DBMS/SQL

Lesson 01: Getting Started with Database

Lesson Objectives

- To understand the following topics:
  - Introduction to Database
  - Characteristics of DBMS
  - Data models
  - Relational DBMS
  - Database Administrator

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1.1: Introduction to Database

What is Data?

- Data (plural of the word datum) is a factual information used as a basis for reasoning, discussion, or calculation
- Data may be numerical data which may be integers or floating point numbers, and non-numerical data such as characters, date etc.
- Data by itself normally doesn't have a meaning associated with it.

e.g:- Jack
01-jan-71
15-jun-05
50000

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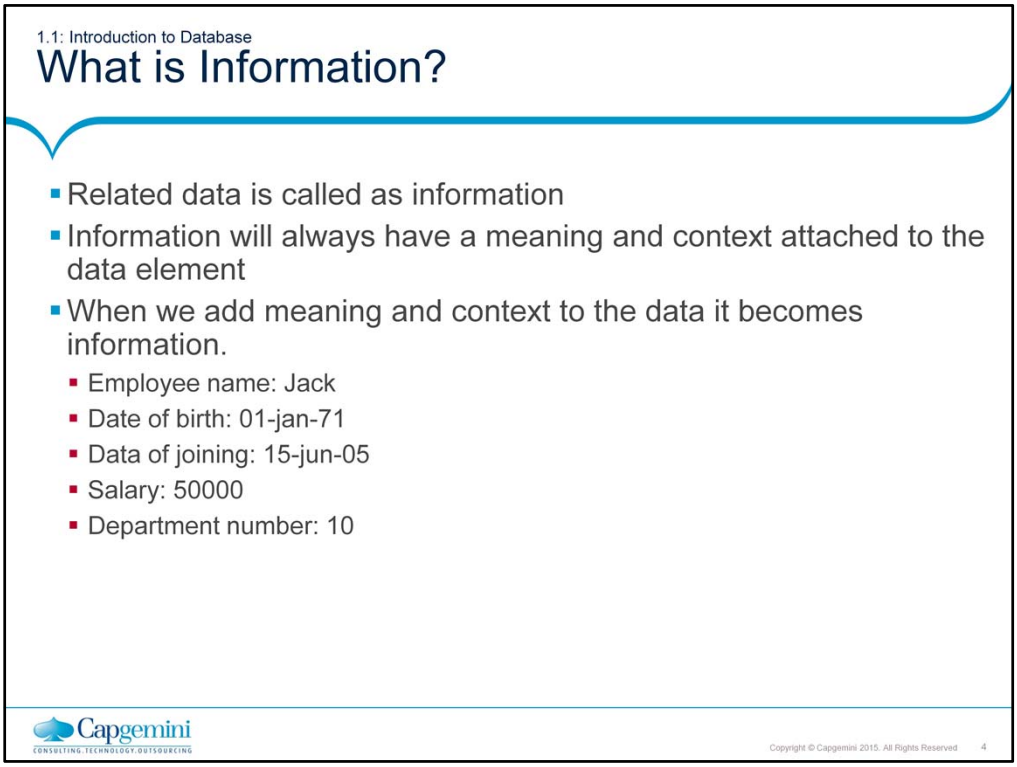
1.1: Introduction to Database
What is Information?
Related data is called as information
Information will always have a meaning and context attached to the data element
When we add meaning and context to the data it becomes information.
Employee name: Jack
Date of birth: 01-jan-71
Data of joining: 15-jun-05
Salary: 50000
Department number: 10
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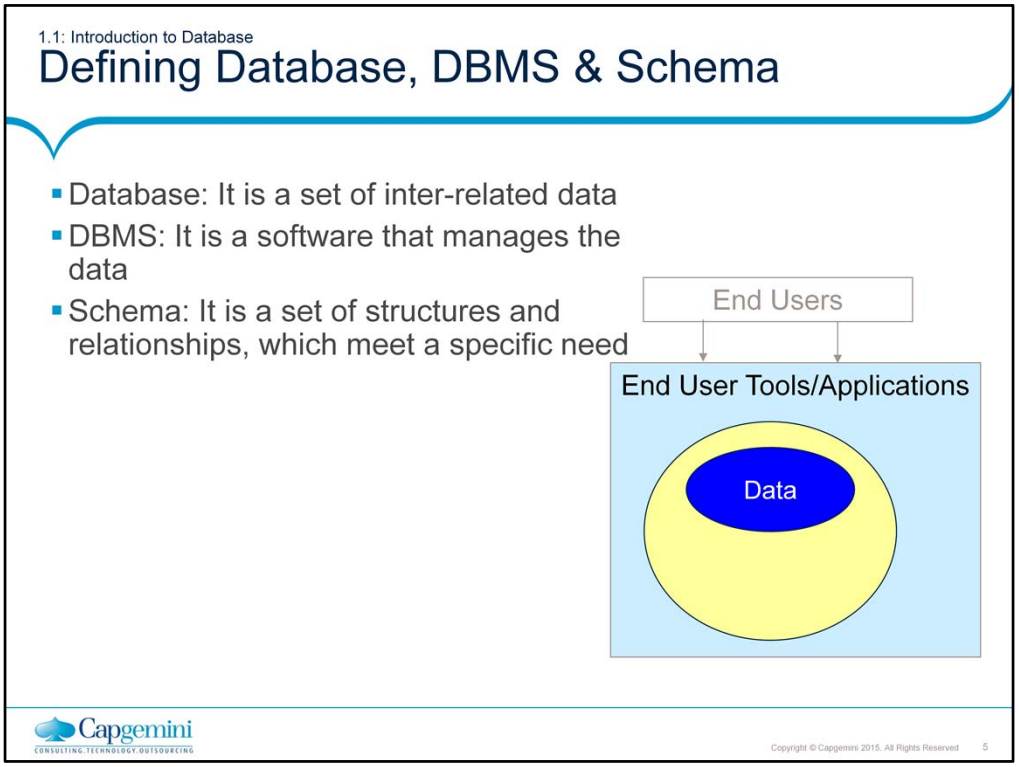
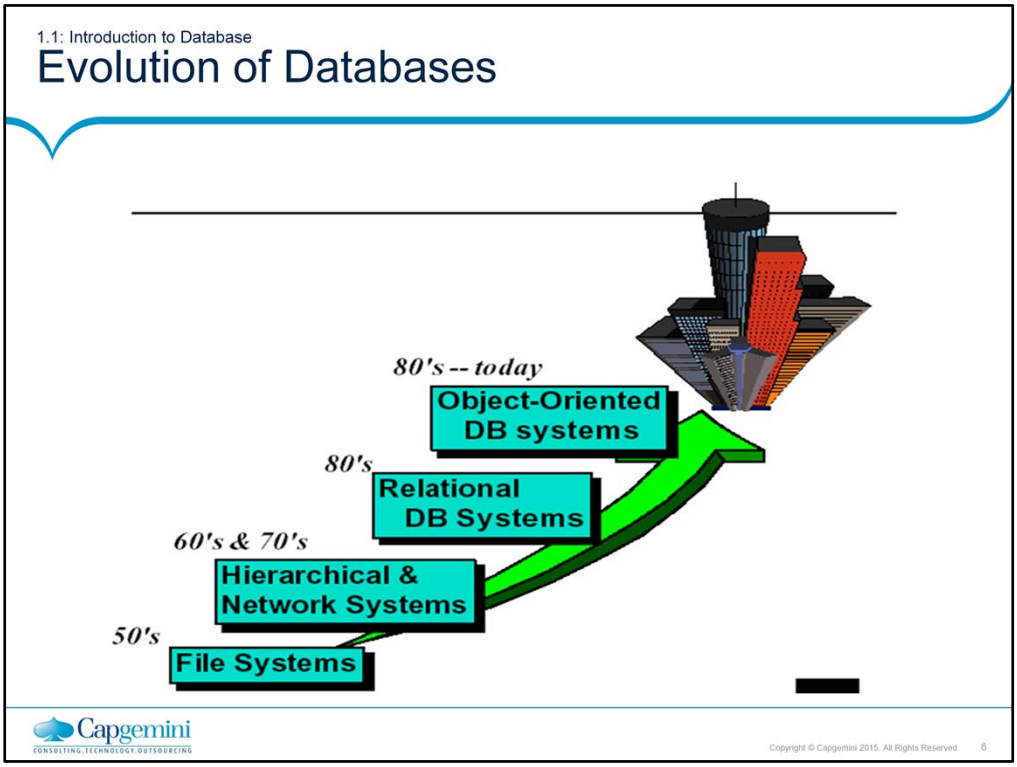


Introduction to Database:
A logically coherent collection of related data (“information”) with inherent meaning, built for a certain application, and representing a subset of the "real-world". For eg: Customer database in bank, Employee Details
The software that manages the database is known as “Database Management System” or “DBMS”. Hence DBMS can be described as "a computer-based record keeping system which consists of software for processing a collection of interrelated data". The general purpose of a DBMS is to provide for the definition, storage, and management of data in a centralized area that can be shared by many users
A set of structures and relationships that meet a specific need is called as a “schema”.


1.1: Introduction to Database
Evolution of Databases
80's -- today
Object-Oriented DB systems
80's
Relational DB Systems
60's & 70's
Hierarchical & Network Systems
50's
File Systems
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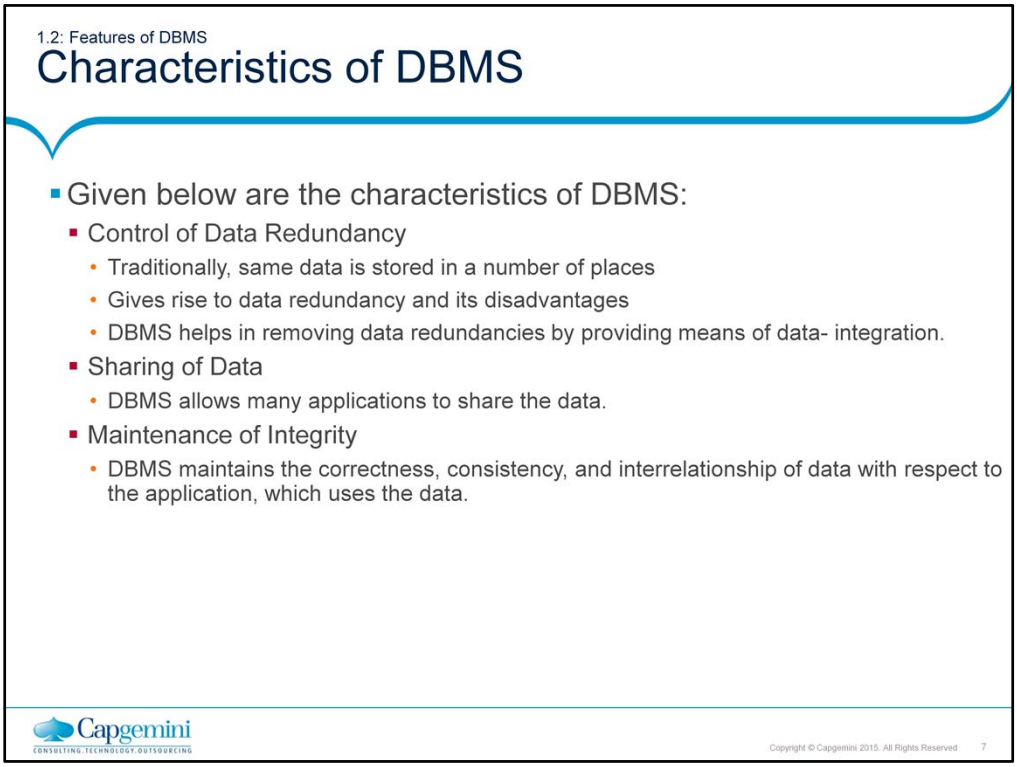

Characteristics of DBMS:

Some of the characteristics of the DBMS are given below:

Control of Data Redundancy

When the same data is stored in a number of files, it results in data redundancy. In such cases, if the data is changed at one place, the change has to be duplicated in each of the files.

The main disadvantages of data redundancy are:

Storage space is wasted.

Processing time may be wasted as more data needs to be handled.

Inconsistencies may creep in.

DBMS helps in removing redundancies by providing means of integration.

Sharing of Data

DBMS allows many applications to share the data.

Maintenance of Integrity

Integrity of data refers to the correctness, consistency and interrelationship of data with respect to the application that uses the data. Some of the aspects of data integrity are:

Many data items can only take a restricted set of values.

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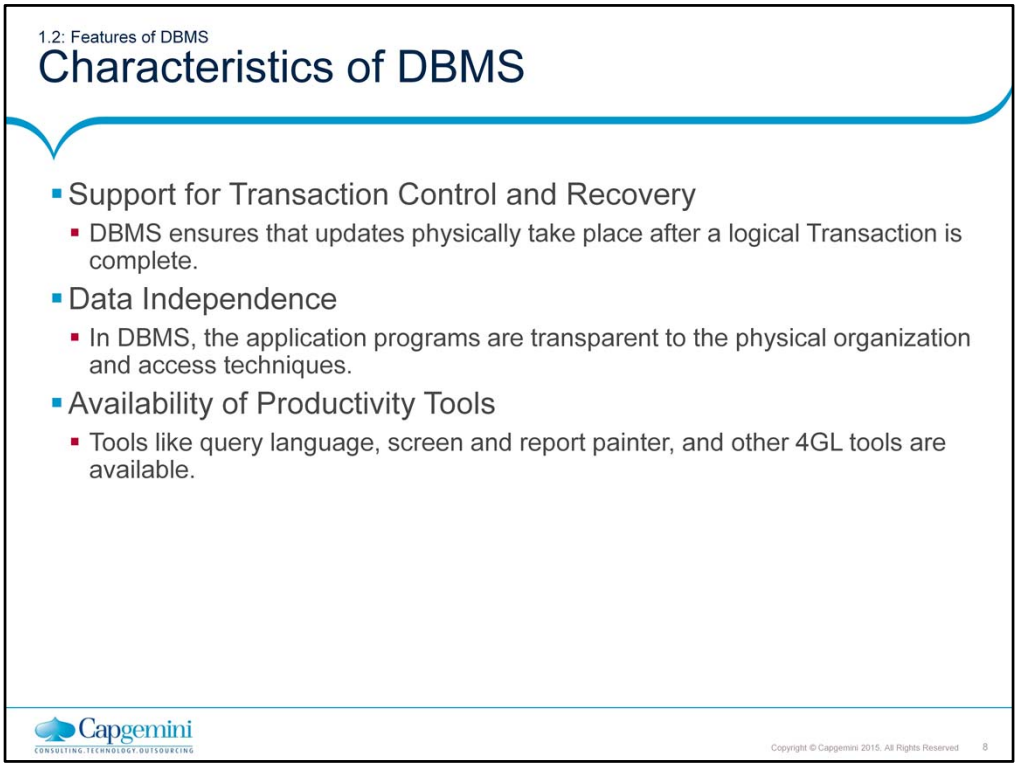


Characteristics of DBMS (contd.):

Certain field values cannot be duplicated across records. Such restrictions, called primary key constraints, can be defined to the DBMS.

Data integrity, which defines the relationships between different files, is called referential integrity rule, which can also be specified to the DBMS

Support for Transaction Control and Recovery

Multiple changes to the database can be clubbed together as a single “logical transaction”.

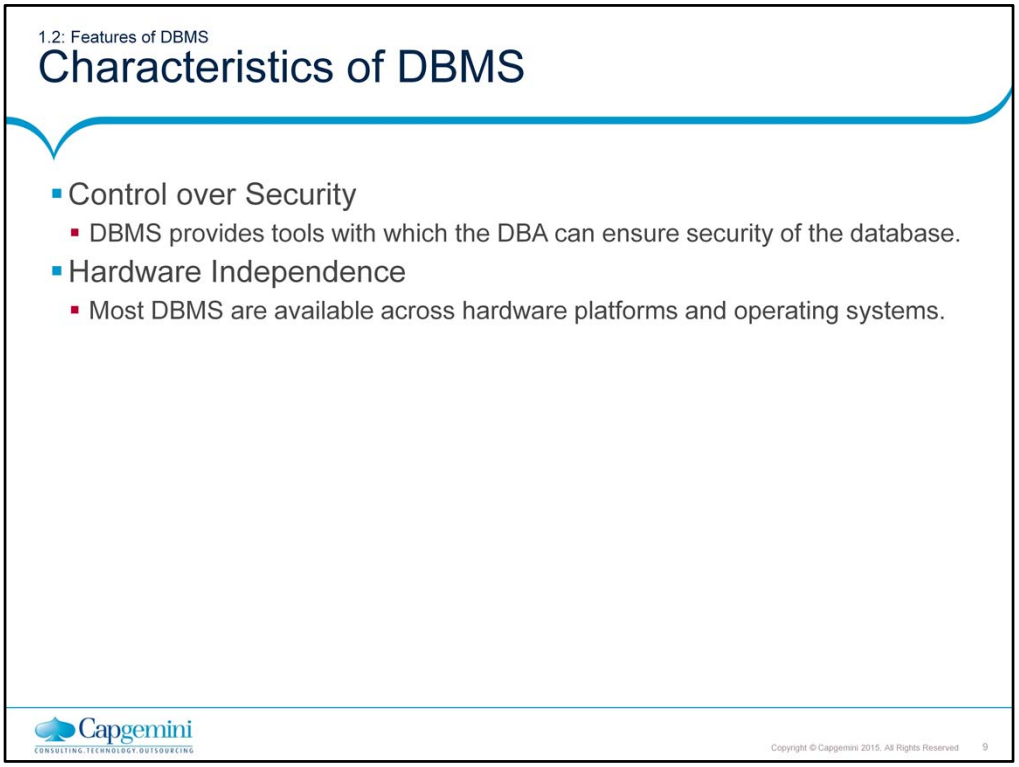
The DBMS ensures that the updates take place physically, only when the logical transaction is complete.

Data Independence

In conventional file based applications, programs need to know the “data organization” and “access technique” to be able to access the data.

This means that if you make any change in the manner the data is organized, then you have to make changes to the application programs that apply to the data.

In DBMS, the application programs are transparent to the “physical organization” and “access techniques”.



Characteristics of DBMS (contd.):

Availability of Productivity Tools

Tools like query language, screen and report painter, and other 4GL tools are available.

These tools can be utilized by the end-users to query, print reports, etc.

SQL is one such language, which has emerged as standard.

Security

DBMSes provide tools, which can be used by the DBA to ensure security of the database.

Hardware Independence

Most DBMSes are available across hardware platforms and operating systems.

Thus the application programs need not be changed or rewritten when the “hardware platform” or “operating system” is changed or upgraded.

1.2: Features of DBMS

Levels of Abstraction

- There are three levels of database abstraction:
  - Conceptual Level:
    - The overall integrated structural organization of the database.
  - Physical Level:
    - The information about how the database is actually stored in the disk.
  - View / External Level:
    - The user view of the database. It is different for different users based on application requirement.

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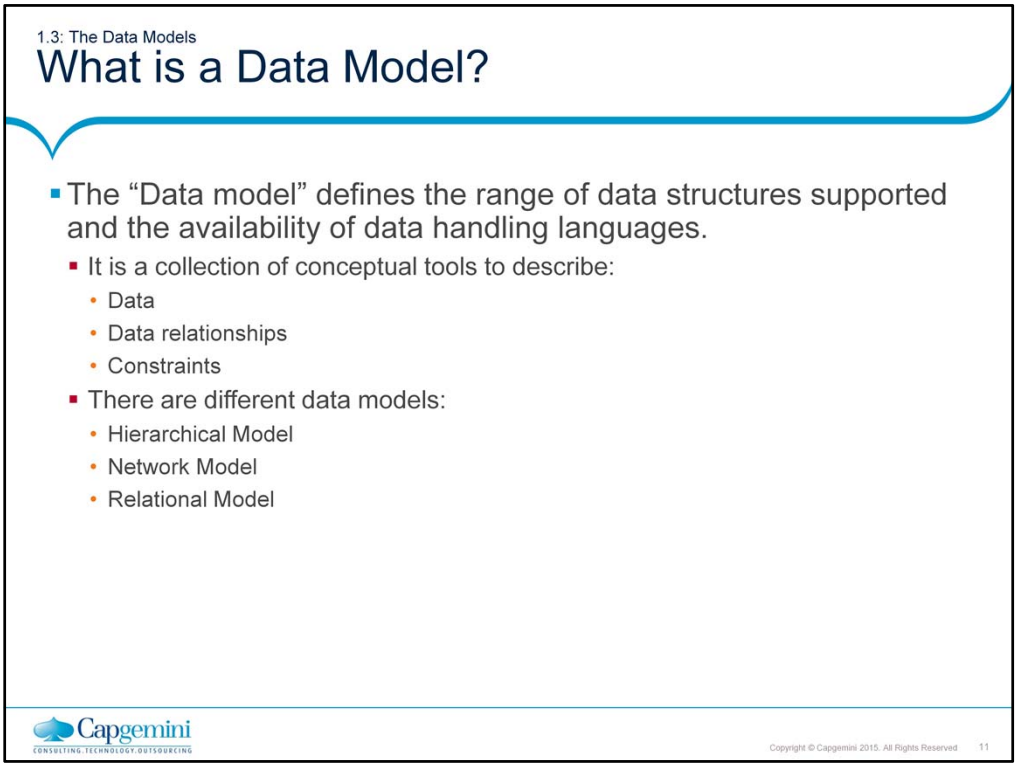


What is a Data Model?

A “Data model” is a conceptual representation of the data structures that are required by a database. The data structures include:

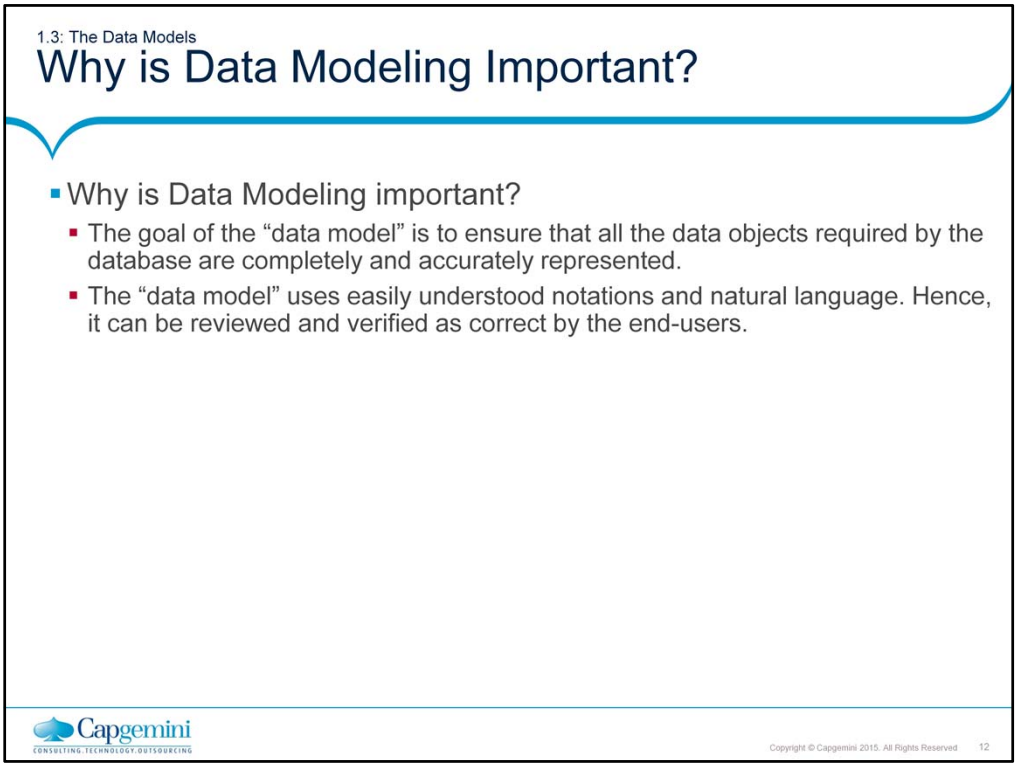
the data objects
the associations between data objects, and
the rules which govern operations on the objects

As the name implies, the “Data model” focuses on the data that is required, and how it should be organized rather than the operations that will be performed on the data.

The DBMS MODELS

The range of “data structures” that are supported, and the availability of data handling languages depend on the model of DBMS on which it is based. The models are:

The hierarchical model
The network model
The relational model



Why is Data Modeling Important?

The “data model” is also detailed enough to be used, by the database developers, as a “blueprint” for building the physical databases. The information contained in the “data model” will be used to define the relational tables, primary and foreign keys, stored procedures, and triggers.

Poorly designed databases require more time in the long-term. Without careful planning you may create a database that:

Omits data required to create critical reports.

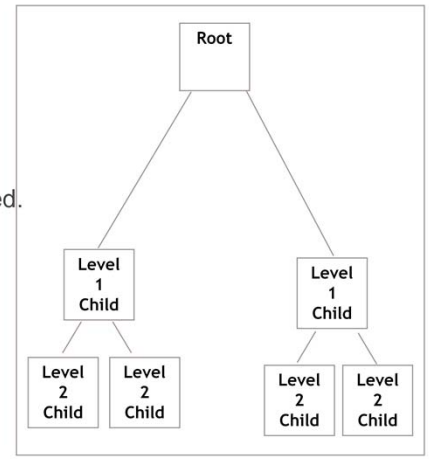
Produces results that are incorrect or inconsistent.

Is unable to accommodate changes in the user requirements.

1.3: The Data Models

Hierarchical Model

- The Hierarchical model:
  - In this model, data is represented by a simple tree-structure.
  - Relationships between entities are represented as parent-child.
  - Many-to-many relationships are not allowed.
  - Parents and children are tied together by links called “pointers”.



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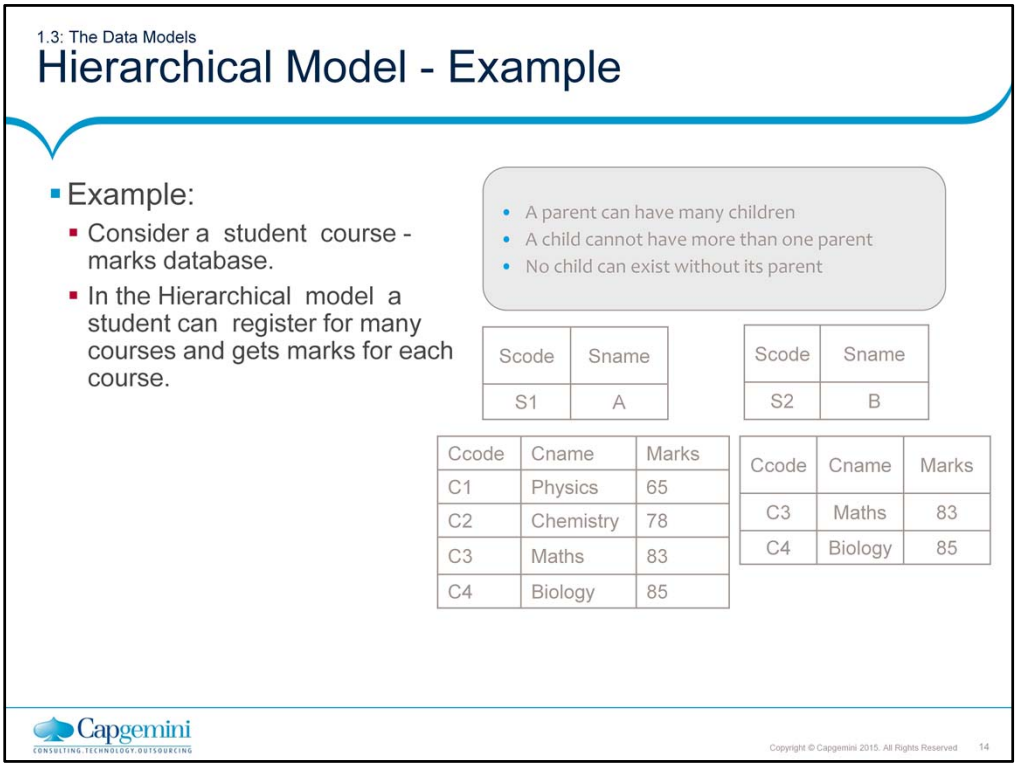
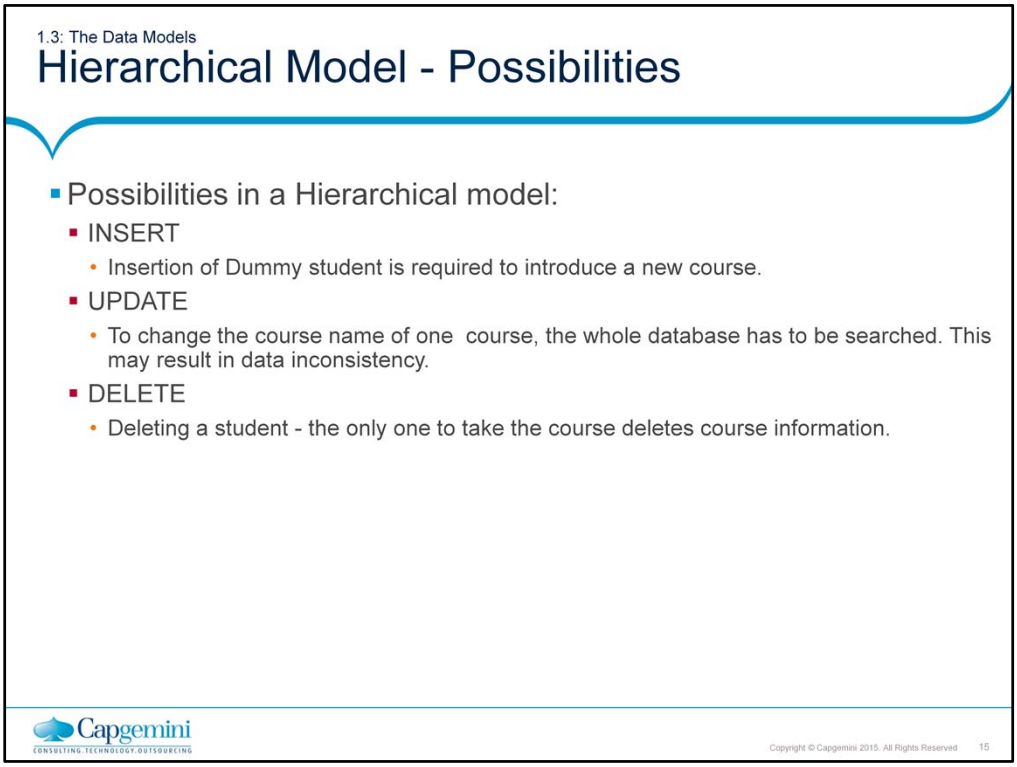


Example of a Hierarchical model:
Consider a student course - marks database. In the Hierarchical model a student can register for many courses, and get marks for each course.
The student record is called as “root”. It has got a course - marks record that is called as “child record”.
In general:

A parent can have many children.
A child cannot have more than one parent.
No child can exist without its parent.



Possibilities in a Hierarchical model:
In the Hierarchical model, following possibilities exist:

INSERT

Since no child record can exist without it's parent, it is not possible to insert the new course details without introducing a dummy student record.

UPDATE

To change the course name of one course, the whole database has to be searched. This may result in data inconsistency.

1.3: The Data Models

Network Model

- The Network model:
  - The Network model solves the problem of data redundancy by representing relationships in terms of “sets” rather than “hierarchy”.
  - A record occurrence may have any number of immediate superiors.
  - The Network model supports many-to-many relationships.
  - There is no restriction on number of parents.
  - A record type can have a number of parent and child record types.
  - It is more complex than the Hierarchical model because of links.
  - It is a superset of the Hierarchical model.

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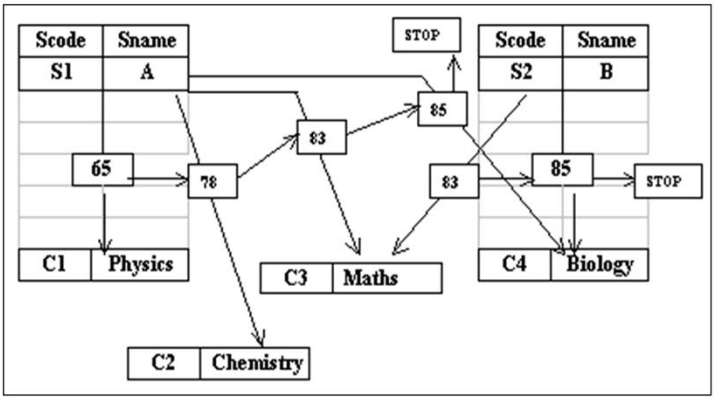
1.3: The Data Models

Network Model - Example

- In the example of student course – marks, "student record" and "course record" is linked together through "marks record".



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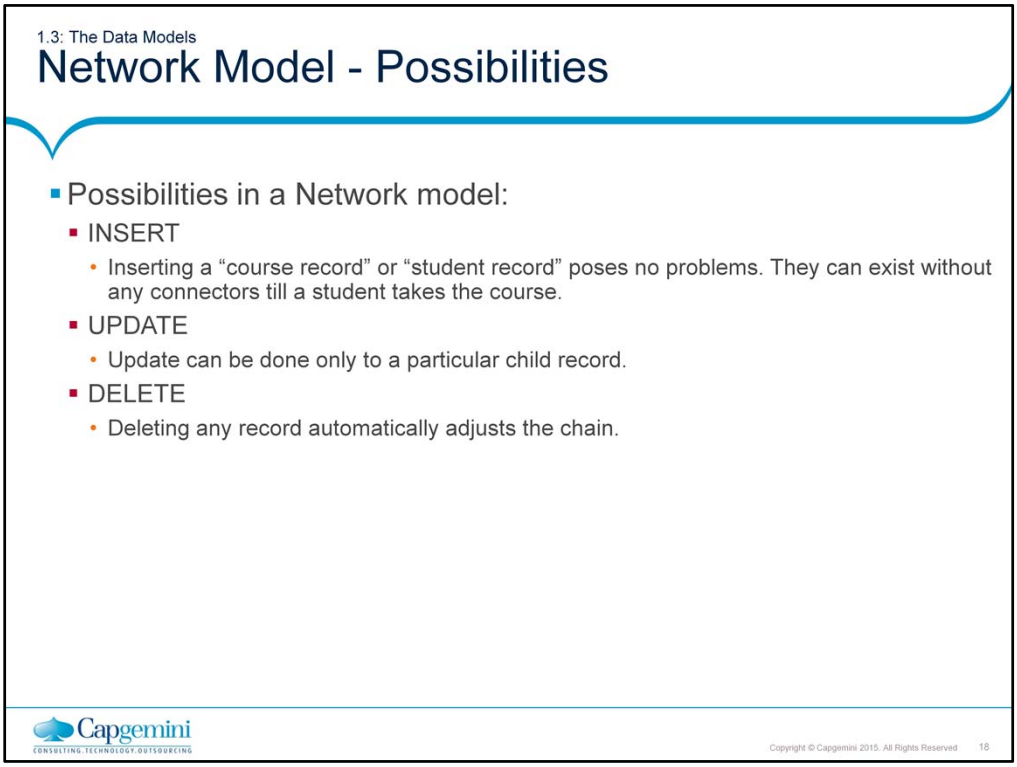
Example of Network model:
In the Network model, the "student record" and "course record" is linked together through a "marks record".
There are no restrictions on number of parents.
A record type can have any number of "parent" and "child" record types.
The Network model is more complex than the Hierarchical model because of it's links.
The Network model can represent any structure that is designed in the Hierarchical model. Hence, it is a superset of the Hierarchical model.



Possibilities in a Network model:
In Network model, following possibilities exist:

INSERT

Inserting a course record or student record poses no problems, as they can exist without any connectors till a student takes the course.

UPDATE

Update can be done only to a particular child record.

DELETE

Deleting any record automatically adjusts the chain.

1.3: The Data Models

Relational Model

- The Relational model:
  - The Relational model developed out of the work done by Dr. E. F. Codd at IBM in the late 1960s. He was looking for ways to solve the problems with the existing models.
  - At the core of the Relational model is the concept of a “table” (also called a “relation”), which stores all data.
  - Each “table” is made up of:
    - “records” (i.e. horizontal rows that are also known as “tuples”), and
    - “fields” (i.e. vertical columns that are also known as “attributes”)

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1.3: The Data Models

Relational Model

- The Relational model:
  - Examples of RDBMS:
    - Oracle
    - Informix
    - Sybase
  - Because of lack of linkages, the Relational model is easier to understand and implement.

Student Table	
Scode	Sname
S1	A
S2	B

Course Table	
Ccode	Cname
C1	Physics
C2	Chemistry
C3	Maths
C4	Biology

Marks Table		
Ccode	Scode	Marks
C1	S1	65
C2	S1	78
C3	S1	83
C4	S1	85
C3	S2	83
C4	S2	85

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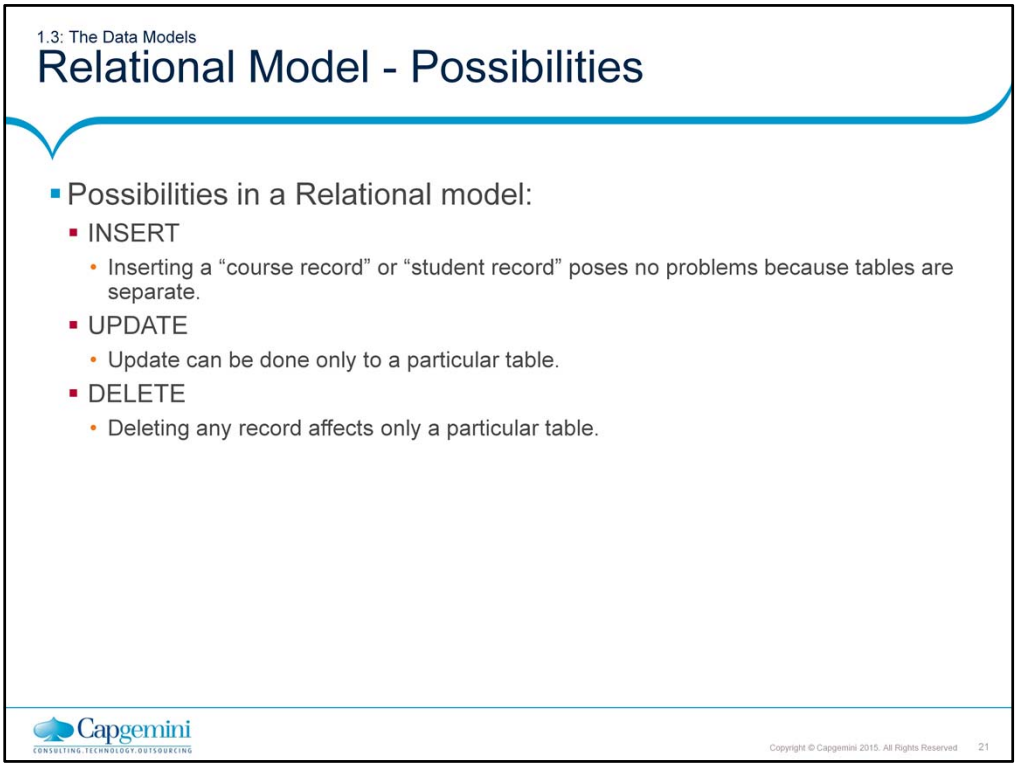


In Relational model, following possibilities exist:

INSERT

Inserting a course record or student record poses no problems, as the insert takes place on different tables

Inserting a child record would first check for the existence of the column column value being present in the parent table.

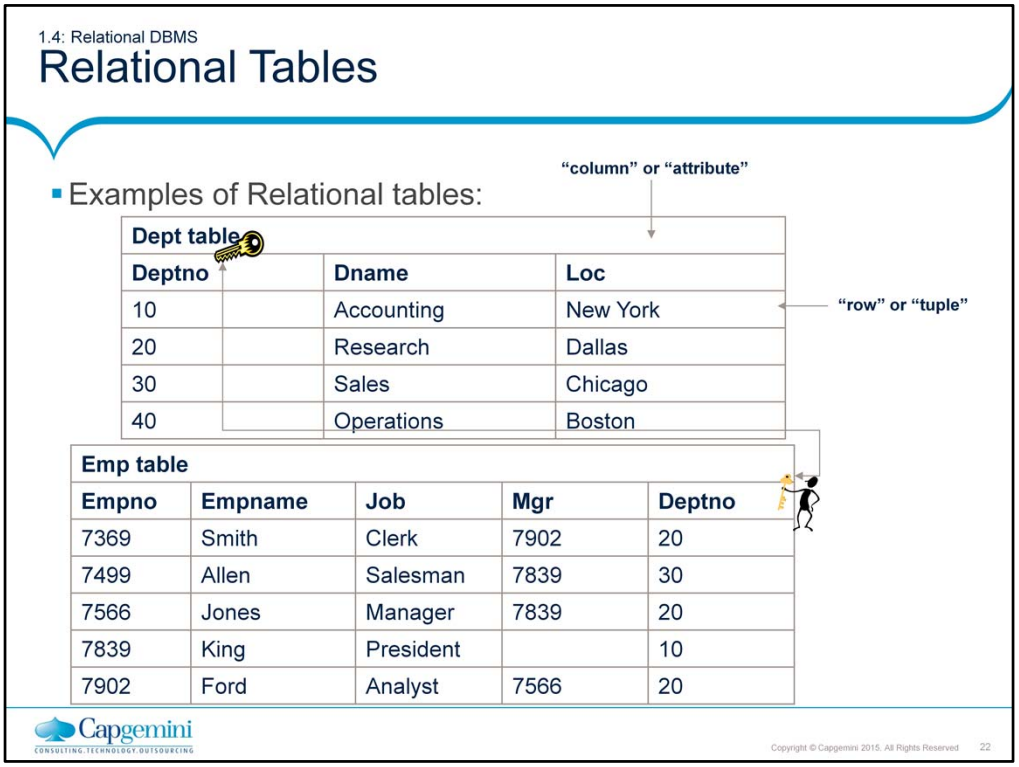
UPDATE

Update can be done only to a particular record, few records by specifying a condition.

DELETE

Deleting a record/few records of a particular table can be done by specifying a condition.

Deleting a parent record would not be allowed if child records exist.

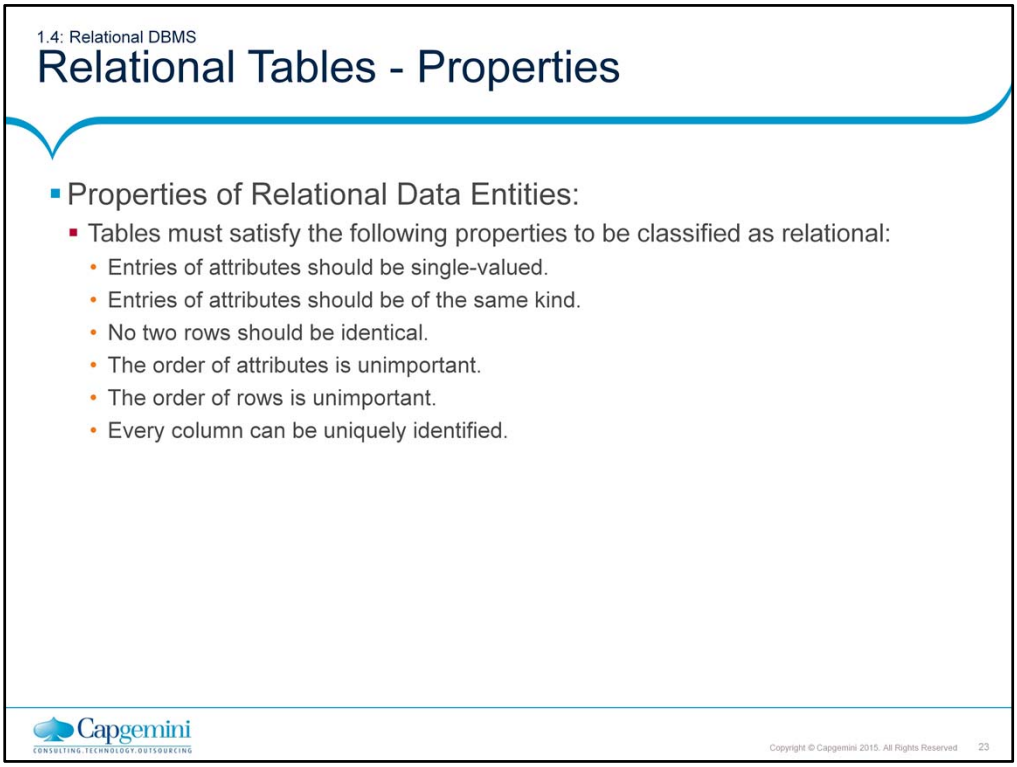


Relational DBMS (RDBMS):
The Relational model presents an orderly, predictable, and intuitive approach for:
- Organizing data,
- Manipulating data, and
- Viewing data

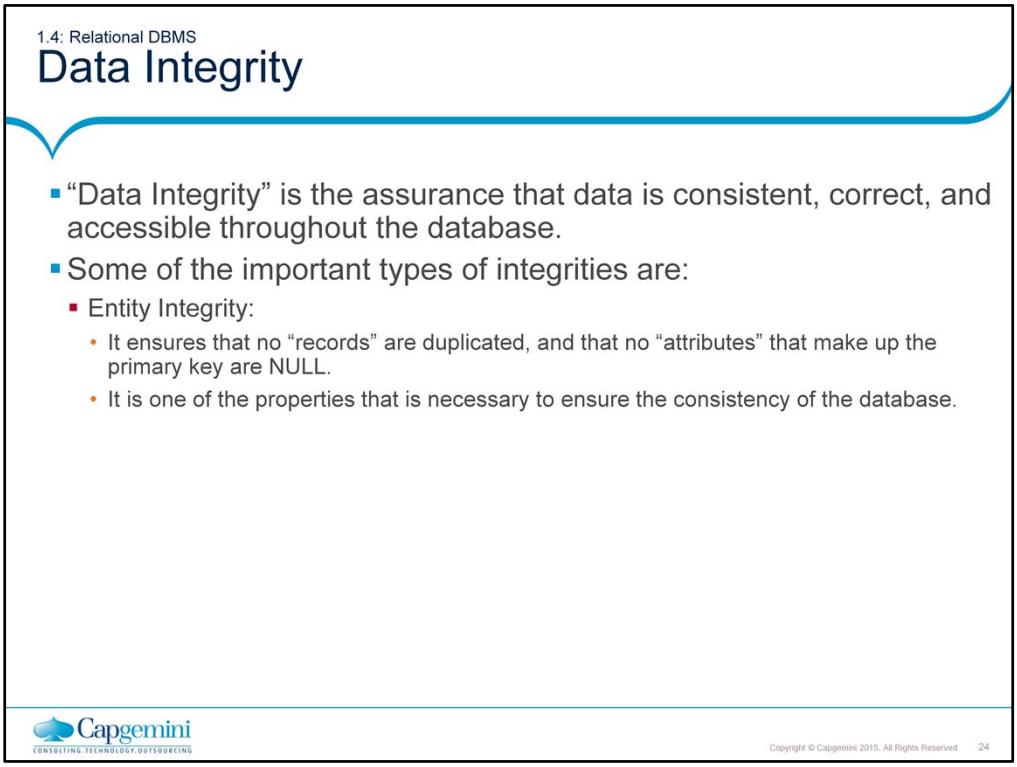
RDBMS Terminology
Relational data consists of relations.
- A relation (or relational table) is a "two dimensional" table with special properties.

A relational table consists of:
- a set of named columns, and
- an arbitrary number of rows

The columns are called as "attributes" or "fields". The rows are called as "tuples" or "records".
Each "attribute" is associated with a "domain".
- A "domain" is a set of values that may appear in one or more columns.



Properties of Relational Data Entities:
Relational tables have six properties,which must be satisfied for any table to be classified as Relational.These are :
Single valued attributes
Same datatype attribute values
Primary key
Attribute order not important
Row order not important
Uniquely identifiable column



Data Integrity:
Data Integrity refers to the wholeness and soundness of the database.
Some of the most important integrities are given below.
Domain Constraints

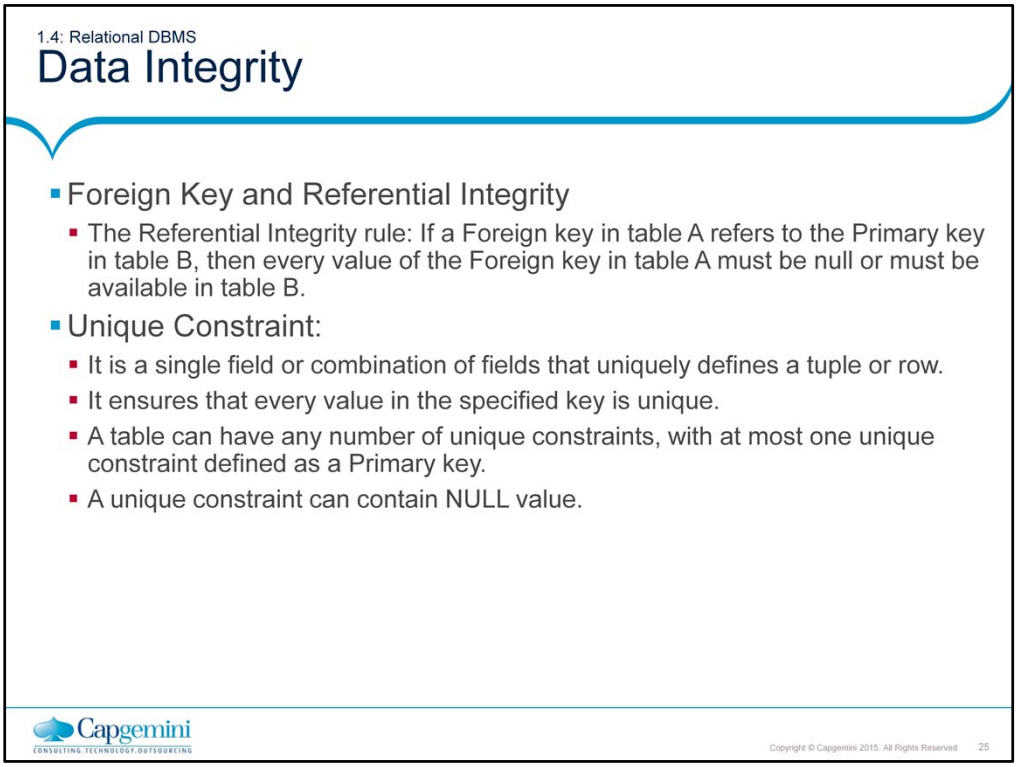
A "domain" is a set of values that are permitted to appear in one or more columns. Once a "domain" is specified and a "column" is associated with the "domain", then the "column" can take only those values that are permitted by the "domain".

Primary Key and Entity Integrity

"Primary key" is a "column" or "set of columns" in a table which uniquely identifies a "row" in a table.

No two rows of the table can have the same values for the Primary key.

Entity integrity is maintained by ensuring that none of the columns that make up the Primary key can take "NULL" (unknown) values.



Data Integrity:

Foreign Key and Referential Integrity

Foreign Key concept relates two tables. The child table's column which refers to the parent table's primary key column is called a foreign key column.

How to differentiate between parent and child table ?

Look at the values in the common column of both the tables. If there are unique values in the column, then this column is a primary key column and is present in the parent table.

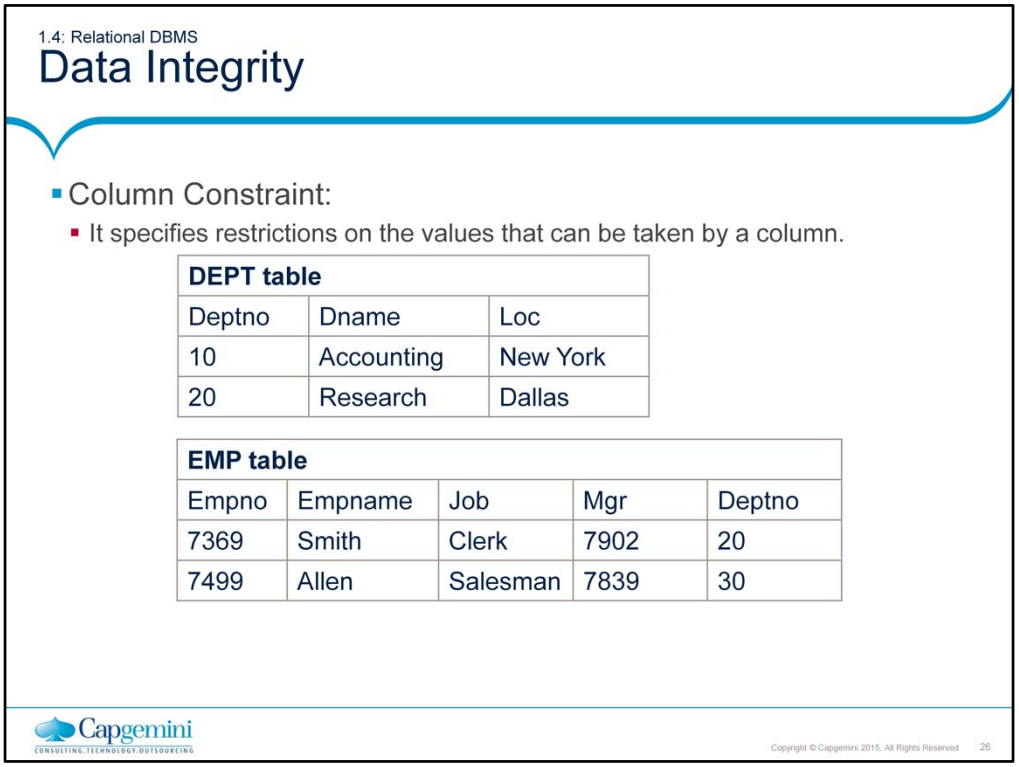
If there are duplicate values in the common column, then this column is a foreign key column and is present in the child table.

A foreign key column can contain null values also, unlike a primary key column

Unique Constraint

Unique constraint is applied to one or more columns to ensure that values in that column cannot repeat.

Applying a primary key constraint automatically makes the column unique and not null



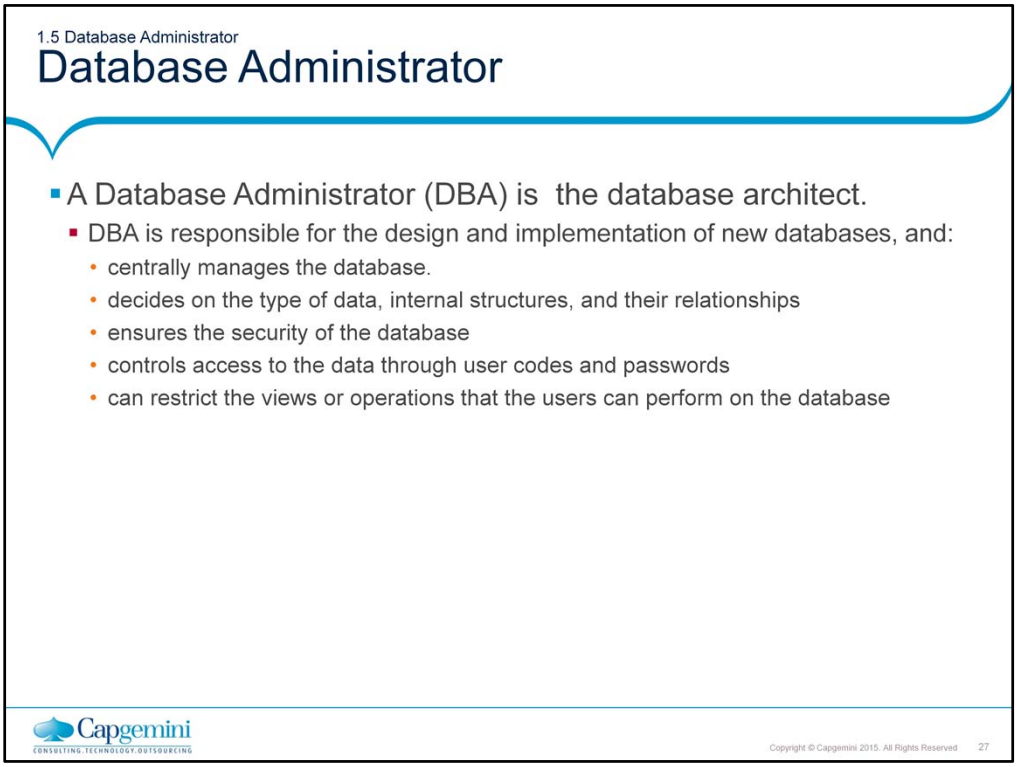
Data Integrity (contd.):

Update Cascade referential Integrity

This means that if a Primary key value is updated, then all Foreign key values dependent on it will be updated to the new value of Primary key. That is to say, if we change the deptno 10 to 50, then all the employees in deptno 10 will be shifted, as well, to deptno 50 (column deptno will be automatically updated).

Column Constraints

These are the constraints, which specify restrictions on the values that can be taken by a column. These restrictions may be defined with or without other values in the same row.


1.5 Database Administrator
Database Administrator
A Database Administrator (DBA) is the database architect.
DBA is responsible for the design and implementation of new databases, and:
centrally manages the database.
decides on the type of data, internal structures, and their relationships
ensures the security of the database
controls access to the data through user codes and passwords
can restrict the views or operations that the users can perform on the database
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Summary

- In this lesson, you have learnt:
  - What is a Database?
  - Characteristics of DBMS
  - The Data models, including:
    - the Hierarchical model
    - the Network model
    - the Relational model
  - Relational DBMS (RDBMS)
  - What is Data Integrity

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Review Question

- Question 1: A DBA ___.
  - Option 1: ensures the security of the application server.
  - Option 2: controls access to the data through the user codes and passwords.
  - Option 3: manages users.
- Question 2: The Physical Level is ___.
  - Option 1: the overall structural organization of the d/b.
  - Option 2: the information about how the database is actually stored in the disk.
  - Option 3: the user view of the database.

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Review Question

- Question 3: There are different data models such as ___.
- Question 4: In Network model, each table is made up “tuples” and “fields”.
  - True / False
- Question 5: A table can have any number of “Unique constraints”.
  - True / False

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Review Question: Match the Following

1. Hierarchical model	a) Inconsistencies may creep in.
2. Network model	b) Many-to-many relationships are not allowed.
3. Data redundancy	c) It is a superset of the Hierarchical model.
4. In DBMS	d) Application programs are transparent to the physical organization and access techniques.

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