

David M. Kroenke and David J. Auer  
**Database Processing:**

Fundamentals, Design, and Implementation



**Chapter Five:**  
**Data Modeling with the**  
**Entity-Relationship**  
**Model**

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**Chapter Objectives**



- the purpose of **the data modeling** process
- **entity-relationship** (E-R) diagrams
- **entities, attributes, and relationships**
- create entity **identifiers**
- **minimum** and **maximum** cardinalities
- To understand **variations** of the E-R model
- To understand and be able to use strong **entity patterns**

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## The Data Model



- **Data model** : blueprint of **database design**.
- **Generalized** and **Abstract**
- **Easier** to change
- **Conceptual** database **problem**

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## E-R Model



- **Entity-Relationship** model

**Entity class**  
(定義欄位)

CUSTOMER Entity

CUSTOMER
CustomerNumber
CustomerName
Street
City
State
Zip
ContactName
Email

屬性及特徵  
**Attributes**

**Entity instance**  
(實際資料)

Two CUSTOMER Instances

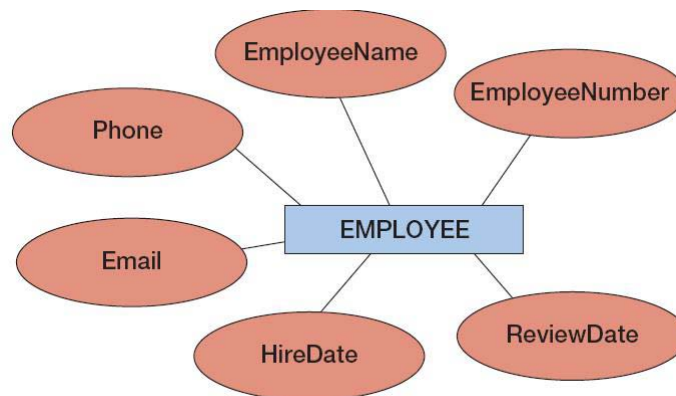
1234  
Ajax Manufacturing  
123 Elm Street  
Memphis  
TN  
32455  
P\_Schwartz  
P\_S@Ajax.com

99890  
Jones Brothers  
434 10th Street  
Boston  
MA  
01234  
Fritz Billingsley  
Fritz@JB.com

相同的屬性  
不同的值

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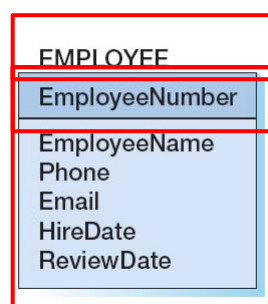
## EMPLOYEE: Attributes in Ellipses



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## EMPLOYEE: Attributes in Entity Rectangle

**Entity Name****Identifier****Attributes**

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## Entity Attribute Display in Data Models



EMPLOYEE

EmployeeNumber

EmployeeName  
Phone  
Email  
HireDate  
ReviewDate

(a) Entity with All  
Attributes

EMPLOYEE

EmployeeNumber

(b) Entity with Identifier  
Attribute Only

EMPLOYEE

(c) Entity with No  
Attributes

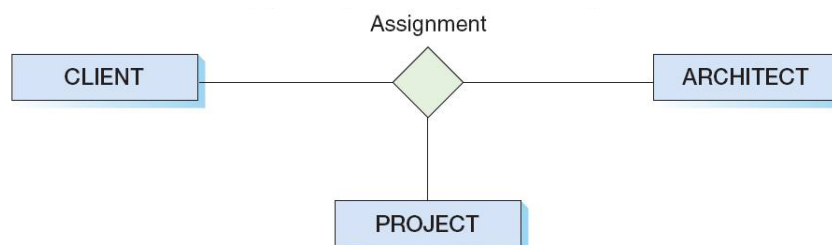
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## Relationships



- Entities can be associated with one another in **relationships**



**Ternary Relationship: degree 3**

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## Cardinality

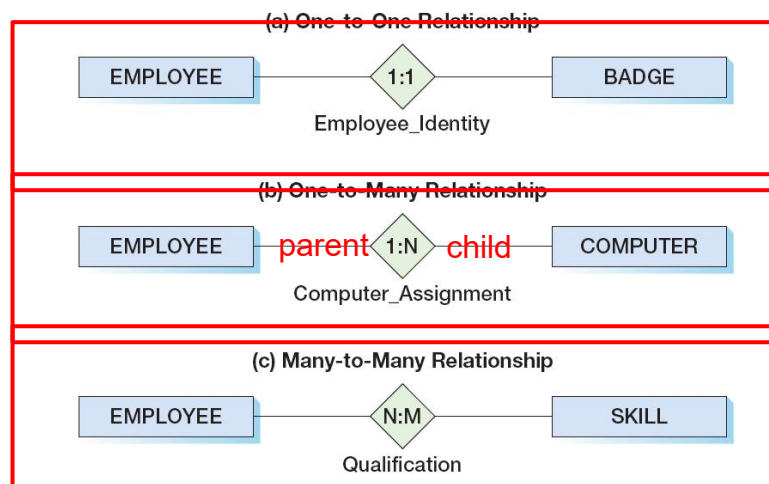


- **Cardinality** : “count”
- **Maximum cardinality** : the maximum number of entity instances that *can* participate in a relationship.
- **Minimum cardinality** : the minimum number of entity instances that *must* participate in a relationship.

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## The Three Types of Maximum Cardinality



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## Minimum Cardinality



- **Minimum cardinality** is the **minimum** number of entity instances that **must** participate in a relationship.
- Minimums are generally stated as either zero or one:
  - zero [0] : optional, *no* - circle
  - one [1] : required, *at least one* – vertical hash mark

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## The Three Types of Minimum Cardinality



(a) Required-to-Required Relationship (M-M)



(b) Optional-to-Optional Relationship (O-O)



(c) Optional-to-Required Relationship (O-O)



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## Data Modeling Notation: IE Crow's Foot I



Symbol	Meaning
	One—Mandatory
	Many—Mandatory
	One—Optional
	Many—Optional

EMPLOYEE

EmployeeNumber

EmployeeName

Phone

Email

HireDate

ReviewDate

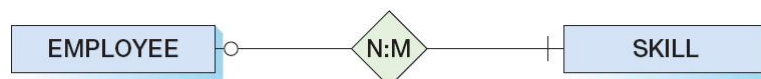
min

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max

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## Data Modeling Notation: IE Crow's Foot II



(a) Original E-R Model Version



(b) Crow's Foot Version

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## Strong Entity Patterns: 1:1 Strong Entity Relationships



(a) Club Membership Data Entry Form

**MEMBER\_LOCKER**

MemberNumber: 1000  
 MemberName: Jones  
 Phone: 123-456-7777  
 Email: Jones@somewhere.com  
 LockerNumber: 2100  
 LockerRoom: Mens

Record: 1 of 4

CLUB\_MEMBER

MemberNumber  
 MemberName  
 Phone  
 Email

(b) Club Locker Report

### CLUB\_LOCKERS

LockerRoom	LockerNumber	MemberNumber	MemberName	LockerSize
Mens	2100	1000	Jones	Med
Mens	2115	3000	Wu	Large
Womens	2200	2000	Abernathy	Large
Womens	2217	4000	Lai	Small

LOCKER

LockerNumber  
 LockerRoom  
 LockerSize

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## Strong Entity Patterns: 1:N Strong Entity Relationships



Company Departments

CompanyName: Ajax Manufacturing  
 City: Sydney

Departments

	DepartmentName	BudgetCode	MailStop
	Accounting	A-100	MS-100
	Production	P-100	MS-400
	Information Systems	IS-200	MS-417
	Sales	S-1400	MS-500

Record: 1 of 4

Record: 1 of 5

COMPANY

CompanyName  
 City


DEPARTMENT

DepartmentName  
 BudgetCode  
 MailStop

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Wireless Access 1





**(a) SUPPLIERS Form**

**SUPPLIERS**

CompanyName:   
 City:   
 Country:   
 Volume (USD):

**PARTS**

PartNumber	PartName	SalesPrice	ReOrderQuantity	QuantityOnHand
1000	Cedar Shakes	\$22.00	100	200
2000	Garage Heater	\$1,750.00	3	
3000	Utility Cabinet	\$55.00	7	

Record: 1 2 3 of 3

Record: 1 2 3 of 5

**COMPANY**

CompanyName

City

Country

Volume

**PART**

PartNumber


PartName

SalesPrice

ReOrderQuantity

QuantityOnHand

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**(b) PART Report**

**PART**

Number	PartName	SalesPrice	ROQ	QOH	CompanyName	City	Country
1000	Cedar Shakes	\$22.00	100	200	Bristol Systems	Mechester	England
					ERS Systems	Vancouver	Canada
					Forrest Supplies	Denver	US
2000	Garage Heater	\$1,750.00	3	4	Bristol Systems	Mechester	England
					ERS Systems	Vancouver	Canada
					Kyoto Importers	Kyoto	Japan
					Forrest Supplies	Denver	US
3000	Utility Cabinet	\$55.00	7	3	Alax Manufacturing	Sydney	Australia
					Forrest Supplies	Denver	US

**COMPANY**

CompanyName

City

Country

Volume

**PART**

PartNumber

PartName

SalesPrice

ReOrderQuantity

QuantityOnHand

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## 2 x 1:N → N:M Relationships

(a) SUPPLIERS Form

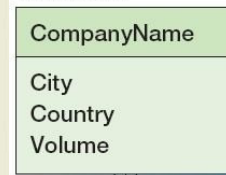
**SUPPLIERS**

CompanyName: Forest Supplies  
 City: Denver  
 Country: US  
 Volume (USD): \$177,990.00

PartNumber	PartName	SalesPrice	ReOrderQuantity	QuantityOnHand
1000	Cedar Shakes	\$22.00	100	200
2000	Garage Heater	\$1,750.00	3	4
3000	Utility Cabinet	\$55.00	7	3

Record: 3 of 3  
 Record: 5 of 5

COMPANY

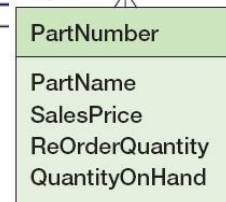


(b) PART Report

*PART*

Number	PartName	SalesPrice	ROQ	QOH	CompanyName	City	Country
1000	Cedar Shakes	\$22.00	100	200	Bristol Systems	Manchester	England
					ERS Systems	Vancouver	Canada
					Forest Supplies	Denver	US
2000	Garage Heater	\$1,750.00	3	4	Bristol Systems	Manchester	England
					ERS Systems	Vancouver	Canada
					Kyoto Importers	Kyoto	Japan
					Forest Supplies	Denver	US
3000	Utility Cabinet	\$55.00	7	3	Asia Manufacturing	Sydney	Australia

PART



## Review



- the **purpose** of the **data modeling** process
- **entity-relationship (E-R)** diagrams
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- To understand **variations** of the E-R model
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