according to the W3C rules)
--pg-map-long-integer (map xs:integer to signed long 64 bits)
--pg-map-integer (map xs:integer to signed int 32 bits, default)
--pg-map-big-decimal (map xs:decimal to BigDecimal according to the W3C rules, default)
--pg-map-double-decimal (map xs:decimal to double precision 64 bits)
--pg-map-float-decimal (map xs:decimal to single precision 32 bits)
--pg-map-timestamp (map xs:date to PostgreSQL timestamp type according to the W3C rules)
--pg-map-date (map xs:date to PostgreSQL date type, default)
--pg-tab-delimiter (use tab separated file)
--no-cache-xsd (retrieve XML Schemata without caching)
--doc-key-name DOC_KEY_NAME (default="document_id")
--ser-key-name SER_KEY_NAME (default="serial_id")
--xpath-key-name XPATH_KEY_NAME (default="xpath_id")
--discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
--inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
--doc-key-if-no-inplace (append document key if no in-place document key, select --no-doc-key options by default)
--no-pgschema-serv (not utilize PgSchema server)
--pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME (default="localhost")
--pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)

Appendix 5. Arguments of the **xml2luceneidx** main class

```
xm2luceneidx: XML -> Lucene full-text indexing
Usage:  --xsd SCHEMA_LOCATION --xml XML_FILE_OR_DIRECTORY --idx-dir
DIRECTORY (default="lucene_index")
        --update (insert if not exists, and update if required,
default)
        --sync CHECK_SUM_DIRECTORY (insert if not exists, update if
required, and delete rows if XML not exists)
        --sync-weak (insert if not exists, no update even if exists,
no deletion)
        --rel (turn on relational model extension)
        --no-rel (turn off relational model extension, default)
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --validate (turn on XML Schema validation)
        --no-validate (turn off XML Schema validation, default)
        --well-formed (validate only whether document is well-formed)
        --xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates
xml.gz suffix) | zip (indicates xml.zip suffix)]
        --shard-size SHARD_SIZE (default=1)
        --min-word-len MIN_WORD_LENGTH (default is 1)
        --numeric-idx (allow to store numeric values in index)
Option: --attr  table_name.column_name
        --field table_name.column_name
        --field-all (index all fields, default)
        --attr-all (all attributes's values are stored as attribute)
        --attr-string (all string values are stored as attribute)
        --attr-integer (all integer values are stored as attribute)
        --attr-float (all float values are stored as attribute)
        --attr-date (all date values are stored as attribute)
        --attr-time (all time values are stored as attribute)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 |
SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int (32 bits) | long (64 bits, default)
| native (default bit of algorithm) | debug (string)]
        --xml-file-prerix-digest DIGESTIBLE_PREFIX (default="")
        --xml-file-ext-digest DIGESTIBLE_EXTENSION (default=".")
        --lower-case-doc-key (lower case document key)
        --upper-case-doc-key (upper case document key)
        --fill-default-value (fill @default value in case of empty)
        --filt-in   table_name.column_name
        --filt-out  table_name.column_name:regex_pattern(|
regex_pattern...)
        --fill-this table_name.column_name:filling_text
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --no-pgschema-serv (not utilize PgSchema server)
```

```
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --max-thrds MAX_THRDS (default is number of available
processors)
```

Appendix 6.1. Arguments of the **luceneidx2dic** (or **luceneidx2ftxt**) main class

```
luceneidx2dic: Lucene index -> Lucene dictionary
Usage:  --idx-dir DIRECTORY (default="lucene_index") --dic-dir
DIRECTORY (default="lucene_dic") --dic DIC_FILE (default="dictionary")
Option: --field FIELD_NAME (default="content")
        --freq FREQ_THRESHOLD (default=10)
```

Appendix 6.2. Arguments of the **luceneidx2ftxt** main class

```
luceneidx2infix: Lucene index -> Lucene analyzed infix suggester
Usage:  --idx-dir DIRECTORY (default="lucene_index") --infix-dir
DIRECTORY (default="lucene_infix")
Option: --field FIELD_NAME (default="content")
        --freq FREQ_THRESHOLD (default=10)
```

Appendix 7. Arguments of the **xml2sphinxds** main class

```
xml2sphinxds: XML -> Sphinx data source (xmlpipe2) conversion for
full-text indexing
Usage:  --xsd SCHEMA_LOCATION --xml XML_FILE_OR_DIRECTORY --ds-dir
DIRECTORY (default="sphinx_xmlpipe2")
        --update (insert if not exists, and update if required,
default)
        --sync CHECK_SUM_DIRECTORY (insert if not exists, update if
required, and delete rows if XML not exists)
        --sync-weak (insert if not exists, no update even if exists,
no deletion)
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --validate (turn off XML Schema validation)
        --no-validate (turn off XML Schema validation, default)
        --well-formed (validate only whether document is well-formed)
        --xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates
xml.gz suffix) | zip (indicates xml.zip suffix)]
        --shard-size SHARD_SIZE (default=1)
        --min-word-len MIN_WORD_LENGTH (default is 1)
        --max-field-len MAX_FIELD_LENGTH (default is 2M)
Option: --ds-name DS_NAME (default name is determined by quoting XSD
file name)
        --attr  table_name.column_name
        --field table_name.column_name
        --mva   table_name.column_name (multi-valued attribute)
        --field-all (index all fields, default)
        --attr-all (all attributes's values are stored as attribute)
        --attr-string (all string values are stored as attribute)
        --attr-integer (all integer values are stored as attribute)
        --attr-float (all float values are stored as attribute)
        --attr-date (all date values are stored as attribute)
        --attr-time (all time values are stored as attribute)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 |
SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int | long (default) | native | debug]
        --xml-file-prerix-digest DIGESTIBLE_PREFIX (default="")
        --xml-file-ext-digest DIGESTIBLE_EXTENSION (default=".")
        --lower-case-doc-key (lower case document key)
        --upper-case-doc-key (upper case document key)
        --fill-default-value (fill @default value in case of empty)
        --filt-in   table_name.column_name
        --filt-out  table_name.column_name:regex_pattern(|
regex_pattern...)
        --fill-this table_name.column_name:filling_text
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --no-pgschema-serv (not utilize PgSchema server)
```

```
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --max-thrds MAX_THRDS (default is number of available
processors)
```

Appendix 8. Arguments of the **dsmerge4sphinx** main class

```
dsmerge4sphinx: Merge Sphinx data source files into one
Usage:  --xsd SCHEMA_LOCATION --dst-ds-dir DIRECTORY
(default="sphinx_xmlpipe2") --src-ds-dir DIRECTORY (repeat until you
specify all directories)
Option: --ds-name DS_NAME (default name is determined by
data_source.conf file)
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
```

Appendix 9. Arguments of the **dicmerge4sphinx** main class

```
dicmerge4sphinx: Sphinx data source -> Sphinx dictionary index
Usage:  --ds-dir DIRECTORY (default="sphinx_xmlpipe2")
        --dic DIC_FILE (repeat until you specify all dictionaries)
Option: --freq FREQ_THRESHOLD (default=10)
```

Appendix 10. Arguments of the **xsd2jsonschema** main class

```
xsd2jsonschema: XML Schema -> JSON Schema conversion
Usage:  --xsd SCHEMA_LOCATION --json JSON_SCHEMA_FILE (default=stdout)
        --schema-ver JSON_SCHEMA_VER (choose from "2019_09" (default),
"draft_v8", "draft_v7", "draft_v6", "draft_v4", or "latest" as
“2019_09“)
        --obj-json (use object-oriented JSON format)
        --col-json (use column-oriented JSON format, default)
        --rel-json (use relational-oriented JSON format)
Option: --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --case-insensitive (all table and column names are lowercase)
        --json-map-date-time (map xs:date to JSON Schema date-time
type according to the W3C rules)
        --json-map-date (map xs:date to JSON Schema date type,
default)
        --field-annotation (retrieve field annotation, default)
        --no-field-annotation (do not retrieve field annotation)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --json-attr-prefix ATTR_PREFIX_CODE (default="")
        --json-simple-cont-name SIMPLE_CONTENT_NAME
(default="content")
        --json-indent-offset INTEGER (default=2, min=0, max=4)
        --json-key-value-offset INTEGER (default=1, min=0, max=4)
        --json-no-linefeed (dismiss line feed code)
        --json-compact (equals to set --json-indent-offset 0 --json-
key-value-offset 0 --json-no-linefeed)
        --json-array-all (use JSON array uniformly for descendants,
effective only in column- and relational-oriented JSON format)
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
```

Appendix 11. Arguments of the **xml2json** main class

```
xml2json: XML -> JSON document conversion
Usage:  --xsd SCHEMA_LOCATION --xml XML_FILE_OR_DIRECTORY --json-dir
DIRECTORY (default="json_work")
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --validate (turn on XML Schema validation)
        --no-validate (turn off XML Schema validation, default)
        --well-formed (validate only whether document is well-formed)
        --xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates
xml.gz suffix) | zip (indicates xml.zip suffix)]
        --schema-ver JSON_SCHEMA_VER (choose from "2019_09" (default),
"draft_v8", "draft_v7", "draft_v6", "draft_v4", or "latest" as
"2019_09")
        --obj-json (use object-oriented JSON format)
        --col-json (use column-oriented JSON format, default)
        --rel-json (use relational-oriented JSON format)
Option: --json-attr-prefix ATTR_PREFIX_CODE (default="")
        --json-simple-cont-name SIMPLE_CONTENT_NAME
(default="content")
        --json-indent-offset INTEGER (default=2, min=0, max=4)
        --json-key-value-offset INTEGER (default=1, min=0, max=4)
        --json-no-linefeed (dismiss line feed code)
        --json-compact (equals to set --json-indent-offset 0 --json-
key-value-offset 0 --json-no-linefeed)
        --json-array-all (use JSON array uniformly for descendants,
effective only in column- and relational-oriented JSON format)
        --case-insensitive (all table and column names are lowercase)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --xml-file-prerix-digest DIGESTIBLE_PREFIX (default="")
        --xml-file-ext-digest DIGESTIBLE_EXTENSION (default=".")
        --lower-case-doc-key (lower case document key)
        --upper-case-doc-key (upper case document key)
        --fill-default-value (fill @default value in case of empty)
        --filt-in   table_name.column_name
        --filt-out  table_name.column_name:regex_pattern(|
regex_pattern...)
        --fill-this table_name.column_name:filling_text
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --max-thrds MAX_THRDS (default is number of available
processors)
```

Appendix 12. Arguments of the **xpathparser** main class

```
xpathparser: XPath 1.0 parser being aware of XML Schema
Usage:  --xsd SCHEMA_LOCATION
        --xpath-query XPATH_QUERY
        --xpath-var KEY=VALUE (repeat until you specify all variables)
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
        --no-doc-key (remove document_id column from all relations,
effective only with relational model extension)
        --ser-key (append serial_id column in child relation of list
holder)
        --xpath-key (append xpath_id column in all relations)
Option: --case-insensitive (all table and column names are lowercase)
        --pg-public-schema (utilize "public" schema, default)
        --pg-named-schema (enable explicit named schema)
        --pg-map-big-integer (map xs:integer to BigInteger according
to the W3C rules)
        --pg-map-long-integer (map xs:integer to signed long 64 bits)
        --pg-map-integer (map xs:integer to signed int 32 bits,
default)
        --pg-map-timestamp (map xs:date to PostgreSQL timestamp type
according to the W3C rules)
        --pg-map-date (map xs:date to PostgreSQL date type, default)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 |
SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int (32 bits) | long (64 bits, default)
| native (default bit of algorithm) | debug (string)]
        --ser-size BIT_SIZE [short (16 bits); | int (32 bits,
default)]
        --doc-key-name DOC_KEY_NAME (default="document_id")
        --ser-key-name SER_KEY_NAME (default="serial_id")
        --xpath-key-name XPATH_KEY_NAME (default="xpath_id")
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
        --doc-key-if-no-inplace (append document key if no in-place
document key, select --no-doc-key options by default)
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
```

Appendix 13. Arguments of the **xpath2xml** main class

```
xpath2xml: XPath 1.0 query evaluation to XML over PostgreSQL
Usage:  --xsd SCHEMA_LOCATION --db-name DATABASE --db-user USER --db-
pass PASSWORD (default="")
        --db-host PG_HOST_NAME (default="localhost")
        --db-port PG_PORT_NUMBER (default=5432)
        --test-ddl (perform consistency test on PostgreSQL DDL)
        --xpath-query XPATH_QUERY (repeatable)
        --xpath-var KEY=VALUE (repeat until you specify all variables)
        --out OUTPUT_FILE_OR_PATTERN (default=stdout)
        --out-dir OUTPUT_DIRECTORY
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
        --no-doc-key (remove document_id column from all relations,
effective only with relational model extension)
        --ser-key (append serial_id column in child relation of list
holder)
        --xpath-key (append xpath_id column in all relations)
Option: --case-insensitive (all table and column names are lowercase)
        --pg-public-schema (utilize "public" schema, default)
        --pg-named-schema (enable explicit named schema)
        --pg-map-big-integer (map xs:integer to BigInteger according
to the W3C rules)
        --pg-map-long-integer (map xs:integer to signed long 64 bits)
        --pg-map-integer (map xs:integer to signed int 32 bits,
default)
        --pg-map-big-decimal (map xs:decimal to BigDecimal according
to the W3C rules, default)
        --pg-map-double-decimal (map xs:decimal to double precision 64
bits)
        --pg-map-float-decimal (map xs:decimal to single precision 32
bits)
        --pg-map-timestamp (map xs:date to PostgreSQL timestamp type
according to the W3C rules)
        --pg-map-date (map xs:date to PostgreSQL date type, default)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 |
SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int (32 bits) | long (64 bits, default)
| native (default bit of algorithm) | debug (string)]
        --ser-size BIT_SIZE [short (16 bits); | int (32 bits,
default)]
        --doc-key-name DOC_KEY_NAME (default="document_id")
        --ser-key-name SER_KEY_NAME (default="serial_id")
        --xpath-key-name XPATH_KEY_NAME (default="xpath_id")
```

--discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
--inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
--doc-key-if-no-inplace (append document key if no in-place document key, select --no-doc-key options by default)
--no-pgschema-serv (not utilize PgSchema server)
--pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME (default="localhost")
--pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
--xml-no-declare (dismiss XML declaration)
--xml-unqualify-def-ns (unqualify default target namespace if possible)
--xml-no-xmlns (dismiss XML namespace declaration)
--xml-no-nil-elem (dismiss nillable element)
--xml-allow-frag (allow fragmented XML document)
--xml-indent-offset INTEGER (default=2, min=0, max=4)
--xml-insert-doc-key (insert document key in result)
--xml-no-linefeed (dismiss line feed code)
--xml-compact (equals to set --xml-indent-offset 0 --xml-no-linefeed)
--verbose (verbose mode)

Appendix 14. Arguments of the **xpath2json** main class

```
xpath2json: XPath 1.0 query evaluation to JSON over PostgreSQL
Usage:  --xsd SCHEMA_LOCATION --db-name DATABASE --db-user USER --db-
pass PASSWORD (default="")
        --db-host PG_HOST_NAME (default="localhost")
        --db-port PG_PORT_NUMBER (default=5432)
        --test-ddl (perform consistency test on PostgreSQL DDL)
        --xpath-query XPATH_QUERY (repeatable)
        --xpath-var KEY=VALUE (repeat until you specify all variables)
        --out OUTPUT_FILE_OR_PATTERN (default=stdout)
        --out-dir OUTPUT_DIRECTORY
        --schema-ver JSON_SCHEMA_VER (choose from "2019_09" (default),
"draft_v8", "draft_v7", "draft_v6", "draft_v4", or "latest" as
“2019_09“)
        --obj-json (use object-oriented JSON format)
        --col-json (use column-oriented JSON format, default)
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
        --no-doc-key (remove document_id column from all relations,
effective only with relational model extension)
        --ser-key (append serial_id column in child relation of list
holder)
        --xpath-key (append xpath_id column in all relations)
Option: --case-insensitive (all table and column names are lowercase)
        --pg-public-schema (utilize "public" schema, default)
        --pg-named-schema (enable explicit named schema)
        --pg-map-big-integer (map xs:integer to BigInteger according
to the W3C rules)
        --pg-map-long-integer (map xs:integer to signed long 64 bits)
        --pg-map-integer (map xs:integer to signed int 32 bits,
default)
        --pg-map-big-decimal (map xs:decimal to BigDecimal according
to the W3C rules, default)
        --pg-map-double-decimal (map xs:decimal to double precision 64
bits)
        --pg-map-float-decimal (map xs:decimal to single precision 32
bits)
        --pg-map-timestamp (map xs:date to PostgreSQL timestamp type
according to the W3C rules)
        --pg-map-date (map xs:date to PostgreSQL date type, default)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 |
SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int (32 bits) | long (64 bits, default)
| native (default bit of algorithm) | debug (string)]
```

```
        --ser-size BIT_SIZE [short (16 bits); | int (32 bits,
default)]
        --doc-key-name DOC_KEY_NAME (default="document_id")
        --ser-key-name SER_KEY_NAME (default="serial_id")
        --xpath-key-name XPATH_KEY_NAME (default="xpath_id")
        --discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
        --inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
        --doc-key-if-no-inplace (append document key if no in-place
document key, select --no-doc-key options by default)
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --json-attr-prefix ATTR_PREFIX_CODE (default="")
        --json-simple-cont-name SIMPLE_CONTENT_NAME
(default="content")
        --json-array-all (use JSON array if possible)
        --json-allow-frag (allow fragmented JSON document)
        --json-indent-offset INTEGER (default=2, min=0, max=4)
        --json-key-value-offset INTEGER (default=1, min=0, max=4)
        --json-insert-doc-key (insert document key in result)
        --json-no-linefeed (dismiss line feed code)
        --json-compact (equals to set --json-indent-offset 0 --json-
key-value-offset 0 --json-no-linefeed)
       --verbose (verbose mode)
```

Appendix 15. Arguments of the **xpath2pgsql** main class

```
xpath2pgsql: Query translation from XPath 1.0 to SQL
Usage:  --xsd SCHEMA_LOCATION --db-name DATABASE --db-user USER --db-
pass PASSWORD (default="")
        --db-host PG_HOST_NAME (default="localhost")
        --db-port PG_PORT_NUMBER (default=5432)
        --test-ddl (perform consistency test on PostgreSQL DDL)
        --xpath-query XPATH_QUERY (repeatable)
        --xpath-var KEY=VALUE (repeat until you specify all variables)
        --out OUTPUT_FILE_OR_PATTERN (default=stdout)
        --out-dir OUTPUT_DIRECTORY
        --no-rel (turn off relational model extension)
        --inline-simple-cont (enable inlining simple content)
        --no-wild-card (turn off wild card extension)
        --doc-key (append document_id column in all relations, default
with relational model extension)
        --no-doc-key (remove document_id column from all relations,
effective only with relational model extension)
        --ser-key (append serial_id column in child relation of list
holder)
        --xpath-key (append xpath_id column in all relations)
Option: --case-insensitive (all table and column names are lowercase)
        --pg-public-schema (utilize "public" schema, default)
        --pg-named-schema (enable explicit named schema)
        --pg-map-big-integer (map xs:integer to BigInteger according
to the W3C rules)
        --pg-map-long-integer (map xs:integer to signed long 64 bits)
        --pg-map-integer (map xs:integer to signed int 32 bits,
default)
        --pg-map-big-decimal (map xs:decimal to BigDecimal according
to the W3C rules, default)
        --pg-map-double-decimal (map xs:decimal to double precision 64
bits)
        --pg-map-float-decimal (map xs:decimal to single precision 32
bits)
        --pg-map-timestamp (map xs:date to PostgreSQL timestamp type
according to the W3C rules)
        --pg-map-date (map xs:date to PostgreSQL date type, default)
        --pg-tab-delimiter (use tab separated file, default)
        --pg-comma-delimiter (use comma separated file)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --hash-by ALGORITHM [MD2 | MD5 | SHA-1 (default) | SHA-224 |
SHA-256 | SHA-384 | SHA-512]
        --hash-size BIT_SIZE [int (32 bits) | long (64 bits, default)
| native (default bit of algorithm) | debug (string)]
        --ser-size BIT_SIZE [short (16 bits); | int (32 bits,
default)]
```

--doc-key-name DOC_KEY_NAME (default="document_id")
--ser-key-name SER_KEY_NAME (default="serial_id")
--xpath-key-name XPATH_KEY_NAME (default="xpath_id")
--discarded-doc-key-name DISCARDED_DOCUMENT_KEY_NAME
--inplace-doc-key-name INPLACE_DOCUMENT_KEY_NAME
--doc-key-if-no-inplace (append document key if no in-place document key, select --no-doc-key options by default)
--no-pgschema-serv (not utilize PgSchema server)
--pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME (default="localhost")
--pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
--verbose (verbose mode)

Appendix 16. Arguments of the **xmlsplitter** main class

```
xmlsplitter: Split large XML file into small ones based on XPath query
Usage:  --xsd SCHEMA_LOCATION --xml SRC_XML_FILE_OR_DIRECTORY --xml-
dir DST_DIRECTORY (default="xml_work")
        --xml-file-ext SRC_FILE_EXTENSION [xml (default) | gz
(indicates xml.gz suffix) | zip (indicates xml.zip suffix)]
        --xpath-doc-key XPATH_EXPR_FOR_DOC_KEY
        --no-wild-card (turn off wild card extension)
        --shard-size SHARD_SIZE (default=1)
Option: --pg-public-schema (utilize "public" schema, default)
        --pg-named-schema (enable explicit named schema)
        --no-cache-xsd (retrieve XML Schemata without caching)
        --no-pgschema-serv (not utilize PgSchema server)
        --pgschema-serv-host PG_SCHEMA_SERV_HOST_NAME
(default="localhost")
        --pgschema-serv-port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
        --verbose (verbose mode)
```

Appendix 17. Arguments of the **xmlvalidator** main class

```
xmlvalidator: Validate XML documents against XML Schema
Usage:  --xsd SCHEMA_LOCATION --xml XML_FILE_OR_DIRECTORY
        --well-formed (validate only whether document is well-formed)
        --xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates
xml.gz suffix) | zip (indicates xml.zip suffix)]
Option: --sync CHECK_SUM_DIRECTORY (generate check sum files)
        --checksum-by ALGORITHM [MD2 | MD5 (default) | SHA-1 | SHA-224
| SHA-256 | SHA-384 | SHA-512]
        --max-thrds MAX_THRDS (default is number of available
processors)
        --del-invalid-xml (delete invalid XML documents)
        --verbose (verbose mode)
```

Appendix 18. Arguments of the **chksumstat** main class

```
chksumstat: Report check sum directory status
Usage:  --xml XML_FILE_OR_DIRECTORY --sync-dir CHECK_SUM_DIRECTORY
        --xml-file-ext FILE_EXTENSION [xml (default) | gz (indicates
xml.gz suffix) | zip (indicates xml.zip suffix)]
Option: --checksum-by ALGORITHM [MD2 | MD5 (default) | SHA-1 | SHA-224
| SHA-256 | SHA-384 | SHA-512]
        --xml-file-prerix-digest DIGESTIBLE_PREFIX (default="")
        --xml-file-ext-digest DIGESTIBLE_EXTENSION (default=".")
        --update (update check sum files anyway)
        --max-thrds MAX_THRDS (default is number of available
processors)
        --verbose (verbose mode)
```

Appendix 19. Arguments of the **pgschemaserv** main class

```
pgschemaserv: PgSchema server control
Usage:  --port PG_SCHEMA_SERV_PORT_NUMBER (default=5430)
Option: --host PG_SCHEMA_SERV_HOST_NAME (default="localhost")
        --lifetime LIFETIME_SECOND (default=1209600)
        --start (start PgSchema server, default)
        --status (report PgSchema server status)
        --stop (stop PgSchema server)
```