DBSeeder - Relational Database Performance Comparison.

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1. Introduction

With **DBSeeder**, the same freely definable dummy data can be generated in currently 23 different relational database systems. The data generation process can be used to compare the performance of the different database systems under the same conditions. Currently the following database management systems are supported:

- AgensGraph
  - client only version
  - commercial, open source
  - derived from PostgreSQL
  - property graph model and relational model
  - **see technical details here**
- Apache Derby
  - client and embedded version
  - open source
  - relational model
  - **see technical details here**
- CockroachDB
  - client only version
  - commercial, open source
  - compatible with PostgreSQL JDBC
  - relational model
  - **see technical details here**
- CrateDB
  - client only version
  - commercial, open source
  - compatible with PostgreSQL
  - relational model
  - **see technical details here**
- CUBRID
  - client only version
  - compatible with MySQL
  - open source
  - relational model
  - **see technical details here**
- Exasol
  - client only version
  - commercial
  - in-memory, column-oriented, relational model
  - **see technical details here**

- Firebird
  - client and embedded (not supported here) version
  - open source
  - relational model
  - **see technical details here**
- H2 Database Engine
  - client and embedded version
  - compatible with HyperSQL, PostgreSQL
  - open source
  - relational model
  - **see technical details here**
- HyperSQL Database
  - client and embedded version
  - open source
  - relational model
  - **see technical details here**
- IBM Db2 Database
  - client only version
  - commercial
  - relational model
  - **see technical details here**
- IBM Informix
  - client only version
  - commercial
  - relational model
  - **see technical details here**
- MariaDB Server
  - client only version
  - derived from MySQL
  - open source
  - relational model
  - **see technical details here**
- Microsoft SQL Server
  - client only version
  - commercial
  - derived from Adaptive Server Enterprise
  - relational model
  - **see technical details here**
- Mimer SQL
  - client only version
  - commercial
  - relational model
  - **see technical details here**
- MonetDB
  - client only version
  - open source
  - column-oriented relational model
  - **see technical details here**
- MySQL Database
  - client only version
  - open source
  - relational model
  - **see technical details here**
- OmniSciDB
  - client only version
  - commercial, open source
  - GPU and CPU version
  - relational model
  - **see technical details here**
- Oracle Database
  - client only version

    - commercial
    - relational model
    - **see technical details here**
- Percona Server for MySQL
    - client only version
    - commercial, open source
    - derived from MySQL
    - relational model
    - **see technical details here**
- PostgreSQL
    - client only version
    - open source
    - relational model
    - **see technical details here**
- Trino Distributed Query Engine
    - compatible with Accumulo, Cassandra, Elasticsearch, Hive, Kudu, MongoDB, MySQL, Pinot, PostgreSQL, Redis, Redshift
    - distributed query engine
    - open source
    - **see technical details here**
- SQLite
    - commercial, open source
    - embedded only version
    - relational model
    - **see technical details here**
- VoltDB
    - client only version
    - commercial, open source
    - derived from H-Store, HyperSQL
    - in-memory relational model
    - **see technical details here**
- YugabyteDB
    - client only version
    - commercial, open source
    - compatible with Cassandra, PostgreSQL, Redis
    - derived from PostgreSQL, RocksDB
    - inspired by Cloud Spanner
    - relational model
    - **see technical details here**

The names of the database, the schema and the user can be freely chosen, unless the respective database management system contains restrictions. If the selected database, schema or user already exist, they are deleted with all including data. `DBSeeder` then creates the selected database, schema or user and generates the desired dummy data.

A maximum of 2 147 483 647 rows can be generated per database table.

The database schema to be used, that is, the required database tables can be user defined using a JSON file. Details can be found here: 2.1 Database Schema.

For the DBMS Microsoft SQL Server, MySQL, Oracle and PostgreSQL the JDBC driver from Trino can optionally be used instead of the original JDBC driver. The prerequisite for this is that Trino is either installed locally (Linux) or is available as a Docker container (Linux and Windows). Details can be found here: 6. Trino - Distributed Query Engine.

1.1 Relational Database Management Systems

DBMS	Ticker Symbol(s)	DBMS Versions	Latest JDBC
AgensGraph	agens	v2.1.1 - v2.1.3	1.4.2-c1
Apache Derby	derby, derby_emb	10.15.2.0	10.15.2.0
CockroachDB	cockroach	v20.2.5 - v21.1.1	see PostgreSQL
CrateDB	cratedb	4.1.6 - 4.5.1	2.6.0
CUBRID	cubrid	10.2 - 11.0	11.0.1.0286

DBMS	Ticker Symbol(s)	DBMS Versions	Latest JDBC
Exasol	exasol	6.2.8-d1 - 7.0.9	7.0.7
Firebird	firebird	3.0.5 - v4.0.0rc1	4.0.3.java11
H2 Database Engine	h2, h2_emb	1.4.200	1.4.200
HyperSQL Database	hsqldb, hsqldb_emb	2.5.1 - 2.6.0	2.6.0
IBM Db2 Database	ibmdb2	11.5.1.0 - 11.5.5.1	11.5.5.0
IBM Informix	informix	14.10 FC3DE - 14.10.FC5DE	4.50.4.1
MariaDB Server	mariadb	10.4.13 - 10.6.1	2.7.3
Microsoft SQL Server	sqlserver	2019-latest	9.2.1.jre15
Mimer SQL	mimer	v11.0.3c - v11.0.5a	3.40
MonetDB	monetdb	Jun2020-SP1 - Oct2020-SP5	3.0.jre8
MySQL Database	mysql	8.0.20 - 8.0.25	8.0.25
OmniSciDB	omnisci	5.6.1	5.6.0
Oracle Database	oracle	12c - 19c	21.1.0.0
Percona Server for MySQL	percona	8.0.23-14	see MySQL
PostgreSQL	postgresql	12.3 - 13.3	42.2.20
SQLite	sqlite	3.32.0 - 3.32.3	3.34.0
Trino Distributed Query Engine	mysql_trino,	339 - 357	357
	oracle_trino,		
	postgresql_trino,		
	sqlserver_trino		
VoltDB	voltdb	9.2.1	10.1.1
YugabyteDB	yugabyte	2.2.2.0-b15 - 2.7.1.1-b1	42.2.7-yb-3

2. Data

2.1 Database Schema

The underlying database schema is defined in a JSON-based parameter file and the associated program code is generated and compiled with the script `scripts/run_db_seeder_generate_schema`. To validate the database schema in the JSON parameter file, the JSON schema file `db_seeder_schema.schema.json` in the directory `src/main/resources` is used.

2.1.1 Structure of the Database Schema Definition File

The definition of a database schema consists of the object `global` with the global parameters and the array `tables`, which contains the definition of the database tables.

2.1.1.1 `globals` - Global Parameters

- `defaultNumberOfRows` - default value for the number of table rows to be generated, if no value is specified in the table definition
- `encodingISO_8859_1` - a string with Western Latin characters is inserted into generated character columns
- `encodingUTF_8` - a string with simplified Chines characters is inserted into generated character columns specified in the table definition
- `nullFactor` - determines the proportion of NULL values in optional columns and must be between 2 and 99 (inclusive): 2 means 50%, 4 means 25%, 10 means 10%, etc., default value is 4

2.1.1.2 `tables` - Database Table Definitions

- `tableName` - database table name
- `numberOfRows` - number of table rows to be generated
- `columns` - an array of column definitions

    - `columnName` - column name
    - `dataType` - data type, is one of BIGINT, BLOB, CLOB, TIMESTAMP or VARCHAR
    - `size` - for data type VARCHAR the maximum size of the column value
    - `precision` - currently not used
    - `notNull` - is a NULL value allowed ?
    - `primaryKey` - is this the primary key column ?
    - `references` - an array of foreign key definitions
        - `referenceTable` - name of the reference database table
        - `referenceColumn` - name of the reference column
    - `defaultValueInteger` - default value for integer columns
    - `defaultValueString` - default value for alphanumeric columns
    - `lowerRangeInteger` - lower limit for an integer column, requires also an upper limit
    - `lowerRangeString` - lower limit for an alphanumeric column, requires also an upper limit
    - `upperRangeInteger` - upper limit for an integer column
    - `upperRangeString` - upper limit for an alphanumeric column
    - `validValuesInteger` - valid values for an integer column
    - `validValuesString` - valid values for an alphanumeric column
- `tableConstraints` - an array of table constraint definitions
    - `constraintType` - constraint type, is one of FOREIGN, PRIMARY or UNIQUE
    - `columns` - an arry with the names of the affected columns
    - `referenceTable` - name of the reference database table, only for foreign keys
    - `referenceColumns` - an arry with the names of the affected reference columns, only for foreign keys

Only either a range restriction (`lowerRange...`, `upperRange...`) or a value restriction (`validValues...`) may be specified for each column.

2.1.2 Mapping of Data Types in the JDBC Driver

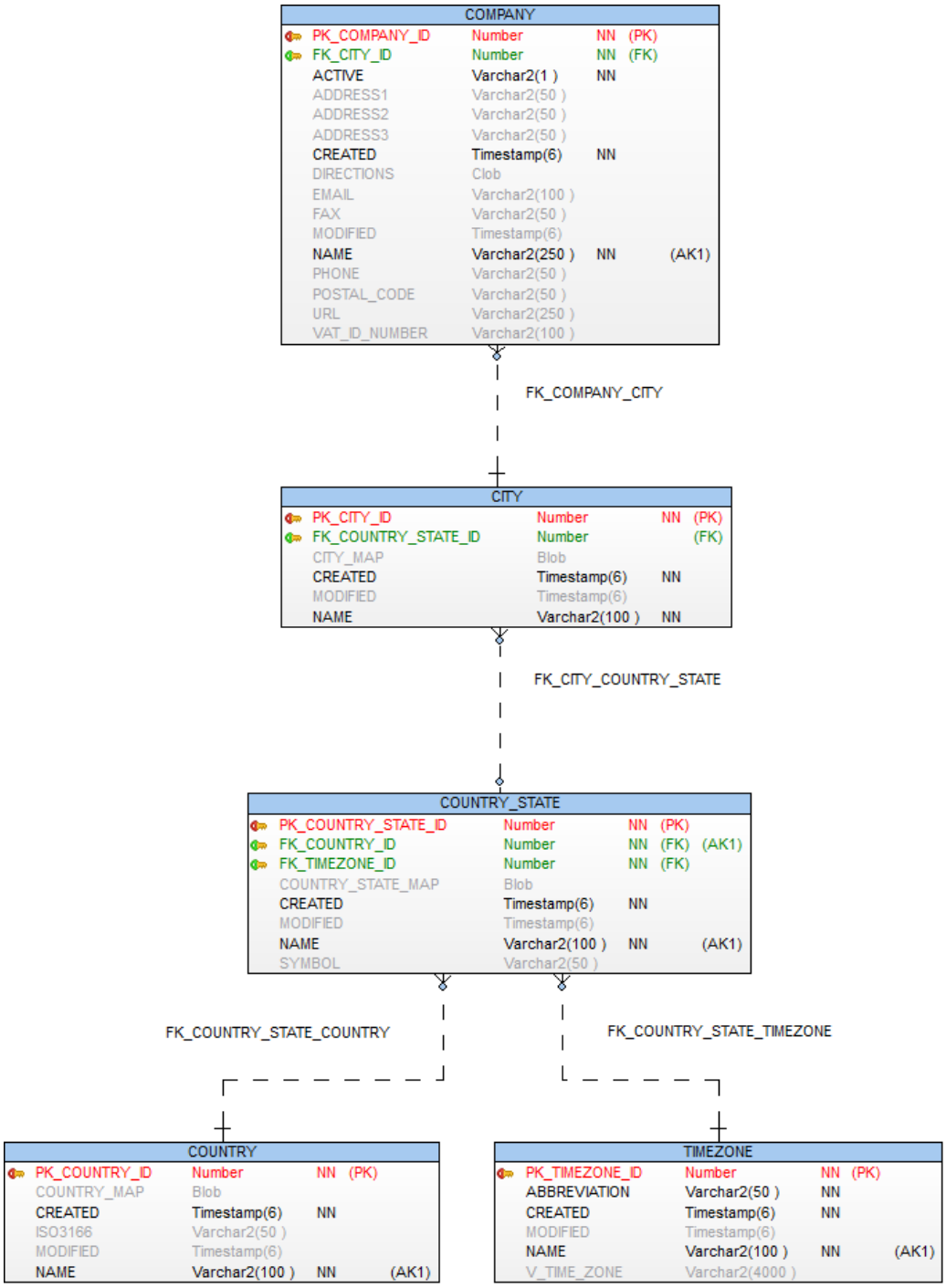
Data Type	JDBC Method
`BIGINT`	`setLong`
`BLOB`	`setBytes`
`CLOB`	`setString`
`TIMESTAMP`	`setTimestamp`
`VARCHAR`	`setNString` (Firebird, MariaDB, MS SQL SERVER and Oracle)
	`setString` (else)

2.1.3 Example File `db_seeder_schema.company.json` in the Directory `resources/json`

This file contains the definition of a simple database schema consisting of the database tables CITY, COMPANY, COUNTRY, COUNTRY_STATE and TIMEZONE.

The abbreviations in the following illustration (created with Toad Data Modeler) mean:

- (AK1) - alternate key (unique key)
- FK - foreign key
- NN - not null
- PK - primary key



2.2 Construction of the Dummy Data Content

The proportion of `NULL` values in optional columns is defined by the global parameter `nullFactor`.

All methods for generating column contents can be overwritten if necessary.

2.2.1 BIGINT

Java method: `getContentBigint`

- If the column parameter `validValuesInteger` is defined in the database schema, a random value is taken from it.
- If the column parameters `lowerRangeInteger` and `upperRangeInteger` are defined in the database schema, a random value is taken from this interval.
- Otherwise the counter for the current row (row number) is used.

2.2.2 BLOB

Java method: `getContentBlob`

- The content of the file `blob.png` from the resource directory (`src/main/resources`) is loaded into these columns.This file contains the company logo of Konnexions GmBH.

2.2.3 CLOB

Java method: `getContentClob`

- The content of the file `clob.md` from the resource directory (`src/main/resources`) is loaded into these columns. This file contains the text of the Konnexions Public License (KX-PL).

2.2.4 TIMESTAMP

Java method: `getContentTimestamp`

- A randomly generated timestamp is assigned to all columns that can contain temporal data.

2.2.5 VARCHAR

Java method: `getContentVarchar`

- If the column parameter `validValuesString` is defined in the database schema, a random value is taken from it.
- If the column parameters `lowerRangeString` and `upperRangeString` are defined in the database schema, a random value is taken from this interval.
- Otherwise content of the column is constructed depending on the row number and the encoding flags as follows:
    - ASCII (all rows where the index modulo 3 is 0):
        - column name in capital letters
        - underscore _
        - current row number left-justified
    - ISO 8859 1 (all rows where the index modulo 3 is 1) :
        - column name in capital letters
        - underscore _
        - a string containing specific Western European characters with accent (e.g. French, Portuguese or Spanish)
        - underscore _
        - current row number left-justified
    - the ISO 8859 1 version can be prevented by choosing `encodingISO_8859_1 false` in the database schema definition
    - UTF-8 (all rows where the index modulo 3 is 2):
        - column name in capital letters
        - underscore _
        - a string containing simplified Chinese characters
        - underscore _
        - current row number left-justified
    - the UTF-8 version can be prevented by choosing `encodingUTF_8 false` in the database schema definition
    - If the resulting value exceeds the permissible column size, the value is shortened accordingly from the left

2.2.6 Examples

1. Table CITY

CITY | Enter a SQL expression to filter results (use Ctrl+Space)

Grid | Text

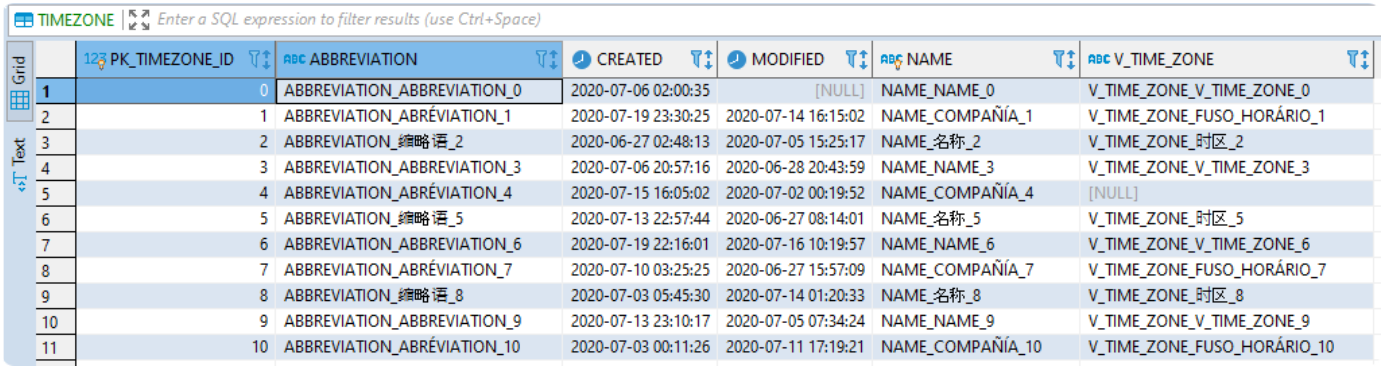
	PK_CITY_ID	FK_COUNTRY_STATE_ID	CITY_MAP	CREATED	MODIFIED	NAME
1	0	417	PNG IHDR Õ Ü çOä... [19664]	2020-07-07 21:16:36	2020-07-09 13:58:19	NAME_NAME_0
2	1	154	[NULL]	2020-07-01 15:29:56	2020-07-11 13:22:42	NAME_COMPAÑÍA_1
3	2	307	PNG IHDR Õ Ü çOä... [19664]	2020-07-03 17:37:20	[NULL]	NAME_名称_2
4	3	270	PNG IHDR Õ Ü çOä... [19664]	2020-07-03 08:17:33	2020-07-03 09:21:59	NAME_NAME_3
5	4	201	PNG IHDR Õ Ü çOä... [19664]	2020-07-09 02:37:50	[NULL]	NAME_COMPAÑÍA_4
6	5	119	PNG IHDR Õ Ü çOä... [19664]	2020-07-13 23:50:00	2020-07-12 20:48:13	NAME_名称_5
7	6	[NULL]	[NULL]	2020-07-20 18:08:54	[NULL]	NAME_NAME_6
8	7	[NULL]	PNG IHDR Õ Ü çOä... [19664]	2020-07-10 02:51:42	2020-07-13 22:11:40	NAME_COMPAÑÍA_7
9	8	261	PNG IHDR Õ Ü çOä... [19664]	2020-07-13 14:53:57	[NULL]	NAME_名称_8
10	9	584	[NULL]	2020-07-13 20:23:48	[NULL]	NAME_NAME_9
11	10	[NULL]	PNG IHDR Õ Ü çOä... [19664]	2020-07-04 17:37:34	[NULL]	NAME_COMPAÑÍA_10
12	11	35	PNG IHDR Õ Ü çOä... [19664]	2020-07-19 01:25:20	2020-06-27 19:33:15	NAME_名称_11
13	12	553	PNG IHDR Õ Ü çOä... [19664]	2020-06-28 16:59:18	[NULL]	NAME_NAME_12
14	13	401	PNG IHDR Õ Ü çOä... [19664]	2020-07-09 15:50:28	2020-07-11 00:37:42	NAME_COMPAÑÍA_13
15	14	127	PNG IHDR Õ Ü çOä... [19664]	2020-07-15 07:32:40	2020-07-01 18:59:11	NAME_名称_14
16	15	296	PNG IHDR Õ Ü çOä... [19664]	2020-07-10 12:51:31	2020-07-17 11:12:31	NAME_NAME_15
17	16	[NULL]	PNG IHDR Õ Ü çOä... [19664]	2020-07-18 19:15:29	2020-07-11 12:23:04	NAME_COMPAÑÍA_16
18	17	523	PNG IHDR Õ Ü çOä... [19664]	2020-07-08 23:38:14	2020-07-09 19:58:29	NAME_名称_17
19	18	230	PNG IHDR Õ Ü çOä... [19664]	2020-07-01 01:32:05	2020-07-11 15:13:29	NAME_NAME_18
20	19	275	[NULL]	2020-07-02 19:47:10	2020-06-28 15:22:39	NAME_COMPAÑÍA_19
21	20	274	PNG IHDR Õ Ü çOä... [19664]	2020-07-19 23:43:47	2020-07-04 22:07:54	NAME_名称_20
22	21	[NULL]	[NULL]	2020-07-11 22:24:56	[NULL]	NAME_NAME_21
23	22	[NULL]	PNG IHDR Õ Ü çOä... [19664]	2020-07-08 03:42:43	2020-07-01 21:37:16	NAME_COMPAÑÍA_22
24	23	[NULL]	PNG IHDR Õ Ü çOä... [19664]	2020-06-27 08:43:04	2020-06-29 23:47:39	NAME_名称_23
25	24	158	PNG IHDR Õ Ü çOä... [19664]	2020-06-28 20:05:01	2020-07-09 22:41:36	NAME_NAME_24

2. Table COUNTRY

COUNTRY | Enter a SQL expression to filter results (use Ctrl+Space)

	PK_COUNTRY_ID	COUNTRY_MAP	CREATED	ISO3166	MODIFIED	NAME
1	0	PNG IHDR Õ Ü çOä... [19664]	2020-06-28 19:36:46	[NULL]	2020-06-30 00:33:11	NAME_NAME_0
2	1	PNG IHDR Õ Ü çOä... [19664]	2020-07-19 07:16:11	ISO3166_CÓDIGO 3166_1	2020-06-27 23:12:01	NAME_COMPAÑÍA_1
3	2	PNG IHDR Õ Ü çOä... [19664]	2020-07-08 22:39:47	ISO3166_ISO 3166标准_2	2020-07-16 18:37:01	NAME_名称_2
4	3	[NULL]	2020-07-21 14:58:16	ISO3166_ISO3166_3	2020-07-16 01:14:12	NAME_NAME_3
5	4	PNG IHDR Õ Ü çOä... [19664]	2020-07-01 19:00:23	ISO3166_CÓDIGO 3166_4	2020-06-29 07:27:24	NAME_COMPAÑÍA_4
6	5	PNG IHDR Õ Ü çOä... [19664]	2020-07-05 00:54:26	ISO3166_ISO 3166标准_5	2020-07-08 02:20:09	NAME_名称_5
7	6	PNG IHDR Õ Ü çOä... [19664]	2020-07-06 22:36:40	ISO3166_ISO3166_6	2020-07-04 08:24:18	NAME_NAME_6
8	7	PNG IHDR Õ Ü çOä... [19664]	2020-07-20 07:33:21	ISO3166_CÓDIGO 3166_7	2020-06-28 06:10:36	NAME_COMPAÑÍA_7
9	8	PNG IHDR Õ Ü çOä... [19664]	2020-07-21 14:34:52	ISO3166_ISO 3166标准_8	[NULL]	NAME_名称_8
10	9	PNG IHDR Õ Ü çOä... [19664]	2020-07-08 08:27:06	ISO3166_ISO3166_9	2020-07-16 00:17:52	NAME_NAME_9
11	10	[NULL]	2020-06-29 04:43:50	ISO3166_CÓDIGO 3166_10	2020-07-14 19:08:27	NAME_COMPAÑÍA_10
12	11	PNG IHDR Õ Ü çOä... [19664]	2020-06-29 11:03:58	ISO3166_ISO 3166标准_11	[NULL]	NAME_名称_11
13	12	PNG IHDR Õ Ü çOä... [19664]	2020-07-16 15:39:56	ISO3166_ISO3166_12	2020-06-27 16:50:58	NAME_NAME_12
14	13	PNG IHDR Õ Ü çOä... [19664]	2020-07-12 01:44:07	[NULL]	[NULL]	NAME_COMPAÑÍA_13
15	14	PNG IHDR Õ Ü çOä... [19664]	2020-07-12 07:01:06	ISO3166_ISO 3166标准_14	2020-07-18 06:54:10	NAME_名称_14
16	15	PNG IHDR Õ Ü çOä... [19664]	2020-07-09 15:54:56	[NULL]	[NULL]	NAME_NAME_15
17	16	PNG IHDR Õ Ü çOä... [19664]	2020-07-16 12:48:24	[NULL]	[NULL]	NAME_COMPAÑÍA_16
18	17	PNG IHDR Õ Ü çOä... [19664]	2020-07-06 08:49:55	ISO3166_ISO 3166标准_17	[NULL]	NAME_名称_17
19	18	[NULL]	2020-07-19 16:21:58	[NULL]	2020-07-02 11:22:09	NAME_NAME_18
20	19	PNG IHDR Õ Ü çOä... [19664]	2020-07-17 04:08:40	ISO3166_CÓDIGO 3166_19	2020-07-04 04:18:40	NAME_COMPAÑÍA_19
21	20	PNG IHDR Õ Ü çOä... [19664]	2020-07-09 16:02:53	[NULL]	2020-07-19 14:04:43	NAME_名称_20
22	21	PNG IHDR Õ Ü çOä... [19664]	2020-06-29 20:47:52	[NULL]	[NULL]	NAME_NAME_21
23	22	[NULL]	2020-07-12 01:36:41	[NULL]	2020-07-03 14:32:35	NAME_COMPAÑÍA_22
24	23	[NULL]	2020-07-19 09:13:19	ISO3166_ISO 3166标准_23	2020-07-12 17:02:15	NAME_名称_23
25	24	PNG IHDR Õ Ü çOä... [19664]	2020-07-02 10:15:05	[NULL]	2020-07-06 00:07:07	NAME_NAME_24

3. Table TIMEZONE



TIMEZONE — Enter a SQL expression to filter results (use Ctrl+Space)

	PK_TIMEZONE_ID	ABBREVIATION	CREATED	MODIFIED	NAME	V_TIME_ZONE
1	0	ABBREVIATION_ABBREVIATION_0	2020-07-06 02:00:35	[NULL]	NAME_NAME_0	V_TIME_ZONE_V_TIME_ZONE_0
2	1	ABBREVIATION_ABRÉVIATION_1	2020-07-19 23:30:25	2020-07-14 16:15:02	NAME_COMPAÑÍA_1	V_TIME_ZONE_FUSO_HORÁRIO_1
3	2	ABBREVIATION_缩略语_2	2020-06-27 02:48:13	2020-07-05 15:25:17	NAME_名称_2	V_TIME_ZONE_时区_2
4	3	ABBREVIATION_ABBREVIATION_3	2020-07-06 20:57:16	2020-06-28 20:43:59	NAME_NAME_3	V_TIME_ZONE_V_TIME_ZONE_3
5	4	ABBREVIATION_ABRÉVIATION_4	2020-07-15 16:05:02	2020-07-02 00:19:52	NAME_COMPAÑÍA_4	[NULL]
6	5	ABBREVIATION_缩略语_5	2020-07-13 22:57:44	2020-06-27 08:14:01	NAME_名称_5	V_TIME_ZONE_时区_5
7	6	ABBREVIATION_ABBREVIATION_6	2020-07-19 22:16:01	2020-07-16 10:19:57	NAME_NAME_6	V_TIME_ZONE_V_TIME_ZONE_6
8	7	ABBREVIATION_ABRÉVIATION_7	2020-07-10 03:25:25	2020-06-27 15:57:09	NAME_COMPAÑÍA_7	V_TIME_ZONE_FUSO_HORÁRIO_7
9	8	ABBREVIATION_缩略语_8	2020-07-03 05:45:30	2020-07-14 01:20:33	NAME_名称_8	V_TIME_ZONE_时区_8
10	9	ABBREVIATION_ABBREVIATION_9	2020-07-13 23:10:17	2020-07-05 07:34:24	NAME_NAME_9	V_TIME_ZONE_V_TIME_ZONE_9
11	10	ABBREVIATION_ABRÉVIATION_10	2020-07-03 00:11:26	2020-07-11 17:19:21	NAME_COMPAÑÍA_10	V_TIME_ZONE_FUSO_HORÁRIO_10

3. Installation

The easiest way is to download a current release of **DBSeeder** from the GitHub repository. You can find the necessary link here. The system requirements are described in the respective release notes.

4. Operating Instructions

4.1 Scripts

4.1.1 Docker Compose

With the command

```
docker-compose up -d
```

a **DBSeeder** specific development container can be started, which performs the following processing:

- all client databases with the database schema `db_seeder_schema.company.json`
- all client databases with the database schema `db_seeder_schema.syntax.json`
- all embeded databases with the database schema `db_seeder_schema.company.json`
- all Trino databases with the database schema `db_seeder_schema.company.json`

For each of these runs, by default a statistics file is created in the file directory `Transfer` with the following file name structure:

```
db_seeder_compose_<db type>_<schema>_<DBSeeder release>_<yyyy.mm.dd>_<hh24.mi.ss>.tsv
```

If these files are to be included in the statistical analysis, they must be copied from the file directory `Transfer` to the file directory `resources/statistics`.

4.1.2 Script `run_db_seeder`

Using the Konnexions development Docker image from Docker Hub (see here) eliminates the need to install the runtime environment.

With the script `run_db_seeder` the complete functionality of the **DBSeeder** application can be used:

- Creating a suitable database
- Generation of any number of dummy data.

All scripts are available in a Windows version (`cmd` / `.bat`) as well as in a Unix version (`bash` / `.sh`). To run the scripts, apart from the prerequisites as release notes (`ReleaseNotes.md`), only the libraries in the `lib` directory and the corresponding script of `run_db_seeder` are required. The creation of the databases also requires a working access to Docker Hub.

All control parameters used in **DBSeeder** (see section 4.2) can be adapted in the scripts to specific needs.

The `run_db_seeder` script is controlled by the following script parameters::

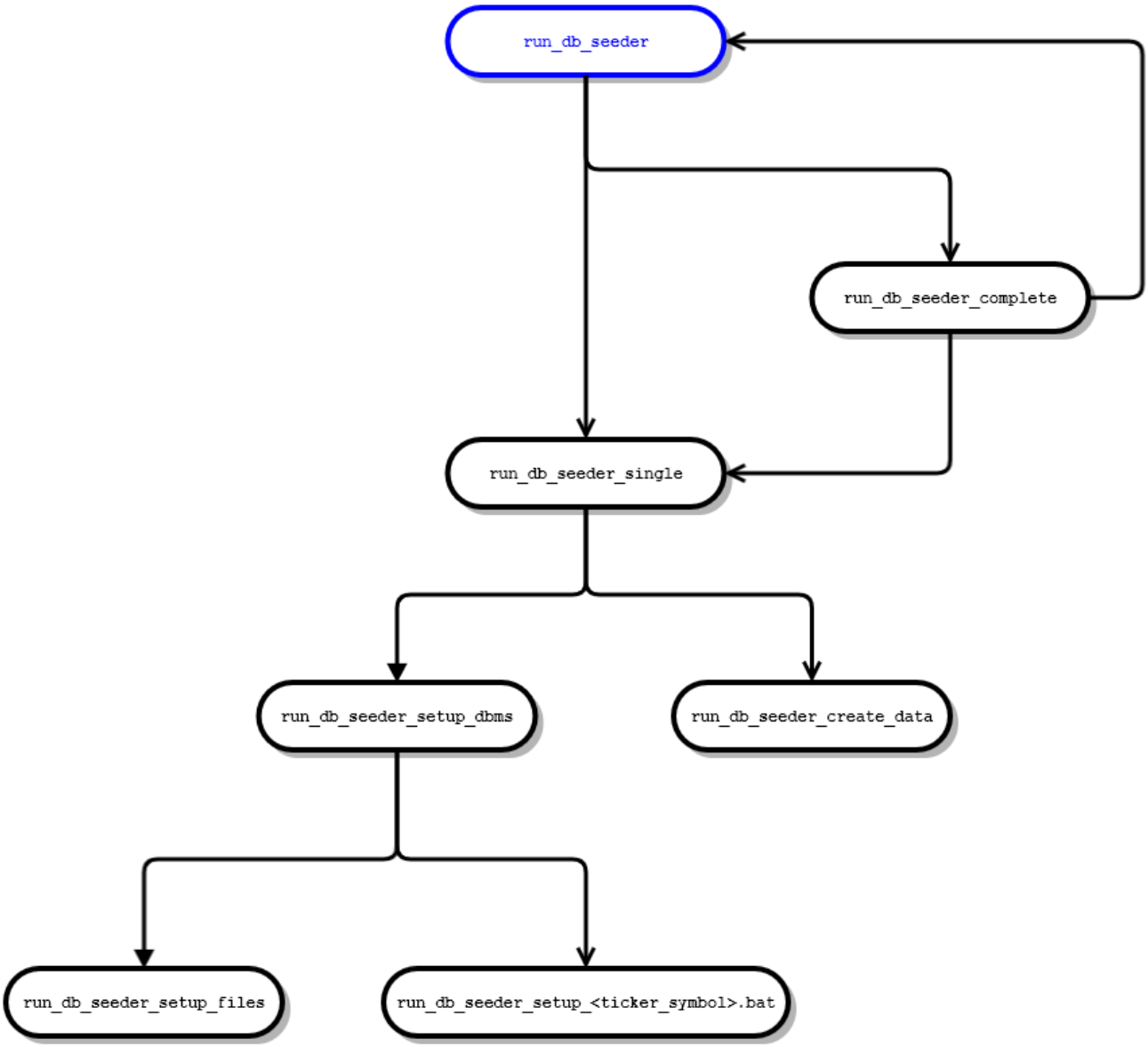
- `DB_SEEDER_DBMS`: the ticker symbol of the desired database management system (default value `sqlite`) or `complete` for all implemented DBMS.
- `DB_SEEDER_SETUP_DBMS`: should an empty database be created:
  - `yes`: a new database is created based on a suitable Docker image
  - otherwise: no database is created

- DB_SEEDER_NO_CREATE_RUNS: Number of dummy data generation runs:
  - 1: one run
  - 2: two runs
  - otherwise: no run

For the run variants complete_client, complete_emb and complete_trino, statistics files with the following data name structure are created in the file directory resources\statistics by default:

```
db_seeder_<bash | cmd>_<db_type>_unknown_<DBSeeder release>.tsv
```

An overview of the structure of the scripts used can be taken from the following diagram:



4.1.3 Script scripts/run_db_seeder_statistics

This script aggregates the existing statistics files into a single overall file. The file name of this overall file is defined with parameter db_seeder.file.statistics.summary.name and the existing statistics files are searched in the file directories according to parameter db_seeder.file.statistics.summary.source. The file format csv or tsv depends on the parameter db_seeder.file.statistics.delimiter.

Example content:

```
ticker symbol   DBMS    version creator db type schema  runtime in ms   start time  end time    host name   no.
cores   operating system    file_name
```

```
agens   AgensGraph  v2.6.0  bash    client  unknown 14  2020-10-05 16:09:36.618076382   2020-10-05
16:09:51.570013623  ubuntu  2   amd64 / Linux / 5.4.0-48-generic    db_seeder_bash_client_unknown_2.6.0
cratedb CrateDB v2.6.0  bash    client  unknown 24  2020-10-05 16:11:40.160409347   2020-10-05
16:12:04.695790414  ubuntu  2   amd64 / Linux / 5.4.0-48-generic    db_seeder_bash_client_unknown_2.6.0
cubrid  CUBRID  v2.6.0  bash    client  unknown 50  2020-10-05 16:13:22.287362093   2020-10-05
16:14:12.339067275  ubuntu  2   amd64 / Linux / 5.4.0-48-generic    db_seeder_bash_client_unknown_2.6.0
```

4.2 Execution Variations

4.2.1 Ubuntu 20.04 LTS (including VMware)

- **Requirements**:
  - Ubuntu 20.04 installed directly or via VMware
  - run `sudo apt update`
  - run `sudo apt install dos2unix git`
  - add the following lines to `.bash_profile`:

    ```
    if [ -f ~/.bashrc ]; then
        source ~/.bashrc
    fi
    ```

  - run `export DOCKER_USERNAME=\<user name\>`
  - run `export DOCKER_PASSWORD=\<password\>`
  - run `git clone https://github.com/KonnexionsGmbH/db_seeder` (cloning the DBSeeder repository)
  - run `cd db_seeder`
  - run `./scripts/run_prep_bash_scripts.sh` (preparing the shell scripts)
  - run `./scripts/run_install_4_ubuntu_20.04_vm_wsl2.sh` (setting up the WSL2 environment)
  - close the Ubuntu shell and reopen it again
  - run `cd db_seeder`
  - run `gradle copyJarToLib`
- **Execution**: run `./run_db_seeder.sh`
- **Issues**:
  - Trino Distributed Query Engine and Microsoft SQL Connector
  - YugabyteDB and Docker image

4.2.1 Ubuntu 20.04 LTS and kxn_dev Image

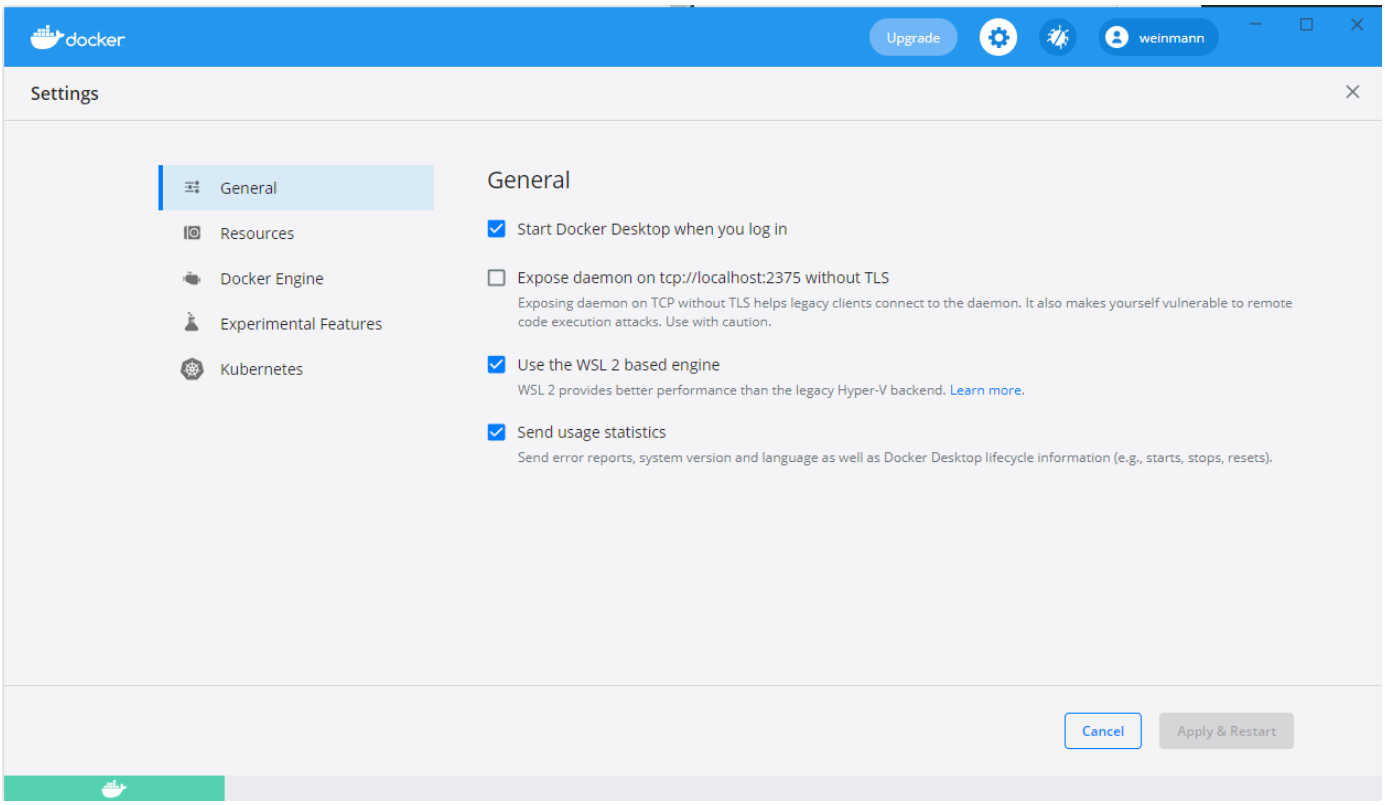
- **Requirements**:
  - pull the `kxn_dev` image from DockerHub: `docker pull konnexionsgmbh/kxn_dev:latest`
  - create an appropriate container: `docker run -it --name kxn_dev -v /var/run/docker.sock:/var/run/docker.sock konnexionsgmbh/kxn_dev:latest bash`
  - run `export DOCKER_USERNAME=\<user name\>`
  - run `export DOCKER_PASSWORD=\<password\>`
  - run `git clone https://github.com/KonnexionsGmbH/db_seeder` (cloning the DBSeeder repository)
  - run `cd db_seeder`
  - run `./scripts/run_prep_bash_scripts.sh` (preparing the shell scripts)
  - run `gradle copyJarToLib`
- **Execution**: `./run_db_seeder.sh`
- **Issues**:
  - Trino Distributed Query Engine and Microsoft SQL Connector

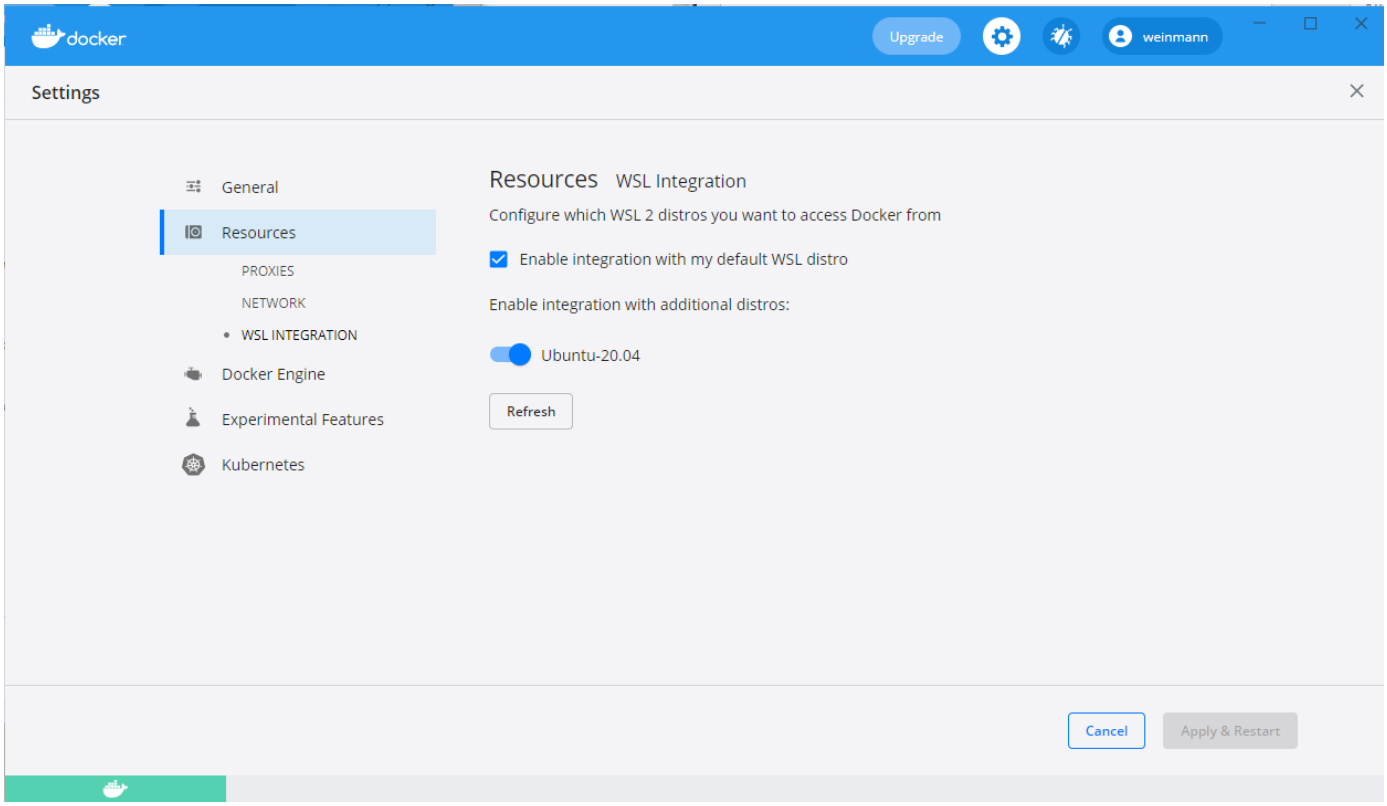
4.2.2 Ubuntu 20.04 LTS and Windows Subsystem Linux 2

- **Requirements**:
  - install Ubuntu 20.04 from Microsoft Marketplace
  - run `sudo apt update`
  - run `sudo apt install dos2unix`
  - add the following lines to `.bash_profile`:

```
if [ -f ~/.bashrc ]; then
    source ~/.bashrc
fi
```

  - activate the `WSL INTEGRATION` for Ubuntu 20.04 in Docker





- **Requirements (continued)**:
  - run `export DOCKER_USERNAME=\<user name\>`
  - run `export DOCKER_PASSWORD=\<password\>`
  - run `git clone https://github.com/KonnexionsGmbH/db_seeder` (cloning the DBSeeder repository)
  - run `cd db_seeder`
  - run `./scripts/run_prep_bash_scripts.sh` (preparing the shell scripts)
  - run `./scripts/run_install_4_ubuntu_20.04_vm_wsl2.sh` (setting up the WSL2 environment)
  - close the Ubuntu shell and reopen it again
  - run `cd db_seeder`
  - run `gradle copyJarToLib`
- **Execution**: run `./run_db_seeder.sh`
- **Issues**:
  - Trino Distributed Query Engine and Microsoft SQL Connector
  - YugabyteDB and Docker image

4.2.3 Windows 10 Pro

- **Requirements**:
  - run `set DOCKER_USERNAME=\<user name\>`
  - run `set DOCKER_PASSWORD=\<password\>`
  - run `git clone https://github.com/KonnexionsGmbH/db_seeder` (cloning the DBSeeder repository)
  - run `cd db_seeder`
- **Execution**: run `run_db_seeder.bat`
- **Issues**:
  - Trino Distributed Query Engine and Microsoft SQL Connector
  - YugabyteDB and Docker image

4.3 Control Parameters

4.3.1 Supported Parameters

The flow control parameters for `DBSeeder` are stored in the properties file `src/main/resources/db_seeder.properties` and can all be overridden by the environment variables defined in the scripts. The following control parameters are currently supported:

```
db_seeder.connection.host=
db_seeder.connection.host.trino=
db_seeder.connection.port=0
```

```
db_seeder.connection.port.trino=0
db_seeder.connection.prefix=
db_seeder.connection.service=
db_seeder.connection.suffix=

db_seeder.database.sys=
db_seeder.database=

db_seeder.file.configuration.name=
db_seeder.file.json.name=resources/json/db_seeder_schema.company.json
db_seeder.file.statistics.delimiter=\t
db_seeder.file.statistics.header=ticker symbol;DBMS;db type;runtime in ms;start time;end time;host name;no.
cores;operating system
db_seeder.file.statistics.name=resources/statistics/db_seeder_local.tsv
db_seeder.file.statistics.summary.name=resources/statistics/db_seeder_summary.tsv
db_seeder.file.statistics.summary.source=resources/statistics;Transfer

db_seeder.password.sys=
db_seeder.password=

db_seeder.schema=

db_seeder.user.sys=
db_seeder.user=
```

4.3.2 Explanation and Cross-reference

Property incl. Default Value [db.seeder.]	Environment Variable [DB_SEEDER_]	Used By	Description
connection.host=<x...x>	CONNECTION_HOST	all client RDBMS	host name or ip address of the database server
connection.host_trino=<x...x>	CONNECTION_HOST_TRINO	Trino	host name or ip address of the Trino distributed query engine
connection.port=<9...9>	CONNECTION_PORT	all client RDBMS	port number of the database server
connection.port_trino=<9...9>	CONNECTION_PORT_TRINO	Trino	port number of the Trino distributed query engine
connection.prefix=<x...x>	CONNECTION_PREFIX	all RDBMS	prefix of the database connection string
connection.service=<x...x>	CONNECTION_SERVICE	oracle	service name of the database connection string
connection.suffix=<x...x>	CONNECTION_SUFFIX	firebird, hsqldb, mysql, percona, voltdb	suffix of the database connection string
database.sys=<x...x>	DATABASE_SYS	agens, cockroach, informix, mariadb, mimer, monetdb, mysql, omnisci, percona,	privileged database name
		postgresql, sqlserver, yugabyte	
database=<x...x>	DATABASE	all DBMS except cratedb, exasol, monetdb, oracle, voltdb	database name
file.configuration.name=<x...x>	FILE_CONFIGURATION_NAME	n/a	directory and file name of the DBSeeder configuration file
file.json.name=<x...x>	FILE_JSON_NAME	scripts/run_db_seeder_generate_schema	directory and file name of the JSON file containing the database schema
file.statistics.delimiter=<x...x>	FILE_STATISTICS_DELIMITER	all DBMS	separator of the statistics file created in `run_db_seeder`

Property incl. Default Value [db.seeder.]	Environment Variable [DB_SEEDER_]	Used By	Description
file.statistics.header=<x...x>	FILE_STATISTICS_HEADER	all DBMS	header line of the statistics file created in `run_db_seeder`
file.statistics.name=<x...x>	FILE_STATISTICS_NAME	all DBMS	file name of the statistics file created in `run_db_seeder`
file.statistics.summary.name=<x...x>	FILE_STATISTICS_SUMMARY_NAME	all DBMS	file name of the summary statistics file created in `run_db_seeder_statistics`
file.statistics.summary.source=<x...x>	FILE_STATISTICS_SUMMARY_SOURCE	all DBMS	directory name(s) (separated by semicolon) of the source directories containing statistics files
password.sys=<x...x>	PASSWORD_SYS	agens, exasol, firebird, ibmdb2, informix, mariadb, mimer, monetdb, mysql, omnisci,	password of the privileged user
		oracle, percona, postgresql, sqlserver	password of the privileged user
password=<x...x>	PASSWORD	all DBMS except cockroach, derby, ibmdb2, informix	password of the normal user
schema=kxn_schema	SCHEMA	agens, derby, exasol, h2, hsqldb, ibmdb2, monetdb, postgresql, sqlserver, yugabyte	schema name
user.sys=<x...x>	USER_SYS	all DBMS except derby, voltdb	name of the privileged user
user=kxn_user	USER	all DBMS except derby, ibmdb2, informix	name of the normal user

4.4 Statistics

5. DBMS Specific Technical Details

DBeaver is a great tool to analyze the database content. Below are also DBeaver based connection parameter examples for each database management system.

AgensGraph / **Apache Derby** / **CockroachDB** / **CrateDB** / **CUBRID** / **Exasol** /
Firebird /
H2 Database Engine /
HyperSQL Database /
IBM Db2 Database / **IBM Informix** / **MariaDB Server** / **Microsoft SQL Server** / **Mimer SQL** / **MonetDB** / **MySQL Database** / **OmniSciDB** /
Oracle Database / **Percona Server for MySQL** / **PostgreSQL** / **SQLite** / **Trino distributed Query Engine** / **VoltDB** / **YugabyteDB**

5.1 AgensGraph

- **data types**:

db seeder Type	AgensGraph Database Type
BIGINT	BIGINT
BLOB	BYTEA
CLOB	TEXT
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:

    - CREATE DATABASE: see PostgreSQL
    - CREATE SCHEMA: see PostgreSQL
    - CREATE TABLE: see PostgreSQL
    - CREATE USER: see PostgreSQL

- **Docker image (latest)**:

    - pull command: `docker pull bitnine/agensgraph:v2.1.3`
    - DockerHub

- **encoding**: see PostgreSQL
- **issue tracking**: GitHub
- **JDBC driver (latest)**:

    - version 1.4.2-c1
    - Maven repository

- **source code**: GitHub

5.2 Apache Derby

- **data types**:

db seeder Type	Apache Derby Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:

    - CREATE DATABASE - n/a
    - CREATE SCHEMA
    - CREATE TABLE
    - CREATE USER - n/a

- **Docker image (latest - only client version``)**:

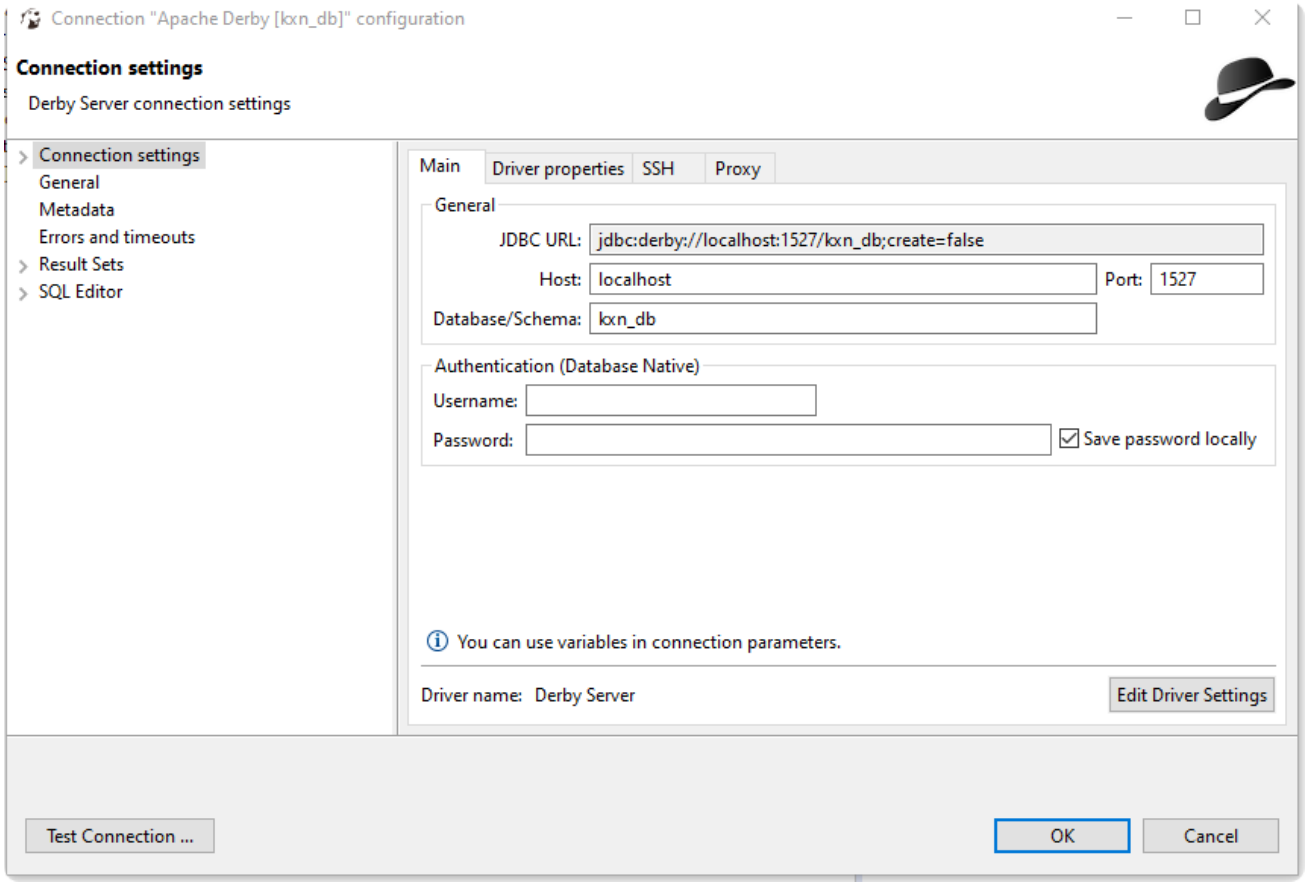
    - pull command: `docker pull konnexionsgmbh/apache_derby:10.15.2.0`
    - DockerHub

- **encoding**: by using the following JVM parameter: `-Dderby.ui.codeset=UTF8`
- **issue tracking**: Jira
- **JDBC driver (latest)**:

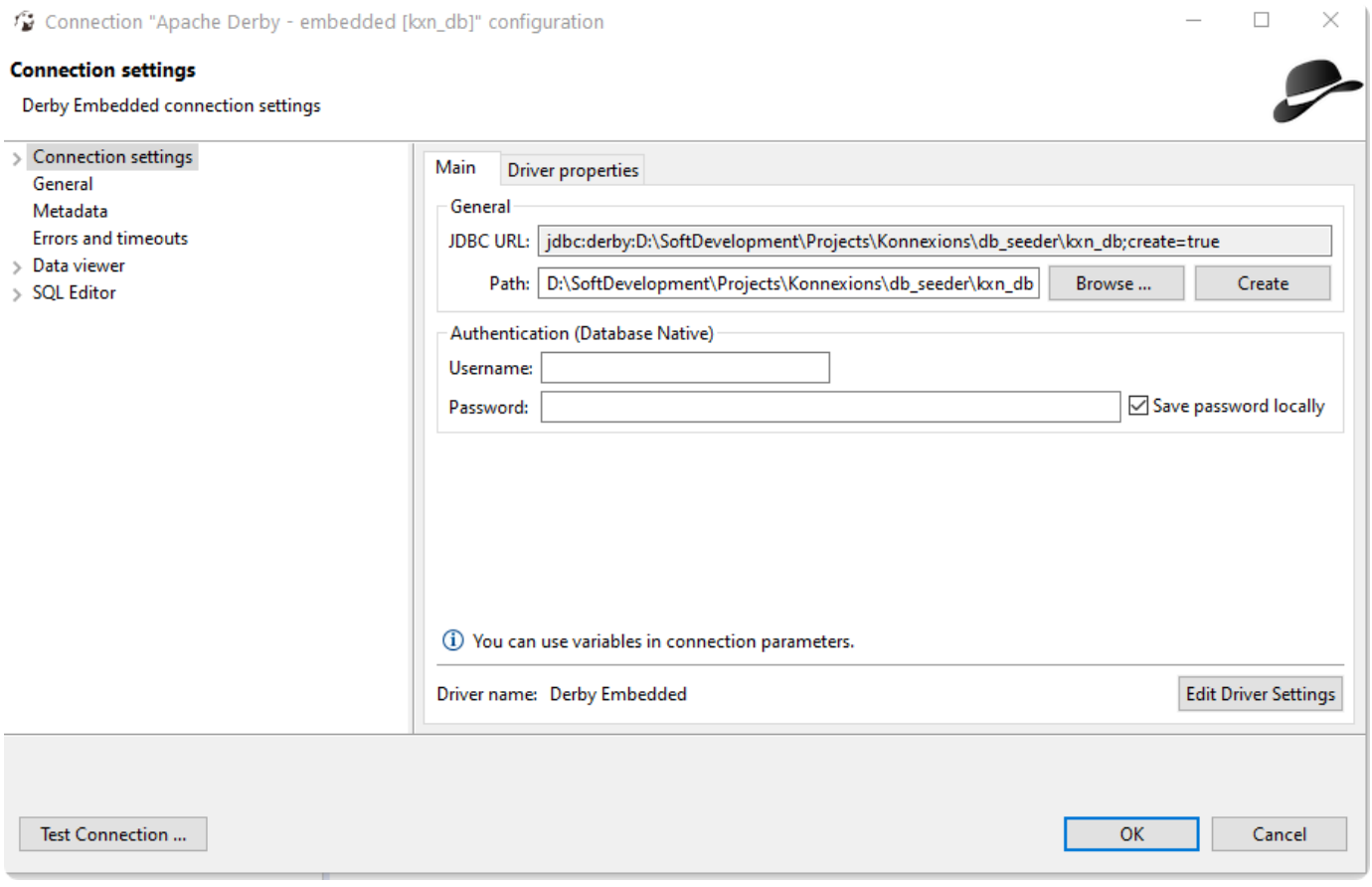
    - version 10.15.2.0
    - client version: Maven repository
    - embedded version: Maven repository

- **source code**: GitHub
- **DBeaver database connection settings**:

  -- client version:



-- embedded version:



5.3 CockroachDB

- **data types**:

db seeder Type	CockroachDB Type

db seeder Type	CockroachDB Type
BIGINT	INT
BLOB	BYTES
CLOB	STRING
TIMESTAMP	TIMESTAMP
VARCHAR	STRING

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull cockroachdb/cockroach:v21.1.1`
  - DockerHub
- **encoding**: by default `utf8` encoding
- **issue tracking**: GitHub
- **JDBC driver (latest)**:
  - same as PostgreSQL
- **privileged database access**: user `root`
- **source code**: GitHub
- **DBeaver database connection settings**:

5.3 CrateDB

- **data types**:

db seeder Type	CrateDB Type
BIGINT	BIGINT
BLOB	OBJECT
CLOB	TEXT
TIMESTAMP	TIMESTAMP
VARCHAR	TEXT

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull crate:4.5.1`
  - DockerHub
- **encoding**: by default `utf8` encoding
- **issue tracking**: GitHub
- **JDBC driver (latest)**:

    - version 2.6.0
    - JFrog Bintray repository

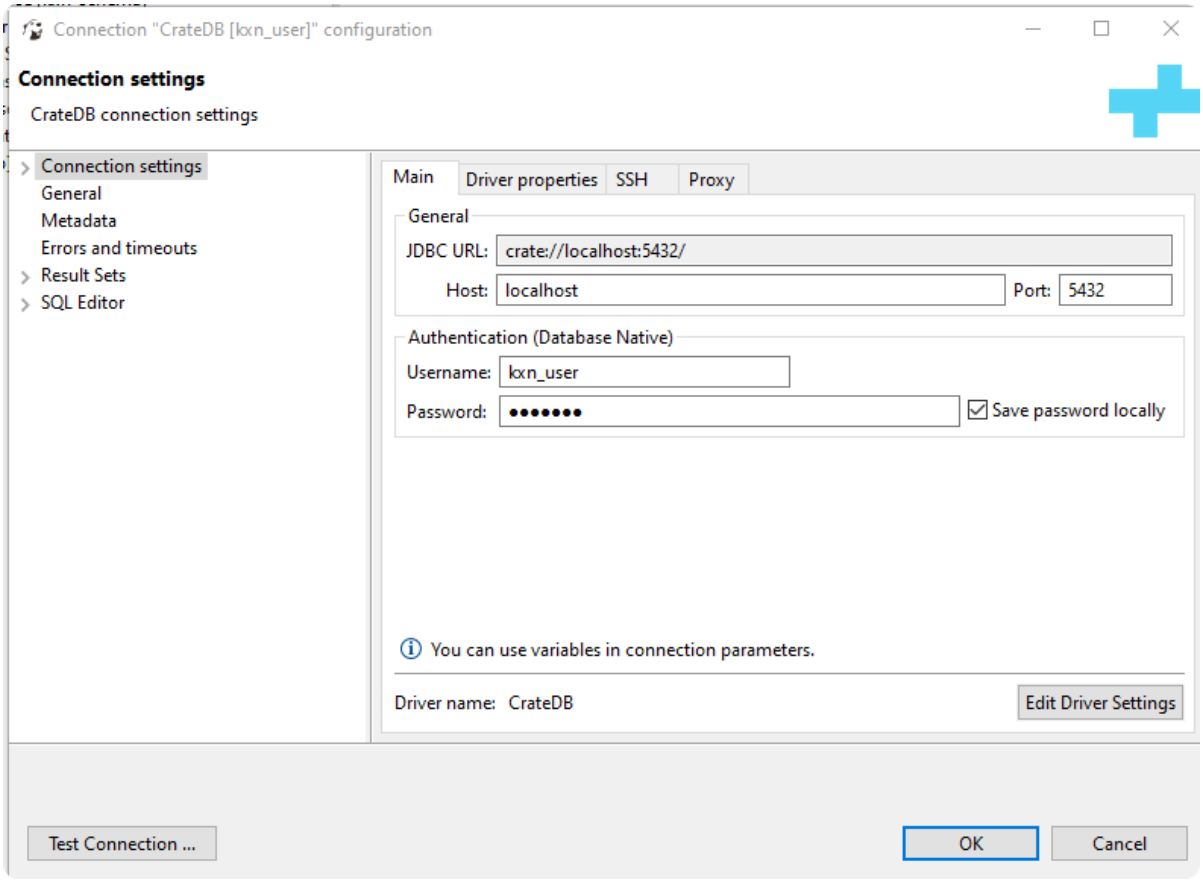
- **privileged database access**: user `crate`

- **restrictions**:

    - no constraints (e.g. foreign keys or unique keys)
    - no transaction concept
    - no triggers
    - only a very proprietary BLOB implementation

- **source code**: GitHub

- **DBeaver database connection settings**:



5.4 CUBRID

- **data types**:

db seeder Type	CUBRID Type
BIGINT	INT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

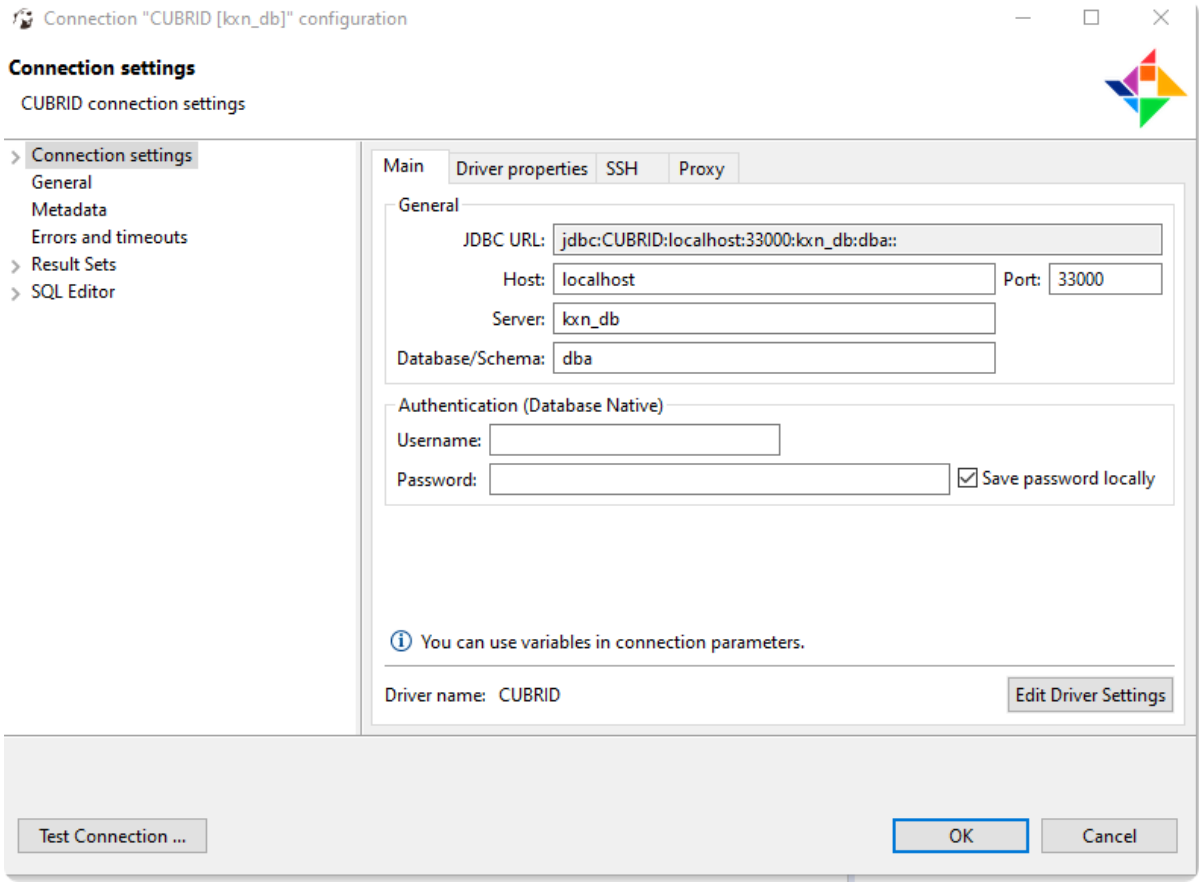
- **DDL syntax**:

    - CREATE DATABASE - n/a
    - CREATE SCHEMA - n/a
    - CREATE TABLE
    - CREATE USER

- **Docker image (latest)**:

    - pull command: `docker pull cubrid/cubrid:11.0`
    - DockerHub

- **encoding**: by specifying after the database name when database is created: `kxn_db de_DE.utf8`
- **issue tracking**:
    - Jira
    - reddit
- **JDBC driver (latest)**:
    - version 11.0.1.0286
    - Maven repository
- **privileged database access**: users `DBA` and `PUBLIC`
- **restrictions**: no full UTF-8 support
- **source code**: GitHub
- **DBeaver database connection settings**:



5.5 Exasol

- **data types**:

db seeder Type	Exasol Type
BIGINT	BIGINT
BLOB	VARCHAR(2000000)
CLOB	VARCHAR(2000000)
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:

    - CREATE DATABASE - n/a
    - CREATE SCHEMA
    - CREATE TABLE
    - CREATE USER

- **Docker image (latest)**:

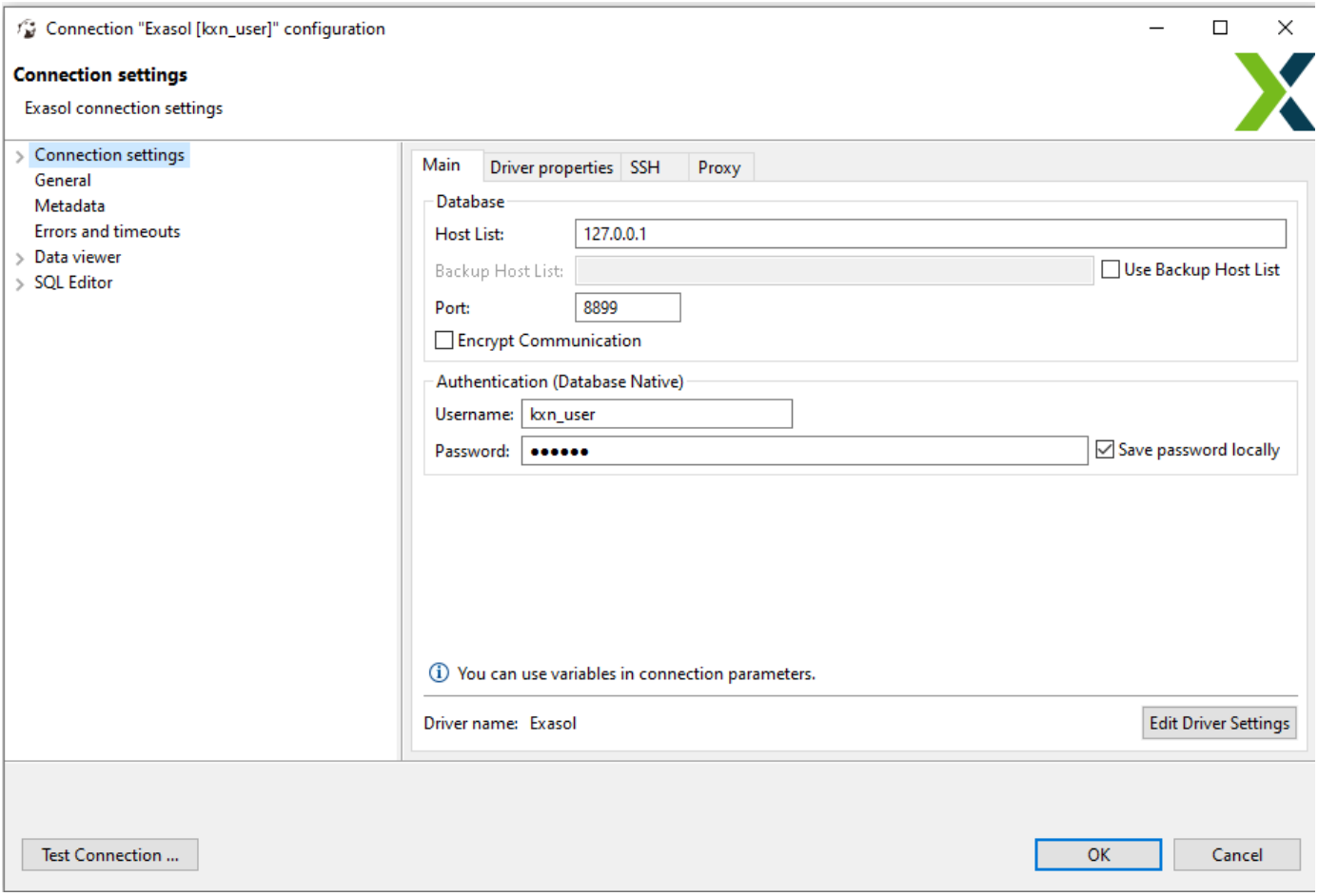
    - pull command: `docker pull exasol/docker-db:7.0.9`
    - DockerHub

- **JDBC driver (latest)**:

    - version 7.0.7
    - Maven repository

- **privileged database access**: user `sys` password `exasol`

- **DBeaver database connection settings**:



5.6 Firebird

- **data types**:

db seeder Type	Firebird Type
BIGINT	INTEGER
BLOB	BLOB
CLOB	BLOB SUB_TYPE 1
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:

    - CREATE DATABASE

    - CREATE SCHEMA - n/a
    - CREATE TABLE
    - CREATE USER

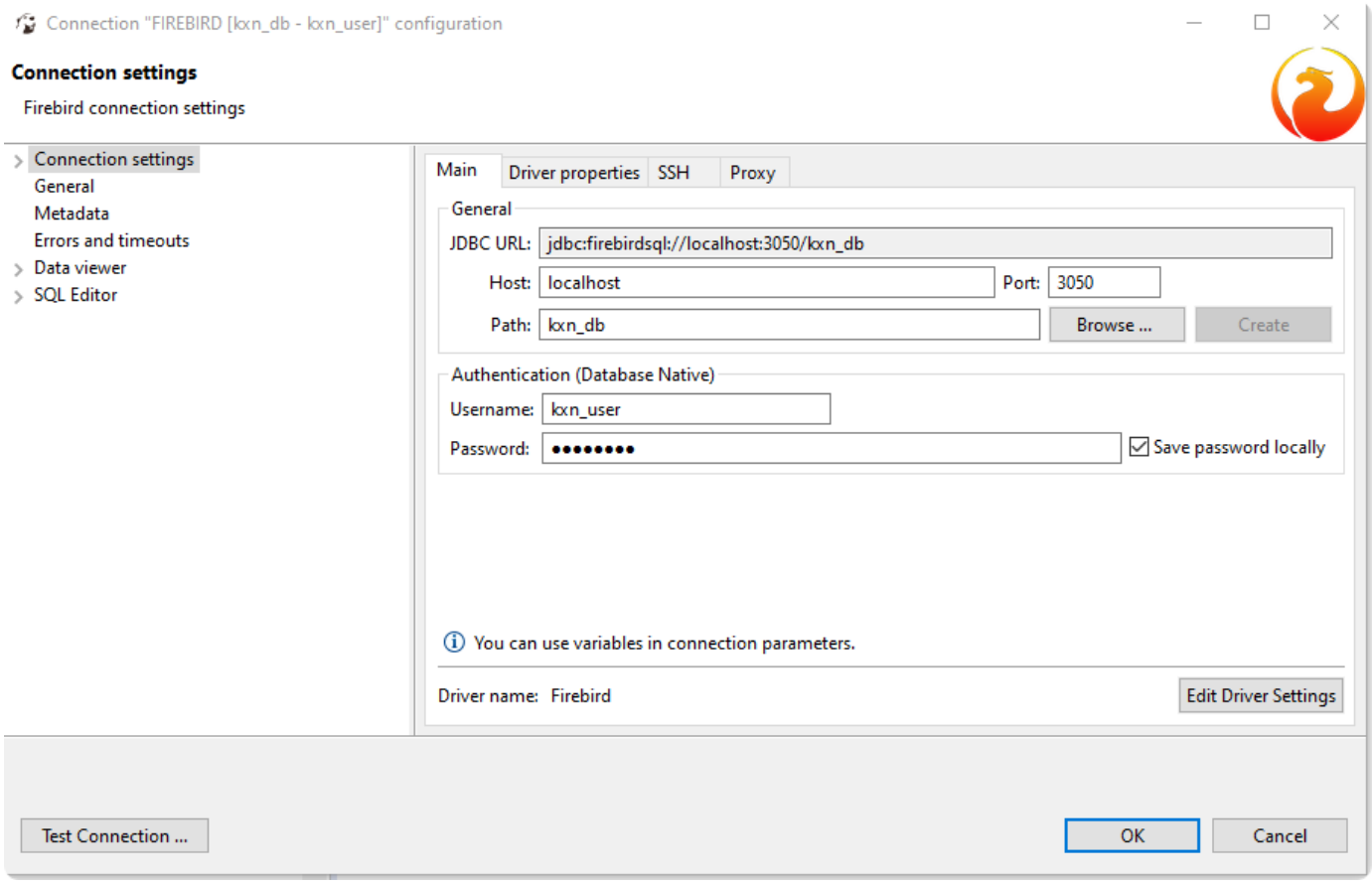
- **Docker image (latest)**:

    - pull command: `docker pull jacobalberty/firebird:v4.0.0rc1`
    - DockerHub

- **encoding**: by using the following JDBC URL parameter: `encoding=UTF8`
- **issue tracking**: Jira
- **JDBC driver (latest)**:

    - version 4.0.3.java11
    - Maven repository

- **privileged database access**: user `SYSDBA`
- **source code**: GitHub
- **DBeaver database connection settings**:



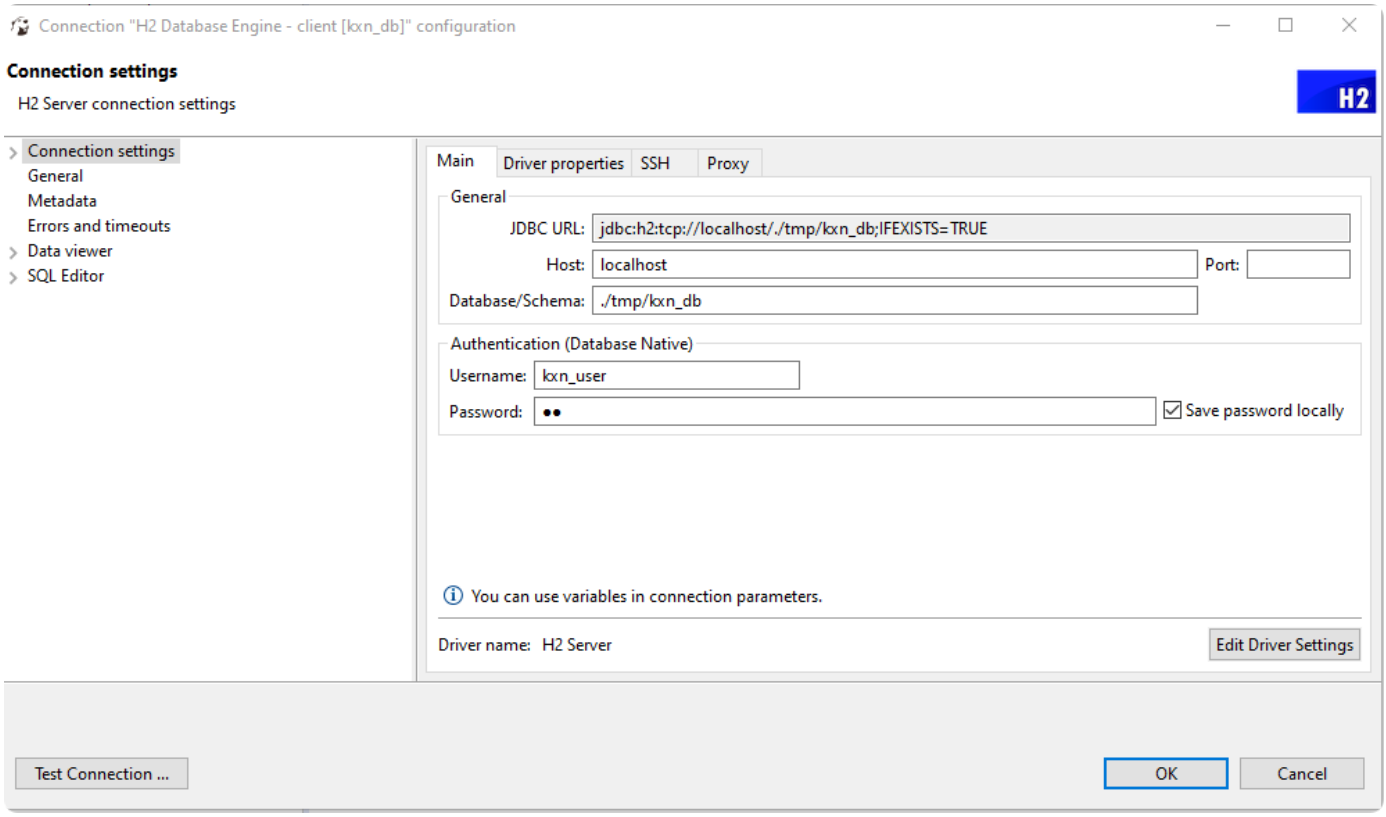
5.7 H2 Database Engine

- **data types**:

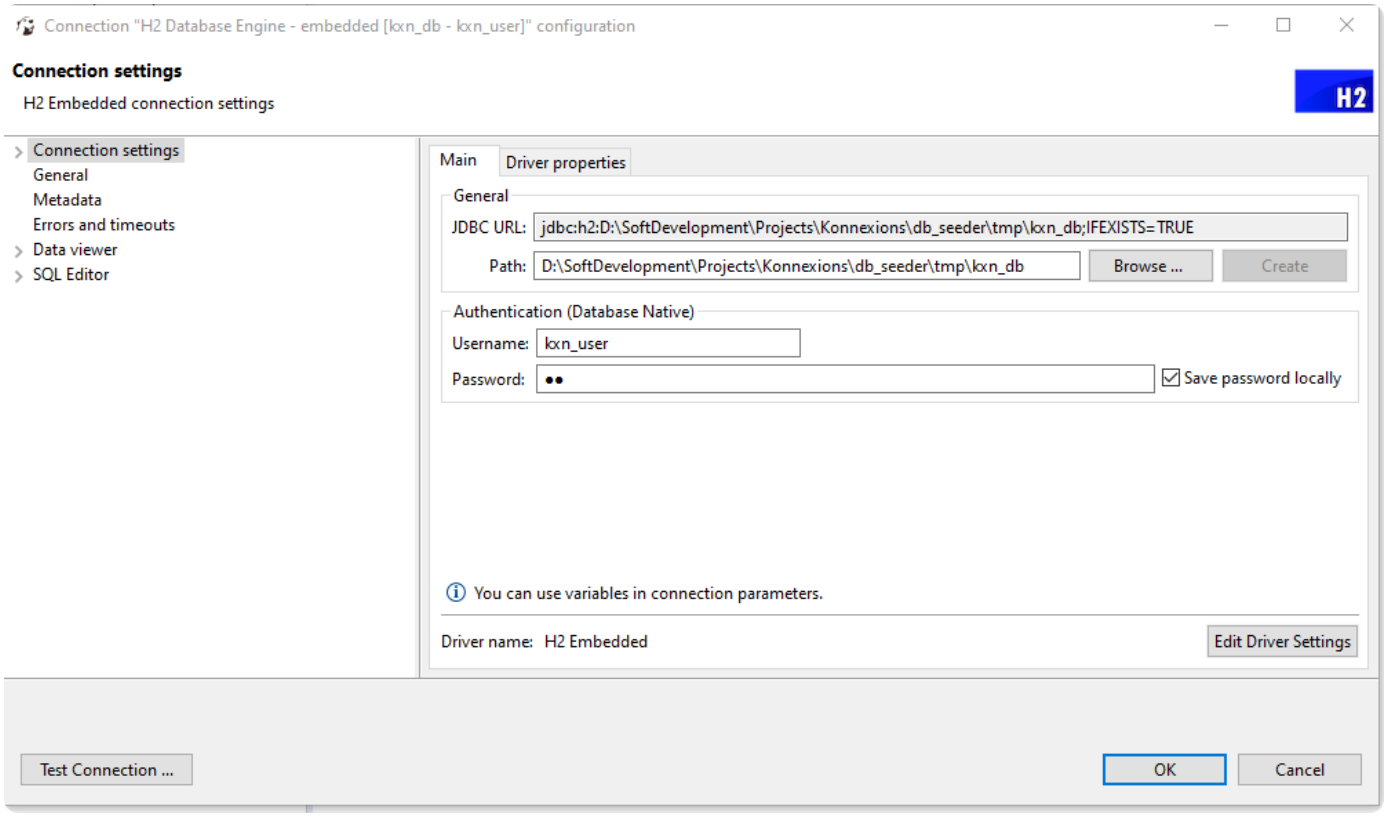
db seeder Type	H2 Database Engine Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull konnexionsgmbh/h2_database_engine:1.4.200`
  - DockerHub
- **encoding**: H2 internally uses Unicode, and supports all character encoding systems and character sets supported by the virtual machine you use.
- **issue tracking**: GitHub
- **JDBC driver (latest)**:
  - version 1.4.200
  - Maven repository
- **privileged database access**: user `sa`
- **source code**: GitHub
- **DBeaver database connection settings**:

  -- client version:



-- embedded version:



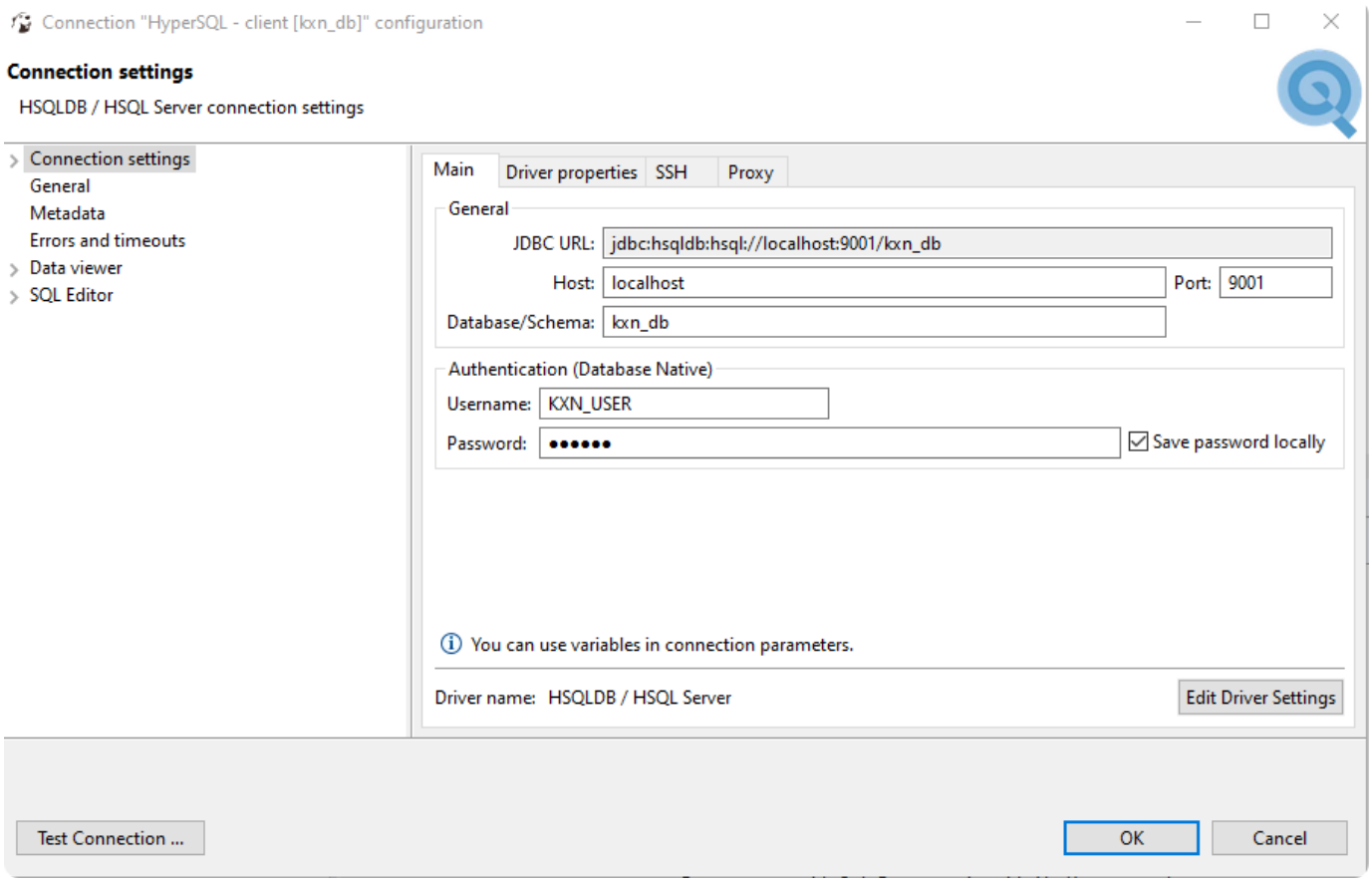
5.8 HyperSQL Database

- **data types**:

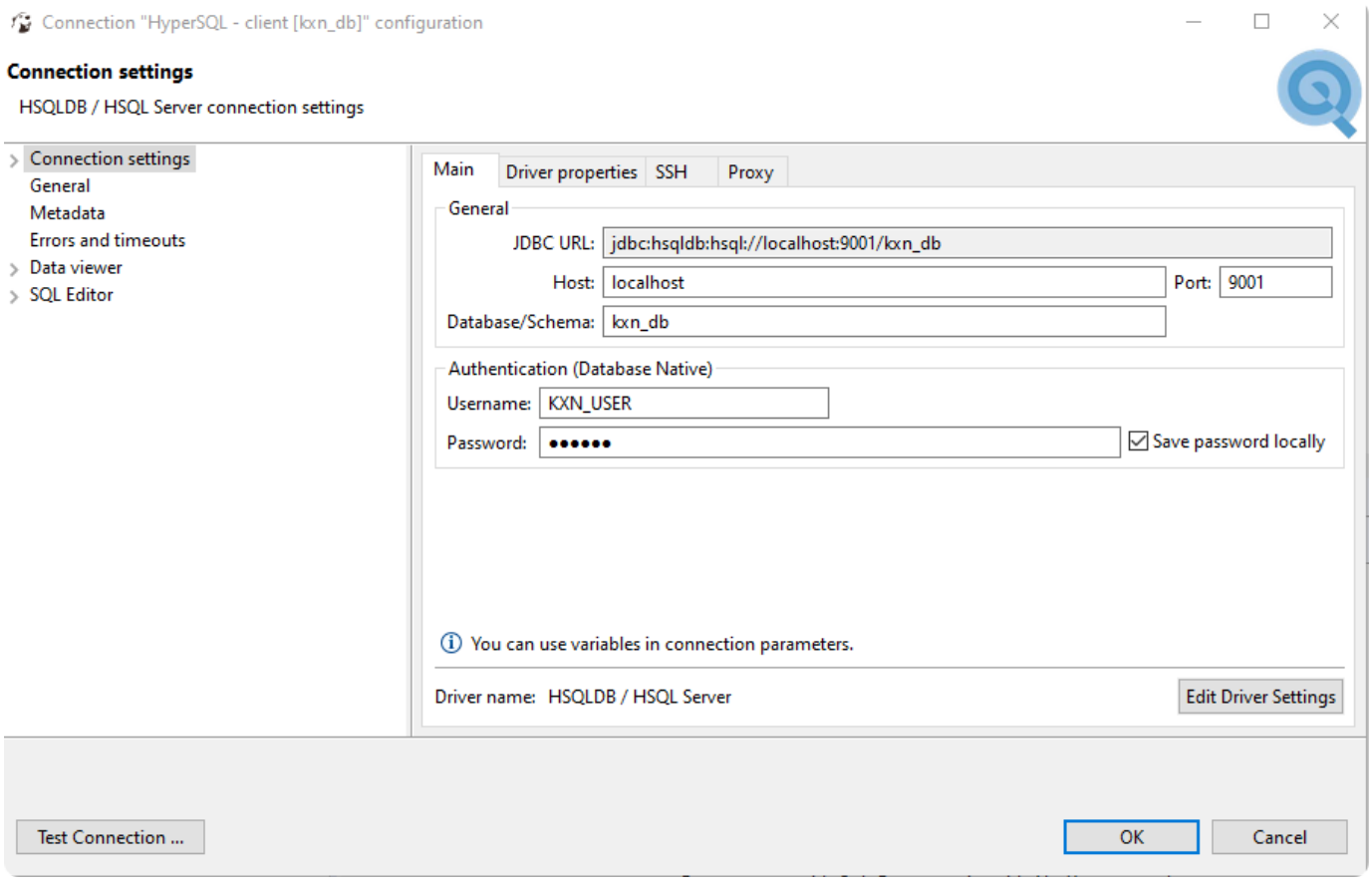
db seeder Type	HyperSQL Database Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull konnexionsgmbh/hypersql_database:2.6.0`
  - DockerHub
- **encoding**: by using the following system property `sqlfile.charset=UTF-8`.
- **issue tracking**: SourceForge
- **JDBC driver (latest)**:
  - version 2.6.0
  - Maven repository
- **privileged database access**: user `SA`
- **source code**: SourceForge
- **DBeaver database connection settings**:

-- client version:



-- embedded version:

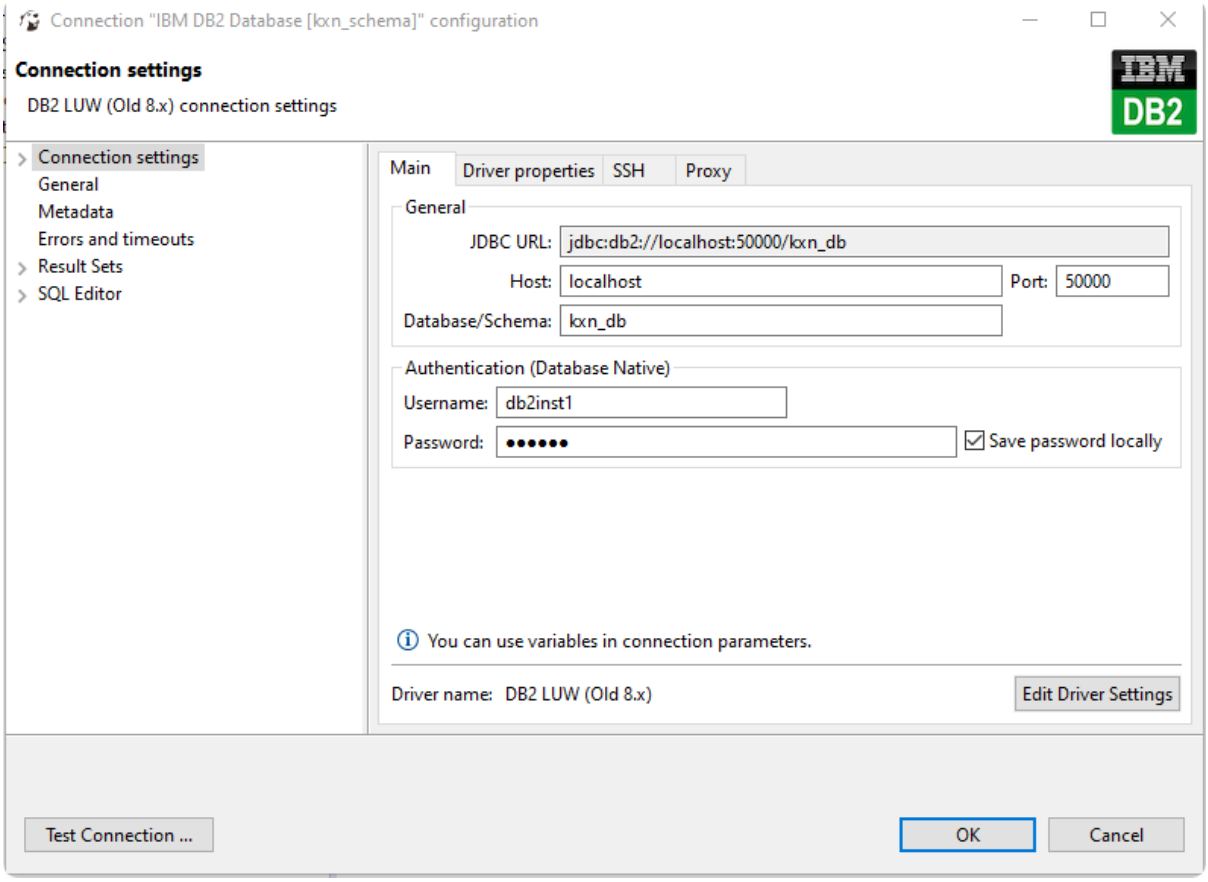


5.9 IBM Db2 Database

- **data types**:

db seeder Type	IBM Db2 Database Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull ibmcom/db2:11.5.5.1`
  - DockerHub
- **encoding**:
  - by using the CCSID clause in the CREATE statements for any of the following objects:
    - Database
    - Table space
    - Table
    - procedure or function
- **JDBC driver (latest)**:
  - version 11.5.54.0
  - Maven repository
- **privileged database access**: user `db2inst1`
- **restrictions**: the IBM Db2 DBMS only accepts operating system accounts as database users
- **DBeaver database connection settings**:



5.10 IBM Informix

- **data types**:

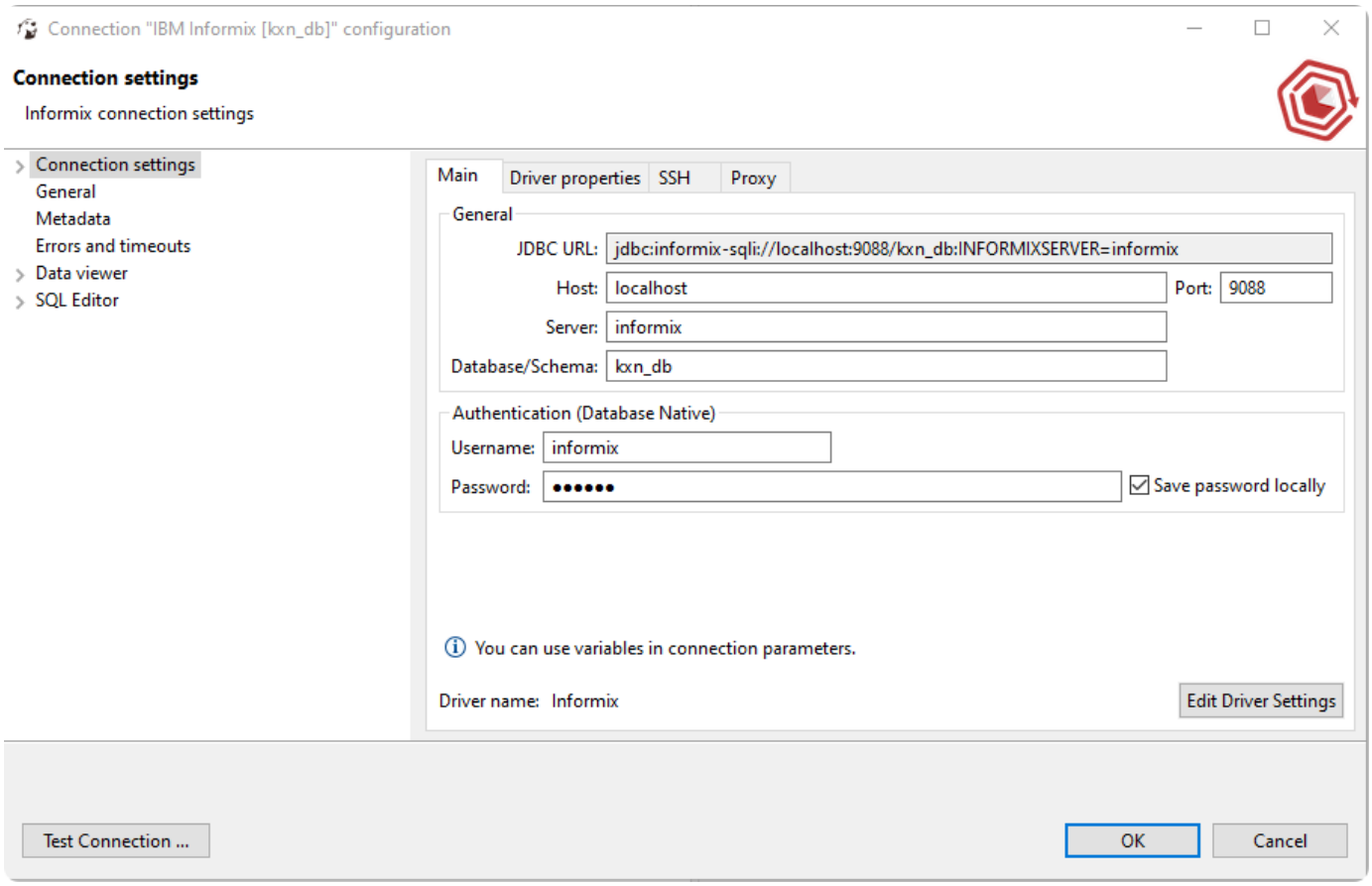
db seeder Type	IBM Informix Database Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	DATETIME YEAR TO FRACTION
VARCHAR	VARCHAR (1-254) / LVARCHAR

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull ibmcom/informix-developer-database:14.10.FC5DE`
  - DockerHub
- **encoding**:
  - code-set conversion value is extracted from the DB_LOCALE value specified at the time the connection is made
- **JDBC driver (latest)**:
  - version 4.50.4.1
  - Maven repository
- **privileged database access**:
  - user `informix`

    - password `in4mix`
    - database / schema `sysmaster`
    - INFORMIXSERVER `informix`

- **restrictions**: the IBM Informix DBMS only accepts operating system accounts or users mapped to operating system accounts as database users

- **DBeaver database connection settings**:



5.11 MariaDB Server

- **data types**:

db seeder Type	MariaDB Type
BIGINT	BIGINT
BLOB	LONGBLOB
CLOB	LONGTEXT
TIMESTAMP	DATETIME
VARCHAR	VARCHAR

- **DDL syntax**:

    - CREATE DATABASE
    - CREATE SCHEMA - n/a
    - CREATE TABLE
    - CREATE USER

- **Docker image (latest)**:

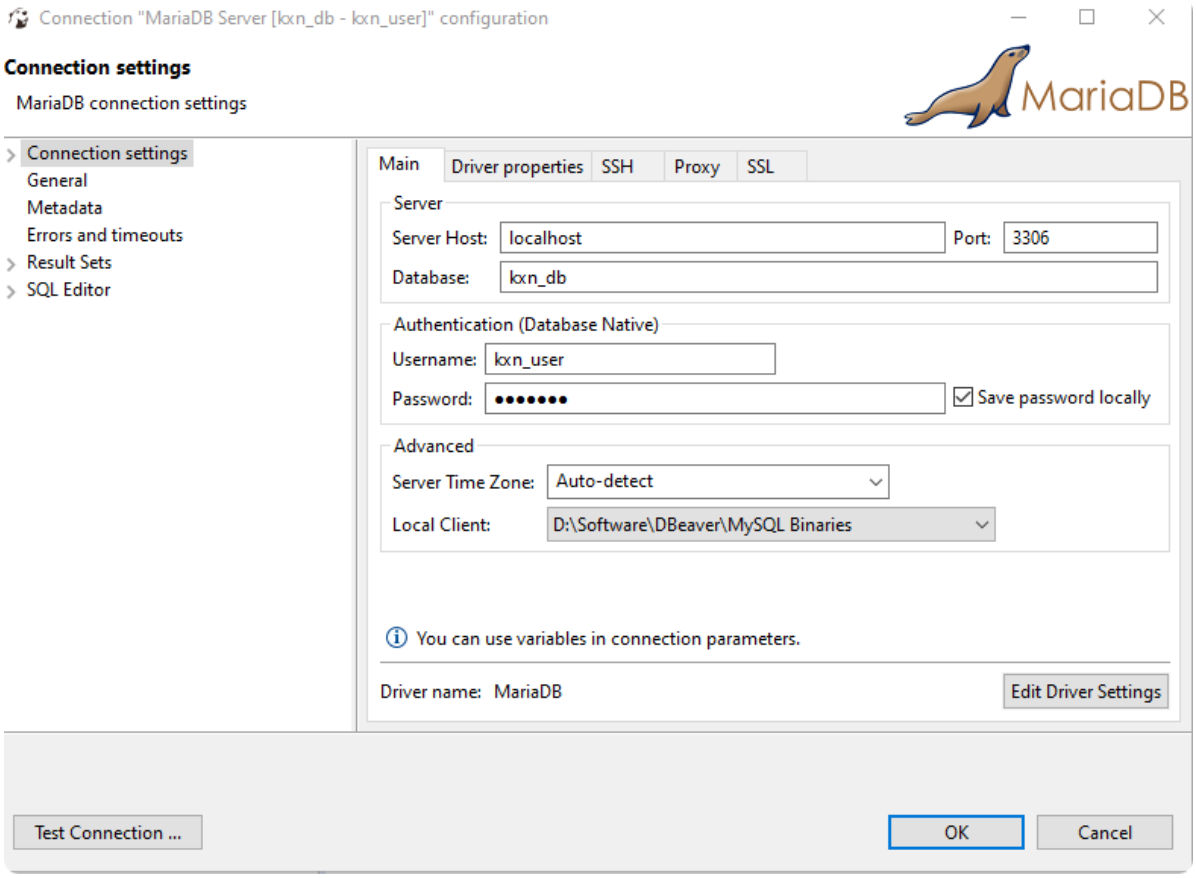
    - pull command: `docker pull mariadb:10.6.1`
    - DockerHub

- **encoding**:

    - server level: `SET character_set_server = 'latin2';`

    - database level: `CHARACTER SET = 'keybcs2'`
    - table level: `CHARACTER SET 'utf8'`
    - column level: `CHARACTER SET 'greek'`

- **issue tracking**: Jira
- **JDBC driver (latest)**:
    - version 2.7.2
    - Maven repository
- **privileged database access**:
    - user: `mysql`
    - password; `root`
- **source code**: GitHub
- **DBeaver database connection settings**:



5.12 Microsoft SQL Server

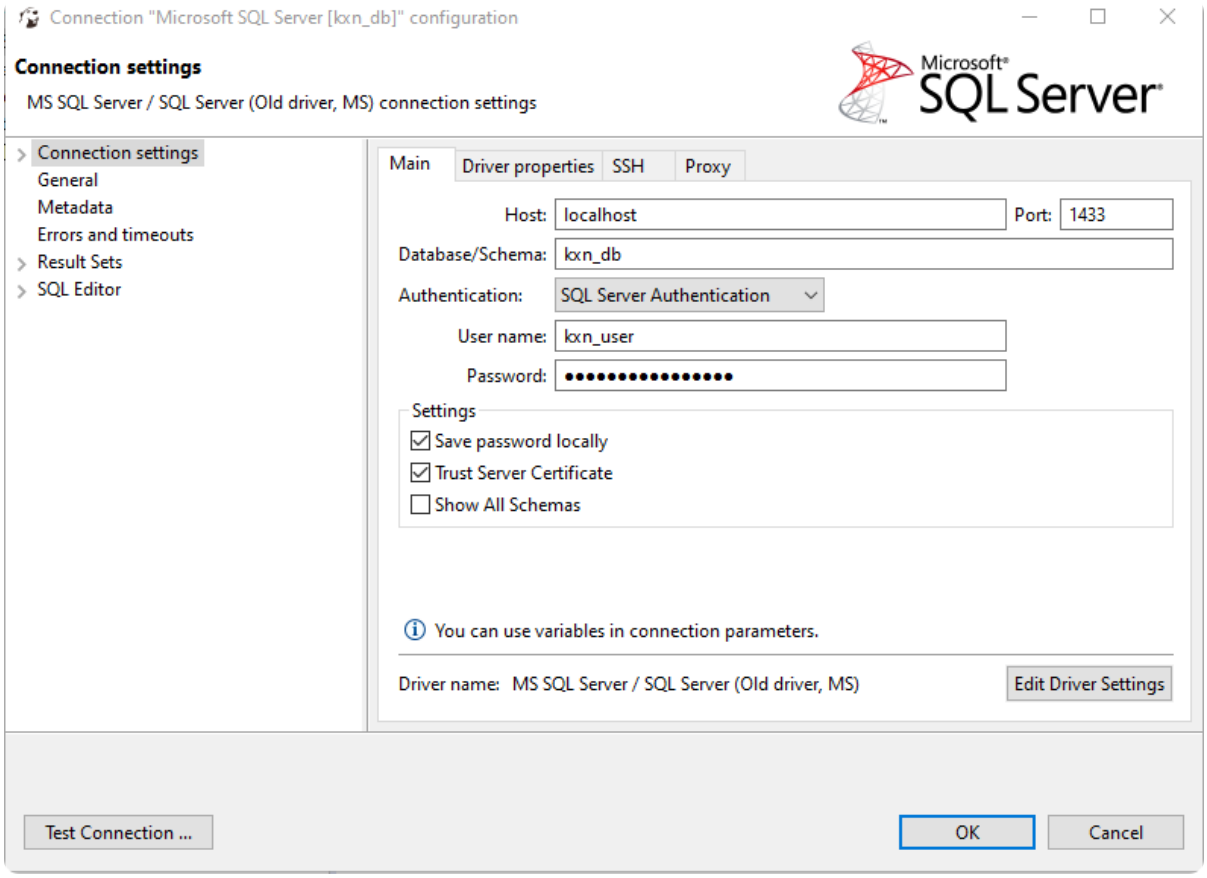
- **data types**:

db seeder Type	Microsoft SQL Server Type
BIGINT	BIGINT
BLOB	VARBINARY (MAX)
CLOB	VARCHAR (MAX)
TIMESTAMP	DATETIME2
VARCHAR	VARCHAR

- **DDL syntax**:
    - CREATE DATABASE
    - CREATE SCHEMA

    - CREATE TABLE
    - CREATE USER

- **Docker image (latest)**:
    - pull command: `docker pull mcr.microsoft.com/mssql/server:2019-latest`
    - DockerHub
- **encoding**: to use the UTF-8 collations that are available in SQL Server 2019 (15.x), you must select UTF-8 encoding-enabled collations (_UTF8)
- **JDBC driver (latest)**:
    - version 9.2.1.jre15
    - Maven repository
- **privileged database access**:
    - database: `master`
    - user: `sa`
- **restrictions**: no full UTF-8 support in the given Docker images
- **DBeaver database connection settings**:

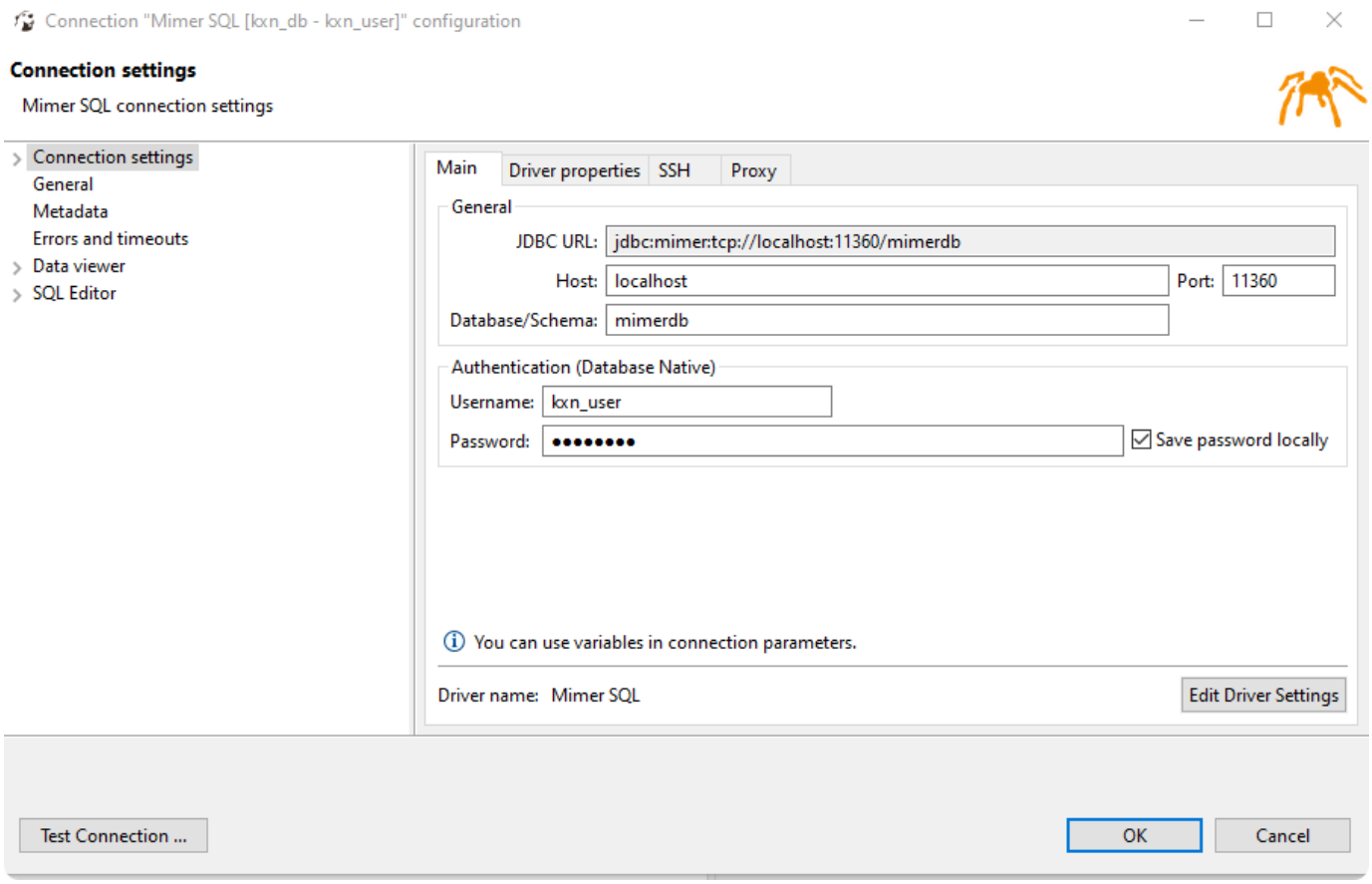


5.13 Mimer SQL

- **data types**:

db seeder Type	MimerSQL Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	NVARCHAR

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull mimersql/mimersql_v11.0.5a`
  - DockerHub
- **encoding**: NCHAR, NVARCHAR
- **JDBC driver (latest)**:
  - version 3.41a
  - Mimer Website
- **privileged database access**:
  - database; `mimerdb`
  - user: `SYSADM`
- **DBeaver database connection settings**:



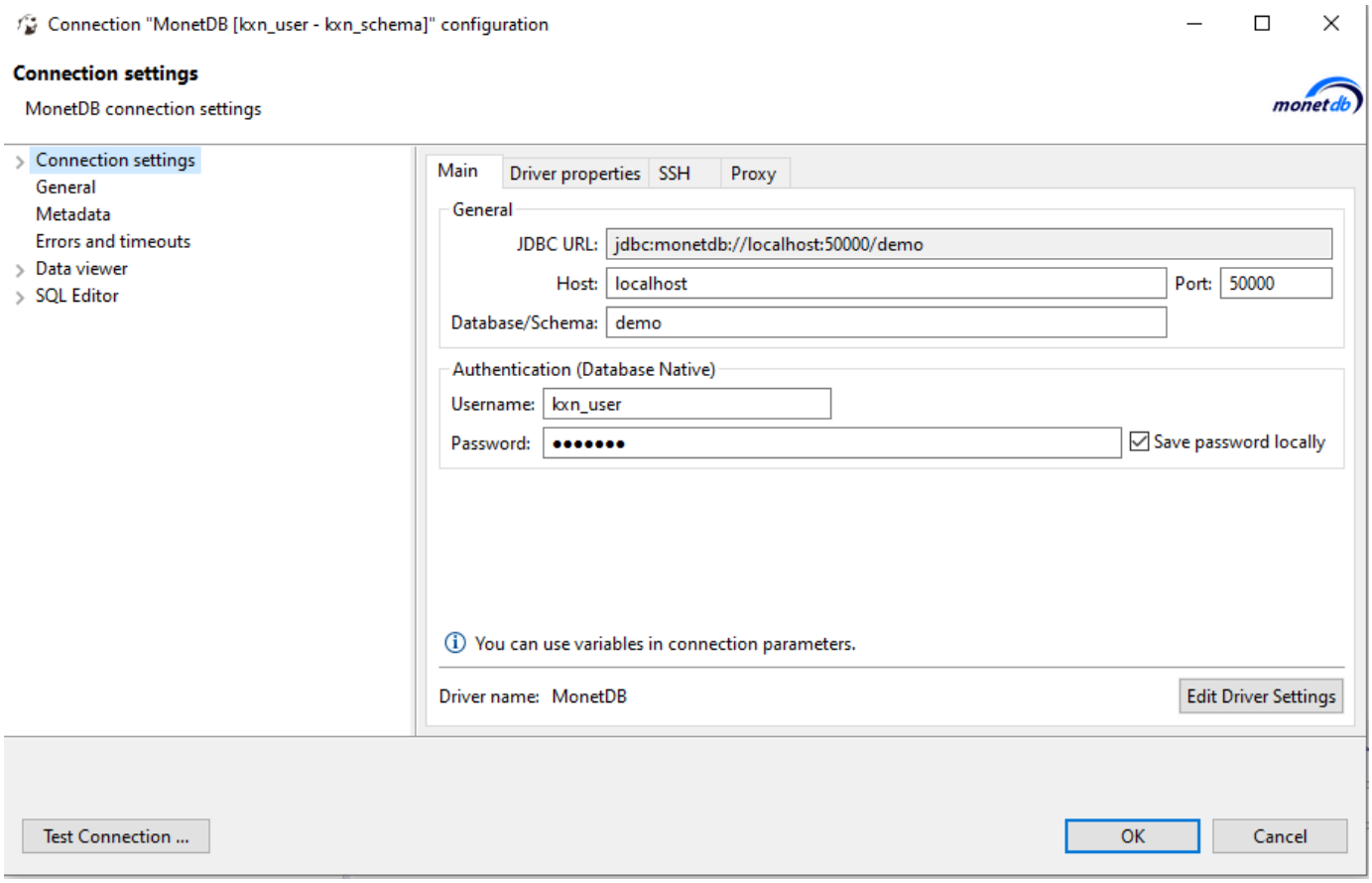
5.14 MonetDB

- **data types**:

db seeder Type	MonetDB Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP

db seeder Type	MonetDB Type
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull monetdb/monetdb:Oct2020-SP5`
  - DockerHub
- **encoding**: no special configuration should be needed
- **issue tracking**: Bugzilla
- **JDBC driver (latest)**:
  - version 3.0.jre8
  - MonetDB Java Download Area
- **privileged database access**:
  - database: `demo`
  - user: `monetdb`
  - password: `monetdb`
- **source code**: monetdb.org
- **DBeaver database connection settings**:

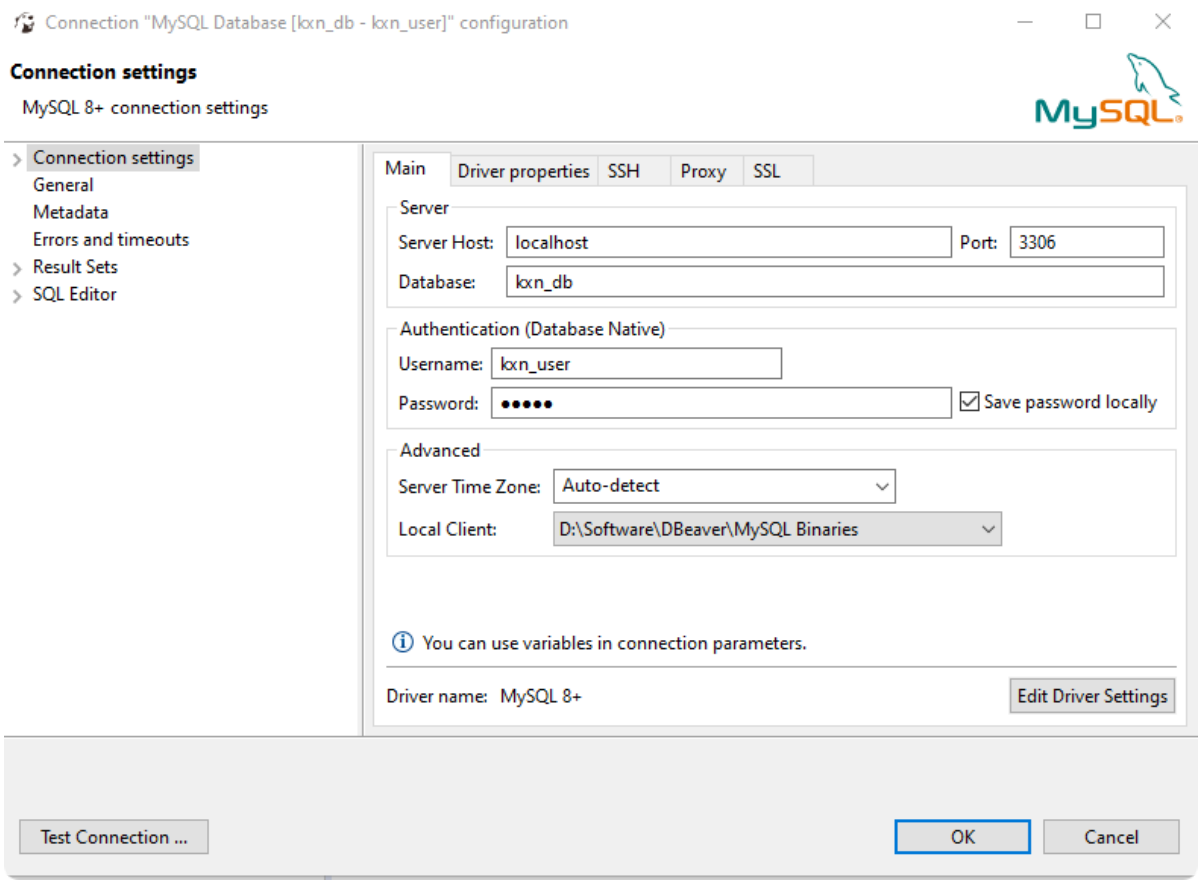


5.15 MySQL Database

- **data types**:

db seeder Type	MySQL Database Type
BIGINT	BIGINT
BLOB	LONGBLOB
CLOB	LONGTEXT
TIMESTAMP	DATETIME
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull mysql:8.0.25`
  - DockerHub
- **encoding**: for applications that store data using the default MySQL character set and collation (utf8mb4, utf8mb4_0900_ai_ci), no special configuration should be needed
- **issue tracking**: GitHub
- **JDBC driver (latest)**:
  - version 8.0.25
  - Maven repository
- **privileged database access**:
  - database: `sys`
  - user: `root`
- **source code**: GitHub
- **DBeaver database connection settings**:



5.16 OmniSciDB

- **data types**:

db seeder Type	OmniSciDB Type
BIGINT	BIGINT
BLOB	TEXT ENCODING DICT(16)
CLOB	TEXT ENCODING DICT(16)
TIMESTAMP	TIMESTAMP(0)
VARCHAR	TEXT ENCODING DICT

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull omnisci/core-os-cpu`
  - DockerHub
- **encoding**: no special configuration should be needed
- **issue tracking**: GitHub
- **JDBC driver (latest)**:
  - version 5.6.0
  - Maven repository
- **privileged database access**:
  - database: `omnisci`

    - user: `admin`

- **restrictions**:

    - column and table names case sensitive
    - max. column length 32767 bytes
    - no binary columns
    - no constraints, e.g. unique keys
    - no foreign / referential keys
    - no primary key
    - no triggerss

- **source code**: GitHub

- **DBeaver database connection settings**:

5.17 Oracle Database

- **data types**:

db seeder Type	Oracle Database Type
BIGINT	NUMBER
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR2

- **DDL syntax**:

    - CREATE DATABASE - n/a
    - CREATE SCHEMA - n/a
    - CREATE TABLE
    - CREATE USER

- **Docker image**: DockerHub

- **encoding**: since Oracle Database 12c Release 2 the default database character set used is the Unicode character set AL32UTF8

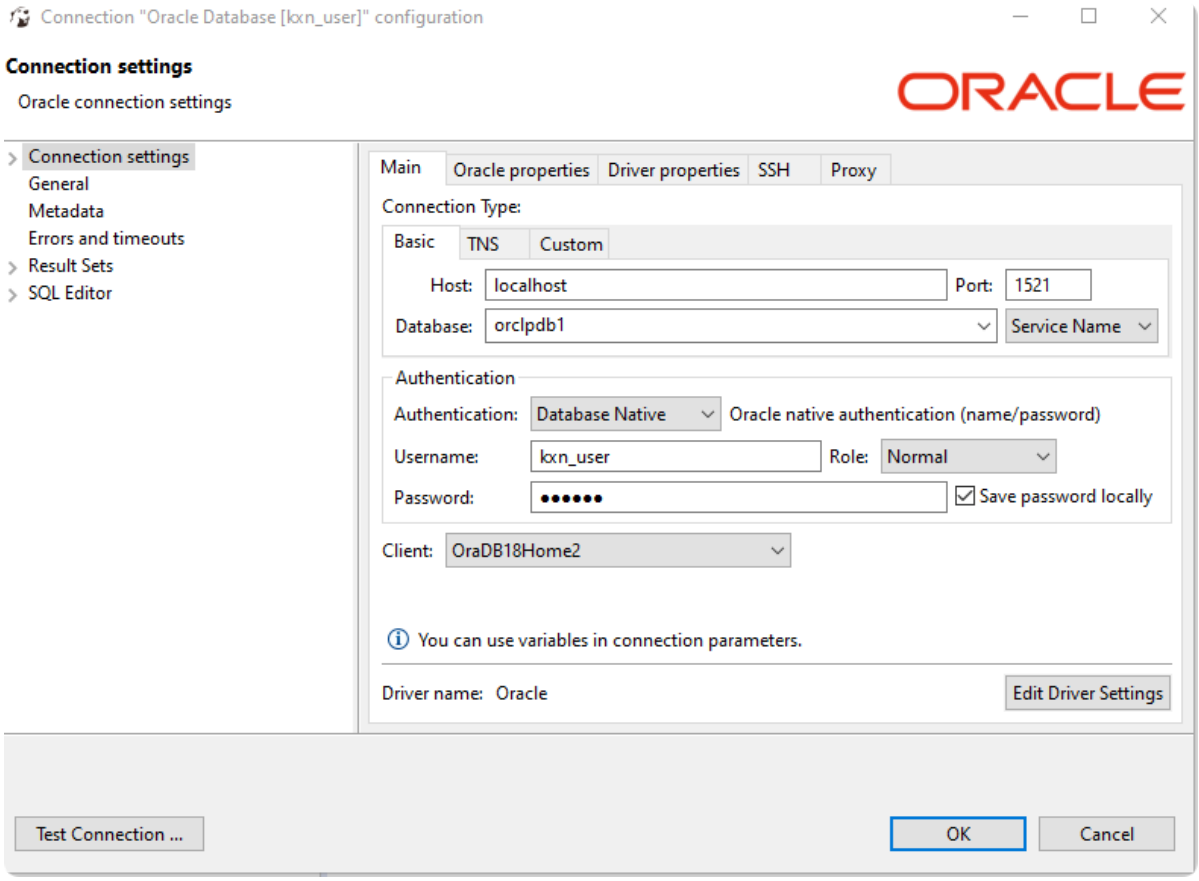
- **JDBC driver (latest)**:

    - version 21.1.0.0
    - Maven repository

- **privileged database access**:

    - database: `orclpdb1`
    - user: `SYS AS SYSDBA`

- **DBeaver database connection settings**:



5.18 Percona Server for MySQL

- **data types**:

db seeder Type	Percona Sercver Type
BIGINT	BIGINT
BLOB	LONGBLOB
CLOB	LONGTEXT
TIMESTAMP	DATETIME
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE: see MySQL Database
  - CREATE SCHEMA - n/a
  - CREATE TABLE: see MySQL Database
  - CREATE USER: see MySQL Database
- **Docker image (latest)**:
  - pull command: `docker pull percona/percona-server:8.0.23-14`
  - DockerHub
- **encoding**: for applications that store data using the default MySQL character set and collation (utf8mb4, utf8mb4_0900_ai_ci), no special configuration should be needed
- **issue tracking**: Jira
- **JDBC driver (latest)**:
  - version 8.0.23
  - Maven repository
- **privileged database access**:

    - database: `sys`
    - user: `root`

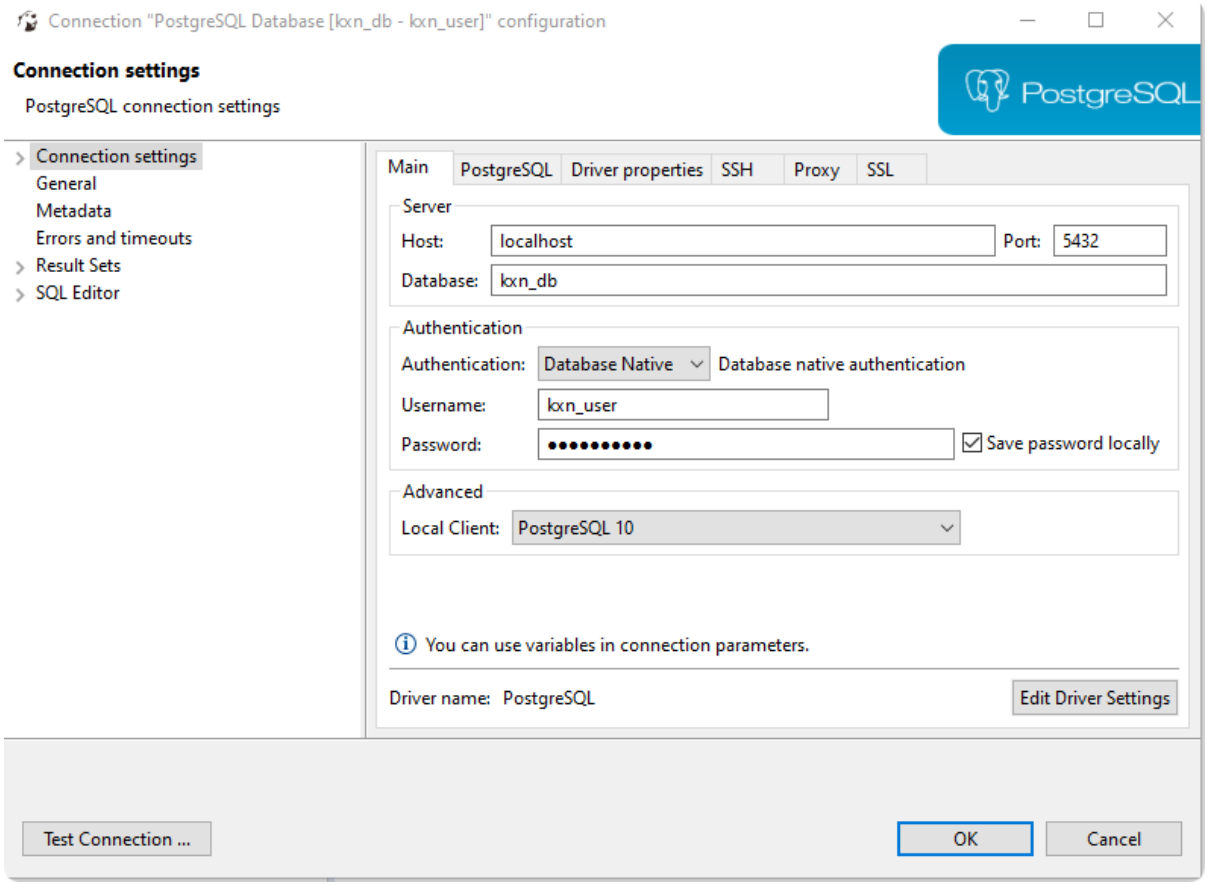
- **source code**: GitHub

5.19 PostgreSQL

- **data types**:

db seeder Type	PostgreSQL Type
BIGINT	BIGINT
BLOB	BYTEA
CLOB	TEXT
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
    - CREATE DATABASE
    - CREATE SCHEMA
    - CREATE TABLE
    - CREATE USER
- **Docker image (latest)**:
    - pull command: `docker pull postgres:13.3-alpine`
    - DockerHub
- **encoding**: when creating the database: `CREATE DATABASE testdb WITH ENCODING 'EUC_KR' ...`
- **issue tracking**: pgsql-bugs
- **JDBC driver (latest)**:
    - version 42.2.19
    - Maven repository
- **source code**: GitHub
- **DBeaver database connection settings**:



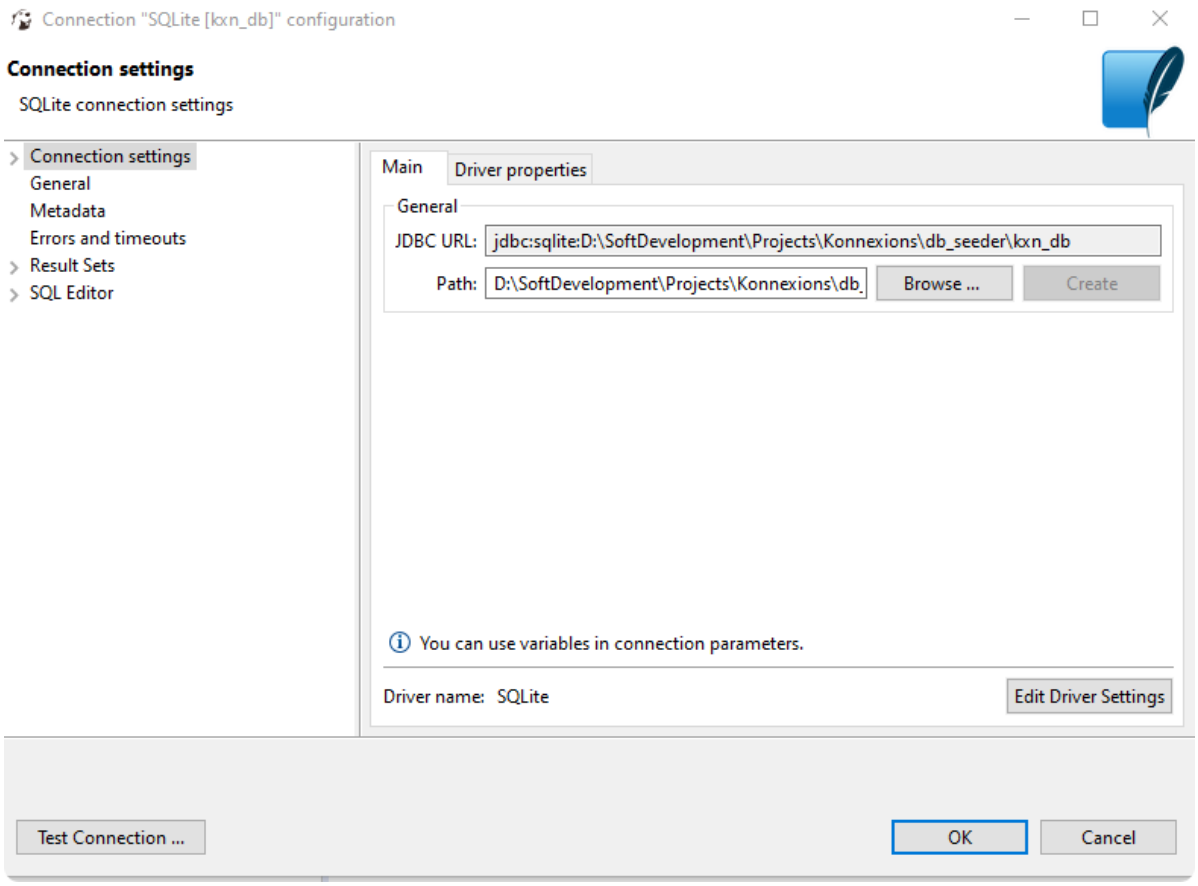
5.20 SQLite

- **data types**:

db seeder Type	SQLite Type
BIGINT	INTEGER
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	DATETIME
VARCHAR	VARCHAR2

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER - n/a
- **encoding**: by using the following parameter: `PRAGMA encoding='UTF-8';`
- **issue tracking**: SQLite Forum
- **JDBC driver (latest)**:
  - version 3.34.0
  - Maven repository
  - determines also the DBMS version
- **restrictions**:
  - no Docker image necessary, hence not available
  - no user management
- **source code**: Fossil

- **DBeaver database connection settings**:



5.21 Trino Distributed Query Engine

- **data types**:

db seeder Type	Trino Database Type
BIGINT	BIGINT
BLOB	BLOB
CLOB	CLOB
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER - n/a
- **Docker image (latest)**:
  - pull command: `docker pull trinodb/trino:357`
  - DockerHub
- **encoding**: full support of UTF-8 (see here)
- **issue tracking**: GitHub
- **JDBC driver (latest)**:
  - version 357
  - Maven repository
- **source code**: GitHub

5.22 VoltDB

- **data types**:

db seeder Type	VoltDB Type
BIGINT	BIGINT
BLOB	VARBINARY(1048576)
CLOB	VARCHAR(1048576)
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE - n/a
  - CREATE SCHEMA - n/a
  - CREATE TABLE
  - CREATE USER - n/a
- **Docker image (latest)**:
  - pull command: `docker pull voltdb/voltdb-community:9.2.1`
  - DockerHub
- **issue tracking**: Jira
- **JDBC driver (latest)**:
  - version 10.1.1
  - Maven repository
- **source code**: GitHub

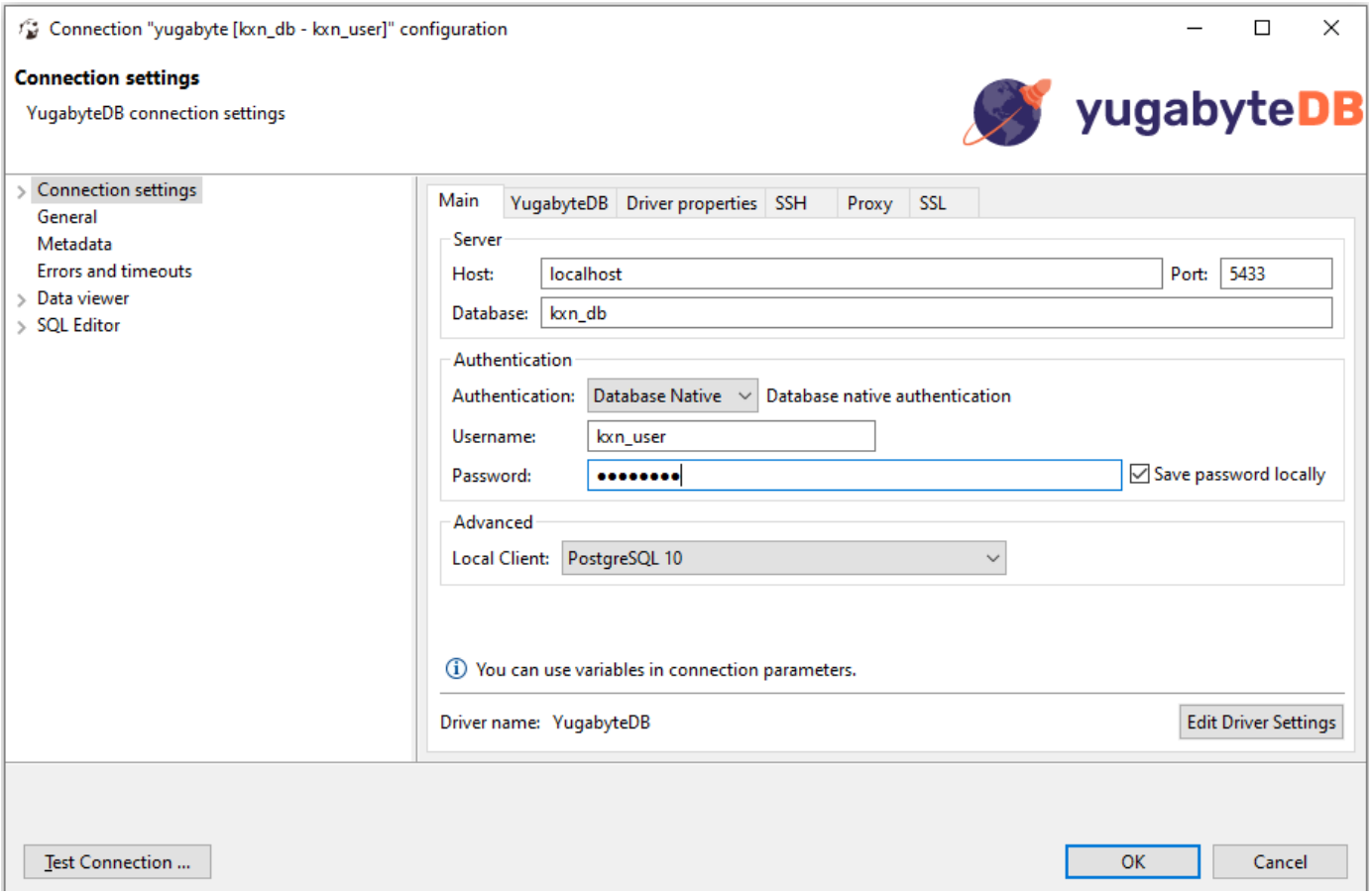
5.23 YugabyteDB

- **data types**:

db seeder Type	YugabyteDB Database Type
BIGINT	BIGINT
BLOB	BYTEA
CLOB	TEXT
TIMESTAMP	TIMESTAMP
VARCHAR	VARCHAR

- **DDL syntax**:
  - CREATE DATABASE
  - CREATE SCHEMA
  - CREATE TABLE
  - CREATE USER
- **Docker image (latest)**:
  - pull command: `docker pull yugabytedb/yugabyte:2.7.1.1-b1`
  - DockerHub
- **encoding**: see PostgreSQL
- **issue tracking**: GitHub
- **JDBC driver (latest)**:
  - version 42.2.7-yb-3
  - Maven repository

- **source code**: GitHub
- **DBeaver database connection settings**:



6. Trino - Distributed Query Engine

The Trino distributed query engine can integrate the following DBMS, among others:

- Microsoft SQL Server via the SQL Server Connector,
- MySQL via the MySQL Connector,
- Oracle via the Oracle Connector, and
- PostgreSQL via the PostgreSQL Connector.

`DBSeeder` makes it possible to use Trino's JDBC driver and the corresponding connectors as an alternative to the JDBC drivers of the DBMS suppliers. To use the Trino JDBC driver, a Trino server is required. With the script `db_seeder_trino_environment` a Trino server can be set up. Since Trino does not support the Windows operating system, a suitable Docker image is created for Windows. For Linux, e.g. Ubuntu, the script can alternatively be used to perform a local installation of the Trino server.