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# INFO20003 Database Systems

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Lecture 06
Unary relationships &
Extended ER Modelling

Semester 1 2018, Week 3

# Administration

- **Feedback**
  - –Please share what you like/dislike about the subject
  - –What can be improved and how

- **Assignment 1**
  - –Will be online on Friday 16/03/18 at 10am
  - –Due date Friday 30/03/18 at 11:59pm
  - –Submit:

  1. One PDF: Conceptual Model (pen and paper Chen's notation, scanned/photo legible), plus Physical Model (Crow's foot notation with Workbench, picture), plus assumptions
  2. Physical model: Workbench file (mwb)

# Coverage

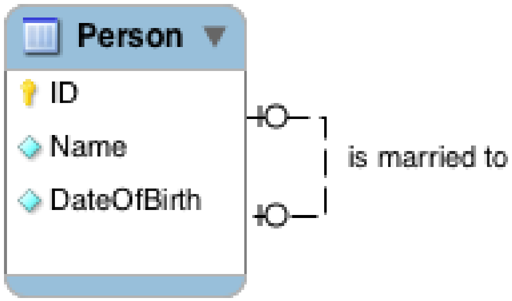
- Unary relationships
- Enhanced ER Modelling
  - Specialisation / Generalisation
  - Inheritance
  - Constraints on Supertype/Subtype relationships

# Unary Relationships

- Operate in the same way exactly as binary relationships
  - **One-to-One**
    - Put a Foreign key in the relation
  - **One-to-Many**
    - Put a Foreign key in the relation
  - **Many-to-Many**
    - Generate an Associative Entity
    - Put two Foreign keys in the Associative Entity
      - Need 2 different names for the Foreign keys
      - Both Foreign keys become the *combined* key of the Associative Entity

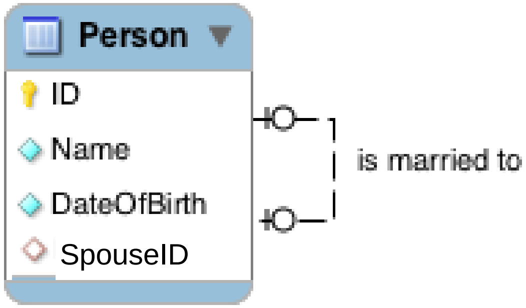
# Unary: One-to-One

## Conceptual Design:




## Logical Design:

- Person = (<u>ID</u>, Name, DateOfBirth, <u>*SpouseID*</u>)




## Implementation:

```
CREATE TABLE Person (
  ID INT NOT NULL,
  Name VARCHAR(100) NOT NULL,
  DateOfBirth DATE NOT NULL,
  SpouseID INT,
  PRIMARY KEY (ID),
  FOREIGN KEY (SpouseID)
  REFERENCES Person (ID)
  ON DELETE RESTRICT
  ON UPDATE CASCADE);
```

| ID | Name | DOB | SpouseID |
|---|---|---|---|
| 1 | Ann | 1969-06-12 | 3 |
| 2 | Fred | 1971-05-09 | NULL |
| 3 | Chon | 1982-02-10 | 1 |
| 4 | Nancy | 1991-01-01 | NULL |

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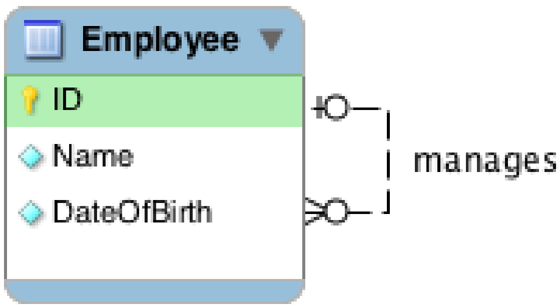
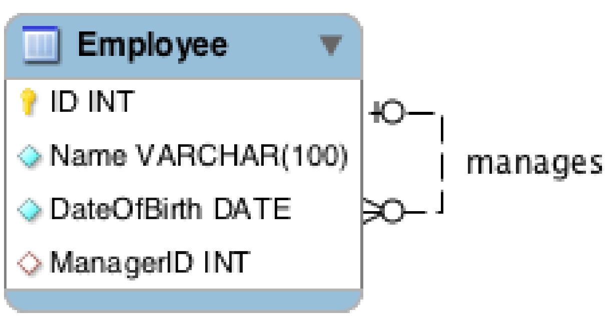
# Unary: One-to-Many

## Conceptual Design:




## Logical Design:

- Employee = (ID, Name, DateOfBirth, *ManagerID*)

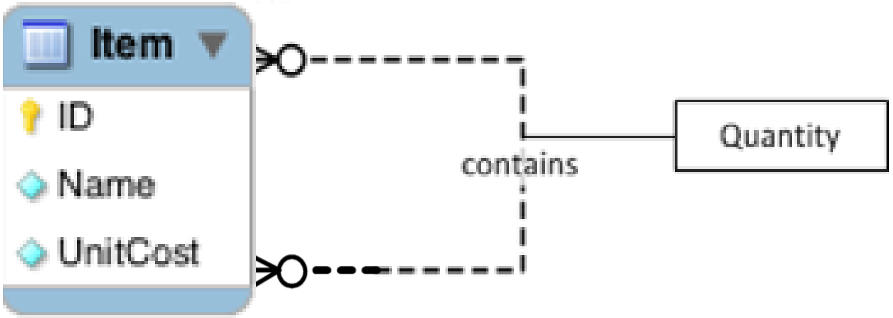


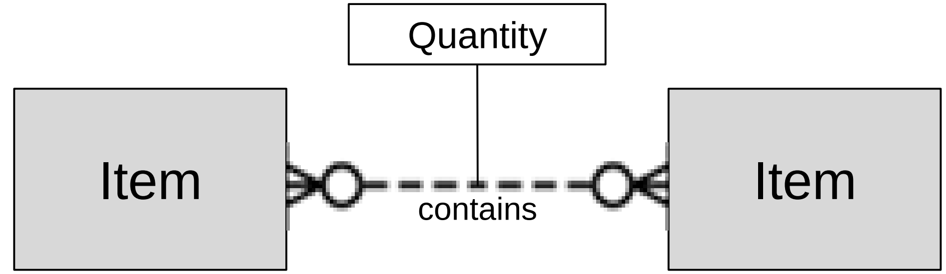

## Implementation:

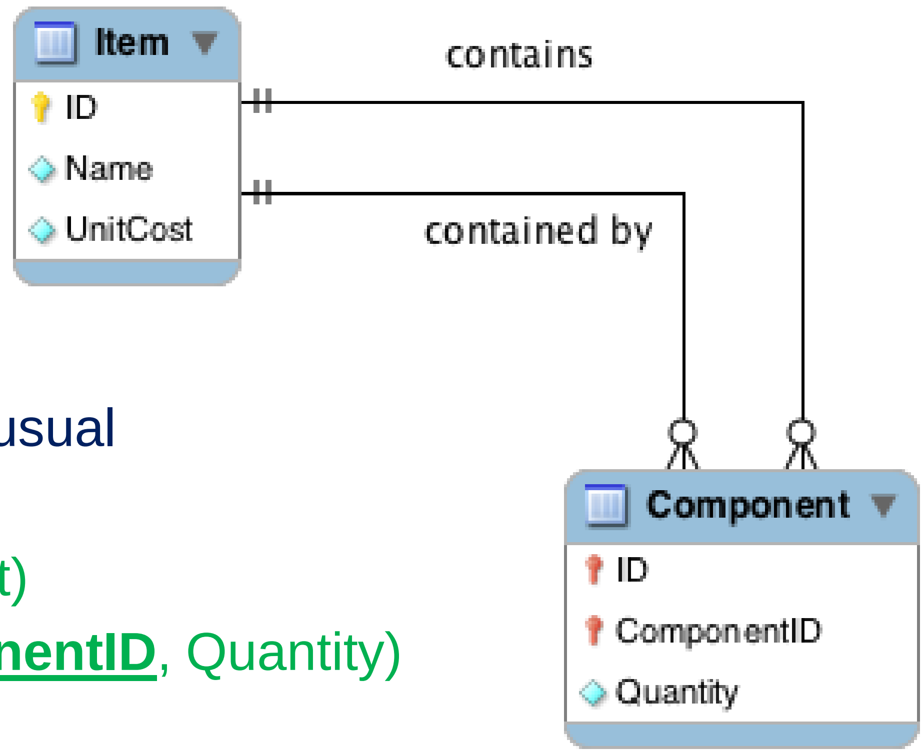
```
CREATE TABLE Employee(
  ID smallint NOT NULL,
  Name VARCHAR(100) NOT NULL,
  DateOfBirth DATE NOT NULL,
  ManagerID smallint ,
  PRIMARY KEY (ID),
  FOREIGN KEY (ManagerID)
  REFERENCES Employee(ID)
  ON DELETE RESTRICT
  ON UPDATE CASCADE);
```

| ID | Name | DOB | MngrID |
|---|---|---|---|
| 1 | Ann | 1969-06-12 | NULL |
| 2 | Fred | 1971-05-09 | 1 |
| 3 | Chon | 1982-02-10 | 1 |
| 4 | Nancy | 1991-01-01 | 1 |

# Unary: Many-to-Many




- **Logical Design:**
  - Create Associative Entity like usual
  - Generate logical model
    - Item = (<u>ID</u>, Name, UnitCost)
    - Component = (**<u>ID, ComponentID</u>**, Quantity)

# Unary: Many-to-Many Implementation

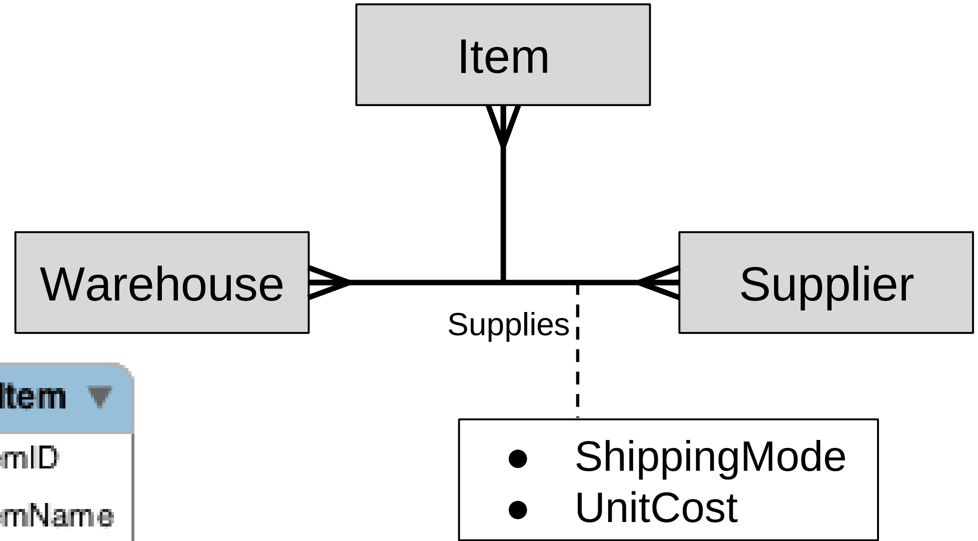
- Implementation

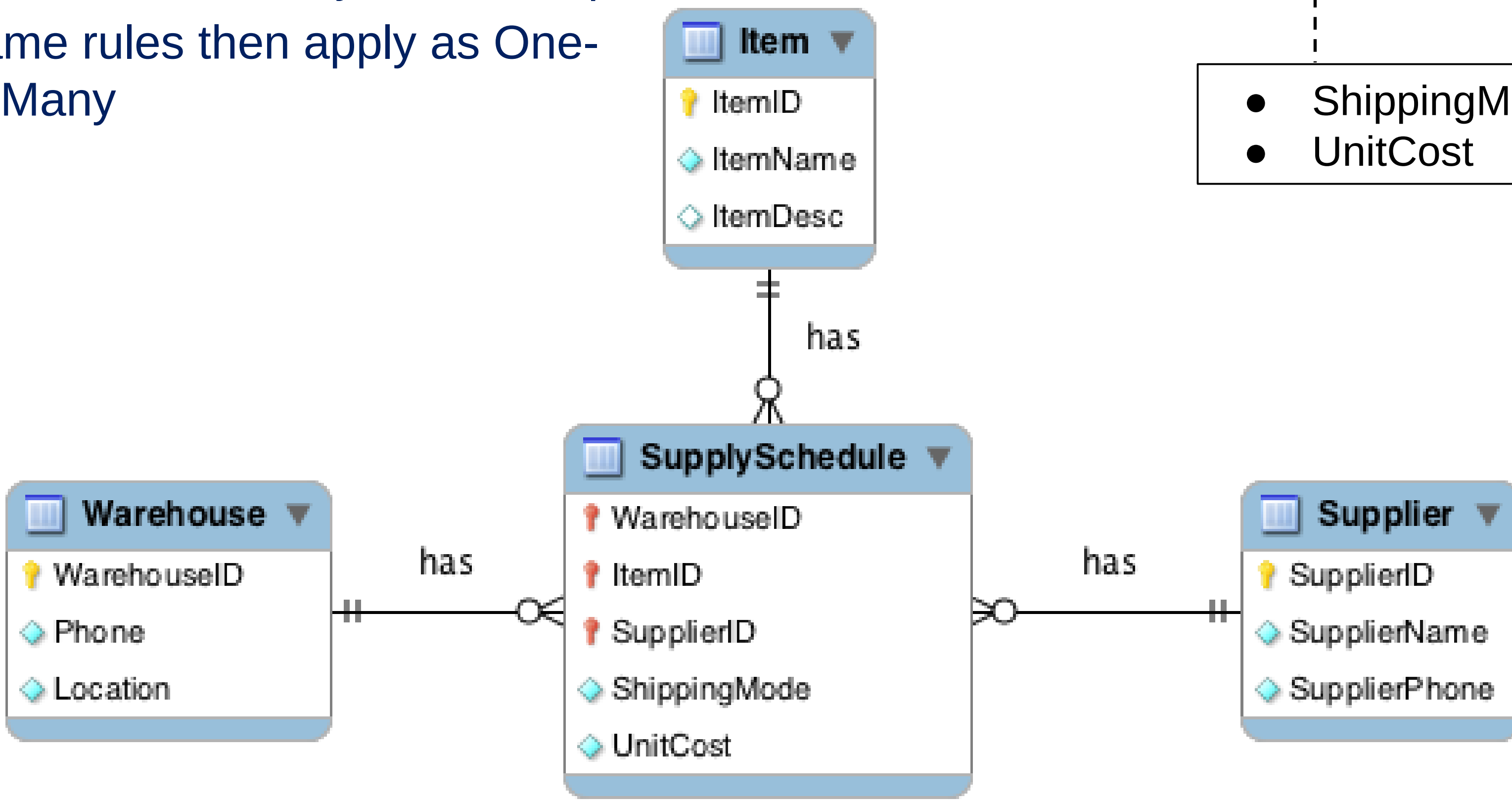
```
CREATE TABLE Part (
   ID                  smallint,
   Name                VARCHAR(100)    NOT NULL,
   UnitCost            DECIMAL(6,2)    NOT NULL,
   PRIMARY KEY  (ID)
) ENGINE=InnoDB;
```

```
CREATE TABLE Component (
   ID                  smallint,
   ComponentID         smallint,
   Quantity            smallint     NOT NULL,
   PRIMARY KEY  (ID, ComponentID),
   FOREIGN KEY (ID) REFERENCES Part(ID)
         ON DELETE RESTRICT
         ON UPDATE CASCADE,
   FOREIGN KEY (ComponentID) REFERENCES Part(ID)
         ON DELETE RESTRICT
         ON UPDATE CASCADE
) ENGINE=InnoDB;
```

# Ternary relationships

- Relationships between three entities
- Logical Design:
  - Generate an Associative Entity
  - Three One-to-Many relationships
  - Same rules then apply as One-to-Many



# Why EER?

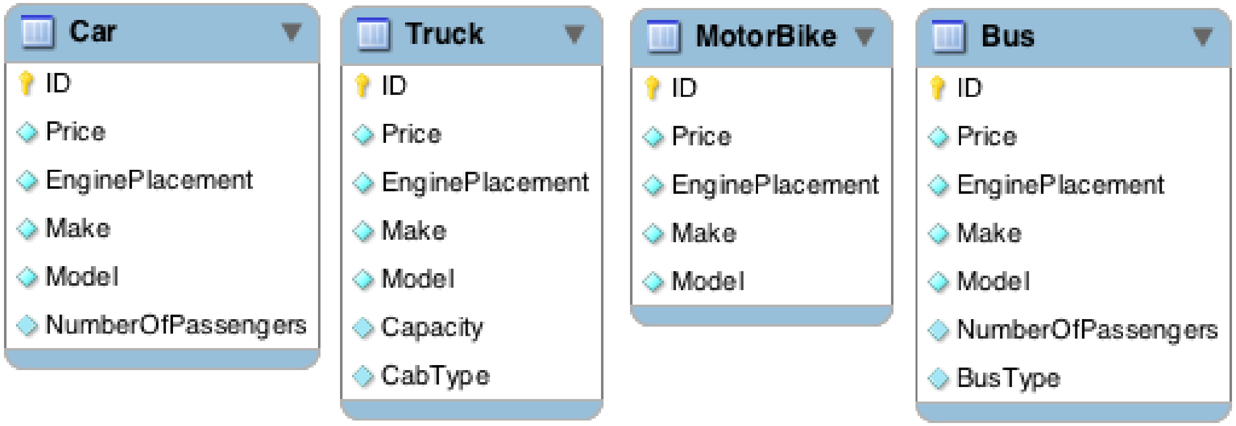
- ER can not adequately capture complex business models
- EER, extends functionality of ER models
  - In particular
    - Can capture supertype / subtype relationships
      - Discussed in the lecture today
    - Allows aggregation of entities
    - Allows capture of business rules that control behaviour

# Consider the Following Scenario

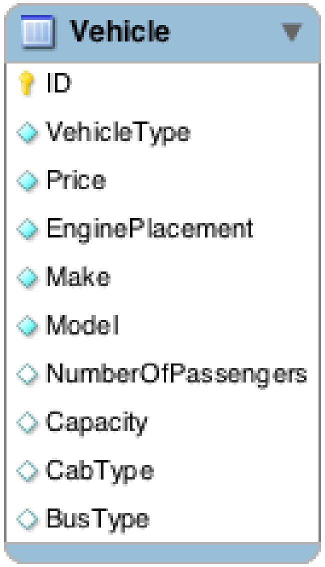
- A vehicle selling organisation sells vehicles.  When selling cars the organisation must record the price, engine displacement, car make, car model, and number of passengers.  When selling trucks the organisation must record the price, engine displacement, truck make, truck model, capacity and cab_type.  When selling motorbikes the price. engine displacement, bike make and bike model.  When selling busses they must know the price, engine displacement, bus make, bus model, bus type and number of passengers.

# Possible Entities

- Solution 1:

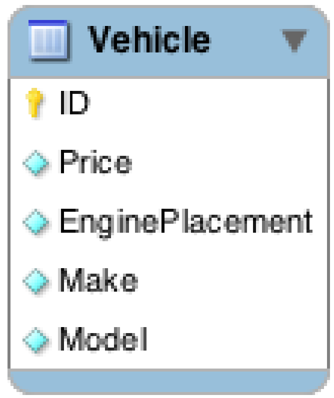



- Solution 2:



# An Alternative Solution - EER

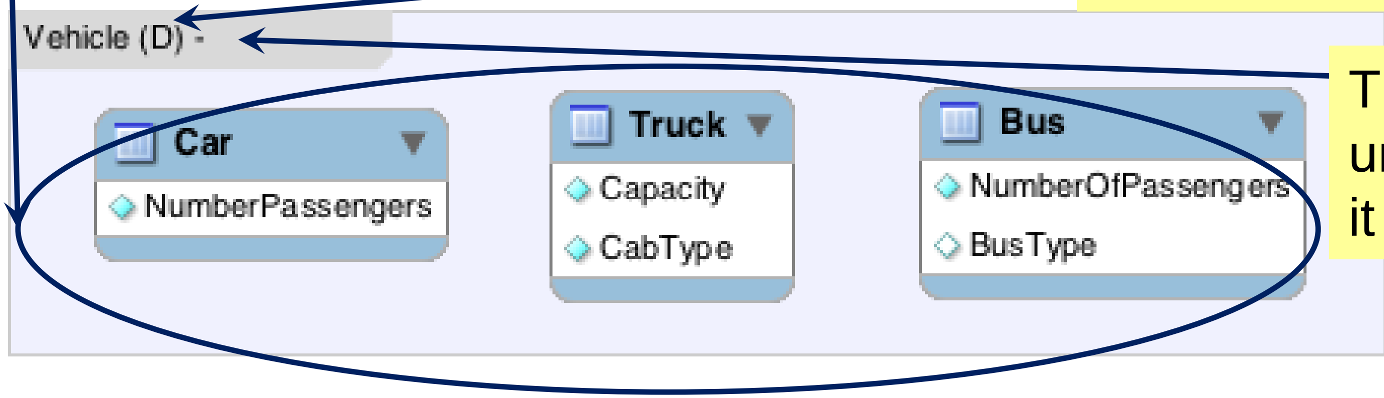
Each of the subtypes inherits all of the attributes of the supertype




What Happened to the Motorbike?

Diagram is saying that a Vehicle could either be a Car, a Truck, a Bus, or none of them…

The 'd' means disjoint (i.e. can be one of these…)

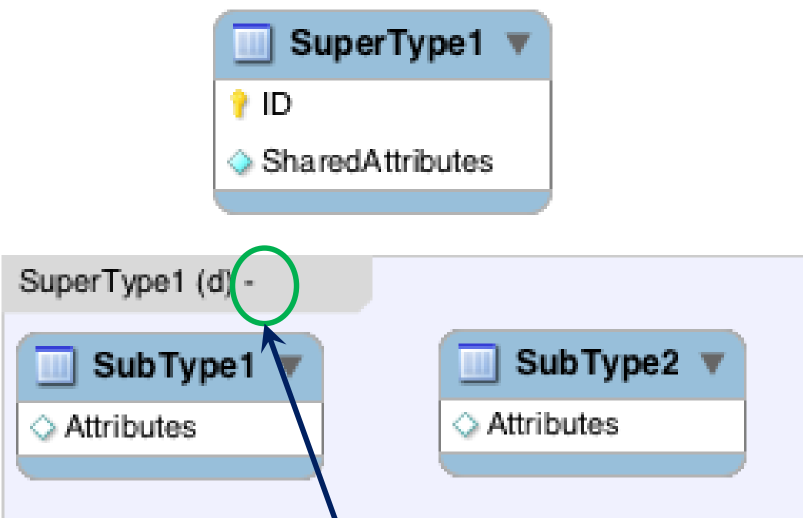


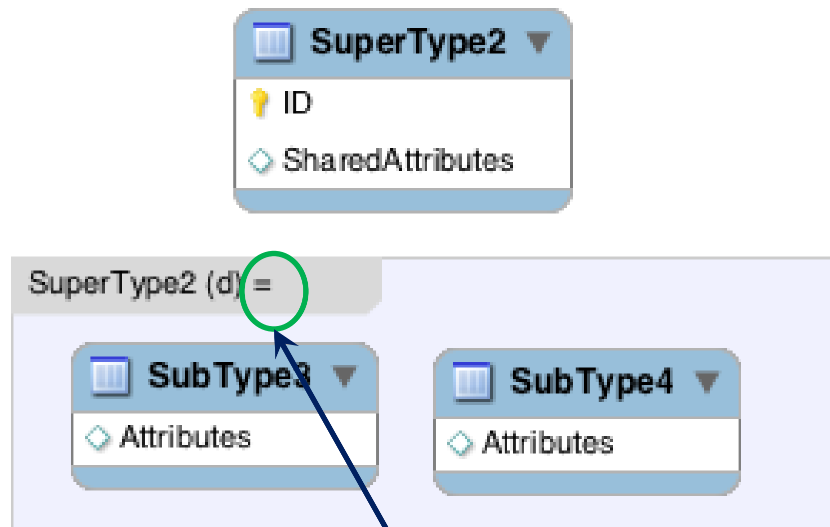

The single line under the 'd' says it can be none

- This is known as a supertype/subtype hierarchy or generalisation/specialisation hierarchy
- Each subtype has properties that are distinct from the others
- Each subtype inherits the properties of the supertype

# Completeness constraint in Super/Subtypes

- **Completeness Constraint**
  - Specifies whether an instance of a supertype must also be an instance of at least one subtype



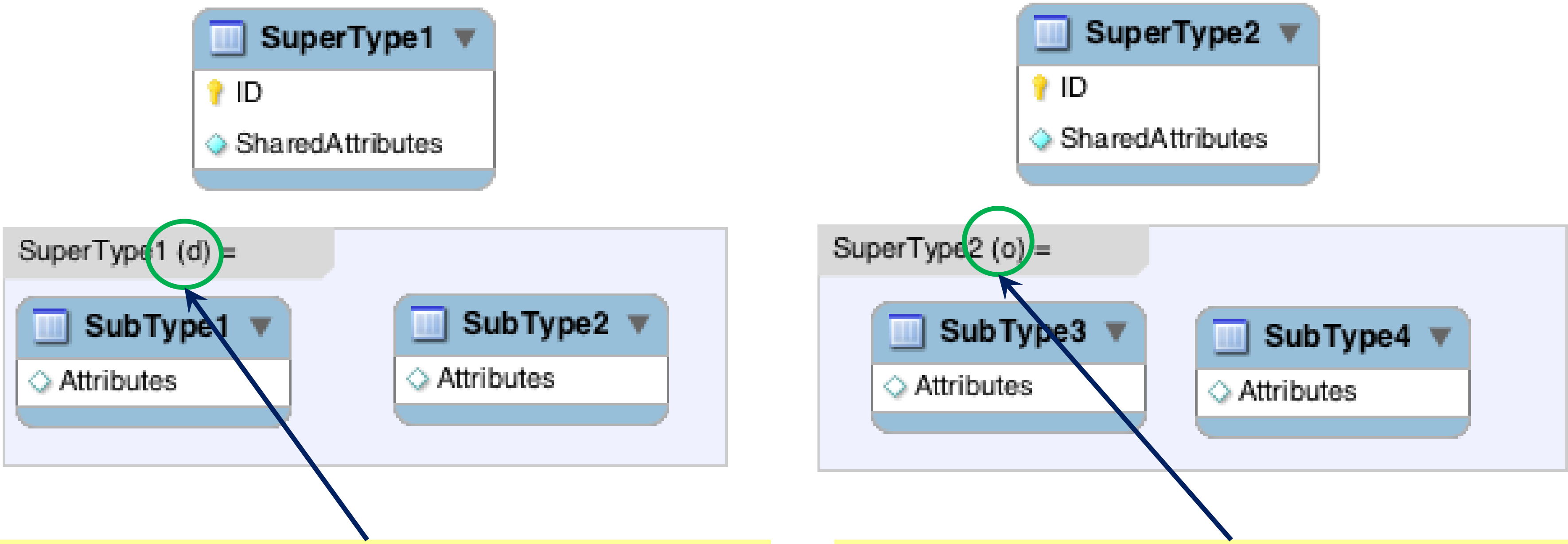




Single Line: the entity of type Supertype1 can be either Subtype1 or Subtype2 or neither

Double line: the entity of type Supertype2 MUST be either Subtype3 or Subtype4

# Disjointness constraint in Super/Subtypes

- **Disjointness Constraint**
  – Specifies whether an instance of a supertype may simultaneously be a member of two (or more) subtypes

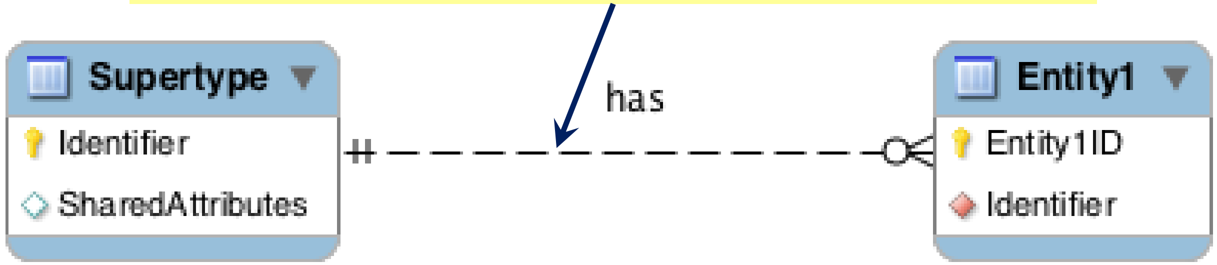


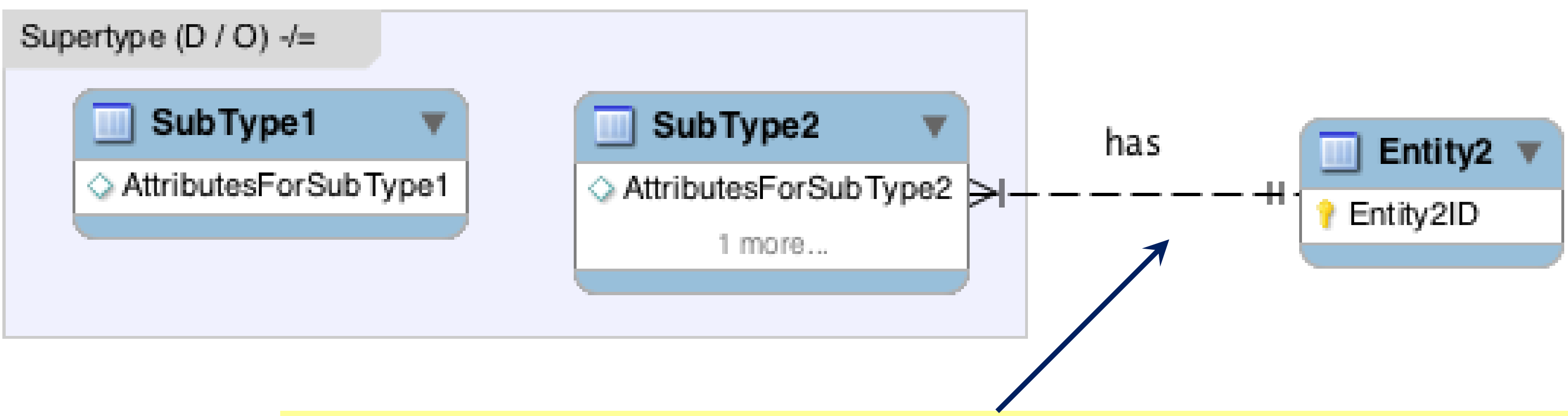

'd' = disjoint (can be one of these), and because of the double must be one of them

'o' = overlapping (can be more than one of these), and because of the double line must be at least one of them

# Relationships with other entities

Every instance of the entities are involved with this relationship (doesn't matter if it is a subtype or supertype)



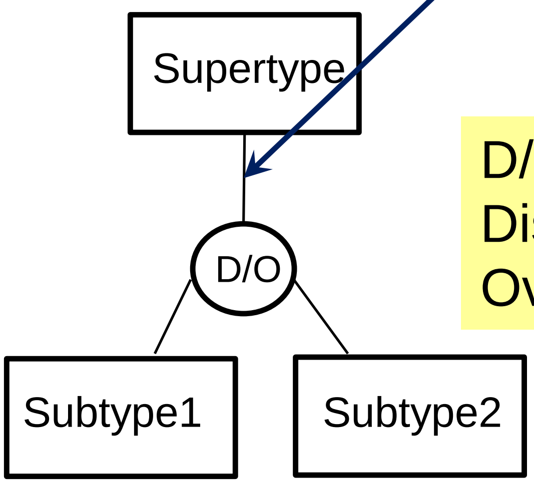




Only instances of Subtype2 are involved with this relationship

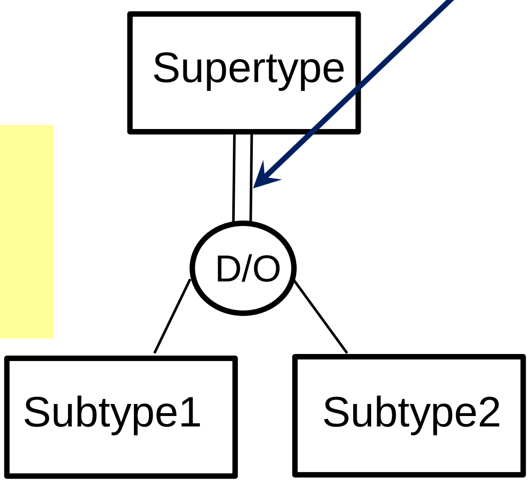
# Supertype/subtype with Chen's notation

Single Line: the entity of type Supertype can be either Subtype1 or Subtype2 or neither

Double line: the entity of type Supertype MUST be either Subtype1 or Subtype2



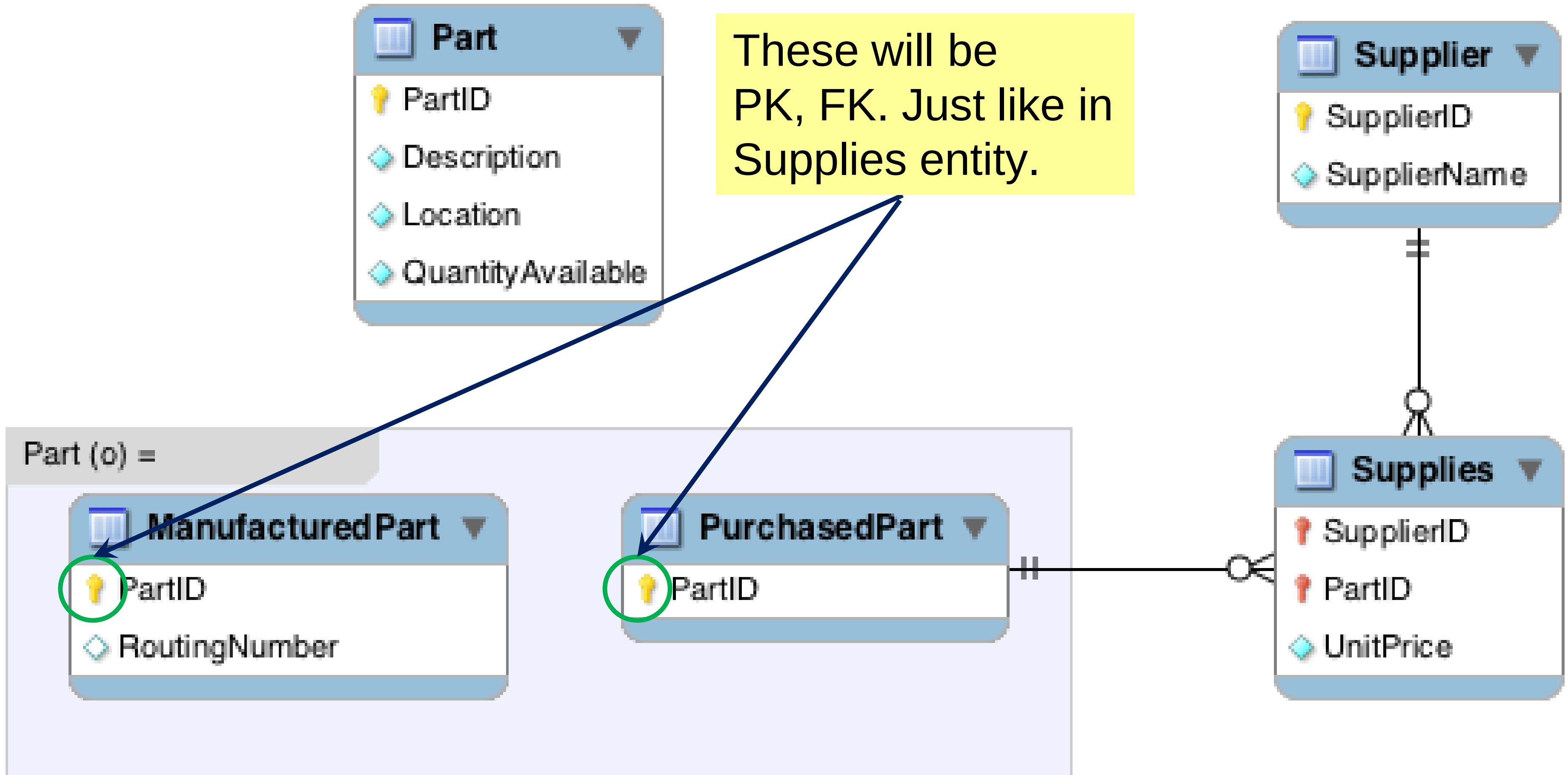

D/O – Disjoint or Overlapping



# Identifying Super/Subtype Situations

- Bottom Up
  - Generalisation
  - Combining a number of entity sets with similar attributes into a higher level entity set
    - Much like the Vehicle example
- Top Down
  - Specialisation
  - Process of defining one or more subtypes of the supertype and forming the relationships
  - Example
  - Part = (<u>ID</u>, Description, QuantityAvailable, Location, RoutingNumber, Supplier)
  - Becoming
    - Part = (<u>ID</u>, Description, QuantityAvailable, Location)
    - ManufacturedPart = (RoutingNumber)
    - SuppliedPart = (Supplier)

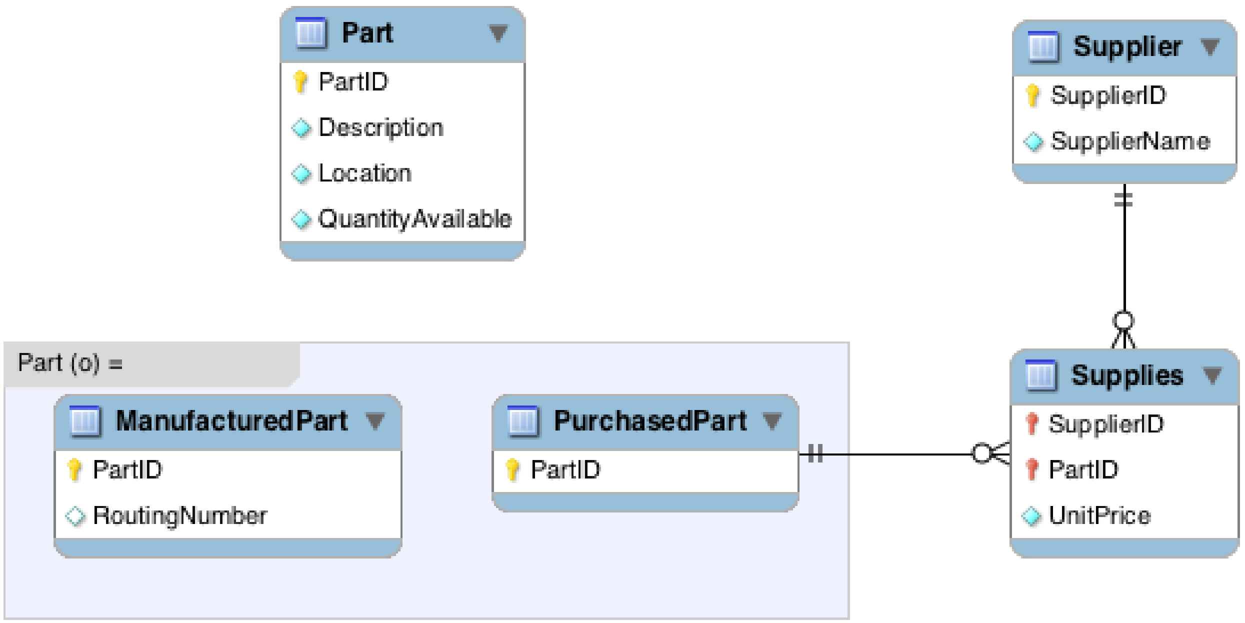
# Example 1: Parts – Logical Design



# Example 1: Parts – Logical Design

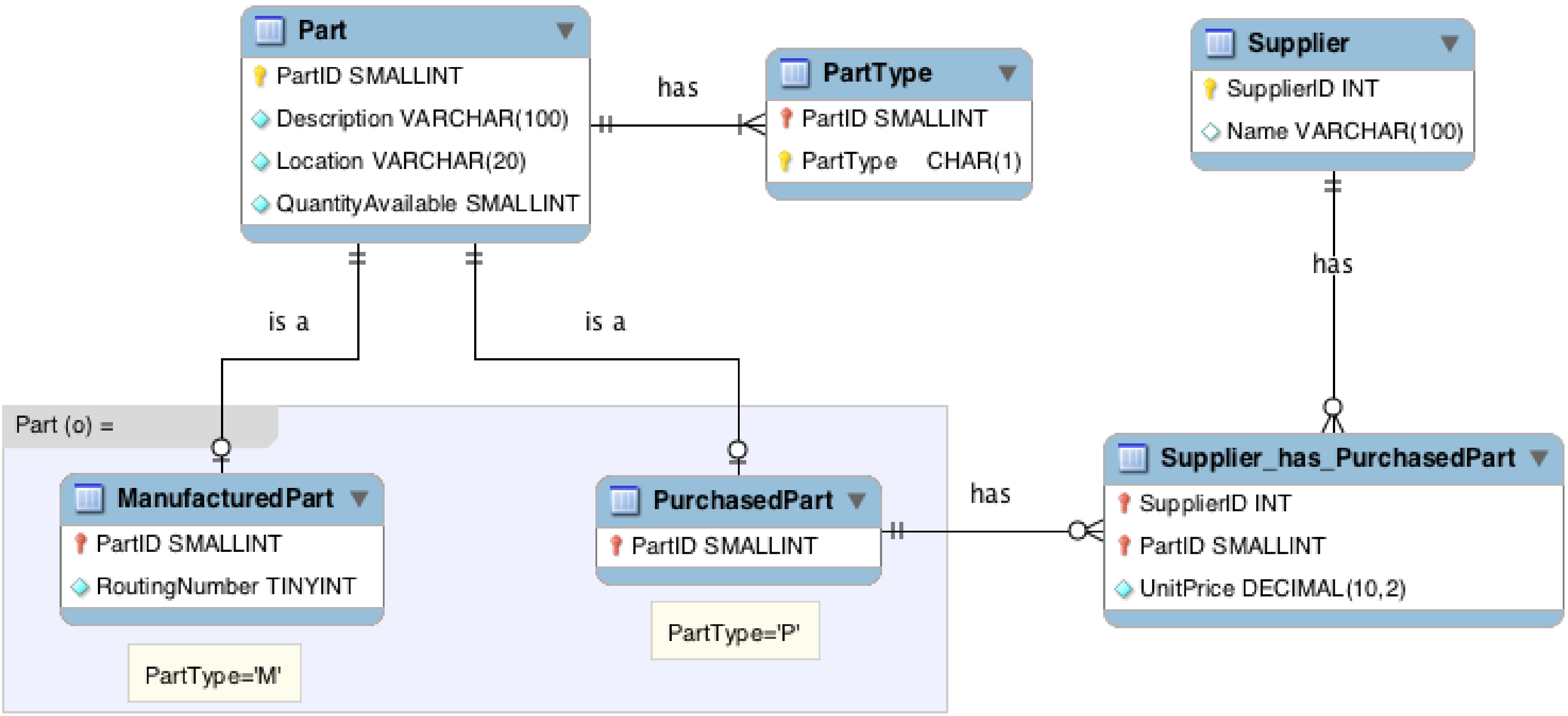
- Part(<u>PartID</u>, Description, Location, QuantityAvailable)
- ManufacturedPart(**<u>PartID</u>**, RoutingNumber)
- PurchasedPart(**<u>PartID</u>**)
- Supplies(**<u>PartID</u>**, **<u>SupplierID</u>**, UnitPrice)
- Supplier(<u>SupplierID</u>, Name)

Note: Underline = PK,
italic and underline = FK,
underline and bold = PFK

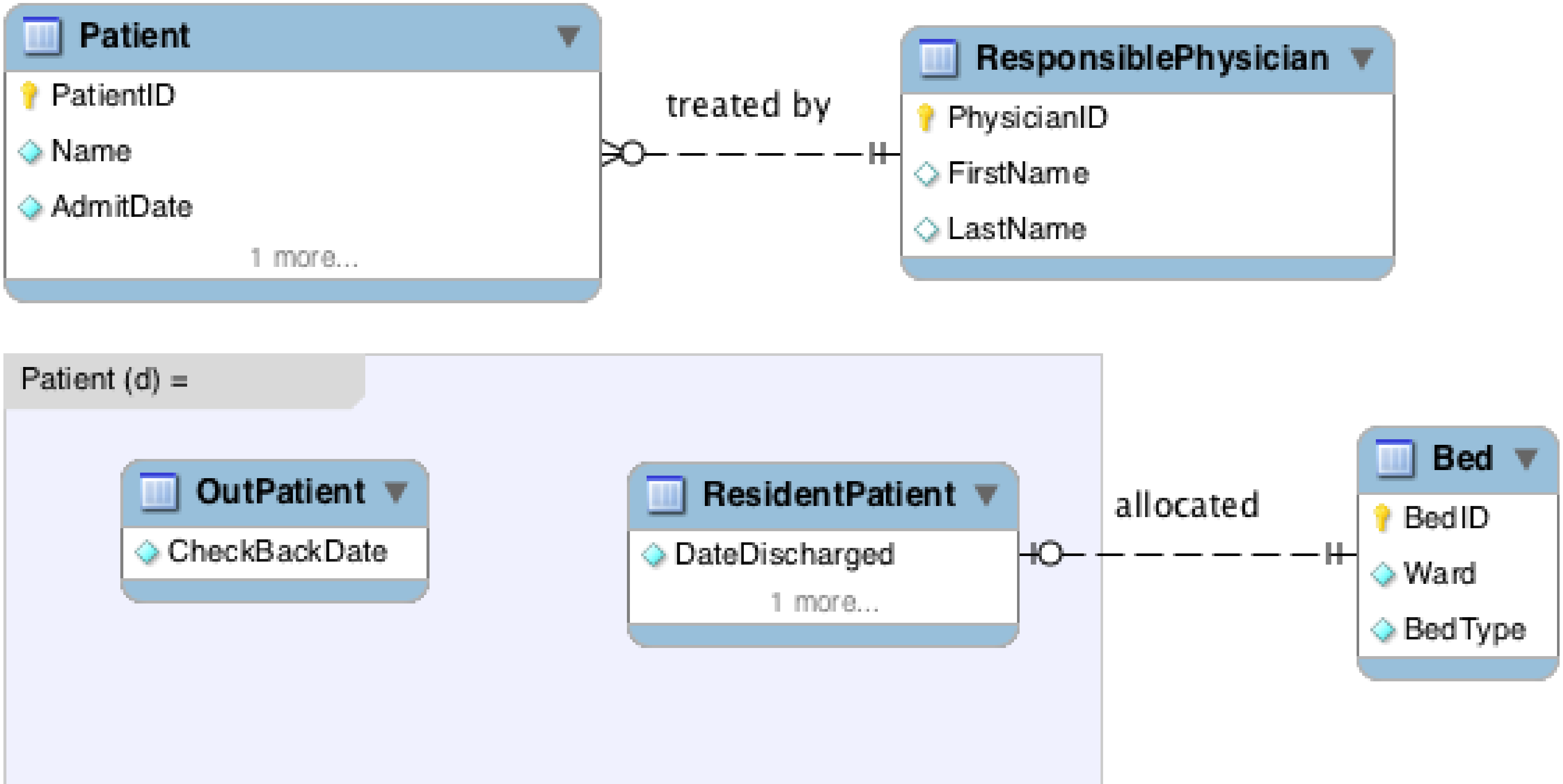


# Example 1: Parts – Physical Design

- Note new entity PartType – Because a part can be overlapping (Manifactured & Purchased at the same time)



# Example 2: Patients (Conceptual)



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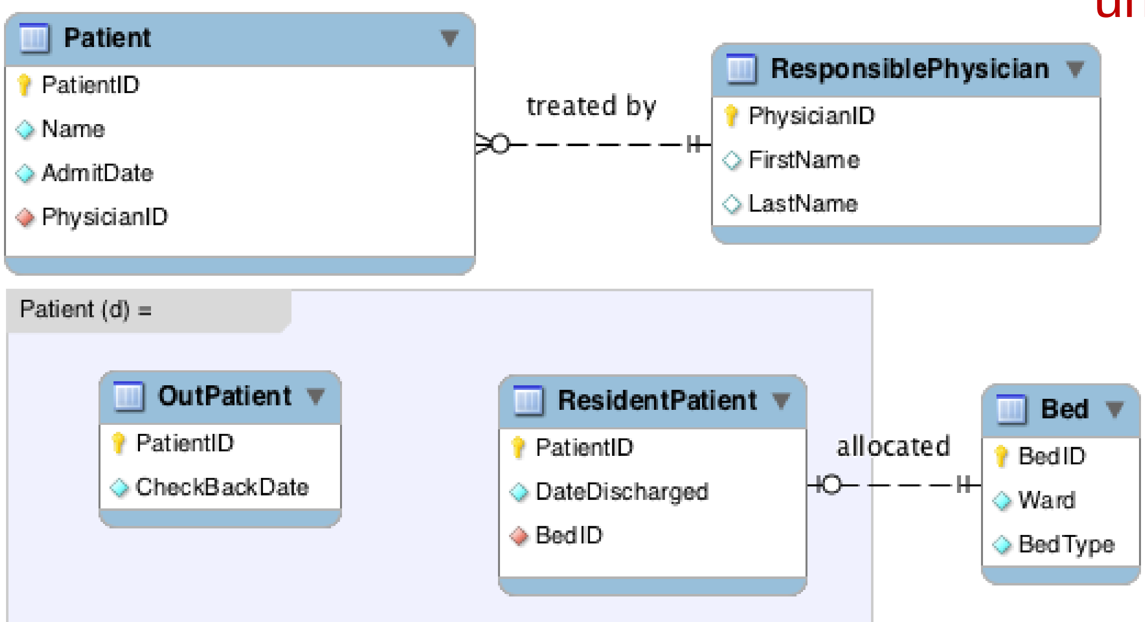
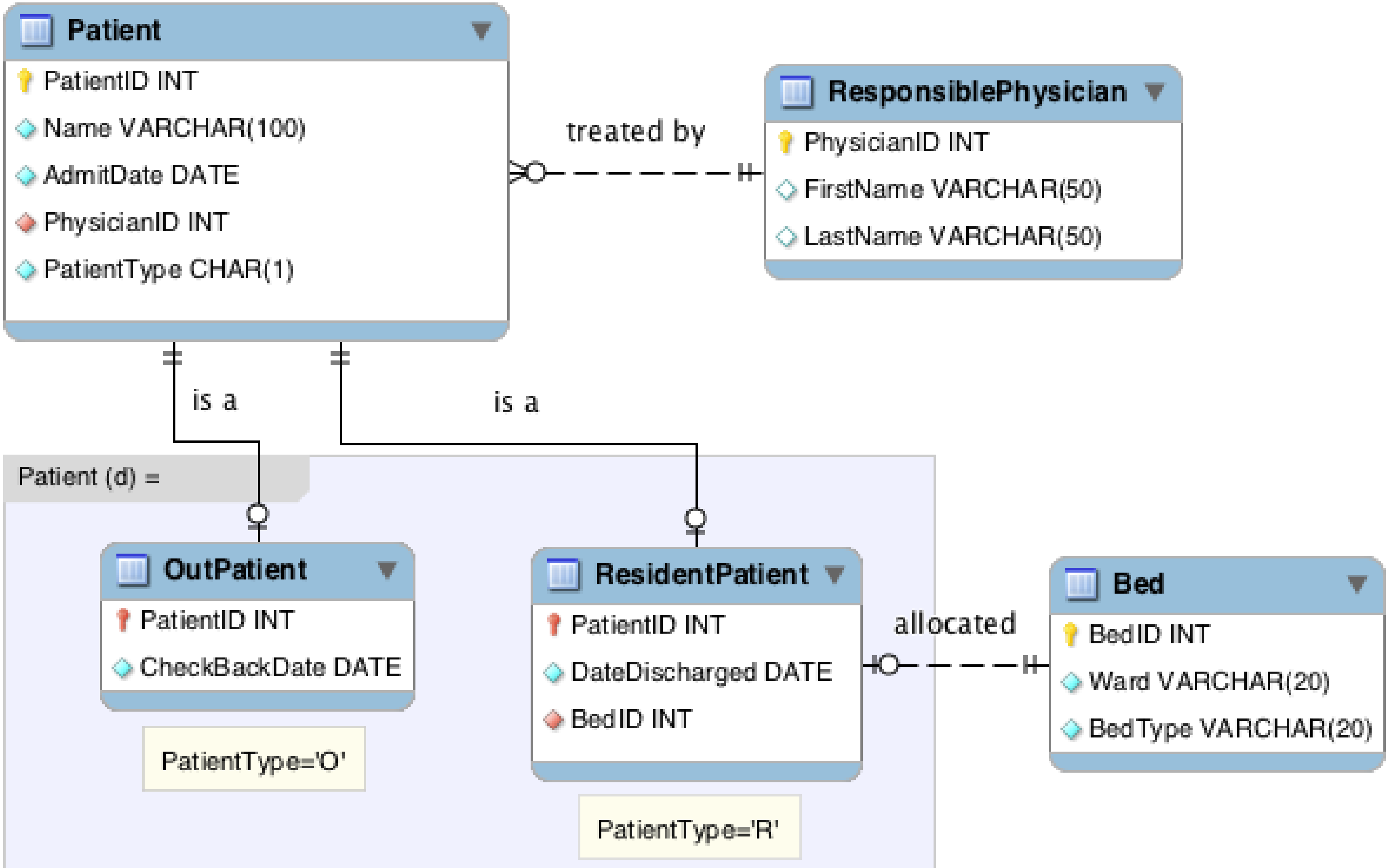
# Example 2: Patients – Logical Design

– Patient = (PatientID, Name, AdmitDate, *PhysicianID*)
– ResponsiblePhysician = (PhysicianID, FirstName, LastName)
– OutPatient = (**PatientID**, CheckBackDate)
– ResidentPatient = (**PatientID**, DateDischarged, *BedID*)
– Bed = (BedID, Ward, BedType)

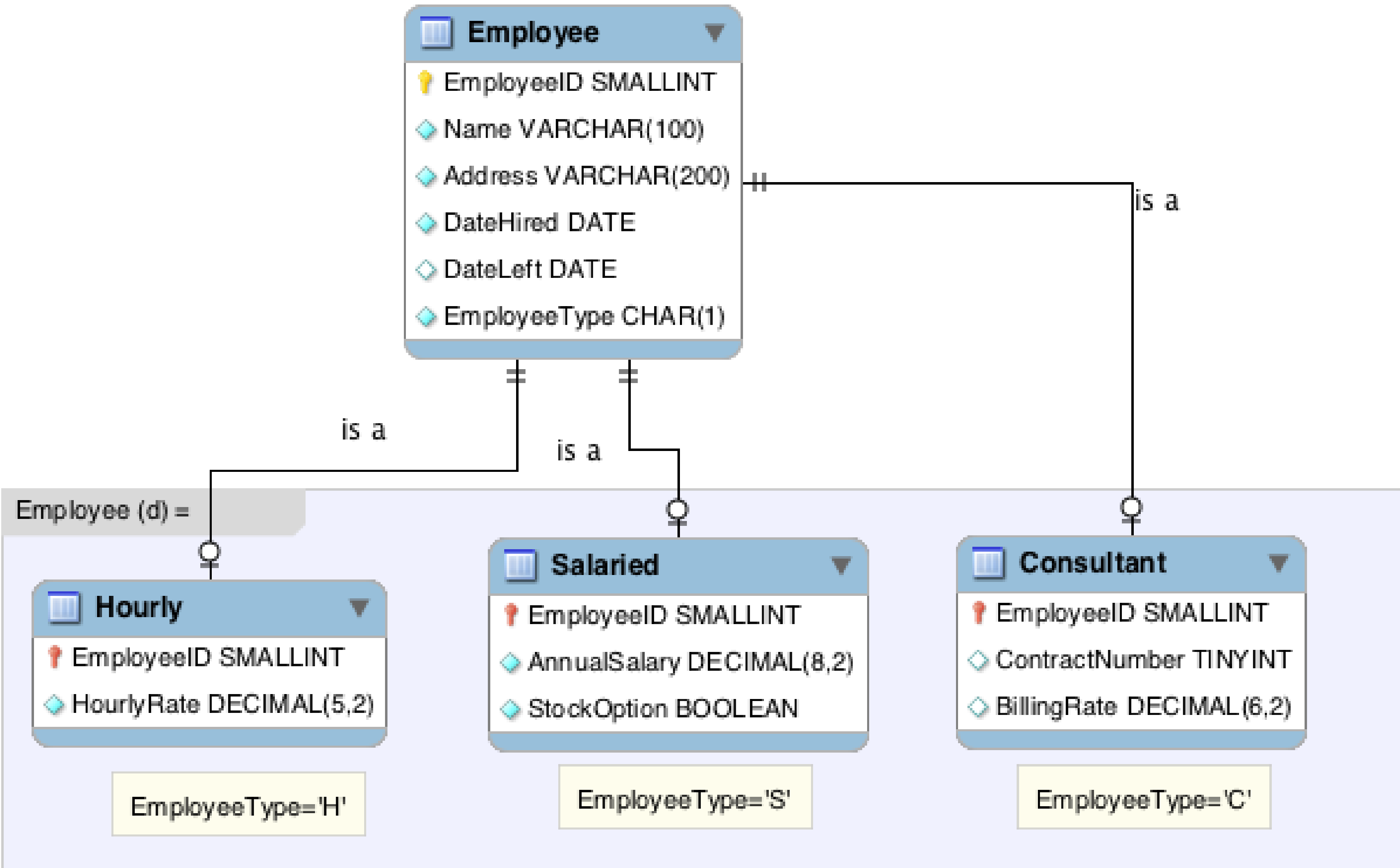
Note: Underline = PK, italic and underline = FK, underline and bold = PFK



# Example 2: Patients – Physical Design



# Example 3: Employee (showing physical only)



# Create Table Statements

```sql
CREATE TABLE Employee (
   ID              SMALLINT       AUTO_INCREMENT,
   Name            VARCHAR(150)   NOT NULL,
   Address         VARCHAR(150)   NOT NULL,
   DateHired       DATE           NOT NULL,
   DateLeft        DATE,
   EmployeeType    CHAR(1)        NOT NULL,
   PRIMARY KEY  (ID)
) ENGINE=InnoDB;
```

```sql
CREATE TABLE Hourly (
   ID              SMALLINT,
   HourlyRate      DECIMAL(5,2)      NOT NULL,
   PRIMARY KEY  (ID),
   FOREIGN KEY (ID) REFERENCES Employee(ID)
         ON DELETE RESTRICT
         ON UPDATE CASCADE
) ENGINE=InnoDB;
```

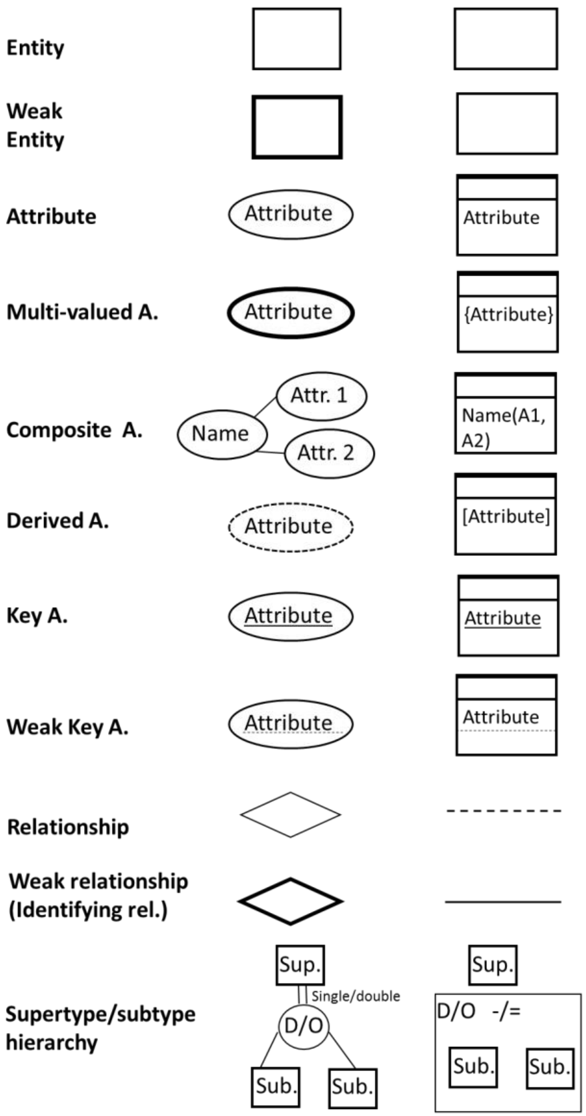
# Create Table Statements

```
CREATE TABLE Salaried (
   ID                    SMALLINT,
   AnnualSalary          DECIMAL(8,2)                 NOT NULL,
   StockOption           CHAR(1)         DEFAULT "N"  NOT NULL,
   PRIMARY KEY  (ID),
   FOREIGN KEY (ID) REFERENCES Employee(ID)
         ON DELETE RESTRICT
         ON UPDATE CASCADE
) ENGINE=InnoDB;
```

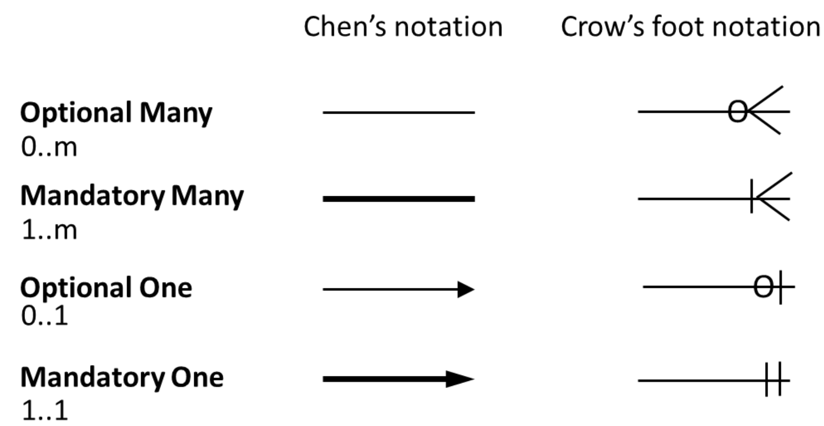
```
CREATE TABLE Consultant (
   ID                    SMALLINT,
   ContractNumber        SMALLINT        NOT NULL,
   BillingRate           DECIMAL(6,2)    NOT NULL,
   PRIMARY KEY  (ID),
   FOREIGN KEY (ID) REFERENCES Employee(ID)
         ON DELETE RESTRICT
         ON UPDATE CASCADE
) ENGINE=InnoDB;
```

# Conceptual Model Mapping

**Concept** **Chen's not.** **Crow's foot not.**

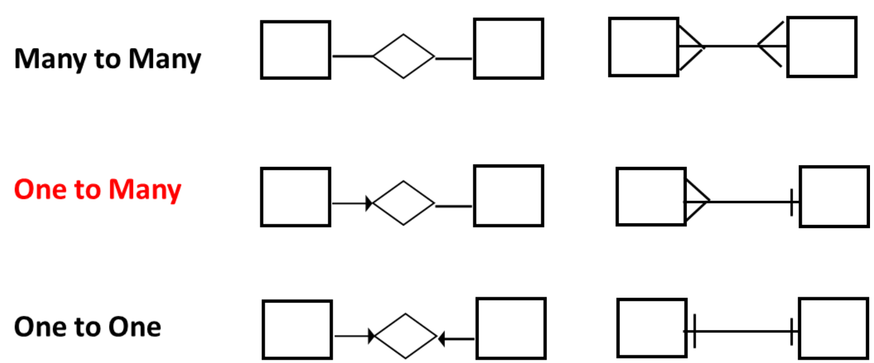



## Relationship cardinalities and constraints




**BINARY Relationship Cardinalities**

Here we just looked at cardinalities and omitted participation constraints (optional/mandatory) for clarity



# What's Examinable

- Need to be able to draw conceptual, logical and physical diagrams (now including EER)
- Create table SQL statements (with integrity constraints)

# Next Lecture

- Relational algebra and calculus
  - –How do we ask queries/interrogate a database
  - –Foundation of SQL queries

# Study groups for Database Systems

- Don't have a study group?
- Want to develop your interpersonal skills (employers *love* this)?
- Want to get more practice in the subject content?
- Want to contribute to the University's world-class research?

Visit our **study group** session.

You'll work with other students to solve database-related problems.

Especially recommended for those new to Melbourne.

Study group session for **INFO20003**:
Jim Potter Room (G16), Old Physics Building
Every Friday, 1-2pm

*Participation in this research project is optional. There is no commitment. The study group session is not assessed. For more information, contact Dr Rina Shvartsman, shvartsman.r@unimelb.edu.au*