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# **pgloader Documentation**

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pgloader loads data from various sources into PostgreSQL. It can transform the data it reads on the fly and submit raw SQL before and after the loading. It uses the *COPY* PostgreSQL protocol to stream the data into the server, and manages errors by filling a pair of *reject.dat* and *reject.log* files.

Thanks to being able to load data directly from a database source, pgloader also supports from migrations from other productions to PostgreSQL. In this mode of operations, pgloader handles both the schema and data parts of the migration, in a single unmanned command, allowing to implement **Continuous Migration**.



pgloader has two modes of operation: loading from files, migrating databases. In both cases, pgloader uses the PostgreSQL COPY protocol which implements a **streaming** to send data in a very efficient way.

### 1.1 Loading file content in PostgreSQL

When loading from files, pgloader implements the following features:

**Many source formats supported** Support for a wide variety of file based formats are included in pgloader: the CSV family, fixed columns formats, dBase files (`db3`), and IBM IXF files.

The SQLite database engine is accounted for in the next section: pgloader considers SQLite as a database source and implements schema discovery from SQLite catalogs.

**On the fly data transformation** Often enough the data as read from a CSV file (or another format) needs some tweaking and clean-up before being sent to PostgreSQL.

For instance in the `geolite` example we can see that integer values are being rewritten as IP address ranges, allowing to target an `ip4r` column directly.

**Full Field projections** pgloader supports loading data into less fields than found on file, or more, doing some computation on the data read before sending it to PostgreSQL.

**Reading files from an archive** Archive formats `zip`, `tar`, and `gzip` are supported by pgloader: the archive is extracted in a temporary directory and expanded files are then loaded.

**HTTP(S) support** pgloader knows how to download a source file or a source archive using HTTP directly. It might be better to use `curl -O- http://... | pgloader` and read the data from *standard input*, then allowing for streaming of the data from its source down to PostgreSQL.

**Target schema discovery** When loading in an existing table, pgloader takes into account the existing columns and may automatically guess the CSV format for you.

**On error stop / On error resume next** In some cases the source data is so damaged as to be impossible to migrate in full, and when loading from a file then the default for pgloader is to use `on error resume next` option, where the rows rejected by PostgreSQL are saved away and the migration continues with the other rows.

In other cases loading only a part of the input data might not be a great idea, and in such cases it's possible to use the `on error stop` option.

**Pre/Post SQL commands** This feature allows pgloader commands to include SQL commands to run before and after loading a file. It might be about creating a table first, then loading the data into it, and then doing more processing on-top of the data (implementing an *ELT* pipeline then), or creating specific indexes as soon as the data has been made ready.

## 1.2 One-command migration to PostgreSQL

When migrating a full database in a single command, pgloader implements the following features:

**One-command migration** The whole migration is started with a single command line and then runs unattended. pgloader is meant to be integrated in a fully automated tooling that you can repeat as many times as needed.

**Schema discovery** The source database is introspected using its SQL catalogs to get the list of tables, attributes (with data types, default values, not null constraints, etc), primary key constraints, foreign key constraints, indexes, comments, etc. This feeds an internal database catalog of all the objects to migrate from the source database to the target database.

**User defined casting rules** Some source database have ideas about their data types that might not be compatible with PostgreSQL implementaion of equivalent data types.

For instance, SQLite since version 3 has a [Dynamic Type System](#) which of course isn't compatible with the idea of a [Relation](#). Or MySQL accepts datetime for year zero, which doesn't exists in our calendar, and doesn't have a boolean data type.

When migrating from another source database technology to PostgreSQL, data type casting choices must be made. pgloader implements solid defaults that you can rely upon, and a facility for **user defined data type casting rules** for specific cases. The idea is to allow users to specify the how the migration should be done, in order for it to be repeatable and included in a *Continuous Migration* process.

**On the fly data transformations** The user defined casting rules come with on the fly rewrite of the data. For instance zero dates (it's not just the year, MySQL accepts `0000-00-00` as a valid datetime) are rewritten to NULL values by default.

**Partial Migrations** It is possible to include only a partial list of the source database tables in the migration, or to exclude some of the tables on the source database.

**Schema only, Data only** This is the **ORM compatibility** feature of pgloader, where it is possible to create the schema using your ORM and then have pgloader migrate the data targeting this already created schema.

When doing this, it is possible for pgloader to *reindex* the target schema: before loading the data from the source database into PostgreSQL using COPY, pgloader DROPS the indexes and constraints, and reinstalls the exact same definitions of them once the data has been loaded.

The reason for operating that way is of course data load performance.

**Repeatable (DROP+CREATE)** By default, pgloader issues DROP statements in the target PostgreSQL database before issuing any CREATE statement, so that you can repeat the migration as many times as necessary until migration specifications and rules are bug free.

The schedule the data migration to run every night (or even more often!) for the whole duration of the code migration project. See the [Continuous Migration](#) methodology for more details about the approach.

**On error stop / On error resume next** **The default behavior of pgloader when** migrating from a database is `on error stop`. The idea is to let the user fix either the migration specifications or the source data, and run the process again, until it works.



In some cases the source data is so damaged as to be impossible to migrate in full, and it might be necessary to then resort to the `on error resume next` option, where the rows rejected by PostgreSQL are saved away and the migration continues with the other rows.

**Pre/Post SQL commands, Post-Schema SQL commands** While pgloader takes care of rewriting the schema to PostgreSQL expectations, and even provides *user-defined data type casting rules* support to that end, sometimes it is necessary to add some specific SQL commands around the migration. It's of course supported right from pgloader itself, without having to script around it.

**Online ALTER schema** At times migrating to PostgreSQL is also a good opportunity to review and fix bad decisions that were made in the past, or simply that are not relevant to PostgreSQL.

The pgloader command syntax allows to ALTER pgloader's internal representation of the target catalogs so that the target schema can be created a little different from the source one. Changes supported include target a different *schema* or *table* name.

**Materialized Views, or schema rewrite on-the-fly** In some cases the schema rewriting goes deeper than just renaming the SQL objects to being a full normalization exercise. Because PostgreSQL is great at running a normalized schema in production under most workloads.

pgloader implements full flexibility in on-the-fly schema rewriting, by making it possible to migrate from a view definition. The view attribute list becomes a table definition in PostgreSQL, and the data is fetched by querying the view on the source system.

A SQL view allows to implement both content filtering at the column level using the SELECT projection clause, and at the row level using the WHERE restriction clause. And backfilling from reference tables thanks to JOINS.

**Distribute to Citus** When migrating from PostgreSQL to Citus, a important part of the process consists of adjusting the schema to the distribution key. Read [Preparing Tables and Ingesting Data](#) in the Citus documentation for a complete example showing how to do that.

When using pgloader it's possible to specify the distribution keys and reference tables and let pgloader take care of adjusting the table, indexes, primary keys and foreign key definitions all by itself.

**Encoding Overrides** MySQL doesn't actually enforce the encoding of the data in the database to match the encoding known in the metadata, defined at the database, table, or attribute level. Sometimes, it's necessary to override the metadata in order to make sense of the text, and pgloader makes it easy to do so.

## 1.3 Continuous Migration

pgloader is meant to migrate a whole database in a single command line and without any manual intervention. The goal is to be able to setup a *Continuous Integration* environment as described in the [Project Methodology](#) document of the [MySQL to PostgreSQL](#) webpage.

1. Setup your target PostgreSQL Architecture
2. Fork a Continuous Integration environment that uses PostgreSQL
3. Migrate the data over and over again every night, from production
4. As soon as the CI is all green using PostgreSQL, schedule the D-Day
5. Migrate without surprise and enjoy!

In order to be able to follow this great methodology, you need tooling to implement the third step in a fully automated way. That's pgloader.

### 1.3.1 Introduction

pgloader loads data from various sources into PostgreSQL. It can transform the data it reads on the fly and submit raw SQL before and after the loading. It uses the *COPY* PostgreSQL protocol to stream the data into the server, and manages errors by filling a pair of *reject.dat* and *reject.log* files.

pgloader knows how to read data from different kind of sources:

- Files
  - CSV
  - Fixed Format
  - DBF
- Databases
  - SQLite
  - MySQL
  - MS SQL Server
  - PostgreSQL
  - Redshift

pgloader knows how to target different products using the PostgreSQL Protocol:

- PostgreSQL
- Citus
- Redshift

The level of automation provided by pgloader depends on the data source type. In the case of CSV and Fixed Format files, a full description of the expected input properties must be given to pgloader. In the case of a database, pgloader connects to the live service and knows how to fetch the metadata it needs directly from it.

### Features Matrix

Here's a comparison of the features supported depending on the source database engine. Some features that are not supported can be added to pgloader, it's just that nobody had the need to do so yet. Those features are marked with . Empty cells are used when the feature doesn't make sense for the selected source database.

Feature	SQLite	MySQL	MS SQL	PostgreSQL	Redshift
One-command migration	✓	✓	✓	✓	✓
Continuous Migration	✓	✓	✓	✓	✓
Schema discovery	✓	✓	✓	✓	✓
Partial Migrations	✓	✓	✓	✓	✓
Schema only	✓	✓	✓	✓	✓
Data only	✓	✓	✓	✓	✓
Repeatable (DROP+CREATE)	✓	✓	✓	✓	✓
User defined casting rules	✓	✓	✓	✓	✓
Encoding Overrides		✓			
On error stop	✓	✓	✓	✓	✓
On error resume next	✓	✓	✓	✓	✓
Pre/Post SQL commands	✓	✓	✓	✓	✓
Post-Schema SQL commands		✓	✓	✓	✓
Primary key support	✓	✓	✓	✓	✓
Foreign key support	✓	✓	✓	✓	
Online ALTER schema	✓	✓	✓	✓	✓
Materialized views		✓	✓	✓	✓
Distribute to Citus		✓	✓	✓	✓

For more details about what the features are about, see the specific reference pages for your database source.

For some of the features, missing support only means that the feature is not needed for the other sources, such as the capability to override MySQL encoding metadata about a table or a column. Only MySQL in this list is left completely unable to guarantee text encoding. Or Redshift not having foreign keys.

## Commands

pgloader implements its own *Command Language*, a DSL that allows to specify every aspect of the data load and migration to implement. Some of the features provided in the language are only available for a specific source type.

## Command Line

The pgloader command line accepts those two variants:

```
pgloader [<options>] [<command-file>]...
pgloader [<options>] SOURCE TARGET
```

Either you have a *command-file* containing migration specifications in the pgloader *Command Language*, or you can give a *Source* for the data and a PostgreSQL database connection *Target* where to load the data into.

### 1.3.2 Pgloader Quick Start

In simple cases, pgloader is very easy to use.

## CSV

Load data from a CSV file into a pre-existing table in your database:

```
pgloader --type csv \
--field id --field field \
--with truncate \
--with "fields terminated by ','" \
./test/data/matching-1.csv \
postgres:///pgloader?tablename=matching
```

In that example the whole loading is driven from the command line, bypassing the need for writing a command in the `pgloader` command syntax entirely. As there's no command though, the extra information needed must be provided on the command line using the `-type` and `-field` and `-with` switches.

For documentation about the available syntaxes for the `-field` and `-with` switches, please refer to the CSV section later in the man page.

Note also that the PostgreSQL URI includes the target *tablename*.

### Reading from STDIN

File based `pgloader` sources can be loaded from the standard input, as in the following example:

```
pgloader --type csv \
--field "usps,geoid,aland,awater,aland_sqmi,awater_sqmi,intptlat,intptlong" \
--with "skip header = 1" \
--with "fields terminated by '\t'" \
- \
postgresql:///pgloader?districts_longlat \
< test/data/2013_Gaz_113CDs_national.txt
```

The dash (-) character as a source is used to mean *standard input*, as usual in Unix command lines. It's possible to stream compressed content to `pgloader` with this technique, using the Unix pipe:

```
gunzip -c source.gz | pgloader --type csv ... - pgsq://target?foo
```

### Loading from CSV available through HTTP

The same command as just above can also be run if the CSV file happens to be found on a remote HTTP location:

```
pgloader --type csv \
--field "usps,geoid,aland,awater,aland_sqmi,awater_sqmi,intptlat,intptlong" \
--with "skip header = 1" \
--with "fields terminated by '\t'" \
http://pgsql.tapoueh.org/temp/2013_Gaz_113CDs_national.txt \
postgresql:///pgloader?districts_longlat
```

Some more options have to be used in that case, as the file contains a one-line header (most commonly that's column names, could be a copyright notice). Also, in that case, we specify all the fields right into a single `-field` option argument.

Again, the PostgreSQL target connection string must contain the *tablename* option and you have to ensure that the target table exists and may fit the data. Here's the SQL command used in that example in case you want to try it yourself:

```
create table districts_longlat
(
    usps      text,
```

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```

    geoid      text,
    aland      bigint,
    awater     bigint,
    aland_sqmi double precision,
    awater_sqmi double precision,
    intptlat   double precision,
    intptlong  double precision
);

```

Also notice that the same command will work against an archived version of the same data.

### Streaming CSV data from an HTTP compressed file

Finally, it's important to note that pgloader first fetches the content from the HTTP URL it to a local file, then expand the archive when it's recognized to be one, and only then processes the locally expanded file.

In some cases, either because pgloader has no direct support for your archive format or maybe because expanding the archive is not feasible in your environment, you might want to *stream* the content straight from its remote location into PostgreSQL. Here's how to do that, using the old battle tested Unix Pipes trick:

```

curl http://pgsql.tapoueh.org/temp/2013_Gaz_113CDs_national.txt.gz \
| gunzip -c \
| pgloader --type csv \
  --field "usps,geoid,aland,awater,aland_sqmi,awater_sqmi,intptlat,intptlong" \
  --with "skip header = 1" \
  --with "fields terminated by '\t'" \
  - \
  postgresql:///pgloader?districts_longlat

```

Now the OS will take care of the streaming and buffering between the network and the commands and pgloader will take care of streaming the data down to PostgreSQL.

### Migrating from SQLite

The following command will open the SQLite database, discover its tables definitions including indexes and foreign keys, migrate those definitions while *casting* the data type specifications to their PostgreSQL equivalent and then migrate the data over:

```

createdb newdb
pgloader ./test/sqlite/sqlite.db postgresql:///newdb

```

### Migrating from MySQL

Just create a database where to host the MySQL data and definitions and have pgloader do the migration for you in a single command line:

```

createdb pagila
pgloader mysql://user@localhost/sakila postgresql:///pagila

```

## Fetching an archived DBF file from a HTTP remote location

It's possible for pgloader to download a file from HTTP, unarchive it, and only then open it to discover the schema then load the data:

```
createdb foo
pgloader --type dbf http://www.insee.fr/fr/methodes/nomenclatures/cog/telechargement/
↳2013/dbf/historiq2013.zip postgresql:///foo
```

Here it's not possible for pgloader to guess the kind of data source it's being given, so it's necessary to use the `-type` command line switch.

## 1.3.3 Pgloader Tutorial

### Loading CSV Data with pgloader

CSV means *comma separated values* and is often found with quite varying specifications. pgloader allows you to describe those specs in its command.

#### The Command

To load data with pgloader you need to define in a *command* the operations in some details. Here's our example for loading CSV data:

```
LOAD CSV
  FROM 'path/to/file.csv' (x, y, a, b, c, d)
  INTO postgresql:///pgloader?csv (a, b, d, c)

  WITH truncate,
       skip header = 1,
       fields optionally enclosed by '"',
       fields escaped by double-quote,
       fields terminated by ','

  SET client_encoding to 'latin1',
       work_mem to '12MB',
       standard_conforming_strings to 'on'

BEFORE LOAD DO
  $$ drop table if exists csv; $$,
  $$ create table csv (
    a bigint,
    b bigint,
    c char(2),
    d text
  );
  $$;
```

#### The Data

This command allows loading the following CSV file content:

```
Header, with a © sign
"2.6.190.56", "2.6.190.63", "33996344", "33996351", "GB", "United Kingdom"
"3.0.0.0", "4.17.135.31", "50331648", "68257567", "US", "United States"
"4.17.135.32", "4.17.135.63", "68257568", "68257599", "CA", "Canada"
"4.17.135.64", "4.17.142.255", "68257600", "68259583", "US", "United States"
"4.17.143.0", "4.17.143.15", "68259584", "68259599", "CA", "Canada"
"4.17.143.16", "4.18.32.71", "68259600", "68296775", "US", "United States"
```

## Loading the data

Here's how to start loading the data. Note that the output here has been edited so as to facilitate its browsing online:

```
$ pgloader csv.load
... LOG Starting pgloader, log system is ready.
... LOG Parsing commands from file "/Users/dim/dev/pgloader/test/csv.load"
```

table name	read	imported	errors	time
before load	2	2	0	0.039s
csv	6	6	0	0.019s
Total import time	6	6	0	0.058s

## The result

As you can see, the command described above is filtering the input and only importing some of the columns from the example data file. Here's what gets loaded in the PostgreSQL database:

```
pgloader# table csv;
 a | b | c | d
-----+-----+---+-----
33996344 | 33996351 | GB | United Kingdom
50331648 | 68257567 | US | United States
68257568 | 68257599 | CA | Canada
68257600 | 68259583 | US | United States
68259584 | 68259599 | CA | Canada
68259600 | 68296775 | US | United States
(6 rows)
```

## Loading Fixed Width Data File with pgloader

Some data providers still use a format where each column is specified with a starting index position and a given length. Usually the columns are blank-padded when the data is shorter than the full reserved range.

### The Command

To load data with pgloader you need to define in a *command* the operations in some details. Here's our example for loading Fixed Width Data, using a file provided by the US census.

You can find more files from them at the [Census 2000 Gazetteer Files](<http://www.census.gov/geo/maps-data/data/gazetteer2000.html>).

Here's our command:

```
LOAD ARCHIVE
FROM http://www.census.gov/geo/maps-data/data/docs/gazetteer/places2k.zip
INTO postgresql:///pgloader

BEFORE LOAD DO
  $$ drop table if exists places; $$,
  $$ create table places
  (
    usps      char(2)  not null,
    fips      char(2)  not null,
    fips_code char(5),
    loc_name  varchar(64)
  );
  $$

LOAD FIXED
FROM FILENAME MATCHING ~/places2k.txt/
WITH ENCODING latin1
(
  usps      from 0 for 2,
  fips      from 2 for 2,
  fips_code from 4 for 5,
  "LocationName" from 9 for 64 [trim right whitespace],
  p        from 73 for 9,
  h        from 82 for 9,
  land     from 91 for 14,
  water    from 105 for 14,
  ldm      from 119 for 14,
  wtm      from 131 for 14,
  lat      from 143 for 10,
  long     from 153 for 11
)
INTO postgresql:///pgloader?places
(
  usps, fips, fips_code, "LocationName"
);
```

## The Data

This command allows loading the following file content, where we are only showing the first couple of lines:

AL0100124Abbeville city								2987	↳
↳ 1353	40301945	120383	15.560669	0.046480	31.566367	-85.251300			
AL0100460Adamsville city								4965	↳
↳ 2042	50779330	14126	19.606010	0.005454	33.590411	-86.949166			
AL0100484Addison town								723	↳
↳ 339	9101325	0	3.514041	0.000000	34.200042	-87.177851			
AL0100676Akron town								521	↳
↳ 239	1436797	0	0.554750	0.000000	32.876425	-87.740978			
AL0100820Alabaster city								22619	↳
↳ 8594	53023800	141711	20.472605	0.054715	33.231162	-86.823829			
AL0100988Albertville city								17247	↳
↳ 7090	67212867	258738	25.951034	0.099899	34.265362	-86.211261			
AL0101132Alexander City city								15008	↳
↳ 6855	100534344	433413	38.816529	0.167342	32.933157	-85.936008			



## Loading the data

Let's start the *pgloader* command with our *census-places.load* command file:

```
$ pgloader census-places.load
... LOG Starting pgloader, log system is ready.
... LOG Parsing commands from file "/Users/dim/dev/pgloader/test/census-places.load"
... LOG Fetching 'http://www.census.gov/geo/maps-data/data/docs/gazetteer/places2k.zip
↪ '
... LOG Extracting files from archive '//private/var/folders/w7/
↪ 9n8v8pw54t1gngfff01j16040000gn/T/pgloader//places2k.zip'
```

table name	read	imported	errors	time
download	0	0	0	1.494s
extract	0	0	0	1.013s
before load	2	2	0	0.013s
places	25375	25375	0	0.499s
Total import time	25375	25375	0	3.019s

We can see that *pgloader* did download the file from its HTTP URL location then *unzipped* it before the loading itself. Note that the output of the command has been edited to facilitate its browsing online.

## Loading MaxMind Geolite Data with pgloader

*MaxMind* provides a free dataset for geolocation, which is quite popular. Using *pgloader* you can download the latest version of it, extract the CSV files from the archive and load their content into your database directly.

### The Command

To load data with *pgloader* you need to define in a *command* the operations in some details. Here's our example for loading the Geolite data:

```
/*
 * Loading from a ZIP archive containing CSV files. The full test can be
 * done with using the archive found at
 * http://geolite.maxmind.com/download/geoip/database/GeoLiteCity_CSV/GeoLiteCity-
↪ latest.zip
 *
 * And a very light version of this data set is found at
 * http://pgsql.tapoueh.org/temp/foo.zip for quick testing.
 */

LOAD ARCHIVE
  FROM http://geolite.maxmind.com/download/geoip/database/GeoLiteCity_CSV/
↪ GeoLiteCity-latest.zip
  INTO postgresql:///ip4r

BEFORE LOAD DO
  $$ create extension if not exists ip4r; $$,
  $$ create schema if not exists geolite; $$,
  $$ create table if not exists geolite.location
```

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```

    (
      locid      integer primary key,
      country   text,
      region    text,
      city      text,
      postalcode text,
      location  point,
      metrocode text,
      areacode  text
    );
$$,
$$ create table if not exists geolite.blocks
    (
      iprange   ip4r,
      locid     integer
    );
$$,
$$ drop index if exists geolite.blocks_ip4r_idx; $$,
$$ truncate table geolite.blocks, geolite.location cascade; $$

LOAD CSV
FROM FILENAME MATCHING ~/GeoLiteCity-Location.csv/
WITH ENCODING iso-8859-1
    (
      locId,
      country,
      region    null if blanks,
      city      null if blanks,
      postalCode null if blanks,
      latitude,
      longitude,
      metroCode null if blanks,
      areaCode  null if blanks
    )
INTO postgresql:///ip4r?geolite.location
    (
      locid,country,region,city,postalCode,
      location point using (format nil "(~a,~a)" longitude latitude),
      metroCode,areaCode
    )
WITH skip header = 2,
fields optionally enclosed by '"',
fields escaped by double-quote,
fields terminated by ','

AND LOAD CSV
FROM FILENAME MATCHING ~/GeoLiteCity-Blocks.csv/
WITH ENCODING iso-8859-1
    (
      startIpNum, endIpNum, locId
    )
INTO postgresql:///ip4r?geolite.blocks
    (
      iprange ip4r using (ip-range startIpNum endIpNum),
      locId
    )
WITH skip header = 2,

```

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```

fields optionally enclosed by '"',
fields escaped by double-quote,
fields terminated by ','

FINALLY DO
  $$ create index blocks_ip4r_idx on geolite.blocks using gist(iprange); $$;

```

Note that while the *Geolite* data is using a pair of integers (*start*, *end*) to represent *ipv4* data, we use the very powerful *ip4r* PostgreSQL Extension instead.

The transformation from a pair of integers into an IP is done dynamically by the pgloader process.

Also, the location is given as a pair of *float* columns for the *longitude* and the *latitude* where PostgreSQL offers the *point* datatype, so the pgloader command here will actually transform the data on the fly to use the appropriate data type and its input representation.

## Loading the data

Here's how to start loading the data. Note that the output here has been edited so as to facilitate its browsing online:

```

$ pgloader archive.load
... LOG Starting pgloader, log system is ready.
... LOG Parsing commands from file "/Users/dim/dev/pgloader/test/archive.load"
... LOG Fetching 'http://geolite.maxmind.com/download/geoip/database/GeoLiteCity_CSV/
↳GeoLiteCity-latest.zip'
... LOG Extracting files from archive '//private/var/folders/w7/
↳9n8v8pw54t1gngfff01j16040000gn/T/pgloader//GeoLiteCity-latest.zip'

```

table name	read	imported	errors	time
download	0	0	0	11.592s
extract	0	0	0	1.012s
before load	6	6	0	0.019s
geolite.location	470387	470387	0	7.743s
geolite.blocks	1903155	1903155	0	16.332s
finally	1	1	0	31.692s
Total import time	2373542	2373542	0	1m8.390s

The timing of course includes the transformation of the *1.9 million* pairs of integer into a single *ipv4 range* each. The *finally* step consists of creating the *GiST* specialized index as given in the main command:

```
CREATE INDEX blocks_ip4r_idx ON geolite.blocks USING gist(iprange);
```

That index will then be used to speed up queries wanting to find which recorded geolocation contains a specific IP address:

```

ip4r> select *
      from   geolite.location l
            join geolite.blocks b using(loid)
      where  iprange >= '8.8.8.8';

-[ RECORD 1 ]-----

```

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```

locid      | 223
country   | US
region    |
city      |
postalcode|
location  | (-97,38)
metrocode |
areacode  |
iprange   | 8.8.8.8-8.8.37.255

Time: 0.747 ms

```

### Loading dBase files with pgloader

The dBase format is still in use in some places as modern tools such as *Filemaker* and *Excel* offer some level of support for it. Speaking of support in modern tools, pgloader is right there on the list too!

### The Command

To load data with pgloader you need to define in a *command* the operations in some details. Here's our example for loading a dBase file, using a file provided by the french administration.

You can find more files from them at the [Insee website](#).

Here's our command:

```

LOAD DBF
  FROM http://www.insee.fr/fr/methodes/nomenclatures/cog/telechargement/2013/dbf/
  ↪historiq2013.zip
  INTO postgresql:///pgloader
  WITH truncate, create table
  SET client_encoding TO 'latin1';

```

Note that here pgloader will benefit from the meta-data information found in the dBase file to create a PostgreSQL table capable of hosting the data as described, then load the data.

### Loading the data

Let's start the *pgloader* command with our *dbf-zip.load* command file:

```

$ pgloader dbf-zip.load
... LOG Starting pgloader, log system is ready.
... LOG Parsing commands from file "/Users/dim/dev/pgloader/test/dbf-zip.load"
... LOG Fetching 'http://www.insee.fr/fr/methodes/nomenclatures/cog/telechargement/
↪2013/dbf/historiq2013.zip'
... LOG Extracting files from archive '//private/var/folders/w7/
↪9n8v8pw54t1gngfff01j16040000gn/T/pgloader//historiq2013.zip'

-----
table name      read  imported  errors  time
-----
download        0      0         0      0.167s
extract         0      0         0      1.010s
create, truncate 0      0         0      0.071s

```

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historiq2013	9181	9181	0	0.658s
Total import time	9181	9181	0	1.906s

We can see that `pgloader` did download the file from its HTTP URL location then *unzipped* it before the loading itself.

Note that the output of the command has been edited to facilitate its browsing online.

### Loading SQLite files with pgloader

The SQLite database is a respected solution to manage your data with. Its embedded nature makes it a source of migrations when a projects now needs to handle more concurrency, which **PostgreSQL** is very good at. `pgloader` can help you there.

### In a Single Command Line

You can

```
$ createdb chinook
$ pgloader https://github.com/lerocha/chinook-database/raw/master/ChinookDatabase/
↳DataSources/Chinook_Sqlite_AutoIncrementPKs.sqlite pgsql:///chinook
```

Done! All with the schema, data, constraints, primary keys and foreign keys, etc. We also see an error with the Chinook schema that contains several primary key definitions against the same table, which is not accepted by PostgreSQL:

```
2017-06-20T16:18:59.019000+02:00 LOG Data errors in '/private/tmp/pgloader/'
2017-06-20T16:18:59.236000+02:00 LOG Fetching 'https://github.com/lerocha/chinook-
↳database/raw/master/ChinookDatabase/DataSources/Chinook_Sqlite_AutoIncrementPKs.
↳sqlite'
2017-06-20T16:19:00.664000+02:00 ERROR Database error 42P16: multiple primary keys_
↳for table "playlisttrack" are not allowed
QUERY: ALTER TABLE playlisttrack ADD PRIMARY KEY USING INDEX idx_66873_sqlite_
↳autoindex_playlisttrack_1;
2017-06-20T16:19:00.665000+02:00 LOG report summary reset
```

table name	read	imported	errors	total time
fetch	0	0	0	0.877s
fetch meta data	33	33	0	0.033s
Create Schemas	0	0	0	0.003s
Create SQL Types	0	0	0	0.006s
Create tables	22	22	0	0.043s
Set Table OIDs	11	11	0	0.012s
album	347	347	0	0.023s
artist	275	275	0	0.023s
customer	59	59	0	0.021s
employee	8	8	0	0.018s
invoice	412	412	0	0.031s
genre	25	25	0	0.021s
invoiceline	2240	2240	0	0.034s
mediatype	5	5	0	0.025s
playlisttrack	8715	8715	0	0.040s
playlist	18	18	0	0.016s

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track	3503	3503	0	0.111s
-----				
COPY Threads Completion	33	33	0	0.313s
Create Indexes	22	22	0	0.160s
Index Build Completion	22	22	0	0.027s
Reset Sequences	0	0	0	0.017s
Primary Keys	12	0	1	0.013s
Create Foreign Keys	11	11	0	0.040s
Create Triggers	0	0	0	0.000s
Install Comments	0	0	0	0.000s
-----				
Total <b>import time</b>	15607	15607	0	1.669s

You may need to have special cases to take care of tho. In advanced case you can use the pgloader command.

## The Command

To load data with pgloader you need to define in a *command* the operations in some details. Here's our command:

```
load database
  from 'sqlite/Chinook_Sqlite_AutoIncrementPKs.sqlite'
  into postgresql:///pgloader

with include drop, create tables, create indexes, reset sequences

set work_mem to '16MB', maintenance_work_mem to '512 MB';
```

Note that here pgloader will benefit from the meta-data information found in the SQLite file to create a PostgreSQL database capable of hosting the data as described, then load the data.

## Loading the data

Let's start the *pgloader* command with our *sqlite.load* command file:

```
$ pgloader sqlite.load
... LOG Starting pgloader, log system is ready.
... LOG Parsing commands from file "/Users/dim/dev/pgloader/test/sqlite.load"
... WARNING Postgres warning: table "album" does not exist, skipping
... WARNING Postgres warning: table "artist" does not exist, skipping
... WARNING Postgres warning: table "customer" does not exist, skipping
... WARNING Postgres warning: table "employee" does not exist, skipping
... WARNING Postgres warning: table "genre" does not exist, skipping
... WARNING Postgres warning: table "invoice" does not exist, skipping
... WARNING Postgres warning: table "invoiceline" does not exist, skipping
... WARNING Postgres warning: table "mediatype" does not exist, skipping
... WARNING Postgres warning: table "playlist" does not exist, skipping
... WARNING Postgres warning: table "playlisttrack" does not exist, skipping
... WARNING Postgres warning: table "track" does not exist, skipping
-----
table name      read  imported  errors  time
-----
create, truncate  0      0          0      0.052s
  Album         347    347        0      0.070s
  Artist        275    275        0      0.014s
  Customer       59     59         0      0.014s
```

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Employee	8	8	0	0.012s
Genre	25	25	0	0.018s
Invoice	412	412	0	0.032s
InvoiceLine	2240	2240	0	0.077s
MediaType	5	5	0	0.012s
Playlist	18	18	0	0.008s
PlaylistTrack	8715	8715	0	0.071s
Track	3503	3503	0	0.105s
index build completion	0	0	0	0.000s
-----				
Create Indexes	20	20	0	0.279s
reset sequences	0	0	0	0.043s
-----				
Total streaming time	15607	15607	0	0.476s

We can see that `pgloader` did download the file from its HTTP URL location then *unzipped* it before loading it.

Also, the *WARNING* messages we see here are expected as the PostgreSQL database is empty when running the command, and `pgloader` is using the SQL commands *DROP TABLE IF EXISTS* when the given command uses the *include drop* option.

Note that the output of the command has been edited to facilitate its browsing online.

## Migrating from MySQL to PostgreSQL

If you want to migrate your data over to `PostgreSQL` from `MySQL` then `pgloader` is the tool of choice!

Most tools around are skipping the main problem with migrating from `MySQL`, which is to do with the type casting and data sanitizing that needs to be done. `pgloader` will not leave you alone on those topics.

### In a Single Command Line

As an example, we will use the `f1db` database from <http://ergast.com/mrd/> which provides a historical record of motor racing data for non-commercial purposes. You can either use their API or download the whole database at <http://ergast.com/downloads/f1db.sql.gz>. Once you've done that load the database in `MySQL`:

```
$ mysql -u root
> create database f1db;
> source f1db.sql
```

Now let's migrate this database into `PostgreSQL` in a single command line:

```
$ createdb f1db
$ pgloader mysql://root@localhost/f1db pgsq://f1db
```

Done! All with schema, table definitions, constraints, indexes, primary keys, *auto\_increment* columns turned into *bigserial*, foreign keys, comments, and if you had some `MySQL` default values such as *ON UPDATE CURRENT\_TIMESTAMP* they would have been translated to a `PostgreSQL` *before update trigger* automatically.

```
$ pgloader mysql://root@localhost/f1db pgsq://f1db
2017-06-16T08:56:14.064000+02:00 LOG Main logs in '/private/tmp/pgloader/pgloader.log'
2017-06-16T08:56:14.068000+02:00 LOG Data errors in '/private/tmp/pgloader/'
2017-06-16T08:56:19.542000+02:00 LOG report summary reset
table name      read  imported  errors  total time
```

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fetch meta data	33	33	0	0.365s
Create Schemas	0	0	0	0.007s
Create SQL Types	0	0	0	0.006s
Create tables	26	26	0	0.068s
Set Table OIDs	13	13	0	0.012s
-----				
fldb.constructorresults	11011	11011	0	0.205s
fldb.circuits	73	73	0	0.150s
fldb.constructors	208	208	0	0.059s
fldb.constructorstandings	11766	11766	0	0.365s
fldb.drivers	841	841	0	0.268s
fldb.laptimes	413578	413578	0	2.892s
fldb.driverstandings	31420	31420	0	0.583s
fldb.pitstops	5796	5796	0	2.154s
fldb.races	976	976	0	0.227s
fldb.qualifying	7257	7257	0	0.228s
fldb.seasons	68	68	0	0.527s
fldb.results	23514	23514	0	0.658s
fldb.status	133	133	0	0.130s
-----				
COPY Threads Completion	39	39	0	4.303s
Create Indexes	20	20	0	1.497s
Index Build Completion	20	20	0	0.214s
Reset Sequences	0	10	0	0.058s
Primary Keys	13	13	0	0.012s
Create Foreign Keys	0	0	0	0.000s
Create Triggers	0	0	0	0.001s
Install Comments	0	0	0	0.000s
-----				
Total import time	506641	506641	0	5.547s

You may need to have special cases to take care of tho, or views that you want to materialize while doing the migration. In advanced case you can use the pgloader command.

## The Command

To load data with pgloader you need to define in a *command* the operations in some details. Here's our example for loading the [MySQL Sakila Sample Database](#).

Here's our command:

```
load database
  from      mysql://root@localhost/sakila
  into postgresql://sakila

WITH include drop, create tables, no truncate,
      create indexes, reset sequences, foreign keys

SET maintenance_work_mem to '128MB', work_mem to '12MB', search_path to 'sakila'

CAST type datetime to timestamptz
      drop default drop not null using zero-dates-to-null,
      type date drop not null drop default using zero-dates-to-null
```

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```

MATERIALIZED VIEWS film_list, staff_list

-- INCLUDING ONLY TABLE NAMES MATCHING ~/film/, 'actor'
-- EXCLUDING TABLE NAMES MATCHING ~<ory>

BEFORE LOAD DO
$$ create schema if not exists sakila; $$;

```

Note that here pgloader will benefit from the meta-data information found in the MySQL database to create a PostgreSQL database capable of hosting the data as described, then load the data.

In particular, some specific *casting rules* are given here, to cope with date values such as *0000-00-00* that MySQL allows and PostgreSQL rejects for not existing in our calendar. It's possible to add per-column casting rules too, which is useful if some of your *tinyint* are in fact *smallint* while some others are in fact *boolean* values.

Finally note that we are using the *MATERIALIZED VIEWS* clause of pgloader: the selected views here will be migrated over to PostgreSQL *with their contents*.

It's possible to use the *MATERIALIZED VIEWS* clause and give both the name and the SQL (in MySQL dialect) definition of view, then pgloader creates the view before loading the data, then drops it again at the end.

## Loading the data

Let's start the *pgloader* command with our *sakila.load* command file:

```

$ pgloader sakila.load
... LOG Starting pgloader, log system is ready.
... LOG Parsing commands from file "/Users/dim/dev/pgloader/test/sakila.load"
  <WARNING: table "xxx" does not exists have been edited away>

```

table name	read	imported	errors	time
before load	1	1	0	0.007s
fetch meta data	45	45	0	0.402s
create, drop	0	36	0	0.208s
actor	200	200	0	0.071s
address	603	603	0	0.035s
category	16	16	0	0.018s
city	600	600	0	0.037s
country	109	109	0	0.023s
customer	599	599	0	0.073s
film	1000	1000	0	0.135s
film_actor	5462	5462	0	0.236s
film_category	1000	1000	0	0.070s
film_text	1000	1000	0	0.080s
inventory	4581	4581	0	0.136s
language	6	6	0	0.036s
payment	16049	16049	0	0.539s
rental	16044	16044	0	0.648s
staff	2	2	0	0.041s
store	2	2	0	0.036s
film_list	997	997	0	0.247s
staff_list	2	2	0	0.135s
Index Build Completion	0	0	0	0.000s

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Create Indexes	41	41	0	0.964s
Reset Sequences	0	1	0	0.035s
Foreign Keys	22	22	0	0.254s
-----				
Total import time	48272	48272	0	3.502s

The *WARNING* messages we see here are expected as the PostgreSQL database is empty when running the command, and pgloader is using the SQL commands *DROP TABLE IF EXISTS* when the given command uses the *include drop* option.

Note that the output of the command has been edited to facilitate its browsing online.

### 1.3.4 PgLoader Reference Manual

pgloader loads data from various sources into PostgreSQL. It can transform the data it reads on the fly and submit raw SQL before and after the loading. It uses the *COPY* PostgreSQL protocol to stream the data into the server, and manages errors by filling a pair of *reject.dat* and *reject.log* files.

pgloader operates either using commands which are read from files:

```
pgloader commands.load
```

or by using arguments and options all provided on the command line:

```
pgloader SOURCE TARGET
```

#### Arguments

The pgloader arguments can be as many load files as needed, or a couple of connection strings to a specific input file.

#### Source Connection String

The source connection string format is as follows:

```
format:///absolute/path/to/file.ext  
format://./relative/path/to/file.ext
```

Where format might be one of *csv*, *fixed*, *copy*, *dbf*, *db3* or *ixf*:

```
db://user:pass@host:port/dbname
```

Where db might be of *sqlite*, *mysql* or *mssql*.

When using a file based source format, pgloader also support natively fetching the file from an http location and decompressing an archive if needed. In that case it's necessary to use the *-type* option to specify the expected format of the file. See the examples below.

Also note that some file formats require describing some implementation details such as columns to be read and delimiters and quoting when loading from *csv*.

For more complex loading scenarios, you will need to write a full fledge load command in the syntax described later in this document.

## Target Connection String

The target connection string format is described in details later in this document, see Section Connection String.

## Options

### Inquiry Options

Use these options when you want to know more about how to use *pgloader*, as those options will cause *pgloader* not to load any data.

- *-h, -help*  
Show command usage summary and exit.
- *-V, -version*  
Show pgloader version string and exit.
- *-E, -list-encodings*  
List known encodings in this version of pgloader.
- *-U, -upgrade-config*  
Parse given files in the command line as *pgloader.conf* files with the *INI* syntax that was in use in pgloader versions 2.x, and output the new command syntax for pgloader on standard output.

### General Options

Those options are meant to tweak *pgloader* behavior when loading data.

- *-v, -verbose*  
Be verbose.
- *-q, -quiet*  
Be quiet.
- *-d, -debug*  
Show debug level information messages.
- *-D, -root-dir*  
Set the root working directory (default to “/tmp/pgloader”).
- *-L, -logfile*  
Set the pgloader log file (default to “/tmp/pgloader/pgloader.log”).
- *-log-min-messages*  
Minimum level of verbosity needed for log message to make it to the logfile. One of critical, log, error, warning, notice, info or debug.
- *-client-min-messages*  
Minimum level of verbosity needed for log message to make it to the console. One of critical, log, error, warning, notice, info or debug.

- `-S, -summary`

A filename where to copy the summary output. When relative, the filename is expanded into `*root-dir*`.

The format of the filename defaults to being *human readable*. It is possible to have the output in machine friendly formats such as *CSV*, *COPY* (PostgreSQL's own COPY format) or *JSON* by specifying a filename with the extension resp. `.csv`, `.copy` or `.json`.

- `-l <file>, -load-lisp-file <file>`

Specify a lisp `<file>` to compile and load into the pgloader image before reading the commands, allowing to define extra transformation function. Those functions should be defined in the `pgloader.transforms` package. This option can appear more than once in the command line.

- `-dry-run`

Allow testing a `.load` file without actually trying to load any data. It's useful to debug it until it's ok, in particular to fix connection strings.

- `-on-error-stop`

Alter pgloader behavior: rather than trying to be smart about error handling and continue loading good data, separating away the bad one, just stop as soon as PostgreSQL refuses anything sent to it. Useful to debug data processing, transformation function and specific type casting.

- `-self-upgrade <directory>`

Specify a `<directory>` where to find pgloader sources so that one of the very first things it does is dynamically loading-in (and compiling to machine code) another version of itself, usually a newer one like a very recent git checkout.

- `-no-ssl-cert-verification`

Uses the OpenSSL option to accept a locally issued server-side certificate, avoiding the following error message:

```
SSL verify error: 20 X509_V_ERR_UNABLE_TO_GET_ISSUER_CERT_LOCALLY
```

The right way to fix the SSL issue is to use a trusted certificate, of course. Sometimes though it's useful to make progress with the pgloader setup while the certificate chain of trust is being fixed, maybe by another team. That's when this option is useful.

## Command Line Only Operations

Those options are meant to be used when using `pgloader` from the command line only, rather than using a command file and the rich command clauses and parser. In simple cases, it can be much easier to use the `SOURCE` and `TARGET` directly on the command line, then tweak the loading with those options:

- `-with "option"`

Allows setting options from the command line. You can use that option as many times as you want. The option arguments must follow the `WITH` clause for the source type of the `SOURCE` specification, as described later in this document.

- `-set "guc_name='value'"`

Allows setting PostgreSQL configuration from the command line. Note that the option parsing is the same as when used from the `SET` command clause, in particular you must enclose the guc value with single-quotes.

- `-field "..."`

Allows setting a source field definition. Fields are accumulated in the order given on the command line. It's possible to either use a `-field` option per field in the source file, or to separate field definitions by a comma, as you would do in the *HAVING FIELDS* clause.

- `-cast "..."`

Allows setting a specific casting rule for loading the data.

- `-type csv|fixed|db3|ixf|sqlite|mysql|mssql`

Allows forcing the source type, in case when the *SOURCE* parsing isn't satisfying.

- `-encoding <encoding>`

Set the encoding of the source file to load data from.

- `-before <filename>`

Parse given filename for SQL queries and run them against the target database before loading the data from the source. The queries are parsed by pgloader itself: they need to be terminated by a semi-colon (;) and the file may include *i* or *ir* commands to *include* another file.

- `-after <filename>`

Parse given filename for SQL queries and run them against the target database after having loaded the data from the source. The queries are parsed in the same way as with the `-before` option, see above.

## More Debug Information

To get the maximum amount of debug information, you can use both the `-verbose` and the `-debug` switches at the same time, which is equivalent to saying `-client-min-messages data`. Then the log messages will show the data being processed, in the cases where the code has explicit support for it.

## Batches And Retry Behaviour

To load data to PostgreSQL, pgloader uses the *COPY* streaming protocol. While this is the faster way to load data, *COPY* has an important drawback: as soon as PostgreSQL emits an error with any bit of data sent to it, whatever the problem is, the whole data set is rejected by PostgreSQL.

To work around that, pgloader cuts the data into *batches* of 25000 rows each, so that when a problem occurs it's only impacting that many rows of data. Each batch is kept in memory while the *COPY* streaming happens, in order to be able to handle errors should some happen.

When PostgreSQL rejects the whole batch, pgloader logs the error message then isolates the bad row(s) from the accepted ones by retrying the batched rows in smaller batches. To do that, pgloader parses the *CONTEXT* error message from the failed *COPY*, as the message contains the line number where the error was found in the batch, as in the following example:

```
CONTEXT: COPY errors, line 3, column b: "2006-13-11"
```

Using that information, pgloader will reload all rows in the batch before the erroneous one, log the erroneous one as rejected, then try loading the remaining of the batch in a single attempt, which may or may not contain other erroneous data.

At the end of a load containing rejected rows, you will find two files in the *root-dir* location, under a directory named the same as the target database of your setup. The filenames are the target table, and their extensions are *.dat* for the rejected data and *.log* for the file containing the full PostgreSQL client side logs about the rejected data.

The *.dat* file is formatted in PostgreSQL the text *COPY* format as documented in <http://www.postgresql.org/docs/9.2/static/sql-copy.html#AEN66609>.

It is possible to use the following WITH options to control pgloader batch behavior:

- *on error stop, on error resume next*

This option controls if pgloader is using building batches of data at all. The batch implementation allows pgloader to recover errors by sending the data that PostgreSQL accepts again, and by keeping away the data that PostgreSQL rejects.

To enable retrying the data and loading the good parts, use the option *on error resume next*, which is the default to file based data loads (such as CSV, IXF or DBF).

When migrating from another RDMBS technology, it's best to have a reproducible loading process. In that case it's possible to use *on error stop* and fix either the casting rules, the data transformation functions or in cases the input data until your migration runs through completion. That's why *on error resume next* is the default for SQLite, MySQL and MS SQL source kinds.

### A Note About Performance

pgloader has been developed with performance in mind, to be able to cope with ever growing needs in loading large amounts of data into PostgreSQL.

The basic architecture it uses is the old Unix pipe model, where a thread is responsible for loading the data (reading a CSV file, querying MySQL, etc) and fills pre-processed data into a queue. Another threads feeds from the queue, apply some more *transformations* to the input data and stream the end result to PostgreSQL using the COPY protocol.

When given a file that the PostgreSQL *COPY* command knows how to parse, and if the file contains no erroneous data, then pgloader will never be as fast as just using the PostgreSQL *COPY* command.

Note that while the *COPY* command is restricted to read either from its standard input or from a local file on the server's file system, the command line tool *psql* implements a *copy* command that knows how to stream a file local to the client over the network and into the PostgreSQL server, using the same protocol as pgloader uses.

### A Note About Parallelism

pgloader uses several concurrent tasks to process the data being loaded:

- a reader task reads the data in and pushes it to a queue,
- at last one write task feeds from the queue and formats the raw into the PostgreSQL COPY format in batches (so that it's possible to then retry a failed batch without reading the data from source again), and then sends the data to PostgreSQL using the COPY protocol.

The parameter *workers* allows to control how many worker threads are allowed to be active at any time (that's the parallelism level); and the parameter *concurrency* allows to control how many tasks are started to handle the data (they may not all run at the same time, depending on the *workers* setting).

We allow *workers* simultaneous workers to be active at the same time in the context of a single table. A single unit of work consist of several kinds of workers:

- a reader getting raw data from the source,
- N writers preparing and sending the data down to PostgreSQL.

The N here is setup to the *concurrency* parameter: with a *CONCURRENCY* of 2, we start  $(+ 1 \ 2) = 3$  concurrent tasks, with a *concurrency* of 4 we start  $(+ 1 \ 4) = 5$  concurrent tasks, of which only *workers* may be active simultaneously.

The defaults are *workers* = 4, *concurrency* = 1 when loading from a database source, and *workers* = 8, *concurrency* = 2 when loading from something else (currently, a file). Those defaults are arbitrary and waiting for feedback from users, so please consider providing feedback if you play with the settings.

As the *CREATE INDEX* threads started by pgloader are only waiting until PostgreSQL is done with the real work, those threads are *NOT* counted into the concurrency levels as detailed here.

By default, as many *CREATE INDEX* threads as the maximum number of indexes per table are found in your source schema. It is possible to set the *max parallel create index WITH* option to another number in case there's just too many of them to create.

## Source Formats

pgloader supports the following input formats:

- csv, which includes also tsv and other common variants where you can change the *separator* and the *quoting* rules and how to *escape* the *quotes* themselves;
- fixed columns file, where pgloader is flexible enough to accomodate with source files missing columns (*ragged fixed length column files* do exist);
- PostgreSQL COPY formatted files, following the COPY TEXT documentation of PostgreSQL, such as the reject files prepared by pgloader;
- dbase files known as db3 or dbf file;
- ixf formatted files, ixf being a binary storage format from IBM;
- sqlite databases with fully automated discovery of the schema and advanced cast rules;
- mysql databases with fully automated discovery of the schema and advanced cast rules;
- MS SQL databases with fully automated discovery of the schema and advanced cast rules.

## Pgloader Commands Syntax

pgloader implements a Domain Specific Language allowing to setup complex data loading scripts handling computed columns and on-the-fly sanitization of the input data. For more complex data loading scenarios, you will be required to learn that DSL's syntax. It's meant to look familiar to DBA by being inspired by SQL where it makes sense, which is not that much after all.

The pgloader commands follow the same global grammar rules. Each of them might support only a subset of the general options and provide specific options.

```
LOAD <source-type>
    FROM <source-url>
    [ HAVING FIELDS <source-level-options> ]
    INTO <postgresql-url>
    [ TARGET TABLE [ "<schema>" ]."<table name>" ]
    [ TARGET COLUMNS <columns-and-options> ]

    [ WITH <load-options> ]

    [ SET <postgresql-settings> ]

[ BEFORE LOAD [ DO <sql statements> | EXECUTE <sql file> ] ... ]
[ AFTER LOAD [ DO <sql statements> | EXECUTE <sql file> ] ... ]
;
```

The main clauses are the *LOAD*, *FROM*, *INTO* and *WITH* clauses that each command implements. Some command then implement the *SET* command, or some specific clauses such as the *CAST* clause.

### Templating with Mustache

pgloader implements the <https://mustache.github.io/> templating system so that you may have dynamic parts of your commands. See the documentation for this template system online.

A specific feature of pgloader is the ability to fetch a variable from the OS environment of the pgloader process, making it possible to run pgloader as in the following example:

```
$ DBPATH=sqlite/sqlite.db pgloader ./test/sqlite-env.load
```

or in several steps:

```
$ export DBPATH=sqlite/sqlite.db
$ pgloader ./test/sqlite-env.load
```

The variable can then be used in a typical mustache fashion:

```
load database
  from '{{DBPATH}}'
  into postgresql://pgloader;
```

It's also possible to prepare a INI file such as the following:

```
[pgloader]
DBPATH = sqlite/sqlite.db
```

And run the following command, feeding the INI values as a *context* for pgloader templating system:

```
$ pgloader --context ./test/sqlite.ini ./test/sqlite-ini.load
```

The mustache templates implementation with OS environment support replaces former *GETENV* implementation, which didn't work anyway.

### Common Clauses

Some clauses are common to all commands:

#### FROM

The *FROM* clause specifies where to read the data from, and each command introduces its own variant of sources. For instance, the *CSV* source supports *inline*, *stdin*, a filename, a quoted filename, and a *FILENAME MATCHING* clause (see above); whereas the *MySQL* source only supports a MySQL database URI specification.

#### INTO

The PostgreSQL connection URI must contains the name of the target table where to load the data into. That table must have already been created in PostgreSQL, and the name might be schema qualified.

Then *INTO* option also supports an optional comma separated list of target columns, which are either the name of an input *field* or the white space separated list of the target column name, its PostgreSQL data type and a *USING* expression.



The *USING* expression can be any valid Common Lisp form and will be read with the current package set to *pgloader.transforms*, so that you can use functions defined in that package, such as functions loaded dynamically with the *-load* command line parameter.

Each *USING* expression is compiled at runtime to native code.

This feature allows pgloader to load any number of fields in a CSV file into a possibly different number of columns in the database, using custom code for that projection.

## WITH

Set of options to apply to the command, using a global syntax of either:

- *key = value*
- *use option*
- *do not use option*

See each specific command for details.

All data sources specific commands support the following options:

- *on error stop, on error resume next*
- *batch rows = R*
- *batch size = ... MB*
- *prefetch rows = ...*

See the section BATCH BEHAVIOUR OPTIONS for more details.

In addition, the following settings are available:

- *workers = W*
- *concurrency = C*
- *max parallel create index = I*

See section A NOTE ABOUT PARALLELISM for more details.

## SET

This clause allows to specify session parameters to be set for all the sessions opened by pgloader. It expects a list of parameter name, the equal sign, then the single-quoted value as a comma separated list.

The names and values of the parameters are not validated by pgloader, they are given as-is to PostgreSQL.

## BEFORE LOAD DO

You can run SQL queries against the database before loading the data from the CSV file. Most common SQL queries are *CREATE TABLE IF NOT EXISTS* so that the data can be loaded.

Each command must be *dollar-quoted*: it must begin and end with a double dollar sign, *\$\$*. Dollar-quoted queries are then comma separated. No extra punctuation is expected after the last SQL query.

## BEFORE LOAD EXECUTE

Same behaviour as in the *BEFORE LOAD DO* clause. Allows you to read the SQL queries from a SQL file. Implements support for PostgreSQL dollar-quoting and the *i* and *ir* include facilities as in *psql* batch mode (where they are the same thing).

## AFTER LOAD DO

Same format as *BEFORE LOAD DO*, the dollar-quoted queries found in that section are executed once the load is done. That's the right time to create indexes and constraints, or re-enable triggers.

## AFTER LOAD EXECUTE

Same behaviour as in the *AFTER LOAD DO* clause. Allows you to read the SQL queries from a SQL file. Implements support for PostgreSQL dollar-quoting and the *i* and *ir* include facilities as in *psql* batch mode (where they are the same thing).

## AFTER CREATE SCHEMA DO

Same format as *BEFORE LOAD DO*, the dollar-quoted queries found in that section are executed once the schema has been created by pgloader, and before the data is loaded. It's the right time to ALTER TABLE or do some custom implementation on-top of what pgloader does, like maybe partitioning.

## AFTER CREATE SCHEMA EXECUTE

Same behaviour as in the *AFTER CREATE SCHEMA DO* clause. Allows you to read the SQL queries from a SQL file. Implements support for PostgreSQL dollar-quoting and the *i* and *ir* include facilities as in *psql* batch mode (where they are the same thing).

## Connection String

The `<postgresql-url>` parameter is expected to be given as a *Connection URI* as documented in the PostgreSQL documentation at <http://www.postgresql.org/docs/9.3/static/libpq-connect.html#LIBPQ-CONNSTRING>.

```
postgresql://[user[:password]@][netloc][:port][/dbname][?option=value&...]
```

Where:

- *user*

Can contain any character, including colon (:) which must then be doubled (::) and at-sign (@) which must then be doubled (@@).

When omitted, the *user* name defaults to the value of the *PGUSER* environment variable, and if it is unset, the value of the *USER* environment variable.

- *password*

Can contain any character, including the at sign (@) which must then be doubled (@@). To leave the password empty, when the *user* name ends with at at sign, you then have to use the syntax user:@.

When omitted, the *password* defaults to the value of the *PGPASSWORD* environment variable if it is set, otherwise the password is left unset.

When no *password* is found either in the connection URI nor in the environment, then pgloader looks for a *.pgpass* file as documented at <https://www.postgresql.org/docs/current/static/libpq-pgpass.html>. The implementation is not that of *libpq* though. As with *libpq* you can set the environment variable *PGPASSFILE* to point to a *.pgpass* file, and pgloader defaults to *~/.pgpass* on unix like systems and *%APPDATA%postgresqlpgpass.conf* on windows. Matching rules and syntax are the same as with *libpq*, refer to its documentation.

- *netloc*

Can be either a hostname in dotted notation, or an ipv4, or an Unix domain socket path. Empty is the default network location, under a system providing *unix domain socket* that method is preferred, otherwise the *netloc* default to *localhost*.

It's possible to force the *unix domain socket* path by using the syntax *unix:/path/to/where/the/socket/file/is*, so to force a non default socket path and a non default port, you would have:

```
postgresql://unix:/tmp:54321/dbname
```

The *netloc* defaults to the value of the *PGHOST* environment variable, and if it is unset, to either the default *unix* socket path when running on a Unix system, and *localhost* otherwise.

Socket path containing colons are supported by doubling the colons within the path, as in the following example:

```
postgresql://unix:/tmp/project::region::instance:5432/dbname
```

- *dbname*

Should be a proper identifier (letter followed by a mix of letters, digits and the punctuation signs comma (,), dash (-) and underscore (\_).

When omitted, the *dbname* defaults to the value of the environment variable *PGDATABASE*, and if that is unset, to the *user* value as determined above.

- *options*

The optional parameters must be supplied with the form *name=value*, and you may use several parameters by separating them away using an ampersand (&) character.

Only some options are supported here, *tablename* (which might be qualified with a schema name) *sslmode*, *host*, *port*, *dbname*, *user* and *password*.

The *sslmode* parameter values can be one of *disable*, *allow*, *prefer* or *require*.

For backward compatibility reasons, it's possible to specify the *tablename* option directly, without spelling out the *tablename=* parts.

The options override the main URI components when both are given, and using the percent-encoded option parameters allow using passwords starting with a colon and bypassing other URI components parsing limitations.

## Regular Expressions

Several clauses listed in the following accept *regular expressions* with the following input rules:

- A regular expression begins with a tilde sign (~),
- is then followed with an opening sign,
- then any character is allowed and considered part of the regular expression, except for the closing sign,
- then a closing sign is expected.

The opening and closing sign are allowed by pair, here's the complete list of allowed delimiters:

```
~//  
~[]  
~{ }  
~()  
~<>  
~" "  
~' '  
~| |  
~##
```

Pick the set of delimiters that don't collide with the *regular expression* you're trying to input. If your expression is such that none of the solutions allow you to enter it, the places where such expressions are allowed should allow for a list of expressions.

## Comments

Any command may contain comments, following those input rules:

- the `-` delimiter begins a comment that ends with the end of the current line,
- the delimiters `/*` and `*/` respectively start and end a comment, which can be found in the middle of a command or span several lines.

Any place where you could enter a *whitespace* will accept a comment too.

## Batch behaviour options

All pgloader commands have support for a *WITH* clause that allows for specifying options. Some options are generic and accepted by all commands, such as the *batch behaviour options*, and some options are specific to a data source kind, such as the *CSV skip header* option.

The global batch behaviour options are:

- *batch rows*  
Takes a numeric value as argument, used as the maximum number of rows allowed in a batch. The default is *25000* and can be changed to try having better performance characteristics or to control pgloader memory usage;
- *batch size*  
Takes a memory unit as argument, such as *20 MB*, its default value. Accepted multipliers are *kB*, *MB*, *GB*, *TB* and *PB*. The case is important so as not to be confused about bits versus bytes, we're only talking bytes here.
- *prefetch rows*  
Takes a numeric value as argument, defaults to *100000*. That's the number of rows that pgloader is allowed to read in memory in each reader thread. See the *workers* setting for how many reader threads are allowed to run at the same time.

Other options are specific to each input source, please refer to specific parts of the documentation for their listing and covering.

A batch is then closed as soon as either the *batch rows* or the *batch size* threshold is crossed, whichever comes first. In cases when a batch has to be closed because of the *batch size* setting, a *debug* level log message is printed with how many rows did fit in the *oversized* batch.

### 1.3.5 Loading CSV data

This command instructs pgloader to load data from a CSV file. Here's an example:

```
LOAD CSV
  FROM 'GeoLiteCity-Blocks.csv' WITH ENCODING iso-646-us
  HAVING FIELDS
  (
    startIpNum, endIpNum, locId
  )
  INTO postgresql://user@localhost:54393/dbname
  TARGET TABLE geolite.blocks
  TARGET COLUMNS
  (
    iprange ip4r using (ip-range startIpNum endIpNum),
    locId
  )
  WITH truncate,
  skip header = 2,
  fields optionally enclosed by '"',
  fields escaped by backslash-quote,
  fields terminated by '\t'

  SET work_mem to '32 MB', maintenance_work_mem to '64 MB';
```

The `csv` format command accepts the following clauses and options.

#### CSV Source Specification: FROM

Filename where to load the data from. Accepts an *ENCODING* option. Use the `-list-encodings` option to know which encoding names are supported.

The filename may be enclosed by single quotes, and could be one of the following special values:

- *inline*  
The data is found after the end of the parsed commands. Any number of empty lines between the end of the commands and the beginning of the data is accepted.

- *stdin*  
Reads the data from the standard input stream.

- *FILENAMES MATCHING*  
The whole *matching* clause must follow the following rule:

```
[ ALL FILENAMES | [ FIRST ] FILENAME ]
MATCHING regexp
[ IN DIRECTORY '...' ]
```

The *matching* clause applies given *regular expression* (see above for exact syntax, several options can be used here) to filenames. It's then possible to load data from only the first match of all of them.

The optional *IN DIRECTORY* clause allows specifying which directory to walk for finding the data files, and can be either relative to where the command file is read from, or absolute. The given directory must exist.

## Fields Specifications

The *FROM* option also supports an optional comma separated list of *field* names describing what is expected in the CSV data file, optionally introduced by the clause *HAVING FIELDS*.

Each field name can be either only one name or a name following with specific reader options for that field, enclosed in square brackets and comma-separated. Supported per-field reader options are:

- *terminated by*

See the description of *field terminated by* below.

The processing of this option is not currently implemented.

- *date format*

When the field is expected of the date type, then this option allows to specify the date format used in the file.

Date format string are template strings modeled against the PostgreSQL *to\_char* template strings support, limited to the following patterns:

- YYYY, YYY, YY for the year part
- MM for the numeric month part
- DD for the numeric day part
- HH, HH12, HH24 for the hour part
- am, AM, a.m., A.M.
- pm, PM, p.m., P.M.
- MI for the minutes part
- SS for the seconds part
- MS for the milliseconds part (4 digits)
- US for the microseconds part (6 digits)
- unparsed punctuation signs: - . \* # @ T / and space

Here's an example of a *date format* specification:

```
column-name [date format 'YYYY-MM-DD HH24-MI-SS.US']
```

- *null if*

This option takes an argument which is either the keyword *blanks* or a double-quoted string.

When *blanks* is used and the field value that is read contains only space characters, then it's automatically converted to an SQL *NULL* value.

When a double-quoted string is used and that string is read as the field value, then the field value is automatically converted to an SQL *NULL* value.

- *trim both whitespace, trim left whitespace, trim right whitespace*

This option allows to trim whitespaces in the read data, either from both sides of the data, or only the whitespace characters found on the left of the streaming, or only those on the right of the string.

## CSV Loading Options: WITH

When loading from a CSV file, the following options are supported:

- *truncate*

When this option is listed, pgloader issues a *TRUNCATE* command against the PostgreSQL target table before reading the data file.

- *drop indexes*

When this option is listed, pgloader issues *DROP INDEX* commands against all the indexes defined on the target table before copying the data, then *CREATE INDEX* commands once the *COPY* is done.

In order to get the best performance possible, all the indexes are created in parallel and when done the primary keys are built again from the unique indexes just created. This two step process allows creating the primary key index in parallel with the other indexes, as only the *ALTER TABLE* command needs an *access exclusive lock* on the target table.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *skip header*

Takes a numeric value as argument. Instruct pgloader to skip that many lines at the beginning of the input file.

- *csv header*

Use the first line read after *skip header* as the list of csv field names to be found in the CSV file, using the same CSV parameters as for the CSV data.

- *trim unquoted blanks*

When reading unquoted values in the CSV file, remove the blanks found in between the separator and the value. That behaviour is the default.

- *keep unquoted blanks*

When reading unquoted values in the CSV file, keep blanks found in between the separator and the value.

- *fields optionally enclosed by*

Takes a single character as argument, which must be found inside single quotes, and might be given as the printable character itself, the special value *t* to denote a tabulation character, the special value *'* to denote a single-quote, or *0x* then an hexadecimal value read as the ASCII code for the character.

The following options specify the same enclosing character, a single quote:

```
fields optionally enclosed by '\''
fields optionally enclosed by '0x27'
```

This character is used as the quoting character in the CSV file, and defaults to double-quote.

- *fields not enclosed*

By default, pgloader will use the double-quote character as the enclosing character. If you have a CSV file where fields are not enclosed and are using double-quote as an expected ordinary character, then use the option *fields not enclosed* for the CSV parser to accept those values.

- *fields escaped by*

Takes either the special value *backslash-quote* or *double-quote*, or any value supported by the *fields terminated by* option (see below). This value is used to recognize escaped field separators when they are to be found within the data fields themselves. Defaults to *double-quote*.

- *csv escape mode*

Takes either the special value *quote* (the default) or *following* and allows the CSV parser to parse either only escaped field separator or any character (including CSV data) when using the *following* value.

- *fields terminated by*

Takes a single character as argument, which must be found inside single quotes, and might be given as the printable character itself, the special value *t* to denote a tabulation character, or *0x* then an hexadecimal value read as the ASCII code for the character.

This character is used as the *field separator* when reading the CSV data.

- *lines terminated by*

Takes a single character as argument, which must be found inside single quotes, and might be given as the printable character itself, the special value *t* to denote a tabulation character, or *0x* then an hexadecimal value read as the ASCII code for the character.

This character is used to recognize *end-of-line* condition when reading the CSV data.

### 1.3.6 Loading Fixed Cols File Formats

This command instructs pgloader to load data from a text file containing columns arranged in a *fixed size* manner. Here's an example:

```
LOAD FIXED
  FROM inline
  (
    a from 0 for 10,
    b from 10 for 8,
    c from 18 for 8,
    d from 26 for 17 [null if blanks, trim right whitespace]
  )
  INTO postgresql:///pgloader
  TARGET TABLE fixed
  (
    a, b,
    c time using (time-with-no-separator c),
    d
  )

  WITH truncate

  SET work_mem to '14MB',
     standard_conforming_strings to 'on'

BEFORE LOAD DO
  $$ drop table if exists fixed; $$,
  $$ create table fixed (
    a integer,
    b date,
    c time,
```

(continues on next page)



(continued from previous page)

```

        d text
    );
    $$;

01234567892008052011431250firstline
  01234562008052115182300left blank-padded
12345678902008052208231560another line
  2345609872014092914371500
  2345678902014092914371520

```

The *fixed* format command accepts the following clauses and options.

### Fixed File Format Source Specification: FROM

Filename where to load the data from. Accepts an *ENCODING* option. Use the *-list-encodings* option to know which encoding names are supported.

The filename may be enclosed by single quotes, and could be one of the following special values:

- *inline*

The data is found after the end of the parsed commands. Any number of empty lines between the end of the commands and the beginning of the data is accepted.

- *stdin*

Reads the data from the standard input stream.

- *FILENAMES MATCHING*

The whole *matching* clause must follow the following rule:

```

[ ALL FILENAMES | [ FIRST ] FILENAME ]
MATCHING regexp
[ IN DIRECTORY '...' ]

```

The *matching* clause applies given *regular expression* (see above for exact syntax, several options can be used here) to filenames. It's then possible to load data from only the first match of all of them.

The optional *IN DIRECTORY* clause allows specifying which directory to walk for finding the data files, and can be either relative to where the command file is read from, or absolute. The given directory must exist.

### Fields Specifications

The *FROM* option also supports an optional comma separated list of *field* names describing what is expected in the *FIXED* data file.

Each field name is composed of the field name followed with specific reader options for that field. Supported per-field reader options are the following, where only *start* and *length* are required.

- *start*

Position in the line where to start reading that field's value. Can be entered with decimal digits or *0x* then hexadecimal digits.

- *length*

How many bytes to read from the *start* position to read that field's value. Same format as *start*.

Those optional parameters must be enclosed in square brackets and comma-separated:

- *terminated by*

See the description of *field terminated by* below.

The processing of this option is not currently implemented.

- *date format*

When the field is expected of the date type, then this option allows to specify the date format used in the file.

Date format string are template strings modeled against the PostgreSQL *to\_char* template strings support, limited to the following patterns:

- YYYY, YYY, YY for the year part
- MM for the numeric month part
- DD for the numeric day part
- HH, HH12, HH24 for the hour part
- am, AM, a.m., A.M.
- pm, PM, p.m., P.M.
- MI for the minutes part
- SS for the seconds part
- MS for the milliseconds part (4 digits)
- US for the microseconds part (6 digits)
- unparsed punctuation signs: - . \* # @ T / and space

Here's an example of a *date format* specification:

```
column-name [date format 'YYYY-MM-DD HH24-MI-SS.US']
```

- *null if*

This option takes an argument which is either the keyword *blanks* or a double-quoted string.

When *blanks* is used and the field value that is read contains only space characters, then it's automatically converted to an SQL *NULL* value.

When a double-quoted string is used and that string is read as the field value, then the field value is automatically converted to an SQL *NULL* value.

- *trim both whitespace, trim left whitespace, trim right whitespace*

This option allows to trim whitespaces in the read data, either from both sides of the data, or only the whitespace characters found on the left of the streaming, or only those on the right of the string.

### Fixed File Format Loading Options: WITH

When loading from a *FIXED* file, the following options are supported:

- *truncate*

When this option is listed, pgloader issues a *TRUNCATE* command against the PostgreSQL target table before reading the data file.

- *disable triggers*

When this option is listed, pgloader issues an `ALTER TABLE ... DISABLE TRIGGER ALL` command against the PostgreSQL target table before copying the data, then the command `ALTER TABLE ... ENABLE TRIGGER ALL` once the `COPY` is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *skip header*

Takes a numeric value as argument. Instruct pgloader to skip that many lines at the beginning of the input file.

### 1.3.7 Loading COPY Formatted Files

This commands instructs pgloader to load from a file containing COPY TEXT data as described in the PostgreSQL documentation. Here's an example:

```
LOAD COPY
  FROM copy://./data/track.copy
  (
    trackid, track, album, media, genre, composer,
    milliseconds, bytes, unitprice
  )
  INTO postgresql:///pgloader
  TARGET TABLE track_full

  WITH truncate

  SET work_mem to '14MB',
     standard_conforming_strings to 'on'

BEFORE LOAD DO
  $$ drop table if exists track_full; $$,
  $$ create table track_full (
    trackid      bigint,
    track        text,
    album        text,
    media        text,
    genre        text,
    composer     text,
    milliseconds bigint,
    bytes        bigint,
    unitprice    numeric
  );
  $$;
```

The `COPY` format command accepts the following clauses and options.

#### COPY Formatted Files Source Specification: FROM

Filename where to load the data from. This support local files, HTTP URLs and zip files containing a single dbf file of the same name. Fetch such a zip file from an HTTP address is of course supported.

- *inline*

The data is found after the end of the parsed commands. Any number of empty lines between the end of the commands and the beginning of the data is accepted.

- *stdin*

Reads the data from the standard input stream.

- *FILENAMES MATCHING*

The whole *matching* clause must follow the following rule:

```
[ ALL FILENAMES | [ FIRST ] FILENAME ]  
MATCHING regexp  
[ IN DIRECTORY '...' ]
```

The *matching* clause applies given *regular expression* (see above for exact syntax, several options can be used here) to filenames. It's then possible to load data from only the first match of all of them.

The optional *IN DIRECTORY* clause allows specifying which directory to walk for finding the data files, and can be either relative to where the command file is read from, or absolute. The given directory must exist.

### COPY Formatted File Options: WITH

When loading from a *COPY* file, the following options are supported:

- *delimiter*

Takes a single character as argument, which must be found inside single quotes, and might be given as the printable character itself, the special value `t` to denote a tabulation character, or `0x` then an hexadecimal value read as the ASCII code for the character.

This character is used as the *delimiter* when reading the data, in a similar way to the PostgreSQL *COPY* option.

- *null*

Takes a quoted string as an argument (quotes can be either double quotes or single quotes) and uses that string as the *NULL* representation in the data.

This is similar to the *null COPY* option in PostgreSQL.

- *truncate*

When this option is listed, pgloader issues a *TRUNCATE* command against the PostgreSQL target table before reading the data file.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *skip header*

Takes a numeric value as argument. Instruct pgloader to skip that many lines at the beginning of the input file.

### 1.3.8 Loading DBF data

This command instructs pgloader to load data from a *DBF* file. Here's an example:

```
LOAD DBF
  FROM http://www.insee.fr/fr/methodes/nomenclatures/cog/telechargement/2013/
  ↪dbf/reg2013.dbf
  INTO postgresql://user@localhost/dbname
  WITH truncate, create table;
```

The *dbf* format command accepts the following clauses and options.

### DBF Source Specification: FROM

Filename where to load the data from. This support local files, HTTP URLs and zip files containing a single dbf file of the same name. Fetch such a zip file from an HTTP address is of course supported.

### DBF Loading Options: WITH

When loading from a *DBF* file, the following options are supported:

- *truncate*

When this option is listed, pgloader issues a *TRUNCATE* command against the PostgreSQL target table before reading the data file.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *create table*

When this option is listed, pgloader creates the table using the meta data found in the *DBF* file, which must contain a list of fields with their data type. A standard data type conversion from DBF to PostgreSQL is done.

- *table name*

This options expects as its value the possibly qualified name of the table to create.

## 1.3.9 Loading IXF Data

This command instructs pgloader to load data from an IBM *IXF* file. Here's an example:

```
LOAD IXF
  FROM data/nsitra.test1.ixf
  INTO postgresql://pgloader
  TARGET TABLE nsitra.test1
  WITH truncate, create table, timezone UTC

BEFORE LOAD DO
  $$ create schema if not exists nsitra; $$,
  $$ drop table if exists nsitra.test1; $$;
```

The *ixf* format command accepts the following clauses and options.

## IXF Source Specification: FROM

Filename where to load the data from. This support local files, HTTP URLs and zip files containing a single ixf file of the same name. Fetch such a zip file from an HTTP address is of course supported.

## IXF Loading Options: WITH

When loading from a *IXF* file, the following options are supported:

- *truncate*

When this option is listed, pgloader issues a *TRUNCATE* command against the PostgreSQL target table before reading the data file.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *create table*

When this option is listed, pgloader creates the table using the meta data found in the *DBF* file, which must contain a list of fields with their data type. A standard data type conversion from *DBF* to PostgreSQL is done.

- *table name*

This options expects as its value the possibly qualified name of the table to create.

- *timezone*

This options allows to specify which timezone is used when parsing timestamps from an *IXF* file, and defaults to *UTC*. Expected values are either *UTC*, *GMT* or a single quoted location name such as *'Universal'* or *'Europe/Paris'*.

### 1.3.10 Loading From an Archive

This command instructs pgloader to load data from one or more files contained in an archive. Currently the only supported archive format is *ZIP*, and the archive might be downloaded from an *HTTP* URL.

Here's an example:

```
LOAD ARCHIVE
  FROM /Users/dim/Downloads/GeoLiteCity-latest.zip
  INTO postgresql:///ip4r

BEFORE LOAD
  DO $$ create extension if not exists ip4r; $$,
     $$ create schema if not exists geolite; $$,

  EXECUTE 'geolite.sql'

LOAD CSV
  FROM FILENAME MATCHING ~/GeoLiteCity-Location.csv/
  WITH ENCODING iso-8859-1
  (
```

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```

        locId,
        country,
        region    null if blanks,
        city      null if blanks,
        postalCode null if blanks,
        latitude,
        longitude,
        metroCode null if blanks,
        areaCode  null if blanks
    )
INTO postgresql:///ip4r?geolite.location
(
    locid, country, region, city, postalCode,
    location point using (format nil "~a,~a" longitude latitude),
    metroCode, areaCode
)
WITH skip header = 2,
     fields optionally enclosed by '"',
     fields escaped by double-quote,
     fields terminated by ','

AND LOAD CSV
FROM FILENAME MATCHING ~/GeoLiteCity-Blocks.csv/
WITH ENCODING iso-8859-1
(
    startIpNum, endIpNum, locId
)
INTO postgresql:///ip4r?geolite.blocks
(
    iprange ip4r using (ip-range startIpNum endIpNum),
    locId
)
WITH skip header = 2,
     fields optionally enclosed by '"',
     fields escaped by double-quote,
     fields terminated by ','

FINALLY DO
    $$ create index blocks_ip4r_idx on geolite.blocks using gist(iprange); $$;

```

The *archive* command accepts the following clauses and options.

### Archive Source Specification: FROM

Filename or HTTP URI where to load the data from. When given an HTTP URL the linked file will get downloaded locally before processing.

If the file is a *zip* file, the command line utility *unzip* is used to expand the archive into files in *\$TMPDIR*, or */tmp* if *\$TMPDIR* is unset or set to a non-existing directory.

Then the following commands are used from the top level directory where the archive has been expanded.

### Archive Sub Commands

- command [ *AND* command ... ]

A series of commands against the contents of the archive, at the moment only *CSV*, ‘*FIXED*’ and *DBF* commands are supported.

Note that commands are supporting the clause *FROM FILENAME MATCHING* which allows the pgloader command not to depend on the exact names of the archive directories.

The same clause can also be applied to several files with using the spelling *FROM ALL FILENAMES MATCHING* and a regular expression.

The whole *matching* clause must follow the following rule:

```
FROM [ ALL FILENAMES | [ FIRST ] FILENAME ] MATCHING
```

## Archive Final SQL Commands

- *FINALLY DO*

SQL Queries to run once the data is loaded, such as *CREATE INDEX*.

### 1.3.11 Migrating a MySQL Database to PostgreSQL

This command instructs pgloader to load data from a database connection. pgloader supports dynamically converting the schema of the source database and the indexes building.

A default set of casting rules are provided and might be overloaded and appended to by the command.

Here’s an example using as many options as possible, some of them even being defaults. Chances are you don’t need that complex a setup, don’t copy and paste it, use it only as a reference!

```
LOAD DATABASE
  FROM      mysql://root@localhost/sakila
  INTO     postgresql://localhost:54393/sakila

WITH include drop, create tables, create indexes, reset sequences,
      workers = 8, concurrency = 1,
      multiple readers per thread, rows per range = 50000

SET PostgreSQL PARAMETERS
  maintenance_work_mem to '128MB',
  work_mem to '12MB',
  search_path to 'sakila, public, "$user"'

SET MySQL PARAMETERS
  net_read_timeout = '120',
  net_write_timeout = '120'

CAST type bigint when (= precision 20) to bigserial drop typemod,
type date drop not null drop default using zero-dates-to-null,
-- type tinyint to boolean using tinyint-to-boolean,
type year to integer

MATERIALIZED VIEWS film_list, staff_list

-- INCLUDING ONLY TABLE NAMES MATCHING ~/film/, 'actor'
-- EXCLUDING TABLE NAMES MATCHING ~<ory>
-- DECODING TABLE NAMES MATCHING ~/messed/, ~/encoding/ AS utf8
-- ALTER TABLE NAMES MATCHING 'film' RENAME TO 'films'
```

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```

-- ALTER TABLE NAMES MATCHING ~/_list$/ SET SCHEMA 'mv'

ALTER TABLE NAMES MATCHING ~/_list$/, 'sales_by_store', ~/sales_by/
SET SCHEMA 'mv'

ALTER TABLE NAMES MATCHING 'film' RENAME TO 'films'
ALTER TABLE NAMES MATCHING ~/. ./ SET (fillfactor='40')

ALTER SCHEMA 'sakila' RENAME TO 'pagila'

BEFORE LOAD DO
  $$ create schema if not exists pagila; $$,
  $$ create schema if not exists mv;    $$,
  $$ alter database sakila set search_path to pagila, mv, public; $$;

```

The *database* command accepts the following clauses and options.

### MySQL Database Source Specification: FROM

Must be a connection URL pointing to a MySQL database.

If the connection URI contains a table name, then only this table is migrated from MySQL to PostgreSQL.

See the *SOURCE CONNECTION STRING* section above for details on how to write the connection string. The MySQL connection string accepts the same parameter *sslmode* as the PostgreSQL connection string, but the *verify* mode is not implemented (yet).

```

mysql://[user[:password]@[netloc][:port][/dbname][?option=value&...]

- *options*

The same notation rules as found in the *Connection String* parts of the
documentation apply, and we have a specific MySQL option: `useSSL`. The
value for `useSSL` can be either `false` or `true`.

If both `sslmode` and `useSSL` are used in the same connection string,
pgloader behavior is undefined.

```

The MySQL connection string also accepts the *useSSL* parameter with values being either *false* or *true*.

Environment variables described in <http://dev.mysql.com/doc/refman/5.0/en/environment-variables.html> can be used as default values too. If the user is not provided, then it defaults to *USER* environment variable value. The password can be provided with the environment variable *MYSQL\_PWD*. The host can be provided with the environment variable *MYSQL\_HOST* and otherwise defaults to *localhost*. The port can be provided with the environment variable *MYSQL\_TCP\_PORT* and otherwise defaults to *3306*.

### MySQL Database Migration Options: WITH

When loading from a *MySQL* database, the following options are supported, and the default *WITH* clause is: *no truncate, create schema, create tables, include drop, create indexes, reset sequences, foreign keys, downcase identifiers, unify index names*.

- *include drop*

When this option is listed, pgloader drops all the tables in the target PostgreSQL database whose names appear in the MySQL database. This option allows for using the same command several times in a row until you figure out all the options, starting automatically from a clean environment. Please note that *CASCADE* is used to ensure that tables are dropped even if there are foreign keys pointing to them. This is precisely what *include drop* is intended to do: drop all target tables and recreate them.

Great care needs to be taken when using *include drop*, as it will cascade to *all* objects referencing the target tables, possibly including other tables that are not being loaded from the source DB.

- *include no drop*

When this option is listed, pgloader will not include any *DROP* statement when loading the data.

- *truncate*

When this option is listed, pgloader issue the *TRUNCATE* command against each PostgreSQL table just before loading data into it.

- *no truncate*

When this option is listed, pgloader issues no *TRUNCATE* command.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *create tables*

When this option is listed, pgloader creates the table using the meta data found in the *MySQL* file, which must contain a list of fields with their data type. A standard data type conversion from *DBF* to PostgreSQL is done.

- *create no tables*

When this option is listed, pgloader skips the creation of table before loading data, target tables must then already exist.

Also, when using *create no tables* pgloader fetches the metadata from the current target database and checks type casting, then will remove constraints and indexes prior to loading the data and install them back again once the loading is done.

- *create indexes*

When this option is listed, pgloader gets the definitions of all the indexes found in the MySQL database and create the same set of index definitions against the PostgreSQL database.

- *create no indexes*

When this option is listed, pgloader skips the creating indexes.

- *drop indexes*

When this option is listed, pgloader drops the indexes in the target database before loading the data, and creates them again at the end of the data copy.

- *uniquify index names, preserve index names*

MySQL index names are unique per-table whereas in PostgreSQL index names have to be unique per-schema. The default for pgloader is to change the index name by prefixing it with *idx\_OID* where *OID* is the internal numeric identifier of the table the index is built against.

In some cases like when the DDL are entirely left to a framework it might be sensible for pgloader to refrain from handling index unique names, that is achieved by using the *preserve index names* option.

The default is to *uniquify index names*.

Even when using the option *preserve index names*, MySQL primary key indexes named “PRIMARY” will get their names uniquified. Failing to do so would prevent the primary keys to be created again in PostgreSQL where the index names must be unique per schema.

- *drop schema*

When this option is listed, pgloader drops the target schema in the target PostgreSQL database before creating it again and all the objects it contains. The default behavior doesn't drop the target schemas.

- *foreign keys*

When this option is listed, pgloader gets the definitions of all the foreign keys found in the MySQL database and create the same set of foreign key definitions against the PostgreSQL database.

- *no foreign keys*

When this option is listed, pgloader skips creating foreign keys.

- *reset sequences*

When this option is listed, at the end of the data loading and after the indexes have all been created, pgloader resets all the PostgreSQL sequences created to the current maximum value of the column they are attached to.

The options *schema only* and *data only* have no effects on this option.

- *reset no sequences*

When this option is listed, pgloader skips resetting sequences after the load.

The options *schema only* and *data only* have no effects on this option.

- *downcase identifiers*

When this option is listed, pgloader converts all MySQL identifiers (table names, index names, column names) to *downcase*, except for PostgreSQL *reserved* keywords.

The PostgreSQL *reserved* keywords are determined dynamically by using the system function *pg\_get\_keywords()*.

- *quote identifiers*

When this option is listed, pgloader quotes all MySQL identifiers so that their case is respected. Note that you will then have to do the same thing in your application code queries.

- *schema only*

When this option is listed pgloader refrains from migrating the data over. Note that the schema in this context includes the indexes when the option *create indexes* has been listed.

- *data only*

When this option is listed pgloader only issues the *COPY* statements, without doing any other processing.

- *single reader per thread, multiple readers per thread*

The default is *single reader per thread* and it means that each MySQL table is read by a single thread as a whole, with a single *SELECT* statement using no *WHERE* clause.

When using *multiple readers per thread* pgloader may be able to divide the reading work into several threads, as many as the *concurrency* setting, which needs to be greater than 1 for this option to kick be activated.

For each source table, pgloader searches for a primary key over a single numeric column, or a multiple-column primary key index for which the first column is of a numeric data type (one of *integer* or *bigint*). When such an index exists, pgloader runs a query to find the *min* and *max* values on this column, and then split that range into many ranges containing a maximum of *rows per range*.

When the range list we then obtain contains at least as many ranges than our concurrency setting, then we distribute those ranges to each reader thread.

So when all the conditions are met, pgloader then starts as many reader thread as the *concurrency* setting, and each reader thread issues several queries with a *WHERE id >= x AND id < y*, where  $y - x = \text{rows per range}$  or less (for the last range, depending on the max value just obtained).

- *rows per range*

How many rows are fetched per *SELECT* query when using *multiple readers per thread*, see above for details.

- *SET MySQL PARAMETERS*

The *SET MySQL PARAMETERS* allows setting MySQL parameters using the MySQL *SET* command each time pgloader connects to it.

## MySQL Database Casting Rules

The command *CAST* introduces user-defined casting rules.

The cast clause allows to specify custom casting rules, either to overload the default casting rules or to amend them with special cases.

A casting rule is expected to follow one of the forms:

```
type <mysql-type-name> [ <guard> ... ] to <pgsql-type-name> [ <option> ... ]
column <table-name>.<column-name> [ <guards> ] to ...
```

It's possible for a *casting rule* to either match against a MySQL data type or against a given *column name* in a given *table name*. That flexibility allows to cope with cases where the type *tinyint* might have been used as a *boolean* in some cases but as a *smallint* in others.

The *casting rules* are applied in order, the first match prevents following rules to be applied, and user defined rules are evaluated first.

The supported guards are:

- *when unsigned*

The casting rule is only applied against MySQL columns of the source type that have the keyword *unsigned* in their data type definition.

Example of a casting rule using a *unsigned* guard:

```
type smallint when unsigned to integer drop typemod
```

- *when default 'value'*

The casting rule is only applied against MySQL columns of the source type that have given *value*, which must be a single-quoted or a double-quoted string.

- *when typemod expression*

The casting rule is only applied against MySQL columns of the source type that have a *typemod* value matching the given *typemod expression*. The *typemod* is separated into its *precision* and *scale* components.

Example of a cast rule using a *typemod* guard:

```
type char when (= precision 1) to char keep typemod
```

This expression casts MySQL *char(1)* column to a PostgreSQL column of type *char(1)* while allowing for the general case *char(N)* will be converted by the default cast rule into a PostgreSQL type *varchar(N)*.

- *with extra auto\_increment*

The casting rule is only applied against MySQL columns having the *extra* column *auto\_increment* option set, so that it's possible to target e.g. *serial* rather than *integer*.

The default matching behavior, when this option isn't set, is to match both columns with the extra definition and without.

This means that if you want to implement a casting rule that target either *serial* or *integer* from a *smallint* definition depending on the *auto\_increment* extra bit of information from MySQL, then you need to spell out two casting rules as following:

```
type smallint with extra auto_increment
  to serial drop typemod keep default keep not null,

type smallint
  to integer drop typemod keep default keep not null
```

The supported casting options are:

- *drop default, keep default*

When the option *drop default* is listed, pgloader drops any existing default expression in the MySQL database for columns of the source type from the *CREATE TABLE* statement it generates.

The spelling *keep default* explicitly prevents that behaviour and can be used to overload the default casting rules.

- *drop not null, keep not null, set not null*

When the option *drop not null* is listed, pgloader drops any existing *NOT NULL* constraint associated with the given source MySQL datatype when it creates the tables in the PostgreSQL database.

The spelling *keep not null* explicitly prevents that behaviour and can be used to overload the default casting rules.

When the option *set not null* is listed, pgloader sets a *NOT NULL* constraint on the target column regardless whether it has been set in the source MySQL column.

- *drop typemod, keep typemod*

When the option *drop typemod* is listed, pgloader drops any existing *typemod* definition (e.g. *precision* and *scale*) from the datatype definition found in the MySQL columns of the source type when it created the tables in the PostgreSQL database.

The spelling *keep typemod* explicitly prevents that behaviour and can be used to overload the default casting rules.

- *using*

This option takes as its single argument the name of a function to be found in the *pgloader.transforms* Common Lisp package. See above for details.

It's possible to augment a default cast rule (such as one that applies against *ENUM* data type for example) with a *transformation function* by omitting entirely the *type* parts of the casting rule, as in the following example:

```
column enumerate.foo using empty-string-to-null
```

## MySQL Views Support

MySQL views support allows pgloader to migrate view as if they were base tables. This feature then allows for on-the-fly transformation from MySQL to PostgreSQL, as the view definition is used rather than the base data.

### MATERIALIZED VIEWS

This clause allows you to implement custom data processing at the data source by providing a *view definition* against which pgloader will query the data. It's not possible to just allow for plain *SQL* because we want to know a lot about the exact data types of each column involved in the query output.

This clause expect a comma separated list of view definitions, each one being either the name of an existing view in your database or the following expression:

```
*name* `AS` `$$` *sql query* `$$`
```

The *name* and the *sql query* will be used in a *CREATE VIEW* statement at the beginning of the data loading, and the resulting view will then be dropped at the end of the data loading.

### MATERIALIZED ALL VIEWS

Same behaviour as *MATERIALIZED VIEWS* using the dynamic list of views as returned by MySQL rather than asking the user to specify the list.

## MySQL Partial Migration

### INCLUDING ONLY TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expression* used to limit the tables to migrate to a sublist.

Example:

```
including only table names matching ~/film/, 'actor'
```

### EXCLUDING TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expression* used to exclude table names from the migration. This filter only applies to the result of the *INCLUDING* filter.

```
excluding table names matching ~<ory>
```

## MySQL Encoding Support

### DECODING TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expressions* used to force the encoding to use when processing data from MySQL. If the data encoding known to you is different from MySQL's idea about it, this is the option to use.

```
decoding table names matching ~/messed/, ~/encoding/ AS utf8
```

You can use as many such rules as you need, all with possibly different encodings.

## MySQL Schema Transformations

### ALTER TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expressions* that you want to target in the pgloader *ALTER TABLE* command. Available actions are *SET SCHEMA*, *RENAME TO*, and *SET*:

```
ALTER TABLE NAMES MATCHING ~/_list$/, 'sales_by_store', ~/sales_by/
SET SCHEMA 'mv'

ALTER TABLE NAMES MATCHING 'film' RENAME TO 'films'

ALTER TABLE NAMES MATCHING ~/. / SET (fillfactor='40')

ALTER TABLE NAMES MATCHING ~/. / SET TABLESPACE 'pg_default'
```

You can use as many such rules as you need. The list of tables to be migrated is searched in pgloader memory against the *ALTER TABLE* matching rules, and for each command pgloader stops at the first matching criteria (regex or string).

No *ALTER TABLE* command is sent to PostgreSQL, the modification happens at the level of the pgloader in-memory representation of your source database schema. In case of a name change, the mapping is kept and reused in the *foreign key* and *index* support.

The *SET ()* action takes effect as a *WITH* clause for the *CREATE TABLE* command that pgloader will run when it has to create a table.

The *SET TABLESPACE* action takes effect as a *TABLESPACE* clause for the *CREATE TABLE* command that pgloader will run when it has to create a table.

## MySQL Migration: limitations

The *database* command currently only supports MySQL source database and has the following limitations:

- Views are not migrated,
  - Supporting views might require implementing a full SQL parser for the MySQL dialect with a porting engine to rewrite the SQL against PostgreSQL, including renaming functions and changing some constructs.
  - While it's not theoretically impossible, don't hold your breath.
- Triggers are not migrated
  - The difficulty of doing so is not yet assessed.
- Of the geometric datatypes, only the *POINT* database has been covered. The other ones should be easy enough to implement now, it's just not done yet.

## Default MySQL Casting Rules

When migrating from MySQL the following Casting Rules are provided:

Numbers:

```
type int with extra auto_increment to serial when (< precision 10)
type int with extra auto_increment to bigserial when (<= 10 precision)
type int to int          when (< precision 10)
type int to bigint      when (>= 10 precision)
type tinyint with extra auto_increment to serial
type smallint with extra auto_increment to serial
type mediumint with extra auto_increment to serial
type bigint with extra auto_increment to bigserial

type tinyint to boolean when (= 1 precision) using tinyint-to-boolean

type tinyint when unsigned to smallint drop typemod
type smallint when unsigned to integer drop typemod
type mediumint when unsigned to integer drop typemod
type integer when unsigned to bigint drop typemod

type tinyint to smallint drop typemod
type smallint to smallint drop typemod
type mediumint to integer drop typemod
type integer to integer drop typemod
type bigint to bigint drop typemod

type float to float drop typemod
type double to double precision drop typemod

type numeric to numeric keep typemod
type decimal to decimal keep typemod
```

**Texts:**

```
type char to char keep typemod using remove-null-characters
type varchar to varchar keep typemod using remove-null-characters
type tinytext to text using remove-null-characters
type text to text using remove-null-characters
type mediumtext to text using remove-null-characters
type longtext to text using remove-null-characters
```

**Binary:**

```
type binary to bytea
type varbinary to bytea
type tinyblob to bytea
type blob to bytea
type mediumblob to bytea
type longblob to bytea
```

**Date:**

```
type datetime when default "0000-00-00 00:00:00" and not null
  to timestamptz drop not null drop default
  using zero-dates-to-null

type datetime when default "0000-00-00 00:00:00"
  to timestamptz drop default
  using zero-dates-to-null

type datetime with extra on update current timestamp when not null
```

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```

to timestamptz drop not null drop default
using zero-dates-to-null

type datetime with extra on update current timestamp
to timestamptz drop default
using zero-dates-to-null

type timestamp when default "0000-00-00 00:00:00" and not null
to timestamptz drop not null drop default
using zero-dates-to-null

type timestamp when default "0000-00-00 00:00:00"
to timestamptz drop default
using zero-dates-to-null

type date when default "0000-00-00" to date drop default
using zero-dates-to-null

type date to date
type datetime to timestamptz
type timestamp to timestamptz
type year to integer drop typemod

```

**Geometric:**

```
type point to point using pgloader.transforms::convert-mysql-point
```

Enum types are declared inline in MySQL and separately with a *CREATE TYPE* command in PostgreSQL, so each column of Enum Type is converted to a type named after the table and column names defined with the same labels in the same order.

When the source type definition is not matched in the default casting rules nor in the casting rules provided in the command, then the type name with the typemod is used.

**1.3.12 Migrating a SQLite database to PostgreSQL**

This command instructs pgloader to load data from a SQLite file. Automatic discovery of the schema is supported, including build of the indexes.

Here's an example:

```

load database
  from sqlite:///Users/dim/Downloads/lastfm_tags.db
  into postgresql:///tags

with include drop, create tables, create indexes, reset sequences

  set work_mem to '16MB', maintenance_work_mem to '512 MB';

```

The *sqlite* command accepts the following clauses and options.

**SQLite Database Source Specification: FROM**

Path or HTTP URL to a SQLite file, might be a *.zip* file.

## SQLite Database Migration Options: WITH

When loading from a *SQLite* database, the following options are supported:

When loading from a *SQLite* database, the following options are supported, and the default *WITH* clause is: *no truncate, create tables, include drop, create indexes, reset sequences, downcase identifiers, encoding 'utf-8'*.

- *include drop*

When this option is listed, pgloader drops all the tables in the target PostgreSQL database whose names appear in the SQLite database. This option allows for using the same command several times in a row until you figure out all the options, starting automatically from a clean environment. Please note that *CASCADE* is used to ensure that tables are dropped even if there are foreign keys pointing to them. This is precisely what *include drop* is intended to do: drop all target tables and recreate them.

Great care needs to be taken when using *include drop*, as it will cascade to *all* objects referencing the target tables, possibly including other tables that are not being loaded from the source DB.

- *include no drop*

When this option is listed, pgloader will not include any *DROP* statement when loading the data.

- *truncate*

When this option is listed, pgloader issue the *TRUNCATE* command against each PostgreSQL table just before loading data into it.

- *no truncate*

When this option is listed, pgloader issues no *TRUNCATE* command.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.

This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *create tables*

When this option is listed, pgloader creates the table using the meta data found in the *SQLite* file, which must contain a list of fields with their data type. A standard data type conversion from SQLite to PostgreSQL is done.

- *create no tables*

When this option is listed, pgloader skips the creation of table before loading data, target tables must then already exist.

Also, when using *create no tables* pgloader fetches the metadata from the current target database and checks type casting, then will remove constraints and indexes prior to loading the data and install them back again once the loading is done.

- *create indexes*

When this option is listed, pgloader gets the definitions of all the indexes found in the SQLite database and create the same set of index definitions against the PostgreSQL database.

- *create no indexes*

When this option is listed, pgloader skips the creating indexes.

- *drop indexes*

When this option is listed, pgloader drops the indexes in the target database before loading the data, and creates them again at the end of the data copy.

- *reset sequences*

When this option is listed, at the end of the data loading and after the indexes have all been created, pgloader resets all the PostgreSQL sequences created to the current maximum value of the column they are attached to.

- *reset no sequences*

When this option is listed, pgloader skips resetting sequences after the load.

The options *schema only* and *data only* have no effects on this option.

- *schema only*

When this option is listed pgloader will refrain from migrating the data over. Note that the schema in this context includes the indexes when the option *create indexes* has been listed.

- *data only*

When this option is listed pgloader only issues the *COPY* statements, without doing any other processing.

- *encoding*

This option allows to control which encoding to parse the SQLite text data with. Defaults to UTF-8.

## SQLite Database Casting Rules

The command *CAST* introduces user-defined casting rules.

The cast clause allows to specify custom casting rules, either to overload the default casting rules or to amend them with special cases.

## SQLite Database Partial Migrations

### INCLUDING ONLY TABLE NAMES LIKE

Introduce a comma separated list of table name patterns used to limit the tables to migrate to a sublist.

Example:

```
including only table names like 'Invoice%'
```

### EXCLUDING TABLE NAMES LIKE

Introduce a comma separated list of table name patterns used to exclude table names from the migration. This filter only applies to the result of the *INCLUDING* filter.

```
excluding table names like 'appointments'
```

## Default SQLite Casting Rules

When migrating from SQLite the following Casting Rules are provided:

Numbers:

```
type tinyint to smallint using integer-to-string
type integer to bigint    using integer-to-string

type float to float      using float-to-string
type real to real        using float-to-string
type double to double precision using float-to-string
type numeric to numeric  using float-to-string
type decimal to numeric  using float-to-string
```

**Texts:**

```
type character to text drop typemod
type varchar   to text drop typemod
type nvarchar  to text drop typemod
type char      to text drop typemod
type nchar     to text drop typemod
type nvarchar  to text drop typemod
type clob      to text drop typemod
```

**Binary:**

```
type blob      to bytea
```

**Date:**

```
type datetime to timestamptz using sqlite-timestamp-to-timestamp
type timestamp to timestamptz using sqlite-timestamp-to-timestamp
type timestamptz to timestamptz using sqlite-timestamp-to-timestamp
```

### 1.3.13 Migrating a MS SQL Database to PostgreSQL

This command instructs pgloader to load data from a MS SQL database. Automatic discovery of the schema is supported, including build of the indexes, primary and foreign keys constraints.

Here's an example:

```
load database
  from mssql://user@host/dbname
  into postgresql:///dbname

including only table names like 'GlobalAccount' in schema 'dbo'

set work_mem to '16MB', maintenance_work_mem to '512 MB'

before load do $$ drop schema if exists dbo cascade; $$;
```

The *mssql* command accepts the following clauses and options.

#### MS SQL Database Source Specification: FROM

Connection string to an existing MS SQL database server that listens and welcome external TCP/IP connection. As pgloader currently piggybacks on the FreeTDS driver, to change the port of the server please export the *TDS*PORT environment variable.

## MS SQL Database Migration Options: WITH

When loading from a *MS SQL* database, the same options as when loading a *MS SQL* database are supported. Please refer to the MS SQL section. The following options are added:

- *create schemas*

When this option is listed, pgloader creates the same schemas as found on the MS SQL instance. This is the default.

- *create no schemas*

When this option is listed, pgloader refrains from creating any schemas at all, you must then ensure that the target schema do exist.

## MS SQL Database Casting Rules

### CAST

The cast clause allows to specify custom casting rules, either to overload the default casting rules or to amend them with special cases.

Please refer to the MS SQL CAST clause for details.

## MS SQL Views Support

MS SQL views support allows pgloader to migrate view as if they were base tables. This feature then allows for on-the-fly transformation from MS SQL to PostgreSQL, as the view definition is used rather than the base data.

### MATERIALIZED VIEWS

This clause allows you to implement custom data processing at the data source by providing a *view definition* against which pgloader will query the data. It's not possible to just allow for plain *SQL* because we want to know a lot about the exact data types of each column involved in the query output.

This clause expect a comma separated list of view definitions, each one being either the name of an existing view in your database or the following expression:

```
*name* `AS` `$$` *sql query* `$$`
```

The *name* and the *sql query* will be used in a *CREATE VIEW* statement at the beginning of the data loading, and the resulting view will then be dropped at the end of the data loading.

### MATERIALIZED ALL VIEWS

Same behaviour as *MATERIALIZED VIEWS* using the dynamic list of views as returned by MS SQL rather than asking the user to specify the list.

## MS SQL Partial Migration

### INCLUDING ONLY TABLE NAMES LIKE

Introduce a comma separated list of table name patterns used to limit the tables to migrate to a sublist. More than one such clause may be used, they will be accumulated together.

Example:

```
including only table names like 'GlobalAccount' in schema 'dbo'
```

### EXCLUDING TABLE NAMES LIKE

Introduce a comma separated list of table name patterns used to exclude table names from the migration. This filter only applies to the result of the *INCLUDING* filter.

```
excluding table names matching 'LocalAccount' in schema 'dbo'
```

## MS SQL Schema Transformations

### ALTER SCHEMA '...' RENAME TO '...'

Allows to rename a schema on the flight, so that for instance the tables found in the schema 'dbo' in your source database will get migrated into the schema 'public' in the target database with this command:

```
alter schema 'dbo' rename to 'public'
```

### ALTER TABLE NAMES MATCHING ... IN SCHEMA '...'

Introduce a comma separated list of table names or *regular expressions* that you want to target in the pgloader *ALTER TABLE* command. Available actions are *SET SCHEMA*, *RENAME TO*, and *SET*:

```
ALTER TABLE NAMES MATCHING ~/_list$/, 'sales_by_store', ~/sales_by/  
  IN SCHEMA 'dbo'  
  SET SCHEMA 'mv'  
  
ALTER TABLE NAMES MATCHING 'film' IN SCHEMA 'dbo' RENAME TO 'films'  
  
ALTER TABLE NAMES MATCHING ~/. / IN SCHEMA 'dbo' SET (fillfactor='40')  
  
ALTER TABLE NAMES MATCHING ~/. / IN SCHEMA 'dbo' SET TABLESPACE 'tblspc'
```

You can use as many such rules as you need. The list of tables to be migrated is searched in pgloader memory against the *ALTER TABLE* matching rules, and for each command pgloader stops at the first matching criteria (regex or string).

No *ALTER TABLE* command is sent to PostgreSQL, the modification happens at the level of the pgloader in-memory representation of your source database schema. In case of a name change, the mapping is kept and reused in the *foreign key* and *index* support.

The *SET ()* action takes effect as a *WITH* clause for the *CREATE TABLE* command that pgloader will run when it has to create a table.

The *SET TABLESPACE* action takes effect as a *TABLESPACE* clause for the *CREATE TABLE* command that pgloader will run when it has to create a table.

The matching is done in pgloader itself, with a Common Lisp regular expression lib, so doesn't depend on the *LIKE* implementation of MS SQL, nor on the lack of support for regular expressions in the engine.

## MS SQL Driver setup and encoding

pgloader is using the *FreeTDS* driver, and internally expects the data to be sent in utf-8. To achieve that, you can configure the FreeTDS driver with those defaults, in the file *~/freets.conf*:

```
[global]
  tds version = 7.4
  client charset = UTF-8
```

## Default MS SQL Casting Rules

When migrating from MS SQL the following Casting Rules are provided:

Numbers:

```
type tinyint to smallint
type float to float using float-to-string
type real to real using float-to-string
type double to double precision using float-to-string
type numeric to numeric using float-to-string
type decimal to numeric using float-to-string
type money to numeric using float-to-string
type smallmoney to numeric using float-to-string
```

Texts:

```
type char to text drop typemod
type nchar to text drop typemod
type varchar to text drop typemod
type nvarchar to text drop typemod
type xml to text drop typemod
```

Binary:

```
type binary to bytea using byte-vector-to-bytea
type varbinary to bytea using byte-vector-to-bytea
```

Date:

```
type datetime to timestampz
type datetime2 to timestampz
```

Others:

```
type bit to boolean
type hierarchyid to bytea
type geography to bytea
type uniqueidentifier to uuid using sql-server-uniqueidentifier-to-uuid
```

### 1.3.14 Migrating a PostgreSQL Database to PostgreSQL

This command instructs pgloader to load data from a database connection. Automatic discovery of the schema is supported, including build of the indexes, primary and foreign keys constraints. A default set of casting rules are provided and might be overloaded and appended to by the command.

Here's a short example of migrating a database from a PostgreSQL server to another:

```
load database
  from pgsq://localhost/pgloader
  into pgsq://localhost/copy

including only table names matching 'bits', ~/utilisateur/ in schema 'mysql'
including only table names matching ~/geolocations/ in schema 'public'
;
```

#### PostgreSQL Database Source Specification: FROM

Must be a connection URL pointing to a PostgreSQL database.

See the *SOURCE CONNECTION STRING* section above for details on how to write the connection string.

```
pgsq://[user[:password]@][netloc][:port][/dbname][?option=value&...]
```

#### PostgreSQL Database Migration Options: WITH

When loading from a *PostgreSQL* database, the following options are supported, and the default *WITH* clause is: *no truncate, create schema, create tables, include drop, create indexes, reset sequences, foreign keys, downcase identifiers, unify index names, reindex*.

- *include drop*

When this option is listed, pgloader drops all the tables in the target PostgreSQL database whose names appear in the MySQL database. This option allows for using the same command several times in a row until you figure out all the options, starting automatically from a clean environment. Please note that *CASCADE* is used to ensure that tables are dropped even if there are foreign keys pointing to them. This is precisely what *include drop* is intended to do: drop all target tables and recreate them.

Great care needs to be taken when using *include drop*, as it will cascade to *all* objects referencing the target tables, possibly including other tables that are not being loaded from the source DB.

- *include no drop*

When this option is listed, pgloader will not include any *DROP* statement when loading the data.

- *truncate*

When this option is listed, pgloader issue the *TRUNCATE* command against each PostgreSQL table just before loading data into it.

- *no truncate*

When this option is listed, pgloader issues no *TRUNCATE* command.

- *disable triggers*

When this option is listed, pgloader issues an *ALTER TABLE ... DISABLE TRIGGER ALL* command against the PostgreSQL target table before copying the data, then the command *ALTER TABLE ... ENABLE TRIGGER ALL* once the *COPY* is done.



This option allows loading data into a pre-existing table ignoring the *foreign key constraints* and user defined triggers and may result in invalid *foreign key constraints* once the data is loaded. Use with care.

- *create tables*

When this option is listed, pgloader creates the table using the meta data found in the *MySQL* file, which must contain a list of fields with their data type. A standard data type conversion from *DBF* to *PostgreSQL* is done.

- *create no tables*

When this option is listed, pgloader skips the creation of table before loading data, target tables must then already exist.

Also, when using *create no tables* pgloader fetches the metadata from the current target database and checks type casting, then will remove constraints and indexes prior to loading the data and install them back again once the loading is done.

- *create indexes*

When this option is listed, pgloader gets the definitions of all the indexes found in the *MySQL* database and create the same set of index definitions against the *PostgreSQL* database.

- *create no indexes*

When this option is listed, pgloader skips the creating indexes.

- *drop indexes*

When this option is listed, pgloader drops the indexes in the target database before loading the data, and creates them again at the end of the data copy.

- *reindex*

When this option is used, pgloader does both *drop indexes* before loading the data and *create indexes* once data is loaded.

- *drop schema*

When this option is listed, pgloader drops the target schema in the target *PostgreSQL* database before creating it again and all the objects it contains. The default behavior doesn't drop the target schemas.

- *foreign keys*

When this option is listed, pgloader gets the definitions of all the foreign keys found in the *MySQL* database and create the same set of foreign key definitions against the *PostgreSQL* database.

- *no foreign keys*

When this option is listed, pgloader skips creating foreign keys.

- *reset sequences*

When this option is listed, at the end of the data loading and after the indexes have all been created, pgloader resets all the *PostgreSQL* sequences created to the current maximum value of the column they are attached to.

The options *schema only* and *data only* have no effects on this option.

- *reset no sequences*

When this option is listed, pgloader skips resetting sequences after the load.

The options *schema only* and *data only* have no effects on this option.

- *downcase identifiers*

When this option is listed, pgloader converts all *MySQL* identifiers (table names, index names, column names) to *downcase*, except for *PostgreSQL reserved* keywords.

The PostgreSQL *reserved* keywords are determined dynamically by using the system function `pg_get_keywords()`.

- *quote identifiers*

When this option is listed, pgloader quotes all MySQL identifiers so that their case is respected. Note that you will then have to do the same thing in your application code queries.

- *schema only*

When this option is listed pgloader refrains from migrating the data over. Note that the schema in this context includes the indexes when the option *create indexes* has been listed.

- *data only*

When this option is listed pgloader only issues the *COPY* statements, without doing any other processing.

- *rows per range*

How many rows are fetched per *SELECT* query when using *multiple readers per thread*, see above for details.

## PostgreSQL Database Casting Rules

The command *CAST* introduces user-defined casting rules.

The cast clause allows to specify custom casting rules, either to overload the default casting rules or to amend them with special cases.

A casting rule is expected to follow one of the forms:

```
type <type-name> [ <guard> ... ] to <pgsql-type-name> [ <option> ... ]
column <table-name>.<column-name> [ <guards> ] to ...
```

It's possible for a *casting rule* to either match against a PostgreSQL data type or against a given *column name* in a given *table name*. So it's possible to migrate a table from a PostgreSQL database while changing and *int* column to a *bigint* one, automatically.

The *casting rules* are applied in order, the first match prevents following rules to be applied, and user defined rules are evaluated first.

The supported guards are:

- *when default 'value'*

The casting rule is only applied against MySQL columns of the source type that have given *value*, which must be a single-quoted or a double-quoted string.

- *when typemod expression*

The casting rule is only applied against MySQL columns of the source type that have a *typemod* value matching the given *typemod expression*. The *typemod* is separated into its *precision* and *scale* components.

Example of a cast rule using a *typemod* guard:

```
type char when (= precision 1) to char keep typemod
```

This expression casts MySQL *char(1)* column to a PostgreSQL column of type *char(1)* while allowing for the general case *char(N)* will be converted by the default cast rule into a PostgreSQL type *varchar(N)*.

- *with extra auto\_increment*

The casting rule is only applied against PostgreSQL attached to a sequence. This can be the result of doing that manually, using a *serial* or a *bigserial* data type, or an *identity* column.

The supported casting options are:

- *drop default, keep default*

When the option *drop default* is listed, pgloader drops any existing default expression in the MySQL database for columns of the source type from the *CREATE TABLE* statement it generates.

The spelling *keep default* explicitly prevents that behaviour and can be used to overload the default casting rules.

- *drop not null, keep not null, set not null*

When the option *drop not null* is listed, pgloader drops any existing *NOT NULL* constraint associated with the given source MySQL datatype when it creates the tables in the PostgreSQL database.

The spelling *keep not null* explicitly prevents that behaviour and can be used to overload the default casting rules.

When the option *set not null* is listed, pgloader sets a *NOT NULL* constraint on the target column regardless whether it has been set in the source MySQL column.

- *drop typemod, keep typemod*

When the option *drop typemod* is listed, pgloader drops any existing *typemod* definition (e.g. *precision* and *scale*) from the datatype definition found in the MySQL columns of the source type when it created the tables in the PostgreSQL database.

The spelling *keep typemod* explicitly prevents that behaviour and can be used to overload the default casting rules.

- *using*

This option takes as its single argument the name of a function to be found in the *pgloader.transforms* Common Lisp package. See above for details.

It's possible to augment a default cast rule (such as one that applies against *ENUM* data type for example) with a *transformation function* by omitting entirely the *type* parts of the casting rule, as in the following example:

```
column enumerate.foo using empty-string-to-null
```

## PostgreSQL Views Support

PostgreSQL views support allows pgloader to migrate view as if they were base tables. This feature then allows for on-the-fly transformation of the source schema, as the view definition is used rather than the base data.

### MATERIALIZED VIEWS

This clause allows you to implement custom data processing at the data source by providing a *view definition* against which pgloader will query the data. It's not possible to just allow for plain *SQL* because we want to know a lot about the exact data types of each column involved in the query output.

This clause expect a comma separated list of view definitions, each one being either the name of an existing view in your database or the following expression:

```
*name* `AS` `$$` *sql query* `$$`
```

The *name* and the *sql query* will be used in a *CREATE VIEW* statement at the beginning of the data loading, and the resulting view will then be dropped at the end of the data loading.

## MATERIALIZER ALL VIEWS

Same behaviour as *MATERIALIZER VIEWS* using the dynamic list of views as returned by PostgreSQL rather than asking the user to specify the list.

## PostgreSQL Partial Migration

### INCLUDING ONLY TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expression* used to limit the tables to migrate to a sublist.

Example:

```
including only table names matching ~/film/, 'actor' in schema 'public'
```

### EXCLUDING TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expression* used to exclude table names from the migration. This filter only applies to the result of the *INCLUDING* filter.

```
excluding table names matching ~<ory> in schema 'public'
```

## PostgreSQL Schema Transformations

### ALTER TABLE NAMES MATCHING

Introduce a comma separated list of table names or *regular expressions* that you want to target in the pgloader *ALTER TABLE* command. Available actions are *SET SCHEMA*, *RENAME TO*, and *SET*:

```
ALTER TABLE NAMES MATCHING ~/_list$/, 'sales_by_store', ~/sales_by/  
  IN SCHEMA 'public'  
  SET SCHEMA 'mv'  
  
ALTER TABLE NAMES MATCHING 'film' IN SCHEMA 'public' RENAME TO 'films'  
  
ALTER TABLE NAMES MATCHING ~/. / IN SCHEMA 'public' SET (fillfactor='40')  
  
ALTER TABLE NAMES MATCHING ~/. / IN SCHEMA 'public' SET TABLESPACE 'pg_default'
```

You can use as many such rules as you need. The list of tables to be migrated is searched in pgloader memory against the *ALTER TABLE* matching rules, and for each command pgloader stops at the first matching criteria (regex or string).

No *ALTER TABLE* command is sent to PostgreSQL, the modification happens at the level of the pgloader in-memory representation of your source database schema. In case of a name change, the mapping is kept and reused in the *foreign key* and *index* support.

The *SET ()* action takes effect as a *WITH* clause for the *CREATE TABLE* command that pgloader will run when it has to create a table.

The *SET TABLESPACE* action takes effect as a *TABLESPACE* clause for the *CREATE TABLE* command that pgloader will run when it has to create a table.

## PostgreSQL Migration: limitations

The only PostgreSQL objects supported at this time in pgloader are extensions, schema, tables, indexes and constraints. Anything else is ignored.

- Views are not migrated,

Supporting views might require implementing a full SQL parser for the MySQL dialect with a porting engine to rewrite the SQL against PostgreSQL, including renaming functions and changing some constructs.

While it's not theoretically impossible, don't hold your breath.

- Triggers are not migrated

The difficulty of doing so is not yet assessed.

- Stored Procedures and Functions are not migrated.

## Default PostgreSQL Casting Rules

When migrating from PostgreSQL the following Casting Rules are provided:

```
type int with extra auto_increment to serial
type bigint with extra auto_increment to bigserial
type "character varying" to text drop typemod
```

### 1.3.15 Migrating a PostgreSQL Database to Citus

This command instructs pgloader to load data from a database connection. Automatic discovery of the schema is supported, including build of the indexes, primary and foreign keys constraints. A default set of casting rules are provided and might be overloaded and appended to by the command.

Automatic distribution column backfilling is supported, either from commands that specify what is the distribution column in every table, or only in the main table, then relying on foreign key constraints to discover the other distribution keys.

Here's a short example of migrating a database from a PostgreSQL server to another:

```
load database
from pgsq1:///hackathon
into pgsq1://localhost:9700/dim

with include drop, reset no sequences

cast column impressions.seen_at to "timestamp with time zone"

distribute companies using id
-- distribute campaigns using company_id
-- distribute ads using company_id from campaigns
-- distribute clicks using company_id from ads, campaigns
-- distribute impressions using company_id from ads, campaigns
;
```

Everything works exactly the same way as when doing a PostgreSQL to PostgreSQL migration, with the added functionality of this new *distribute* command.

## Distribute Command

The distribute command syntax is as following:

```
distribute <table name> using <column name>
distribute <table name> using <column name> from <table> [, <table>, ...]
distribute <table name> as reference table
```

When using the distribute command, the following steps are added to pgloader operations when migrating the schema:

- if the distribution column does not exist in the table, it is added as the first column of the table
- if the distribution column does not exist in the primary key of the table, it is added as the first column of the primary of the table
- all the foreign keys that point to the table are added the distribution key automatically too, including the source tables of the foreign key constraints
- once the schema has been created on the target database, pgloader then issues Citus specific command `create_reference_table()` and `create_distributed_table()` to make the tables distributed

Those operations are done in the schema section of pgloader, before the data is loaded. When the data is loaded, the newly added columns need to be backfilled from referenced data. pgloader knows how to do that by generating a query like the following and importing the result set of such a query rather than the raw data from the source table.

## Citus Migration Example

With the migration command as above, pgloader adds the column `company_id` to the tables that have a direct or indirect foreign key reference to the `companies` table.

We run pgloader using the following command, where the file `./test/citus/company.load` contains the pgloader command as shown above.

```
$ pgloader --client-min-messages sql ./test/citus/company.load
```

The following SQL statements are all extracted from the log messages that the pgloader command outputs. We are going to have a look at the `impressions` table. It gets created with a new column `company_id` in the first position, as follows:

```
CREATE TABLE "public"."impressions"
(
  company_id          bigint,
  "id"                bigserial,
  "ad_id"             bigint default NULL,
  "seen_at"           timestamp with time zone default NULL,
  "site_url"          text default NULL,
  "cost_per_impression_usd" numeric(20,10) default NULL,
  "user_ip"           inet default NULL,
  "user_data"         jsonb default NULL
);
```

The original schema for this table does not have the `company_id` column, which means pgloader now needs to change the primary key definition, the foreign keys constraints definitions from and to this table, and also to *backfill* the `company_id` data to this table when doing the COPY phase of the migration.

Then once the tables have been created, pgloader executes the following SQL statements:

```
SELECT create_distributed_table('public"."companies"', 'id');
SELECT create_distributed_table('public"."campaigns"', 'company_id');
SELECT create_distributed_table('public"."ads"', 'company_id');
SELECT create_distributed_table('public"."clicks"', 'company_id');
SELECT create_distributed_table('public"."impressions"', 'company_id');
```

Then when copying the data from the source PostgreSQL database to the new Citus tables, the new column (here `company_id`) needs to be backfilled from the source tables. Here's the SQL query that pgloader uses as a data source for the `ads` table in our example:

```
SELECT "campaigns".company_id::text, "ads".id::text, "ads".campaign_id::text,
       "ads".name::text, "ads".image_url::text, "ads".target_url::text,
       "ads".impressions_count::text, "ads".clicks_count::text,
       "ads".created_at::text, "ads".updated_at::text

FROM   "public"."ads"
JOIN   "public"."campaigns"
      ON ads.campaign_id = campaigns.id
```

The `impressions` table has an indirect foreign key reference to the `company` table, which is the table where the distribution key is specified. pgloader will discover that itself from walking the PostgreSQL catalogs, and you may also use the following specification in the pgloader command to explicitly add the indirect dependency:

```
distribute impressions using company_id from ads, campaigns
```

Given this schema, the SQL query used by pgloader to fetch the data for the `impressions` table is the following, implementing online backfilling of the data:

```
SELECT "campaigns".company_id::text, "impressions".id::text,
       "impressions".ad_id::text, "impressions".seen_at::text,
       "impressions".site_url::text,
       "impressions".cost_per_impression_usd::text,
       "impressions".user_ip::text,
       "impressions".user_data::text

FROM   "public"."impressions"

JOIN   "public"."ads"
      ON impressions.ad_id = ads.id

JOIN   "public"."campaigns"
      ON ads.campaign_id = campaigns.id
```

When the data copying is done, then pgloader also has to install the indexes supporting the primary keys, and add the foreign key definitions to the schema. Those definitions are not the same as in the source schema, because of the adding of the distribution column to the table: we need to also add the column to the primary key and the foreign key constraints.

Here's the commands issued by pgloader for the `impressions` table:

```
CREATE UNIQUE INDEX "impressions_pkey"
  ON "public"."impressions" (company_id, id);

ALTER TABLE "public"."impressions"
  ADD CONSTRAINT "impressions_ad_id_fkey"
  FOREIGN KEY (company_id, ad_id)
  REFERENCES "public"."ads" (company_id, id)
```

Given a single line of specification `distribute companies using id` then pgloader implements all the necessary schema changes on the fly when migrating to Citus, and also dynamically backfills the data.

### Citus Migration: Limitations

The way pgloader implements `reset sequence` does not work with Citus at this point, so sequences need to be taken care of separately at this point.

## 1.3.16 Support for Redshift in pgloader

The command and behavior are the same as when migration from a PostgreSQL database source. pgloader automatically discovers that it's talking to a Redshift database by parsing the output of the `SELECT version()` SQL query.

### Redshift as a data source

Redshift is a variant of PostgreSQL version 8.0.2, which allows pgloader to work with only a very small amount of adaptation in the catalog queries used. In other words, migrating from Redshift to PostgreSQL works just the same as when migrating from a PostgreSQL data source, including the connection string specification.

### Redshift as a data destination

The Redshift variant of PostgreSQL 8.0.2 does not have support for the `COPY FROM STDIN` feature that pgloader normally relies upon. To use `COPY` with Redshift, the data must first be made available in an S3 bucket.

First, pgloader must authenticate to Amazon S3. pgloader uses the following setup for that:

- `~/.aws/config`

This INI formatted file contains sections with your default region and other global values relevant to using the S3 API. pgloader parses it to get the region when it's setup in the `default` INI section.

The environment variable `AWS_DEFAULT_REGION` can be used to override the configuration file value.

- `~/.aws/credentials`

The INI formatted file contains your authentication setup to Amazon, with the properties `aws_access_key_id` and `aws_secret_access_key` in the section `default`. pgloader parses this file for those keys, and uses their values when communicating with Amazon S3.

The environment variables `AWS_ACCESS_KEY_ID` and `AWS_SECRET_ACCESS_KEY` can be used to override the configuration file

- `AWS_S3_BUCKET_NAME`

Finally, the value of the environment variable `AWS_S3_BUCKET_NAME` is used by pgloader as the name of the S3 bucket where to upload the files to `COPY` to the Redshift database. The bucket name defaults to `pgloader`.

Then pgloader works as usual, see the other sections of the documentation for the details, depending on the data source (files, other databases, etc). When preparing the data for PostgreSQL, pgloader now uploads each batch into a single CSV file, and then issue such as the following, for each batch:

```
COPY <target_table_name>
  FROM 's3://<s3 bucket>/<s3-filename-just-uploaded>'
  FORMAT CSV
  TIMEFORMAT 'auto'
  REGION '<aws-region>'
```

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```
ACCESS_KEY_ID '<aws-access-key-id>'
SECRET_ACCESS_KEY '<aws-secret-access-key>;'
```

This is the only difference with a PostgreSQL core version, where pgloader can rely on the classic COPY FROM STDIN command, which allows to send data through the already established connection to PostgreSQL.

### 1.3.17 Transformation Functions

Some data types are implemented in a different enough way that a transformation function is necessary. This function must be written in *Common lisp* and is searched in the *pgloader.transforms* package.

Some default transformation function are provided with pgloader, and you can use the *-load* command line option to load and compile your own lisp file into pgloader at runtime. For your functions to be found, remember to begin your lisp file with the following form:

```
(in-package #:pgloader.transforms)
```

The provided transformation functions are:

- *zero-dates-to-null*

When the input date is all zeroes, return *nil*, which gets loaded as a PostgreSQL *NULL* value.

- *date-with-no-separator*

Applies *zero-dates-to-null* then transform the given date into a format that PostgreSQL will actually process:

```
In:  "20041002152952"
Out: "2004-10-02 15:29:52"
```

- *time-with-no-separator*

Transform the given time into a format that PostgreSQL will actually process:

```
In:  "08231560"
Out: "08:23:15.60"
```

- *tinyint-to-boolean*

As MySQL lacks a proper boolean type, *tinyint* is often used to implement that. This function transforms *0* to *'false'* and anything else to *'true'*.

- *bits-to-boolean*

As MySQL lacks a proper boolean type, *BIT* is often used to implement that. This function transforms 1-bit bit vectors from *0* to *f* and any other value to *t*.

- *int-to-ip*

Convert an integer into a dotted representation of an ip4.

```
In:  18435761
Out: "1.25.78.177"
```

- *ip-range*

Converts a couple of integers given as strings into a range of ip4.

```
In: "16825344" "16825599"  
Out: "1.0.188.0-1.0.188.255"
```

- *convert-mysql-point*

Converts from the *astext* representation of points in MySQL to the PostgreSQL representation.

```
In: "POINT(48.5513589 7.6926827) "  
Out: "(48.5513589,7.6926827) "
```

- *integer-to-string*

Converts a integer string or a Common Lisp integer into a string suitable for a PostgreSQL integer. Takes care of quoted integers.

```
In: "\"0\""  
Out: "0"
```

- *float-to-string*

Converts a Common Lisp float into a string suitable for a PostgreSQL float:

```
In: 100.0d0  
Out: "100.0"
```

- *hex-to-dec*

Converts a string containing an hexadecimal representation of a number into its decimal representation:

```
In: "deadbeef"  
Out: "3735928559"
```

- *set-to-enum-array*

Converts a string representing a MySQL SET into a PostgreSQL Array of Enum values from the set.

```
In: "foo,bar"  
Out: "{foo,bar}"
```

- *empty-string-to-null*

Convert an empty string to a null.

- *right-trim*

Remove whitespace at end of string.

- *remove-null-characters*

Remove *NUL* characters (*0x0*) from given strings.

- *byte-vector-to-bytea*

Transform a simple array of unsigned bytes to the PostgreSQL bytea Hex Format representation as documented at <http://www.postgresql.org/docs/9.3/interactive/datatype-binary.html>

- *sqlite-timestamp-to-timestamp*

SQLite type system is quite interesting, so cope with it here to produce timestamp literals as expected by PostgreSQL. That covers year only on 4 digits, 0 dates to null, and proper date strings.

- *sql-server-uniqueidentifier-to-uuid*

The SQL Server driver receives data fo type uniqueidentifier as byte vector that we then need to convert to an UUID string for PostgreSQL COPY input format to process.

- *unix-timestamp-to-timestampz*

Converts a unix timestamp (number of seconds elapsed since beginning of 1970) into a proper PostgreSQL timestamp format.

- *varbinary-to-string*

Converts binary encoded string (such as a MySQL *varbinary* entry) to a decoded text, using the table's encoding that may be overloaded with the *DECODING TABLE NAMES MATCHING* clause.

### 1.3.18 Reporting Bugs

pgloader is a software and as such contains bugs. Most bugs are easy to solve and taken care of in a short delay. For this to be possible though, bug reports need to follow those recommandations:

- include pgloader version,
- include problematic input and output,
- include a description of the output you expected,
- explain the difference between the ouput you have and the one you expected,
- include a self-reproducing test-case

### Test Cases to Reproduce Bugs

Use the *inline* source type to help reproduce a bug, as in the pgloader tests:

```
LOAD CSV
FROM INLINE
INTO postgresql://dim@localhost/pgloader?public."HS"

WITH truncate,
     fields terminated by '\t',
     fields not enclosed,
     fields escaped by backslash-quote,
     quote identifiers

SET work_mem to '128MB',
    standard_conforming_strings to 'on',
    application_name to 'my app name'

BEFORE LOAD DO
$$ create extension if not exists hstore; $$,
$$ drop table if exists "HS"; $$,
$$ CREATE TABLE "HS"
(
    id      serial primary key,
    kv      hstore
)
$$;
```

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```
1  email=>foo@example.com, a=>b
2  test=>value
3  a=>b, c=>"quoted hstore value", d=>other
4  baddata
```

## CHAPTER 2

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### Indices and tables

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- `modindex`
- `search`