

## IT420: Database Management and Organization

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### The Relational Model (Chapter 3, pg 71-81)

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## Database Design Process

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- Requirements analysis
- Conceptual design: Entity-Relationship Model
- **Logical design: transform ER model into relational schema**
- Schema refinement: Normalization
- Physical tuning

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## Goals

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- Understand:
  - The relational model
  - Relational model terminology

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## Relational Database

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- A **relation** is a two-dimensional table
- **Relation schema** describes the structure for the table
  - Relation name
  - Column names
  - Column types
- A **relational database** is a set of relations

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## Relation Example

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EMPLOYEE(EmployeeNumber:integer,  
FirstName:string,  
LastName:string,  
Department:string,  
Email:string,  
Phone:integer)

EmployeeNumber	FirstName	LastName	Department	Email	Phone
100	Jerry	Johnson	Accounting	JJ@somewhere.com	236-9987
200	Mary	Abernathy	Finance	MA@somewhere.com	444-8898
300	Liz	Smathers	Finance	LS@somewhere.com	777-0098
400	Tom	Caruthers	Accounting	TC@somewhere.com	236-9987
500	Tom	Jackson	Production	TJ@somewhere.com	444-9980
600	Eleanore	Caldera	Legal	EC@somewhere.com	767-0900
700	Richard	Bandalone	Legal	RB@somewhere.com	767-0900

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## Relation

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- All entries in a column are of the same kind
- Each column has a unique name
- Cells of the table hold a single value
- The order of the columns is not important
- The order of the rows is not important
- No two rows may be identical
  
- Rows contain data about entity instances
- Columns contain data about attributes of the entity

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## Tables That Are Not Relations

EmployeeNumber	FirstName	LastName	Department	Email	Phone
100	Jerry	Johnson	Accounting	JJ@somewhere.com	236-9987
200	Mary	Abernathy	Finance	MA@somewhere.com	444-8898
300	Liz	Smathers	Finance	LS@somewhere.com	777-0098
400	Tom	Caruthers	Accounting	TC@somewhere.com	236-9987
					236-0991
500	Tom	Jackson	Production	TJ@somewhere.com	444-9980
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					767-0011

EmployeeNumber	FirstName	LastName	Department	Email	Phone
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400	Tom	Caruthers	Accounting	TC@somewhere.com	236-9987
					Fax: 236-9987
					Home: 555-7171
500	Tom	Jackson	Production	TJ@somewhere.com	444-9980
600	Eleanore	Caldera	Legal	EC@somewhere.com	767-0900
					Fax: 236-9987
					Home: 555-7171
700	Richard	Bandalone	Legal	RB@somewhere.com	767-0900

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## Alternative Terminology

- Although not all tables are relations, the terms table and relation are normally used interchangeably
- The following sets of terms are equivalent:

Table	Column	Row
Relation	Attribute	Tuple
File	Field	Record

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## Integrity Constraints (IC)

- IC: condition that must be true for any instance of the database
- ICs are **specified** when schema is **defined**
- ICs are **checked** when relations are **modified**
- A **legal instance** of a relation is one that satisfies all specified ICs
- DBMS should not allow illegal instances

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## Keys

- A **key** is a combination of one or more columns that is used to identify rows in a relation
- A **composite key** is a key that consists of two or more columns
- A set of columns is a **key** for a relation if :
  - No two distinct rows can have same values in all key columns, and
  - This is not true for any subset of the key
- Part 2 false? A **superkey**

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## Keys in EMPLOYEE Relation

EmployeeNumber	FirstName	LastName	Department	Email	Phone
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300	Liz	Smathers	Finance	LS@somewhere.com	777-0098
400	Tom	Caruthers	Accounting	TC@somewhere.com	236-9987
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## Candidate and Primary Keys

- A **candidate key** is a key
- A **primary key** is a candidate key selected as the primary means of identifying rows in a relation:
  - There is one and only one primary key per relation
  - The primary key may be a composite key
  - The **ideal primary key** is short, numeric and never changes

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## Surrogate Keys

- A **surrogate key** as an artificial column added to a relation to serve as a primary key:
  - DBMS supplied
  - Short, numeric and never changes – an ideal primary key!
  - Has artificial values that are meaningless to users
- Remember Access

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## Surrogate Keys

NOTE: The primary key of the relation is underlined below:

- RENTAL\_PROPERTY without surrogate key:  
 RENTAL\_PROPERTY (Street, City, State/Province, Zip/PostalCode, Country, Rental\_Rate)
- RENTAL\_PROPERTY with surrogate key:  
 RENTAL\_PROPERTY (PropertyID, Street, City, State/Province, Zip/PostalCode, Country, Rental\_Rate)

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## Foreign Keys and Referential Integrity Constraints

- A **foreign key** is the primary key of one relation that is placed in another relation to form a link between the relations
- A **referential integrity constraint**: the values of the foreign key must exist as primary key values in the corresponding relation → No 'dangling references'

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## Foreign Key with a Referential Integrity Constraint

NOTE: The primary key of the relation is underlined and any foreign keys are in *italics* in the relations below:

DEPARTMENT (DepartmentName, BudgetCode, ManagerName)  
 EMPLOYEE (*EmployeeNumber*, EmployeeName, *DepartmentName*)

Where EMPLOYEE.DepartmentName must exist in DEPARTMENT.DepartmentName

- Can you name a data model w/o referential integrity?

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## ICE: Is This a Relation? Why?

A	X	C	A
John	Ryan	MD	jr@gmail.com
Bob	Smith	MD, VA, NY	bsm@gmail.com
Alice	Brown	CA	
Jane	Doe	WA	jd@yahoo.com
John	Ryan	MD	jr@gmail.com
5	4	5	4

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## ICE: Find PK, AK

X	Y	Z	W
John	Ryan	MD	<a href="mailto:jr@gmail.com">jr@gmail.com</a>
Bob	Smith	MD	<a href="mailto:bsm@gmail.com">bsm@gmail.com</a>
Alice	Brown	CA	
John	Doe	WA	<a href="mailto:jd@yahoo.com">jd@yahoo.com</a>

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## Summary – Relational Model

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- 2-D tables
- Relational schema: structure of table
- Constraints
  - Domain
  - Key
    - Candidate, Primary, Alternate, Surrogate
    - Foreign key – Referential integrity constraint

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