Relational Database Design Bootcamp

Mark Niebergall
Longhorn PHP 2019
https://joind.in/talk/9d7a6
https://github.com/mbniebergall/database-bootcamp

Mark Niebergall

- PHP since 2005
- Masters degree in MIS
- Senior Software Engineer
- Drug screening project
- Utah PHP Co-Organizer
- CSSLP, SSCP Certified and SME
- Father, long distance running, fishing, skiing

Survey

- Beginner - know of databases but haven’t written SQL?
- Intermediate - know how to write queries, create tables?
- Advanced - database administrator, years of experience?

Relational Database Design Bootcamp

- 3 hour tutorial
- Hands-on learning
- Learn concepts
- Design databases

Relational Database Design Bootcamp

- 1:00-1:30 Key concepts
- 1:30-2:00 Class Project Design
- 2:00-2:10 Break
- 2:10-2:30 Class Project Design (continued)
- 2:30-3:00 Group Projects
- 3:00-3:10 Break
- 3:10-3:30 Group Projects
- 3:30-3:50 Group Project Presentations
- 3:50-4:00 Review and Discussion

Relational Database Design Bootcamp

- Ask questions anytime
  - Others probably have same question

Objectives

- Increased knowledge and experience with relational database design

Objectives

- Know how to create tables with relationships
- Ensure data integrity
- Understand database normalization
- Tweak database performance

Setup

- Access to any MySQL server
  - Free community server https://dev.mysql.com/downloads/mysql/
  - Ideally version 8, minimum 5.7+
  - MySQL client of your choice
    - Sequel Pro: Mac, free, https://www.sequelpro.com/
    - PhpStorm: https://www.jetbrains.com/help/phpstorm/relational-databases.html
    - Terminal or Cmd

Overview

- Use cases
- Data types
- Create tables
- Constraints
- Normalization
- Design principles
- Performance

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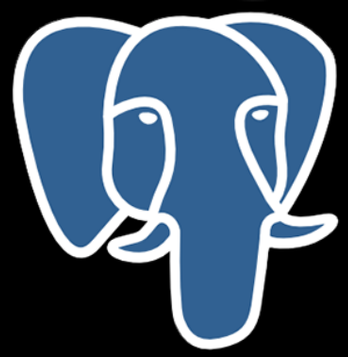
Use Cases

- Database
  - Storage of data
  - Organized into tables
  - Relationships represented with constraints
  - Replacement for spreadsheets

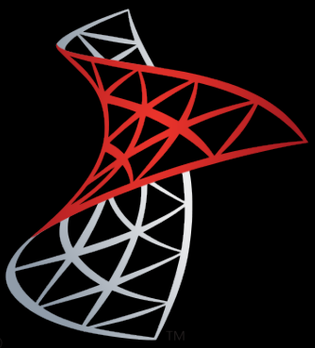
Use Cases



PostgreSQL

ORACLE

Microsoft



IBM

DB2

Use Cases

- Online store
- Students at a school
- Warehouse inventory
- Medical providers
- Biology research

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- Use cases
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Data Types

- Name all 8 PHP data types?
- Name 2 PHP pseudo data types?

Data Types

- Name all 8 PHP data types?
  - Scalar: boolean, integer, float, string
  - Compound: array, object
  - Special: resource, null

- Name 2 PHP pseudo data types?
  - Compound: callable, iterable

Data Types

- Database types
  - Numeric
  - Date and time
  - String
  - JSON

Data Types

- Numeric
  - BIT: BIT(4) 1001
  - BOOL: 0 or 1
  - INT: +/- 2147483647
  - DECIMAL: DECIMAL(6, 2) 123456.78

Data Types

- Date and Time
  - DATE
  - TIME
  - DATETIME
  - TIMESTAMP

Data Types

- String
  - CHAR
  - VARCHAR
  - BLOB
  - TEXT
  - ENUM

Data Types

- JSON
  - {“name”: “widget”, “description”: “does something”}
  - [123, 4567]
  - {“id”: 321, “codes”: [“abc”, “xyz”]}

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Create Tables

- Data modeling
  - Logical grouping
  - Reduce duplicate data
  - Table relationships

Create Tables

- CREATE DATABASE warehouse;

Create Tables

- USE warehouse;

```
CREATE TABLE item (
    id INT NOT NULL AUTO_INCREMENT,
    code VARCHAR(20) NULL,
    quantity INT NOT NULL DEFAUL 0,

    PRIMARY KEY (id),

    CONSTRAINT UK_item_code
        UNIQUE KEY (code)

) ENGINE=INNODB;
```

Create Tables

- USE warehouse;

```
ALTER TABLE item
    ADD COLUMN description VARCHAR(200) NULL
        AFTER code;
```

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Constraints

- Ensure data
  - CONSTRAINT UK_key_name
    UNIQUE KEY (column_name[, column_b, …])
  - NULL value considerations

Constraints

- Ensure data
  - CONSTRAINT FK_name
    FOREIGN KEY (table_column)
    REFERENCES another_table (that_table_column)
    ON DELETE NO ACTION
    ON UPDATE CASCADE

Constraints

- Ensure data
  - CONSTRAINT FK_name
    FOREIGN KEY (column_a, column_b)
    REFERENCES another_table (column_a, column_b)
    ON DELETE NO ACTION
    ON UPDATE CASCADE

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Normalization

- Reduce data redundancy
- Increase data integrity

Normalization

- Levels of Normal Form
  - 1NF
  - 2NF
  - 3NF
  - EKNF (Elementary Key)
  - BCNF (Boyce-Codd)
  - 4NF
  - ETNF (Essential Tuple)
  - 5NF
  - DKNF (Domain Key)
  - 6NF

Normalization

- Considerations
  - Performance
  - Data size

Normalization

Food Inventory Sheet - Microsoft Excel

File | Home | Insert | Page Layout | Formulas | Data | Review | View | Team

Normal | Page Layout | Page Break Preview | Custom Views | Full Screen — Workbook Views
Ruler | Formula Bar | Gridlines | Headings — Show
Zoom | 100% | Zoom to Selection — Zoom
New Window | Arrange All | Freeze Panes | Split | Hide | Unhide | View Side by Side | Synchronous Scrolling | Reset Window Position — Window
Save Workspace | Switch Windows — Macros

H8 | 0

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Item #	Description	Vendor	Category	Size	Unit	Starting Qty	Starting Value	Wk 1 Qty	Wk 1 Cost	Wk 2 Qty	Wk 2 Cost	Wk 3 Qty	Wk 3 Cost	Wk 4 Qty
2	492229	TURKEY SLICED .5 OZ	Ben E Keith	2 - FROZEN FOOD	0	0	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
3	662371	DRESSING CAESAR CREAMY	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
4	779243	MARGARINE LIQUID OLEO	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
5	815306	LID PLAS SOUFFLE CLEAR	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
6	860055	LID PLAS 16SL SLOTTED	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
7	860060	CUP FOAM 16OZ 16J16	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
8	774704	PAPRIKA	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	1.00	$ 5.79	0.00	$ -	0.00
9	664005	Mustard Prepared	Ben E Keith	4 - GROCERY	512	fl oz	0.00	$ -	1.00	$ 3.75	0.00	$ -	0.00	$ -	0.00
10	750100	CHEESE PARMESAN SHRED	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	0.00	$ -	1.00	$ 13.27	0.00
11	250025	EGG FRESH SHELL MED USDA AA	Ben E Keith	1 - PRODUCE	0	0	0.00	$ -	1.00	$ 15.89	0.00	$ -	0.00	$ -	0.00
12	686034	VINEGAR APPL CIDER 40GRAIN	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	1.00	$ 17.77	0.00	$ -	0.00
13	29078	LIME 12 CT	Ben E Keith	1 - PRODUCE	12	ct	0.00	$ -	2.00	$ 8.99	0.00	$ -	0.00	$ -	0.00
14	650547	TOMATO DICED W/GREEN CHILES	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	1.00	$ 18.88	0.00	$ -	0.00	$ -	0.00
15	286500	Ice Cream Vanilla Cr 3 Gal	Ben E Keith	6 - DAIRY	384	fl oz	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
16	650474	KETCHUP FANCY 33% SOLIDS	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	1.00	$ 20.69	0.00	$ -	0.00	$ -	0.00
17	140005	MUSHROOM WHITE SMALL BUTTON	Ben E Keith	1 - PRODUCE	0	0	0.00	$ -	1.00	$ 20.98	0.00	$ -	0.00	$ -	0.00
18	771131	CROUTON SEASONED HOMESTYLE	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	1.00	$ 22.30	0.00	$ -	0.00
19	660409	SAUCE LOUISIANA RED HOT	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	1.00	$ 11.24	0.00	$ -	1.00	$ 11.24	0.00
20	150015	Onion Green Iceless W/Root	Ben E Keith	1 - PRODUCE	32	oz	0.00	$ -	1.00	$ 8.29	1.00	$ 8.29	0.00	$ -	0.00
21	780009	SUGAR BROWN LIGHT IN BAGS	Ben E Keith	4 - GROCERY	0	0	0.00	$ -	0.00	$ -	1.00	$ 27.69	0.00	$ -	0.00
22	155030	Onion Yellow Jumbo	Ben E Keith	1 - PRODUCE	800	oz	0.00	$ -	0.00	$ -	1.00	$ 13.99	0.00	$ -	0.00
23	774173	Pepper Red Crushed	Ben E Keith	4 - GROCERY	52	oz	0.00	$ -	0.00	$ -	0.00	$ -	0.00	$ -	0.00
24	920919	TUMBLER 20 OZ AMBER	Ben E Keith	8 - EQUIP & SUPPLY	0	0	0.00	$ -	0.00	$ -	1.00	$ 29.99	0.00	$ -	0.00

Inventory | Graphs | DescriptionLookup | CategoryLookup | Week1 | Week2 | Week3 | Week4 | Week5

Select destination and press ENTER or choose Paste

100%

https://i.stack.imgur.com/7JoKT.jpg

Overview

- Use cases
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- Design principles
- Performance

Design Principles

- Practical data mapping

Design Principles

- Naming that makes sense

Design Principles

- Correct data types

Design Principles

- Accurately reflects relationships
  - Boil down to simplest form

Design Principles

- S - Single Responsibility: do one thing well
- O - Open-Closed: open for extension, closed for modification
- L - Liskov Substitution: replaceable with subtypes
- I - Interface Segregation: break apart interfaces logically
- D - Dependency Inversion: dependence on abstraction

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Performance

- Decreases as data volume increases

Performance

- Denormalization
  - Use constraints to retain data integrity

Performance

- Database indexes
  - INDEX IX_name (column_a)
  - ALTER TABLE some_table
    ADD INDEX IX_name (column_a, column_b);

Performance

- Avoid
  - LIKE ‘%abc%’
  - JOIN table t ON t.a = x.a OR t.b = y.b
  - WHERE (t.a = x.a OR t.b = y.b)
  - COUNT(*) [no limit set]
  - ORDER BY CONCAT(non_index_varchar_a, b)
  - GROUP BY a, b, c

Performance

- EXPLAIN
  - EXPLAIN SELECT…
  - EXPLAIN DELTE…
  - EXPLAIN INSERT…
  - EXPLAIN REPLACE…
  - EXPLAIN UPDATE…

Performance

- EXPLAIN
  - Fast: Using index
  - Okay: Using where
  - Slow: Using filesort
  - Slow: Using temporary

Performance

```
EXPLAIN
SELECT COUNT(b.code) AS building_code_count,
       b.code,
       i.description
FROM building b
JOIN rack r
    ON r.building_id = b.id
JOIN shelf s
    ON s.rack_id = r.id
JOIN location l
    ON s.id = l.shelf_id
JOIN location_item li
    ON l.id = li.location_id
JOIN item i
    ON i.barcode = li.item_barcode

WHERE b.code LIKE '%5%'
AND i.description LIKE '%pig%'

GROUP BY b.code, i.description;
```

Performance

1,SIMPLE,b,,index,PRIMARY,UK_building_code,22,,8,12.5,Using where; Using index; Using temporary; Using filesort

1,SIMPLE,i,,ALL,PRIMARY,,,,10,11.11,Using where; Using join buffer (Block Nested Loop)

1,SIMPLE,r,,ref,"PRIMARY,FK_rack_building",FK_rack_building,4,warehouse.b.id,9,100,Using index

1,SIMPLE,s,,ref,"PRIMARY,UK_shelf",UK_shelf,4,warehouse.r.id,9,100,Using index

1,SIMPLE,l,,ref,"PRIMARY,FK_location_shelf",FK_location_shelf,4,warehouse.s.id,9,100,Using index

1,SIMPLE,li,,eq_ref,"PRIMARY,UK_item_location",PRIMARY,46,"warehouse.l.id,warehouse.i.barcode",1,100,Using index

Performance

- Make it work, make it fast, make it right
- Performance tuning during project building

Performance

- Considerations
  - Disk space
  - Breaking queries apart
  - Combining queries
  - Stored procedures
  - Views
  - Functions
  - User workflows

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Project

- Warehouse inventory on shelves

Project

http://cdn.idplate.com/images/warehouse-rack-bar-code-labels.jpg

Project

- https://github.com/mbniebergall/database-bootcamp

Team Project

- Groups of about 4
- Work together on design
  - Data model with normalization
  - Create database
  - Create tables
  - Populate tables
  - Add indexes

Team Project

- Parking lot
- Elephpant collections
- Family Tree
- Exercise tracker
- Messenger queue
- Pet daycare
- Sports roster
- Driver licenses
- Airline seating

Team Project

- Share
  - Project chosen
  - Tables
  - Relationships
  - Normalization
  - Performance
  - Difficulties

Team Project

Review and Discussion

- Use cases
- Data types
- Create tables
- Constraints
- Normalization
- Design principles
- Performance

Review and Discussion

- Class project
- Group projects

Review and Discussion

- Discussion
  - Denormalization
  - Performance tuning
  - Security
  - Business Logic

Review and Discussion

- Discussion
  - Stored Procedures
  - Functions
  - Triggers
  - Views

Review and Discussion

- Anything PHP

Questions?

- Rate on joind.in https://joind.in/talk/9d7a6