Entity Relationship Modeling

Objectives:

- To illustrate how relationships between entities are defined and refined.
- To know how relationships are incorporated into the database design process.
- To describe how ERD components affect database design and implementation.

1.0 What is Conceptual Database Design?

- Process of describing the data, relationships between the data, relationships between the data, and the constraints on the data.
- After analysis - Gather all the essential data required and understand how the data are related
- The focus is on the *data*, rather than on the processes.
- The output of the conceptual database design is a **Conceptual Data Model** (+ *Data Dictionary*)

2.0 Gathering Information for Conceptual Data Modeling

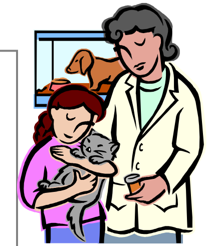
- Two perspectives
  - Top-down
    - Data model is derived from an intimate understanding of the business.
  - Bottom-up
    - Data model is derived by reviewing specifications and business documents.

2.0 Entity-Relationship (ER) Modeling.

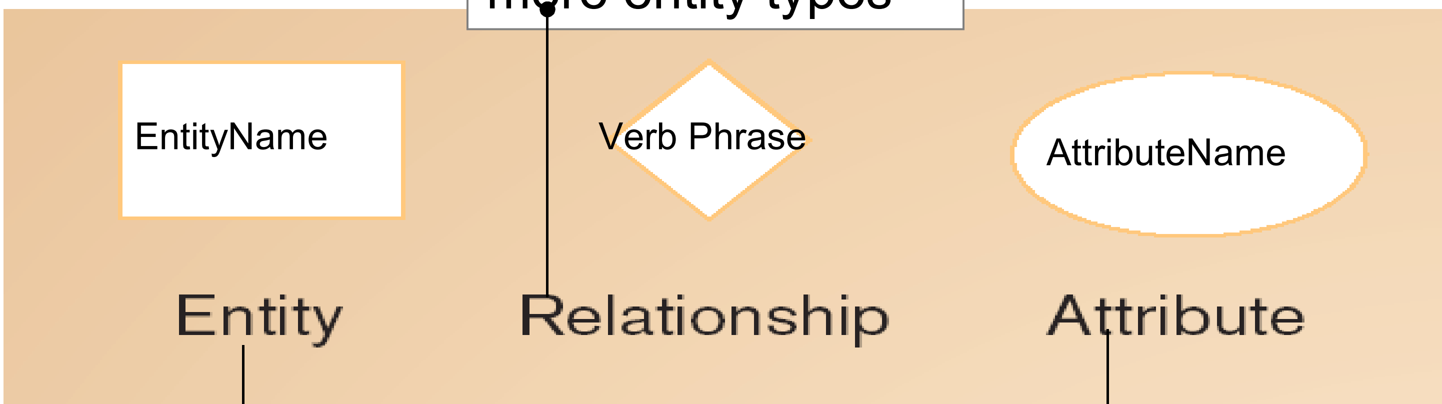
- **ER Modeling** is a *top-down* approach to database design.
- Entity Relationship (ER) Diagram
  - A detailed, logical representation of the entities, associations and data elements for an organization or business
- Notation uses three main constructs
  - Data entities
  - Relationships
  - Attributes

Chen Model & Crow's Foot Model

Chen Notation



Association between the instances of one or more entity types

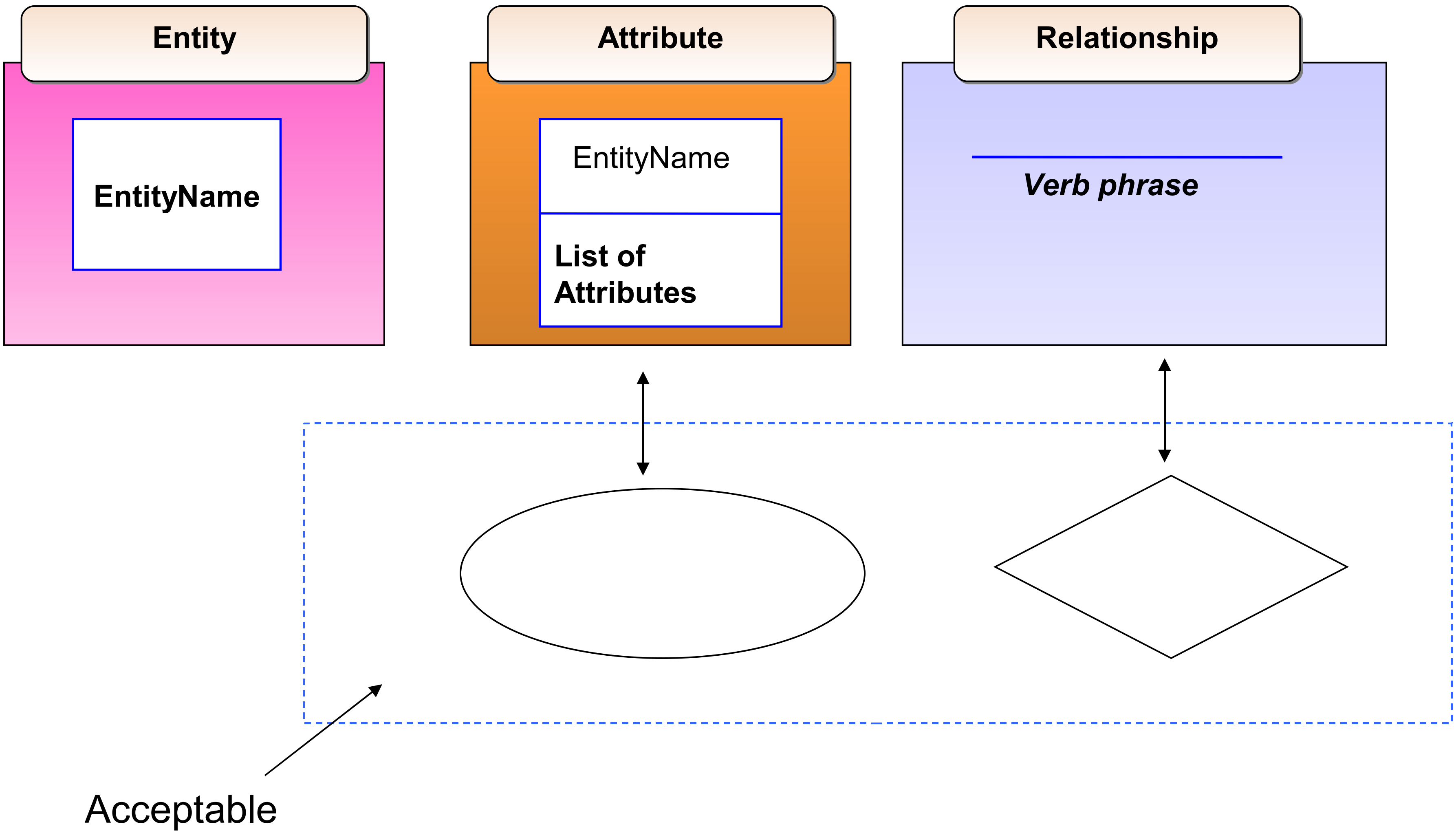


Person, place, object, event or concept about which data is to be maintained

named property or characteristic of an entity

Represents a set or collection of objects in the real world that share the same properties

Crow's Foot Notation



2.1 Entities

- Examples of entities:
  - Person: EMPLOYEE, STUDENT, PATIENT
  - Place: STORE, WAREHOUSE
  - Object: MACHINE, PRODUCT, CAR
  - Event: SALE,REGISTRATION, RENEWAL
  - Concept: ACCOUNT, COURSE




- Guidelines for naming and defining entity types:
  - An entity type name is a singular noun
  - An entity type should be descriptive and specific
  - An entity name should be concise
  - Event entity types should be named for the result of the event, not the activity or process of the event.

2.2 Attributes

- Example of entity types and associated attributes:

  STUDENT: Student_ID, Student_Name, Home_Address, Phone_Number, Major

- Guidelines for naming attributes:
  - An attribute name is a noun.
  - An attribute name should be unique
  - To make an attribute name unique and clear, each attribute name should follow a standard format
  - Similar attributes of different entity types should use similar but distinguishing names.

2.2.1 Identifier Attributes

- Candidate key
  - Attribute (or combination of attributes) that uniquely identifies each instance of an entity type
  - Some entities may have more than one candidate key
    - Ex: A candidate key for EMPLOYEE is Employee_ID, a second is the combination of Employee_Name and Address.
    - If there is more than one candidate key, need to make a choice.

- Identifier
  - A candidate key that has been selected as the unique identifying characteristic for an entity type

2.2.2 Referential Attributes

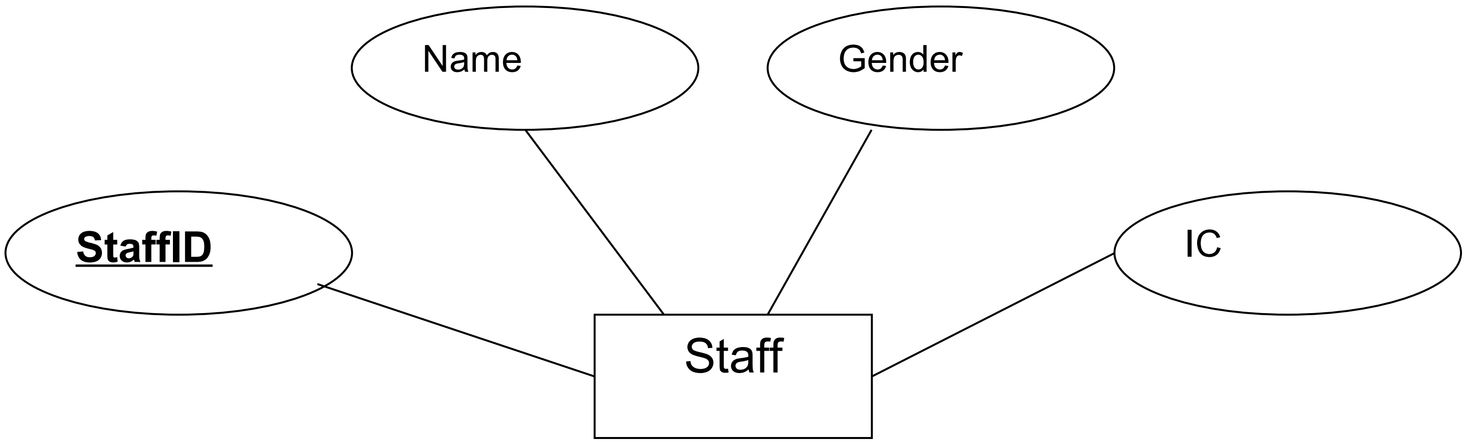
- Make Reference to another instance in another table

Referential attribute: Ties the lecturer entity to another entity that is department.

Instance of Lecturer.

Name	IdNum	DeptID	Email
Ali	105	LG	ali@a.com
Mary	106	IT	mary@a.com
John	107	ENG	john@a.com
Lim	108	IT	lim@a.com

Example



Staff	
PK	**<u>StaffID</u>**
	Name Gender IC

2.3 Relationships

→ Associations between instances of one or more entity types that is of interest

→ Given a name that describes its function.

- relationship name is an <u>active</u> or a <u>passive</u> verb.

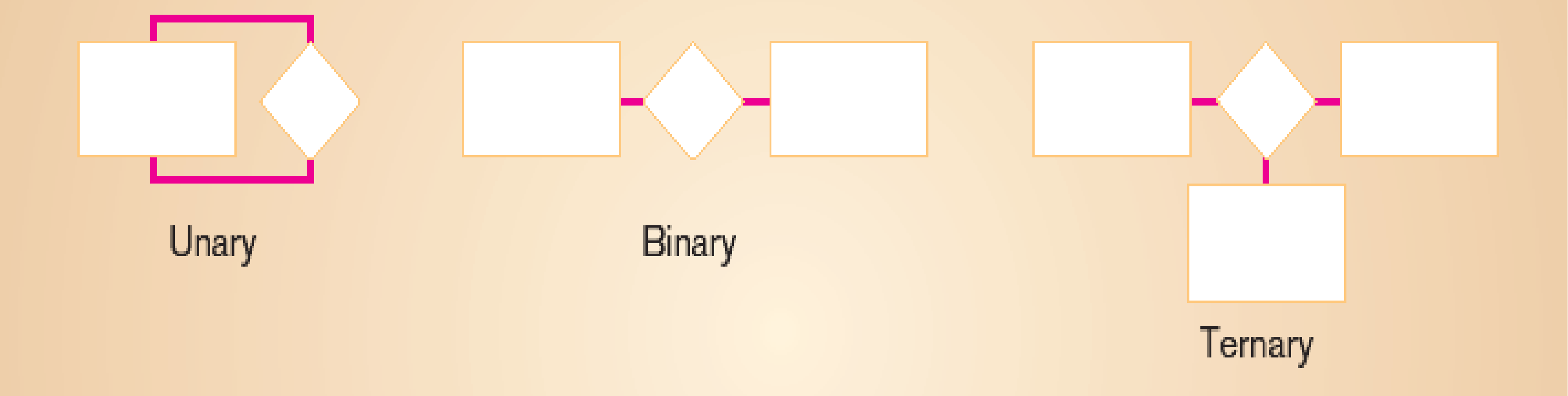
Relationship name:
writes

Author ⟷ **Book**

An author writes one or more books
A book can be written by one or more authors.

2.3.1 Degree of Relationships

- Degree: number of entity types that participate in a relationship
- Three cases
  - **Unary:** between two instances of one entity type
  - **Binary:** between the instances of two entity types
  - **Ternary:** among the instances of three entity types



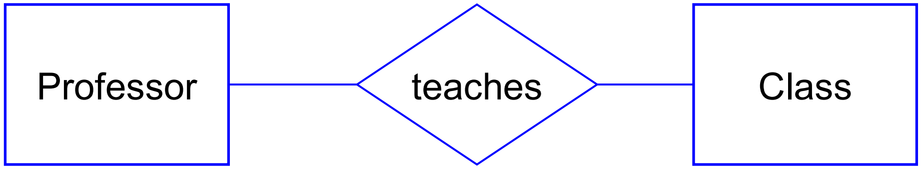
2.4 Cardinality and Connectivity

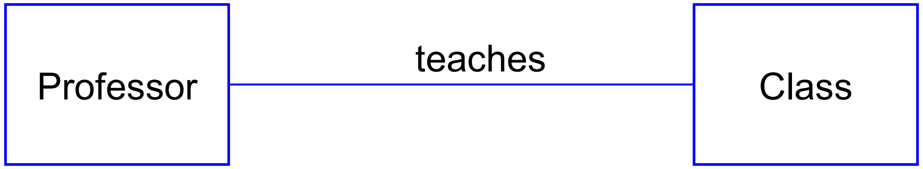
- Relationships can be classified as either
  - one – to – one
  - one – to – many
  - many – to –many

Connectivity

- ***Cardinality*** : minimum and maximum number of instances of Entity B that can (or must be) associated with each instance of entity A.

2.4 Cardinality and Connectivity

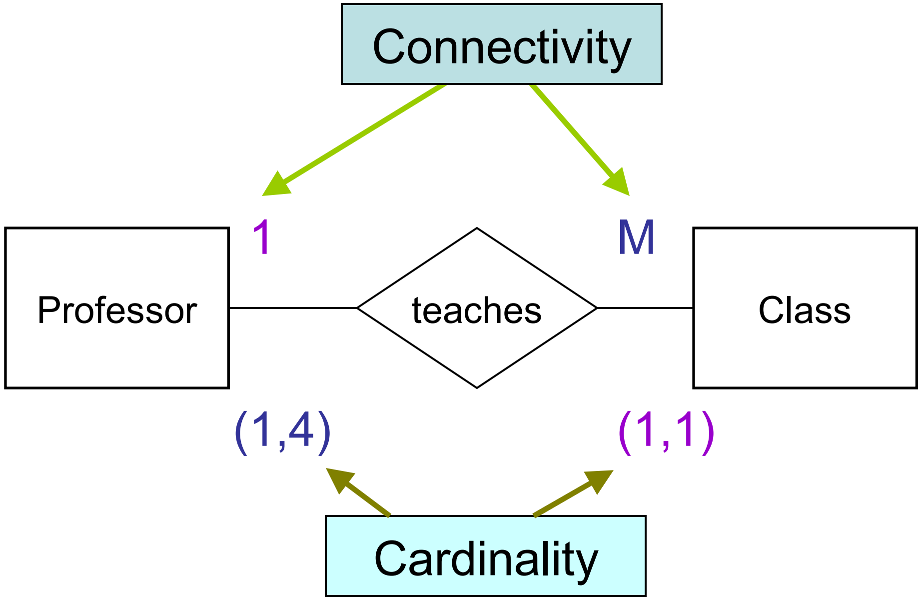


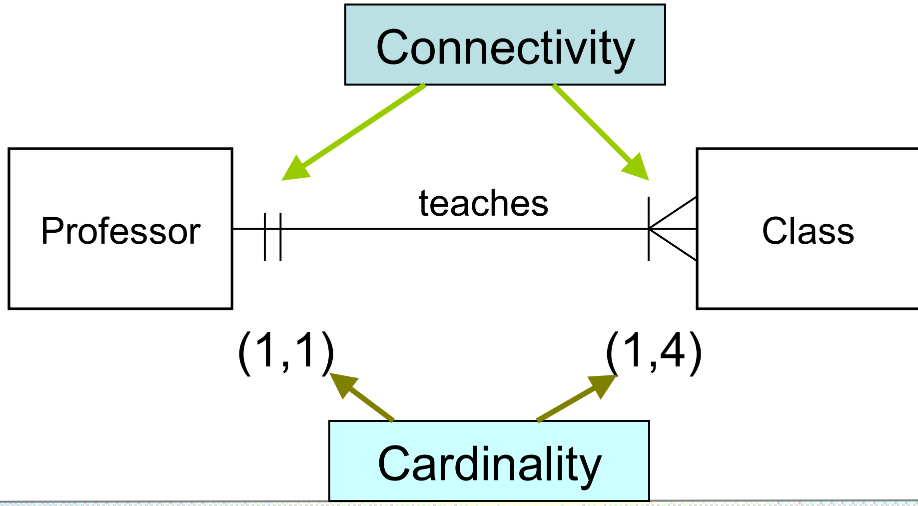


A professor teaches class OR
A class is taught by professor

How Many??

2.4 Cardinality and Connectivity





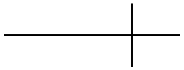
2.4.1 Connectivity

- Chen Model
  - 1 to represent one.
  - M to represent many

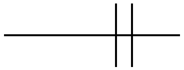
1

M

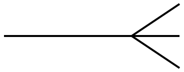
- Crow's Foot



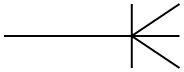
One



Mandatory one , means (1,1)



many

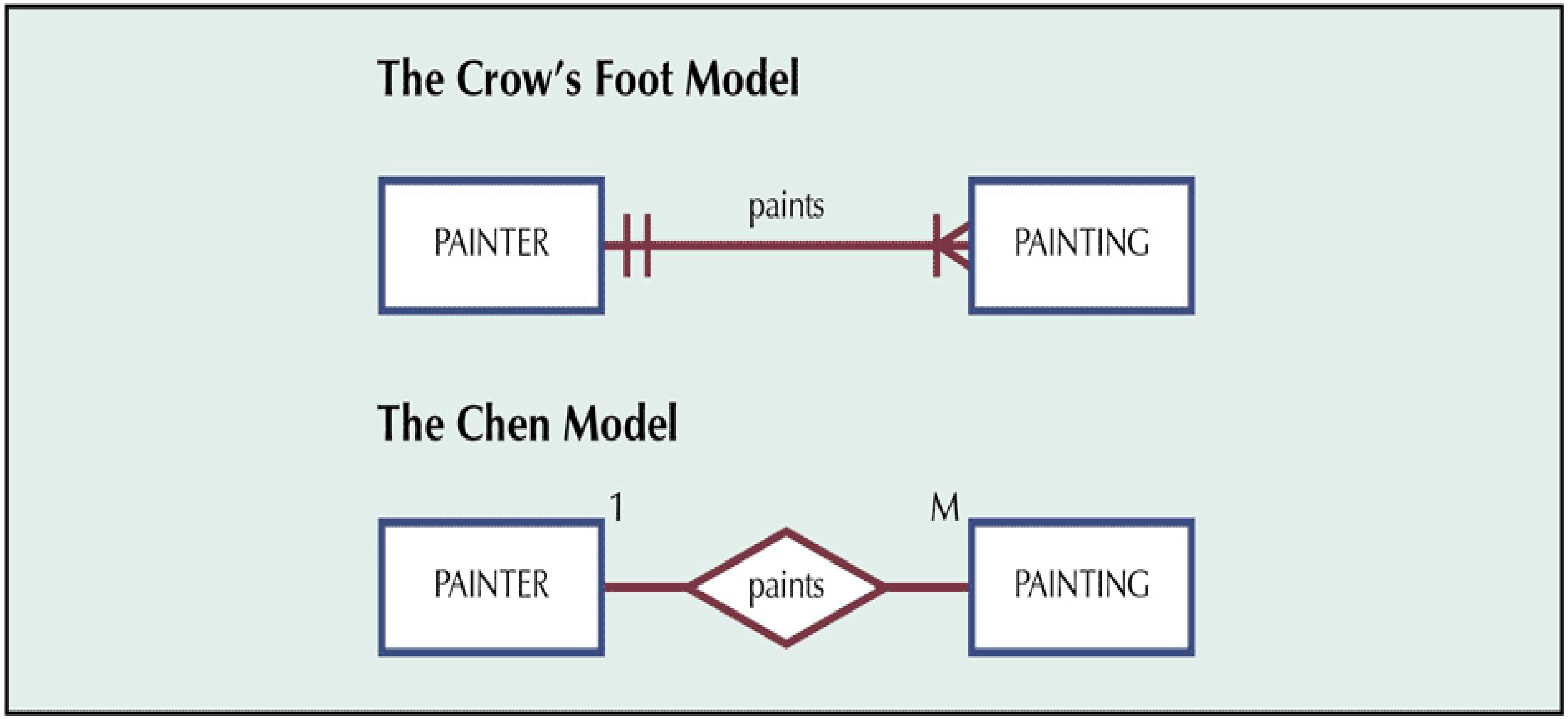


One or many

Optional? – we'll see after this

2.5 Binary Relationships

- **1:M relationship**
  - Relational modeling ideal
  - Should be the norm in any relational database design



The 1: M relationship between PAINTER and PAINTING

Table name: PAINTER
Primary key: PAINTER_NUM
Foreign key: none

Database name: Ch03_Museum

		PAINTER_NUM	PAINTER_LNAME	PAINTER_FNAME	PAINTER_INITIAL
▶	+	123	Ross	Georgette	P
	+	126	Itero	Julio	G

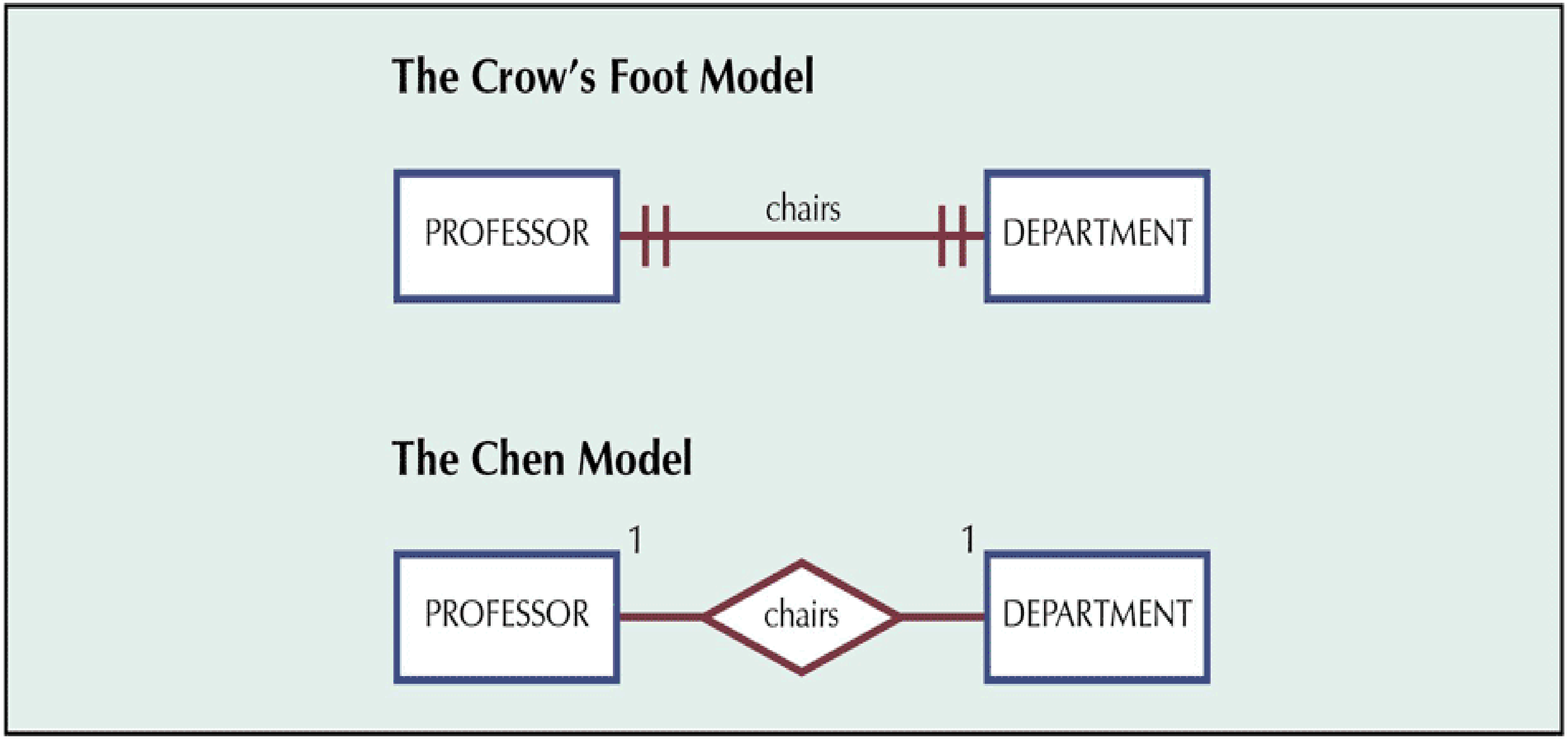
Table name: PAINTING
Primary key: PAINTING_NUM
Foreign key: PAINTER_NUM

	PAINTING_NUM	PAINTING_TITLE	PAINTER_NUM
▶	1338	Dawn Thunder	123
	1339	Vanilla Roses To Nowhere	123
	1340	Tired Flounders	126
	1341	Hasty Exit	123
	1342	Plastic Paradise	126

The Implemented 1:M relationship between PAINTER and PAINTING

2.5 Binary Relationships

- **<u>1:1 relationship</u>**
  - Should be rare in any relational database design
  - A single entity instance in one entity class is related to a single entity instance in another entity class
  - Could indicate that two entities actually belong in the same table



The 1:1 Relationship Between PROFESSOR and DEPARTMENT

Table name: PROFESSOR
Primary key: EMP_NUM
Foreign key: DEPT_CODE

Database name: Ch03_TinyCollege

EMP_NUM	DEPT_CODE	PROF_OFFICE	PROF_EXTENSION	PROF_HIGH_DEGREE
103	HIST	DRE 156	6783	Ph.D.
104	ENG	DRE 102	5561	MA
105	ACCT	KLR 229D	8665	Ph.D.
106	MKT/MGT	KLR 126	3899	Ph.D.
110	BIOL	AAK 160	3412	Ph.D.
114	ACCT	KLR 211	4436	Ph.D.
155	MATH	AAK 201	4440	Ph.D.
160	ENG	DRE 102	2248	Ph.D.
162	CIS	KLR 203E	2359	Ph.D.
191	MKT/MGT	KLR 409B	4016	DBA
195	PSYCH	AAK 297	3550	Ph.D.
209	CIS	KLR 333	3421	Ph.D.
228	CIS	KLR 300	3000	Ph.D.
297	MATH	AAK 194	1145	Ph.D.
299	ECON/FIN	KLR 284	2851	Ph.D.
301	ACCT	KLR 244	4683	Ph.D.
335	ENG	DRE 208	2000	Ph.D.
342	SOC	BBG 208	5514	Ph.D.
387	BIOL	AAK 230	8665	Ph.D.
401	HIST	DRE 156	6783	MA
425	ECON/FIN	KLR 284	2851	MBA
435	ART	BBG 185	2278	Ph.D.

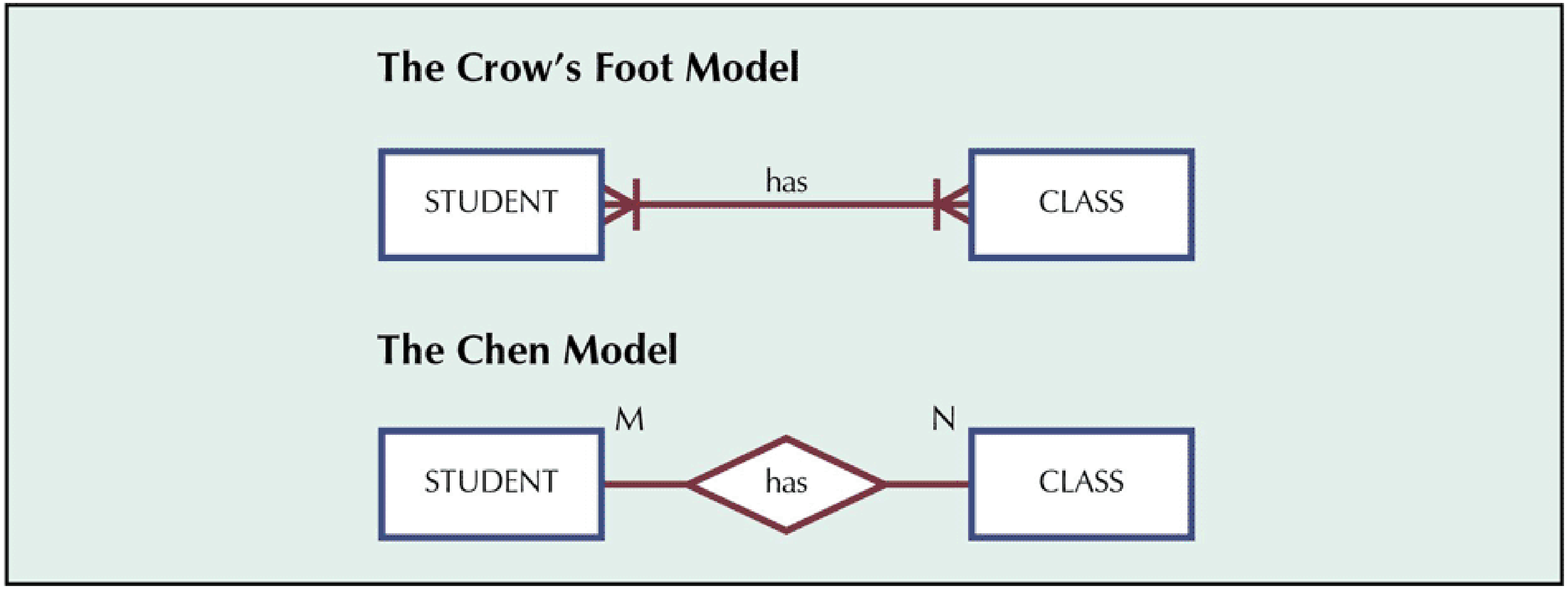
The Implemented 1:1 Relationship Between PROFESSOR and DEPARTMENT

Table name: DEPARTMENT
Primary key: DEPT_CODE
Foreign key: EMP_NUM

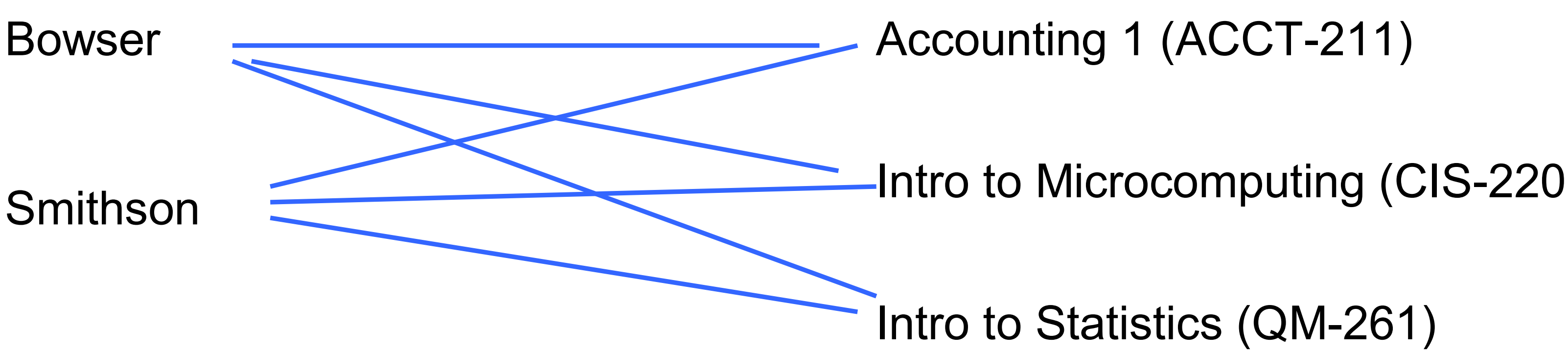
DEPT_CODE	DEPT_NAME	SCHOOL_CODE	EMP_NUM	DEPT_ADDRESS	DEPT_EXTENSION
ACCT	Accounting	BUS	114	KLR 211, Box 52	3119
ART	Fine Arts	A&SCI	435	BBG 185, Box 128	2278
BIOL	Biology	A&SCI	387	AAK 230, Box 415	4117
CIS	Computer Info. Systems	BUS	209	KLR 333, Box 56	3245
ECON/FIN	Economics/Finance	BUS	299	KLR 284, Box 63	3126
ENG	English	A&SCI	160	DRE 102, Box 223	1004
HIST	History	A&SCI	103	DRE 156, Box 284	1867
MATH	Mathematics	A&SCI	297	AAK 194, Box 422	4234
MKT/MGT	Marketing/Management	BUS	106	KLR 126, Box 55	3342
PSYCH	Psychology	A&SCI	195	AAK 297, Box 438	4110
SOC	Sociology	A&SCI	342	BBG 208, Box 132	2008

2.5 Binary Relationships

- <u>**M:N relationships**</u>
  - **Must be avoided because they lead to *data redundancies*.**
  - Can be implemented by breaking it up to produce a set of 1:M relationships
  - Can avoid problems inherent to M:N relationship by creating a ***composite entity or bridge entity***
    - This will be used to link the tables that were originally related in a M:N relationship
    - The composite entity structure includes-as f**oreign keys-at least the primary keys of the tables that are to be linked.**



The M:N Relationship Between STUDENT and CLASS



This CANNOT be implemented as shown next…..

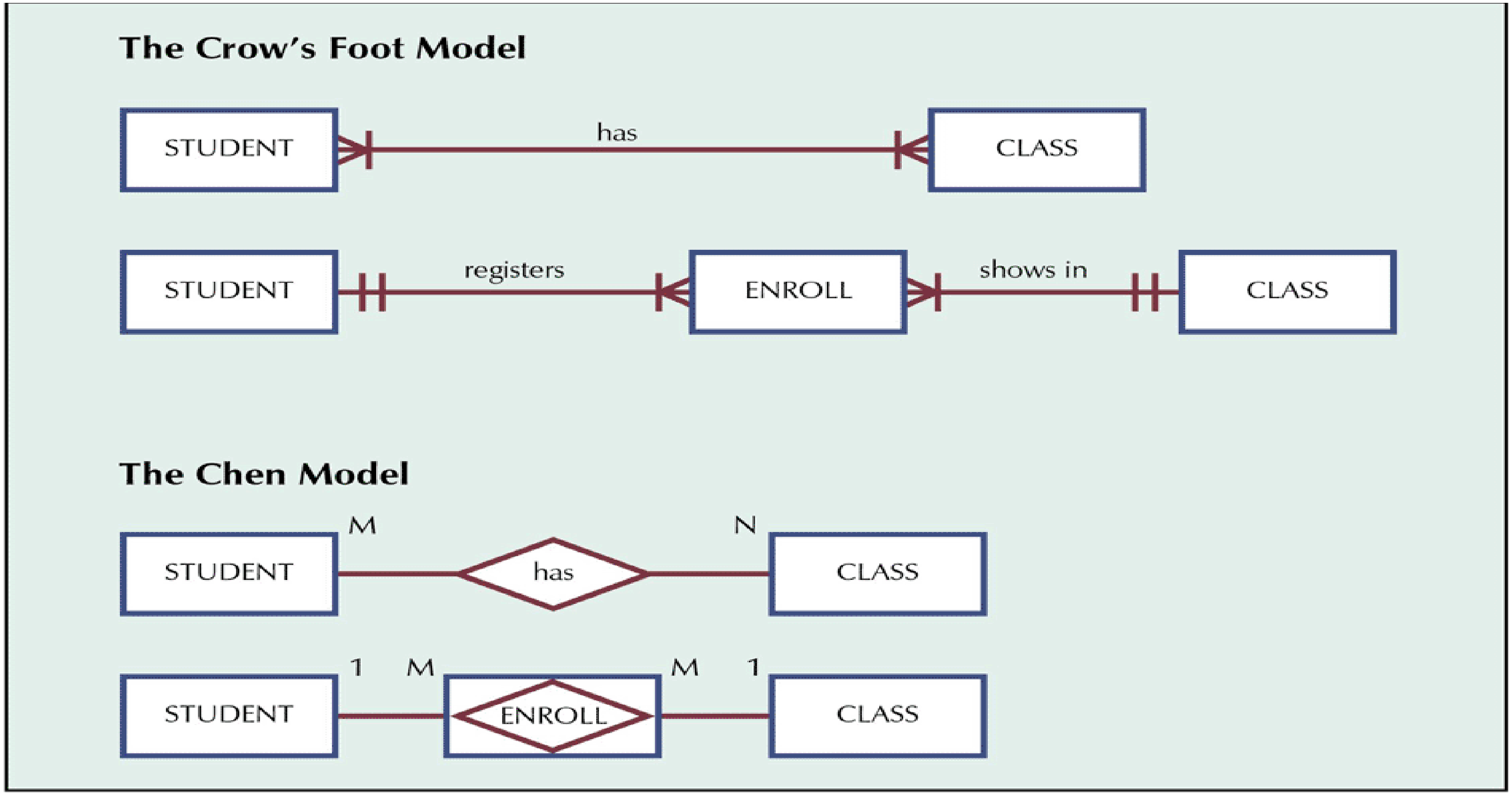
The tables have **many redundancies!!**

Table name: STUDENT
Primary key: STU_NUM + CLASS_CODE Database name: Ch03_CollegeTry
Foreign key: CLASS_CODE

STU_NUM	STU_LNAME	CLASS_CODE
321452	Bowser	10014
321452	Bowser	10018
321452	Bowser	10021
324257	Smithson	10014
324257	Smithson	10018
324257	Smithson	10021

Table name: CLASS
Primary key: CLASS_CODE + STU_NUM
Foreign key: STU_NUM

CLASS_CODE	STU_NUM	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
10014	321452	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10014	324257	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10018	321452	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10018	324257	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10021	321452	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
10021	324257	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114



Changing the M:N relationship to TWO 1:M relationships

Table name: STUDENT
Primary key: STU_NUM
Foreign key: none

STU_NUM	STU_LNAME
321452	Bowser
324257	Smithson

The database designer has 2 main options to define **a composite table's primary key:** either

use the combination of those foreign keys or **create a new primary key.**

Table name: ENROLL
Primary key: CLASS_CODE + STU_NUM
Foreign key: CLASS_CODE, STU_NUM

CLASS_CODE	STU_NUM	ENROLL_GRADE
10014	321452	C
10014	324257	B
10018	321452	A
10018	324257	B
10021	321452	C
10021	324257	C

Foreign keys reference the primary keys in the other tables of which it has a relationship with

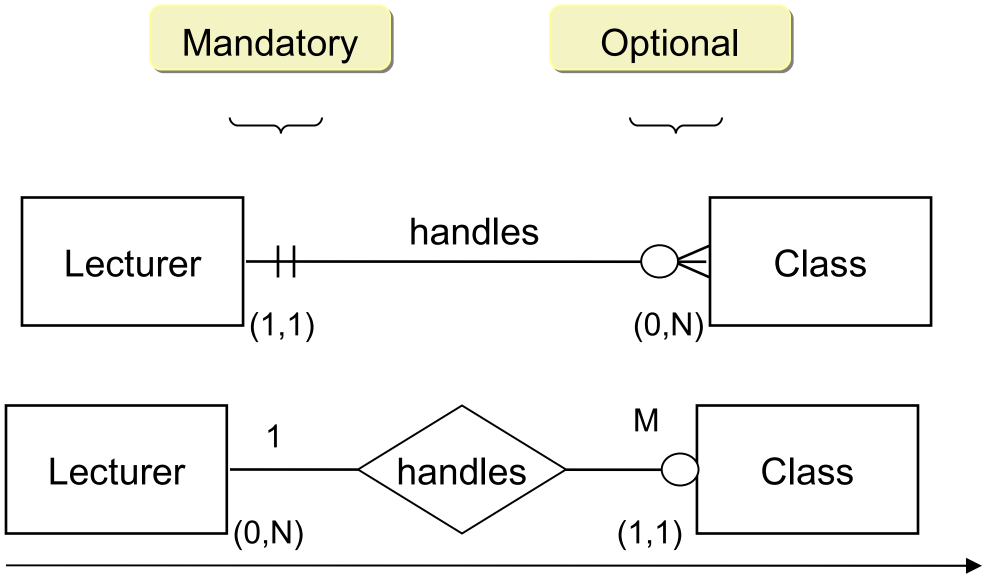
Table name: CLASS
Primary key: CLASS_CODE
Foreign key: CRS_CODE

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10018	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10021	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

Converting the M:N relationship into TWO 1:M relationships

2.6 Mandatory vs. Optional Cardinalities

- Specifies whether an instance must exist or can be absent in the relationship



A Lecturer may handle **zero** or many classes.

A class is handled by one and only one Lecturer.

2.7 How to Evaluate a Data Model?

- A good data model has the following:
  - Accuracy and completeness
  - Non redundancy
  - Enforcement of business rules
  - Data Reusability
  - Stability and Flexibility
  - Communication Effectiveness
  - Simplicity

A Common Mistake

Modeling the **business processes** or **functions** instead of the **data**.

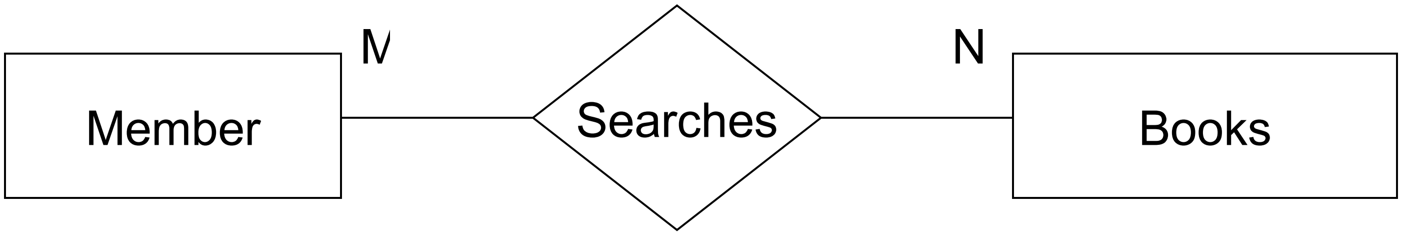
What data we want to keep??

We are interested in modeling the data,

NOT the processes or functions that use

or generate those data.

Example:



Is this part of the data requirement?

Are we interested to know the books searched by the members?

If answer is NO, then DO NOT include that as a relationship.

Use other appropriate diagramming techniques to capture the business processes such as Data Flow Diagram.

Do not mix up the use of ER Modeling with DFD.

~The END~

Q & A