More Data Sources

Getting Data into your App

Admin

- Grads?
- UGrads – must be time for quizzes again

Data

- **Where can we get the data from?**
  - Thank-you my wonderful crew of volunteers
  -

Data

- **Where can we get the data from?**
  - Thank-you my wonderful crew of volunteers
  - Hopefully your found all of them
    - Maybe files
    - Maybe the network (API calls like we've been doing)
    - And maybe databases (we haven't talked about that yet)

Files?

- **What kind of files do lots of programs get data from?**
  - ?

Files?

- **What kind of files do lots of programs get data from?**
  - Text files we've been using already, but even more common
  - How about excel?
  - Used everywhere in the world – and has lots of data
    - Story of first year honors student from a couple of years ago.

Excel and Go

- **There are several go libraries for processing excel files**
  - excelize
  - go-excel
  - unioffice

Excelize

- **There is a go library that works really well with excel files.**
- **(unknown unknowns to known unknowns)**
- **Gone through different maintainers over the years,**
- **Current:**
  - "github.com/xuri/excelize/v2"
  - https://pkg.go.dev/github.com/xuri/excelize/v2
  - Redirect to : https://github.com/qax-os/excelize
- **Grab the sample excel file from website**

Simple Excel Read

```
package main
import (
	"fmt"
	"github.com/xuri/excelize/v2"
	"log"
)
func main() {
	file, err := excelize.OpenFile("MedianIncome.xlsx")
	if err != nil {
		log.Fatal(err)
	}
	all_rows, err := file.GetRows("h08")
	if err != nil {
		fmt.Println("Error getting Rows", err)
	}
	for _, row := range all_rows {
		//the titles all have one real cell, but the data we want all has many cells, so only do work
		//when there is more than one cell in the row
		if len(row) > 1 {
			fmt.Println(row[0], " \t:\t ", row[1])
		}
	}

}
```

Expand the demo

- **Let’s have a look at the data**
  - And do a brief data analysis.
  - We’ll use "github.com/fatih/color" to make sure we can see the differences

- **Here are a few links to go beyond reading data**
  - Unknown unknowns → known unknowns
- **https://www.kelche.co/blog/go/excel/**
- **https://blog.logrocket.com/building-spreadsheets-go-excelize/**
- **https://xuri.me/excelize/en/base/installation.html**
- **Will you be able to cut and paste into your project?**
  - No – but if you understand it, you will be good.

Databases

- **How many of you have worked with databases?**
  - In Dr. Jung's class (or in some other undergrad class for you grads?)
  - In your jobs?
  - Playing around?

Databases before this class?

- How many of you have worked with databases?
- Based on a lot of my other surveys my guess is going to be that about a quarter of you have seen this already and the rest are pretty new
- So for that quarter bear with me for a moment
- References for my images and further reading:
  - https://medium.com/analytics-vidhya/programming-with-databases-in-python-using-sqlite-4cecbef51ab9
-

Databases in 20 minutes or less

- **So with that**
  - We really need to expose all students to some basic data handling in a required class. (you are only required one programming heavy class in the MS program.)
  - In this slideset I'm going to try to summarize a database course in a week or less.
    - This is not a substitute for a real database class!!!!!
    - That said, if you have questions ask them.
  - Part of what I'm trying to do in this class is to give you a taste of some of the programming bits that every graduate student should have

Database History

- **Historically Databases come in lots of difference types**
  - Hierarchical databases
  - Network databases
  - Relational databases
  - Object-oriented databases
  - Graph databases
  - ER model databases
  - Document databases

- **Realistically, today most people care about 2 of those**
  - Relational Databases (SQL)
  - Document Databases (NoSQL)
  - Note on Pronouncing these:
    - Lots of disucussion:
      - https://www.khanacademy.org/computing/computer-programming/sql/sql-basics/v/s-q-l-or-sequel
      - https://database.guide/is-it-pronounced-s-q-l-or-sequel/
    - sqlServer vs MySQL
    - In general I find Americans more likely to use the old IBM “Sequel” pronunciation and the rest of the world to use S-Q-L
    - I learned SQL from a recent immigrant so I often switch back and forth

Relational Databases

- **Relational Databases**
  - Developed in the early 1970s
  - By 1980’s were all but the only type used
  - (document databases making a big inroad in this dominance in last decade)

Relational Databases in a nutshell

- **Database is made up of Tables**
  - Tables consist of rows and columns such that:
    - There is no significance to the order of the columns or rows.
    - Each row contains one and only one value for each column.
    - Each value for a given column has the same type.
      - Caveat: blob field equivalent of void* in most DBMS
    - Each table in the database should hold information about one specific thing, such as employees, products, or customers.
    - Each row should hold a unique value
      - At least one column value (or combo) for each row should be unique

emp_ID	emp_first_name	emp_last_name	emp_phone
10057	Barbara	Ku	1096
10693	Jessica	Anne	7821

RDMS: Primary Key

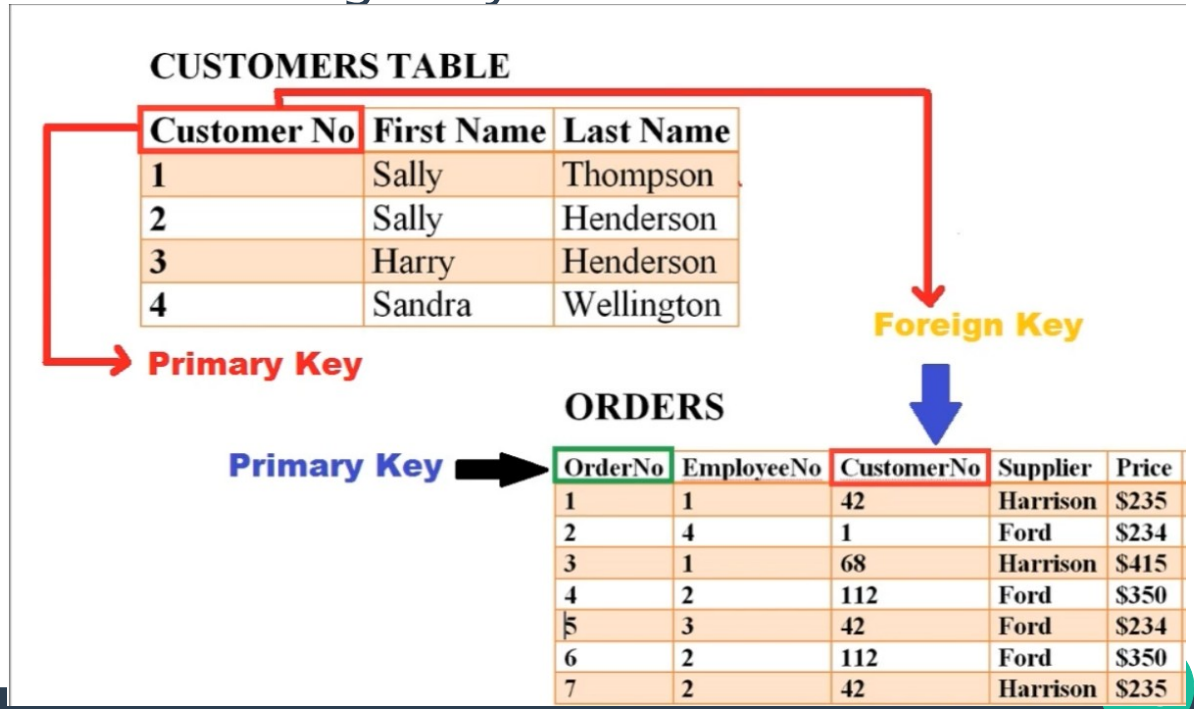
- **Every table has a ‘primary key’**
  - The value in every row (column or columns) that allows the row to be uniquely identified
  - Eg:



- **Usually numeric,**
  - But doesn’t have to be

RDMS: Foreign Key

- **Foreign Keys**
  - Every table can have one or more foreign keys
  - Column in table B has the value of the primary key from Table A
    - Links the records/rows in tables A and B



How Do we represent data

- **Designing a database is a science and art of its own**
  - What should be rows, what should be columns
  - Which things should be tables
    - One-one, one-many, many-many relationships among data in tables
    - Database managers have to make these decisions based on technological and business concerns
      - And these can change over time like programming
      - But harder to refactor the database.
  - Making these decisions are beyond the scope of this course
  - I'll assume any significant database is built for you.

SQL

- **When we interact with a Relational Databas SQL is the only game in town.**
  - The full official standard is currently ISO 9075
  - 14 documents from the ISO each 80+ pages and several cost a fair bit of money
    - Giant, in places somewhat contradictory
    - No one implements the whole thing
    - With stored procedures is Turing complete.
      - Turing complete?

Init in go

- **The init function is special in go**
  - It is called whenever a package is loaded
    - Either the main package or another package
    - Is called by the go system before any other function in the package
      - Including the main function
    - Is called only once per program (even if the package it is in is loaded multiple times)
  - Used to setup resources that need to exist before any other code is called
    - In this case our fonts need to be loaded in init.

sqlite3

- **There are many sql/RDMS databases out there**
  - For my examples we'll use sqlite
    - Very small lightweight RDMS database
  - To use with go, most people suggest the go-sqlite3 driver by user mattn
  - If not using go modules then
  - go install github.com/mattn/go-sqlite3

Getting Sqlite3

- **Any Debian based linux like Ubuntu/kubuntu/Mint etc**
  - sudo apt install sqlite3
  - sudo apt install sqlitebrowser – graphical tool for looking at the data in the database
- **And you are Done**

SQLite3 and Mac/Windows

- There are installers that you can download from the official site for the sqlite browser
- https://sqlitebrowser.org/

Simple DB access

- ```
  import(
  	"database/sql"
  	_ "github.com/mattn/go-sqlite3" //import for side effects
  	"log"
  )

  func main() {
  	myDatabase := OpenDataBase("./Demo.db")
  	defer myDatabase.Close()
  	create_tables(myDatabase)
  }
  ```

- ```
  func OpenDataBase(dbfile string) *sql.DB{
  	database, err := sql.Open("sqlite3", dbfile)
  	if err != nil {
  		log.Fatal(err)
  	}
  	return database
  }
  ```

- Note Unlike in some versions (python) of the sqlite connection library, just opening the database won't create it new.

Create Table

- **Create table statement used to create a new table in the db**
- **Official sqlite docs:**
  - CREATE TABLE [IF NOT EXISTS] [schema_name].table_name (
  - column_1 data_type PRIMARY KEY,
  - column_2 data_type NOT NULL,
  - column_3 data_type DEFAULT 0,
  - table_constraint
  -);
- **Notice that SQL statements end in ‘;’**

Create Table in go function

```
func create_tables(database *sql.DB){
	createStatement1 := "CREATE TABLE IF NOT EXISTS students(    " +
		"banner_id INTEGER PRIMARY KEY," +
		"first_name TEXT NOT NULL," +
		"last_name TEXT NOT NULL," +
		"gpa REAL DEFAULT 0," +
		"credits INTEGER DEFAULT 0);"
	database.Exec(createStatement1)
}
```

- Lets add another table together. And if we have several SQL novices, lets examine what is going on here

```
CREATE TABLE IF NOT EXISTS course(
    course_prefix TEXT NOT NULL,
    course_number INTEGER NOT NULL,
    cap INTEGER DEFAULT 20,
    description TEXT,
    PRIMARY KEY(course_prefix, course_number)
```

The big create table function

- Lets talk about what it all means
- ```
  CREATE TABLE IF NOT EXISTS class_list(
  registration_id INTEGER PRIMARY KEY,
  course_prefix TEXT NOT NULL,
  course_number INTEGER NOT NULL,
  student_id INTEGER NOT NULL,
  registration_date TEXT,
  FOREIGN KEY (student_id) REFERENCES student (banner_id)
  ON DELETE CASCADE ON UPDATE NO ACTION,
  FOREIGN KEY (course_prefix, course_number) REFERENCES
  courses (course_prefix, course_number)
  ON DELETE CASCADE ON UPDATE NO ACTION
  ```
  ```

```
statement := “INSERT INTO STUDENTS (banner_id, first_name, last_name, gpa, credits)
  VALUES (%d, %s, %s, %f, %d)”
for firstName, lastName := range sampleNames{
    randGPA := rand.Float32() + float32(rand.Intn(3))
    randCredits := rand.Intn(120)
    filled_statement := fmt.Sprintf(statement, count,
        firstName, lastName, randGPA, randCredits)
    fmt.Println(filled_statement)
     prepped_statement, err := database.Prepare(filled_statement)
}
```

What could possibly go wrong?

The bigger Picture

- ```
  func add_sample_data(database *sql.DB){
      sampleNames := map[string]string{"John":"Santore", "Enping":"Li", "Margaret":"Black",
          "Seikyung":"Jung", "Haleh":"Khojasteh", "Abdul":"Sattar", "Paul":"Kim", "Poonam":"Kumari"}
      statement := "INSERT INTO STUDENTS (banner_id, first_name, last_name, gpa, credits)" +
          "  VALUES (%d, %s, %s, %f, %d)"
      count := 1001
      for firstName, lastName := range sampleNames{
          randGPA := rand.Float32() + float32(rand.Intn(3))
          randCredits := rand.Intn(120)
          filled_statement := fmt.Sprintf(statement, count, firstName, lastName, randGPA, randCredits)
          fmt.Println(filled_statement)
          prepped_statement, err := database.Prepare(filled_statement)
          if err != nil{
              //cowardly bail out since this is academia
              log.Fatal(err)
          }
          prepped_statement.Exec()
      }
  }
  ```
- This data is hard coded in the functions -but where might we be getting our data from in ‘real life’
  ```

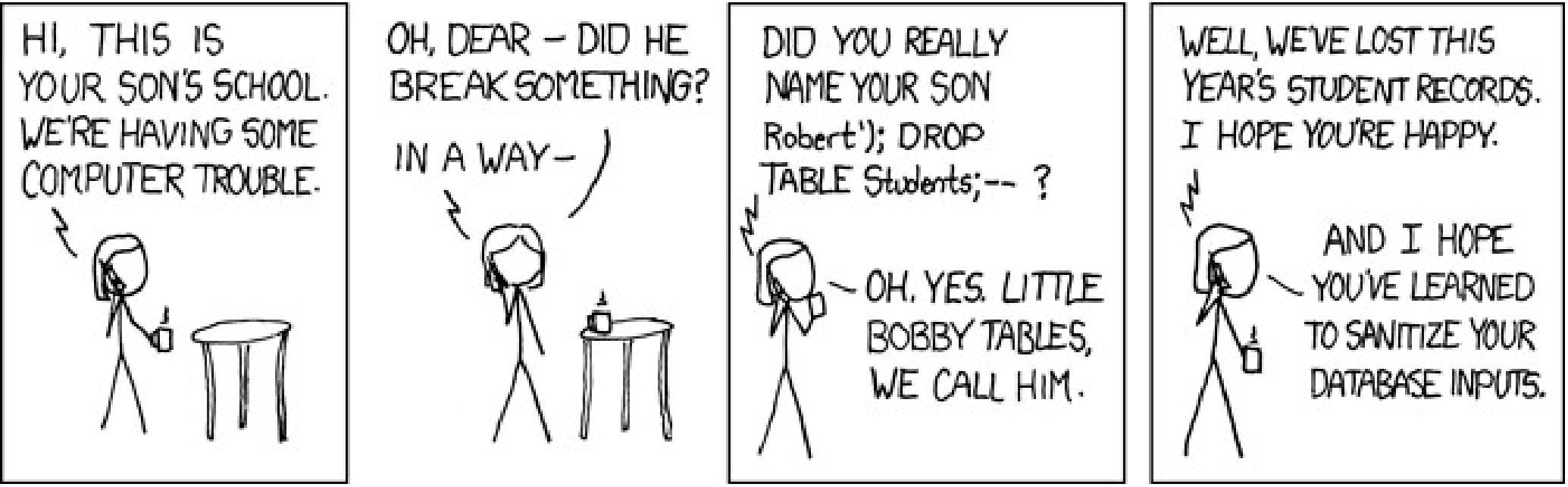
What could possibly go wrong?

- **Where does data come from in real life?**
  - Often users
  - If we Sprintf data from the users in we could end up with what?

What could possibly go wrong?

- **Where does data come from in real life?**
  - Often users
  - If we Sprintf data from the users in we could end up with what?
  - “SQL injection attack”

You all remember little bobby Tables?



DB security

- **App security**
  - These days it isn't just for Dr. Li's classes, need to be thinking about secure apps all the time.
  - So when inserting into databases use the Values (?,?,…) notation
- statement := "INSERT INTO STUDENTS (banner_id, first_name, last_name, gpa, credits)" +
  " VALUES (?, ?, ?, ?, ?)"
  - Now we prepare the statement and execute it.
  - Lets do that now

For Posterity

- **On slide in case you need it later**
-
```
func add_sample_data(database *sql.DB){
	sampleNames := map[string]string{"John":"Santore", "Enping":"Li", "Margaret":"Black",
		"Seikyung":"Jung", "Haleh":"Khojasteh", "Abdul":"Sattar", "Paul":"Kim", "Yiheng":"Liang"}
	statement := "INSERT INTO STUDENTS (banner_id, first_name, last_name, gpa, credits)" +
		"  VALUES (?, ?, ?, ?, ?)"
	count := 1001
	for firstName, lastName := range sampleNames{
		randGPA := rand.Float32() + float32(rand.Intn(4))
		randCredits := rand.Intn(120)
		prepped_statement, err := database.Prepare(statement)
		if err != nil{
			//cowardly bail out since this is academia
			log.Fatal(err)
		}
		prepped_statement.Exec(count, firstName, lastName,randGPA,randCredits)
		count +=1
	}
}
```

- **Now we need some courses.**
- **I’m going to grab my sample data map from an old demo:**
- **https://github.com/jsantore/DemoData/blob/master/ClassMap.go**
- **Our insert statement:**
- insert_statement := "INSERT INTO COURSES (course_prefix, course_number, description) VALUES (?,?,?);"
- **What do we need next?**

Adding Courses

- **Now we need some courses.**
- **I’m going to grab my sample data map from an old demo:**
- **https://github.com/jsantore/DemoData/blob/master/ClassMap.go**
- **Our insert statement:**
- insert_statement := "INSERT INTO COURSES (course_prefix, course_number, description) VALUES (?,?,?);"
- **What do we need next?**
  - Range through the data,
  - Break course into number and prefix

Prepare the Data

- **How are we going to break the course into a prefix and a course number?**

Prepare the Data

- **How are we going to break the course into a prefix and a course number?**
  - Python style slicing is available
  - So we can slice out “comp” and “510”
  - But what do we need to do now?

Prepare the Data

- **How are we going to break the course into a prefix and a course number?**
  - Python style slicing is available
  - So we can slice out “comp” and “510”
  - But what do we need to do now?

Prepare the Data

- **How are we going to break the course into a prefix and a course number?**
  - Python style slicing is available
  - So we can slice out “comp” and “510”
  - But what do we need to do now?
    - Now we need to convert “510” to 510 right? (lets look at the table description)
    -

Let’s Add that sample data

- **Work through it with the students**
  - Now we have data – look at it in the database viewer

Putting the R in RDMS

- **So far none of our data is related to any other**
  - Lets put a little data in the last table and fix that
  - Our statement
  - ```
    INSERT INTO CLASS_LIST (banner_id, course_prefix, course_number,
    registration_date)
        VALUES(1001, 'Comp', 510, DATE('now'))
    ```
  - Lets run this for several banner_id values
  - Lets have everyone register for comp510 – because of course
  - But setup replaceable values for the bannerID
    - Tell me how
    ```

Now we have data

- **Now we have data for all of the tables, but lets look at that last one**

Dates

- **Some RDMS have a datetime type for fields**
- **Not sqlite**
  - Dates can be stored as Strings
  - Dates can be stored as floats/Reals (use julianday function)
  - Dates can be stored as ints (unix time epoch)
- **Two builtin functions you want to think about (for string version)**
  - DATE
  - DATETIME
  - Both take params, most common value is ‘now’

Oops I made a Mistake

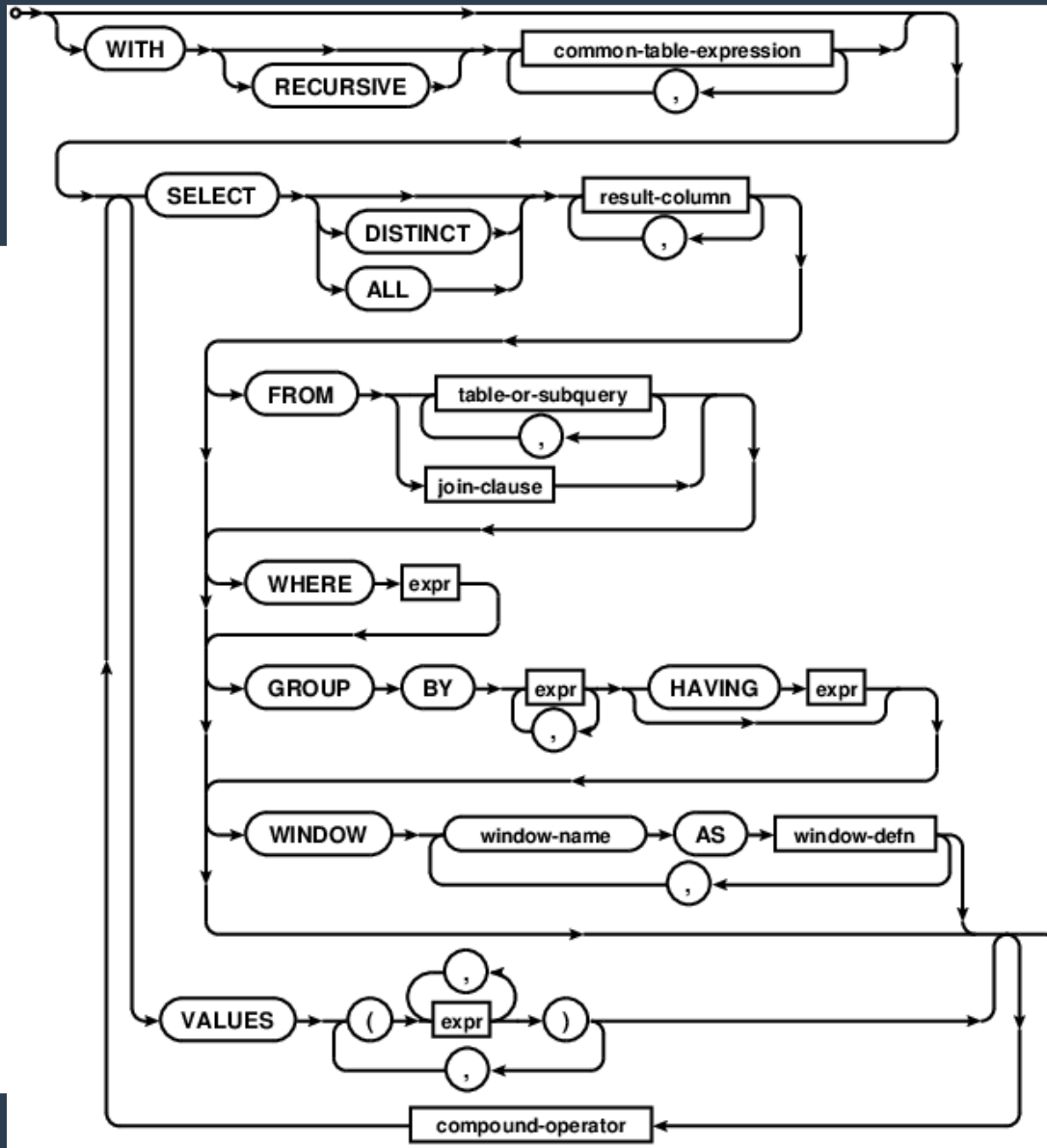
- **Sometimes you make a mistake**
  - Or you operate in Europe under the GDPR
  - GDPR???
    - So many lucky volunteers

Oops I made a Mistake

- **Sometimes you make a mistake**
  - Or you operate in Europe under the GDPR
  - And you need to delete data
  - DELETE Statement
    - Simple example: DELETE FROM table WHERE search_condition;

Using Data

- **Using data in an RDMS**
- **Aka welcome to select**
  - Even in small sqlite the syntax is complex
  - This is the official graph for the finite state machine for select



Bare Bones Select

- **The simplest version of Select**
  - SELECT <columns> FROM <table>
  - Or more interesting:
    - SELECT <columns> FROM <table> WHERE <column name> = <value>

Let’s Try

- **Lets find all the students on probation**
  - First ask the user what the probation cutoff is
    - (eg 2.0 for undergrads and 3.0 for grads etc.)
  - Guide me through this

My Solution

- **For those who lose theirs and for later**
-
```
func getMinGPA() float64{
	reader := bufio.NewReader(os.Stdin)
	fmt.Println("What is the minimum grade for good standing?")
	value, err:= reader.ReadString("\n")
	if err != nil{
		log.Fatal("How did we fail reading standard in??",err)
	}
	min_gpa, err := strconv.ParseFloat(value, 32)
	if err != nil{
		log.Fatal("OK you seem to have typed in something that wasn't a float", err)
	}
	return min_gpa
}
```

Now The Query

- **Now lets make the query and use the data**
- func findProbationStudents(database *sql.DB) {
  - var firstName, lastName string
  - var gpa float64
  - minGpa := getMinGPA()
  - selectStatement := "SELECT first_name, last_name, gpa FROM STUDENTS WHERE gpa < ?"
  - resultSet, err := database.Query(selectStatement, minGpa)
  - if err != nil {
    - log.Fatal("Bad Query", err)
  - }
  - defer resultSet.Close()
  - for resultSet.Next() {
  - err = resultSet.Scan(&firstName, &lastName, &gpa)
  - if err != nil {
    - log.Fatal(err)
  - }
  - fmt.Printf("%s %s is on probation with a GPA of %f\n", firstName, lastName, gpa)
  -

Now go do more.

- **Relational Databases are useful and important**
  - Take comp580 or comp405
  - Learn more on your own
  - This finishes our quick and useful look at relational databases
  - Hopefully many “unknown unknowns → “known unknowns”

