Translating Entity Relationship to Relational Tables

EGCI321: LECTURE05 (WEEK 3)

E-R Diagram to Relational Schema

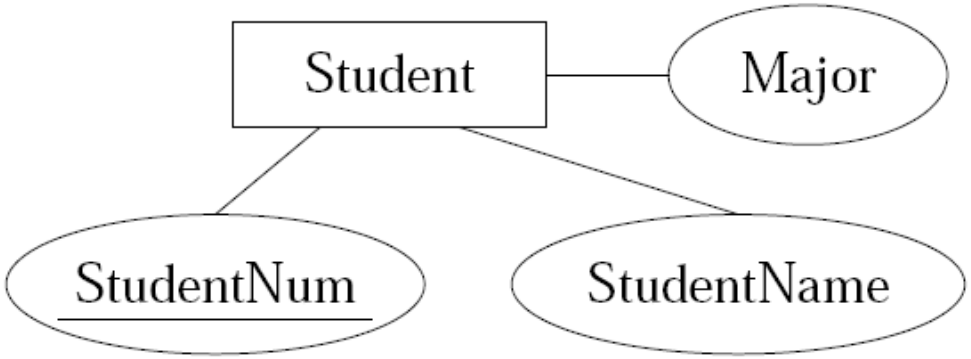
Main Idea:

- Each entity set maps to a new table
- Each attribute maps to a new table column
- Each relationship set maps to either new table columns or to a new table

Representing Strong Entity Sets

- Entity set E with attributes $a_1,...,a_n$ translates to table *E* with attributes $a_1,...a_n$
- Entity of type E $\leftrightarrow$ row in table *E*
- Primary key of entity set $\rightarrow$ primary key of table

Example:



Student

StudentNum	StudentName	Major

Representing Weak Entity Sets

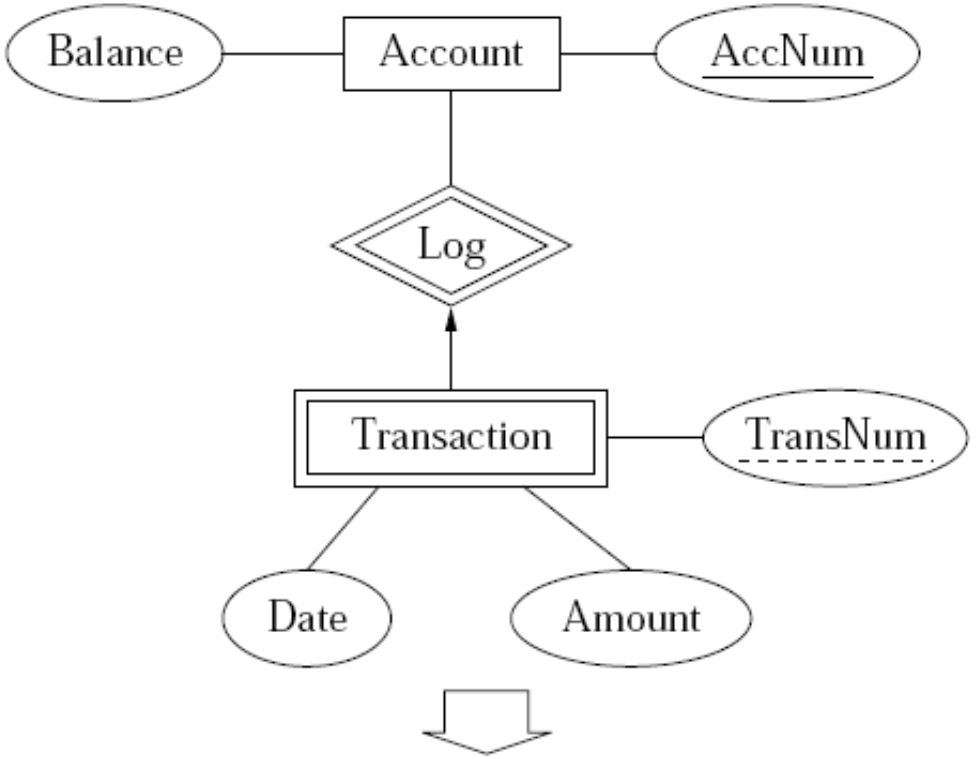
- Weak entity set E translate to table E

- Columns of table *E* should include
  - Attributes of the weak entity set
  - Attributes of the identifying relationship set
  - Primary key attributes of entity set for dominating entities

- Primary key of weak entity $\rightarrow$ set primary key of table

Representing Weak Entity Sets (cont.)

Example:



Account

AccNum	Balance

Transaction

TransNum	AccNum	Date	Amount

Representing Relationship Sets

- If the relationship set is an *identifying relationship* set for a *weak entity* set then no action needed
- If we can deduce the general cardinality constraint (1,1) for a component entity set *E* then add following columns to table *E*
  - Attributes of the relationship set
  - Primary key attributes of remaining component entity sets
- Otherwise: relationship set *R* $\rightarrow$ table *R*

Representing Relationship Sets (cont.)

Columns of table *R* should include:

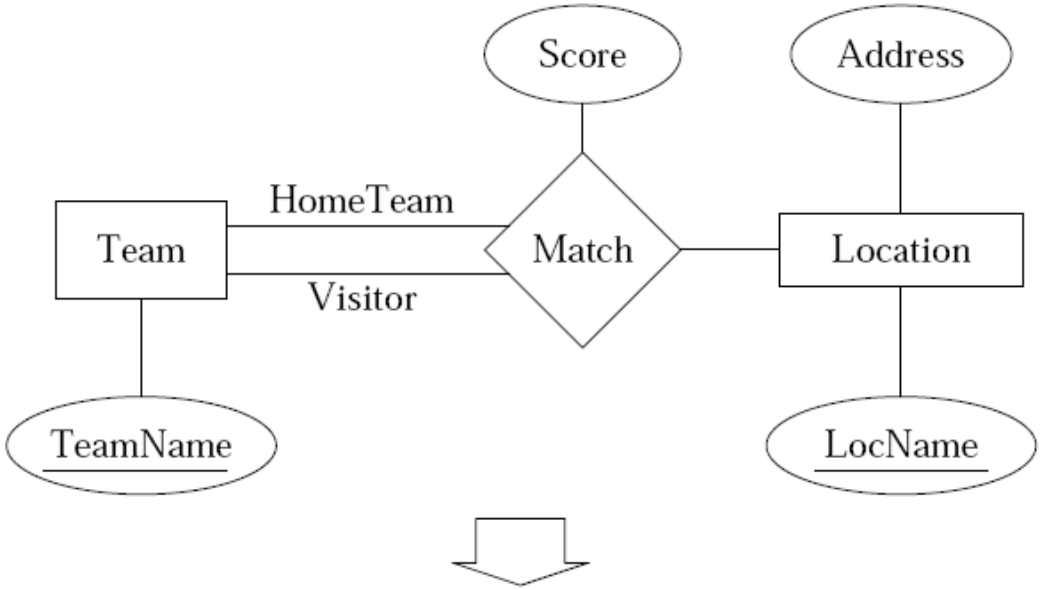
- Attributes of the relationship set
- Primary key attributes of each component entity set

Primary key of table *R* determined as follows

- If we can deduce the general cardinality constraint (0,1) for a component entity set *E*, then take the primary key attributes for *E*
- Otherwise, choose primary key attributes of each component entity

Representing Relationship Sets (cont.)

Example:



Team

TeamName

Location

LocName	Address

Match

HomeTeamName	VisitorTeamName	LocName	Score

Note that the role name of a component entity set should be prepended to its primary key attributes, it supplied

Representing Aggregation

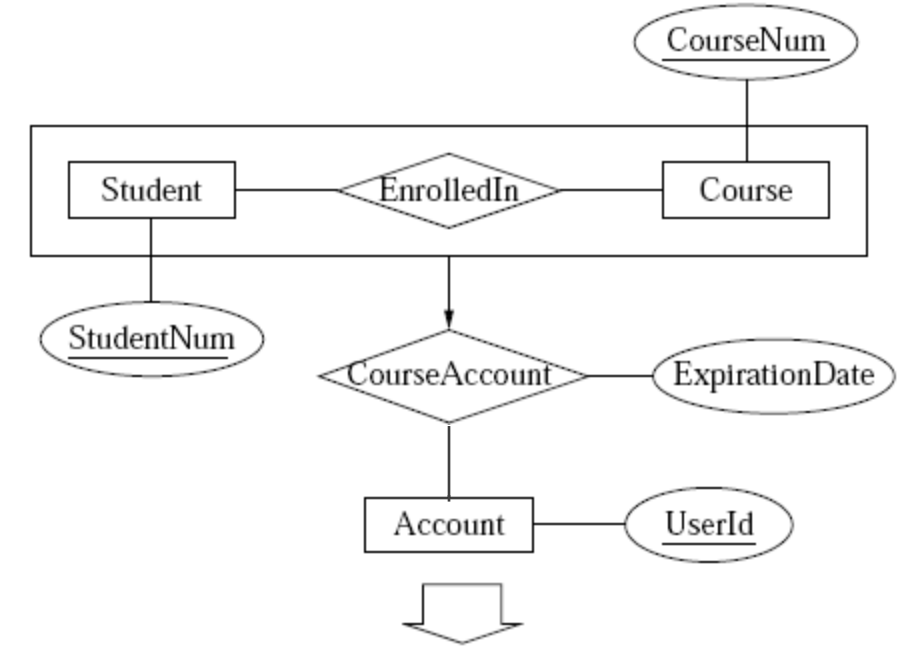
Tabular representation of aggregation of *R*

= tabular representation for relationship *R*

To represent relationship set involving aggregation of *R*, treat the aggregation like an entity set whose primary key is the **primary key** of the table for *R*

Representing Aggregation (cont.)

Example:



Student

StudentNum

Course

CourseNum

Account

UserId

EnrolledIn

StudentNum	CourseNum

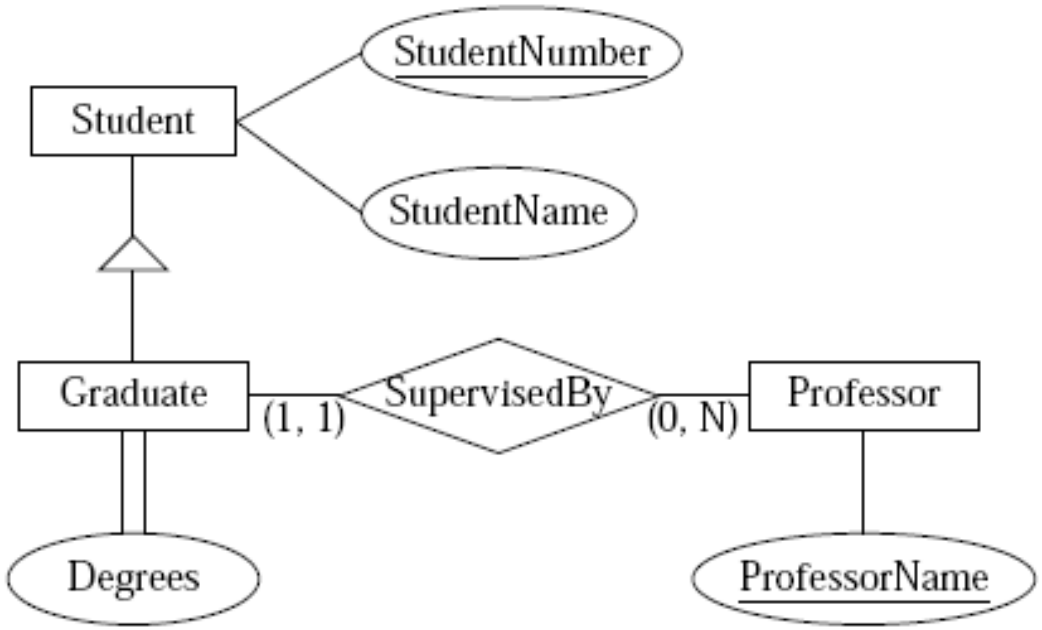
CourseAccount

UserId	StudentNum	CourseNum	ExpirationDate

Representing Specialization

- Create table for higher-level entity set, and treat specialized entity subsets like weak entity sets (without discriminators)

Example:



Student

StudentNumber	StudentName

Graduate

StudentNumber	ProfessorName

Degree

StudentNumber	Degree

Professor

ProfessorName

Representing Generalization (Approach #1)

Create a table for each lower-level entity set only

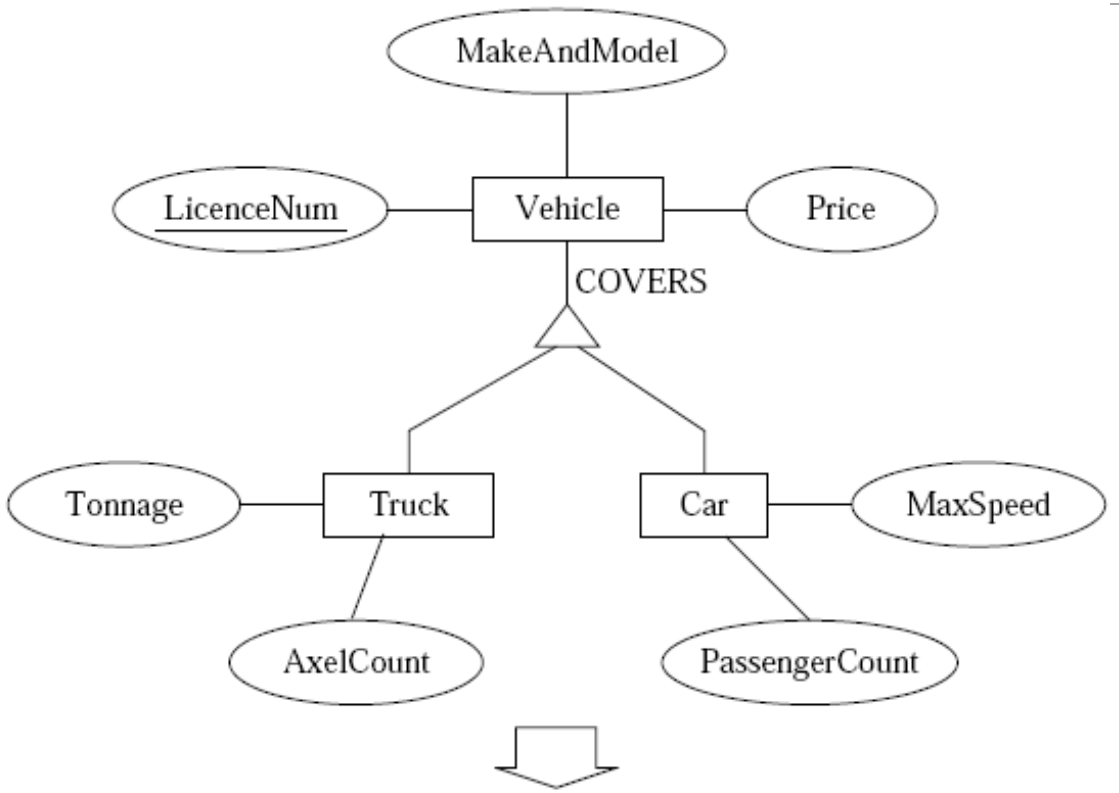
Columns of new tables should include:

- Attributes of lower level entity set
- Attributes of the superset

The higher level entity set can be defined as a view on the tables for the lower-level entity sets

Representing Generalization (Approach #1)

Example:



Truck

LicenceNum	MakeAndModel	Price	Tonnage	AxelCount

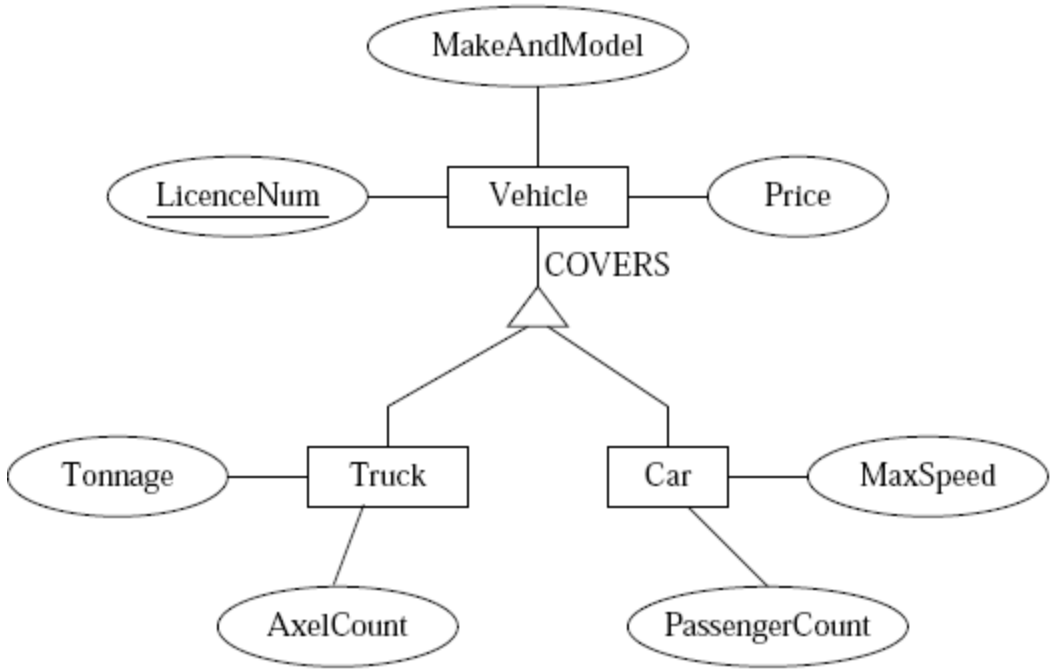
Car

LicenceNum	MakeAndModel	Price	MaxSpeed	PassengerCount

Representing Generalization (Approach #2)

Treat generalization the same as specialization

Example:



Vehicle

LicenceNum	MakeAndModel	Price

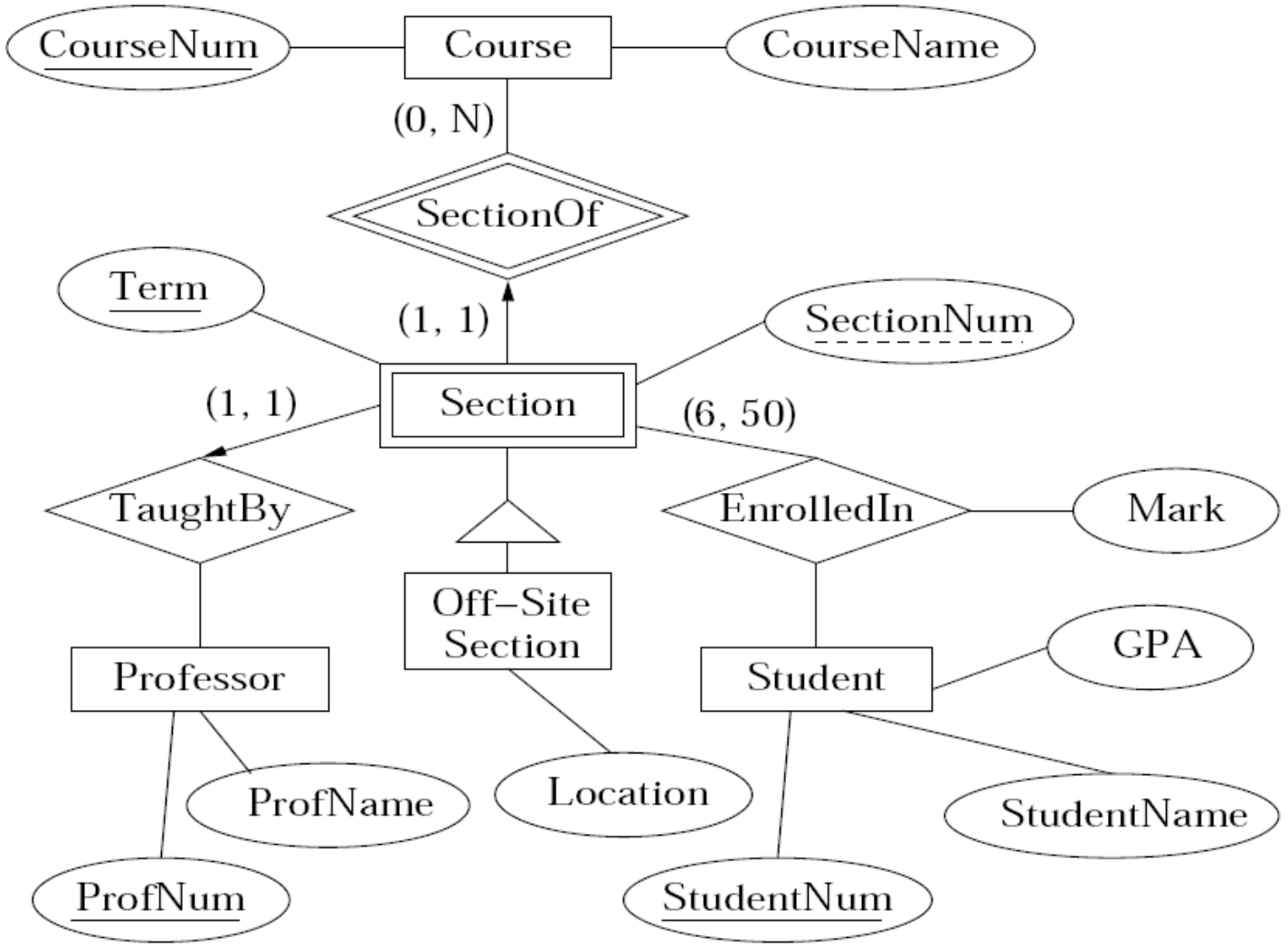
Truck

LicenceNum	Tonnage	AxelCount

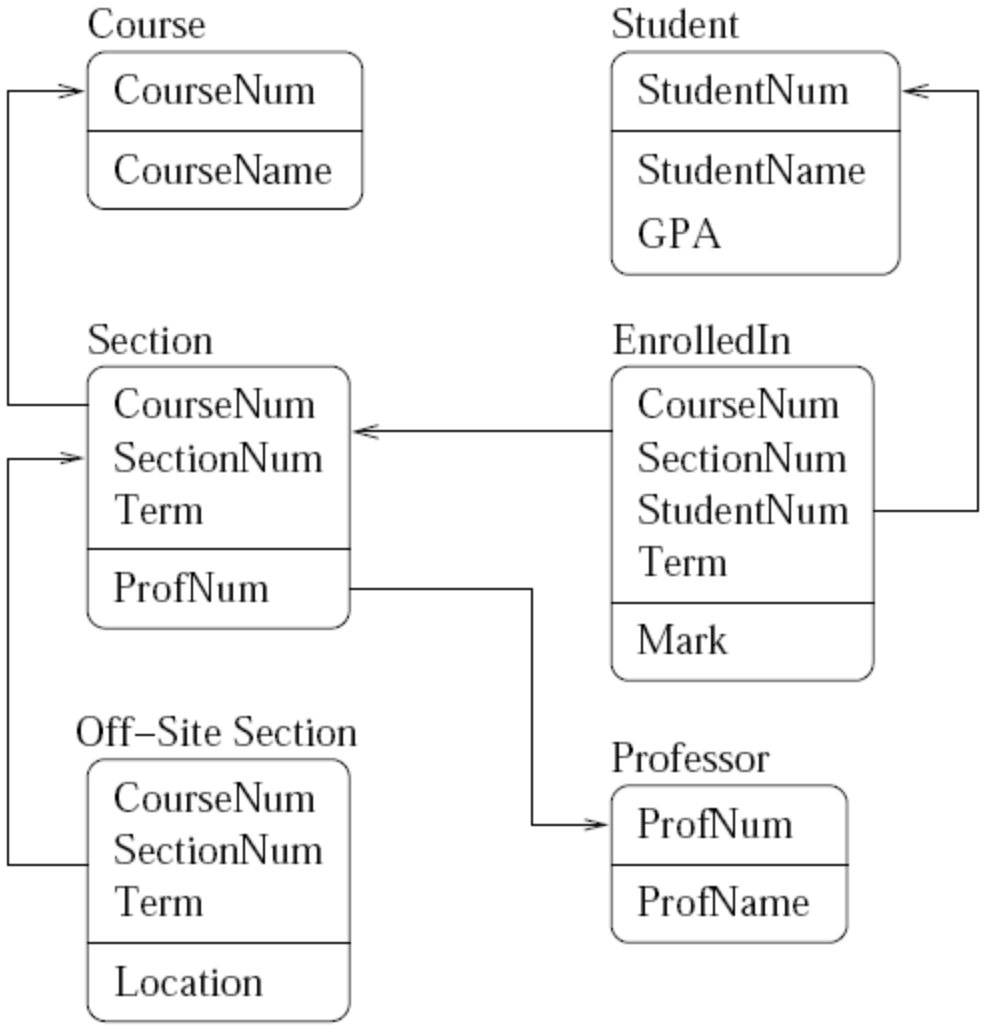
Car

LicenceNum	MaxSpeed	PassengerCount

Example Translation: ER Diagram



Example Translation: Relational Diagram



Rational Model in SQL

SECTION II

Rational Model in SQL

- Creates the Students relation.
  - Observe that the type (domain) of each field is specified and enforced by the DBMS whenever tuples are added or modified.

CREATE TABLE Students (sid NCHAR(20), name NCHAR(20), login NCHAR(10), age INTEGER, gpa REAL)

- Another example: the Enrolled table holds information about courses that students take.

CREATE TABLE Enrolled(sid NCHAR(20), cid NCHAR(20), grade NCHAR(2))

Destroying and Altering Relations

- Destroys the relation Students. The schema information and the *tuples* are deleted.

  DROP TABLE Students

- The schema of Students is altered by adding a new field; every tuple in the current instance is extended with a *null* value in the new field.

  ALTER TABLE Students

  ADD firstYear integer

Adding and Deleting Tuples

- Insert a single tuple using:

```
INSERT INTO  Students (sid, name, login, age, gpa)
VALUES (53688, 'Smith', 'smith@ee', 18, 3.2)
```

- Delete all tuples satisfying some condition (e.g., name = Smith):

```
SET SQL_SAFE_UPDATES = 0;
DELETE
FROM Students as S
WHERE S.name = 'Smith'
```

Review: Integrity Constraints (ICs)

- IC: condition that must be true for *any* instance of the database; e.g., *domain constraints*.
  - 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.
- If the DBMS checks ICs, stored data is more faithful to real-world meaning.
  - Avoids data entry errors, too!

Review: Primary Key Constraints

A set of fields is a key for a relation if :

1. No two distinct tuples can have same values in all key fields, and
2. This is not true for any subsets of the key.
   - Part 2 false? A *superkey*.
   - If there's >1 key for a relation, one of the keys is chosen (by DBA) to be the *primary key.*

E.g., sid is a key for Students. (What about name?) The set {sid, gpa} is a *superkey*.

Primary and Candidate Keys in SQL

Possibly many *candidate keys* (specified using UNIQUE), one of which is chosen as the *primary key*.

"For a given student and course, there is a single grade." vs. "Students can take only one course, and receive a single grade for that course; further, no two students in a course receive the same grade."

```
CREATE TABLE Enrolled (sid NCHAR(20), cid  NCHAR(20), grade NCHAR(2), PRIMARY KEY  (sid,cid) )
```

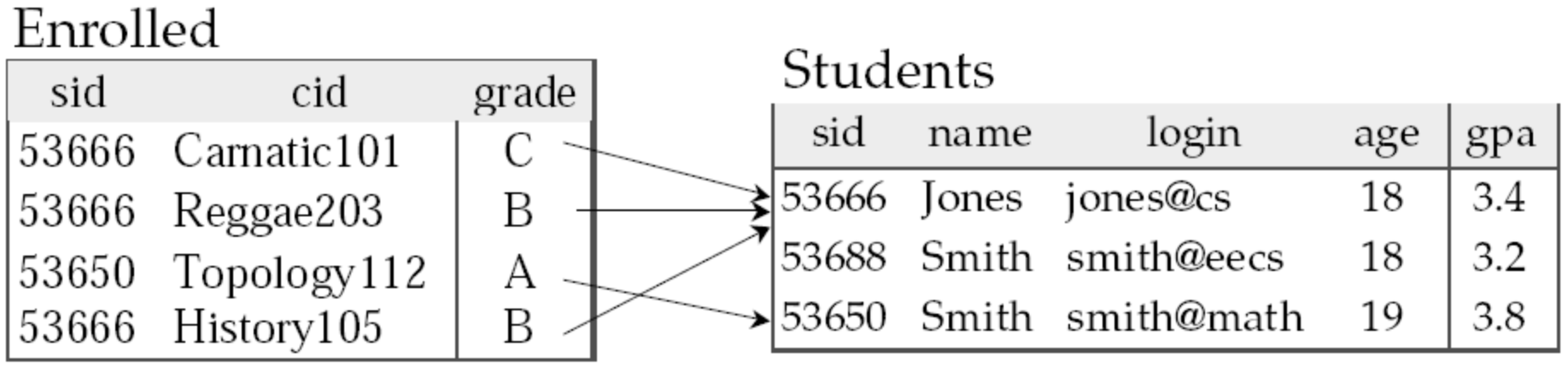
```
CREATE TABLE Enrolled (sid NCHAR(20), cid  NCHAR(20), grade NCHAR(2), PRIMARY KEY  (sid), UNIQUE (cid, grade) )
```

Used carelessly, an IC can prevent the storage of database instances that arise in practice!

Foreign Keys in SQL

Only students listed in the Students relation should be allowed to enrol for courses.

CREATE TABLE Enrolled (sid NCHAR(20), cid NCHAR(20), grade NCHAR(2), PRIMARY KEY (sid,cid), FOREIGN KEY (sid) REFERENCES Students(sid))



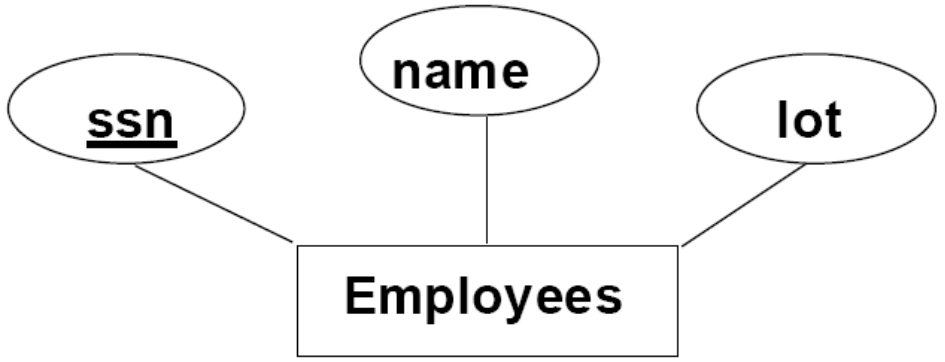
Referential Integrity in SQL

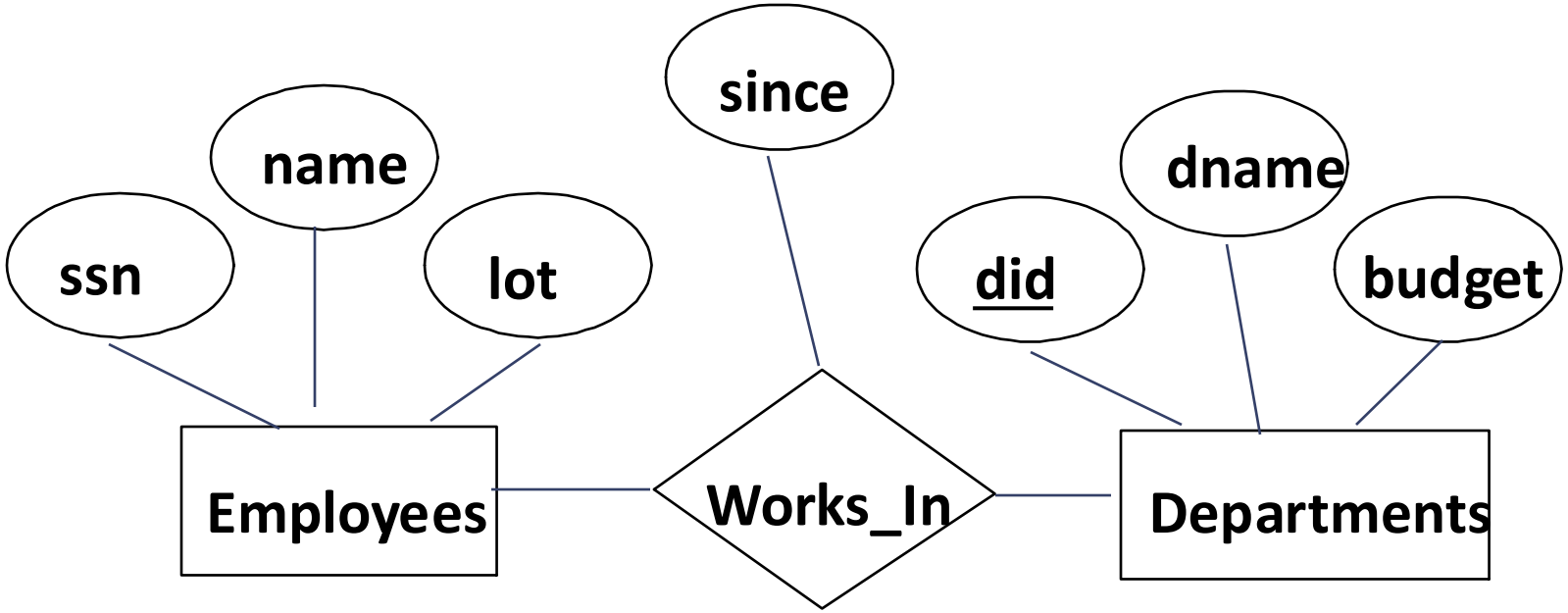
```
CREATE TABLE Enrolled
(sid NCHAR(20),
cid NCHAR(20),
grade NCHAR(2),
PRIMARY KEY  (sid,cid),
FOREIGN KEY (sid)
REFERENCES Students(sid))
```

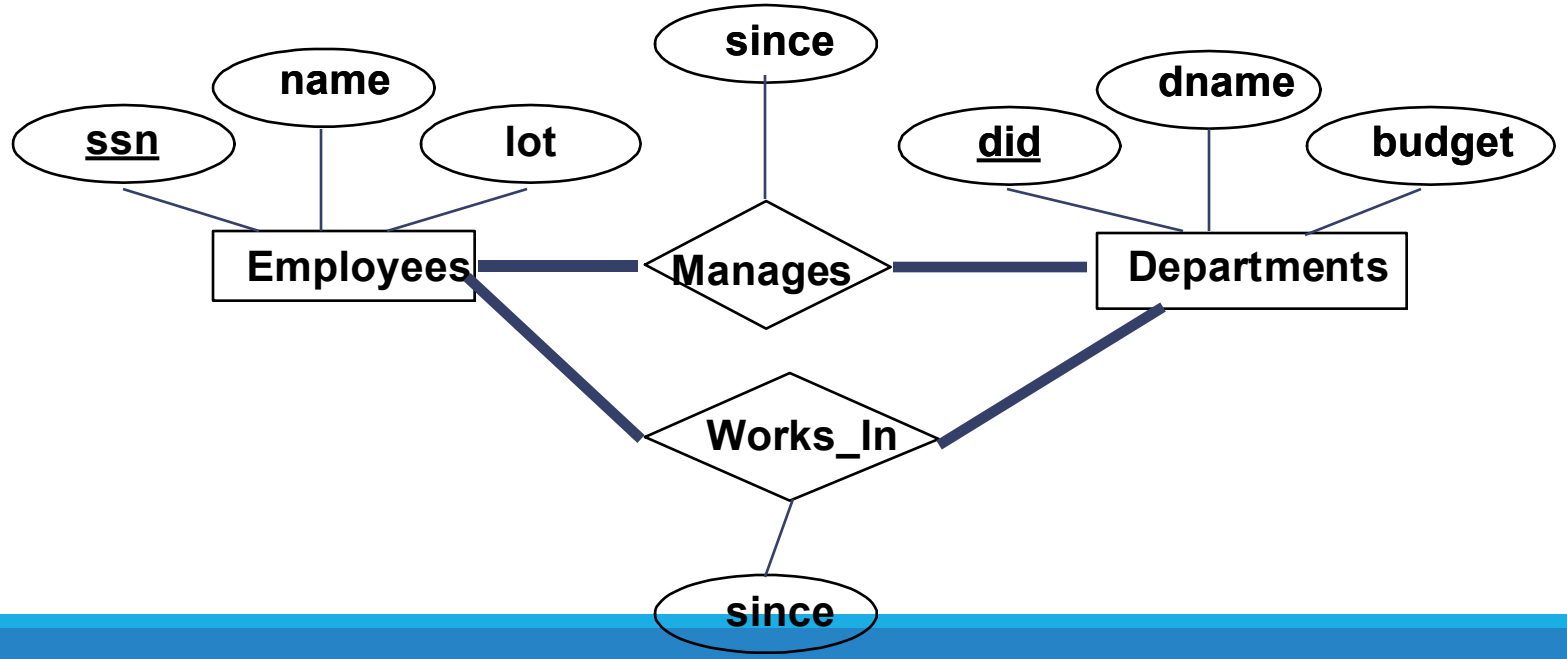
ER to Relational

Entity sets to tables:

CREATE TABLE Employees (ssn CHAR(11), name NCHAR(20), lot INTEGER, PRIMARY KEY (ssn))




since
name
dname
ssn
lot
did
budget
Employees
Works_In
Departments


since
name
dname
ssn
lot
did
budget
Employees
Manages
Departments
Works_In
since

Relationship Sets to Tables

In translating a relationship set to a relation, attributes of the relation must include:

- Keys for each participating entity set (as foreign keys).
  - This set of attributes forms a *superkey* for the relation.

All descriptive attributes.

```
CREATE TABLE Works_In( ssn NCHAR(11), did  NCHAR(11), since  DATE,
PRIMARY KEY (ssn, did), FOREIGN KEY (ssn) REFERENCES Employees(ssn),
FOREIGN KEY (did) REFERENCES Departments(did))
```

Translating ER Diagrams with Key Constraints

Map relationship to a table:

- Note that did is the key now!
- Separate tables for Employees and Departments.

Since each department has a unique manager, we could instead combine Manages and Departments.

```
CREATE TABLE  Manages( ssn CHAR(11), did  NCHAR(11), since  DATE, PRIMARY KEY  (did),
FOREIGN KEY (ssn) REFERENCES Employees(ssn), FOREIGN KEY (did) REFERENCES
Departments(did))

CREATE TABLE  Dept_Mgr( did  NCHAR(11), dname NCHAR(20), budget  REAL, ssn CHAR(11),
since  DATE, PRIMARY KEY  (did), FOREIGN KEY (ssn) REFERENCES Employees(ssn))
```

Reference

1. Ramakrishnan R, Gehrke J., Database management systems, 3rd ed., New York (NY): McGraw-Hill, 2003.