

CS4221/5421: Tutorial 1 — Entity-Relationship Model

Pratik Karmakar

School of Computing,
National University of Singapore

AY25/26 S1



The Problem Statement

Students at the National University of Ngendipura (NUN) buy books for their studies. They also lend and borrow books to and from other students. Your company, Apasaja Private Limited, is commissioned by NUN Students Association (NUNStA) to implement an online book exchange system that records information about students, books that they own and books that they lend and borrow.

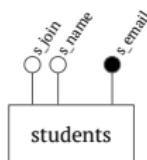
The database records the name, faculty, and department of each student. Each student is identified in the system by his/her email. The database also records the date at which the student joined the university. If a student has graduated, the database record the date of graduation. A department in NUN must belong to exactly one faculty. The database records the title, authors, publisher, language, year as well as the ISBN-10 and ISBN-13 for each book. A book can have several authors but it must have at least one author. The database also records author that currently has no book. It should also record the format of the book (i.e., if the book is hardcover or softcover). The International Standard Book Number, ISBN-10 or -13, is an industry standard for the unique identification of books. It is possible that the database records books that are not owned by any student (e.g., because the owners of a copy graduated or because the book was advised by a lecturer for a course but not yet purchased by any student). A student may own multiple copies of the same book. We differentiate the copy by its copy number. For instance, John may own two copies of the book Database Systems with ISBN-13 number of 9780131873254. The first copy has a copy number of 1 while the second copy has a copy number of 2. The copy number should be a consecutive number starting from 1.

The database also records the date at which a book copy is borrowed and the date at which it is returned. We refer to this information as a loan record. Obviously, a student can only borrow or lend book after he/she is enrolled. For auditing purposes the database records information about the books, the copies and the owners of the copies as long as the owners are students or as there are loan records concerning the copies. For auditing purposes the database records information about graduated students as long as there are loan records concerning books that they owned.

Questions

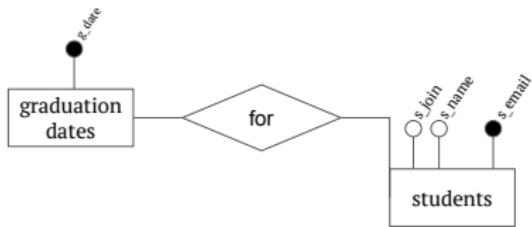
- Entity-Relationship Design
 - Identify entity sets.
 - Identify relationship sets.
 - For each entity set and relationship set, identify its attributes.
 - For each entity set, identify its identifying attributes.
 - Draw the corresponding entity-relationship diagram with the key and participation constraints. Indicate in English the constraints that cannot be captured, if any.
- Logical Design
 - Translate your entity-relationship diagram into a relational schema. Give the SQL DDL statements to create the schema. Declare the necessary integrity constraints. Indicate in English the constraints that cannot be captured, if any.

The ER Diagram



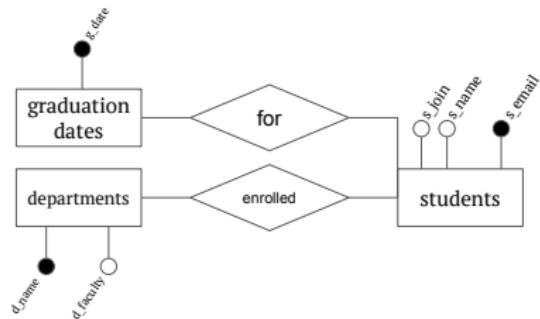
The database records the **name**, **faculty**, and **department** of each student. Each student is identified in the system by his/her **email**. The database also records the date at which the student joined the university. **If a student has graduated, the database record the date of graduation.** A department in NUN must belong to exactly one faculty.

The ER Diagram



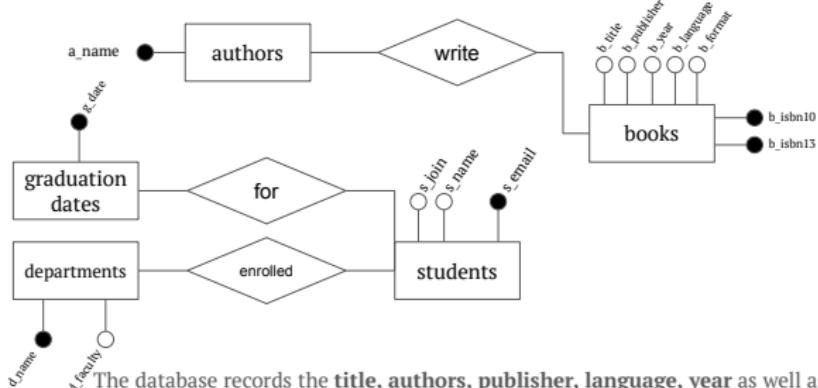
The database records the **name**, **faculty**, and **department** of each student. Each student is identified in the system by his/her **email**. The database also records the date at which the student joined the university. **If a student has graduated, the database record the date of graduation.** A department in NUN must belong to exactly one faculty.

The ER Diagram



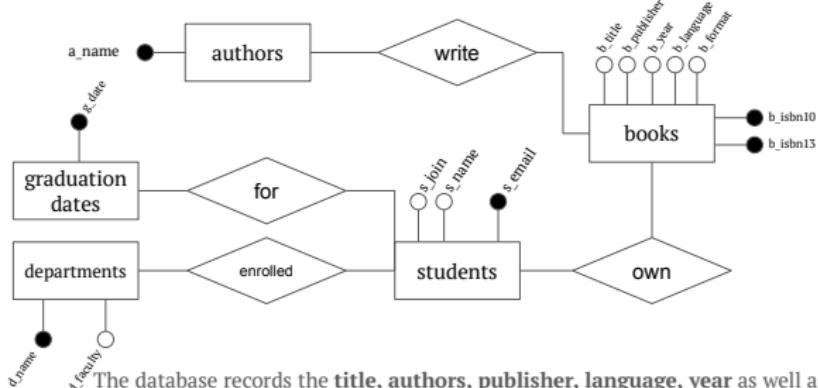
The database records the **name**, **faculty**, and **department** of each student. Each student is identified in the system by his/her **email**. The database also records the **date at which the student joined the university**. If a student has graduated, the database record the date of graduation. **A department in NUN must belong to exactly one faculty.**

The ER Diagram



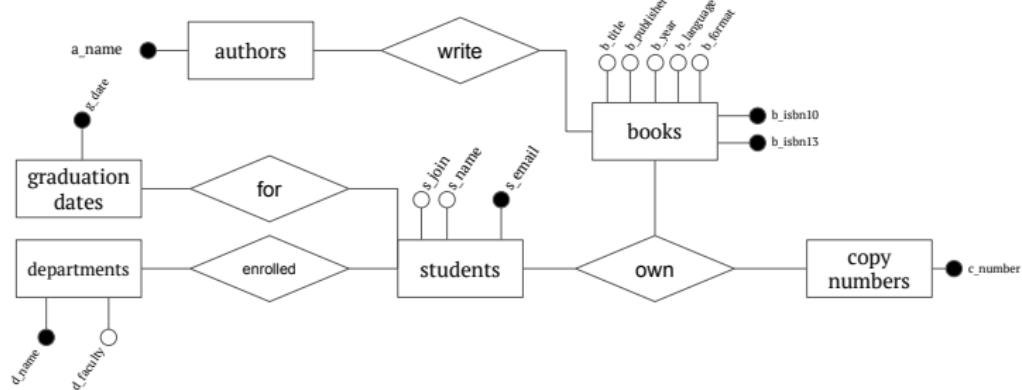
The database records the **title**, **authors**, **publisher**, **language**, **year** as well as the **ISBN-10** and **ISBN-13** for each book. A book can have **several authors** but it must have **at least one author**. The database also records **author that currently has no book**. It should also record the **format of the book** (i.e., if the book is **hardcover** or **paperback**). The International Standard Book Number, **ISBN-10** or **-13**, is an **industry standard for the unique identification of books**. It is possible that the database records books that are not owned by any students (e.g., because the owners of a copy graduated or because the book was advised by a lecturer for a course but not yet purchased by any student).

The ER Diagram



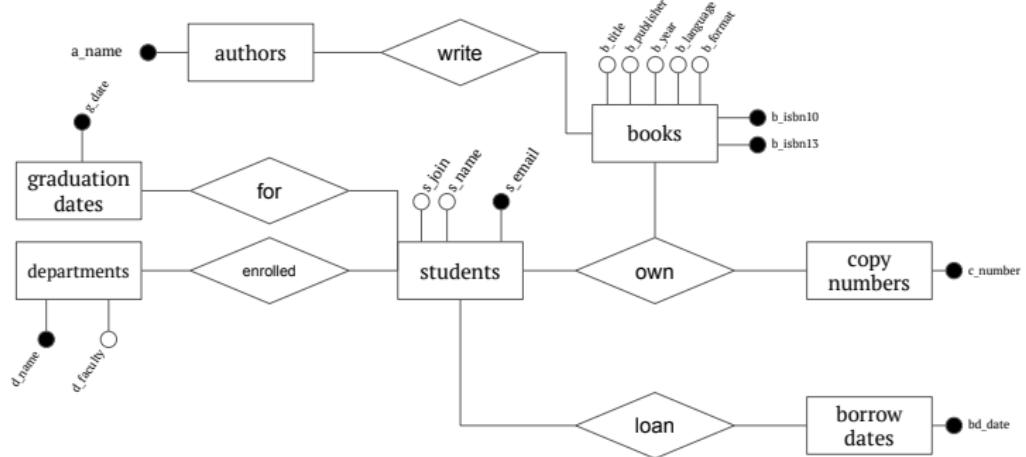
The database records the **title**, **authors**, **publisher**, **language**, **year** as well as the **ISBN-10** and **ISBN-13** for each book. A book can have **several authors** but it must have **at least one author**. The database also records **author** that currently has **no book**. It should also record the format of the book (i.e., if the book is hardcover or paperback). The International Standard Book Number, ISBN-10 or -13, is an industry standard for the unique identification of books. **It is possible that the database records books that are not owned by any students** (e.g., because the owners of a copy graduated or because the book was advised by a lecturer for a course but not yet purchased by any student).

The ER Diagram



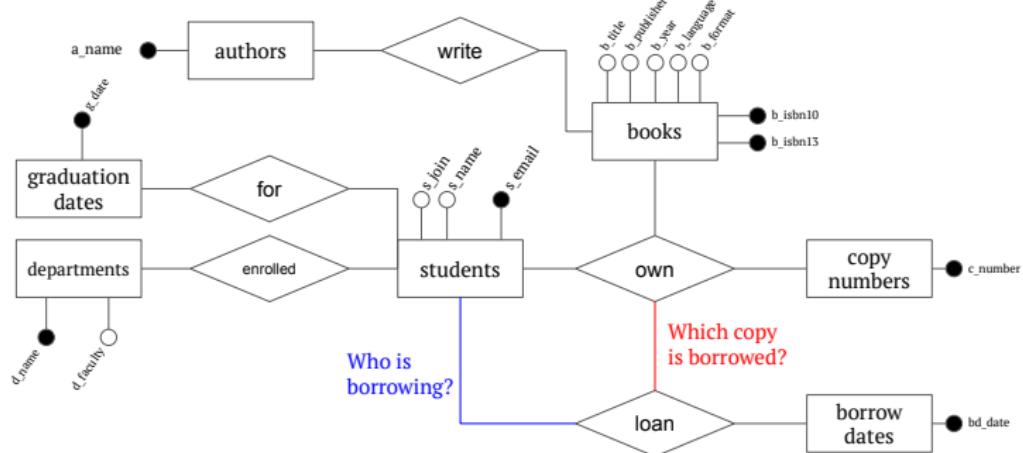
A student may own multiple copies of the same book. We differentiate the copy by its **copy number**. For instance, John may own two copies of the book Database Systems with ISBN-13 number of 9780131873254. The first copy has a copy number of 1 while the second copy has a copy number of 2. The copy number should be a consecutive number starting from 1.

The ER Diagram

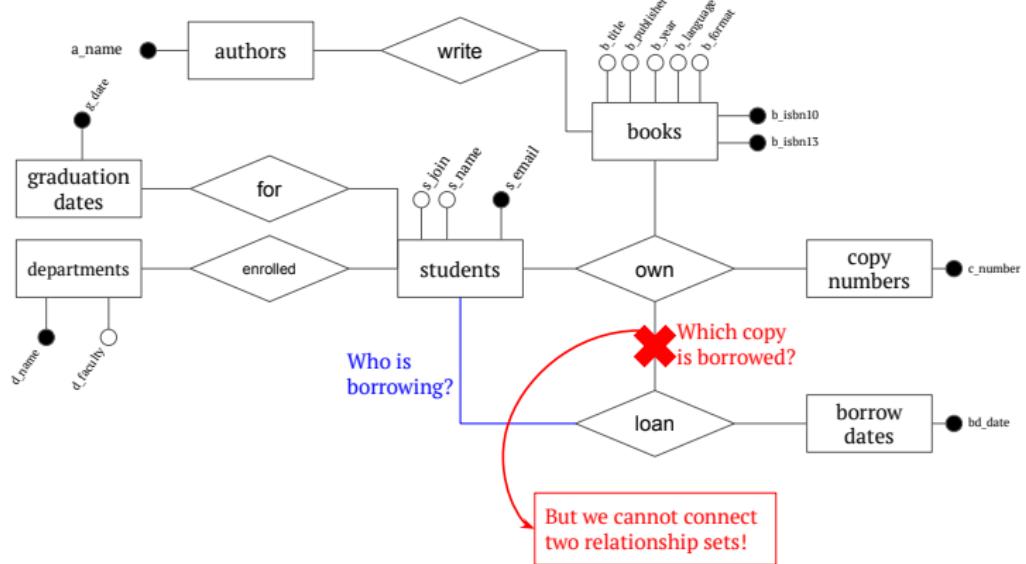


The database also records the **date at which a book copy is borrowed** and the date at which it is returned. We refer to this information as a **loan record**. Obviously, a student can only borrow or lend book after he/she is enrolled.

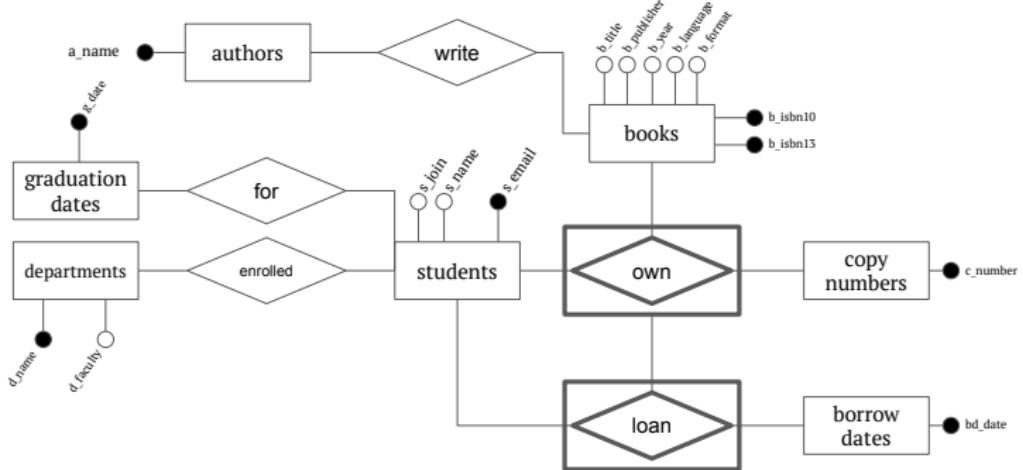
The ER Diagram



The ER Diagram

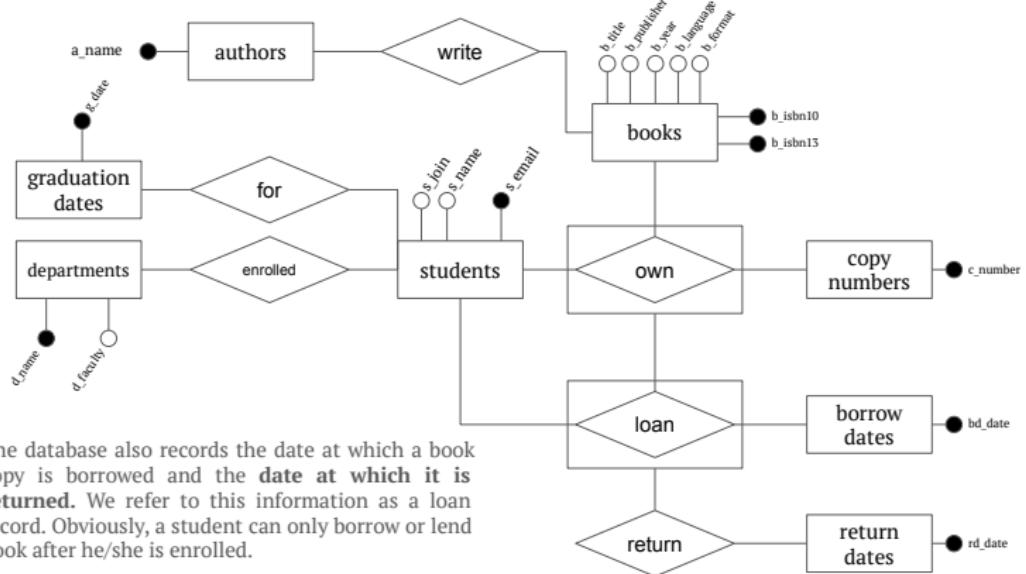


The ER Diagram



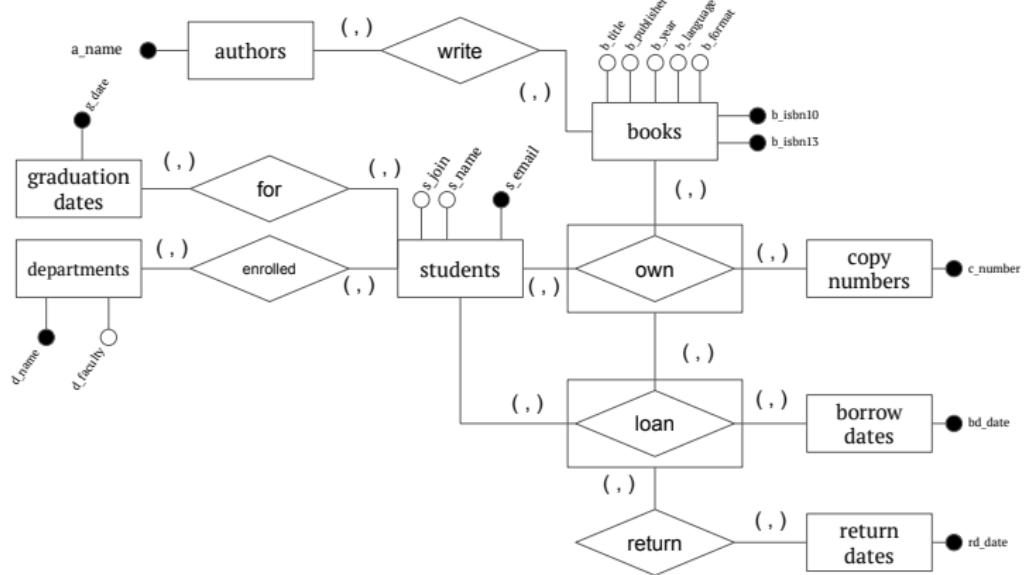
Thus we introduce “Aggregates”.

The ER Diagram

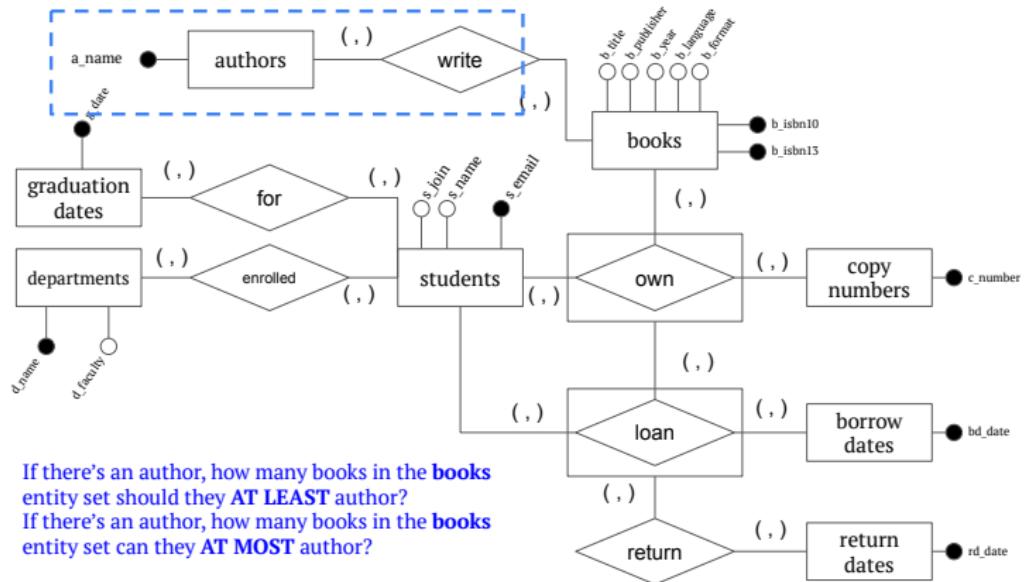


The database also records the date at which a book copy is borrowed and the date at which it is returned. We refer to this information as a loan record. Obviously, a student can only borrow or lend book after he/she is enrolled.

The ER Diagram



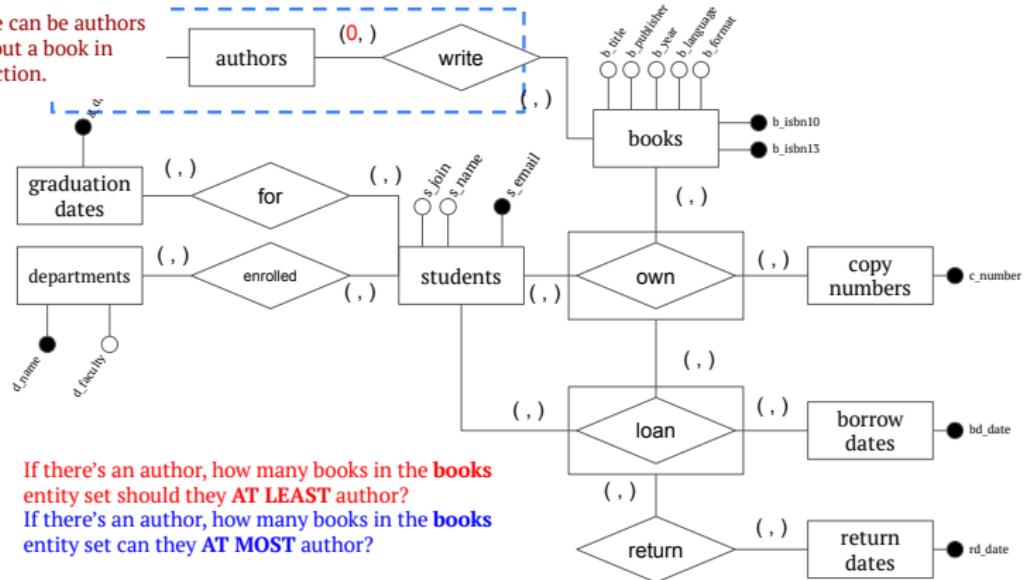
The ER Diagram



1. If there's an author, how many books in the **books** entity set should they AT LEAST author?
2. If there's an author, how many books in the **books** entity set can they AT MOST author?

The ER Diagram

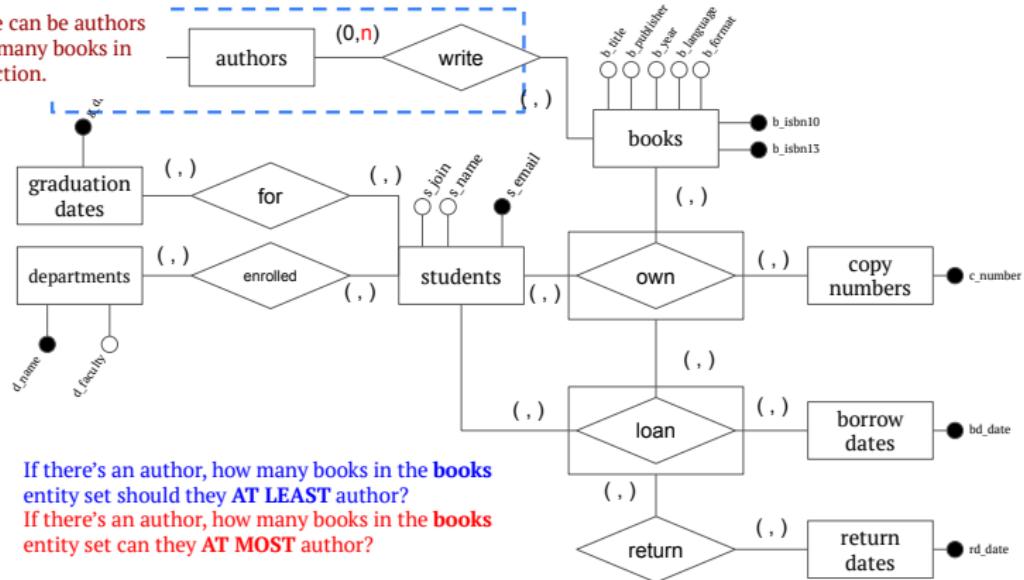
There can be authors without a book in collection.



- If there's an author, how many books in the **books** entity set should they AT LEAST author?
- If there's an author, how many books in the **books** entity set can they AT MOST author?

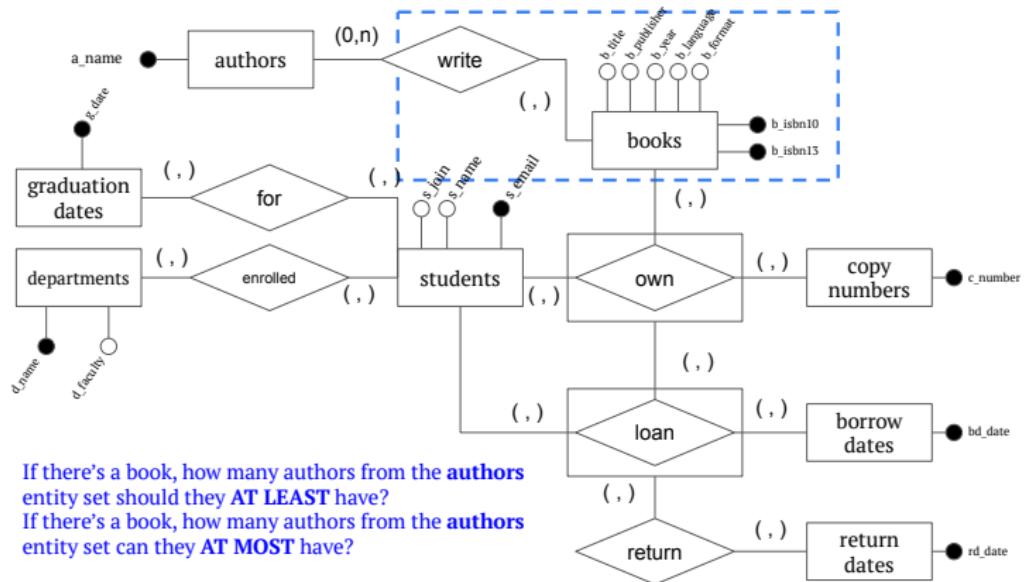
The ER Diagram

There can be authors with many books in collection.



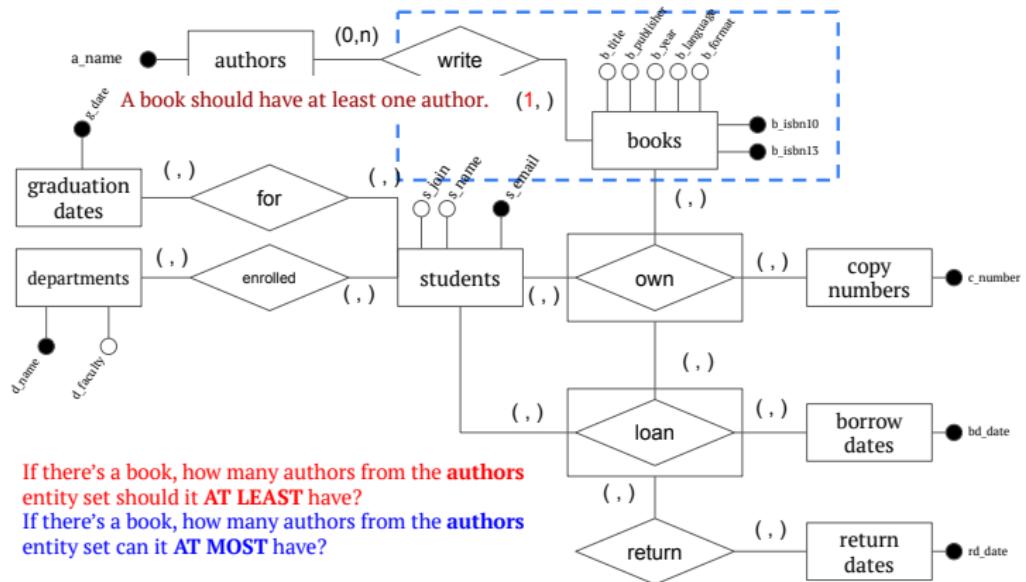
- If there's an author, how many books in the **books** entity set should they AT LEAST author?
- If there's an author, how many books in the **books** entity set can they AT MOST author?

The ER Diagram

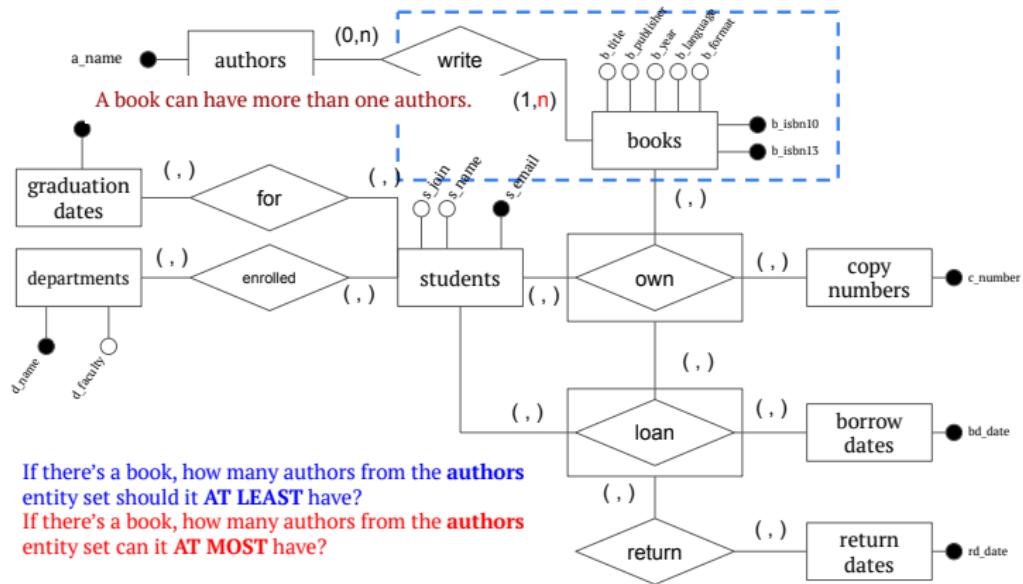


- If there's a book, how many authors from the **authors** entity set should they AT LEAST have?
- If there's a book, how many authors from the **authors** entity set can they AT MOST have?

The ER Diagram

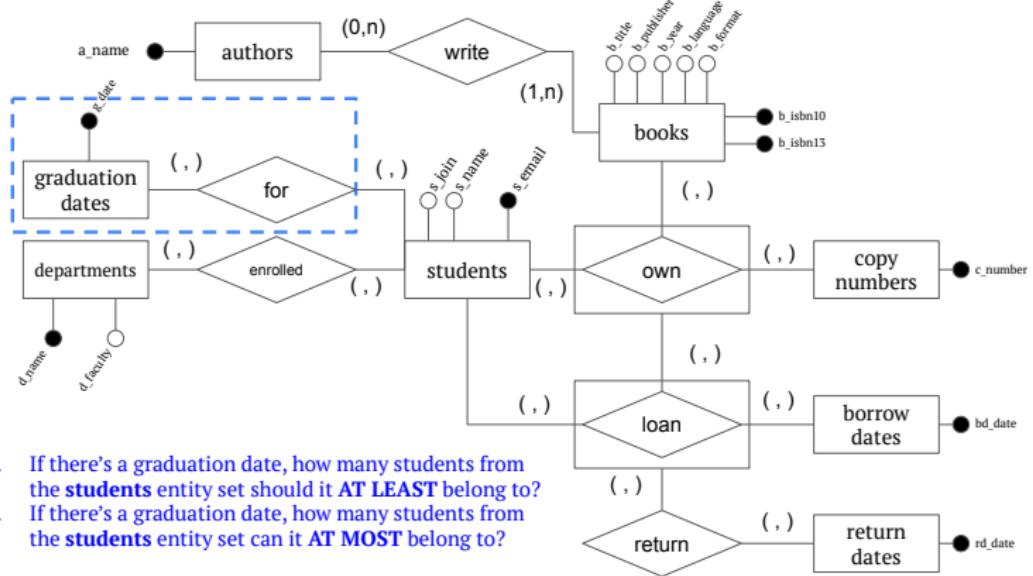


The ER Diagram



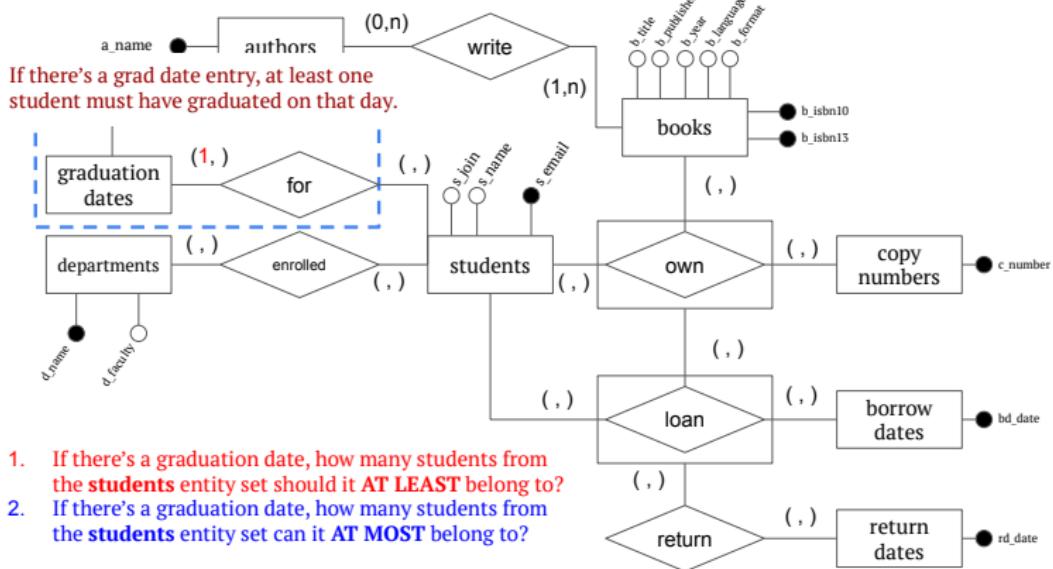
- If there's a book, how many authors from the **authors** entity set should it AT LEAST have?
- If there's a book, how many authors from the **authors** entity set can it AT MOST have?

The ER Diagram



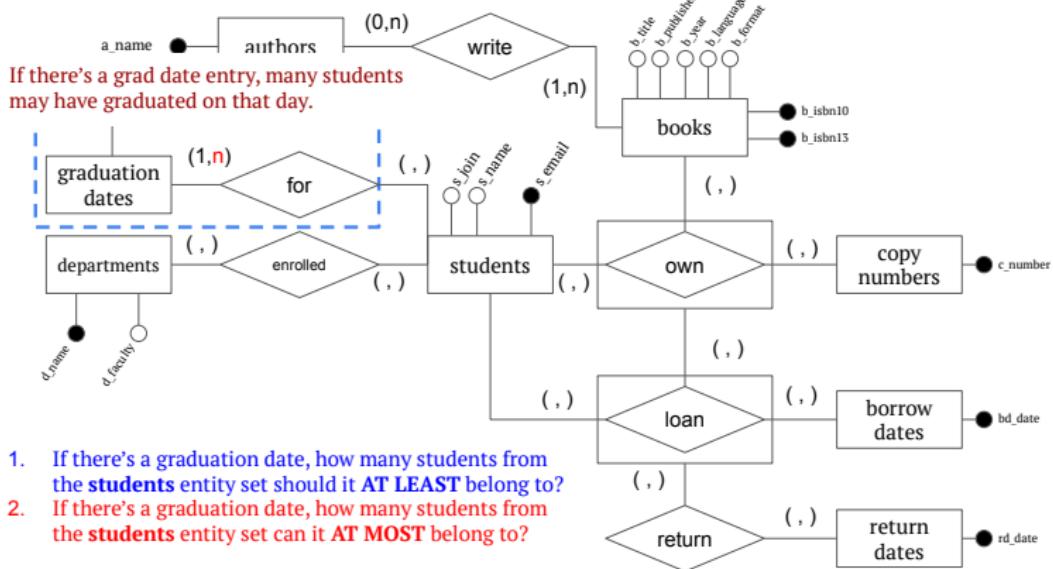
1. If there's a graduation date, how many students from the **students** entity set should it AT LEAST belong to?
2. If there's a graduation date, how many students from the **students** entity set can it AT MOST belong to?

The ER Diagram

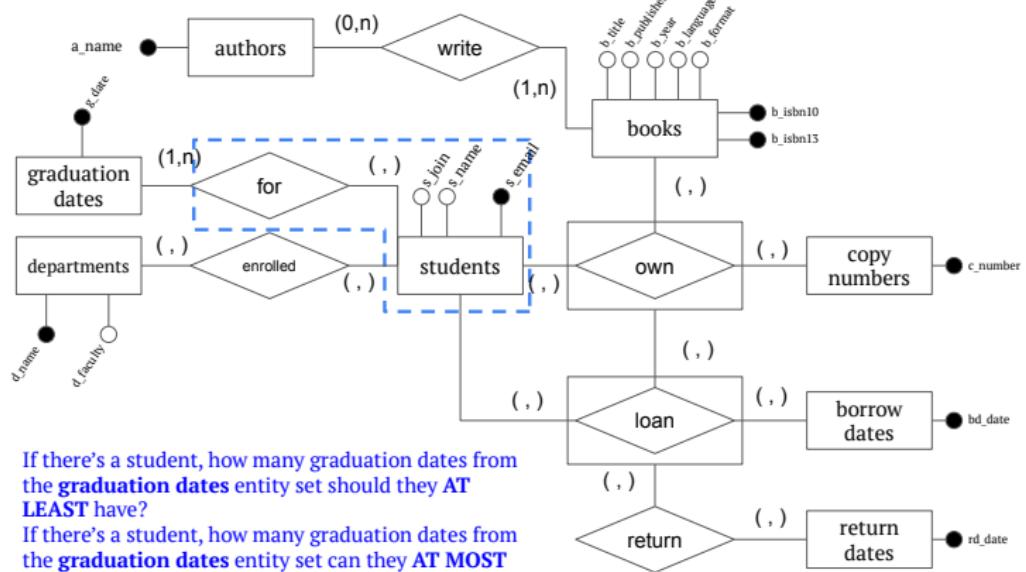


1. If there's a graduation date, how many students from the **students** entity set should it AT LEAST belong to?
2. If there's a graduation date, how many students from the **students** entity set can it AT MOST belong to?

The ER Diagram

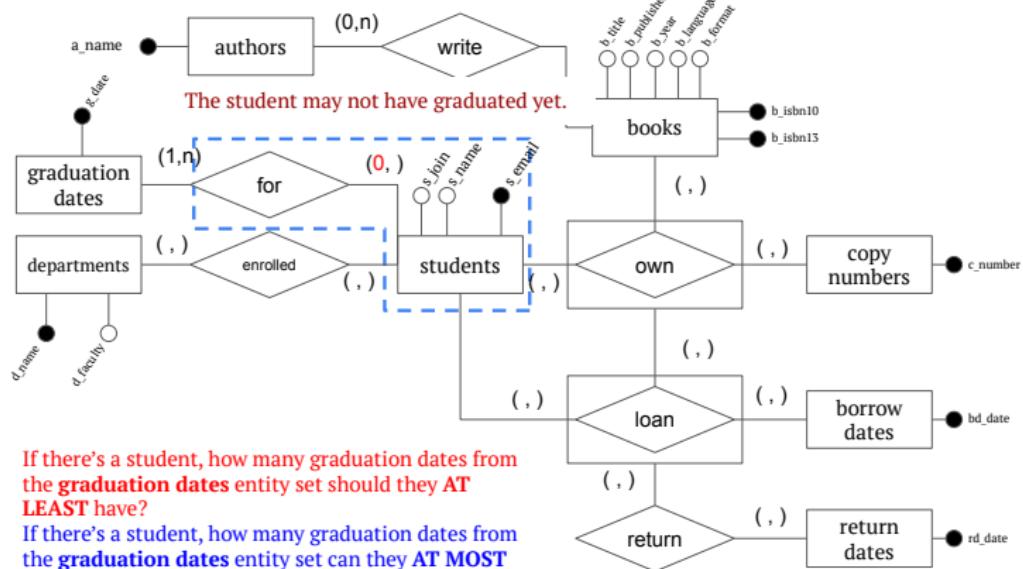


The ER Diagram



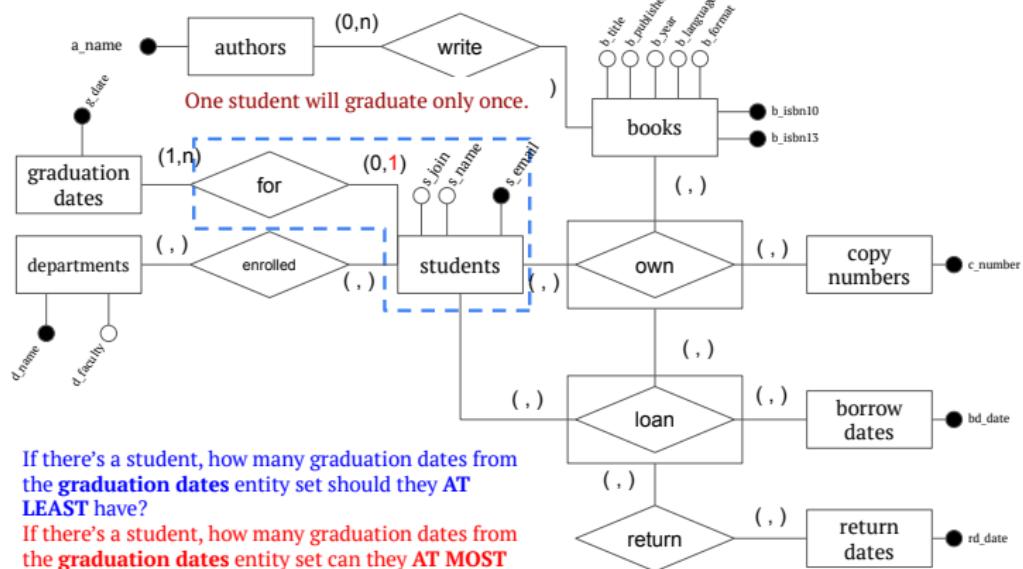
- If there's a student, how many graduation dates from the **graduation dates** entity set should they AT LEAST have?
- If there's a student, how many graduation dates from the **graduation dates** entity set can they AT MOST have?

The ER Diagram



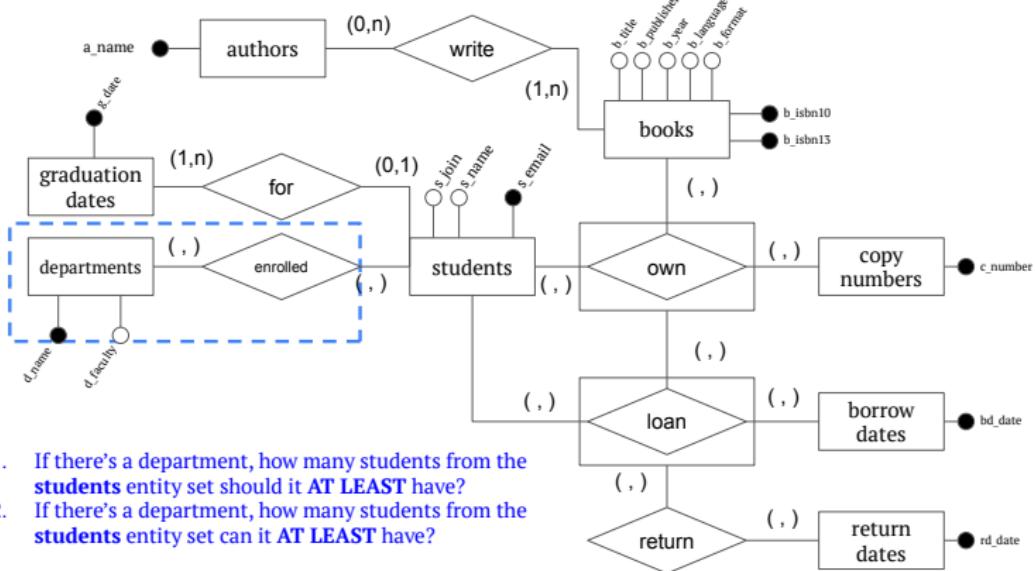
- If there's a student, how many graduation dates from the **graduation dates** entity set should they AT LEAST have?
- If there's a student, how many graduation dates from the **graduation dates** entity set can they AT MOST have?

The ER Diagram



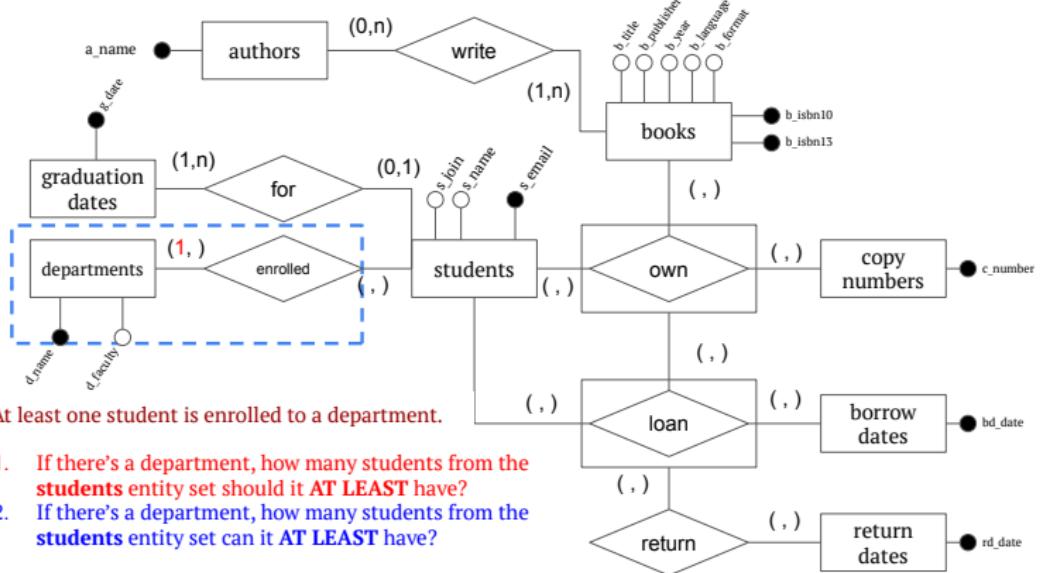
- If there's a student, how many graduation dates from the **graduation dates** entity set should they AT LEAST have?
- If there's a student, how many graduation dates from the **graduation dates** entity set can they AT MOST have?

The ER Diagram

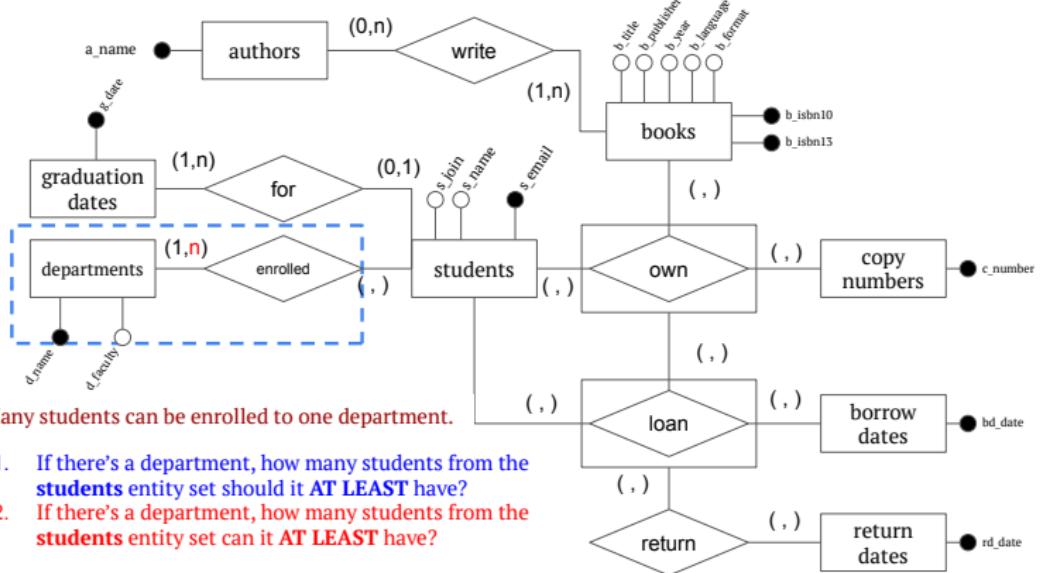


1. If there's a department, how many students from the **students** entity set should it **AT LEAST** have?
2. If there's a department, how many students from the **students** entity set can it **AT LEAST** have?

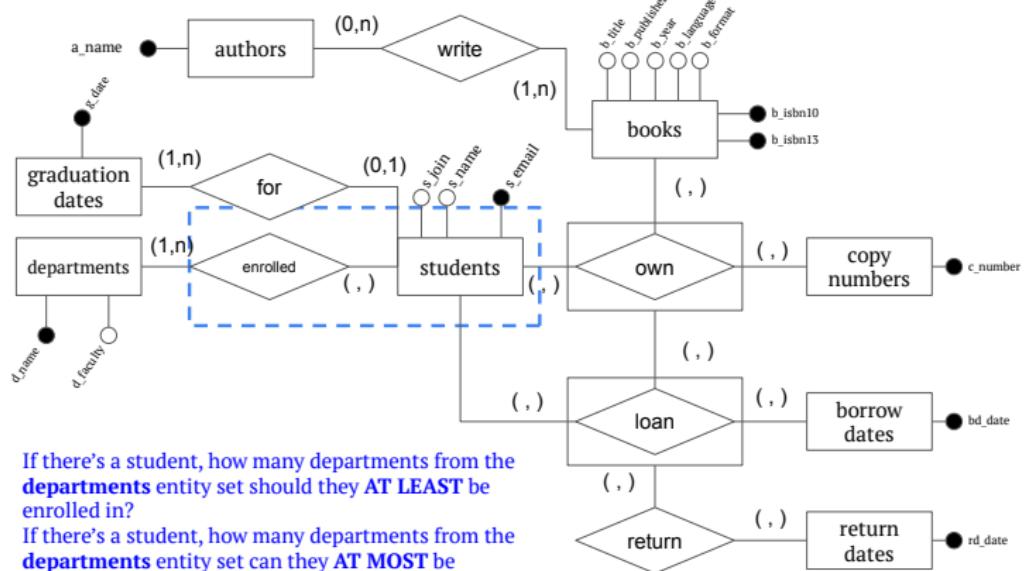
The ER Diagram



The ER Diagram

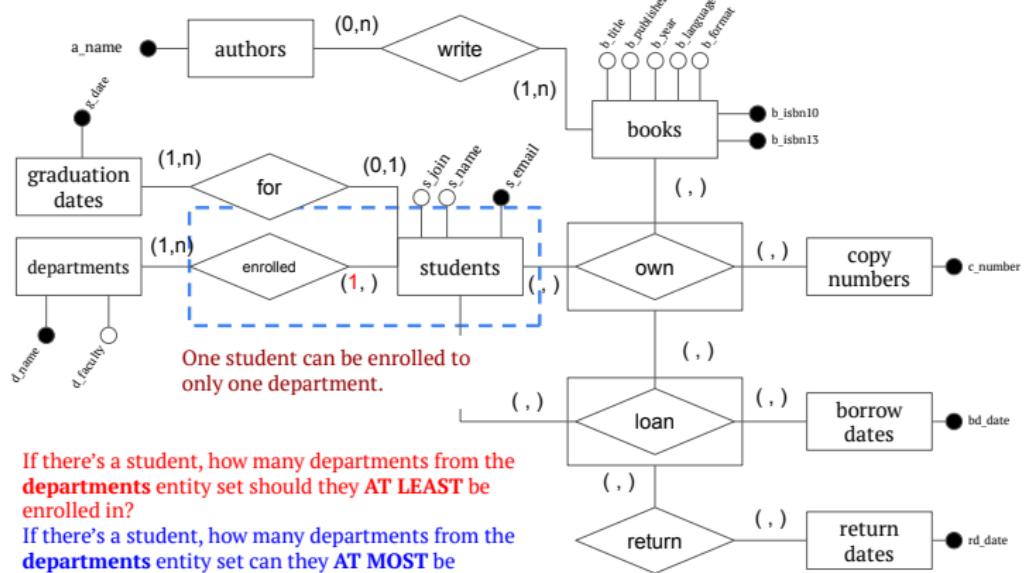


The ER Diagram



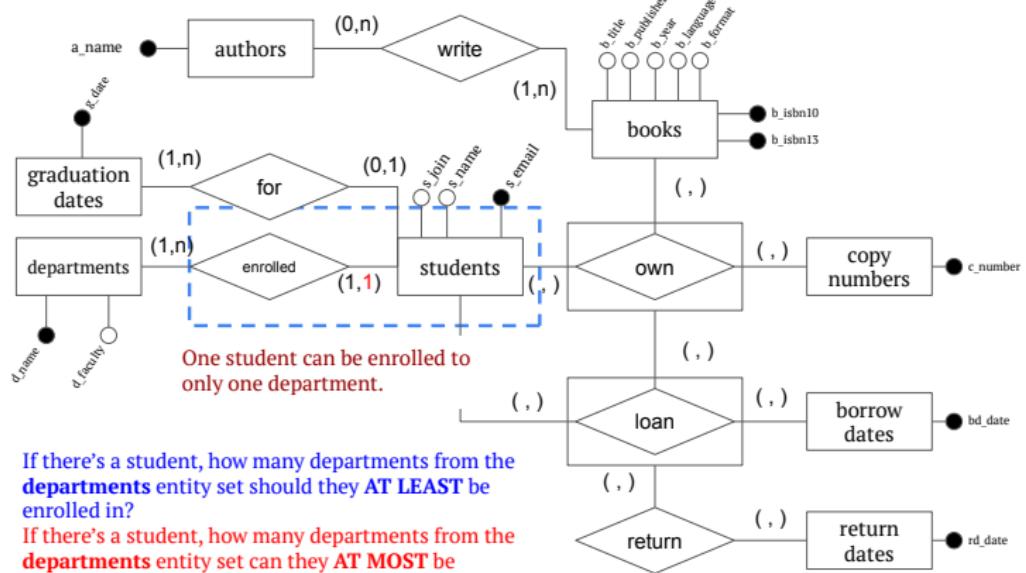
- If there's a student, how many departments from the **departments** entity set should they AT LEAST be enrolled in?
- If there's a student, how many departments from the **departments** entity set can they AT MOST be enrolled in?

The ER Diagram



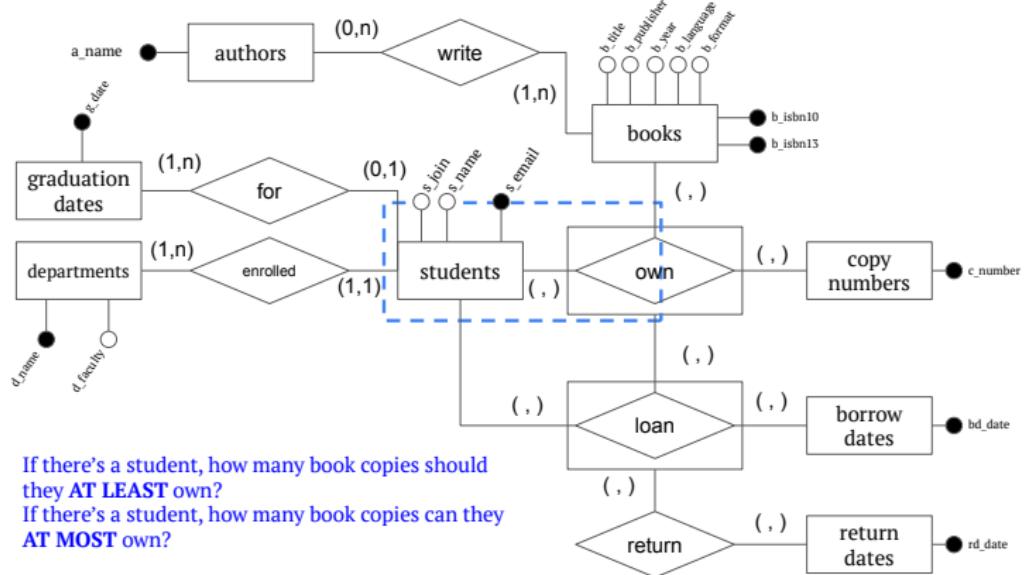
- If there's a student, how many departments from the **departments** entity set should they AT LEAST be enrolled in?
- If there's a student, how many departments from the **departments** entity set can they AT MOST be enrolled in?

The ER Diagram



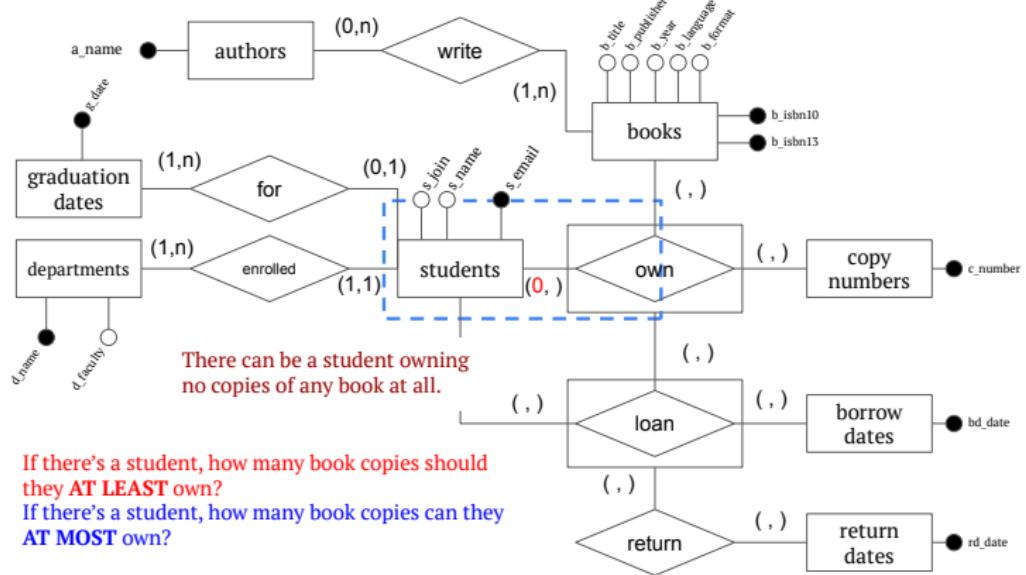
- If there's a student, how many departments from the **departments** entity set should they AT LEAST be enrolled in?
- If there's a student, how many departments from the **departments** entity set can they AT MOST be enrolled in?

The ER Diagram



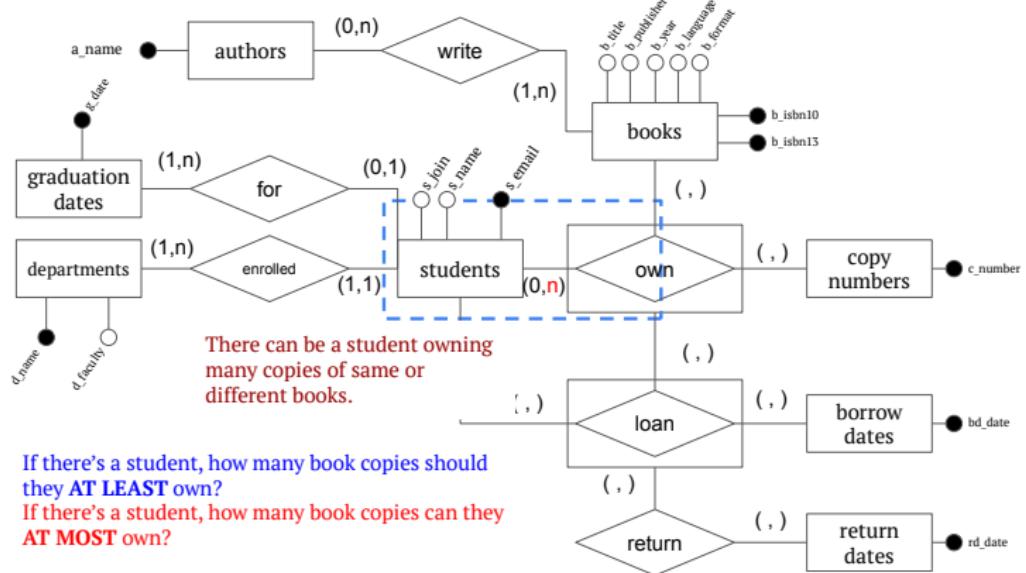
1. If there's a student, how many book copies should they AT LEAST own?
2. If there's a student, how many book copies can they AT MOST own?

The ER Diagram



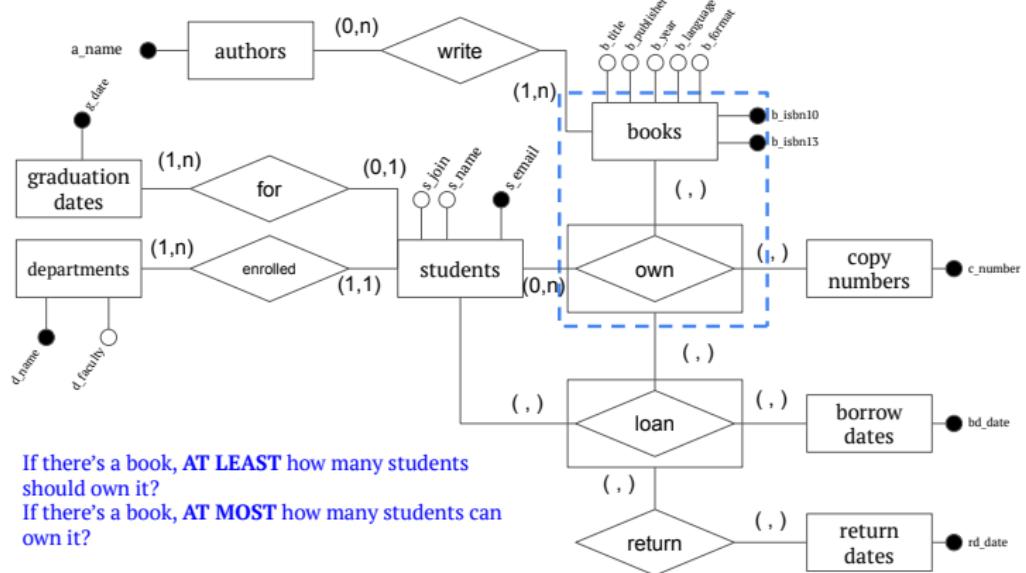
- If there's a student, how many book copies should they AT LEAST own?
- If there's a student, how many book copies can they AT MOST own?

The ER Diagram



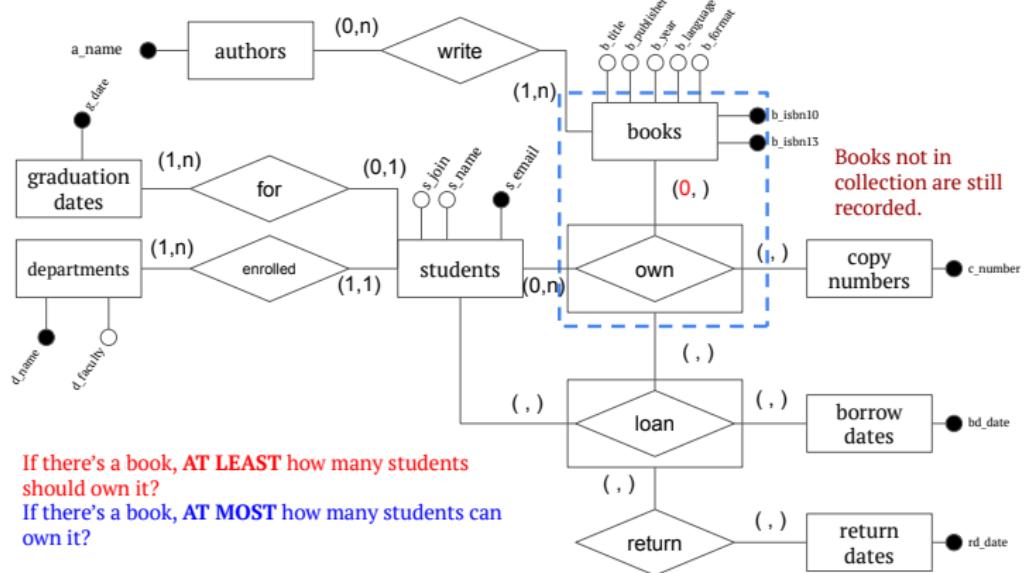
- If there's a student, how many book copies should they AT LEAST own?
- If there's a student, how many book copies can they AT MOST own?

The ER Diagram



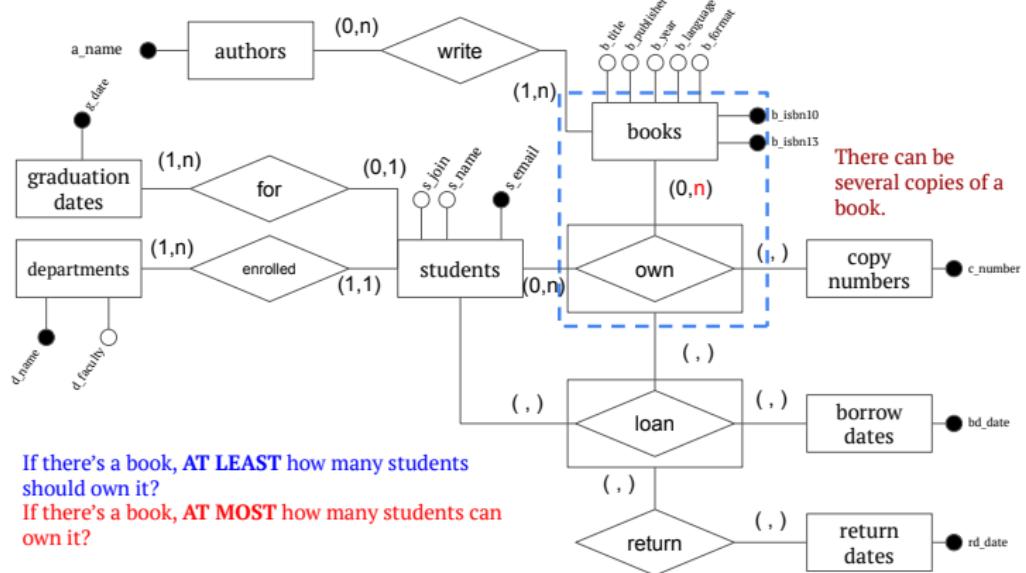
- If there's a book, **AT LEAST** how many students should own it?
- If there's a book, **AT MOST** how many students can own it?

The ER Diagram



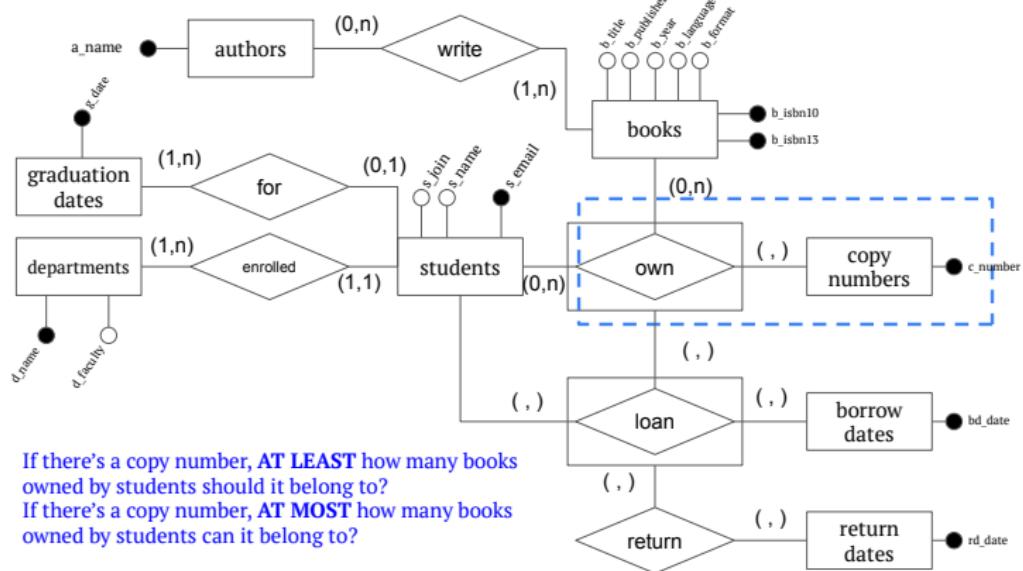
- If there's a book, **AT LEAST** how many students should own it?
- If there's a book, **AT MOST** how many students can own it?

The ER Diagram



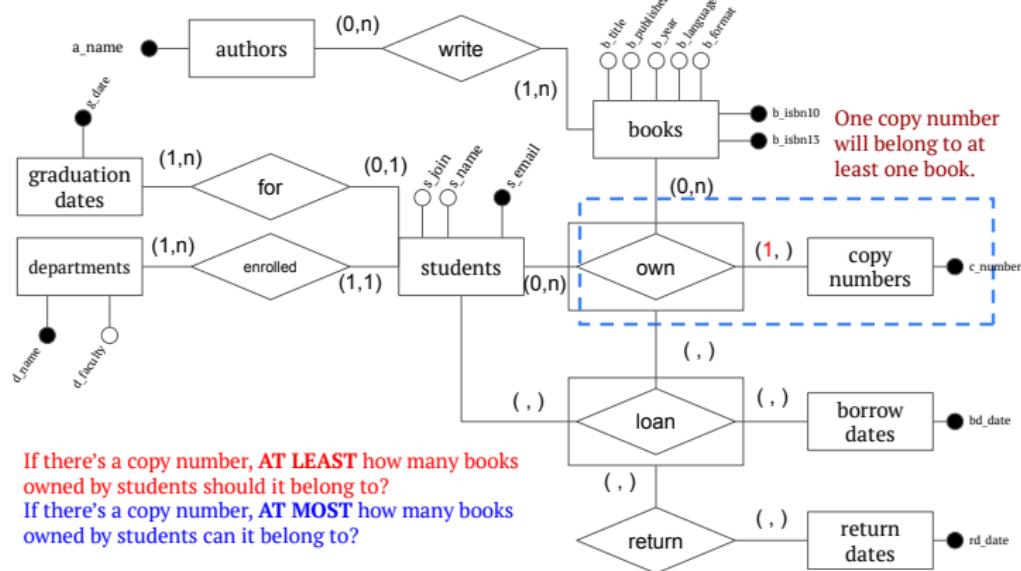
- If there's a book, **AT LEAST** how many students should own it?
- If there's a book, **AT MOST** how many students can own it?

The ER Diagram



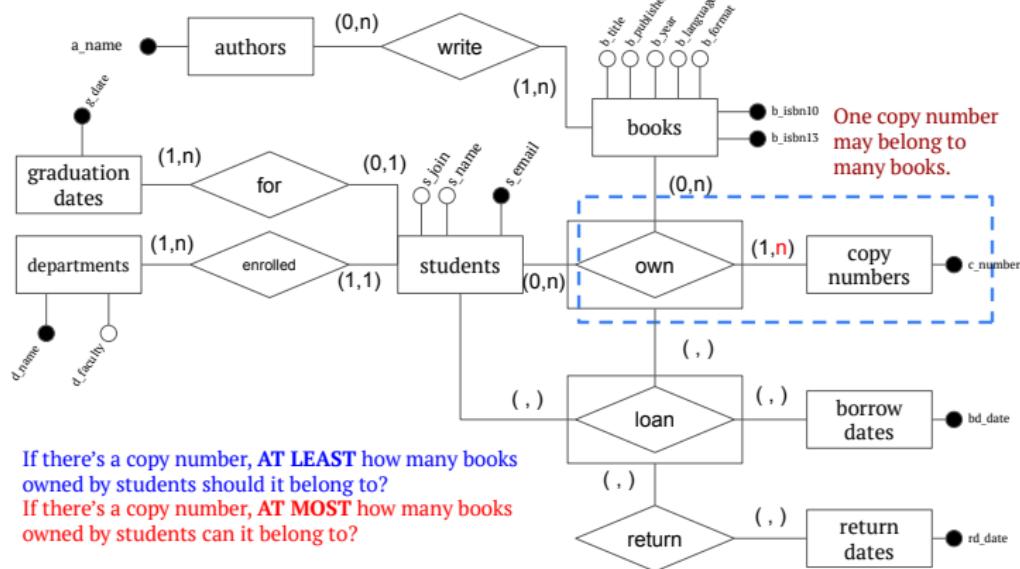
- If there's a copy number, **AT LEAST** how many books owned by students should it belong to?
- If there's a copy number, **AT MOST** how many books owned by students can it belong to?

The ER Diagram



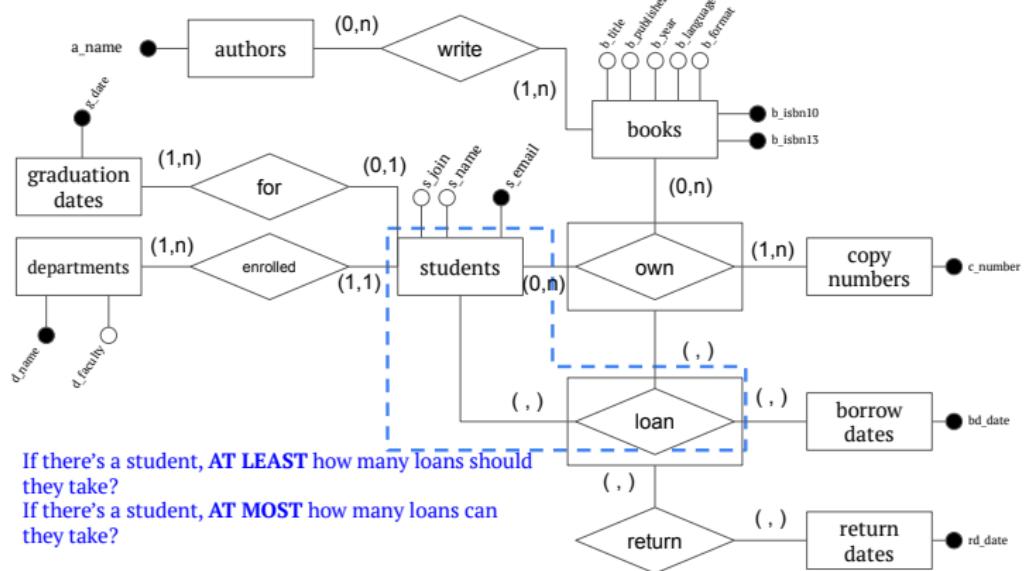
- If there's a copy number, **AT LEAST** how many books owned by students should it belong to?
- If there's a copy number, **AT MOST** how many books owned by students can it belong to?

The ER Diagram



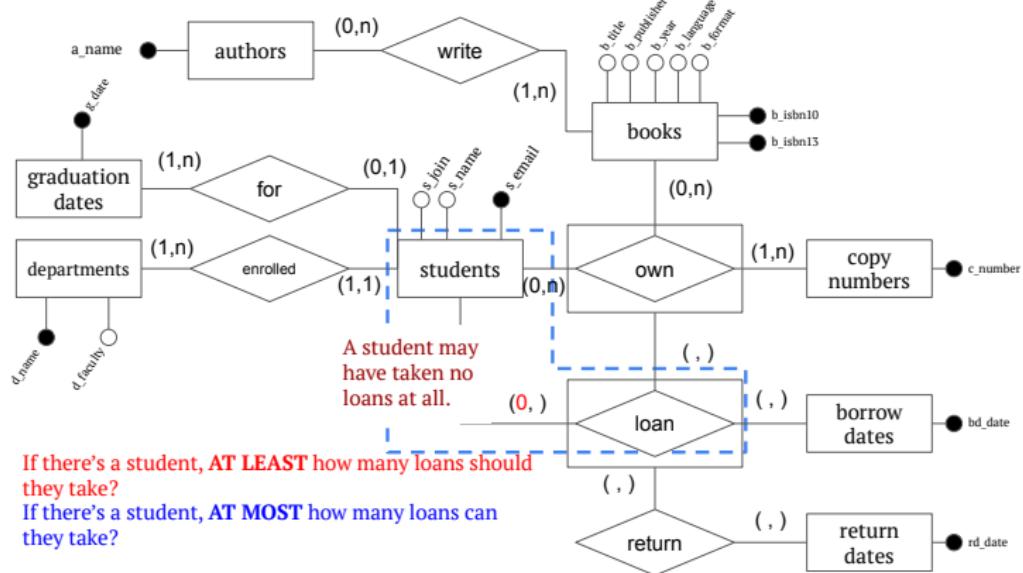
- If there's a copy number, **AT LEAST** how many books owned by students should it belong to?
- If there's a copy number, **AT MOST** how many books owned by students can it belong to?

The ER Diagram



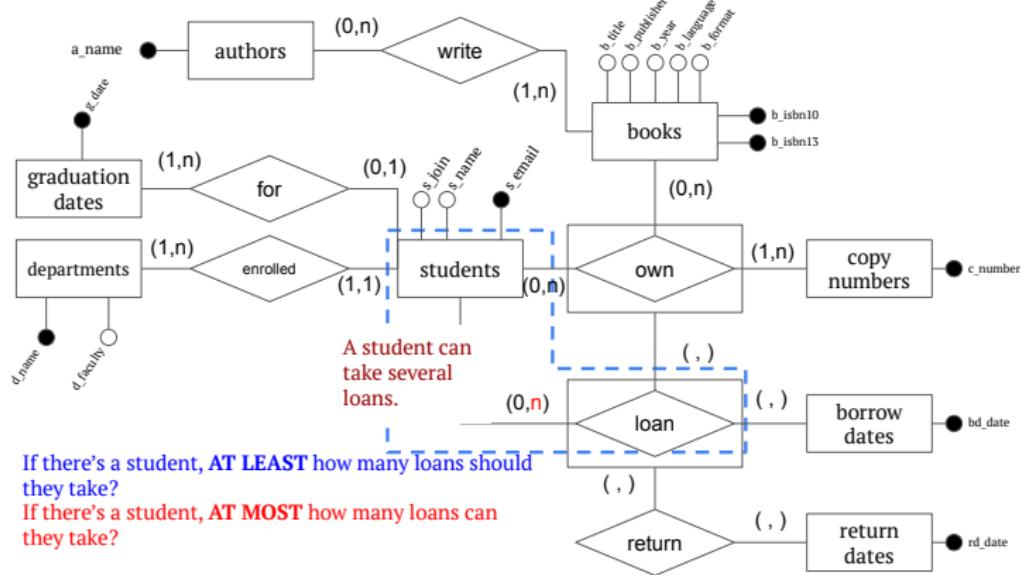
- If there's a student, AT LEAST how many loans should they take?
- If there's a student, AT MOST how many loans can they take?

The ER Diagram

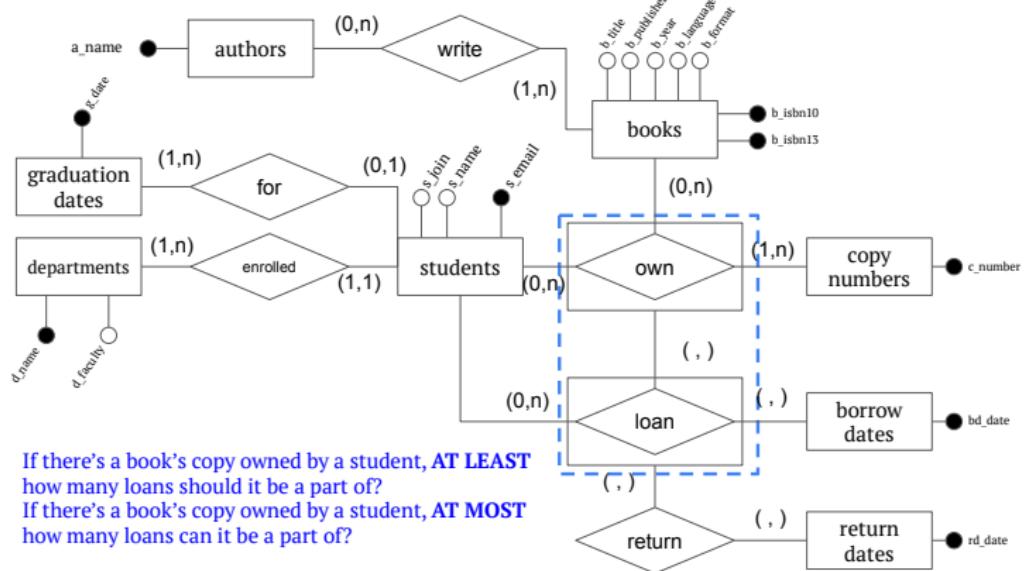


- If there's a student, AT LEAST how many loans should they take?
- If there's a student, AT MOST how many loans can they take?

The ER Diagram

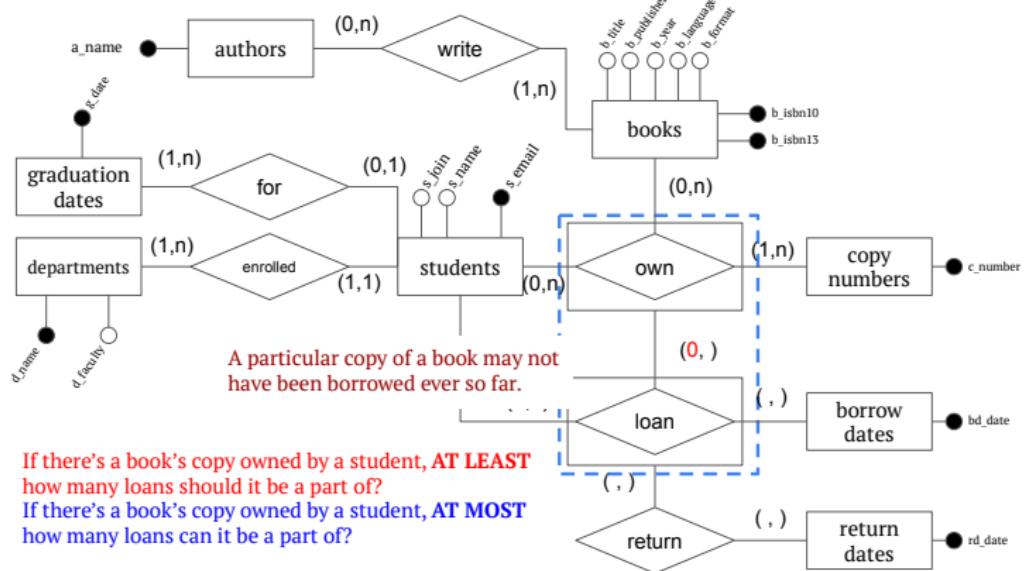


The ER Diagram



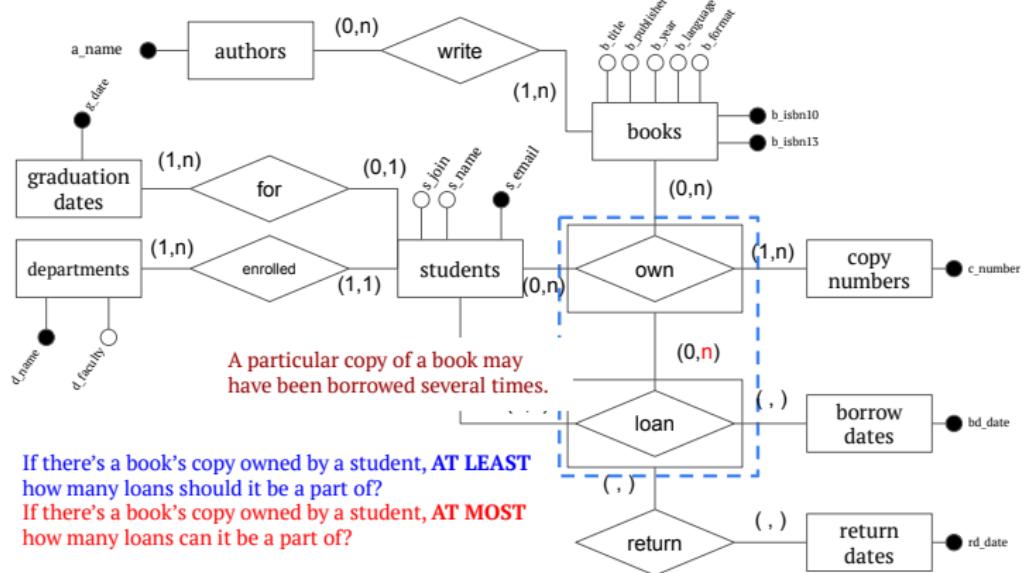
- If there's a book's copy owned by a student, **AT LEAST** how many loans should it be a part of?
- If there's a book's copy owned by a student, **AT MOST** how many loans can it be a part of?

The ER Diagram



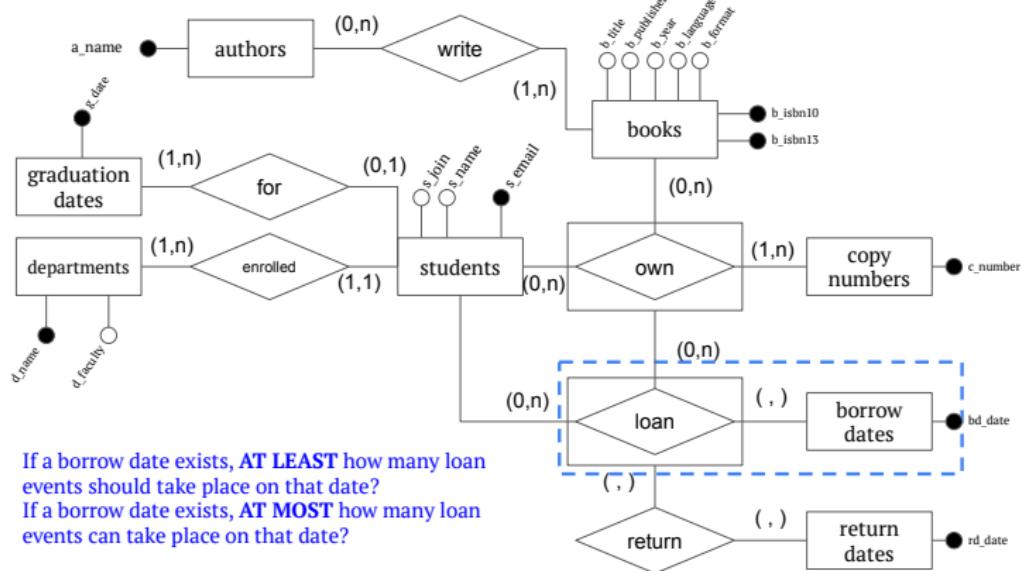
- If there's a book's copy owned by a student, AT LEAST how many loans should it be a part of?
- If there's a book's copy owned by a student, AT MOST how many loans can it be a part of?

The ER Diagram



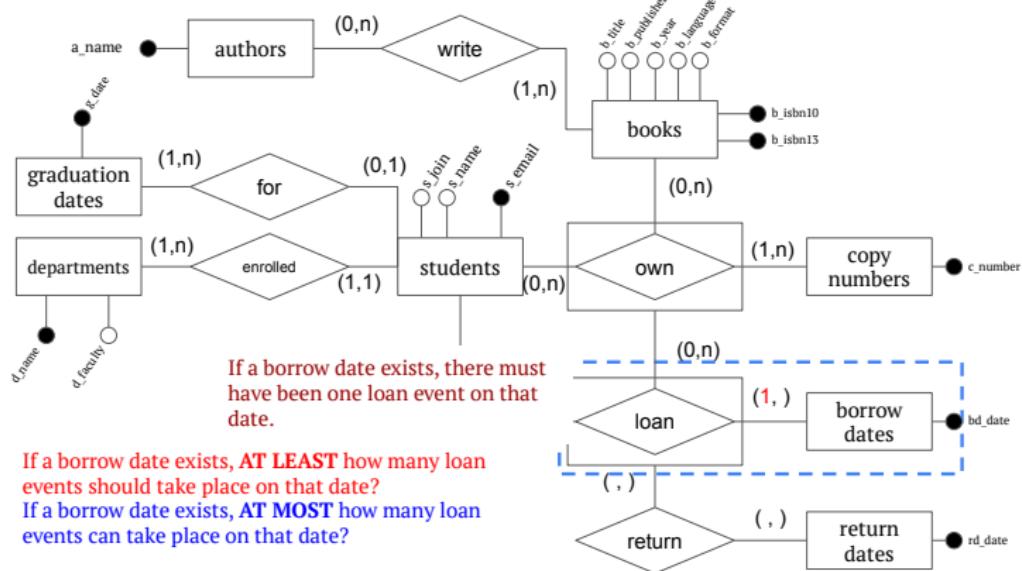
1. If there's a book's copy owned by a student, AT LEAST how many loans should it be a part of?
 2. If there's a book's copy owned by a student, AT MOST how many loans can it be a part of?

The ER Diagram

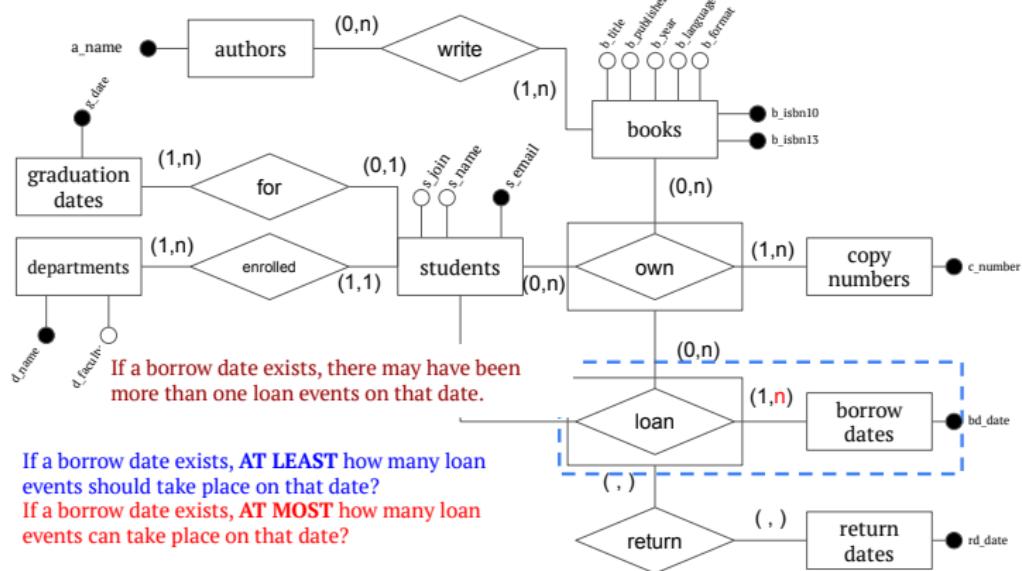


- If a borrow date exists, AT LEAST how many loan events should take place on that date?
- If a borrow date exists, AT MOST how many loan events can take place on that date?

The ER Diagram

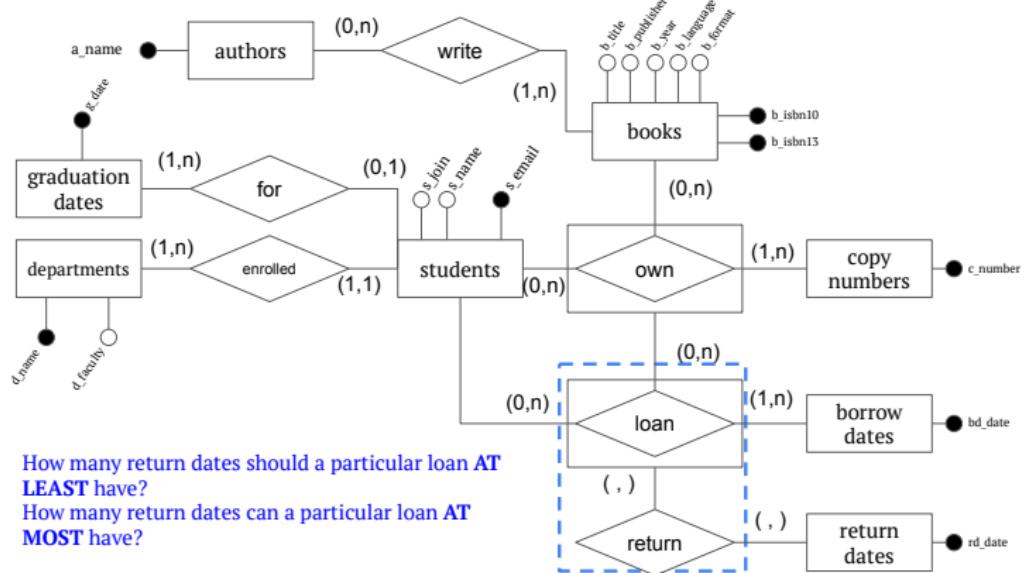


The ER Diagram



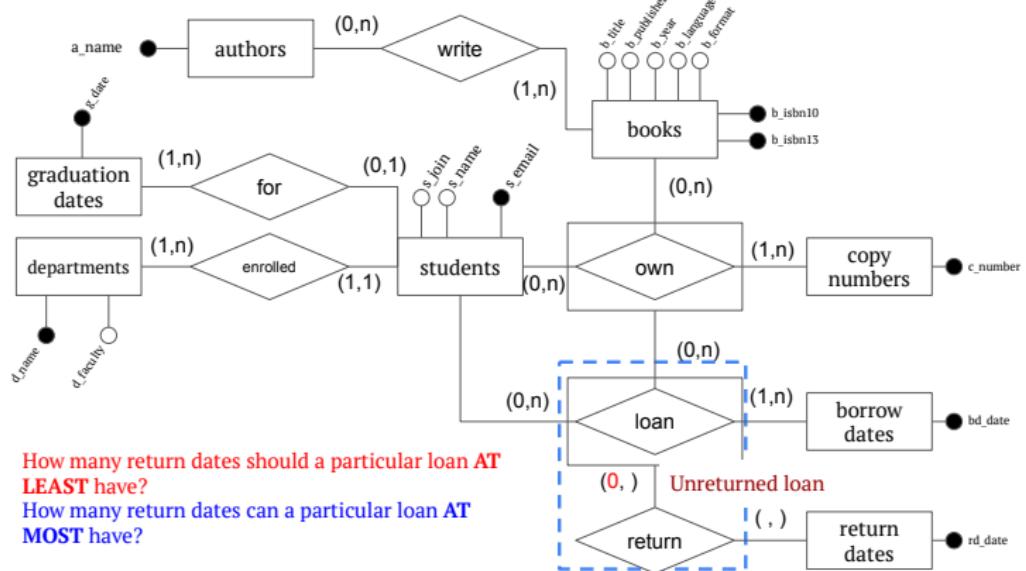
1. If a borrow date exists, AT LEAST how many loan events should take place on that date?
2. If a borrow date exists, AT MOST how many loan events can take place on that date?

The ER Diagram



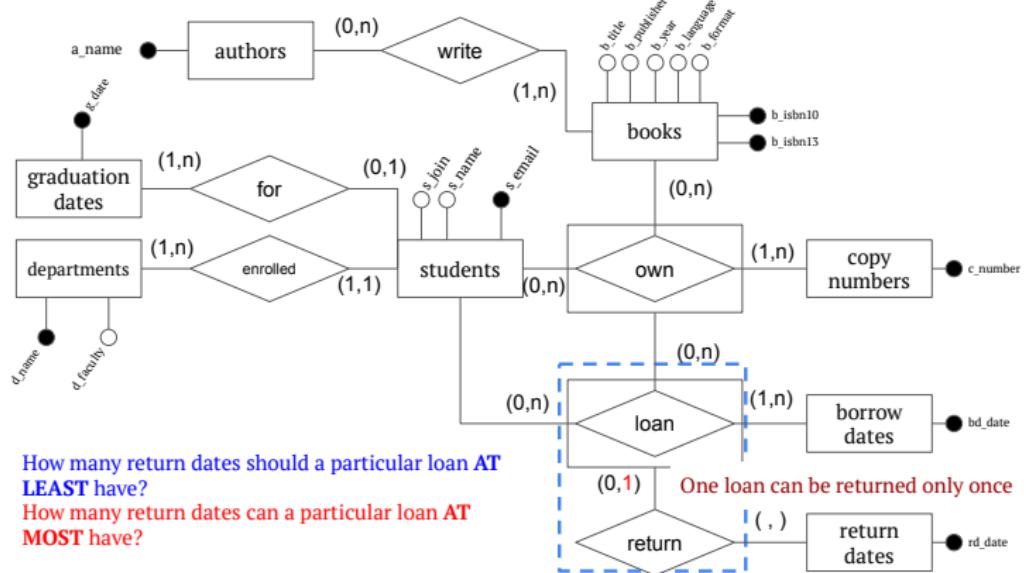
1. How many return dates should a particular loan AT LEAST have?
2. How many return dates can a particular loan AT MOST have?

The ER Diagram



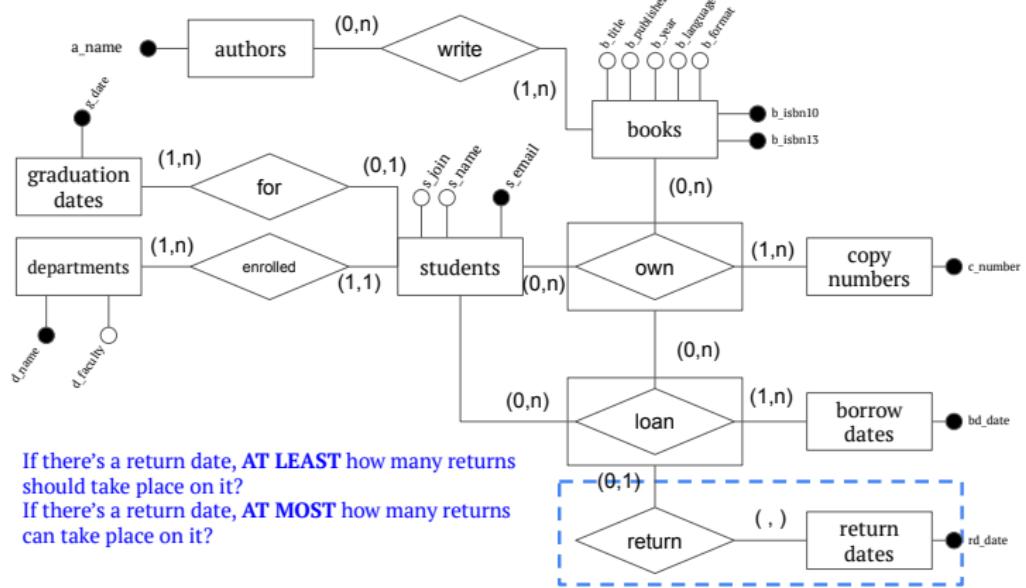
- How many return dates should a particular loan AT LEAST have?
- How many return dates can a particular loan AT MOST have?

The ER Diagram



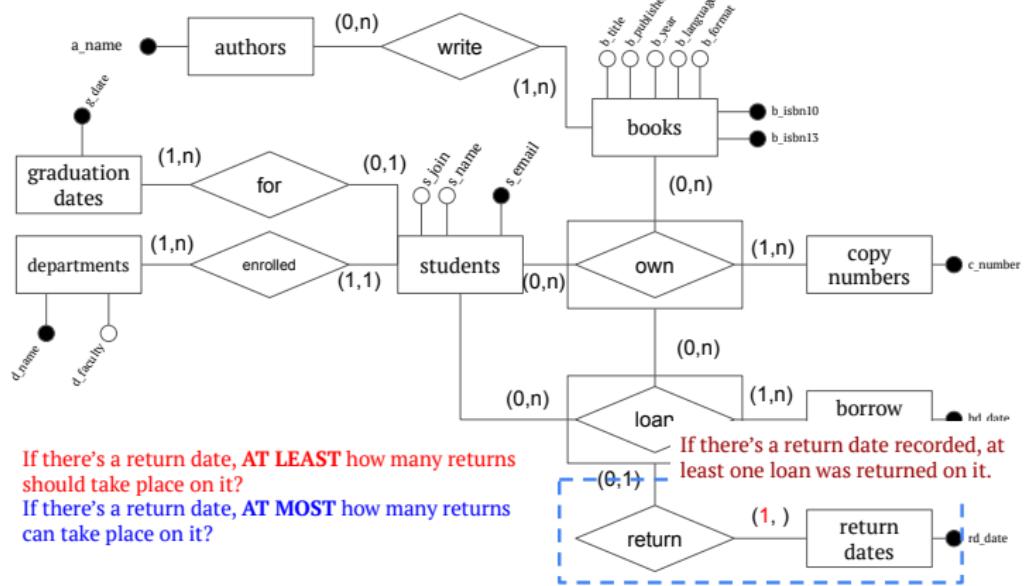
- How many return dates should a particular loan AT LEAST have?
 - How many return dates can a particular loan AT MOST have?
- One loan can be returned only once

The ER Diagram



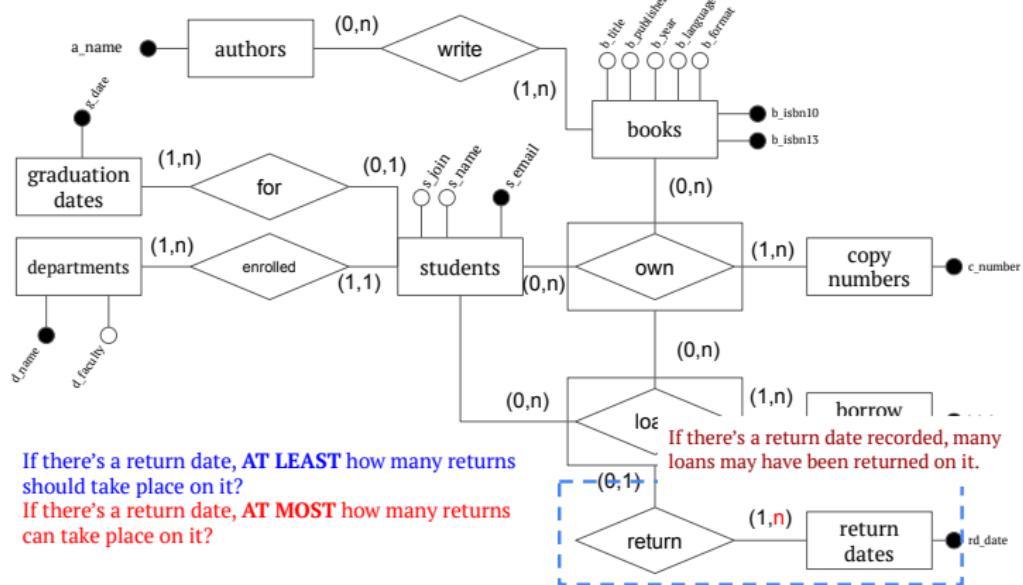
- If there's a return date, AT LEAST how many returns should take place on it?
- If there's a return date, AT MOST how many returns can take place on it?

The ER Diagram



- If there's a return date, AT LEAST how many returns should take place on it?
- If there's a return date, AT MOST how many returns can take place on it?

The ER Diagram



- If there's a return date, AT LEAST how many returns should take place on it?
- If there's a return date, AT MOST how many returns can take place on it?

Constraints **NOT** enforced

There are constraints that have not been enforced here. Those can be enforced using **triggers**.

- The copy number should be a consecutive number starting from 1.
- Obviously, a student can only borrow or lend book after he/she is enrolled.

Constraints NOT enforced

- For the “graduation dates”, we choose to merge the entity set with the `students` (which automatically merge this with the relationship set). Unfortunately, this means `g_date` can be `NULL`.

The alternative is to separate the entity sets. However, with this, the lower bound 1 is not enforced. Additionally, we cannot easily check that `g_date` is greater than or equal to `s_join`.

There is a similar issue with “return dates”.

- or “copy numbers”, we also merge the entity set to the relationship set. This is the same issue of (1,n) participation discussed in lecture. Luckily, “copy numbers” has no other attributes. So merging it allows for all constraints to be enforced.

There is a similar issue with “borrow dates” and with the same solution.

Some Good Practices

- Try to avoid using **overlapping names** of entities/relationships/aggregates. in your diagram.
- Try to avoid using **overlapping names** of **attributes** in different entities/relationships/aggregates.
- Do **NOT** repeat the same attributes in connected entities/relationships/aggregates.

Questions?

Drop a mail at: pratik.karmakar@u.nus.edu