CCT396, Fall 2011

Database Design and Implementation

Yuri Takhteyev
University of Toronto

What is a “Database”?

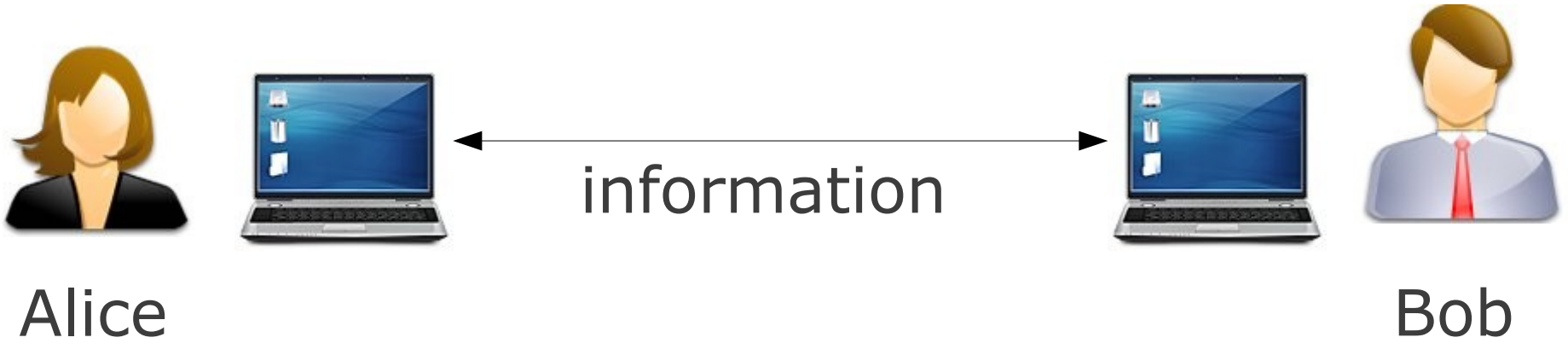
“an organized collection of data”
(digital, managed with software)

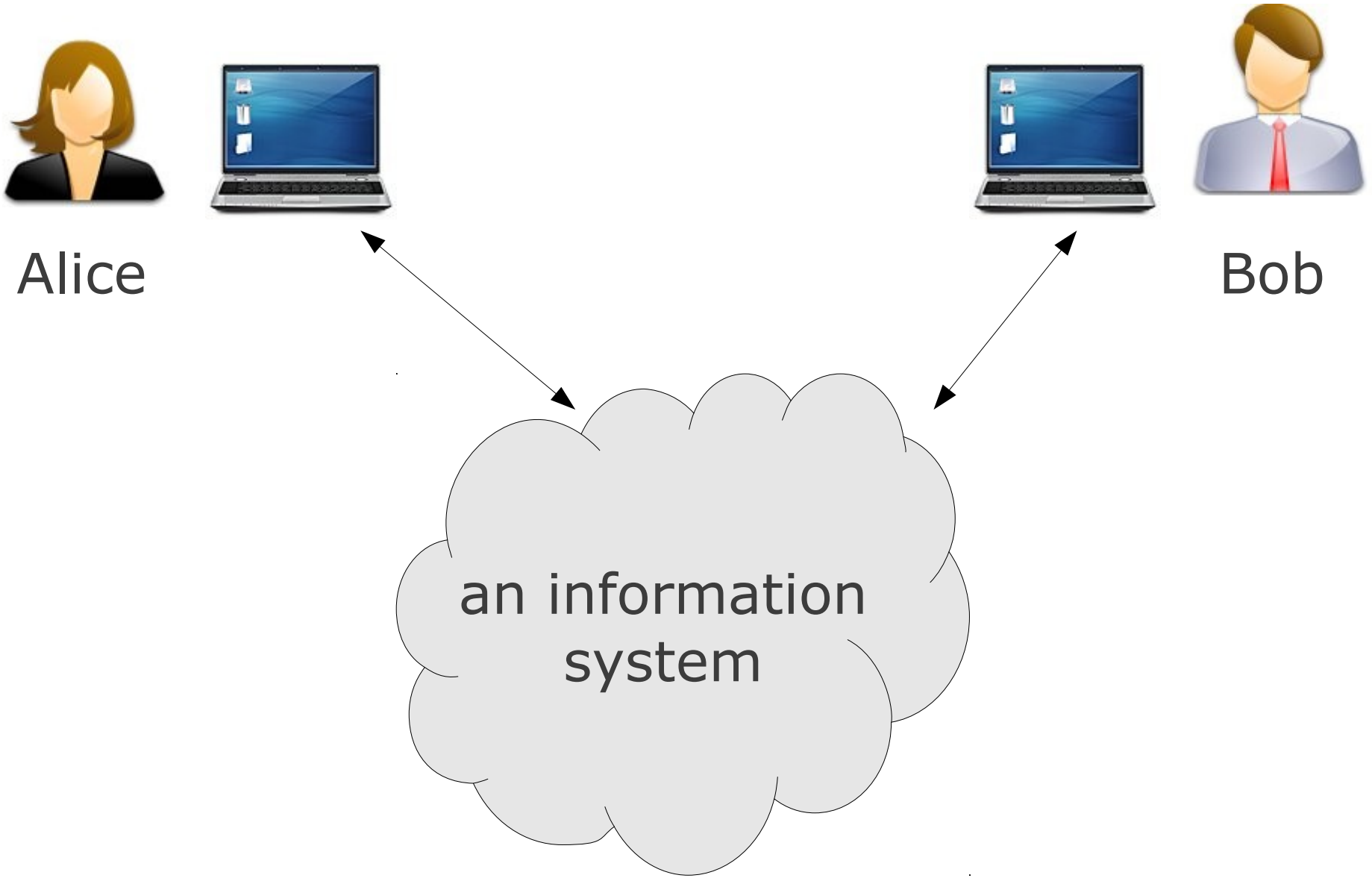
“DBMS”

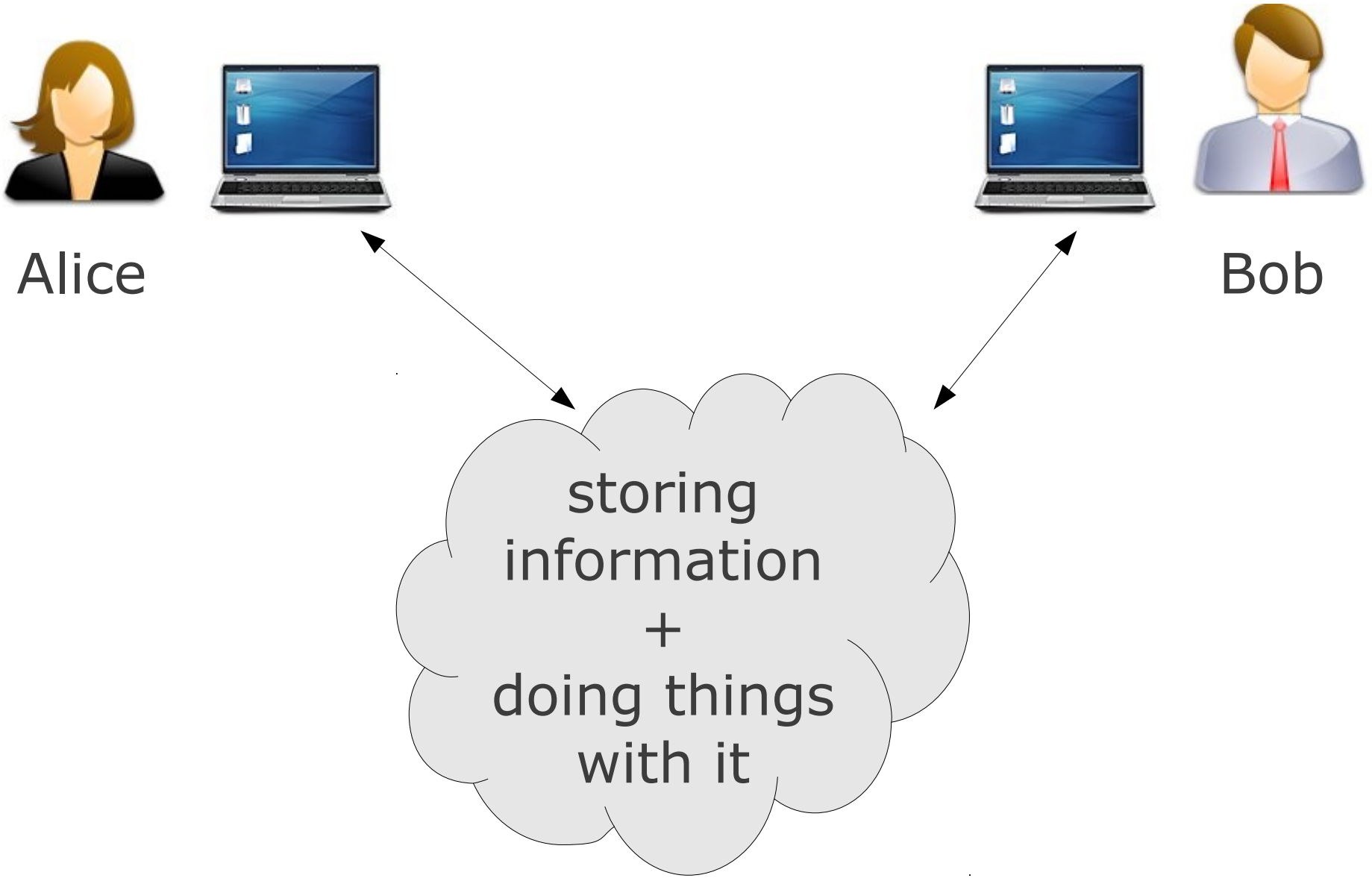
information

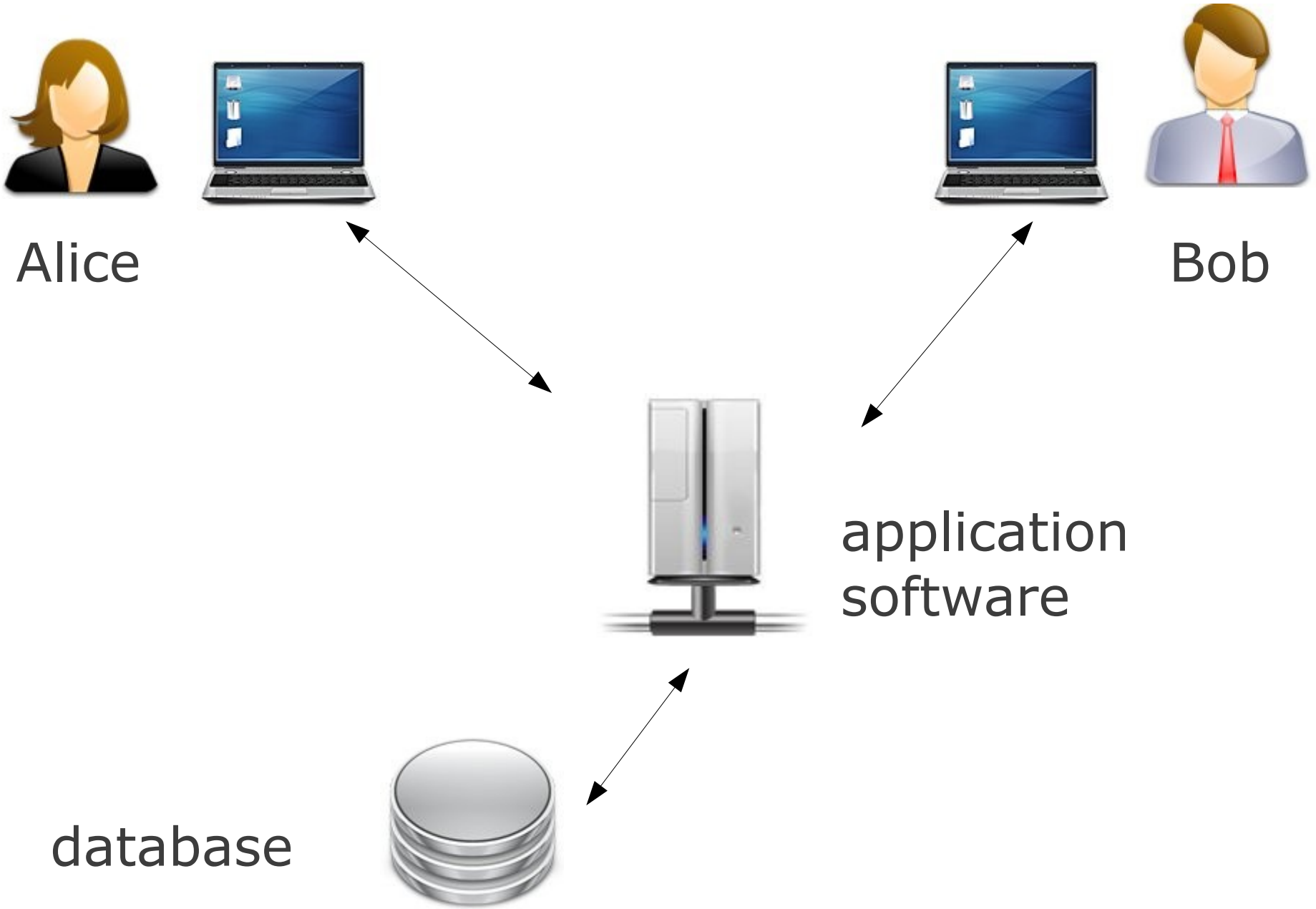
Alice

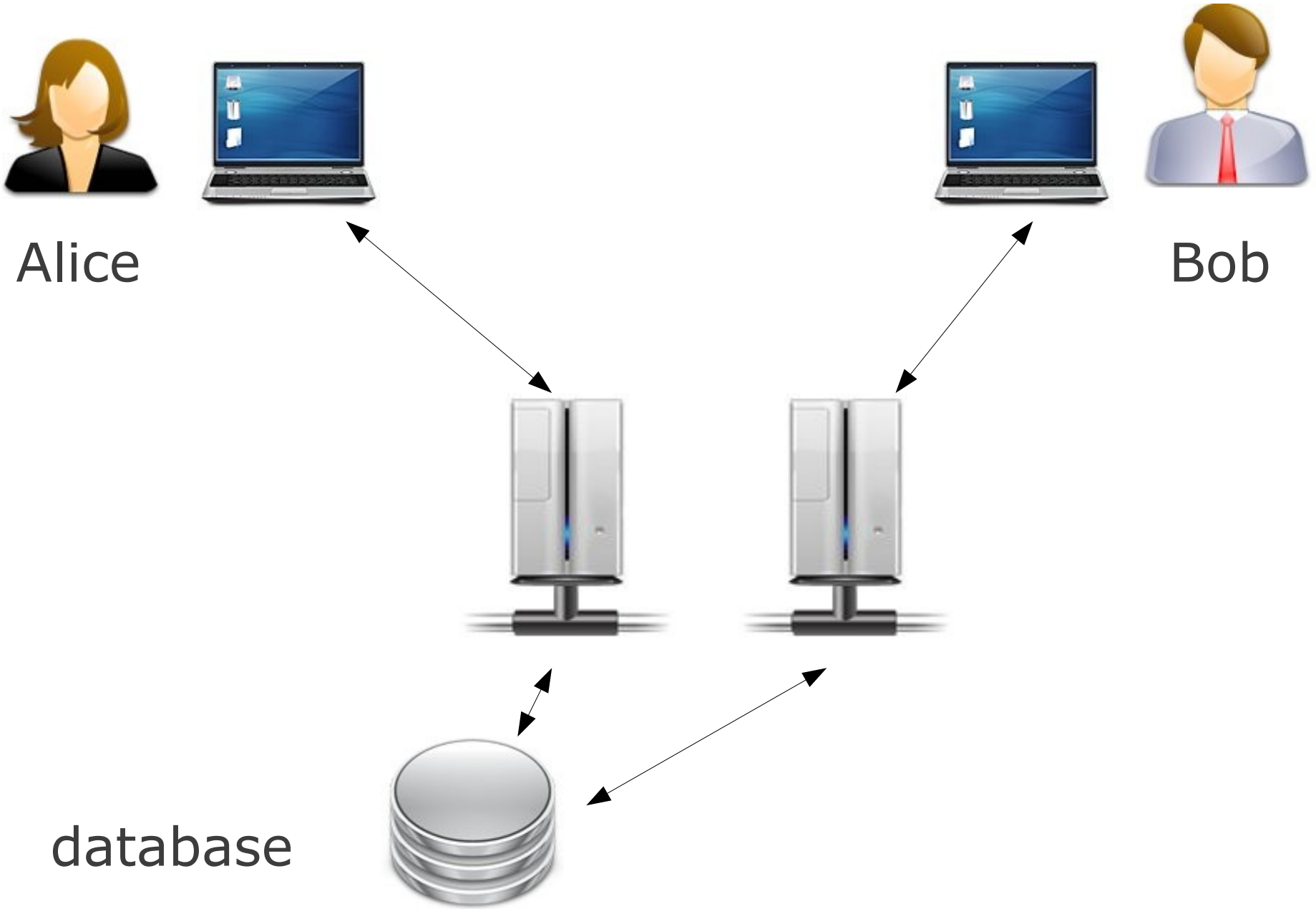
Bob


information
Alice
Bob

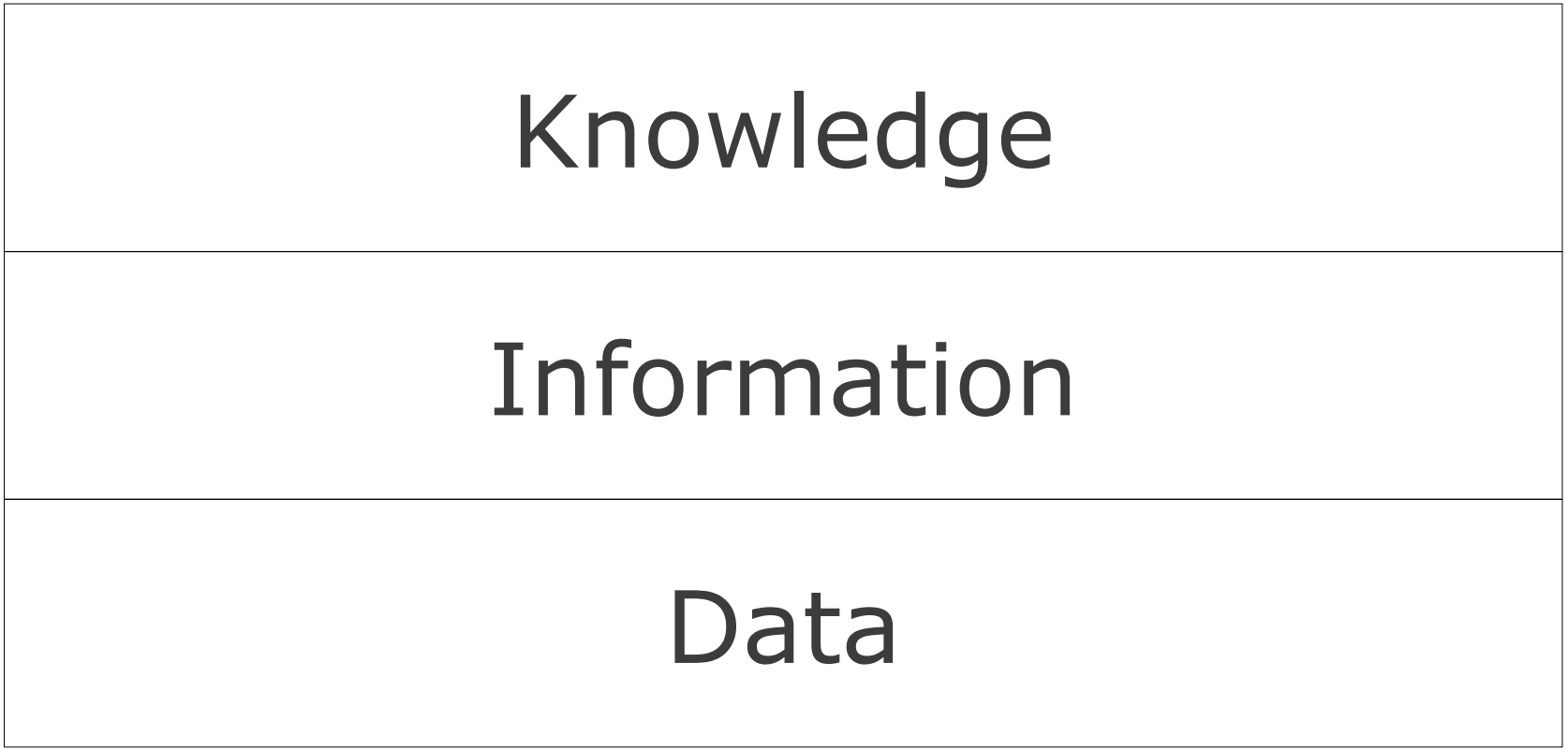

Alice
Bob
an information system


Alice
Bob
storing
information
+
doing things
with it

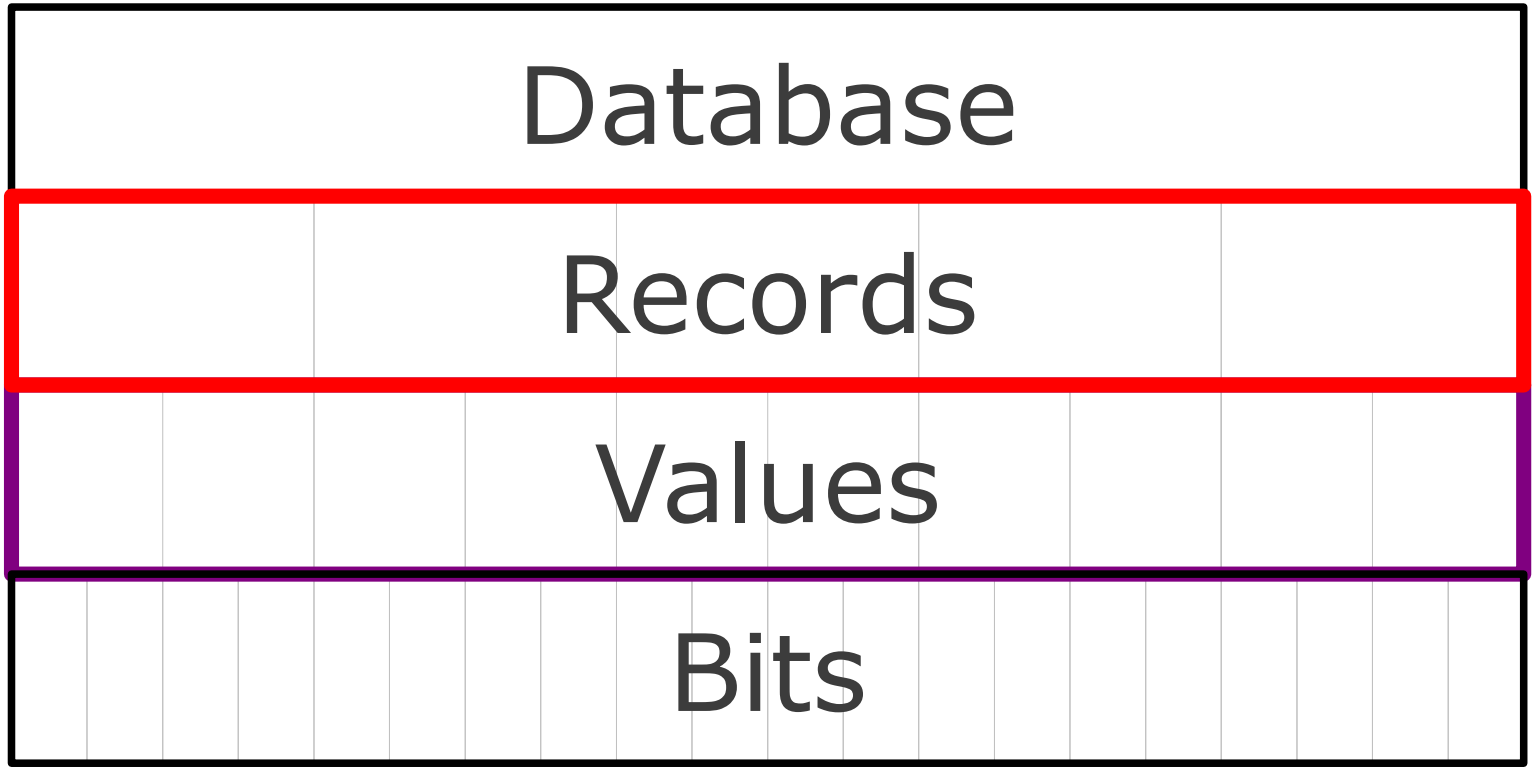

Alice
Bob
application
software
database
“persistent storage”


Alice
Bob
database
“persistent storage”

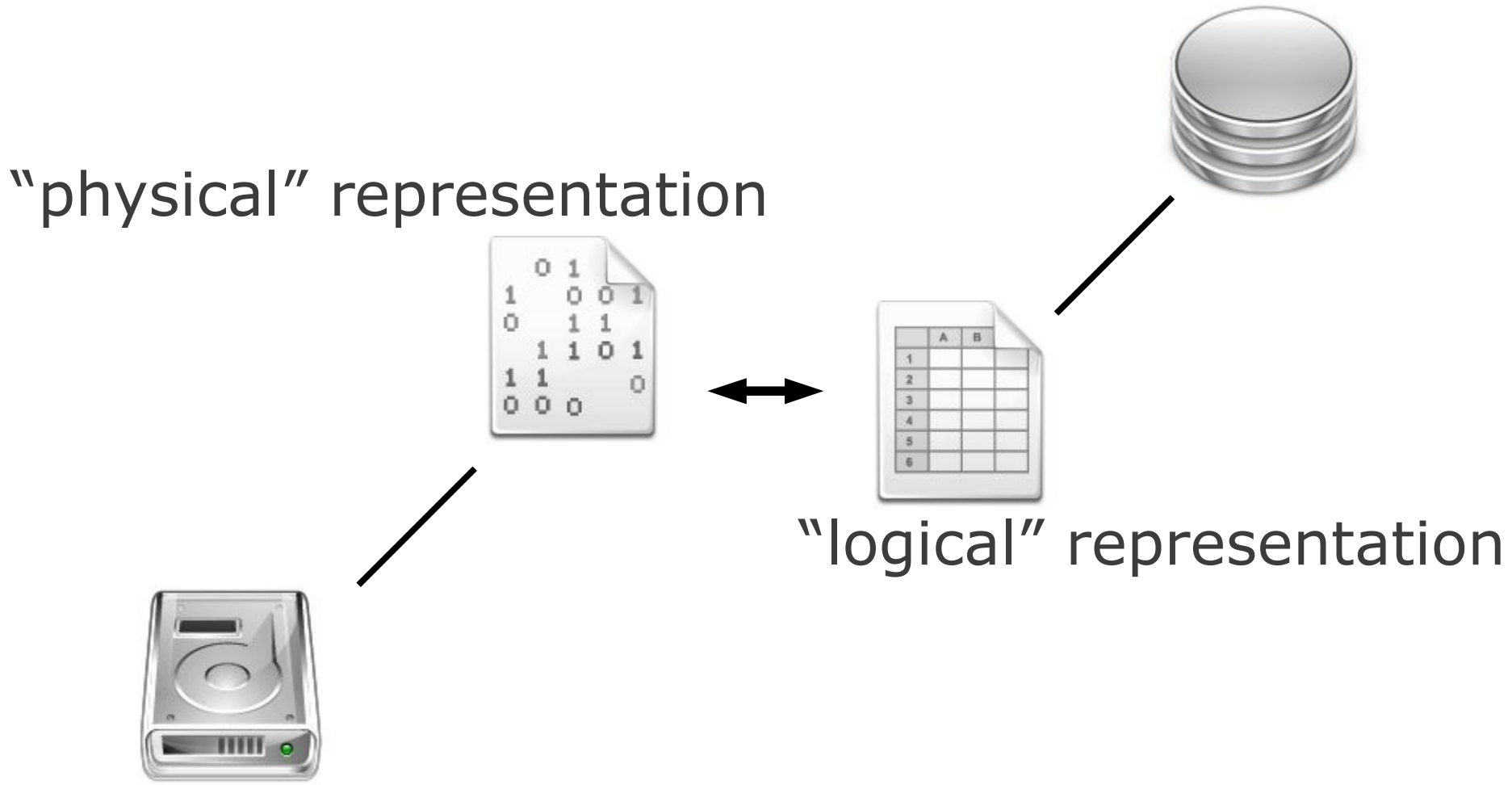
What is Data?



What is Data?



Database Elements



Basic Data Types

Numbers

42, 2.7, 7.2×10^{-19}, 879284337621

Text "Strings"

"Yoda", "Chewbacca", "A long time ago in a galaxy far, far away...."

More Complex Data

Time

"Sept. 7, 2011" (2011-09-07)

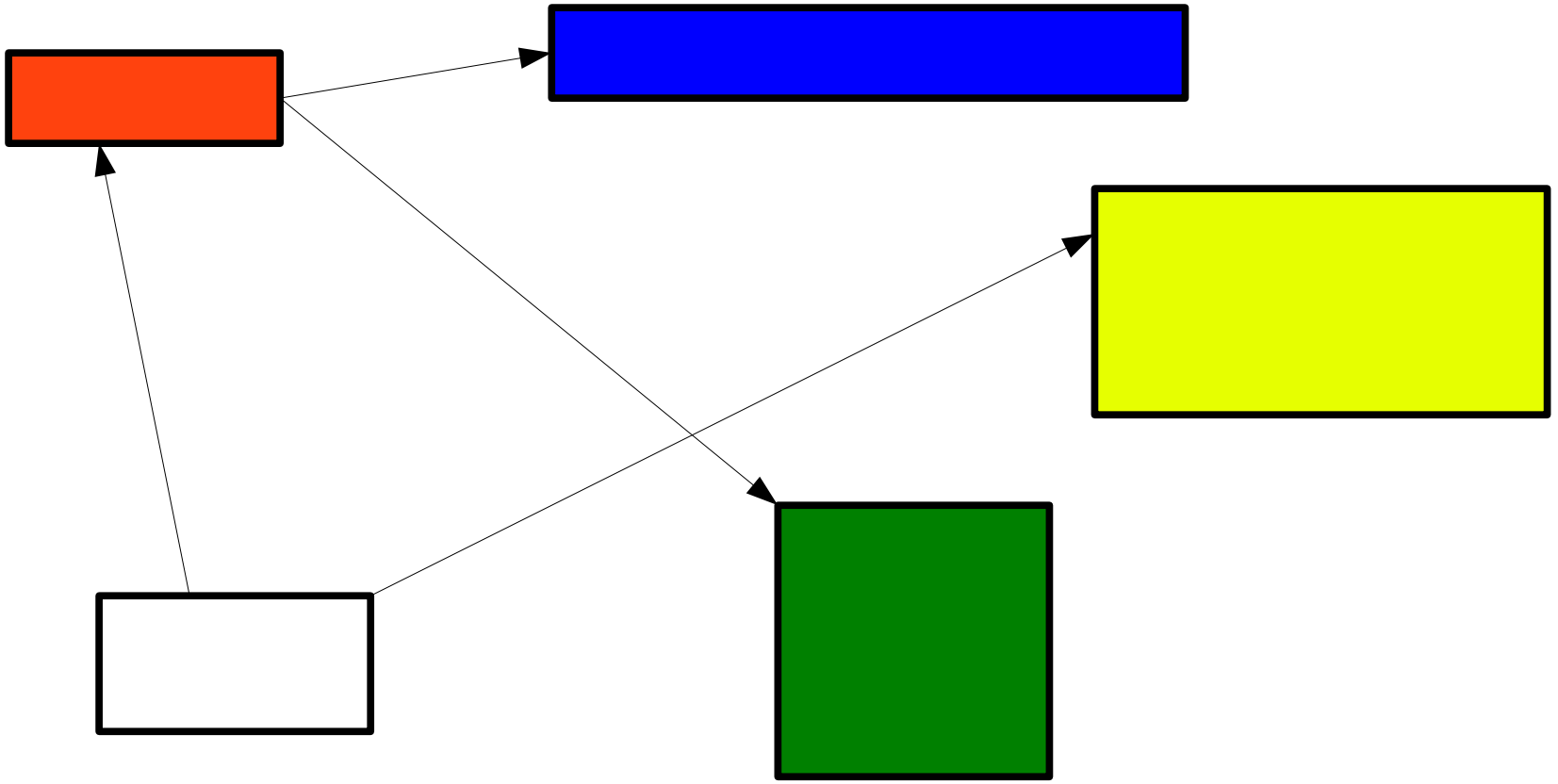
Binary "Blobs"

contents of an image file

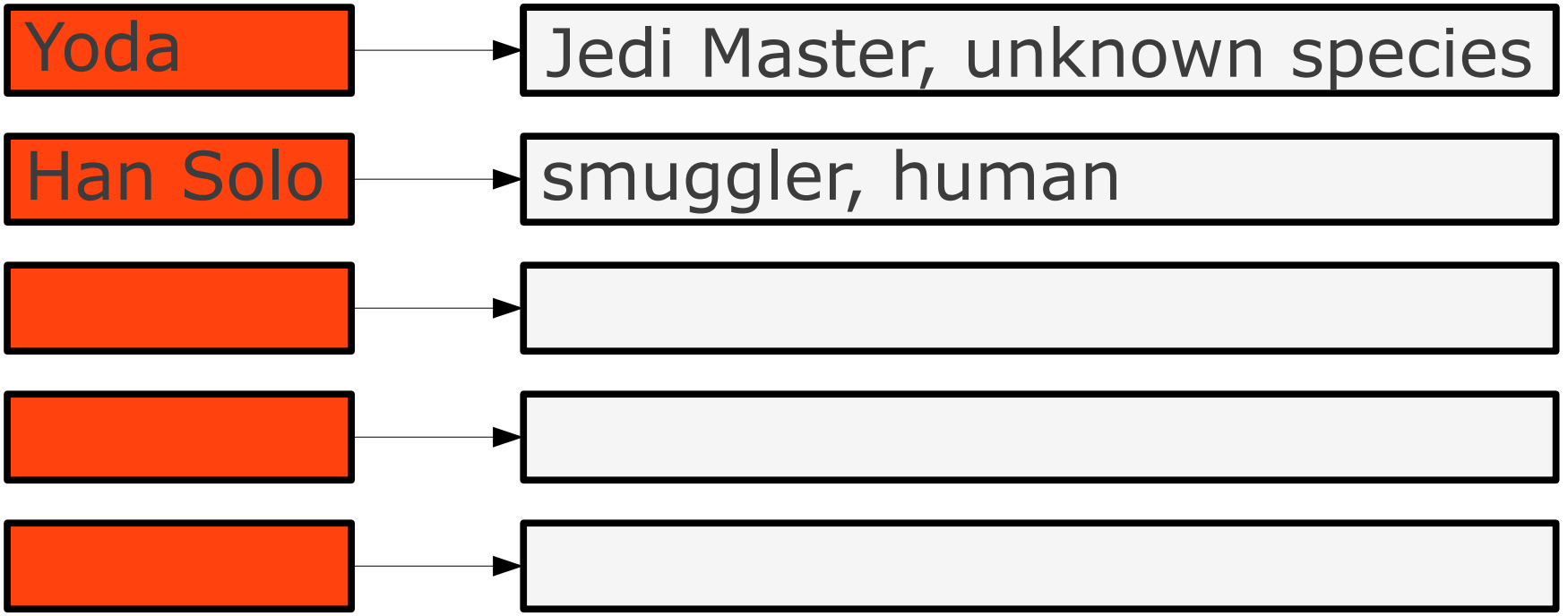
Geometric

a line, a polygon

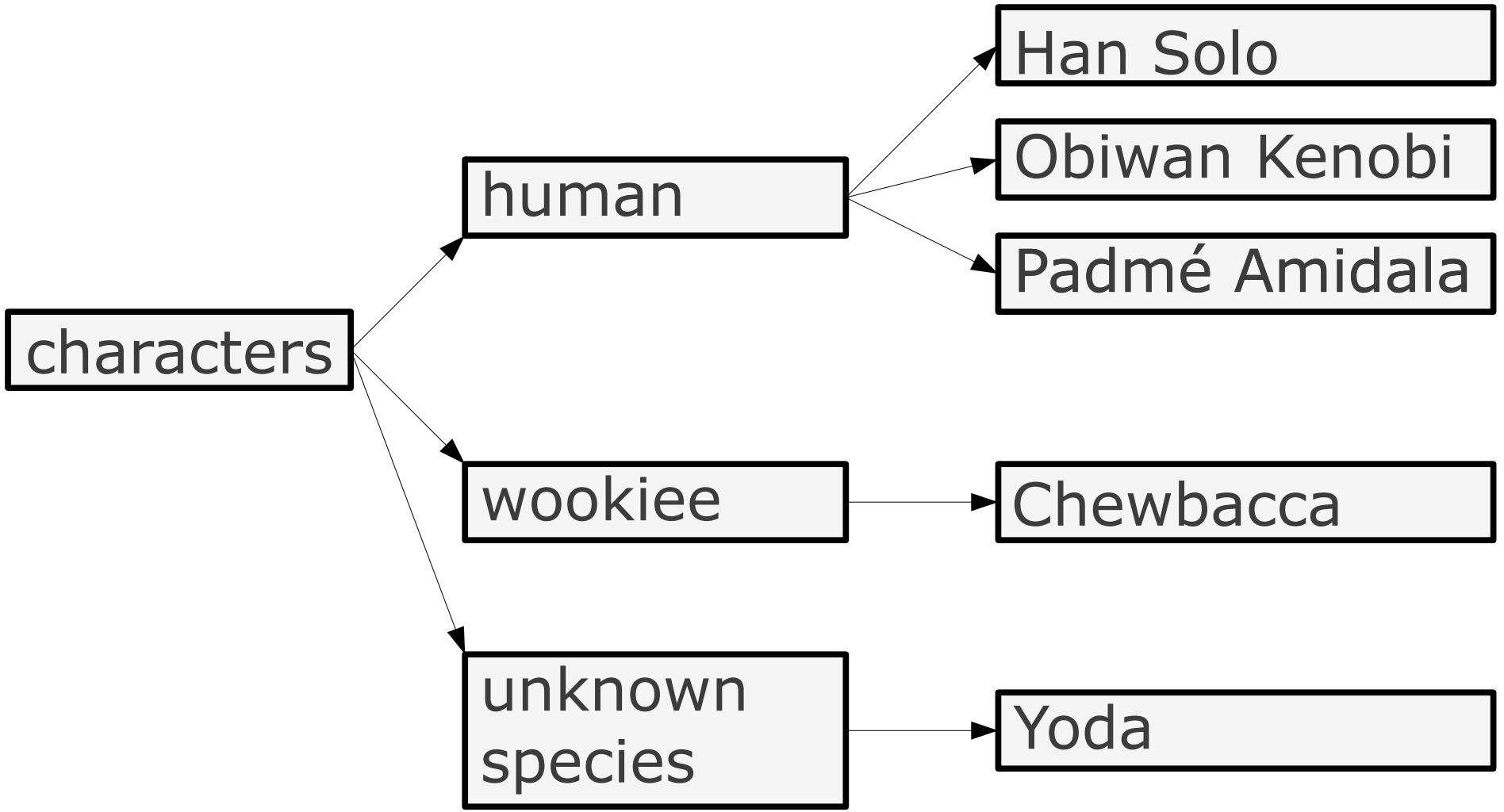
Databases Models



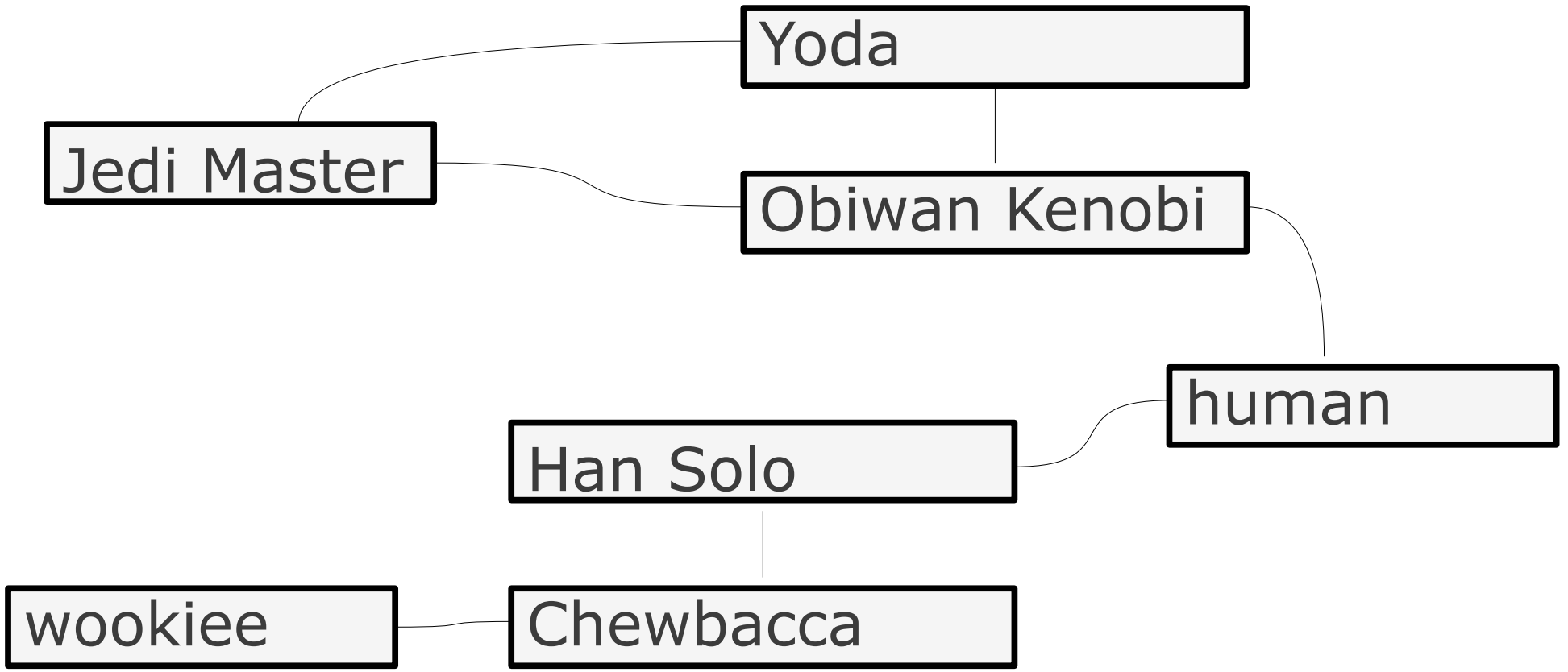
Key-Value



Hierarchical



Network


Yoda
Jedi Master
Obiwan Kenobi
human
Han Solo
wookiee
Chewbacca

Relational

A notion of a “relation”

not to be
confused with
a “relationship”

A Relation

(“Yoda”, “Jedi Master”)

A Relation

(“Yoda”, “Jedi Master”,
“unknown species”)

A Relation

(“Yoda”, “Jedi Master”, “unknown species”)

(“San Solo”, “smuggler”, “Human”)

(“Padmé Amidala”, “queen”, “Human”)

(“Jabba”, “crime lord”, “Hutt”)

(“Jar Jar Binks”, “senator”, “Gungan”)

Another Relation

(“Human”, “humanoid”, 1.7)

(“Gungan”, “humanoid”, 1.89)

(“Hutt”, “gastropod”, 3.5)

(“Ewok”, “furry biped”, 0.9)

And Another

(“humanoid”, 2)

(“gastropod”, 0)

Tabular Form

species

Human	humanoid	1.7
Hutt	gastropod	3.5

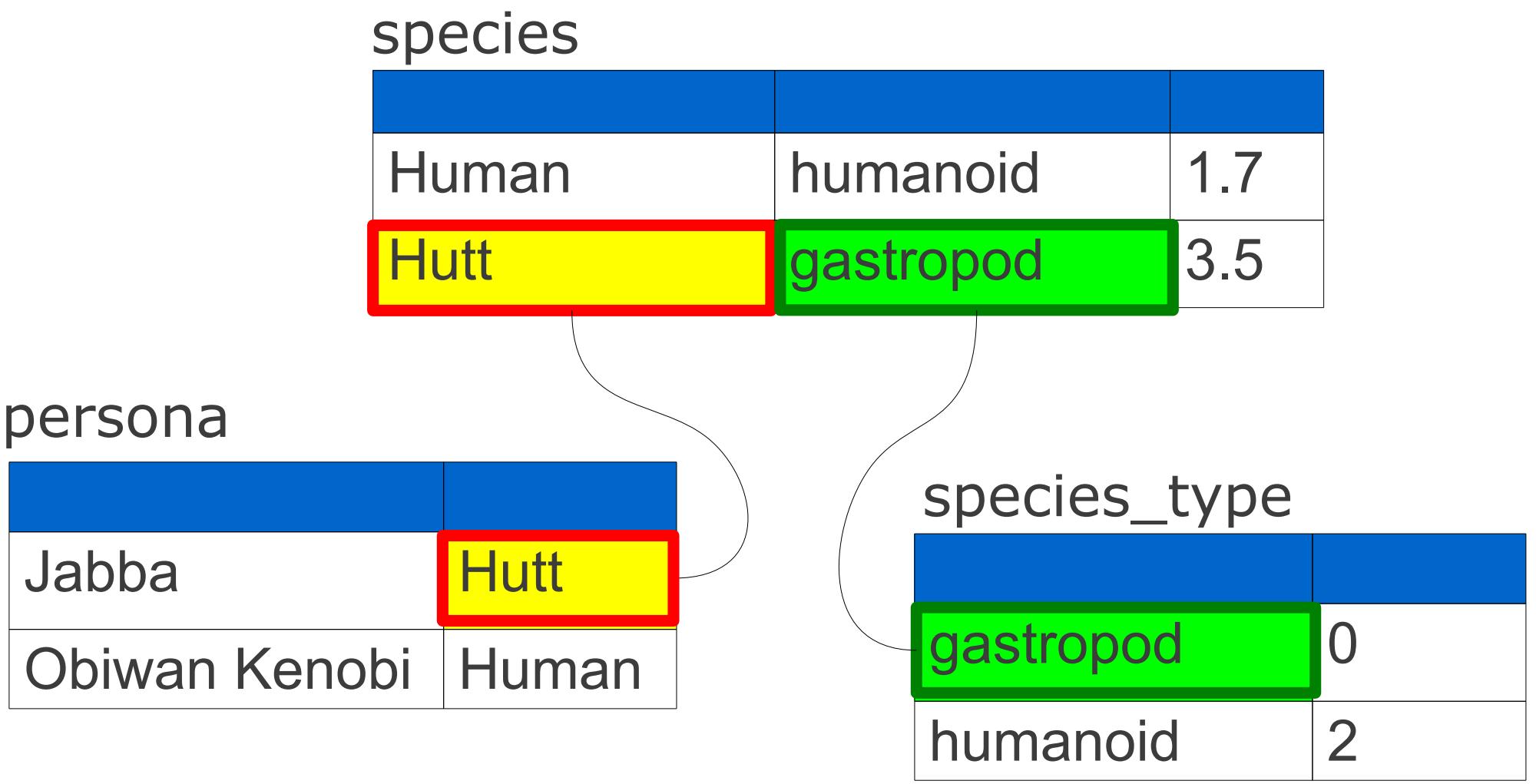
persona

Jabba	Hutt
Obiwan Kenobi	Human

species_type

gastropod	0
humanoid	2

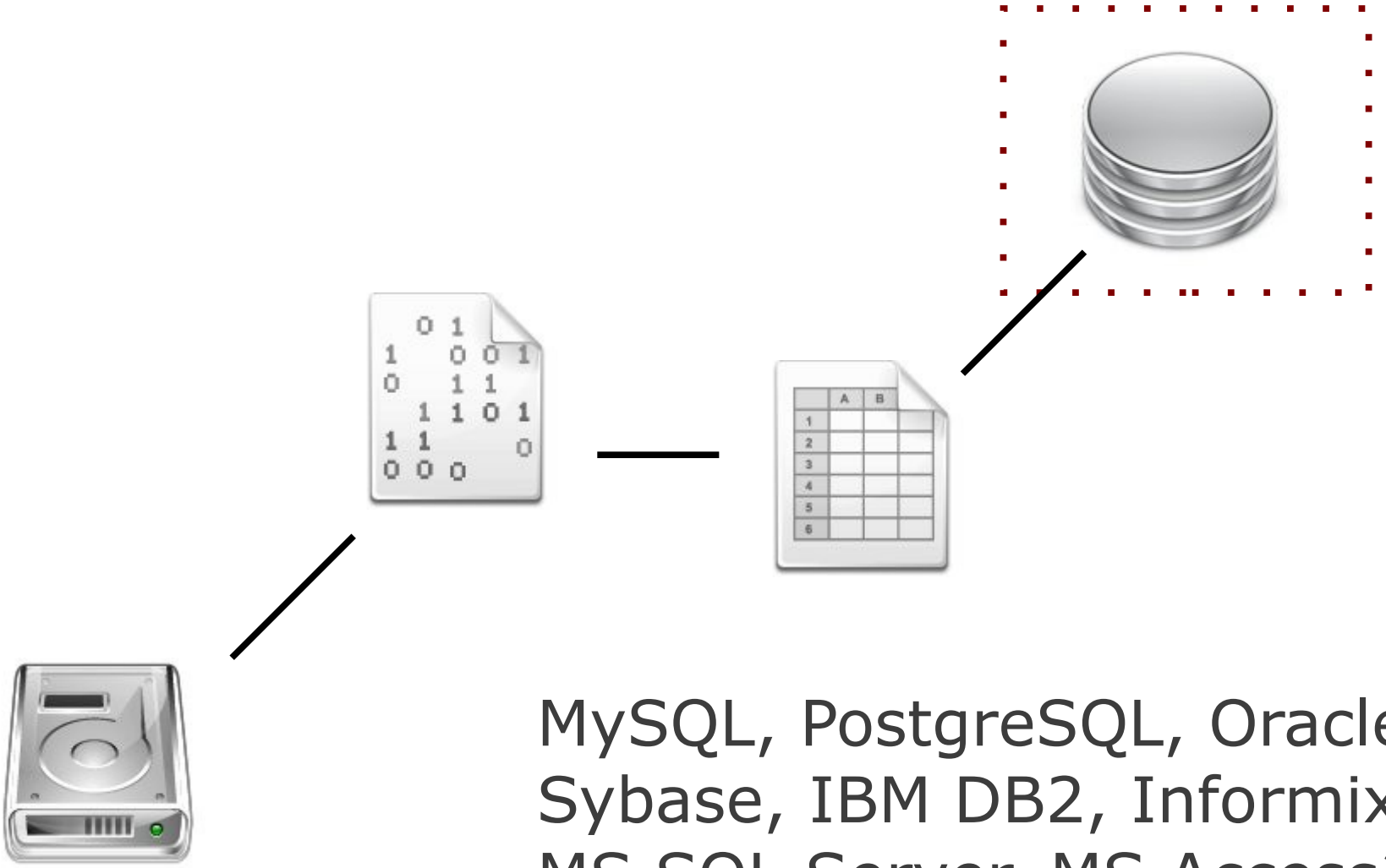
Tabular Form



Relational Data Modeling

Finding a proper relational representation for data

RDBMS

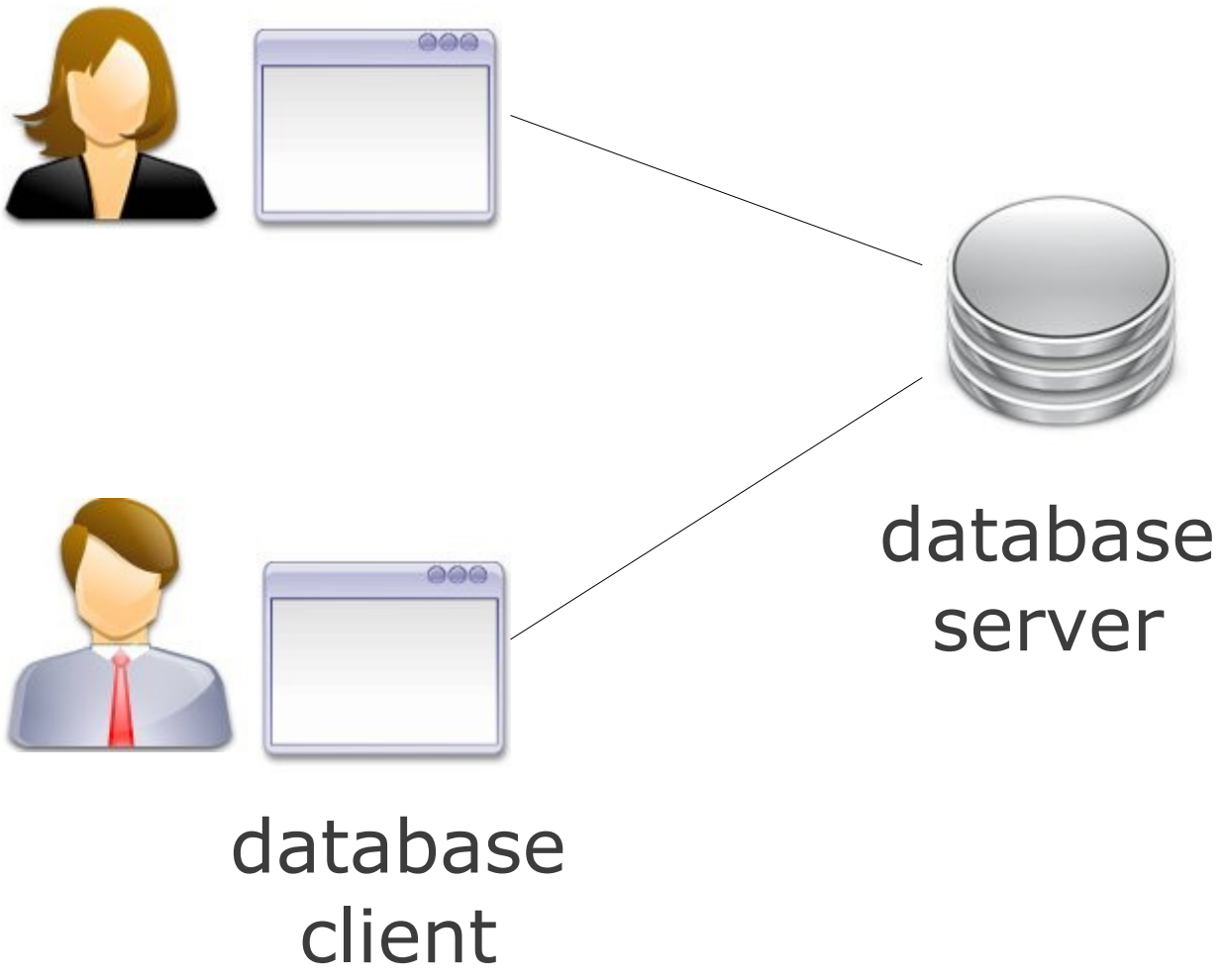


MySQL, PostgreSQL, Oracle,
Sybase, IBM DB2, Informix,
MS SQL Server, MS Access*

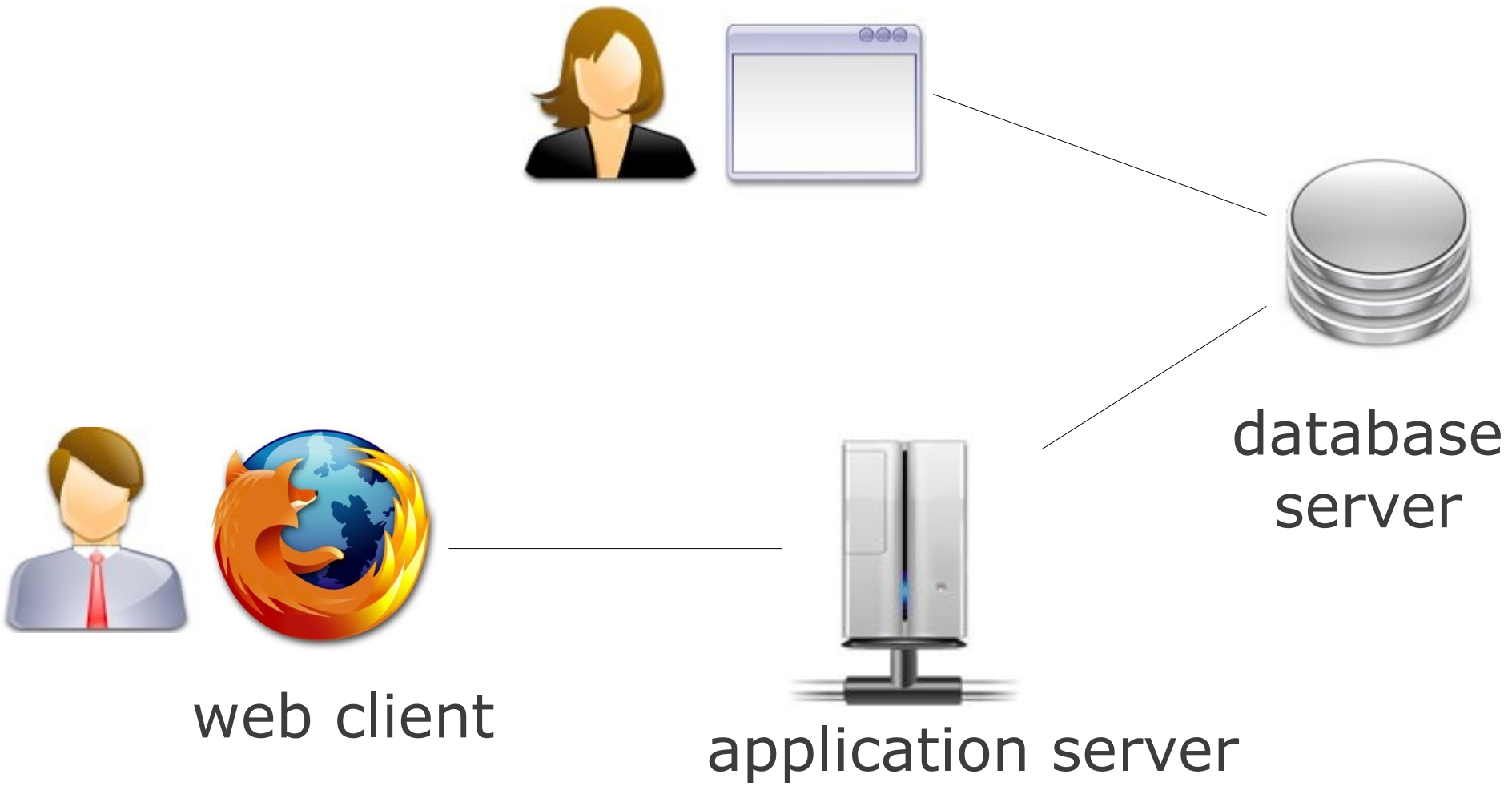
Accessing a Database

Built-in GUI

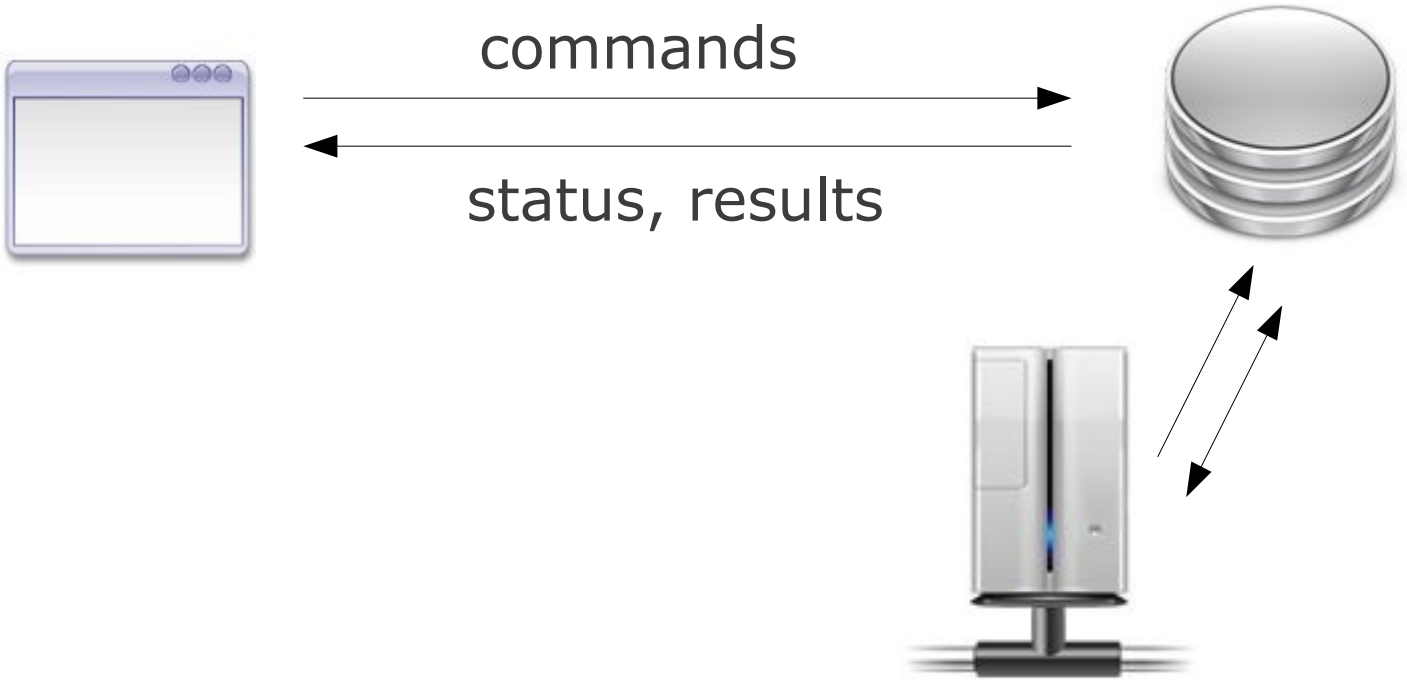
Networked Client



A 3-Tier System



A Query Language



Structured

Query

Language

(Some people say “Sequel”)

An SQL Statement

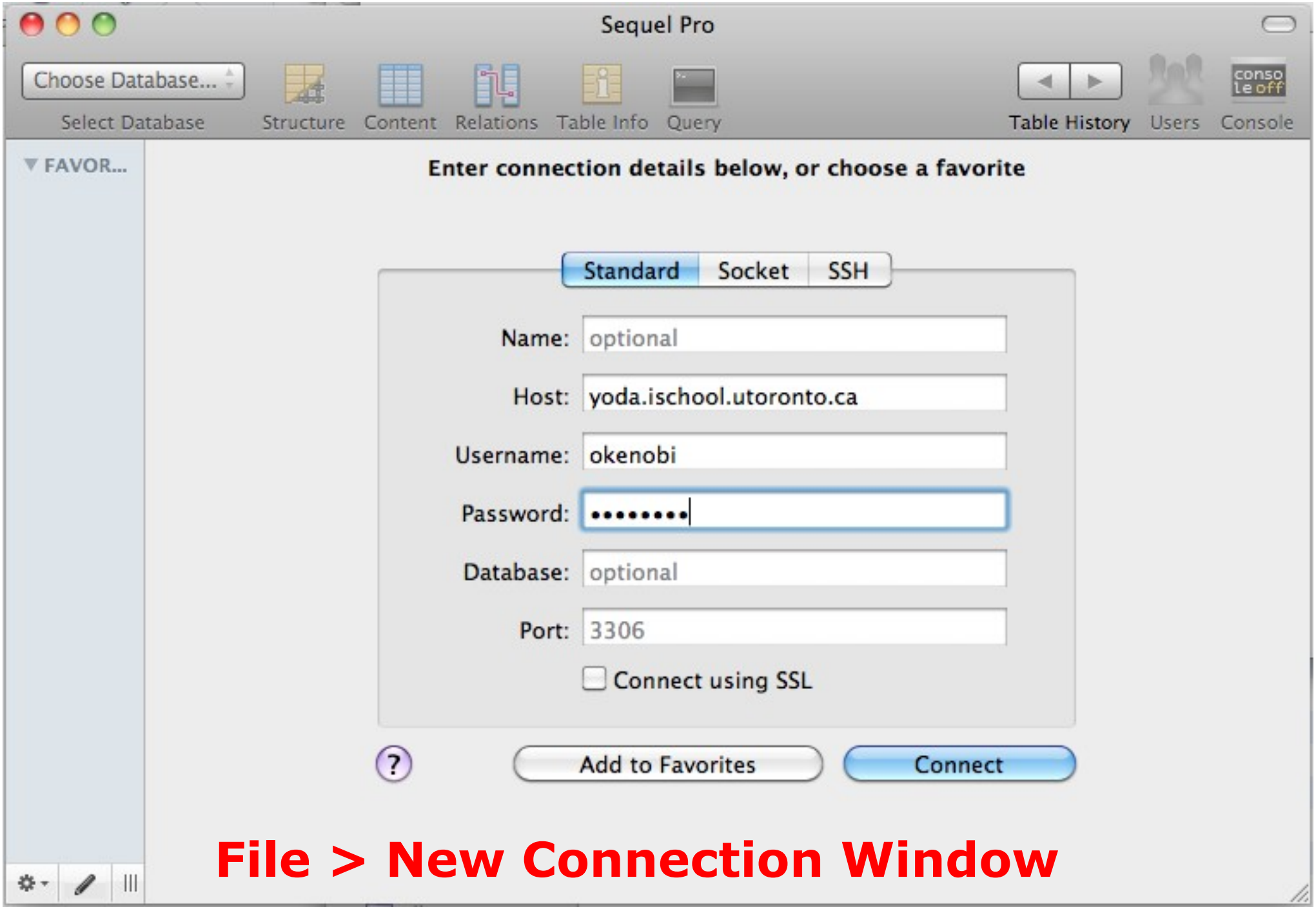
```
select name, occupation
from persona
where species=”Wookiee”;
```

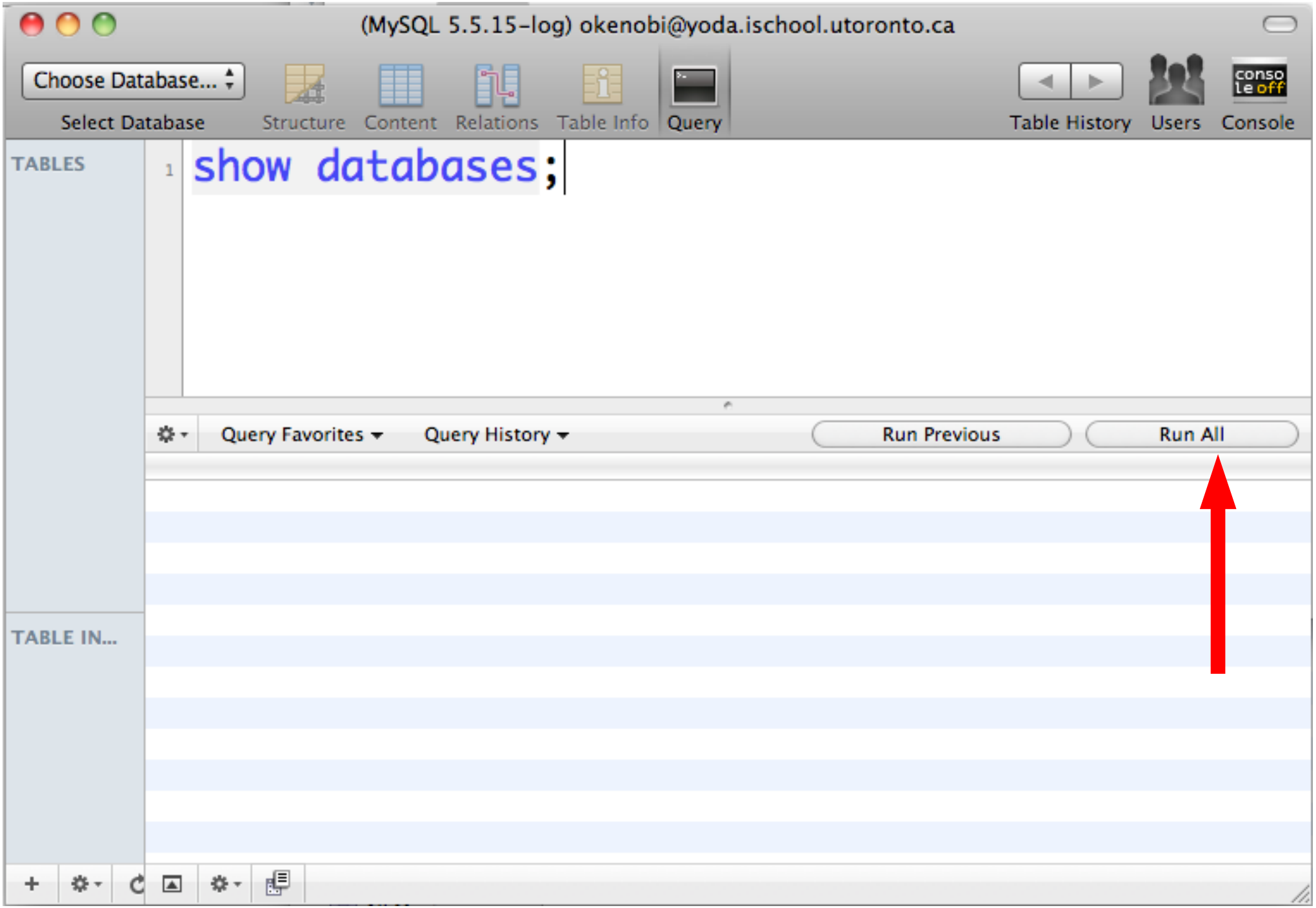
An SQL Statement

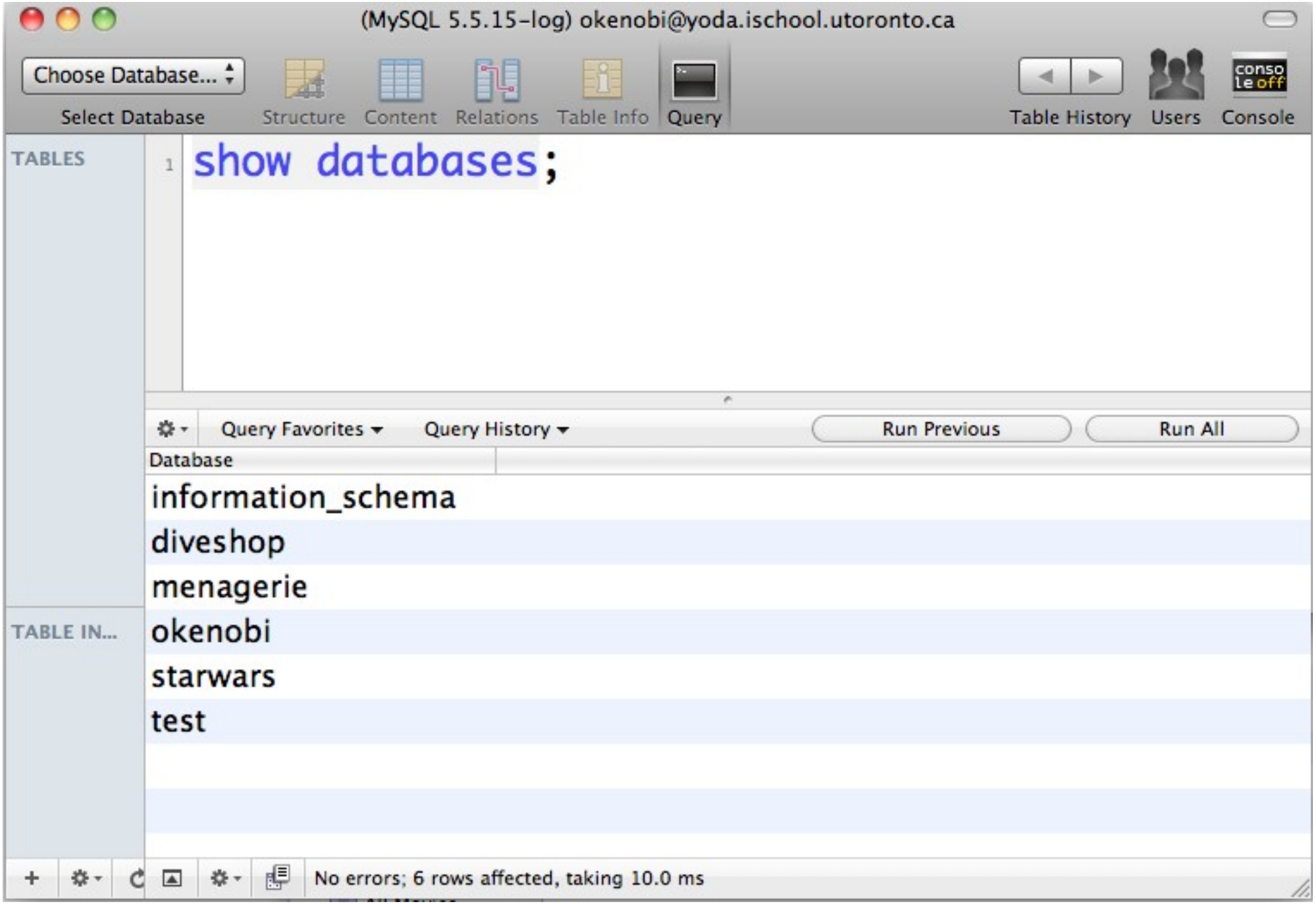
```
select name, occupation
from persona
where species="Wookiee";
```

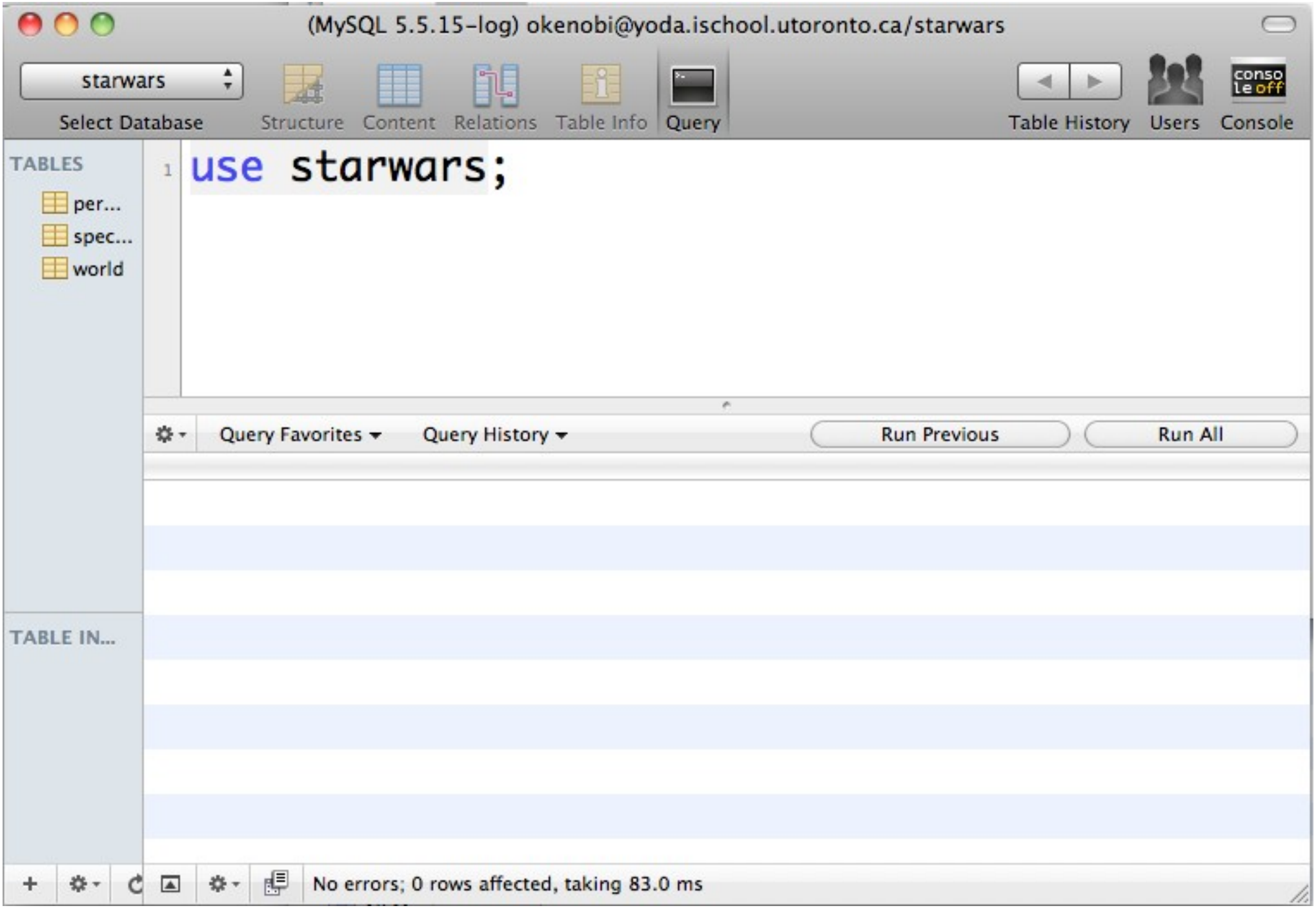
Sequel Pro

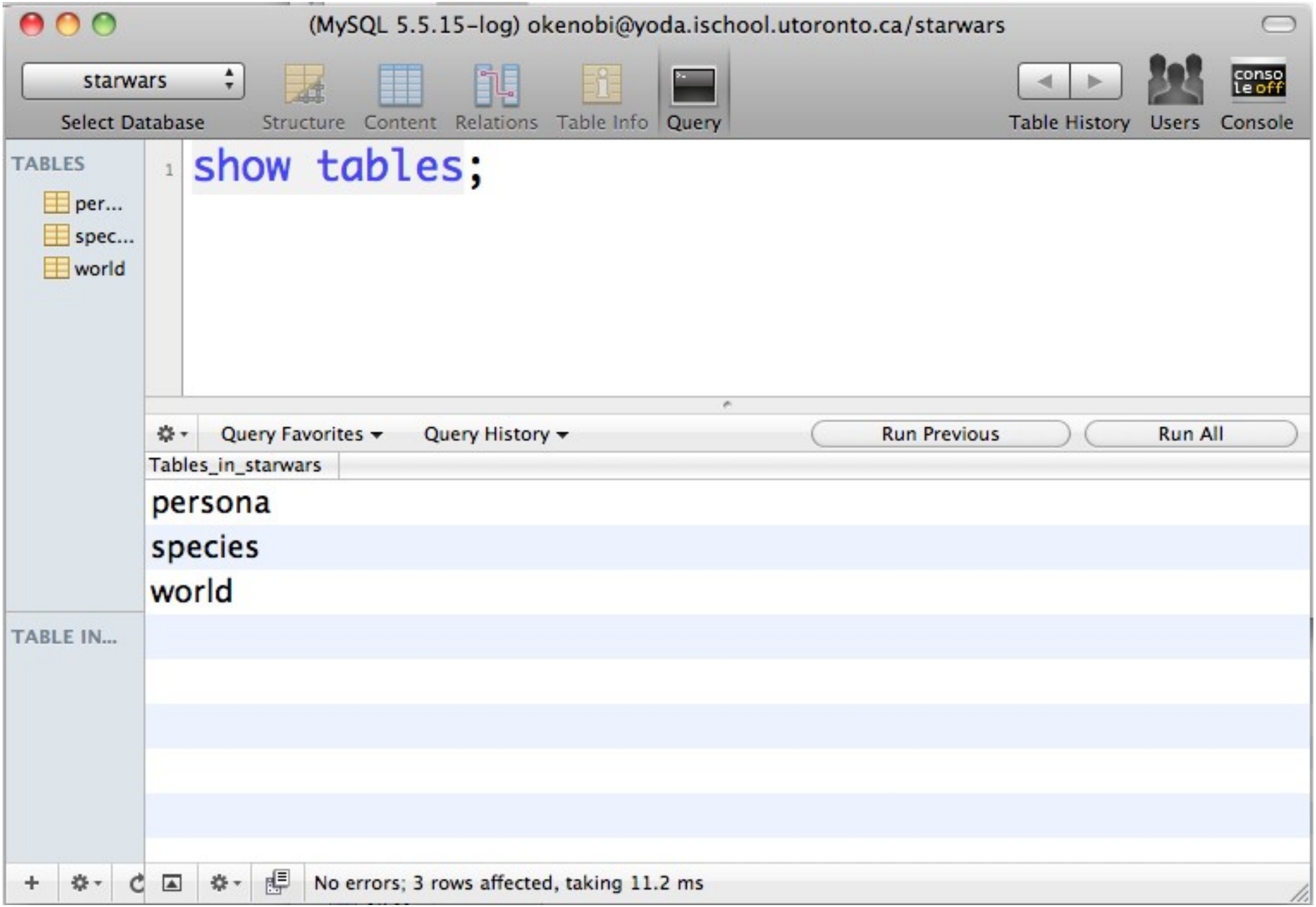
http://www.sequelpro.com/
(also available in this lab)

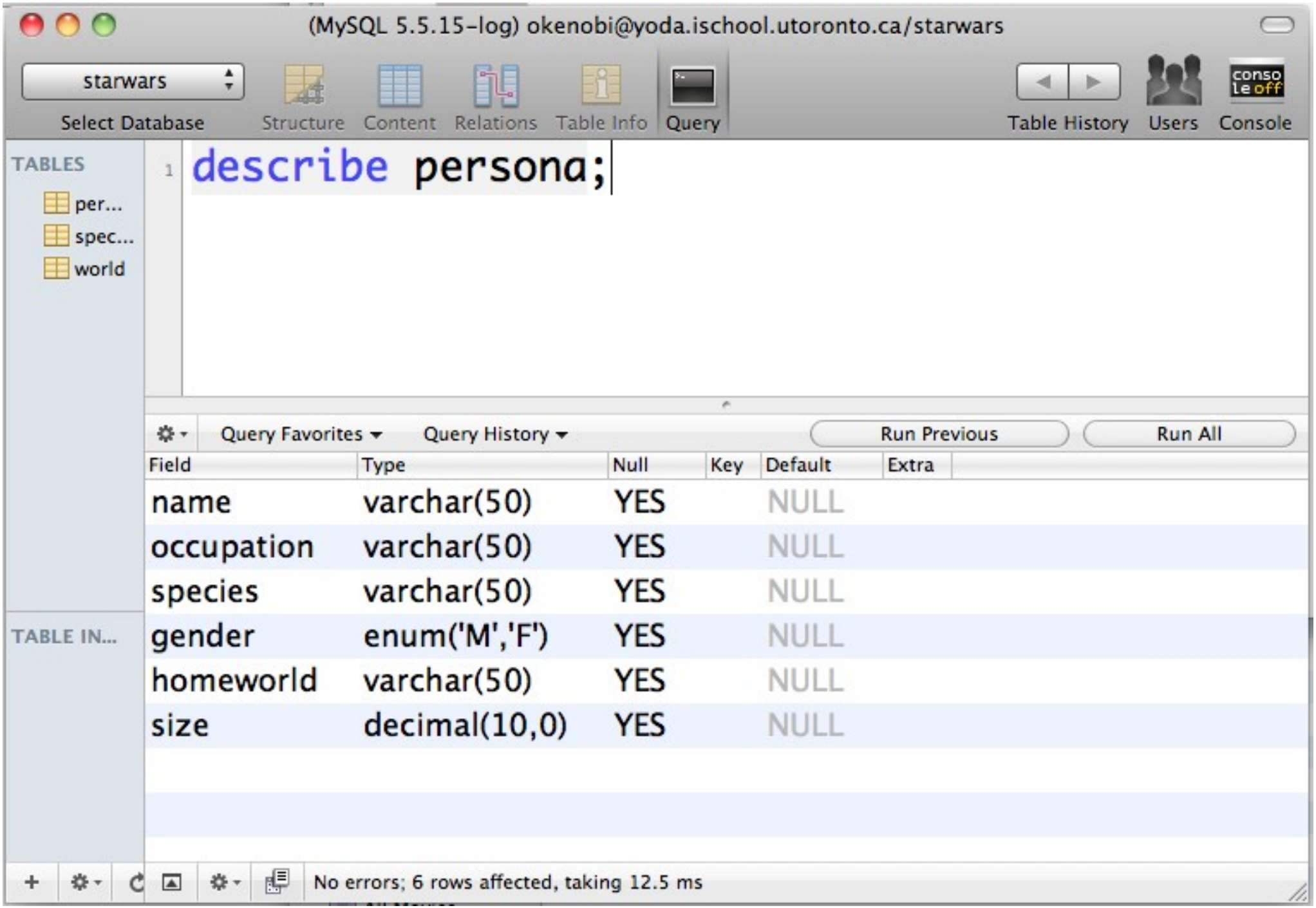

Sequel Pro
Choose Database...
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
FAVOR...
Enter connection details below, or choose a favorite
Standard
Socket
SSH
Name:
optional
Host:
yoda.ischool.utoronto.ca
Username:
okenobi
Password:
Database:
optional
Port:
3306
Connect using SSL
Add to Favorites
Connect
File > New Connection Window

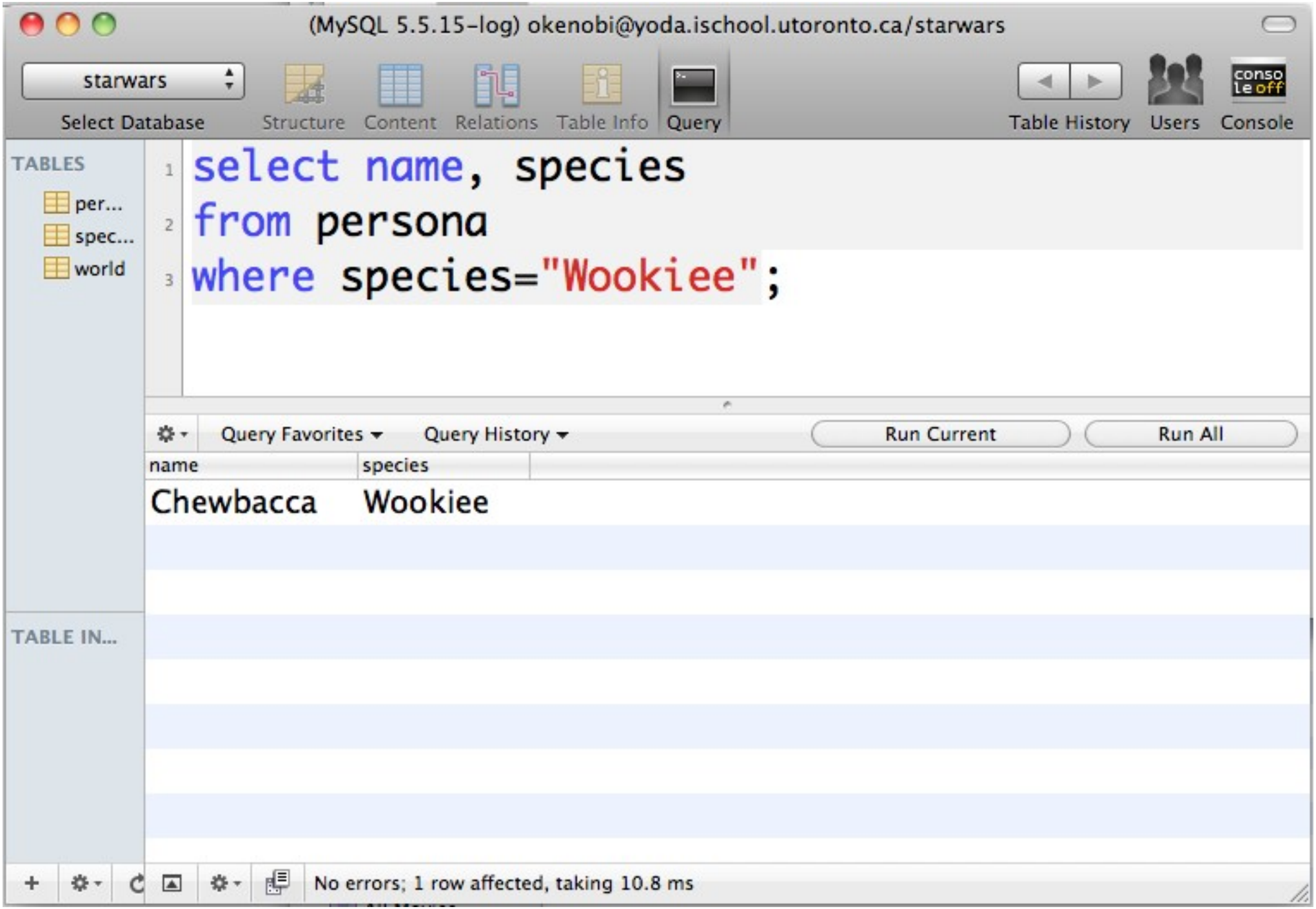

(MySQL 5.5.15-log) okenobi@yoda.ischool.utoronto.ca
Choose Database...
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
TABLES
1
show databases;
Query Favorites
Query History
Run Previous
Run All
TABLE IN...


(MySQL 5.5.15-log) okenobi@yoda.ischool.utoronto.ca
Choose Database...
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
TABLES
1
show databases;
Query Favorites
Query History
Run Previous
Run All
Database
information_schema
diveshop
menagerie
TABLE IN...
okenobi
starwars
test
No errors; 6 rows affected, taking 10.0 ms


(MySQL 5.5.15-log) okenobi@yoda.ischool.utoronto.ca/starwars
starwars
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
TABLES
per...
spec...
world
1 use starwars;
Query Favorites
Query History
Run Previous
Run All
TABLE IN...
No errors; 0 rows affected, taking 83.0 ms


(MySQL 5.5.15-log) okenobi@yoda.ischool.utoronto.ca/starwars
starwars
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
TABLES
per...
spec...
world
1
show tables;
Query Favorites
Query History
Run Previous
Run All
Tables_in_starwars
persona
species
world
TABLE IN...
No errors; 3 rows affected, taking 11.2 ms


(MySQL 5.5.15-log) okenobi@yoda.ischool.utoronto.ca/starwars
starwars
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
TABLES
per...
spec...
world
1 describe persona;
Query Favorites
Query History
Run Previous
Run All
Field Type Null Key Default Extra
name varchar(50) YES NULL
occupation varchar(50) YES NULL
species varchar(50) YES NULL
gender enum('M','F') YES NULL
homeworld varchar(50) YES NULL
size decimal(10,0) YES NULL
TABLE IN...
No errors; 6 rows affected, taking 12.5 ms


(MySQL 5.5.15-log) okenobi@yoda.ischool.utoronto.ca/starwars
starwars
Select Database
Structure
Content
Relations
Table Info
Query
Table History
Users
Console
TABLES
per...
spec...
world
1 select name, species
2 from persona
3 where species="Wookiee";
Query Favorites
Query History
Run Current
Run All
name
species
Chewbacca
Wookiee
TABLE IN...
No errors; 1 row affected, taking 10.8 ms

An SQL Statement

```
select name, occupation
from persona
where species="Wookiee";
```

- SQL keywords are not case-sensitive (de facto)
- text strings usually are are
- names or tables and fields usually are

An SQL Statement

so:

select = SELECT* = seLecT**

from = FROM* = From**

* some people prefer this

** ugly, don't do this

but:

persona != PERSONA != Persona

"Wookiee" != "wookiee"

Quotes

Text strings

must always be quoted

Names

can be, sometimes must be

Quote Types

“, ”, and "

" must be closed by ", ' by '

The Semi-Colon

Don’t forget the semi-colon;

A Terminal App / Bash

OSX:

"Terminal" (pre-installed)

Linux:

"gnome-terminal" (pre-installed)

Windows:

"git-bash" from Git

http://code.google.com/p/msysgit/

(you can use PuTTY if you prefer)

Local v Remote

Local:

Your laptop / desktop

Remote:

Another computer you are using (via your "local" machine)

Hint: Check the name in the prompt, e.g.: yuri@**chai**:~$

SSH

ssh **okenobi**@yoda.ischool.utoronto.ca

- your password is your student ID
- you will need to change your password

You will need to re-enter your **original** password before entering the new one. That is, the sequence is:

original, original again, new, new again.

MySQL

mysql
connect to mysql
mysql -u *username* -p
connect to mysql as a *okenobi*, with a password

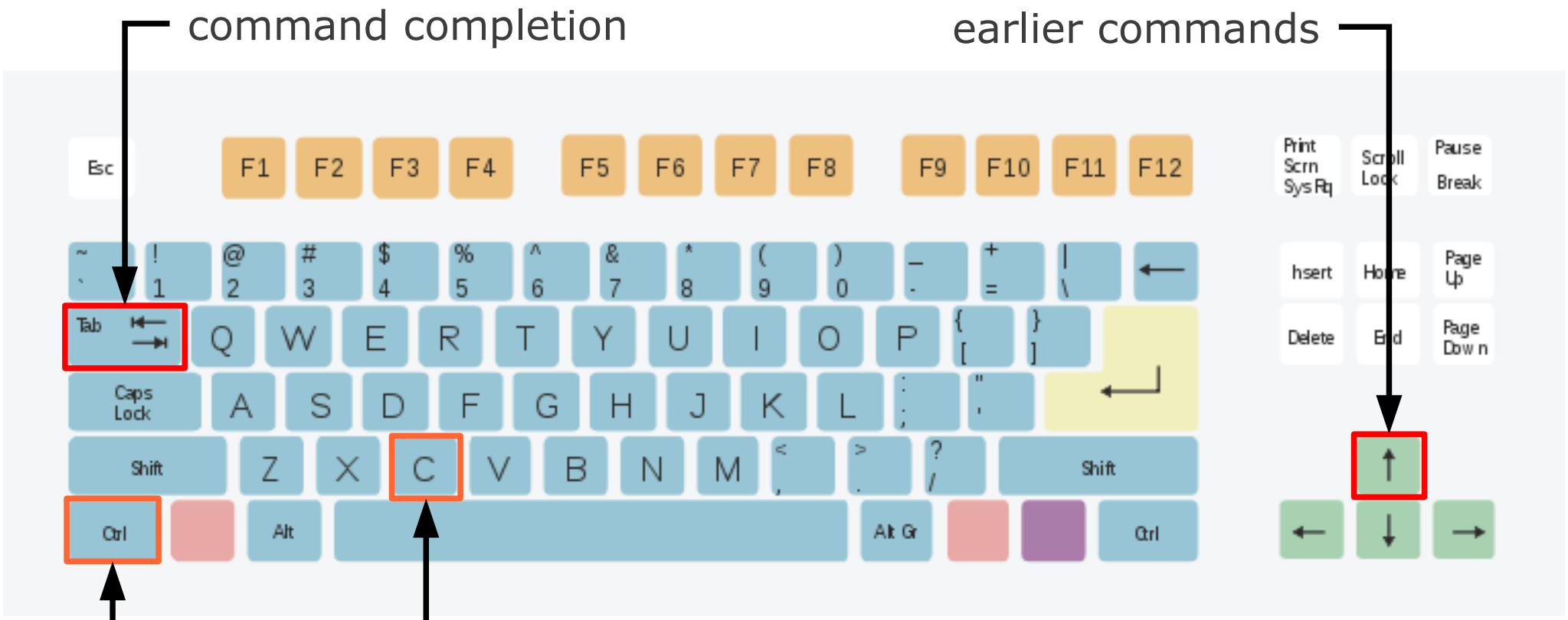
MySQL Prompt

mysql>

do not confuse with the bash prompt!

Hint: type “exit” or ^C to exit.

Important Keys



"Ctrl+C" is usually represented as "^C"

image source:http://upload.wikimedia.org/wikipedia/commons/thumb/3/3a/Qwerty.svg/1000px-Qwerty.svg.png

SQL via SSH

```
mysql> use starwars;
Database changed
mysql> select name, occupation from
persona where species="Wookiee";

+------------+-------------+
| name       | occupation  |
+------------+-------------+
| Chewbacca  | co-pilot    |
+------------+-------------+
1 row in set (0.00 sec)
```

This Course

http://takhteyev.org/courses/11F/cct395/

Contact Information

Office hours:

- Wed, 5-6 pm, Rm. 3008

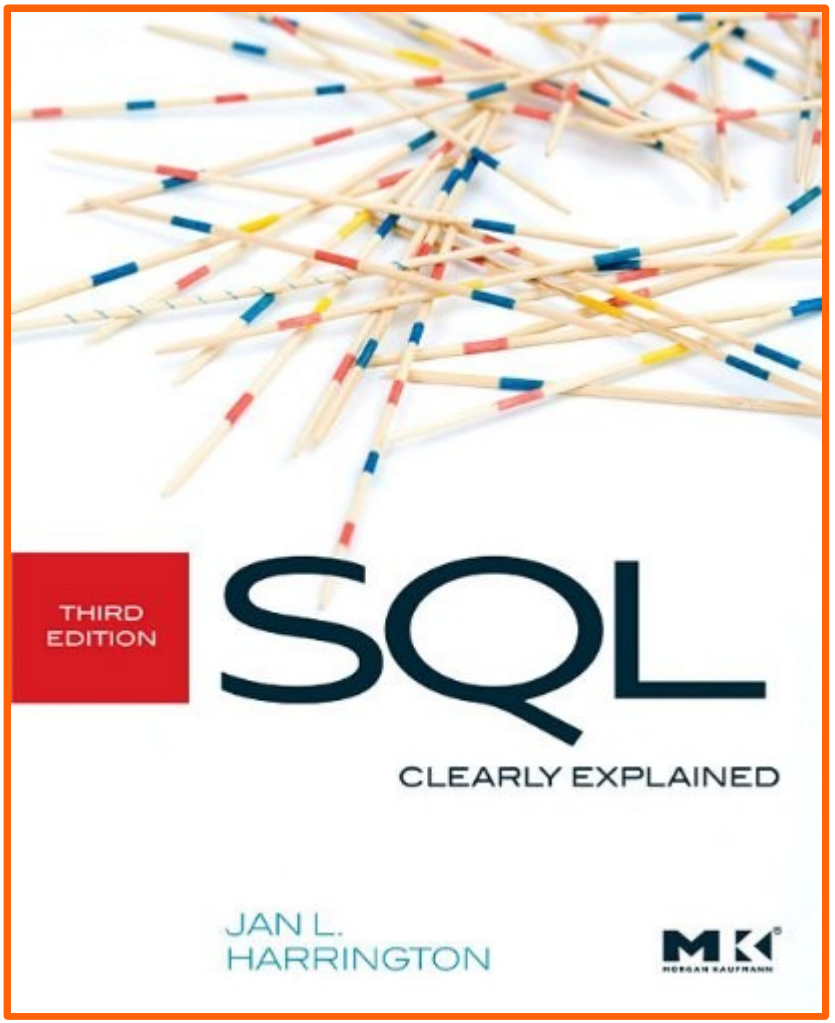
Email:

- use the Q&A system if possible
- if emailing, use UToronto mail
- put “CCT395” in the subject line
- expect 2 day turn-around

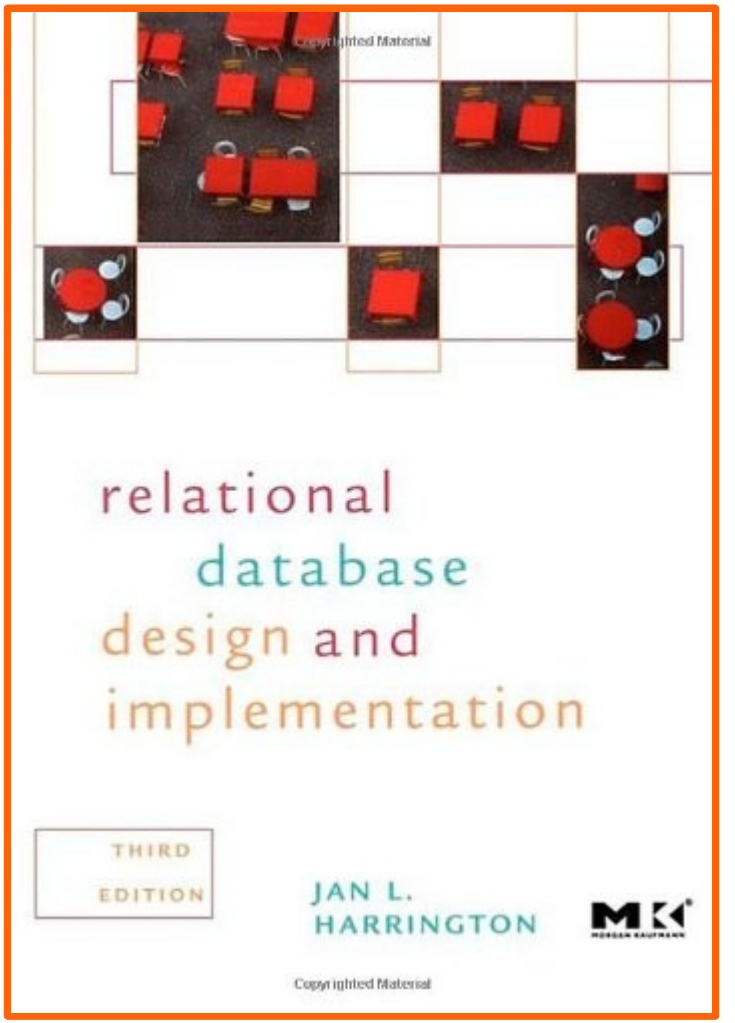
The Q&A System

http://cct395.ischool.utoronto.ca/

- use for all non-private questions
- feel free to **answer** too!


THIRD
EDITION
SQL
CLEARLY EXPLAINED
JAN L.
HARRINGTON

"SQL"


relational
database
design and
implementation
THIRD
EDITION
JAN L.
HARRINGTON
Copyrighted Material

"RDD"

The Course Outline

Relational Algebra

persona

name	occupation	species
Obi-Wan Kenobi	Jedi Master	Human
Yoda	Jedi Master	NULL
Jabba	crime lord	Hutt
Chewbacca	co-pilot	Wookiee
Luke Skywalker	Jedi Knight	Human
Padmé Amidala	queen	Human

Projection

persona

name	occupation	species
Obi-Wan Kenobi	Jedi Master	Human
Yoda	Jedi Master	NULL
Jabba	crime lord	Hutt
Chewbacca	co-pilot	Wookiee
Luke Skywalker	Jedi Knight	Human
Padmé Amidala	queen	Human

Projection

persona

name	species
Obi-Wan Kenobi	Human
Yoda	NULL
Jabba	Hutt
Chewbacca	Wookiee
Luke Skywalker	Human
Padmé Amidala	Human

Selection

persona

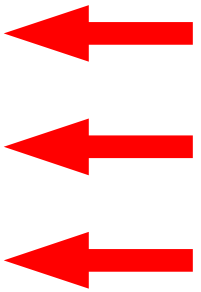
name	occupation	species
Obi-Wan Kenobi	Jedi Master	Human
Yoda	Jedi Master	NULL
Jabba	crime lord	Hutt
Chewbacca	co-pilot	Wookiee
Luke Skywalker	Jedi Knight	Human
Padmé Amidala	queen	Human

(“Restriction” in Harrington)

Selection

persona

name	occupation	species
Obi-Wan Kenobi	Jedi Master	Human
Luke Skywalker	Jedi Knight	Human
Padmé Amidala	queen	Human



(“Restriction” in Harrington)

Columns vs Rows

Projection:

choosing columns (fields)
by name

Selection:

choosing rows with a condition

Basic SELECT

```
   select
3. «list of fields»
1. from «source table»
2. where «conditions»;
```

selection followed by projection

Skipping Projection

```
select
*
from «table»
where «condition»;
```

For instance:

```
select *
from persona
where species="Human";
```

Skipping Selection

```
select
*
from «table»;
```

For instance:

```
select *
from persona;
```

LIMIT

```
select ... from ... limit «N»;
```

For instance:

```
select name from persona
limit 5;
```

Sorting the Results

```
select ... from ... where ...
order by «expression»;
```

For instance:

```
select name from persona
order by size;
```

Questions?