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SQL For Data Science

Feb 7th - Josiah Baker, Steve Mortimer

Why Learn SQL?

Fundamental Data Science Skills

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1. **Ubiquitous** - It's everywhere in the data community
2. SQL teaches you **Relational Algebra** and **Set Theory**
3. Expands Your **Computing Power**
4. Ease of **Access** - You can get started today

What is a Relational Database?

Key Terminology and Concepts

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- **Rows** represent single items (“Josiah”)
- **Columns** are labeled attributes of an Item (“Occupation: Data Scientist”, “Employer: ForRent”)
- **Tables** are sets of rows that share the same attributes (“Employees”)
- **Views** are sets of any rows from different tables in response to a query (“Get me all Data Scientists in DE”)
- Proposed in 1970 by E. F. Codd while working at IBM

Source: Wikipedia

Why Relational Databases?

Key Terminology and Concepts

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Relational data models:

- Are very easy to extend
- Improve and maintain data integrity
- Allow for re-assembling data many different ways without reorganizing the underlying structure

“Normalization” is the extent to which the data replicated into multiple places within the database.

Highly Normalized = Little Redundancy = More Joins

Denormalized = More Redundancy = Less Joins

Getting Started

The AdventureWorks Database

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Adventure Works Cycles is a fictitious bicycle manufacturer

Scenarios include:

- Manufacturing
- Sales
- Purchasing
- Product Management
- Contact Management
- Human Resources

Data needs to be hosted on a running database!

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Connecting to the database server requires a set of credentials

You will need:

- Host - *ec2-23-21-219-105.compute-1.amazonaws.com*
- Port - *5432*
- Username - *dcppkvqqofzvbp*
- Password - *12709a63bbb19e91b950008dab2d0301df1d48a6853d43cdf43964fcc863b6db*
- Database Name - *d6bkkvg5ahrfdo*

Check the database is running: (open your command window)

```
telnet ec2-23-21-219-105.compute-1.amazonaws.com 5432
```

HOST PORT

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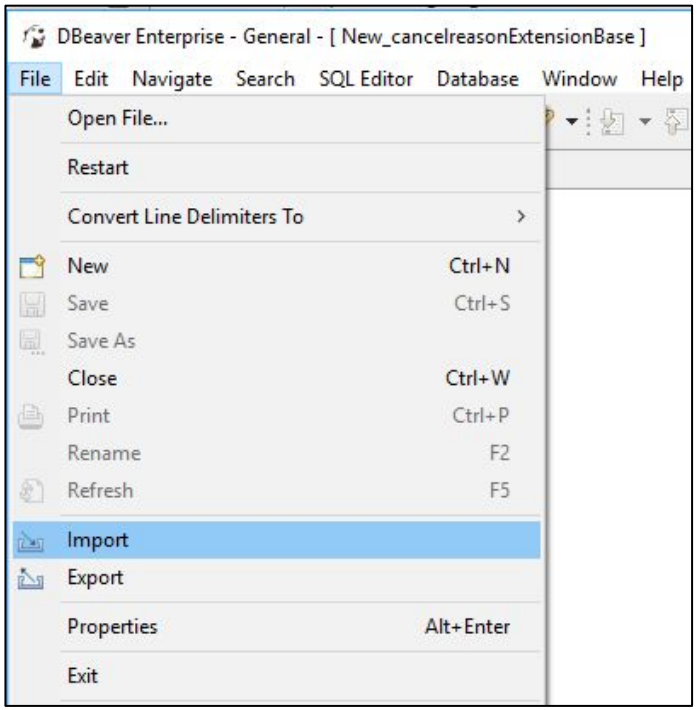
A SQL Client is a program to query databases

First, install DBeaver - http://dbeaver.jkiss.org/download/

Second, download profile (contains connection and SQL scripts)

Third, import the profile into DBeaver

Open up DBeaver -> File -> Import



Getting Started

DBeaver - A SQL Client (continued)

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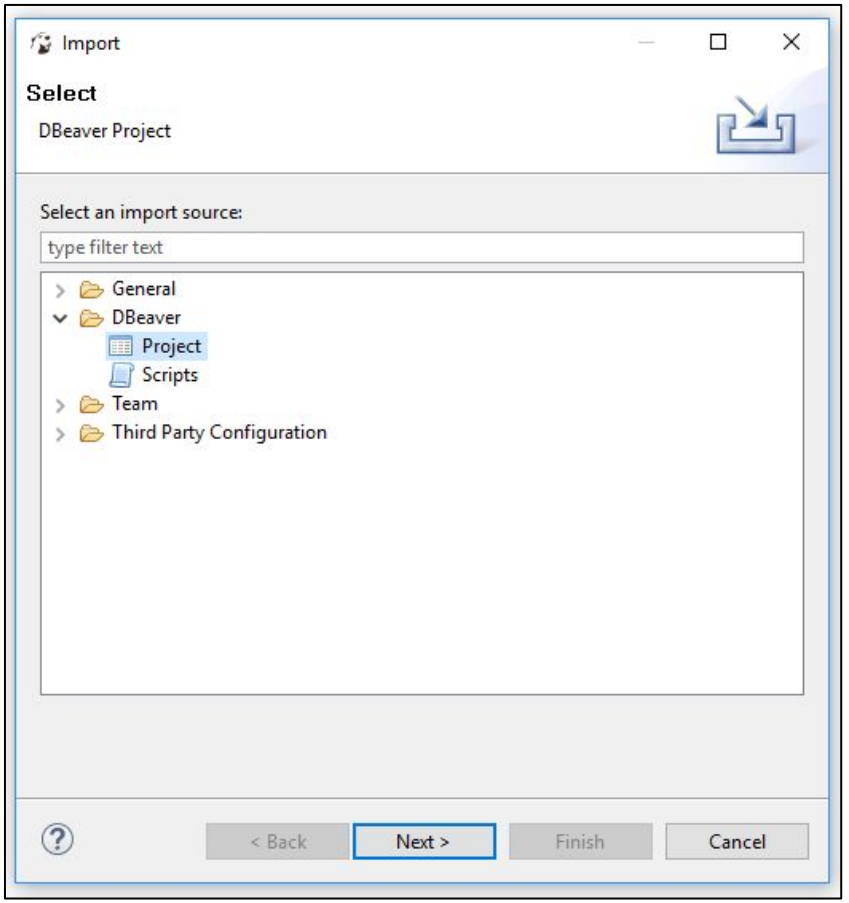
Next,

Select “Project” as the file type you’d like to import

Click “Next”



Getting Started

DBeaver - A SQL Client (continued)

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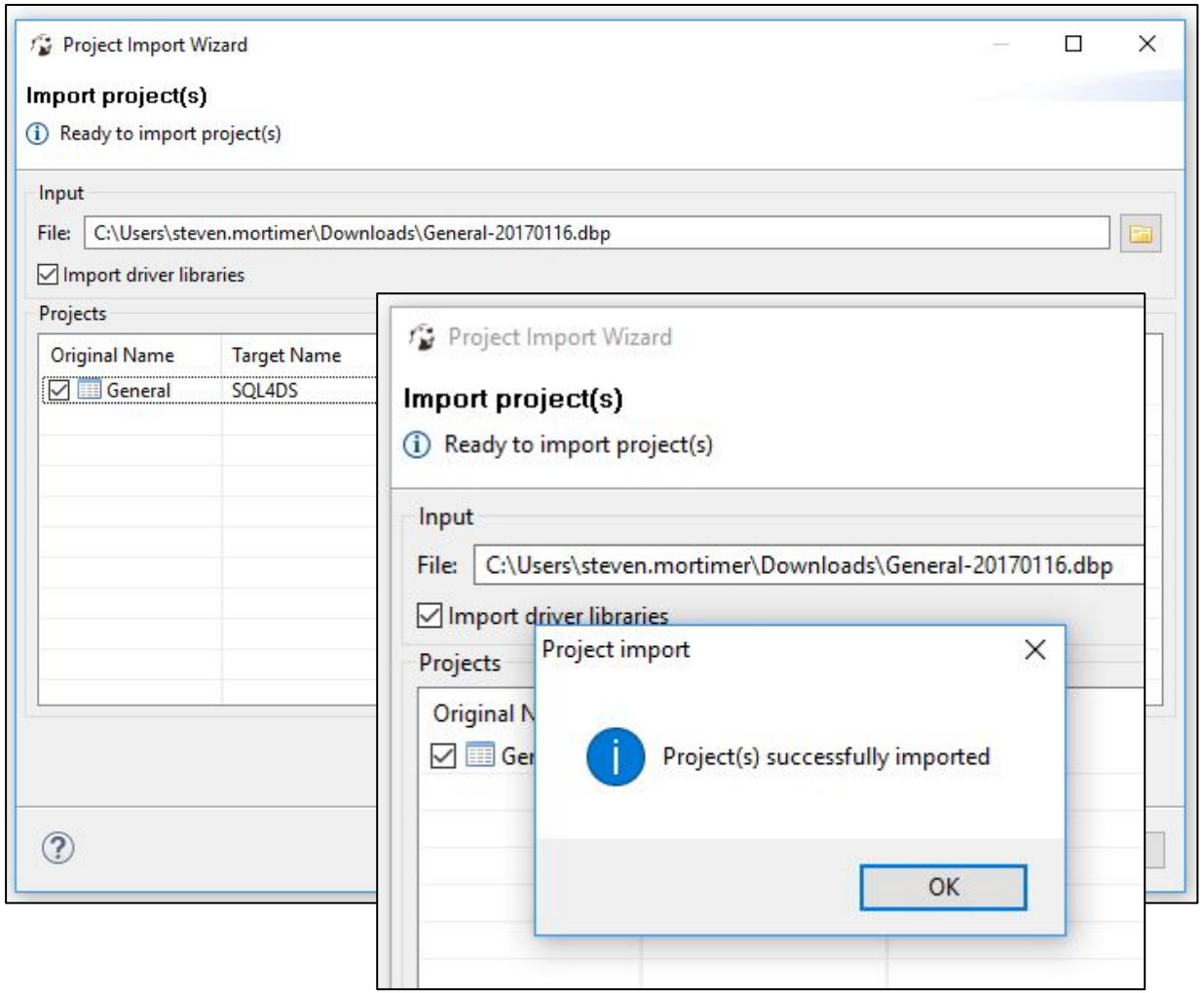
Next,

Select the .dbp file that you downloaded

Ensure that “Import driver libraries” is checked

Change the Target Name to “SQL4DS”

Click “Finish”



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DBeaver - A SQL Client (continued)

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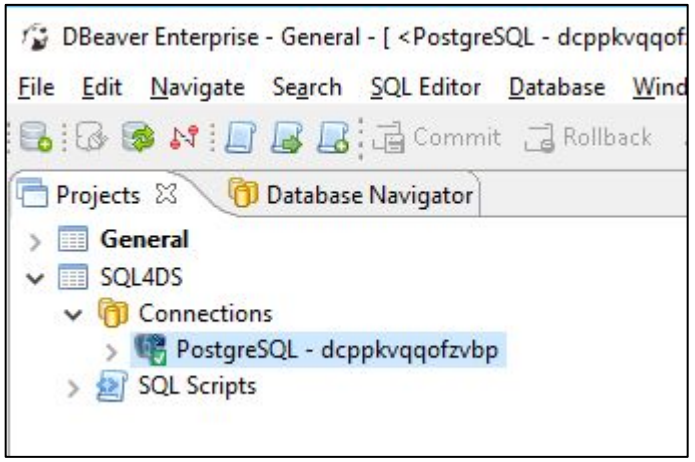
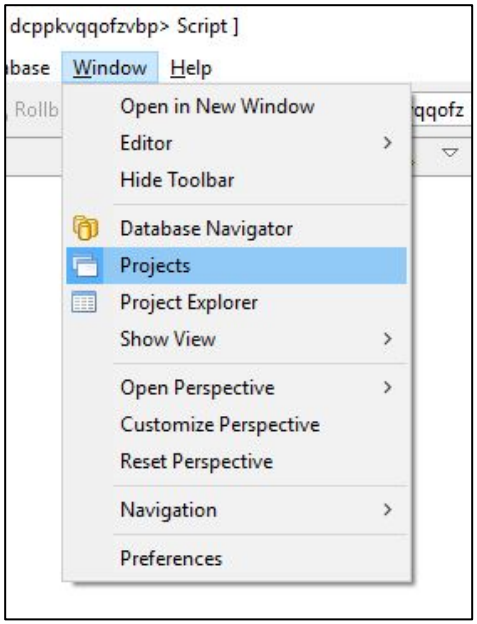
Click on SQL4DS Project. You should see a connection “PostgreSQL” with green check.



If you do not see a “Projects” tab, go to “Window” -> “Projects”



Getting Started

DBeaver - A SQL Client (continued)

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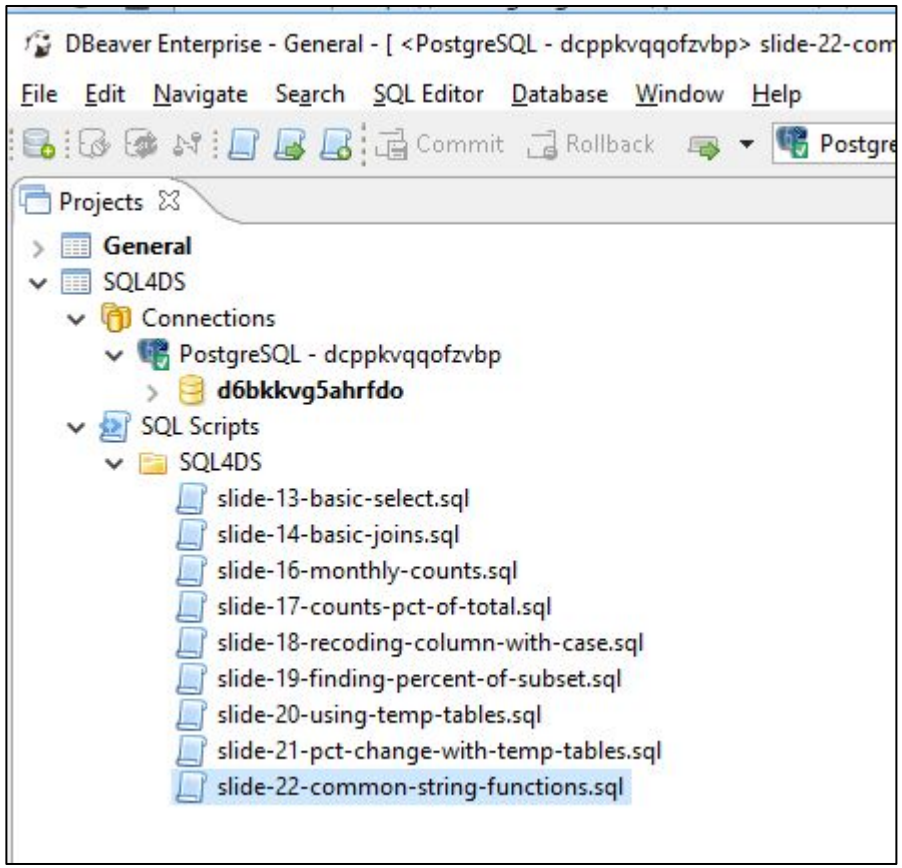
If you click on arrow to expand the “SQL Scripts” you will see scripts and folders of scripts that are part of your profile.

There is a folder called “SQL4DS” with all scripts for this presentation



PostgreSQL (Database)

- Do you have connection credentials?
- Can you “telnet”?

DBeaver (SQL Client)

- Installed?
- Do you have project or connection profile?
- Can you connect to database?
- Can you see scripts? Do they execute?

The SQL Basics

SELECT, FROM, WHERE

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The basic outline of a SQL query is SELECT, FROM, WHERE

```
SELECT
    productid
  , name
  , listprice
FROM production.product
WHERE productnumber = 'LO-C100'
;
```

SQL is declarative, just tell the database what you want! But… it can get messy so format your queries to be easy to read.

[See the SQL Style Guidelines Cheatsheet]

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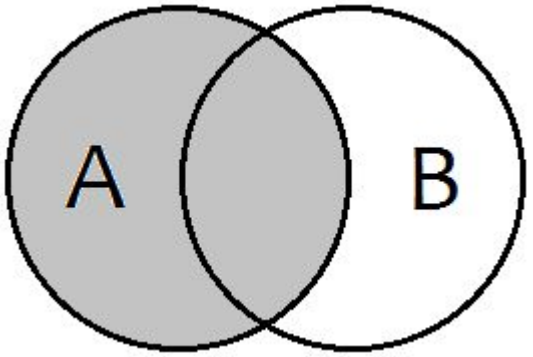
A “JOIN” connects data from 2 or more tables (similar to VLOOKUP)

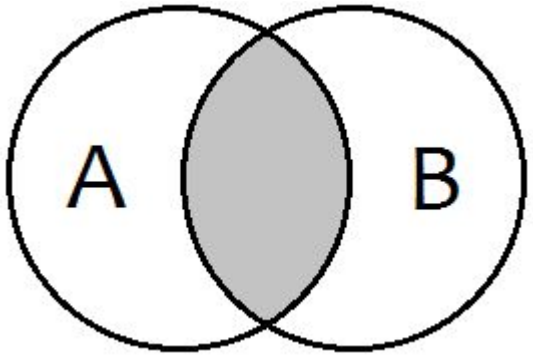
```
SELECT COUNT(*) -- 504 records
FROM production.product p
LEFT JOIN production.productcategory as pc
  ON p.productsubcategoryid = pc.productcategoryid
;
```

LEFT JOIN




```
SELECT COUNT(*) -- 105 records
FROM production.product p
INNER JOIN production.productcategory as pc
  ON p.productsubcategoryid = pc.productcategoryid
;
```

INNER JOIN



The SQL Basics

The JOINs Cheatsheet

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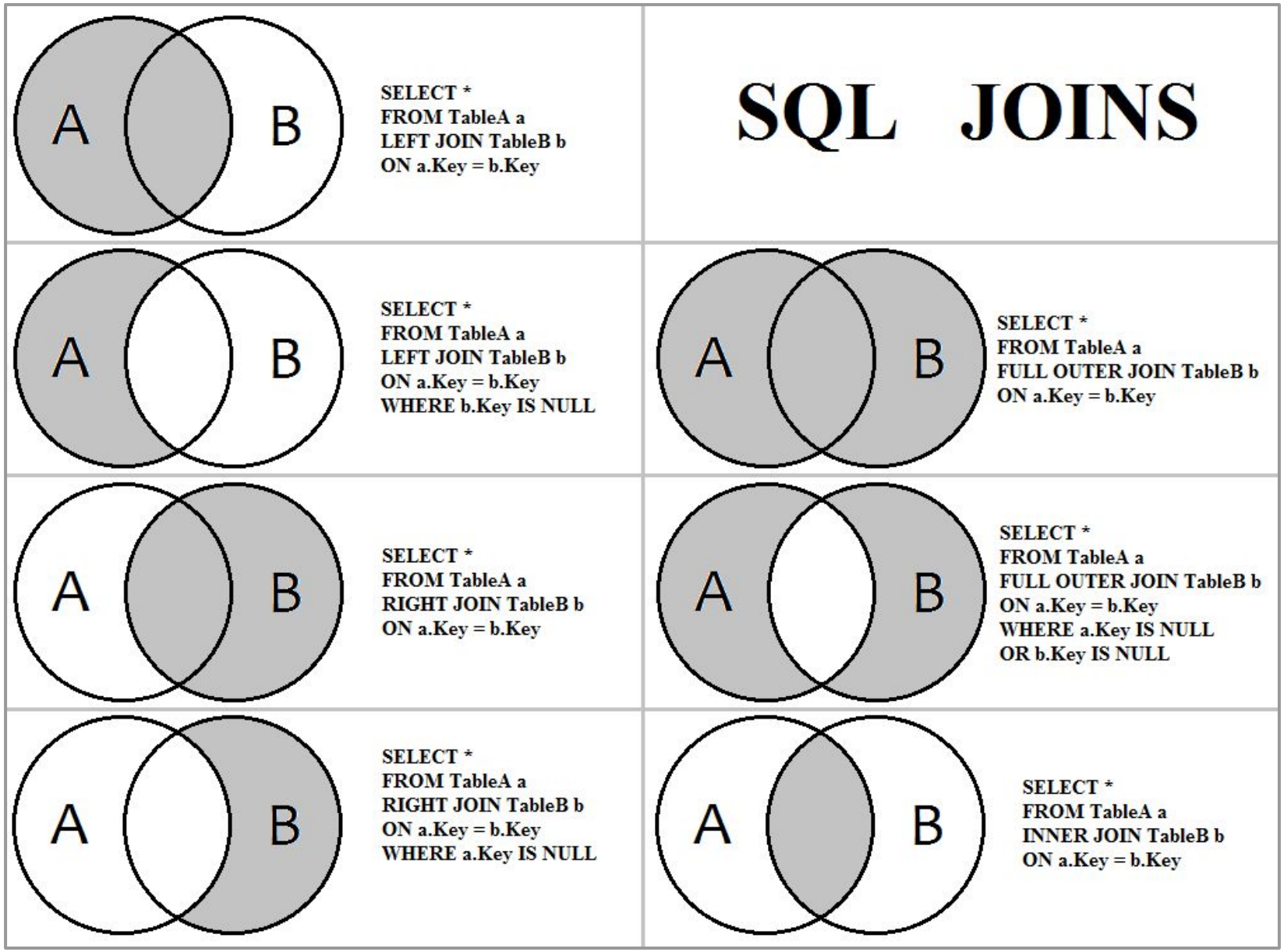

Find Out Count of Transactions per Month

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The GROUP BY Statement

```
SELECT   p.name
       , COUNT(*) AS total
FROM production.transactionhistory th
INNER JOIN production.product p
  ON th.productid = p.productid
WHERE TO_CHAR(transactiondate, 'YYYY-MM') = '2014-01'
GROUP BY p.name
;
```

Count by Month for All Months in 2014.
Don't Copy/Paste! Group it!

```
SELECT   TO_CHAR(th.transactiondate, 'YYYY-MM') AS month
       , p.name
       , COUNT(*) AS total
FROM production.transactionhistory th
INNER JOIN production.product p
  ON th.productid = p.productid
WHERE DATE_PART('year', transactiondate) = '2014'
GROUP BY month, p.name
;
```

Find Out Distribution of Products by Category

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Divide by Total Count to get Proportion of Total

```
SELECT    pc.name AS category
        , COUNT(p.productid)
        , CAST(COUNT(p.productid) AS decimal) / (
                SELECT COUNT(*) FROM production.product) AS pct
FROM production.product p
INNER JOIN production.productcategory pc
  ON p.productsubcategoryid = pc.productcategoryid
GROUP BY category
;
```

Be careful! Always inspect your results!!

```
SELECT    pc.name AS category
        , COUNT(p.productid)
        , CAST(COUNT(p.productid) AS decimal) / (
                SELECT COUNT(*) FROM production.product) AS pct
FROM production.product p
LEFT JOIN production.productcategory pc
  ON p.productsubcategoryid = pc.productcategoryid
GROUP BY category
;
```

Recoding a Column with CASE

The CASE Statement

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"CASE" follows *WHEN-THEN-ELSE* logic to change values, here we rename bikes and components to "Core".

```
SELECT
    p.name
  , CASE
      WHEN pc.name = 'Bikes' OR pc.name = 'Components' THEN 'Core'
      ELSE 'Non-Core'
    END AS finance_category
FROM production.product p
LEFT JOIN production.productcategory pc
  ON p.productsubcategoryid = pc.productcategoryid
;
```

Find Out What Percent of Products are “Core”

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Convert to 0 or 1 and the Average = the Proportion

```
SELECT
    AVG(core_indicator) AS pct_core
FROM production.product p
LEFT JOIN (
 SELECT
      productcategoryid
    , CASE
        WHEN name = 'Bikes' OR name = 'Components' THEN 1
        ELSE 0
      END AS core_indicator
  FROM production.productcategory
) pc
  ON p.productsubcategoryid = pc.productcategoryid
;
```

Note: The product table is LEFT JOIN’ed to a “subquery”. A subquery is its own query that is part of a larger query.

Using Temp Tables

Smaller, Separate Tables to Make it Easier

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```
WITH t AS (
  SELECT   productid
         , TO_CHAR(transactiondate, 'YYYY-MM') AS month
  FROM production.transactionhistory
  WHERE DATE_PART('year', transactiondate) = '2014'
)

, t2 AS (
  SELECT t.*, p.name
  FROM t
  INNER JOIN production.product p
    ON t.productid = p.productid
)

SELECT month, name, COUNT(*) AS total
FROM t2
GROUP BY month, name
ORDER BY month, name
;
```

Find Out the Percent Change Month over Month

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The LAG Statement

```
, monthly AS (
  SELECT month, COUNT(*) AS total
  FROM t2
  GROUP BY month
  ORDER BY month
)
, lagged AS (
  SELECT
      month
    , total
    , LAG(total) OVER (ORDER BY month) AS prior_month
  FROM monthly
)

SELECT month, total, prior_month,
       (total::float - prior_month) / prior_month AS pct_diff
FROM lagged
;
```

Manipulate Strings and Find via Fuzzy Match

Text Columns can be Modified and Searched as Needed

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```
SELECT
    name AS original
  , LENGTH(name) AS str_length
  , UPPER(name) AS str_upper
  , SUBSTRING(name, 1, 3) AS str_sub
  , REPLACE(name, 'a', 'zzz') AS str_replace
  , CONCAT('PREFIX_', name) AS str_concat
FROM production.product
WHERE productnumber LIKE 'LO%'
;
```

LENGTH, UPPER, SUBSTRING, REPLACE, CONCAT will modify a column. LIKE will perform a fuzzy match

Resources

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Many Places to Learn and Practice

W3Schools - http://www.w3schools.com/sql/

Hacker Rank - https://www.hackerrank.com/domains/sql/select

SQL Zoo - http://sqlzoo.net/wiki/AdventureWorks

Codecademy - https://www.codecademy.com/learn/learn-sql

Other Norfolk Data Science Members!

Experienced SQL users are all around you

Questions

We're Here to Help

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In Person - Ask Now!

Via Chat - Join the Norfolk Data Science Community on Slack

http://norfolkdatasci.herokuapp.com/

Via Email

Steve - reportmort@gmail.com

Josiah - josiahfbaker@gmail.com


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