



CIS 412

DATABASE MANAGEMENT SYSTEMS

Chapter 5

Database Design 1: Normalization

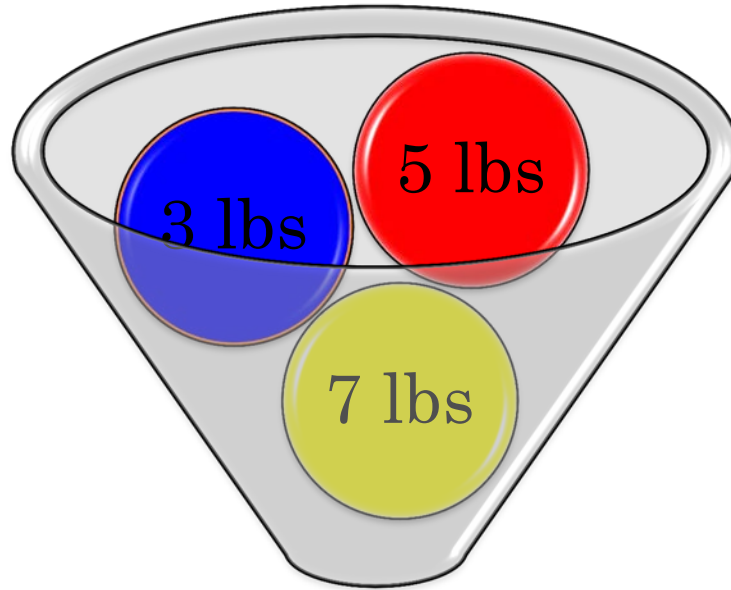
FUNCTIONAL DEPENDENCIES



Cookie Cost is *Functionally Dependent* on Number of Boxes



FUNCTIONAL DEPENDENCIES - NON-EQUATIONS



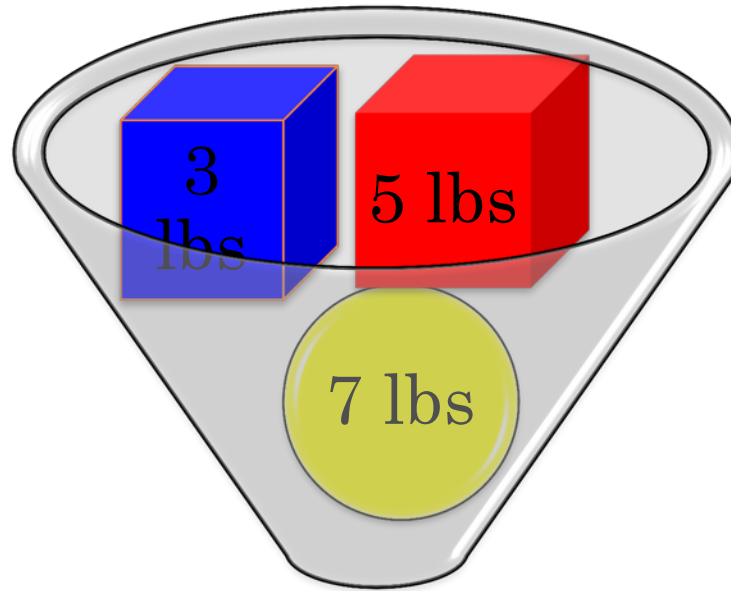
Weight is *Functionally Dependent* on Object Color



Object Color *Determines* Weight



FUNCTIONAL DEPENDENCIES - NON-EQUATIONS



Shape is *Functionally Dependent* on Object Color



Object Color *Determines* Shape



FUNCTIONAL DEPENDENCIES

Shape and Weight are *Functionally Dependent* on Object Color



Object Color *Determines* Shape and Weight

Another way to represent - **TABLE**

| Object Color | Weight | Shape |
|--------------|--------|-------|
| Red | 5 | Cube |
| Blue | 3 | Cube |
| Yellow | 7 | Ball |



COMPOSITE FUNCTIONAL DEPENDENCIES

Composite Functional Dependencies

The determinant has more than one attribute

Grade is *Functionally Dependent* on ClassNumber and StudentNumber




ANOMALIES – IRREGULARITIES IN TABLES

○ Insertion anomaly

- Cannot add a record to a table because you do not know the entire primary key value

Primary Key



| Employee Num | Position ID | LastName | PositionDesc | StartDate | HealthPlan | PlanDesc |
|--------------|-------------|-----------|--------------|------------|------------|----------------|
| 2173 | 2 | Hennessey | Manager | 12/14/2008 | B | Managed HMO |
| 4519 | 1 | Noordsy | Director | 04/23/2010 | A | Managed PPO |
| 4519 | 3 | Noordsy | Analyst | 11/11/2004 | A | Managed PPO |
| 8005 | 3 | Amidon | Analyst | 06/05/2009 | C | Health Savings |
| 8005 | 4 | Amidon | Clerk | 07/02/2007 | C | Health Savings |
| 8112 | 1 | Wandzell | Director | 12/15/2009 | A | Managed PPO |
| 8112 | 2 | Wandzell | Manager | 10/4/2008 | A | Managed PPO |

Add Cathy Corbett with EmployeeNum 3322



ANOMALIES

○ Deletion anomaly

- Occurs when you delete data from a table and unintentionally lose other critical data.


Primary Key

| Employee Num | Position ID | LastName | PositionDesc | StartDate | HealthPlan | PlanDesc |
|--------------|-------------|-----------|--------------|------------|------------|----------------|
| 2173 | 2 | Hennessey | Manager | 12/14/2008 | B | Managed HMO |
| 4519 | 1 | Noordsy | Director | 04/23/2010 | A | Managed PPO |
| 4519 | 3 | Noordsy | Analyst | 11/11/2004 | A | Managed PPO |
| 8005 | 3 | Amidon | Analyst | 06/05/2009 | C | Health Savings |
| 8005 | 4 | Amidon | Clerk | 07/02/2007 | C | Health Savings |
| 8112 | 1 | Wandzell | Director | 12/15/2009 | A | Managed PPO |
| 8112 | 2 | Wandzell | Manager | 10/4/2008 | A | Managed PPO |

ANOMALIES

- Update anomaly
 - Changing one field value requires updates in multiple places

Primary Key



| Employee Num | Position ID | LastName | PositionDesc | StartDate | HealthPlan | PlanDesc |
|--------------|-------------|-----------|--------------|------------|------------|----------------|
| 2173 | 2 | Hennessey | Manager | 12/14/2008 | B | Managed HMO |
| 4519 | 1 | Noordsy | Director | 04/23/2010 | A | Managed PPO |
| 4519 | 3 | Noordsy | Analyst | 11/11/2004 | A | Managed PPO |
| 8005 | 3 | Amidon | Analyst | 06/05/2009 | C | Health Savings |
| 8005 | 4 | Amidon | Clerk | 07/02/2007 | C | Health Savings |
| 8112 | 1 | Wandzell | Director | 12/15/2009 | A | Managed PPO |
| 8112 | 2 | Wandzell | Manager | 10/4/2008 | A | Managed PPO |

NORMALIZATION

- The process of removing anomalies in your database
- Sets of rules to normalize a database are called **normal forms**

Unnormalized Employee Table with Repeating data

Employee

repeating group

| EmpNum | PosID | FirstName | LastName | PositionDesc | PayGrade | StartDate | HealthPlan | PlanDesc |
|--------|-------|-----------|-----------|--------------|----------|------------|------------|----------------|
| 2173 | 2 | Barbara | Hennessey | Manager | 40 | 12/14/2008 | B | Managed HMO |
| 4519 | 1 | Lee | Noordsy | Director | 45 | 04/23/2010 | A | Managed PPO |
| | 3 | | | Analyst | 30 | 11/11/2004 | | |
| 8005 | 3 | Pat | Amidon | Analyst | 30 | 06/05/2009 | C | Health Savings |
| | 4 | | | Clerk | 20 | 07/02/2007 | | |
| 8112 | 1 | Chris | Wandzell | Director | 45 | 12/15/2009 | A | Managed PPO |
| | 2 | | | Manager | 40 | 10/4/2008 | | |


CONVERSION TO 1NF

- A table is in first normal form if it does not contain repeating groups.
- Expand the primary key and create a composite key

Employee Table after conversion to 1NF

Employee

Primary Key



| EmpNum | PosID | FirstName | LastName | PositionDesc | PayGrade | StartDate | HealthPlan | PlanDesc |
|--------|-------|-----------|-----------|--------------|----------|------------|------------|----------------|
| 2173 | 2 | Barbara | Hennessey | Manager | 40 | 12/14/2008 | B | Managed HMO |
| 4519 | 1 | Lee | Noordsy | Director | 45 | 04/23/2010 | A | Managed PPO |
| 4519 | 3 | Lee | Noordsy | Analyst | 30 | 11/11/2004 | A | Managed PPO |
| 8005 | 3 | Pat | Amidon | Analyst | 30 | 06/05/2009 | C | Health Savings |
| 8005 | 4 | Pat | Amidon | Clerk | 20 | 07/02/2007 | C | Health Savings |
| 8112 | 1 | Chris | Wandzell | Director | 45 | 12/15/2009 | A | Managed PPO |
| 8112 | 2 | Chris | Wandzell | Manager | 40 | 10/4/2008 | A | Managed PPO |

CONVERSION TO 2NF

- Remove partial dependencies – a dependency on “part” of the key
- Steps:
 - Identify the functional dependencies for every field in the table
 - Create new tables, if necessary, so that the field is functionally dependent on the entire primary key, not part of it.
- Note that a table in 1NF with a single-field primary key is automatically in 2NF.



CONVERSION TO 2NF

What are the functional dependencies?

Emp Num \rightarrow FirstName, LastName, HealthPlan, PlanDesc


PosID \rightarrow PositionDesc, PayGrade

EmpNum, PosID \rightarrow StartDate

HealthPlan \rightarrow PlanDesc

Employee

Primary Key



| EmpNum | PosID | FirstName | LastName | PositionDesc | PayGrade | StartDate | HealthPlan | PlanDesc |
|--------|-------|-----------|-----------|--------------|----------|------------|------------|----------------|
| 2173 | 2 | Barbara | Hennessey | Manager | 40 | 12/14/2008 | B | Managed HMO |
| 4519 | 1 | Lee | Noordsy | Director | 45 | 04/23/2010 | A | Managed PPO |
| 4519 | 3 | Lee | Noordsy | Analyst | 30 | 11/11/2004 | A | Managed PPO |
| 8005 | 3 | Pat | Amidon | Analyst | 30 | 06/05/2009 | C | Health Savings |
| 8005 | 4 | Pat | Amidon | Clerk | 20 | 07/02/2007 | C | Health Savings |
| 8112 | 1 | Chris | Wandzell | Director | 45 | 12/15/2009 | A | Managed PPO |
| 8112 | 2 | Chris | Wandzell | Manager | 40 | 10/4/2008 | A | Managed PPO |

AFTER CONVERSION TO 2NF

Employee

Primary Key

| EmpNum | FirstName | LastName | HealthPlan | PlanDesc |
|--------|-----------|-----------|------------|----------------|
| 2173 | Barbara | Hennessey | B | Managed HMO |
| 4519 | Lee | Noordsy | A | Managed PPO |
| 8005 | Pat | Amidon | C | Health Savings |
| 8112 | Chris | Wandzell | A | Managed PPO |

Position

Primary Key

| PosID | PositionDesc | PayGrade |
|-------|--------------|----------|
| 1 | Director | 45 |
| 2 | Manager | 40 |
| 3 | Analyst | 30 |
| 4 | Clerk | 20 |

Employment

Primary Key

| EmpNum | PosID | StartDate |
|--------|-------|------------|
| 2173 | 2 | 12/14/2008 |
| 4519 | 1 | 04/23/2010 |
| 4519 | 3 | 11/11/2004 |
| 8005 | 3 | 06/05/2009 |
| 8005 | 4 | 07/02/2007 |
| 8112 | 1 | 12/15/2009 |
| 8112 | 2 | 10/04/2008 |



CONVERSION TO 3NF

Employee table still has a functional dependency

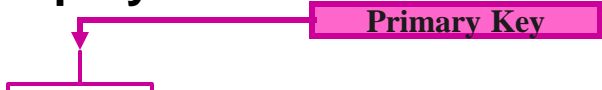
HealthPlan →

Plan Desc

So break out the Health Plan information and create a 4th table

Employee


Primary Key



| EmpNum | FirstName | LastName | HealthPlan | PlanDesc |
|--------|-----------|-----------|------------|----------------|
| 2173 | Barbara | Hennessey | B | Managed HMO |
| 4519 | Lee | Noordsy | A | Managed PPO |
| 8005 | Pat | Amidon | C | Health Savings |
| 8112 | Chris | Wandzell | A | Managed PPO |


AFTER CONVERSION TO 3NF

Employee




| EmpNum | FirstName | LastName | HealthPlan |
|--------|-----------|-----------|------------|
| 2173 | Barbara | Hennessey | B |
| 4519 | Lee | Noordsy | A |
| 8005 | Pat | Amidon | C |
| 8112 | Chris | Wandzell | A |

HealthBenefits




| HealthPlan | PlanDesc |
|------------|----------------|
| A | Managed PPO |
| B | Managed HMO |
| C | Health Savings |

Position




| PosID | PositionDesc | PayGrade |
|-------|--------------|----------|
| 1 | Director | 45 |
| 2 | Manager | 40 |
| 3 | Analyst | 30 |
| 4 | Clerk | 20 |

Employment



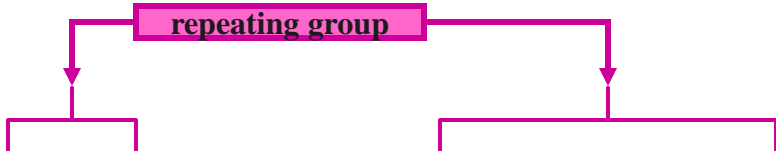
| EmpNum | PosID | StartDate |
|--------|-------|------------|
| 2173 | 2 | 12/14/2008 |
| 4519 | 1 | 04/23/2010 |
| 4519 | 3 | 11/11/2004 |
| 8005 | 3 | 06/05/2009 |
| 8005 | 4 | 07/02/2007 |
| 8112 | 1 | 12/15/2009 |
| 8112 | 2 | 10/04/2008 |



NORMALIZATION EXAMPLE #2

Unnormalized Customer Table with Repeating data

Client



| ClientID | BusinessName | Address | Contact | PhoneType | Phone | InvNum | InvAmt | InvDue |
|----------|-----------------|---|-----------------|-----------|--------------|--------|----------|------------|
| 1234 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | Cell | 316-266-3333 | 1 | \$300 | 10/21/2009 |
| | | | | Office | 316-266-3332 | 2 | \$450 | 11/21/2009 |
| 5679 | Waterworks | 13234 N. Broadway, Wichita, KS 67778 | Melissa Gilbert | Office | 316-222-3455 | 3 | \$20,000 | 5/1/2009 |
| | | | | | | 4 | \$400 | 11/21/2009 |
| 2594 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | Cell | 316-852-9684 | 235 | \$1,354 | 2/13/2009 |
| | | | | Office | 316-248-5562 | | | |
| | | | | Fax | 316-564-5849 | | | |
| | | | | Pager | 316-999-9546 | | | |



Not broken into smallest usable data

What do you think the primary key might be to take this to 1NF?



CONVERSION TO 1NF EXAMPLE

After conversion to 1NF

Client

Primary Key

| ClientID | PhoneType | InvNum | BusinessName | Address | Contact | Phone | InvAmt | InvDue |
|----------|-----------|--------|-----------------|--------------------------------------|-----------------|--------------|----------|------------|
| 1234 | Cell | 1 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3333 | \$300 | 10/21/2009 |
| 1234 | Cell | 2 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3332 | \$450 | 11/21/2009 |
| 1234 | Office | 1 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3333 | \$300 | 10/21/2009 |
| 1234 | Office | 2 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3333 | \$450 | 11/21/2009 |
| 5679 | Office | 3 | Waterworks | 13234 N. Broadway, Wichita, KS 67778 | Melissa Gilbert | 316-222-3455 | \$20,000 | 5/1/2009 |
| 5679 | Office | 4 | Waterworks | 13234 N. Broadway, Wichita, KS 67778 | Melissa Gilbert | 316-222-3544 | \$400 | 11/21/2009 |
| 2594 | Cell | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-852-9684 | \$1,354 | 2/13/2009 |
| 2594 | Office | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-248-5562 | \$1,354 | 2/13/2009 |
| 2594 | Fax | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-564-5849 | \$1,354 | 2/13/2009 |
| 2594 | Pager | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-999-9546 | \$1,354 | 2/13/2009 |

CONVERSION TO 2NF EXAMPLE

What are the functional dependencies?

ClientID → BusinessName, Address, Contact

PhoneType → Phone

InvNum → InvAmt, InvDue

Not broken into smallest usable data


Primary Key

| ClientID | PhoneType | InvNum | BusinessName | Address | Contact | Phone | InvAmt | InvDue |
|----------|-----------|--------|-----------------|--------------------------------------|-----------------|--------------|----------|------------|
| 1234 | Cell | 1 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3333 | \$300 | 10/21/2009 |
| 1234 | Cell | 2 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3332 | \$450 | 11/21/2009 |
| 1234 | Office | 1 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3333 | \$300 | 10/21/2009 |
| 1234 | Office | 2 | Wichita Gidgets | P.O. Box 1234 Wichita, KS 67208 | John Doe | 316-266-3333 | \$450 | 11/21/2009 |
| 5679 | Office | 3 | Waterworks | 13234 N. Broadway, Wichita, KS 67778 | Melissa Gilbert | 316-222-3455 | \$20,000 | 05/1/2009 |
| 5679 | Office | 4 | Waterworks | 13234 N. Broadway, Wichita, KS 67778 | Melissa Gilbert | 316-222-3544 | \$400 | 11/21/2009 |
| 2594 | Cell | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-852-9684 | \$1,354 | 2/13/2009 |
| 2594 | Office | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-248-5562 | \$1,354 | 2/13/2009 |
| 2594 | Fax | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-564-5849 | \$1,354 | 2/13/2009 |
| 2594 | Pager | 235 | Arena Trust | 234 N. Emporia, Wichita, KS 67202 | Alice Alverson | 316-999-9546 | \$1,354 | 2/13/2009 |

AFTER CONVERSION TO 2NF - EXAMPLE

Client


Primary Key



| ClientID | BusinessName | LastName | FirstName | Street | City | State | Zip |
|----------|-----------------|----------|-----------|-------------------|---------|-------|-------|
| 1234 | Wichita Gadgets | Doe | John | P.O.Box 1234 | Wichita | KS | 67208 |
| 5679 | Wateworks | Gilbert | Melissa | 13234 N. Broadway | Wichita | KS | 67778 |
| 2594 | Arena Trust | Averson | Alice | 234 N. Emporia | Wichita | KS | 67202 |

Invoice


Primary Key



| InvNum | ClientID | InvAmt | InvDue |
|--------|----------|-------------|------------|
| 1 | 1234 | \$300.00 | 10/11/2009 |
| 2 | 1234 | \$450.00 | 11/21/2009 |
| 3 | 5679 | \$20,000.00 | 05/1/2009 |
| 4 | 5679 | \$400.00 | 11/21/2009 |
| 235 | 2594 | \$1,354.00 | 02/13/2009 |

ClientPhone

Primary Key




| ClientID | PhoneType | Phone |
|----------|-----------|--------------|
| 1234 | Cell | 316-266-3333 |
| 1234 | Office | 316-266-3332 |
| 2594 | Cell | 316-852-9684 |
| 2594 | Office | 316-248-5562 |
| 2594 | Fax | 316-564-5849 |
| 2594 | Pager | 316-999-5646 |
| 5679 | Office | 316-222-3455 |

CONVERSION TO 3NF - EXAMPLE

ClientPhone table still has a redundancy
PhoneType

So break out the Phone Type information and create a 4th table

ClientPhone



A pink box labeled "Primary Key" has a pink arrow pointing to the "PhoneType" column header. Another pink line connects the "ClientID" column header to the "PhoneType" column header, indicating a relationship.

| ClientID | PhoneType | Phone |
|----------|-----------|--------------|
| 1234 | Cell | 316-266-3333 |
| 1234 | Office | 316-266-3332 |
| 2594 | Cell | 316-852-9684 |
| 2594 | Office | 316-248-5562 |
| 2594 | Fax | 316-564-5849 |
| 2594 | Pager | 316-999-5646 |
| 5679 | Office | 316-222-3455 |

AFTER CONVERSION TO 3NF - EXAMPLE

Client

Primary Key

| ClientID | BusinessName | LastName | FirstName | Street | City | State | Zip |
|----------|-----------------|----------|-----------|-------------------|---------|-------|-------|
| 1234 | Wichita Gadgets | Doe | John | P.O.Box 1234 | Wichita | KS | 67208 |
| 5679 | Wateworks | Gilbert | Melissa | 13234 N. Broadway | Wichita | KS | 67778 |
| 2594 | Arena Trust | Averson | Alice | 234 N. Emporia | Wichita | KS | 67202 |

PhoneType

Primary Key

| PhoneTypeID | PhoneType |
|-------------|-----------|
| 1 | Cell |
| 2 | Office |
| 3 | Fax |
| 4 | Pager |

Invoice

Primary Key

| InvNum | ClientID | InvAmt | InvDue |
|--------|----------|-------------|------------|
| 1 | 1234 | \$300.00 | 10/11/2009 |
| 2 | 1234 | \$450.00 | 11/21/2009 |
| 3 | 5679 | \$20,000.00 | 05/1/2009 |
| 4 | 5679 | \$400.00 | 11/21/2009 |
| 235 | 2594 | \$1,354.00 | 02/13/2009 |

ClientPhone

Primary Key

| ClientID | PhoneTypeID | Phone |
|----------|-------------|--------------|
| 1234 | 1 | 316-266-3333 |
| 1234 | 2 | 316-266-3332 |
| 2594 | 1 | 316-852-9684 |
| 2594 | 2 | 316-248-5562 |
| 2594 | 3 | 316-564-5849 |
| 2594 | 4 | 316-999-5646 |
| 5679 | 2 | 316-222-3455 |



CREATE THIS DATABASE IN ACCESS

Remember!

Data types

Relationships

Referential Integrity

Client

Primary Key

| ClientID | BusinessName | LastName | FirstName | Street | City | State | Zip |
|----------|-----------------|----------|-----------|-------------------|---------|-------|-------|
| 1234 | Wichita Gadgets | Doe | John | P.O.Box 1234 | Wichita | KS | 67208 |
| 5679 | Wateworks | Gilbert | Melissa | 13234 N. Broadway | Wichita | KS | 67778 |
| 2594 | Arena Trust | Averson | Alice | 234 N. Emporia | Wichita | KS | 67202 |

PhoneType

Primary Key

| PhoneTypeID | PhoneType |
|-------------|-----------|
| 1 | Cell |
| 2 | Office |
| 3 | Fax |
| 4 | Pager |

Invoice

Primary Key

| InvNum | ClientID | InvAmt | InvDue |
|--------|----------|-------------|------------|
| 1 | 1234 | \$300.00 | 10/11/2009 |
| 2 | 1234 | \$450.00 | 11/21/2009 |
| 3 | 5679 | \$20,000.00 | 05/1/2009 |
| 4 | 5679 | \$400.00 | 11/21/2009 |
| 235 | 2594 | \$1,354.00 | 02/13/2009 |

ClientPhone

Primary Key

| ClientID | PhoneTypeID | Phone |
|----------|-------------|--------------|
| 1234 | 1 | 316-266-3333 |
| 1234 | 2 | 316-266-3332 |
| 2594 | 1 | 316-852-9684 |
| 2594 | 2 | 316-248-5562 |
| 2594 | 3 | 316-564-5849 |
| 2594 | 4 | 316-999-5646 |
| 5679 | 2 | 316-222-3455 |

DIFFERENT KINDS OF KEYS

➤ Natural Key

(logical or intelligent)

- Inherent characteristic of the item
- ISBN, SSN, UPC, VIN

➤ Artificial Key

- Not an inherent characteristic
- Visible to users
- Invoice ID, ClientID

➤ Surrogate Key (synthetic key)

- System-generated primary key
- Hidden from users
- PhoneTypeID

NORMALIZATION EXAMPLE # 3

Unnormalized Spreadsheet with Repeating Data

Music

| Album | Tracks | Artist | Artist Country |
|------------------|--|-----------|----------------|
| Abby Road | Here Comes the Sun Octopus Garden Something | Beatles | UK |
| Blond on Blond | Rainy Day Woman Sad Eyed Lady of the Lowlands Stuck in Mobile with the Memphis Blues Again | Bob Dylan | US |
| Yellow Submarine | Yellow Submarine Hey Bulldog All You Need is Love | Beatles | UK |

What do you think the primary key might be to take this to 1NF?

CONVERSION TO 1NF – EXAMPLE #3

Music

| Tracks | Album | Artist | Artist Country |
|--|------------------|-----------|----------------|
| Here Comes the Sun | Abby Road | Beatles | UK |
| Octopus Garden | Abby Road | Beatles | UK |
| Something | Abby Road | Beatles | UK |
| Rainy Day Woman | Blond on Blond | Bob Dylan | US |
| Sad Eyed Lady of the Lowlands | Blond on Blond | Bob Dylan | US |
| Stuck in Mobile with the Memphis Blues | Blond on Blond | Bob Dylan | US |
| Yellow Submarine | Yellow Submarine | Beatles | UK |
| Hey Bulldog | Yellow Submarine | Beatles | UK |
| All You Need is Love | Yellow Submarine | Beatles | UK |

Determine 3NF for this and create the tables in Access. Use good data types, references and referential integrity. *HINT: You will need to create 3 Surrogate Keys for this database!*



NORMALIZED— EXAMPLE #3

tblAlbum

| AlbumID | AlbumTitle |
|---------|------------------|
| 1 | Abby Road |
| 2 | Blond on Blond |
| 3 | Yellow Submarine |

tblArtist

| ArtistID | Artist | Artist Country |
|----------|-----------|----------------|
| 1 | Bob Dylan | US |
| 2 | Beatles | UK |

tblTracks

| Track ID | TrackName | Album ID | Artist ID |
|----------|--|----------|-----------|
| 1 | Here Comes the Sun | 1 | 2 |
| 2 | Octopus Garde3n | 1 | 2 |
| 3 | Something | 1 | 2 |
| 4 | Rainy Day Woman | 2 | 1 |
| 5 | Sad Eyed Lady of the Lowlands | 2 | 1 |
| 6 | Stuck in Mobile with the Memphis Blues | 2 | 1 |
| 7 | Yellow Submarine | 3 | 2 |
| 8 | Hey Bulldog | 3 | 2 |
| 9 | All You Need is Love | 3 | 2 |



NORMALIZATION EXAMPLE # 4

Contact

| ContactID | LastName | FirstName | Organization |
|-----------|----------|-----------|--|
| 1 | Miller | John | Walmart, National Retailers Association, Parsons Chamber of Commerce |
| 2 | O'Connor | Dennis | Labette County, Parsons Chamber of Commerce |
| 3 | Brunner | Nicholas | Leadership Cowley County |
| 4 | Fischer | Cindy | Civic Leadership Training, Leadership 2000 |
| 5 | Fountain | Wendy | WSU, Friends University |

Contacts can have one or more organizations. How can we modify the database to handle this situation?

NORMALIZED— EXAMPLE #4

tblContact

| ContactID | LastName | FirstName |
|-----------|----------|-----------|
| 1 | Miller | John |
| 2 | O'Connor | Dennis |
| 3 | Brunner | Nicholas |
| 4 | Fischer | Cindy |
| 5 | Fountain | Wendy |

tblOrganization

| OrgID | Organization |
|-------|--------------------------------|
| 1 | Walmart |
| 2 | National Retailers Association |
| 3 | Labette County |
| 4 | Parsons Chamber of Commerce |
| 5 | Leadership Cowley County |
| 6 | Civic Leadership Training |
| 7 | Leadership 2000 |
| 8 | WSU |
| 9 | Friends University |

tblContactOrganization

| ContactID | OrgID |
|-----------|-------|
| 1 | 1 |
| 1 | 2 |
| 1 | 4 |
| 2 | 3 |
| 2 | 4 |
| 3 | 5 |
| 4 | 6 |
| 4 | 7 |
| 5 | 8 |
| 5 | 9 |

