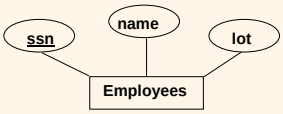
The Entity-Relationship Model

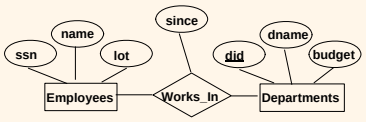
Entities



ER Model Basics

- *Entity*: Real-world object distinguishable from other objects. An entity is described (in DB) using a set of *attributes*
- *Entity Set*: A collection of similar entities. E.g., all employees
  - All entities in an entity set have the same set of attributes
  - Each entity set has a *key*
  - Each attribute has a *domain*

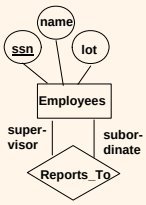
Relationships



ER Model Basics (Contd.)

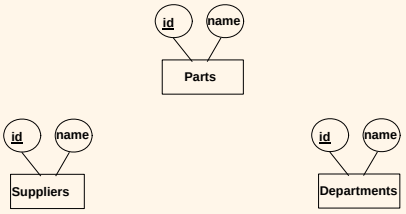
- *Relationship*: Association among two or more entities.
  - E.g., Attishoo works in Pharmacy department.
- *Relationship Set*: Collection of similar relationships.
  - An n-ary relationship set R relates n entity sets E1 ... En
  - Each relationship in R involves entities e1 in E1, ..., en in En

Relationships (Contd.)



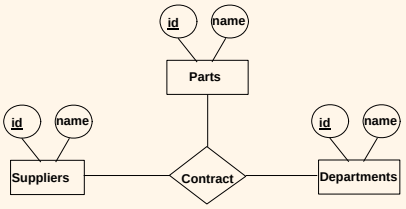
- Want to capture supervisor-subordinate relationship

Relationships (Contd.)

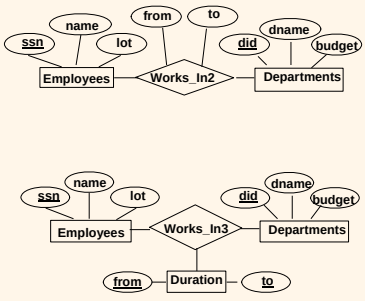


- Want to capture information that a Supplier s supplies Part p to Department d

Ternary Relationship

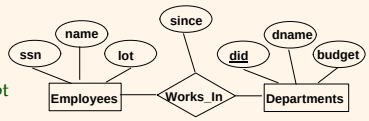


How are these different?

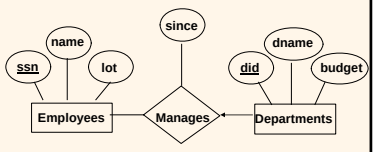


Key Constraints

- An employee can work in many departments; a dept can have many employees



- Each dept has at most one manager, according to the *key constraint* on Manages.

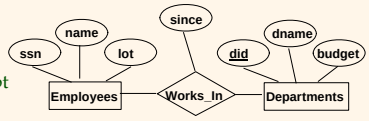


Key Constraints: Examples

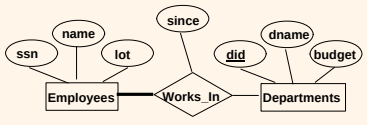
- Example Scenario 1: An inventory database contains information about parts and manufacturers. Each part is constructed by exactly one manufacturer.
- Example Scenario 2: A customer database contains information about customers and sales persons. Each customer has exactly one primary sales person.
- What do the ER diagrams look like?

Participation Constraints

- An employee can work in many departments; a dept can have many employees



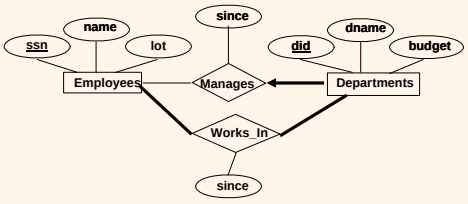
- Each employee works in at least one department according to the *participation constraint* on Works_In



Participation Constraints: Examples

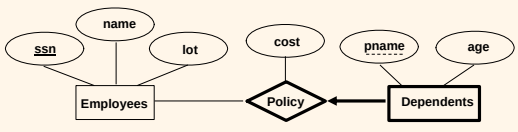
- Example Scenario 1 (Contd.): Each part is constructed by exactly one or more manufacturer.
- Example Scenario 2: Each customer has exactly one primary sales person.

What does this mean?



Weak Entities

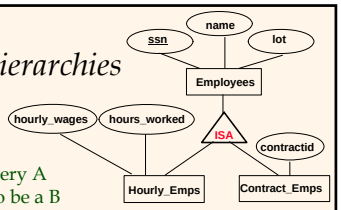
- A *weak entity* can be identified uniquely only by considering the primary key of another (*owner*) entity.
  - Owner entity set and weak entity set must participate in a one-to-many relationship set (one owner, many weak entities).
  - Weak entity set must have total participation in this *identifying* relationship set.



Exercise

- Give two real-life examples where each of the following would occur:
  - A key constraint
  - A participation constraint
  - A weak entity set

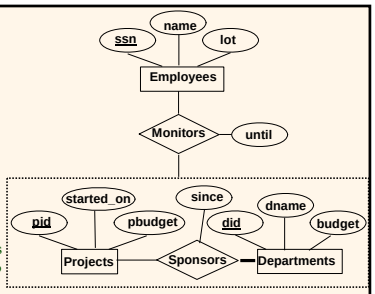
ISA (`is a') Hierarchies



- As in C++, or other PLs, attributes are inherited.
- If we declare A **ISA** B, every A entity is also considered to be a B entity.
- *Overlap constraints*: Can Joe be an Hourly_Emps as well as a Contract_Emps entity? *(Allowed/disallowed)*
- *Covering constraints*: Does every Employees entity also have to be an Hourly_Emps or a Contract_Emps entity? *(Yes/no)*
- Reasons for using ISA:
  - To add descriptive attributes specific to a subclass.
  - To identify entitities that participate in a relationship.

Aggregation

- Used when we have to model a relationship involving (entitity sets and) a *relationship set*.
  - *Aggregation* allows us to treat a relationship set as an entity set for purposes of participation in (other) relationships.



- *Aggregation vs. ternary relationship*:
- Monitors is a distinct relationship, with a descriptive attribute.
- Also, can say that each sponsorship is monitored by at most one employee.

ER Modeling: Case Study

Drugwarehouse.com has offered you a free life-time supply of prescription drugs (no questions asked) if you design its database schema. Given the rising cost of health care, you agree. Here is the information that you gathered:

- Patients are identified by their SSN, and we also store their names and age.
- Doctors are identified by their SSN, and we also store their names and specialty.
- Each patient has one primary care physician, and we want to know since when the patient has been with her primary care physician.
- Each doctor has at least one patient.

Conceptual Design Using the ER Model

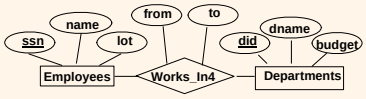
- Design choices:
  - Should a concept be modeled as an entity or an attribute?
  - Should a concept be modeled as an entity or a relationship?
  - Identifying relationships: Binary or ternary? Aggregation?
- Constraints in the ER Model:
  - A lot of data semantics can (and should) be captured.
  - But some constraints cannot be captured in ER diagrams.

Entity vs. Attribute

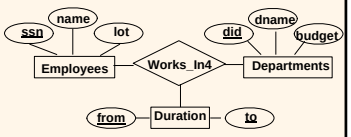
- Should *address* be an attribute of Employees or an entity (connected to Employees by a relationship)?
- Depends upon the use we want to make of address information, and the semantics of the data:
  - If we have several addresses per employee, *address* must be an entity (since attributes cannot be set-valued).
  - If the structure (city, street, etc.) is important, e.g., we want to retrieve employees in a given city, *address* must be modeled as an entity (since attribute values are atomic).

Entity vs. Attribute (Contd.)

- Works_In4 does not allow an employee to work in a department for two or more periods.

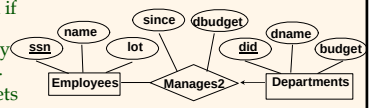


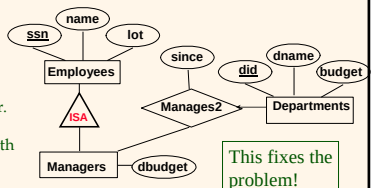
- Similar to the problem of wanting to record several addresses for an employee: We want to record *several values of the descriptive attributes for each instance of this relationship.* Accomplished by introducing new entity set, Duration.



Entity vs. Relationship

- First ER diagram OK if a manager gets a separate discretionary budget for each dept.
- What if a manager gets a discretionary budget that covers *all* managed depts?
  - Redundancy: *dbudget* stored for each dept managed by manager.
  - Misleading: Suggests *dbudget* associated with department-mgr combination.

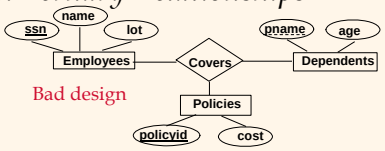


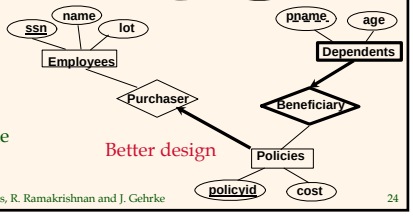


This fixes the problem!

Binary vs. Ternary Relationships

- If each policy is owned by just one employee, and each dependent is tied to the covering policy, first diagram is inaccurate.
- What are the additional constraints in the 2nd diagram?





Binary vs. Ternary Relationships (Contd.)

- Previous example illustrated a case when two binary relationships were better than one ternary relationship.
- An example in the other direction: a ternary relation Contracts relates entity sets Parts, Departments and Suppliers, and has descriptive attribute *qty*. No combination of binary relationships is an adequate substitute:
  - S "can-supply" P, D "needs" P, and D "deals-with" S does not imply that D has agreed to buy P from S.
  - How do we record *qty*?

Summary of Conceptual Design

- *Conceptual design* follows *requirements analysis*
- ER model popular for conceptual design
- Basic constructs: *entities*, *relationships*, and *attributes*
- Some additional constructs: *weak entities*, *ISA hierarchies*, and *aggregation*.
- Note: There are many variations on ER model.

Summary of Conceptual Design

- *Conceptual design* follows *requirements analysis*,
  - Yields a high-level description of data to be stored
- ER model popular for conceptual design
  - Constructs are expressive, close to the way people think about their applications.
- Basic constructs: *entities*, *relationships*, and *attributes* (of entities and relationships).
- Some additional constructs: *weak entities*, *ISA hierarchies*, and *aggregation*.
- Note: There are many variations on ER model.

Summary of ER (Contd.)

- Several kinds of integrity constraints can be expressed in the ER model: *key constraints*, *participation constraints*, and *overlap/covering constraints* for ISA hierarchies. Some *foreign key constraints* are also implicit in the definition of a relationship set.
  - Some constraints (notably, *functional dependencies*) cannot be expressed in the ER model.
  - Constraints play an important role in determining the best database design for an enterprise.

Summary of ER (Contd.)

- ER design is *subjective*. There are often many ways to model a given scenario! Analyzing alternatives can be tricky, especially for a large enterprise. Common choices include:
  - Entity vs. attribute, entity vs. relationship, binary or n-ary relationship, whether or not to use ISA hierarchies, and whether or not to use aggregation.
- Ensuring good database design: resulting relational schema should be analyzed and refined further. FD information and normalization techniques are especially useful.