

Entity Relationship Model

Database Systems (CSCI 440)

Fall 2014

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Montana State University

Midterm #1:

in-class Friday, October 3, 2014

Project Proposal:

by 5pm: Wednesday, October 8, 2014

Reading:

Chapter 7



Definition

Entity-Relationship (ER) model is a popular high-level conceptual data model frequently used for the conceptual design of databases.

Definition

ER diagrams are diagrammatic notation associated with the ER model.



Step 1: Requirements Collection and Analysis

Database designers interview prospective database users to understand and document data requirements.

Results:

- ① data requirements
- ② functional requirements of the application



Step 2: Conceptual Design

- Description of data requirements
- Includes detailed descriptions of the
 - entity types
 - relationships, and
 - constraints

Result:

- 1 high-level data model



Step 3: Logical design

Transforms the relational or object-relational database model into implementation data model. This is also known as a data model mapping.

Result:

- 1 database schema in implementation data model of DBMS



Step 4: Physical Design Phase

Internal storage structures, file organizations, indexes, access paths, and physical design parameters for the database files specified.

Result:

- ① database schema in implementation data model of DBMS



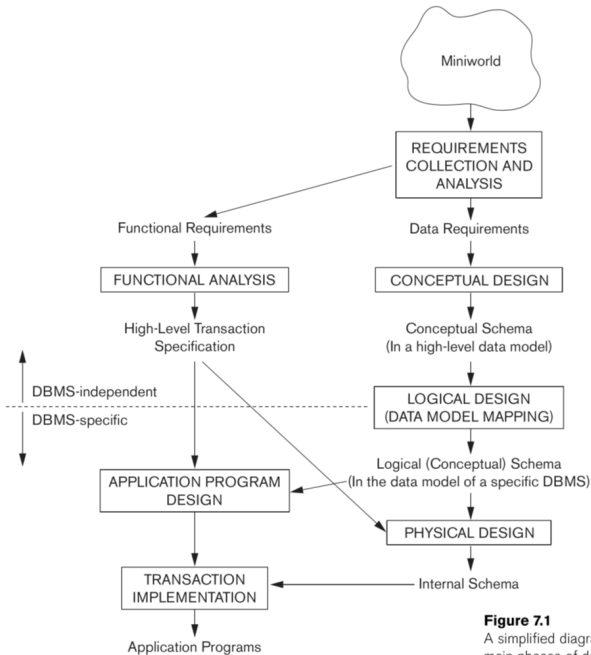


Figure 7.1

A simplified diagram to illustrate the main phases of database design.

Definition

Entity is a thing in real world with independent existence.

Definition

Attributes are particular properties that describe an entity.

Types of attributes:

- Composite versus simple (atomic) attributes
- Single-valued versus multivalued attributes
- Stored versus derived attributes
- NULL values
- Complex attributes



COMPANY

- Employees, departments, and projects
- Company is organized into departments
- Department controls a number of projects
- Employee:
 - store each employee's name
 - Social Security number
 - address
 - salary
 - sex (gender)
 - and birth date
- Keep track of the dependents of each employee



EMPLOYEE

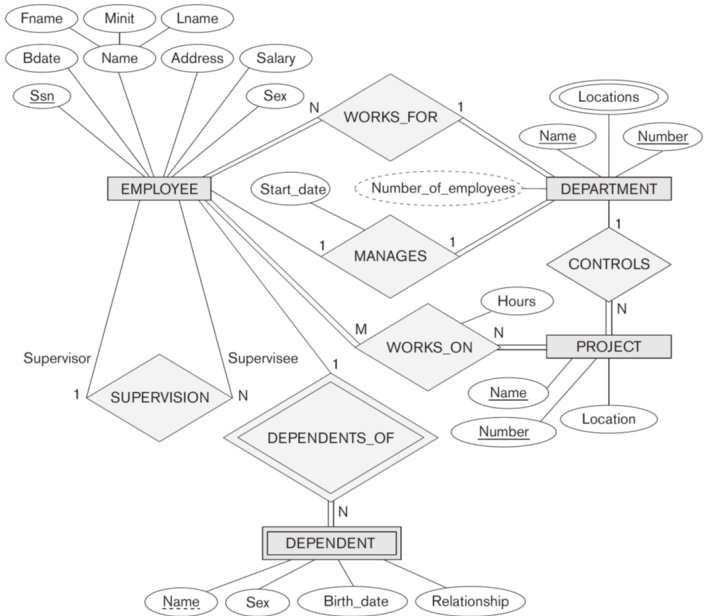
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John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

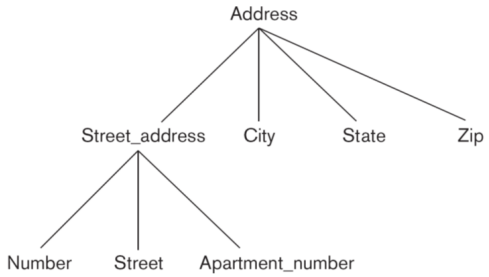
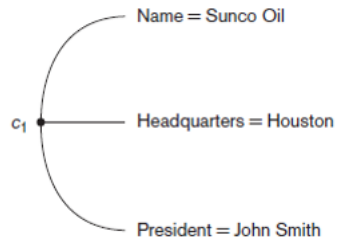
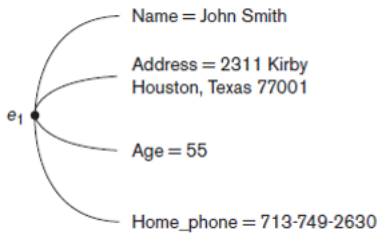
DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

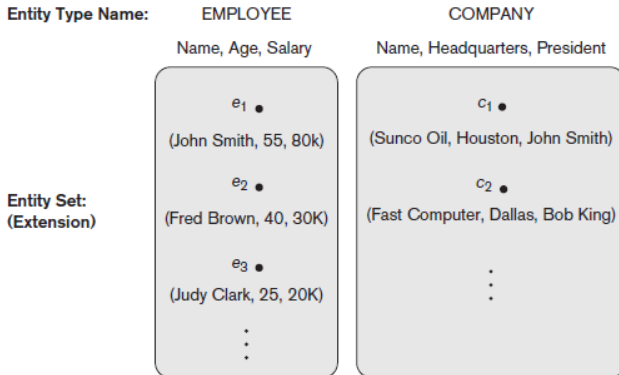
<u>Dnumber</u>	<u>Dlocation</u>
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston





Definition

Entity Type is a collection (or set) of entities that have the same attributes.



Definition

A **key** or **uniqueness constraint** on attributes requires values to be distinct for each individual entity in entity set.

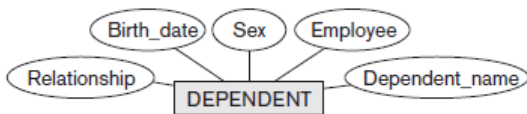
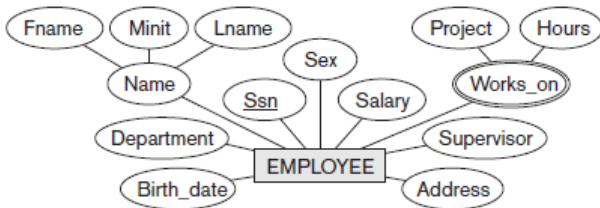
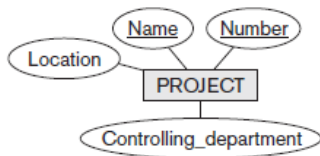
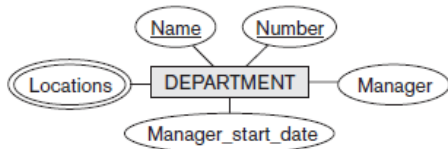
Definition

This is known as a **key attribute** whose uniqueness property must hold for every entity set of the entity type.

Definition

Value set (or domain of values) specifies set of values that may be assigned to that attribute for each individual entity





Definition

A **relationship** occurs when an attribute of one entity type refers to another entity type.

In ER, we represent references as relationships, not attributes.



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Formal Definition

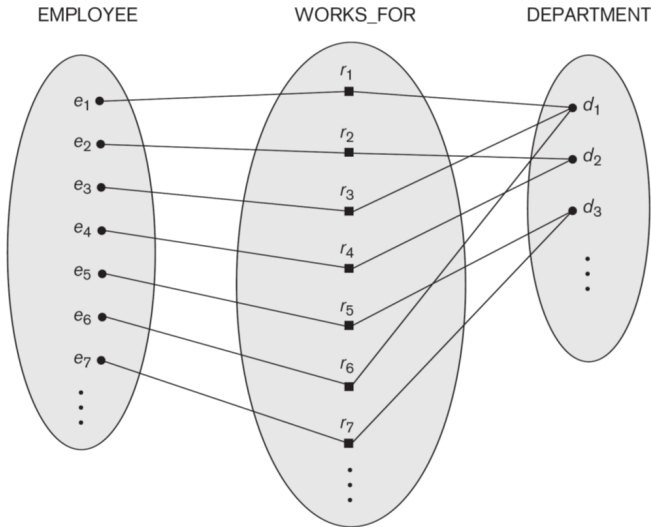
Relationship type R among n entity types E_1, E_2, \dots, E_n defines a set of associations among entities from these entity types.

Formal Definition

Each **relationship instance** r_i associates n individual entities (e_1, e_2, \dots, e_n) and each entity e_j in r_i is a member of entity set E_j .

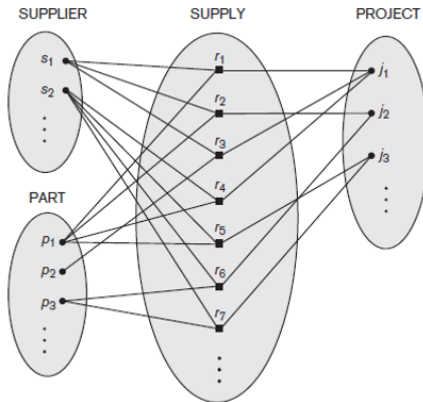


Relationship Set



Definition

Number of participating entity types is the **degree** of a relationship type (e.g., binary, ternary, etc.).



Definition

Role names signify the role that a participating entity plays in each relationship instance.



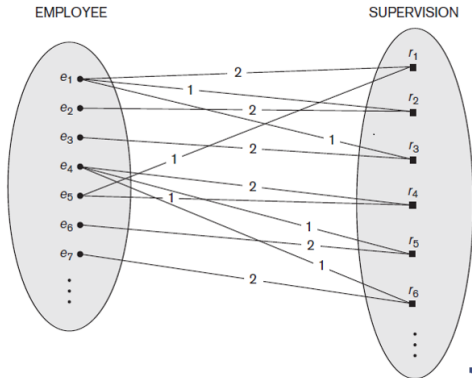
Definition

Role names signify the role that a participating entity plays in each relationship instance.

Definition

Recursive relationships

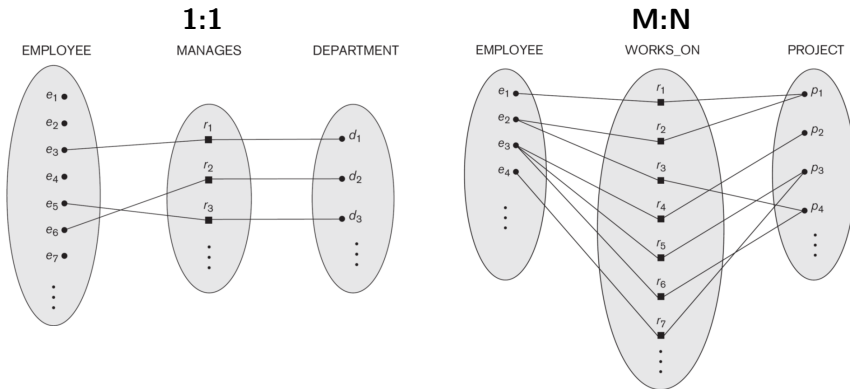
occur when the same entity type participates more than once in a relationship type in different roles. In these case, you must specify role name.



Constraints on Binary Relationship Types

Definition

The **cardinality ratio** for a binary relationship specifies maximum number of relationship instances in which entity can participate.



Constraints on Binary Relationship Types

1:N Relationship Type

For an 1:N relationship type, the relationship attribute can be migrated only to entity type on N-side of relationship.

M:N Relationship Type

For an M:N relationship type, some attributes may be determined by combination of participating entities and must be specified as relationship attributes.

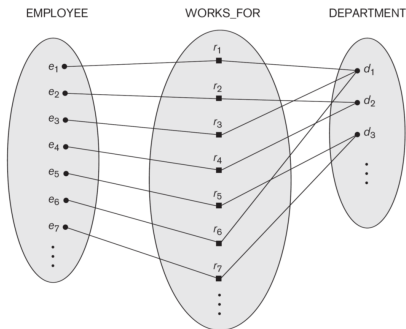


Constraints on Binary Relationship Types

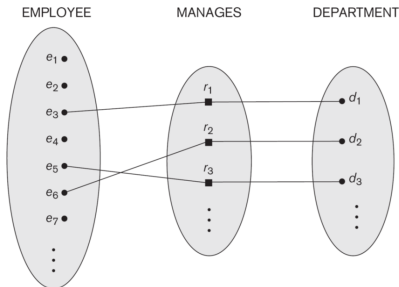
Definition

Participation constraint – *total* or *partial* – specifies whether existence of entity depends on its being related to another entity

Total



Partial



Definition

Total participation is also called **existence dependency**.

Definition

Weak Entity do not have key attributes of their own and are identified as related to specific entities from another entity type.

Definition

Identifying Relationship relates a weak entity type to its owner. A weak entity always has a total participation constraint (existence dependency) with respect to its identifying relationship.



Refine ER Design for COMPANY

- ① Change the attributes that represent relationships into relationship types.
- ② Determine cardinality ratio and participation constraint of each relationship type.



EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
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DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

PROJECT

<u>Pname</u>	<u>Pnumber</u>	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

Symbol

Meaning



Entity



Weak Entity



Relationship



Identifying Relationship



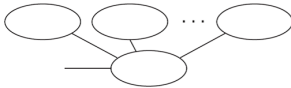
Attribute



Key Attribute



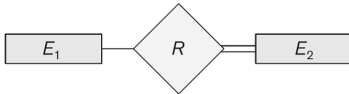
Multivalued Attribute



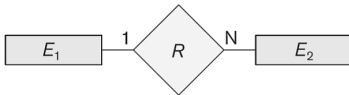
Composite Attribute



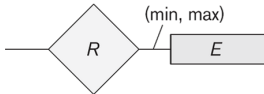
Derived Attribute



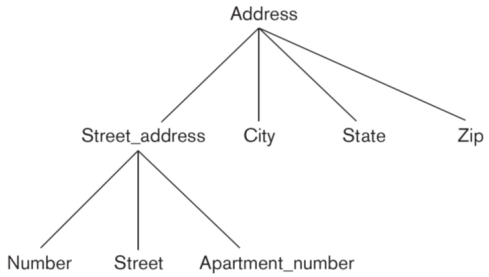
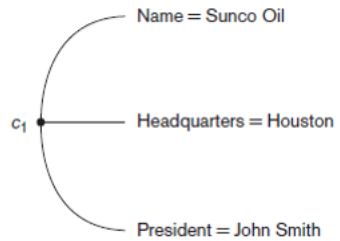
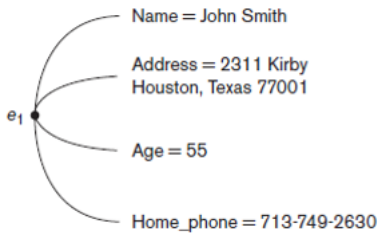
Total Participation of E_2 in R

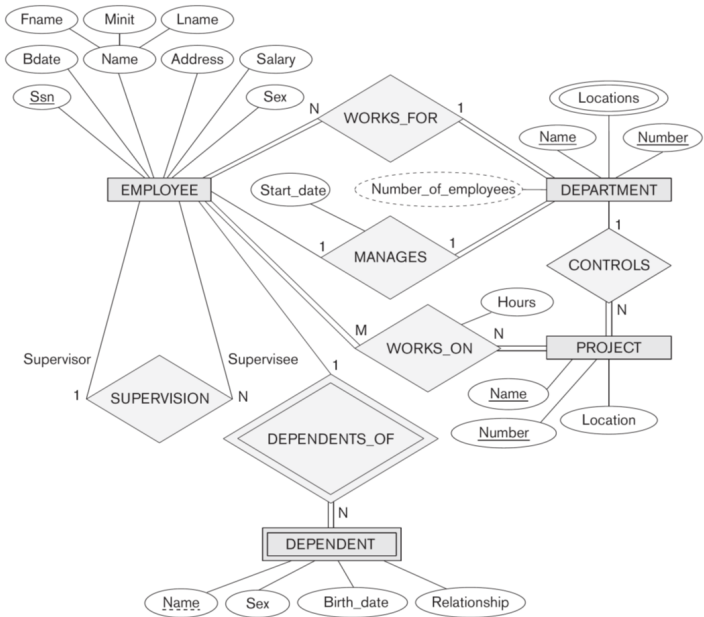


Cardinality Ratio 1: N for $E_1:E_2$ in R



Structural Constraint (min, max)
on Participation of E in R





Important

Choose names that convey meanings attached to different constructs in schema.

Nouns give rise to entity type names.

Verbs indicate names of relationship types.

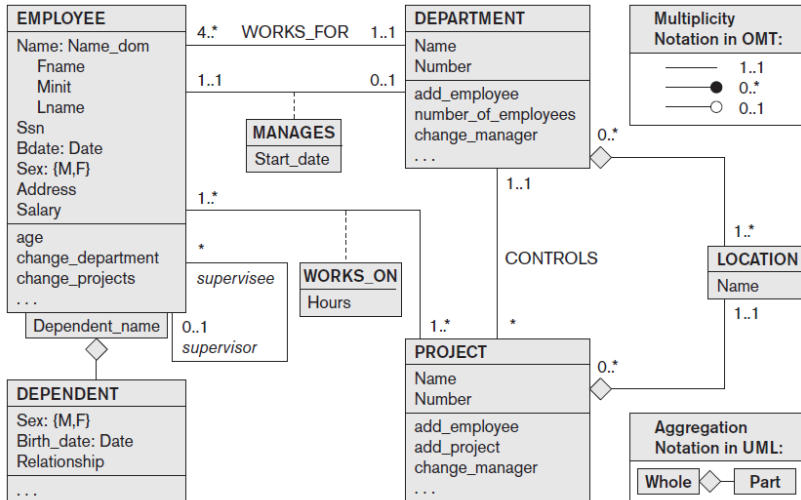
Choose binary relationship names to make ER diagram readable from left to right and from top to bottom.



Design Choices for ER

- 1 Model concept first as an attribute
- 2 Refine into a relationship if attribute is a reference to another entity type
- 3 Identify any attribute that exists in several entity types
- 4 Elevate to an independent entity type
 - o Can also be applied in the inverse





Associations: relationship types

Relationship instances: links

Binary association

- Represented as a line connecting participating classes
- May optionally have a name

Link attribute: placed in a box connected to the associations line by a dashed line



Multiplicities: min..max, asterisk (*) indicates no maximum limit on participation

Types of relationships: **association** and **aggregation**

Distinguish between **unidirectional** and **bidirectional associations**

Model weak entities using **qualified association**



Definition

Degree of a relationship type is the number of participating entity types.

Binary is relationship type of degree two.

Ternary is a relationship type of degree three.



Binary versus Ternary

Some database design tools permit only binary relationships.

- Ternary relationship must be represented as a weak entity type
- No partial key and three identifying relationships

Alternately, represent ternary relationship as a regular entity type, by introducing an artificial or surrogate key.



