

# Chapter 6

## Developing Data Models for Business Databases

# OUTLINE

- Guidelines for analyzing business information needs
- Transformations for generating alternative designs
- Finalizing an Entity Relationship Diagram
- Schema Conversion

# BUSINESS DATA MODELING PROBLEMS

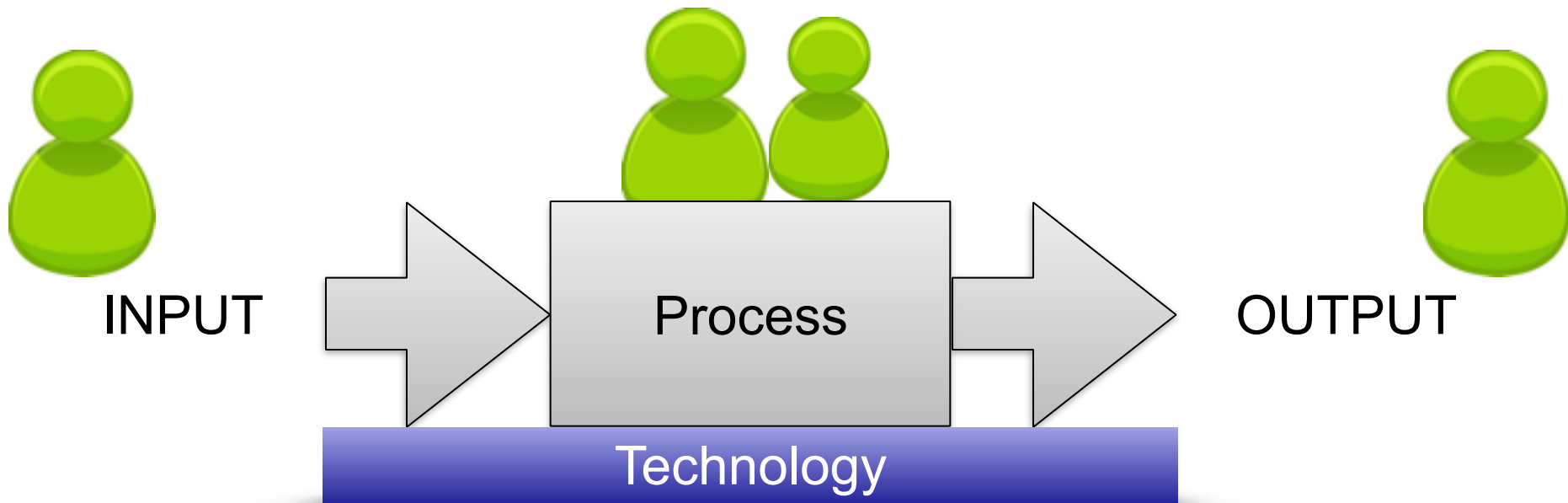
- Poorly defined requirements
  - Conflicting statements
  - Wide scope
  - Missing details
  - Many stakeholders
  - Requirements in many formats
- Add structure
  - Eliminate irrelevant details
  - Add missing details
  - Narrow scope

In collecting the requirements, you will need to

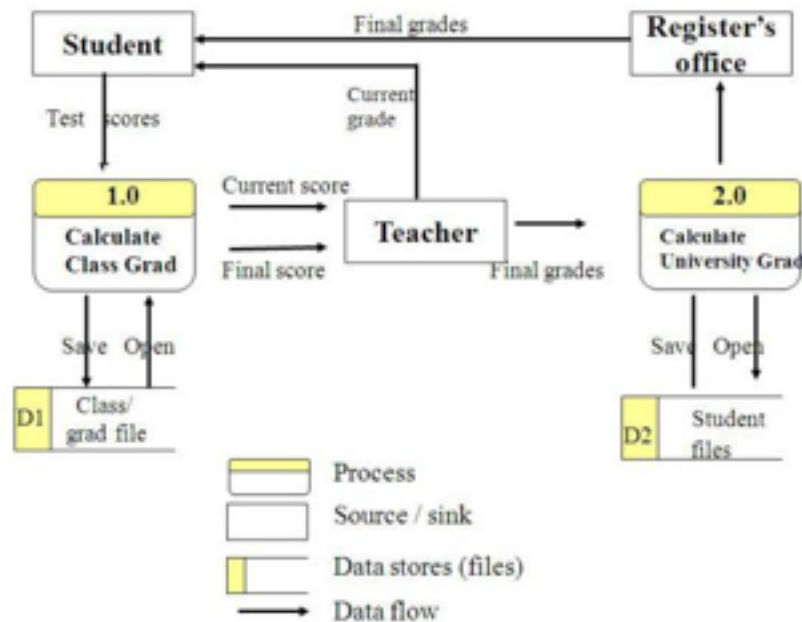
- conduct interviews,
- review documents and system documentation,
- and examine existing data.

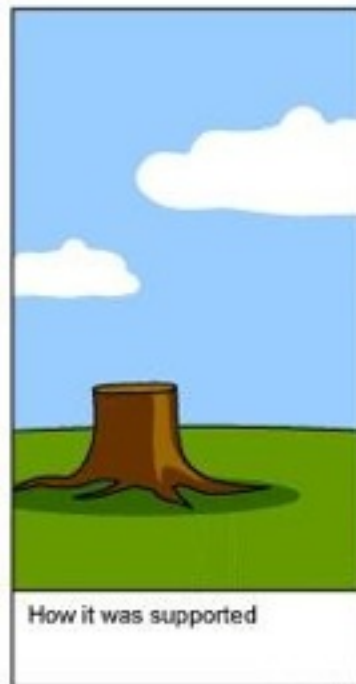
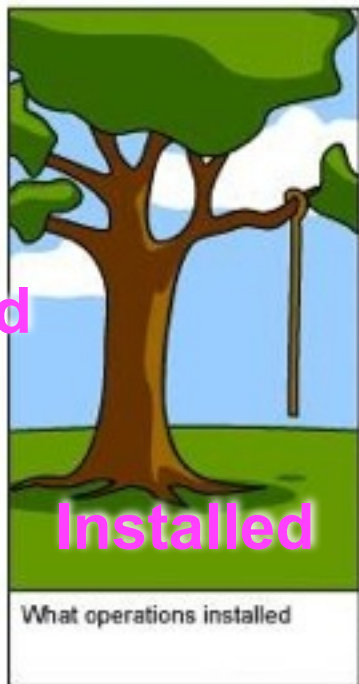
# For each division, collect

- Organization chart
- Human resources
- Business processes
  - Activities
    - Data used, data sources, frequency
    - Information produced, frequency
      - Dissemination
    - Time used
- Problems: people, process, technology, data



### Example of Data Flow Diagram





# STEPS OF NARRATIVE PROBLEM ANALYSIS

- Identify entity types and attributes
- Determine primary keys
- Add relationships
  - Determine connections
  - Determine relationship cardinalities
  - Simplify relationships



# DETERMINE ENTITY TYPES AND ATTRIBUTES

- For entity types, find nouns that represent
  - groups of people,
  - places,
  - things, *and*
  - events
- For attributes, look for properties that provide
  - details about the entity types
- Simplicity principal: consider as an attribute unless other details

# DETERMINE PRIMARY KEYS

- **Stable:** never change after assigned
- **Single purpose:** no other purpose
- **Good choices:** automatically generated values(Integer)
- Compromise choice for **industry practices**
- Identify other unique attributes

# ENTITY IDENTIFICATION EXAMPLE

## Electricity Bill

**End Date** **Start Date** **Meter #**

Tear here

LIPA - Rate 281 - Secondary, Commercial, Large, General Use

<b>ELECTRIC - ENERGY</b>	Meter # 84857115	<b>DELIVERY &amp; SYSTEM CHARGES</b>	
11/03/2009 ACTUAL reading	75403	Basic Service : 29 day(s) @ \$ .7220	\$ 20.94
10/05/2009 ACTUAL reading	-75176	4086 KWH @ \$ .0387	158.13
Difference	227	Demand 21.0 KW	180.26
Meter Multiplier	x 18	<b>Subtotal</b>	<b>359.33</b>
KWH Used in 29 day(s)	4086		

**Energy Usage**

<b>ELECTRIC - DEMAND</b> (Rounded to nearest .5 kw)		<b>POWER SUPPLY CHARGES</b>	
ACTUAL reading	39.99	4086 KWH @ \$ .103249	421.88
ACTUAL reading	-38.82		
Difference	1.17	<b>OTHER CHARGES</b>	
Meter Multiplier	x 18	Revenue-Based PILOTS	7.04
Recorded Demand (KW)	21.0	Suffolk Property Tax Adjustment	14.45
		Sales Tax @ 8.625 %	69.23
		<b>Subtotal</b>	<b>90.72</b>

**KWH USAGE**

4086	5269
ACT	ACT
this year	last year

average temp.  
54°F this year  
54°F last year

**Total Charges** **\$ 871.93**

**Total Cost**



-meter number

# ENTITY IDENTIFICATION EXAMPLE

<b>Customer</b>
<u>CustNo</u>
CustName
CustAddr
CustType

<b>Meter</b>
<u>MeterNo</u>
MtrAddr
MtrSize
MtrModel

<b>Reading</b>
<u>ReadNo</u>
ReadTime
ReadLevel
EmpNo



(commercial or residential)

<b>Bill</b>
<u>BillNo</u>
BillDate
BillStartDate
BillEndDate
BillDueDate

consumption  
period

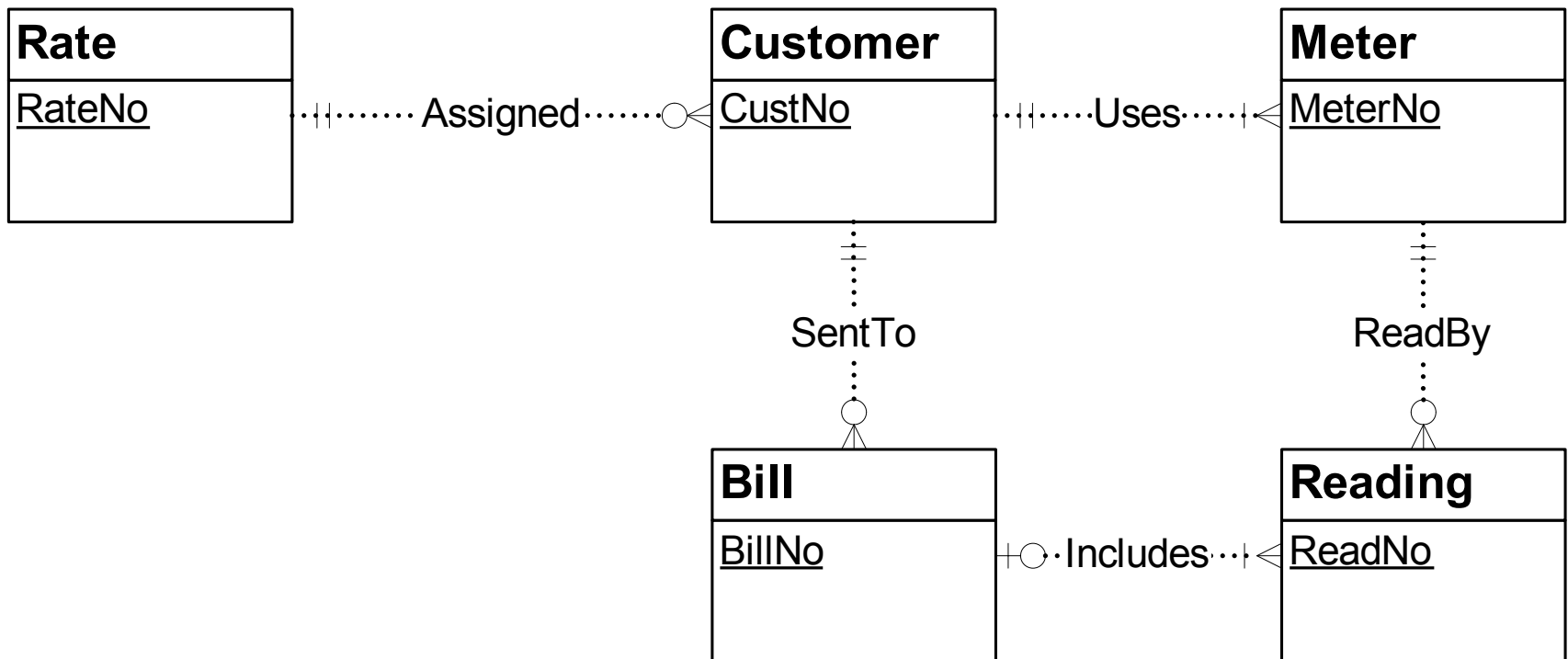
<b>Rate</b>
<u>RateNo</u>
RateDesc
RateFixedAmt
RateThresh
RateVarAmt

Electricity Utility System

# IDENTIFY RELATIONSHIPS

- Identify relationships connecting entity types
  - associations among nouns representing entity types
  - Sentences that involve an entity type having
    - another entity type as a property
    - a collection of another entity type

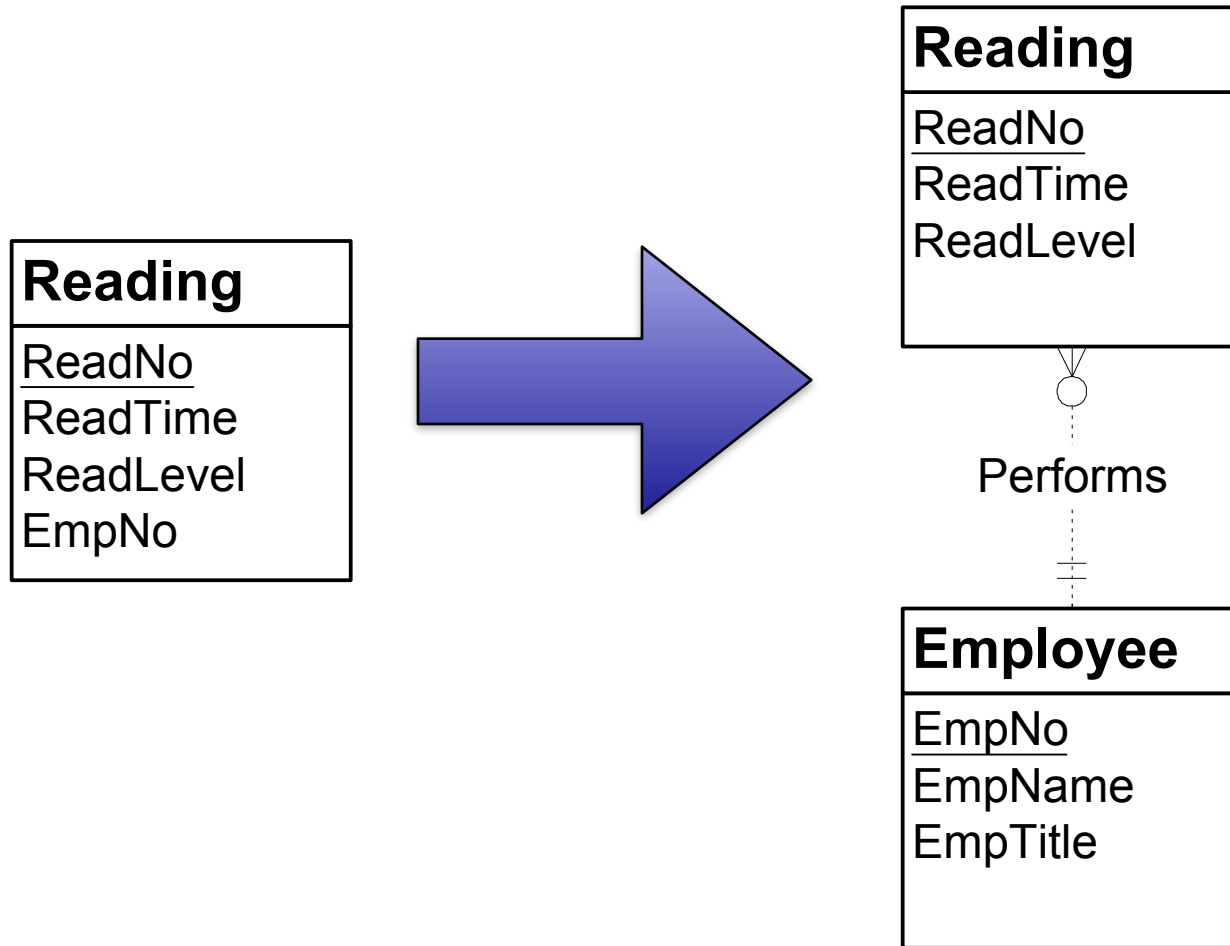
# RELATIONSHIP IDENTIFICATION EXAMPLE



# DIAGRAM REFINEMENTS

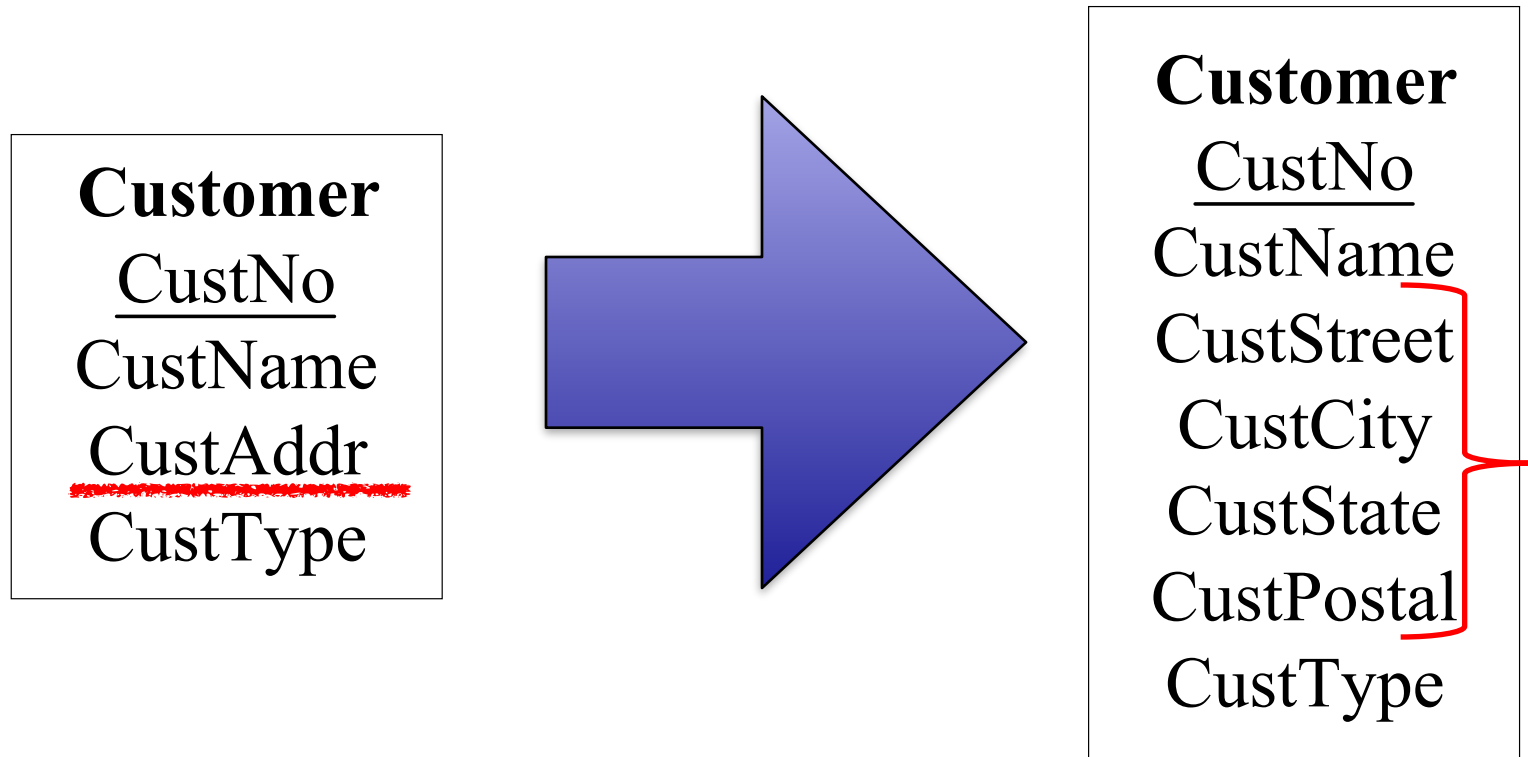
- Construct initial ERD
- *Revise many times*
- Generate feasible alternatives and evaluate according to requirements
- Gather additional requirements if needed
- Use transformations to suggest feasible alternatives

# ATTRIBUTE TO ENTITY TYPE *TRANSFORMATION*



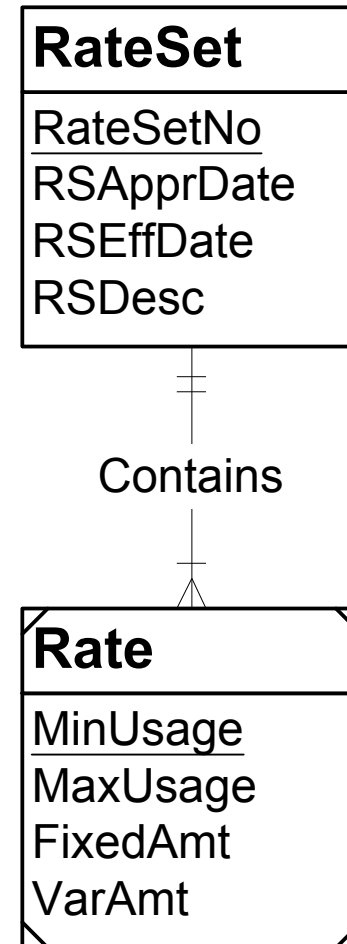
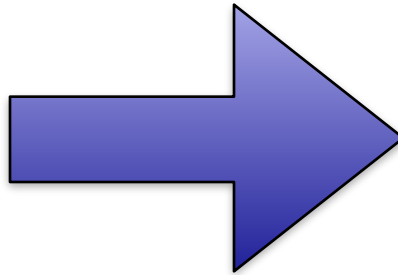
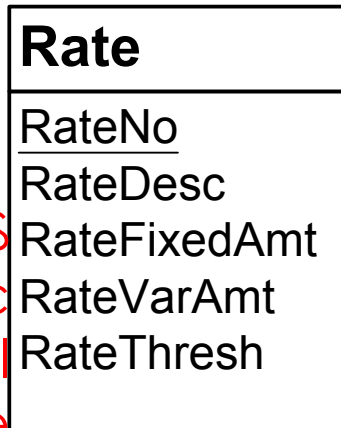


# COMPOUND ATTRIBUTE TRANSFORMATION

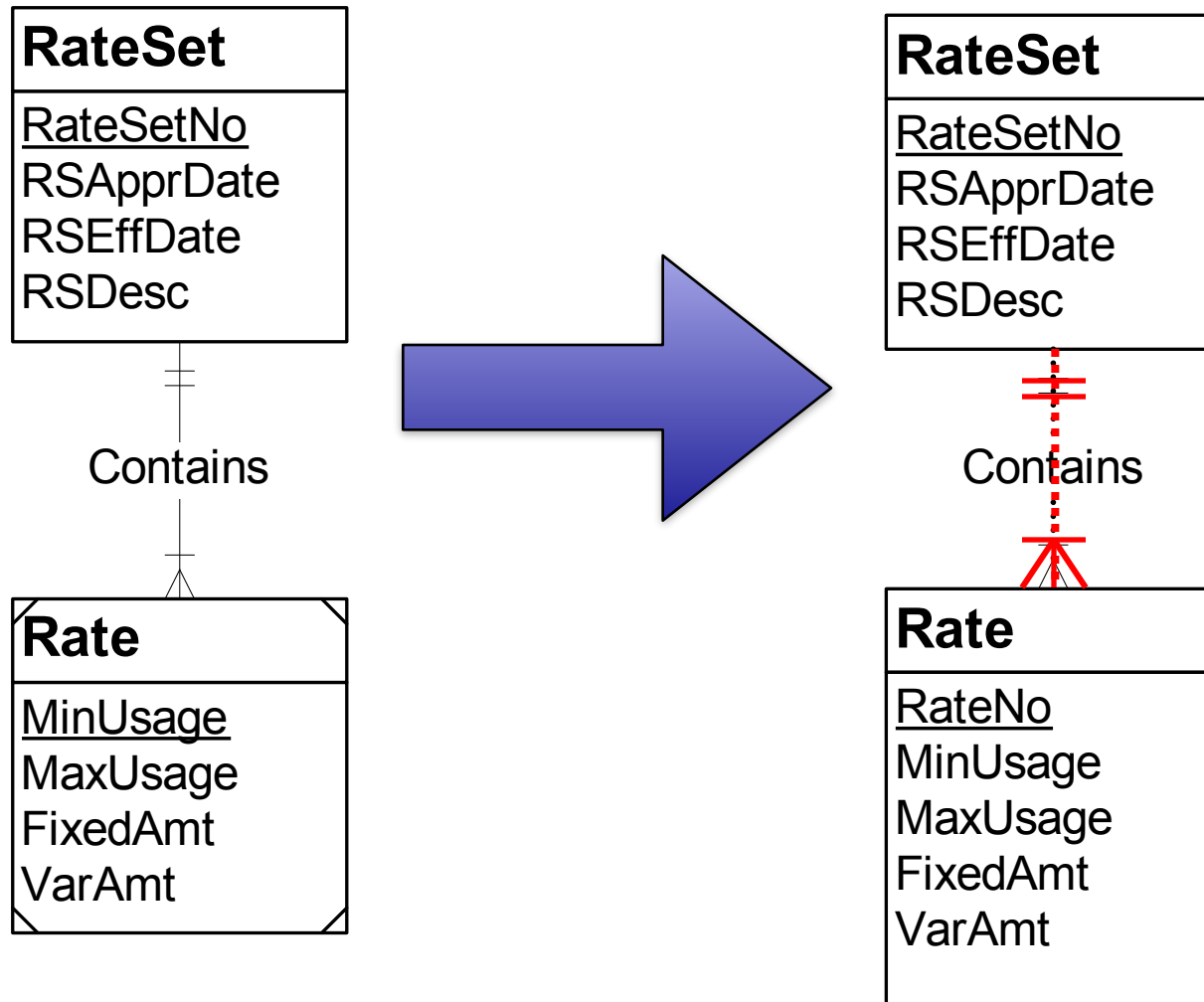


# ENTITY TYPE EXPANSION TRANSFORMATION

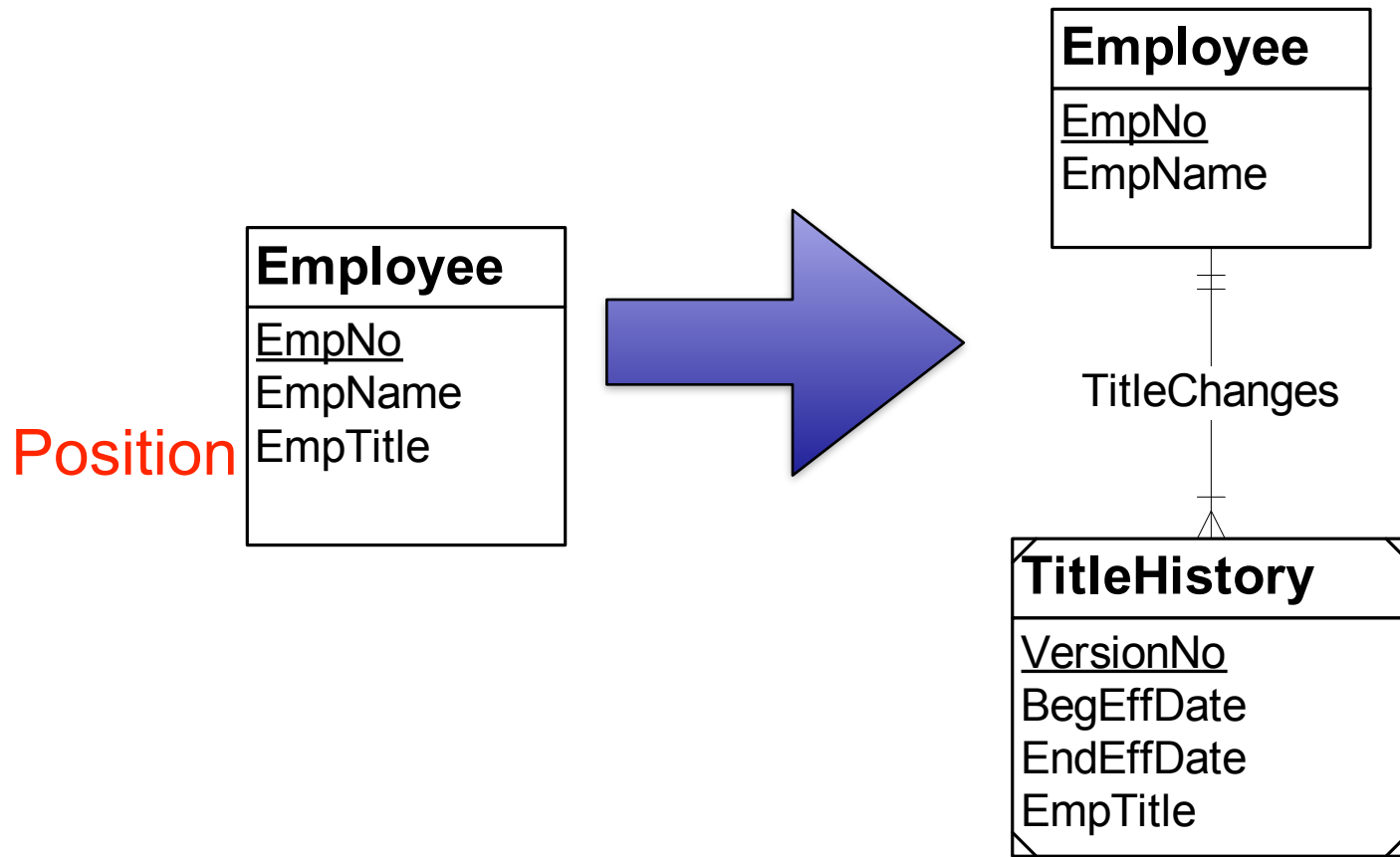
- \$
- \$ per cubic
- Min level
- for fixed rate



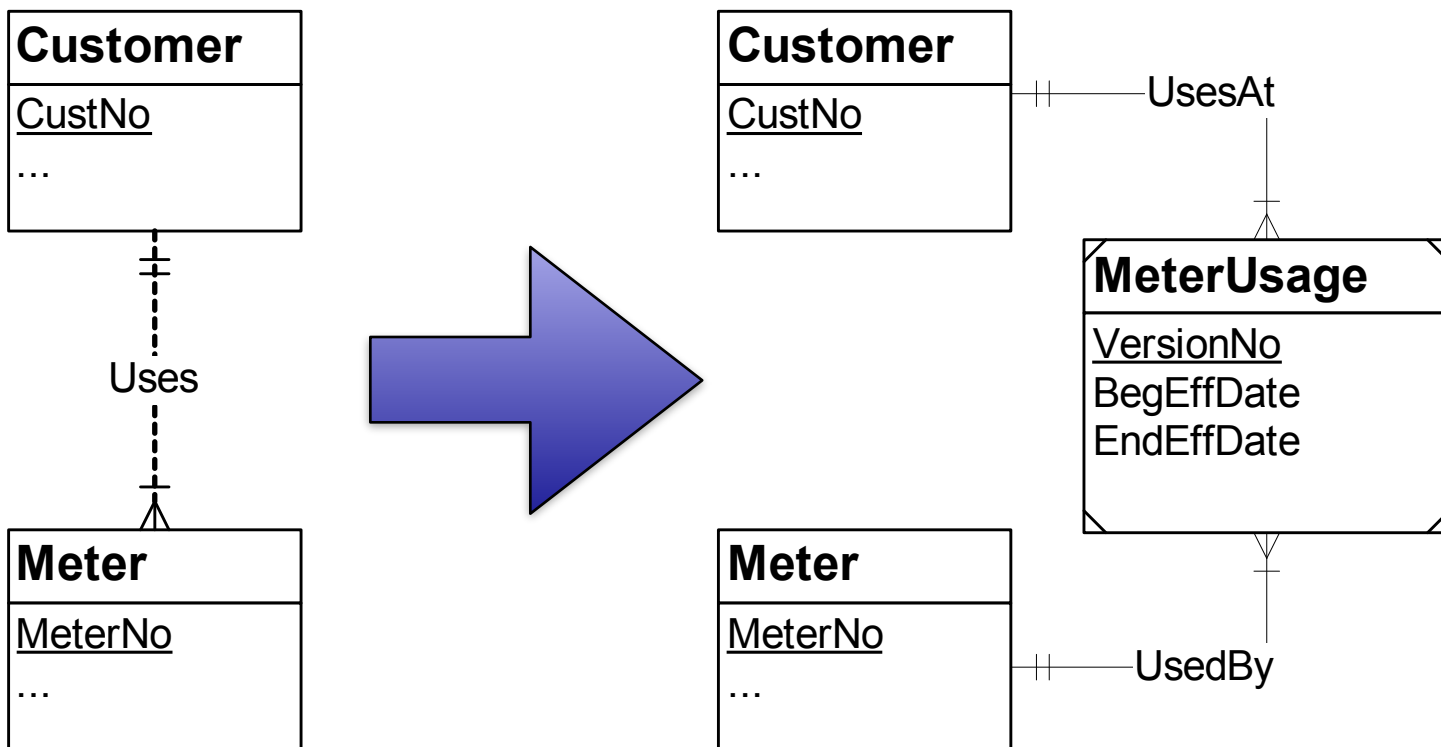
# WEAK TO STRONG ENTITY TRANSFORMATION



# ATTRIBUTE HISTORY TRANSFORMATION

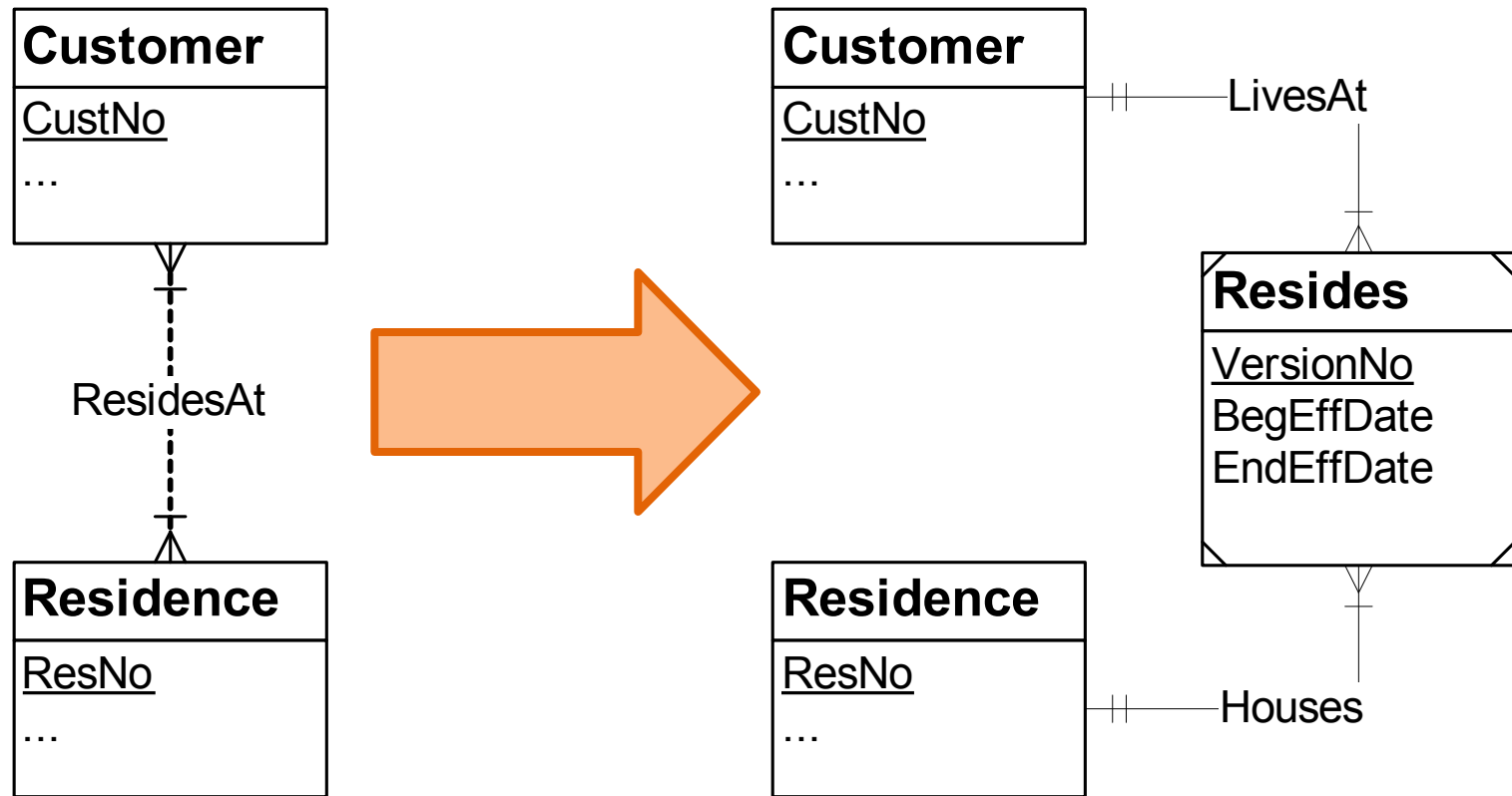


# 1-M RELATIONSHIP TRANSFORMATION



If a meter can be reused by customers

# M-N RELATIONSHIP TRANSFORMATION



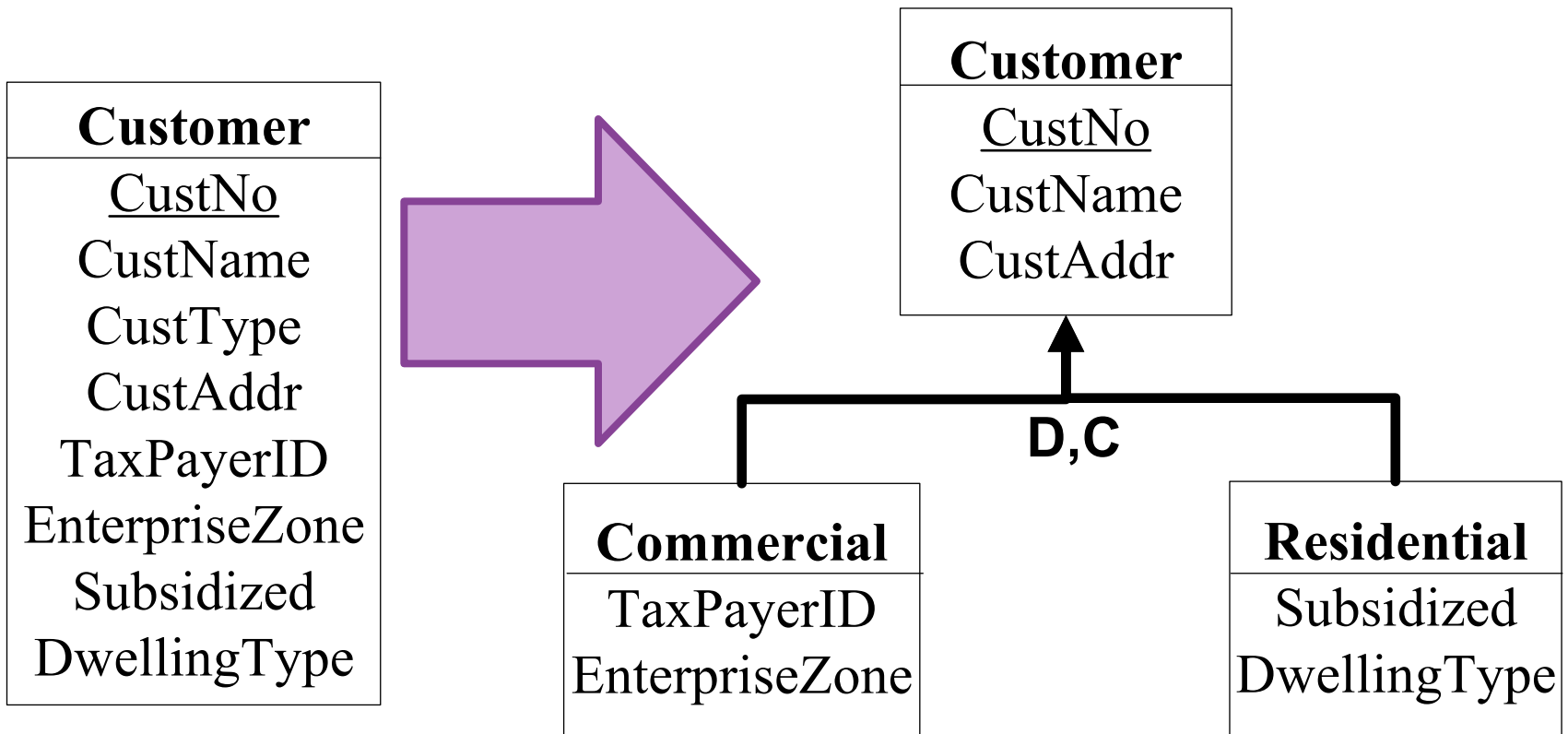
# LIMITED HISTORY TRANSFORMATION

Employee	
<u>EmpNo</u>	
EmpName	
EmpCurrTitle	}
EmpCurrTitleBegEffDate	
EmpCurrTitleEndEffDate	
EmpPrevTitle	}
EmpPrevTitleBegEffDate	
EmpPrevTitleEndEffDate	

**Current Title**

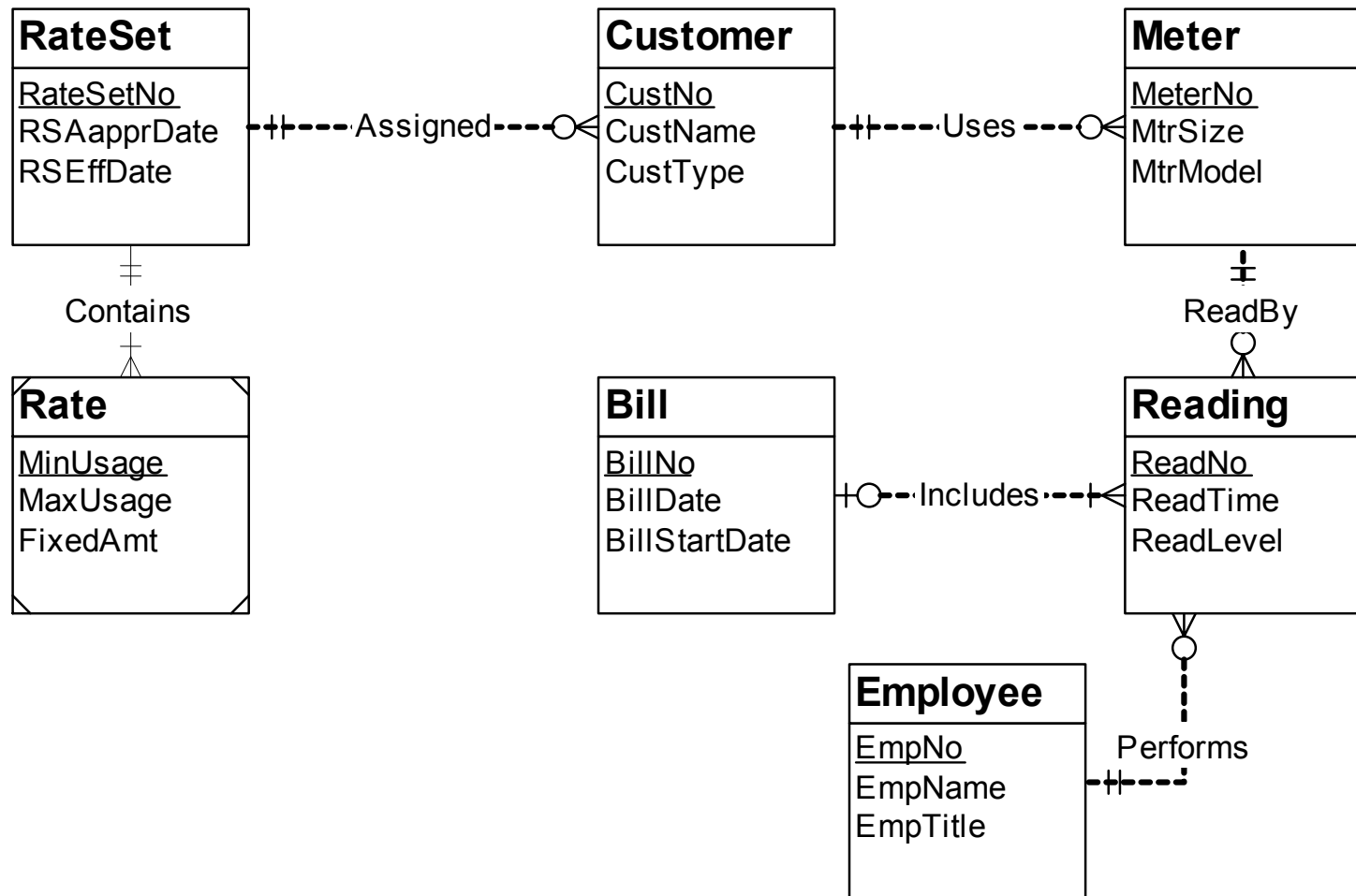
**Previous Title**

# GENERALIZATION HIERARCHY TRANSFORMATION





# EXAMPLE ENTITY TYPE CLUSTER



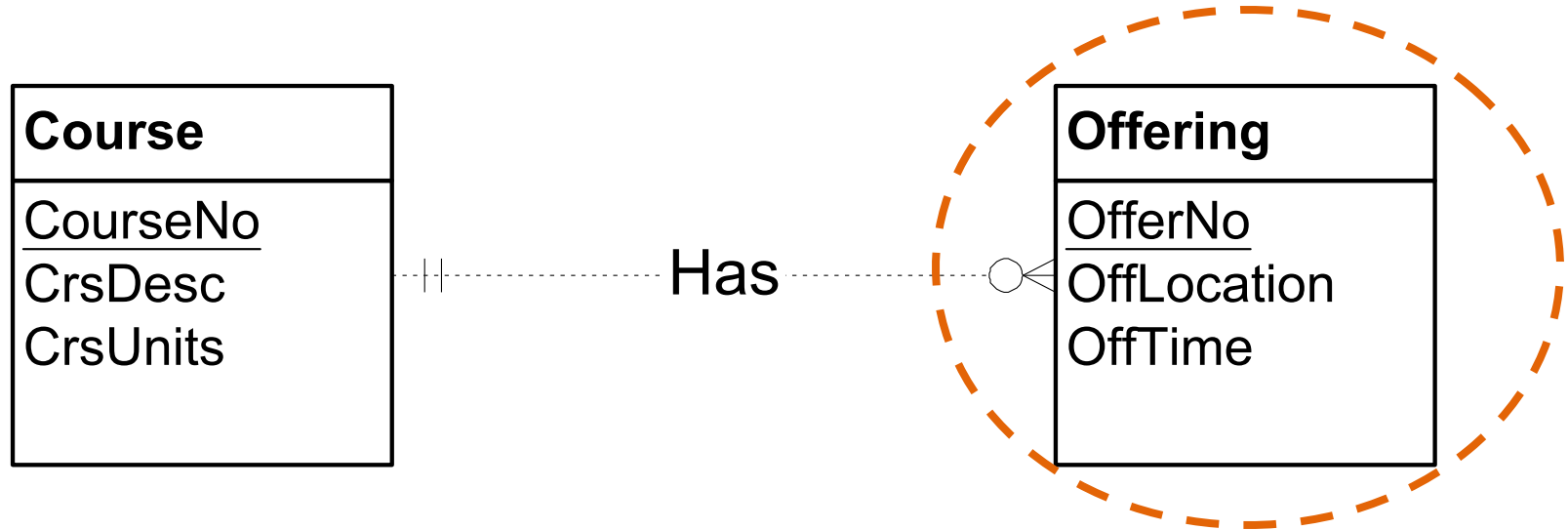
# SUMMARY OF DATA MODELING GUIDELINES

- Use notation precisely
- Strive for simplicity
- ERD connections
  - Avoid over connecting the ERD
  - Identify hub(s) of the ERD
- Use specialized patterns carefully
- Justify important design decisions

# SUMMARY OF BASIC CONVERSION RULES

- Entity type → a table.
- 1-M relationship → add a foreign key in the table corresponding to the entity type near the crow's foot symbol.
- M-N relationship → an associative table with a combined primary key.
- Identifying relationship → adds a column to a primary key.

# APPLICATION OF BASIC RULES (I)



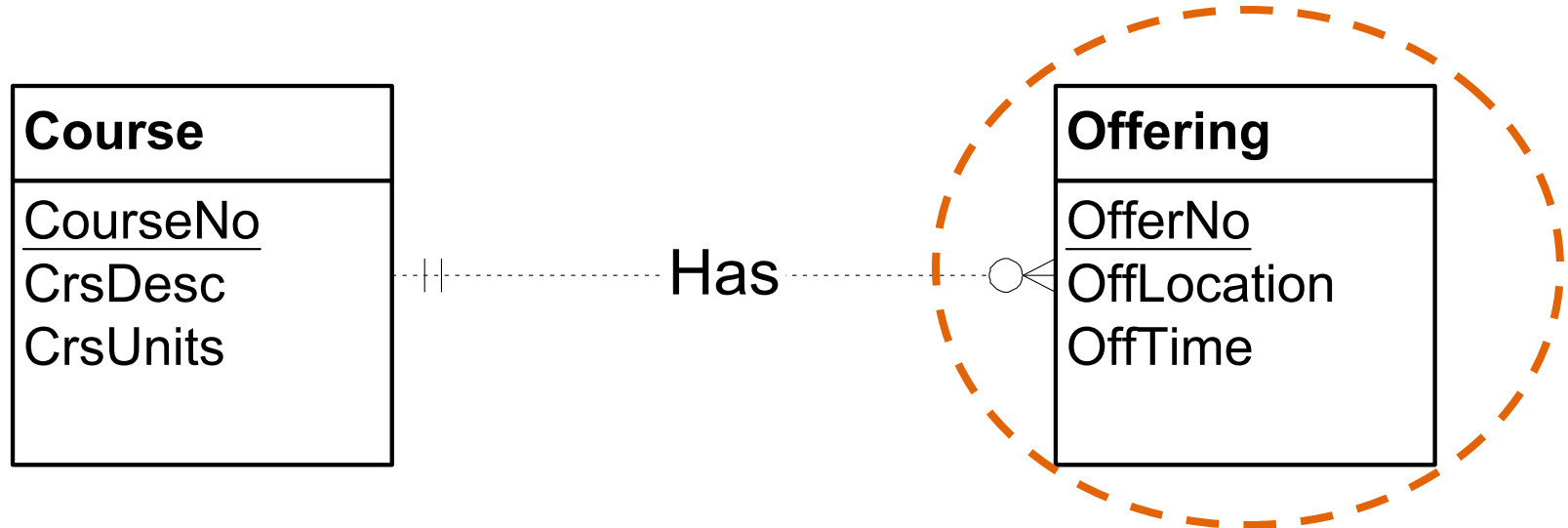
CREATE TABLE **Course** (

CourseNo Integer,

CrsDesc String

CrsUnit Integer, PRIMARY KEY (**CourseNo**) )

# APPLICATION OF BASIC RULES (I)



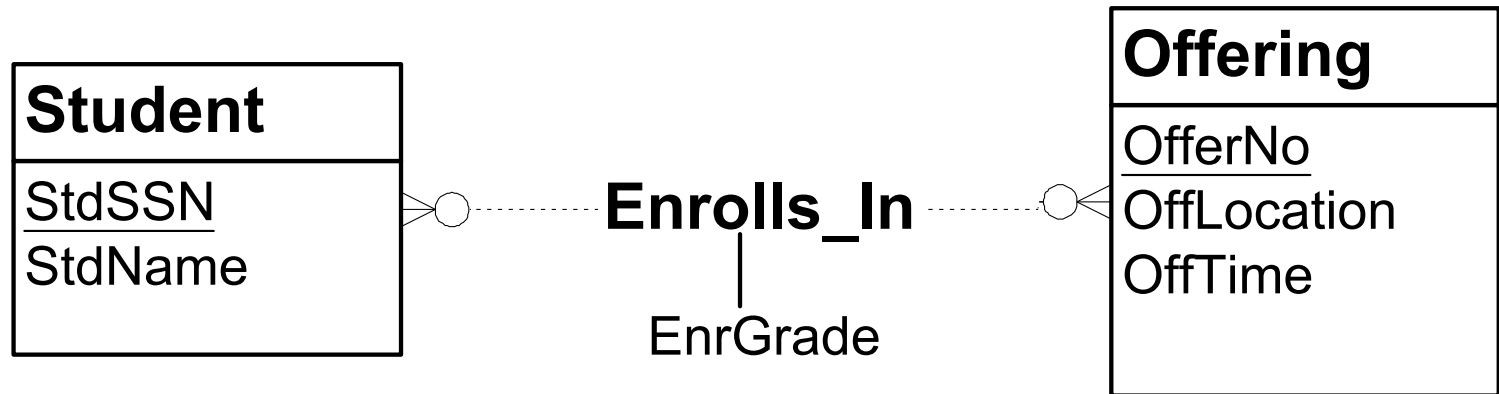
CREATE TABLE **Offering** (...

PRIMARY KEY **OfferNo**,

FOREIGN KEY (**CourseNo**) REFERENCES **Course** )

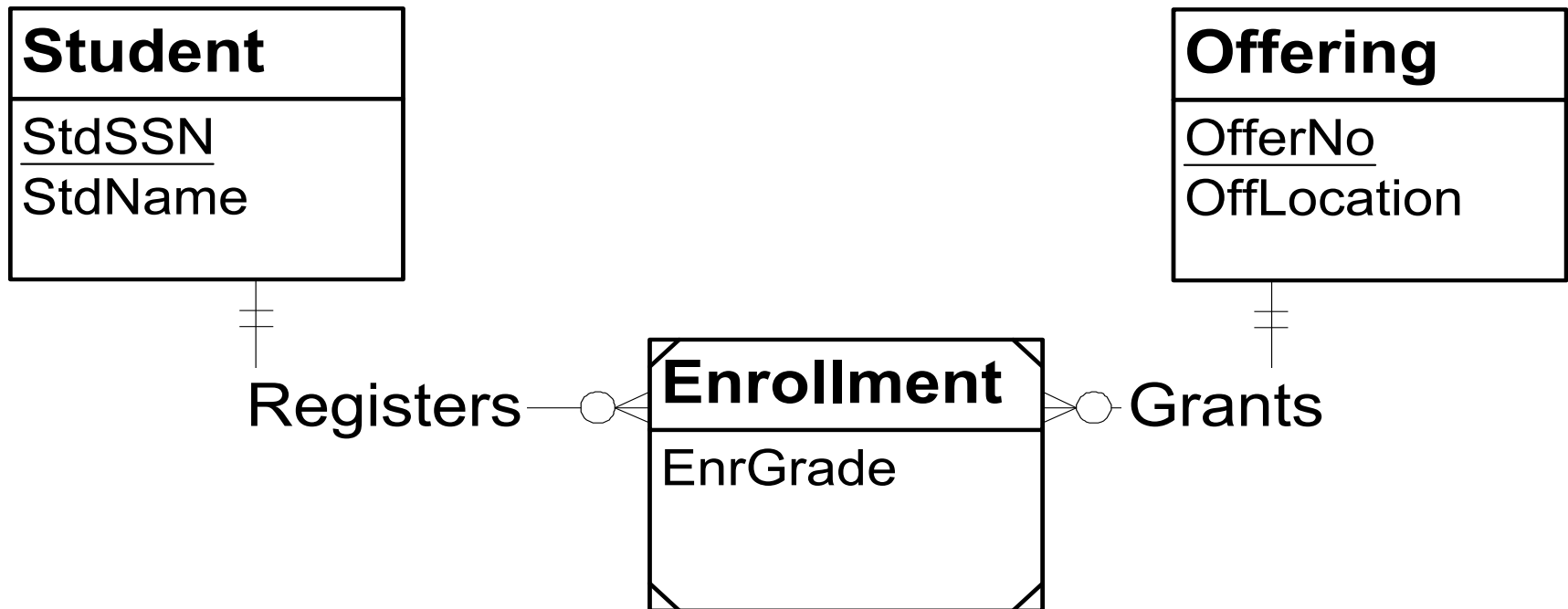
Add CourseNo

# APPLICATION OF BASIC RULES (II)



```
CREATE TABLE Enrollment (StdSSN Integer,  
OfferNo Integer, EnrGrade Number(4,2),  
PRIMARY KEY (StdSSN, OfferNo),  
FOREIGN KEY (StdSSN) REFERENCES Student,  
FOREIGN KEY (OfferNo) REFERENCES Offering )
```

# APPLICATION OF BASIC RULES (III)



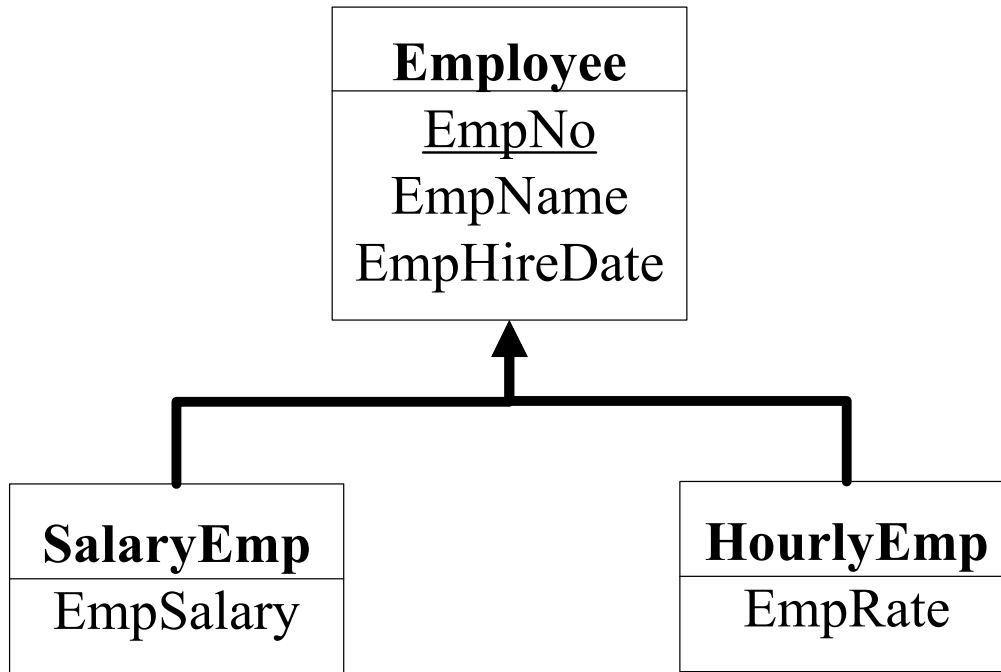
- Same conversion result as the previous slide
- Different application of rules

# GENERALIZATION HIERARCHY RULE

- Mimic generalization hierarchy as much as possible
  - Each subtype table contains specific columns plus the primary key of its parent table.
  - Foreign key constraints for subtype tables
  - **CASCADE DELETE** option for referenced rows
- Reduce need for null values
- Need joins and **outer joins** to combine tables



# GENERALIZATION HIERARCHY EXAMPLE



- Employee table: EmpNo (PK)

- SalaryEmp table: EmpNo (PK), EmpNo (FK)

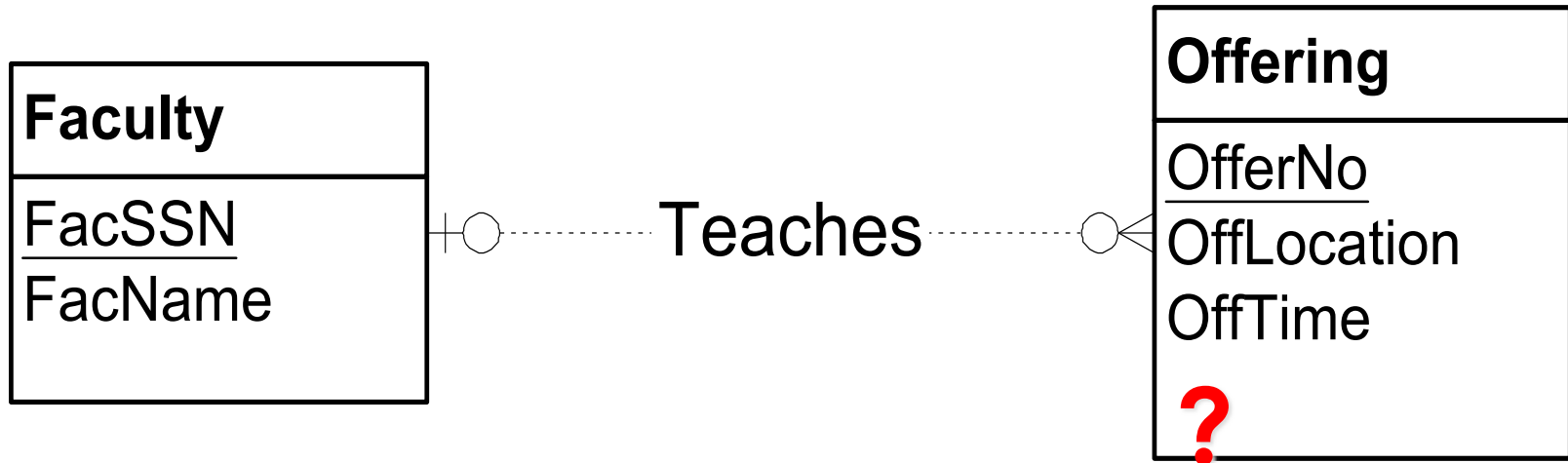
- HourlyEmp table: EmpNo (PK), EmpNo (FK)

set **CASCADE DELETE** option for Foreign Keys  
to avoid deleting an employee data of SalaryEmp and HourlyEmp.

# OPTIONAL 1-M RULE

- Separate table for each optional 1-M relationship
- Avoids null values
- Requires an extra table and join operation
- Controversial: in most cases 1-M rule is preferred

# OPTIONAL 1-M EXAMPLE



```
CREATE TABLE Teaches (... PRIMARY KEY (OfferNo) ,  
    FOREIGN KEY(OfferNo) REFERENCES Offering,  
    FOREIGN KEY(FacSSN) REFERENCES Faculty )
```

Avoids null values

# 1-1 RELATIONSHIPS



*Office must have an employee*

```
CREATE TABLE Office (...  
PRIMARY KEY (OfficeNo) ,  
FOREIGN KEY(EmpNo) REFERENCES Employee,  
UNIQUE (EmpNo) )
```

# SUMMARY

- Data modeling is an important skill
- Use notation precisely
- Preference for simpler designs
- Consider alternative designs
- Review design for common errors
- Work many problems