

Database Modeling

Normalization

1NF

1st Normal Form

Prerequisites

Tables, columns in place

All tables have a primary key

1NF

1. All cells should contain atomic data
 - a. A single cell can only contain 1 value
2. No repeating columns

Employee

| EmployeeID | FirstName | LastName | Email | ... |
|------------|-----------|----------|------------|-----|
| 551 | Les | Adams | ladams@ | ... |
| 552 | Jill | Baker | jbaker@ | ... |
| 553 | Stephen | Jackson | s.jackson@ | ... |

Employee

| EmployeeID | FirstName | LastName | Email | ... | ComputerSerial |
|------------|-----------|----------|------------|-----|----------------|
| 551 | Les | Adams | ladams@ | ... | XP5435512 |
| 552 | Jill | Baker | jbaker@ | ... | WA2324451 |
| 553 | Stephen | Jackson | s.jackson@ | ... | BC32345412 |

Employee

| EmployeeID | FirstName | LastName | Email | ... | ComputerSerial |
|------------|-----------|----------|------------|-----|----------------------------------|
| 551 | Les | Adams | ladams@ | ... | XP5435512 , XA5543231 |
| 552 | Jill | Baker | jbaker@ | ... | WA2324451 |
| 553 | Stephen | Jackson | s.jackson@ | ... | BC32345412 , ZZ87656, XX21312 |

Employee

| EmployeeID | FirstName | LastName | Email | ... | ComputerSerial |
|------------|-----------|----------|------------|-----|---|
| 551 | Les | Adams | ladams@ | ... | XP5435512, XAF543231 |
| 552 | Jill | Baker | jbaker@ | ... | WA2324451 |
| 553 | Stephen | Jackson | s.jackson@ | ... | BF32345412, ZZ87656, XX21312 |

violates 1NF

Atomic Data

Employee

| EmployeeID | FirstName | LastName | Email | ... | ComputerSerial | ComputerSerial2 | ComputerSerial3 |
|------------|-----------|----------|------------|-----|----------------|-----------------|-----------------|
| 551 | Les | Adams | ladams@ | ... | XP5435512 | XA5543231 | |
| 552 | Jill | Baker | jbaker@ | ... | WA2324451 | | |
| 553 | Stephen | Jackson | s.jackson@ | ... | BC32345412 | ZZ87656 | XX21312 |

Employee

| EmployeeID | FirstName | LastName | Email | ... | ComputerSerial | ComputerSerial2 | ComputerSerial3 |
|------------|-----------|----------|------------|-----|----------------|-----------------|-----------------|
| 551 | Les | Adams | ladams@ | ... | XP5435512 | XA5543231 | |
| 552 | Jill | Baker | jbaker@ | ... | WA2324451 | | |
| 553 | Stephen | Jackson | s.jackson@ | ... | BC32345412 | ZZ87656 | XX21312 |

Violates 1NF
Repeating columns

Solution

Employee

| EmployeeID | FirstName | LastName | Email | ... |
|------------|-----------|----------|------------|-----|
| 551 | Les | Adams | ladams@ | ... |
| 552 | Jill | Baker | jbaker@ | ... |
| 553 | Stephen | Jackson | s.jackson@ | ... |

Computer

| Serial | EmployeeID | Description | ... |
|------------|------------|---------------|-----|
| XP5435512 | 551 | Dell Laptop | ... |
| XA5543231 | 551 | Apple MacBook | ... |
| WA2324451 | 552 | Acer Desktop | ... |
| BC32345412 | 553 | MacBook Pro | ... |
| ZZ87656 | 553 | HP Server | ... |
| XX21312 | 553 | iPad 3 | ... |

Employee

| EmployeeID | FirstName | LastName | Email | ... |
|------------|-----------|----------|------------|-----|
| 551 | Les | Adams | ladams@ | ... |
| 552 | Jill | Baker | jbaker@ | ... |
| 553 | Stephen | Jackson | s.jackson@ | ... |

Computer

| Serial | EmployeeID | Description | ... |
|------------|------------|---------------|-----|
| XP5435512 | 551 | Dell Laptop | ... |
| XA5543231 | 551 | Apple MacBook | ... |
| WA2324451 | 552 | Acer Desktop | ... |
| BC32345412 | 553 | MacBook Pro | ... |
| ZZ87656 | 553 | HP Server | ... |
| XX21312 | 553 | iPad 3 | ... |

What about this?

| id | name | last_name | address | zip |
|----|---------------------|-----------|----------------------------|------|
| 2 | Claus | Bové | Victor Bendix Gade 6, 4.th | 2100 |
| 3 | Tove-Line Merete | Bitss | H.C Andersens vej 17 | 9210 |

What about this?

| id | name | last_name | address | zip |
|----|---------------------|-----------|----------------------------|------|
| 2 | Claus | Bové | Victor Bendix Gade 6, 4.th | 2100 |
| 3 | Tove-Line Merete | Bitss | H.C Andersens vej 17 | 9210 |

| id | name | last_name | address | house_no | floor | zip |
|----|---------------------|-----------|--------------------|----------|-------|------|
| 2 | Claus | Bové | Victor Bendix Gade | 6 | 4.th | 2100 |
| 3 | Tove-Line Merete | Bitss | H.C Andersens vej | 17 | | 9210 |

2NF

Second normal form:

"Any non-key field should be dependent on the entire primary key."

Events

| Course | Date | CourseTitle | Room | Capacity | Available | ... |
|--------|-----------|------------------|------|----------|-----------|-----|
| SQL101 | 3/1/2013 | SQL Fundamentals | 4A | 12 | 4 | |
| DB202 | 3/1/2013 | Database Design | 7B | 14 | 7 | |
| SQL101 | 4/14/2013 | SQL Fundamentals | 7B | 14 | 10 | |
| SQL101 | 5/28/2013 | SQL Fundamentals | 12A | 8 | 8 | |
| CS200 | 4/15/2012 | C Programming | 4A | 12 | 11 | |

Events

| Course | Date | CourseTitle | Room | Capacity | Available | ... |
|--------|-----------|------------------|------|----------|-----------|-----|
| SQL101 | 3/1/2013 | SQL Fundamentals | 4A | 12 | 4 | |
| DB202 | 3/1/2013 | Database Design | 7B | 14 | 7 | |
| SQL101 | 4/14/2013 | SQL Fundamentals | 7B | 14 | 10 | |
| SQL101 | 5/28/2013 | SQL Fundamentals | 12A | 8 | 8 | |
| CS200 | 4/15/2012 | C Programming | 4A | 12 | 11 | |

composite primary key

Events

| Course | Date | CourseTitle | Room | Capacity | Available | ... |
|--------|-----------|------------------|------|----------|-----------|-----|
| SQL101 | 3/1/2013 | SQL Fundamentals | 4A | 12 | 4 | |
| DB202 | 3/1/2013 | Database Design | 7B | 14 | 7 | |
| SQL101 | 4/14/2013 | SQL Fundamentals | 7B | 14 | 10 | |
| SQL101 | 5/28/2013 | SQL Fundamentals | 12A | 8 | 8 | |
| CS200 | 4/15/2012 | C Programming | 4A | 12 | 11 | |

composite primary key

Solution

Events

| Course | Date | Room | Capacity | Available | ... |
|--------|-----------|------|----------|-----------|-----|
| SQL101 | 3/1/2013 | 4A | 12 | 4 | |
| DB202 | 3/1/2013 | 7B | 14 | 7 | |
| SQL101 | 4/14/2013 | 7B | 14 | 10 | |
| SQL101 | 5/28/2013 | 12A | 8 | 8 | |
| CS200 | 4/15/2012 | 4A | 12 | 11 | |



Course

| CourseID | Title | ... |
|----------|------------------|-----|
| SQL101 | SQL Fundamentals | ... |
| DB202 | Database Design | ... |
| CS200 | C Programming | ... |

3NF

Third normal form:

"No **non-key** field is dependent on
any other **non-key** field."

Events

| Course | Date | Room | Capacity | Available | ... |
|--------|-----------|------|----------|-----------|-----|
| SQL101 | 3/1/2013 | 4A | 12 | 4 | |
| DB202 | 3/1/2013 | 7B | 14 | 7 | |
| SQL101 | 4/14/2013 | 7B | 14 | 10 | |
| SQL101 | 5/28/2013 | 12A | 8 | 8 | |
| CS200 | 4/15/2012 | 4A | 12 | 11 | |

Course

| CourseID | Title | ... |
|----------|------------------|-----|
| SQL101 | SQL Fundamentals | ... |
| DB202 | Database Design | ... |
| CS200 | C Programming | ... |

Events

| Course | Date | Room | Capacity | Available | ... |
|--------|-----------|------|----------|-----------|-----|
| SQL101 | 3/1/2013 | 4A | 12 | 4 | |
| DB202 | 3/1/2013 | 7B | 14 | 7 | |
| SQL101 | 4/14/2013 | 7B | 14 | 10 | |
| SQL101 | 5/28/2013 | 12A | 8 | 8 | |
| CS200 | 4/15/2012 | 4A | 12 | 11 | |

Course

| CourseID | Title | ... |
|----------|------------------|-----|
| SQL101 | SQL Fundamentals | ... |
| DB202 | Database Design | ... |
| CS200 | C Programming | ... |

Events

| Course | Date | Room | Available | ... |
|--------|-----------|------|-----------|-----|
| SQL101 | 3/1/2013 | 4A | 4 | |
| DB202 | 3/1/2013 | 7B | 7 | |
| SQL101 | 4/14/2013 | 7B | 10 | |
| SQL101 | 5/28/2013 | 12A | 8 | |
| CS200 | 4/15/2012 | 4A | 11 | |

Course

| CourseID | Title | ... |
|----------|------------------|-----|
| SQL101 | SQL Fundamentals | ... |
| DB202 | Database Design | ... |
| CS200 | C Programming | ... |

Room

| Room | Capacity |
|------|----------|
| 4A | 12 |
| 7B | 14 |
| 12A | 8 |

OrderItem

| ID | OrderID | ProductID | Quantity | UnitPrice | Total |
|-------|---------|-----------|----------|-----------|----------|
| 10011 | 454 | A43 | 4 | \$10.00 | \$40.00 |
| 10012 | 455 | B56 | 2 | \$5.00 | \$10.00 |
| 10013 | 456 | A22 | 1 | \$9.99 | \$9.99 |
| 10014 | 456 | A43 | 55 | \$10.00 | \$550.00 |
| 10015 | 457 | C77 | 10 | \$75.00 | \$750.00 |

OrderItem

| ID | OrderID | ProductID | Quantity | UnitPrice | Total |
|-------|---------|-----------|----------|-----------|----------|
| 10011 | 454 | A43 | 4 | \$10.00 | \$40.00 |
| 10012 | 455 | B56 | 2 | \$5.00 | \$10.00 |
| 10013 | 456 | A22 | 1 | \$9.99 | \$9.99 |
| 10014 | 456 | A43 | 55 | \$10.00 | \$550.00 |
| 10015 | 457 | C77 | 10 | \$75.00 | \$750.00 |

OrderItem

| ID | OrderID | ProductID | Quantity | UnitPrice | Total |
|-------|---------|-----------|----------|-----------|----------|
| 10011 | 454 | A43 | 4 | \$10.00 | \$40.00 |
| 10012 | 455 | B56 | 2 | \$5.00 | \$10.00 |
| 10013 | 456 | A22 | 1 | \$9.99 | \$9.99 |
| 10014 | 456 | A43 | 55 | \$10.00 | \$550.00 |
| 10015 | 457 | C77 | 10 | \$75.00 | \$750.00 |

OrderItem

| ID | OrderID | ProductID | Quantity | UnitPrice |
|-------|---------|-----------|----------|-----------|
| 10011 | 454 | A43 | 4 | \$10.00 |
| 10012 | 455 | B56 | 2 | \$5.00 |
| 10013 | 456 | A22 | 1 | \$9.99 |
| 10014 | 456 | A43 | 55 | \$10.00 |
| 10015 | 457 | C77 | 10 | \$75.00 |

OrderItem

| ID | OrderID | ProductID | Quantity | UnitPrice | Total |
|-------|---------|-----------|----------|-----------|----------|
| 10011 | 454 | A43 | 4 | \$10.00 | \$40.00 |
| 10012 | 455 | B56 | 2 | \$5.00 | \$10.00 |
| 10013 | 456 | A22 | 1 | \$9.99 | \$9.99 |
| 10014 | 456 | A43 | 55 | \$10.00 | \$550.00 |
| 10015 | 457 | C77 | 10 | \$75.00 | \$750.00 |

if needed, a read-only
calculated column

first normal form ➡ second normal form ➡ third normal form

(1NF)

no repeating values,
no repeating groups

(2NF)

no non-key values based on
just **part** of a composite key

(3NF)

no non-key values based on
other non-key values