

CCT396, Fall 2011

# Database Design and Implementation

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# What is a “Database”?

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

↑  
“DBMS”



Alice



information



Bob



Alice



information



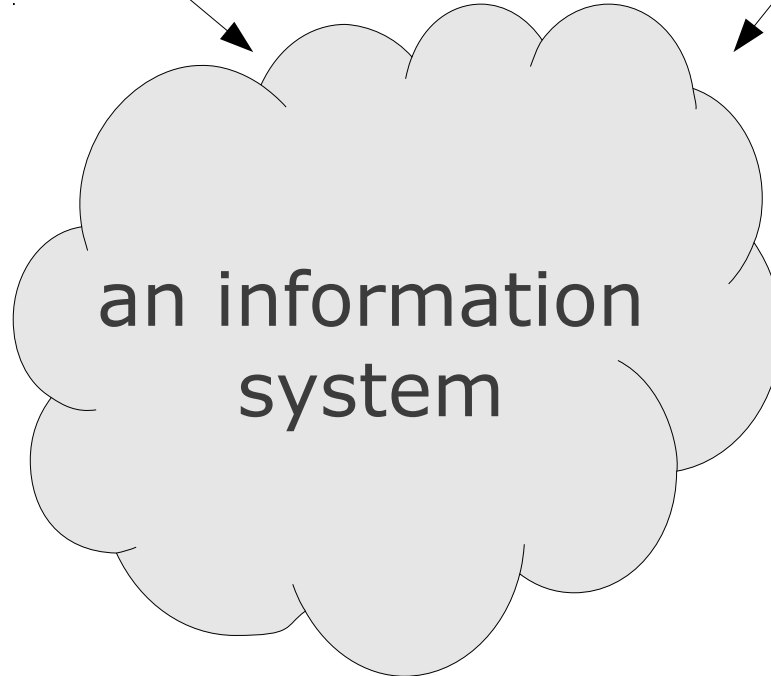
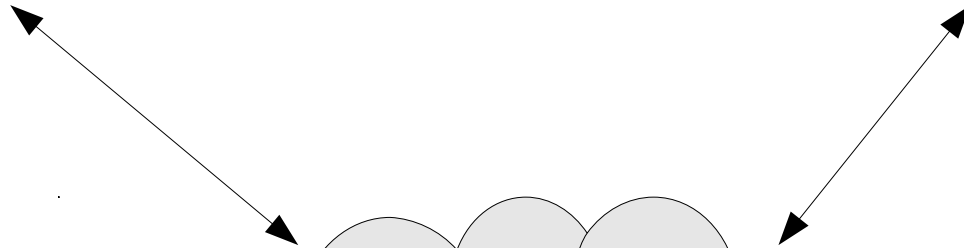
Bob



Alice



Bob

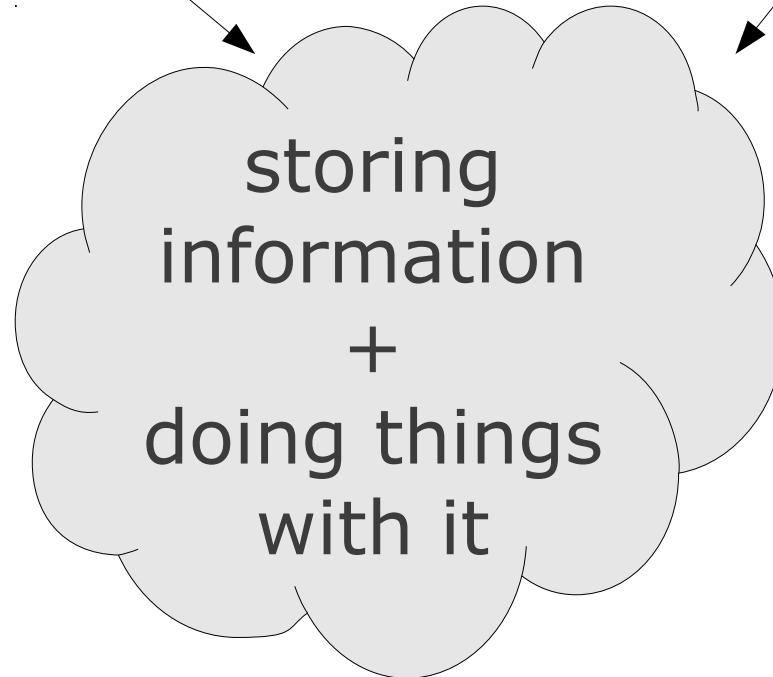
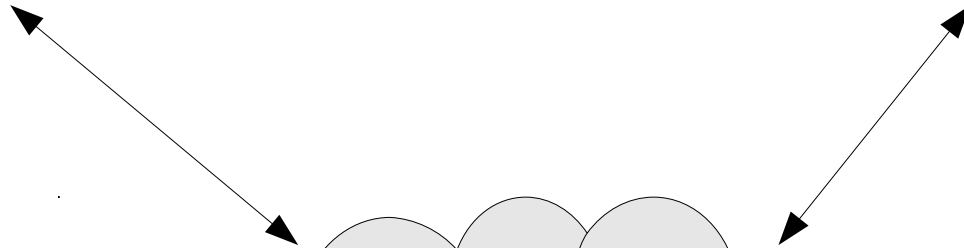




Alice

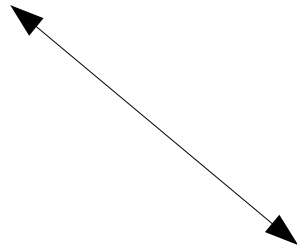


Bob

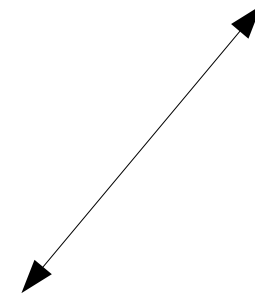




Alice



Bob

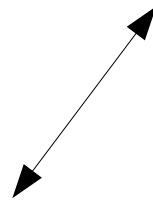


application software



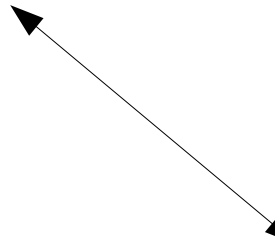
database

"persistent storage"

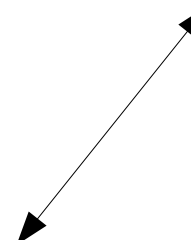




Alice

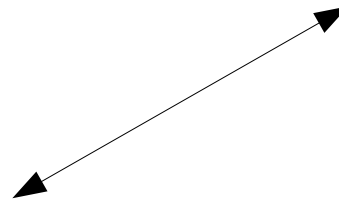


Bob



database

"persistent storage"





# What is Data?

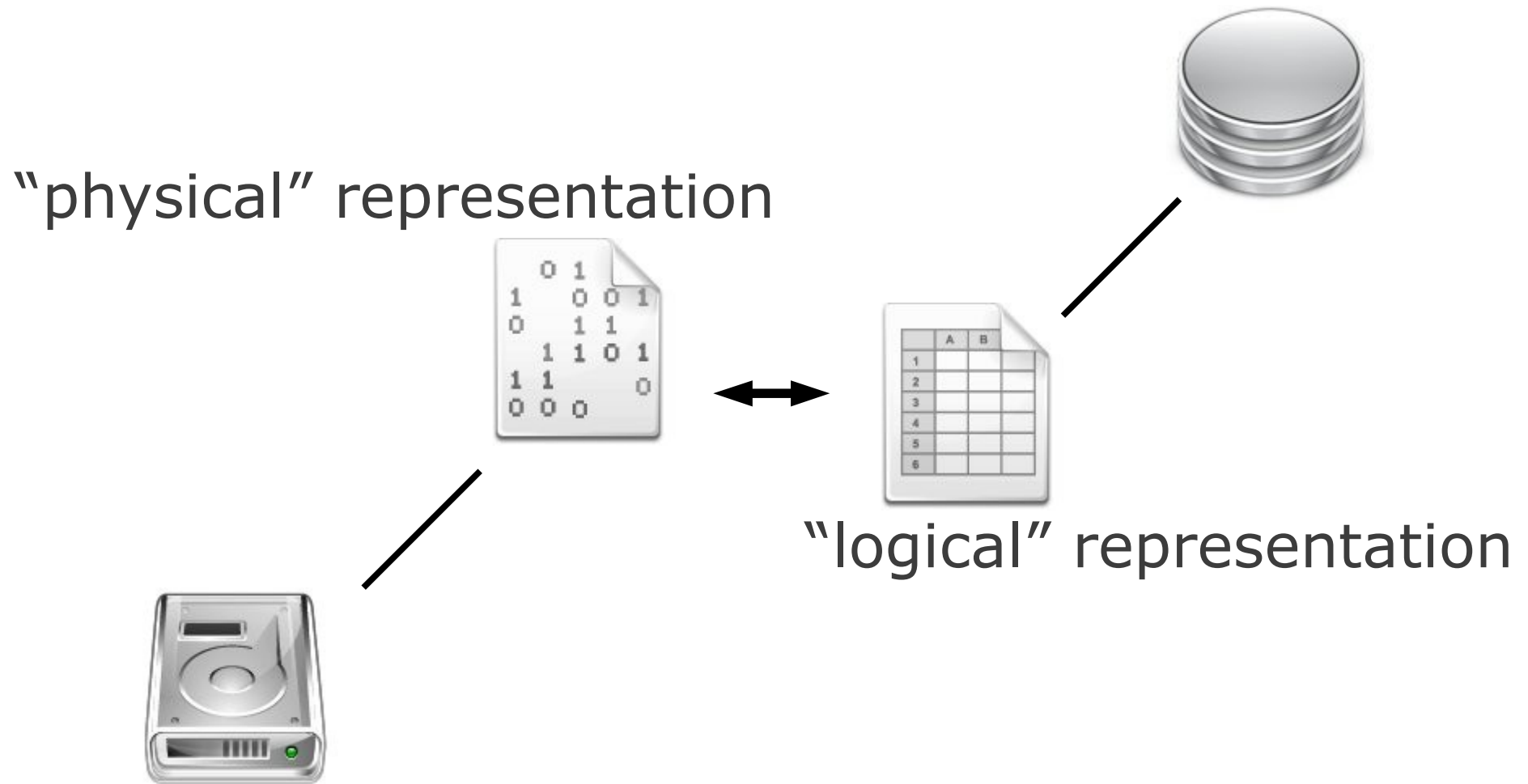
Knowledge

Information

Data



# Database Elements



# Basic Data Types

## Numbers

42, 2.7,  $7.2 \times 10^{-19}$ , 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)

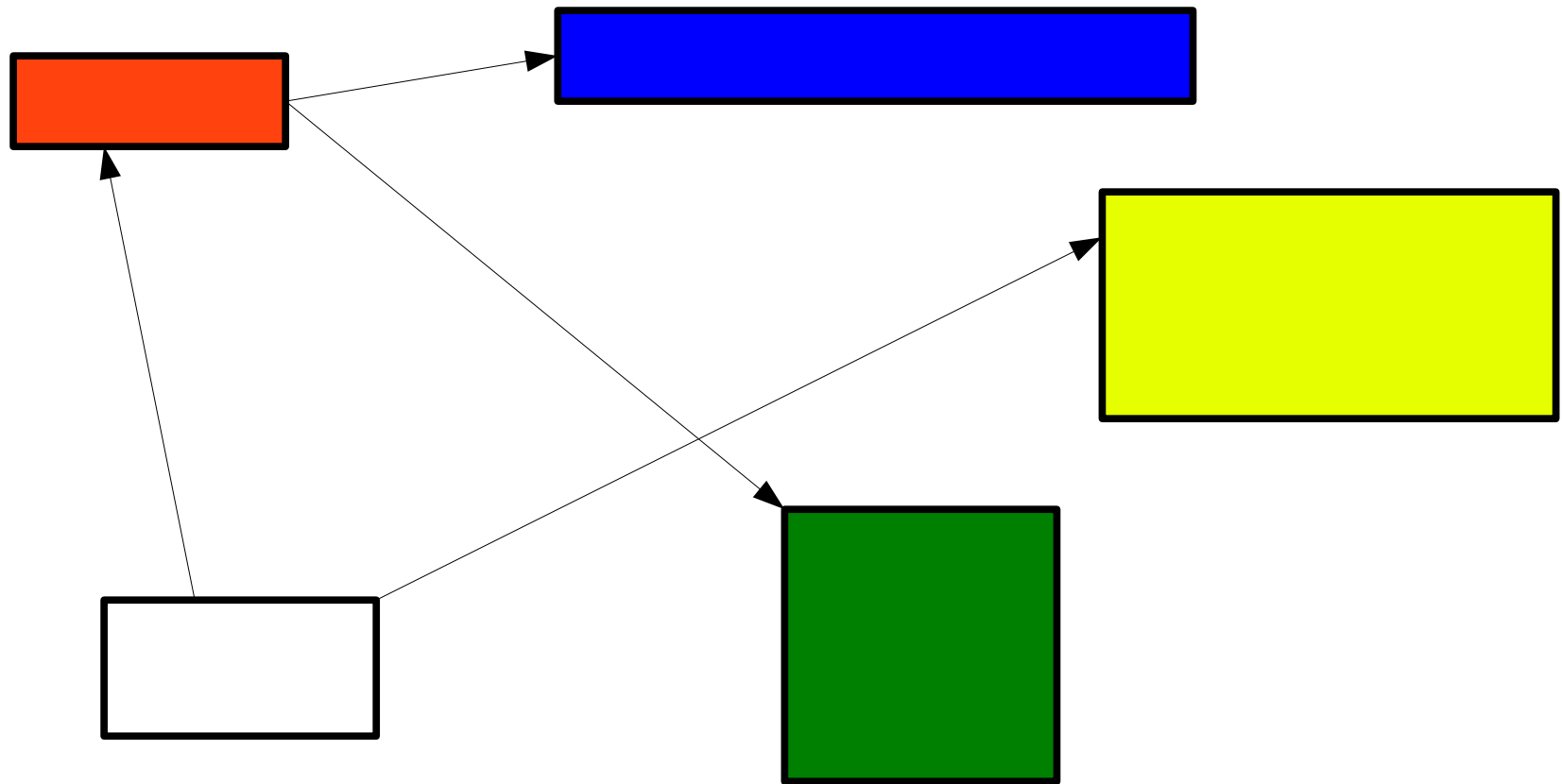
## **Binary “Blobs”**

contents of an image file

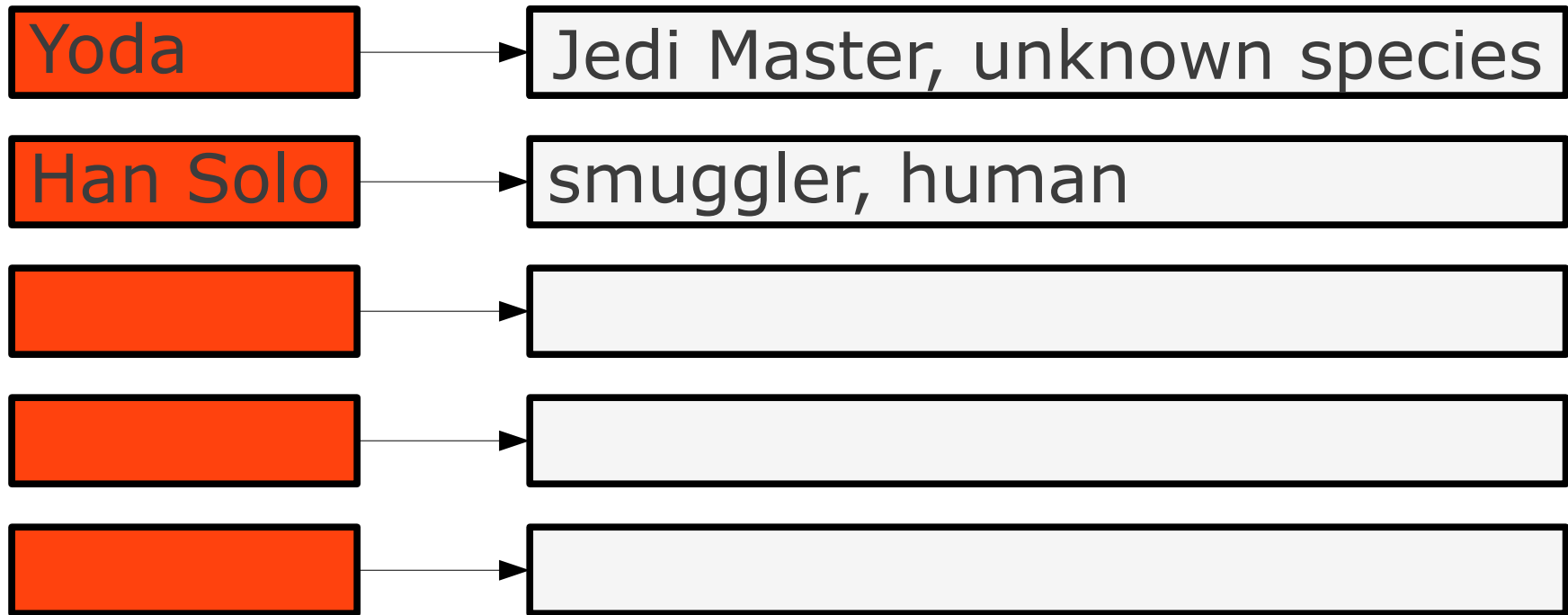
## **Geometric**

a line, a polygon

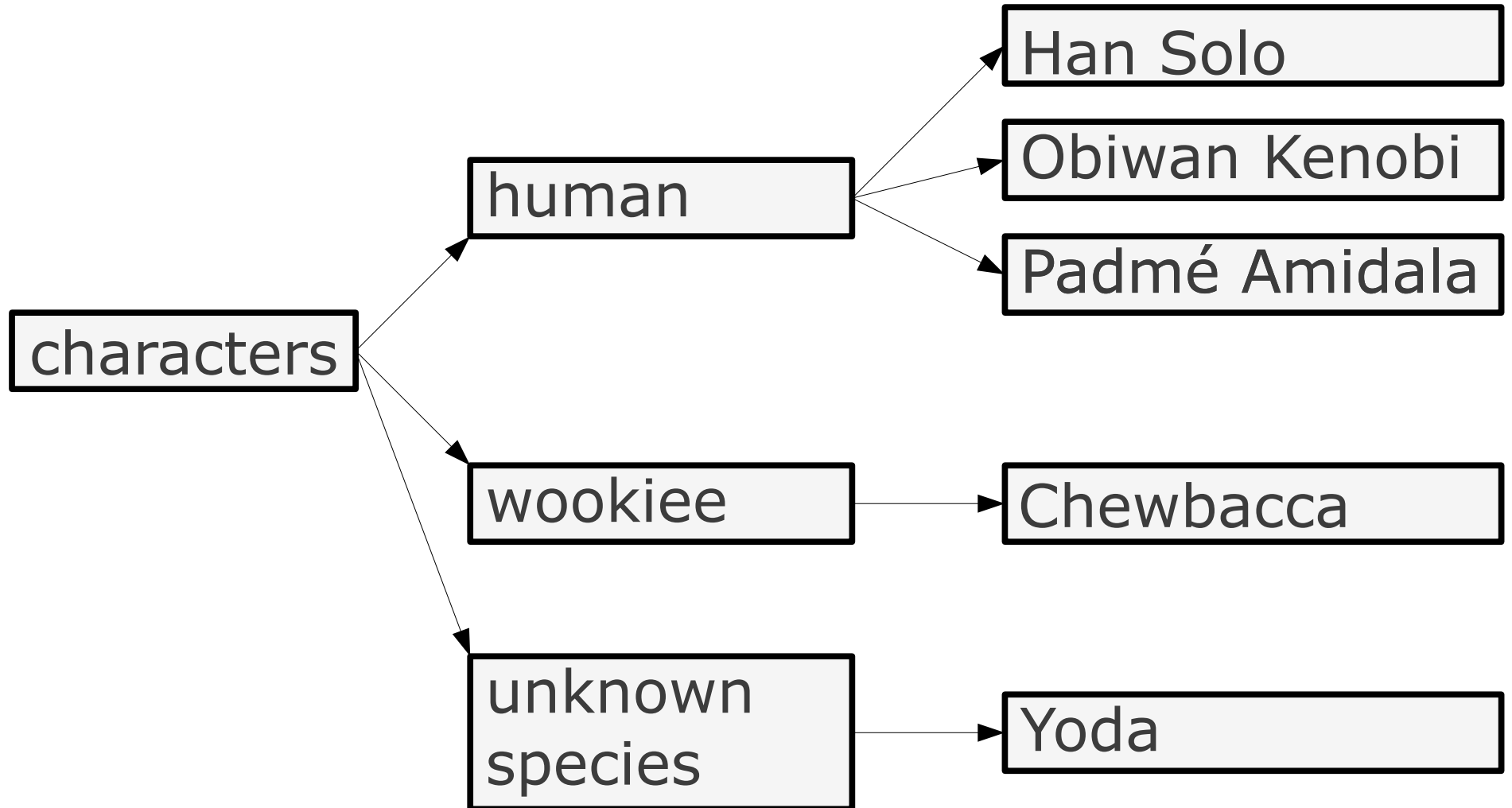
# Databases Models



# Key-Value

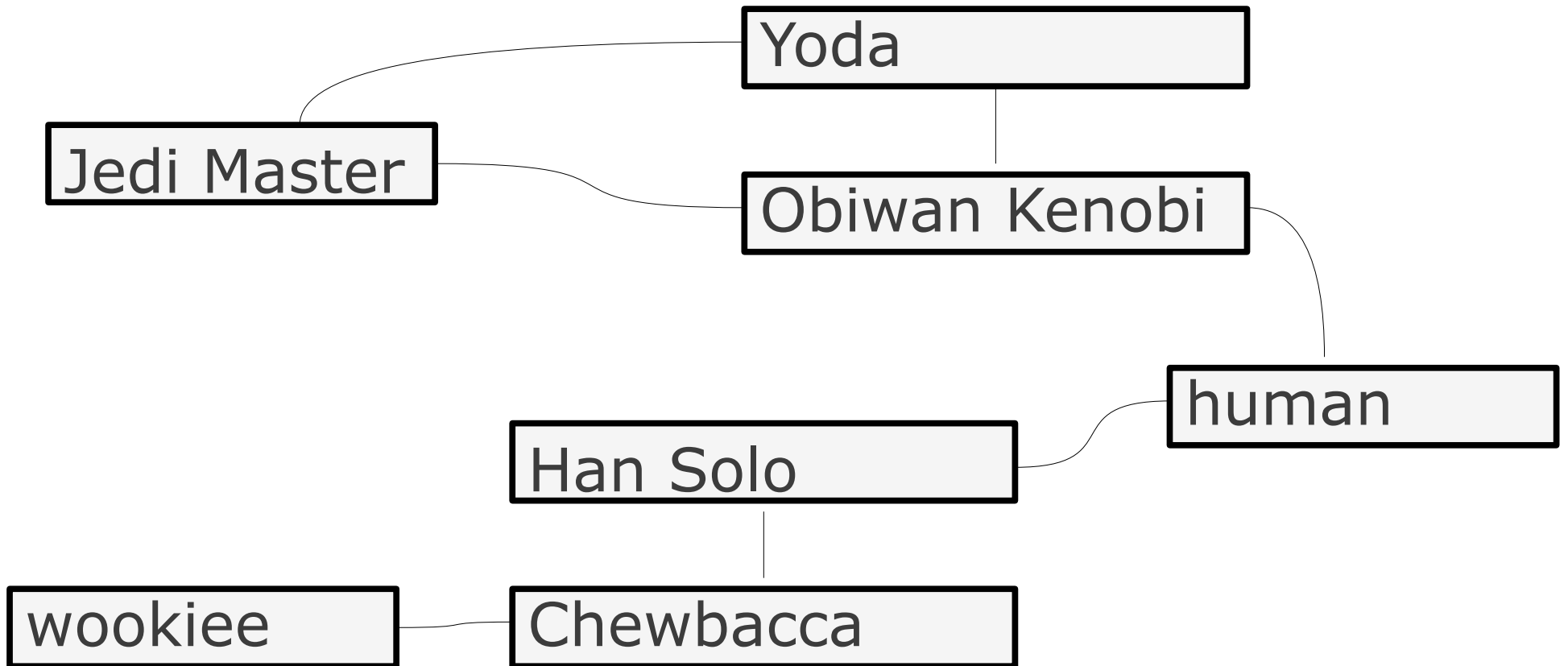


# Hierarchical





# Network



# 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

species

Human	humanoid	1.7
Hutt	gastropod	3.5

persona

Jabba	Hutt
Obiwan Kenobi	Human

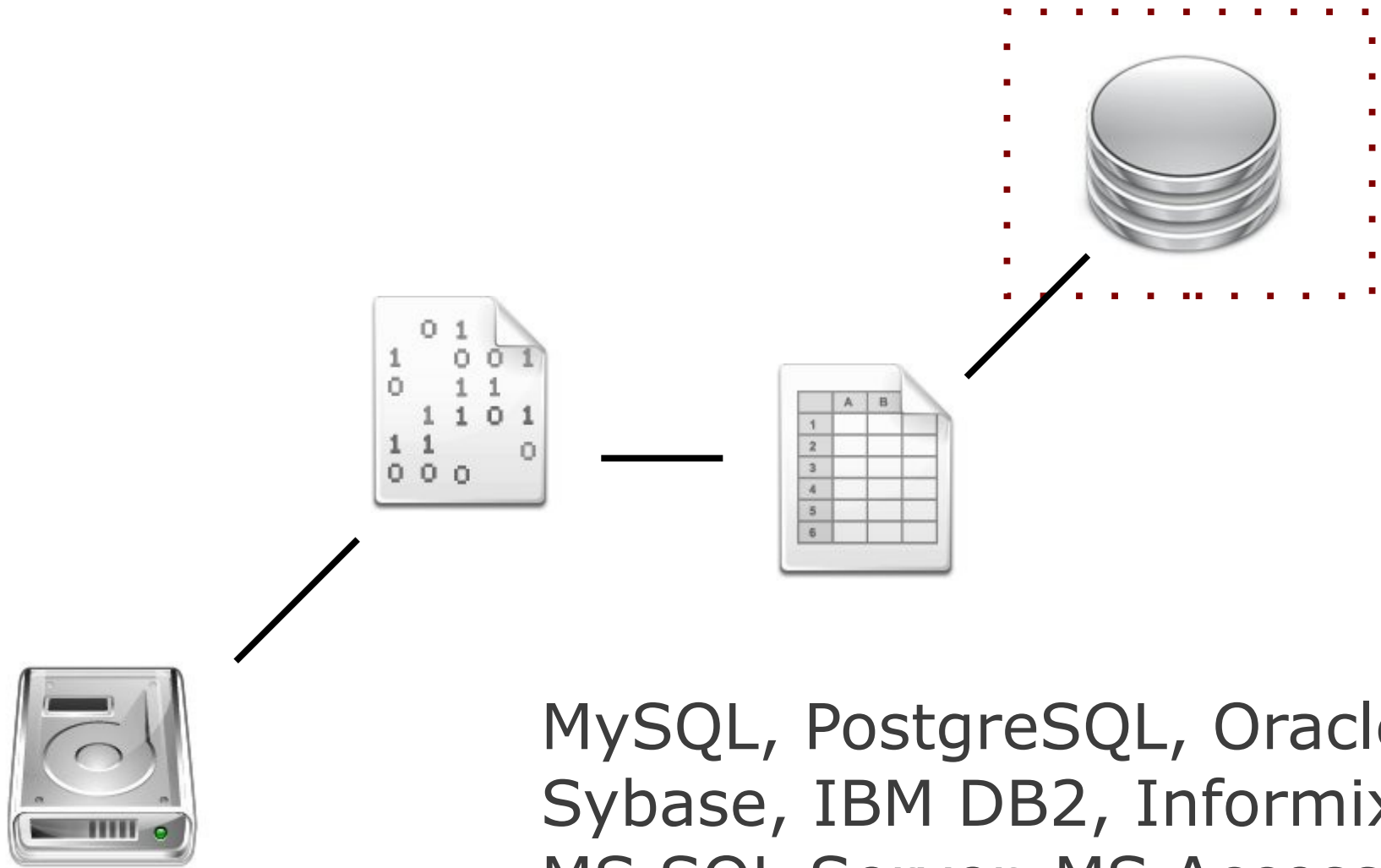
species\_type

gastropod	0
humanoid	2

# Relational Data Modeling

Finding a proper relational  
representation for data

# RDBMS



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

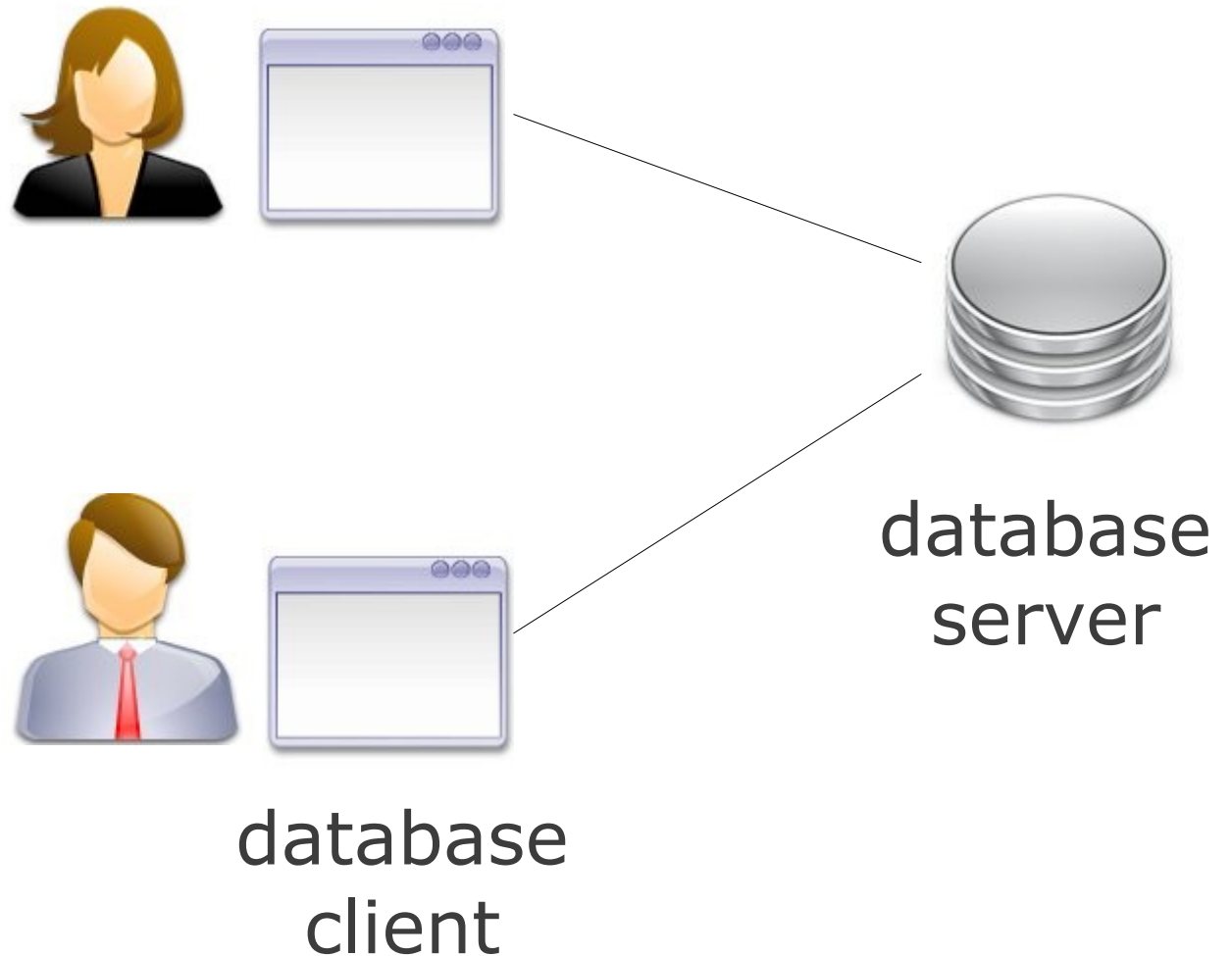
# Accessing a Database



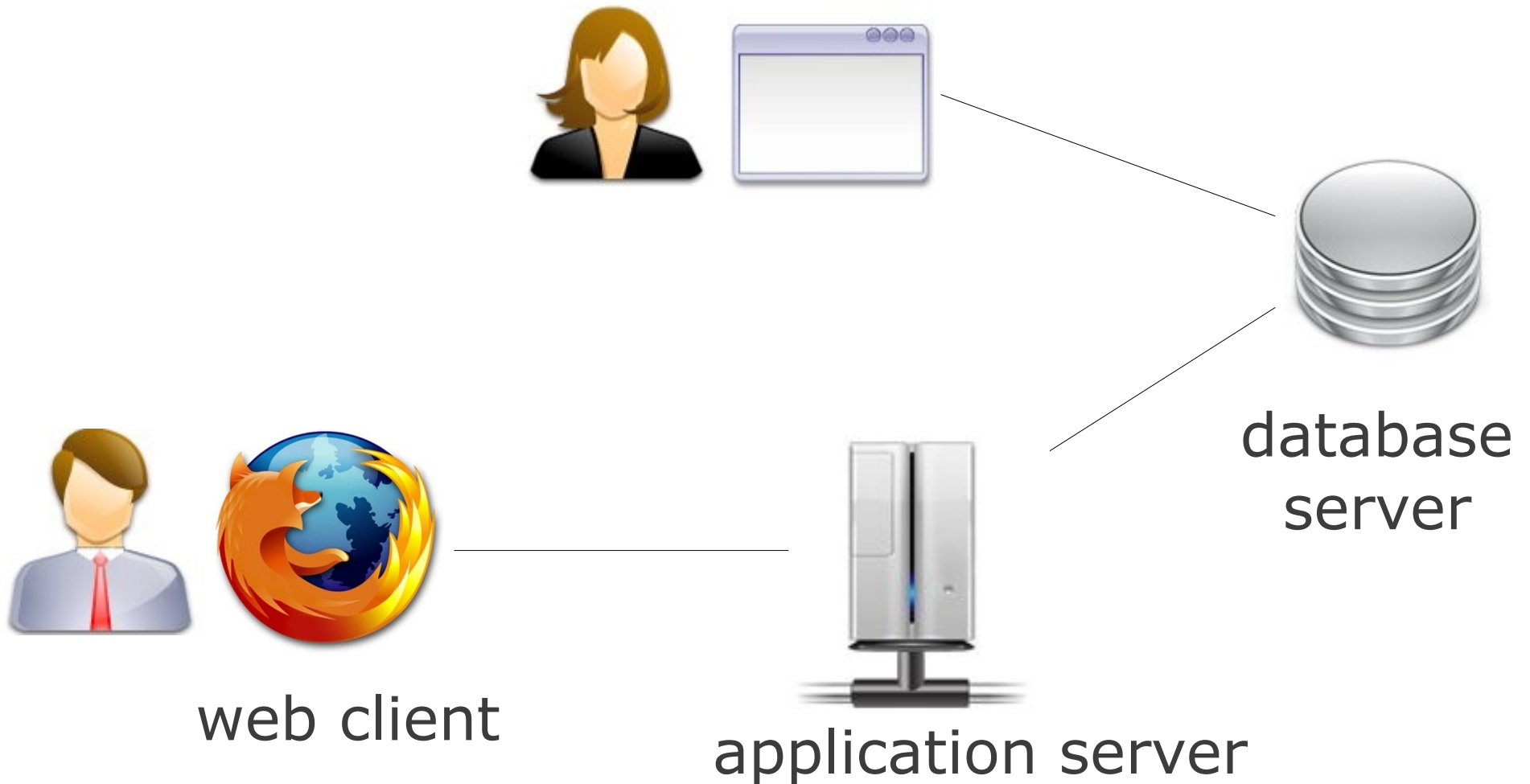
# Built-in GUI



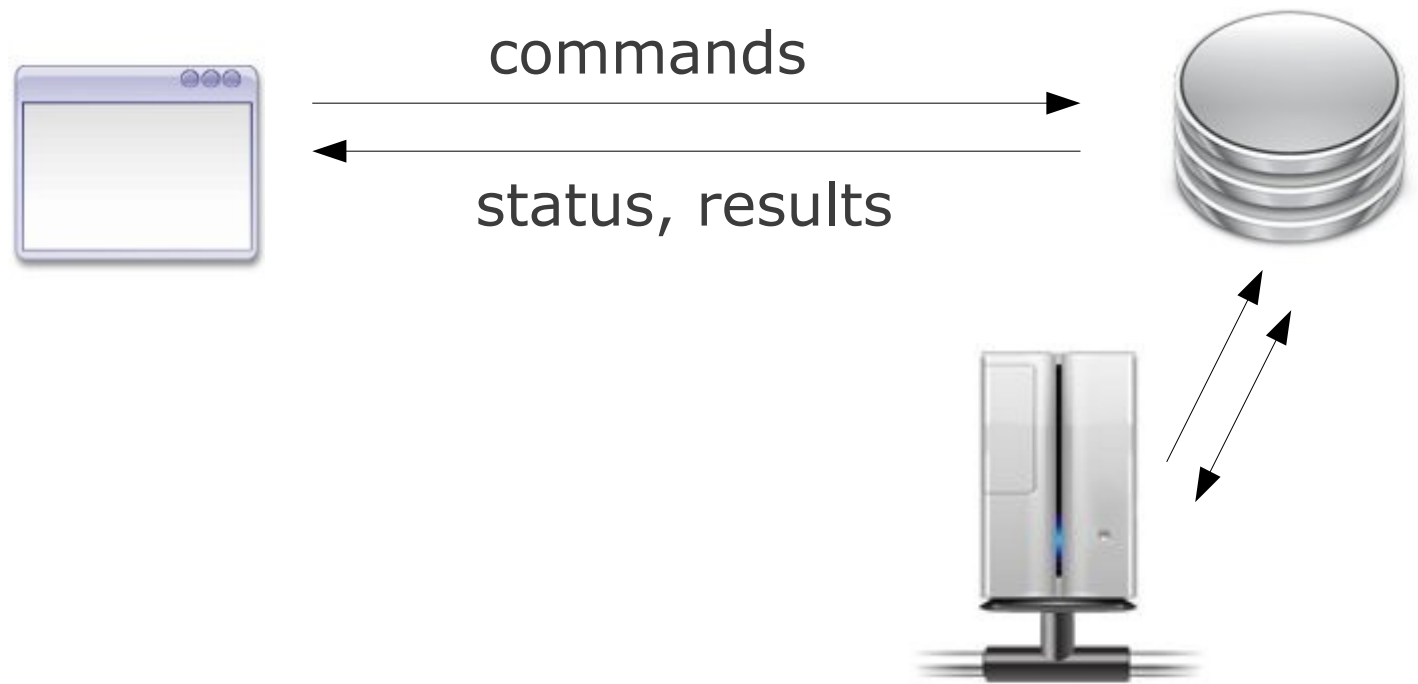
# Networked Client



# A 3-Tier System



# A Query Language





# Structured Query Language

(Some people say “Sequel”)

# An SQL Statement

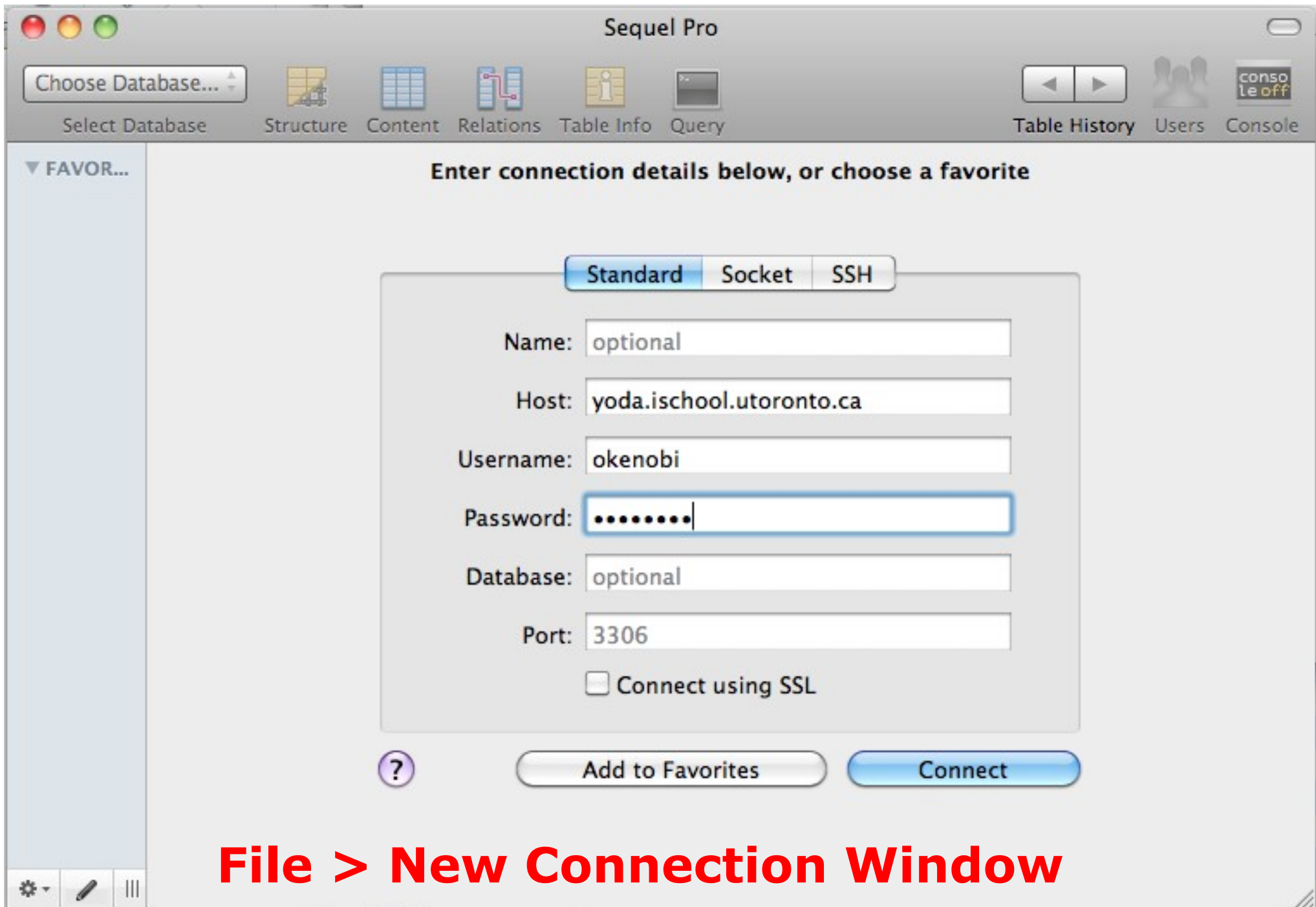
```
select name, occupation  
from persona  
where species="Wookiee";
```

# An SQL Statement

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

# Sequel Pro

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



**File > New Connection Window**

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...



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

okenobi

starwars

test

TABLE IN...



No errors; 6 rows affected, taking 10.0 ms

starwars

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...



starwars

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

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

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...

# An SQL Statement

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

- SQL keywords are not case-sensitive (de facto)
- text strings usually 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>**

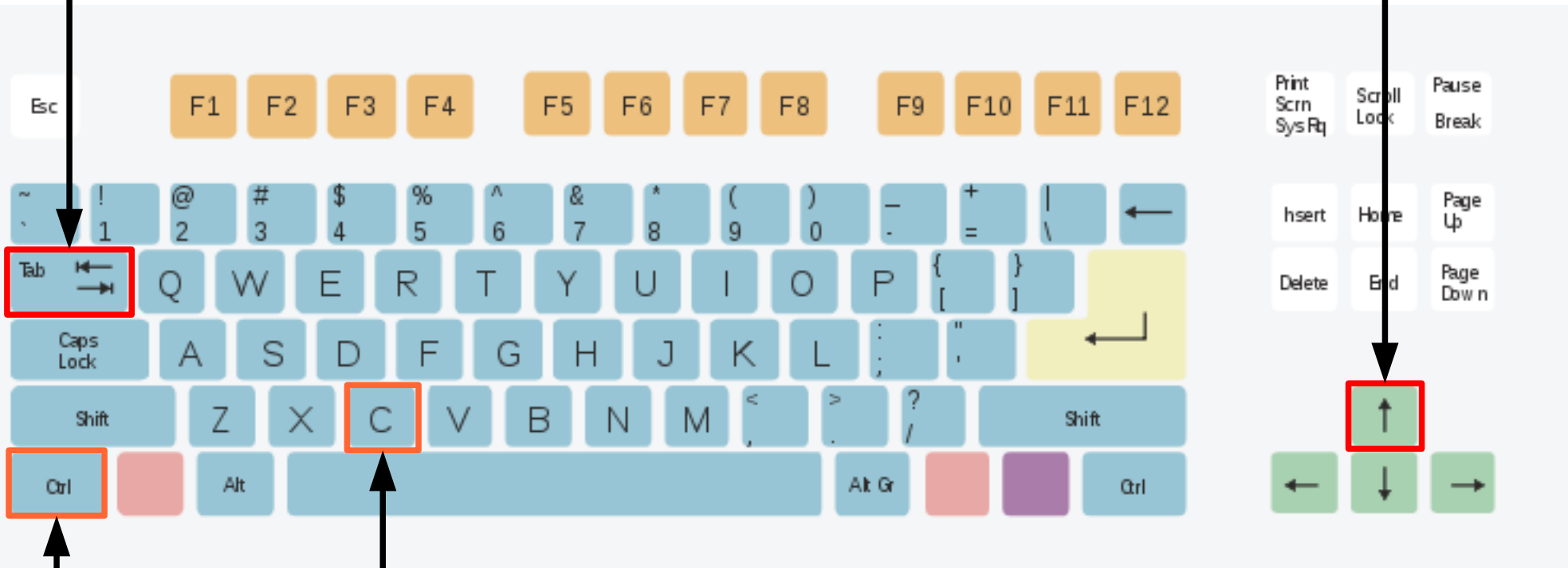
do not confuse with the bash prompt!

Hint: type "exit" or ^C to exit.

# Important Keys

command completion

earlier commands



quit

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

# 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:**

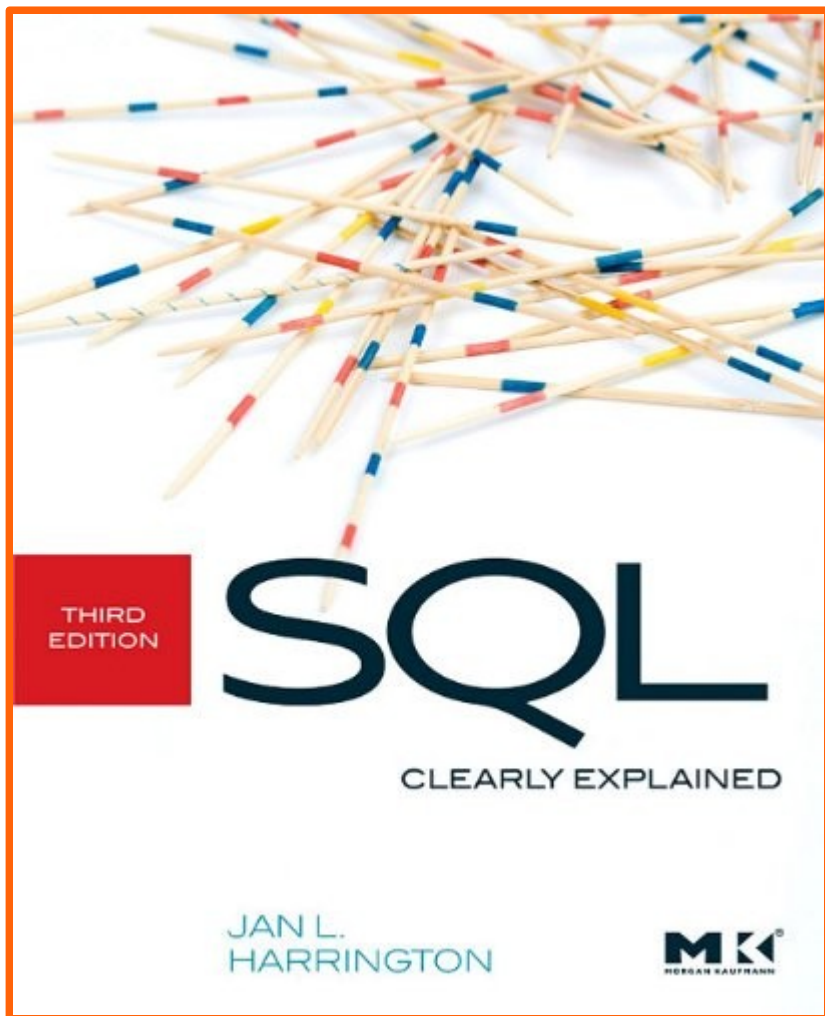
- use the Q&A system if possible
- if emailing, use UToronto mail
- put "CCT395" in the subject line
- expect 2 day turn-around



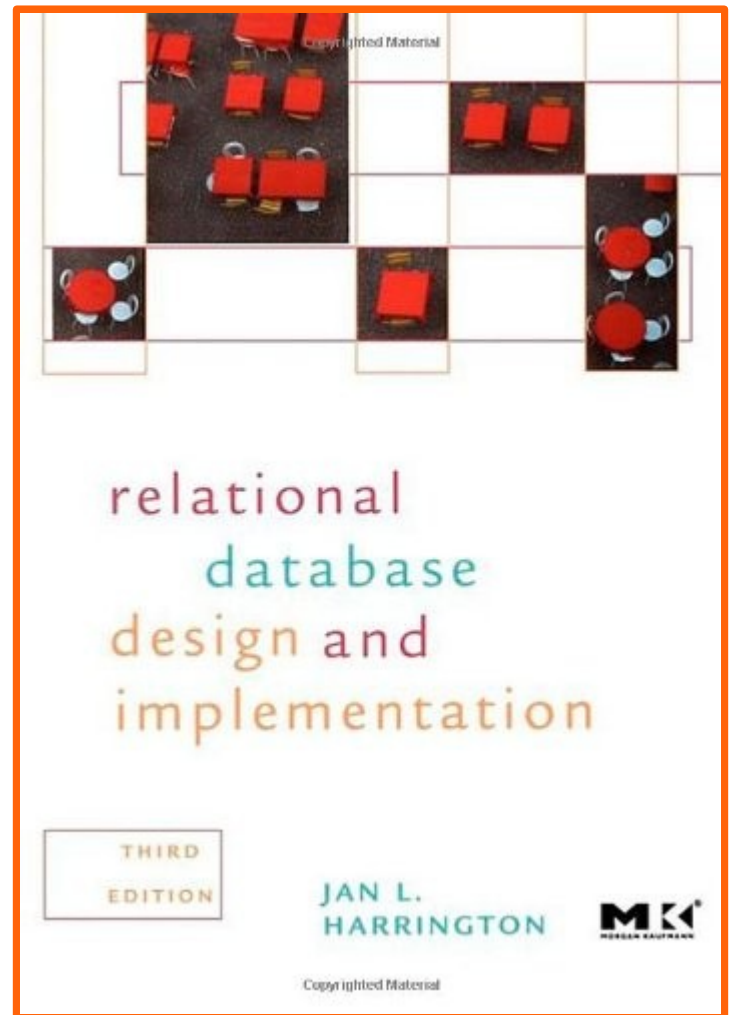
# The Q&A System

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

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



“SQL”



“RDD”

# The Course Outline

# Relational Algebra

persona

<b>name</b>	<b>occupation</b>	<b>species</b>
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

<b>name</b>	<b>occupation</b>	<b>species</b>
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

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



# Selection

persona

<b>name</b>	<b>occupation</b>	<b>species</b>
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

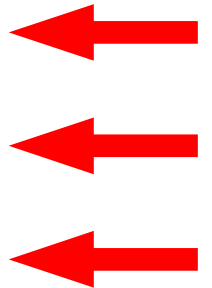


(“Restriction” in Harrington)

# Selection

persona

<b>name</b>	<b>occupation</b>	<b>species</b>
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?