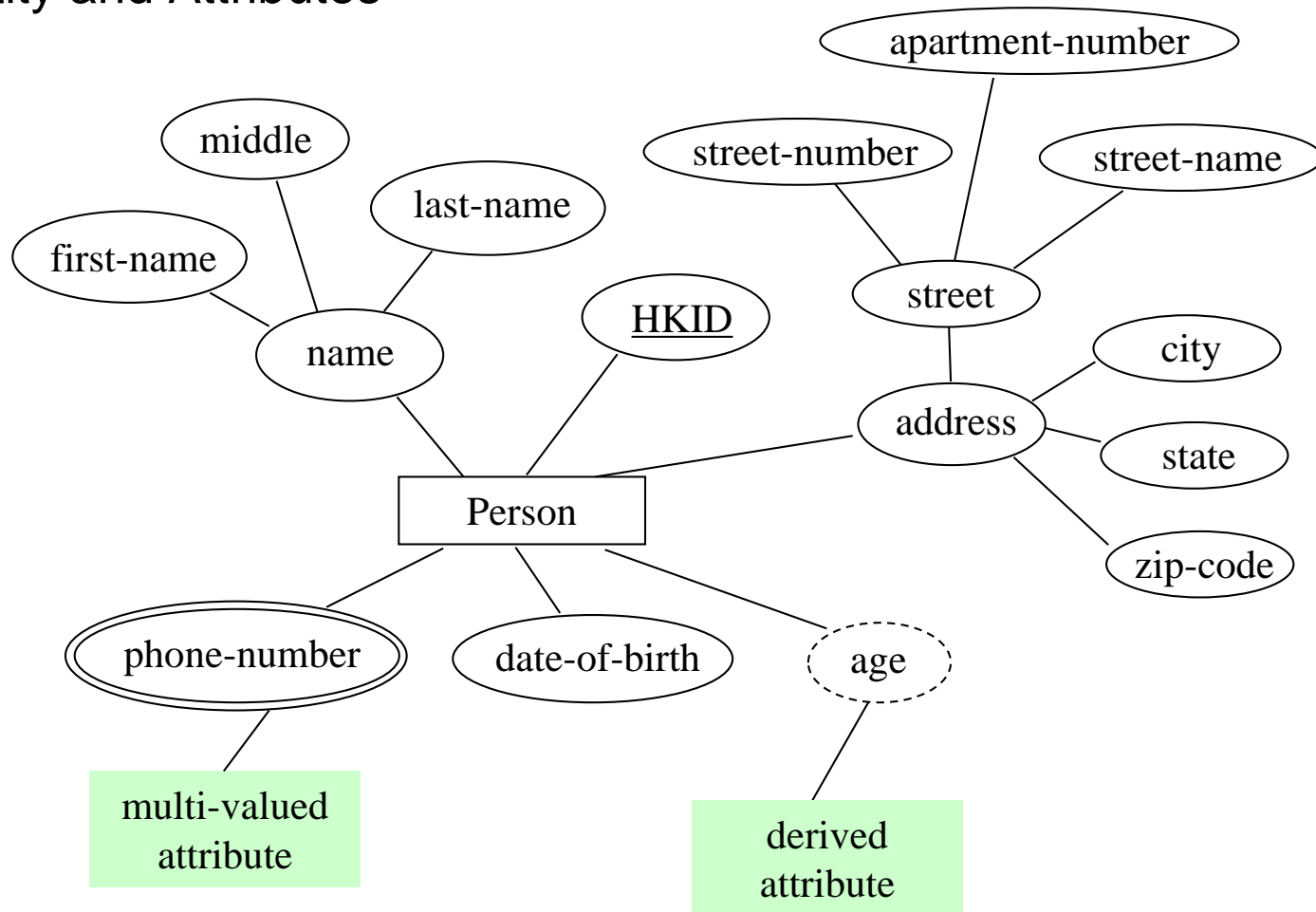


Entity Relationship (ER) Model (Part 2)

Recap

Entity and Attributes



Outline

- ❑ Relationship set

- ❑ Constraints on relationship sets

 - one-to-one (1-1)

 - one-to-many (1-m)

 - many-to-one (m-1)

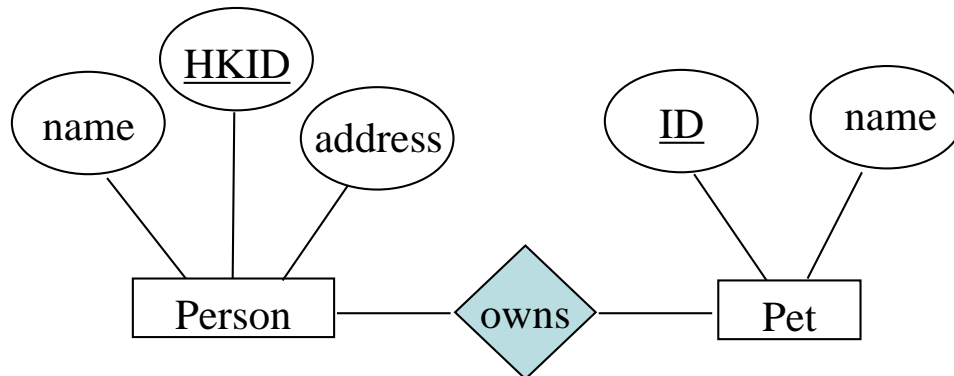
 - many-to-many (m-m)

The R in ER: Relationships

- A **relationship** describes the connection between entities.
- Examples of relationship:
 - A person owns a pet.
 - A person bought a CD.
 - A person lives at an address.

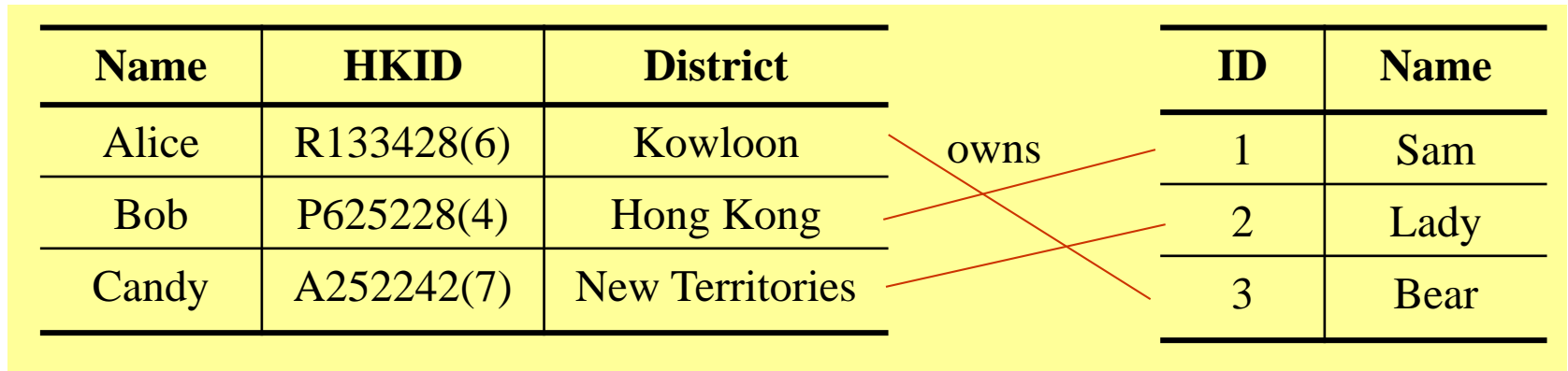
What is a Relationship?

- ❑ There can be **only one relationship** for every **unique combination of entities**.
- ❑ This means that **the relationship is uniquely determined by the keys of its entities**.
- ❑ Example: the key for “owns” is $\{Person.HKID, Pet.ID\}$



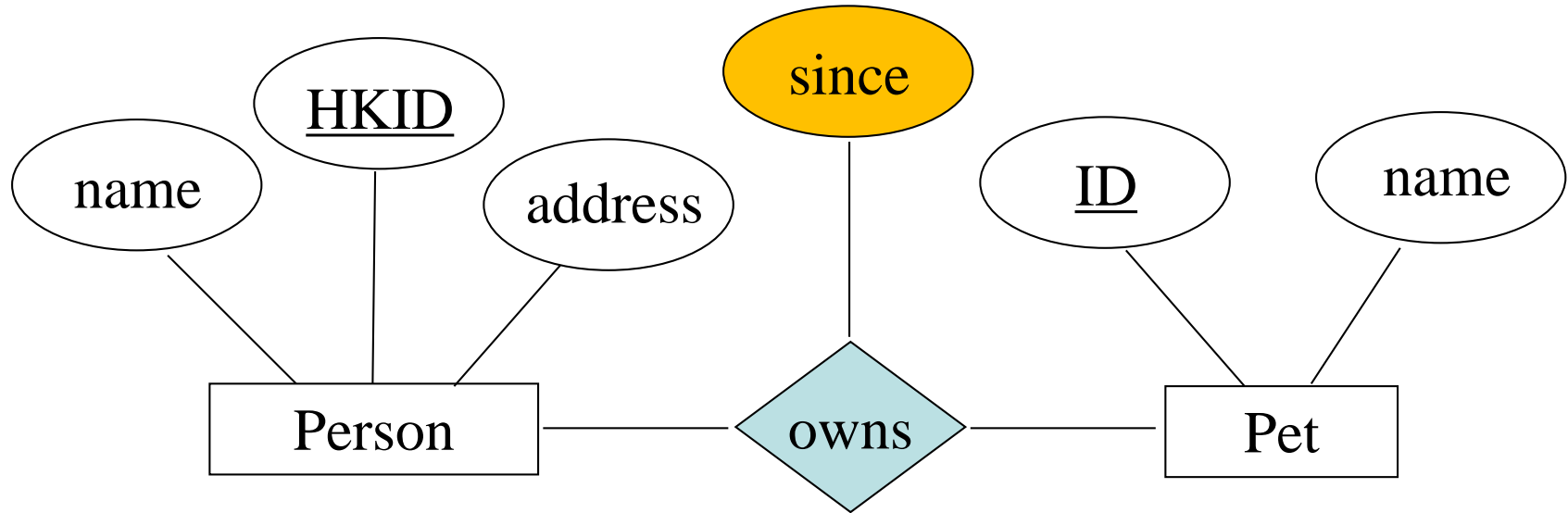
Relationship Set

- A **relationship set** captures relationships of the same “type”.



- Each link is a **relationship**, and the set of all links constitutes a **relationship set**.

Relationship with an Attribute

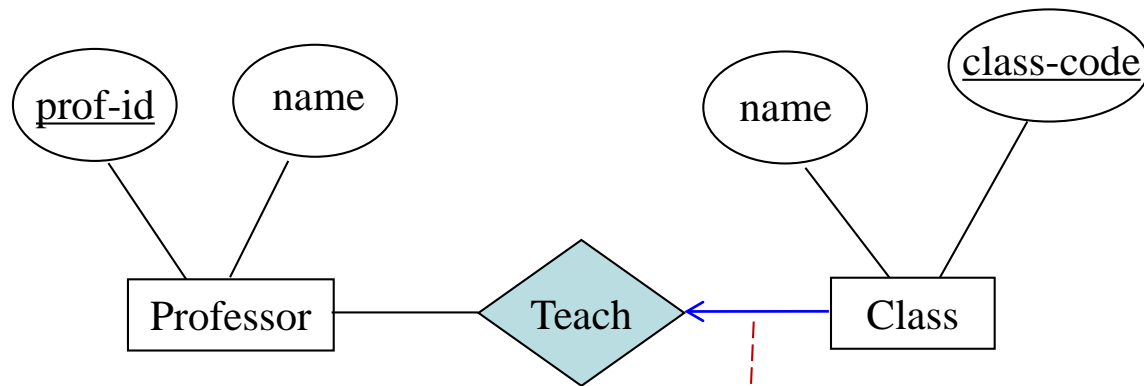


Question 1

1. Draw the ER diagram for the CS database with the following information:
 - A student should have his/her id (std-id) and name.
 - A class should have its class code (class-code) and name.
 - A professor should have his/her id (prof-id) and name.
 - A student can **enroll** many classes.
 - A class can be **enrolled** by many students.
 - A class is **taught** by at most a professor (i.e., no joint teaching) at a specific time and venue.
 - A professor can **teach** many classes.

Constraints on Relationship Sets

- ❑ In the example above: A class can be taught by at most one professor, while a professor can teach more than one class.
- ❑ This is an example of a **one-to-many constraint**. We can represent it using an **arrow (one←many)**.



A class can be taught by at most one professor

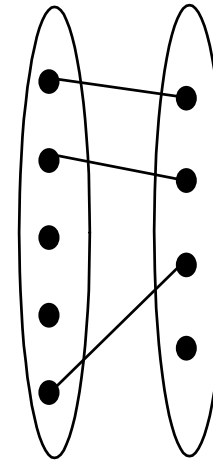
Constraints on Relationship Sets

- ❑ Each relationship set is associated with two constraints.
 - Cardinality constraint
 - Participation constraint

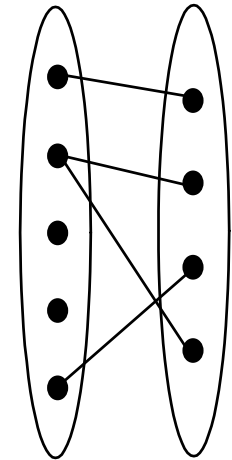
- ❑ These constraints offer a powerful way to model real-world connections.

Cardinality Constraint

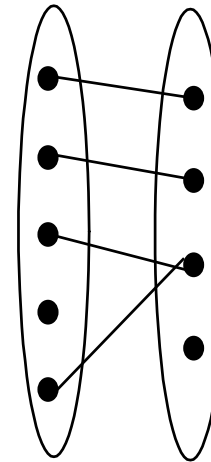
- ❑ Cardinality constraint is imposed on the relationship set.
- ❑ There are four types of cardinality constraints.
 - One-to-one
 - One-to-many
 - Many-to-one
 - Many-to-many



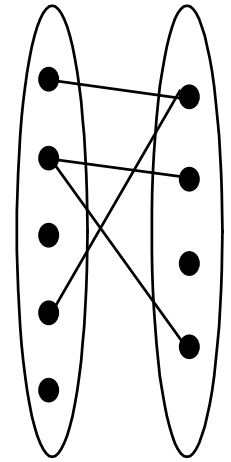
1-to-1



1-to-Many

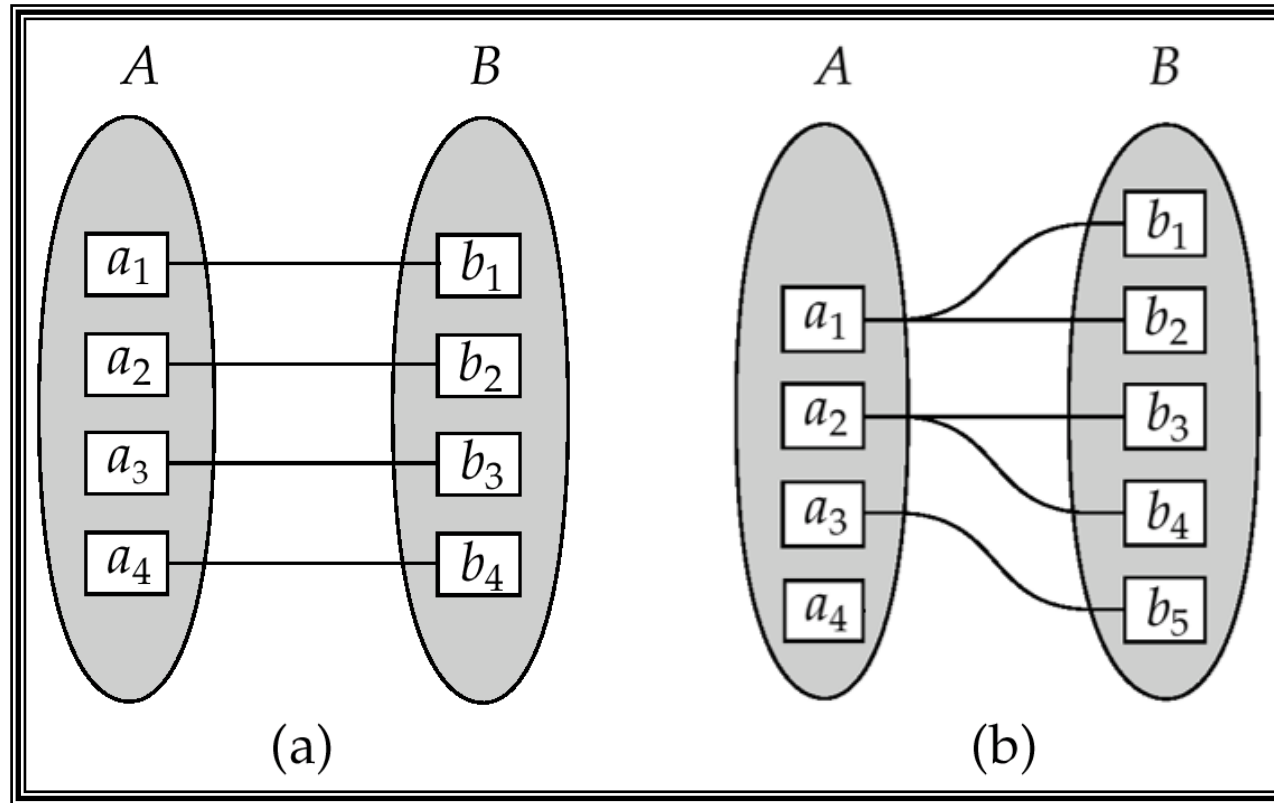


Many-to-1



Many-to-Many

Cardinality Constraint

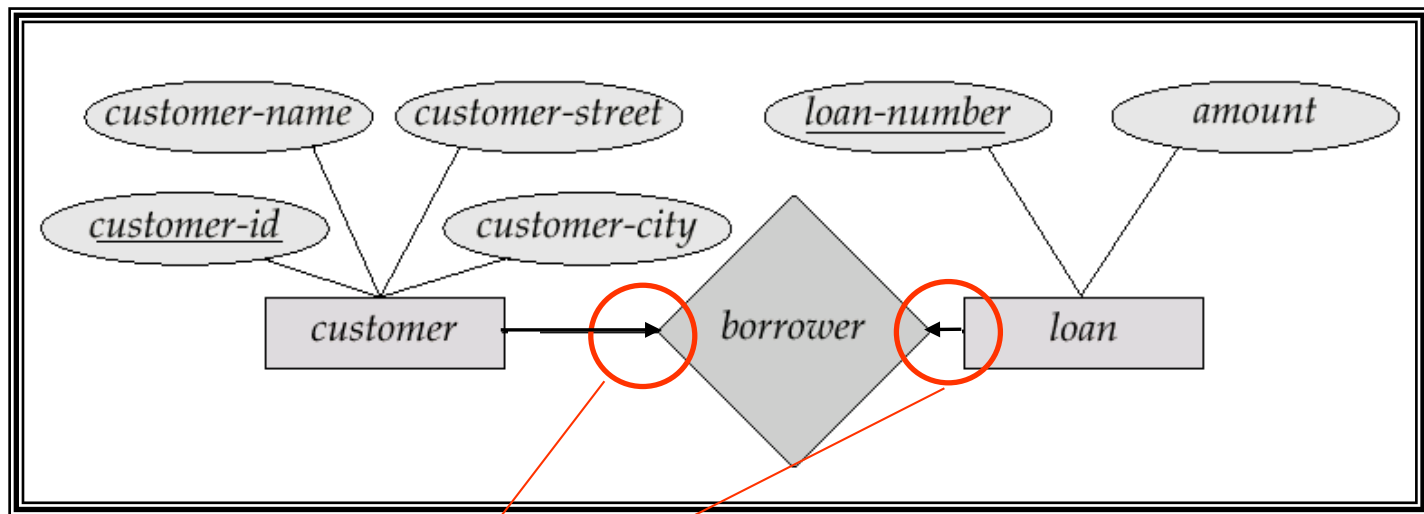


One to one (e.g., husband-wife)

One to many (e.g., student-book)

One-to-One Representation

- ❑ A customer can borrow **at most one** loan (0 or 1).
- ❑ A loan can be borrowed by **at most one** customer.

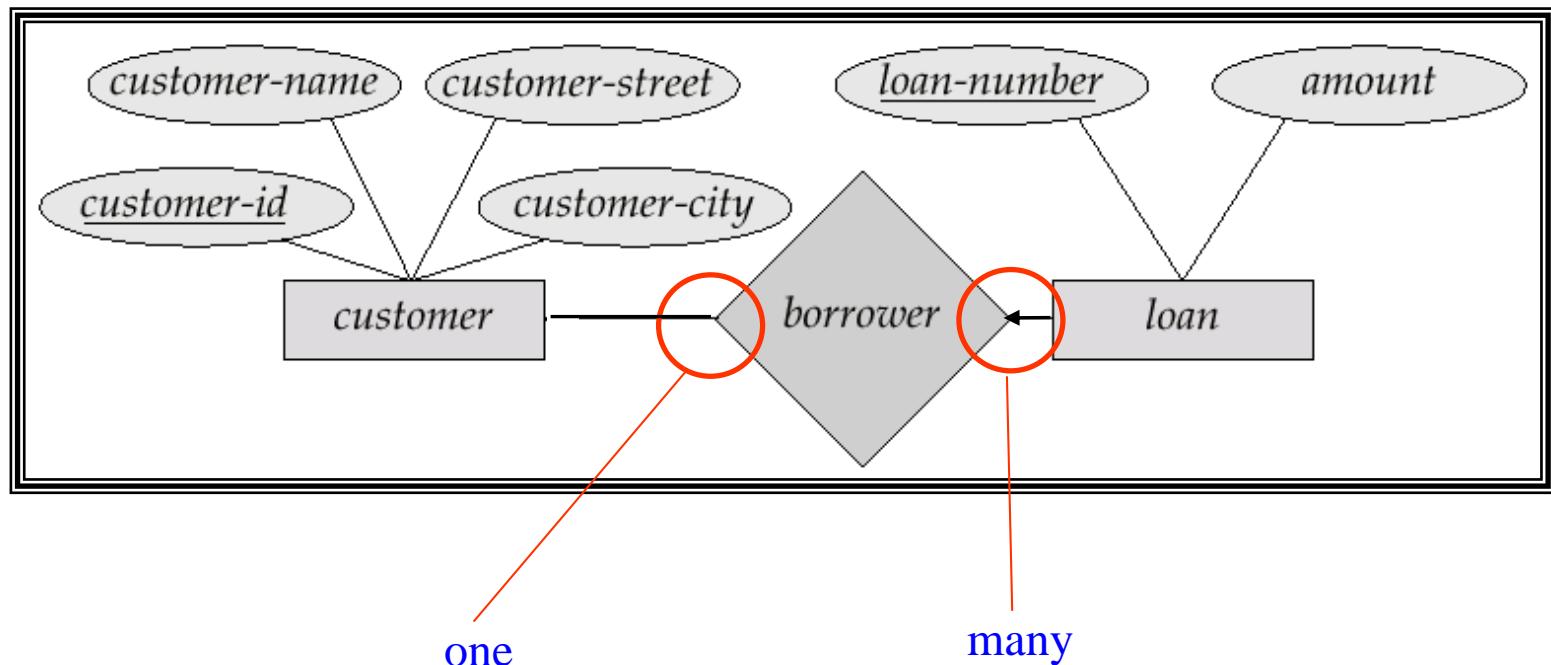


one

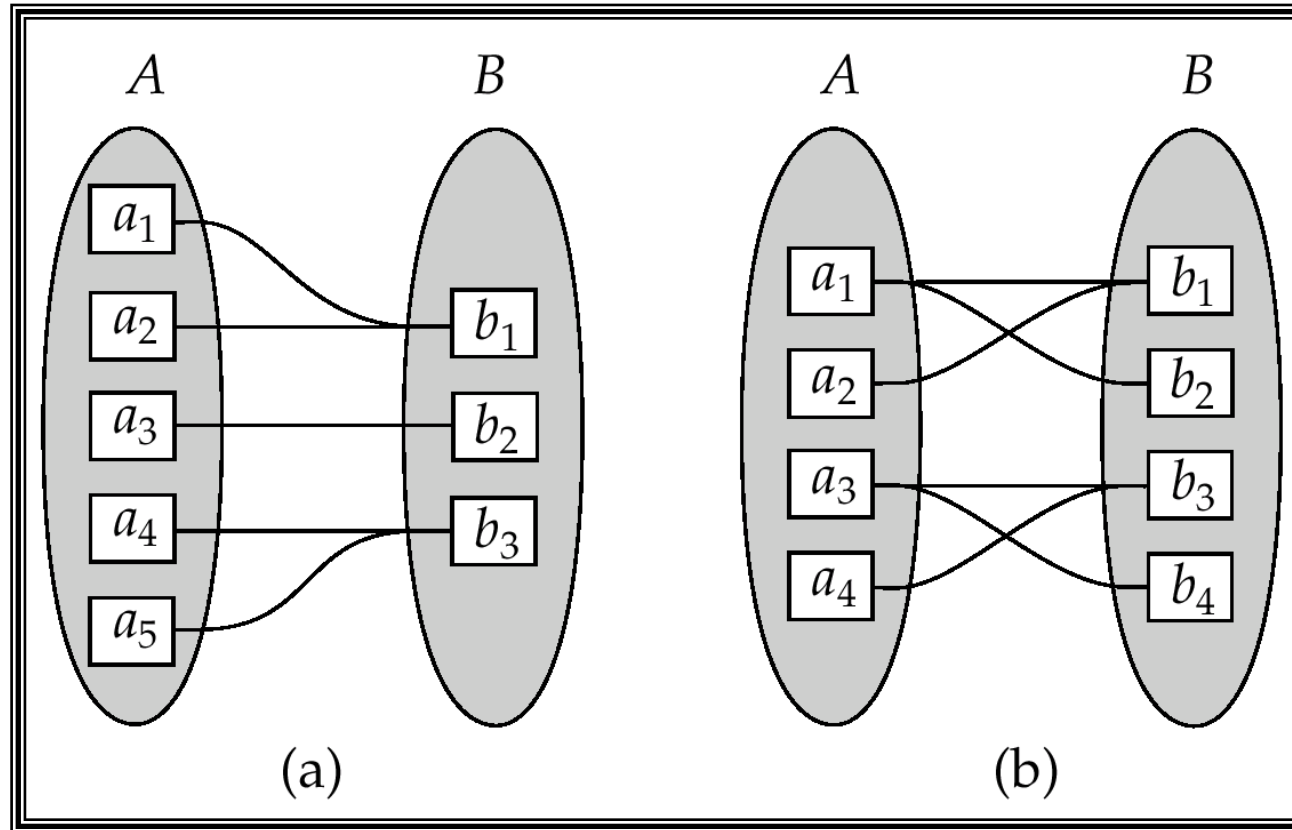
What is the meaning of these arrows?

One-to-Many Representation

- ❑ A customer can borrow **many** loans (0 or more).
- ❑ A loan can be borrowed by **at most one** customer.



Cardinality Constraint

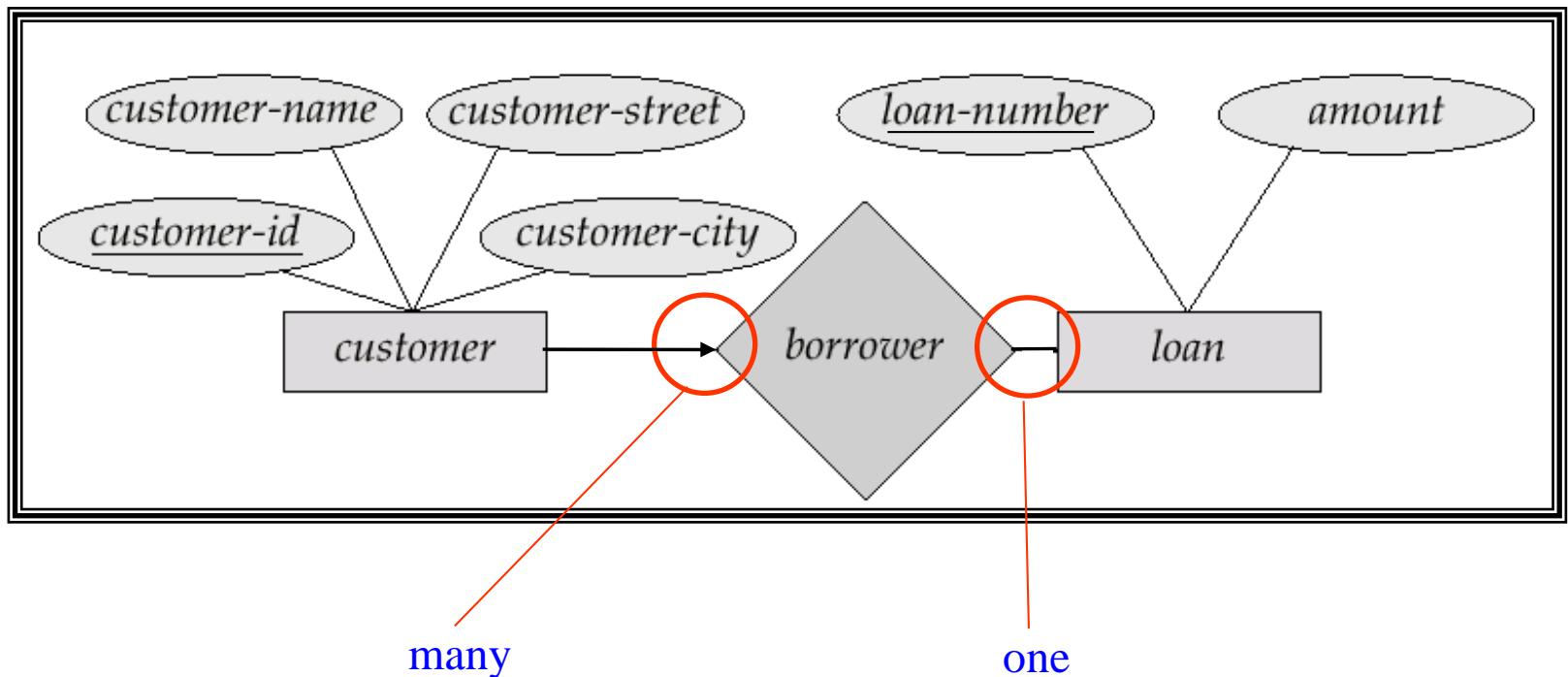


Many to one (e.g., child-father)

Many to many (e.g., friendship)

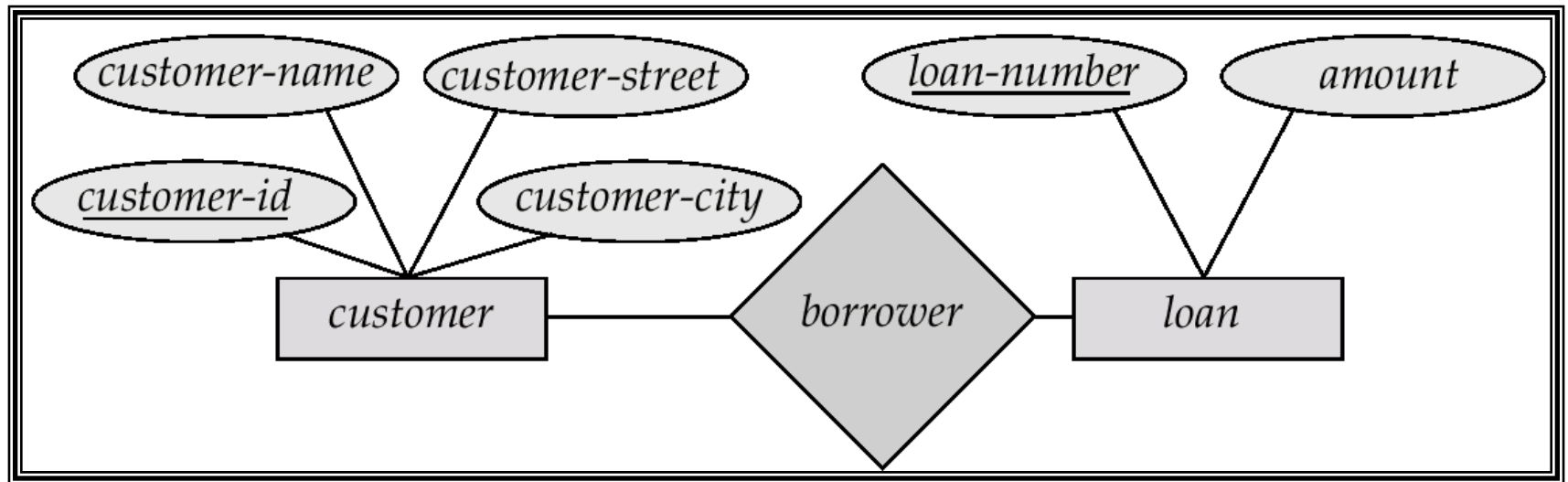
Many-to-One Representation

- ❑ A customer can borrow **at most one** loan.
- ❑ A loan can be shared by **many** customers.



Many-to-Many Representation

- ❑ A customer can borrow many loans.
- ❑ A loan can be shared by many customers.



Question 2

2. Draw the ER diagram for the library database with the following information.
- Each user has his/her user id (user-id), name, and address.
 - Each book has its book id (book-id), book name (book-name), and publisher name (publisher-name).
 - Each author has his/her author id (author-id) and name.
 - Each user can **borrow many** books.
 - Each book can be **borrowed by at most one** user.
 - Each book can be **written by multiple** authors.
 - Each author can **write multiple** books.

Question 3

□ Repeat Question 2 with

- Each user can **borrow at most one** book.
- Each book can be **borrowed by at most one** user.
- Each book can be **written by at most one** author.
- Each author can **write multiple** books.

Participation Constraint

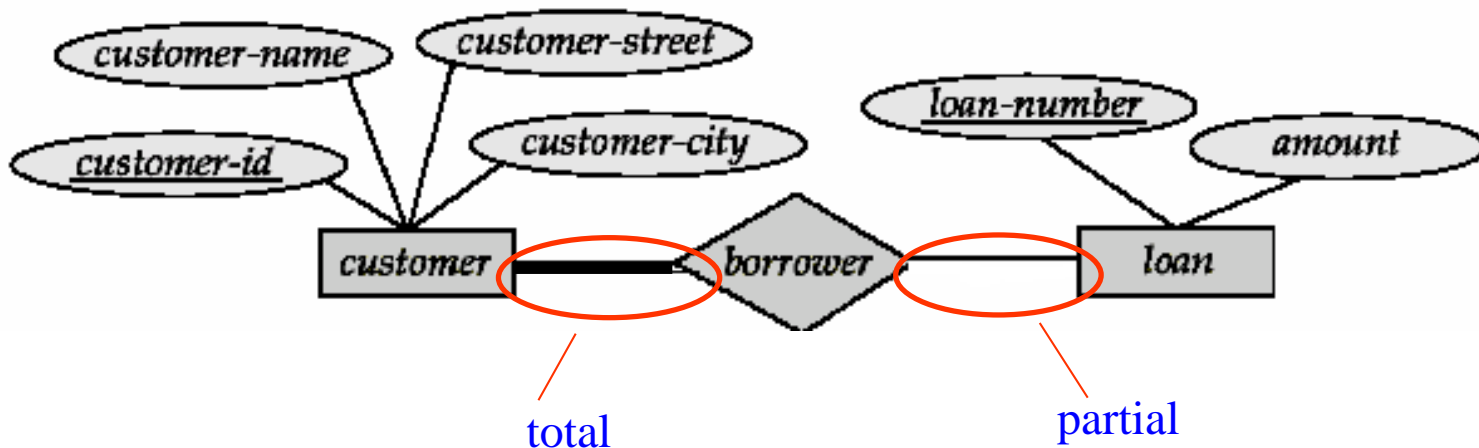
- ❑ In the previous **one-to-one cardinality constraint** example, a man/woman can be married to **at most** one woman/man (but the man/woman can also be *unmarried*).
- ❑ When we allow unmarried people in the “husband-wife” relationship, this is said to have **partial** participation (otherwise **total** participation).

Participation Constraint

- ❑ **Total participation**: Every entity in the entity set must participate in *at least one* relationship.
- ❑ **Partial participation**: Some entities may not participate.
- ❑ Participation Constraints are indicated by bold lines in ER diagrams.

Participation Constraint

- ❑ What can be implied from the participation constraints in this relationship?



- ❑ Example:

- Every customer must borrow at least a loan.
- Some loan may not be borrowed by any customer.

More on Constraints

- ❑ Cardinality constraints.

- 1-1, 1-m, m-1, m-m

- ❑ Participation constraints.

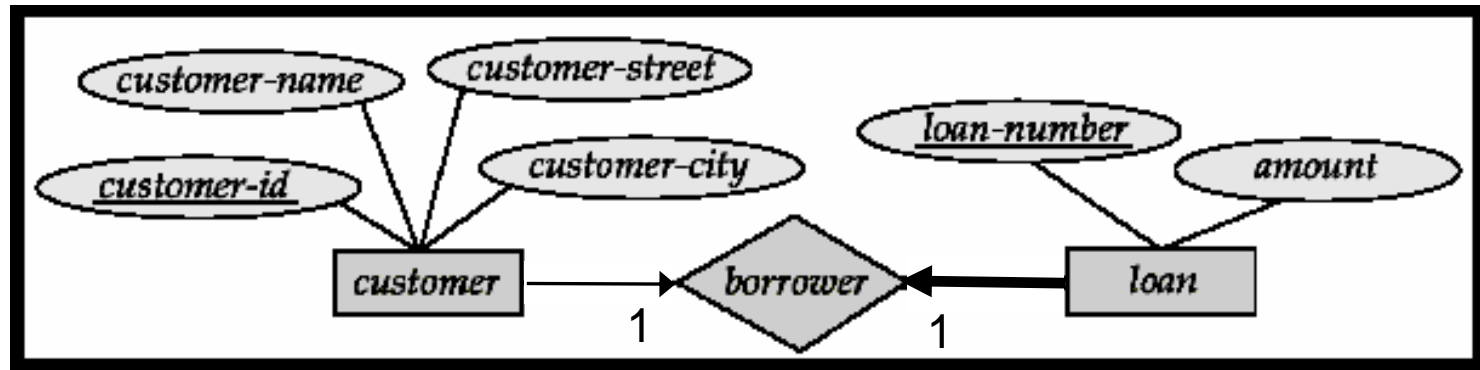
- Partial, total

- ❑ The two types of constraints are independent.

- ❑ Each cardinality constraint can be used with any participation constraint.

More on Constraints

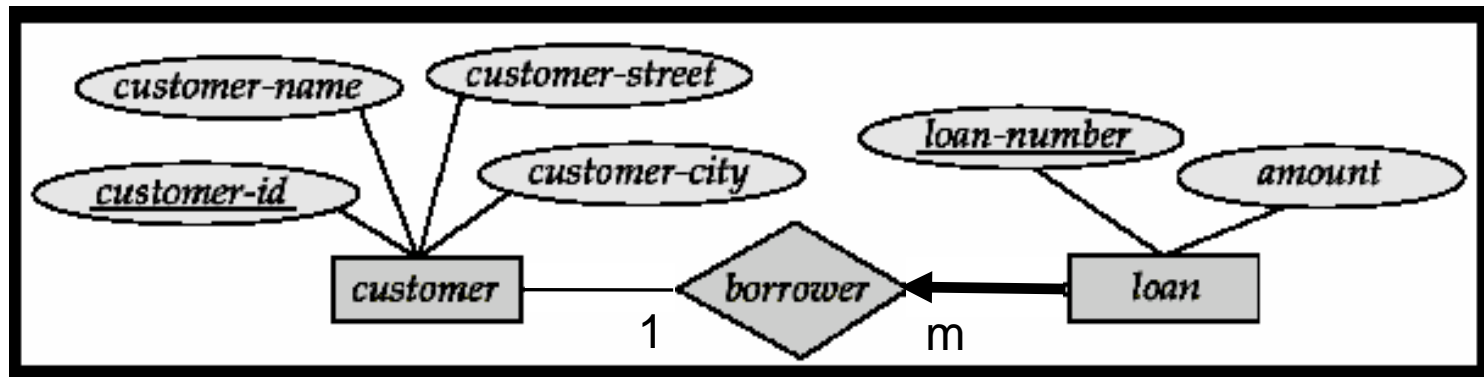
❑ What can you imply in the following relationships?



- A customer can borrow at most a loan.
- A loan can be borrowed by at most a customer.
- Each loan must be borrowed.

More on Constraints

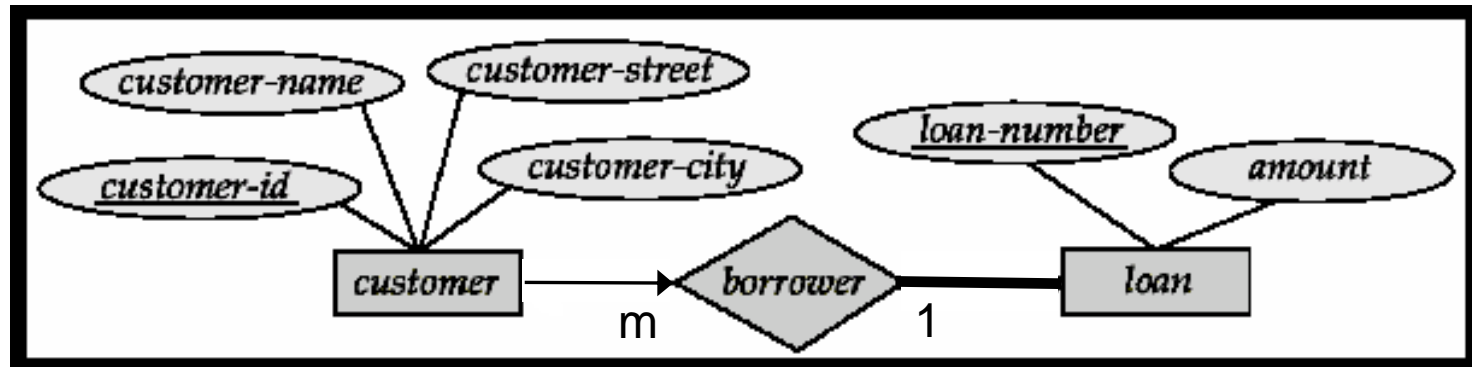
□ What can you imply in the following relationships?



- A customer can borrow many loans.
- A loan can be borrowed by at most one customer.
- Each loan must be borrowed.

More on Constraints

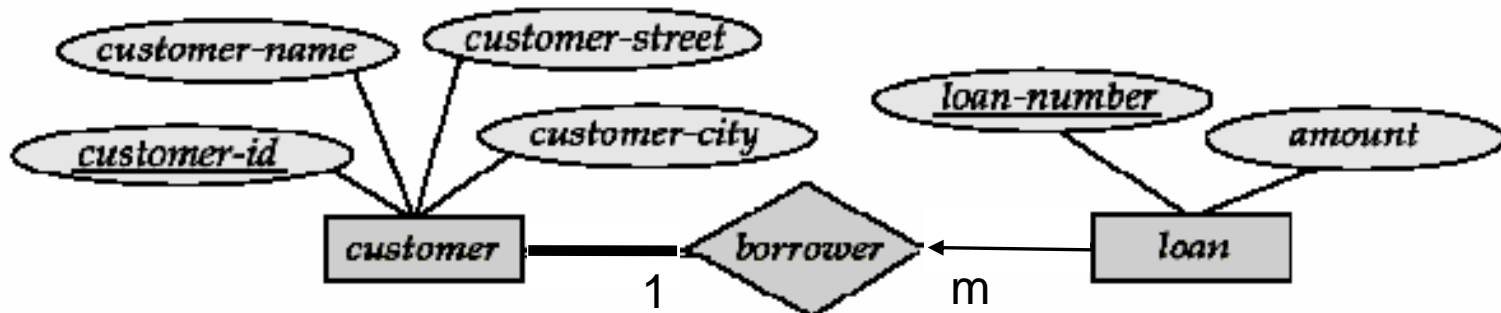
❑ What can you imply in the following relationships?



- A loan can be borrowed by many customers.
- A customer can borrow at most one loan.
- Each loan must be borrowed.

More on Constraints

□ What can you imply in the following relationships?



- A customer can borrow many loans.
- A loan can be borrowed by at most one customer.
- Each customer must borrow some loan(s).

Question 4

Repeat Question 1 with:

- A student **may not** enroll in any class.
- A class must have **at least** 20 students.
- A professor **may not** teach any class.
- A class **must** be taught by **at most one** professor.

Question 5

Repeat Question 2 with:

- Each user **may not** borrow any book.
- Each book **may not** be borrowed by any user or borrowed by **at most one** user.
- Each book **must** be written by **at least one** authors.
- Each author **must** write **at least one** book.

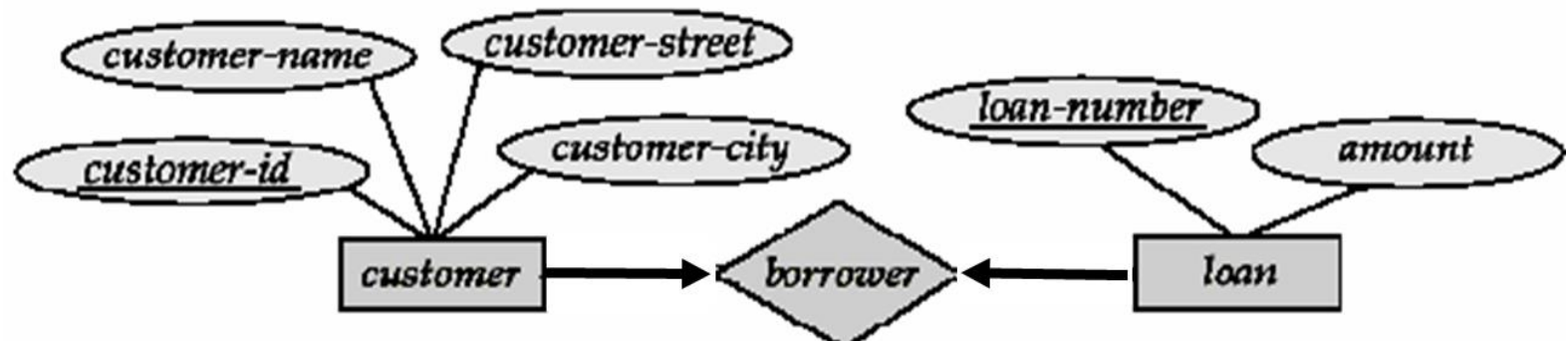
Question 6

- ❑ In a university,
- a professor has a staff id (sid), name, and department.
 - each professor can hire multiple research assistants.
 - each research assistant has a staff id (rid), name, and funded project id (pid).
 - each research assistant must be hired by one professor.

Draw the ER diagram to model the relationship between professors and research assistants.

Question 7

❑ What can you imply in the following relationships?



What have we learned about ER diagrams?

□ Entity sets

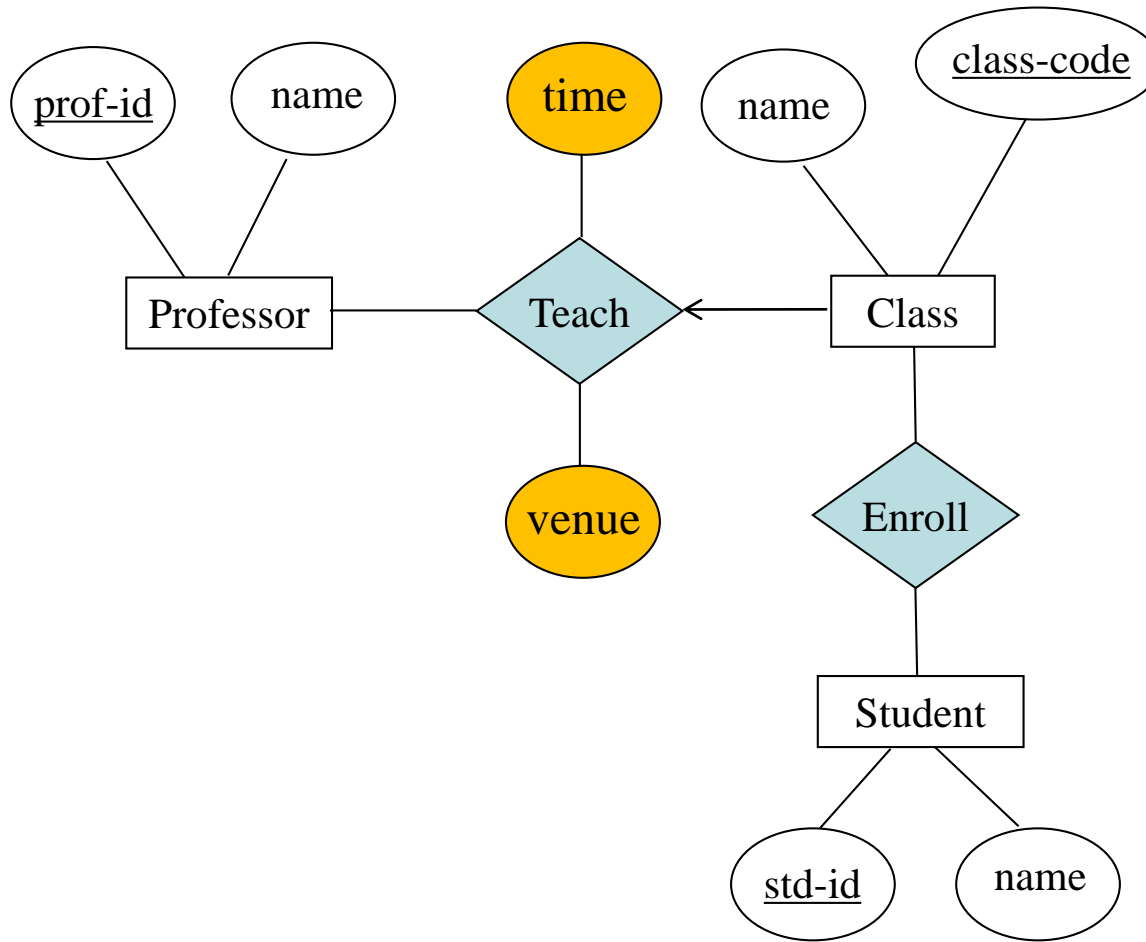
- Attributes

□ Relationship sets

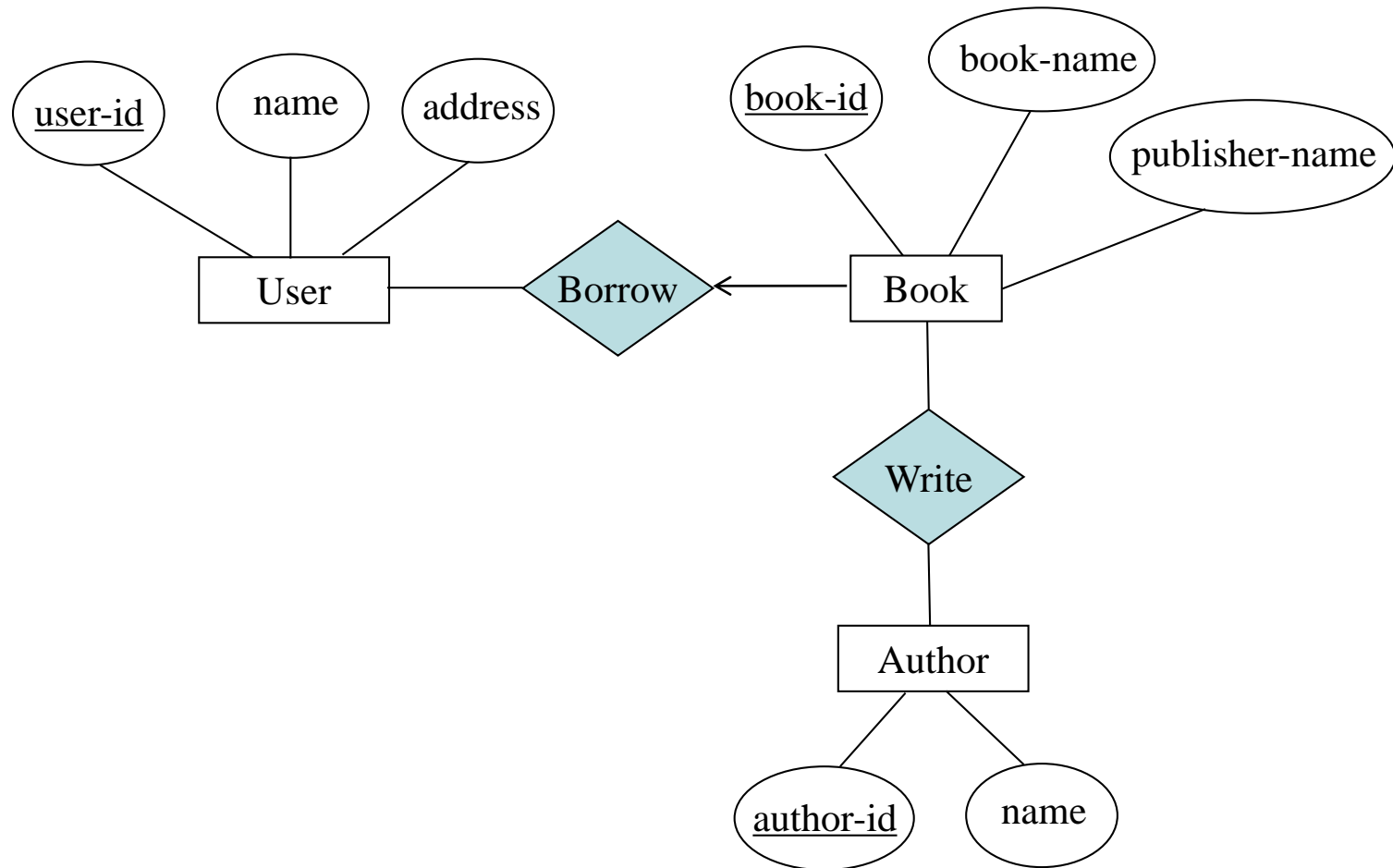
- 1-1, 1-m, m-1, m-m
- total/partial participation
- Attributes



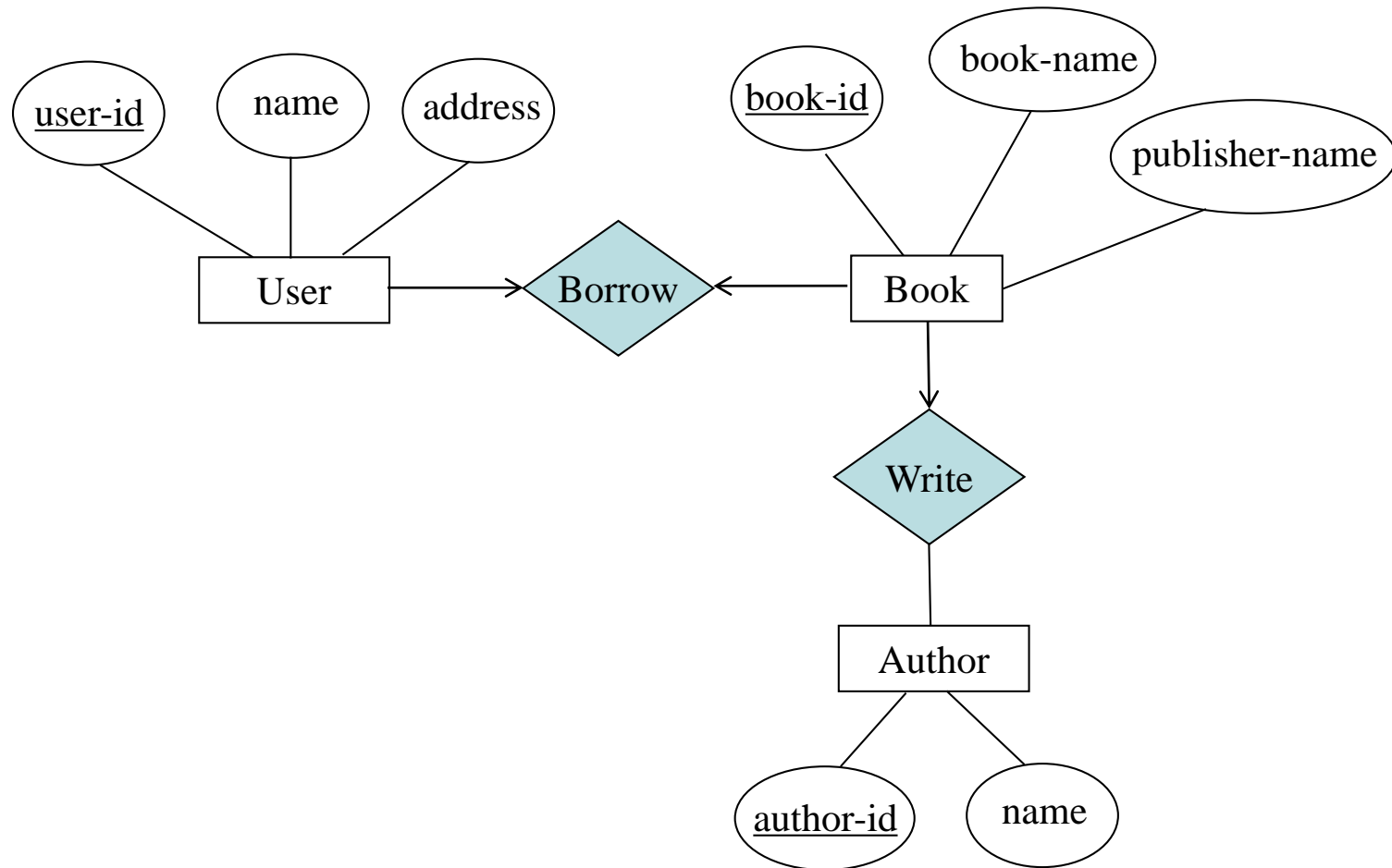
Solution to Question 1



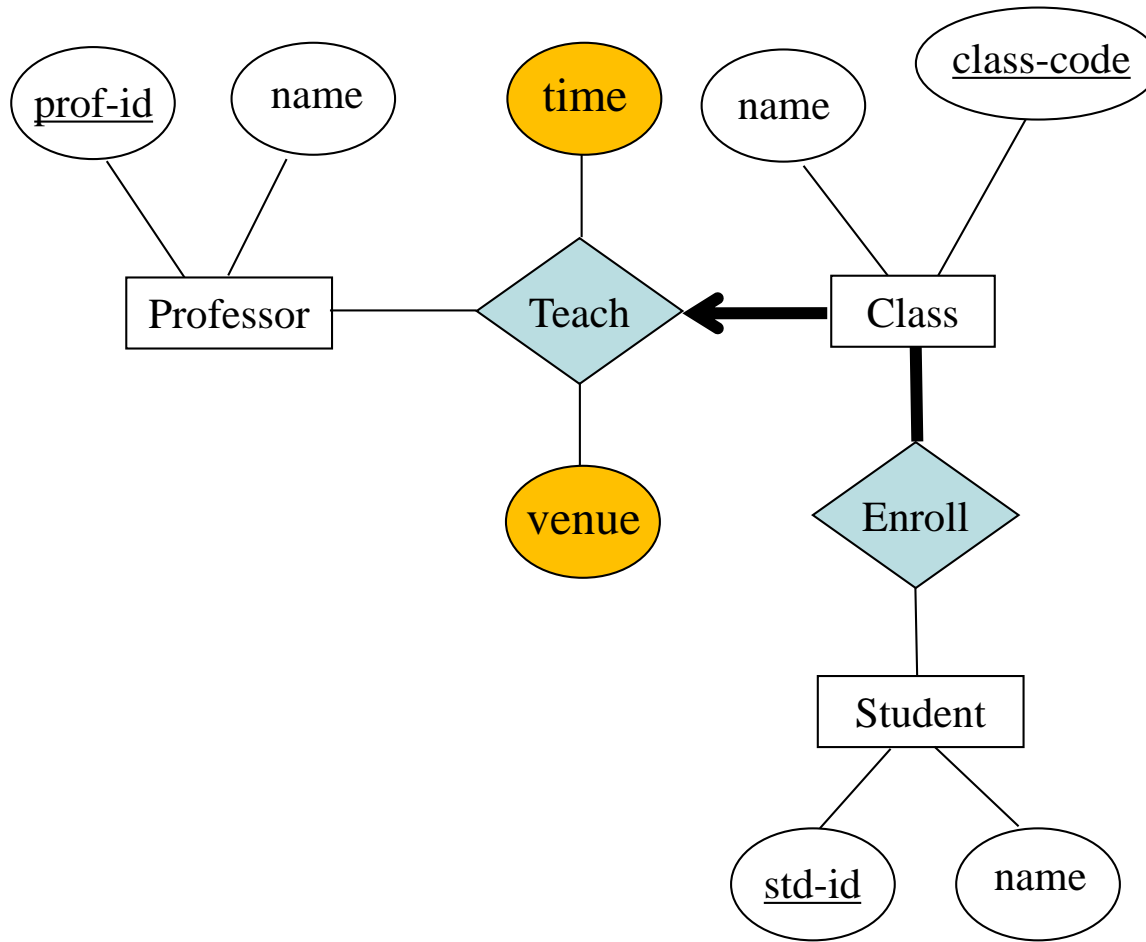
Solution to Question 2



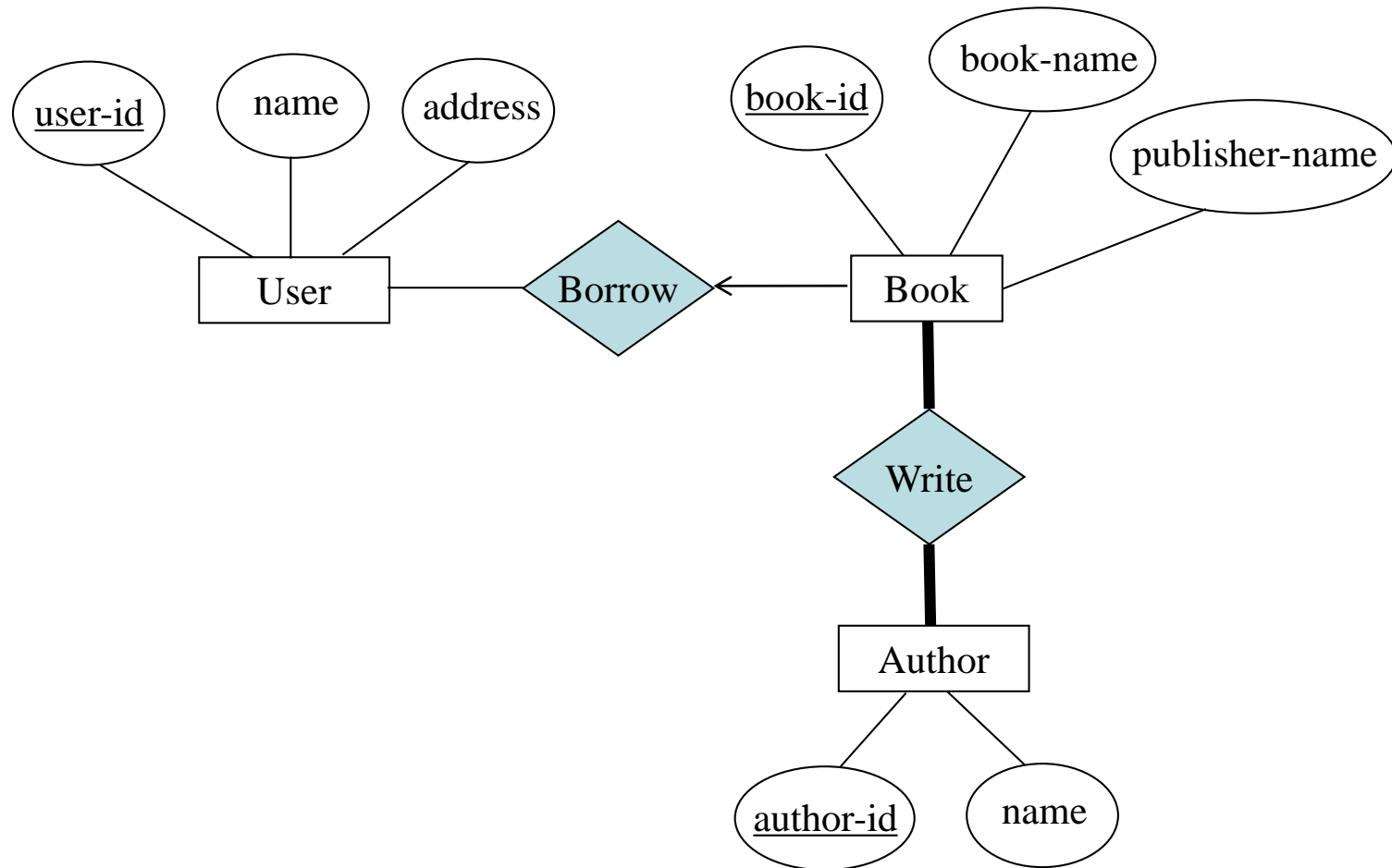
Solution to Question 3



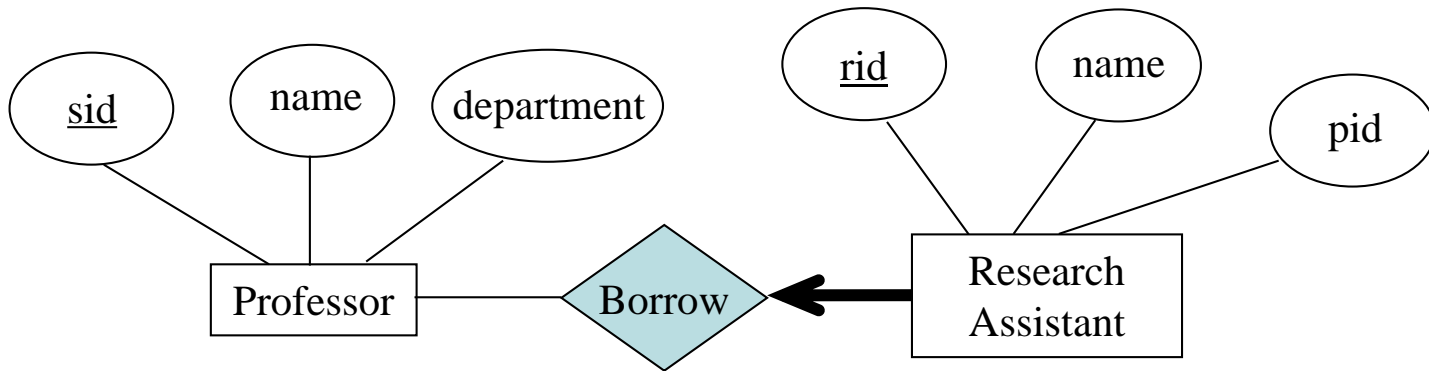
Solution to Question 4



Solution to Question 5



Solution to Question 6



Solution to Question 7

- ❑ Each customer should borrow exactly one loan.
- ❑ Each loan should be borrowed by exactly one customer.

