Using basic SQL

Outline

1. The SQL language
2. Create objects
3. Handling data
4. Querying data

1. The SQL language

- One of the ways to interact with PostgreSQL is to use the standard SQL query language
- Can access your PostgreSQL system from the psql program, a fancy Java or .NET application → knowing how to use SQL is an important skill to have
- The better your SQL skills, the better your application will perform

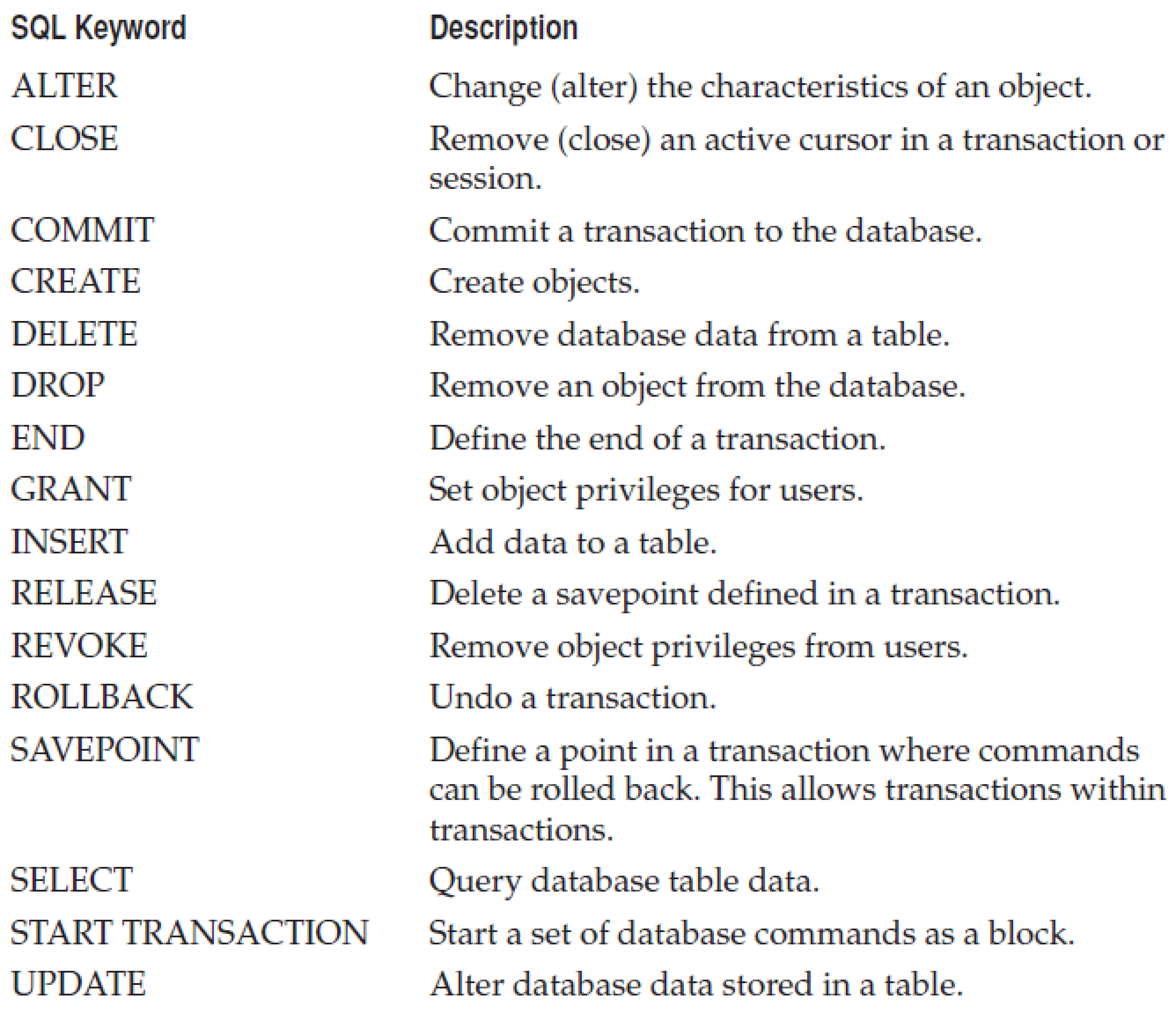
SQL History

- The Structured Query Language (SQL) has been around since the early 1970s as a language for interacting with relational database systems
- The first commercial SQL product, called Structured English Query Language (SEQUEL), was released by IBM in 1974
- In 1986 the American National Standards Institute (ANSI) formulated the first attempt to standardize SQL named ANSI SQL89
- additional updates have been made to the ANSI SQL standard, resulting in SQL92 (SQL 2) and SQL99
- PostgreSQL conforms to the ANSI SQL 92/99 standards

PostgreSQL SQL format

- A SQL command consists **of *tokens*, separated by white space**, and **terminated by a semicolon**
- The command tokens identify actions, and data used in the command
  - Keywords
  - Identifiers
  - Literals

PostgreSQL SQL Keywords



SQL Keyword	Description
ALTER	Change (alter) the characteristics of an object.
CLOSE	Remove (close) an active cursor in a transaction or session.
COMMIT	Commit a transaction to the database.
CREATE	Create objects.
DELETE	Remove database data from a table.
DROP	Remove an object from the database.
END	Define the end of a transaction.
GRANT	Set object privileges for users.
INSERT	Add data to a table.
RELEASE	Delete a savepoint defined in a transaction.
REVOKE	Remove object privileges from users.
ROLLBACK	Undo a transaction.
SAVEPOINT	Define a point in a transaction where commands can be rolled back. This allows transactions within transactions.
SELECT	Query database table data.
START TRANSACTION	Start a set of database commands as a block.
UPDATE	Alter database data stored in a table.

SQL Literals

- **String** data types (characters, variable-length characters, time strings, and date strings) must be enclosed in single quotes
- If there is single quote within a string ➔ preceding it with a **backslash**: 'O\'Leary’

SQL Identifiers

- SQL command *identifiers* define database objects used in the command (database name, schema name, or table name)

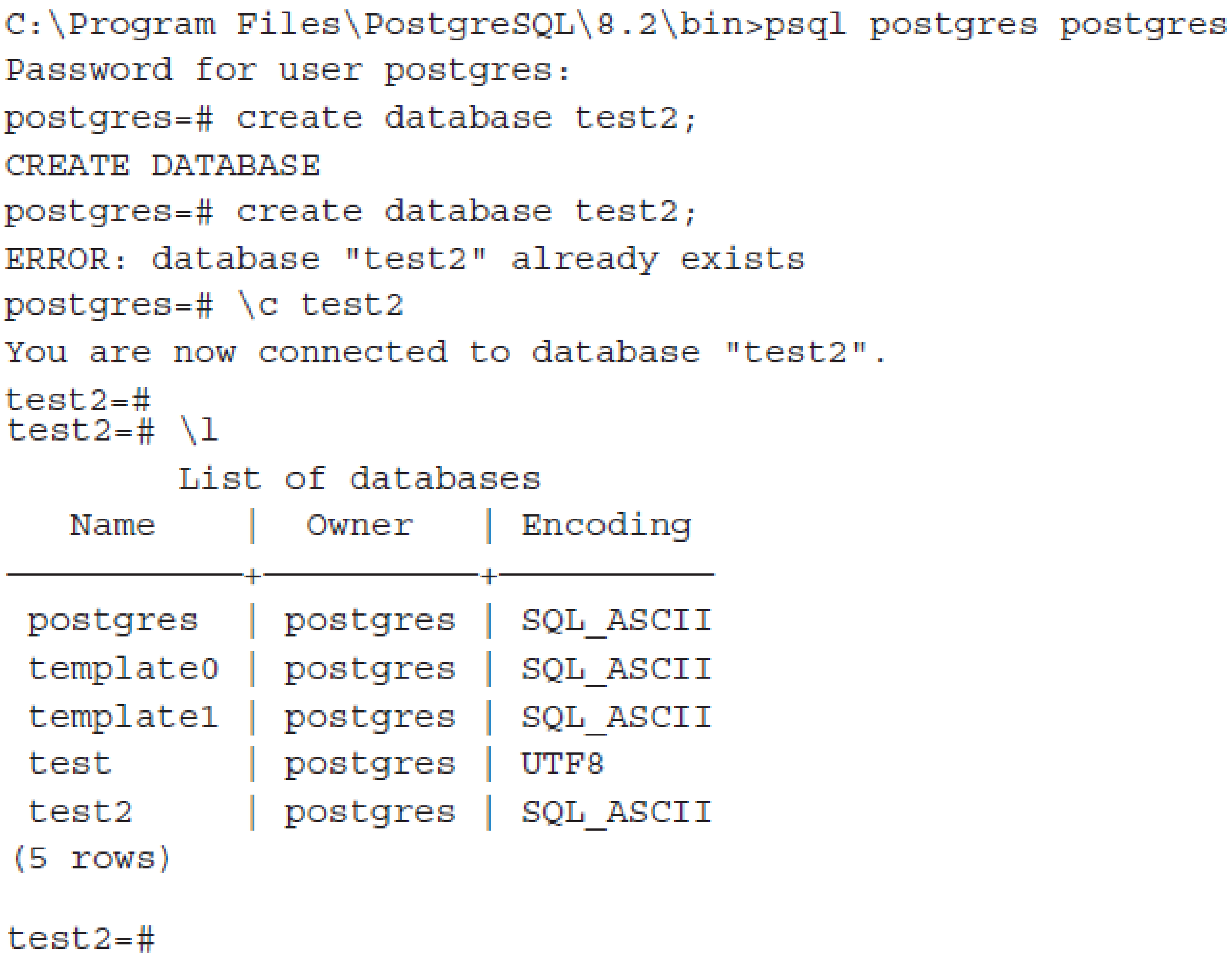
- Identifiers are **case sensitive** in PostgreSQL
  - Customer, CUSTOMER, CusTomer → customer
  - “”: store."Customer" , "Store"."Customer"

- Identifier names **vs. keywords**
  - SELECT * from SELECT; :NO
    →SELECT * from "select"; : YES
  - Using keywords as table names is an extremely bad habit to acquire
  - Try to avoid using keywords as identifiers at all cost

2. Create objects

Creating a Database

- CREATE DATABASE *name* [[WITH]
```
                    [OWNER owner]
                    [TEMPLATE template]
                    [ENCODING encoding]
                    [TABLESPACE tablespace]
                    [CONNECTIONLIMIT connlimit]]
```
- The default template used to create the database will be template1
- \l: list of databases
- DROP DATABASE [IF EXISTS] *name*
  - recover from the DROP DATABASE command is to restore the database from the last backup
- You must be a **superuser** or have the special **CREATEDB privilege**



```
C:\Program Files\PostgreSQL\8.2\bin>psql postgres postgres
Password for user postgres:
postgres=# create database test2;
CREATE DATABASE
postgres=# create database test2;
ERROR: database "test2" already exists
postgres=# \c test2
You are now connected to database "test2".
test2=#
test2=# \l
        List of databases
   Name    |  Owner   | Encoding
-----------+----------+-----------
 postgres  | postgres | SQL_ASCII
 template0 | postgres | SQL_ASCII
 template1 | postgres | SQL_ASCII
 test      | postgres | UTF8
 test2     | postgres | SQL_ASCII
(5 rows)

test2=#
```

Creating a Schema

- CREATE SCHEMA [IF NOT EXISTS] [*schemaname*] [AUTHORIZATION *username* [*schema elements*]]

  Example: create schema store authorization fred;

  - \dn: List of schemas
  - the invoking user must have the **CREATE privilege** for the current database
- DROP SCHEMA [IF EXISTS] schemaname [CASCADE | RESTRICT]
  - Default: RESTRICT →remove only if empty
  - NOT empty →CASCADE: Automatically drop objects (tables, functions, etc.) that are contained in the schema

  file:///C:/Program%20Files/PostgreSQL/9.4/doc/postgresql/html/sql-createschema.html

```
test2=# create schema store authorization fred;
CREATE SCHEMA
test2=# \dn
        List of schemas
        Name            |  Owner
--------------------+----------
 information_schema | postgres
 pg_catalog         | postgres
 pg_toast           | postgres
 public             | postgres
 store              | fred
(5 rows)

test2=#
```

Creating a Table

- CREATE TABLE command can be **extremely complex**
  - primary key, foreign keys, table constraints

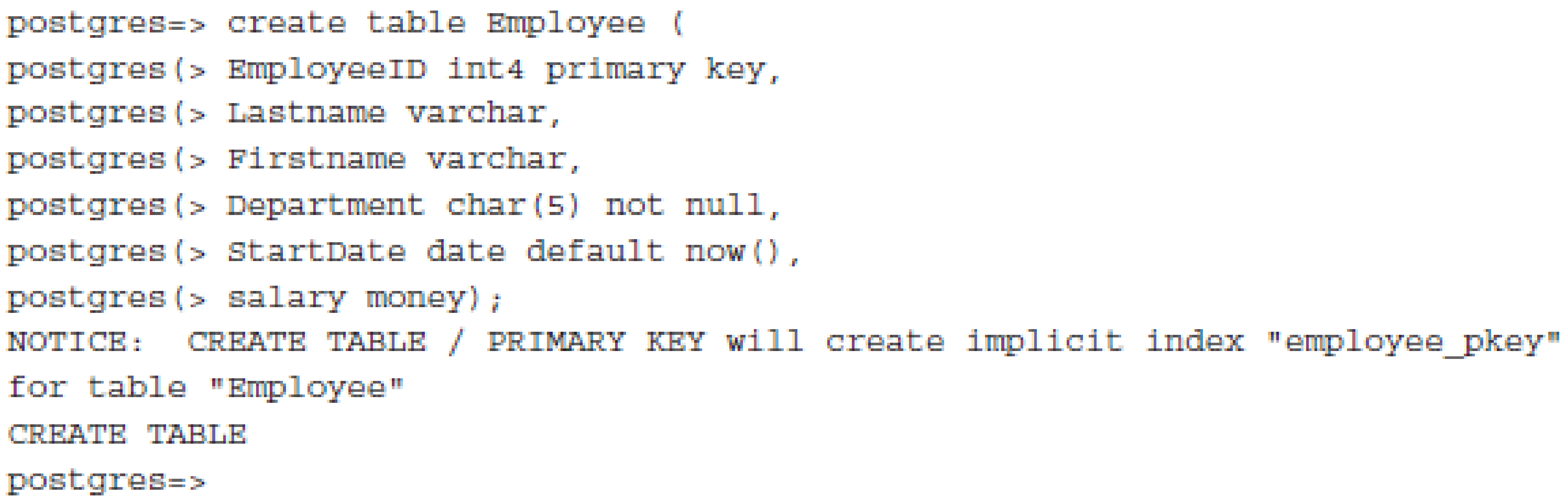
- Instead of trying to include all of the information required to create a table
  - create a base definition of a table using the CREATE TABLE command
  - add additional elements using ALTER TABLE commands

Defining the Base Table

- CREATE TABLE *tablename* (*column1 datatype*, *column2 datatype, ...*);
- Database administrators often split the statement into several command-line entries

```
create table store."Customer" (
        "CustomerID" varchar,
        "LastName" varchar,
        "FirstName" varchar,
        "Address" varchar,
        "City" varchar,
        "State" char,  "Zip" char(5), "Phone" char(8));
\dt store.
```

PRIMARY KEY



```
postgres=> create table Employee (
postgres(> EmployeeID int4 primary key,
postgres(> Lastname varchar,
postgres(> Firstname varchar,
postgres(> Department char(5) not null,
postgres(> StartDate date default now(),
postgres(> salary money);
NOTICE:  CREATE TABLE / PRIMARY KEY will create implicit index "employee_pkey"
for table "Employee"
CREATE TABLE
postgres=>
```

Adding Additional Table Elements

- Format: ALTER TABLE *tablename action*
- Test:

```
\d store."Customer"
alter table store."Customer" add primary key ("CustomerID");
alter table store."Customer" alter column "Phone" set not null;

\d store."Customer"
```

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Adding Additional Table Elements

ALTER TABLE … ADD CONSTRAINT CHECK (condition);

ALTER TABLE … ADD CONSTRAINT

FOREIGN KEY (*column_name* [, ...]) REFERENCES *reftable* [(*refcolumn* [, ...])]

[MATCH FULL | MATCH PARTIAL | MATCH SIMPLE]

[ON DELETE *action*] [ON UPDATE *action*]

[DEFERRABLE | NOT DEFERRABLE]

[INITIALLY DEFERRED | INITIALLY IMMEDIATE];

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Example

```
create table “Order”
(“OrderID" varchar,
  “CustomerID" varchar,
  “ProductID” varchar,
  “Quantity" integer);

ALTER TABLE "Order" ADD CONSTRAINT order_pk PRIMARY
    KEY ("OrderID");
ALTER TABLE "Order" ADD CONSTRAINT order_fk2 FOREIGN
    KEY  ("CustomerID") REFERENCES "Customer"("CustomerID");
```

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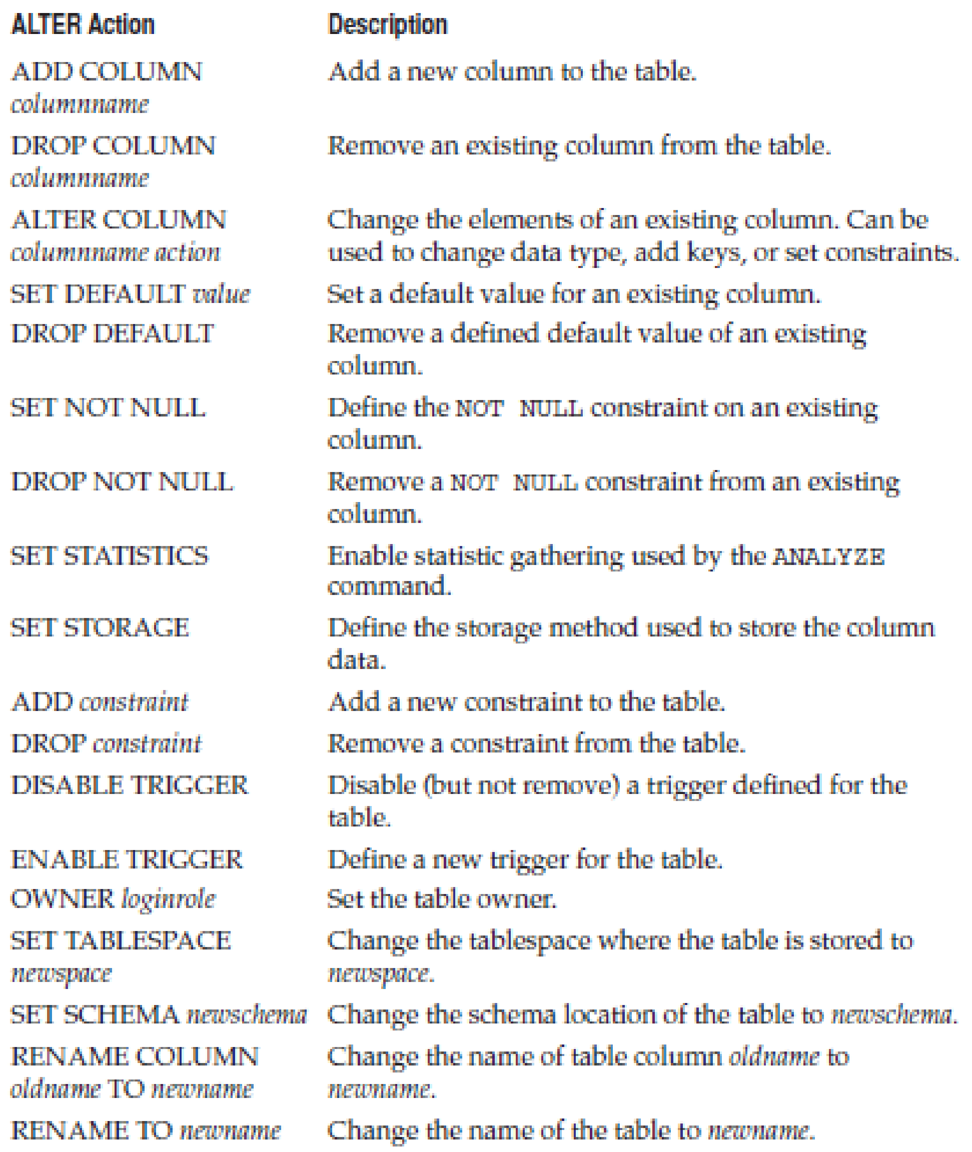
ALTER TABLE Actions



ALTER Action	Description
ADD COLUMN *columnname*	Add a new column to the table.
DROP COLUMN *columnname*	Remove an existing column from the table.
ALTER COLUMN *columnname action*	Change the elements of an existing column. Can be used to change data type, add keys, or set constraints.
SET DEFAULT *value*	Set a default value for an existing column.
DROP DEFAULT	Remove a defined default value of an existing column.
SET NOT NULL	Define the `NOT NULL` constraint on an existing column.
DROP NOT NULL	Remove a `NOT NULL` constraint from an existing column.
SET STATISTICS	Enable statistic gathering used by the `ANALYZE` command.
SET STORAGE	Define the storage method used to store the column data.
ADD *constraint*	Add a new constraint to the table.
DROP *constraint*	Remove a constraint from the table.
DISABLE TRIGGER	Disable (but not remove) a trigger defined for the table.
ENABLE TRIGGER	Define a new trigger for the table.
OWNER *loginrole*	Set the table owner.
SET TABLESPACE *newspace*	Change the tablespace where the table is stored to *newspace*.
SET SCHEMA *newschema*	Change the schema location of the table to *newschema*.
RENAME COLUMN *oldname* TO *newname*	Change the name of table column *oldname* to *newname*.
RENAME TO *newname*	Change the name of the table to *newname*.

Creating Group and Login Roles

- CREATE ROLE *rolename* [[WITH] *options*]
- CREATE ROLE command uses the NOLOGIN option to create a Group Role
  - CREATE ROLE management WITH NOLOGIN;
- ALTER ROLE command
  - CREATE ROLE wilma IN ROLE management;
  - ALTER ROLE wilma LOGIN PASSWORD 'pebbles' INHERIT;

  The INHERIT parameter tells PostgreSQL to allow the Login Roles to inherit any privileges assigned to the Group Roles they belong to.
- **Test:** \du

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Option	Description
ADMIN *rolelist*	Add one or more roles as administrative members of the new role.
CONNECTION LIMIT *'value'*	Limit the number of connections the role can have to the database. The default is `-1`, which is unlimited connections.
CREATEDB	Allow the role to create databases on the system.
CREATEROLE	Allow the role to create new roles on the system.
ENCRYPTED	Encrypt the role password within the PostgreSQL system tables.
IN ROLE *rolelist*	List one or more roles that the new role will be a member of.
INHERIT	Specify that the role will inherit all of the privileges of roles it is a member of.
LOGIN	Specify that the role can be used to log into the system (a Login Role).
NOLOGIN	Specify that the role cannot be used to log into the system (a Group Role).
PASSWORD *passwd*	Specify the password for the role.
ROLE *rolelist*	List one or more roles that will be added as members to the new role.
SUPERUSER	Specify that the new role will have superuser privileges. Only the superuser can use this option.
VALID UNTIL *'date'*	Specify a date when the role will expire.

Assigning Privileges

- GRANT *privlist* ON *object* TO *roles [WITH GRANT OPTION]*
- There are two types of GRANT commands, depending on what the *object* specified in the command is:
  - Granting privileges on **database objects** to one or more roles**: schema, table, view, tablespace, …**
  - Granting **membership in a role**

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Granting Privileges on Database Objects

- Default = table objects, other database object = specify the object type
  - **GRANT usage ON schema store TO management;**
- It is easy to get caught up in figuring out privileges for tables and forget to give your users access to the schema
  - **GRANT select, insert, update ON store."Customer" TO management;**
- Instead of seeing an entry for public, you will see an entry with no name
  - **GRANT select ON store."Customer" TO public;**
  - \z store."Customer"
  - \dp store."Customer"

Granting Privileges on Roles

- GRANT command
  - **GRANT management TO wilma [WITH ADMIN OPTION];**
    - WITH ADMIN OPTION is specified, the member can in turn grant membership in the role to others
  - membership in a role **cannot** be granted to PUBLIC

- REVOKE SQL command
  - **REVOKE update ON store."Customer" FROM management;**

  - **REVOKE management FROM wilma;**

file:///C:/Program%20Files/PostgreSQL/9.4/doc/postgresql/html/sql-revoke.html

Notes

- PUBLIC group
  - includes all roles
  - default privileges granted to PUBLIC: CONNECT and CREATE TEMP TABLE for databases; EXECUTE privilege for functions; and USAGE privilege for languages
  - "WITH GRANT OPTION" cannot be granted to PUBLIC
  - membership in a role **cannot** be granted to PUBLIC

- Object **owner**:
  - Has all privileges by default on the object;
  - implicitly has all grant options for the object

3. Handling data

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Inserting Data

- INSERT INTO *table* [(*columnlist*)] VALUES (*valuelist*)
  - insert into store."Customer" values ('BLU001', 'Blum', 'Rich', '123 Main St.', 'Chicago', 'IL', '60633', '555-1234');
- If you do not want to enter all of the values into a record, you can use the optional *columnlist* parameter
  - insert into store."Customer" ("CustomerID", "LastName", "Phone") values ('BLU002', 'Blum', '555-4321');
- Constraints
  - NOT NULL
  - DEFAULT VALUE → use DEFAULT or not list this column in the *columnlist* parameter

Modifying Data

- UPDATE *table* SET *column* = *value* [WHERE *condition*]
  - update store."Customer" set "FirstName" = 'Barbara';

- The WHERE clause allows you to restrict the records that the UPDATE command applies to
  - update store."Customer" set "FirstName" = 'Rich‘ WHERE "CustomerID" = 'BLU001';

Deleting Data

- DELETE FROM *table* [WHERE *condition*]
- delete from store."Customer" where "CustomerID" = 'BLU001';

4. Querying data

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The Basic Query Format

- SELECT *columnlist* FROM *table*
- The output of the SELECT command is called a *result set*. By default, the records are not displayed in any particular order.
- Specify the order of the displayed records, you must use the ORDER BY clause

```
select "CustomerID", "LastName", "FirstName"
from store."Customer"
order by "FirstName";
```

Filtering Output Data

- The WHERE clause is used to determine what records satisfy the condition of the query.

```
select "CustomerID", "LastName", "FirstName"
from store."Customer "
where "City" = 'Gary';
```

Querying from Multiple Tables

- select "Order"."OrderID", "Customer"."CustomerID", "Customer"."LastName", "Customer"."FirstName", "Customer"."Address"

  from store."Order", store."Customer"

  where "Order"."OrderID" = 'ORD001' and "Order"."CustomerID" = "Customer"."CustomerID";

Using Joins

- SELECT *columnlist*
  FROM *table1 jointype* JOIN *table2* ON *condition*

- Join types:
  - INNER JOIN Only display records found in both tables
  - LEFT JOIN Display all records in *table1* and the matching records in *table2* (outer joins)
  - RIGHT JOIN Display all records in *table2* and the matching records in *table1* (outer joins)
  - CROSS JOIN == t1 INNER JOINT t2 ON TRUE
- NATURAL keyword →join using the common column name

Using Joins

- **select** "Order"."OrderID", "Customer"."CustomerID", "Customer"."LastName", "Customer"."FirstName", "Customer"."Address"

  from store."Order" **natural inner join** store."Customer";

- **select** "Order"."OrderID", "Customer"."CustomerID", "Customer"."LastName","Customer"."FirstName", "Customer"."Address“

  from store."Order" **natural right join** store."Customer"

Using Aliases

- SELECT *columnlist* FROM *table* AS *alias*

- **select** a."OrderID", b."CustomerID", b."LastName", b."FirstName", b."Address"

  from store."Order" as a, store."Customer" as b

  where a."OrderID" = 'ORD001' and a."CustomerID" = b."CustomerID";